8520A
Digital Multimeter

Operator Manual

FLUKE®

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John Fluke Mfg. Co., Inc., P.O. Box C9090, Everett, Washington 98206

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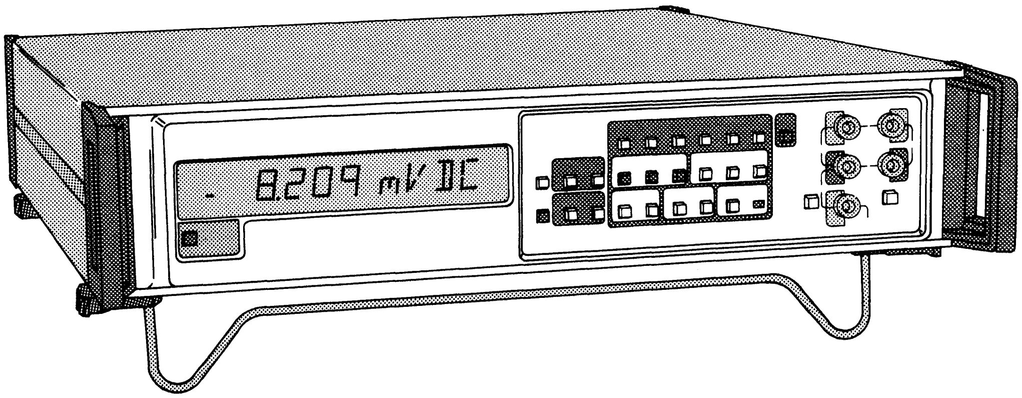

8520A Digital Multimeter

Section 1
Introduction and Specifications

1-1. THE 8520A INSTRUCTION MANUAL SET

1-2. The John Fluke Model 8520A Digital Multimeter is documented by a set of three manuals: the 8520A Operator Manual, the 8520A Calibration Manual, and the 8520A Service Manual. The 8520A Operator Manual introduces the operator to the 8520A, familiarizes the operator with all instrument controls, connectors and indicators, and presents detailed local and remote operating information and procedures. The 8520A Calibration Manual provides general maintenance procedures, performance tests, and calibration adjustment procedures. The 8520A Service Manual contains the theory of operation, troubleshooting information, a list of replaceable parts, and schematics. As Figure 1-1 shows, the three manuals can either be separated for use in different areas or joined together in a single binder.

1-3. The information in this, the 8520A Operator Manual, is divided into nine sections:

1. INTRODUCTION AND SPECIFICATIONS	Introduces both the 8520A Digital Multimeter and the Instruction Manual Set and lists the instrument's specifications.
2. SHIPPING AND SERVICE INFORMATION	If there is a problem with your 8520A, this section tells you how to get it corrected and how to ship the instrument.
3. INSTALLATION AND MAINTENANCE	How to physically install the 8520A -- including connecting line powerand the IEEE-488 interface operator maintenance.
4. FAMILIARIZATION	Describes the location and basic function of all instrument controls, connectors and indicators.
5. OPERATING NOTES	Provides information about the 8520A that every operator needs to know. For example, the Input Overload Limits.
6. LOCAL OPERATION	Describes local (front panel) operation procedures for each multimeter function of the 8520A.

7. MATH PROGRAMS	Presents a detailed description of each math program: what the program does, how to use the program, program options, and program data.
8. IEEE-488 (REMOTE OPERATION)	Description of 8520A operation via the IEEE-488 Interface.
9. ACCESSORIES AND OPTIONS	Describes each accessory briefly and details the -010 Option.

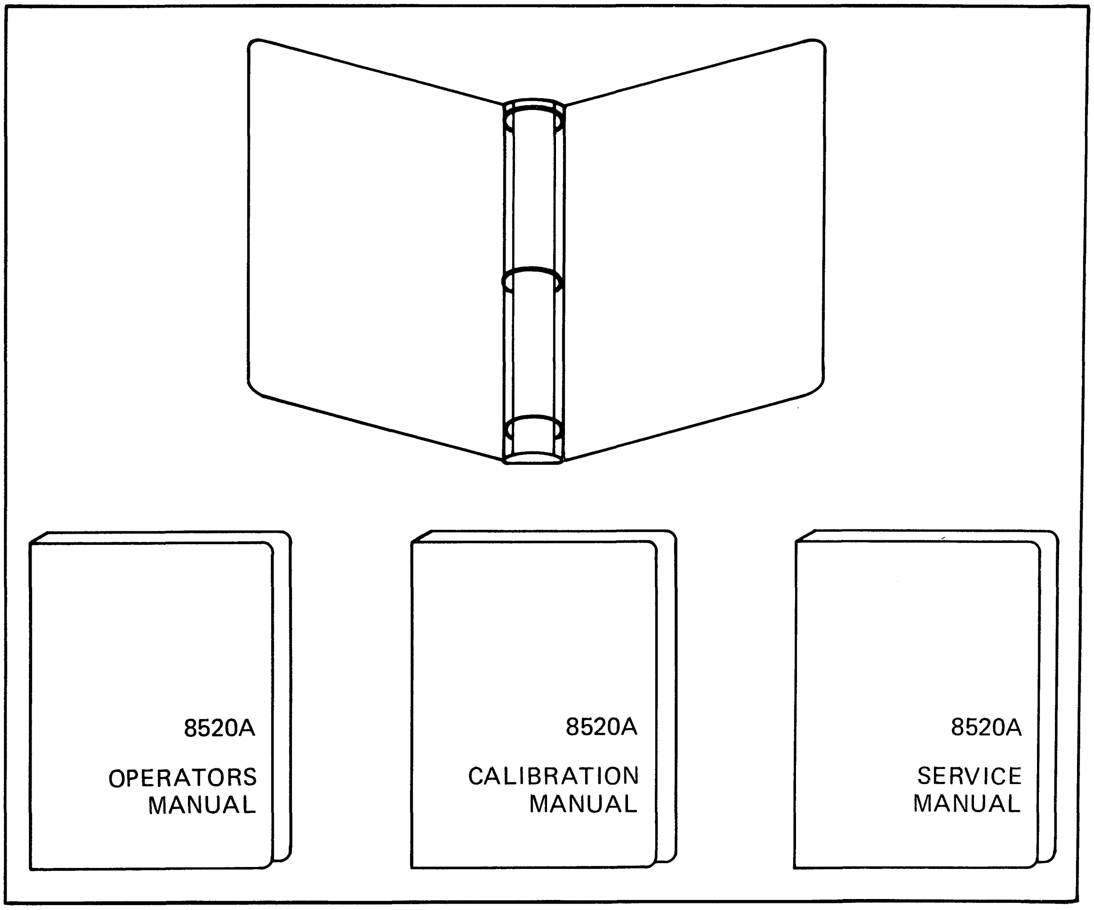

Figure 1-1. 8520A Instruction Manual Set

1-4. THE 8520A DIGITAL MULTIMETER

1-5. The John Fluke Model 8520A Digital Multimeter is designed for use in an automated test system or as an independent device. The 5-½ digit instrument can be operated locally from the front panel or remotely via an IEEE-488 1978 interface. The 8520A can directly measure dc, ac, and ac+dc voltage; resistance (both 2 and 4 wire); and conductance (the reciprocal of resistance). While the range of measurement can be manually selected, all functions except conductance (nS) have full autoranging capabilities (conductance only has one range). When measurement function and range are selected, the 8520A automatically programs the reading rate and filter for optimum measurement accuracy. Other values for reading rate and filter can be manually selected. The seven math programs allow more sophisticated processing of measurement data (such as computing the peak-to-peak value, percentage of deviation, rise time, etc.) and additional measurement functions. For example, the standard 8520A can make voltage ratio measurements and an 8520A equipped with the -010 Option can make voltage ratio measurements, dB measurements, and temperature measurements in addition to the direct voltage and resistance measurements. The burst feature of the 8520A allows the operator to capture up to 50 readings (400 with the -010 Option) at various reading rates and to display the readings at a different rate, to delay the time after a trigger before the readings are taken, or to look at what happened to the signal before the trigger occured. The TRIGGER controls allow internal triggering, manual triggering, triggering via the IEEE-488 interface, and triggering from an external source. All measurements can be guarded.

1-6. DC voltage can be measured from a 1 μV up to 1000V in five ranges: 100 mV, 1V, 10V, 100V, and 1000V. Ac and ac+dc voltage can be measured from 10 μV ac rms to 650V ac rms in four ranges -- 1V, 10V, 100V, and 650V ac rms -- over the frequency range of 10 Hz to 1 MHz.

1-7. Resistance can be measured in two ways. Either directly using the Ω2 WIRE and Ω4 WIRE functions or inversely using the conductance function. The Ω2 WIRE and Ω4 WIRE functions provide measurement of resistance from 100 μohm to 20 Mohm in seven ranges: 10 ohms, 100 ohms, 1000 ohms, 10 kohms, 100 kohm, 1 Mohm, and 10 Mohm. Conductance provides fast, accurate, noise-free measurement of resistances from 10 MOhm up to 10,000 Mohm in a single range - 100 nS. Conductance is displayed in the international units, Siemens which is equal to the reciprocal of ohms (S = 1/Ω).

1-8. The standard 8520A has seven math programs:

#1	TEST	Four diagnostic self-test programs
#2	ZERO	Automatic meter zeroing for dc voltage offsets and resistance offsets (such as test lead resistance)
#3	XREF	Ratio between the input voltage and an external reference voltage
#4	OSR	Subtracts an offset (OFST) from the input, multiplies by a scale factor (SCAL), divides by a ratio factor (RATO), and displays the result
#5	⊿PCT	Displays the percentage deviation of the input with respect to a stored nominal value
#6	PEAK	Captures upper and lower peak values and computes peak-to-peak value
#7	LIM	Tests the reading against stored upper and lower limits and displays the results of each reading, the number HIGH, the number LOW, the number that PASS, and the TOTAL number of readings

The -010 Option provides an additional seven Math Programs:

#8	STAT	Statistics program that computes mean, standard deviation, variance, number of reading, bias, sum of the squares, sum of readings, difference, and the sum of the differences
#9	LFAC	Computes the ac rms value of inputs 10 Hz and below
#10	dB	Computes dB, dBm, or dBV ratio
#11	RTD	RTD thermometer measurements
#12	JV C	Works with the John Fluke 80T-150C to measure temperature in °C
#13	JV F	Works with the John Fluke 80T-150F to measure temperature in °F
#14	THMS	Thermistor linearization

These math programs can be exercised on measurement data while the readings are being taken or after the readings have been captured in burst memory.

1-9. OPTIONS AND ACCESSORIES

1-10. The 8520A has one option, the -010 Option. This is a software option which provides an additional seven math programs (#8 through #14) and an additional 350 locations of burst memory. The accessories available for use with the 8520A are listed in Table 1-1.

Table 1-1. 8520A Accessories

MODEL OR PART NO.	NAME
Y8599	Rack Ears (for Rack Slide Mounting)
M00-203-600	Rack Ear Mounting Assembly
M00-260-610	18-inch Rack Slides
M00-280-610	24-inch Rack Slides
80F-5	High Voltage Probe
80F-15	High Voltage Probe
81RF	High Frequency Probe
82RF	High Frequency Probe
Y8001	IEEE-488 Std. Cable, 1 Meter Length
Y8002	IEEE-488 Std. Cable, 2 Meter Length
Y8003	IEEE-488 Std. Cable, 4 Meter Length
Y2025	100Ω RTD Temperature Probe
80T-150C	Universal Temperature Probe (°C)
80T-150F	Universal Temperature Probe (°F)

1-11. SPECIFICATIONS

1-12. Table 1-2 lists the specifications for the 8520A.

Table 1-2. 8520A Specifications

DC VOLTS

INPUT CHARACTERISTICS:

RANGE	FULL-SCALE	RESOLUTION	INPUT RESISTANCE
100 mV	199.999	1 μV	⩾10,000 MΩ
1V	1.99999	10 μV	⩾10,000 MΩ
10V	16.0100	100 μV	⩾10,000 MΩ
100V	130.100	1 mV	10 MΩ
1000V	1024.00	10 mV	10 MΩ

ACCURACY ±(% of input + number of digits)

RANGE	24 HOURS 23°C ±1°C	90 DAYS 18°C to 28°C	1 YEAR 18°C to 28°C	PLUS TEMP. COEFFICIENT PER °C*
100 mV	0.003 + 5	0.0065 + 6	0.011 + 10	0.0005 + 0.5
1V	0.003 + 1	0.006 + 2	0.011 + 2	0.0005 + 0.15
10V	0.002 + 1	0.005 + 1	0.009 + 1	0.0004 + 0.10
100V	0.003 + 1	0.007 + 2	0.012 + 2	0.0005 + 0.15
1000V	0.0035 + 1	0.0065 + 1	0.011+1 1	0.0005 + 0.10

**From 22°C to 0°C or 24°C to 50°C, 24 hours specification*
From 18°C to 0°C or 28°C to 50°C, 90 day or 1 year specification

HIGH SPEED ACCURACY: ±(% of input + least significant bit)*

RANGE	90 DAYS 18°C to 28°C	1 YEAR 18°C to 28°C	PLUS TEMP. COEFFICIENT PER °C
100 mV	0.01 + 1	0.015 + 1	0.001 + .1
1V	0.01 + 1	0.015 + 1	0.001 + .05
10V	0.01 + 1	0.015 + 1	0.001 + .05
100V	0.01 + 1	0.015 + 1	0.001 + .05
1000V	0.01 + 1	0.015 + 1	0.001 + .05

**Typical with 60 Hz line, remote operation, 500 readings per second, 2-byte binary output with 14 bits of data.*

TYPICAL NORMAL MODE REJECTION:

LINE FREQ.	FILTER SETTLING TIME					
	25 ms	50 ms	100 ms	200 ms	500 ms	1s
50 Hz	65 dB	68 dB	71 dB	80 dB	*83 dB	86 dB
60 Hz	65 dB	68 dB	71 dB	85 dB	*88 dB	91 dB
400 Hz	53 dB	56 dB	60 dB	120 dB	*123 dB	126 dB

**Guaranteed minimum rejection*

COMMON MODE REJECTION: True 100 dB at 50 Hz and 60 Hz with 1 kΩ unbalance in either lead. Effective CMR is equal to normal mode rejection plus true CMR.

MAXIMUM INPUT: ±1000V Peak, HI to LO or GUARD to chassis terminals, and ± 200V Peak, GUARD to LO terminals, for any range.

Table 1-2. 8520A Specifications (cont)

MAXIMUM READING RATE:

OPERATION	RESOLUTION	LINE	READING RATE
Local/Remote	5-1/2 digits	50 Hz 60 Hz	200 rdgs/sec 240 rdgs/sec
Remote	4-1/2 digits	50 Hz 60 Hz	>500 rdgs/sec >500 rdgs/sec

Input Current ⩽50pA for 30 days @ 18° to 20°C

AC VOLTS (TRUE RMS)

INPUT CHARACTERISTICS

RANGE	FULL–SCALE	RESOLUTION	INPUT IMPEDANCE
1V 10V 100V 650V	1.99999 16.0100 130.100 650.00	10 μV 100 μV 1 mV 10 mV	1MΩ,⩽100pF at the V/Ω INPUT terminal

ACCURACY: ±(% of input + % of full-scale)

For 650V range multiply %Fs error shown by 1.6

FREQUENCY	24 HOURS 23°C±1°C			90 DAYS 23°C to 28°C			1 YEAR 18°C to 28°C		
	% of INPUT	+ % FS AC	+ % FS AC+DC	% of INPUT	+ % FS AC	+ % FS AC+DC	% of INPUT	+ % FS AC	+ % FS AC+DC
10 Hz to 20 Hz*	3.0	0.5	0.6	3.0	0.6	0.7	3.5	0.6	0.7
20 Hz to 40 Hz*	0.4	0.3	0.4	0.5	0.5	0.6	0.6	0.6	0.7
40 Hz to 20 kHz	0.08	0.02	0.06	0.1	0.03	0.08	0.15	0.05	0.16
20 kHz to 100 kHz	1.0	0.3	0.4	1.0	0.3	0.4	2.0	0.6	0.8
100 kHz to 300 kHz	2.4	0.6	0.6	2.4	0.6	0.6	4.0	1.0	1.0
300 kHz to 1 MHz	8.0	2.5	2.5	8.0	2.5	2.5	15.0	5.0	5.0

*Assumes smoothing using the Statistics Math Program (#8).

TEMPERATURE COEFFICIENT: 18°C to 0°C or 28°C to 50°C, to 20 kHz.
AC MODE: ±(.007% of input + .007% FS)/°C
AC + DC MODE: ±(.007% of input +.014% FS)/°C

MAXIMUM INPUT: ±1000V, Peak HI to LO or GUARD to chassis terminals, and ±200V Peak GUARD to LO terminals for any range.

CREST FACTOR: Exceeds 4:1 @ full scale, increasing downscale.

MAXIMUM READING RATE: 10 rdgs/sec.

Table 1-2. 8520A Specifications (cont)

OHMS

INPUT CHARACTERISTICS:

RANGE	FULL-SCALE	RESOLUTION	CURRENT THRU UNKNOWN	OPEN CIRCUIT VOLTAGE
10Ω	19.9999	100 μΩ	10 mA	<8V
100Ω	199.999	1mΩ	10 mA	
1000Ω	1999.99	10mΩ	1.0 mA	
10 kΩ	19.9999	100mΩ	0.1 mA	
100 kΩ	199.999	1Ω	14.5 μA (max)	
1 MΩ	1.99999	10Ω	1.5 μA (max)	
10 MΩ	19.999	1 kΩ	1.5 μA (max)	

ACCURACY: ±(% of input + number of digits)

RANGE	24 HOURS 23°C ±1°C	90 DAYS 18°C to 28°C	1 YEAR 18°C to 28°C	PLUS TEMP. COEFFICIENT PER °C*
10Ω	0.0045 + 6	0.0080 + 7	0.0140 + 12	0.0007 + 0.2
100Ω	0.0035 + 2	0.0070 + 2	0.0125 + 3	0.0007 + 0.2
1000Ω	0.0035 + 2	0.0070 + 2	0.0125 + 3	0.0007 + 0.2
10kΩ	0.0035 + 2	0.0070 + 2	0.0125 + 3	0.0007 + 0.2
100kΩ	0.0040 + 2	0.0090 + 2	0.0140 + 3	0.0012 + 0.2
1MΩ	0.0090 + 2	0.0160 + 2	0.0200 + 3	0.0020 + 0.2
10MΩ	0.0300 + 1	0.0440 + 1	0.0450 + 3	0.0030 + 0.2

**From 18°C to 0°C or 28°C to 50°C*

MAXIMUM INPUT: ±400V peak for any range.

MAXIMUM READING RATE: 10/SEC at 100KΩ and above.

OPERATION	RESOLUTION	LINE	READING RATE
Local/Remote	5-1/2 digits	50 Hz	200 rdgs/sec
		60 Hz	240 rdgs/sec
Remote	4-1/2 digits	50 Hz	>500 rdgs/sec
		60 Hz	>500 rdgs/sec

CONDUCTANCE

RANGE: 100 nS

FULL-SCALE: 202.00 nS

RESOLUTION: 0.01 nS

Table 1-2. 8520A Specifications (cont)

ACCURACY: ±(% of input + number of digits)

24 HOURS 23°C±1°C	90 DAYS 18°C to 28°C	1 YEAR 18°C to 28°C	*PLUS TEMP. COEFFICIENT PER °C
0.04 + 5	0.05 + 5	0.06 + 5	0.004 + 1

**From 18°C to 0°C or 28°C to 50°C*

MAXIMUM INPUT: ±400V peak

MAXIMUM READING RATE: 10 rdgs/sec

EXTERNAL REFERENCE

OPERATING RANGE: ±0.5V dc to ±33V dc as long as external reference is within ±16.5V of input LO terminal.

INPUT IMPEDANCE: 10,000 MΩ between external reference HI or LO terminals and input LO terminals.

ACCURACY:

X-REF VOLTAGE	ACCURACY
16.5V to 33V	±(A + B + 20 ppm)
0.5V to 16.5V	±[A + B + (400 ppm ÷ |Vref|)]

NOTE: A = DC 10 volt range accuracy
B = Input voltage or resistance range accuracy

MAXIMUM INPUT: ±180V peak between external reference HI or LO and input LO; ±360V peak between external reference HI and LO.

TRANSFER ACCURACY:

The following accuracy specifications apply when:

——Filter settling time is 500 or 1000 ms.
——Measurements are made more than 2 hours after warm-up.
——Measurements are made within one range.
——Standard is checked at least every hour.
——Ambient temperature stability within ±1°C.

DC VOLTAGE:

RANGE	±(% of input + number of digits)
100 mV	0.0020 + 4
1V	0.0020 + 1
10V	0.0010 + 1
100V	0.0020 + 1
1000V	0.0020 + 1

Table 1-2. 8520A Specifications (cont)

AC VOLTAGE (all ranges):

FREQUENCY	±(% of input + % of full-scale)
10 Hz to 20 Hz	1.0 + 0.2
20 Hz to 40 Hz	0.1 + 0.1
40 Hz to 20 kHz	0.005 + 0.007
20 kHz to 100 kHz	0.100 + 0.030
100 kHz to 1 MHz	0.500 + 0.060

AC VOLTAGE, DC COUPLED: Same as AC Voltage except 40Hz—20KHz, 0.005+0.010

RESISTANCE:

RANGE	±(% of input + number of digits)
10Ω	0.0030 + 5
100Ω	0.0020 + 2
1000Ω	0.0020 + 2
10 kΩ	0.0020 + 2
100 kΩ	0.0020 + 2
1 MΩ	0.0050 + 2
10 MΩ	0.0100 + 1

CONDUCTANCE: ±(0.02% of input + 0.02 nS)

GENERAL:

INTERFACE: IEEE-488-1978 is standard.

TEMPERATURE: 0°C to 50°C operating; −25°C to +75°C non-operating.

RELATIVE HUMIDITY: ⩽95% at 25°C, ⩽75% at 40°C, ⩽45% at 50°C.

SHOCK AND VIBRATION: Meets MIL-T-28800B for type III, Class 5, Style E.

POWER: 100, 120, 220, or 240V ac, ±10%; 50, 60, or 400 Hz ±5%, ⩽50W.

SIZE: 8.89 cm H/47.00 cm L/43.18 cm W—(3 1/2 in H/18 1/2 in L/17 in W) See Figure 1-2.

WEIGHT: 9.56 kg (21 lbs)

PROTECTION CLASS CODE 1: (Relates solely to insulation or grounding properties in IEC 348).

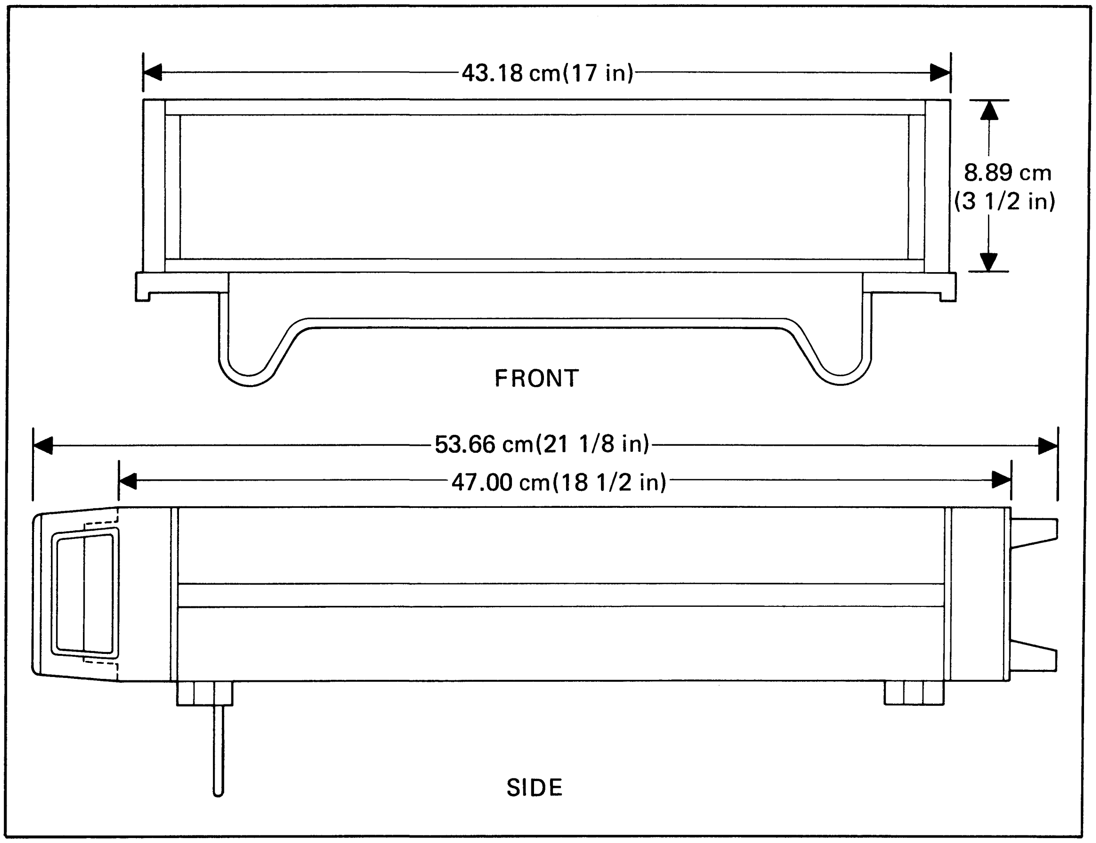
43.18 cm(17 in)
8.89 cm
(3 1/2 in)
FRONT
53.66 cm(21 1/8 in)
47.00 cm(18 1/2 in)
SIDE

Figure 1-2. Outline Drawing

Section 2
Shipping and Service Information

2-1. SHIPPING INFORMATION

2-2. The 8520A is packaged and shipped in a foam-packed container. When you receive the 8520A, inspect the instrument thoroughly for possible shipping damage. Special instructions for inspection and claims are included in the shipping container.

2-3. If reshipment is necessary, use the original container. If the original container is not available, order a new container from John Fluke Mfg. Co., Inc. / P.O. Box C9090 / Everett, WA 98206, telephone (206) 342-6300.

2-4. SERVICE INFORMATION

2-5. Each John Fluke Model 8520A Digital Multimeter is warranted for a period of 1 year upon delivery to the original purchaser. The WARRANTY is located at the front of this manual.

2-6. Factory authorized calibration and service for each Fluke product is available at various worldwide locations. See following pages. If requested, the customer will be provided with an estimate before any work begins on instruments that are beyond the warranty period.

2-7. QUESTIONS? PROBLEMS?

2-8. For any additional information, contact your nearest John Fluke Sales Representatives (listed on the following pages) or the John Fluke Mfg. Co., Inc. at the address or telephone number given above.

U.S. SALES AREAS

AK, Anchorage
Harry Lang & Associates
1371 Hillcrest Drive #303
Anchorage, AK 99503
(907) 279-5741

AL, Huntsville
John Fluke Mfg. Co., Inc.
3322 S. Memorial Parkway
Suite 96
Huntsville, AL 35801
(205) 881-6220
(404) 396-3224 (Atlanta)

AZ, Tempe
John Fluke Mfg. Co., Inc.
2125 S. 48th Street
Suite 104
Tempe, AZ 85282
(602) 967-8724
(602) 790-9881 (Tucson)

CA, Los Angeles
John Fluke Mfg. Co., Inc.
20902 South Bonita St.
Carson, CA 90746
(213) 538-3900 or
(714) 761-2449

CA, Santa Clara
John Fluke Mfg. Co., Inc.
2300 Walsh Ave., Bldg. K
Santa Clara, CA 95051
(408) 727-0513

CA, Tustin
John Fluke Mfg. Co., Inc.
15445 Red Hill Ave., Suite F
Tustin, CA 92680
(714) 838-8863
(714) 226-1254 (San Diego)

CO, Denver
John Fluke Mfg. Co., Inc.
1980 South Quebec St. #4
Denver, CO 80231
(303) 750-1222

CT, Hartford
John Fluke Mfg. Co., Inc.
124 Hebron Ave.
Glastonbury, CT 06033
(203) 633-0777

FL, Orlando
John Fluke Mfg. Co., Inc.
940 N. Fern Creek Ave.
Orlando, FL 32803
(305) 896-4881

GA, Atlanta
(404) 396-3224

HI, Honolulu
EMC Corporation
2979 Ualena St.
Honolulu, HI 96819
(808) 836-1138

IA, Iowa City
(319) 354-2811

IL, Chicago
John Fluke Mfg. Co., Inc.
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Rolling Meadows, IL 60008
(312) 398-0850

IN, Indianapolis
John Fluke Mfg. Co., Inc.
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Corporate Square West
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(317) 244-2456

KA, Kansas City
John Fluke Mfg. Co., Inc.
4550 West 109th St.
Suite 130
Shawnee Mission, KA 66211
(913) 381-9800

LA, New Orleans
(504) 455-0814

MA, Burlington
John Fluke Mfg. Co., Inc.
25 "B" Street
Burlington, MA 01803
(617) 273-4674

MD, Rockville
John Fluke Mfg.Co., Inc.
5640 Fishers Lane
Rockville, MD 20852
(301) 770-1570
(301) 792-7060 (Baltimore)

MI, Detroit
John Fluke Mfg. Co., Inc.
13955 Farmington Rd.
Livonia, MI 48154
(313) 522-9140

MN, Minneapolis
John Fluke Mfg. Co., Inc.
7373 West 147th St.
Suite 196
Apple Valley, MN 55124
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MO, St. Louis
John Fluke Mfg. Co., Inc.
300 Brookes Dr., Suite 100
Hazelwood, MO 63042
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(214) 233-9990

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Stafford, TX 77477
(713) 491-5995
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Seattle, WA 98188
(206) 575-3765

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Australia 2137
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Proteco Coasin Cia., Ltda.
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78530 BUC
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38 FL Shinjuko Nomura Bldg.
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C.P.O. Box 8446
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Section 3
Installation and Maintenance

3-1. MOUNTING: RACK OR BENCH

3-2. The 8520A is designed to be either placed directly on the work bench or to be mounted in standard 18-inch or 24-inch deep equipment racks. The non-marring feet and tilt-down bail (bottom, front) aid bench operation. The bail can be used to tilt the front panel of the 8520A to a convenient operating position. Table 3-1 lists the three rack-mounting accessories available for use with the 8520A. Figure 3-1 shows the accessories.

Table 3-1. Rack Mounting Accessories

NAME	MODEL NUMBER
18-inch Rack Slide	M00-260-610
24-inch Rack Slide	M00-280-610
Rack Ears	M03-203-600
Rack Ears (use w/slides)	Y8599

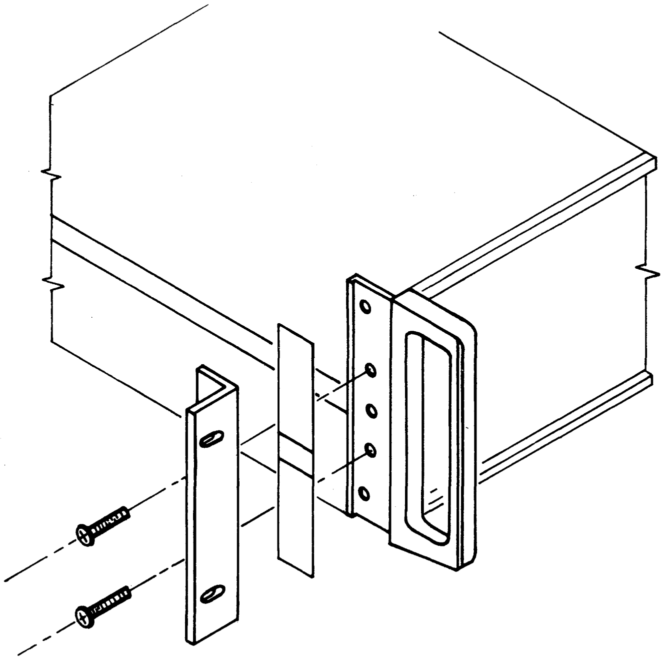
3-3. INPUT LINE POWER

WARNING

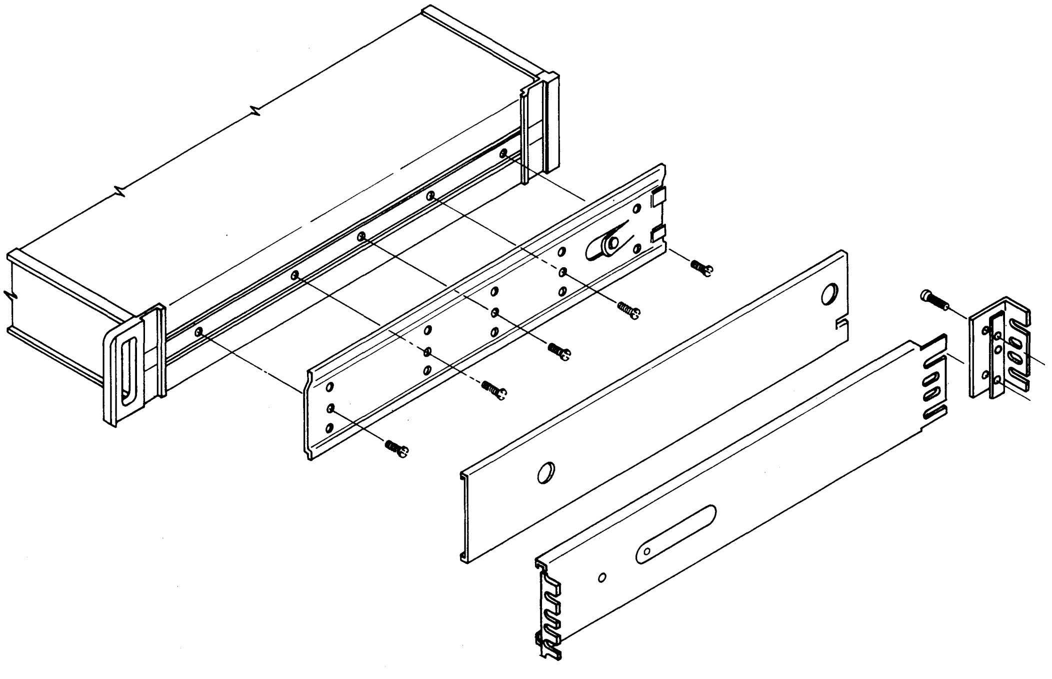
TO AVOID SHOCK HAZARD OR INSTRUMENT DAMAGE CONNECT THE INSTRUMENT POWER LINE GROUND TO EARTH GROUND. DO NOT BREAK THIS PROTECTIVE CONNECTION BY USING A TWO CONDUCTOR EXTENSION CORD.

3-4. The 8520A can be set up to operate from line voltages of 100, 120, 220 or 240 ±10% VAC at frequencies from 50, 60, or 400 Hz ±5% (qualified service personnel can find the line voltage selection procedure in the 8520A Calibration Manual). When the POWER switch is set to ON, the 8520A senses the line frequency and makes software adjustments that provide the optimum line noise rejection for that frequency.

3-5. The power cables shipped with the 8520A depends upon the factory selected line voltage. Factory selected line voltage is marked on a decal which is located on the rear panel immediately to the left of the fuse. Provide a line power receptacle that is compatible with both the power requirements of the unit and the plug on the line power cable.



RACK EARS MO3-203-601



18 OR 24-INCH RACK SLIDES
MOO-260-610 OR MOO-280-610

Figure 3-1. Rack Mounting Accessories

3-6. IEEE-488

3-7. Mechanical/Electrical Connection

3-8. The IEEE-488 Connector (rear panel) mates with standard 24-conductor IEEE-488 cables. Figure 3-2 shows the pin-outs on the connector. IEEE-488 connections are confined within the following limits:

1. No more than 15 devices may be connected in a single IEEE-488 Bus system.

2. The total length of cable used in one IEEE-488 Bus system must not exceed 20 meters.

3. The total length of cable must also not exceed 2 meters times the number of devices in the system.

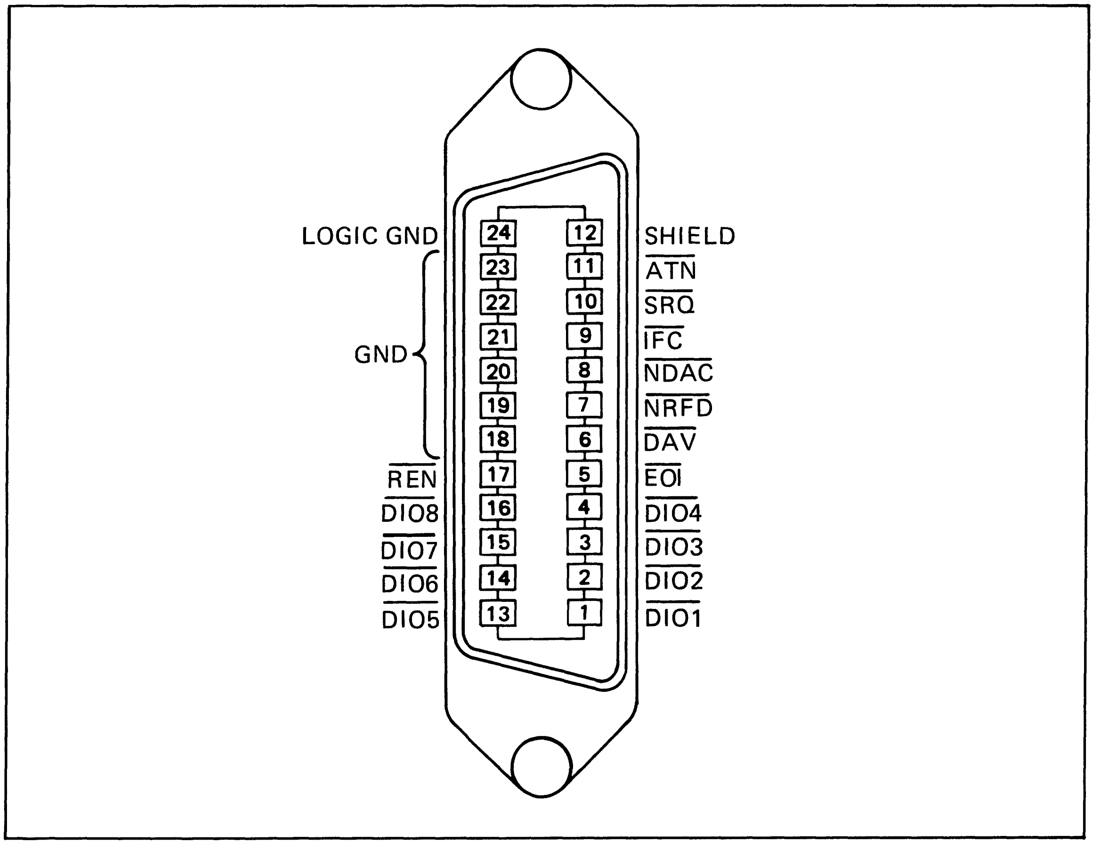

LOGIC GND
GND
REN
DIO8
DIO7
DIO6
DIO5
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
SHIELD
ATN
SRQ
IFC
NDAC
NRFD
DAV
EOI
DIO4
DIO3
DIO2
DIO1

Figure 3-2. IEEE-488 Connector

Combinations of 1, 2, and 4 meter IEEE cables can be used to meet the cable length restrictions. For example, when only an 8520A is connected to a controller, the number of devices is 2. Multiplying by 2 meters, the maximum length that the cable can be is 4 meters (2 devices X 2 meters/device = 4 meters). Therefore, a 1, 2, or 4 meter cable could be used to connect the 8520A and the controller. When connecting more than 10 devices, a combination of 1, 2, or 4 meter cables can be used (not to equal more than 20 meters). Available cables are listed in Table 3-2.

Table 3-2. IEEE-488 Cable Accessories

MODEL NUMBER	NAME
Y8001	IEEE Standard Cable, 1 Meter
Y8002	IEEE Standard Cable, 2 Meters
Y8003	IEEE Standard Cable, 4 Meters

3-9. IEEE-488 Address Switch Setting

3-10. There are eight IEEE-488 ADDRESS switches (rear panel). Set the switches to the following positions desired:

1. INSTR ADDRESS: These five switches are used to select the IEEE-488 address of the 8520A. Table 3-3 shows the position of switches for each possible address.

2. TRIGGER: Set the switch to the up position to select triggering on the rising clock edges of the input to the BNC TRIGGER terminal. Set the switch to the down position, to select triggering on the falling edge of the input to the BNC TRIGGER terminal.

3. TALK ONLY: Set the switch to the up position if the 8520A is to be connected only to a listen only device. Set the switch to the down position if the 8520A is to be used with a controller.

4. SHIELD: Set the switch to the up position to connect the shield on the IEEE-488 Interface Cable to the 8520A ground. Set the switch to the down position to disconnect the shield on the IEEE-488 Interface Cable from the 8520A ground.

Table 3-3. IEEE-488 Addresses

DISPLAYED VALUE	INSTR ADDRESS				
	A5	A4	A3	A2	A1
00	DN	DN	DN	DN	DN
01	DN	DN	DN	DN	UP
02	DN	DN	DN	UP	DN
03	DN	DN	DN	UP	UP
04	DN	DN	UP	DN	DN
05	DN	DN	UP	DN	UP
06	DN	DN	UP	UP	DN
07	DN	DN	UP	UP	UP
08	DN	UP	DN	DN	DN
09	DN	UP	DN	DN	UP
10	DN	UP	DN	UP	DN
11	DN	UP	DN	UP	UP
12	DN	UP	UP	DN	DN
13	DN	UP	UP	DN	UP
14	DN	UP	UP	UP	DN
15	DN	UP	UP	UP	UP

Table 3-3. IEEE-488 Address (cont)

DISPLAYED VALUE	INSTR ADDRESS				
	A5	A4	A3	A2	A1
16	UP	DN	DN	DN	DN
17	UP	DN	DN	DN	UP
18	UP	DN	DN	UP	DN
19	UP	DN	DN	UP	UP
20	UP	DN	UP	DN	DN
21	UP	DN	UP	DN	UP
22	UP	DN	UP	UP	DN
23	UP	DN	UP	UP	UP
24	UP	UP	DN	DN	DN
25	UP	UP	DN	DN	UP
26	UP	UP	DN	UP	DN
27	UP	UP	DN	UP	UP
28	UP	UP	UP	DN	DN
29	UP	UP	UP	DN	UP
30	UP	UP	UP	UP	DN

3-11. LINE-POWER FUSE REPLACEMENT

WARNING

TO AVOID SHOCK HAZARD, PERFORM THE FUSE REPLACEMENT PROCEDURE EXACTLY AS PRESENTED. LINE POWER VOLTAGE IS PRESENT AT THE FUSE AND THE RECEPTACLE.

NOTE

Operator maintenance is limited to fuse replacement. All other maintenance procedures should be performed only by qualified repair personnel. These maintenance procedures appear in the 8520A Calibration Manual and in the 8520A Service Manual.

3-12. Use the following procedure to replace the line power fuse. Insure that the new fuse is the proper type for the line voltage being used. Fuse types according to line voltage are as follows:

For 100 or 120V ac, use MDL ½
For 220 or 240V ac, use MDL ¼

1. On the front panel of the 8520A, push the POWER switch to the OFF (out) position.

2. Disconnect the 8520A power cord from line power.

3. On the rear panel of the 8520A, locate the fuseholder. The fuseholder is in the upper right corner of the rear panel.

4. Turn the fuseholder about ¼ turn counterclockwise.

5. Pull the fuseholder from the 8520A. The fuse is attached to the fuseholder.

6. Place a new fuse in the fuseholder.

7. Insert the fuse and fuseholder back into the rear panel.

8. Push the fuseholder in as far as it will go and turn it about ¼ turn clockwise.

9. Connect the line power cord to line power.

10. On the front panel of the 8520A, push the POWER switch to the ON (in) position. If the line power fuse blows when power is on, the instrument requires service -- contact your nearest Fluke service center (a complete list of the service centers is located in the Shipping and Service Information Section).

Section 4

Familiarization

4-1. INTRODUCTION

4-2. The material in the following paragraphs is designed to acquaint the operator with the 8520A. Each control, connector, and indicator is identified in Location of Controls, Connectors, and Indicators. Function of controls, Connectors, and Indicators describes the function of each of these features (the descriptions are not operating instructions). As each 8520A feature is described, locate that feature on the 8520A. It is recommended that the contents of the section be read and thoroughly understood before attempting to operate the instrument.

4-3. LOCATION OF CONTROLS, CONNECTORS, AND INDICATORS

4-4. The location of all front panel controls, connectors, and indicators is shown in Figure 4-1. Each front panel feature is identified in Table 4-1. The location of all rear panel controls and connectors is shown in Figure 4-2. The rear panel features are identified in Table 4-2.

4-5. FUNCTION OF CONTROLS, CONNECTORS, AND INDICATORS

4-6. The information in the following paragraphs describes the function of each control, connector, and indicator. The material is presented in the same order as Tables 4-1 and 4-2. Features belonging to functional groups will be described under a single heading. For example, the three range controls will be described under RANGE.

4-7. Power On/Off

4-8. The POWER switch not only connects or disconnects line power to the instrument but, on power up, causes the instrument to display model number, tell what options are installed, state the IEEE-488 address, and initialize the instrument to the power on default conditions. The default conditions are hardware and software set-ups that the microprocessor automatically places in effect when the instrument is initialized. (See the default material in the Operation section of this manual for additional information.) When the POWER switch is pushed from the OFF position to the ON position, the instrument will display:

8520A (standard instrument)
or
8520A-01 (-010 Option installed)

for 1 second then the instrument will display the IEEE-488 address of the instrument for 1 second. For example, if the IEEE-488 Address switches on the rear panel are set to select an address of 2, the instrument will display:

IEEE = 02

Then the microprocessor will establish the following Power On default conditions:

function	dc volts (VDC in right display)
range	100V (The 100 decimal point is on)
reading rate	2/SEC
filter	500 mSEC
math programs	Clears all variables from memory and loads predetermined values in all programable constant locations, no programs are selected, SHIFT LED is off.

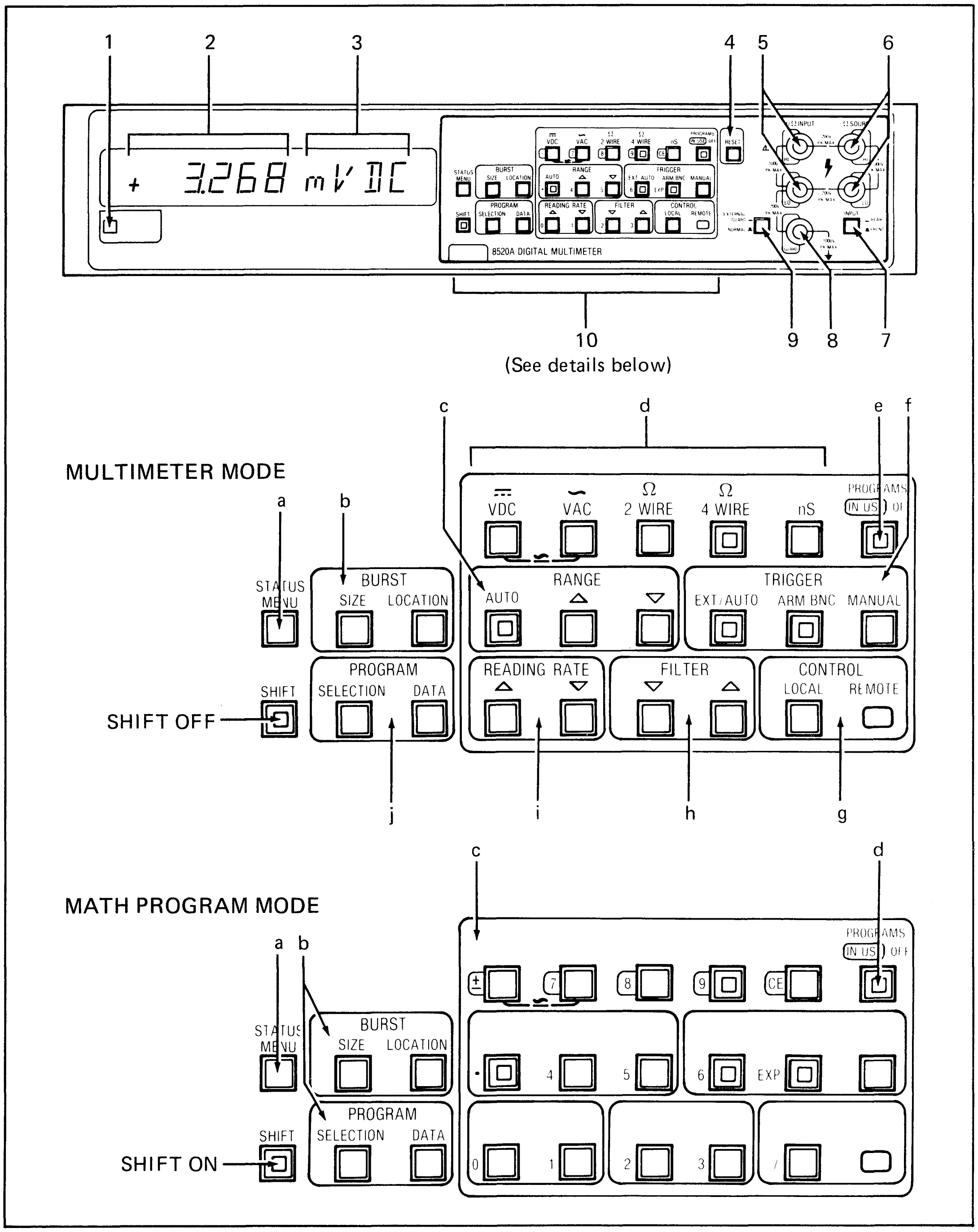

1
2
3
4
5
6
+ 3.268 mV DC
8520A DIGITAL MULTIMETER
10
(See details below)
9
8
7
MULTIMETER MODE
a
b
c
d
e
f
STATUS MENU
BURST
SIZE
LOCATION
VDC
VAC
2 WIRE
4 WIRE
nS
PROGRAMS
IN USE OFF
RANGE
AUTO
TRIGGER
EXT/AUTO
ARM BNC
MANUAL
SHIFT
PROGRAM
SELECTION
DATA
READING RATE
FILTER
CONTROL
LOCAL
REMOTE
SHIFT OFF
j
i
h
g
MATH PROGRAM MODE
SHIFT ON
±
7
8
9
CE
·
4
5
6
EXP
0
1
2
3
/

Figure 4-1. 8520A Front Panel Controls, Connectors and Indicators

Table 4-1. 8520A Front Panel Controls, Connectors and Indicators

REF NO.	NAME	FUNCTION
1	POWER ON/OFF Switch	Push ON (in)/push OFF (out) for line power and POWER ON default set-up (See Defaults in the Operation section of this manual).
2	Left Display	5 1/2, 7-segment LED digits with polarity indication and six decimal point positions.
3	Right Display	Four, 14-segment alphanumeric LED digits.
4	RESET Switch	Momentary contact pushbutton used to reset the instrument to two different default set-ups. (See Defaults in the Operation section of this manual.
5	V/Ω INPUT HI Terminal LO Terminal	Recessed terminals (for increased operator safety). HI is red. LO is black. Voltages and resistances to be measured are applied to these terminals.
6	Ω SOURCE HI Terminal LO Terminal	Recessed terminals (for increased operator safety). HI is red. LO is black. The ohms source output is present at these terminals when the Ω 4 WIRE measurement function is selected (the 8520A opens these terminals when any other function is selected).
7	INPUT REAR/FRONT Switch	Push to REAR (in) to connect the instrument to the Rear Analog Input terminals. Push to FRONT (out) to connect the instrument to the front panel terminals.
8	GUARD Terminal	Blue recessed terminal used for External Guard Operation.
9	EXTERNAL GUARD/NORMAL Switch	Push to NORMAL (in) to disconnect/push to EXTERNAL GUARD (out) to connect the GUARD terminal and the internal guard circuit.
10	Keyboard Switches	23 momentary pushbuttons and one indicator (REMOTE). The pushbuttons are dual function controls. Each control has one function when the instrument is in the Multimeter Mode and another function when the instrument is in the Math Program Mode. Six of the pushbuttons have an integral LED to indicate the status of the control.
	SHIFT	Push to shift between the Multimeter Mode (LED off) and the Math Program Mode (LED on).
MULTIMETER MODE OF OPERATION (SHIFT LED off)		
a	STATUS	Push to display present function, Range, Reading Rate, and Filter.
b	BURST SIZE	Push to display current burst size.
c	RANGE	Three range controls that can enable autoranging (AUTO LED on), select the next higher (▲) or lower (▼) range.
d	Function	Five software interlocked controls that determine the measurement function.

Table 4-1. 8520A Front Panel Controls, Connectors and Indicators (cont)

REF NO.	NAME	FUNCTION
e	PROGRAMS IN USE/OFF	Push to enable or disable the math program(s) selected. The math programs are in use when the LED is on.
f	TRIGGER	Three controls that determine instrument triggering.
g	CONTROL	Push LOCAL to select local (front panel) control of the instrument. REMOTE on indicates that an external device has assumed control of the instrument via the IEEE-488 interface.
h	FILTER	Push to decrease (▼) or increase (▲) settling time and rejection of filter.
i	READING RATE	Push to select next faster (▲) or next slower (▼) Reading Rate.
j	PROGRAM SELECTION	Push to display the number(s) of the math program(s) selected.
MATH PROGRAM MODE OF OPERATION (SHIFT LED on)		
a	MENU	Push and release to step or push and hold to scroll through the menu of math programs.
b	Numeric Terminator Buttons	Four controls used after Numeric Keyboard entries.
	BURST	
	SIZE	Used following Numeric Keyboard entries to program burst size.
	LOCATION	Used following Numeric Keyboard entries to display the contents of any location in burst memory.
	PROGRAM	
	SELECTION	Used following Numeric Keyboard entries to select math programs and to enter data.
	DATA	Used following either a Numeric Keyboard entry or use of the MANUAL TRIGGER control to store and enter data.
c	Numeric Keyboard	Controls used to enter numeric values, to select math programs, or retrieve constants or data.
d	PROGRAMS IN USE/OFF	Used to enable or disable the math program(s) selected. The LED on indicates that the selected math programs(s) are in use.

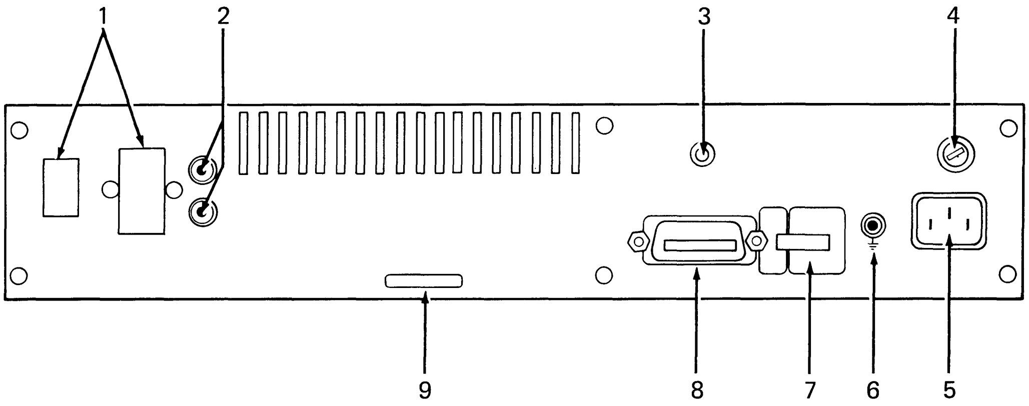


Figure 4-2. 8520A Rear Panel Controls and Connectors

Table 4-2. 8520A Rear Panel Controls and Connectors

REF NO.	NAME	FUNCTION
1	REAR ANALOG INPUTS (J6)	20 pin connector and pin assignment chart. Duplicates the function of the front panel V/Ω INPUT, Ω SOURCE, and GUARD terminals.
2	EXTERNAL REFERENCE HI Terminal (J25) LO Terminal (J26)	Binding posts. HI is red. LO is black. External reference signal is applied to these terminals.
3	BNC TRIGGER Terminal (J7)	BNC connector for input of external trigger.
4	FUSE	Line power fuse, F201, and chart listing the appropriate line power fuse for each line power configuration.
5	Line Power Receptacle	Receptacle for line power cable.
6	Terminal (J9)	Binding post connected to chassis ground.
7	IEEE-488 ADDRESS Switches	Eight recessed toggle switches.
	INST ADDRESS	Determine the IEEE-488 address of the 8520A.
	TRIGGER	Select rising or falling edge of BNC TRIGGER input for triggering.
	TALK ONLY	Enable/disable IEEE-488 Talk Only (TON) function.
	SHIELD	Connect/disconnect IEEE-488 Interface cable and 8520A ground.
8	IEEE-488 CONNECTOR	Standard 24 pin IEEE-488 receptacle.
9	Instrument Model Number and Instrument Serial Number	

4-9. Display

4-10. The display of the 8520A will be described as two distinct sections -- left display and right display - since each part has its own function and method of forming display characters. The two halves work together to provide the operator with measurement data, operator prompts, and other information.

4-11. Modified Engineering Notation

4-12. The 8520A displays extremely large or small data values in engineering notation in order to provide maximum resolution. The right display indicates the use of engineering notation by displaying E followed by the power-of-ten. A minus sign after the E indicates division by the display power-of-ten (1 E-03 means .001), and a positive sign after the E indicates multiplication by the displayed power-of-ten (1 E+03 means 1000). For operator convenience, the 8520A engineering notation changes in multiples of three powers-of-ten (E-3, E-6, E-9, etc.) to match the change in the power-of-ten relationship that occurs between most electronic units (μV, mV, V, kV).

4-13. Left Display

4-14. The left display is shown in Figure 4-3. The 5½ digits display measured values, programmed values, program location, the results of math program computations, microprocessor prompts (to the operator), and instrument error indications. Note that four of the decimal point positions are labeled with the corresponding instrument range of measurement (the 10 MOhm range is not labeled).

4-15. Right Display

4-16. The right display is shown in Figure 4-3. The four alphanumeric digits display modifier units such as selected measurement function and range, programmable constant and variable name, program name, register number, etc.

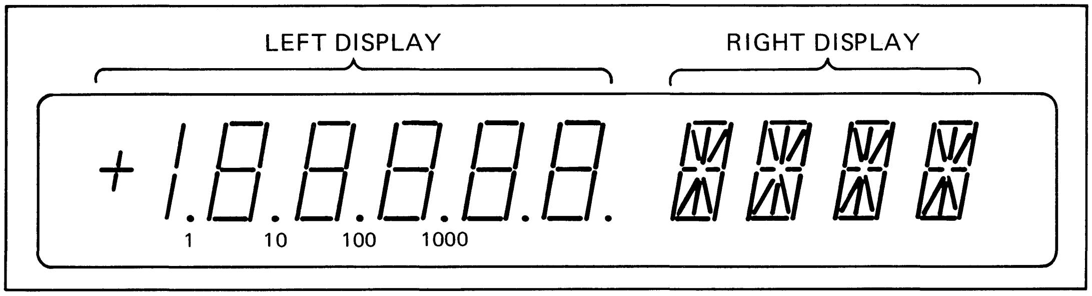


Figure 4-3. 8520A Right and Left Displays

4-17. Reset

4-18. The RESET control initializes the instrument to one of two default conditions (See defaults in the Operation Section of this manual). Push RESET once to clear the variable stored in the selected math program(s) accumulating registers. The instrument will display:

PUSH RST (push RESET)

for 1 second and then resume the interrupted operation. If RESET is pushed again while PUSH RST is displayed, the instrument returns to the following reset default conditions:

function	dc volts (VDC in right display)
range	100V (The 100 decimal point is on)
reading rate	2/SEC
filter	500 mSEC
math programs	No change (programmable constants remain at last programmed values, no programs selected, SHIFT LED is off).

4-19. V/Ω Input Terminals

4-20. The resistances and voltages to be measured are applied to these terminals. Do not apply a potential to the HI terminal greater than 1000V peak with respect to the LO terminal. Do not apply an input to the LO terminal that is greater than 200V peak with respect to ground. The terminals are recessed to decrease the opportunity for the operator to come in contact with the potential applied to the terminals. The use of these terminals is discussed in the Operation Section of this manual.

4-21. Ω Source Terminals

4-22. These terminals are only used when making 4 wire resistance measurements. When the Ω4 WIRE measurement function is selected, the ohms source output appears across the terminals. Use of these terminals is described in the Operation Section of this manual. Do not apply a potential to the SOURCE HI terminal that is greater than 400V peak with respect to the SOURCE LO terminal or greater than 200V peak with respect to the V/Ω INPUT HI terminal. Do not apply a potential to the Ω SOURCE LO terminal that is greater than 200V peak with respect to the V/Ω INPUT LO terminal.

4-23. Input Rear/Front

4-24. The position of this control determines whether the instrument circuitry is connected to the front panel terminals of the REAR ANALOG INPUT connector. Remove all input potentials before switching.

4-25. Guard Terminal

4-26. When properly connected, the GUARD terminal may reduce noise and improve the accuracy of some measurements. Do not apply a potential to the GUARD terminal that is greater than 1000V peak with respect to earlth ground or greater than 200V peak with respect to the V/Ω INPUT terminal. Use of the GUARD terminal is described in the Operation Section of this manual.

4-27. External Guard/Normal

CAUTION

To prevent instrument damage, push this control to NORMAL when making normal Ω2 WIRE measurements.

4-28. The position of this control determines whether or not the GUARD terminal is connected to the internal guard circuit. The control is usually left at the NORMAL position.

4-29. Keyboard Switches

4-30. The keyboard switches are momentary contact pushbuttons. The function of each control changes when the instrument is shifted between the multimeter mode of operation and the math program mode of operation. The integral LEDs in the SHIFT, AUTO

(RANGE), EXT/AUTO (TRIGGER), and Ω4 WIRE controls indicate the status selected by the control. The functions of the keyboard switches are as follows:

1. SHIFT: Push to shift between the multimeter mode of operation and the math mode of operation. The LED is on when the instrument is in the math mode of operation.

2. MULTIMETER MODE OF OPERATION (SHIFT LED off)

   a. STATUS: When STATUS is pushed, the instrument steps through the following display sequence (if STATUS is pushed and held, the 8520A will scroll through the the sequence at a 1 second rate). Assume that no other control has been pushed since POWER was set to ON.

STTS	(status)
100 VDC	(range and function)
rr 2/SEC	(reading rate)
F 500 mSEC	(filter)

   b. BURST SIZE: When BURST SIZE is pushed, the instrument displays, for 1 second, the number of readings programmed for burst size. After 1 second, the instrument returns to the interrupted multimeter operation. Assuming that a burst size of 10 readings has been programmed, the instrument will display:

10 = SIZE	(burst size = 10 readings)

   c. RANGE: Each multimeter function has several ranges of measurement. If autoranging is enabled (AUTO LED on), the instrument will automatically select the proper range for maximum resolution. When shifting from a low range to a higher range, the 8520A does not change range at the same point as when going from a higher range to a lower range. Table 4-3 shows these autorange change points. Each range can also be selected manually using the ▲ and ▼ pushbuttons. Table 4-4 lists all ranges for each measurement function. The three RANGE controls and their functions are as follows:

   AUTO: Push to enable/push to disable autoranging. When autoranging is selected, the AUTO LED is on.

   ▲ Push to select the next higher range.

   ▼ Push to select the next lower range.

   d. Function switches: These five pushbuttons are software interlocked so that only one measurement function can be selected at a time. All measurement functions except VA+D are selected by pushing one control. VA+D is selected by pushing both the V DC and the V AC controls at the same time. When any measurement function is selected, the instrument automatically enables autoranging (AUTO RANGE LED on) and selects the default reading rate and filter setting. Table 4-5 lists the proper control(s) to push for each measurement function of the instrument, shows the possible right display(s) for that function, and lists the default reading rate and filter.

   e. PROGRAMS IN USE/OFF: Push to enable or disable the math program selected. The math programs are in use when the LED is on.

Table 4-3. Autoranging Change Points

FUNCTION	RANGE	DOWN WHEN LESS THAN	UP WHEN MORE THAN
VDC VAC VA+D	100 mV	————————————	199.999mV
	1V	.15000V	1.99999V
	10V	1.5000V	16.0100V
	100V	12.000V	130.100V
	1000V DC or 650V AC	96.00V	
Ω2 WIRE Ω4 WIRE	10 Ohm	————————————	19.9999 Ohm
	100 Ohm	15.000 Ohm	199.999 Ohm
	1000 Ohm	150.00 Ohm	1999.99 Ohm
	10kOhm	1.5000kOhm	19.9999kOhm
	100kOhm	15.000kOhm	199.999kOhm
	1 MOhm	150.00kOhm	1.99999MOhm
	10MOhm	1.5000MOhm	

Table 4-4. Measurement Ranges

FUNCTION	V DC	V AC	VA+D	Ω(2 & 4 WIRE)	nS
Available Ranges	100 mV 1V 10V 100V 1000V	1V 10V 100V 650V	1V 10V 100V 650V	10Ω 100Ω 1000Ω 10 kΩ 100 kΩ 1 MΩ 10 MΩ	100 nS

Table 4-5. Selecting Measurement Function

TO MEASURE	PUSH	RIGHT DISPLAY	DEFAULT	
			READING RATE	FILTER
dc voltages	VDC	mVDC or VDC	2/Sec	500 msec
ac voltages	VAC	VAC	2/Sec	500 msec
ac signal on a dc level	VDC & VAC	VA+D	2/Sec	500 msec
Low value resistance	Ω4 WIRE	Ohm, kOhm, MOhm	2/Sec	500 msec
High value resistance	Ω2 WIRE	Ohm, kOhm, MOhm	2/Sec	500 msec
Extremely high resistance	nS	nS	2/Sec	FAST

f. TRIGGER: Three software controls determine what trigger source the instrument will use. The controls and their function are as follows:

EXT/AUTO: Push to change state.
AUTO (LED off): Enables continuous triggering from the internal source.
EXT (LED on): Triggering is controlled by either the ARM BNC or the MANUAL pushbutton.

ARM BNC: Push to arm the BNC TRIGGER terminal located on the rear panel. The trigger signal must be TTL levels (from either switch closure or TTL signal sources). If the LED is on, external triggering is enabled. If the LED is off, external triggering is disabled.

MANUAL: Push to trigger a preprogrammed number of readings (the preprogrammed number of internal triggers = burst size). Places EXT/AUTO in EXT (LED on).

g. CONTROL Remote/Local Control

LOCAL: Push to select local (front panel) operation. The IEEE-488 controller can disable this control.

REMOTE: Indicator is on when control of the 8520A has been assumed by an external device via the IEEE-488 interface.

h. FILTER: Two controls used to select one of the filter settling times listed in Table 4-6. When reading rate or measurement function is changed, the filter settling time for optimum accuracy is automatically selected (See Function Switches or RANGE in this portion of the manual for the default setting). For more information about using the FILTER control, see the Selecting Reading Rate and Filter portion of the Operating Note late in this manual. The controls and their functions are:

▼ Push to decrease the settling time and rejection of the filter. The new filter will be displayed for 1 second after the control is released.

▲ Push to increase the settling time and rejection of the filter. The new filter will be displayed for 1 second after the control is released.

Table 4-6. Available Filter

FUNCTION	FRONT PANEL ✻	IEEE-488 CODE
VDC and Low Ohms	5 msec	F0
	25 msec	F1
	50 msec	F2
	100 msec	F3
	200 msec	F4
	500 msec	F5
	1000 msec	F6

Table 4-6. Available Filter (cont)

FUNCTION	FRONT PANEL ✱	IEEE-488 CODE
VAC and VA+D	100 msec 200 msec 500 msec 1000 msec	F3 F4 F5 F6
High Ohms and nS	FAST SLOW	F5 F6

✱ Displayed settling times are worst case for normal operation.

NOTES:

1. *Filtering is a combination of analog and digital filtering.*
2. *The 8520A is capable of delaying a reading until the filtered data is valid (after the settling time has elapsed). This is accomplished by enabling filter timeout.*
3. *F5 is forced when any function key is pushed.*
4. *Filter settling times for High Ohms and nS:*

CODE	FAST (msec)	SLOW (msec)
R4	100	1
R5	200	2
R6	300	4
Z3R4	200	2

i. READING RATE: Two controls are used to select the reading rate. The reading rate available depends upon line frequency. The reading rates available for each line frequency environment are listed in Table 4-7. When a new measurement function is selected, a default reading rate is automatically programmed (See the function switches in this portion of the manual for a list of the default reading rates). When a new reading rate is selected, a compatible filter is automatically selected. Table 4-8 lists the default filter settings. For information on use of the READING RATE controls, see Selecting Reading Rate and Filter in Operating Note section. The READING RATE controls and their functions are as follows:

▲ Push to select the next faster reading rate. The new reading rate is displayed for 1 second after the control is released.

▼ Push to select the next slower reading rate. The new reading rate is displayed for 1 second after the control is released.

j. PROGRAM SELECTION: Push to display the number(s) of the math program(s) selected. For example, if math programs #4 and #6 have been selected, the instrument will display:

46 =PRG

The program number will remain in the display for 1 second after the control is released.

Table 4-7. Available Reading Rates

MEASUREMENT FUNCTION AND RANGE	READING RATE			REMOTE CODE
	50 Hz	60 Hz	400 Hz	
VDC, all ranges, and all ranges below 100 kOhm (lowΩ).	ASYNCHRONOUS			D0
	200/sec	240/sec	228/sec	D1
	100/sec	120/sec	114/sec	D2
	50/sec	60/sec	57/sec	D3
	40/sec	40/sec	38/sec	D4
	20/sec	20/sec	19/sec	D5
All functions and ranges	10/sec	10/sec	9.5/sec	D6
	5/sec	5/sec	4.8/sec	D7
	2/sec	2/sec	1.9/sec	D8
	1/sec	1/sec	1/sec	D9
	30/min			D10
	12/min			D11
	6/min			D12
	2/min			D13
	1/min			D14
	30/hr			D15
	12/hr			D16
	6/hr			D17
	2/hr			D18
	1/hr			D19

Table 4-8. Default Filter

MEASUREMENT FUNCTION	SELECT READING RATE	THE RESULTING DEFAULT FILTER IS:	
		LOCAL	REMOTE
VDC or lowΩ	ASYNC	5 msec	F0
	240, 200/sec	5 msec	F0
	120, 100/sec	5 msec	F0
	60, 50/sec	25 msec	F1
	40/sec	25 msec	F1
	20/sec	50 msec	F2
All Functions	10/sec	100 msec	F3
	5/sec	200 msec	F4
	2/sec	500 msec	F5
	1/sec	1000 msec	F6
	30/min	1000 msec	F6
	12/min	1000 msec	F6
	6/min	1000 msec	F6
	2/min	1000 msec	F6
	1/min	1000 msec	F6
	30/hr	1000 msec	F6
	12/hr	1000 msec	F6
	6/hr	1000 msec	F6
	2/hr	1000 msec	F6
	1/hr	1000 msec	F6

3. MATH PROGRAM MODE OF OPERATION (SHIFT LED on)

a. MENU: Push to display the menu of math programs available. Programs #1 through #7 are available in a standard 8520A. Seven additional programs (#8 through #14) are available on instruments equipped with the -010 Option. The MENU control can be used to step (push and release) or scroll (push and hold) through the menu.

b. BURST: Two controls used to program burst size or to display the contents of one location in burst memory. The controls and their function are:

SIZE: Enter the number of readings desired as the new burst size (using the numeric keyboard) then push BURST SIZE to store this value as the new burst size.

LOCATION: Enter the burst memory location desired (0-50 for standard instruments, 0-400 for instruments equipped with the -010 Option) then push BURST LOCATION to display the contents of that location.

c. Numeric Keyboard:

±	Push to change sign.
0 thru 9	Push to enter digit.
.	Push to enter decimal point.
/	Push to specify burst memory scan limits.
EXP	Push to enter exponential multipliers of base ten. (Push EXP then enter the power.)
CE	Push to clear the entry.

d. PROGRAMS IN USE/OFF: Push to enable or disable the math programs selected. The math programs are in use when the LED is on.

e. PROGRAM: Two controls used to select the math program(s) and enter values for any programmable constants used by the program(s).

SELECTION: Used in conjunction with either the MENU or data keyboard controls to select or stack math program(s) or math register(s).

DATA: Used in conjunction with the MANUAL TRIGGER, BURST LOCATION, and data keyboard controls to enter data.

Section 5
Operating Notes

5-1. INTRODUCTION

5-2. The following paragraphs provide information necessary for successful operation of the 8520A. Do not apply input potentials that exceed the input overload limits listed in the Operating Notes.

5-3. INPUT OVERLOAD LIMITS

WARNING

TO AVOID SHOCK HAZARD OR EQUIPMENT DAMAGE, DO NOT APPLY INPUT POTENTIALS THAT EXCEED THE INPUT OVERLOAD LIMITS.

5-4. The input overload limits for the 8520A are listed in Table 5-1.

5-5. ERROR CODES

5-6. The 8520A will display error codes to indicate that the input is at a dangerous potential, that the instrument has problems or that the operator has made a mistake. Table 5-2 lists the error codes and explains the meaning of each.

Table 5-1. 8520A Input Overload Limits

TERMINALS	FUNCTION	MAXIMUM INPUT
V/ΩINPUT	VDC VAC VA+D	HI terminal 1000V peak with respect to LO terminal
	Ω2 WIRE Ω4 WIRE nS	HI terminal 400V peak with respect to LO terminal
ΩSOURCE	Ω4 WIRE	Ω SOURCE HI terminal 400V peak with respect to Ω SOURCE LO terminal. Ω SOURCE HI 200V peak with respect to V/Ω INPUT HI. Ω SOURCE LO 200V peak with respect to V/Ω INPUT LO.
GUARD	any	1000V peak with respect to earth ground. 200V peak with respect to the V/Ω INPUT LO terminal.
REAR ANALOG INPUTS (6)	Same limits as the corresponding front panel terminals between the rear panel terminals. 1000V peak between the front and rear panel terminals.	
EXTERNAL REFERENCE	180V peak with respect to V/Ω Input LO terminal	
BNC TRIGGER	30V Peak	

5-7. DEFAULTS

5-8. Defaults are hardware and software set-ups that the 8520A automatically places in effect when specific events occur. The defaults protect the instrument and allow the operator to initialize the instrument to various set-ups. The events that trigger defaults and the default conditions are listed below in Table 5-3. The initial conditions referred to in the table are as follows:

function	dc volts (VDC in right display).
range	100V (The 100 decimal is on).
reading rate	2/SEC
filter	500 mSEC

Table 5-2. Error Codes

ERROR	DISPLAY	EXPLANATION
00	Blank	No Errors
01	Err01 HV	High Voltage present with ohms function selected
02	None	Syntax error during remote operation
03	Err03 NOVR	Numeric or register overflow
03	Err03 RTD	Failure of RTD algorithm to converge
04	Err04 KEY	Invalid use of a control
05	Err05 FLTR	Cannot increase filter in ASYNC reading rate
06	Err06 ZERO	ZERO (Math Program #2) cannot be selected with the VAC or VA+D function.
07	Err07 IEEE	IEEE-488 input buffer overflow
08	or VXRF	External Reference input > ±16.5V dc with Math Program #3 selected.
09	ur VXRF	±0.5V dc difference between EXTERNAL REFERENCE HI and LO terminals with Math Program #3 selected.
10	HHHHH (function)	Normal input overrange
11	Err11 HDWR	Improper echo from A/D Microprocessor
12	rrtoo FAST	Reading rate too fast for selected filter and/or Math Program.
14	Err14 ROM	ROM checksum error
15	Err15 RAM	RAM does not check out
16	Err16 LINE	Cannot determine line frequency at POWER ON.
17	Err17 HDWR	Sync failure between the microprocessor and the A/D Converter.
18	OPen INPT	V/Ω INPUT terminals not open during Analog Test (Math Program #1)
22	Err22 HDWR	Error while measuring volts for ohms change
23	Err23 HDWR	Time error, incorrect response from A/D Converter
24	Err24 HDWR	Resync error : instrument controller to A/D Converter
25	Err25 HDWR	Ohms Reference Error
30	Err30 UART	No A/D response to microprocessor within time limits.
31	Err31 UART	Microprocessor detects parity error
32	Err32 UART	Microprocessor detects overrun error
33	Err33 UART	Parity and overrun errors (Error Codes 31 & 32)
34	Err34 UART	Microprocessor detects framing error
35	Err35 UART	Parity and framing errors (Error Codes 31 & 34)
36	Err36 UART	Overrun and framing errors (Error Codes 32 & 34)
37	Err37 UART	Parity, overrun, and framing errors (Error Codes 31, 32, & 34)
A1	ErrA1 GARD	Undefined interrupt at A/D
A3	ErrA3 GARD	Analog interrupt activated
A5	ErrA5 GARD	Parity, overrun, or framing error at A/D
A7	ErrA7 GARD	Illegal command at A/D

Table 5-2. Error Codes (cont)

NOTE

When an error (or safety hazard) exists, the front panels will display the general form "ErrXX" name" where XX is a 2 digit error number, and "name" is a 4 letter mnemonic describing the error. The 2 digit error number is stored into the short status buffer and is accessible via the "GS" command. The following paragraphs describe the error messages.

1. "Err01 HV" is displayed when the user attempts to put the 8520A into ohms, or the 8520A is in ohms, and a voltage in excess of 16.5 volts exists on the analog input. When the 8520A is displaying this message, it causes new IEEE bus activity.
2. Error 02 is generated by the user sending invalid command characters over the IEEE bus. Since this condition only occurs in remote operation, no front panel message is displayed.
3. "Err03 NOVR" is displayed when a numeric overflow condition exists. This will happen when the user programs math registers too large (for addition, subtraction, and multiplication) or too small (division). When math program P11 (RTD conversion) has an out of range input, or when the result fails to converge in 10 iterations, "Err03 RTD" will be displayed.
4. "Err04 KEY" is displayed for any keyboard related error. Any invalid key sequences will cause this error. Example: (SHIFT) (4) (DATA) causes "Err04 KEY".
5. "Err05 FLTR" is displayed when the 8520A has the asynchronous reading rate selected and the user tries to select a filter other than the 5 msec filter.
6. "Err06 ZERO" is displayed when the user tries to use P2 (ZERO) when VAC or VA+D is selected.
7. "Err07 IEEE" is displayed when the 8520A command input buffer overflows. This can happen when the user doesn't use any termination characters in the string, or if characters are sent faster than can be processed. The 8520A command input buffer is 64 bytes long.
8. Error 08 is generated by the external reference program. "or VXRF" is displayed when one of the external reference inputs has over ±16.5 volts on it, while program P3 is selected and "IN USE".
9. Error 09 is generated by the external reference program. "ur VXRF" is displayed when the difference between EXTERNAL REFERENCE HI and LO terminals is less than ±.5 volts, while program P3 is selected and "IN USE".
10. Error 10 is caused by a normal analog overrange. The display will show "+HHH.HH VDC" in (VDC) when the condition exists.
11. "Err11 HDWR" is displayed when the 8048 processor in the 8520A doesn't echo properly.
12. Error 12 is displayed as "rrtoo FAST". The current reading rate is too fast for the function, range, filter, and math selected.
13. "Err14 ROM" is displayed when the ROM checksum test fails.
14. "Err15 RAM" is displayed when the RAM test fails.

Table 5-2. Error Codes (cont)

15. "Err16 LINE" is displayed when the 8520A can not determine the line frequency.
16. "Err17 HDWR" is displayed when the 8520A Z80 processor cannot communicate with the 8048 processor.
17. Error 18 is displayed as "OPEn INPT". This condition occurs when the analog test of math program P1=TEST is selected.
18. "Err22 HDWR" is displayed when the 8520A has guard crossing problems while testing for high voltage before going into ohms.
19. "Err23 HDWR" is displayed when the 8048 processor does not return an expected reading.
20. "Err24 HDWR" is displayed when the Z80 fails to resynchronize with the 8048 while in external trigger, synchronous reading rate mode.
21. "Err25 HDWR" is displayed when a guard crossing error occurs while the 8520A is taking an ohms reference measurement.
22. "Err30 UART" is displayed when the Z80 is expecting an echo from the 8048, and it does not occur within a specific time interval.
23. "Err3x UART" where x is 1, 2, 3, 4, 5, 6, 7 is displayed when the X80 UART detects a framing, overrun, or parity error. Parity errors are "1", overrun errors are "2", and framing errors are "4". The FOP error numbers are added together to produce one octal digit from 1 to 7.
24. "ErrA1 GARD" is displayed when an undefined interrupt occurs in the 8048 processor.
25. "ErrA3 GARD" is displayed when the "Analog Interrupt" flip-flop is activated on the Analog PCB.
26. "ErrA5 GARD" is displayed when the 8048 UART detects a framing, overrun, or parity error.
27. "ErrA7 GARD" is displayed when the 8048 receives an illegal command.
28. When math is on (IN USE), "H" is flashed on the 14-segment displays approximately once per second, if the voltage measured is over 42.4 volts DC or 30.0 volts AC, or any time the 8520A has a overrange on the analog input.

5-9. HIGH/LOW OHMS

5-10. Both the Ω2 WIRE and the Ω4 WIRE resistance measurement functions have two distinct operating modes: high ohms and low ohms. Low ohms starts at the 10Ω range and goes through the 10 kΩ range. High ohms starts at the 100 kΩ range and continues through the highest ohms measurements. The low ohms mode uses a current source and the high ohms mode uses a voltage source. The 8520A does not buffer the input in front of the filters so the resistance being measured is part of the circuit that determines the filter time constant. Therefore, high ohms is slower than low ohms.

Table 5-3. Defaults

EVENT	CLEAR VARIABLES FOR SELECTED PROGRAMS?	RESET MATH PROGRAM CONSTANTS TO PRE-DETERMINED VALUES?	PLACE IN INITIAL CONDITIONS
Push POWER to ON	Yes	Yes	Yes
Push RESET once	Yes	No	No
Push RESET twice within 1 second	Yes	No	Yes
Automatically SHIFT to the Multimeter Mode (SHIFT LED off)?	No	No	Yes

5-11. BURST AND TRIGGER

5-12. The burst feature of the 8520A, when properly used with the TRIGGER controls allows the operator to expand and contract time intervals, look at data that occured before an event (trigger), or delay the time after an event (trigger) that occurs before readings are taken. The burst size determines how many readings will be taken, the polarity of burst size determines how the readings are taken. If the polarity is positive, the 8520A will store the designated number of readings then stop and wait for the next trigger. If the polarity of burst size is negative, the 8520A will store one reading for each trigger. Used in conjunction with the reading rate feature, the 8520A can store readings at a very fast rate then display (or transmit on the IEEE-488 interface) readings at a very slow rate (and vice-versa).

e what [illegible]

5-13. Think of burst memory as a continuous circle (Figure 5-1) with 50 storage positions (400 if the -010 Option is installed). These positions can be accessed by the 8520A using location numbers -1 to -999 and +1 to +999 (there is no location number 0). Obviously, location #1, #51, etc., contain the same information (#1, #40, etc., for instruments equipped with the -010 Option). The 8520A is constantly storing new readings in burst memory unless you program burst sizes so that the 8520A takes N readings and stops. Figure 5-2 shows the effects of programming four very different burst sizes. In part A of the figure, a burst size of +1 is programmed. The last reading captured is stored at a location +1; the reading before that at location -1, etc. After all 50 locations have been filed, each new reading will replace the oldest reading previously captured. Part B off Figure 5-2, shows a burst size of +50 programmed. After trigger occurs, the 8520A will capture 50 readings in locations +1 through +50. The new readings have taken the place of the reading stored before. Part C of Figure 5-2 shows a burst size of 40 programmed. When trigger occurs, the 8520A captures 40 readings in locations +1 through +40, but the the 8520A was capturing readings continuously before measurements that occured before trigger. In part D of the figure, burst size has been programmed at +999. When trigger occurs, the 8520A will capture 999 readings and stop. Only the last 50 readings are in burst memory and the first of these readings was captured 949 divided by the reading rate after trigger occurred. Using this method, the reading(s) of interest can be delayed a minimum of 1/reading rate and a maximum of 999/reading rate. For 60 Hz operation, this is a minimum delay of 04.17 msec and a maximum time delay of 41 days, 15 hours. The Operating Section contains procedures for displaying burst size, programming burst size, displaying the contents of burst memory, and burst and trigger operation with all possible combinations of programmed burst size and trigger controls settings.

5-14. GUARD OPERATION

5-15. Most measurements are made with the equipment connection shown in part A of Figure 5-3. The DMM ground and the device ground are at the same potential and there is no need to use the GUARD terminal. In this case the 8520A front panel EXTERNAL GUARD/NORMAL control is set to the NORMAL position. But sometimes there is a significant difference between the two ground potentials (Figure 5-3, part B) or the measurement is made at some non-grounded or floating point (Figure 5-3, part C). Now there is an external source (known as the common mode source) acting through one of the test leads. Left uncorrected, this will cause a common mode noise error in the measurement. The 8520A has a system of shields and an internal guard circuit which can be connected via the GUARD terminal and the EXTERNAL GUARD/NORMAL control to minimize the effects of the common mode noise. Figure 5-4 shows three ways that the GUARD terminal can be connected. The connection shown in part A of the figure is usually the easiest connection to make, but does little to solve the common mode noise problem -- the circuit will cause an offset in the accuracy of the measurement (the offset may be insignificant, however). The connection shown in part B is better but the common mode current is still passing through the source resistance so there will still be an offset in the measurement. The connection shown in part C is the best of the three. The majority of the common mode current is being shunted away from the source resistance so the effects of common mode noise on the measurement accuracy are minimized. Practical considerations will usually dictate which of the three connections are used.

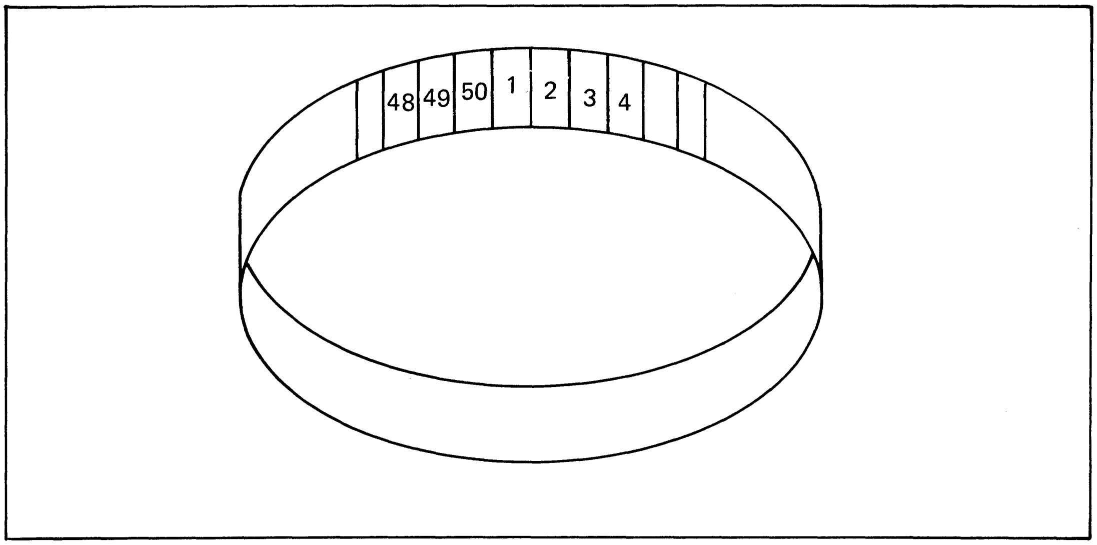
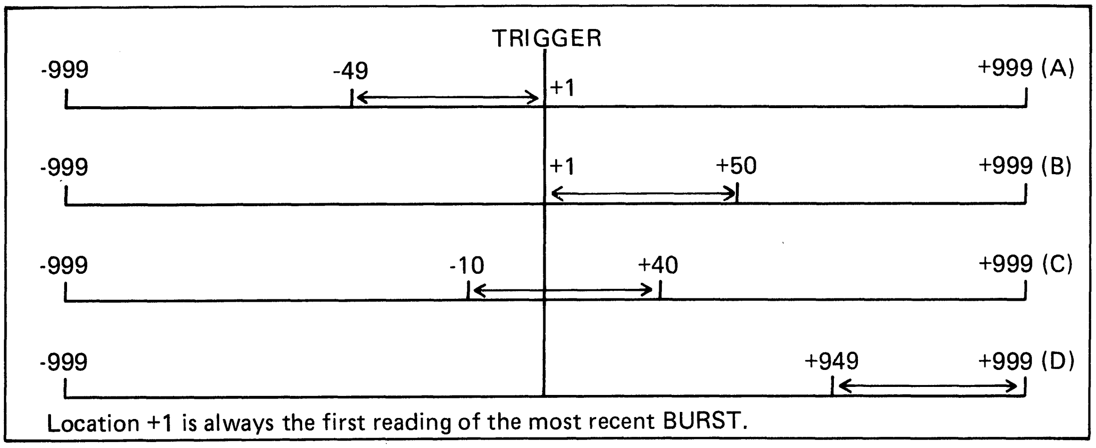
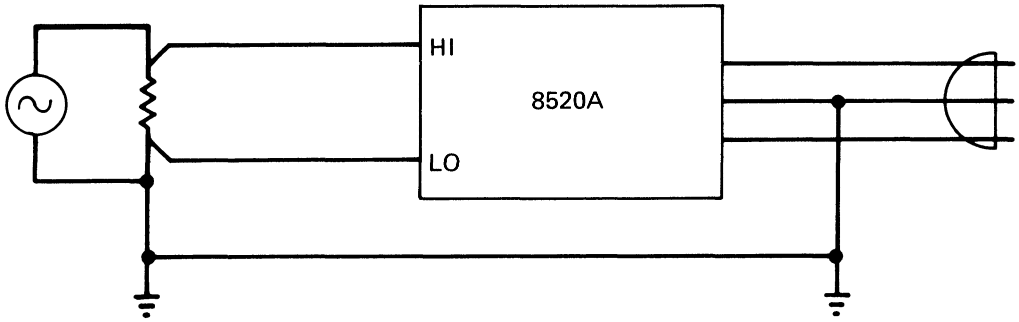


Figure 5-1. Burst Memory

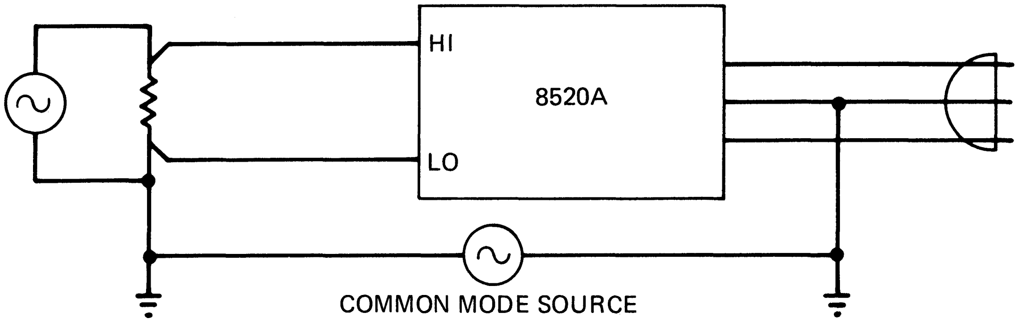


Location +1 is always the first reading of the most recent BURST.

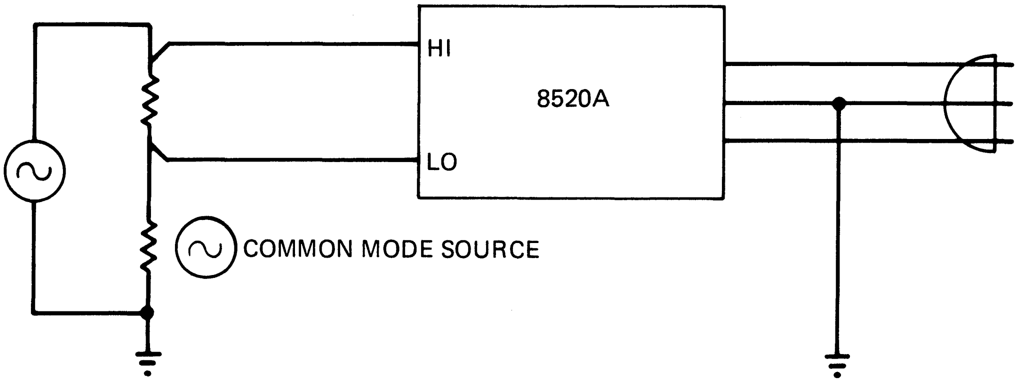
Figure 5-2. Burst Size



A. WELL GROUNDED MEASUREMENT

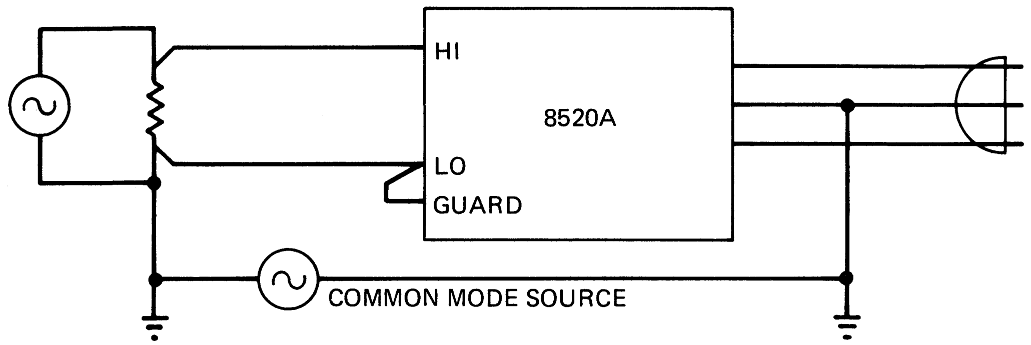

HI
8520A
LO
COMMON MODE SOURCE

B. POORLY GROUNDED MEASUREMENT

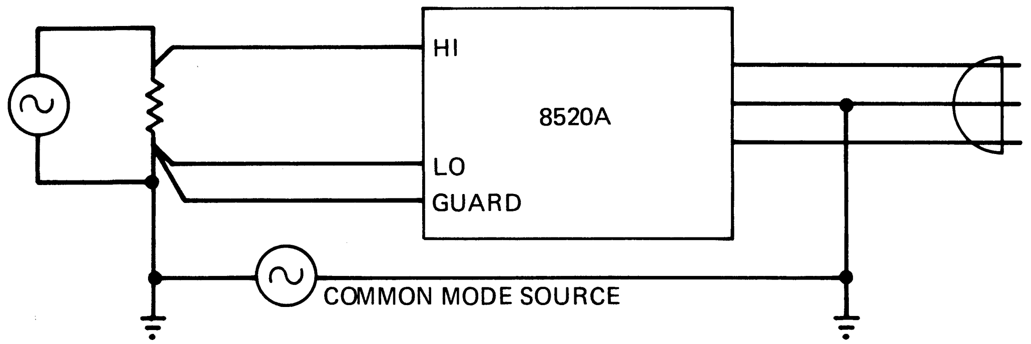

HI
8520A
LO
COMMON MODE SOURCE

C. FLOATING MEASUREMENT

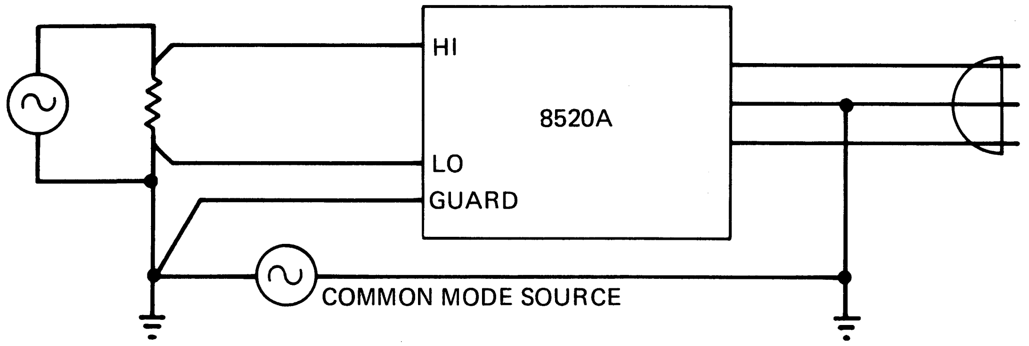
Figure 5-3. Common Mode Noise


HI
8520A
LO
GUARD
COMMON MODE SOURCE

A. GOOD


HI
8520A
LO
GUARD
COMMON MODE SOURCE

B. BETTER


HI
8520A
LO
GUARD
COMMON MODE SOURCE

C. BEST

Figure 5-4. Guard Connections

5-16. As a rule of thumb, guarded voltage and resistance measurements are necessary when:

1. Long test leads are used and the signal source impedance is high.
2. Floating measurements are made and the common mode voltage is a high potential, a high frequency, or both.
3. Operating the DMM in the presence of high-level radiated noise (the most common is stray fields at line frequency).

5-17. For Guard operation, complete the equipment connection desired, push EXTERNAL GUARD/NORMAL to the EXTERNAL GUARD position, and make the measurment.

5-18. READING RATE AND FILTER

5-19. Reading Rate and Filter features of the 8520A interact. When in AUTO TRIGGER (LED off), the 8520A is continuously sampling the unknown signal at either about 200 samples/sec (asynchronous) or a know multiple of line frequency (synchronous); for example, 240 samples/sec in 60 Hz line power environments. The Filter feature of the 8520A controls a combination of analog and digital filters to produce excellent rejection of line related noise (NMRR) and delay the reading long enough to insure that the reading is valid. Selecting a reading rate automatically selects the filter that provides optimum measurement accuracy. If the 8520A cannot operate at the selected reading rate due to added internal processing time, the display will flash:

rrtoo FAST

Reduce reading rate until the error code no longer flashes on the display. If the ASYNC Reading Rate is selected, filter is set to 5 msec. Any attempt to change the filter will result in a display of:

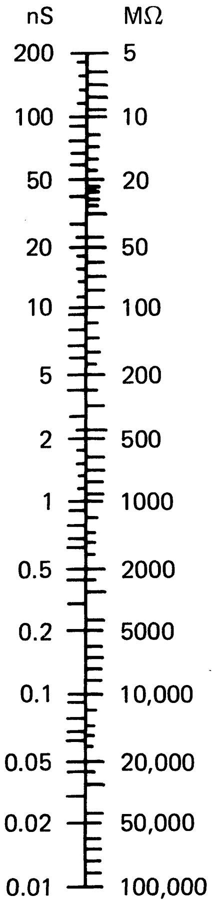
Err05 FLTR

Selecting a measurement function or turning the 8520A on will automatically select a reading rate and filter (see the function switches material in the Familiarization Section).

5-20. CONDUCTANCE-TO-RESISTANCE CONVERSION

5-21. The nS measurement function of your 8520A displays conductance in the international units, Siemens. One siemen equals the reciprocal of 1 ohm ($S = 1/\Omega$). The 8520A units of display are nanosiemens. One nanosiemen equals the reciprocal of 1000 megohms ($1\ nS = 1/1{,}000\ M\Omega$). To find the value of resistance equivalent to the measured conductance value, use the conductance-to-resistance conversion material presented in Figure 5-5.

*nS-TO-MΩ
100nS RANGE



Find the approximate resistance value using the conversion scale. Then, on the Interpolation Table, locate the most significant digit of the display reading on the vertical NO. column, and the next digit on the horizontal NO. row. The number at the intersecting coordinates represents the unknown resistance value. For example, a reading of 52.0 nS is equal to 19.MΩ. Decimal point location is determined from the scale approximation.

CONVERSION SCALE
*S = Siemens = 1/Ω = INTERNATIONAL UNIT OF CONDUCTANCE FORMERLY KNOWN AS THE MHO.

Interpolation Table (l/no.)

NO.	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1	1	.909	.833	.769	.714	.667	.625	.588	.556	.526
2	.500	.476	.455	.435	.417	.400	.385	.370	.375	.345
3	.333	.323	.313	.303	.294	.286	.278	.270	.263	.256
4	.250	.244	.238	.233	.227	.222	.217	.213	.208	.204
5	.200	.196	.192	.187	.185	.182	.179	.175	.172	.169
6	.167	.164	.161	.159	.156	.154	.152	.149	.147	.145
7	.143	.141	.139	.137	.135	.133	.132	.130	.128	.127
8	.125	.123	.122	.121	.119	.118	.116	.115	.114	.112
9	.111	.110	.109	.108	.106	.105	.104	.103	.102	.101

Figure 5-5. Conductance-to-Resistance Conversion

Section 6
Local Operation

6-1. INTRODUCTION

6-2. This section of the manual describes exactly how to operate your 8520A locally (from the front panel) in each of its multimeter functions (including burst). Use of the guard, burst, and various trigger features is described in the Operating Notes section earlier in this manual. Math program operation is described in the next section of this manual (Math Program Operation). Remote operation (via the IEEE-488 1978 interface) is presented in the IEEE-488 (REMOTE OPERATION) section later in this manual.

6-3. Philosophy of 8520A Multimeter Mode Operation

6-4. The philosophy of operation for the 8520A is "simplicity". The internal chain-of-command is set up so that selection of a measurement function automatically programs range, reading rate, and filter (among other things). Selection of a range can change the reading rate and filter. Selection of a reading rate automatically programs filter. In line with this philosophy, the operator should set up the instrument starting with the most important parameter and change the less important parameters as needed. That is:

1. Select function.
2. Select range.
3. Select reading rate.
4. Select filter.
5. Set the INPUT REAR/FRONT and EXTERNAL GUARD/NORMAL switches.
6. Connect the 8520A as required.
7. If necessary, program burst size.
8. If necessary, set-up the TRIGGER controls.
9. Trigger the instrument.
10. Use the measured value(s), record the measured value(s), exercise one of the math programs on the measured value, etc.

6-5. Front Panel and Rear Panel Terminals

6-6. Operation will be described using the front panel V/Ω INPUT, ΩSOURCE, and GUARD terminals INPUT REAR/FRONT switch at the FRONT (out) position. Operation using the rear panel REAR ANALOG INPUT terminals is the same except that the INPUT REAR/FRONT control must be set to the REAR (in) position.

6-7. OPERATION AS A DC VOLTMETER

6-8. Figure 6-1 graphically demonstrates how to measure dc voltage using the 8520A.

6-9. OPERATION AS AN AC VOLTMETER

6-10. Figure 6-2 graphically demonstrates how to measure ac voltage using the 8520A.

6-11. OPERATION AS AN AC+DC VOLTMETER

6-12. Figure 6-3 graphically demonstrates how to measure ac+dc voltages using the 8520A.

6-13. OPERATION AS A 2-WIRE OHMMETER

CAUTION

To prevent instrument damage, make sure that the external GUARD/NORMAL control is set to the NORMAL position when the GUARD terminal is not connected in the circuit.

NOTE

When the 10 MOhm range is selected, the 100 decimal point turns on instead of the 10 decimal point. The displayed value is correct the display has been shifted one position to the right.

6-14. Use the Ω2 WIRE function for convenient measurement of resistance. When measuring resistances less than 20 kOhm, the resistance of the test leads may cause significant errors. Use Math Program #2 (ZERO) to automatically subtract the test lead resistance from the displayed value (resistance displayed = resistance measured - test lead resistance). Figure 6-4 graphically demonstrates how to measure resistance using the Ω2 WIRE function of the 8520A.

6-15. OPERATON AS A 4-WIRE OHMMETER

NOTE

When the 10 MOhm range is selected, the 100 decimal point turns on instead of the 10 decimal point. The display value is correct - the display has been shifted on position to the right.

6-16. Use the Ω4 WIRE function for the most accurate measurement of resistance values below 20 kohm. The Ω4 WIRE function separates the current source and measurement links so the effects of test lead resistance is removed from the measured value. Figure 6-5 graphically demonstrates how to measure resistance using the Ω4 WIRE function of the 8520A.

6-17. OPERATION AS A CONDUCTANCE METER

6-18. Use the conductance function (nS) to measure resistance from 10MΩ to 100,000 MΩ. Siemens, the units of conductance, is equal to the reciprocal of ohms (S = 1 / Ω). To find the value of resistance equivilant to the measured conductance value, either divide 1 by the conductance value or use the Conductance-to- Resistance Conversion material in the Operating Notes. Figure 6-6 graphically demonstrates how to measure conductance using the 8520A.

6-19. BURST OPERATION

6-20. Introduction

6-21. As explained earlier in the Operating Notes, burst operation allows the operator several unconventional operations such as looking at data that occured before an event (trigger), expanding and contracting time intervals, and delaying the time after an event (trigger) occurs before a set of readings are taken. Two operation procedures follow: Displaying Burst Size, and Burst And Trigger Operation.

6-22. Displaying Burst Size

6-23. Use the following procedure to display the number of readings currently programmed as burst size.

1. Push SHIFT so that the LED is off.

2. Push BURST SIZE. The 8520A will display the burst size for about 1 sceond after the control is released. For example, if a burst size of 10 readings is programmed, the 8520A will display:

   10 = SIZE.

6-24. Burst and Trigger Operation

6-25. The operation of the 8520A changes dramatically depending upon the positions of the TRIGGER controls, programmed burst size, and application of external or manual triggering signals. Figure 6-7 shows the operation of the 8520A and the storage locations used in burst memory for each combination of burst sizes and positions of the TRIGGER controls.

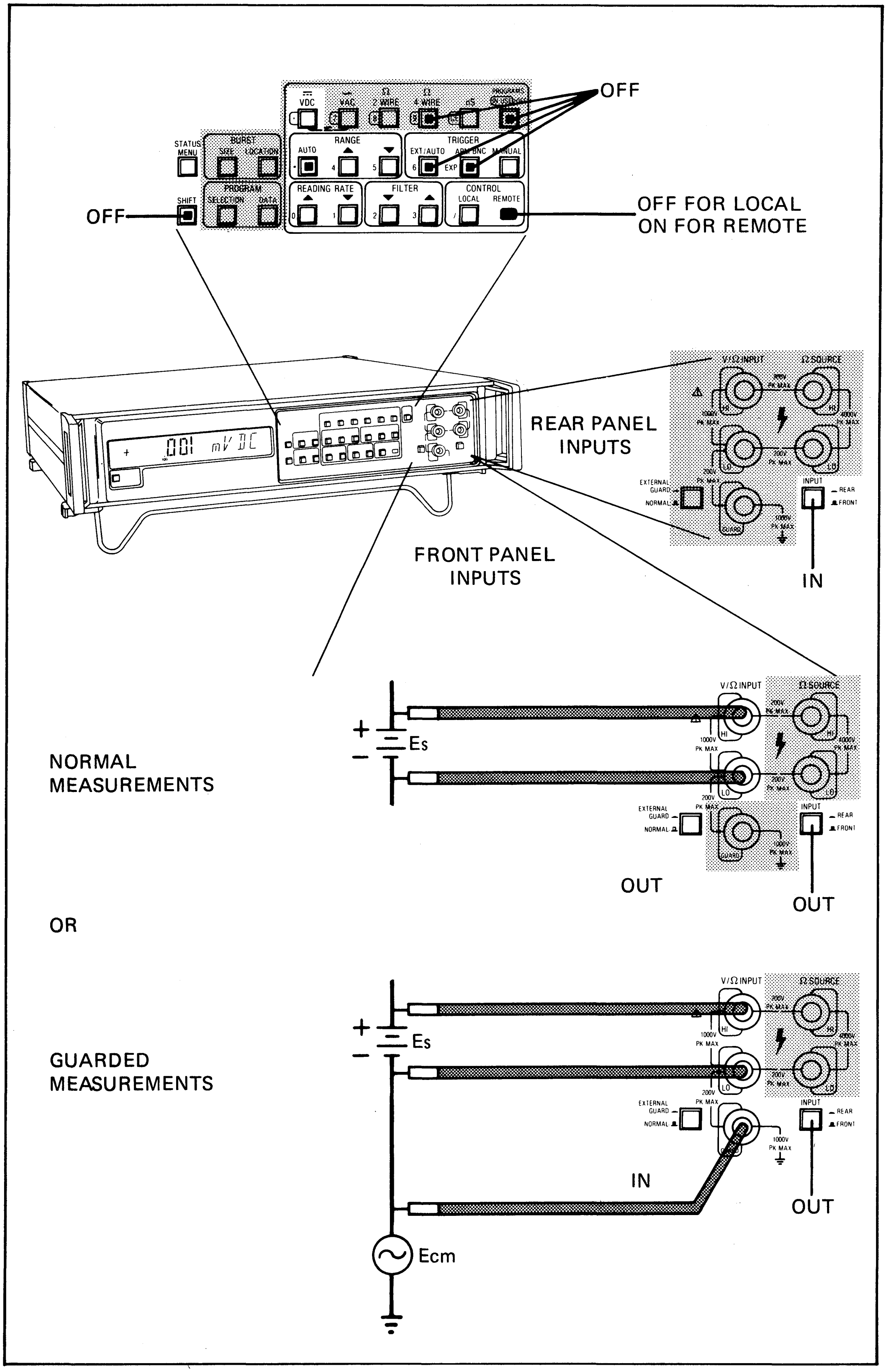

OFF
OFF
OFF FOR LOCAL
ON FOR REMOTE
VDC
VAC
2 WIRE
4 WIRE
nS
PROGRAMS IN USE
STATUS MENU
BURST
SIZE
LOCATION
RANGE
AUTO
TRIGGER
EXT/AUTO
ARM BNC
MANUAL
EXP
SHIFT
PROGRAM
SELECTION
DATA
READING RATE
FILTER
CONTROL
LOCAL
REMOTE
REAR PANEL
INPUTS
FRONT PANEL
INPUTS
V/Ω INPUT
Ω SOURCE
HI
LO
GUARD
EXTERNAL GUARD
NORMAL
INPUT
REAR
FRONT
1000V PK MAX
200V PK MAX
IN
NORMAL
MEASUREMENTS
Es
OUT
OUT
OR
GUARDED
MEASUREMENTS
Es
IN
OUT
Ecm

Figure 6-1. DC Voltage Measurement

HINT

For fast selection of 100V dc measurement, push RESET twice!

- Remove instrument inputs.
- Insure that the SHIFT and PROGRAMS IN USE/OFF LEDs are off.
- SELECT THE FUNCTION: Push VDC
The instrument established the VDC Default conditions.
The visible results are that the AUTO RANGE LED is on and the display is +.010 mV DC to -.010 mV DC (the display may ramp up if the input terminals are open).
- SELECT THE RANGE: If autoranging is desired, proceed. If a specific range of measurement is desired, push the ▲ or ▼ RANGE control to select the range desired.
- SELECT THE READING RATE: Pushing VDC establishes a reading rate of 2/SEC. If a different reading rate is desired, push the ▲ or ▼ READING RATE control to select the reading rate desired. Remember that selecting a reading rate automatically changes filter to a predetermined value.
- SELECT THE FILTER: Pushing VDC establishes a filter of 500 mSEC. If a different filter is desired, push the ▲ or ▼ FILTER control to select the filter desired.
- SELECT THE TRIGGER: Push EXT/AUTO and ARM BNC TRIGGER controls so that the LEDs are off (instrument in AUTO TRIGGER) see Burst v.s. Trigger Operation for operation in other trigger modes.
- CONNECT THE EQUIPMENT: As shown on the facing page and set the INPUT REAR/FRONT and EXTERNAL GUARD/NORMAL controls to the positions indicated.
- READ: The measured value in the display.

NOTE

Applicable math programs can be exercised on the measurements.

Figure 6-1. DC Voltage Measurement (cont)

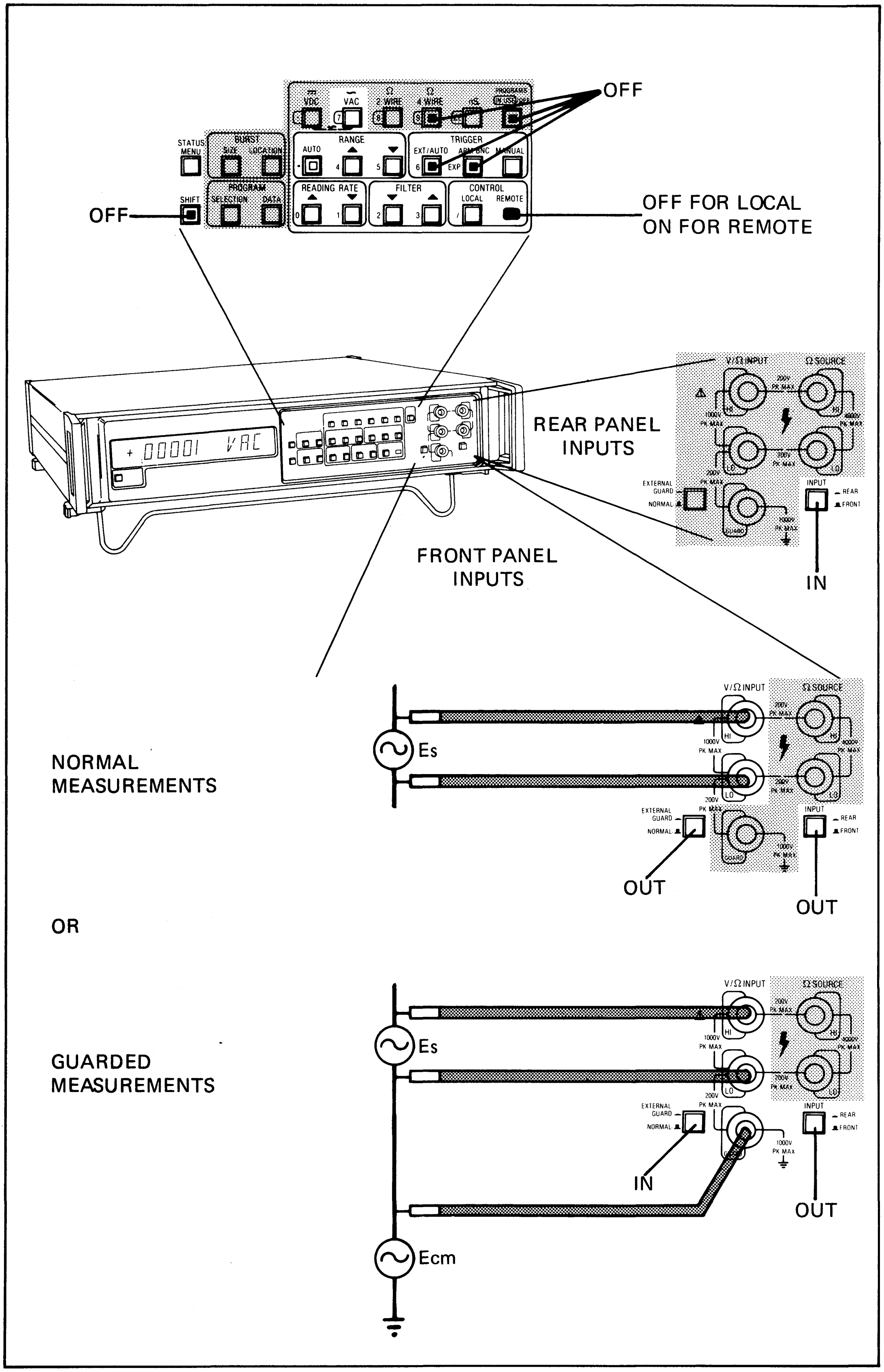

OFF
VDC
VAC
2 WIRE
4 WIRE
nS
PROGRAMS
STATUS MENU
BURST
SIZE
LOCATION
RANGE
AUTO
TRIGGER
EXT/AUTO
ARM/SNC
EXP
MANUAL
PROGRAM
SHIFT
SELECTION
DATA
READING RATE
FILTER
CONTROL
LOCAL
REMOTE
OFF
OFF FOR LOCAL
ON FOR REMOTE
+ 00001 VAC
REAR PANEL
INPUTS
V/Ω INPUT
Ω SOURCE
HI
LO
1000V PK MAX
200V PK MAX
EXTERNAL GUARD
NORMAL
GUARD
INPUT
REAR
FRONT
IN
FRONT PANEL
INPUTS
NORMAL
MEASUREMENTS
Es
OUT
OUT
OR
GUARDED
MEASUREMENTS
Es
IN
OUT
Ecm

Figure 6-2. AC Voltage Measurement

- Remove instrument inputs.
- Insure that the SHIFT and PROGRAMS IN USE/OFF LEDs are off.
- SELECT THE FUNCTION: Push VAC
The instrument establishes the VAC Default conditions.
The visible results are that the AUTO RANGE LED is on and the display is +.00100 VAC to -.00100 VAC with the input shorted.
- SELECT THE RANGE: If autoranging is desired, proceed. If a specific range of measurement is desired, push the ▲ or ▼ RANGE control to select the range desired.
- SELECT THE READING RATE: Pushing VAC establishes a reading rate of 2/SEC. If a different reading rate is desired, push the ▲ or ▼ READING RATE control to select the reading rate desired. Remember that selecting a reading rate automatically changes filter to a predetermined value.
- SELECT THE FILTER: Pushing VAC establishes a filter of 500 mSEC. If a different filter is desired, push the ▲ or ▼ FILTER control to select the filter desired.
- SELECT THE TRIGGER: Push EXT/AUTO and ARM BNC TRIGGER controls so that the LEDs are off (instrument in AUTO TRIGGER) see Burst v.s. Trigger Operation for operation in other trigger modes.
- CONNECT THE EQUIPMENT: As shown on the facing page and set the INPUT REAR/FRONT and EXTERNAL GUARD/NORMAL controls to the positions indicated.
- READ: The measured value in the display.

NOTE

Applicable math programs can be exercised on the measurements.

Figure 6-2. AC Voltage Measurement (cont)

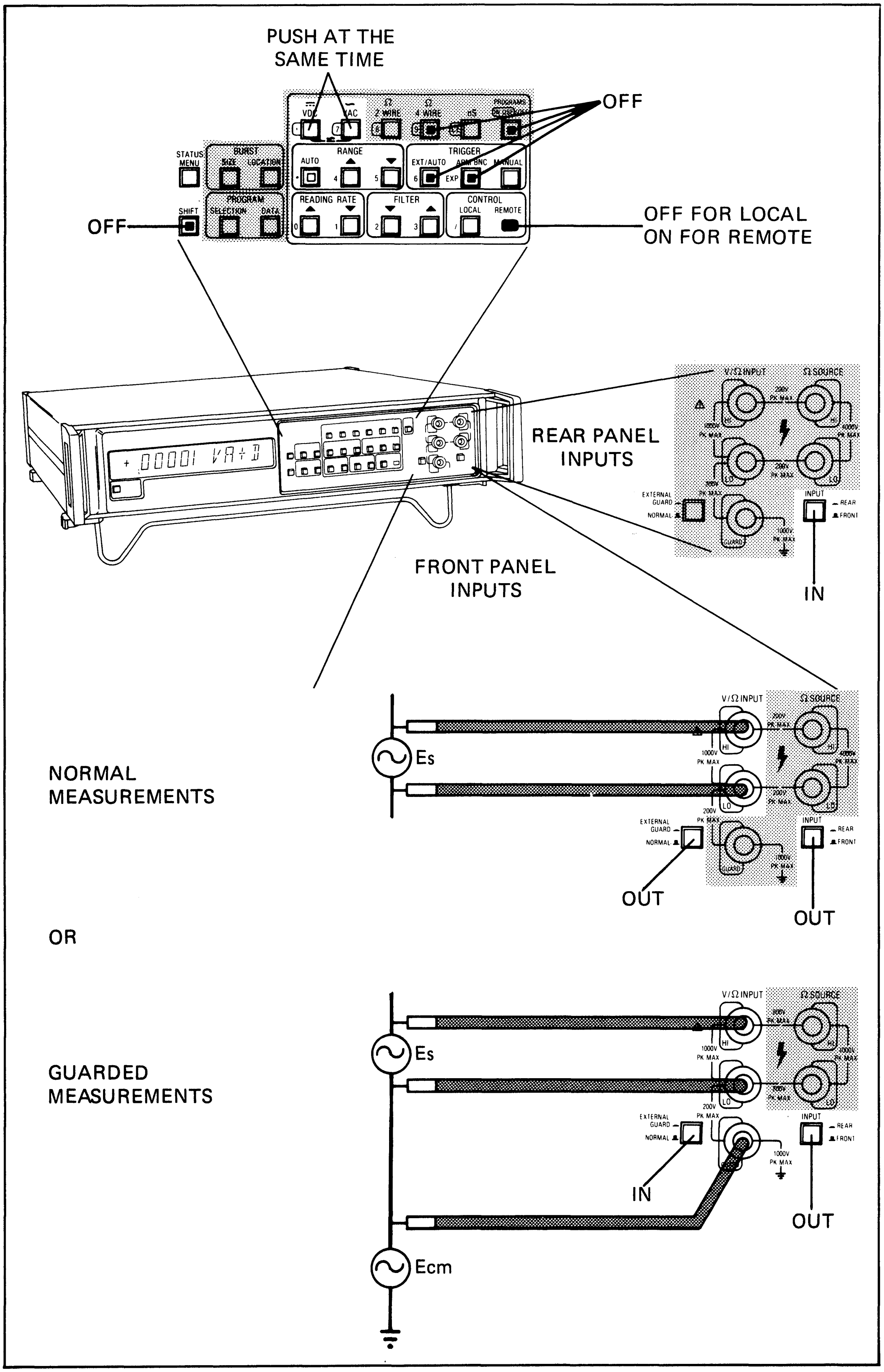

PUSH AT THE SAME TIME
OFF
VDC
AC
2 WIRE
4 WIRE
nS
PROGRAMS
STATUS MENU
BURST
SIZE
LOCATION
RANGE
AUTO
TRIGGER
EXT/AUTO
ARM BNC
MANUAL
EXP
OFF
SHIFT
PROGRAM
SELECTION
DATA
READING RATE
FILTER
CONTROL
LOCAL
REMOTE
OFF FOR LOCAL
ON FOR REMOTE
REAR PANEL INPUTS
V/Ω INPUT
Ω SOURCE
200V PK MAX
1000V PK MAX
HI
LO
GUARD
EXTERNAL GUARD
NORMAL
INPUT
REAR
FRONT
IN
FRONT PANEL INPUTS
NORMAL MEASUREMENTS
Es
OUT
OUT
OR
GUARDED MEASUREMENTS
Es
IN
OUT
Ecm

Figure 6-3. AC + DC Voltage Measurement

- Remove instrument inputs.

- Insure that the SHIFT and PROGRAMS IN USE LEDs are off.

- SELECT THE FUNCTION: Push VDC and VAC AT THE SAME TIME. The instrument extablishes the VA+D Default conditions. The visible result is that the AUTO RANGE LED is on.

- SELECT THE RANGE: If autoranging is desired, proceed. If a specific range of measurement is desired, push the ▲ or ▼ RANGE control to select the range desired.

- SELECT THE READING RATE: Pushing VDC and VAC establishes a reading rate of 2/SEC. If a different reading rate is desired, push the ▼ or ▲ READING RATE control to select the reading rate desired. Remember that selecting a reading rate automatically changes filter to a predetermined value.

- SELECT THE FILTER: Pushing VDC and VAC establishes a filter of 500 mSEC. If a different filter is desired, push the ▲ or ▼ FILTER control to select the filter desired.

- SELECT THE TRIGGER: Push EXT/AUTO and ARM BNC TRIGGER controls so that the LEDs are off (instrument in AUTO TRIGGER) see Burst v.s. Trigger Operation for operation in other trigger modes.

- CONNECT THE EQUIPMENT: As shown on the facing page and set the INPUT REAR/FRONT and EXTERNAL GUARD/NORMAL controls to the positions indicated.

- READ: The measured value in the display.

NOTE

Applicable math programs can be exercised on the measurements.

Figure 6-3. AC+DC Voltage Measurement (cont)

NOTE

When the 10MΩ range is selected, the 100 decimal point will be on (instead of the 10 decimal point). The display is correct but has been shifted one position to the right.

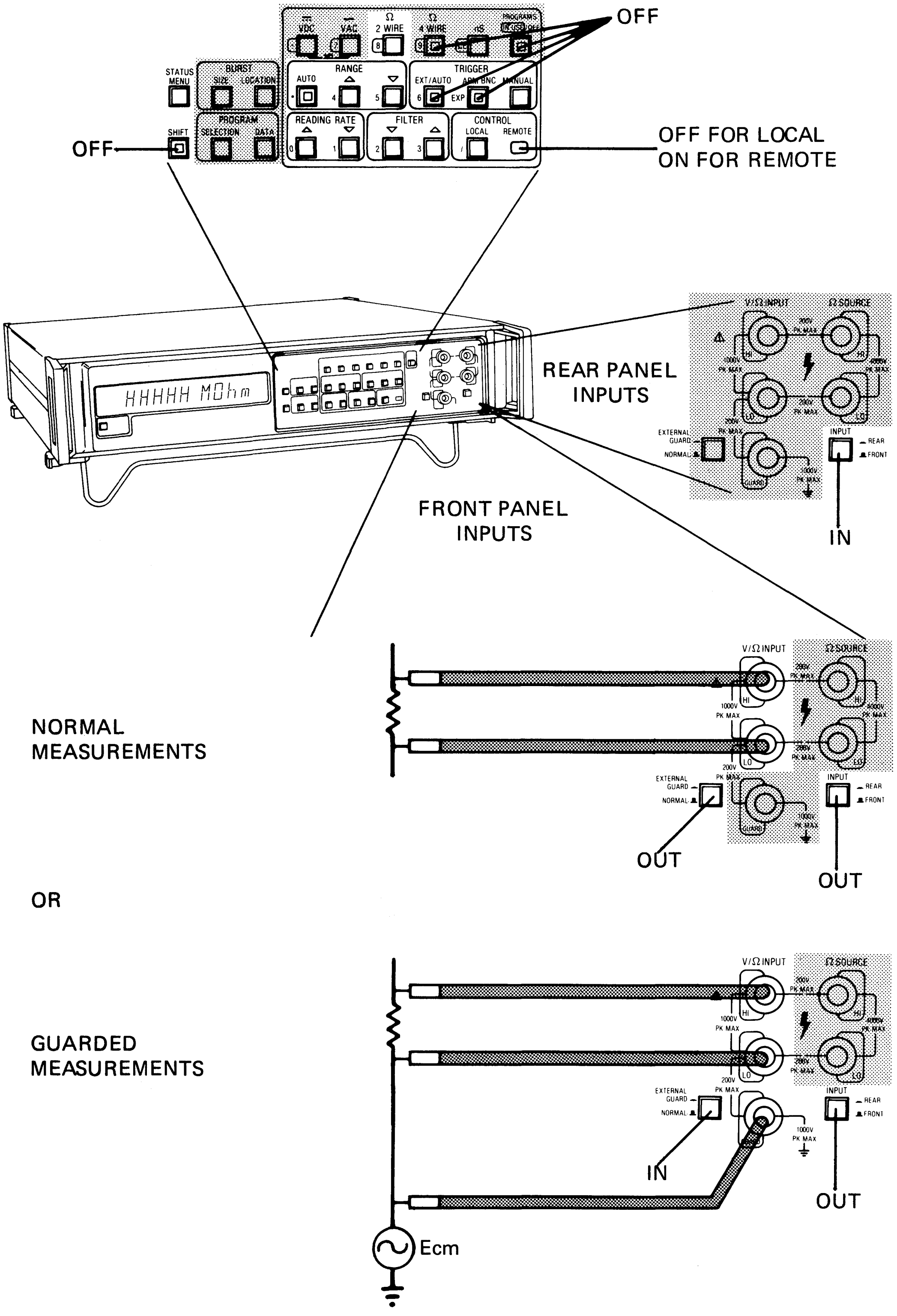

VDC
VAC
Ω 2 WIRE
Ω 4 WIRE
nS
PROGRAMS
OFF
STATUS MENU
BURST
SIZE
LOCATION
RANGE
AUTO
TRIGGER
EXT/AUTO
ARM BNC
MANUAL
EXP
PROGRAM
SELECTION
DATA
SHIFT
READING RATE
FILTER
CONTROL
LOCAL
REMOTE
OFF
OFF FOR LOCAL
ON FOR REMOTE
HHHHH MOhm
REAR PANEL INPUTS
V/Ω INPUT
Ω SOURCE
200V PK MAX
1000V PK MAX
4000V PK MAX
HI
LO
EXTERNAL GUARD
NORMAL
GUARD
INPUT
REAR
FRONT
FRONT PANEL INPUTS
IN
NORMAL MEASUREMENTS
OUT
OUT
OR
GUARDED MEASUREMENTS
IN
OUT
Ecm

Figure 6-4. 2-Wire Resistance Measurements

Use Ω2 WIRE to measure resistances from 0Ω to 20 MΩ

WARNING

TO AVOID SHOCK HAZARD AND/OR INSTRUMENT DAMAGE, REMOVE ALL ELECTRICAL ENERGY FROM THE DEVICE BEING MEASURED.

- Remove instrument inputs.
- Insure that the SHIFT and PROGRAMS IN USE/OFF LEDs are off.
- SELECT THE FUNCTION: Push Ω2 WIRE
The instrument establishes the Ω2 WIRE Default conditions.
The visible results are that the Ω2 WIRE and AUTO RANGE LEDs are on and the display is HH.HHH Mohm (overrange) if the input terminals
- SELECT THE RANGE: If autoranging is desired, proceed. If a specific range of measurement is desired, push the ▲ or ▼ RANGE control to select the range desired.
- SELECT THE READING RATE: Pushing Ω2 WIRE establishes a reading rate of 2/SEC. If a different reading Rate is desired, push the ▲ or ▼ READING RATE control to select the reading rate desired. Remember that selecting a reading rate automatically changes filter to a predetermined value.
- SELECT THE FILTER. Pushing Ω2 WIRE establishes a filter to 500 mSEC. If a different filter is desired, push the ▲ or ▼ FILTER control to select the filter desired.
- SELECT THE TRIGGER: Push EXT/AUTO and ARM BNC TRIGGER controls so that the LEDs are off (instrument in AUTO TRIGGER) see Burst v.s. Trigger Operation for operation in other trigger modes.
- CONNECT THE EQUIPMENT: As shown on the facing page and set the INPUT REAR/FRONT and EXTERNAL GUARD/NORMAL controls to the positions indicated.

NOTE

If the instrument displays Err01 HV, there is electrical energy present in the device being measured (charge capacitors, the device is turned on, etc).

- READ: The measured value in the display.

NOTE

Math Program #2 allows the test lead resistance to be removed from the measured value before the results are displayed.

Figure 6-4. 2-Wire Resistance Measurements (cont)

NOTE

When the 10MΩ range is selected, the 100 decimal point will be on (instead of the 10 decimal point). The display is correct but has been shifted one position to the right.

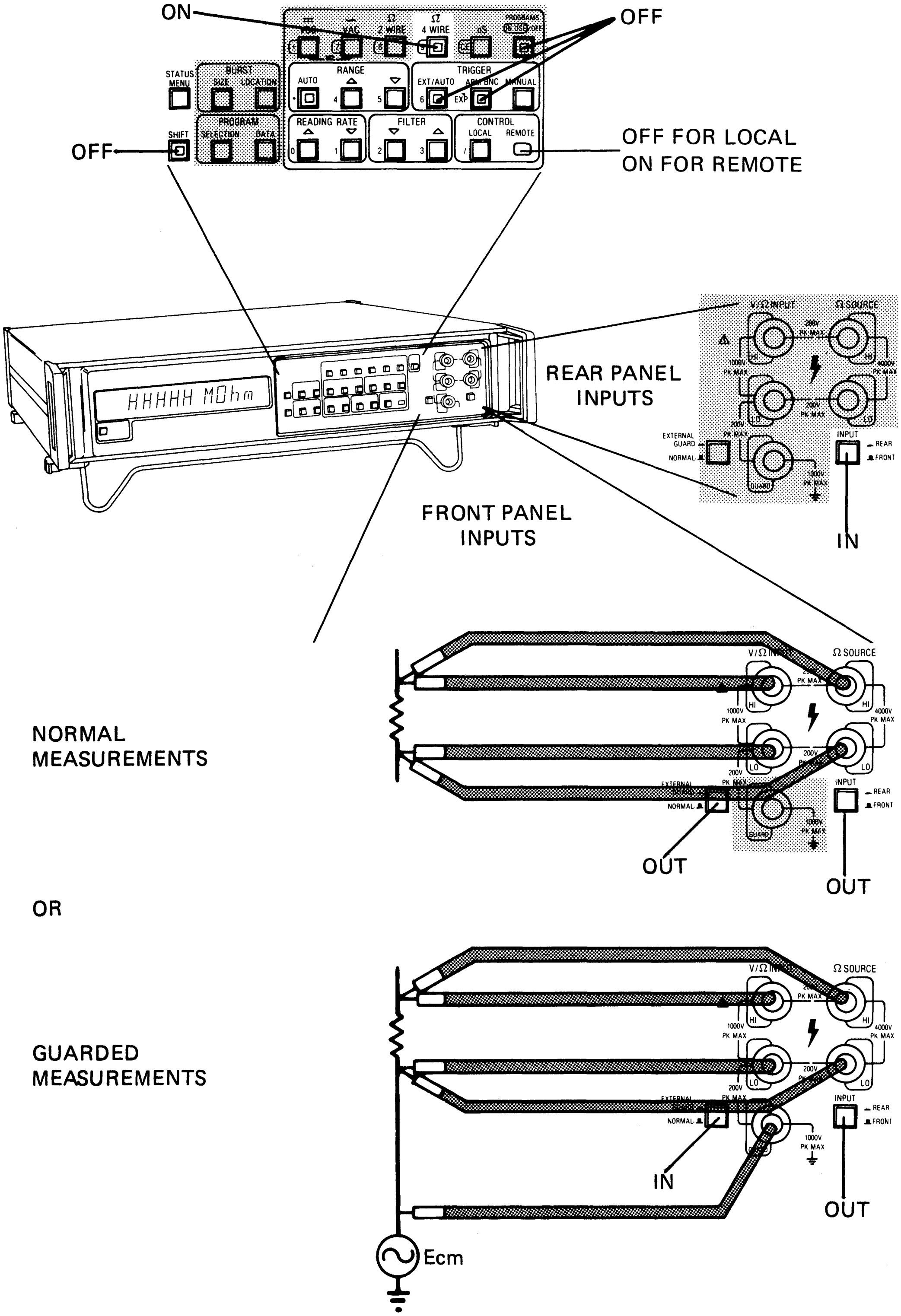

ON
OFF
OFF
OFF FOR LOCAL
ON FOR REMOTE
VDC
VAC
Ω 2 WIRE
Ω 4 WIRE
nS
PROGRAMS IN USE OFF
STATUS MENU
BURST
SIZE
LOCATION
RANGE
AUTO
TRIGGER
EXT/AUTO
ARM BNC
MANUAL
EXP
PROGRAM
SHIFT
SELECTION
DATA
READING RATE
FILTER
CONTROL
LOCAL
REMOTE
HHHHH MOhm
REAR PANEL INPUTS
FRONT PANEL INPUTS
V/Ω INPUT
Ω SOURCE
HI
LO
GUARD
1000V PK MAX
200V PK MAX
4000V PK MAX
EXTERNAL GUARD
NORMAL
INPUT
REAR
FRONT
IN
NORMAL MEASUREMENTS
OUT
OUT
OR
GUARDED MEASUREMENTS
IN
OUT
Ecm

Figure 6-5. 4-Wire Resistance Measurements

Use Ω4 WIRE to measure resistances from 0Ω to 2 MΩ

WARNING

TO AVOID SHOCK HAZARD AND/OR INSTRUMENT DAMAGE, REMOVE ALL ELECTRICAL ENERGY FROM THE DEVICE BEING MEASURED.

- Remove instrument inputs.

- Insure that the SHIFT and PROGRAMS IN USE/OFF LEDs are off.

- SELECT THE FUNCTION: Push Ω4 WIRE
The instrument establishes the Ω4 WIRE Default conditions.
The visible results are that the Ω4 WIRE and AUTO RANGE LED are on and the display is HH.HHH MOhm (overrange) if the input terminals are open).

- SELECT THE RANGE: If autoranging is desired, proceed. If a specific range of measurement is desired, push the ▲ or ▼ RANGE control to select the range desired.

- SELECT THE READING RATE: Pushing Ω4 WIRE establihes a reading rate of 2/SEC. If a different reading rate is desired, push the ▲ or ▼ READING RATE control to select the reading rate desired. Remember that selecting a reading rate automatically changes filter to a predetermined value.

- SELECT THE FILTER: Pushing Ω4 WIRE establishes a filter of 500 mSEC. If a different filter is desired, push the ▲ or ▼ FILTER control to select the filter desired.

- SELECT THE TRIGGER: Push EXT/AUTO and ARM BNC TRIGGER control so that the LEDs are off (instrument in AUTO TRIGGER) see Burst v.s. Trigger Operation for other trigger mode operation.

- CONNECT THE EQUIPMENT: As shown on the facing page and set the INPUT REAR/FRONT and EXTERNAL GUARD/NORMAL controls to the positions indicated.

NOTE

If the instrument displays Err01 HV, there is electrical energy present in the device being measured (charged capacitors, the device is turned on, etc).

- READ: The measured value in the display.

Figure 6-5. 4-Wire Resistance Measurements(cont)

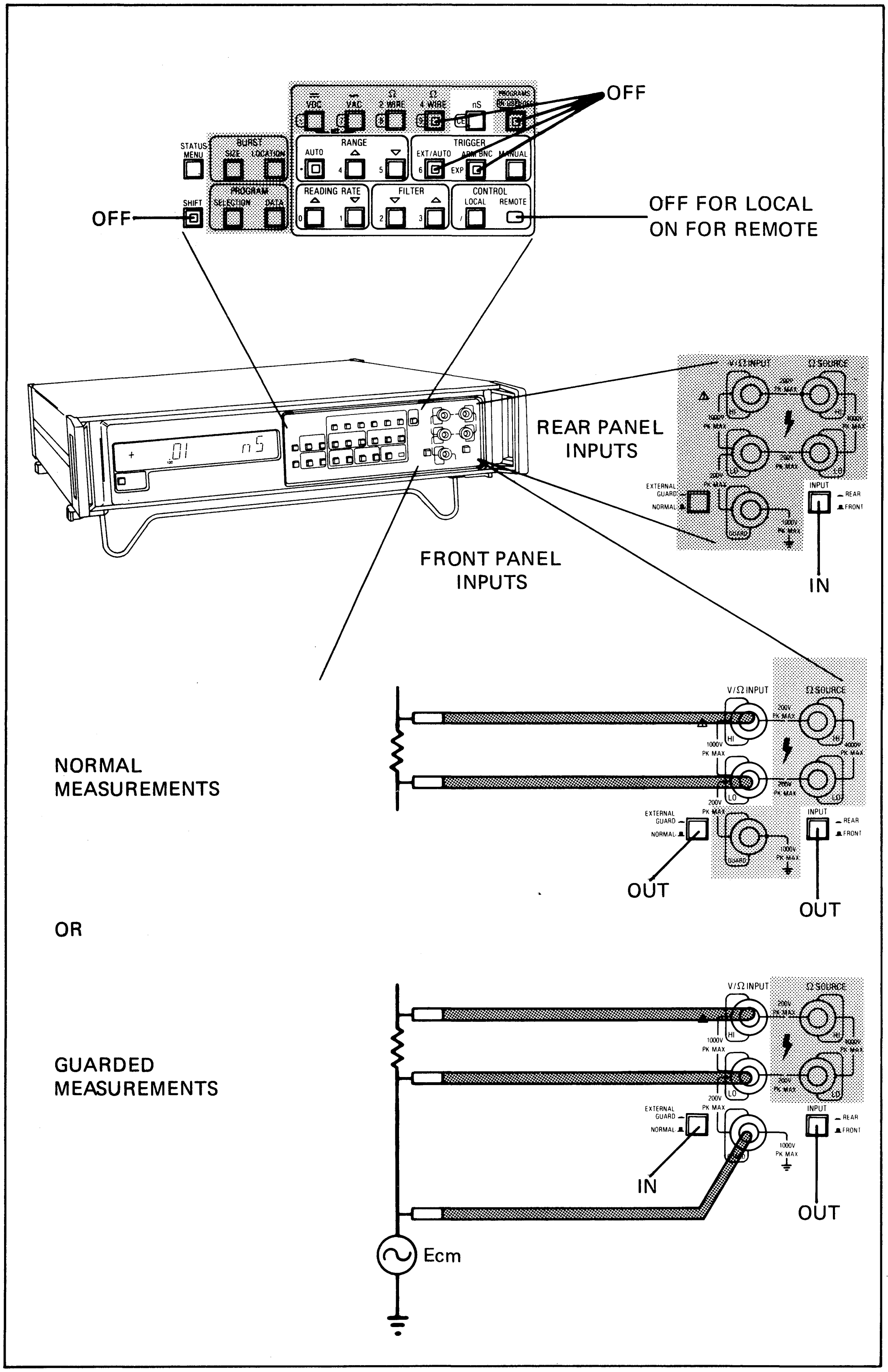

VDC
VAC
Ω 2 WIRE
Ω 4 WIRE
nS
PROGRAMS
OFF
STATUS MENU
BURST
SIZE
LOCATION
RANGE
AUTO
TRIGGER
EXT/AUTO
ARM BNC
MANUAL
EXP
SHIFT
PROGRAM
SELECTION
DATA
READING RATE
FILTER
CONTROL
LOCAL
REMOTE
OFF
OFF FOR LOCAL
ON FOR REMOTE
V/Ω INPUT
Ω SOURCE
HI
LO
GUARD
200V PK MAX
1000V PK MAX
EXTERNAL GUARD
NORMAL
INPUT
REAR
FRONT
REAR PANEL INPUTS
FRONT PANEL INPUTS
IN
NORMAL MEASUREMENTS
OUT
OUT
OR
GUARDED MEASUREMENTS
IN
OUT
Ecm

Figure 6-6. Conductance Measurements

Use nS to measure resistances from 10 MΩ to 100,000 MΩ

WARNING

TO AVOID SHOCK HAZARD AND/OR INSTRUMENT DAMAGE, REMOVE ALL ELECTRICAL ENERGY FROM THE DEVICE BEING MEASURED.

- Remove the instrument inputs.

- Insure that the SHIFT and PROGRAMS IN USE LEDs are off.

- SELECT THE FUNCTION: Push nS
The instrument establishes the nS Default conditions. The visible results are that the AUTO RANGE LED is off and the display is <.10 nS (if the input is open.)

- THE RANGE OF MEASUREMENT IS 100 nS.

- SELECT THE READING RATE: Pushing nS establishes a reading rate of 2/SEC. If a differenct reading rate is desired, push the ▲ or ▼ READING RATE control to select the desired reading rate.

- SELECT THE FILTER: Pushing nS establishes the Fast Filter. If a different filter is desired, push the ▲ or ▼ Filter Control to select the filter desired.

- SELECT THE TRIGGER: Push EXT/AUTO and ARM BNC TRIGGER controls so that the LEDs are off (instrument in AUTO TRIGGER) see Burst v.s. Trigger Operation for operation in other trigger modes.

- CONNECT THE EQUIPMENT: As shown on the facing page and set the INPUT REAR/FRONT and EXTERNAL GUARD/NORMAL controls to the positions indicated.

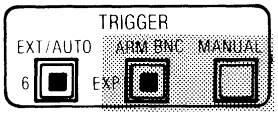
NOTE

If the instrument displays Err01 HV there is electrical energy present in the device being measured (charged capacitor, the device is turned on, etc).

- READ: The measure value in the display.

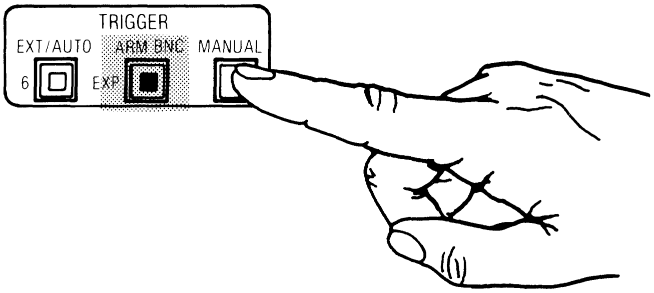
Figure 6-6. Conductance Measurements (cont)

AUTO


TRIGGER
EXT/AUTO
ARM BNC
MANUAL
6
EXP

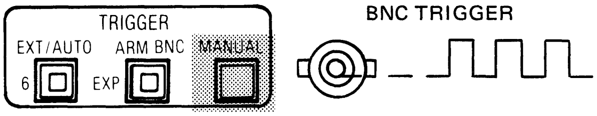
BURST SIZE	INTERNAL TRIGGER	READINGS			BURST MEMORY LOCATION	
		HOW MANY	WHEN	COMMENTS	LAST READING	BEFORE LAST READING
+1	YES	1	Each Trigger	Doesn't stop	1	-1, -2, -3. . .
+N	YES	1	Each Trigger	Doesn't stop	N	N-1, N-2. . .
–N	YES	1	Each Trigger	Doesn't stop	N	N-1, N-2. . .

MANUAL


TRIGGER
EXT/AUTO
ARM BNC
MANUAL
6
EXP

BURST SIZE	INTERNAL TRIGGER	READINGS			BURST MEMORY LOCATION	
		HOW MANY	WHEN	COMMENTS	LAST READING	BEFORE LAST READING
+N	NO	N	Starts after Manual Trigger	Takes N readings then stops	N	N-1, N-2. . .
–N	NO	1	Each Manual Manual Trigger	Not a useful mode	N	N-1, N-2. . .

EXTERNAL


TRIGGER
EXT/AUTO
ARM BNC
MANUAL
6
EXP
BNC TRIGGER

BURST SIZE	INTERNAL TRIGGER	READINGS			BURST MEMORY LOCATION	
		HOW MANY	WHEN	COMMENTS	LAST READING	BEFORE LAST READING
+1	NO	1	Each BNC pulse	Doesn't DISARM	1	-1, -2, -3. . .
+N	NO	N	Starts after First BNC pulse	Takes N readings, DISARMS BNC, and stops	N	N-1, N-2. . .
–N	NO	1	Each BNC pulse	Takes N readings then DISARMS BNC	N	N-1, N-2. . .

Figure 6-7. Burst vs Trigger Operation

Section 7
Math Programs

SECTION	TITLE	PAGE
7A	Math Program #1 – TEST	7A-1
7B	Math Program #2 – ZERO	7B-1
7C	Math Program #3 – XREF	7C-1
7D	Math Program #4 – OFFSET, SCALE, RATIO (OSR)	7D-1
7E	Math Program #5 – ΔPCT	7E-1
7F	Math Program #6 – PEAKS	7F-1
7G	Math Program #7 – LIMITS	7G-1
7H	Math Program #8 – STATISTICS	7H-1
7I	Math Program #9 – Low Frequency AC RMS Voltage	7I-1
7J	Math Program #10 – dB Ratio	7J-1
7K	Math Program #11 – RTD Temperature Conversion	7K-1
7L	Math Program #12 – John Fluke 80T-150C Conversion	7L-1
7M	Math Program #13 – John Fluke 80T-150T Conversion	7M-1
7N	Math Program #14 – Thermistor Linerization	7N-1

7-1. INTRODUCTION

7-2. This section of the manual provides procedures for operating the math programs. There are nine procedures that can be performed in the math program mode (SHIFT LED on): programming burst size, looking at data stored in burst memory (either scanning or stepping through burst memory), selecting math programs, stacking math programs, entering measurement data directly, entering measurement data stored in burst memory, looking at a math register (program stops), using the Display Option register (monitor a math register without stopping a program), and implementing the math program selected. Section 7 describes these general procedures. Note that every use of the math program mode requires the following sequential use of the controls.

SHIFT so that the LED is on	(get into Math Program Mode)
then	
enter data	(Data can be entered numerically using either the numeric keyboard or MENU or a reading can be taken and entered using the MANUAL TRIGGER control, or a reading stored in burst memory can be entered using BURST LOCATION).
then	
numerical terminator button	(use the data for BURST SIZE, BURST LOCATION, PROGRAM DATA, or PROGRAM SELECTION).

7-3. Specific procedures are presented for each math program in a separate subsection. The standard 8520A contains math programs numbers 1 through 7. The 8520A equipped with the -010 Option contains an additional seven programs -- math programs number 8 through 14. Table 7-1 lists each math program by number, name, and function.

7-4. PROGRAM WARNINGS

WARNING

WHEN THE MATH PROGRAMS ARE IN USE (PROGRAMS IN USE/OFF LED ON), THE 8520A FLASHES HHHH IN THE RIGHT DISPLAY WHEN A VOLTAGE EQUAL TO OR GREATER THAN 30V AC RMS OR 42.4V DC IS PRESENT ON THE INPUT TERMINALS OF THE 8520A NO MATTER WHAT NUMERICAL VALUE IS DISPLAYED.

7-5. When a math program is in use (PROGRAM IN USE/OFF LEDon), high voltage inputs to the 8520A may not be displayed as such on the 8520A. This possible operator hazard is indicated by HHHH flashing at a 1 second rate in the right display at any time the instrument input is greater than 30V ac rms or 42.4V dc or peak ac and the PROGRAMS IN USE/OFF LED is on.

7-6. PROGRAMMING BURST SIZE

7-7. Use the following procedure to change the polarity and size of the burst.

1. Push SHIFT so that the LED is on. The 8520A will display:

"?" NMBR

Table 7-1. 8520A Math Programs

NO.	NAME	DESCRIPTION	DISPLAY (PROGRAMS IN USE/OFF LED on)
STANDARD PROGRAMS			
0		None––used to deselect programs	
1	TEST	Four diagnostic self-test programs	Test results
2	ZERO	Automatic meter zero to dc voltage or resistance offset	Corrected measurements
3	XREF	External reference ratio	Ratio of front to rear input
4	OSR	Offset, scale, ratio	$\frac{(\text{Input}-\text{Offset})\ \text{Scale}}{\text{Ratio}}$
5	Δ PCT	Percent Deviation	% deviation from a nominal value
6	PEAK	Peak value storage	DMM measurement
7	LIM	Input tested against limits	HIGH, PASS, LOW
OPTIONAL PROGRAMS (-010 OPTION)			
8	STAT	Statistics	DMM Measurement
9	LFAC	RMS ac value of inputs below 10Hz	RMS value
10	dB	dB, dBm, or dBV ratio	Measurement in dB, dBm, or dBV
11	RTD	RTD thermometer	Temperature in °C, °F, or °K
12	JVC	Operation with John Fluke 80T-150C temperature probe accessory	Temperature in °C, °F, or °K
13	JVF	Operation with John Fluke 80T-150F	Temperature in °F, °C, or °K
14	THMS	Thermistor linearization	Temperature in °C, °F, or °K

2. Enter the number of readings that is the size of the desired burst. If the opposite polarity burst is desired, push ±. For example, if BURST SIZE is +10, to program a burst size of -30, push ±, then 3, then 0. The 8520A will display:

-30 NMBR

3. Push BURST SIZE. The 8520A will display:

-30 = SIZE

for about 1 second after the control is released, then the 8520A will exit the Math Program Mode.

7-8. DISPLAYING THE CONTENTS OF BURST MEMORY

7-9. The contents of burst memory can either be displayed one location at a time or scanned. Remember that measurements can be captured in burst memory at one reading rate and displayed (or transmitted on the IEEE-488 interface) at another reading rate. Remember also that if burst size is less than 50 (less than 400 for instruments equipped with the -010 Option), there is data stored from previously triggered bursts.

7-10. Stepping Through Burst Memory

7-11. Use this procedure to display the contents of burst memory one location at a time.

1. Push SHIFT so that the LED is on. The 8520A will display:

"?" NMBR

2. Enter number of the burst memory location to be displayed. For example, to display burst memory location 5, push 5. The 8520A will display:

5 NMBR

3. Push BURST LOCATION. While BURST LOCATION is depressed, the location number is displayed. When BURST LOCATION is released, the 8520A will display the contents of burst memory location 5.

4. Push BURST LOCATION again to advance to the next location.

5. To advance in the other direction, push ±, then BURST LOCATION.

7-12. Scanning Burst Memory

7-13. Use this procedure to scan a sequence of burst memory locations.

1. Use the READING RATE controls to select the speed that the 8520A will sequence from one location to the next. For example, to have the contents of a new location displayed each second, select a reading rate of 1/SEC.

2. Push SHIFT so that the LED is on. The 8520A will display:

"?" NMBR

3. Enter the number of the first burst memory location in the sequence, then push /, then enter the number of the last location in the sequence. For example, to display the contents of burst memory locations 10 through 30, push 1, then 0, then /, then 3, then 0. The 8520A will display:

10 /030

4. Push BURST LOCATION. The 8520A will display the contents of burst memory location 10 through 30 at the reading rate selected then will exit the math program mode (SHIFT LED on).

7-14. SELECTING ONE PROGRAM

7-15. There are two procedures that select a single math program depending upon whether or not you know the program number: one procedure if you know the number of the math program that you want to select and a second procedure if you don't know the number of the program that you want to select. Note that selecting a program is not the same as implementing the program.

7-16. Selecting a Program When the Program Number is Known

7-17. Use the following procedure to select a math program when the math program number is known:

1. Push SHIFT: The SHIFT LED turns on and the instrument displays:

"?" NMBR

2. If the math program number is known, enter the number using the data keyboard then push PROGRAM SELECTION. The math program is now

selected. If there are any programmable constants, the 8520A will display prompts to let the operator use the existing constants or program new constants. See the Math Program Section for a detailed description of each math program.

Example: You want to select Math Program #2 (ZERO) to remove the effects of a dc voltage offset. No zero reference value has been stored since the instrument was turned on. The VDC measurement function is selected.

Push SHIFT.

The 8520A displays:

"?" NMBR

Push 2.

The 8520A displays:

2 NMBR

Push PROGRAM SELECTION

The 8520A displays:

2 = ZERO

for about 1 second then displays:

r2.1 = DZRO

for about 1 second, then displays:

+.00000 DZRO

Assuming that you want a zero reference of zero volts, push PROGRAM DATA. The 8520A will exit the math program mode.

7-18. Selecting a Program When the Program Number is Not Known

7-19. Use the following procedure to select a math program when you are not sure of or do not know the math program number.

1. Push SHIFT: The SHIFT LED turns on and the instrument displays:

"?" NMBR

2. Push and hold the MENU control. The math program menu will scroll through the display at a 1 second rate. When the math program you want appears in the display, release the MENU control and push PROGRAM SELECTION. The math program is now selected.

Example: You want to select zero reference math program. No zero reference has been programmed since the instrument was turned on. The instrument is in VDC.

Push SHIFT.

The 8520A displays:

"?" NMBR

Push and hold MENU.

The 8520A displays:

MENU

for about 1 second, then displays:

1 = TEST

for about 1 second then displays:

2 = ZERO

Since this is the math program you want to select, release MENU (2 = ZERO remains in the display). Push PROGRAM SELECTION. The 8520A continues to display:

2 = ZERO

for about 1 second, then displays:

r2.1 = DZRO

for about 1 second, then displays:

+.00000 DZRO

Assuming that you want a zero reference of zero volts, push PROGRAM DATA. The 8520A will exit the math program mode.

7-20. STACKING (selecting several) PROGRAMS

7-21. Up to three programs can be stacked with a few exceptions. Math Program numbers 0 (no program) and 1 (instrument self-test) cannot be stacked with any other math program. Math Program Numbers 11, 12, 13, and 14 (the four temperature measurement programs) are mutually exclusive. That is, only one of these programs can be selected at one time. Each of these four math programs requires that the 8520A use a different type of accessory which is compatible only with that math program. Other math programs can be stacked with any one of these four programs. The math programs will be used by the 8520A in the sequence they were programmed. For example, if you stack Math Program #3 and #6 as 36, the 8520A will exercise Math Program#3, then Math Program #6. Use the following procedure to stack math programs:

1. Push SHIFT: the SHIFT LED turns on and the 8520A displays:

   "?" NMBR

2. Enter the math program numbers in the sequence you want the programs used and push PROGRAM SELECTION. The math programs are stacked and the

8520A will display prompts for any programmable constants for the stacked math programs.in the sequence that the programs were stacked.

Example: Stack Math Program #3 and #6.

Push 3.

The 8520A displays:

3 NMBR

Push 6.

The 8520A displays:

36 NMBR

Push PROGRAM SELECTION.

36 NMBR remains in the display for about 1 second then the 8520A displays:

3 = XREF

for about 1 second, then displays:

6 = PEAK

for about 1 second and then returns to the Multimeter Mode (SHIFT LED will turn off).

7-22. ENTERING DIRECT MULTIMETER MEASUREMENT DATA

7-23. At times the operator will want to enter measurement data into a math register. Use the following procedure to enter one multimeter reading into a math register. Assume that the math program has been selected and that the 8520A has asked for data to store in a math register.

1. Push MANUAL TRIGGER. The results of one reading is in the Left Display.
2. If the results of the reading are unsatisfactory, continue pushing MANUAL TRIGGER until a satisfactory reading is obtained.
3. Once the displayed data is satisfactory, push PROGRAM DATA. The 8520A will proceed with the sequence of that particular test.

7-24. ENTERING THE CONTENTS OF ONE BURST MEMORY LOCATION AS DATA

7-25. Use the following procedure to enter the contents of one burst memory location as math program data. Assume that the math program has been selected and that the 8520A has asked for data to store in a math register.

1. Use the Numeric Keyboard to enter the burst memory location number.
2. Push BURST LOCATION. The 8520A displays the contents of that location in burst memory.

3. Push PROGRAM DATA. The 8520A will proceed with the sequence of that particular program.

7-26. IMPLEMENTING MATH PROGRAM(s)

WARNING

WHEN MATH PROGRAMS ARE IN USE, THE 8520A WILL FLASH HHH IN THE RIGHT DISPLAY TO INDICATE THAT A POTENTIAL SHOCK HAZARD (A VOLTAGE EQUAL TO OR GREATER THAN 30V AC RMS OR 42.4V DC OR PEAK AC) IS PRESENT AT THE INPUT TERMINALS OF THE INSTRUMENT.

7-27. To implement (use) the math programs selected, push PROGRAMS IN USE/OFF. The LED turns on and the 8520A exercises the math program(s) selected. While math programs are being exercised, hazardous voltage levels may be present at the 8520A inputs while numerically low voltage indications are displayed. For example, if 1000V dc is being applied to the 8520A input while Math Program #2 is being used when zero reference of 999 volts is programmed, the 8520A will display 1.00. To warn the operator that there is a voltage reagter than 30V ac rms or 42.4V dc or peak ac applied to the 8520A input, HHHH will flash in the right display. To discontinue use of the math program(s) selected, push PROGRAMS IN USE/OFF again. The LED will turn off and the instrument will not exercise the selected math program(s).

7-28. DISPLAYING THE CONTENTS OF A MATH REGISTER

7-29. The contents of any math register can be displayed at any time but, if the program is in use, the program will stop. Use the following procedure to display one of the Math Memory locations listed in Table 7-2.

1. Push SHIFT so that the LED is on. The 8520A will display:

   "?" NMBR

2. Use the Numeric Keyboard to enter the register number (see Table 7-2). For example, to look at OZRO, push 2, then ., then 2. The 8520A will display:

   2.2 NMBR

3. Push PROGRAM SELECTION. The 8520A will display:

   r2.2 = OZRO

   for about 2 second, then (suppose OZRO is 4.0 ohms):

   +4.00000 OZRO

4. To stop looking at the math register, push SHIFT so that the LED is off. The 8520A will go to the multimeter mode.

7-30. DISPLAY OPTION REGISTER (0.1)

7-31. Regardless of what the name implies, the Display Option Register is a standard feature in all 8520A multimeters. Math register 0.1, the Display Option Register, provides the operator with the option of displaying the contents of any math register (see Table 7-1) without affecting the function of the math program. For example, while using Math Program #7 (LIMIT) the operator can watch the total number of readings accumulate in register 7.6 using the following procedure:

1. Select the Display Option Register as follows:

Push SHIFT so that the LED is on. The 8520A will display:

"?" NMBR

Push 0, then ., then 1. The 8520A will display:

0.1 NMBR

Push PROGRAM SELECTION. The 8520A will display:

0.1 = OPT

for about 1 second, then displays:

0.0 DOPT

2. Select the math register to be displayed as follows:

According to our example, push 7, then ., then 6, then PROGRAM DATA. The 8520A will display the contents of register 7.6 (the total number of readings) as the count accumulate when math programs are in use.

Table 7-2. Math Registers

REGISTER NUMBER	RIGHT DISPLAY	DESCRIPTION	DATA TYPE
0.0	–	Display Register (DMM Mode)	
0.1	DOPT	Display Option	
2.0	none	Zero Output	Computed Variable
2.1	DZRO	DC ZERO (voltage measurement)	Programmable Constant
2.2	OZRO	Ohms Zero (Resistance measurement)	Programmable Constant
3.0	XREF	External Reference Output	Computed Variable
3.1	VXRF	External Reference Voltage	Computed Variable
3.2	XRFH	External Reference Voltage High	Measured Variable
3.3	XRFL	External Reference Voltage Low	Measured Variable
4.0	none	Offset, Scale, Ratio Output	Computed Variable
4.1	OFST	Offset	Programmable Constant
4.2	SCAL	Scale	Programmable Constant
4.3	RATO	Ratio	Programmable Constant
5.0	ΔPCT	Percent of Deviation Output	Computed Variable

Table 7-2. Math Registers (cont)

REGISTER NUMBER	RIGHT DISPLAY	DESCRIPTION	DATA TYPE
5.1	NOM	Reference	Programmable Constant
6.0	none	Peaks	Computed Variable
6.1	HIPK	Upper Peak Value	Measured Variable
6.2	LOPK	Lower Peak Value	Measured Variable
6.3	PKPK	Peak-to-Peak Value	Computed Variable
7.0	none	Limits Output (High, Low, Pass)	Computed Variable
7.1	ULMT	Upper Limit	Programmable Constant
7.2	LLMT	Lower Limit	Programmable Constant
7.3	N HI	Number of High Readings	Computed Variable
7.4	N LO	Number of Low Readings	Computed Variable
7.5	NPAS	Number of Pass Readings	Computed Variable
7.6	NTTL	Total Number of Readings	Computed Variable
8.0	none	Statistics Output	Computed Variable
8.1	NUM	Number of Readings	Computed Variable
8.2	AVE	Average of the Readings	Computed Variable
8.3	STDV	Standard Deviation	Computed Variable
8.4	VAR	Variance of Readings	Computed Variable
8.5	SUM	Sum of the Readings	Computed Variable
8.6	SMSQ	Sum of the Squares of the Readings	Computed Variable
8.7	BIAS	First Reading of the Sequence	Measured Variable
8.8	DIF	Reading Minus Bias	Computed Variable
8.9	SDIF	Sum of the Differences	Computed Variable
9.0	LFAC	Low Frequency RMS Volts Output	Computed Variable
9.1	NUM	Number of Readings	Computed Variable
9.2	SMSQ	Sum of the Squares of the Readings	Computed Variables
9.3	ACLF	Unfiltered LFAC	Computed Variable
9.4	RSUM	Filter Summing	Computed Variable
10.0	dB	dB Output	Computed Variable
10.1	Vr	Voltage Reference	Programmable Constant
10.2	Ri	Input Resistance	Programmable Constant
10.3	RL	Load Resistance	Programmable Constant
10.4	Pr	Power Reference	Programmable Constant
11.0	°C	RTD Degrees Celsius Output	Computed Variable
11.1	°K	RTD Degrees Kelvin Output	Computed Variable

Table 7-2. Math Registers (cont)

REGISTER NUMBER	RIGHT DISPLAY	DESCRIPTION	DATA TYPE
11.2	°F	RTD Degrees Fahrenheit Output	Computed Variable
11.3	R0	Resistance at 0 Degrees Celsius	Programmable Constant
11.4	ALPH	Slope of the resistance curve.	Programmable Constant
11.5	DELT	Parameter "Delta"	Programmable Constant
11.6	BETA	Low temperature Parameter "beta"	Programmable Constant
12.0	°C	JF 80T-150C Output	Computed Variable
12.1	°K	JF 80T-150C Equivalent °Kelvin	Computed Variable
12.2	°F	JF 80T-150C Equivalent Degrees F	Computed Variable
13.0	°F	JF 80T-150F Output	Computed Variable
13.1	°C	JF 80T-150F Equivalent °Celsius	Computed Variable
13.2	°K	JF 80T-150F Equivalent °Kelvin	Computed Variable
14.0	°C	Thermistor Output Degrees Celsius	Computed Variable
14.1	°K	Equivilant Degrees Kelvin	Computed Variable
14.2	°F	Equivilant Degrees Fahrenheit	Computed Variable
14.3	A0	Parameter A0	Programmable Constant
14.4	A1	Parameter A1	Programmable Constant
14.5	A2	Parameter A2	Programmable Constant
14.6	A3	Parameter A3	Programmalbe Constant

Section 7A
Math Program #1 — TEST

7A-1. INTRODUCTION

7A-2. Math Program #1 consists of four self test that provide a confidence check of the 8520A. Math program #1 is not a performance test. The 8520A can pass all four Math Program #1 tests and still be operating out of specifications. All four tests can be selected from the front panel of the 8520A but only Test #1 can be selected via the IEEE-488 Interface. The four tests are:

TEST #1 -- ANALOG -- Checks the function of the analog circuitry of the 8520A.

TEST #2 -- DIGITAL -- Checks the function of the digital circuitry of the 8520A.

TEST #3 -- KEY LED -- Checks the function of each front panel software control (key) and each segment of every LED.

TEST #4 -- TROUBLESHOOTING -- Provides a constant, repetitive pulse pattern on the 8520A display lines. This is a troubleshooting aid for use by trained repair personnel.

7A-3. TEST #1 -- ANALOG

7A-4. Introduction

7A-5. Self-test #1 first checks the input terminals of the 8520A for high voltage. If a voltage is present, the 8520A will display:

Err01 HV

until the voltage is removed. Next, the 8520A makes a conductance measurement across the input terminals. If the measurement is greater than 1 nS (less than 1,000 MΩ), the 8520A will display:

OPEn INPUT (open the input)

until the input terminals are opened. Once the first two conditions are met, the 8520A will make 16 internal sub-tests and measure analog voltage for each sub-test. If the analog voltage is within the limits listed in Table 7A-1, the 8520A will display the measured voltage and state that the instrument has passed the analog voltage test for that sub-test then proceed to the next sub-test. For example, a display of:

-.0003 PS03

indicates that the 8520A passed sub-tests 3 and the analog measured was -.0003. If the analog voltage is not within the specified limits, the 8520A will display the measured voltage, state that the test failed, and — if in local operation — stop (when in remote, the 8520A will proceed through the 16 sub-tests without stopping). For example, a display of:

+.95168 FL13

indicates that sub-tests 13 failed and the measured value was +9.5168. If in local operation, push PROGRAM DATA to proceed. Once the 16 sub-tests have been completed, the 8520A will ask for the number of the next test by displaying:

"?" TEST

The results of the analog voltage measurements for sub-tests 1 through 16 are stored in burst memory locations 1 through 16, respectively. The Math Program Operation section describes general operating procedures for math programs.

7A-6. Operation

7A-7. Use the following procedure to select TEST #1 of Math Program #1.

1. Push SHIFT so that the LED is on. The 8520A will display:

"?" NMBR

Table 7A-1. Analog Test Limits

SUB-TEST NUMBER	NAME	LIMITS	
		MAXIMUM	MINIMUM
01	1000V dc Zero Check	+.0003	–.0003
02	100V dc Zero Check	+.0004	–.0004
03	100mV dc Zero Check	+.0010	–.0010
04	10V dc Gain Check	+6.5100	+6.4900
05	1000Vdc Gain Check	+.0976	+.0968
06	100V dc Gain Check	+.7791	+.7759
07	100mV dc Gain Check	+6.2311	+6.2091
08	10 MOhm Range Check	+4.4978	+4.4678
09	1V ac Zero Check	+.0448	–.0100
10	10V ac Zero Check	+.0250	–.0100
11	100V ac Zero Check	+.0185	–.0100
12	650V ac Zero Check	+.0185	–.0100
13	1V ac Gain Check	+9.4871	+9.4437
14	10V ac Gain Check	+4.5012	+4.4662
15	100V ac Gain Check	+.5738	+.5471
16	650V ac Gain Check	+.0830	+.0570

2. Select Math Program #1 as follows:

Push 1. The 8520A will display:

1 NMBR

Push PROGRAM SELECTION. The 8520A will display:

1 = TEST

for about 1 second, then display:

"?" TEST

3. Select the TEST #1 as follows:

Push 1. The 8520A will display:

1 TEST

Push PROGRAM DATA. If there is no high voltage at the input of the 8520A, after 1 second, the 8520A will display:

. nS

If the conductance across the input terminals is greater than 1 nS, the 8520A will display:

OPEn INPT

until the input of the 8520A is opened. If the conductance across the input terminals is less than 1 nS, the 8520A will proceed to the next test or display the measured value with a failed test indication and stop (until PROGRAM DATA is pushed). After all 16 sub-tests and measurements have been made, the 8520A will ask for the number of the next test by displaying:

"?" TEST

4. The measured values for sub-tests 1 through 16 are located in burst memory locations 1 through 16, respectively.

7A-8. TEST #2 -- DIGITAL

7A-9. Introduction

7A-10. TEST #2 performs three digital test routines: a ROM checksum test, a RAM read/write test, and a guard crossing circuitry test. If one or more of the tests fail, the 8520A will display:

Err14	ROM	(if the Rom checksum fails)
Err15	RAM	(if the RAM read/write test fails)
Err17	HDWR	(if the guard crossing circuitry test fails)

for 1 second before proceeding to the next test. If all three tests pass, the 8520A will display:

PASS DGTL

for about 1 second and the 8520A will ask for the number of the next test by displaying:

"?" TEST

7A-11. Operation

7A-12. Use the following procedure to select TEST #2 of Math Program #1.

1. Push SHIFT so that the LED is on. The 8520A will display:

"?" NMBR

2. Select Math Program #1 as follows:

Push 1. The 8520A will display:

1 NMBR

Push PROGRAM SELECTION. The 8520A will display:

1 = TEST

for about 1 second, then display:

"?" TEST

3. Select TEST #2 as follows:

Push 2. The 8520A will display:

2 TEST

Push PROGRAM DATA. The 8520A will remain unchanged for about 1 second, then:

If the 8520A passed all three tests, the display will be:

PASS DGTL

If the 8520A failed any test, the error code will be displayed for about 1 second.

4. The 8520A will ask for the number of the next test by displaying:

"?" TEST

7A-13. TEST #3 -- KEY & LED TESTS

7A-14. Introduction

7A-15. TEST #3 has two parts: the KEY Test and the LED Test. The KEY Test allows the operator to check the function of each control on the front panel except POWER ON/OFF, EXTERNAL GUARD/NORMAL, and REAR/FRONT. The LED Test allows the operator to check the function of each segment of every LED. Once TEST #3 has been selected, pushing RESET alone will start or stop the LED Test. Pushing any other key except SHIFT will return to the KEY Test. Pushing SHIFT alone will cause the 8520A to exit TEST #3 and ask for the next test number by displaying:

"?" TEST

7A-16. Operation

7A-17. Use the following procedure to select TEST #3, exercise the KEY Test and exercise the LED Test.

1. Push SHIFT so that the LED is on. The 8520A will display:

"?" NMBR

2. Select Math Program #1 as follows:

Push 1. The 8520A will display:

1 NMBR

Push PROGRAM SELECTION. The 8520A will display:

1 = TEST

for about 1 second, then display:

"?" TEST

3. Select TEST #3 as follows:

Push 3. The 8520A will display:

3 TEST

Push PROGRAM DATA. The 8520A will display:

PUSH KEYS

to indicate that the instrument is ready to exercise the KEY Tests.

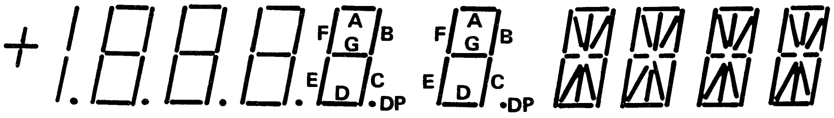
4. KEY TEST -- Sequentially push the controls listed in the Key Switch column of Table 7A-2 and insure that the corresponding LED segments indicated in the table are actually on in the 8520A display.

5. LED TEST -- Push RESET to start the LED test. The LED Test can be stepped or scrolled. The test will step each time RESET is pushed and released or the test will scroll while RESET is pushed and held. Figure 7A-1 shows the sequence that the LED segments are turned on. Note that in the first step, all segments of every LED are on.

NOTE

To exit LED Test and enter KEY Test, push any key except RESET or SHIFT. To exit the KEY and LED Tests, push SHIFT.

Table 7A-2. Keyswitch Test

KEYSWITCH	 F A G B E D C DP F A G B E D C DP	
VDC (+/–)	D	DP
VAC (7)	C	DP
Ω2 WIRE (8)	DP	E
Ω 4 WIRE (8)	G	E
nS (CE)	F	E
PROGRAMS IN USE/OFF	E	E
STATUS (MENU)	G	G
BURST SIZE	F	G
BURST LOCATION	E	G
AUTO RANGE (.)	D	G
▲RANGE (4)	C	G
▼RANGE (5)	DP	D
EXT/AUTO TRIGGER (6)	G	D
ARM BNC TRIGGER (EXP)	F	D
MANUAL TRIGGER	E	D
PROGRAM SELECTION	F	F
PROGRAM DATA	E	F
READING RATE ▲ (0)	D	F
READING RATE ▼ (1)	C	F
FILTER ▼ (2)	DP	C
FILTER ▲ (3)	G	C
LOCAL (/)	F	C
At the Same Time: SHIFT and PROGRAM SELECTION	G and F	F
At the Same Time: RESET and nS (CE)	D and F	E

7A-18. TEST #4 -- TROUBLESHOOTING

7A-19. Introduction

7A-20. Test #4 is provided as a troubleshooting aid for qualified repair personnel. The test sends a constant hexidecimal 40 across the guard crossing circuit. The 8520A display is a seemingly random pattern with the word FLUKE the only recognizable display. The pattern repeats (FLUKE will appear in the display) about every 64 seconds.

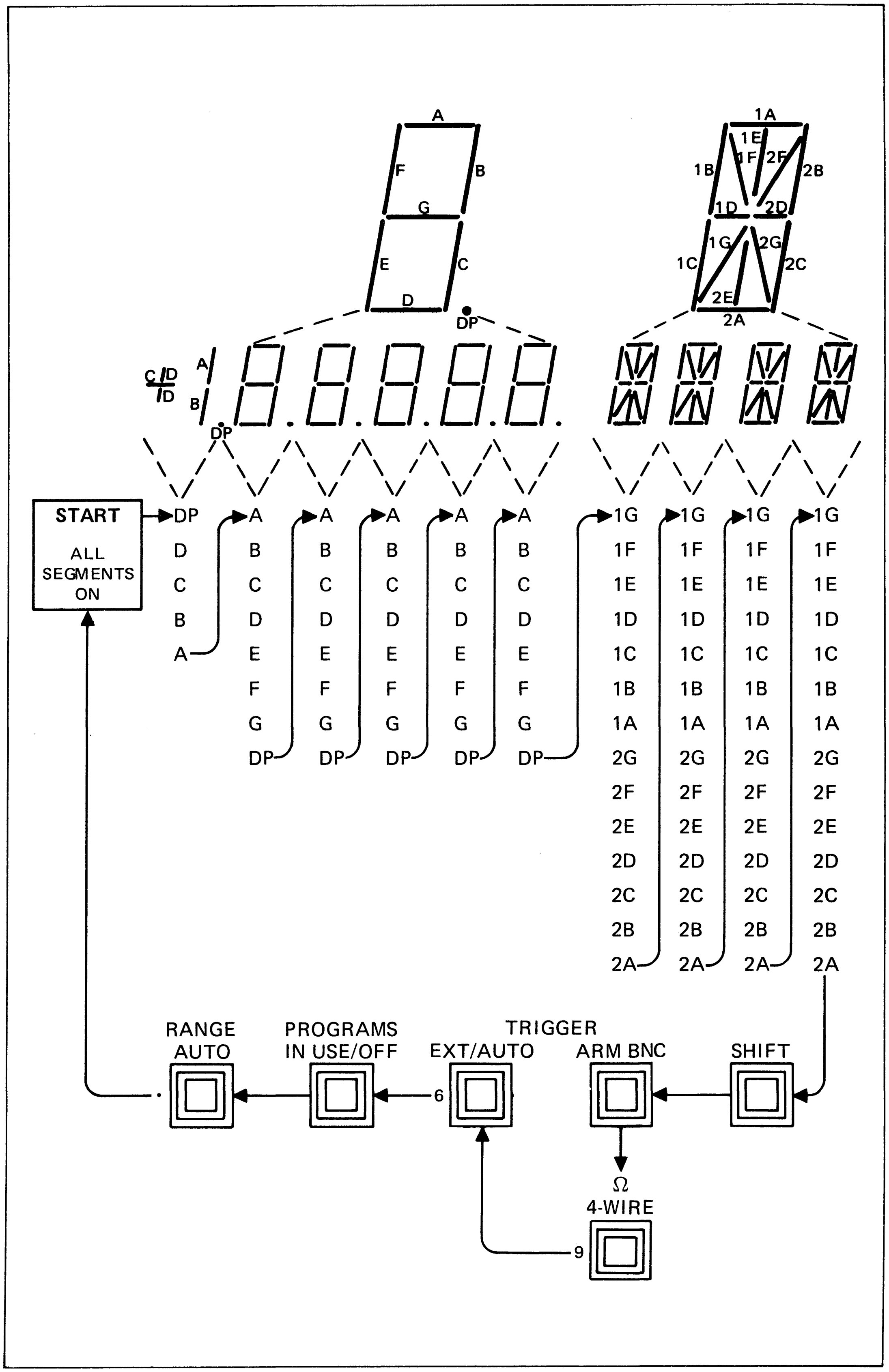

A
B
C
D
E
F
G
DP
1A
1B
1C
1D
1E
1F
2A
2B
2C
2D
2E
2F
1G
2G
C/D
/D
START
ALL SEGMENTS ON
DP D C B A
A B C D E F G DP
1G 1F 1E 1D 1C 1B 1A 2G 2F 2E 2D 2C 2B 2A
RANGE AUTO
PROGRAMS IN USE/OFF
TRIGGER
EXT/AUTO
ARM BNC
SHIFT
Ω 4-WIRE
6
9

Figure 7A-1. LED Test Sequence

7A-21. Operation

7A-22. Use the following procedure to select Test #4 of Math Program #1:

1. Push SHIFT so that the LED is on. The 8520A will display:

"?" NMBR

2. Select Math Program #1 as follows:

Push 1. The 8520A will display:

1 NMBR

Push PROGRAM SELECTION. The 8520A will display:

1 = TEST

for about 1 second, then will display:

"?" TEST

3. Select TEST #4 as follows:

Push 4. The 8520A will display:

4 TEST

Push PROGRAM DATA. The 8520A will display a seemingly random pattern with:

FLUKE

repeated about every 64 seconds.

4. To exit Test #4, push any key.

Section 7B
Math Program #2 — ZERO

7B-1. INTRODUCTION

7B-2. Math Program #2 ZEROs the 8520A display to a programmed offset. The program can only be used in the VDC, Ω2 WIRE, Ω4 WIRE, and nS measurement functions. The primary intent of Math Program #2 is to allow the 8520A to remove the effects of offsets such as test lead resistance from the displayed measurement value.

7B-3. AS Table 7B-1 show, there are two separate storage locations for offsets: dc volts zero (DZRO) and ohms zero (OZRO). If the 8520A is in VDC before Math Program #2 is selected, the offset will be stored in the DZRO math register. If any of the three resistance measurement functions are selected before Math Program #2 is selected, the offset will be stored in the OZRO math register. If the instrument is in any other measurement function when Math Program #2 is selected, the instrument will display an error message and will not go into the math program. After Math Program #2 has been selected, pushing PROGRAMS IN USE/OFF so that the LED is on will result in the stored offset being subtracted from the measurment data and the difference being displayed. For example, if 1V is in DZRO and the 8520A is connected to an 11V dc source, +10.000 will be displayed. Table 7B-1 lists the registers for Math Program #2.

Table 7B-1. Math Program #2 Registers

REGISTER NUMBER	RIGHT DISPLAY	DESCRIPTION	FORMULA	DEFAULT VALUE
r2.0	none	Measured value less the offset	I-Z	0
r2.1	DZRO	VDC zero offset (same for any range)	Z	0
r2.2	OZRO	Ω2 WIRE, Ω4 WIRE, and nS zero offset (same for any range)	Z	0
where I=Input to the 8520A Z = Offset				

NOTE

When using the OZRO portion of Math Program #2, be sure that the value stored as zero reference was taken using the same measurment function that is *consequences of not following procedure is: if.01 was stored for leads resistance as OZRO using the Ω2 WIREfunction and then Math Program #2 is enabled (PROGRAMS IN USE/OFF LED on) with the nS measurement function selected, the stored OZRO is now interpreted by the 8520A as being .01 nS the equivalent of 100 MOhms of resistance). This value is seven orders of magnitude larger than the measurement, so the result will appear to be an error.*

7B-4. OPERATION

NOTE

If the zero offset register contain any value but zero, the actual display of your 8520A may differ from the display described in the following examples.

7B-5. The procedures for storing zero offsets are the same for DZRO and OZRO, so the procedures below will describe both at the same time. You can either store an arbitrary number (for example to subtract a known dc offset from voltage measurements) or you can store an offset measured by the 8520A. The first of the following procedures tells how to store an arbitrary zero offset and the second procedure tells how to store a measured zero offset.

7B-6. Storing an Arbitrary Offset

7B-7. Use the following procedure to store an arbitrary value for a zero offset:

1. Select the desired measurement function (VDC, Ω2 WIRE, Ω4 WIRE, or nS).
2. Select Math Problem #2 as follows:

Push SHIFT so that the LED is on. The 8520A will display:

"?" NMBR

Push 2. The 8520A will display:

2 NMBR

Push PROGRAM SELECTION. The 8520A will display:

2 = ZERO

for about 1 second, then:

r2.1 = DZRO (if VDC was selected)

or

r2.2 = OZRO (if Ω2 WIRE, Ω4 WIRE, or nS was selected)

will flash through the display, then the 8520A will display:

+.00000 DZRO (if VDC was selected)

or

+.00000 OZRO (if Ω2 WIRE, Ω4 WIRE, or nS was selected)

3. Enter the arbitrary offset as follows:

For example, enter an arbitrary offset of +1V using the data keyboard.

Push 1. The 8520A will display:

1 DZRO

Push PROGRAM DATA. The 8520A will return to the multimeter mode (SHIFT LED off).

7B-8. Storing a Measured Offset

7B-9. Use the following procedure to store a measured offset.

1. Set up the 8520A to make the type of measurements desired. For example, to zero the test lead resistance from Ω2 WIRE measurement, select the Ω2 WIRE function, AUTOranging, etc., and short the two test leads together.

2. Select Math Problem #2 as follows:

Push SHIFT so that the LED is on. The 8520A will display:

"?" NMBR

Push 2. The 8520A will display:

2 NMBR

Push PROGRAM SELECTION. The 8520A will display:

2 = ZERO

for about 1 second then:

r2.2 = OZRO

will flash through the display (if VDC had been selected, r2.1 = DZRO would have flashed through the display) then:

+.00000 OZRO

will remain in the display.

3. Have the 8520A take one reading of test lead resistance and store that value as OZRO as follows:

Push MANUAL TRIGGER. The 8520A will take one reading to use as OZRO. Assuming the test leads resistance is 1 ohm, the 8520A would display:

+1.0000 Ohm

If this reading is not satisfactory, continue to push MANUAL TRIGGER. Until a satisfactory value is displayed.

Push PROGRAM DATA. The 8520A will store the reading as OZRO and return to the multimeter mode.

Section 7C

Math Program #3 — XREF

7C-1. INTRODUCTION

7C-2. Math Program #3 computes the ratio of an unknown signal applied to the input of the 8520A to a reference voltage applied to the EXTERNAL REFERENCE terminals on the rear panel. When Math Program #3 is used (PROGRAMS IN USE/OFF LED on), the ratio is displayed.

7C-3. The potentials applied to the rear panel EXTERNAL REFERENCE terminals have the following limits:

1. The difference between the two potentials must be greater than ±0.5V dc. If the difference is less than ±0.5V dc, the 8520A will display the under range error message:

ur VXRF

2. Each potential must be less than +16.5V dc and greater than -16.5V dc with respect to the low input terminal. If either potential is outside these limits, the 8520A will display the over range error message:

or VXRF

7C-4. Table 7C-1 lists the registers for Math Program #3. The Math Program Section presented general operating procedures for math programs. The procedures that follow are specific to Math Program #3.

Table 7C-1. Math Program #3 Registers

REGISTER NUMBER	RIGHT DISPLAY	DESCRIPTION	FORMULA	DEFAULT VALUE
r3.0	none	External Reference Ratio	$\frac{\text{Input}}{\text{XH}-\text{XL}}$	0
r3.1	VXRF	External Reference Voltage	XH−XL	0
r3.2	XRFH	External Reference High Input	XH	0
r3.3	XRFL	External Reference Low Input	XL	0

7C-5. OPERATION

7C-6. The following procedure and example describe how to use Math Program #3 to make ratio measurements using the 8520A.

1. REFERENCE terminals. For the example, assume the external reference voltage is +10.00V dc with the low input terminal and the low EXTERNAL REFERENCE terminal are both at 0V dc or at GND.

2. Set the 8520A up for the measurement desired. For example, select VDC, 100V range.

3. Select Math Program #3 as follows:

Push SHIFT so that the LED is on. The 8520A will display:

"?" NMBR

Push 3. The 8520A will display:

3 NMBR

Push PROGRAM SELECTION. The 8520A will display:

3 = XREF

for about 1 second, then the 8520A will return to the multimeter mode.

4. Apply an input of 90V dc to the 8520A input. The 8520A will display:

90.000 VDC

5. Push PROGRAMS IN USE/OFF so that the LED is on. The 8520A will display:

+9.0000

or 90V dc/10V dc.

Section 7D
Math Program #4
OFFSET, SCALE, RATIO (OSR)

7D-1. INTRODUCTION

7D-2. Math Program #4 subtracts a preprogrammed offset (OFST) from the 8520A input, multiplies the difference by a scale factor (SCAL), and divides the product by a ratio factor (RATO) or

$$\text{8520A display} = \frac{(\text{Input - OFST})\ \text{SCAL}}{\text{RATO}}$$

7D-3. The default values for OFST = 0 and for SCAL and RATO = 1, so using Math Program #4 with the default values programmed will not create any difference between the actual value of the input and the displayed value.

7D-4. Table 7D-1 lists the registers for Math Program #4. The Math Program Operation Section describes general operating procedures for the math programs.

Table 7D-1. Math Program #4 Registers

REGISTER NUMBER	RIGHT DISPLAY	DESCRIPTION	FORMULA	DEFAULT VALUE
r4.0	none		$\frac{(I-O)S}{R}$	0
r4.1	OFST	Offset	O	0
r4.2	SCAL	Scale	S	+1.00000
r4.3	RATO	Ratio	R	+1.00000
where I = Input to the 8520A				

7D-5. OPERATION

7D-6. Use the following procedure to select and set-up Math program #4. As an example, the following will be programmed: OFST = 5V dc, SCAL = 2, and RATO = 4.

1. Select Math Problem #4 as follows:

Push SHIFT so that the LED is on. The 8520A will display:

"?" NMBR

Push 4. The 8520A will display:

4 NMBR

Push PROGRAM SELECTION. The 8520A will display:

4 = OSR

for about 1 second, then display:

r4.1 = OFST

for 1 second, then display:

+.00000 OFST

2. Program the new offset as follows:

Push 5. The 8520A will display:

5 OFST

Push PROGRAM DATA. The 8520A will store the offset and then display:

r4.2 = SCAL

for 1 second, then display:

+1.00000 SCAL

3. Program the new scale factor as follows:

Push 2. The 8520A will display:

2 SCAL

Push PROGRAM DATA. The 8520A will store the scale factor then display:

r4.3 = RATO

for 1 second, then display:

+1.00000 RATO

4. Program the new ratio as follows:

Push 4. The 8520A will display:

4 RATO

Push PROGRAM DATA. The 8520A will store the ratio and return to the multimeter mode.

5. Verify operation of Math Program #4 as follows:

a. Select the VDC function, AUTOranging and apply +15V dc to the 8520A input. The 8520A will display:

+15.0000 VDC

b. Push the PROGRAMS IN USE/OFF control so that the LED is on. The 8520A will display:

+5.0000

c. Verify the 8520A display by performing the math manually.

$$\text{8520A display} = \frac{(\text{Input - OFST})\ \text{SCAL}}{\text{RATO}}$$

$$= \frac{(+15\text{V dc} - 5\text{V dc})2}{4}$$

$$= \frac{(10\text{V dc})2}{4}$$

$$= \frac{20\text{V dc}}{4}$$

$$= 5\text{V dc}$$

Section 7E

Math Program #5 —ΔPCT

7E-1. INTRODUCTION

7E-2. Math Program #5 computes the percent difference between the unknown 8520A input and a preprogrammed nominal value. When Math Program #5 is in use (PROGRAMS IN USE/OFF LED on), the 8520A displays the computed percentage of difference. That is, the 8520A will display:

$$\frac{100(\text{measured value - nominal value})}{\text{nominal value}}$$

7E-3. Math Program #5 allows the operator to program any nominal value. The registers for math program #5 are listed in Table 7E-1. The math program operation section presents general math program operation procedures.

Table 7E-1. Math Program #5 Registers

REGISTER NUMBER	RIGHT DISPLAY	DESCRIPTION	FORMULA	DEFAULT VALUE
r5.0	Δ PCT	Percent difference	$\frac{(I-N)\,100}{N}$	0
r5.1	NOM	Nominal value	N	0

7E-4. OPERATION

7E-5. Use the following procedure to select Math Program #5 and program the nominal value. For an example, the procedure will program a nominal value of 100 ohms.

1. Select Math Problem #5 as follows:

Push SHIFT so that the LED is on. The 8520A will display:

"?" NMBR

Push 5. The 8520A will display:

5 NMBR

Push PROGRAM SELECTION. The 8520A will display:

5 = ΔPCT

for about 1 second, then display:

r5.1 = NOM

for about 1 second, then display:

+.00000 NOM

2. Program the nominal value manually as follows: (Use the procedures in the Math Program Operation Section either to use a reading stored in burst memory, or to take and use a measurement reading for nominal value).

Push 1, then 0, then 0. The 8520A will display:

100 NOM

Push PROGRAM DATA. The 8520A will return to the multimeter mode.

3. Check the function of the math program as follows:

a. Set-up the 8520A for 2-wire resistance measurements and place 10 ohms of resistance across the 8520A input. The 8520A will display:

10.0000 Ohm

b. Push PROGRAMS IN USE/OFF so that the LED is on. The 8520A will display:

-90.000 PCT

indicating that the difference between the measured resistance and the nominal value is 90% less than the nominal value.

c. Place 110 ohms across the 8520A input. The 8520A will display:

+10.000 PCT

indicating that the input is 10% greater than the nominal value.

Section 7F
Math Program #6 — PEAKS

7F-1. INTRODUCTION

7F-2. Math Program #6 measures and stores the highest and lowest values of the input signal in a set of readings (the peaks) and computes the algebraic peak-to-peak value. Once a set of readings has been processed by Math Program #6, it is necessary to manually retrieve the high peak, low peak, and peak-to-peak values. To prepare the 8520A for processing another set of readings, push RESET once. The Math Program Operation Section describes general procedures for Math Program Operation. Table 7F-1 lists the registers for Math Program #6.

Table 7F-1. Math Program #6 Registers

REGISTER NUMBER	RIGHT DISPLAY	DESCRIPTION	FORMULA	DEFAULT VALUE
r6.0	none	Input	I	0
r6.1	HIPK	High Peak Input	H = I if I $\geqslant$ H	−1 E+18
r6.2	LOPK	Low Peak Input	L = I if I $<$ L	+1 E+18
r6.3	PKPK	Peak-to-Peak	H−L	0

7F-3. OPERATION

7F-4. There are three procedures for operating Math Program #6: Selecting Math Program #6, Implementing Math Program #6, and Displaying the Results of Math Program #6.

7F-5. Selecting Math Program #6

7F-6. Use the following procedure to select Math Program #6:

Push SHIFT so that the LED is on. The 8520A will display:

"?" NMBR

Push 6. The 8520A will display:

6 NMBR

Push PROGRAM SELECTION. The 8520A will display:

6 = PEAK

for about 1 second, then return to the multimeter mode.

7F-7. Implementing Math Program #6

7F-8. Math Program #6 can be exercised on data as it is being measured or on data that has been stored in burst memory. To implement Math Program #6, select the program using the preceeding procedure then push PROGRAMS IN USE/OFF so that the LED is on.

7F-9. Displaying the Results of Math Program #6

7F-10. After Math Program #6 has been used to process a series of readings, use the following procedure to display the results. Assume that the high measurement was +5.5V and that the low measurement was –4.5V.

1. Push SHIFT so that the LED is on. The 8520A will display:

"?" NMBR

2. Push 6, then ., then 1, (math register number 6.1 is the HI Peak). The 8520A will display:

6.1 NMBR

3. Push PROGRAM SELECTION. The 8520A will display:

r6.1 = HIPK

for 1 second, then:

+5.5000 HIPK

4. Push PROGRAM DATA. The 8520A will display:

r6.2 = LOPK

for 1 second, then:

–4.5000 LOPK

5. Push PROGRAM DATA. The 8520A will display:

r6.3 = PKPK

for 1 second, then:

+10.0000 PKPK

6. Push PROGRAM DATA. The 8520A will return to the multimeter mode.

Section 7G
Math Program #7 — LIMITS

7G-1. INTRODUCTION

7G-2. Math Program #7 examines each reading to determine whether or not the value lies within a preprogrammed set of limits. As each reading is processed by the program, the 8520A will display that the reading passed (was between the preprogrammed limits), was low, or was high. The program accumulates a count on the number of high readings, the number of low readings, the number of readings that passed, and the total number of readings taken (NTTL). The program can either process readings as they are taken or after they have been stored in burst memory. After the readings have been processed, it is necessary to manually retrieve the accumulated results. To prepare the 8520A for processing another series of readings, push RESET once. Table 7G-1 lists the registers of Math Program #7. The Math Program Operation Section presents general procedures for operating math programs.

7G-3. OPERATION

7G-4. There are three procedures: Selecting Math Program #7, Implementing Math Program #7, and Displaying the Results of Math Program #7.

Table 7G-1. Math Program #7 Registers

REGISTER NUMBER	RIGHT DISPLAY	DESCRIPTION	FORMULA	DEFAULT VALUE
r7.0		Limits test on input	Compare I to UL and LL	
	HIGH		if $I \geq UL$, set $NH=NH+1$	
	LOW		if $I < LL$, set $NL=NL+1$	
	PASS		if $LL < I < UL$, set $NP=NP+1$	
r7.1	ULMT	Upper Limt	UL	0
r7.2	LLMT	Lower Limit	LL	0
r7.3	N HI	Number of High Readings	NH	0
r7.4	N LO	Number of Low Readings	NL	0
r7.5	NPAS	Number of readings that passed	NP	0
r7.6	NTTL	Total Number of Readings		0

7G-5. Selecting Math Program #7

7G-6. Select Math Program #7 as follows. As an example, program the upper limit as +3V and the lower limit as -3V.

1. Push SHIFT so that the LED is on. The 8520A will display:

"?" NMBR

2. Push 7. The 8520A will display:

7 NMBR

3. Push PROGRAM SELECTION. The 8520A will display:

7 = LIM

for about 1 second, then display:

r7.1 = ULMT

for 1 second, then:

+.0000 ULMT

4. Enter the upper limit as follows:

Push 3. The 8520A will display:

3 ULMT

Push PROGRAM DATA. The 8520A will display:

r7.2 = LLMT

for 1 second, then:

+.00000 LLMT

5. Enter the lower limit as follows:

Push ± then 3. The 8520A will display:

-3 LLMT

Push PROGRAM DATA. The 8520A will return to the multimeter mode.

7G-7. Implementing Math Program #7

7G-8. Implementing Math Program #7 by pushing PROGRAM IN USE/OFF so that the LED is on. Remember that the TRIGGER and BURST controls can be used to take a specific number of readings or take readings at a specific point in time after a trigger has occured.

7G-9. Displaying the Results of Math Program #7

7G-10. Use the following procedure to display the results of Math Program #7. For an example, assume that 20 readings are taken and that 5 readings are high and 4 are low.

1. Push SHIFT so that the LED is on. The 8520A will display:

"?" NMBR

2. Display the number of high readings by selecting register 7.3 as follows:

Push 7, then ., then 3. The 8520A will display:

7.3 NMBR

Push PROGRAM SELECTION. The 8520A will display:

r7.3 = N HI

for 1 second, then display:

5 N HI

3. Display the number of low readings by pushing PROGRAM DATA. The 8520A will display:

r7.4 = N LO

for 1 second, then display:

4 N LO

4. Display the number of readings that passed by pushing PROGRAM DATA. The 8520A will display:

r7.5 = NPAS

for 1 second, then display:

11 NPAS

5. Display the total number of readings by pushing PROGRAM DATA. The 8520A will display:

r7.6 = NTTL

for 1 second, then display:

20 NTTL

6. Push PROGRAM DATA. The 8520A will return to the multimeter mode.

Section 7H
Math Program #8 — STATISTICS

7H-1. INTRODUCTION

7H-2. Math Program #8 computes the mean variance, and standard deviation of a series of readings either as the readings are taken or after the readings are stored (burst). If the program is used to process a series of readings as the readings are taken, the computations will include all readings after the program is enabled (PROGRAMS IN USE/OFF) or since the program was initialized (RESET). All computations except variance use standard formulas. Variance takes into account an initial value called BIAS. The 8520A will store the first readiing in the sequence as BIAS. The use of BIAS provides improved computational accuracy for certain cases of small variance. The results of the computations must be retrieved manually -- they are not automatically displayed (use the procedure for looking at a Math Register that was presented earlier in the Display Option Register portion of Section 7 to continuously display a result of computations). Other statistical data is also available such as the sum of the squares of the readings, the sum of the differences, etc. Table 7H-1 lists all of math registers for Math Program #8. The Math Program Operation Section presents general procedures for: selecting math programs, stacking math programs, entering measurment directly, entering measurement data stored in Burst Memory, looking at a math register (program stops), using the Display Option Register (monitor a math register without stopping the program), and implementing the math program(s) selected. The procedures that follow are specific to Math Program #8.

7H-3. OPERATION

7H-4. There are three procedures for operating Math Program #8: Selecting Math Program #8, Implementing Math Program #8, and Displaying the Results of Math Program #8 Computations.

7H-5. Selecting Math Program #8

7H-6. Select Math Problem #8 as follows:

1. Push SHIFT so that the LED is on. The 8520A will display:

   "?" NMBR

2. Push 8. The 8520A will display:

   8 NMBR

3. Push PROGRAM SELECTION. The 8520A will display:

8 = STAT

for about 1 second, then return to the multimeter mode (SHIFT LED off).

Table 7H-1. Math Program #8 Registers

REGISTER NUMBER	RIGHT DISPLAY	DESCRIPTION	FORMULA	DEFAULT VALUE
r8.0	none	Input	I	0
r8.1	NUM	Number of Inputs (readings)	n	0
r8.2	AVE	Average	$\frac{1}{n}\sum_{i=1}^{n} Ii$	0
r8.3	STDV	Standard Deviation	$\sqrt{\sigma^2}$	0
r8.4	VAR	Variance	$\frac{1}{n-1}\left\{\sum_{i=1}^{n}(Ii-b)^2-\frac{1}{n}\left[\sum_{i=1}^{n}(Ii-b)\right]^2\right\}$	0
r8.5	SUM	Sum of the Inputs	$\sum_{i=1}^{n} Ii$	0
r8.6	SMSQ	Sum of the Squares	$\sum_{i=1}^{n}(Ii-b)^2$	0
r8.7	BIAS	First Input (I) after RESET	b	0
r8.8	DIF	Difference between Input	I—b	0
r8.9	SDIF	Sum of the Difference	$\sum_{i=1}^{n}(Ii-b)$	0

7H-7. Implementing Math Program #8

7H-8. To implement the math program, push PROGRAMS IN USE/OFF so that the LED is on. To disable the program, push PROGRAMS IN USE/OFF so that the LED is off.

7H-9. Displaying the Results of Math Program #8 Computations

7H-10. Display the data (starting at math register 8.1) as follows:

1. Push SHIFT so that the LED is on. The 8520A will display:

"?" NMBR

2. Push 8, then ., then 1. The 8520A will display:

8.1 NMBR

3. Push PROGRAM SELECTION. The 8520A will display:

r8.1 = NUM

for about 1 second, then the 8520A will display the number of readings taken.

4. The PROGRAM DATA control is used to retrieve the rest of the data as follows:

PUSH	LEFT DISPLAY	RIGHT DISPLAY	
PROGRAM DATA	r8.2 = Average of the Readings	AVG AVG	for 1 second
PROGRAM DATA	r8.3 = Standard Deviation	STDV STDV	for 1 second
PROGRAM DATA	r8.4 = Variance	VAR VAR	for 1 second
PROGRAM DATA	r8.5 = Sum of the Readings	SUM SUM	for 1 second
PROGRAM DATA	r8.6 = Sum of the squares	SMSQ SMSQ	for 1 second
PROGRAM DATA	r8.7 = Bias	BIAS BIAS	for 1 second
PROGRAM DATA	r8.8 = Reading minus Bias	DIF DIF	for 1 second
PROGRAM DATA	r8.9 = Sum of the Differences	SDIF SDIF	for 1 second
PROGRAM DATA	The 8520A will return to the multimeter mode (SHIFT LED off).		

Section 7I
Math Program #9
Low Frequency AC RMS Voltage

7I-1. INTRODUCTION

7I-2. Math Program #9 displays a running computation of the rms value of all readings taken after the program is enabled (PROGRAMS IN USE/OFF) or since the program was initilized (RESET). This allows the rms values of low frequency ac signals (0.1 Hz to 10 Hz, typically) to be measured accurately. Before Math Program #9 can be properly implemented, the 8520A must be set up as follows:

function	VDC
range	any fixed range -- must not be in AUTO
reading rate	greater than 5 times the input frequency
filter	5 mSEC

The maximum number of readings is limited to twenty readings per second with line synchronous operation and slightly higher with asynchronous operation. Therefore, only signals with frequency up to 4 Hz can be measured directly (reading rate = 5 X 4 Hz = 20/sec which is the maximum reading rate). Frequencies greater than 4 Hz (and 10 Hz or less) must be captured in burst memory and then read out at a slower reading rate as required by Math Program #9. To start the rms computation again, push RESET once. Table 7I-1 lists all the registers for Math Program #9. The Math Program Operation Section presents general procedures for: selecting math programs, stacking math programs, entering measurement directly, entering measurement data stored in burst memory, looking at a math register (program stops), using the Display Option Register (monitor a math register without stopping the program), and implementing the math program(s) selected. The procedure that follow are specific to Math Program #9.

7I-3. OPERATION

7I-4. There are four procedures: Selecting Math Program #9, Implementing Math Program #9, Displaying Data Stored in Math Memory, and Initializing the RMS Value.

7I-5. Selecting Math Program #9

7I-6. Select Math Problem #9 as follows:

1. Push SHIFT so that the LED is on. The 8520A will display:

   "?" NMBR

2. Push 9. The 8520A will display:

   9 NMBR

Table 7I-1. Math Program #9 Register

REGISTER NUMBER	RIGHT DISPLAY	DESCRIPTION	FORMULA	DEFUALT VALUE
r9.0	LFAC	filtered LFAC	$V_{32}/32$ where V is the contents of r9.4	0
r9.1	NUM	number of Inputs (readings)	n	0
r9.2	SMSQ	Sum of the Squares	$\sum_{i=1}^{n} Ii^2$	0
r9.3	ACLF	RMS value (LFAC)	$\sqrt{\frac{1}{n}\sum_{i=1}^{n} Ii^2}$	0
r9.4	RSUM	Filter Summing	V_i = sum of the last i consecutive values of r9.3 i = 1,2,. . .32; then back to 1,2,. . .32; etc.	0

3. Push PROGRAM SELECTION. The 8520A will display:

9 = LFAC

for about 1 second after the control is released, then return to the multimeter mode (SHIFT LED off).

7I-7. Implementing Math Program #9

7I-8. Implement Math Program #9 as follows:

1. Assuming that the program has been selected as just described, and the frequency of the input signal is 4 Hz or less, set-up the 8520A as follows:

function	VDC
range	any fixed range -- must not be in AUTO
reading rate	greater than 5 times the input frequency
filter	5 mSEC

then push PROGRAMS IN USE/OFF so that the LED is on. The results of the running rms computation will be automatically displayed.

2. Assume that the program has been selected and the readings have been captured in burst memory (see the Operation Section), process the contents of burst memory using Math Program #9 as follows:

a. Push SHIFT so the LED is on.

b. Push PROGRAMS IN USE/OFF so the LED is on.

c. Select the portion of burst memory to be scanned using the procedure presented in the Operation Section.

d. The 8520A display is the rms value of the readings scanned.

7I-9. Displaying Data Stored in Math Registers

7I-10. Manually retrieve data from the registers of Math Program #9 as follows:

1. Push SHIFT so that the LED is on. The 8520A will display:

   "?" NMBR

2. Push 9, then, then 0. The 8520A will display:

   9.0 NMBR

3. Push PROGRAM SELECTION. The 8520A will display:

   r9.0 = LFAC

   for about 1 second after the control is released, then:

   The rms value LFAC

4. Retrieve the rest of the data using PROGRAM DATA as follows:

PUSH	LEFT DISPLAY	RIGHT DISPLAY
PROGRAM DATA	r9.1 = Number of readings	NUM for 1 second, then NUM
PROGRAM DATA	r9.2 = Sum of the squares of the readings	SMSQ for 1 second, then SMSQ
PROGRAM DATA	r9.3 = Unfiltered	ACLF for 1 second, then ACLF
PROGRAM DATA	r9.4 = Filter summing	RSUM for 1 second, then RSUM
PROGRAM DATA	The 8520A will return to the multimeter mode (SHIFT LED off).	

Section 7J

Math Program #10 — dB Ratio

7J-1. INTRODUCTION

NOTE

For purposes of explanation throughout Math Program #10 it is understood that:

V is the unknown voltage input to the 8520A
Vr is the reference voltage
Pr is the reference power
Ri is the input resistance
RL is the load resistance.

7J-2. Math Program #10 can compute and display dB, dBm, or dBV. As Table 7J-1 shows, the initial value of all programmable constants for Math Program #10 is 1.0. The type of dB computation performed is determined by which of these constants are programmed to a different value.

7J-3. dB can be computed two ways: using a voltage reference or using a power reference. To compute dB transducer power gain, Vr, Ri, and RL must be programmed. The formula used for this method is $dB = 10 \log(V^2/Vr^2)(Ri/RL)$.

7J-4. To compute dBm, program Pr and RL. The formula is $dBm = 10 \log(V^2/RL)/Pr$

7J-5. To compute dBV, program Vr. The formula used for this method is $dBV = 20 \log (V/Vr)$.

7J-6. The Math Program Operation section presents general procedures for: selecting math programs, stacking math programs, entering measurement data directly, entering measurement data stored in burst memory, looking at a math register (program stops), using the Display Option Register (monitor a math register without stopping the program), and implementing the math program(s) selected. The procedures that follow are specific to Math Program #10.

7J-7. OPERATION

7J-8. Four procedures are presented below: Selecting dB Computations of Transducer Power Gain, Selecting dBm Computations, Selecting dBV Computations, and Implementing Math Program #10.

Table 7J-1. Math Program #10 Registers

REGISTER NUMBER	RIGHT DISPLAY	DESCRIPTION	FORMULA	DEFAULT VALUE
r10.0	dB	Computed dB,dBm, dBV	20log (I/Vr)+10log (Ri/PrRL)	0
r10.1	Vr	Reference Voltage	Vr	1.0
r10.2	Ri	Input Resistance	Ri	1.0
r10.3	RL	Load Resistance	RL	1.0
r10.4	Pr	Reference Power	Pr	1.0

7J-9. Selecting dB Computations with a Voltage Reference

NOTE

For example, suppose the reference voltage is +5 V dc, input resistance is 50 ohms, and the load resistance is 75 ohms.

7J-10. Select dB computations with a voltage reference as follows:

1. Push SHIFT so that the LED in on. The 8520A will display:

   "?" NMBR

2. Push 1, then 0. The 8520A will display:

   10 NMBR

3. Push PROGRAM SELECTION. The 8520A will display:

   10 = dB

   for 1 second after the control is released, then:

   r10.1 = Vr

   for 1 second, then:

   +1.00000 Vr

4. Enter the reference voltage value as follows:
   a. Push 5. The 8520A will display:

      5 Vr

   b. Push PROGRAM DATA. The 8520A will display:

      r10.2 = Ri

      for 1 second after the control is released, then:

      +1.00000 Ri

5. Enter the input resistance as follows:
   a. Push 5, then 0. The 8520A will display:

      50 Ri

b. Push PROGRAM DATA. The 8520A will display:

r10.3 = RL

for 1 second after the control is released, then:

+1.00000 RL

6. Enter the load resistance as follows:

a. Push 7, then 5. The 8520A will display:

75 RL

b. Push PROGRAM DATA. The 8520A will display:

r10.4 = Pr

for 1 second after the control is released, then

+1.00000 Pr

7. Reference power must remain 1, so push PROGRAM DATA. The 8520A will return to the multimeter mode (SHIFT LED off).

7J-11. Selecting dBm Computations

NOTE

For example, suppose the reference is 1 mW and the load resistance is 50 ohms.

7J-12. Select dBm computations as follows:

1. Push SHIFT so that the LED is on. The 8520A will display:

"?" NMBR

2. Push 1, then 0. The 8520A will display:

10 NMBR

3. Push PROGRAM SELECTION. The 8520A will display:

10 = dB

for about 1 second after the control is released, then:

r10.1 = Vr

for 1 second, then:

+1.00000 Vr

4. Vr must remain +1, so push PROGRAM DATA. The 8520A will display:

r10.2 = Ri

for 1 second, then:

+1.00000 Ri

5. Ri must remain +1, so push PROGRAM DATA. The 8520A will display:

r10.3 = RL

for 1 second, then:

+1.00000 RL

6. Program the new RL as follows:
   a. Push 5, then 0. The 8520A will display:

   50 RL

   b. Push PROGRAM DATA. The 8520A will display:

   r10.4 = Pr

   for 1 second, then:

   +1.00000 Pr

7. Program the new reference power as follows:
   a. Push 1, then EXP, then ±, then 3. The 8520A will display:

   1 E-03

   b. Push PROGRAM DATA. The 8520A will exit the math program.

7J-13. Selecting dBV Computation

NOTE

For example, suppose that the reference voltage is +5V.

7J-14. Select dBV computations as follows:

1. Push SHIFT so that the LED is on. The 8520A will display:

"?" NMBR

2. Push 1, then 0. The 8520A will display:

10 NMBR

3. Push PROGRAM SELECTION. The 8520A will display:

10 = dB

for about 1 second after the control is released, then:

r10.1 = Vr

for 1 second, then:

+1.00000 Vr

4. Program the new voltage reference as follows:

a. Push 5. The 8520A will display:

+5 Vr

b. Push PROGRAM DATA. The 8520A will display:

r10.2 = Ri

for 1 second, then:

+1.00000 Ri

5. Use the PROGRAM DATA control to sequence through the remaining constants to make sure that they are +1.0. The 8520A will return to the multimeter mode (SHIFT LED off).

7J-15. Implementing Math Program #10

7J-16. To implement Math Program #10, push PROGRAMS IN USE/OFF so the LED is on. To make another dB measurement apply another input.

Section 7K
Math Program #11
RTD Temperature Conversion

7K-1. INTRODUCTION

7K-2. Math Program #11 computes and displays (in degrees Celsius) the temperature equivilant to the resistance of a resistance temperature detector (RTD) connected to the input of the 8520A. The equivalent temperature in degrees Kelvin and in degrees Fahrenheit is also computed. Both are available but you must either use the Display Option Register or manually retrieve the data from the Math Registers. The instrument automatically loads alpha, beta, and delta parameters (see Table 7K-1) for the most common type RTD, but the operator has the option of loading parameters specific to his RTD. Each time the RTD is used, it is recommended that ice point reference be used with the 8520A and the RTD to store the proper R0 (This procedure will be described in the procedures that follow). Four wire resistance measurements are recommended for maximum accuracy but three and two wire measurements can be made. The readings must be taken on the proper resistance range for the RTD (for example, if a 100Ω RTD is used, manually select the 1000 Ohm range) to insure that the measurments are made on the range that will create the least amount of current flow. Minimizing the current flow minimizes the heating caused by thermal currents in the RTD. Minimizing the heating minimizes the measurement error. The Math Program Operation Section presents general procedures for: selecting math programs, stacking math programs, entering measurement directly, entering measurement data stored in burst memory, looking at a math register (program stops), using the Display Option Register (monitor a math register without stopping the program), and implementing the math program(s) selected. Figure 7K-1 shows the approximate melting temperatures of some important metals.

7K-3. RTD THERMOMETRY

7K-4. Introduction

7K-5. The following paragraphs provide general information about RTD devices.

7K-6. Principle of RTD

7K-7. Resistance Temperature Detectors (RTD) are based on the principle that the conductivity of a metal changes in a predictable manner as it's temperature changes. RTDs are used in applications where accuracy is required. For example, the International Practical Temperature Scale is based on precision platinum RTDs.

7K-8. RTD Parameters

7K-9. Four parameters are used in describing RTDs: R0, Alpha, Delta, and Beta.

R0 is the resistance of the RTD at 0°C.

Alpha is a constant which approximates the slope of the temperature/resistance curve from 0°C to 100°C. In platinum RTDs, the Alpha value is the guide to the purity of the metal in the RTD. The higher the Alpha the higher the purity of the platinum. The purity is not indicative of accuracy. For consistent, accurate RTDs it is best to have the amount of impurity controlled to a consistent level. Alpha is also a guide to linearity.

Delta is a constant used in the mathematical description of the temperature/resistance curve above 100°C.

Beta is a constant used in the mathematical description of the temperature/resistance curve for -183°C to 0°C.

Table 7K-1. Math Program #11 Register

REGISTER NUMBER	RIGHT DISPLAY	DESCRIPTION	FORMULA	DEFAULT VALUE
r11.0	°C	RTD Degrees Celsius	T	0
r11.1	°K	RTD Degrees Kelvin	T+273.15	0
r11.2	°F	RTD Degrees Fahrenheit	1.8T+32	0
r11.3	RO	RTD resistance at 0 Degrees Cesius	R0	100
r11.4	ALPH	ALPHA	$\frac{R100-R0}{100(R0)}$	.00385
r11.5	DELT	DELTA	$\frac{At'-[(Rh/R0)-1]}{A[(t'/100)-1]\,[t'/100]}$	1.45
r11.6	BETA	BETA	$\frac{1+A[Tl-(D)Tl\,(\frac{Tl}{100}-1)/100]-Rl/R0}{A[\,(Tl/100)-1]\,[Tl/100]^3}$	.11

where t' = Th – .045[Th/100] [(Th/100) – 1] [(Th/419.58) – 1] [(Th/630.74) –1]

R100 = RTD resistance at 100 degrees Celsius

R0 = RTD resistance at 0 degrees Celsius

Th = Some high temperature calebration point. Typically the melting point of zinc or tin.

Rh = RTD resistance at Th.

Tl = Some low temperature calibration point. Typically the boiling point of O_2 or N_2.

Rl = RTD resistance at Tl.

7K-10. Circuitry

7K-11. WIRE CONFIGURATION

7K-12. Figure 7K-2 show three wire configurations for temperature measurements using RTDs. The 4-wire configuration removes the effects of lead resistance, probe resistance, and ambient changes in lead resistance from the measured temperature. Use 4-wire configuration for precision measurement. Use the 3-wire or 2-wire configuration for applications where precision is not required or where lead resistance, probe resistance, and ambient changes in lead resistance are not significant.

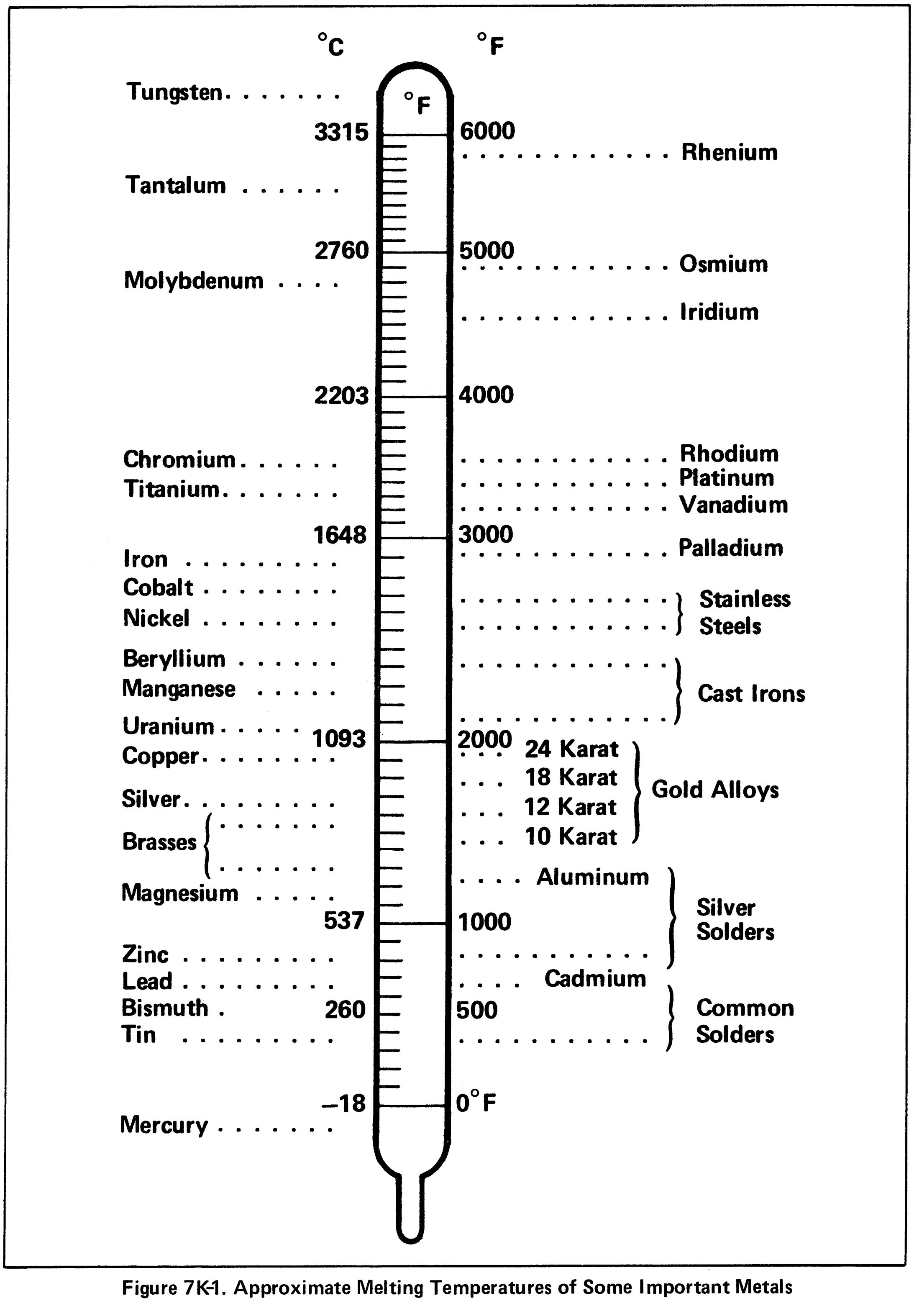
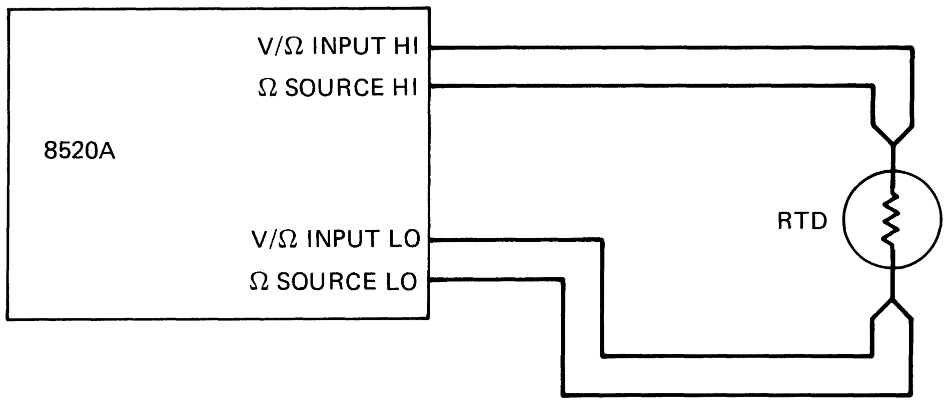
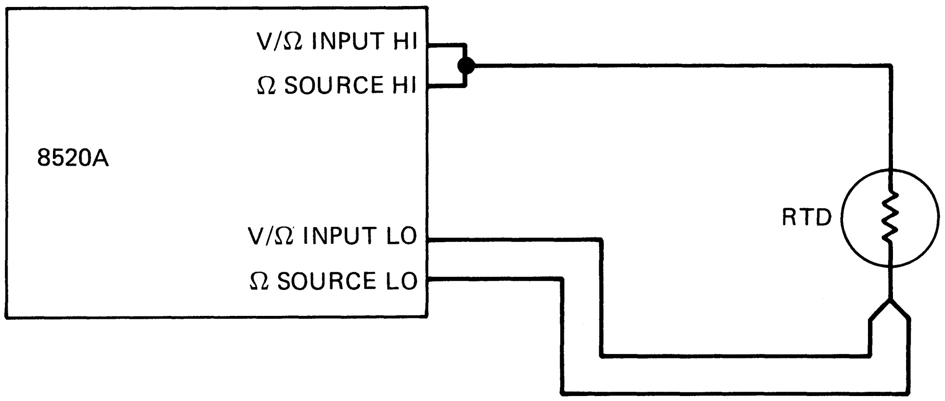


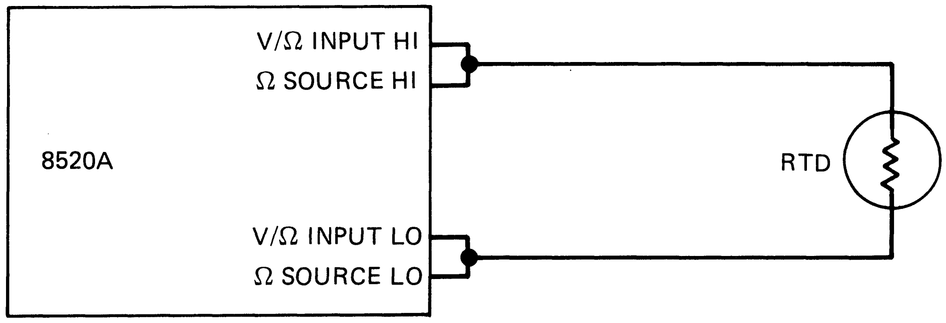
Figure 7K-1. Approximate Melting Temperatures of Some Important Metals


V/Ω INPUT HI
Ω SOURCE HI
8520A
V/Ω INPUT LO
Ω SOURCE LO
RTD

4 - WIRE CONFIGURATION


V/Ω INPUT HI
Ω SOURCE HI
8520A
V/Ω INPUT LO
Ω SOURCE LO
RTD

3 - WIRE CONFIGURATION


V/Ω INPUT HI
Ω SOURCE HI
8520A
V/Ω INPUT LO
Ω SOURCE LO
RTD

2 - WIRE CONFIGURATION

Figure 7K-2. Wire Configuration

7K-13. 8520A METHOD

7K-14. The 8520A uses the potentiometric method. The 8520A applies a constant current through the RTD and measures the resulting voltage. Using this method, there is no lead wire error when 4-wire RTDs are measured because no current flows in the leads. 2-wire and 3-wire measurement will have lead wire error caused by current flowing in the leads. This can be eliminated at one point by calibrating the RTD being used with the 8520A.

7K-15. OPERATION

7K-16. Three operation procedures are presented below: Selecting Math Program #11, Implementing Math Program #11, and Displaying Equivalent Degrees Kelvin and Fahrenheit.

7K-17. Selecting Math Program #11

7K-18. Select Math Program #11 as follows:

1. Push SHIFT so that the LED is on. The 8520A will display:

   "?" NMBR

2. Push 1 twice. The 8520A will display:

   11 NMBR

3. Push PROGRAM SELECTION. The 8520A will display:

   11 = RTD

   for about 1 second after the control is released, then:

   r11.3 = RO

   for 1 second, then:

   +100.000 RO

4. The 8520A is now ready for entry of RO, the resistance at 0 degrees Celsius. You have the option of either using the stored value or using an ice point reference to enter the most accurate value possible. If the stored value is acceptable, skip steps a and b.

   a. Place the RTD in an ice point environment.

   b. Push MANUAL TRIGGER (the 8520A will take and display a reading).

   c. Push PROGRAM DATA. The 8520A will display:

   r11.4 = ALPH

   for 1 second, then:

   +3.8500 E-03

5. You have the option of using either the stored value for ALPHA (+.00385) or entering a new value. If the stored value is acceptable skip step a).

   a. Suppose the ALPHA of your RTD (written on the probe) is +.00405, enter the ALPHA using either standard or scientific notation. That is, either sequentially push ., then 0, then 0, then 4, then 0, then 5, or sequentially push 4, then ., then 0, then 5, then EXP, then ±, then 3.

   b. Push PROGRAM DATA. The 8520A will display:

   r11.5 = DELT

   for 1 second, then:

   +1.45000 DELT

6. You have the option of either using the stored value for DELTA (+1.45) or entering a new value. To enter the new DELTA, use the procedure just described for entering ALPHA. Push PROGRAM DATA. The 8520A will display:

   r11.6 = BETA

   for 1 second, then:

   +110.000 E-03

7. You have the option of either using the stored value for BETA (+0.11) or entering a new value. To enter the new BETA, use theprocedure just described for entering ALPHA. Push PROGRAM DATA. The 8520A will exit the math program mode.

7K-19. Implementing Math Program #11

7K-20. Implement Math Program #11

1. Set-up the 8520A for 4-wire resistance measurement, using the RTD (2 and 3 wire measurements can also be made). To maximize the accuracy of measurement and minimize the self heating due to the current source to the 8520A, select the range appropriate for the RTD. For example, select the 1000 ohm range for a 100 ohm RTD.

2. Push PROGRAM IN USE/OFF so that the LED is on. The 8520A will display the temperature of the RTD environment in degrees Celsius. For the equivalent temperature in degrees Kelvin of Fahrenheit, see the following procedure.

7K-21. Displaying Equivalent Degrees Kelvin and Fahrenheit

7K-22. Display the equivalent temperature in degrees Kelvin and Fahrenheit either using the Display Option Register or as follows:

1. Push SHIFT so that the LED is on. The 8520A will display:

   "?" NMBR

2. Push 1 twice, then ., then 1. The 8520A will display:

   11.1 NMBR

3. Push PROGRAM SELECTION. The 8520A will display:

r11.1 = °K

for about 1 second, then the 8520A will display the equivalent temperature in degrees Kelvin.

4. Push PROGRAM DATA. The 8520A will display:

r11.2 = °F

for 1 second, then the 8520A will display the equivalent temperature in degrees Fahrenheit.

5. Push SHIFT so that the LED is off (the 8520A returns to the multimeter mode).

Section 7L
Math Program #12
John Fluke 80T-150C Conversion

7L-1. INTRODUCTION

7L-2 Math Program #12 works in conjunction with the John Fluke 80T-150°C Temperature Probe to measure and display temperature in degrees Celsius. The equivalent temperature in degrees Kelvin and Fahrenheit is available but must either be displayed using the Display Option Register or be manually retrieved from math memory. This program cannot be stacked with math Program #1, #11, #13, or #14. Measurements using the 80T-150 are made on the 100 mV range of the VDC function. The Math Program Operation Section presents general procedures for: selecting math programs, stacking math programs, entering measurement directly, entering measurement data stored in burst memory, looking at a math register (program stops), using the Display Option Register (monitor a math register without stopping the program), and implementing the math program(s) selected. The procedures that follow are specific to Math Program #12. Table 7L-1 lists all math registers for Math Program #12.

7L-3. OPERATION

7L-4. Three operation procedures are present below: Selecting Math Program #12, Implementing Math Program #12, and Displaying Equivalent Degrees Kelvin and Fahrenheit.

7L-5. Selecting Math Program #12

7L-6. Select Math Program #12 as follows:

1. Push SHIFT so that the LED is on. The 8520A will display:

"?" NMBR

Table 7L-1. Math Program #13 Registers

REGISTER NUMBER	RIGHT DISPLAY	DESCRIPTION	FORMULA	DEFAULT VALUE
r12.0	°C	Temperature °Celsius	T = Input X 1000	0
r12.1	°K	Temperature °Kelvin	T + 273.15	0
r12.2	°F	Temperature °Fahrenheit	1.8T + 32	0

2. Push 1, then 2. The 8520A will display:

12 NMBR

3. Push PROGRAM SELECTION. The 8520A will display:

12 = JV C

for about 1 second, then the 8520A will return to the multimeter mode (SHIFT LED off).

7L-7. Implementing Math Program #12

7L-8. Implement Math Program #12 as follows:

1. Select the VDC measurement function, 100 mV range.

2. Connect the 80T-150C to the input of the 8520A.

3. Push PROGRAM IN USE/OFF so that the LED is on. The 8520A will display the temperature of the RTD environment in degrees Celsius. For the equivalent temperature in degrees Kelvin or Fahrenheit, see the following procedure.

7L-9. Displaying Equivalent Degrees Kelvin and Fahrenheit

7L-10. Display the equivalent temperature in degrees Kelvin and Fahrenheit either using the Display Option Register or as follows:

1. Push SHIFT so that the LED is on. The 8520A will display:

"?" NMBR

2. Push 1, then 2, then ., then 1. The 8520A will display:

12.1 NMBR

3. Push PROGRAM SELECTION. The 8520A will display:

r12.1 = °K

for about 1 second, then the 8520A will display the Kelvin equivalent of the measured temperature.

4. Push PROGRAM DATA. The 8520A will display:

r12.2 = °F

for 1 second, then the 8520A will display the Fahrenheit equivalent of the measured temperature.

5. Push SHIFT so that the LED is off. The 8520A will return to VDC measurement function and display the temperature in °C.

Section 7M
Math Program #13
John Fluke 80T-150F Conversion

7M-1. INTRODUCTION

7M-2. Math Program #13 works in conjunction with the John Fluke 80T-150F Temperature Probe to measure and display temperature in degrees Fahrenheit. The equivalent temperature in degrees Kelvin and Celsius is available and can either be displayed using the Display Option Register or be manually retrieved from math registers. This program cannot be stacked with Math Program #1, #11, #12, or #14. Temperatures below 200°F are measured on the 100V range of the VDC measurement function. Temperatures 200°F and above are measured on the 1V range. The Math Program Operation Section presents general procedures for: selecting math programs, stacking math programs, entering measurement data directly, entering measurement data stored in burst memory, looking at a math register (program stops), using the Display Option Register (monitor a math register without stopping the program), and implementing the math program(s) selected. The procedures that follow are specific to Math Program #13. The Math Registers allocated to Math Program #13 are listed in Table 7M-1.

7M-3. OPERATION

7M-4. Three operation procedures are presented below: Selecting Math Program #13, Implementing Math Program #13, and Displaying Equivalent Degrees Kelvin and Celsius.

7M-5. Selecting Math Program #13

7M-6. Select Math Program #13 as follows:

1. Push SHIFT so that the LED is on. The 8520A will display:

"?" NMBR

Table 7M-1. Math Program #13 Registers

REGISTER NUMBER	RIGHT DISPLAY	DESCRIPTION	FORMULA	DEFAULT VALUE
r13.0	°F	Temperature °Fahrenheit	T = Input X 1000	0
r13.1	°C	Temperature °Celsius	5/9 (T–32)	0
r13.2	°K	Temperature °Kelvin	T + 273.15	0

2. Push 1, then 3. The 8520A will display:

13 NMBR

3. Push PROGRAM SELECTION. The 8520A will display:

13 = JV F

for about 1 second, then the 8520A will return to the multimeter mode (SHIFT LED off).

7M-7. Implementing Math Program #13

7M-8. Implement Math Program #13 as follows:

1. Select the VDC measurement function, 100 mV range to measure temperatures below 200° F or 1V range to measure temperature 200° F and above.

2. Connect the 80T-150F to the input of the 8520A.

3. Push PROGRAM IN USE/OFF so that the LED is on. The 8520A will display the temperature of the environment of the 80T-150F probe tip in degrees Fahrenheit. For the equivalent temperature in degreesCelsius or Kelvin, see the following procedure.

7M-9. Displaying Equivalent Degrees Celsius and Kelvin

7M-10. Display the equivalent temperature in degrees Celsius and Kelvin either by using the Display Option Register or as follows:

1. Push SHIFT so that the LED is on. The 8520A will display:

"?" NMBR

2. Push 1, then 3, then ., then 1. The 8520A will display:

13.1 NMBR

3. Push PROGRAM SELECTION. The 8520A will display:

r13.1 = °C

for about 1 second, then the 8520A will display the Celsius equivalent of the measured temperature.

4. Push PROGRAM DATA. The 8520A will display:

r13.2 = °K

for 1 second, then the 8520A will display the Kelvin equivalent of the measured temperature.

5. Push SHIFT so that the LED is off. The 8520A will return to the VDC measurement function, displaying the temperature in °F.

Section 7N
Math Program #14
Thermistor Linearization

7N-1. INTRODUCTION

7N-2. Math Program #14 converts the resistance of a thermistor to temperature in degrees Celsius (on a linearized curve) and displays the results. The equivalent temperature is available in degrees Kelvin and Fahreheit but must be manually retrieved. This program cannot be stacked with Math Programs #1, #11, #12, and #13. For the greatest accuracy, use 4 wire resistance measurement (2 and 3 wire measurements can be made).

7N-3. The program uses four resistance-temperature characteristics of the thermistor: A0, A1, A2, and A3. The default values which are automatically stored (see Table 7N-1) match the nominal characteristics of the YSI 44007, Fenwall UUA35J1, Omega UUA35J3, or equivalent over the range of -80°C to +150°C (-112°F to +302°F). The characteristics of a calibrated thermistor or a different thermistor type can be substituted. The math program computes temperature according to the following formula: $1/T = A0 + A1(\ln R) + A2(\ln R)^2 + A3(\ln R)^3$, where T = temperature in degrees Celsuis and R = resistance. For additonal information,contact your nearest John Fluke Sales representative. The shipping and Service Information Section contains the address and telephone number of each John Fluke Sales representative.

7N-4. The Math Program Operation Section presents general procedures for: selecting math programs, stacking math programs, entering measurement data directly, entering measurement data stored in burst memory, looking at a math register (program stops), using the Display Option register (monitor a math register without stopping the program), and implementing the math program(s) selected. The procedures that follow are specific to Math Program #14. Table 7N-1 lists all Math Registers for Math Program #14.

7N-5. THERMISTOR THERMOMETRY

7N-6. Thermistors are semiconductor devices whose resistance is a function of their absolute temperature. Most applications use a region of thermistor operation where the thermistor exhibits negative temperature characteristics. That is, if temperature increases the resistance of the thermistor decreases and if temperature decreases, resistance increases. The relationship between the temperature of a thermistor and the resistance of a thermistor can be stated as:

$$R(T1)/R(T2) = e^{\beta}\,(T2-T1)/T1T2$$

where R(T1) is the resistance at absolute temperature T1.
R(T2) is the resistance at absolute temperature T2.
e is the natural logarithm 2.718.
β is a constant which depends upon the thermistor material.

Table 7N-1. Math Program #14 Registers

REGISTER NUMBER	RIGHT DISPLAY	DESCRIPTION	FORMULA	DEFAULT VALUE
r14.0	°C	Temp. °Celsius	$1/T = A0 + A1 \ln R + A2(\ln R)^2$ $+ A3(\ln R)^3$	0
r14.1	°K	Temp. °Kelvin	$T + 273.15$	0
r14.2	°F	Temp. °Fahrenheit	$1.8T + 32$	0
r14.3	A0	Constant A0	$A0 = -D1(X2)(X3)(X4)$ $-D2(X1)(X3)(X4)$ $-D3(X1)(X2)(X4)$ $-D4(X1)(X2)(X3)$	1.282015 E-3
r14.4	A1	Constant A1	$A1 = D1[(X2)(X3)+(X2)(X4)$ $+(X3)(X4)]$ $+D2[(X1)(X3)+(X1)(X4)$ $+(X3)(X4)]$ $+D3[(X1)(X2)+(X1)(X4)$ $+(X2)(X4)]$ $+D4[(X1)(X2)+(X1)(X3)$ $+(X2)(X3)]$	.2372517 E-3
r14.5	A2	Constant A2	$A2 = -D1(X2+X3+X4)$ $-D2(X1+X3+X4)$ $-D3(X1+X2+X4)$ $-D4(X1+X2+X3)$	−116.2073 E-09
14.6	A3	Constant A3	$A3 = D1+D2+D3+D4$	96.82669 E-09

where $D1 = Y1/(X1-X2)(X1-X3)(X1-X4)$

$D2 = Y2/(X2-X1)(X2-X3)(X2-X4)$

$D3 = Y3/(X3-X1)(X3-X2)(X3-X4)$

$D4 = Y4/(X4-X1)(X4-X2)(X4-X3)$

$Xn = \ln Rn$

$Yn = 1/(Tn+273.15)$

(Rn,Tn) are four pairs of resistance/temperature values read off a thermistor specification sheet. For example, the resistance-temperature points for the default values of A0, A1, A2, and A3 are:

n	Temperature °C (Tn)	Resistance (Rn)
1	−80	3685 kOhm
2	0	16.33 kOhm
3	70	875.7 Ohm
4	150	92.7 Ohm

7N-7. Precision thermistor thermometry must take into consideration errors caused by self-heating of the thermistor. The source current of the 8520A ohms range used to measure the thermistor resistance will cause a power dissapation of

$$P=I^2xR$$

Where P=Power dissapated in the thermistor
I=Measurement current
R=Resistance of the thermistor

The thermistor will thus stabilize at a temperature higher than the ambient being measured. For general purpose use with the recommended devices it is sufficient to allow the 8520A to autorange; for improved absolute accuracy at elevated temperatures the 8520A ohms range may need to be fixed on the next higher range than that selected by autorange.

7N-8. Circuitry

7N-9. Figure 7N-1 shows three wire configurations for temperature measurements using thermistors. The 4-wire configuration removes the effects of lead resistance, probe resistance, and ambient changes in lead resistance from the measured temperature. Use 4-wire configuration for precision measurements. Use the 3-wire or 2-wire configuration for applications where precision is not required or where lead resistance, probe resistance, and ambient changes in lead resistance are not significant.

7N-10. 8520A Measurement Method

7N-11. The 8520A uses the potentiometric method. The 8520A applies a constant current through the thermistor and measures the resulting voltage. Using this method, there is no lead wire error when 4-wire thermistors are measured because no current flows in the leads. 2-wire and 3-wire measurements will have lead wire error caused by current flowing in the leads. This can be eliminated at one point by calibrating the thermistor being used with the 8520A.

7N-12. OPERATION

7N-13. Three operation procedures are presented below: Selecting Math Program #14, Implementing Math Program #14, and Displaying Equivalent Degrees Kelvin and Fahrenheit.

7N-14. Selecting Math Program #14

7N-15. Select Math Program #14 as follows:

1. Push SHIFT so that the LED is on. The 8520A will display:

   "?" NMBR

2. Push 1, then 4. The 8520A will display:

   14 NMBR

3. Push PROGRAM SELECTION. The 8520A will display:

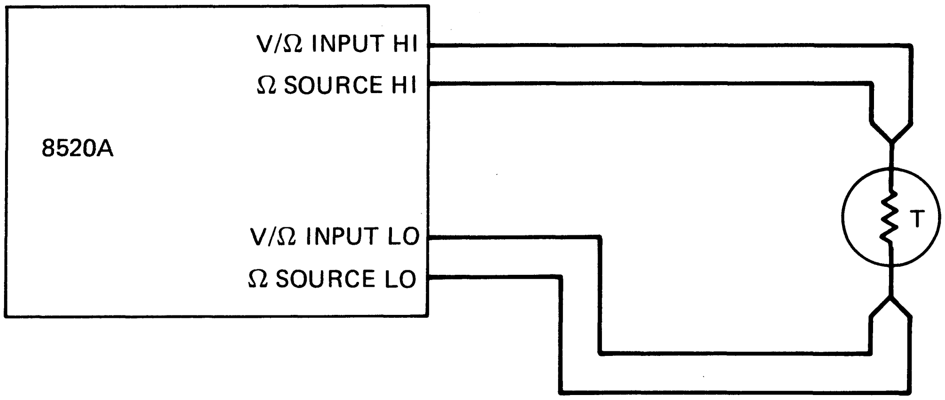
   14 = THMS

   for about 1 second after the control is released, then:

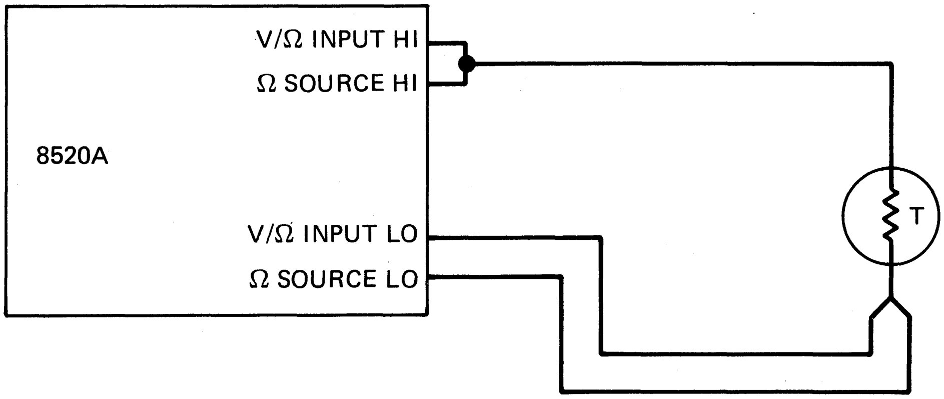
   r14.3 = A0

   for 1 second, then:

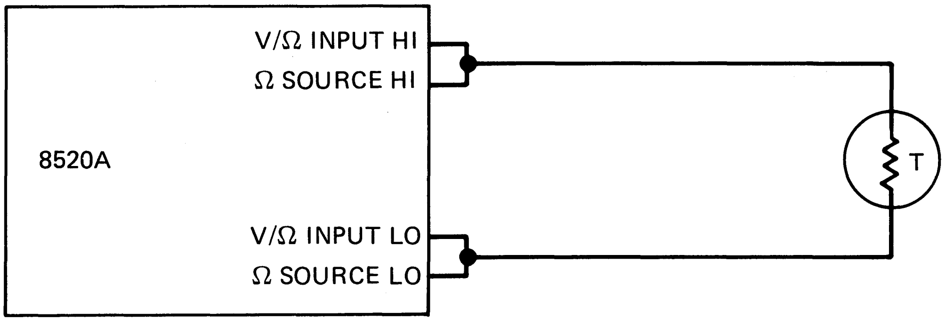
   +1.28201 E-03


V/Ω INPUT HI
Ω SOURCE HI
8520A
V/Ω INPUT LO
Ω SOURCE LO
T

4 - WIRE CONFIGURATION


V/Ω INPUT HI
Ω SOURCE HI
8520A
V/Ω INPUT LO
Ω SOURCE LO
T

3 - WIRE CONFIGURATION


V/Ω INPUT HI
Ω SOURCE HI
8520A
V/Ω INPUT LO
Ω SOURCE LO
T

2 - WIRE CONFIGURATION

Figure 7N-1. Wire Configuration

4. You can either use the stored value for A0 or enter a new value using the numeric keyboard. Push PROGRAM DATA. The 8520A will display:

r14.4 = A1

for 1 second, then:

+2.3725 E-03

5. You can either use the stored value for A1 or enter a new value using the numeric keyboard. Push PROGRAM DATA. The 8520A will display:

r14.5 = A2

for 1 second, then:

-116.207 E-09

6. You can either use the stored value for A2 or enter a new value using the numeric keyboard. Push PROGRAM DATA. The 8520A will display:

r14.6 = A3

for 1 second, then:

+96.827 E-09

7. You can either use the stored value for A3 or enter a new value using the numeric keyboard. Push PROGRAM DATA. The 8520A will return to the multimeter mode.

7N-16. Implementing Math Program #14

7N-17. Implement Math Program #14 as follows:

1. Set-up the 8520A for 4-wire resistance measurement (2 and 3 wire measurements can also be made) with the appropriate range for the thermistor selected.

2. Connect the thermistor to the input of the 8520A.

3. Push PROGRAM IN USE/OFF so that the LED is on. The 8520A will display the temperature of the thermistor environment in degrees Celsius. For the equivalent temperature in degrees Kelvin of Fahrenheit, see the following procedure.

7N-18. Displaying Equivalent Degrees Kelvin and Fahrenheit

7N-19. Display the equivalent temperature in degrees Kelvin and Fahrenheit either using the Display Option Register or as follows:

1. Push SHIFT so that the LED is on. The 8520A will display:

"?" NMBR

2. Push 1, then 4, then ., then 1. The 8520A will display:

14.1 NMBR

3. Push PROGRAM SELECTION. The 8520A will display:

r14.1 = °K

for about 1 second, then the 8520A will display the Kelvin equivalent of the measured temperature.

4. Push PROGRAM DATA. The 8520A will display:

r14.2 = °F

for 1 second, then the 8520A will display the Fahrenheit equivalent of the measured temperature.

5. Push SHIFT so that the LED is off. The 8520A will return to the multimeter mode (SHIFT LED off).

Section 8
IEEE-488 (Remote Operation)

8-1. INTRODUCTION

8-2. The 8520A is designed to operate in a system environment, via an integral IEEE-488 interface. When addressed on the IEEE-488 Bus the instrument goes to remote, the front panel REMOTE indicator illuminates and all switches on the front panel are disabled except the POWER switch and, unless programmed disabled, the CONTROL LOCAL keyswitch.

8-3. Each 8520A is equipped with a IEEE-488 standard interface. It contains the subsets listed in Table 8-1. Each subset includes a brief description. If further details are required refer to the IEEE STD 488, Digital Interface for Programmable Instrumention.

8-4. Once the instrument is in the remote mode, full control to the instrument is exercised through the bus controller. Commands can be sent on the bus to disable the CONTROL LOCAL keyswitch, preventing return to front panel control. The POWER switch cannot be controlled remotely and must be manually operated from the front panel.

Table 8-1. IEEE-488 Subsets

ID FUNCTION	CAPABILITY DESCRIPTION
SH1 Source Handshake	Complete Capability
AH1 Acceptor Handshake	Complete Capability
T5 Talker	Basic Talker, Serial Poll, Talk Only Unaddress at My Listen Address
L4 Listener	Basic Listener, Unaddress at My Talk Address
SR1 Service Request	Complete Capability
RL1 Remote/Local	Complete Capability
PPO Parallel Poll	No Capability
DC1 Device Clear Interface	Complete Capability
DT1 Device Trigger Interface	Complete Capability
CO Controller	No Capability
E2 Electrical Interface	Three-state drivers

8-5. Communications between the controlling device on the bus and the 8520A must be in standard ASCII code; however, only the seven low order bits of the ASCII code are used; the eighth bit is ignored. The instrument accepts codes in both upper and lower case for commands. Characters represented by hex codes 20 and below, 5B, 5C, 5D, 5F, 6D, 7B, 7C, 7E, and 7F are ignored, unless they follow the KE or KV commands. Spaces (hex code 20) may be inserted in a command string to improve clarity and readability but they are ignored by the instrument.

8-6. Output messages can be transmitted in either ASCII or binary. The format is selectable at the discretion of the operator.

8-7. Program instructions may be combined in a command string of up to 64 characters, including a terminator or execute command. The instructions in the command string are held in a buffer until an execute command is read, then they are processed in the sequence they were entered. If two or more entries deal with the same item; e.g., two function instructions or two reading rate instructions, both are executed, however, the last one executed determines the final state of the instrument.

8-8. Instruction may be broken into fourteen classifications for explanatory purposes. A complete set of instructions is shown in Table 8-2. A breakdown by classification follows in subsequent paragraphs.

8-9. Section 3 of this manual describes the mechanical / electrical connection of the 8520A to the IEEE-488 interface and describes the possible configuration of the rear panel IEEE-488 ADDRESS switches. Complete with the connections and switch settings before attempting operation on the IEEE-488 Bus.

8-10. IEEE-488 Status

8-11. When the instrument is turned on (POWER pushed to ON) or RESET is pushed twice, the 8520A will display the IEEE-488 Status. Table 8-3 lists the possible IEEE Status displays.

8-12. Talk Only Mode

8-13. The talk only mode prepares the 8520A to respond with a reading every time that a listening device indicates that it is ready for data. Connected to a device, such as a printer, and in the internal trigger mode, the result would be the printer constantly printing the next reading.

8-14. Readings can be ouput either singly as a trigger is received (Burst size equals one) or as a group take at a high rate displayed at a slower rate (scan mode).

8-15. The talk only mode is selected with a switch (S103 TALK ONLY) on the rear panel. Once selected with the switch the system must be initialized, i.e. power ON or RESET, before the switch setting is read.

8-16. Immediate Characters

8-17. There are two immediate characters that interrupt any measurement in progress for immediate action. Both output themselves as a one-byte character to the IEEE-488 bus in addition to their other features.

Table 8-2. Instruction Set

FUNCTION

V	VDC
VA	VAC
VC	DC+AC V
Z2	2 Term OHMS
Z3	Nano Siemens
Z4	4 Term OHMS

"R3R7D8F5M0N5," is performed also.

Z3 performs "R4D8F5M0N5,"

RANGE

R0	100 mVDC, 10 OHMS
R1	1 VOLT, 100 OHMS
R2	10 VOLT, 1000 OHMS
R3	100 VOLT, 10K OHMS
	R4, R5, R6=Hi Ohms
R4	1000 VOLT, 100K OHMS
	100 nSiemens
R5	AUTO VOLT,1M OHMS
R6	AUTO VOLT, 10M OHMS
R7	AUTO RANGE
R8	FIX RANGE

When in ohms and the reading rate is faster than D6, R4 thru R6 will be converted to R3.

TRIGGER

T0	Internal trigger (continuous)
T1	External trigger

PROGRAMS IN USE/OFF

M0	Programs off
M1	Programs "IN USE"

READING RATE

DC volts and Low Ohms

	Readings/second			deflt filter
D0	ASYNChronous			F0
	400Hz	60Hz	50Hz	
D1	228	240	200	F0
D2	114	120	100	F0
D3	57	60	50	F1
D4	38	40	40	F1
D5	19	20	20	F2
All functions and ranges				
D6	9.5	10	10	F3
D7	4.8	5	5	F4
D8	1.9	2	2	F5
D9	1	1	1	F6
		Readings/minute		
D10		30		F6
D11		12		F6
D12		6		F6
D13		2		F6
D14		1		F6
		Readings/hour		
D15		30		F6
D16		12		F6
D17		6		F6
D18		2		F6
D19		1		F6

400 Hz is .03% fast for reading rates slower than 2/sec.

Note that the "D" command changes the filter.

When in ohms and R4 thru R6, D0 thru D5 are converted to D6.

FILTER

	DC volts :	AC volts	: Hi Ohms
	Lo Ohms :	DC+AC	: nSiemens
F0	5mSEC	100mSEC	FAST
F1	25mSEC	100mSEC	FAST
F2	50mSEC	100mSEC	FAST
F3	100mSEC	100mSEC	FAST
F4	200mSEC	200mSEC	FAST
F5	500mSEC	500mSEC	FAST
F6	1000mSEC	1000mSEC	SLOW

FAST = 300mSEC max

SLOW = 4000mSEC max

Table 8-2. Instruction Set (cont)

BURST MEMORY CONTROL

Bn Burstsize = n; max n = +/–999
GMn Transmit memory location
max n = +/–999
Wn/m Transmit memory from n to m
max n,m = +/–999
Yn/m Scan memory from n to m

(W and Y perform selected math if 'M1' is active)

PROGRAMS

P0	"NONE" program *
P1	TEST *
P2	ZERO
P3	EXTERNAL REFERENCE
P4	OFFSET, SCALE, RATIO
P5	PERCENT DEVIATION
P6	PEAK VALUES
P7	LIMITS
P8	STATISTICS
P9	LF RMS
P10	DB RATIO
P11	RTD TEMP CONVERSION
P12	80T-150 C PROBE
P13	80T-150 F PROBE
P14	THERMISTOR CONVERSION

Pabc = up to 3 programs allowed
* may not be grouped
P11, 12, 13, 14,should not be grouped with each other.

MATH PROGRAM REGISTERS

GRr	Transmit register r
KRr/v	Keep data v in register r

STATUS

GF	Transmit full status
GS	Transmit short status
KEs	Keep 's' as error response
KVs	Keep 's' as overrange response

IMMEDIATE CHARACTERS

*	Reset to default state
%	Force 8520 to look at command buffer and clear 8520 output buffer
&	Clear serial poll "rsv"

*,% both output one byte to 488 bus

TERMINATOR COMMANDS

,	Execute command string
?	Execute, trigger, and transmit
!	Execute, arm BNC trigger, and transmit

MISC CONTROL

x=N or I (i.e. N1 or I1)

x1	Front panel on/off
x2	Filter timeout on/off
x3	Linefeed yes/no
x4	ASCII/binary
x5	Normal/High speed
x6	EOI on/off
x7	Lock/Unlock reading transfer

SERIAL POLL

Si jkm Enable serial poll option

0001	Output ready, Overrange, Error
0002	Overrange
0004	Error
0010	End of burst
0020	New high peak
0040	New low peak
0100	Reading HIGH
0200	Reading PASS
0400	Reading LOW
1000	LFAC reading ready
2000	undefined
4000	undefined

Acceptable forms
Sm, Skm, Sjkm, Sijkm
S1=S01=S001=S0001
Add options for multiple SRQ
S11=Output ready, end of burst

Table 8-3. IEEE Status

DISPLAY	STATUS
IEEE = (address, 0-30)	IEEE Address of the 8520A
IEEE = OFF	Untalk or unlisten setting the illegal address 31——the 8520A will not respond to GPIB commands
IEEE = TON	Talk Only switch is at ON
IEEE = BRK	IEEE-488 interface is nonoperational

8-18. The instrument is reset to the default state with the (*) character, i.e., 100 volt dc range, a reading rate of two readings per second, a filter settling time of 500 ms, internal trigger, programs off, and halt character, represented by a percent sign (%), immediately stops any measurements in progress, clears the output buffer, and reads the command buffer.

8-19. The clear rsv character (&) clears the internal request for a service bit in the serial poll response byte. The last byte of any 8520A output also clears the rsv bit.

8-20. Terminator Commands

8-21. The three terminator commands are acted upon by the instrument at the completion of the task in progress. They cause the instrument to process the command buffer, which contains the command string of up to 64 characters, and then perform any other applicable operation.

8-22. The comma (,) terminator executes the command string in the command buffer (up to 63 characters plus the terminator). There is no response or reading generated by the comma terminator since it does not trigger or arm the trigger; however, if it is not preceded by a transmit command (i.e., GS, GRr, etc.) the designated data is placed on the IEEE-488 bus.

8-23. A reading is returned with the question mark (?) terminator in addition to execution of the command string. The command generates a trigger which causes transmission of the resultant reading to the bus. If the string includes a transmit command (G), the requested data is transmitted prior to the triggered reading.

8-24. The exclamation point (!) terminator executes the command string and then arms the BNC TRIGGER TERMINAL instead of generating a trigger. It then awaits the arrival of an external trigger. When triggered the resultant reading is transmitted to the bus. If the string executed includes a transmit command (G), the requested data is transmitted prior to the reading.

8-25. Function Instructions

8-26. The function instructions (Table 8-4) correspond to the function keyswitches on the front panel. Programming a function causes several other events to occur automatically. These are results in automatic autoranging (R8) (ignored for nanosiemens), commands for 2 readings per second (D8), 500 ms (FAST for high ohms or nanosiemens) filter settling time (F5), programs off (M0), and normal speed (N5). Autorange begins with the 100V or 10 KΩ range (R3) for all functions except nanosiemens, which has only the one fixed range (100 nS).

Table 8-4. Function Instructions

CODE	FUNCTION
V	VDC
VA	VAC
VC	VA+D
Z2	Ω2 WIRE
Z3	nS
Z4	Ω4 WIRE

8-27. Range Instructions

8-28. The range instruction codes are listed and explained in Table 8-5. Instructions R4, R5, and R6 select the high ohms mode which changes the operation of the instrument from a current to voltage reference. R8 removes the instrument from autorange and locks (or fixes) it in its current range.

8-29. Reading Rate Instructions

8-30. Table 8-6 contains a list of the reading rate instruction codes and the rates at the various input line frequencies. Also included are the default filter settling times. Each time the reading rate is changed, the default filter is selected; however, the filter settling time may be altered from the default after the reading rate is selected, if desired. The 400 Hz reading rates are nominally the same as the 60 Hz from 1 per second to 1 per hour; however, they are in actuality 0.03% faster than shown in the table. Rates faster than 10 readings per second are available only when measuring dc voltages or low ohms (10 k range and below).

8-31. Filter Instructions

8-32. The filter settling times assigned to each filter instruction code vary with the function selected. Times for each code are listed in Table 8-7. Only a fast or slow time is selectable for a high ohms selection. Times vary with the range selected being measured, with the maximum times 300 ms for fast and 4 seconds for slow.

8-33. Program Instructions

8-34. Program selection codes and titles are given in Table 8-8. Each listed instruction code calls the same program described in section 7 of this manual. Up to three programs can be entered, e.g., P467, as part of an instruction string; however, P0 and P1 cannot be combined with others and only one of codes P11, P12, P13, and P14 should be included in the command. Anytime a P command is executed the accumulating registers of the program specified are cleared.

8-35. Programs in Use/Off Instructions

8-36. The program-in-use instruction consist of M1 to turn on the programs feature and M0 to turn it off. The instruction operates in the same manner as the PROGRAMS IN USE/OFF control.

Table 8-5. Range Instructions

CODE	RANGE				
	VOLTS		OHMS	nS	HI OHMS
	VDC	VAC/VA+D			
R0	100mV	Auto	10Ω	–	No
R1	1 V	1 V	100Ω	–	No
R2	10 V	10 V	1000Ω	–	No
R3	100 V	100V	10kΩ	–	No
R4	1000 V	1000 V	100kΩ	100	Yes
R5	AUTO	AUTO	1MΩ	–	Yes
R6	AUTO	AUTO	10MΩ	–	Yes
R7	AUTO	AUTO	AUTO	–	If selected
R8	Fix	Fix	Fix	–	If selected

Table 8-6. Reading Rate Instructions

RR CODE	READING RATE AT INPUT LINE FREQUENCY			DEFAULT FILTER CODE
	60 Hz	50 Hz	400 Hz	
D0*	Asynchronous			F0
D1*	240/s	200/s	228/s	F0
D2*	120/s	100/s	114/s	F0
D3*	60/s	50/s	57/s	F1
D4*	40/s	40/s	38/s	F1
D5*	20/s	20/s	19/s	F2
D6	10/s	10/s	9.5/s	F3
D7	5/s	5/s	4.8/s	F4
D8	2/s	2/s	1.9/s	F5
D9	1/s	1/s	1/s	F6
D10	30/m	30/m	30/m	F6
D11	12/m	12/m	12/m	F6
D12	6/m	6/m	6/m	F6
D13	2/m	2/m	2/m	F6
D14	1/m	1/m	1/m	F6
D15	30/hr	30/hr	30/hr	F6
D16	12/hr	12/hr	12/hr	F6
D17	6/hr	6/hr	6/hr	F6
D18	2/hr	2/hr	2/hr	F6
D19	1/hr	1/hr	1/hr	F6

*Code selectable only when DC Volts or Low Ohms selected.

Table 8-7. Filter Instructions

CODE	SETTLING TIME		
	DCV/LOΩ	ACV/AC+DC	HIΩ/nS
F0	5 ms	100 ms	Fast
F1	25 ms	100 ms	Fast
F2	50 ms	100 ms	Fast
F3	100 ms	100 ms	Fast
F4	200 ms	200 ms	Fast
F5	500 ms	500 ms	Fast
F6	1000 ms	1000 ms	Slow

Table 8-8. Program Instructions

CODE	TITLE	NOTE
P0	None	Cannot be stacked
P1	TEST	Cannot be stacked
P2	ZERO	
P3	External Reference	
P4	Offset, Scale, and Ratio	
P5	Percent Deviation	
P6	Peak Values	
P7	Limits	
P8*	Statistics	
P9*	Low Frequency RMS Volts	
P10*	dB Ratio	
P11*	RTD Temperature Conversion	Stack only 1 of P11-P14
P12*	80T-150C Probe	Stack only 1 of P11-P14
P13*	80T-150F Probe	Stack only 1 of P11-P14
P14*	Thermistor Conversion	Stack only 1 of P11-P14

*Available as Option -010

8-37. Trigger Instruction

8-38. The instruction T1 is programmed to select an external trigger. This command corresponds to the TRIGGER EXT/AUTO LED illuminated. Transmit TO to return the instrument to an internal (continuous) trigger.

8-39. Burst Instructions

8-40. The burst size is set with the instruction Bn, with n representing the number of readings. The number can be set from -999 through -1 to +1 and then to +999. The Bn command functions in the same manner as the BURST SIZE keyswitch front panel, i.e., if the number # is positive, the assigned number of readings are taken when triggered at the set reading rate, while if the number is negative, one reading is taken at each trigger until the assigned number of readings have been taken.

8-41. To transmit on the IEEE-488 bus the data in a particular location, program the instruction GMn, with n being the memory location desired. The number may be anywhere from -999 to +999.

8-42. The data stored in a series of memory locations can be transmitted on the IEEE-488 bus using the instruction Wn/m with the n being the address of the starting memory location and m the address of the ending location. The data transmitted is acted upon by the selected program prior to transmission if the instruction M1 is active.

8-43. A series of memory locations can be scanned using the instruction Yn/m, with n being the address of the starting memory location and m the address of the ending location. The locations scanned are neither displayed on the instrument front panel or output and are on the IEEE-488 bus. If M1 is active, the data is acted upon by the selected program(s) prior to display.

8-44. Program Register Instructions

8-45. The contents of a particular program register can be transmitted on the IEEE-488 bus with the instruction GRr. The r character represents the register number to be read. For example, to place the contents of register 7.5 on the bus, the command would be GR7.5 followed by one of the terminator instructions. This would place on the bus the contents of register 7.5, i.e., the number of readings within the prescribed limits during operation of the limits program.

8-46. Instruction KRr/v allows the operator to keep or store data in a given register. This can be used to load constants or parameters into a program register for use in computations during program operations. For example, the instruction to store a 5.1V value in the offset register 2.1 would be KR2.1/5.1.

8-47. Status Instructions

8-48. Two of the four status instructions allow the operator to request and recieve information on the status of the instrument. The other two are used to load data to be used as an error or overrange response.

8-49. The full status of the instrument is transmitted to the IEEE-488 bus with the GF instruction. Output is the contents of the full status buffer, which has imbedded spaces to provide for all possible combinations of commands. The format, with the number of allotted characters per command is shown in Figure 8-1.

8-50. The short status instruction (GS) transmits the two digit error code followed by a carriage return and line feed. The error codes were defined in the manual operation portion of this section.

8-51. The instruction KEs and KVs allow the operator to program a string of bytes as an error or overrange indication, respectively. Any combination of 8 bit bytes up to fourteen characters in length may be used for s except the five immediate and termination characters. After the string is inserted by the operator an error or overrange results in the output of the respective string to the bus.

A	A	B	B	C	C	C	D	D	E	E	F	F	G	G	G
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

G	G	G	G	H	H	H	H	H	I	I	I	I	I	J	J
17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32

J	J	J	J	J	J	J	J	J	J	J	J	K	L	M
33	34	35	36	37	38	39	40	41	42	43	44	45	46	47

TOTAL CHARACTER	CHARACTER NO'S	FUNCTION
A 2	1-2	Function Code
B 2	3-4	Range Code
C 3	5-7	Reading Rate Code
D 2	8-9	Filter Code
E 2	10-11	Trigger Code
F 2	12-13	Programs In Use/Off Code
G 7	14-20	Programs Selected Codes
H 5	21-25	Burst Size
I 5	26-30	Serial Poll Codes
J 14	31-44	Miscellaneous Control Codes
K 1	45	Terminator (always a comma ",")
L 1	46	Carriage Return
M 1	47	Line Feed (program selectable)

Figure 8-1. Full Status Message Format

8-52. Miscellaneous Control Instructions

8-53. The miscellaneous control instructions consist of either the character N for enable or I for inhibit preceding a numeric representing a partial control. The instructions are listed in Table 8-9 and described below.

8-54. Instruction 1 enables (ON) or disables (OFF) the front panel. Normal front panel operations can be performed when the front panel is enabled. When it is disabled the keyswitches are not interrogated and the display is disabled, resulting in a local lockout type condition.

8-55. Instruction 2 enables (ON) or disables (OFF) the software timeout used to delay the start of a reading. The timeout period is determined by the filter selected. The timeout feature is in effect for the first reading after a trigger or after autoranging. Other readings are not delayed when the asynchronous mode is selected; the timeout interval is zero.

8-56. Instruction 3 enables or disables the transmission of an automatic line feed character at the end of an ASCII reading. This instruction does not effect any linefeed character included in the error (KE) or overrange (KV) responses.

Table 8-9. Miscellaneous Control Instructions

NUMERIC	ACTION	"N"	"I"
1	Front Panel	ON	OFF
2	Filter Time Out	ON	OFF
3	Line Feed	YES	NO
4	Code Format	ASCII	Binary
5	Speed	Normal	High
6	EOI	ON	OFF
7	Reading Transfer	LOCK	UNLOCK

8-57. Instruction 4 selects either the ASCII or binary message format. In the ASCII format, the output is twelve characters of data plus a carriage return and the program selectable line feed (N3). The binary format outputs four bytes of binary data.

8-58. Instruction 5 selects either the normal DMM mode (speed) of operations or the high speed mode. The high speed mode outputs a two byte binary format message. The normal mode outputs the format selected by instruction 4.

8-59. Instruction 6 enables or disables the use of the IEEE EOI line. If enabled the EOI line is activated with the last byte of each output.

8-60. Instruction 7 locks or unlocks the reading transfer feature. In lock, the instrument outputs a reading and waits for the listener to accept it before continuing. This is the normal mode of operation. Unlock makes the most recent reading available for output; however, it does not have to be output to a display or printing device. The reading could be output at random intervals or output to burst memory at a high rate of speed for output to the bus at some later time at a rate acceptable to a printer. If unlock is used with the burst memory, a reading must be taken from the 8520A to clear the output buffer at the end of the burst. If the bus controller leaves the 8520A as a talker when in unlock, the 8520A attempts to output another reading, if one is available. For that reason, if readings are taken at random intervals, two readings should be taken and the first discarded to insure the most recent reading is used.

8-61. HIGH SPEED MODE

8-62. The high speed mode allows the operator to obtain reading rates of up to 500 readings per second while sacrificing only one digit of resolution. In addition, the data is sent in a binary format acceptable by virtually all data processors. Characteristics of the high speed mode are listed below:

1. Data readings are to ±14 bits of resolution.
2. Readings must be in DC volts or low ohms, i.e., 10 KΩ range or less. A syntax error message results when a high ohms range (100 KΩ or greater) or any other function, including external reference, is selected with the high speed mode selected.
3. The range must be fixed . There is no autoranging capability.
4. Asynchronous reading rate (D0) is forced. The trigger may be either internal or external.
5. No selectable filtering. The fast analog filter (F0) is forced.

6. No math program capability. The instruction "M0 " is forced.

7. The complete burst capability is retained.

8. The front panel is turned off and no indicators are shown.

9. The filter timeout is disabled.

10. The calibration mode is disabled.

11. No ohms protection.

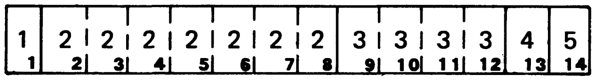
12. The overrange response is not sent in the high speed mode. An error message of 2900 Hex or A900 Hex is sent for a positive or negative overrange respectively. High speed overrange values for the respective ranges are: 100 mV (.25000), 1V (2.0000), 10V (16.000), 100V (128.00), 1000V (1024.0), 10Ω (25.000), 100Ω (200.00), 1000Ω (2000.0), and 10 KΩ (20.000).

8-63. READING MESSAGE FORMATS

8-64. When a reading is transmitted it can be used in one of four different formats, as determined by the message format selected and program status. The formats are ASCII, four byte binary (standard speed mode), two byte binary (high speed mode), and math program special applications. Each format is further described below.

8-65. ASCII Format

The standard ASCII format contains twelve characters of data, a carriage return, and instructions selectable line feed. The reading message begins with a sign; followed by seven characters of data, i.e., five and one half digits or data and a floating decimal point except for the 10 MOhms and 100 nanosiemens range that have four and a half digits and floating decimal point preceded by a zero, and four characters to define the exponent; followed by the carriage return; and the line feed, if selected. The exponents is in modified engineering notation, i.e., it appears only in multiples of three from E+00 up to E+18 and down to E-18. Refer to Figure 8-2 for a format sample and to Table 8-10 for format examples.



1 Sign (+ or –)
2 Reading absolute value. Floating decimal point designates range.
3 Exponent in modified engineering notation.
4 Carriage Return
5 Line Feed (program selectable.)

Figure 8-2. ASCII Format

Table 8-10. ASCII Format Example

MESSAGE TRANSMITTED	EXPLANATION		
	VALUE	RANGE	RATIONALE
+010.015E-03 CRLF	10.015 mV dc	100 mV	No MΩ or mV ac ranges
+158.898E-03 CRLF	158.898 mV dc	100 mV	No MΩ or mV ac ranges
–0.39976E+00 CRLF	–0.39976V dc	1V	No –V ac or Ω/max mV range 199.999
+1.00022E+00 CRLF	1.00022V	1V	No 1Ω range
+05.1023E+00 CRLF	5.1023	10V or 10Ω	Max 1V range 1.99999
+18.0000E+00 CRLF	18.0000Ω	10Ω	Max 10V range 16.0100
+050.101E+00 CRLF	50.101	100V or 100Ω	Max 10V range 16.0100/10Ω range 19.9999
–100.000E+00 CRLF	–100.000V dc	100V	No –V ac or Ω
+178.396E+00 CRLF	178.396Ω	100Ω	Max 100V range 130.100
+1005.25E+00 CRLF	1005.25	1000V or 1000Ω	Max 1000V ac range 650.00
+1025.00E+00 CRLF	1025.00Ω	1000Ω	Max 1000V range 1024.00 dc and 650.00 ac
+10.0000E+03 CRLF	10.0000 kΩ	10 kΩ	Exceeds voltage limits
+100.000E+03 CRLF	100.000 kΩ	100 kΩ	Exceeds voltage limits
+1.00000E+06 CRLF	1.00000 MΩ	1 MΩ	Exceeds voltage limits
+010.000E+06 CRLF	10.000 MΩ	10 MΩ	Exceeds voltage limits/max 10 MΩ range 19.999
+0100.00E-09 CRLF	100.00 nS	100 nS	Exceeds voltage limits/max 100 nS range 202.00

8-66. Four Byte Binary Format

8-67. This format uses an implied binary point rather than using a character to represent the binary point. The meter uses un-normalized floating point arithmetic, which means the value of the mantissa ranges between -0.9999999 and +0.9999999. The four byte format can only be used in the standard speed mode of operations. Only the two byte format can be used for the high speed mode. Refer to Figure 8-3 for an explanation of the four byte message format.

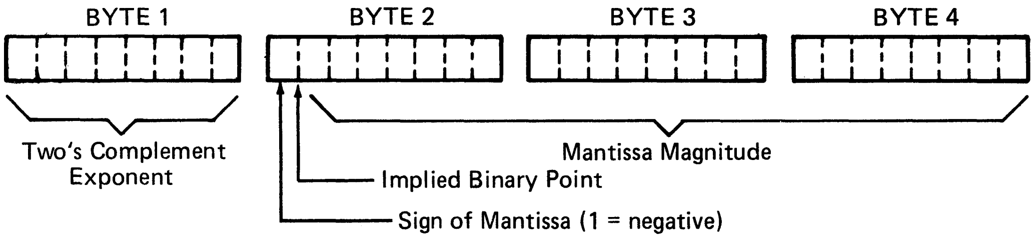
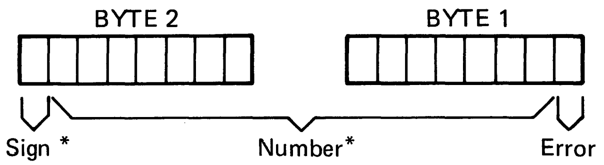


Figure 8-3. Four Byte Binary Format

8-68. Two Byte Binary Format (High Speed Mode)

8-69. The two bytes of the high speed mode can be treated as a 16-bit binary number in the format shown in Figure 8-4. If the message is treated as a 16-bit binary number it can be converted to the decimal value using the methods also shown in Figure 8-4. All conversions required that the fixed range be known. If the 16-bit binary number is odd, i.e. the LSB of byte 1 is a 1, the 8520A is in overrange and the message is 29 (Byte 2)00 (byte 1) for a positive overrange or A9 (byte 2)00 (byte 1) for a negative overrange.



*Two's complement

CONVERSION FORMULA

Step 1 Convert BYTE 2 to a decimal number
Step 2 Convert BYTE 1 to a decimal number
Step 3 A = (BYTE 2)(256) + BYTE 1.
Step 4 If A ⩾32768 then A = A - 65536
Step 5 A = A/32768
Step 6 R=A(MR) ; R = Result in volts or ohms, as applicable

where, MR = Multiplier Range

R0	100 mV = 0.25	10Ω = −25
R1	1V = 2	100Ω = −200
R3	10V = 16	1000Ω = −2000
R4	1000V = 1024	10 kΩ = −20,000

Example #1 Positive Voltage (10V range)

	BYTE 2	BYTE 1
Message	0000 1001	0100 0010

Step 1 Byte 2 = 9
Step 2 Byte 1 = 66
Step 3 A = 9 (256) + 66 = 2370
Step 4 A = 2370
Step 5 A 2370/32768 = 0.0723
Step 6 R = (0.0723) (16) = 1.1568V

Figure 8-4. 2 Byte Binary Format Conversion Examples

Example #2 Negative Voltage (100 mV range)

Message 1010 1110   0011 0110

Step 1 Byte 2 = 174
Step 2 Byte 1 = 54
Step 3 A = (174) (256) + 54 = 44598
Step 4 A = 44598 – 65536 = – 20938
Step 5 A = -20938/32768 = -0.638977
Step 6 R = (–0.638977) (0.25) = –0.1597442V = –159.744 mV

Example #3 Resistance (100Ω range)

NOTE: Due to the reverse current path used resistance readings will have the sign bit high.

Message 1100 0000   0000 0000

Step 1 Byte 2 = 192
Step 2 Byte 1 = 0
Step 3 A = 192 (256) + 0 = 49152
Step 4 A = 49152 – 65536 = –16384
Step 5 A = –16384/32768 = –0.5
Step 6 R = (-0.5) (-200) = 100

Figure 8-4. Byte Binary Format Conversion Examples (cont)

8-70. Special Formats

8-71. Five special message formats are available for use with the math programs. If the Limits Program (#7) is selected or is last program performed from a group of programs the response to a request for a reading is a three character ASCII coded message plus a fourth character that is program selectable. The message begins with the sign and a one character numeric code, followed by a carriage return and the program selectable line feed. The codes are: +2 when the output is high, +1 when the output is within the set limits and is a pass, and -1 if the output is low. If the binary output mode is selected (I4) the output is a single byte of data coded 0000 0010 for high, 0000 0001 for pass, or 1111 1111 for low.

8-72. If the Display Option Register feature has been selected to display some register reading, the number of the register can be obtained by asking for a reading of the Display Option Register. The response will be the ASCII coded number of the register (e.g. 3.1, 6.3, 11.2, etc) followed by a carriage return and the program selectable line feed.

8-73. IEEE STANDARD INSTRUCTIONS

8-74. The controller can place three IEEE-488 standard instructions on the bus. These are the universal clear, selected device clear, and the group execute trigger (GET).

8-75. The reaction of the instrument to the universal and selected device clear instructions is the same as when the immediate character Reset (*) is sent in a character string. Any measurement in progress is interrupted, the instrument is reset to the default state and the one byte character * is output on the bus.

8-76. A GET instruction from the Controller triggers a reading from the 8520A if any one of the following conditions are met: The instrument is in local, expecting a ? or ! character, in external trigger and is not armed with an ! in external trigger and armed, or in internal trigger. When the 8520A receives a GET instruction, it automatically goes into the external trigger mode (T1). A delay should be programmed following a command string. When a GET instruction is used so the command string can be processed, The length of the delay should vary with the length and contents of the command string. If the GET instructions are sent faster than the 8520A can handle them the subsequent instructions are ignored, until the instrument is again able to handle them.

8-77. SERIAL POLL INSTRUCTION

8-78. Events or conditions that instruct the 8520A to place a SRQ (Service Request) on the bus are program selectable. The instruction used in S i j k l with i, j, k, and l representing octal number that are decoded to represent the enabled events. Table 8-11 is a list of the possible serial poll instructions and Table 8-12 gives examples of the coded instruction. In all cases leading zeroes can be suppressed, as shown in the examples.

8-79. When a serial poll is performed the 8520A responds with a one byte message. Each bit of the serial poll response byte represents an event or condition and is described in Table 8-13. If the RSV bit (#7) is a zero it is an indication that the 8520A did not issue the SRQ. If the RSV bit is a one, one or more of the other bits is set to indicate which of the enabled SRQ conditions occurred. Table 8-14 gives several examples of coded responses and their decoded meanings.

8-80. The rsv bit in the serial poll response byte can be cleared in two ways. One method is with the transfer of the last byte of data associated with the SRQ i.e. output ready, overrrange, and error. The other method is for SRQ's that do not have data output. With them the rsv bit can be cleared using the immediate instruction (&). Immediate instructions are acted upon as soon as received and do not require a terminator.

8-81. PROGRAM EXAMPLES

8-82. The following paragraphs contain several programming examples to an the operator in using the DMM.

Table 8-11. Serial Poll Instructions

CODE	ITEM
0000	SRQ Disabled
0001	Output ready, Overrange, Error
0002	Overrange
0004	Error
0010	End of burst
0020	New high peak
0040	New low peak
0100	Reading High
0200	Reading Pass
0400	Reading Low
1000	Low frequency AC Reading Ready
2000	Undefined - do not use
4000	Undefined - do not use

Table 8-12. Serial Poll Response

BIT	
8 (MSB)	0 (not used)
7	rsv (IEEE request for service)
6	Error (0004)
5	0 (not used)
4	Logical OR of the SRQ for Transmit Command (0004) New High Peak (0010) New Low Peak (0020) Reading High (0100) Reading Pass (0200) Reading Low (0400) LFAC Ready (2000)
3	End of Burst (0010)
2	Overrange (0020)
1(LSB)	Output Ready (0001)

Table 8-13. Serial Poll Response Examples

HEX MSG	DECODED MESSAGE
00	Service not required
41	Output ready
42	Overrange
43	Output Ready and Overrange
44	End of Burst
48	One of the logical OR functions
60	Error

Table 8-14. Serial Poll Instruction Examples

INSTRUCTION	GENERATION OF AN SRQ RESULTS FROM:
S0002 or S002 or S02 or S2	An overrange Only
S0014 or S014 or S14	The end of a burst (S0010) An error (S0004)
S0271 or S271	A reading pass (S0200) A new low peak (S0040) A new high peak (S0020) The end of a burst (S0010) The output ready, an overrange, and an error (S0001)
S1502	A low frequency ac ready (S1000) A reading low (S0400) A reading high (S0100) An overrange (S0002)

8-83. The following control strings will set the DMM to the condtions listed:

1. ? - Processes any commands in the buffer, then triggers a reading and waits to output, if necessary.

2. VC? - Selects direct coupled AC Volts, then triggers a reading and waits to output. Default assignments of 100V range, autorange, two readings per second, 500 msec filter settling time, normal speed, and math off are mode with the function selection.

3. VROT1, - Selects volts dc, the 100 mV range, and the external trigger then waits for a trigger command. Default assignments of two readings per second, 500 msec filter settling time, normal speed, and math off are mode with the function selection.

4. VAR2M1 - Places volts ac, 10 volt range, and math on commands into the input buffer then waits for a termination character before processsing the command.

5. B50I7? - Sets burst size of fifty readings and unlocks measurement output necessity for each reading, then triggers fifty readings to be taken per meter's present configuration.

6. P56M1Y1/100, - Selects, enables, and process with the percent deviation (#5) and (#6) program on measurements stored in memory locations 1 through 100. The result of the processing is stored in the accumulating register 6.1 (high peak), 6.2 (low peak) and 6.3 (peak-to-peak) to await a GR instruction.

7. GR 6.2, - Commands the 8520A to transmit the contents of register 6.2 (i.e. the low peak resulting from the usage of the peak program). The data is output from the 8520A during the next input to the controller from the 8520A.

8. VR1T1D1I4! - Selects volts dc, the 1 volts range, and external trigger, 240 readings per second, the binary output format, and arms the bnc trigger. Default assignments of math off, normal speed, and front panel on are made with the function selection. A reading is taken and output with receipt of a BNC trigger.

9. VR2T0I7I5? - Selects dc volts, the 10 volt range, internal trigger, the unlock reading transfer feature, and the high speed mode. Default assignments of the asynchronous reading rate, 5 msec filter settling time, math programs off, and fix the range (in 10 volts) are made with the high speed mode selection. The high speed mode also automatically disables front panel operations. This command string programs the 8520A to store measurements in the internal memory at its maximum reading rate.

8-84. Some typical status messages and their decoded explanations follow:

1. V R7D8 F5T1M0P14 B1 S0000 N1N2N3N4N5N6N7,(CR)(LF)

V = V DC Function
R7 = Autorange
D8 = Reading Rate is 2/sec
F5 = Filter is 500 ms
T1 = External Trigger
M0 = Math Programs Off
P14 = Math Program #14 is Selected

B1 = Burst Size is 1
S0000 = Serial Poll Disabled
N1 = Front Panel On
N2 = Filter Time Out On
N3 = Line Feed Yes
N4 = ASCII Output
N5 = Normal Speed
N6 = EOI On
N7 = Reading Transfer Locked
, = Terminator
CR = Carriage Return (Automatic)
LF = Line Feed (Program Selectable N3)

2. Z2 R5D9F6T0M0P6 B1 S0061 N1N2I3N4N5N6N7, CR

Z2 = Two Terminal Ohms
R5 = 1 Mohm
D9 = 1 Reading per second
F6 = Slow Filter Settling Time
T0 = Internal Trigger
M1 = Math Programs On
P6 = Peak Values Program Selected
B1 = Burst Size is 1
S0061 = Serial Poll Response for:
    New low peak (S0040)
    New high peak (S0020)
    Output ready, error, and overrange (S0001)
N1 = Front Panel On
N2 = Filter Time Out On
I3 = Line Feed No
N4 = ASCII Output
N5 = Normal Speed
N6 = EOI On
N7 = Reading Transfer Locked
, = Terminator
CR = Carriage Return (Automatic)

Section 9
Accessories and Options

OPTION/ MODEL NO.	DESCRIPTION	PAGE
	ACCESSORIES	
	Rack Ears	900-1
M00-260-610	18-inch Rack Slide	900-2
M00-280-610	24-inch Rack Slide	900-2
80F-5	High Voltage Probe	900-2
80F-15	High Voltage Probe	900-2
81RF	High Frequency Probe	900-4
82RF	High Frequency Probe	900-4
80T-150F and 80T-150C	Temperature Probe	900-6
Y2025	RTD Probe	900-6
	OPTIONS	
-010	-010 Option	910-1

9-1. INTRODUCTION

9-2. This section of the manual contains a brief description of each accessory and the introduction and operation information for each option available for use with the John Fluke model 8520A Digitial Multimeter. Descriptions of the accessories forms subsection 900. Introduction and operation material for each option forms additional subsections. The location of an option or accessory if facilitated by the use of unique paragraph and page numbering which corresponds to the option number. For example, all the pages and paragraphs of the accessory subsection will be numbered 900-1, 900-2, 900-3... All of the pages and paragraphs of the -010 Option will be numbered 910-1, 910-2, 910-3... For option information other then introduction and operation, see the 8520A Calibration Manual or the 8520A Service Manual.

Accessories

900-1. INTRODUCTION

900-2. This material briefly describes each accessory available for use with your instrument. For more information, refer to the instruction sheet included with each accessory. When ordering an accessory, include both model number and name.

900-3. RACK EARS

900-4. The Rack Ears accessory is shown in Figure 900-1. Use Y8599 when the instrument is installed with Rack Slides or M03-203-600 when slides are not used.

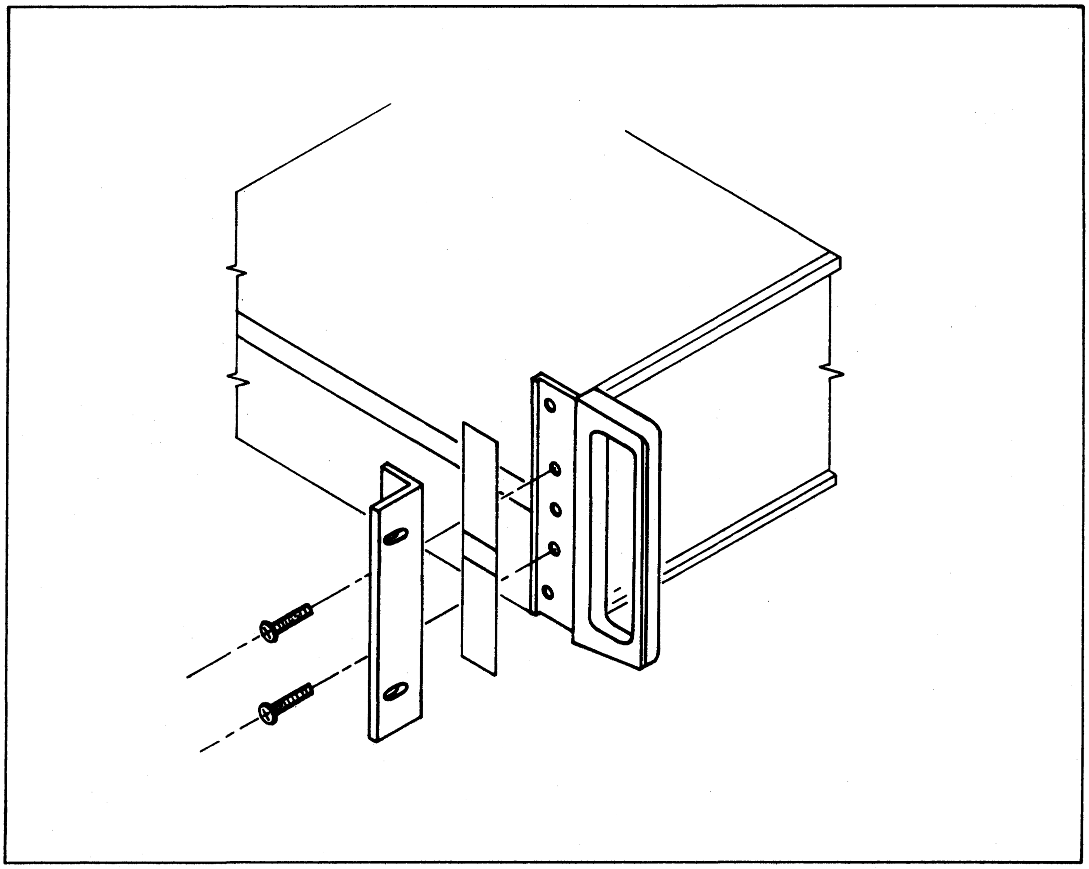


Figure 900-1. Rack Ears

900-5. 18-INCH RACK SLIDE (M00-260-610)

900-6. Use the 18-inch Rack Slide to mount your 8520A in a standard 18 inch deep equipment rack. The 18-inch Rack Slide is shown in Figure 900-2.

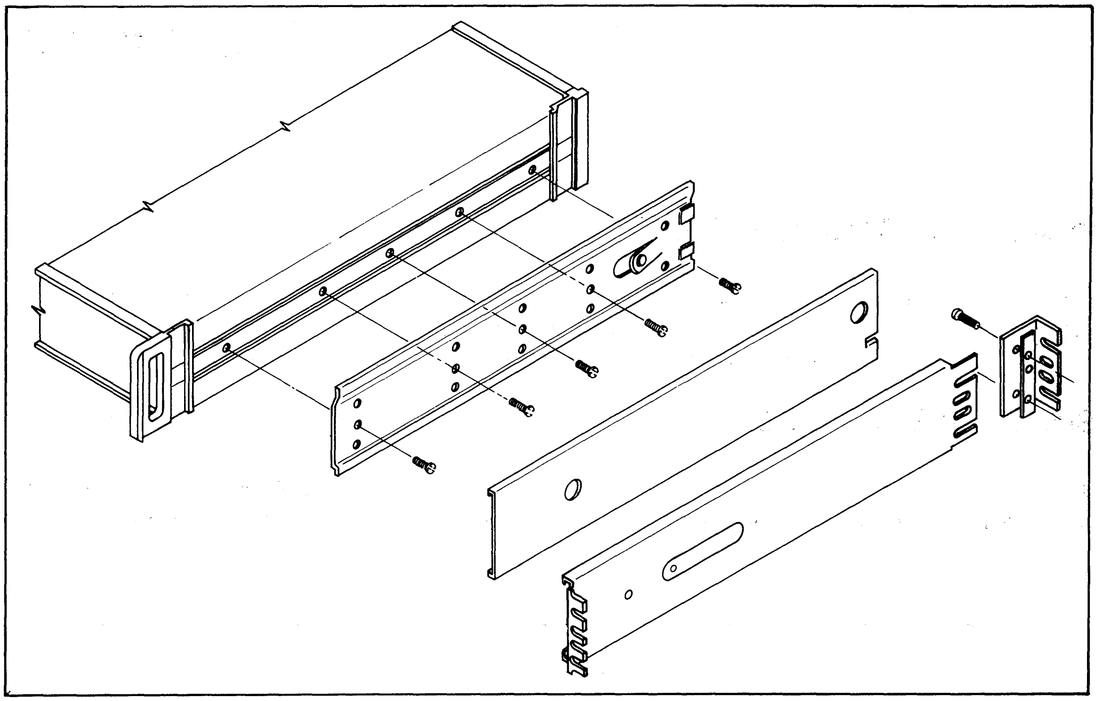


Figure 900-2. 18-Inch Rack Slide

900-7. 24-INCH RACK SLIDE (M00-280-610)

900-8. Use the 24-inch Rack Slide to mount your 8520A in a standard 24 inch deep equipment rack. The 24-inch Rack Slide is shown in Figure 900-3.

900-9. HIGH VOLTAGE PROBE (80F-5)

900-10. The Model 80F-5 Voltage Divider shown in Figure 900-4, allows measurement of up to 5k volts dc. Division ratio of this accessory is 1000:1. Accuracy and stability of the division ratio is ensured using special metal film resistors that have matched temperature coefficients.

900-11. Three versions of the 80F-5 are available: the basic 80F-15 which has 10 MΩ input impedance, an -01 Option for voltmeters have 11 MΩ input impedance, and the -02 Option for voltmeters having an infinite input impedance (1000 MΩ or greater) at null.

900-12. HIGH VOLTAGE PROBE (80F-15)

900-13. The Model 80F-15 High Voltage Probe shown in Figure 900-5, allows measurements up to 15k volts dc. The division ratio of this accessory is 1000:1. Accuracy and stability of the division ratio is ensured by the use of special metal film resistors with matching temperature coefficients.

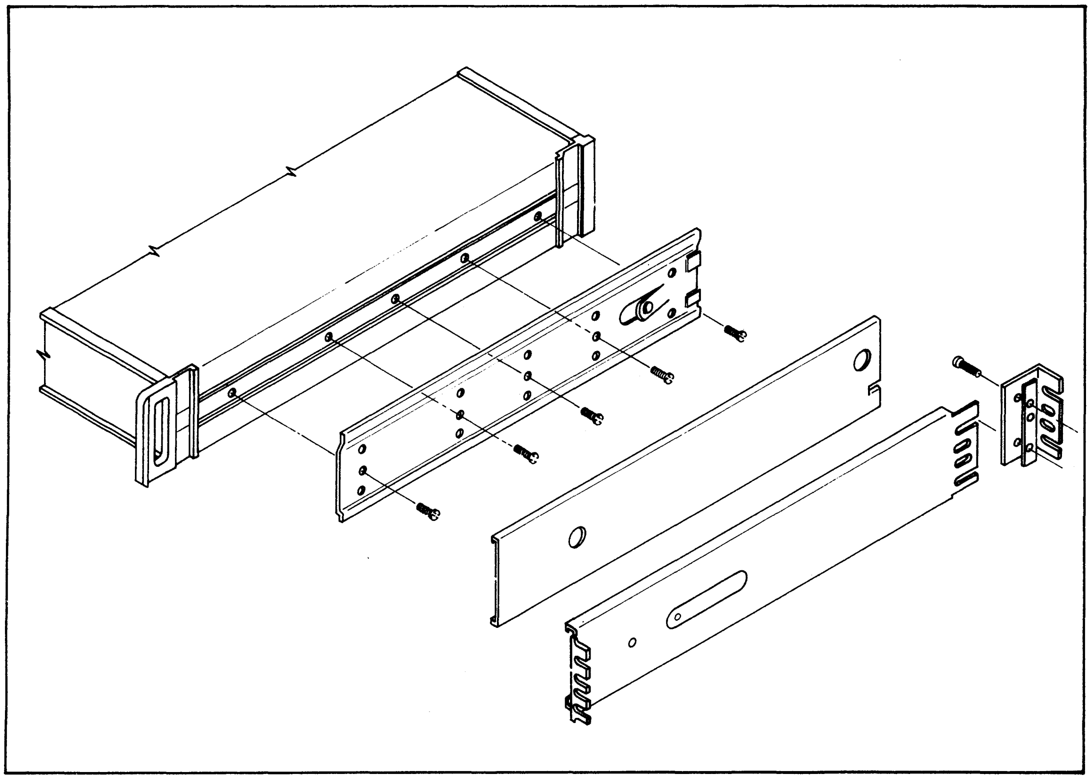


Figure 900-3. 24-Inch Rack Slide

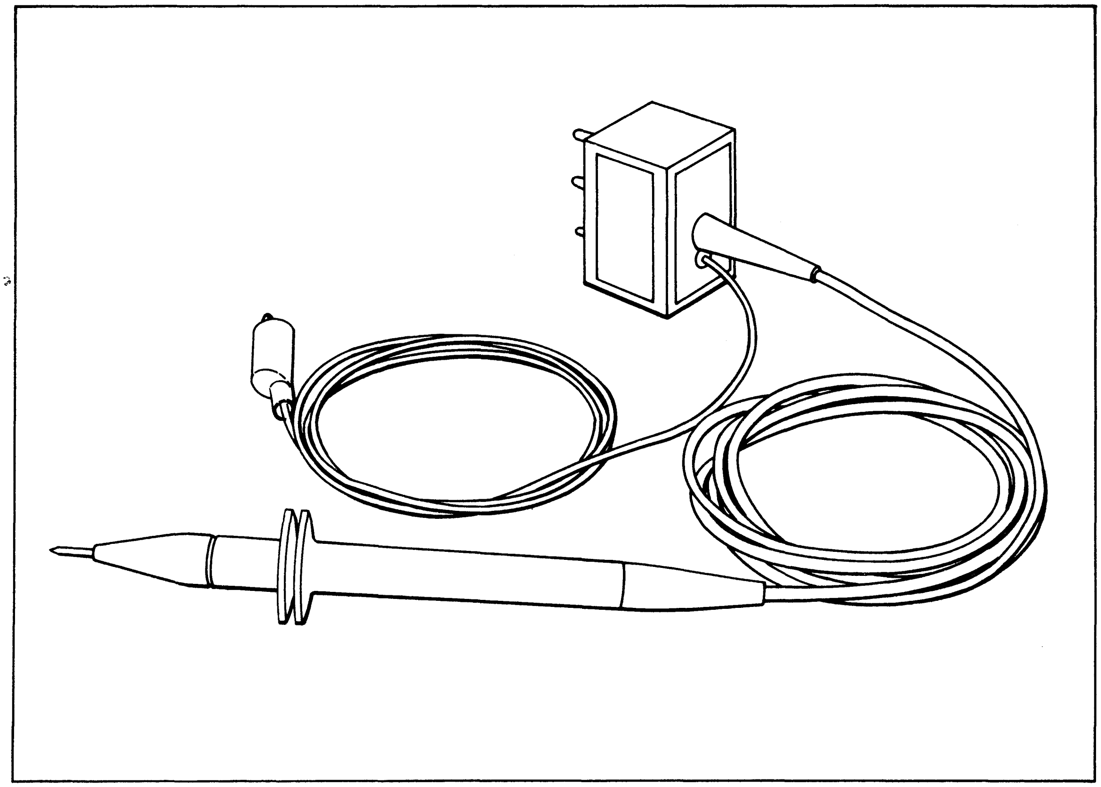


Figure 900-4. 80F-5 Voltage Divider

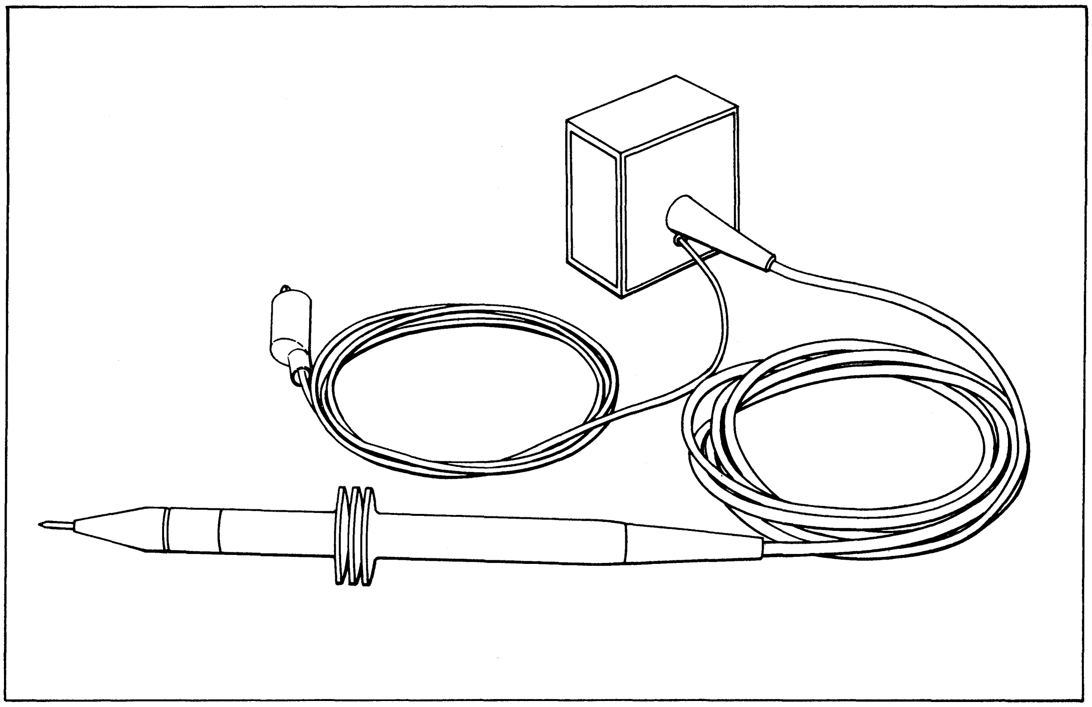


Figure 900-5. 80F15 High Frequency Probe

900-14. Three versions of the 80F-15 are available: the basic 80F-15 which has 10 MΩ input impedance, an -01 Option for voltmeters have 11 MΩ input impedance, and the -02 Option for voltmeters having an infinite input impedance (1000 MΩ or greater) at null.

900-15. HIGH FREQUENCY PROBE (81RF)

900-16. Introduction

900-17. The Model 81RF High Frequency Probe (Figure 900-6) extends the frequency range of your voltmeter to include ac voltage measurements from 0.25 to 20V ac rms at 100 kHz to 100 MHz. The 81RF operates in conjunction with the dc voltage ranges and is calibrated to be equivalent to the rms value of a sine wave input.

900-18. Specifications

Frequency Response: ±1 dB from 100 kHz to 100 MHz.
Extended Frequency: Useful for relative reading from 20 kHz to 250 MHz.
Response: Responds to peak value input; calibrated to read rms value of a sine wave.

900-19. HIGH FREQUENCY PROBE (82RF)

900-20. Introduction

900-21. The Model 82RF High Frequency Probe (Figure 900-7) allows measurements from 0.25 to 30V ac rms at 100 kHz to 500 MHz. It is designed to be used with voltmeters having an input impedance higher than 10 MΩ provided the input is externally shunted to make the equivalent input impedance equal to 10 MΩ.

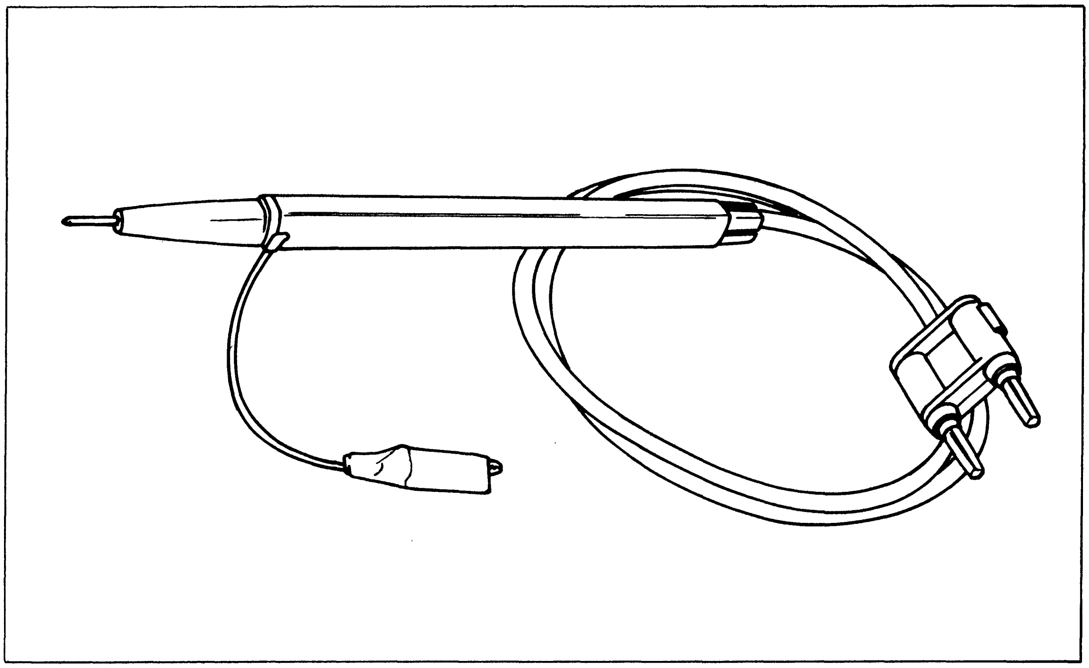


Figure 900-6. 81RF High Frequency Probe

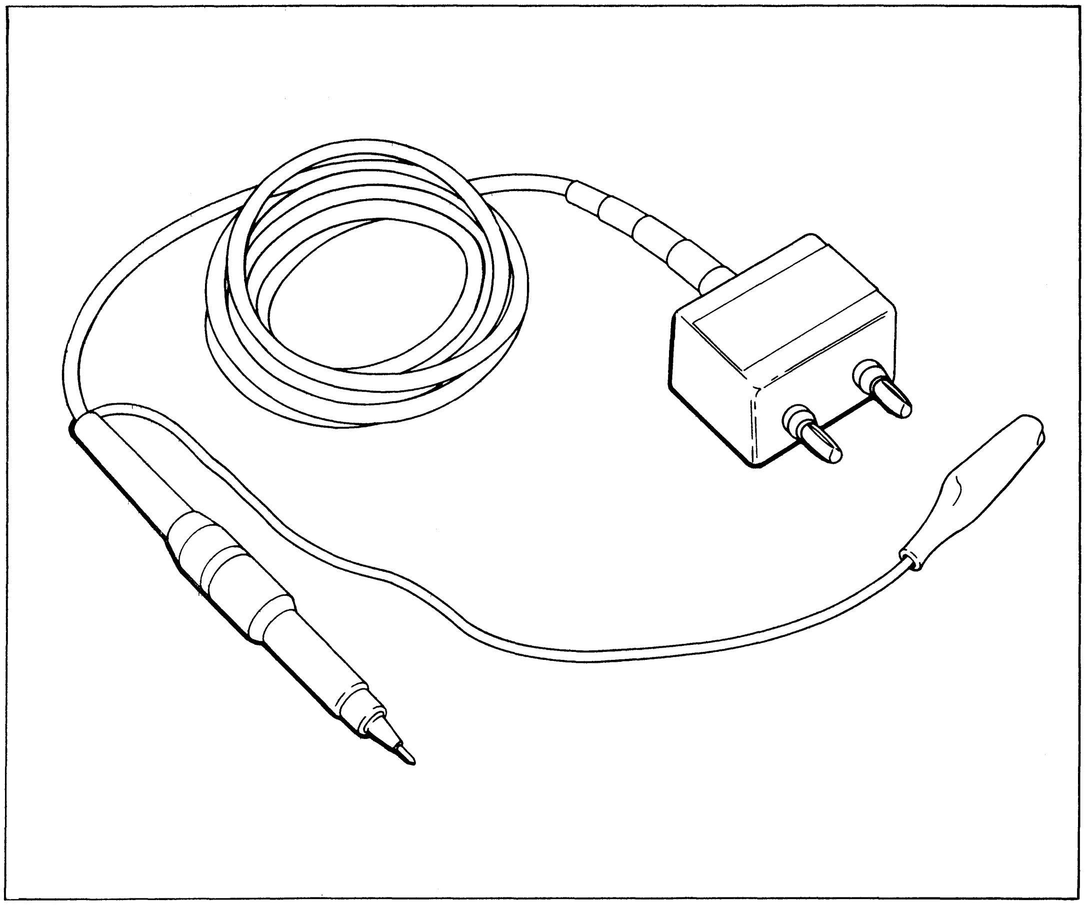


Figure 900-7. 82RF High Frequency Probe

900-22. Specifications

Frequency Response: 3 dB from 100 kHz to 500 MHz.
Extended Frequency Response: Useful for relative readings from 20 kHz to 700 MHz.
Response: Responds to peak value of the input; calibrated to read rms value of a sine wave.
Voltage Range: 0.25 to 30V ac rms.
Maximum DC Input: 200V dc.
Input Impedance: 2 MΩ shunted by 4 pF.

900-23. TEMPERATURE PROBE (80T-150F AND 80T-150C)

900-24. Introduction

900-25. The 80T-150 Temperature Probe (Figure 900-8) allows the 8520A to measure temperature. The accessory is ideally suited for surface, ambient, liquid measurements, and lends itself easily to a wide range of design, troubleshooting, and evaluation applications. A rugged, fast-responding probe tip with a 350V standoff makes the 80T-150 versatile and easy to use. There are two versions of the 80T-150: the 80T150C which measures temperature in degrees Celsius and the 80T-150F which measures temperature in degrees Fahrenheit.

900-26. Specifications

Range (°C or °F field selectable by internal jumpers): -50°C to +150°C or -58°F to +302°F
Accuracy: ±1°C (1.8°F) from 0°C to 100°C (32°F to 212°F) decreasing linearity to ±3°C (5.4°F) at -50°C (-58°F) and +150°C (302°F).
Resolution: 0.1°C on 100 mV range.
Voltage Standoff: 350V dc or peak ac.
Power: Internal disposable battery; 1,000 hours of continuous use.

900-27. RTD PROBE (Y2025)

900-28. Introduction

900-29. The Model Y2025 (Figure 900-9) is a high quality platinum RTD Probe.

900-30. Specifications

Nominal Resistance: 100 ±0.1% at 0°C
Temperature Coefficient: .00385Ω/Ω/°C of resistance
Temperature Range: -220°C to +750°C
Power Rating: 50 mW maximum in 3 fps flowing water
Maximum Voltage, Platinum: 200V ac
Element to Sheath Resistance: 100 MΩ over the operating temperature range.
Platinum Element to Sheath Resistance Stability: 0.1%/year, maximum.
Sheath Material: 304 or 316 Stainless Steel
Leads: AWG 22 or 24, Type E Teflon Insulated Copper
Lead Stranding: 7 of #30 or 19 of #34 (for #22 AWG) or 7 of #32 or 19 of #36 (for #24 AWG)
Performance Standards: Conforms to DIN 43760
Active Length: First 1 inch measured from Probe Tip

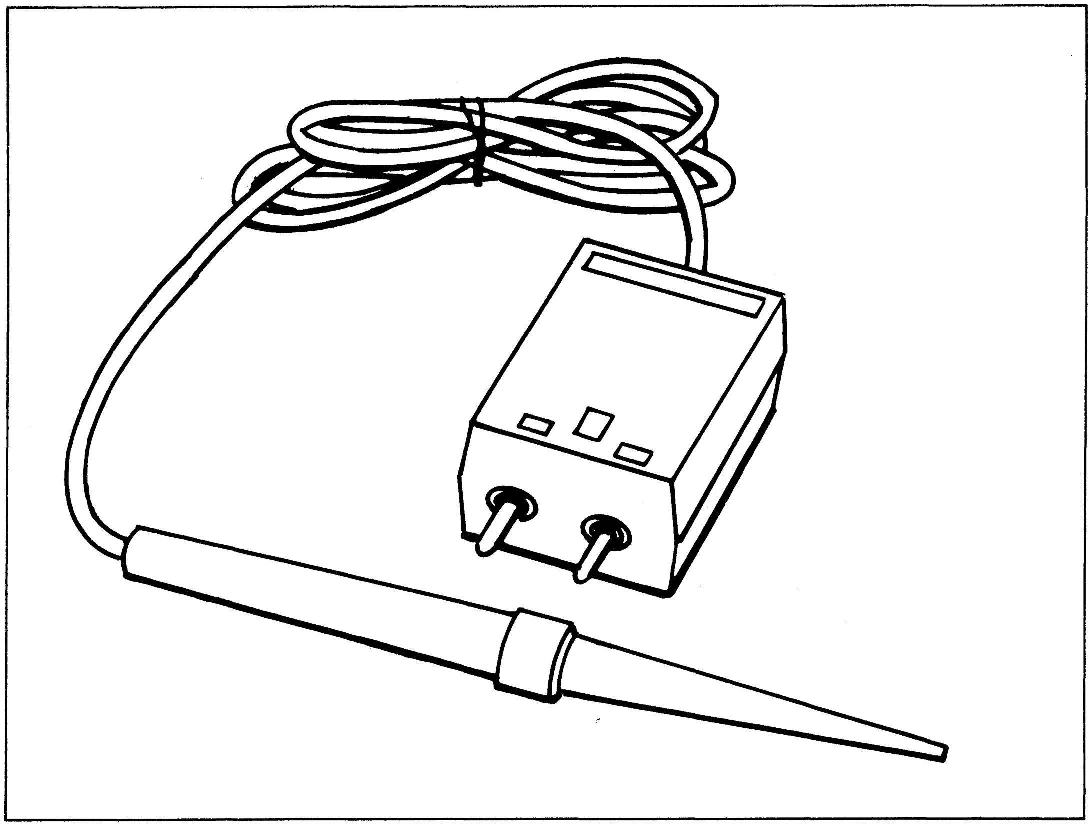


Figure 900-8. 80T-150

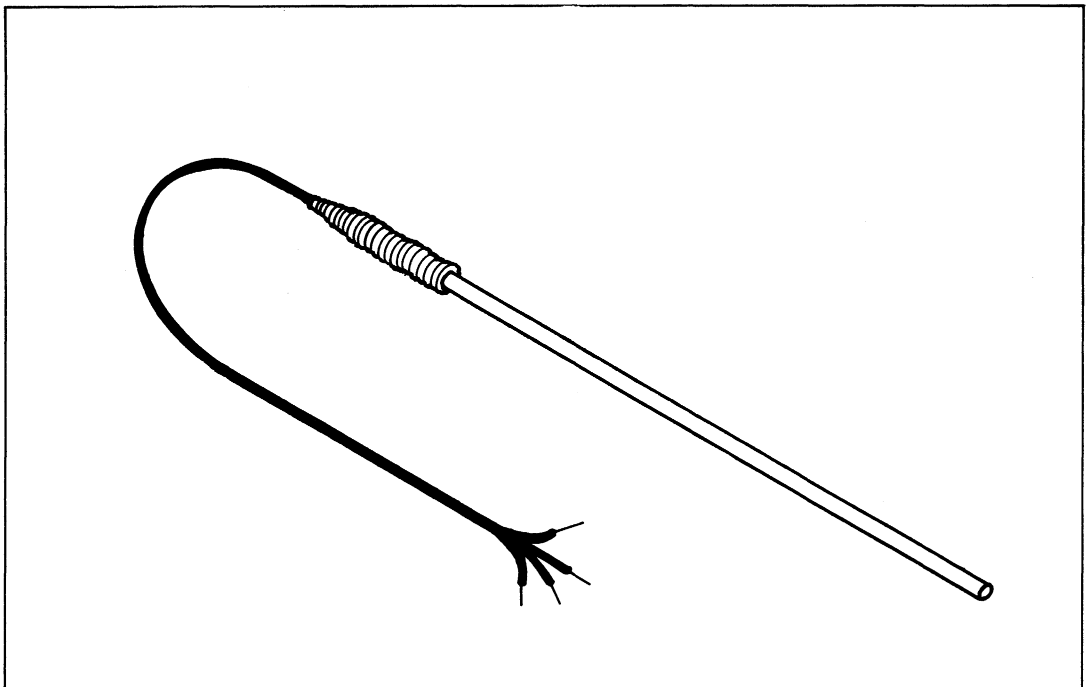


Figure 900-9. Y2025

-010 Option

910-1. INTRODUCTION

910-2. The -010 is a software option. It provides the 8520A with an additional seven math programs (see Table 910-1) and an additional 350 locations in Burst Memory. Operation with the -010 installed is so similar to operation of a standard 8520A that throughout this manual, both the standard 8520A and the 8520A equipped with a -010 Option have been described concurrently.

Table 910-1. Optional Math Programs

NO.	NAME	DESCRIPTION	DISPLAY (PROGRAMS IN USE/OFF LED no)
8	STAT	Statistics	DMM Measurement
9	LFAC	RMS ac value of inputs below 10Hz	RMS Value
10	dB	dB, dBm, or dBV ratio	Measurement in dB, dBm, or dBV
11	RTD	RTD Thermometer	Temperature in°C, °F, or °K
12	JVC	Operation with John Fluke 80T-150C Temperature Probe accessory	Temperature in °C, °F, or °K
13	JVF	Operation with John Fluke 80T-150F	Temperature in °F, °C, or °K
14	THMS	Thermistor Linearization	Temperature in °C, °F, or °K