PUBLICATION NO. 980553

5005
5006
DIGITAL MULTIMETERS

S/N. 001839

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WARRANTY

Within one year of purchase, Racal-Dana will repair or replace your instrument, at our option, if in any way it is defective in material or workmanship. All parts and labor charges will be paid by Racal-Dana Instruments. Just call Racal-Dana Product Service at (714) 833-1234 in U.S.A., Windsor (07535) 69811 in England, 027-7575 in France, or 06102-2861/2 in Germany for assistance. We will advise you the proper shipping address for your prepaid shipment. Your instrument will be returned to you freight prepaid.

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FOR YOUR SAFETY

Before undertaking any maintenance procedure, whether it be a specific troubleshooting or maintenance procedure described herein or an exploratory procedure aimed at determining whether there has been a malfunction, read the applicable section of this manual and note carefully the WARNING and CAUTION notices contained therein.

The equipment described in this manual contains voltage hazardous to human life and safety and which is capable of inflicting personal injury. The cautionary and warning notes are included in this manual to alert operator and maintenance personnel to the electrical hazards and thus prevent personal injury and damage to equipment.

If this instrument is to be powered from the AC line (mains) through an autotransformer (such as a Variac or equivalent) ensure that the common connector is connected to the neutral (earthed pole) of the power supply.

Before operating the unit ensure that the protective conductor (green wire) is connected to the ground (earth) protective conductor of the power outlet. Do not defeat the protective feature of the third protective conductor in the power cord by using a two conductor extension cord or a three-prong/two-prong adapter.

Maintenance and calibration procedures contained in this manual sometimes call for operation of the unit with power applied and protective covers removed. Read the procedures carefully and heed Warnings to avoid "live" circuit points to ensure your personal safety.

Before operating this instrument.

1. Ensure that the instrument is configured to operate on the voltage available at the power source. See Installation section.
2. Ensure that the proper fuse is in place in the instrument for the power source on which the instrument is to be operated.
3. Ensure that all other devices connected to or in proximity to this instrument are properly grounded or connected to the protective third-wire earth ground.

If at any time the instrument:

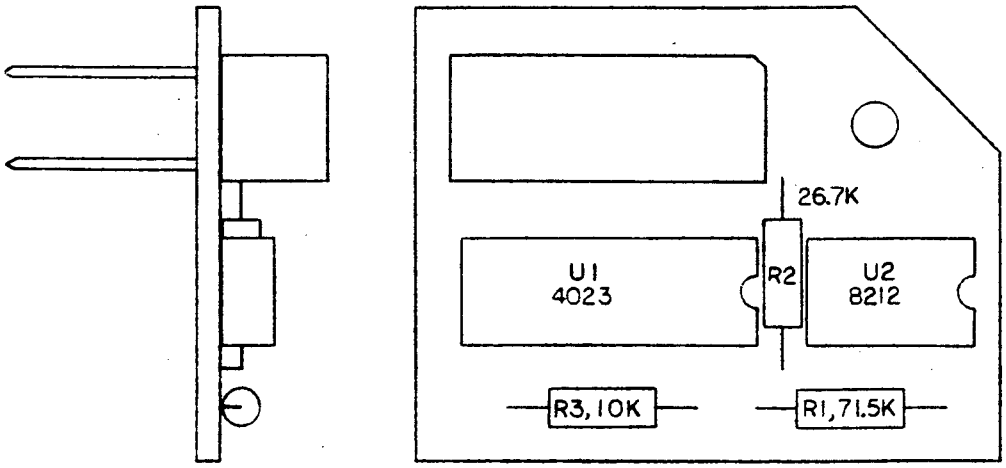
- Fails to operate satisfactorily
- Shows visible damage
- Has been stored under unfavorable conditions
- Has sustained stress

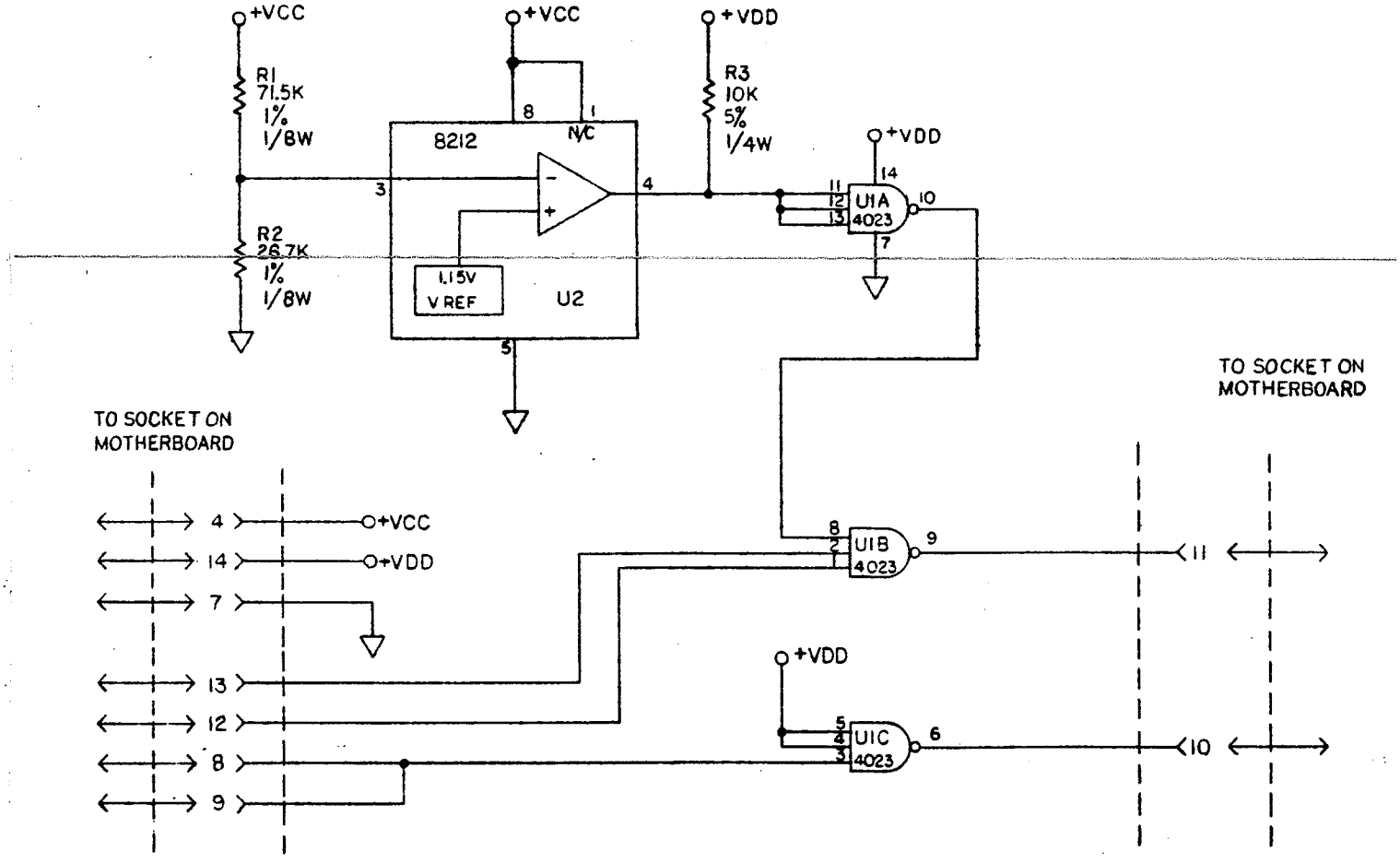
It should not be used until the performance has been checked by qualified personnel.

ADDENDUM

October 20, 1981

On Motherboards up to revision H, a plug-in assembly P/N 401683 replaces U42.





401683 - PCB Assy, NON-VOL, PWR. DOWN

REF DES	RACAL-DANA P/N	DESCRIPTION	FSC	MANU P/N
R3	000103	RES CARBON 10K 5% 1/4W	81349	RC07GF103J
R1	010643	RES METAL 71.5K 1% 1/10W	81349	RN55C7152F
R2	010697	RES METAL 26.7K 1% 1/10W	81349	RN55C267F
U2	230515	IC MICROPOWER VOLTAGE DETECTOR	32293	ICL8212CPA
U1	230588	IC CMOS TRIPLE 3 INPUT NANDGATE	27014	CD4023C

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SECTION 1 GENERAL DESCRIPTION

1.1 PURPOSE.

1.1.1 Racal-Dana Instruments prepared this Instruction Manual for the Micro 5000 Series Digital Multimeter (DMM). The manual provides the user with the operating procedures necessary to employ the features designed into the instrument. Also, the manual details the calibration and maintenance procedures required by technical people to obtain the maximum performance specified by Racal-Dana in the published specifications. It is recommended that the users and technicians read this manual before operating the instrument.

1.2 SCOPE.

1.2.1 The Instruction Manual presents the information for the Models 5005 and 5006 concurrently as one throughout the manual. Special attention is given to the features that are unique to each model as the subjects are presented in context. The sections in the manual include: General Description, Installation, Operation, Theory of Operation, Maintenance, Drawings and Parts List.

1.3 PRODUCT SUPPORT GROUP.

1.3.1 The Racal-Dana Irvine complex maintains a complete Engineering laboratory, Field Engineers, service department and parts department to support the product commitment. Further support is provided by a network of area service centers and Field Representatives, the complete list appears on the last two pages of the manual. The warranty program declaration is presented in the forward section of this manual, also service personnel are available for service consultation.

1.4 ELECTRICAL DESCRIPTION.

1.4.1 The Racal-Dana Model 5005 or 5006 microprocessor (μP) based digital multimeter (DMM) is a 5-1/2 digit auto-ranging multimeter. The basic functions include 5 DC volt scales ranging from 0.1 volt to 1 KV; 4 AC volt scales ranging from 1 volt to 1 KV, and 6 resistance measurement scales ranging from 0.1K ohm to 10,000K ohms. The chart in Table 1.1 represents the DMM function and ranges. For systems applications, the Model 5005 or 5006 features an IEEE-488-1978 (GPIB) interface.

1.4.2 The DMM measurement process depicted in the block diagram Figure 1.1 consists of three major parts:

Table 1.1 - DMM Function and Range

RANGE	FUNCTION		
	DC	AC	OHMS
.1V	■		
1V	■	■	
10V	■	■	
100V	■	■	
1000V	■	■	
.1KΩ			■
1KΩ			■
10KΩ			■
100KΩ			■
1000KΩ			■
10000KΩ			■

a) The Signal Conditioning section where the input signal is switched, scaled, attenuated, rectified and filtered under microprocessor control.

b) The Analog-to-Digital converter employs a Quantized Feedback conversion technique, to change the DC voltage into a representative digital signal.

c) The μP-based digital section translates the analog to digital (A/D) converter output to a numerical value for the instrument display and GPIB output that represents the value of the input signal. The digital section also provides function selection, range control, decimal placement and programming.

1.5 MECHANICAL DESCRIPTION.

1.5.1 The DMM physical configuration is outlined in Figure 1.2, a dimensional outline projecting the front and rear views from the top elevation. The front panel contains the keyboard switches, the LED display, and Input terminals. The rear panel contains Input terminals, 24 pin GPIB connector, GPIB address switch, two BNC connectors, 3 prong AC power plug and fuse.

1.6 POWER REQUIREMENTS.

1.6.1 The DMM is designed to operate from a wide range of AC line voltages and frequencies with 120 VAC and 60 Hz considered standard. The selectable multi-tapped primary winding will accommodate line voltages of 100,

Table 1.2 - Specifications

GENERAL SPECIFICATIONS	
Power Requirements:	100, 120, 220 or 240 ± 10% 25 Watts maximum 60 Hz Standard 50 Hz Available
Weight:	15 lbs.
Dimensions:	3.5" Height x 14" Deep x 16.6" Wide
Rack Mounting:	Standard Corporate Package
Warranty:	Standard Warranty Statement
Temperature Range: Operating Storage	 0°C to 50°C –40°C to +70°C @ 80% R.H.
Humidity, Operating:	< 75% RH; 0°C to 40°C < 50% RH; 40°C to 50°C
Fuse:	.5 Amp "Slo-Blo" (115V) .25 Amp "Slo-Blo" (220V)
Battery:	A 3.0V lithium battery provides power for the non-volatile memory whenever the DMM is turned off. Battery life is 3 years minimum at a 50° C ambient temperature. Battery is not rechargeable.

DMM GENERAL	
Data Display:	5 full decades plus overrange digit in 5-1/2 digit mode. 4 full decades plus overrange digit in 4-1/2 digit mode.
Overload Indication:	Display reads "OL".
Warmup Time to 24 hr. Specifications:	2 hours.
Warmup Time to Fully Stabilize to 6 mo. Specifications:	1 hour.
Maximum Common Mode Voltage:	1000V peak or DC, Guard to case. 250V Peak or DC, Analog Common to Guard.
Overrange:	100% overrange with full accuracy on all ranges and functions except 1KV (1000V DC or 1500V peak AC max.)
Ranging:	Autorange standard Upranges at approx. 225% of range. Downranges at approx. 20% of range. Manual range standard.

DMM GENERAL continued		
Read Rate: * (Internal Trigger, External or GPIB Trigger)	4 Readings/Sec in 5-1/2 digit mode (60 Hz instrument). 3.3 Readings/Sec (50 Hz instrument).	
Timeout Delays: These delays are inserted between each ranging required during autorange and before the final reading.	DC .1 KΩ to 1000 KΩ 10,000 KΩ AC Any function with FILTER selected	30 mS 40 mS 300 mS 400 mS 500 mS
Autorange Delay:	See Timeout Delays above.	
Filter:	Selectable 3-Pole active filter. Filter response is ≥35 dB down at 50 Hz (≥37 dB down at 60 Hz), attenuating 18 dB per octave above 60Hz to –60 dB or greater.	

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

* See p. 1-5 for 4½ Digit Mode Specifications

Table 1.2 - Specifications continued

DC FUNCTION continued	
Input Bias Current (at time of calibration):	≤ 50 pa at 23°C ± 1°C
Input Bias Current T.C.:	≤ 10 pa/°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 KΩ in either lead:	140 dB at DC 120 dB at 60 Hz (50 Hz on 50 Hz instruments).
Readout Noise:	0.1V Range: ≤ 4 digits p-p Other Ranges: ≤ 3 digits p-p.
Settling Time with up to 10 KΩ 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 KΩ Source Resistance: (filtered)	470 ms to within 10 digits of final value.

OHMS FUNCTION	
Ranges:	0.1, 1, 10, 100, 1000 and 10,000 KΩ
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 KΩ	10 ma
	1 KΩ	1 ma
	10 KΩ	100 μa
	100 KΩ	10μa
	1000 KΩ	1μa
	10,000 KΩ	100 na
Resolution:	0.001% of Range in 5-1/2 digit mode (1 milliohm in .1 KΩ Range). 0.01% of Range in 4-1/2 digit mode (10 milliohms in .1 KΩ Range).	
Accuracy, Short Term, 5-1/2 Digit Mode (after DIGITAL ZERO Command):	24 hrs., 23°C ± 1°C ± (0.03% Rdg + 5 digits).	
Accuracy, 6 months, 23°C ± 5°C, 5-1/2 Digit Mode (after DIGITAL ZERO Command):	± (0.1% Rdg + 10 digits).	
Temperature Coefficient, 5-1/2 Digit Mode (after DIGITAL ZERO Command at new Temperature):	.1 KΩ - 1000 KΩ Ranges: ± (0.01% Rdg + 2 digits)/°C. 10,000 KΩ Range: ± (0.015% Rdg + 2 digits)/°C.	
Voltage Protection: (without damage)	± 375 VDC or peak AC.	
Settling Time: (Unfiltered)	0.1 KΩ - 100 KΩ Range: 30 ms to within 10 digits of final value. 1000 KΩ Range: 40 ms to within 10 digits of final value. 10,000 KΩ Range: 300 ms to within 10 digits of final value.	
Settling Time: (Filtered)	500 ms to within 10 digits of final value.	

Table 1.2 - Specifications continued

MODEL 5005 AVERAGING AC/DC CONVERTER	
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 20 KHz decreasing linearly to 20V RMS at 1 MHz. Maximum input voltage on any range: $<2x10^7$ Volt-Hz
Accuracy 6 months: 23°C ± 5°C **(All Ranges included except: 1000V Range from 100 KHz to 250 KHz Range)** **For inputs greater than 500V, add .1% of reading to above**	30 Hz to 50 Hz: ± (2% of rdg) ± .02% of F. S. (Filtered) 50 Hz to 30 KHz: ± 0.1% of reading ± .02% of F. S. 30 KHz to 100 KHz: ± .15% of reading ± .02 of F. S. 100 KHz to 250 KHz 1V, 10V, 100V Ranges: ± 1% of rdg ± .1% of F. S. 1 KV Range: Not applicable 250 kHz to 1 MHz ± (20% R + 4% 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)
Settling Time	400 msec maximum to settle to .1% of F. S.
Common Mode	>80 dB at 60 Hz with 100Ω unbalance in either lead.
Input Impedance	1 MΩ ± 0.1% in series with .22 μF, shunted by less than 200 pF to common.
Temperature Coefficient	30 Hz to 30 KHz: (+ .01% rdg + .002% F.S.) /°C 30 KHz to 250 KHz: (± .05% rdg ± .005% F. S.)°C

MODEL 5006 TRUE RMS AC/DC CONVERTER	
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 DC/RMS or 1500V peak, decreasing to 20V RMS at 1 MHz. 2×10^7 V Hz max in any range
Settling Time: Zero to Full Scale	Settles to within .01% of range. 400 msec
Input Impedance Front Input	1 MΩ ± .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 100 Ω unbalance in either lead. DC and 60 Hz	80 dB
Accuracy, Short Term AC coupled **Sine Wave Input .1% F.S.≤ V_{IN} ≤200% F.S.** **For V_{IN}≥500V add .1% of reading to above.** **Frequency x V_{IN} ≤$2x10^7$V-Hz** **≤75% R. H. For DC coupled, add .02% F.S. to AC specs.**	(24 Hrs., 25°C ± 1°C) 20 Hz - 30 Hz: (Filtered) ± (0.5% R + .03% F. S.) 30 Hz - 50 Hz: (Filtered) ± (.25% R + .03% F. S.) 50 Hz - 20 KHz: ± (.09% R + .03% F. S.) 20 KHz - 50 KHz: ± (.09% R + .09% F. S.) 50 KHz - 100 KHz: ± (.38% R + .18% F. S.) 100 KHz - 300 KHz: 10,100V Range ± (3% R + .5% F. S.) 1V Range: ± (5% R + 1% F. S.) 300 kHZ - 1 MHz: ± (23% R + 5% F. S.)

Table 1.2 - Specifications continued

TRUE RMS AC (5006) continued	
Accuracy, Long Term, AC Coupled, Sine Wave Input .1% F. S. ≤ V_{IN} ≤200% F. S. For V_{IN} > 500V, add .1% of reading to above Frequence x V_{IN} ≤ $2x10^7$ V-Hz ≤75% R. H. for DC coupled, add.02% F. S. to AC specs	(6 Months, 25°C ± 5°C) 20 Hz - 50 Hz (Filtered): Same as 24 hour spec. ± .03% F. S. 50 Hz - 20 KHz: Same as 24 hour spec. ± (.03% R ± .03% F. S.) 20 KHz - 50 KHz: Same as 24 hour spec. ± (.05% R ± .04% F. S.) 50 KHz - 100 KHz: ± (.6% R ± .3% F. S.) 100 KHz - 300 KHz 10,100V Range: ± (4% R ± 1% F.S.) 1V Range: ± (6% R ± 2% F.S.) 300 KHz - 1 MHz: ± (24% R + 6% F. S.)
Temperature Coefficients 0°C to 50°C AC coupled (to 20 KHz) 1, 10, 100, 1000V Ranges DC coupled (to 20 KHz) 1, 10, 100, 1000V Ranges	 ± (.005% R + .003% F. S.) / °C ± (.005% R + .005% F. S.) / °C
Crest Factor	7:1 at Full Scale $7 \times \sqrt{\frac{F.S.}{V_{IN}}}$ for other voltages

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

EXTERNAL REFERENCE (SOFTWARE RATIO)	
Available Functions	DC/DC, AC/DC, Ohms/DC DC/AC, AC/AC, Ohms/AC
Available Ranges	All ranges normally available, including AUTORANGE
Maximum Input Voltage	± 400 V maximum instantaneous voltage between SIGNAL and REFERENCE input terminals
Accuracy	± [(Signal Accuracy) + (Reference Accuracy) • (RR/RI* or 1.0, whichever is greater)]

*RR = Reference Range
RI = Reference Input

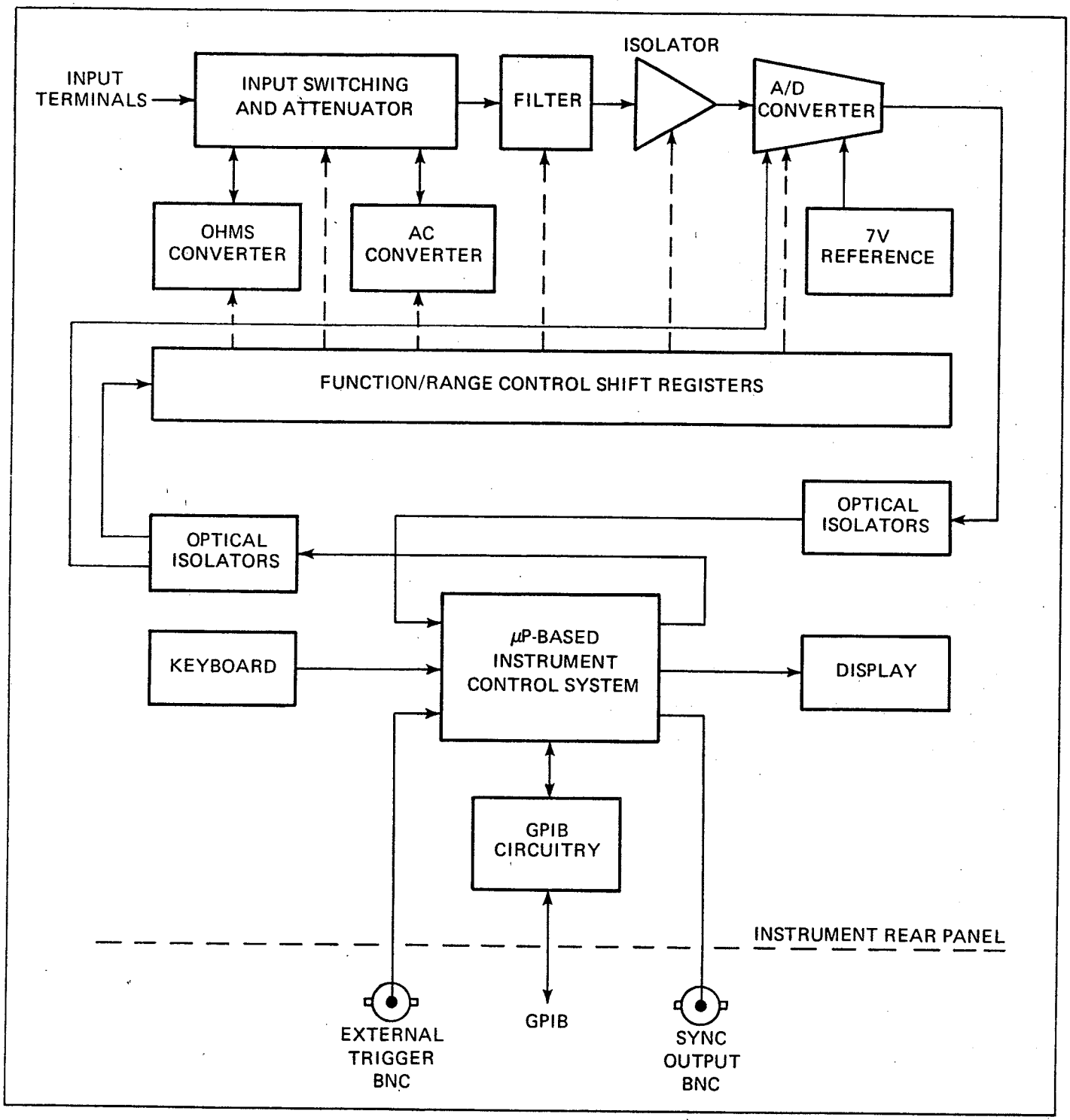


Figure 1.1 - Model 5005/5006 DMM Block Diagram

120, 220, and 240 VAC ± 10%, 47 to 440 Hz. The installation, section 2 presents the AC line cord requirements, and the AC primary voltage selection instructions.

1.7 SPECIFICATIONS.

1.7.1 The published specifications for the Racal-Dana Model 5005/5006 are listed in Table 1.2. These specifications establish the validation for the calibration and speci fication checks listed in this manual.

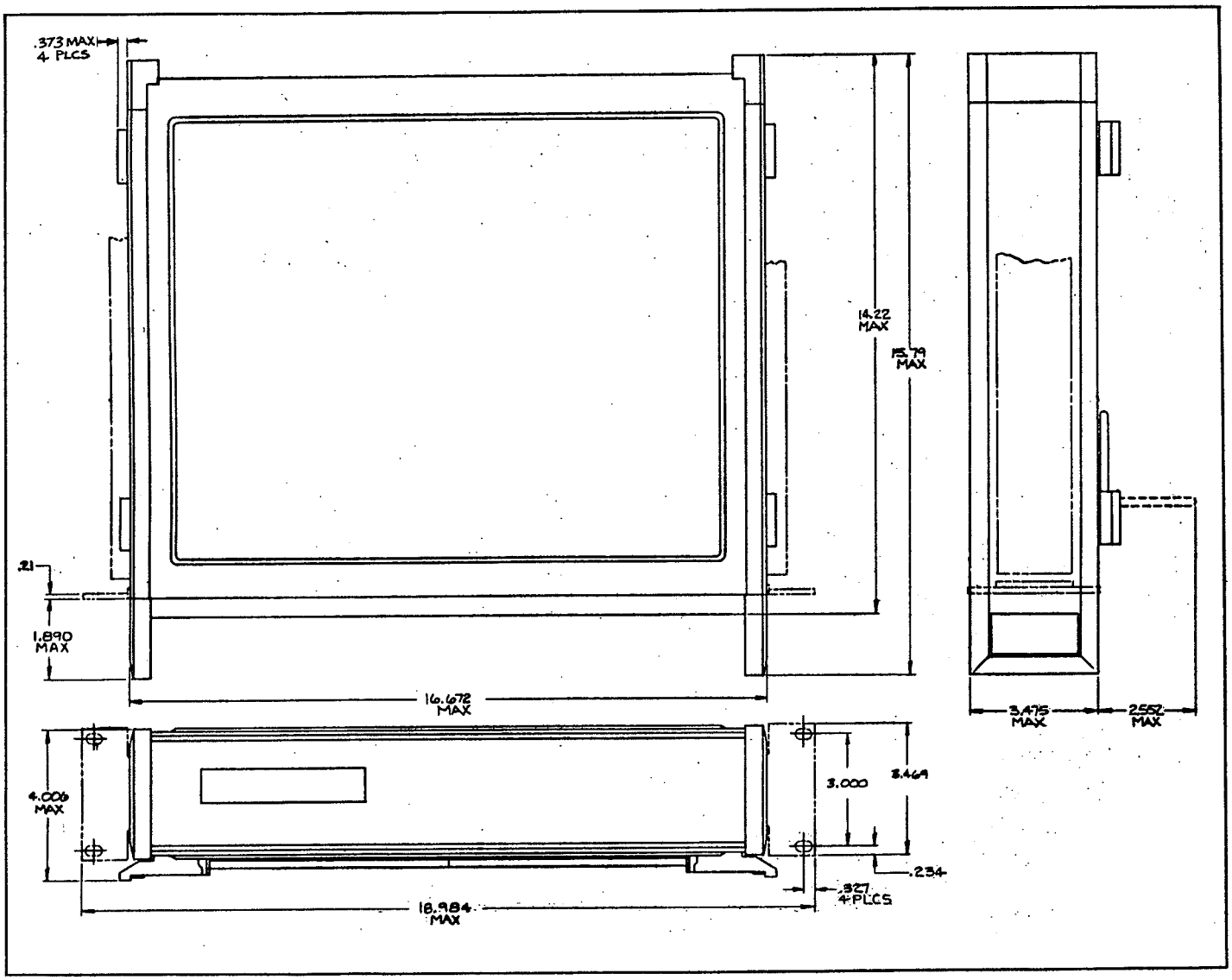


Figure 1.2 - Dimensional Outline

SECTION 2 INSTALLATION

2.1 PURPOSE

2.1.1 This section describes the instrument installation for bench or rack mounting and optional package installation as may be required.

2.2 DMM UNPACKING AND INSPECTION.

2.2.1 The instrument's carton and plastic-foam packaging meets the impact and drop requirements of the NSTC Test Procedures 1 and 1A. This precaution eliminates most shipping problems.

2.2.2 Prior to unpacking the instrument, examine the exterior of the shipping carton for any signs of damage (all irregularities should be noted on the shipping bill). Carefully remove the instrument from the carton's plastic-foam packaging and inspect the instrument for any signs of damage. Notify the carrier immediately if damage is apparent and a qualified personnel should check the unit for safety.

2.3 BENCH OPERATION.

2.3.1 Each instrument is equipped with a tilt ball or "kickstand" to elevate the front of the instrument for easy operation. The tilt ball is attached to the two forward feet at the bottom of the instrument. When used, the ball is pulled down to its vertical position.

2.4 EQUIPMENT-RACK INSTALLATION.

2.4.1 General.

2.4.1.1 The instrument can be mounted in a standard 19 inch equipment-rack with an optional "FIXED-MOUNT" installation package or an optional "SLIDE-MOUNT" installation package. The instructions for each installation are described in subsections 2.4.2 and 2.4.3, listed next.

2.4.2 Fixed-Mount Installation. Option 60.

2.4.2.1 The fixed-mount installation package includes a pair of handle-sub corner inserts for the non-handle installation, a pair of custom mount angle-brackets and 4 flat head 8-32 x 5/16 screws. To install the angle-brackets, refer to Figure 2.1 for an illustrated example then proceed as follows.

2.4.2.2 To remove the bench feet, bail, or top and bottom covers, unscrew the two phillips-head retaining screws from the corner-feet about 3/4 inch. To slide off the side panels remove the retaining screws and corner feet completely.

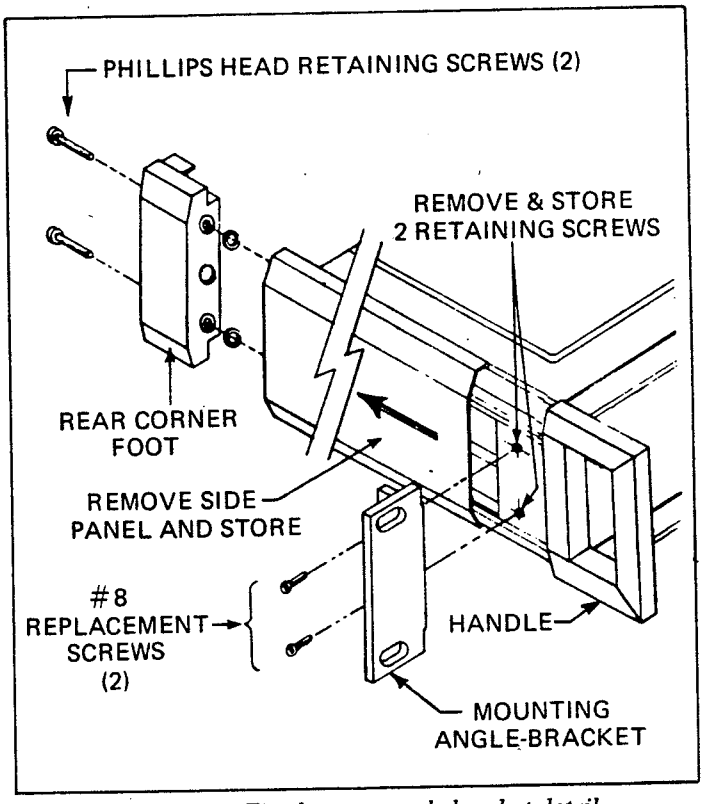


Figure 2.1 - Fixed-mount angle-bracket detail

2.4.2.3 Next, slide the cover 1/2 inch towards the rear panel then lift off. Remove the four bench-feet from the bottom cover by unscrewing the phillips-head retaining screw from each foot.

2.4.2.4 Remove the side panels by sliding them down the retaining track in the direction of the rear corner-feet. With the side panels off, the handle brackets retaining screws are exposed. Store the panels wherever convenient.

2.4.2.5 The two retaining screws in each handle are removed but either the handle or the handle-sub corner insert must remain in the handle position.

2.4.2.6 The angle-bracket is placed over the handle or handle-sub with the screw holes aligned over the handle holes. Insert the 2 flat-head #8-32 x 5/16 screws through both the angle-bracket and handle, then screw to the frame.

2.4.2.7 Re-install the feet at each corner of the cabinet to complete the installation.

2.4.3 Slide-Mount Installation. Option 67.

2.4.3.1 The slide-mount installation package includes the following hardware:

a. 2 custom-mount angle-brackets
b. 6 alignment blocks
c. 2 front slide-mount brackets
d. 2 rear slide-mount brackets
e. 2-triple-rail slide-mount assemblies
f. 12 self-anchoring #10-32 tinnerman nuts
g. 8 Phillips pan-head screws#10-32 x 1/2
h. 6 slotted #8-32 x 3/8 pan-head screws with nuts, washers, and lock washers.
i. 8 phillips pan-head, self-tapping screws #8-32 x 5/16
j. 4 phillips flat-head, self-tapping screws #8-32 x 5/16
k. 4 phillips pan-head screws #10-32 x 3/4
l. 2 alignment spacers (washers) #8 x 1/16
m. 2 handle-sub corner inserts

2.4.3.2 To install the Alignment Blocks in the channels along each side of the instrument, remove the side panels from the instrument by first removing two corner-feet by extracting the two phillips-head retaining screws. This detail is shown in Figures 2.1 and 2.2.

2.4.3.3 Next slide the covers 1/2 inch toward the rear panel then lift off. Remove the four bench-feet from the bottom cover.

2.4.3.4 Remove the side panels by sliding them down the retaining track in the direction of the rear corner-feet. With the side panels off, the handle brackets retaining screws are exposed. Store the panels wherever convenient.

2.4.3.5 The 2 handle-retaining screws are removed from each handle. This permits the handles to slip freely from the instrument.

2.4.3.6 Slide 3 alignment-blocks down each channel which are exposed by the removed handles. The drawing in Fig. 2.2 presents the front-left corner of the instrument with the handle removed. The alignment-blocks will move freely along the length of the channel on each side of the instrument.

2.4.3.7 Next, the handles, or the handle-subs, are returned to the original handle position and the custom-mount angle bracket is placed over the handle with the screw holes

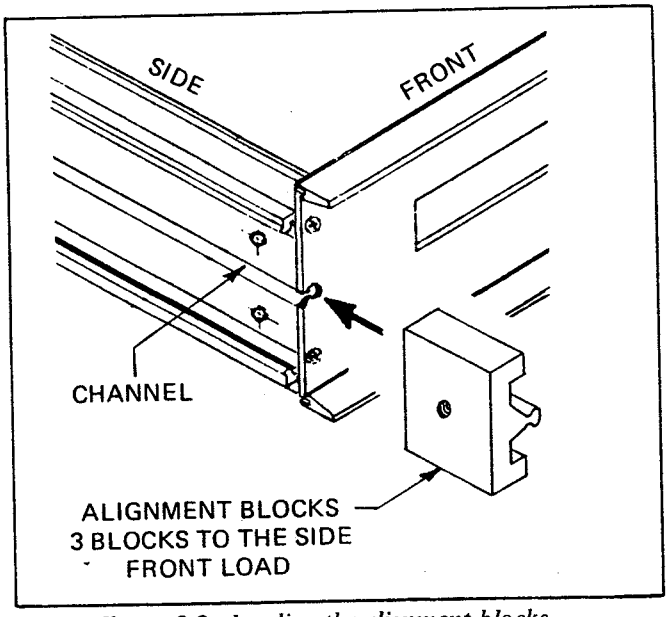


Figure 2.2 - Loading the alignment blocks

aligned over the handle holes. Insert 2 phillips flat-head 8-32 x 5/16 screws through both the angle-bracket and the handle, then secure to the frame. The installation of the custom mount angle-bracket completes the instrument preparation.

2.4.3.8 The following paragraph describes the preparation of the triple-rail slide-mount assembly for installation inside the equipment rack. The hole alignment on the slide-mount is an important consideration during installation, therefore physically extend and retract the slide-mount. An extended view of the slide-mount with the rear mounting bracket attached is shown in Fig. 2.3. As the slide-mount is extended and retracted, it should be noted that all holes on the instrument-rail and the rack-rail are accessible either directly or through the enlarged holes in the center-rail.

2.4.3.9 Preparing the triple-rail slide-mount for rack installation requires the following assembly:

a. Place the front slide-mount bracket, (with one mounting slot) with nut-fastening slots down, on the bench.

b. Position the front end (slide-out end) of the slide-mount over and parallel to the bracket, with the rack-rail resting within the bracket, approximately 3/4 inch from the front edge of the bracket.

c. Adjust the rails to align the rack-rail and the front-bracket holes, then place a slotted pan-head #8-32 x 3/8 screw through the holes. Attach the matching washer, lock-washer and nut to the screw and secure firmly, while maintaining the 3/4 inch dimension to the front of the bracket. Refer to Fig. 2.3 for illustrations that detail the slide-mount and bracket assembly.

d. Position the rear bracket on the opposite end of the slide-mount in the same manner as the front bracket. Adjust the rails to align the holes and place two #8-32- 3/8 screws through the holes securing the slide-mount loosely to the rear bracket with washers, lock-washer and nut.

e. Slide two self-anchoring #10-32 tinnerman nuts onto each front and rear mounting-bracket nut-fastening slots.

f. Complete the second slide-mount and bracket assembly in the same manner.

2.4.3.10 The following equipment-rack assembly instructions may require the assistance of another person. The slide-mount assembly is positioned in the designated area of the equipment rack and the installation sequence follows: NOTE: If the rack flange is tapped for #10-32 screws, drill out with a 1/4 inch diameter drill bit two places for each bracket.

a. Hold the front bracketted-end (with tinnerman nuts) of the slide-mount behind the rack flange, while the second person holds the rear-bracket end.

b. Secure the front bracket to the rack flange with two #10-32 x 1/2 screws. Seat the bracket firmly against the rack flange before tightening the screws.

c. Install the second bracket-slide-mount assembly on the rack in the same manner as the first, then set the front dimension between the slide-mounts at 16-5/8 inches.

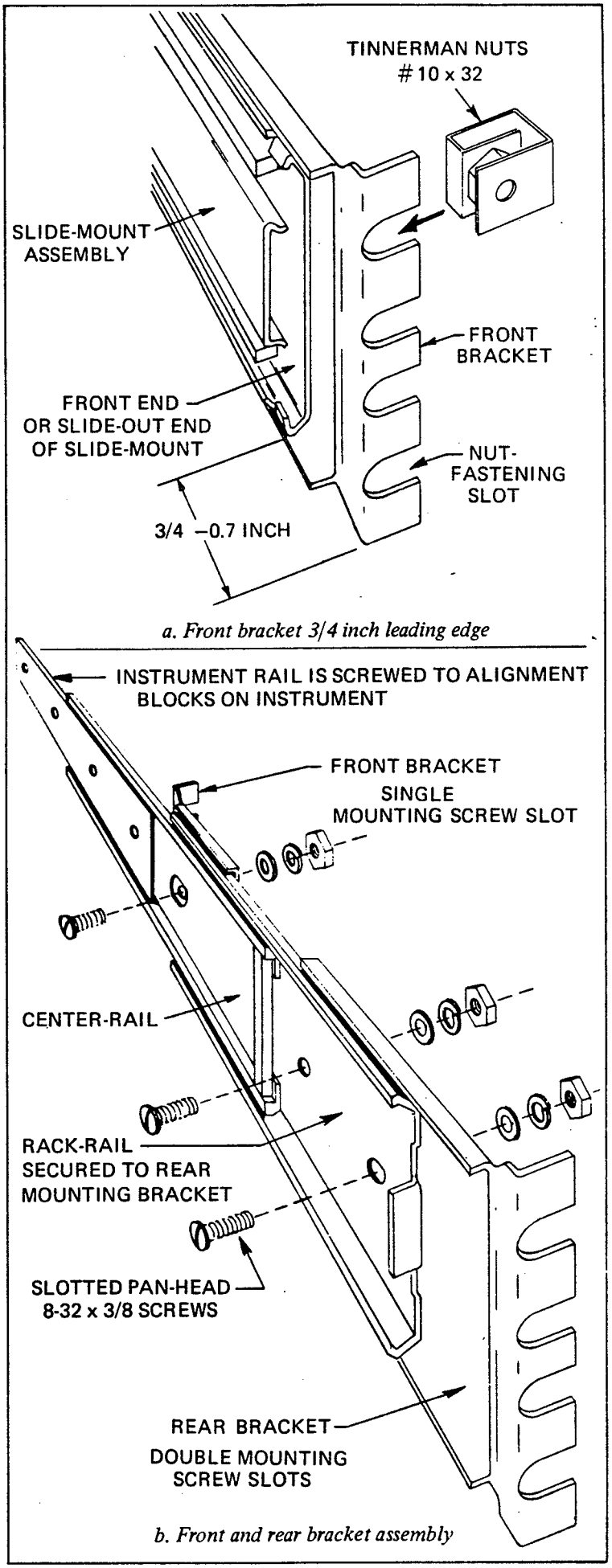


Figure 2.3 - Slide-mount and bracket assembly

d. Extend the length of the rear mounting bracket until the bracket seats behind the rack flange. Tighten the rear-bracket assembly screws.

e. The distance between the slide-mounts at the rear bracket position must be 16-5/8 inches. If a filler-plate is required to secure the slide-mount at 16-5/8 inches employ the dimensions supplied in Fig. 2.4 for calculations.

f. Secure the rear bracket (with tinnerman nuts) to the rack flange (or filler-plate) with two #10-32 x 1/2 screws in each bracket.

g. The triple-rail slide-mounts should move freely to the maximum extended position If not, clear any obstacle before installing the instrument.

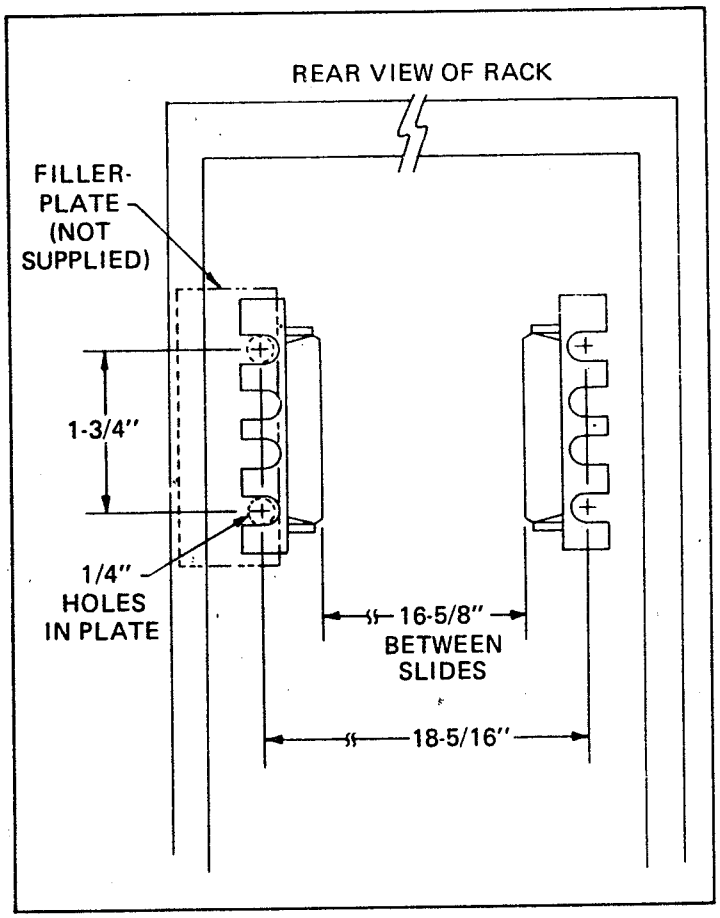


Figure 2.4 - Rear end slide-mount rack dimensions

2.4.3.11 The following procedure which describes the instrument installation to the side-mount implies that another person will assist.

a. Pull the rails to the maximum extended length. Insert a #8-32 x 5/16 Phillips pan-head self-tapping screw inward through the first mounting hole in each instrument rail. On the other side of the instrument rail, place an alignment spacer on the same screw.

b. Position the instrument between rails so that first screw-hole immediately behind the handle on each side, line up with the screws held by the rails. Keeping the alignment spacer between the rail and instrument seat the self-tapping screws to a pull-up position. The unit and slide-mount assembly are illustrated in Fig. 2.5.

c. Using the first mounting screw as a pivot, align the instrument with the rails and slide the front alignment-block behind the second hole on the rail. When hole alignment is obtained, screw in another #8-32 x 5/16 self-tapping screw.

d. Repeat this procedure for the remaining alignment-blocks. It is necessary to slide the rails to and fro until an access hole is located in the center-rail which aligns the instrument rail hole with the alignment-block hole.

e. Firmly seat all the self-tapping screws through the instrument rails. The instrument should slide freely on the rail.

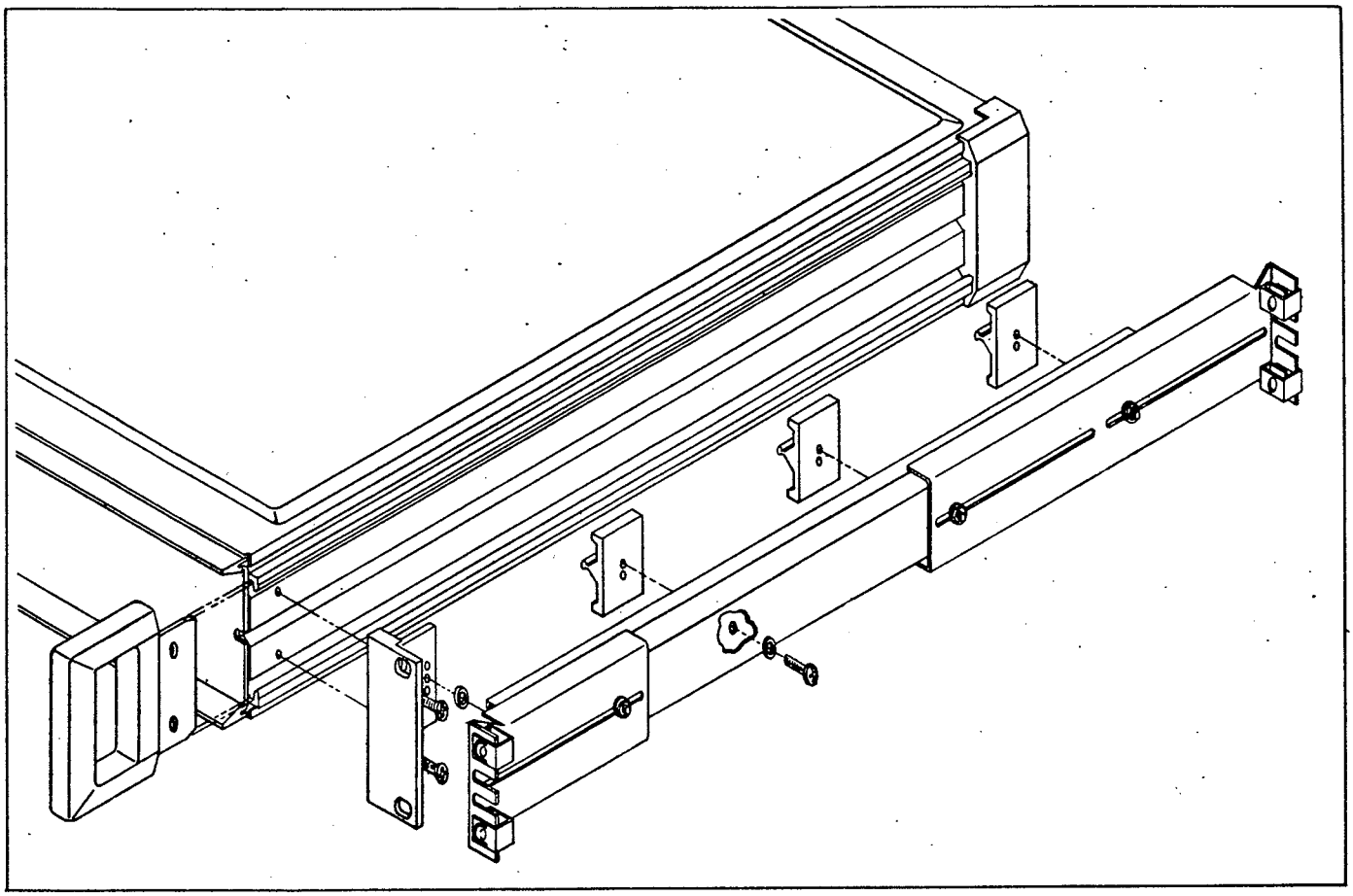


Figure 2.5 - Slide-mount and Instrument Assembly

2.4.3.12 Locking the instrument into the normal operating position on the rack requires the following assembly:

a. Slide two #10-32 self-anchoring tinnerman nuts on the rack flange (each side) inline with the slots in the angle-bracket. If the rack-flange is tapped for #10-32 screws, omit the tinnerman nuts.

b. Slide the instrument fully into the rack until the angle-bracket strikes the slide-mount bracket screws. Secure in place with 4 Phillips pan-head #10-32 x 3/4 screws. The installation is complete.

2.5 AC POWER CONNECTIONS.

2.5.1 Standard units operate on either 100, 120, 220 or 240 volts, 60 Hz (50 to 400 Hz available). Power consumption is less than 25 watts. Operation on any one of the four line voltages is selected by the placement of a small printed circuit card (P2), located in J2 receptacle on the main PCB. Selection of a specific line voltage is accomplished as follows:

2.5.1.1 Disconnect the power cord from the AC power source.

WARNING

Removal of covers exposes potentially lethal voltages. Avoid contact with internal electrical connections while unit is connected to AC power source.

2.5.1.2 Remove the instrument top cover by removing each corner foot as described in paragraph 2.4.2.2. Next, slide the top cover toward the rear panel approximately half inch, then lift the cover from the frame.

2.5.1.3 Remove the two screws holding the plastic protective cover over the voltage selector.

2.5.1.4 Remove the voltage card-selector P2 from the J2 receptacle, then reinsert it permitting the desired line voltage number to be visible through the small view window on the rear panel of the instrument.

2.5.1.5 To reassemble the instrument, place the top cover on the frame with the side flanges fitting correctly in the frame grooves and the front edge of the cover approximately one inch from the front panel. When correctly seated on the frame, slide the cover forward until the front edge slides under the front panel. Replace the rear corner feet, insuring that the top cover rear corners slide under the paw on each rear foot.

2.6 GROUNDING REQUIREMENTS.

2.6.1 The front panel and cabinet of the instrument are grounded in accordance with MIL-T-28800B to protect the user from possible injury due to shorted circuits. The three conductor AC power cable (P/N 600620) supplied with the instrument maintains a low impedance path to ground when connected to a three wire single phase AC receptacle. This device or other devices connected to or in proximity to this instrument must maintain the third-wire earth ground intact as stated in current regulations.

2.7 SHIPPING CONTAINER REQUIREMENTS.

2.7.1 When shipping the instrument, the original shipping carton with the plastic packaging forms and plastic dust cover provide the necessary protection during trans-shipments. This carton should be preserved if possible.

2.7.2 When the original shipping carton is not available, reconstruct the packaging using a can of spray plastic foam to surround the plastic-wrapped unit in the carton.

2.8 INPUT-OUTPUT CABLES.

2.8.1 The input terminals used on the front and rear panels are standard banana jacks. The spacing among the banana jacks permits a molded dual banana plug to be connected directly between binding posts. The dual banana plug cables are available under Racal-Dana part number 402190.

2.8.2 The BNC connectors mounted on the rear panel are standard items common to systems installations, therefore not supplied by Racal-Dana.

2.8.3 The interface connector, common to IEEE-488-78 and Racal-Dana's GPIB; mounted on the rear panel accepts the standard IEEE-488 connector, Racal-Dana's part number 406845, GPIB cable, 1 meter (3.28 ft.); 406844, GPIB cable, 2 meters (6.56 ft.); 406846, GPIB cable, 4 meters (13.12 ft.).

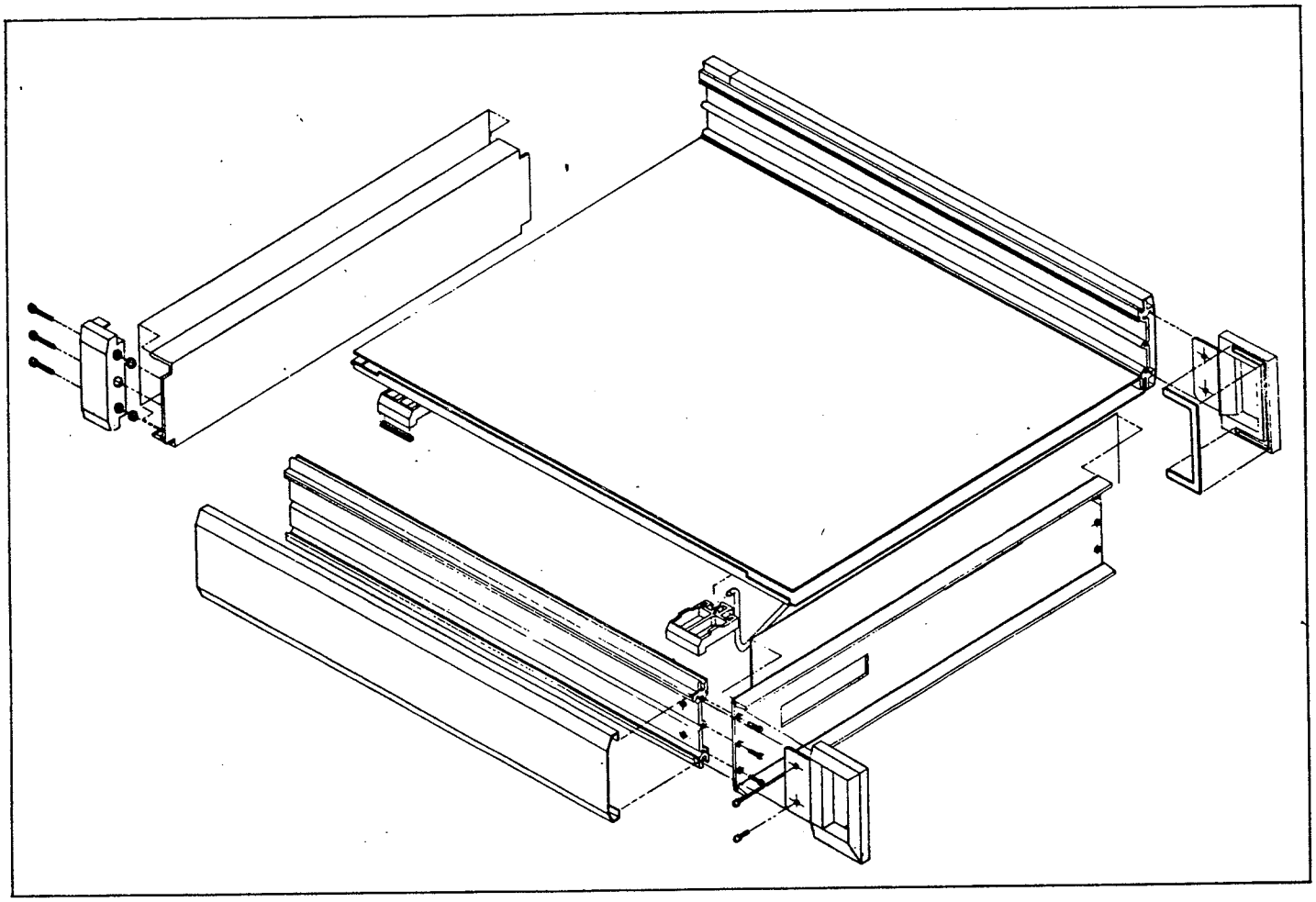


Figure 2.6 - Cabinet Exploded View

SECTION 3 OPERATION

3.1 INTRODUCTION.

3.1.1 This section contains operating information for the DMM. The information contains illustrations of all front and rear panel controls, indicators and connectors along with tabular listing of the function and purpose for each. Operating instructions for manual or bench operation are presented in two ways; a description of each operating feature followed where necessary, with a step-by-step operating example. Some operating features or functions are simple one or two step operations and thus no operating examples are included.

3.1.2 Remote operation via the IEEE-STD-488-1978 General Purpose Interface Bus is one of the principal features of the DMM. This section presents bus address selection information and a tabular listing of the device-dependent messages used to program the instrument. Also included is a GPIB program, measurement and data transfer example.

3.2 OPERATION.

3.2.1 Before operating the instrument, it is strongly recommended that the operator read this entire section in order to avoid damage to the unit. After reading the operating instructions, refer to the installation section, then check the position of the line voltage selector through the viewing window on the rear panel.

> CAUTION
>
> This instrument may be damaged if operated on line voltage other than that called for by the line voltage selection card, P2.

> WARNING
>
> Removal of covers exposes potentially lethal voltages. Avoid contact with internal electrical connections while unit is connected to AC power source.

3.2.2 After ensuring that the line voltage selector is in the proper position and the cover on the instrument replaced, connect the power cord to the AC outlet and depress the POWER switch to power-up to DMM. The DMM will display 5005 or 5006 upon applying power and the LED annunciators and AUTO are ON.

3.3 CONTROLS AND INDICATORS.

3.3.1 The front panel keyboard switches execute all the functions and modes of operation when the DMM local function is selected.

3.3.2 The panel designators, keyboard switches (refer to as key) and locations for all controls, indicators, and connectors are illustrated on Figure 3.1 and Figure 3.2. The description for each are itemized in Table 3.1 and Table 3.2.

3.4 BASIC MEASUREMENTS.

3.4.1 Digital Zero Command.

3.4.1.1 This procedure should be employed after turn-on and at other selected intervals to verify the DMM's zero accuracy in the DC function.

3.4.1.2 To check the DMM's zero accuracy, short the HI-LO INPUT terminals together and verify a display read-out of zero $\pm$ 3 digits in each DC range. If the reading exceeds this limit in any range, perform a digital zero command as described below:

a) Short the HI-LO INPUT terminals.

b) Select the DC function, .1 range.

c) Depress and hold the .1 Range Key until the display reads "CAL 0", verifying that the zero command was enabled. Release the .1 range key.

d) REMOTE OPERATION: The GPIB command K2, the digital zero command program instruction is described in paragraph 3.5.18.

3.4.2 Range Control.

3.4.2.1 Upon initialization, the DMM goes to its home state; autorange and continuous readings. With a signal applied to the input HI-LO terminals, the autorange will set the range to match whatever signal the DMM sees at the input terminals. For example, if a 6 volt battery is connected to the input terminals and the DMM is initialized by power turn-on, the DMM goes through the auto-test routine and the autorange will select the 10 volt range.

3.4.2.2 To manually disable autorange, depress one of the range keys. This action extinguishes the autorange annunciator and the DMM will now respond to the selected range.

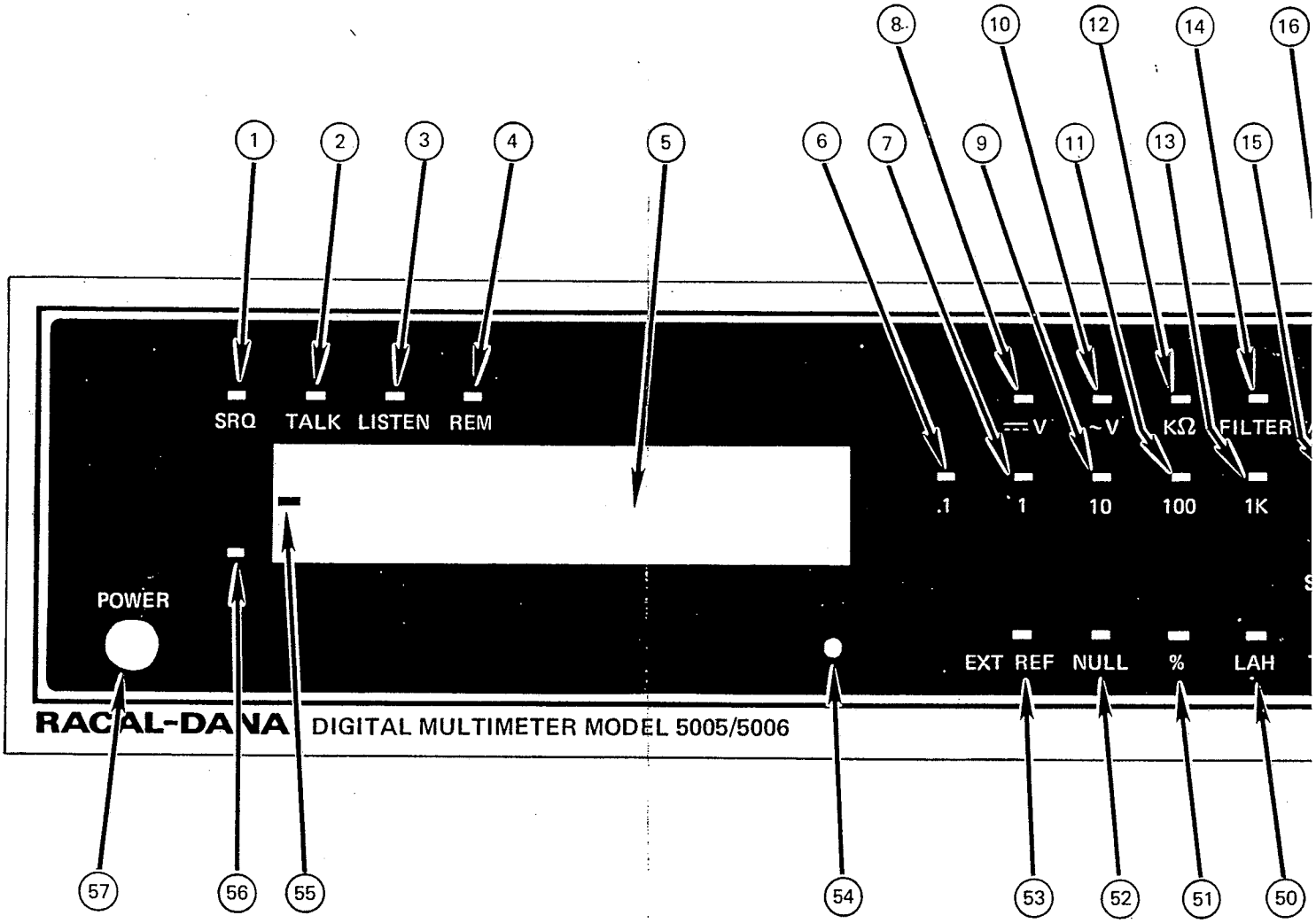
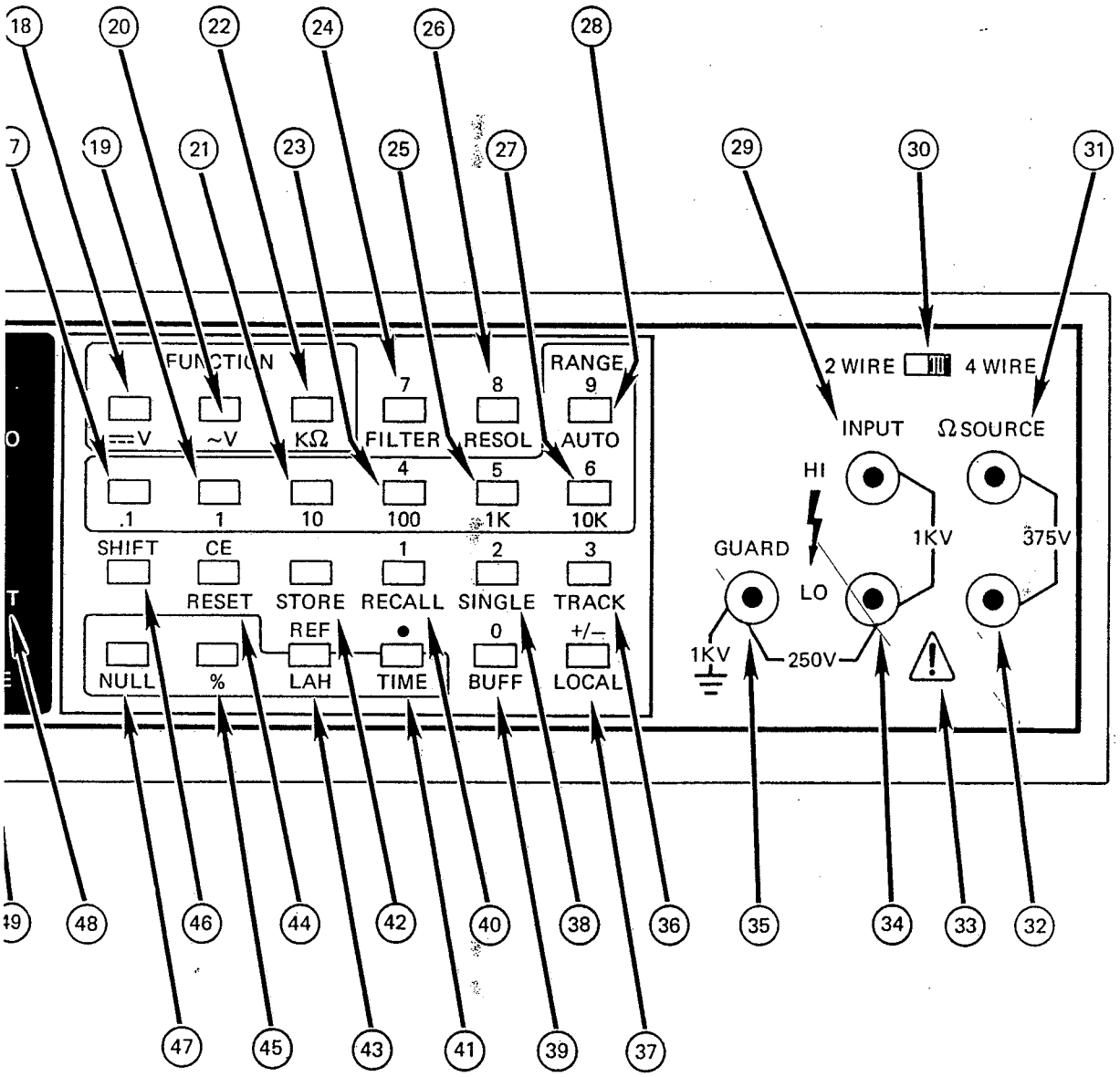


Figure 3.1 - Front Panel Location Guide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KΩ
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BUFF
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4 WIRE
INPUT
ΩSOURCE
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1KV
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3.4.2.2 To manually disable autorange, depress one of the range keys. This action extinguishes the autorange annunciator and the DMM will now respond to the selected range.

Table 3.1 - Front Panel Controls, Connectors and LEDs

Reference	Designator/Label	Functions
(1)	SRQ LED ANNUNCIATOR	ON: Indicates that the DMM is transmitting a service request (interrupt) to the controller in systems operation.
(2)	TALK LED ANNUNCIATOR	ON: Indicates that the DMM is programmed by the controller to function as a talker on the GPIB.
(3)	LISTEN LED ANNUNCIATOR	ON: Indicates that the DMM is programmed by the controller to function as a listener on the GPIB.
(4)	REM LED ANNUNCIATOR	ON: Indicates that the controller has placed the instrument in the remote operation mode.
(5)	DISPLAY LEDs 7-SEGMENT	These LEDs display the value of the input signal with appropriate decimal point. They are also used to display constants and function symbols.
(6) ↓ (16)	MATCHING DESIGNATORS ANNUNCIATOR LEDs	This group of designators match the designators for Function, Range, Filter and Auto-Ranging. The illuminated LED agrees with the key selected.
(17)	□ .1 RANGE SELECTOR KEY	Selects .1 VDC or .1 KΩ ranges. ".1" annunciators illuminate.
(18)	□ ⎓V FUNCTION SELECTOR KEY	Selects DC Function, enables autoranging and continuous readings (internal trigger). ⎓ V annunciator is illuminated.
(19)	□ 1 RANGE SELECTOR KEY	Selects 1 VDC, 1 VAC or 1 KΩ ranges. "1" annunciator is illuminated.
(20)	□ ~ V FUNCTION SELECTOR KEY	Selects True RMS AC Function, enables autoranging and continuous readings (internal trigger). ~ V annunciator is illuminated.
(21)	□ 10 RANGE SELECTOR KEY	Selects 10 VDC, 10 VAC or 10 KΩ ranges. "10" annunciator is illuminated.
(22)	□ KΩ FUNCTION SELECTOR KEY	Selects Resistance Function, enables auto-ranging and continuous readings (internal trigger). KΩ annunciator is illuminated.
(23)	□ 100 RANGE SELECTOR KEY	Selects 100 VDC, 100 VAC or 100 KΩ ranges. "100" annunciator is illuminated.
(24)	□ FILTER FILTER SELECTOR KEY	Toggles the 3-pole active filter. FILTER annunciator is illuminated when filter is selected.
(25)	□ 1K RANGE SELECTOR KEY	Selects 1 KVDC, 1 KVAC or 1000 KΩ ranges. "1K" annunciator is illuminated.
(26)	□ RESOL RESOLUTION SELECTOR KEY	Selects 4-1/2 digit mode if operating in 5-1/2 digit mode; selects 5-1/2 digit mode if in 4-1/2 digit mode.

Table 3.1 - Front Panel Controls, Connectors and LEDs continued

Reference	Designator/Label	Functions
(27)	☐ 10K RANGE SELECTOR KEY	Selects 10,000 KΩ range. "10K" annunciator is illuminated.
		NOTE: Selection of any range key disables auto-ranging.
(28)	AUTO AUTO-RANGING SELECTOR KEY	Toggles AUTO ranging mode. If AUTO ranging is selected, depressing this key or a range key returns to manual range control. AUTO annunciator is illuminated when in auto-ranging mode.
(29)	HI INPUT BANANA JACK	+ Signal Input (J104).
(30)	2-WIRE/4-WIRE SWITCH	Front panel mounted slide switch that connects Ω SOURCE terminals to INPUT terminals for two wire resistance measurements when in 2-wire position. Terminals are disconnected in 4-wire position.
(31)	Ω SOURCE BANANA JACK	Ω CURRENT RETURN (J105).
(32)	Ω SOURCE BANANA JACK	Ω CURRENT SOURCE (J103).
(33)	⚠ CAUTION SYMBOL	REFER TO THE MANUAL IN ORDER TO PROTECT THE INSTRUMENT AGAINST DAMAGE.
(34)	LO INPUT BANANA JACK	– Signal Input (J102).
(35)	GUARD BANANA JACK	Front Panel connector to internal guard shield (J101).
(36)	☐ TRACK READ-OUT SELECTOR KEY	Causes instrument to take continuous readings at maximum read rate (internal trigger).
(37)	☐ LOCAL LOCAL SELECTOR KEY	Returns control from GPIB to front panel (if not disabled from controller). Displays instrument's GPIB address while Key is held depressed.
(38)	☐ SINGLE READ-OUT SELECTOR KEY	Causes instrument to go into "Hold" mode. Takes single reading each time Key is depressed.
(39)	☐ BUFF DATA BUFFER SELECTOR KEY	Provides a means for recalling previous readings from the data buffer to the display. Pressing the button for more than 5 seconds will clear the data buffer.
(40)	☐ RECALL RECALL SELECTOR KEY	Enables RECALL access for the constants previously stored as Null, %, LAH, and BUFF.
(41)	☐ TIME TIME SELECTOR KEY	Provides a means of taking a series of measurements under control of the voltmeters built-in real-time clock. Start time, stop time and reading intervals can be selected and entered via the keyboard. TIME annunciator is illuminated when instrument is under control of Time function.

Table 3.1 - Front Panel Controls, Connectors and LEDs continued

Reference	Designator/Label	Functions
(42)	☐ STORE STORE ENABLER KEY	Stores number on display, last reading or numerical entry.
(43)	☐ LOW-AVERAGE-HIGH LAH FUNCTION SELECTOR KEY	Selects function that compares the present reading with previously determined Low (most negative) or High (most positive) readings. Stores the present reading in place of one of these if it is found to be lower or higher. Also calculates and stores the average value of a selected number of readings. The Low, Average, High or number of readings averaged can be selected for a continuous display or recalled from memory and displayed. The number of readings to be averaged can be entered prior to selection of LAH operation, and this number can be recalled from memory and displayed. LAH annunciator is illuminated when function is enabled.
(44)	☐ RESET RESET KEY	Removes previously selected "Math" functions. Enables continuous readings and lights all front panel annunciators and display segments.
(45)	☐ PERCENT FUNCTION % SELECTOR KEY	Calculates and displays: $\frac{\text{Reading-Percent Constant}}{\text{Percent Constant}} \times 100$ which is the percentage deviation of the input reading from a reference value called "Percent Constant" (stored reading or constant entered via keyboard). % annunciator is illuminated when % function is enabled.
(46)	☐ TOGGLE SHIFT KEY	Allows access to numeral entry, Ext. Ref and Clear Entry keys. SHIFT annunciator indicates whether the keyboard is in the shifted or unshifted mode.
(47)	☐ NULL FUNCTION NULL SELECTOR KEY	Selects Null function. When selected, the number on the display is stored as a Null constant and is subtracted from all future readings until the Null function is disabled by depressing the NULL key again. The Null constant can be either the measurement value at the time Null is selected or a value entered via the keyboard. NULL annunciator is illuminated when Null function is enabled.

Table 3.1 - Front Panel Controls, Connectors and LEDs continued

Reference	Designator/Label	Functions
	DOUBLE KEY-STROKE ENTRY The following keys are SHIFT functions	
	□ SHIFT CE □	The "Clear Entry" key clears numbers entered into display and returns the instrument to its previous state.
	□ SHIFT N □	Where N = 0 to 9. Enters numbers into display in preparation for storage in memory as constants (e.g., Null Constant, Reference Value for percent deviation, etc.). Depressing these keys does not unshift keyboard.
	□ SHIFT □ +/–	Reverses sign (polarity) of number entered into display. Depressing this key does not unshift keyboard.
	□ SHIFT □ REF	Enables and disables the external reference selection mode. When enabled,"REF" is displayed on the front panel read-out. Refer to Section 3.4 for complete procedure.
	□ STORE □ NULL	Stores number on display (last reading or numerical entry) as Null Constant.
	□ STORE □ %	Stores number on display (last reading or numerical entry) as Percent Constant for percent deviation calculation.
	□ STORE □ LAH	Stores numerical entry on display as number of readings to be averaged (c).
	□ STORE □ TIME X □	Stores numeral entry on display as parameter associated. with Time function, where X is: 1. START Time 2. STOP Time 3. Time INTERVAL 4. Time SUBINTERVAL 5. N (number of readings per INTERVAL) 6. PRESENT Time
	□ STORE SHIFT □ N □	Where N = 0 to 9. Stores the present instrument setting into the buffer program location 0 to 9.
	□ RECALL □ %	Displays Reference Value used in percent calculations.
	□ RECALL □ LAH	Recalls Low (L), Average of last N readings (A), High (H), number of readings that have been averaged (n), and the number of readings to be averaged (c). The number of readings to be averaged (c) is entered via the keyboard prior to selecting LAH operation. c = 4 if no entry is made.

Table 3.1 - Front Panel Controls, Connectors and LEDs continued

Reference	Designator/Label	Functions
	☐ RECALL ☐ BUFF	Recalls readings stored in buffer memory to the display.
	☐ RECALL ☐ NULL	Displays value of Null constant.
	SHIFT ☐ N ☐ ☐ RECALL	Where N = 0 to 9. Recalls machine settings previously stored in program buffer and programs the instrument to these settings.
(48) ↓ (53)	MATCHING DESIGNATORS ANNUNCIATOR LEDS	This group of annunciator LEDs match the designators for SHIFT, TIME, LAH, %, NULL and External Reference.
(54)	CALIBRATION SWITCH	Spring loaded pushbutton switch, accessible through hole in front panel. Switch is held depressed during software calibration to enter calibration constants into Non-Volatile Memory.
(55)	SIGN INDICATOR	LED illuminates to display the negative sign when the display reading is negative.
(56)	READ-RATE INDICATOR	Front panel LED indicator that illuminates when the DMM takes a reading.
(57)	POWER SWITCH	Push-on, Push-off type switch on front panel.

Table 3.2 - Rear Panel Terminals and Control

Reference	Designator/Label	Functions
(1)	Ω SOURCE BANANA JACK	Ω Current Return (J206).
(2)	INPUT HI BANANA JACK	+ Signal Input (J207).
(3)	SYNC OUTPUT BNC CONNECTOR	Outputs negative going TTL pulses each time a reading is displayed. Used to synchronize input scanners, such as Racal-Dana 1200.
(4)	FUSE HOLDER	.5 Amp "Slo-Blo" (115V). .25 Amp "Slo-Blo" (220V).
(5)	AC POWER PLUG	Accepts Racal-Dana AC cord 600620., and European standard cord P/N 600858.
(6)	ADDRESS SWITCH	GPIB ADDRESS SWITCH. DMM bus number selector.
(7)	GPIB CONNECTOR	GPIB port (J201).
(8)	EXTERNAL TRIGGER BNC CONNECTOR	A negative going TTL level pulse applied to this connector initiates a measurement cycle when in " Hold " mode.
(9)	LINE VOLTAGE SELECTOR WINDOW	The selected AC voltage viewing window.
(10)	GUARD BANANA JACK	Rear panel connector to internal guard shield (J205) connected internally to front panel guard connector (J101).
(11)	INPUT-LO BANANA JACK	–Signal Input (J204).
(12)	Ω SOURCE BANANA JACK	Ω Current Source (J203).
(13)	EXT. REF HI-BANANA JACK	External Reference INPUT. HI-J211.
(14)	EXT. REF LO-BANANA JACK	External Reference INPUT LO-J201.

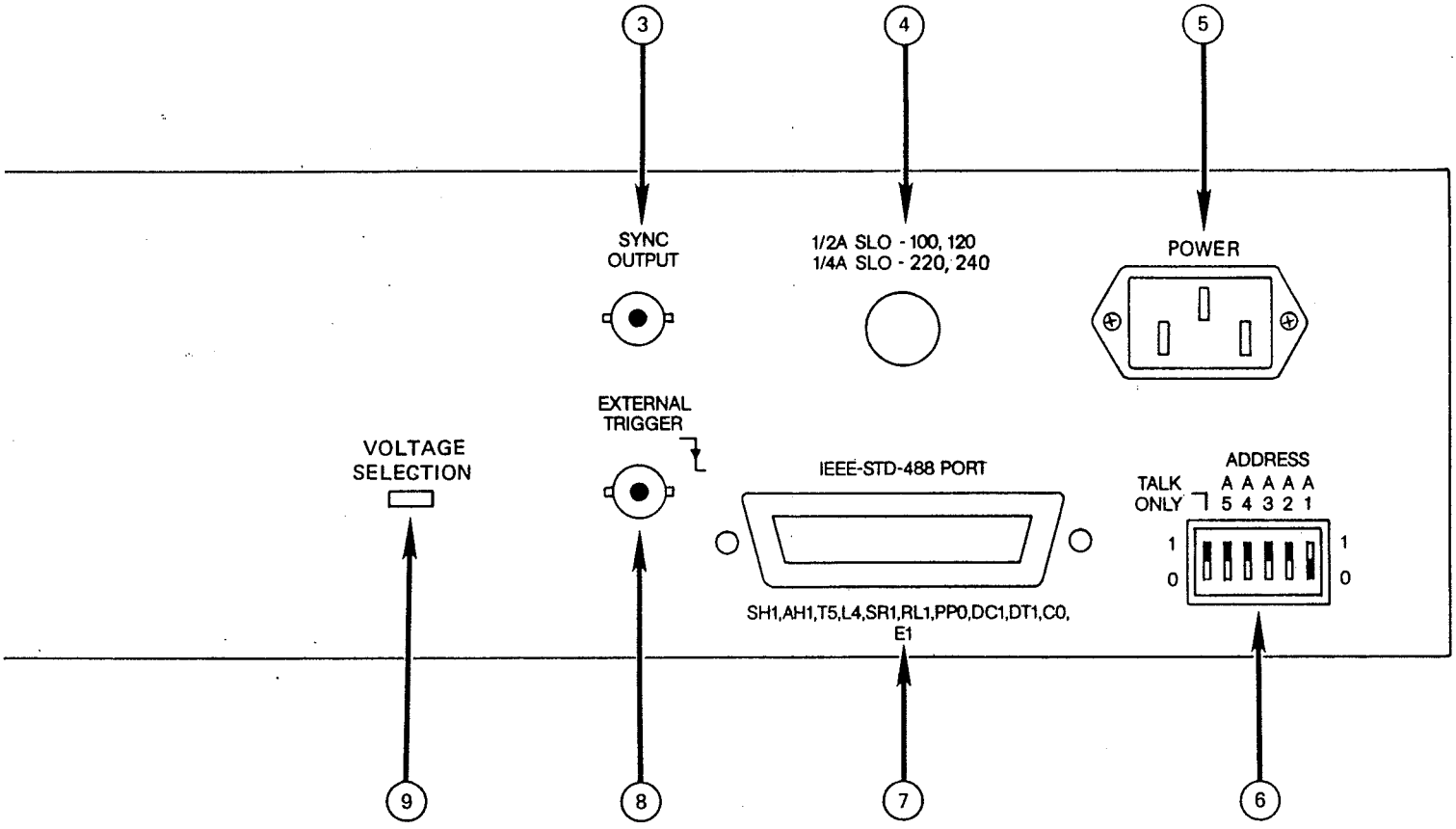
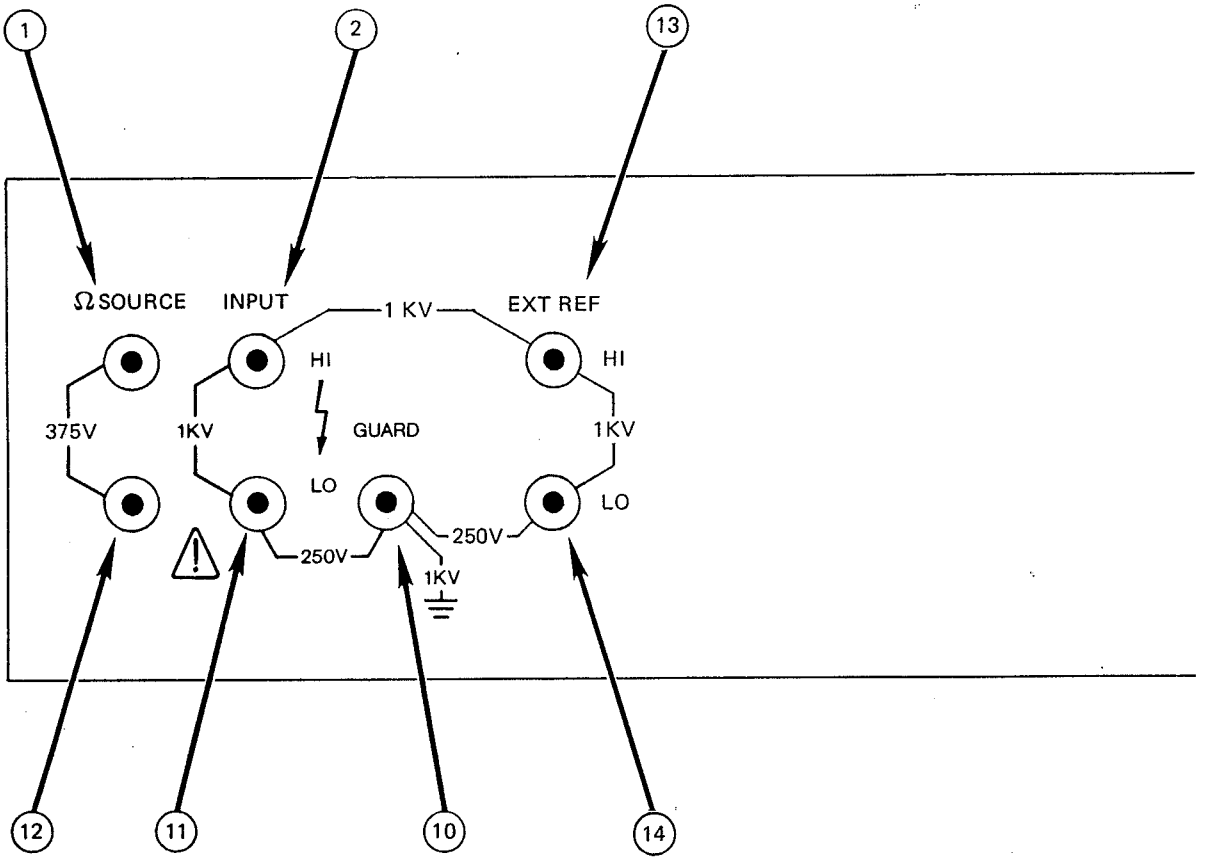


Figure 3.2 - Rear Panel


1
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10
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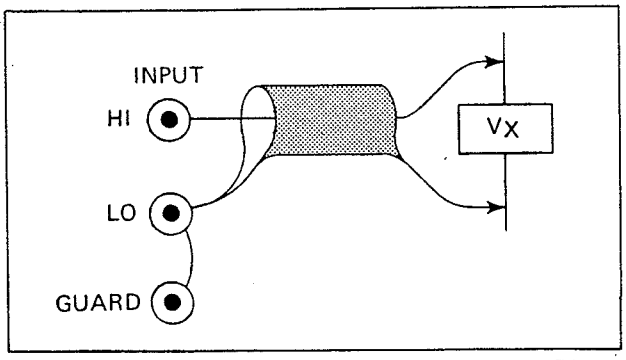

Figure 3.3 - DC, AC Measurement Connections Using Coaxial Cable

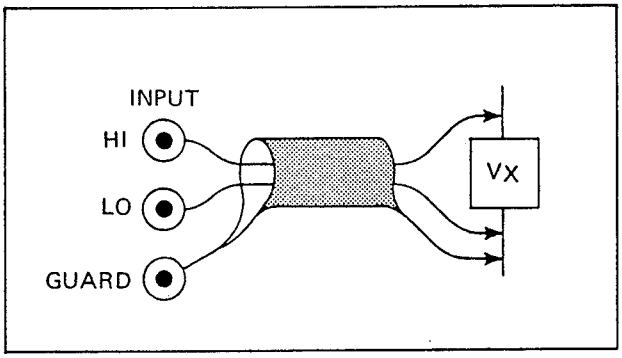

Figure 3.4 - DC, AC Measurement Connection Using Two Conductor Shielded Cable

3.4.3 DC Volts Measurements.

3.4.3.1 The basic instrument is capable of measuring DC volts in 5 ranges: 0.1V, 1V, 10V, 100V, 1000V. To measure DC voltage proceed as follows:

3.4.3.2 Complete the DMM turn-on procedure as described in paragraph 3.2.2, then check the zero accuracy of the instrument as described in paragraph 3.4.1.

3.4.3.3 Connect the DC voltage to the INPUT HI-LO terminals, refer to Figure 3.3 and Figure 3.4, and read the value from the display and range annunciators.

3.4.4 AC Volts Measurements.

3.4.4.1 The DMM is capable of measuring AC volts in 4 ranges: 1V, 10V, 100V, 1000V. To measure AC voltage proceed as follows:

3.4.4.2 Complete the DMM turn-on procedure as described in paragraph 3.2.2.

3.4.4.3 Select the AC volts function by pressing the AC key, then verify that the AC annunciator LED is on.

3.4.4.4 Connect the AC voltage to the INPUT HI-LO terminals, refer to Figure 3.3 and Figure 3.4, and read the value from the display and range annunciators.

3.4.4.5 AC Voltage measurements for the Model 5005 Averaging AC to DC Converter are always AC coupled (DC component of input is blocked). For the Model 5006 True RMS to DC Converter, AC Voltage Measurements can be made either as AC coupled or DC coupled.

3.4.4.6 To select DC coupled operating (AC + DC mode) for the 5006 AC converter, proceed as follows:

a) Set DMM power switch to off.

WARNING

These instructions are for use by qualified personnel only. To avoid electric shock, do not perform any servicing other than that contained in the operating instructions unless you are qualified to do so.

b) Unplug power cord.
c) Remove top cover (see 2.5.1.2).

WARNING

Removal of covers exposes potentially lethal voltages. Avoid contact with internal electrical connections while unit is connected to AC power source.

d) Extract RMS Converter and remove top guard shield on converter board.
e) Set S1 and S2 switches to DC (toward center of board).
f) Replace guard shield and reinstall RMS Converter in unit.
g) Install top cover (see 2.5.1.5).
h) Set connect power cord and set AC power switch to ON. To select AC coupled operation, perform steps (a) through (h) above, but in step (e), set S1 and S2 switches to AC (away from center of board).

3.4.5 Resistance Measurements.

3.4.5.1 The DMM is capable of measuring resistance values in six ranges, starting at 100 ohms full scale to 10,000,000 ohms full scale. The correlation between the front panel keyboard and resistance selection is best described by the chart that compares range designators and resistance scales, as follows:

a) When the KΩ function is selected, the range keys carry a scaled factor of 1000 or range key "1" equals one thousand ohms full scale.
b) Range keys and resistance measurement comparison:

Range Key	Ohms - Full Scale	
.1	100	Ohms
1	1000	Ohms
10	10,000	Ohms
100	100,000	Ohms
1K	1,000,000	Ohms
10K	10,000,000	Ohms

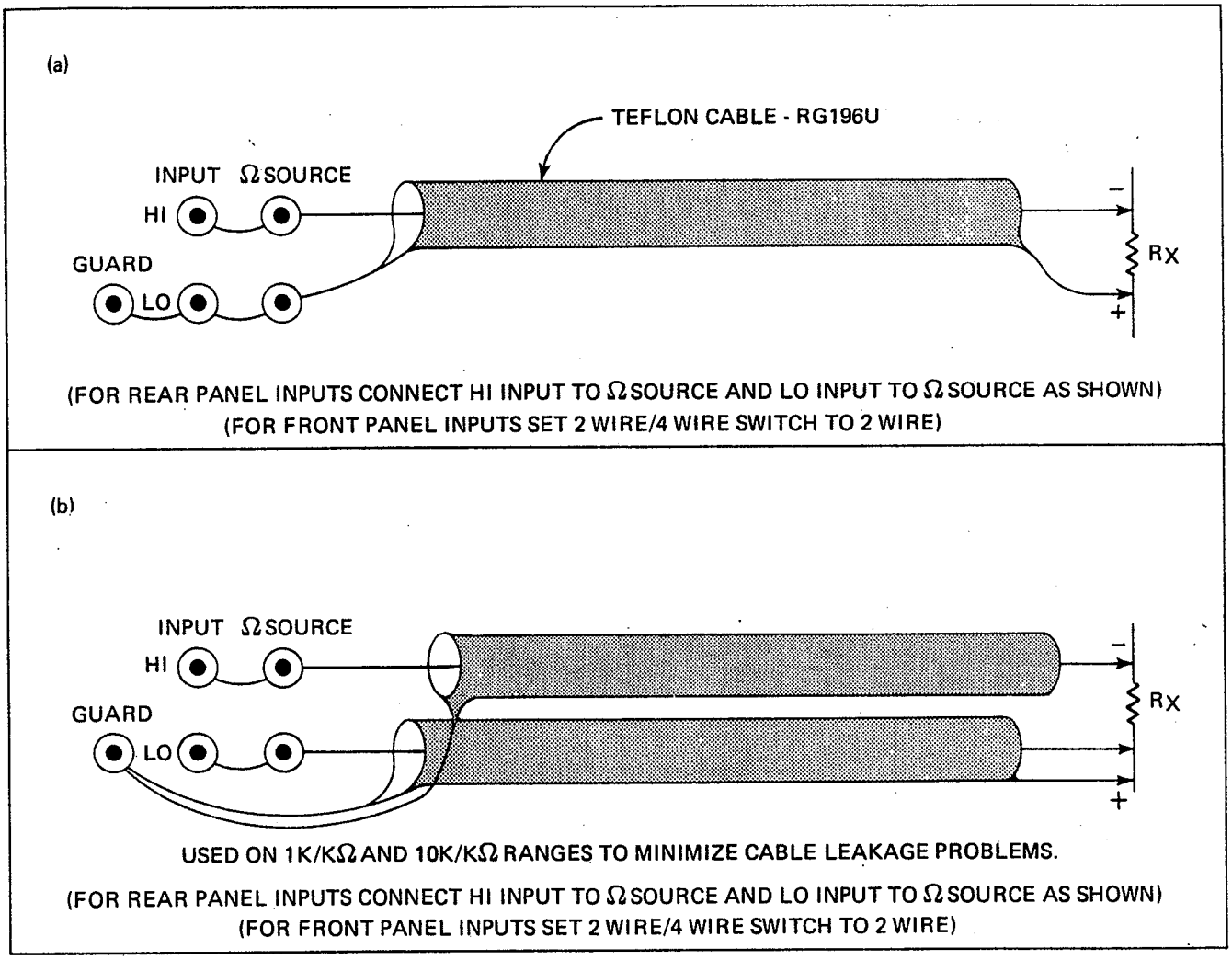

Figure 3.5 - Two Wire Ohms Measurements

3.4.5.2 Furthermore, the operator has the option of selecting two-wire or four-wire mode of operation through the front panel switch, No. 30 on Figure 3.1. This selection is determined by the accuracy required by the User and the environment. The application and description for each system is described in the procedures that follow.

3.4.5.3 Two-Wire measurements through the Front or Rear Panel INPUT terminals are connected as shown in Figure 3.5A and 3.5B using Teflon shielded cable as indicated. The Two-Wire/Four-Wire switch on the front panel, No. 30 on Figure 3.1, is placed in the two-wire position, this automatically connects the Ohms Source terminals to the Voltage Input (sense) terminals. When rear terminal input is used, a jumper is required between the Ohms Source terminal and the HI Input, then another jumper is required between the other Ohms Source terminal and the LO Input terminal. These connections and the GUARD connection to LO input are shown on Figure 3.5. When performing polarity sensitive resistance measurements (e.g.semiconductor junctions), note the polarity of the voltage across the Ω SOURCE terminals (upper terminal is negative with respect to lower terminal).

3.4.5.4 Accurate measurements can be obtained with the two-wire system presented, except in the .1 and 1 ranges. At low resistance levels, lead resistance between Rx and the DMM can become a significant error factor. In this instance a four wire system is recommended to minimize lead resistance errors.

3.4.5.5 When measuring resistances in the 1K/KΩ and 10K/KΩ ranges, cable leakage may cause measurement errors if the connections of Figure 3.5A are used. The amount of inaccuracy will depend on the cable insulation and environmental conditions (e.g., high relative humidity, etc). For this reason, teflon insulation is recommended to minimize cable leakage. If teflon cable is not used, then the two wire cable wiring diagram of Figure 3.5B is recommended.

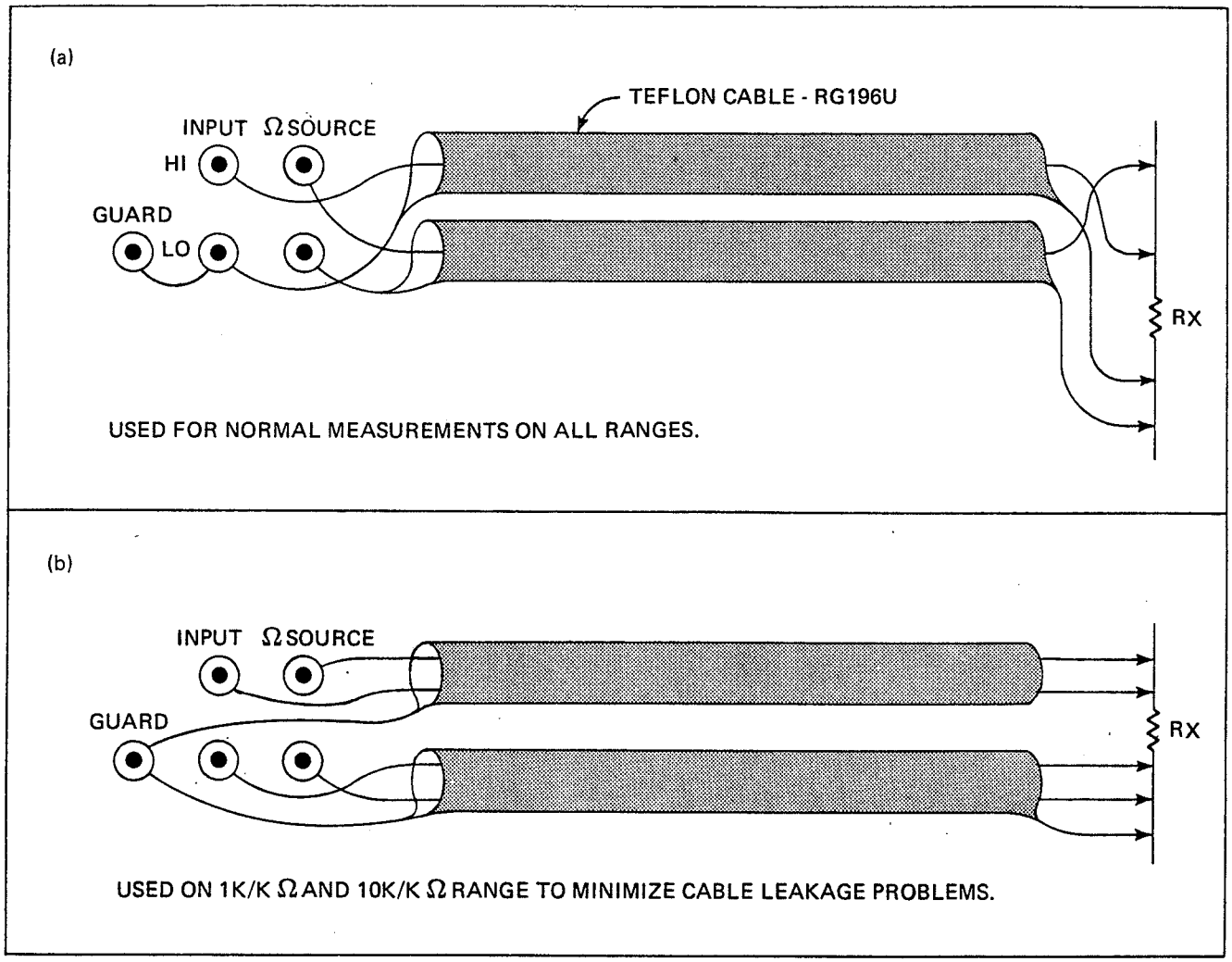

Figure 3.6 - Four Wire Ohms Measurement

3.4.5.6 Four Wire Measurement System is used in most systems applications, particularly where the device to be measured is at a remote location requiring interconnection by cables from several feet to hundreds of feet in length. When measuring low resistance values over long cables, most resistance problems can be resolved by the use of the four-wire measurement system.

3.4.5.7 The 2-Wire/4-Wire switch is set to 4-wire when front panel terminals are used for Four-Wire measurements. The four-wire resistance measurement diagrams are shown in Figure 3.6A and 3.6B. If teflon insulated coaxial cable is used, accurate measurements can be made on all ranges and under severe environmental conditions. Figure 3.6B shows the recommended connections when using two-conductor shielded cable. This wiring system eliminates most cable leakage problems when high resistances are measured with relatively high leakage cables.

3.4.6 DMM Extended Software Capability (ESC) Features.

3.4.6.1 The Extended Software Capability increases the program capabilities of the DMM. The features include NULL, %, LAH, TIME, Program Buffer and Data Buffer. The application and control description were presented in Section 3.3. Additional information continues in this section.

3.4.6.2 These programs were designed to operate either separately or in various combinations. For instance, the % and LAH function can be used together to determine average

and worst-case percentage variations. In an another example, the Time Function and Data Buffer can be used together to monitor an input signal at pre-determined intervals and store the resulting readings for later recall. In general when two or more ESC features are enabled simultaneously, they will take place in the order shown in the ESC Feature Flow Chart, Figure 3.7.

3.4.6.3 When reviewing the Flow Chart, notice that the Time Function does not appear as a discrete block in this figure. The time function, if enabled, determines when a reading is permitted to take place; the reason will be seen later. A block for the Program Buffer was intentionally omitted since the program buffer affects the entire DMM's configuration, rather than each individual reading.

3.4.6.4 Keyboard operation which makes use of the STORE, RECALL, REF, or numeric entry keys causes the DMM to abort the sequence shown in Figure 3.7, and instead responds only to the keyboard input. When the operator has finished with keyboard operations, he can return to the Flow Chart sequence by pressing the SHIFT then CE (clear entry) keys. Other keys such as Function, Range or the RESET key may be used, but possible interaction may occur with the DMM's setup in various ways (see the description for each key in Table 3.1).

3.4.7 STORE and RECALL Procedures.

3.4.7.1 The STORE key is used in conjunction with other keys to store readings, numerical constants and Instrument Program Settings in the DMM's memory.

3.4.7.2 The general procedure for STORING READINGS is presented next:

a) If a reading is not presently displayed, depress the SINGLE or TRACK key.

b) Press the STORE key.

c) Press the key or keys which specify the storage location. The STORE key operations of the Extended Software Capability (ESC) features are listed in Table 3.3.

NOTE

If any ESC features are enabled, (NULL, %, etc.) the number stored will not match the number displayed. The ESC Flow Diagram presented in Figure 3.7 can be used as an aid to understand this phenomenon because the Flow Chart indicates that the Input Buffer contains the unprocessed reading rather than the output of NULL, Percent, etc.

3.4.7.3 STORING NUMERICAL CONSTANTS is presented next:

a) Press the SHIFT key, the SHIFT annunciator LED will illuminate.

b) Press the Numerical Entry Keys as required to enter the constant. The enteries will appear on the display.

c) Press the STORE key.

d) Press one of the key sequences shown in Table 3.3, Store Key Operations.

NOTE

If an error is made keying the STORE procedure, press SHIFT and clear entry (CE) keys to return the DMM to its previous state.

3.4.7.4 The RECALL KEY is used in conjunction with other keys to examine data which is stored in the DMM's memory and to recall Instrument settings from the program buffer. The RECALL Key sequences in Table 3.4 show all the possible sequences, along with other details.

NOTE

If any error is made keying the RECALL procedure, press the SHIFT and clear entry (CE) keys to return the DMM to its previous state.

3.4.8 Low-Average-High Function.

3.4.8.1. The DMM provides a Low-Average-High (LAH) measurement capability. When used in this mode the instrument performs the following operations:

a) Stores the least positive (or most negative) value measured during LAH operation;

b) Stores the value of the most positive (or least negative) measurement made during LAH operation;

c) Calculates the average value of all measurements taken during the LAH average cycle;

d) Counts the number of measurements taken during the LAH average cycle.

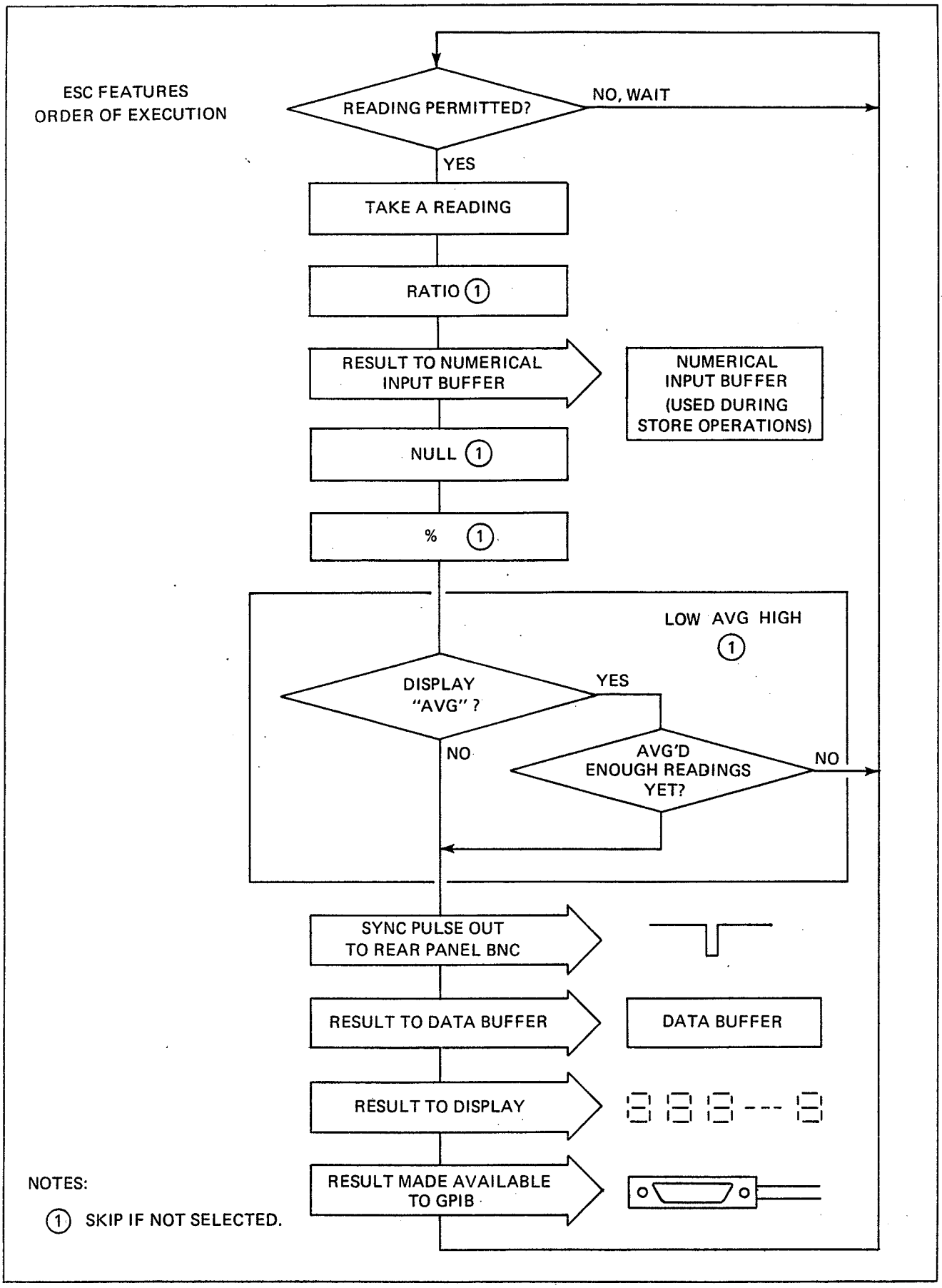

Figure 3.7 - Extended Software Capability Feature Flow Chart

Table 3.3 - Store Key Operations

Key Sequence	Storage Location	Power-Up Value	Units	Notes	For More Info See Paragraph
STORE □ □ NULL	Null Constant	0.00	Volts or Kohms	Null Function should be enabled before Null constant is stored.	3.4.10
STORE □ □ %	Percent Constant	0.00	Volts or Kohms		3.4.11
STORE □ □ LAH	LAH Average Cycle Count C	4	Dimensionless	C, the LAH Average cycle constant should be between 1 and 10,000. If C = 10,000 A and N will not periodically reset.	3.4.8
STORE □ 1 □ TIME	Start Time	00.0000	Hr. Min Sec	(1)	3.4.9
STORE □ 2 □ TIME	Stop Time	99.0000	Hr. Min Sec	(1)	
STORE □ 3 □ TIME	Interval	00.0000	Hr. Min Sec	(2)	
STORE □ 4 □ TIME	Subinterval	00.0000	Hr. Min Sec	(2)	
STORE □ 5 □ TIME	N (number)	1	Dimensionless	(3)	
STORE □ 6 □ TIME	Present Time	00.0000	Hr. Min Sec	(1) (4)	
STORE □ SHIFT □ 9 . . . 0 □	Program Buffer	Empty	N/A	Stores the entire DMM's present setting into the Program Buffer, and initializes the Data Buffer.	3.4.12

(1) A time-of-day number which should be set between 00.0000 and 95,5959 for normal operation, or set greater than 95.5959 to place constant at infinity on time scale.

(2) An elapsed-time constant same numerical limits apply as in (1)

(3) An Integer, normally set between 1 and 99

(4) Automatically increments to track the passing of time.

Table 3.4 - Recall Key Operations

Key Sequence	Recall Location	Power-Up Value	Units	Notes	For More Info See Paragraph
RECALL NULL	Null Constant	0.00	Volts or Kohms		3.4.10
RECALL %	Percent Constant	0.00	Volts or Kohms		3.4.11
RECALL LAH	Lowest Reading	Blank Display	Volts or Kohms	(1) (1) A blank display indicates that no answer is presently available (answer is "the empty set"). (2) Automatically initialized every C readings.	3.4.8
RECALL LAH	Average Reading	Blank Display	Volts or Kohms	(1) (2)	
RECALL LAH	Highest Reading	Blank Display	Volts or Kohms	(1)	
RECALL LAH	Number of Readings	0	Dimensionless	(2)	
RECALL LAH	Average Cycle Constant	4	Dimensionless		
RECALL TIME 1	Start Time	00.0000	Hr. Min Sec		3.4.9
RECALL TIME 2	Stop Time	99.0000	Hr. Min Sec		
RECALL TIME 3	Interval	00.0000	Hr. Min Sec		
RECALL TIME 4	Subinterval	00.0000	Hr. Min Sec		
RECALL TIME 5	N (number)	1	Dimensionless		
RECALL TIME 6	Present Time	00.0000	Hr. Min Sec		
RECALL BUFF			Volts or Kohms	Number at right side of display during pressing of BUF key indicates buffer location #.	3.4.12
RECALL SHIFT 9 . . . 0			N/A	Programs entire instrument to setting previously stored in locations 0-9.	3.4.12

3.4.8.2 The length of the LAH average cycle is determined by an operator entered number using the procedure described in paragraph 3.4.8.4. The number entered will equal the number of readings the operator wants to average in each LAH average cycle up to a maximum of 10,000. If selected for display, a new average is displayed at the end of each LAH average cycle. However, the low and high values are derived from all readings taken since the LAH function was selected.

> **NOTE**
>
> The LAH function will update the minimum and maximum readings indefinitely, but will not update the average or the number of measurements readings beyond the first 10,000 samples.

3.4.8.3 The operator may select the lowest (most negative) measurement (L), average measurement (A), highest (most positive) measurement (H), number of measurements (n), or the present reading (r) to be displayed while the LAH function is selected. The desired display selection is described in the following procedure:

a) Depress and hold the LAH key. As long as the key is depressed, the display will repeat the sequence "L, A, H, n, r" in the least significant digit location.

b) To display the most negative reading, release the LAH key while the "L" is displayed.

c) To display the average reading, release the LAH key while the "A" is displayed.

d) To display the most positive reading, release the LAH key while the "H" is displayed.

e) To display the number of measurements taken during each LAH Average cycle, release the LAH key while the "n" is displayed.

f) To display the present measurement reading, release the LAH key while the "r" is displayed.

3.4.8.4 The desired number of measurements to be averaged during each LAH average cycle is programmed prior to entering the LAH function as follows:

a) Press the SHIFT key.

b) Key in the number of measurements to be averaged (e.g., press the 5 key and then the 8 key to select 58 measurements).

c) Press the STORE key.

d) Press the LAH key. The number of measurements constant (c) will remain in memory until it is changed or until power is removed from the instrument.

e) Select the desired display by following the procedure in the preceding paragraph. If the average reading is selected for display, the display will be updated each time the selected number of measurements is completed (e.g., every 58 measurements).

f) If the operator is not interested in using the LAH function's averaging capabilities, the LAH average cycle constant need not be initialized.

3.4.8.5 The operator, when using the RECALL key has access to the data stored during LAH operation. Press the key RECALL, then LAH and a letter will appear in the least significant digit location. Upon release of the LAH key, the letter will be replaced with the following corresponding data:

a) C: Number of readings averaged each LAH average cycle, operator entered as described in 3.4.8.4.

b) L: The least positive (most negative) reading that has occurred since the LAH function was selected.

c) A: The average computed over N readings (see N below).

d) H: The most positive (least negative) reading that has occurred since the LAH function was selected.

e) N: The number of readings taken during the present LAH average cycle.

> **NOTE**
>
> If the number of measurements to be averaged (C) is entered as zero, then the average will be taken over one reading (i.e., zero defaults to one), (C) will default to 10,000 if entered as >10,000. The number of measurements constant is initialized to four (C = 4) at power-up.

f) The Average is calculated and updated in memory as each reading is taken (up to 10,000). The average of "N" readings can be recalled before the average of " C " readings is displayed (if selected for display).

3.4.8.6 SYNC OUTPUT: As can be seen in Fig. 3.7, a pulse appears at the SYNC output each time the display is updated. When "average" is selected for display, the pulse will occur only once per LAH average cycle. Refer to paragraph 3.4.14.2 for a description of the SYNC output signal.

3.4.8.7 APPLICATIONS: A general list follows:

a) Low Frequency noise (less than 6 Hz) can be averaged resulting in a "quieter" display.