KUSAM-MECO®

An ISO 9001:2008 Company

500,000 COUNTS AUTORANGING TRUE RMS DIGITAL MULTIMETER WITH VFD FEATURE & PC INTERFACE

19 FUNCTIONS 59 RANGES

Model KM 869

SPECIAL FEATURES :

- Beep-Jack Audible & Visible Input Warning
- 41 Segment Analog Bar-graph
- Relative Zero Mode
- PC Interface Capability
- VFD-V & VFD-Hz readings
- Crest (Instantaneous Peak Hold) function
- T1-T2 differential Temperature readings.
- 500,000 counts stable DCV mode

FEATURES :

- DC Voltage Basic Accuracy 0.02%
- AC; AC+DC True RMS Conversion AC. AC+DC Voltage Bandwidth upto 100kHz (V) & 10kHz (A)
- 5-4/5 Digit 500,000 counts large easy to read LCD Dual display with white Backlight
- Fast Measurements, 5/sec; Fully Auto-Ranging
- Record MAX, MIN & AVG. Readings
- MAX & MIN readings & Data Hold Function
- dBm function with 20 selectable values
- High speed Capacitance measurement
- 1000V General Input Protection
- Logic & Line Level Frequency
- Logic Level Duty Cycle Readings & Diode Tester
- Fast Audible Continuity & Diode tester
- Auto Power Off

GENERAL SPECIFICATIONS

- **Sensing :** AC, AC+DC True RMS
- **Display :**
  4-4/5 Digits 50,000 counts fast mode.
  Selectable stable mode
  5-4/5 Digits 500,000 counts for DC Voltage &
  5 digits 99,999 counts for Hz
- **Polarity :** Automatic
- **Update Rate :**
  4-4/5 Digits fast mode: 5 per second nominal;
  5-4/5 Digits stable mode : 1.25 per second nominal;
  41 Segments Bar-graph : 60 per second max
- **Operating Temperature :** 0°C to 45°C
- **Relative Humidity :** Max. 80% R.H. for Temperature up to 31°C decreasing linearly to 50% R.H. at 45°C
- **Pollution degree :** 2
- **Storage Temperature :** -20°C to 60°C, <80% R.H. (with battery removed)
- **Altitude :** Operating below 2000m
- **Temperature Coefficient :** nominal 0.15 x (specified accuracy)/°C @ (0°C ~ 18°C or 28°C ~ 45°C), or otherwise specified
- **Power Consumption :**
  6.5mA typical; 8mA for VFD ranges
- **Low Battery :** Below approx 7V
- **APO Timing :** Idle for 17 minutes
- **APO Consumption :** 70 A typical
- **Power Supply :** Single 9V battery
- **Weight :** Approx. 635gm with holster
- **Dimension :** 208(L) x 103(W) x 64.5(H) mm with holster.

ACCESSORIES :

Test lead (pair), Holster, Battery installed, User Manual, Carrying case, One BKP60 banana plug type-K Thermocouple.

SAFETY :

- Double insulation per IEC61010-1 2nd Ed., EN61010-1 2nd Ed., UL61010-1 2nd Ed., & CAN/CSA C22.2 No. 61010.1-0.92 to Category IV 1000V AC & DC.
- **Transient Protection :** 12 kV (1.2/50 s surge)
- **Terminals (to COM) Measurement Category :**
  V/A/mA A : CAT IV 1000V AC & DC
- **Overload Protection :**
  A & mA : 0.44A/1000V, IR 10kA or better, F Fuse
  A : 11A/1000V, IR 20kA or better, F Fuse
  V, mV, & Others : 1050Vrms, 1450Vpeak
- **EMC :** Meets EN61326-1:2006 (EN55022, EN61000-3-2, EN61000-3-3, EN61000-4-2, EN61000-4-3, EN61000-4-4, EN61000-4-5, EN61000-4-6, EN61000-4-8, EN61000-4-11)
  In an RF field of 3V/m :
  Capacitance function is not specified
  Other function ranges :
  Total Accuracy = Specified Accuracy + 100 dgts
  Performance above 3V/m is not specified.
- Rugged fire retarded casing with battery access door
- Replaceable protective holster with probe-holders & Tilt-stand.
- 1000V (Ohm, Capacitance & all other Functions) Input protection.
- 1000V High Breaking Capacity fuses protection on Current inputs.
- LVD meets EN61010-1 CAT IV 1kV.

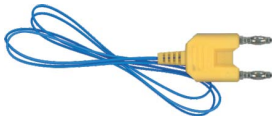
OPTIONAL ACCESSORIES :

PC interface kit, Bkb32 banana pins to K-type socket plug adaptor & Magnetic Hanger.

Current Clamp CA300, Current Clamp Adaptor CA500, CA1000, CA2000, High Voltage Probe PD-28.

Software CD

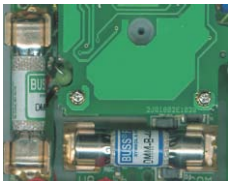
Software Cable



Thermocouple

Software

Magnetic Hanger



Fuse

All Specifications are subject to change without prior notice

KUSAM-MECO®

ELECTRICAL SPECIFICATIONS : KM 869

Accuracy is (%readings digits+number of digits) or otherwise specified, at 23°C±5°C & less than 75% R.H. True RMS Voltage & Current accuracies are specified from 5% to 100% of range or otherwise specified. Maximum Crest Factor < 3:1 at full scale & <6:1 at half scale, and with frequency components within the specified frequency bandwidth for non-sinusoidal waveforms.

DC VOLTAGE

Range	Resolution	Accuracy *
500.00 mV	10 V	±(0.02%rdg+2dgts)
5.0000 V	100 V	±(0.02%rdg+2dgts)
50.000 V	1 mV	±(0.03%rdg+2dgts)
500.00 V	10 mV	±(0.04%rdg+2dgts)
1000.0 V	100 mV	±(0.15%rdg+2dgts)

* In 500,000 mode the basic resolution is 1 V

NMRR : >60dB @ 50/60Hz

CMRR : >120dB @ DC, 50/60Hz, Rs=1k

Input Impedance : 10M , 60pF nominal

(80pF nominal for 500mV range)

AC, DC AC & AC+ DC AC VOLTAGE

Range	Resolution	Accuracy *
20Hz ~ 45Hz		
500.00 mV	10 V	±(1.5%rdg+40dgts)
5.0000 V	100 V	±(1.5%rdg+40dgts)
50.000 V	1 mV	±(1.5%rdg+40dgts)
500.00 V	10 mV	Unspec'd
1000.0 V	100 mV	Unspec'd
DC, 45Hz ~ 300Hz		
500.00 mV	10 V	±(0.35%rdg+20dgts)
5.0000 V	100 V	±(0.8%rdg+30dgts)
50.000 V	1 mV	±(0.8%rdg+30dgts)
500.00 V	10 mV	±(0.5%rdg+40dgts)
1000.0 V	100 mV	±(0.5%rdg+40dgts)
300Hz ~ 5kHz		
500.00 mV	10 V	±(0.35%rdg+20dgts)
5.0000 V	100 V	±(0.5%rdg+40dgts)
50.000 V	1 mV	±(0.5%rdg+40dgts)
500.00 V	10 mV	±(0.5%rdg+40dgts)
1000.0 V	100 mV	±(0.8%rdg+40dgts) (300Hz ~ 1kHz)
5kHz ~ 20kHz		
500.00 mV	10 V	±(0.5%rdg+30dgts)
5.0000 V	100 V	±(0.8%rdg+40dgts)
50.000 V	1 mV	±(0.8%rdg+40dgts)
500.00 V	10 mV	±(0.5%rdg+40dgts)
1000.0 V	100 mV	Unspec'd
20kHz ~ 100kHz		
500.00 mV	10 V	±(2.5%rdg+40dgts)
5.0000 V	100 V	±(4.0%rdg+40dgts)**
50.000 V	1 mV	±(4.0%rdg+40dgts)**
500.00 V	10 mV	Unspec'd
1000.0 V	100 mV	Unspec'd

*** From 5% to 10% of range :** Specified accuracy + 80 dgts

**** From 5% to 10% of range :** Specified accuracy + 180 dgts

From 10% to 15% of range : Specified accuracy + 100 dgts

CMRR : >75dB @ DC to 60Hz, Rs=1k

Input Impedance : 10M , 60pF nominal

(80pF nominal for 500mV range)

Residual reading less than 50 digits with test leads shorted.

DC LOOP CURRENT %4~20mA

4mA : 0% (zero)
20mA : 100% (span)
Resolution : 0.01%
Accuracy : ±25d

DC CURRENT

Range	Resolution	Accuracy	Burden Voltage
500.00 A	10 nA	±(0.15%rdg+20dgts)	0.15 mV/ A
5000.0 A	100 nA	±(0.1%rdg+20dgts)	0.15 mV/ A
50.000 mA	1 A	±(0.15%rdg+20dgts)	3.3 mV/mA
500.00 mA	10 A	±(0.15%rdg+30dgts)	3.3 mV/mA
5.0000 A	100 A	±(0.5%rdg+20dgts)	45 mV/A
10.000 A*	1 mA	±(0.5%rdg+20dgts)	45 mV/A

*10A continuous, >10A to 20A for 30 second max with 5 minutes cool down interval

AC, DC AC & AC+DC AC CURRENT

Range	Resolution	Accuracy	Burden Voltage
DC, 50Hz ~ 60Hz			
500.00 A	10 nA	±(0.5%rdg+50dgts)	0.15 mV/ A
5000.0 A	100 nA	±(0.5%rdg+50dgts)	0.15 mV/ A
50.000 mA	1 A	±(0.5%rdg+50dgts)	3.3 mV/mA
500.00 mA	10 A	±(0.5%rdg+50dgts)	3.3 mV/mA
5.0000 A	100 A	±(0.5%rdg+50dgts)	45 mV/A
10.000 A*	1 mA	±(0.5%rdg+50dgts)	45 mV/A
40Hz ~ 1kHz			
500.00 A	10 nA	±(0.7%rdg+50dgts)	0.15 mV/ A
5000.0 A	100 nA	±(0.7%rdg+50dgts)	0.15 mV/ A
50.000 mA	1 A	±(0.7%rdg+50dgts)	3.3 mV/mA
500.00 mA	10 A	±(0.7%rdg+50dgts)	3.3 mV/mA
5.0000 A	100 A	±(0.7%rdg+50dgts)	45 mV/A
10.000 A*	1 mA	±(0.7%rdg+50dgts)	45 mV/A
1kHz ~ 10kHz			
500.00 A	10 nA	±(2.0%rdg+50dgts)	0.15 mV/ A
5000.0 A	100 nA	±(2.0%rdg+50dgts)	0.15 mV/ A
50.000 mA	1 A	±(2.0%rdg+50dgts)	3.3 mV/mA
500.00 mA	10 A	±(2.0%rdg+50dgts)	3.3 mV/mA
5.0000 A	100 A	Unspec'd	45 mV/A
10.000 A*	1 mA	Unspec'd	45 mV/A

*10A continuous, >10A to 20A for 30 second max with 5 minutes cool down interval

~Hz LINE LEVEL FREQUENCY

AC Function Range	Sensitivity (Sine RMS)	Range
500 mV	100 mV	10Hz ~ 200kHz
5 V	0.5 V	10Hz ~ 200kHz
50 V	5 V	10Hz ~ 100kHz
500 V	50 V	10Hz ~ 100kHz
1000 V	500 V	10Hz ~ 10kHz
VFD 5 V	0. 5V ~ 2 V*	10Hz ~ 440Hz
VFD 50 V	5V ~ 20 V*	10Hz ~ 440Hz
VFD 500 V	50V ~ 200V*	10Hz ~ 440Hz
500 A	50 A	10Hz ~ 10kHz
5000 A	500 A	10Hz ~ 10kHz
50 mA	5 mA	10Hz ~ 10kHz
500 mA	50 mA	10Hz ~ 10kHz
5 A	1 A	10Hz ~ 3kHz
10 A	10 A	10Hz ~ 3kHz

Accuracy : 0.02% + 4d

*VFD sensitivity linearly decreases from 200Hz to 440Hz

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ELECTRICAL SPECIFICATIONS : KM 869

VFD AC VOLTAGE

Range	Resolution	Accuracy *
5Hz~20Hz		
5.0000 V	100 V	±(3%rdg+80dgts)
50.000 V	1 mV	±(3%rdg+80dgts)
500.00 V	10 mV	±(3%rdg+80dgts)
1000.0 V	100 mV	±(3%rdg+80dgts)
20Hz~200Hz		
5.0000 V	100 V	±(2%rdg+50dgts)
50.000 V	1 mV	±(2%rdg+50dgts)
500.00 V	10 mV	±(2%rdg+50dgts)
1000.0 V	100 mV	±(2%rdg+50dgts)
200Hz~440Hz		
5.0000 V	100 V	±(6%rdg+80dgts)**
50.000 V	1 mV	±(6%rdg+80dgts)**
500.00 V	10 mV	±(6%rdg+80dgts)**
1000.0 V	100 mV	±(6%rdg+80dgts)**

* Not specified for fundamental frequency >440Hz

**Accuracy linearly decreases from 2% + 50d @ 200Hz to 6%+80d @ 440Hz

dBm

Range & Accuracy are subjected to ACmV, ACV & reference impedance selected. Typical 600 reference impedance ranges:

At ACmV : -29.83dBm to -03.80dbm

At ACV : -01.09dBm to 62.22dBm

Input Impedance : 10M , 60pF nominal

Selectable reference impedance of 4, 8, 16, 32, 50, 75, 93, 110, 125, 135, 150, 200, 250, 300, 500, 600, 800, 900, 1000 & 1200

CREST MODE (Instantaneous Peak Hold)

Accuracy : Specified accuracy ± 100 digits for changes >0.8ms in duration

Hz LOGIC LEVEL FREQUENCY

Range	Accuracy
5.000Hz ~ 1.0000MHz	0.002% + 4d

Sensitivity : 2.5Vp square wave

T1-T2 DUAL TYPE-K TEMPERATURE

Range	Accuracy*
-50.0°C to 1000.0°C	0.3% + 1.5°C
-58.0°F to 1832.0°F	0.3% + 3.0°F

* Thermocouple accuracy not included

Supplied thermocouple suitable for measurement upto 250°C.

OHMS

Range	Resolution	Accuracy
500.00	10 m	±(0.07%rdg+10dgts)
5.0000 k	100 m	±(0.07%rdg+2dgts)
50.000 k	1	±(0.1%rdg+2dgts)
500.00 k	10	±(0.1%rdg+2dgts)
5.0000 M	100	±(0.3%rdg+6dgts)
50.000 M	1 k	±(2.0%rdg+6dgts)
99.99 nS*	0.01 nS	±(2.0%rdg+10dgts)

Open Circuit Voltage : <1.3V DC (<3V DC for 500 range)

*From 0% to 10% of range : Specified accuracy + 30dgts

CAPACITANCE

Range	Resolution	Accuracy *
50.00 nF	10 pF	±(0.8%rdg+3dgts)
500.0 nF	100 pF	±(0.8%rdg+3dgts)
5.000 F	1 nF	±(1.5%rdg+3dgts)
50.00 F	10 nF	±(2.5%rdg+3dgts)
500.0 F**	100 nF	±(3.5%rdg+3dgts)
5.000 mF**	1 F	±(5.0%rdg+5dgts)
25.00 mF**	10 F	±(6.5%rdg+5dgts)

*Accuracies with film capaitor or better

**In manual-ranging mode, measurements not specified below 45.0 F / 0.450mF / 4.50mF (450 counts) for 500.0 F / 5.000mF / 25.00mF ranges respectively

%DUTY CYCLE

Range	Accuracy
0.1% ~ 99.99%	3d/kHz + 2d

Input Frequency : 5Hz -- 500kHz, 5V Logic Family

AUDIBLE CONTINUITY TESTER

Audible threshold	between 20 and 200
Response time	<100 s

DIODE TESTER

Range	2.0000V
Accuracy	1% + 1d
Test Current (Typical)	0.4mA
Open Circuit Voltage	<3.5V DC

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WHAT IS DC + AC TRUE RMS

DC AC TRUE RMS

DC AC True RMS is a term which identifies a DMM that responds accurately to the total effective RMS value regardless of the waveform, and is given by the expression :

$$\sqrt{DC^2 + (AC\ rms)^2}$$

DC + AC True RMS voltage is the total effective voltage having the same heating value corresponding a DC voltage. With DC + AC True RMS voltage measurement, you can accurately measure the voltage values regardless of the waveforms such as: square, sawtooth, triangle, pulse trains, spikes, as well as distorted waveforms with the presence of harmonics and DC components / Harmonics and DC components may cause:

1) Overheated transformers, generators and motors to burn out faster than their rated life
2) Circuit breakers to trip prematurely
3) Fuses to blow
4) Neutrals to overheat due to triplen harmonics present on the neutral (180Hz)
5) Bus bars and electrical panels to vibrate

Only AC or True RMS and Average responding meters can introduce significant errors in many applications.

See TABLE 2 for typical example.

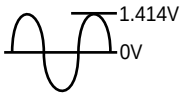
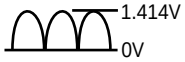
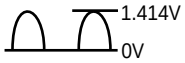
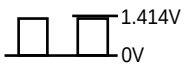
INPUT WAVEFORM	DC + AC TRMS	AC RMS	AVERAGE RESPONSE
Sine 	1.000V ERROR= 0% CF=1.414	1.000V ERROR= 0% CF=1.414	1.000V ERROR= 0%
Full wave rectified Sine 	1.000V ERROR= 0% CF=1.414	0.436V ERROR= 56.4% CF=3.247	0.421V ERROR= 57.9%
Half wave rectified Sine 	0.707V ERROR= 0% CF=2.000	0.546V ERROR= 22.7% CF=2.591	0.550V ERROR= 22.2%
50% duty pulse train 	1.000V ERROR= 0% CF=1.414	0.707V ERROR= 29.3% CF=2.000	0.785V ERROR= 21.5%

TABLE 2. WAVEFORMS AND CREST FACTORS

KUSAM-MECO®

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USE TRUE RMS WHEN MEASURING AC WAVEFORMS

The waveforms on today's AC power lines are anything but clean. Electronic equipment such as office computers, with their switching power supplies, produce harmonics that distort power-line waveforms. These distortions make measuring AC voltage inaccurate when you use an averaging DMM.

Average voltage measurements work fine when the signal you're measuring is a pure sine wave, but errors mount as the waveform distorts. By using true RMS measurements, however, you can measure the equivalent heating effect that a voltage produces, including the heating effects of harmonics. Table 1 shows the difference between measurements taken on averaging DMMs & those taken on true RMS DMMs. In each case, the measured signal's peak-to-peak value is 2V. Therefore, the peak value is 1V.

For a 1-V peak sine wave, the average & RMS values are both 0.707V. But when the input signal is no longer a sine wave, differences between the RMS values & the average readig values occur. Those errors are most prominent when you are measuring square waves & pulse waveforms, which are rich in harmonics.

Table 1. Average versus true RMS comparison of typical waveforms.

Waveform	Actual Pk-Pk	True RMS Reading	Average Reading	Reading Error
Sine Wave	2.000	0.707	0.707	0%
Triangle Wave	2.000	0.577	0.555	-3.8%
Square Wave	2.000	1.000	1.111	+11.1%
Pulse (25% duty Cycle)	2.000	0.433	0.416	-3.8%
Pulse (12.5% duty Cycle)	2.000	0.331	0.243	-26.5%
Pulse (6.25% duty Cycle)	2.000	0.242	0.130	-46.2%

One limitation to making true RMS measurements is crest factor, and you should consider crest factor when making AC measurements. Crest factor is the ratio of a waveform's peak ("crest") voltage to its RMS voltage. Table 2 shows the crest factors for ideal waveforms.

Table 2. Crest factors of typical waveforms.

Waveform	Crest Factor
DC	1.000
Square Wave	1.000
Sine Wave	1.414
Triangle Wave	1.732
Pulse (25% duty Cycle)	1.732
Pulse (12.5% duty Cycle)	2.646
Pulse (6.25% duty Cycle)	3.873

A DMM's specifications should tell you the maximum crest factor that the meter can handle while maintaining its measurement accuracy. True RMS meters can handle higher crest factors when a waveform's RMS voltage is in the middle of the meter's range setting. Typically, a DMM may tolerate a crest factor of 3 near the top of its scale but it might handle a crest factor of 5 that's in the middle of the range. Therefore, if you're measuring waveforms with high crest factors (greater than 3), you should adjust the DMM so the measured voltage is closest to the center of the measurement range.

Another limitation of true RMS is speed. If you're measuring relatively clean sine waves, then you can save time & money by using as averaging DMM. True RMS meters cost more than averaging meters and can take longer to produce measurements, especially when measuring millivolt-level AC signals. At those low levels, true RMS meters can take several seconds to stabilize a reading. Averaging meters won't leave you waiting.