

# RACAL-DANA SERIES $\mu$ 5000-THE WORKHORSE SERIES

The  $\mu$ 5000 Series has been designed to provide a state-of-the-art series of digital multimeters featuring those capabilities you have requested most often. Performance extremes have been avoided to assure a series of multimeters whose price/performance ratio is the best available.

## NEW DESIGN CONCEPTS

The marriage of standard off-the-shelf LSI circuits, Racal-Dana designed LSI, and microprocessor circuits gives the  $\mu$ 5000 its unique capabilities. Complicated mathematical computations - which you can more easily perform in your calculator or computer - and have been bypassed so that we can include key operational features that enhance the measurement power of the  $\mu$ 5000.

Enhanced measurement power, ease of operation/programming and economical price were our goals--and results.

## FULL GPIB SYSTEM FEATURES

All  $\mu$ 5000 models include full GPIB interface as a standard feature. Fully compliant to IEEE-STD-488-1978, the Racal-Dana GPIB provides the highest level of all applicable subsets. This assures ease of use in your system.

## IEEE-488-1978 Standard Interface Subset Capacity

GPIB Subset	Description	Applicable Capability
SH1	Source Handshake	Complete Capability
AH1	Acceptor Handshake	Complete Capability
T5	Talker	Complete Capability (1) Basic Talker (2) Serial Poll (3) Talk only Mode (4) Unaddress if MLA
TE0	Extended Talker	None
L4	Listener	Complete except Listen Only (1) Basic Listener (2) Unaddress if MTA
LE0	Extended Listener	None
SR1	Service Request	Complete Capability
RL1	Remote/Local	Complete Capability (1) REN - Remote Enable (2) LLO - Local Lockout (3) GTL - Go to Local
PP0	Parallel Poll	No Capability
DC1	Device Clear	Complete Capability (1) DCL - Device Clear (2) SDC - Selected Device Clear
DT1	Device Trigger	Complete Capability GET - Group Execute Trigger
C0	Controller	No Capability
E1	Open Collector Bus Drivers	

## CHOICE OF CAPABILITY

The  $\mu$ 5000 Series contains four models offering a broad range of capabilities. Now it is possible to match your requirements without sacrificing performance or paying for features you don't need. The four models are:

**MODEL 5003** - a basic 3-function multimeter with full GPIB interface, useful features such as Digital<sup>TM</sup> parallel front & rear inputs, external trigger, and sync output are included.

**MODEL 5004** - a 3-function multimeter featuring full GPIB interface, switchable front and rear inputs, full annunciation of all controls, and microprocessor-enhanced performance (MEP)<sup>TM</sup>.

**MODEL 5005** - a 3-function multimeter providing full GPIB interface, software ratio, parallel front and rear inputs, and microprocessor enhanced performance (MEP)<sup>TM</sup> and high accuracy, wide bandwidth AC voltage measurements.

**MODEL 5006** - a 3-function multimeter with full GPIB interface, software ratio, parallel front and rear inputs, microprocessor-enhanced performance (MEP)<sup>TM</sup> and True RMS, wide bandwidth AC measurements.

# MICROPROCESSOR-ENHANCED PERFORMANCE (MEP)<sup>TM</sup>

Models 5004, 5005, and 5006 contain the unique Racal-Dana MEP<sup>TM</sup> features. The power of the microprocessor has been used to improve and enhance the measurement power of the  $\mu 5000$ . To assure simplicity of operation, complicated "calculator" functions have been replaced by functional controls designed to enhance the measurement power of the digital multimeter. These features include null, offset, percent deviation, LAH, time, and buffer memory.

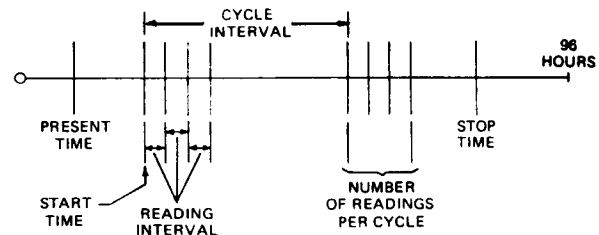
**NULL** - a single push-button allows any present reading to be stored as a zero offset. This allows lead resistance, system thermal voltages, or other inputs to be nulled.

**OFFSET** - allows any value to be stored from the numeric keyboard as a zero offset to be subtracted from future measurements.

**PERCENT DEVIATION** - Pushing this button asserts the formula  $\% = x - c / c \times 100$  where,  $x$  = measured value, and  $c$  = value stored as a constant. The constant may be either a present reading or a value entered from the numeric keyboard.

**LAH** - Racal-Dana's LAH function allows the  $\mu 5000$  to capture and store the lowest and highest reading and the average of all reading taken in a series of measurements. These values are available for recall either from the front panel or through the GPIB interface. Through use of a scrolling technique from the front panel (or directly from the GPIB interface) a low peak, high peak, or average mode may be selected. The  $\mu 5000$  will then update the display or output data only when a new peak or average is available. The number of readings per average may be programmed allowing average mode to be used for digital filtering or smoothing.

**TIME** - This function allows the  $\mu 5000$  to operate "off-line", under control of the internal time clock. Models 5004, 5005, and 5006, contain this 96-hour elapsed time clock. In addition to displaying elapsed time, the clock may be used to control the measurement timing. The time line below highlights the broad control capability of this clock.



**BUFFER MEMORY** - Internal RAMs allow storage of up to 120 readings. When combined with the time function, this allows unattended or off-line operation with data retrieved at the end of the measurement sequence.

This feature also may be used for storage of measurement setups. Up to 10 complete instrument configurations may be stored. These setups may then be recalled by front panel push-button or by two character program commands. This will significantly reduce the amount of time required to program the  $\mu 5000$  during real time operation.

## DIGICAL<sup>TM</sup>

First pioneered in the Racal-Dana 6000 the Digical<sup>TM</sup>, Digital Calibration concept allows the models 5003 and 5004 to be completely calibrated without any internal adjustments. All calibration constants are stored in non-volatile memory. To calibrate, simply set to cal mode, connect to your house standards, and push the appropriate front panel push-buttons to correct for any errors.

### CALIBRATION OVER GPIB

The  $\mu 5000$  carries the Digical<sup>TM</sup> concept forward to allow for automatic calibration. When using an automatic calibration system appropriate GPIB commands may be substituted for the front panel push-button operations.

Due to the wide bandwidth on the AC Voltage function of Models 5005 and 5006 the Digical techniques apply only to the DC Volts and ohms functions of these models.

## SWITCHABLE FILTER

The Series  $\mu 5000$  provides a 3-pole active filter which may be selected when required for increased broadband noise rejection. The basic integrating design provides a high level of rejection of power (mains) related noise frequencies.

### TWO RESOLUTION MODES/ READ RATES

The  $\mu 5000$  provides 5-1/2 and 4-1/2 digit resolution modes. The 5-1/2-digit mode provides maximum resolution and a read rate of 4 readings per second. (3.3/second @ 50Hz) For faster measurement speed, the 4-1/2 digit mode provides ten times faster internal read rate and an externally triggered speed of 20 readings per second (18/second @ 50Hz).

## SPECIFICATIONS

GENERAL SPECIFICATIONS	
<b>Power Requirements:</b>	100, 120, 220 or 240 $\pm$ 10% 25 Watts maximum 60 Hz 50 Hz-Option 04
<b>Weight:</b>	25 lbs.
<b>Dimensions:</b>	3.5" Height x 19" Deep x 16.6" Wide (14" Deep on 5005, 5006)
<b>Warranty:</b>	1 year
<b>Temperature Range:</b>	
Operating	0°C to 50°C
Storage	-40°C to +70°C @ 80% R.H.
<b>Humidity, Operating:</b>	< 75% RH; 0°C to 40°C < 50% RH; 40°C to 50°C
<b>Vibration, Operating:</b>	Meets Class 4 requirements of MIL-T-28800B
<b>Fuse:</b>	.5 Amp "Slo-Blo" (115V) .25 Amp "Slo-Blo" (220V)
<b>Data Display:</b>	5 full decades plus overrange digit in 5-1/2 digit mode. 4 full decades plus overrange digit in 4-1/2 digit mode.
<b>Overload Indication:</b>	Display reads "OL".
<b>Warmup Time to 24 hr. Specifications:</b>	2 hours.
<b>Warmup Time to Fully Stabilize to 6 mo. Specifications:</b>	1 hour.
<b>Maximum Common Mode Voltage:</b>	1000V peak or DC, Guard to case. 250V Peak or DC, Analog Common to Guard.
<b>Overrange:</b>	100% overrange with full accuracy on all ranges and functions except 1000 Volt ranges.
<b>Ranging:</b>	Manual and Autorange Standard Upranges at approx. 225% of range. Downranges at approx. 20% of range.

DMM GENERAL continued	
<b>Read Rate: (5½ digit) (Internal Trigger, External or GPIB Trigger)</b>	4 Readings/Sec (60 Hz instrument). 3.3 Readings/Sec (50 Hz instru- ment).
<b>Timeout Delays:</b>	DC 30 mS .1 K $\Omega$ to 1000 K $\Omega$ 40 mS 10,000 K $\Omega$ 300 mS AC 400 mS Any function with FILTER 500 mS selected These delays are inserted between each ranging required during auto- range and before the final reading.
<b>Autorange Delay:</b>	See Timeout Delays above.
<b>Type of A/D Conversion:</b>	Extended Quantized Feedback

DC FUNCTION	
<b>Ranges:</b>	0.1, 1, 10, 100, 1 KV.
<b>Resolution:</b>	0.001% of Range in 5-1/2 digit mode (1 $\mu$ V on 0.1V Range). 0.01% of Range in 4-1/2 digit mode (10 $\mu$ V on 0.1V Range).
<b>Maximum Input Voltage:</b>	$\pm$ 1000V DC or peak AC.
<b>Accuracy, Short Term, 5-1/2 Digit Mode (after DIGITAL ZERO Command):</b>	24 hrs., 23°C $\pm$ 1°C $\pm$ (0.007% R <sub>dg</sub> + 3 digits).
<b>Accuracy, 6 months, 23°C <math>\pm</math> 5°C, 5-1/2 Digit Mode (after DIGITAL ZERO Command):</b>	1V Range: $\pm$ (0.01% R <sub>dg</sub> + 6 digits) Other Ranges: $\pm$ (0.02% R <sub>dg</sub> + 6 digits)
<b>Temperature Coefficient, 5-1/2 Digit Mode (after DIGITAL ZERO Command at new temperature):</b>	$\pm$ (0.0003% R <sub>dg</sub> + 1 digit)/°C
<b>Input Resistance:</b>	0.1, 1, 10V Ranges: $\geq$ 1000 Megohms 100, 1 KV Ranges: 10 Megohms

DC FUNCTION continued	
Input Bias Current (at time of calibration):	$\leq 50 \text{ pa}$ at $23^{\circ}\text{C} \pm 1^{\circ}\text{C}$
Input Bias Current T.C.:	$\leq 10 \text{ pa}/^{\circ}\text{C}$
Normal Mode Rejection Ratio: Unfiltered	60 dB at 60 Hz (50 Hz on 50 Hz instruments).
Filtered	95 dB at 60 Hz 90 dB at 50 Hz on 50 Hz instruments.
Common Mode Rejection Ratio with up to $1 \text{ K}\Omega$ in either lead:	140 dB at DC 120 dB at 60 Hz (50 Hz on 50 Hz instruments).
Readout Noise:	0.1V Range: $\leq 4$ digits p-p Other Ranges: $\leq 3$ digits p-p.
Settling Time with up to $10 \text{ K}\Omega$ Source Resistance: (unfiltered)	0.1V Range: 10 ms to within 10 digits of final value. 1V, 10V Ranges: 5 ms to within 10 digits of final value. 100V, 1 KV Ranges: 10 ms to within 20 digits of final value.
Settling Time with up to $10 \text{ K}\Omega$ Source Resistance: (filtered)	470 ms to within 10 digits of final value.

OHMS FUNCTION	
Ranges:	0.1, 1, 10, 100, 1000 and $10,000 \text{ K}\Omega$
Measurement Scheme:	Modified 4-Wire.
Voltage Across Unknown (Approx.):	-1V at F.S. -2V at 100% overrange.
Open Circuit Voltage:	-6V DC maximum.

OHMS FUNCTION continued		
Current Through Unknown (Approx.):	Range	Current
	$.1 \text{ K}\Omega$	10 ma
	$1 \text{ K}\Omega$	1 ma
	$10 \text{ K}\Omega$	$100 \mu\text{a}$
	$100 \text{ K}\Omega$	$10 \mu\text{a}$
	$1000 \text{ K}\Omega$	$1 \mu\text{a}$
	$10,000 \text{ K}\Omega$	100 na
Resolution:	0.001% of Range in 5-1/2 digit mode (1 milliohm in $.1 \text{ K}\Omega$ Range). 0.01% of Range in 4-1/2 digit mode (10 milliohms in $.1 \text{ K}\Omega$ Range).	
Accuracy, Short Term, 5-1/2 Digit Mode (after DIGITAL ZERO Command):	24 hrs., $23^{\circ}\text{C} \pm 1^{\circ}\text{C}$ $\pm (0.03\% \text{ Rdg} + 5 \text{ digits})$ .	
Accuracy, 6 months, $23^{\circ}\text{C} \pm 5^{\circ}\text{C}$ , 5-1/2 Digit Mode (after DIGITAL ZERO Command):	$\pm (0.1\% \text{ Rdg} + 10 \text{ digits})$ .	
Temperature Coefficient, 5-1/2 Digit Mode (after DIGITAL ZERO Command at new Temperature):	$.1 \text{ K}\Omega - 1000 \text{ K}\Omega$ Ranges: $\pm (0.01\% \text{ Rdg} + 2 \text{ digits})/^{\circ}\text{C}$ . $10,000 \text{ K}\Omega$ Range: $\pm (0.015\% \text{ Rdg} + 2 \text{ digits})/^{\circ}\text{C}$ .	
Voltage Protection: (without damage)	$\pm 375 \text{ VDC}$ or $264 \text{ VAC}$ .	
Settling Time: (Unfiltered)	$0.1 \text{ K}\Omega - 100 \text{ K}\Omega$ Range: 30 ms to within 10 digits of final value. $1000 \text{ K}\Omega$ Range: 40 ms to within 10 digits of final value. $10,000 \text{ K}\Omega$ Range: 300 ms to within 10 digits of final value.	
Settling Time: (Filtered)	500 ms to within 10 digits of final value.	

<b>TRUE RMS AC FUNCTION (Models 5003 &amp; 5004)</b>	
<b>Ranges:</b>	1, 10, 100, 750V
<b>Maximum Input Voltage:</b>	1100V peak (750V RMS sinewave).
<b>Resolution:</b>	.001% of Range in 5-1/2 Digit Mode (10 $\mu$ V in 1V Range). .01% of Range in 4-1/2 Digit Mode (100 $\mu$ V in 1V Range).
<b>Accuracy, Short Term, 5-1/2 Digit Mode Sinewave Input:</b> .1% F.S. $\leq$ Vin $\leq$ 200% F.S. Frequency x Vin = $2 \times 10^7$ V - Hz	24 hrs., 23°C $\pm$ 1°C. 45 Hz - 10 KHz $\pm$ (0.3% Rdg + 80 digits). 10 KHz - 20 KHz: $\pm$ (0.5% Rdg + 100 digits).
<b>Accuracy, 6 months, 23°C <math>\pm</math> 5°C, 5-1/2 Digit Mode Sinewave Input:</b> .1% F.S. $\leq$ Vin $\leq$ 200% F.S.	45 Hz - 10 KHz: $\pm$ (0.5% Rdg + 100 digits). 10 KHz - 20 KHz: $\pm$ (0.75% Rdg + 150 digits).
<b>Temperature Coefficient:</b>	$\pm$ (0.02% Rdg + 20 digits)/°C.
<b>Crest Factor:</b>	4:1 at Full Scale $4 \sqrt{\frac{\text{Range}}{\text{Input}}}$ at lower input levels.
<b>Input Impedance:</b>	1 M $\Omega$ in series with .22 $\mu$ F, shunted by less than 100 pF.
<b>Settling Time (Zero - F.S. or F.S. -10% F.S.):</b> Unfiltered	250 ms to within 100 digits of final value.
Filtered	350 ms to within 100 digits of final value.

<b>4-1/2 DIGIT MODE</b>	
<b>Functions and Ranges:</b>	All Functions and Ranges.
<b>Selection:</b>	May be selected via front panel keyboard (RESOL Key) or GPIB command.
<b>Display:</b>	4 full decades plus overrange digit.
<b>Read Rate: (Internal Trigger):</b>	40 readings/sec (60 Hz instrument) 33 readings/sec (50 Hz instrument)
<b>(External or GPIB Trigger):</b>	20 readings/sec (60 Hz instrument) 18 readings/sec (50 Hz instrument)
<b>Accuracy (same conditions as 5-1/2 digit mode):</b>	"X" % Rdg + "Y" digits where: "X" is the percentage error specified for 5-1/2 digit operation, or $\pm$ .01%, whichever is greater. "Y" is equal to the number of digits specified for 5-1/2 digit operation divided by 10, or $\pm$ 5 digits, whichever is greater.
<b>Normal Mode Rejection Ratio:</b>	Same as for 5-1/2 digit operation.

<b>MODEL 5005</b> <b>AC FUNCTION (Average Responding)</b>	
Ranges	4 Ranges, 1 through 1000V
Resolution	.001% F.S. in 5½ Digit Mode .01% F.S. in 4½ Digit Mode
Maximum Input Voltages	1000V RMS From 30 Hz to 10 KHz decreasing linearly to 100V RMS at 100 KHz  100V maximum above 100 KHz with maximum voltage Hz product of $2 \times 10^7$ .
Frequency Range	30 Hz to 1 MHz
Accuracy 6 months + 5°C	30 Hz to 50 Hz + .2% of Rdg ± .02% of F. S. (Filtered)  50 Hz to 30 KHz ± 0.1% of rdg ± .02% F.S.  30 KHz to 100 KHz ± .15% of rdg ± .02% of F. S.  <u>100KHz to 250 KHz</u>  1V, 10V, 100V Ranges: ± 1% of rdg ± .1% of F. S. 1KV Range: Not applicable.
Zero Offset	20 digits - 1V range 5 digits - 10V range 5 digits - 100V range 5 digits - 1000V range
Noise Due to Ripple	30 Hz to 50KHz .01% of F. S.  50 KHz to 250 KHz .006% F.S.
Overload Recovery	1.5 seconds maximum to .1% of F.S. from 1000V overload.  600 ms maximum to .1% of F.S. from 100% overload. (4 times full scale)

<b>AC FUNCTION (5005) continued</b>	
Settling Time	600 Msec maximum to settle to .1% of F. S.
Common Mode	80 dB at 60 Hz with 100Ω unbalance in either lead.
Input Impedance	200 pF shunt capacitance with. .22 μF in series with 1 meg on all ranges
Temperature	30 Hz to 30 KHz (+ .01% rdg + .002% F.S.) /°C  30 KHz to 250 KHz (+ .05%rdg + .005%F.S.) /°C

<b>MODEL 5006</b> <b>TRUE RMS AC FUNCTION</b>	
Ranges	4 Ranges: 1V to 1KV
Resolution	.001% of Range in 5½ Digit Mode .01% of Range in 4½ Digit Mode
Maximum Input Voltage	1000V RMS or 1500V peak, decreasing to 20V RMS at 1 MHz. $2 \times 10^7 \times \text{Hz max any range}$
Filtering "Filter" In	± .01% ripple at 100 Hz
Settling Time (Zero to Full Scale)	Settles to within .01% of range. 400 msec
Settling Time (Full Scale to 10% of Full Scale)	Settles to within .01% of range. 400 msec
Input Impedance Front Input	1M ±.1% in series with .22 μF, shunted by less than 200 pF to common. In DC mode the .22 μF Capacitor is shorted.
Common Mode Rejection with 100Ω unbalance in either lead. DC and 60 Hz.	80 dB

TRUE RMS AC (5006) continued	
Accuracy, Short Term AC coupled	(24 Hrs., 25°C + 1°C) <u>10 Hz - 20 Hz (Filtered)</u> ± (2% R ± .03% F.S.)
Sine Wave Input .1% F.S. V <sub>in</sub> 200% F.S.	<u>20 Hz - 30 Hz (Filtered)</u> ± (0.5% R ± .03% F.S.)  <u>30 Hz - 50 Hz (Filtered)</u> ± (.25% R ± .03% F.S.)
For V <sub>in</sub> ≥ 500V add .1% of reading to above.	<u>50 Hz - 20 KHz</u> ± (.09%R ± .03% F.S.)
Frequency x V <sub>in</sub> < 2x10 <sup>7</sup> -Hz	<u>20 KHz - 50 KHz</u> ± (.09% R ± .09% F.S.)
≤ 75% R.H. for DC Coupled, add .02% F.S. to AC	<u>50KHz - 100 KHz</u> ± (38%R + .18% F.S.)  <u>100KHz - 300KHz</u> 10,100, 1000V Range ± (3%R. +5 F.S.)  <u>1V Range</u> ± (5%R + 1% F.S.)
Accuracy, (AC Coupled sine wave input) 0.1% F.S.	(90 Days, 25°C + 5°C) <u>10Hz - 50Hz (Filt.)</u> Same as 24 hour spec. + .02% F.S.
For V <sub>in</sub> > 500V, add .1% of reading	<u>50 Hz - 20 KHz (Both)</u> Same as 24 hour spec. ± (.02% R + .02% F.S.)  <u>20KHz - 50 KHz (Both)</u> + (.1% R ± .1% F.S.)  <u>50KHz - 100KHz (Both)</u> ± (.4%R ± .2% F.S.)

TRUE RMS AC (5006) continued	
For DC coupled, add .02% F.S. to AC specs	<u>100KHz - 300 KHz (Both)</u> Same as 24 hour spec.
Accuracy, (AC coupled, Sine Wave Input) ≥ 0.1% F.S.	(6 months, 25°C ± 5°C) <u>10Hz-50Hz (Filtered)</u> Same as 24 hour spec. ± .03% F.S.
≤ 500V input	<u>50Hz - 20 KHz</u> Same as 24 hour spec ± (.03%R ± .03% F.S.)  <u>20KHz - 50KHz</u> Same as 24 hour spec. ± (.05%R ± .04% F.S.)  <u>50KHz - 100KHz</u> ± (.6%R ± .3% F.S.)  <u>100KHz - 300KHz</u> 10,100,1000 Range ± (4% R ± 1% F.S.)  1 Range: ± (6% R ± 2% F.S.)
Temperature Coefficients 0°C to 50°C AC coupled (to 20KHz) 1,10,100, 1000V Ranges	± (.005%R + .003% F.S.) /°C
DC coupled (to 20KHz) 1,10,100, 1000V Ranges	+ (.005%R + .005% F.S.) /°C
Crest Factor	7:1 at Full Scale

Racal-Dana's policy is one of continuous development and consequently the company reserves the right to vary from the descriptions and specifications in this publications.

For current prices, please contact your local Racal-Dana representative.

**RACAL-DANA INSTRUMENTS INC.,**

18912 Von Karman Ave., Irvine Ca 92715, Telephone: 714-833-1234, TWX: 910-595-1136, TLX: 67-8341

**RACAL-DANA INSTRUMENTS LTD.,**

Duke Street, Windsor, Berkshire SL4 1SB, England, Telephone: Windsor (07535) 69811, TLX: 847013

**RACAL-DANA INSTRUMENTS S.A.,**

91 Route des Gardes, 92190 Meudon-Bellevue, France, Telephone: (1) 534-7575, TLX: 200207

**RACAL-DANA INSTRUMENTS LTD., (DEUTSCHLAND)**

Hermanstrasse 29, D-6078 Neu Isenburg, Federal Republic of Germany, Telephone: 06102-2861-2, TLX: 412896

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