8020B

Digital Multimeter

Instruction Manual

FLUKE

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Section 1
Introduction and Specifications

1-1. INTRODUCTION

1-2. Your John Fluke Model 8020B is a pocket-size digital multimeter that is ideally suited for application in the field, lab, shop or home. Some of the features of your instrument are:

- All VOM functions plus conductance and continuity (8 in all) are included as standard.

  DC Voltage - 100 μV to 1000V
  AC Voltage - 100 μV to 750V
  DC Current - 1 μA to 2000 mA
  AC Current - 1 μA to 2000 mA
  Resistance - 0.1Ω - 20 MΩ
  Diode Test
  Conductance - 0.1 ns to 200 ns and .001 ms to 2 ms (S = siemens = 1/Ω).
  Continuity - Provides an immediate audible indication when continuity is detected.

- CONDUCTANCE - A new multimeter function that allows fast, accurate, noise free resistance measurements up to 10,000 MΩ.

- A high contrast 3-1/2 digit liquid crystal display that can be easily read from across the room. No more worries about bent needles, parallax, etc.

- Each range has:

  Full auto-polarity operation
  Overrange indication
  Effective protection from overloads

- Dual slope integration measurement technique to ensure noise-free measurements.

- Long term calibration stability - 2 years. Easy calibration - few adjustments.

- Lightweight - 369 grams (13 ounces).

- Up to 200 hours of continuous operation can be expected from a single, inexpensive, 9V, alkaline battery (transistor radio/calculator type).
- Low battery voltage automatically detected and displayed.
- Line operation is possible using a Model A81 Battery Eliminator (see Section 6, Accessories).
- Protected test leads - finger guards on the probes and shrouded contacts on the connectors discourage accidental contact with circuit voltages.
- A full line of accessories that extend the range and scope of your instrument.

1-3. PREPARING FOR OPERATION

1-4. Unpacking

1-5. Your 8020B was packed and shipped in an especially designed protective container. This manual, the multimeter, one 9V battery, and two test leads (one red and one black) should be packed in the shipping container. Check your shipment thoroughly. If anything is wrong with your shipment, contact the place of purchase immediately. If satisfaction is not obtained, contact the nearest John Fluke Service Center. A list of these service centers is located at the end of this manual.

1-6. If reshipment is necessary, please use the original shipping container. If the original container is not available, a new one can be obtained from the John Fluke Mfg. Co., Inc. Please state the instrument model number when requesting a new shipping container.

1-7. Battery and/or Fuse Installation/Replacement

1-8. Your 8020B is designed to operate on a single, inexpensive, 9V battery of the transistor radio/calculator variety (NEDA 1604). When you receive your 8020B the battery will not be installed in the DMM. Once the battery is installed, you can expect a typical operating life of up to 200 hours with an alkaline battery or 100 hours with a carbon-zinc battery. When the battery has exhausted about 80% of its useful life, the BT indicator will appear in the upper left corner of the display. Your 8020B will operate properly for at least 20 hours after BT appears. Use the following procedure to install or replace the battery and to replace the fuse.

WARNING

TO AVOID ELECTRICAL SHOCK HAZARDS REMOVE THE INPUT SIGNAL AND THE TEST LEADS FROM THE INPUT TERMINALS, AND SET THE POWER SWITCH TO OFF BEFORE OPENING THE BATTERY COMPARTMENT.

1. Set the 8020B power switch to OFF.

2. Remove the test leads from external circuit connections and from the 8020B input terminals.

3. Open the battery compartment on the bottom of the 8020B using the method shown in Figure 1-1.

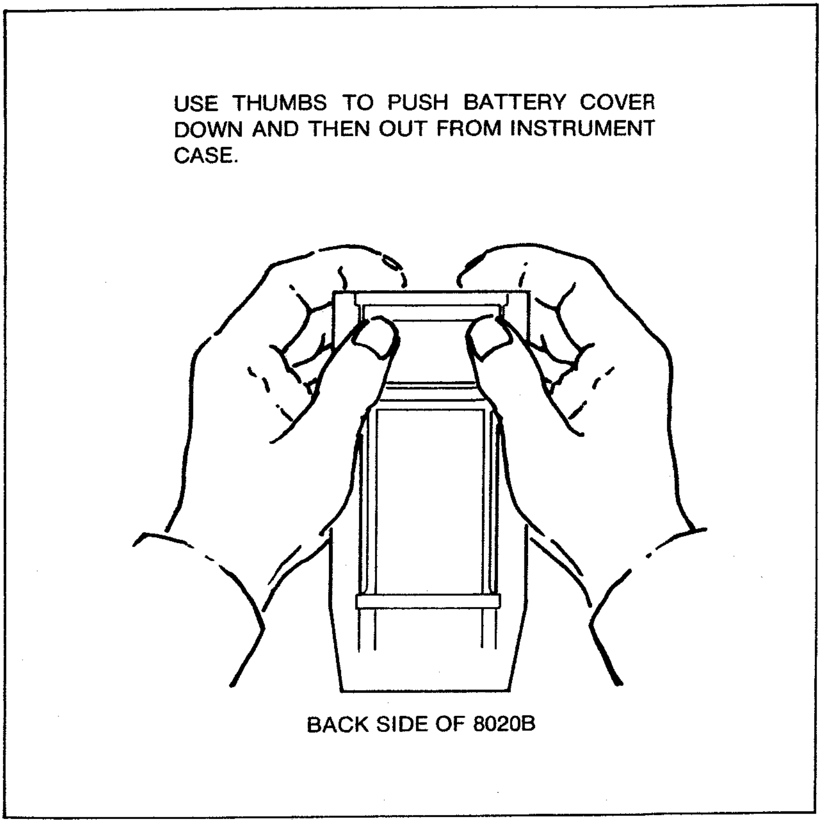


Figure 1-1. Removing the Battery Cover

4. Tilt the battery out as shown in Figure 1-2.

5. If fuse F1 is to be replaced, use a pointed tool such as a probe tip or small screwdriver to pry F1 from its holder. Replace the defective fuse with fuse type AGX2. (Instruments that accommodate metric fuses use type F.)

6. Disconnect the battery clip from the battery.

7. Press the battery clip onto the replacement battery and return both to the battery compartment.

8. Make sure the battery leads are routed by the broad side of the battery and fully within the confines of the battery compartment before sliding the cover into place.

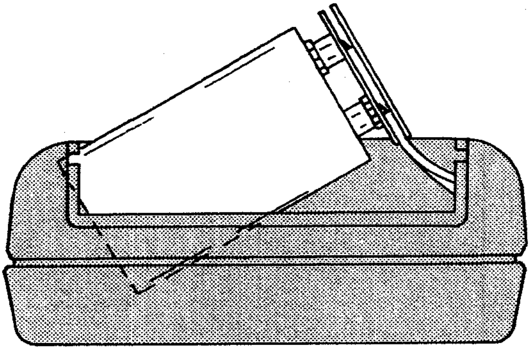


Figure 1-2. Battery Removal

WARNING

DO NOT OPERATE THE 8020B UNTIL THE BATTERY COVER IS IN PLACE AND FULLY CLOSED.

1-9. PHYSICAL FEATURES

1-10. Before using your 8020B we suggest that you take a few minutes to get acquainted with your instrument. All of the externally accessible physical features of the 8020B are shown in Figure 1-3 and described in Table 1-1. Locate each feature on your 8020B as you read the description.

1-11. INITIAL CHECK-OUT PROCEDURE

1-12. Now that you have installed the battery, and know where everything is, let's make sure the unit is working properly. We'll run through a simple check-out procedure, starting with turn-on. No equipment other than the test leads will be required. If a problem is encountered, please recheck the battery, fuses, switch settings, and test lead connections before contacting your nearest authorized John Fluke Service Center.

NOTE

This procedure is intended to verify overall instrument operation, and is not meant as a substitute for the formal Performance Test given in Section 4. Limits shown exceed the specifications because the procedure uses one measurement to check another.

1. Set the power switch to OFF and all range and function switches to the released (out) position.

2. Set the power switch to ON and observe the display. It should read 00.0 ±0.1.

3. Connect the red test lead to the V/Ω input terminal.

4. Touch the red probe tip to the COMMON input terminal, and sequentially depress each of the six range switches starting at the top (20 MΩ). The display should read zero ±one digit and the decimal point should be positioned as follows:

a. 20M - 0.00
b. 2000k - 000
c. 200k - 00.0
d. 20k - 0.00
e. 2k - .000
f. 200 - 00.0

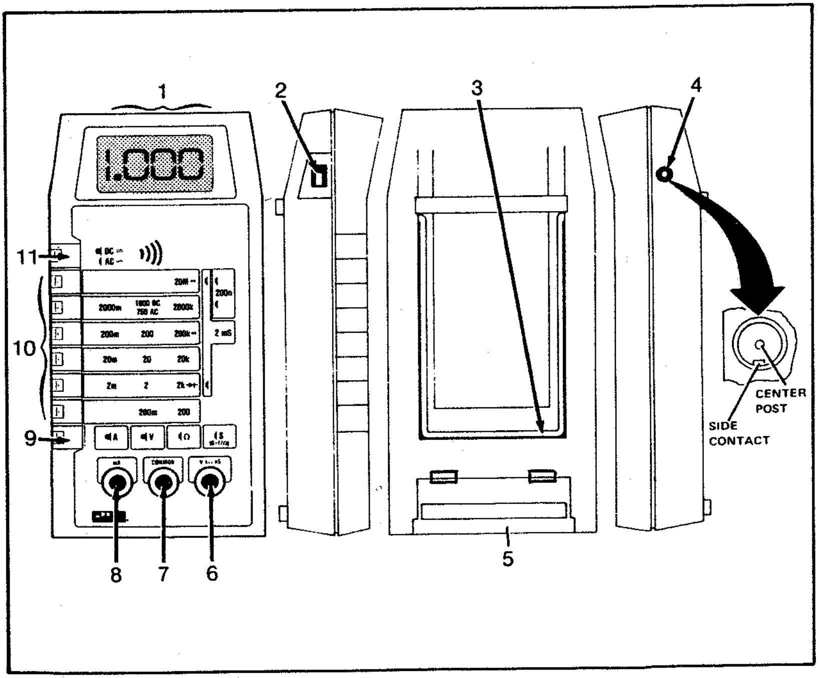


Figure 1-3. Controls, Indicators and Connectors

Table 1-1. 8020B Controls, Indicators and Connectors

ITEM NO.	NAME	FUNCTION
1	Display	A 3-1/2 digit display (1999 max, with decimal point and minus polarity indication, used to indicate measuremet values, overrange conditions, and a low battery condition.
2	Power Switch	A slide switch used to turn the instrument off and on.
3	Tilt Bail	A removable fold-out stand which allows the instrument to be either tilted for bench-top applications or hung from a hook in the absence of a work surface.
4	Battery Eliminator and Connector	An external input power connector for use with the Model A81 Battery Eliminator accessory. (A81 is available in a variety of voltage and plug configurations. See Section 6.)
5	Battery Compartment and Cover	Cover for the 9V battery and the current-protection fuse. Refer to figure 1-1 for battery cover removal instructions.
6	V/Ω/S Input Connector	Protected test lead connector used as the high input for all voltage, resistance, continuity and conductance measurements. Will accept banana plugs.
7	COMMON Input Connector	Protected test lead used as the low or common input for all measurements. Will accept banana plugs.
8	mA Input Connector	Protected test lead connector used as the high input for all current measurements. Will accept banana plugs.

Table 1-1. 8020B Controls, Indicators and Connectors (cont)

ITEM NO.	NAME	FUNCTION
9	mA/V-Ω/S Switch	A push-push switch (push on - push off, do not pull to select function) which is operated in conjunction with the high input connectors to select either the mA/V or Ω (conductance) measurement functions. When the switch is in or depressed Ω is selected. The mA or V function is selected in the out position depending upon the location of the high input lead.
10	Range Switches	Interlocked push-button switches for selecting ranges; i.e., press the desired range switch to select that range and cancel previous switch depressions. Do not pull the switches to select a range. Voltage: 200 mV, 2v, 20V, 200V, 1000V dc/750V ac Current: 2 mA, 20 mA, 200 mA, 2000 mA Resistance: 200Ω, 2 kΩ, 20 kΩ, 200 kΩ, 2000 kΩ, 20 MΩ Conductance: 100 nS or 2 mS (S = siemens = 1/Ω = international unit of conductance). Conductance requires simultaneous depression of two range switches.
11	DC/AC/))) Switch	A push-push switch (push on - push off, do not pull to select function) used to select the ac or dc measurement function when measuring current or voltage. When in, or depressed, the ac function is selected. Output selects dc. When used with the Ω or S functions, the in position enables the audible continuity tone.

5. Press the 20V range switch and remove the probe from the COMMON input terminal.

6. Look inside of the battery eliminator connector on the right side of the 8020B and locate the connector contacts (center post and side contact as shown in Figure 1-3).

7. Touch the red probe tip to the center post of the battery eliminator connector. The display should read approximately -6.1V dc.

8. Touch the probe tip to the side contact of the battery eliminator connector. The display should read approximately 2.9V dc. Notice that the sum of the two readings is equal to the battery voltage (typically 8 to 10V dc). Remove the probe from the battery jack.

9. Depress the lower function button (Ω) and sequentially depress each of the six range switches. The display should read 1 as the most significant digit with no other numbers shown. This is the standard overrange indication. Notice that the decimal point changes position with the range switch settings just as it did in step 4 of this procedure.

10. Touch the red probe tip to the COMMON input terminal, and sequentially press each of the range buttons. The display should read zero at each range setting. Lead resistance may be sufficient to cause a one or two tenths (0.1 or 0.2Ω) indication on the 200Ω range.

11. Touch the red probe tip to the mA input connector and press the 200Ω switch. The display should read 99.0 to 101.0.

12. Press the 2 kΩ switch. The display should read .099 to .101. Remove the probe from the mA input connector.

13. Simultaneously depress the 2000 kΩ and the 20 MΩ range switches. This selects the 200 nS range. The display should read 00.0 to 01.0 (minimum conductance, maximum resistance).

14. Touch the red probe tip to the COMMON input connector. An overrange indication should be displayed since conductance is the reciprocal of resistance.

15. Connect the black test lead to the COMMON input connector.

16. Depress both AC/DC switch and the 750V ac range switch. Set the mA/V-Ω switch to the voltage (out) position.

WARNING

THE LOCAL LINE VOLTAGE IS MEASURED IN THE FOLLOWING STEP. BE CAREFUL NOT TO TOUCH THE PROBE TIPS WITH YOUR FINGERS, OR TO ALLOW THE PROBE TIPS TO CONTACT EACH OTHER.

17. Measure the local ac line voltage at a convenient output receptacle. The voltage should be displayed with 1 volt resolution.

18. If the 8020B has responded properly to this point, it is operational and ready for use.

1-13. ACCESSORIES

1-14 Table 1-2 lists the accessories available for use with the Model 8020B. Detailed information about each accessory is provided in brochures that are available at your local distributor.

1-15. SPECIFICATIONS

1-16. Table 1-3 lists the 8020B specifications. These specifications assume a 2 year calibration cycle and an operating temperature of 18°C to 28°C (64°F to 82°F) at a relative humidity of up to 90% unless otherwise noted.

Table 1-2. 8020B Accessories

ACCESSORY	DESCRIPTION
A81	Battery Eliminator
C25	Ruggedized Soft Case
C90	Vinyl Carrying Case
TL70	Right Angled Test Leads
80i-400	400 Amp Current Probe
80i-600	600 Amp Current Probe
80J-10	10 Amp Current Shunt
80K-6	6 kV High Voltage Probe
80K-40	40 kV High Voltage Probe
80TK	Thermocouple Module
80T-150	Temperature Probe
83RF	High Frequency Probe
85RF	High Frequency Probe
Y8100	AC/DC Current Probe
Y8101	15 Amp Current Probe
Y8105	Hard Case
Y8132	Safety Designed Test Lead Set
Y8134	Deluxe Test Lead Set
Y8140	Slim Test Lead Set

Table 1-3. 8020B Specifications

The following specifications assume a 2-year calibration cycle and an operating temperature of 18°C to 28°C (64°F to 82°F) at a relative humidity up to 90%, unless otherwise noted.

FUNCTIONS .... DC Volts, AC Volts, DC Current, AC Current, Resistance, Conductance, and Continuity.

Table 1-3. 8020B Specifications (cont)

DC VOLTS

RANGE	RESOLUTION	ACCURACY FOR 2 YEARS
±200 mV	100 μV	±(0.1% of reading +1 digit)
±2V	1 mV	
±20V	10 mV	
±200V	100 mV	
±1000V	1V	

Overvoltage Protection ...... 1000V dc or peak ac on all ranges.
Input Impedance .... 10 MΩ, all ranges.
Normal Mode Rejection Ratio >60 dB at 50 Hz and 60 Hz.
Common Mode Rejection Ratio (1 kΩ unbalance) ...... >100 dB at dc, 50 Hz and 60 Hz.
Response Time .... Less than one second.

AC VOLTS (Average Sensing, RMS Calibrated For Sinewave)

RANGE	RESOLUTION	ACCURACY		
		45 Hz to 1 kHz	1 kHz to 2 kHz	2 kHz to 5 kHz
200 mV	100 μV	±(0.75% of reading +2 digits)	±(1.5% of reading +3 digits)	±(5% of reading +5 digits)
2V	1 mV			
20V	10 mV			
200V	0.1V			Not specified
750V	1V	±1% of reading +2 digits	Not specified	

Overload Protection .... 750V rms or 1000V peak continuous, except 200 mV ac ranges (15 seconds maximum above 300V rms ac).
Common Mode Rejection Ratio (1 kΩ unbalance) ...... >60 dB at 50 Hz and 60 Hz.
Volt-Hz Product .... 10^7 max (200V @ 50 kHz).
Input Impedance .... 10 MΩ in parallel with <100 pF.

DC CURRENT

RANGE	RESOLUTION	ACCURACY FOR 2 YEARS	BURDEN VOLTAGE
2 mA	1 μA	±(0.75% of reading +1 digit)	0.3V max
20 mA	10 μA		
200 mA	100 μA		
2000 mA	1 mA		0.9V max

Overload Protection .... 2A/250V fuse, in series with a 3A/600V fuse.

Table 1-3. 8020B Specifications (cont)

AC CURRENT

RANGE	RESOLUTION	ACCURACY FOR 2 YEARS		BURDEN VOLTAGE
		45 Hz to 450 Hz	450 Hz to 1 kHz	
2 mA	1 μA	±(3% rdg +2 d)	Not Specified	0.3V rms max
20 mA	10 μA	±(1.5% of reading +2 digits)		
200 mA	100 μA			
2000 mA	1 mA			0.9V rms max

Overload Protection .... 2A/250V fuse, in series with a 3A/600V fuse.

RESISTANCE

RANGE	RESOLUTION	ACCURACY FOR 2 YEARS	FULL-SCALE VOLTAGE	MAXIMUM TEST CURRENT
200Ω	0.1Ω	±(0.2% of reading +3 digits)	<0.25V	.35 mA
2 kΩ ▶|	1Ω	±(0.1% of reading +1 digit)	>1.0V	1.1 mA
20 kΩ	10Ω		<0.25V	13 μA
200 kΩ	100Ω		>0.7V	13 μA
2000 kΩ	1 kΩ	±(2% of reading +1 digit)	<0.25V	0.13 μA
20 MΩ	10 kΩ		>.7V	0.13 μA

Overload Protection .... 500V dc rms ac on all ranges. 15 seconds maximum above 300 volts.

Open Circuit Voltage .... Less than 1.5V on all ranges except 2 kΩ range is less than 3.5V.

Diode Test (Hi-Lo Ohms) ... 2 kΩ, 200 kΩ, and 20 MΩ ranges supply enough voltage to turn on junctions allowing a "Diode Test". The 2 kΩ range is preferred and is marked with a diode symbol. 200Ω, 20 kΩ, and 2000 kΩ ranges can make in-circuit measurements without turning on silicon junctions.

CONDUCTANCE

RANGE	ACCURACY
2 mS	±(0.2% of reading +1 digit)
200 nS	±(2.0% of reading +10 digits)

Overload Protection .... 500V dc/rms ac on all ranges.
Open Circuit Voltage .... 2 mS <3.5V
200 nS <1.5V
Diode Test .... Both ranges will forward bias a typical PN junction.

Table 1-3. 8020B Specifications (cont)

CONTINUITY (for Passive Circuit Testing)*	
Ranges	All resistance ranges. (2 kΩ range recommeded for lowest resistance threshold)
Indication	
CONTINUITY	Audible tone
OPEN CIRCUIT	No audible tone
Response Time	50 μs (Minimum duration of continuity or open to toggle audible tone) on 2 kΩ range. Pulse stretcher holds tone on or off for approximately 200 ms.
Overload Protection	500V dc/rms ac on all ranges.
GENERAL	
Protection Class 2	Relates solely to insulation or grounding properties defined in IEC 348.
Maximum Common Mode Voltage	500V dc/rms ac.
Power Requirements	Single 9V battery, NEDA 1604.
BATTERY LIFE	
Alkaline	200 hours typical.
Zinc Carbon	100 hours typical.
BATTERY INDICATOR	"BT" on display illuminates when approximately 20% of battery life remains.
Display	3½ digit LCD (2,000 count), autozero, autopolarity.
Size	L x W x H: 18.0 cm x 8.6 cm x 4.5 cm (7.1 in x 3.4 in x 1.8 in)
Weight	0.37 kg. (13 oz)
ENVIRONMENTAL	
Temperature	0°C to 50°C (32°F to 122°F) operating. -35°C to +60°C (-31°F to 140°F) storage.
Relative Humidity	0 to 80%, 0°C to 35°C (32-95°F) on 2 MΩ, 20 MΩ, and 200 nS ranges. 0-90%, 0°C to 35°C (32-95°F) on all other ranges. 0 to 70%, 35°C to 50°C (95-122°F)
Temperature Coefficient	<0.1 times the applicable accuracy specification per °C for 0°C to 18°C and 28°C to 50°C (32°F to 64.4°F and 50.4°F to 122°F).

Section 2
Operating Instructions

2-1. INTRODUCTION

2-2. To fully utilize the measurement capabilities of your 8020B, a basic understanding of its measurement techniques and limitations is required. This section of the manual provides that information, plus a few applications that may prove useful. For example, did you know your 8020B will provide direct-reading dc current gain (beta) measurements for both NPN and PNP transistors? Read this section of the manual to find out how it's done.

2-3. INPUT POWER

2-4. Battery Life

2-5. The 8020B is designed to operate on an single, inexpensive 9V battery of the transistor radio/calulator variety (NEDA 1604). If an alkaline battery is used, a typical operating life of up to 200 hours can be expected. Carbon-zinc batteries will have a useful life of up to 100 hours. In either event, the 8020B will display a BT (in upper, left-hand corner) when the battery has exhausted approximately 80% of its useful life. When BT first appears, the battery is capable of properly operating the 8020B for at least another 20 hours.

CAUTION

To ensure multimeter operation within the accuracy specifications, the battery should be replaced when the voltage measured at the center of the battery eliminator connector falls below -3.00 volts (with respect to the COMMON input). If the battery voltage falls to a point where the "BT" is displayed and the digital display is inactive or no longer responds to an input signal, the battery should be replaced immediately to prevent damage to the LCD.

2-6. Line Power Operation

2-7. You can operate your 8020B from line power by using the A81 Battery Eliminator Accessory. Refer to Section 6 for additional information about the A81.

2-8. OPERATING NOTES

2-9. The following paragraphs will familiarize you with the capabilities and limitations of your Model 8020B and instruct you in routine operator maintenance.

2-10. Input Overload Protection

CAUTION

Exceeding the maximum input overload limits can damage your instrument. A transient overload protection circuit is designed into the 8020B to protect it against short duration high energy pulses. The components used limit the protection to approximatly five pulses per second for 6 KV, 10 microsecond pulses, and about 0.6 watts average for lower amplitude pulses. Fast repetition rate pulses, such as those from a TV set, can damage the protection components; RJ1 - RJ4, R1 and R2. If any of these components require replacement, use only Fluke parts to ensure product safety. (R2 is a special flameproof fusible resistor. Use exact replacement to ensure safety.)

2-11. Each measurement function and its associated ranges are equipped with input overload protection. The overload limits for each function and range are given in Table 2-1.

Table 2-1. Input Overload Limits

SELECTED FUNCTION	SELECTED RANGE	INPUT CONNECTIONS	MAX. INPUT OVERLOAD
Voltage	200 mV, 2V, 20V, 200V, 750V ac, 1000V dc	V/kΩ and COMMON	1000V dc or peak ac on dc ranges. 1000V dc or 750V rms on ac range - 15 seconds max. on 200 mV ac range.
Current	2 mA, 20 mA, 200 mA, 2000 mA	mA and COMMON	2A max. Fuse protected in circuits with open circuit voltage ≤250V dc/rms ac. Do not use above 250V.
Resistance Conductance, or Continuity	200Ω, 2 kΩ, 20 kΩ, 200 kΩ, 2000 kΩ, 20 MΩ, 200 nS, 2 mS	V/Ω and COMMON	500V dc or rms ac. 15 seconds maximum above 300 volts.
ANY	ANY	COMMON	500V dc/rms ac with respect to earth ground.

2-12. Input Connections to COMMON

WARNING

TO AVOID ELECTRICAL SHOCK AND /OR INSTRUMENT DAMAGE DO NOT CONNECT THE COMMON INPUT TERMINAL TO ANY SOURCE OF MORE THAN 500 VOLTS DC OR RMS AC ABOVE EARTH GROUND.

2-13. The 8020B may be operated with the COMMON input terminal at a potential of up to 500V dc or 500V rms ac above earth ground. If this limit is exceeded, instrument damage may occur. This, in turn, may result in a safety hazard for the operator.

2-14. Fuse Check

2-15. The current (mA) function contains two fuses. Check them as follows:

1. Complete the set up steps for the RESISTANCE (Ω) function and select the 2 kΩ range.

2. Touch the red test probe to the mA input jack so that the V-Ω input and mA input are connected together.

3. If the display reads approximately .100 kΩ, both fuses are good.

4. If the display reads overrange, 1 followed by blank digits, one or both fuses need replacement. See the following paragraph for replacement instructions.

2-16. Fuse Replacement

2-17. All ac and dc current ranges are fuse protected. Two series fuses are used:

1. F1, 2A@ 250V, replaceable at the battery compartment (see section 1 "Battery or Fuse Installation/Replacement")

2. F2, 3A@ 600V backup fuse (see section 4, Battery/Backup Fuse Replacement).

2-18. The Display

2-19. The Front Panel Display on your 8020B is a 3-1/2 digit Liquid Crystal Display. The 1/2 digit is the extreme left digit location. So, the displayed value can range from 000 through 1999. For convenience, in discussion, the 1999 is rounded to 2000. The decimal point position is determined by selected range and is not affected by the measurement function selected. Polarity, on the other hand is only used for the dc voltage and current measurement functions. A minus sign indicates that the input signal is negative with respect to the COMMON input terminal. Positive inputs are indicated by the absence of the minus sign.

NOTE

The minus sign (-) may flash momentarily as the 8020B comes out of an overrange condition. This will most likely be seen in the ohms mode as the open circuit test leads are applied to an in-range resistance value. If the minus sign remains on for in-range ohms readings, the circuit is live (a negative voltage is present at the input terminals due to charged capacitors, etc.), and incorrect resistance readings will be observed.

2-20. The Display has two abnormal status indicators, one for low battery power and one for instrument overrange. a "BT" is displayed when approximately 80% of the battery's life is exhausted (battery replacement is indicated). And, a "1" followed by three blanked digits is displayed (decimal point may be present) as an overrange indication. This does not necessarily mean that the instrument is being exposed to a damaging input condition. For example, when measuring resistance an open-input will cause an overrange indication.

NOTE

When the 8020B is powered with the A81 Battery Eliminator the "BT" indicator may come on. However, instrument operation will be normal.

2-21. The liquid crystal display used in the 8020B is a rugged and reliable unit which will give years of satisfactory service. Display life can be extended by observing the following practices:

1. Protect the display from extended exposure to bright sunlight.

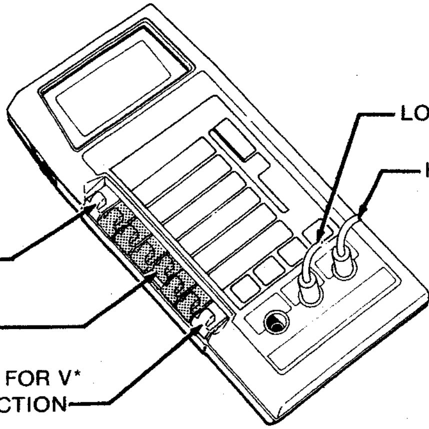
2. Keep the voltmeter out of high temperature, high humidity environments, such as, the dash of a car on a hot, sunny day. Otherwise, the display may temporarily turn black. Recovery occurs at normal operating temperature.

3. Note that the display operation may be slowed in extremely low temperature environments. No damage will occur to the LCD, but response time is greatly increased. Recovery occurs at normal operating temperature.

2-22. OPERATION

2-23. The five figures, 2-1 through 2-5, each illustrate one of the measurement functions of the Model 8020B. Each figure has two parts. The top part shows your 8020B as it should look when ready to perform that type of measurement. The bottom part of the figure lists, in sequential order, the steps you should perform to make that type of measurement with your 8020B. To operate your 8020B turn to the operation figure corresponding to the measurement function desired and perform the steps listed in the figure. Operate the Model 8020B in accordance with the Input Overload Protection and the Input Connections to COMMON portions of the Operating Notes presented earlier in this section.

VOLTS (V)



**NOTE: The Function switches are push-push type. Operate these switches by pushing to the RIGHT▶only! Do not push or pull these switches to the left (out or off) positions.*

- Connect the test leads as shown above.
- Depress the switch beside the range desired (20V is shown selected).
- Set the AC/DC switch out for DC or in For AC (DC is shown selected).
- Ensure that all other switches are at the out or off positions.

WARNING

TO AVOID ELECTRICAL SHOCK AND/OR INSTRUMENT DAMAGE, DO NOT CONNECT THE 8020B TERMINALS TO SOURCES THAT EXCEED THE FOLLOWING LIMITS WHEN MEASURING VOLTAGES:

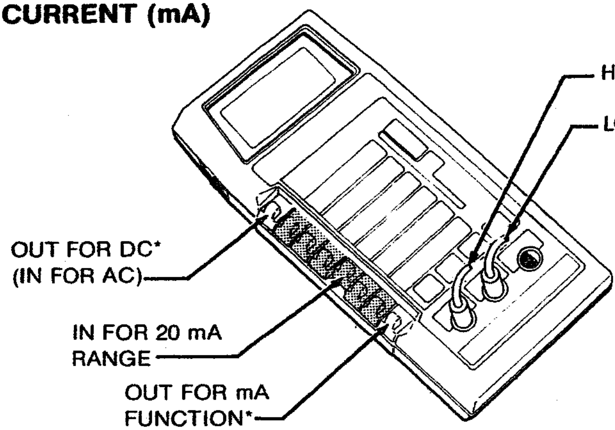
COMMON: 500V DC OR RMS AC WITH RESPECT TO EARTH GROUND.

V-Ω-S: 1000V DC OR 750V RMS AC WITH RESPECT TO THE COMMON TERMINAL (INTHE AC FUNCTION, 200 mV RANGE, SOURCES GREATER THAN 300V DC OR RMS AC SHOULD NOT BE CONNECTED LONGER THAN 15 SECONDS).

- Connect the test leads to the circuit being measured.
- Read the measured value on the display. The minus sign will appear if the V-Ω-S terminal is negative with respect to the COMMON terminal.

Figure 2-1. Volts Operation

CURRENT (mA)



**NOTE: The Function switches are push-push type. Operate these switches by pushing to the RIGHT▶only! Do not push or pull these switches to the left (out or off) positions.*

- Connect the test leads as shown.
- Depress the switch beside the range desired (20 mA range shown selected).
- Set the AC/DC switch out for DC or in for AC.
- Ensure that all other switches are at the out or off positions.

WARNING

TO AVOID ELECTRICAL SHOCK AND/OR INSTRUMENT DAMAGE, DO NOT CONNECT THE 8020B TERMINALS TO SOURCES THAT EXCEED THE FOLLOWING LIMITS WHEN MEASURING CURRENT:

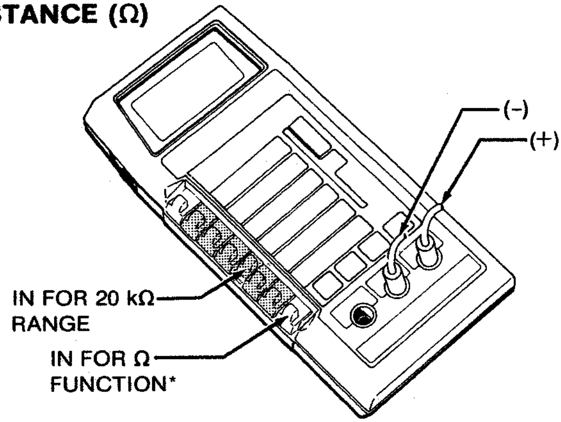
COMMON: 500V DC OR RMS AC WITH RESPECT TO EARTH GROUND.

mA: CURRENT OF 2 AMPS OR OPEN CIRCUIT VOLTAGE OF 600V DC/RMS AC. DO NOT ATTEMPT CURRENT MEASUREMENT WHERE THE POTENTIAL IS ABOVE 600V DC OR RMS AC.

- Connect the test leads to the circuit being measured.
- Read the measured value on the display. In DC the minus sign will appear if the mA terminal is negative with respect to the COMMON terminal. If unit fails to read properly, see Fuse Check located earlier in this section.

Figure 2-2. Current Operation

RESISTANCE (Ω)



**NOTE: The Function switches are push-push type. Operate these switches by pushing to the RIGHT▶only! Do not push or pull these switches to the left (out or off) positions.*

- Connect the test leads as shown.
- Depress the mA-V-Ω-S switch.
- Depress the switch beside the range desired (20k is shown selected).
- Ensure that all other switches are at the out or off positions.
- Make sure that the device being measured contains no electrical energy.

WARNING

TO AVOID ELECTRICAL SHOCK AND/OR INSTRUMENT DAMAGE, DO NOT CONNECT THE 8020B TERMINALS TO SOURCES THAT EXCEED THE FOLLOWING LIMITS WHEN MEASURING RESISTANCE OR CONTINUITY:

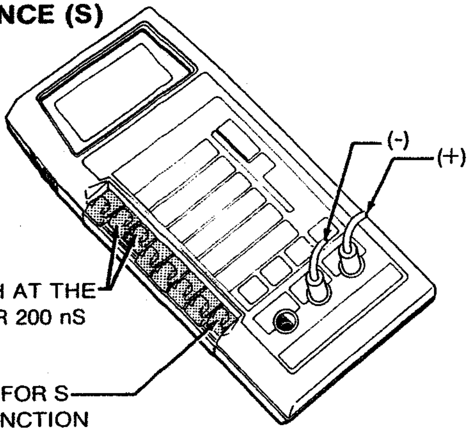
COMMON: 500V DC OR RMS AC WITH RESPECT TO EARTH GROUND.

V-Ω-S: 500V DC OR RMS AC WITH RESPECT TO THE COMMON TERMINAL. (15 SECONDS MAXIMUM ABOVE 300V.)

- Connect the test leads across the device being measured.
- Read the measured value on the display.

Figure 2-3. Resistance Operation

CONDUCTANCE (S)



**NOTE*
The Function switches are push-push type. Operate these switches by pushing to the RIGHT only! Do not push or pull these switches to the left (out or off) positions.

- Connect the test leads as shown.
- Depress the mA-V-Ω-S function switch.
- AT THE SAME TIME, depress both of the range switches. (The 200 nS range is shown selected.)
- Ensure that all other switches are at the out or OFF positions.
- Ensure that the device being measured contains no electrical energy.

WARNING

TO AVOID ELECTRICAL SHOCK AND/OR INSTRUMENT DAMAGE, DO NOT CONNECT THE 8020B TERMINALS TO SOURCES THAT EXCEED THE FOLLOWING LIMITS WHEN MEASURING VOLTAGES:

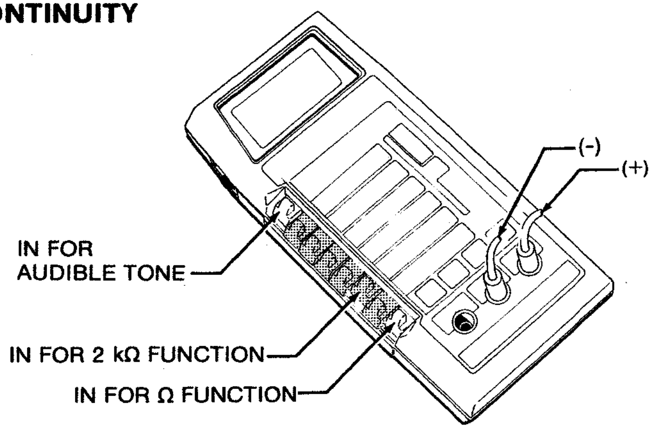
COMMON: 500V DC OR RMS AC WITH RESPECT TO EARTH GROUND.

V-Ω-S: 500V DC OR RMS AC WITH RESPECT TO THE COMMON TERMINAL. (15 SEC MAX ABOVE 300V.)

- Connect the test leads across the device being measured.
- Read the measured value in the display.
- See Measurement Techniques section for Conductance-Resistance Conversion chart.

Figure 2-4. Conductance Operation

CONTINUITY



**NOTE*
The Function switches are push-push type. Operate these switches by pushing to the RIGHT only! Do not push or pull these switches to the left (out or off) positions.

- Connect the test leads as shown.
- Depress the mA-V-Ω-S function switch.
- Depress the 2 kΩ range switch.
- Depress the AC/DC function switch.
- Ensure that all other switches are at the out or off position.
- Ensure that the device being measured contains no electrical energy.

WARNING

TO AVOID ELECTRICAL SHOCK AND/OR INSTRUMENT DAMAGE, DO NOT CONNECT THE 8020B TERMINALS TO SOURCES THAT EXCEED THE FOLLOWING LIMITS WHEN MEASURING CONDUCTANCE:

COMMON: 500V DC OR RMS AC WITH RESPECT TO EARTH GROUND.

V-Ω-S: 500V DC OR RMS AC WITH RESPECT TO THE COMMON TERMINAL. (15 SEC MAX ABOVE 300V.)

- Connect the leads to the circuit being measured.
- Continuity between the test leads will cause the audible tone to sound.

Figure 2-5. Continuity Operation

2-24. MEASUREMENT TECHNIQUES

2-25. The following paragraphs offer you techniques that improve the measurement accuracy of your 8020B. While these techniques arein general use throughout the electronics industry, these paragraphs offer specific information for use with your 8020B.

2-26. AC Measurement

2-27. The ac ranges of the 8020B employ an average responding ac converter. This means that the unit measures the average value of the input, and displays it as an equivalent rms value for a sine wave. As a result, measurement errors are introduced when the input wave form is distorted (non-sinusoidal). The amount of error depends upon the amount of distortion. Figure 2-6 shows the relationship between sine, square and triangular waveforms, and the required conversion factors.

2-28. Voltage AC/DC

2-29. The 8020B is equipped with five ac and five dc voltage ranges; 200 mV, 2V, 20V, 200V, 750V ac/1000V dc. All ranges present an input impedance of 10 MΩ. On the ac ranges, this is shunted by less than 100 pF. When making measurements, be careful not to exceed the overload limits given earlier in Table 2-1.

2-30. Measurement errors, due to circuit loading, can result when making either ac or dc voltage measurements on circuits with high source resistance. However, in most cases the error is negligible (≤0.1%) as long as the source resistance of the measurement circuit is 10 kΩ or less. If circuit loading does present a problem, the percentage of error can be calculated using the appropriate formula in Figure 2-7.

2-31. Current AC/DC

WARNING

INSTRUMENT DAMAGE AND OPERATOR INJURY MAY RESULT IF THE FUSE BLOWS WHILE CURRENT IS BEING MEASURED IN A CIRCUIT WHICH EXHIBITS AN OPEN CIRCUIT VOLTAGE GREATER THAN 600V. DO NOT ATTEMPT AN IN-CIRCUIT CURRENT MEASUREMENT WHERE THE POTENTIAL IS GREATER THAN 600V DC OR RMS AC.

2-32. Four ac and four dc current ranges are included on the 8020B; 2 mA, 20 mA, 200 mA, and 2000 mA. Each range is diode protected to 2 amps and fuse protected above 2 amps. If either fuse blows, refer to fuse replacement information given earlier in this section.

2-33. In high electrical noise environments (near ignition switches, flourescent lights, relay switches, etc.) unstable or erroneous readings (exceeding specifications) may occur. The effect is most obvious when measuring low level current on the 2 mA range. If an erratic or erroneous reading is suspected, temporarily jumper the V/Ω connector to the mA connector. This is recommended for the 2 mA and 20 mA ranges only.

CAUTION

To avoid possible instrument damage and/or erroneous measurements remove the temporary V/Ω-to-mA jumper before attempting voltage or resistance measurements.

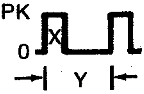
INPUT WAVEFORM	DISPLAY MULTIPLIER FOR MEASUREMENT CONVERSION			
	PK-PK	0-PK	RMS	AVG
SINE PK 0  PK-PK	2.828	1.414	1.000	0.900
RECTIFIED SINE (FULL WAVE) PK 0  PK-PK	1.414	1.414	1.000	0.900
RECTIFIED SINE (HALF WAVE) PK 0  PK-PK	2.828	2.828	1.414	0.900
SQUARE PK 0  PK-PK	1.800	0.900	0.900	0.900
RECTIFIED SQUARE PK 0  PK-PK	1.800	1.800	1.272	0.900
RECTANGULAR PULSE D=X/Y PK 0  X Y PK-PK	0.9/D	0.9/D	$0.9/D^{1/2}$	0.9D
TRIANGLE SAWTOOTH PK 0  PK-PK	3.600	1.800	1.038	0.900

Figure 2-6. Waveform Conversion

1. DC VOLTAGE MEASUREMENTS

Loading Error in % = 100 x Rs ÷ (Rs + 10^7)

Where: Rs = Source resistance in ohms of circuit being measured.

2. AC VOLTAGE MEASUREMENTS

First, determine input impedance, as follows: *

$$Z\ in = \frac{10^7}{\sqrt{1 + (2\pi F \bullet Rin \bullet C)^2}}$$

Where: Zin = effective input impedance
Rin = 10^7 ohms
Cin = 100 x 10^{-12} Farads
F = frequency in Hz

Then, determine source loading error as follows: *

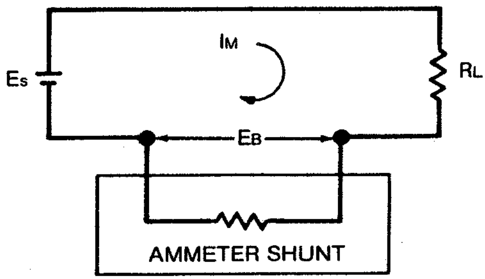
$$\text{Loading Error in \%} = \frac{100 \times Zs}{Zs + Zin}$$

Where: Zs = source impedance
Zin = input impedance (calculated)

*Vector algebra required

Figure 2-7. Voltage Measurement Error Calculations

2-34. Full-scale burden voltage (voltage drop across the fuse and current shunt) for all ranges except 2000 mA is less than 300 mV. The 2000 mA range has a full-scale burden voltage of less than 900 mV. These voltage drops can affect the accuracy of a current measurement, if the current source is unregulated and the shunt plus fuse resistance represents a significant portion (1/1000 or more) of the source resistance. If burden voltage does present a problem, the percentage of error can be calculated using the formula in Figure 2-8. This error can be minimized by using the highest current range that gives the necessary resolution. For example, if 20 mA is measured on the 2000 mA range the burden voltage is approximately 5 mV.



E_S = Source voltage
R_L = Load resistance + Source resistance
I_M = Measured current (display reading in mA)
E_B = Burden voltage (calculated), i.e., Display reading expressed as a % of full-scale $(100 \times \frac{\text{READING}}{\text{FULL-SCALE}})$ times full-scale burden voltage for selected range. See Table.

RANGE	MAXIMUM BURDEN VOLTAGE
2 mA to 200 mA	0.3V
2000 mA	0.9V

Maximum current error due to Burden Voltage

$$\text{IN \%} = 100 \times \frac{E_B}{E_S - E_B}$$

$$\text{IN mA} = \frac{E_B \times I_M}{E_S - E_B}$$

Example: $E_S = 14V$, $R_L = 9\Omega$, $I_M = 1497$ mA,

$$E_B = 100 \times \frac{1497}{2000} \times 0.9 \text{ (from Table)} =$$

$$74.9\% \times 0.9 = 0.674V$$

$$\text{Error in \%} = 100 \frac{.674}{14 - .674} = 100 \frac{.674}{13.326} = 5.06\%$$

Increase displayed current by 5.06% to obtain true current.

$$\text{Error in mA} = \frac{.674 \times 1497}{14 - .674} = \frac{1009}{13.326} = 76 \text{ mA}$$

Increase displayed current by 76 mA to obtain true current.

Figure 2-8. Current Measurement Error Calculations

2-35. Resistance

2-36. Six direct reading resistance scales are provided on the 8020B: 20 MΩ, 2000 kΩ, 200 kΩ, 20 kΩ, 2 kΩ and 200Ω. All scales employ a two-wire measurement technique. As a result, test lead resistance may influence measurement accuracy on the 200Ω range. To determine the error, short the test leads together and read the lead resistance. Correct the measurement by subtracting the lead resistance from the measurement reading. The error is generally on the order of 0.2 to 0.3 ohms for a standard pair of test leads.

2-37. In-circuit resistance measurements can be made using the 200Ω, 20 kΩ and 2000 kΩ ranges. The full scale measurement voltage produced on these ranges is not sufficient to forward bias silicon diode/emitter-base junctions, and thus, enables resistance values to be measured without removing diodes and transistors from the circuit. Conversely, the 2 kΩ, 200 kΩ, and 20 MΩ ranges produce a measurement voltage sufficient to forward bias a P-N junction. These ranges enable both diode- and transistor-junction checks to be made conveniently. Full scale voltage and short circuit current for each resistance range is given in Table 2-2. All values shown are referenced to the COMMON input terminal; i.e., the V/Ω/S terminal is positive.

NOTE

Any change (greater than one or two digits) in apparent resistance when test leads are reversed may indicate either the presence of a diode junction or a voltage in the circuit.

CAUTION

Turn test circuit power off and discharge all capacitors before attempting in-circuit resistance measurements.

2-38. Three of the 8020B resistance ranges have a high enough open-circuit voltage to turn on a silicon junction. These ranges (2 kΩ, 200 kΩ, and 20 MΩ) can be used to check silicon diodes and transistors. The 2 kΩ range is preferred for this function and is marked with a diode symbol. The open-circuit voltage of the three alternate ranges (200Ω, 2kΩ, and 2 MΩ) is not high enough to turn on a silicon junction. Use these three ranges to make in-circuit resistance measurements. For all resistance ranges, the V/Ω/S input terminal is positive with respect to the COMMON input terminal.

Table 2-2. Voltage/Current Capability of Resistance Ranges

RANGE	FULL-SCALE VOLTAGE (TYPICAL)	SHORT CIRCUIT CURRENT (TYPICAL)
20 MΩ	+800 mV	+0.12 μA
2000 kΩ	+200 mV	+0.12 μA
200 kΩ	+800 mV	+12 μA
20 kΩ	+200 mV	+12 μA
2 kΩ-⯈⊢	+1.1V	+1.0 mA
200Ω	+55 mV	+0.3 mA

2-39. Continuity

2-40. Audibly confirmed continuity measurements may be made using any of the resistance or conductance ranges. The 2 kΩ range is recommended for this mode since it provides the lowest resistance threshold, approximately 110 ohms. On this range a measured resistance lower than 110 ohms initiates the audible tone. To determine the exact threshold, use a variable resistor and note the display reading at which the tone switches on and/or off.

2-41. Intermittent open or short circuits with a duration of at least 50 us are detectable on all continuity ranges. A continuously intermittent connection is heard as a series of beeps. A series of beeps (due to environmental noise) is also encountered when a measurement is near the threshold of the selected range. The approximate thresholds for the continuity ranges are as follows:

RANGE	THRESHOLD
200 nS	900 kilohms
2 mS	110 ohms
20 MΩ	900 kilohms
2000 kΩ	900 kilohms
200 kΩ	9 kilohms
20 kΩ	9 kilohms
2 kΩ	110 ohms
200Ω	360 ohms

2-42. Conductance

2-43. The conductance ranges, (200 nS and 2 mS) are included on the 8020B for making both conductance and resistane measurements. When either range is selected the display reads the measurement results in terms of conductance (1/Ω). If resistance readings are required, refer to the conductance-to-resistance conversion information given in Figure 2-9.

2-44. The 200 nS range is intended for use in making fast, accuracte, high-resistance measurements from 5 MΩ to 10,000 MΩ. Ordinarily, resistance measurements within this range are plagued by noise pick-up and require careful shielding. However, by measuring the resistance in terms of conductance, standard test leads are adequate for the 8020B to make noise-free measurements up to 10,000 MΩ. High value resistors, and low leakage components (i.e., diodes, etc.) are natural candidates for the 200 nS conductance range. Refer to applications later in this section for additional information.

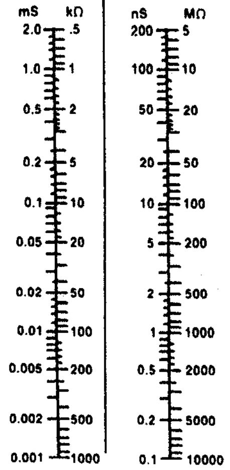
2-45. The 2 mS range, in terms of resistance, starts at 500Ω and goes up to 1 MΩ. It is intended for use in making either resistance measurements or direct-reading dc current gain (beta) measurements on transistors. Beta measurements require the use of a special test fixture, and are discussed later in this section under applications.

2-46. APPLICATIONS

2-47. The applications described in the following paragraphs are suggested as useful extensions of the 8020B measurement capabilities. However, they are not intended as the equivalent of a manufacturer's recommended test methods. Rather, they are intended to provide repeatable and meaningful indications which will allow operator to make sound judgments concerning the condition of the device being tested; i.e., good, marginal, or defective.

*mS-to-kΩ *nS-to-kΩ

2 mS Range (1/mS = kΩ) | 200 nS Range (1000/nS = MΩ)



Conversion Scales

* *S= siemens=1/Ω=International unit of conductance formerly known as the mho.*

Find the approximate resistance value using one of the scales at left. Then, on the table below, 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 19.2 MΩ. Decimal point location is determined from the scale approximation.

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 2-9. Conductance-to-Resistance Conversion

2-48. Transistor Tester

NOTE

The transistor tester described in the following paragraphs provides approximate test information. Beta is measured using a VCE of about 2V and an IC of about 200 μA. The test method is very useful for making comparative and matching measurements.

2-49. Select the 2 mS range, plug the fixture shown in Figure 2-10 into the V/Ω/S and COMMON input terminals, and you have tranformed your 8020B into a transistor tester. Now, plug a transistor into the test socket and the 8020B will determine the following:

1. Transistor type (NPN or PNP).
2. Collector-to-emitter leakage (ICEs).
3. Beta from 1 to 1000 without changing range.

2-50. Transistor type is determined by setting the switch on the fixture to BETA and observing the display. If a low reading ($\leqslant$0.010) is obtained, reverse the test fixture at the input terminals. If the collector is now positioned at the COMMON input terminal, the transistor is a PNP type. An NPN type will have its collector positioned at the V/Ω/S input terminals. If the transistor is defective the indications will be as follows regardless of fixture position:

1. A shorted transistor will cause an overload indication.
2. An open transistor will read 0.001 or less.

2-51. After the transistor fixture is properly positioned, set the switch to ICEs for the leakage test. The transistor is turned off in this test (base shorted to emitter), and should appear as a very low conductance (high resistance) from collector-to-emitter. Therefore, the lower the reading, the lower the leakage. Silicon transistors that read more than 0.002 (6 μA) should be considered questionable.

2-52. Beta is determined by setting the fixture switch to BETA, and observing the display. Mentally shift the decimal point three places to the right and read beta directly. For example, a display reading of 0.127 indicates a dc current gain (beta) of 127.

NOTE

Beta is a termperature sensitive parameter. Therefore, repeatable readings can only be obtained by allowing the transistor to stabilize at the ambient temperature while being tested. Avoid touching the transistor's case with your fingers.

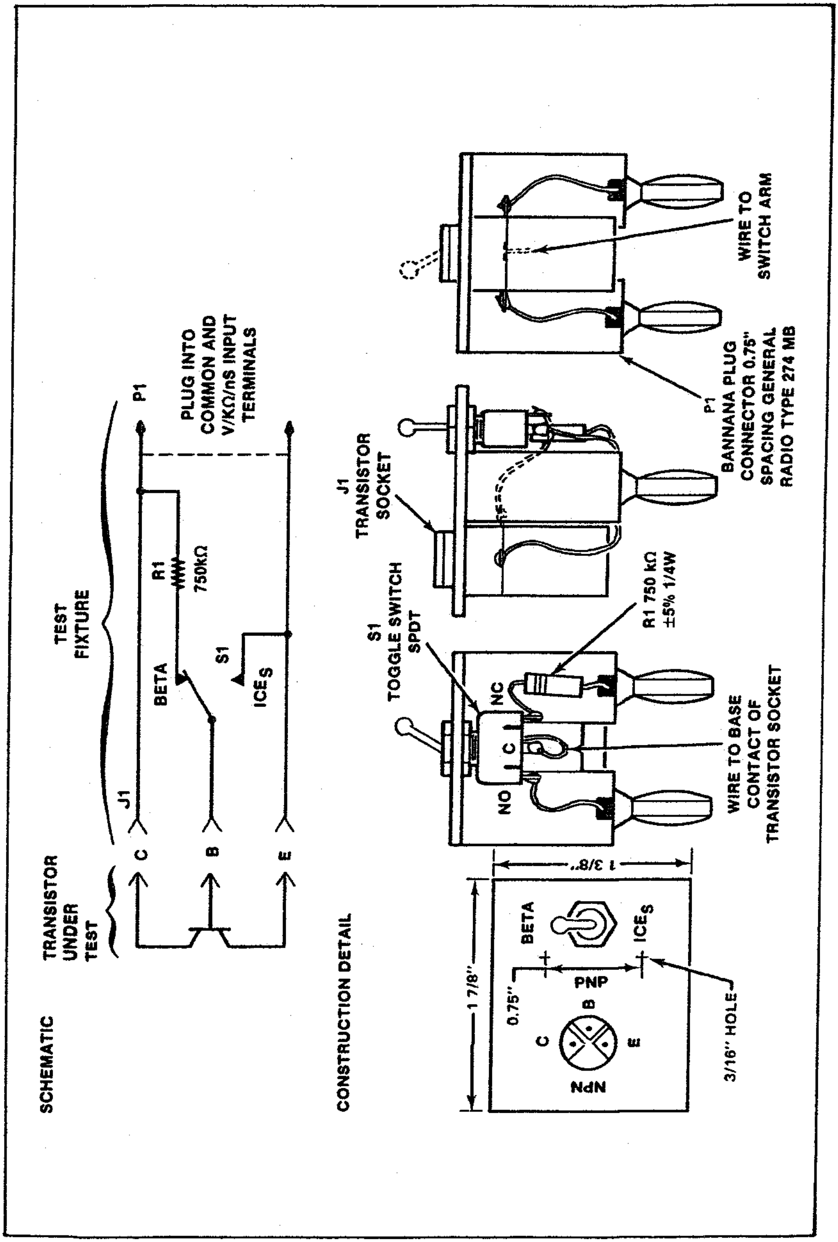


Figure 2-10. Transistor Beta Test Fixture

2-53. Leakage Tester

2-54. The 200 nS conductance range effectively extends the resistance measurement capability of the 8020B (up to 10,000 MΩ) to the point where it can be used to provide useful leakage measurements on passive components. For example, you can detect leaky diodes, cables, connectors, printed circuit boards (pcbs), etc. In all cases, the test voltage is <5V dc.

2-55. RESISTIVE COMPONENTS

2-56. Leakage testing on purely resistive components such as cables and pcbs is straightforward. Select the 200 nS range, install the test leads in the V/Ω/S and COMMON input terminals, connect the leads to the desired test points on the unit-under-test, and read leakage in terms of conductance. If an overrange occurs, select a resistance range that provides an on-scale reading.

NOTE

Under high humidity conditions (>80%) conductance measurements may be in error. To ensure accurate measurements connect clean test leads to the 8020B and (with the leads open) read the residual leakage in nanosiemens. Correct subsequent measurements by subtracting the residual from the readings. (Finger prints or other contamination on the pcb may also cause residual conductance readings.)

2-57. DIODES

2-58. Diode leakage (IR) tests require that the diode junction be reverse biased when being measured. This is accomplished by connecting the anode of the diode to the COMMON input terminal and its cathode to the V/Ω/S input terminal. Leakage can then be read in terms of conductance. In the event of an overrange, select a resistance range that provides an on-scale reading.

Section 3
Theory of Operation

3-1. INTRODUCTION

3-2. This section of the manual contains an overall functional description followed by a block diagram analysis of the 8020B. A detailed schematic of the 8020B appears in Section 7.

3-3. OVERALL FUNCTIONAL DESCRIPTION

3-4. The Model 8020B as shown in Figure 3-1, is a hand-held 8 function digital multimeter. It features a total of 26 measurement ranges (dc volts-five, ac volts-five, ohms-six, dc current-four, ac current-four, and conductance-two); a high contrast, easy-to-read, 3-1/2 digit liquid crystal display; long battery life (up to 200 hours); and overload protection for all ranges.

3-5. Operation centers around a custom LSI chip, U1, which contains a dual slope a/d converter and a display driver. Peripherals to U1 include range and function switches, input signal conditioners, and the display. When an input signal is applied to the 8020B it is routed through the range switches to one of four input signal conditioners as determined by the function switch setting. Each conditioner scales and, if necessary, rectifies the input so that an acceptable dc input level (−0.2 to +0.2V dc) is presented to the a/d converter.

3-6. Timing for the overall operation of the a/d converter is derived from an external quartz crystal whose frequency is a multiple of the local line frequency. This allows the conditioned dc input data to be integrated over a single line cycle, thus optimizing both common mode and normal mode rejection.

3-7. Digitized measurement data is presented to the display as four decoded digits (seven segments) plus polarity. Decimal point position on the display is determined by the range switch settings.

3-8. BLOCK DIAGRAM ANALYSIS

3-9. A/D Converter

3-10. The entire analog-to-digital conversion process is accomplished by a single custom A/D Converter and Display Driver IC, U1. The IC employs the dual slope method of a/d conversion, and requires a series of external components to establish the basic timing and reference levels required for operation. These include an integrating capacitor, an autozero capacitor, and a flying capacitor (for applying a reference level of either polarity). Since the power consumed for display operation is very low, the IC also contains the latches, decoders, and drivers required for the display.

3-11. The digital control portion of the a/d conversion process is an internal function of U1, and is keyed to the external crystal frequency. As a result, the conversion process is continuously repeated, and the display is updated at the end of every conversion cycle.

3-12. A simplified circuit diagram of the analog portion of the a/d converter is shown in Figure 3-2. Each of the switches shown represent analog gates which are operated by the digital section of the a/d converter. Basic timing for switch operation and, therefore, a complete measurement cycle is also included in the figure.

3-13. Any given measurement cycle performed by the a/d converter can be divided into three consecutive time periods, autozero (AZ), integrate (INTEG), and read. Both autozero and integrate are fixed time periods whose lengths are multiples of the clock frequency. A counter determines the length of both time periods by providing an overflow at the end of every 10,000 clock pulses. The read period is a variable time which is proportional to the unknown input voltage. The value of the voltage is determined by counting the number of clock pulses that occur during the read period.

3-14. During autozero a ground reference is applied as an input to the a/d converter. Under ideal conditions the output of the comparator would also go to zero. However, input-offset-voltage errors accumulate in the amplifier loop, and appear at the comparator output as an error voltage. This error is impressed across the AZ capacitor where it is stored for the remainder of the measurement cycle. The stored level is used to provide offset voltage correction during the integrate and read periods.

3-15. The integrate period begins at the end of the autozero period. As the period begins, the AZ switch opens and the INTEG switch closes. This applies the unknown input voltage to the input of the a/d converter. The voltage is buffered and passed on to the integrator to determine the charge rate (slope) on the INTEG capacitor. By the end of the fixed integrate period the capacitor is charged to a level proportional to the unknown input voltage. This voltage is translated to a digital indication by discharging the capacitor at a fixed rate during the read period, and counting the number of clock pulses that occur before it returns to the original autozero level.

3-16. As the read period begins, the INTEG switch opens and the read switch closes. This applies a known reference voltage to the input of the a/d converter. The polarity of this voltage is automatically selected to be opposite that of the unknown input voltage, thus, causing the INTEG capacitor to discharge at a fixed rate (slope). When the charge is equal to the initial starting point (autozero level), the read period is ended. Since the discharge slope is fixed during the read period, the time required for discharge is proportional to the unknown input voltage.

3-17. The autozero period and, thus, a new measurement cycle begins at the end of the read period. At the same time the counter is released for operation by transferring its contents (previous measurement value) to a series of latches. This stored data is then decoded and buffered before being used for driving the liquid crystal display.

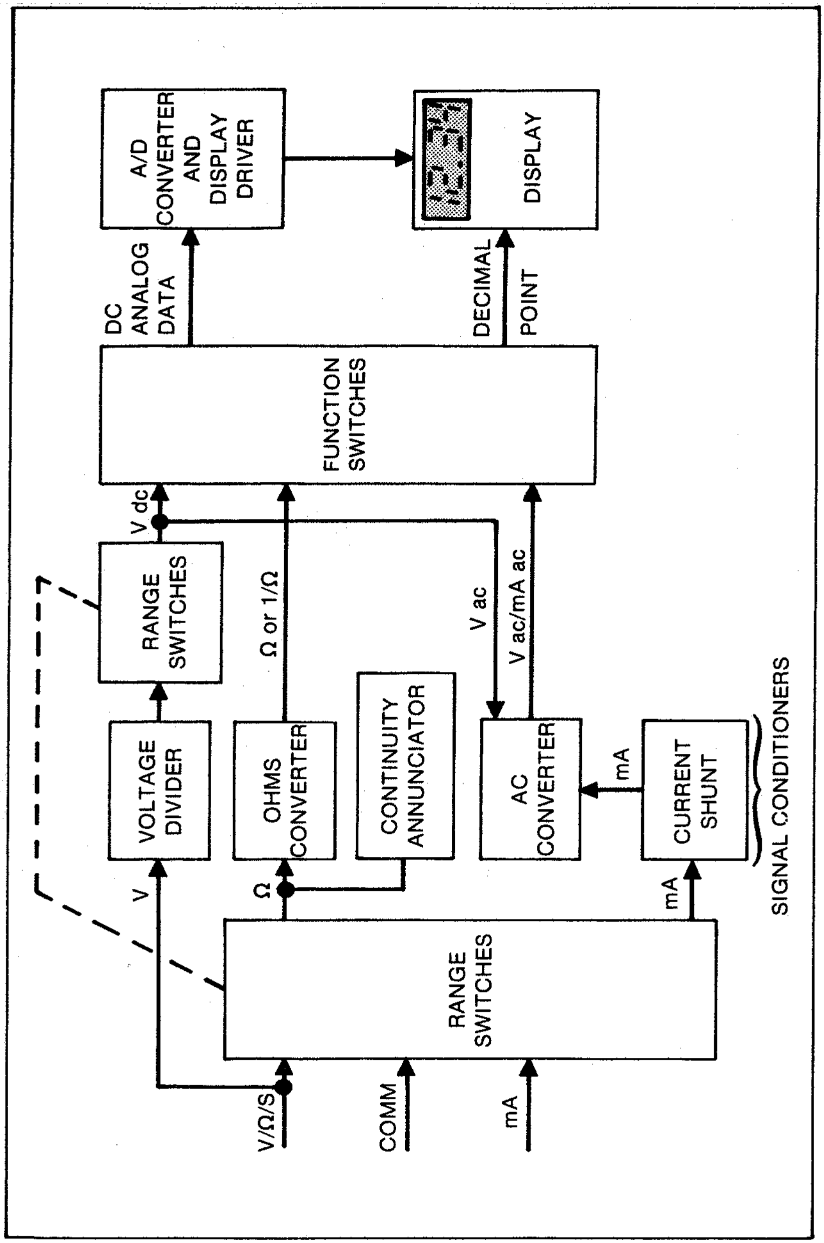


Figure 3-1. 8020B Simplified Block Diagram

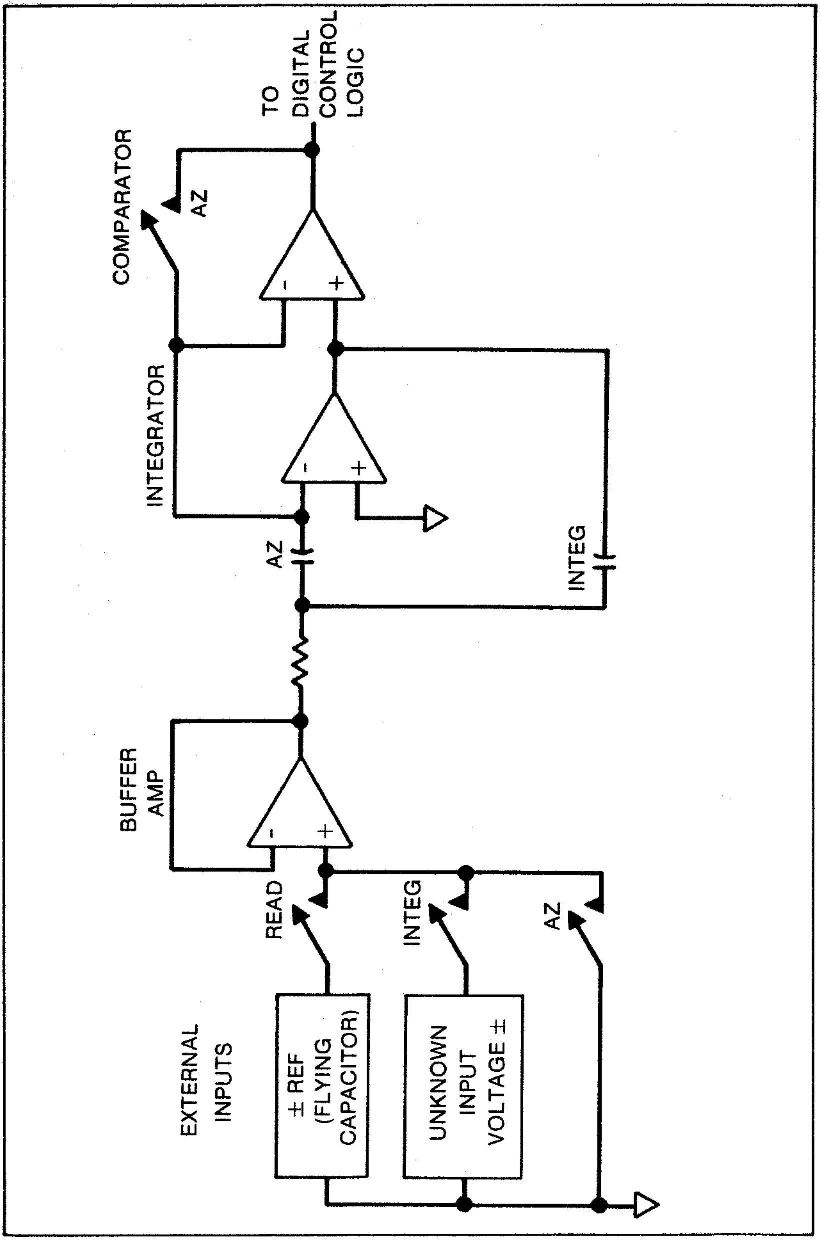


Figure 3-2. Dual Slope A/D Converter

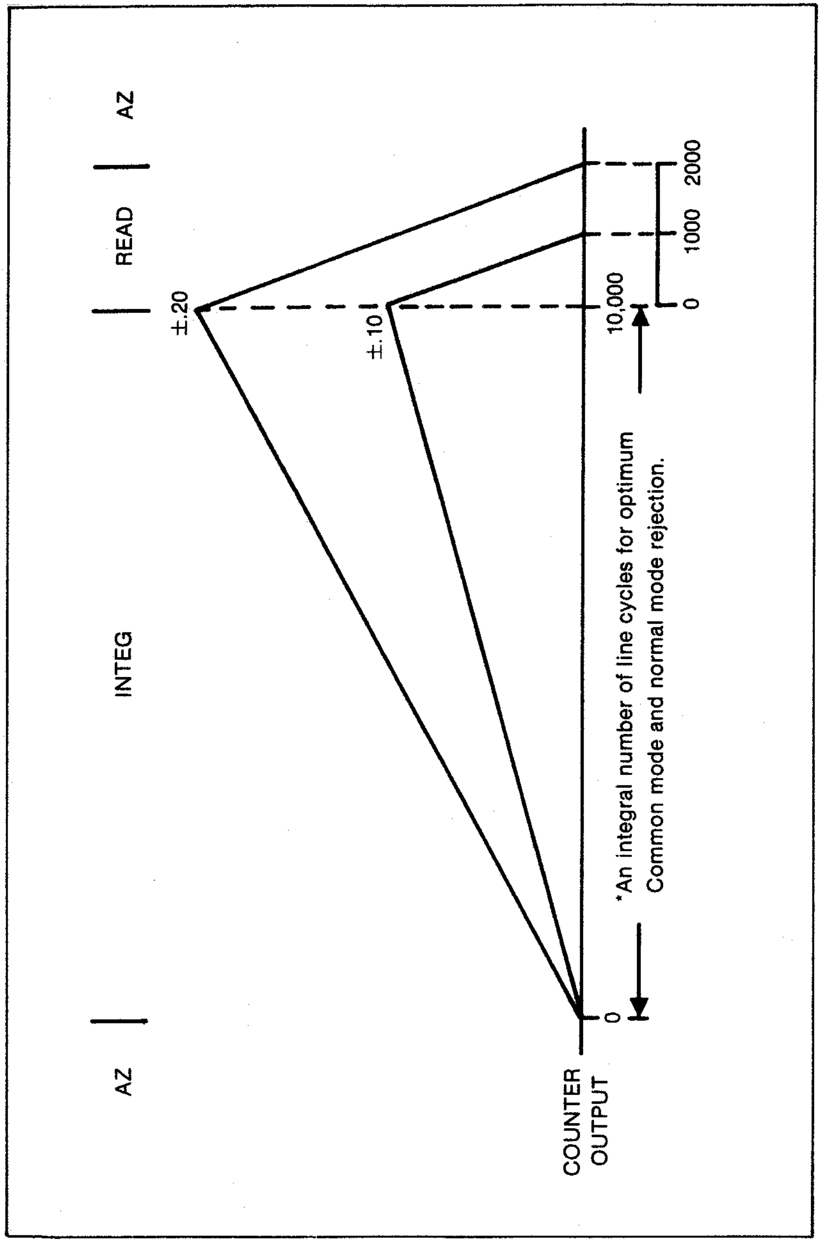


Figure 3-2. Dual Slope A/D Converter (cont)

3-18. Input Signal Conditioners

3-19. The a/d converter requires two externally supplied input voltages to complete a measurement cycle. One is reference voltage and the other is an unknown dc voltage within the range of -0.2 to +0.2V dc. If the function being measured is other than a dc voltage within the ±0.2 range, it must be scaled and/or conditioned before being presented to the a/d converter. for example, higher dc levels must be divided; ac inputs must be divided, rectified, and filtered; and resistance and current inputs must be scaled and converted to dc voltlage levels. The following paragraphs describe the input signal conditioners used for each of the 8020B measurement functions.

3-20. VOLTAGE MEASUREMENT

3-21. Both the ac and dc voltage ranges use an over-voltage-protected, 10 MΩ input divider as shown in Figure 3-3 View A. Under normal conditions, assuming a dc input level on the proper range, the divider output is a -0.2 to +0.2 dc signal, and is an exact (power-of-10) ratio of the input signal. If the VAC function is selected, the divider output is ac coupled to an active full-wave rectifier whose dc output is calibrated to equal the rms level of the ac inputs. The conditioned signal for the selected function (V ac or V dc) is then passed through a filter before being presented to the a/d converter as the unknown input.

3-22. CURRENT MEASUREMENT

3-23. Current measurements are made using a fuse protected, switchable, four-terminal current shunt (0.1Ω, 1Ω, 10Ω, 100Ω) to perform the current-to-voltage conversion required by the a/d converter. See Figure 3-3 View B. The voltage (IR) drop produced across the selected shunt may be either ac or dc depending upon the selected function, mA AC or mA DC. If the input current is dc and the dc function is selected, the IR drop is passed through a low-pass filter, and presented as the unknown input to the a/d converter. However, if the input current is ac and the AC function is selected, the IR drop is rectified by the ac converted before going to the low-pass filter. In either event the a/d converted receives a dc input voltage proportional to the current passing through the selected shunt.

3-24. RESISTANCE MEASUREMENTS

3-25. Resistance measurements are made using a ratio technique as shown in Figure 3-3C. When the Ω function is selected, a simple series circuit is formed by the internal reference voltage, a reference resistor from the voltage divider (selected by range switches), and the external unknown resistor. The ratio of the two resistor values is equal to the ratio of their respective voltage drops. Therefore, since the value of one resistor is known, the value of the second can be determined by using the voltage drop across the known resistor as a reference. This determination is made directly by the a/d converter.

3-26. Overall operation of the a/d converter during a resistance measurement is basically as described earlier in this section, with one exception. The reference voltage present during a voltage measurement is replaced by the voltage drop across the reference resistor. This allows the voltage across the unknown resistor to be read during the integrate period, and compared against the reference resistor during the read period. As before, the length of the read period is a direct indication of the value of the unknown.

3-27. CONDUCTANCE MEASUREMENTS

3-28. Conductance measurements are made using a ratio technique similar to that used in making resistance measurements. See Figure 3-3 View C. The main difference is that only two ranges are provided (200 nS and 2 mS), and the function of the range and unknown resistors in the measurement cycle is reversed. That is, the voltage drop across the range resistor is used as the unknown input during the integrate period, and the voltage across the unknown resistor is used for the reference input during the read period. As a result the display provides a reading that is the reciprocal (1 / Ω) of the unknown input resistance, i.e., the higher the input resistance the lower the display reading.

3-29. CONTINUITY MEASUREMENTS

3-30. Continuity is a measurement feature that supplements the resistance and conductance measurement functions. The feature is enabled when the V / Ω and the AC / DC function switches are both pressed in. When a measurement is made, continuity is indicated by an audible tone. No tone indicates an open circuit or a circuit resistance above the threshold of the range selected.

3-31. The continuity circuit consists of a comparator, a one-shot, and a tone generator. See Figure 3-3 View D. During a measurement, R pull-up and V source develop a voltage across the measured resistance. The comparator compares this voltage against an internal 100 mV threshold reference. If the input voltage is greater than the 100 mV reference, the tone generator is not enabled, a no-continuity indication. Conversely, an indication of less than 100 mV causes the comparator to enable the tone generator which emits an audible continuity indication.

3-32. Since the values of V source and R pull-up vary with the selected range, it is convenient to think of the 100 mV threshold as a resistance threshold. The resistance threshold and the V source/ R pull-up values for each continuity range are given in the following list:

RANGE	R pull-up	V source (VOLTS)	THRESHOLD RESISTANCE
200Ω	4 kilohms	1.2 volts	360 ohms
2 kΩ	3 kilohms	2.8 volts	110 ohms
2 mS	3 kilohms	2.8 volts	110 ohms
20 kΩ	100 kilohms	1.2 volts	9 kilohms
200 kΩ	100 kilohms	1.2 volts	9 kilohms
2000 kΩ	10 megohms	1.2 volts	900 kilohms
20 MΩ	10 megohms	1.2 volts	900 kilohms
200 nS	10 megohms	1.2 volts	900 kilohms

3-33. Extremely short changes in a continuity condition (intermittent open or short circuits) are detected by the one-shot, and the appropriate indication is maintained for approximately 200 ms. This pulse stretching effect ensures that a reliable audio tone is generated for continuity changes as short as 50 μs.

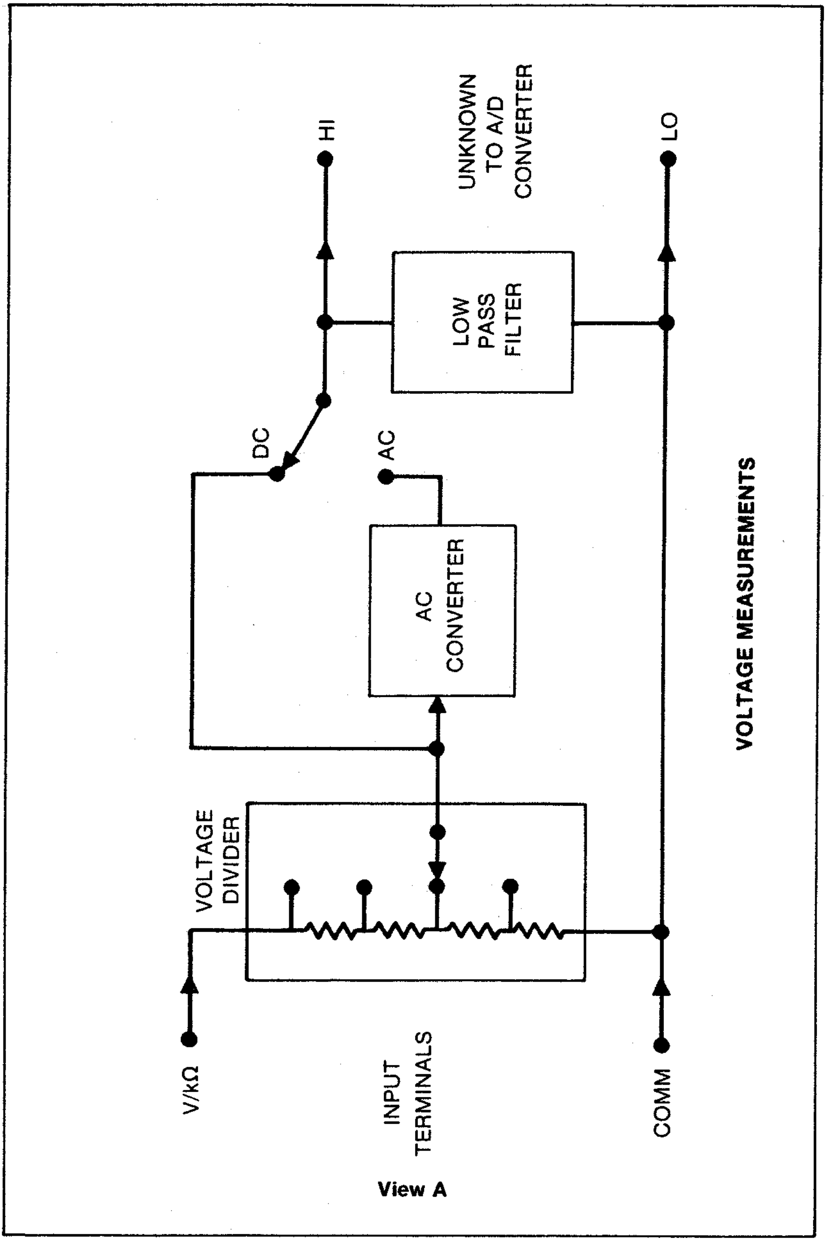


Figure 3-3. Input Signal Conditioners

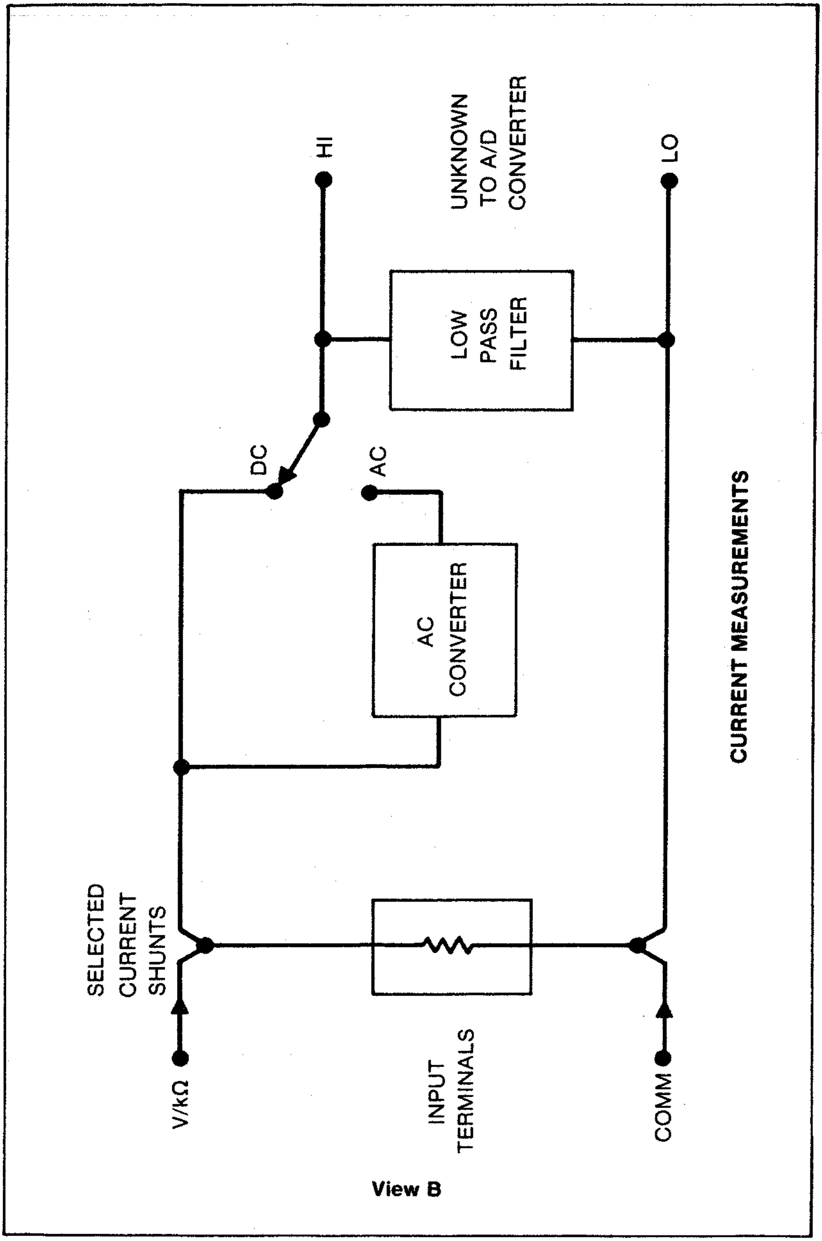
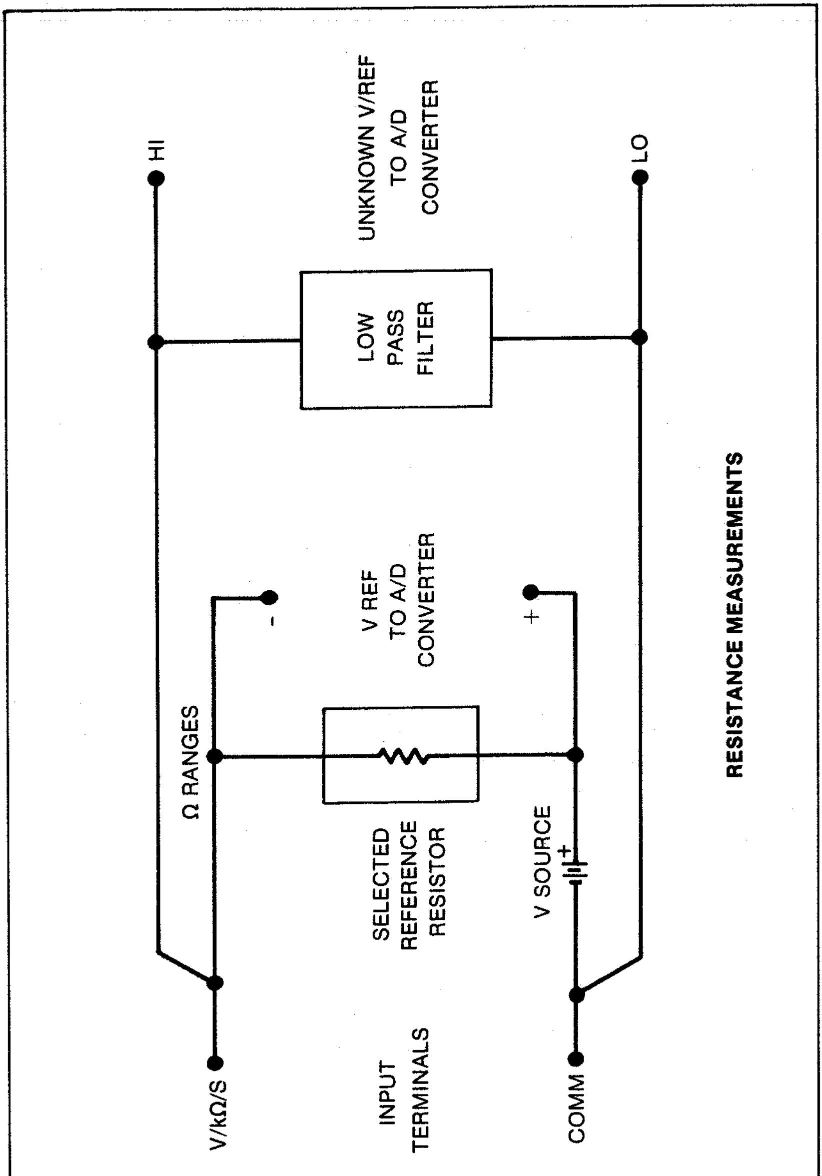


Figure 3-3. Input Signal Conditioners (cont)



View C

Figure 3-3. Input Signal Conditioners (cont)

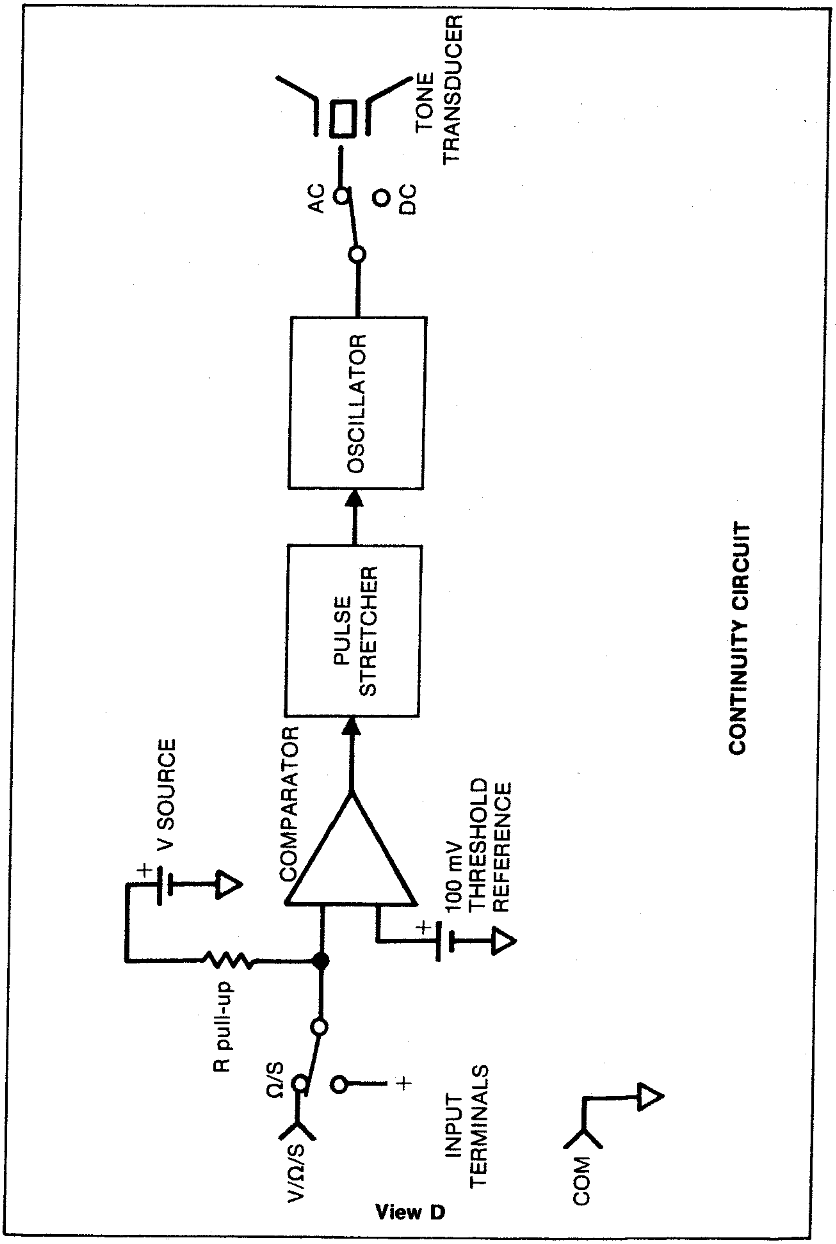
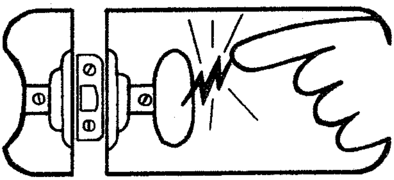


Figure 3-3. Input Signal Conditioners (cont)

static awareness

A Message From
John Fluke Mfg. Co., Inc.



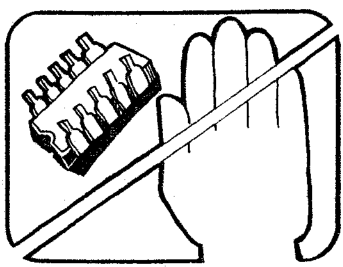
Some semiconductors and custom IC's can be damaged by electrostatic discharge during handling. This notice explains how you can minimize the chances of destroying such devices by:

1. Knowing that there is a problem.
2. Learning the guidelines for handling them.
3. Using the procedures, and packaging and bench techniques that are recommended.

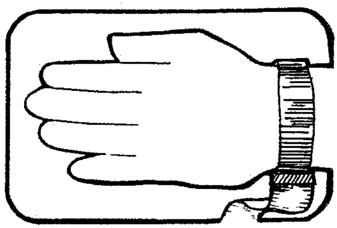
The Static Sensitive (S.S.) devices are identified in the Fluke technical manual parts list with the symbol

" ⊗ "

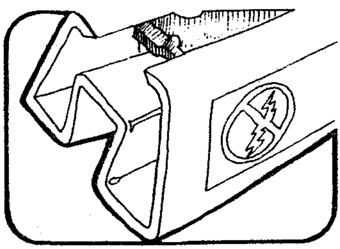
The following practices should be followed to minimize damage to S.S. devices.



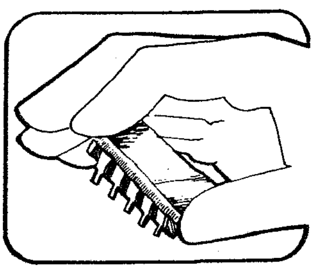
1. MINIMIZE HANDLING



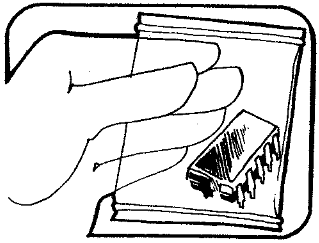
3. DISCHARGE PERSONAL STATIC BEFORE HANDLING DEVICES



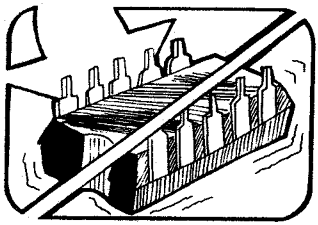
2. KEEP PARTS IN ORIGINAL CONTAINERS UNTIL READY FOR USE



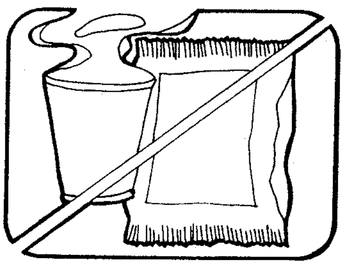
4. HANDLE S.S. DEVICES BY THE BODY



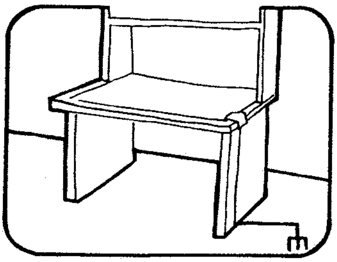
5. USE ANTI-STATIC CONTAINERS FOR HANDLING AND TRANSPORT



6. DO NOT SLIDE S.S. DEVICES OVER ANY SURFACE



7. AVOID PLASTIC, VINYL AND STYROFOAM IN WORK AREA



8. HANDLE S.S. DEVICES ONLY AT A STATIC-FREE WORK STATION

9. ONLY ANTI-STATIC TYPE SOLDER-SUCKERS SHOULD BE USED.

10. ONLY GROUNDED TIP SOLDERING IRONS SHOULD BE USED.

Anti-static bags, for storing S.S. devices or pcbs with these devices on them, can be ordered from the John Fluke Mfg. Co., Inc.. See section 5 in any Fluke technical manual for ordering instructions. Use the following part numbers when ordering these special bags.

John Fluke Part No.	Bag Size
453522	6" x 8"
453530	8" x 12"
453548	16" x 24"
454025	12" x 15"

Section 4
Maintenance

WARNING

THESE SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID ELECTRIC SHOCK, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN THE OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.

4-1. INTRODUCTION

4-2. This section of the manual contains maintenance information for the Model 8020B. This includes service information, general maintenance, performance test, calibration and troubleshooting. The performance test is recommended as an acceptance test when the unit is first received, and later as a preventive maintenance tool to verify proper instrument operation. A 2-year calibration cycle is recommended to maintain the specifications given in Section 1 of this manual. The test equipment required for both the performance test and calibration is listed in Table 4-1. If the recommended equipment is not available, instruments having equivalent specifications may be used.

4-3. SERVICE INFORMATION

4-4. The 8020B is warranted for a period of two years upon delivery to the original purchaser. Conditions of the warranty are given at the rear of this manual.

4-5. Malfunctions that occur within the limits of the warranty will be corrected at no charge. Simply mail the instrument (postpaid) to your nearest authorized (in-warranty) Fluke Technical Service Center. A complete list of service centers are provided at the rear of this manual. Dated proof-of-purchase will be required for all in-warranty repairs.

4-6. Factory authorized service centers are also available for calibration and / or repair of instruments that are beyond their warranty period. Contact your nearest authorized Fluke Technical Service Center for a cost quotation. Ship the instrument and remittance in accordance with instructions received.

Table 4-1. List of Recommended Test Equipment

INSTRUMENT TYPE	REQUIRED CHARACTERISTICS	RECOMMENDED MODEL
	PREFERRED	
DMM Calibrator	John Fluke 5100A family	John Fluke Models 5100A, 5101A, 5102A
	ALTERNATE	
AC Calibrator	Voltage Range: 0 to 750V ac Frequency Range: 100 to 450 Hz: ±0.25% Voltage Accuracy: 100 to 450 Hz: ±0.1%	John Fluke Models 5200A and 5215A
DC Calibrator	Voltage Range: 0 to 1000V dc Accuracy: ±0.025%	John Fluke Model 343A
DC Current Calibrator	Current Range: 2 mA to 2A Accuracy: ±0.2%	John Fluke Model 382A
Decade Resistor or Individual Resistors	Resistance Values: 190Ω, 1.9 kΩ, 19 kΩ, 190 kΩ, 1.9 MΩ, and 10 MΩ Accuracy: ±0.025% Power Rating: ≥1/8 watt	ESI Model DB62

4-7. GENERAL INFORMATION

4-8. Access Information

NOTE

To avoid contaminating the pcb with oil from the fingers, handle it by the edges or wear gloves. If the pcb does become contaminated, refer to the cleaning procedure given later in this section.

4-9. BACKUP FUSE (F2) AND CALIBRATION ACCESS

4-10. Use the following procedure to access the 8020B calibration adjustments.

1. Set the power switch to OFF.

2. Disconnect test leads and battery eliminator, if attached.

3. Open the battery compartment and disconnect the battery.

4. Remove the three phillips-head screws from the bottom of the case.

5. Turn the instrument face-up and grasp the top cover at both sides of the input connectors. Then, pull the top cover from the unit.

6. Backup Fuse (F2) all adjustments necessary to complete the calibration procedure are now accessible (see Figure 4-1).

4-11. COMPONENT/PCB ACCESS

4-12. Use the following procedure to remove the Main PCB Assembly from the case:

1. Complete the calibration access procedure.

2. Remove the screw from shield.

3. Using your index finger, lift the lower right-hand corner of the pcb. When the pcb is freed, pull it to the right until it clears the shelf under the buttons, and then lift up. Handle the PCB by its edges to prevent surface contamination.

4. To reassemble the 8020B logically reverse this procedure.

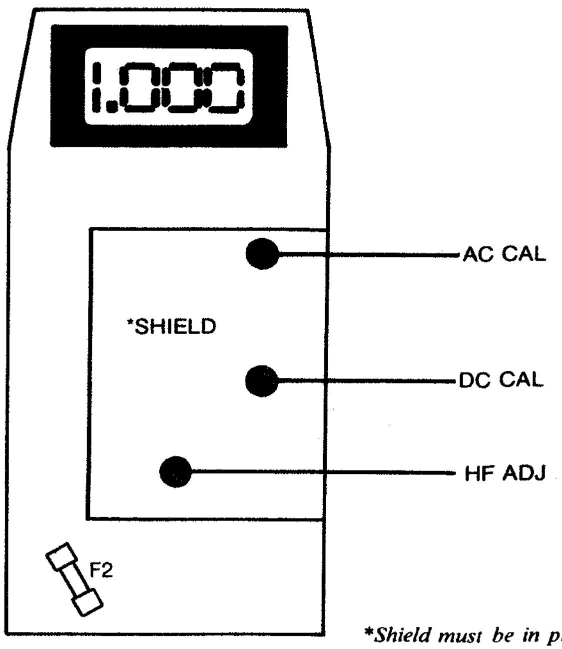


Figure 4-1. Calibration Adjustment Locations

NOTE

When installing the pcb, route the battery-clip wires behind the post on the left-hand side of the bottom case, and thread the battery-clip through the battery-cover opening. Also make sure that the removable plastic lip that resides beneath the range switch pushbuttons is properly installed in the bottom case. The green power switch cap should also be mounted on the power switch.

4-13. DISPLAY ACCESS

4-14. Refer to Figure 4-2 and the following procedure to remove/replace the LCD assembly.

1. Remove the Main PCB Assembly using the PCB access procedure.

2. Place your thumbs on either side of the display lens and carefully slide the lens out of the LCD bracket.

3. Turn the LCD bracket upside down, gently tap it against your palm. The LCD should fall out.

NOTE

When installing the LCD make certain that its flat surface is facing out and its connector pattern is on top of and makes contact with, the flexible layered connector. All of the parts indicated in figure 4-2 must be thoroughly cleaned and free of particles to assure proper display operation.

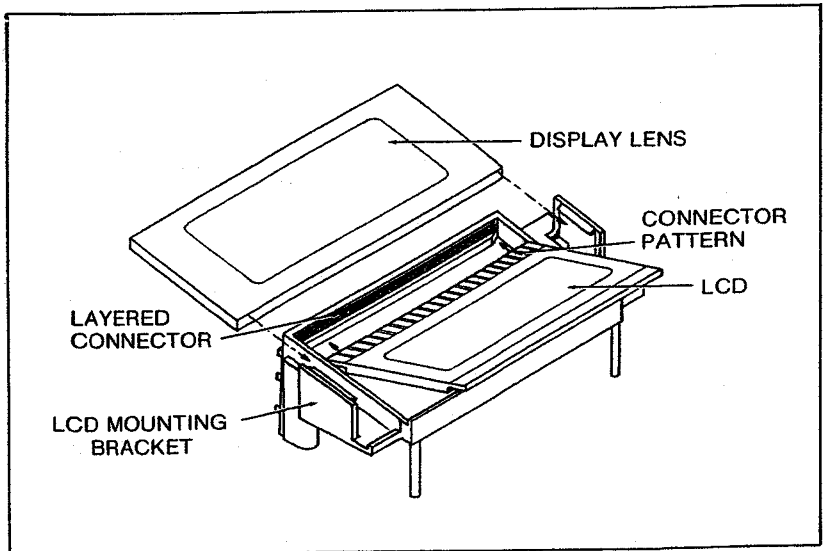


Figure 4-2. LCD Display Assembly

4-15. LSI (U1) ACCESS

4-16. Use the following procedure to remove/replace the A/D Converter and Display Driver IC, U1.

1. Remove the pcb assembly using the component/pcb access procedure.

2. On the bottom of the pcb locate and remove the two phillips-head screws from the display assembly.

3. Lift the display assembly from the pcb to expose U1.

CAUTION

U1 is a MOS device and is subject to damage by static discharge. Observe the precautions given later in this section under troubleshoooting before attempting to remove or replace U1.

4. Use a screw driver or a reasonable substitute to rock (by prying up on each end of the IC) the IC out of it socket.

5. When installing U1 make sure all pins are lined up in the socket, and then carefully press it into place.

4-17. Cleaning

CAUTION

Do not use aromatic hydrocarbons or chlorinated solvents for cleaning. These solutions will react with the plastic materials used in the instrument.

CAUTION

Do not allow the liquid crystal display to get wet. Remove the Display Assembly before washing the pcb and do not install it until the pcb has been fully dried.

4-18. Clean the front panel and case with a mild solution of detergent and water. Clean dust from the circuit board with low pressure (<20 psi) dry air. Contaminates can be removed from the circuit board with demineralized water and a soft brush (remove the Display Assembly before washing, and avoid getting excessive amounts of water on the switches). Dry with clean, dry air at low pressure, and then bake at 50 to 60°C (124-140°F) for 24 hours.

4-19. Battery/Backup Fuse Replacement

WARNING

BATTERY/FUSE REPLACEMENT SHOULD ONLY BE PERFORMED AFTER THE TEST LEADS HAVE BEEN REMOVED FROM THE INPUT JACKS, AND THE POWER SWITCH IS SET TO OFF. BACKUP FUSE REPLACEMENT PROCEDURES MUST BE PERFORMED BY QUALIFIED SERVICE PERSONNEL ONLY. USE ONLY THE RECOMMENDED FUSE TYPE FOR REPLACEMENT.

4-20. Refer to Section 1 of this manual for battery and main fuse (F1) replacement procedure. Use the following procedure to replace the backup fuse (F2).

1. Complete the Backup Fuse and Calibration Access procedure located earlier in this section.

2. Using a pointed tool such as a probe tip, pry the backup fuse from its holder.

3. Replace the defective backup fuse with a 3A, 600V type BBS-3 only.

4-21. PERFORMANCE TEST

4-22. The performance test is used to compare the 8020B performance with the list of specifications given in Section 1 of this manual. It is recommended for incoming inspection, periodic maintenance, and to verify specifications. If the instrument fails any part of the test, calibration and/or repair is indicated.

4-23. Initial Procedure

4-24. Establish the following test conditions before continuing with the Performance Test:

1. Allow the unit to stabilize at an ambient temperature of 23 ±5°C (73 ±9°F).

2. Check and, if necessary, replaced the fuses and battery.

3. Set the power switch to ON.

4-25. Display Test

4-26. The following procedure is used to test the operation of all display digits and segments:

1. Select the Ω function and the 20 kΩ range. The display should be blanked with the exception of the overrange indicator (1) in the left hand column and a decimal point in the center of the display.

2. Connect a Decade Resistor between the V/Ω/S and COMMON input terminals.

3. Set the Decade Resistor to 10 kΩ and verify a display of 10.00 ±3 digits.

4. Sequentially increase the resistance in 1.11 kΩ steps and verify the operation of each digit and its segments.

5. Disconnect the Decade Resistor at the input terminals, and select the 2000 kΩ range. A decimal point should not be displayed.

6. Sequentially select the 200, 20 and 2 kΩ range. The decimal point should appear in the tenths, hundredths, and thousandths position, respectively.

4-27. Resistance/Conductance Test

4-28. The operation and accuracy of the resistance and conductance ranges are tested in the following procedure:

1. Connect the Decade Resistor between the V/Ω/S and COMMON input terminals.
2. Refer to Table 4-2, and select the range and input conditions specified in step 1. Verify that the display reading is within the limits shown.
3. Execute and verify steps 2 through 8 of Table 4-2, using the procedure described in step 2.

4-29. Continuity Test

4-30. Use the following procedure to verify proper operation of the continuity function:

1. Select the Ω function and 2 kΩ range.
2. Connect the test leads to the COMMON and V/Ω terminals.
3. Depress the AC/DC switch to activate the audible tone.
4. Momentarily short the test leads together and observe that the tone sounds.

WARNING

THE LOCAL LINE VOLTAGE IS USED IN THE FOLLOWING STEP. BE CAREFUL NOT TO TOUCH THE PROBE TIPS WITH YOUR FINGERS OR TO ALLOW THE 120V ACRECEPTACLE TO BECOME SHORTED.

Table 4-2. Resistance/Conductance Check

STEP	RANGE	DECADE RESISTOR		JOHN FLUKE 5100A/5101A/5102A	
		INPUT RESISTANCE	DISPLAY READING	INPUT RESISTANCE	DISPLAY READINGS
1	200Ω	Short	00.0 to 00.2	Short	00.0 to 00.2
2	2 kΩ	Short	0.000 to 0.001	Short	.000 to 0.001
3	200Ω	190Ω	189.3 to 190.7	100Ω	99.5 to 100.5
4	2 kΩ	1.9 kΩ	1.897 to 1.903	1 kΩ	.998 to 1.002
5	20 kΩ	19 kΩ	18.97 to 19.03	10 kΩ	9.98 to 10.02
6	200 kΩ	190 kΩ	189.7 to 190.3	100 kΩ	99.8 to 100.2
7	2000 kΩ	1900 kΩ	1861 to 1939	1000 kΩ	980 to 1020
8	20 MΩ	10 MΩ	9.80 to 10.20	10 MΩ	9.80 to 10.20
9	200 nS	10 MΩ	97.0 to 103.0	10 MΩ	97.0 to 103.0
10	200 nS	Open	01.0 to 00.0	Open	01.0 to 00.0

5. At a convenient 120V ac receptacle, insert the test leads as if to measure the line voltage. A series of beeps at a rate of approximately 5 to 10 per second indicates proper operation of the pulse stretcher circuit.

4-31. DC Voltage Test

4-32. Use the following procedure to check the accuracy and overall operation of the dc voltage ranges:

WARNING

CONNECT THE GROUND/COMMON/LOW SIDE OF THE VOLTAGE CALIBRATOR TO COMMON ON THE 8020B.

1. Set the DC Calibrator for a zero volt output.

2. Connect the DC Calibrator output to the V/Ω/S and COMMON input terminals of the 8020B (calibrator ground/common/low to 8020B COMMON.

3. With reference to Table 4-3, select the 8020B voltage range given in step 1, and set the DC Calibrator output to the corresponding 8020B input voltage. Verify that the display reading is within the limits shown.

4. Execute and verify steps 2 through 7 of Table 4-3, using the procedure described in step 3.

4-33. AC Voltage Test

4-34. The ac voltage ranges are checked for accuracy and operation using the following procedure:

WARNING

CONNECT THE GROUND/COMMON/LOW SIDE OF THE AC CALIBRATOR TO COMMON ON THE MODEL 8020B.

1. Set the AC Calibrator for a zero volt ac output.

Table 4-3. DC Voltage Checks

STEP	VOLTAGE RANGE	INPUT VOLTAGE, DC	DISPLAY READING
1	200 mV	+190.0 mV	189.7 to 190.3
2	200 mV	-190.0 mV	-189.7 to -190.3
3	2V	0.0V	-.001 to .001
4	2V	+1.9V	1.897 to 1.903
5	20V	+19V	18.97 to 19.03
6	200V	+190V	189.7 to 190.3
7	1000V	+1000V	998 to 1002

2. Connect the AC Calibrator output to the V/Ω/S and COMMON input terminals for the 8020B (calibrator ground/common/low to 8020B COMMON).

3. With reference to Table 4-4, select the 8020B voltage range given in step 1, and set the AC Calibrator output to the corresponding 8020B input voltage and frequency. Verify that the display reading is within the limits shown.

4. Execute and verify steps 2 through 12 of Table 4-4, using the procedure described in step 3.

4-35. DC Current Test

4-36. The following procedure is used to check the operation and accuracy of the dc current ranges.

1. Set the output of the DC Current Calibrator to zero mA.

2. Connect the output of the DC Current Calibrator to the (A) and COMMON input terminals on the 8020B.

Table 4-4. AC Voltage Test

STEP	VOLTAGE RANGE	INPUT		DISPLAY READING	
		VOLTAGE	FREQ.		
1	200 mV	Short	-	00.0 to 00.2	
2	200 mV	190 mV	100 Hz	188.4 to 191.6	
3	200 mV	19 mV	100 Hz	18.7 to 19.3	
4	200 mV	190 mV	5 kHz	180.0 to 199.9	
5	2V	1.9V	5 kHz	1.800 to 1.999	
6	2V	1.9V	100 Hz	1.884 to 1.916	
7	20V	19V	100 Hz	18.84 to 19.16	
8	20V	19V	5 kHz	18.00 to 19.99	
9	200V	100V	2 kHz	98.2 to 101.8	*
10	200V	190V	100 Hz	188.4 to 191.6	*
11	750V	750V	100 Hz	741 to 759	*
12	NO TEST				*
9	200V	190V	2 kHz	186.9 to 193.1	**
10	200V	190V	100 Hz	188.4 to 191.6	**
11	750V	750V	100 Hz	741 to 759	**
12	750V	750V	1 kHz	741 to 759	**

*Perform if using John Fluke 5100A/5101A/5102A.
**Perform if using alternate equipment listed in Table 4-1.

3. With reference to Table 4-5, select the 8020B current range indicated in step 1, and set the calibrator output to provide the corresponding 8020B input current. Verify that the display reading is within the limits shown.

4. Execute and verify steps 2 through 4 of Table 4-5, using the procedure described in step 3.

4-37. CALIBRATION

4-38. Under normal operating conditions, the 8020B should be calibrated once every two years to maintain the specifications given in Section 1 of this manual. If instrument repairs have been made or if the unit fails the performance test, immediate calibration is indicated. Equipment required for calibration is given in Table 4-1. If the necessary equipment is not available, your nearest authorized Fluke Technical Service Center will be happy to help. A list of these service centers, as well as shipping information, is given at the back of this manual.

4-39. Use the following procedure to calibrate the 8020B.

NOTE

This procedure assumes an ambient temperature of 23 ±2°C (70 to 77°F) and a relative humidity of less than 80%. The temperature of the unit should be allowed to stabilize for at least 30 minutes before calibration begins.

1. Remove the top cover from the 8020B using the access procedure given in paragraph 4-10 in this section.

2. Set the 8020B power switch to ON and select the 200 mV DC range.

3. Set the output of the DC Calibrator to +190.0 mV and connect it to the 8020B input terminals; + to V/Ω/S, and – to COMMON.

4. Adjust the DC CAL pot (R5), as shown in Figure 4-1, for a display of 190.0 or 190.1. (Use a plastic adjustment tool or a plastic screw driver for all adjustments.)

5. Disconnect the DC Calibrator from the 8020B input terminals.

6. Select the 200 mV AC range on the 8020B.

Table 4-5. DC Current (mA) Checks

STEP	CURRENT RANGE	INPUT CURRENT, DC	DISPLAY READING
1	2 mA	+1.9 mA	1.885 to 1.915
2	20 mA	-19 mA	-18.85 to -19.15
3	200 mA	+190 mA	188.5 to 191.5
4	2000 mA	+1900 mA	1885 to 1915

7. Set the output of the AC Calibrator to 190 mV at 100 Hz, and connect it to the 8020B input terminals; V/Ω/S and COMMON.

8. Adjust the AC CAL pot (R9) for a display of 190.0 (an occasional flash of ±1 digit is acceptable).

9. Select the 2V ac range on the 8020B and set the AC Calibrator output to 1.9V at 5 kHz.

10. Adjust the HF ADJ (C1) for a display of 1.895 to 1.905.

11. Execute the performance test, paragraphs 4-22 through 4-36 in this section, to ensure that all fixed range resistors and other non-adjustable components are operating within their specified limits.

4-40. TROUBLESHOOTING

CAUTION

Static discharge can damage MOS components contained in the 8020B.

4-41. When troubleshooting or repairing the 8020B use the precautions listed on the Static Awareness sheet to prevent damage from static discharge. Never remove, install or otherwise connect or disconnect components without first setting the 8020B power switch to OFF.

4-42. A troubleshooting guide for the 8020B is given in Table 4-6. To properly use the guide complete the performance test given earlier in this section and note any discrepancies. Then locate the heading of the procedure in question in the Test and Symptom column (Table 4-6). Under that heading isolate the symptom that approximates the observed malfunction. Possible causes are listed to the right of the selected symptom. Details necessary to isolate a particular cause can be derived from the theory of operation in Section 3 and the schematic diagram in Section 7.

Table 4-6. Troubleshooting Guide

TEST AND SYMPTOM	POSSIBLE CAUSE
INITIAL PROCEDURE	
BT is displayed when unit is turned on.	Low battery, Q3, U2, U1. (See also operating note for A81 accessory.)
Display blank.	Dead battery, power switch, VR2 shorted, U1, battery connector.

Table 4-6. Troubleshooting Guide (cont)

TEST AND SYMPTOM	POSSIBLE CAUSE
DISPLAY TEST	
One or more segments will not light through entire test.	Display interconnect, display, or A/D Converter U1.
Decade inoperative or one or more segments always lit.	U1.
Improper decimal point indication.	Range switches, Z6, U2, or display. (Check signals at U2 to isolate.)
Minus sign improperly displayed.	U1.
Display lit but does not respond to changes in input.	Reference VR1, crystal Y1, A/D Converter U1.
RESISTANCE/CONDUCTANCE TEST	
Displayed reading is out of tolerance on at least one but not all ranges.	Range resistor Z1.
Readings are noisy on all ranges.	Thermistor RT1, R2 open.
Readings are out of tolerance on high ohms.	RJ1, RJ2, RJ3, RJ4 damaged from severe overload.
Residual reading with test leads open	PCB is contaminated (see cleaning procedure, Section 4.)
DC VOLTAGE TEST	
Display reading is out of tolerance on 200 mV range.	Out of calibration (DC), Vref (VR1) in error, Z2, U1, S1.
Only 200 mV range works - other ranges read 000.	R2 - fusible resistor open.
Readings are out of tolerance on all ranges except 200 mV.	Range resistor Z1, Z3, Z4.

Table 4-6. Troubleshooting Guide (cont)

TEST AND SYMPTOM	POSSIBLE CAUSE
AC VOLTAGE TEST	
Displayed reading is out of tolerance on 200 mV range.	Out of calibration (AC), AC converter defective, AR1.
Only 200 mV range works - other ranges read 000.	R2 - fusible resistor open.
2V range is out of tolerance with 1.9V, 5 kHz input.	HF adjust (C1) out of calibration.
Readings are out of tolerance on all ranges except 200 mV.	Z1, Z3, Z4, AR1.
DC CURRENT TEST	
Input does not affect display.	Fuse F1 and/or F2 open, CR1, CR2.
Displayed reading is out of tolerance on one or more ranges.	If 2000 mA and 200 mA ranges are okay, Z3 is defective. Otherwise Z4 is defective.
CONTINUITY TEST	
Tone doesn't sound when test leads are shorted.	S1G, S8B, AR20, U20, LS1, Board interconnection, defective test lead, test lead in mA jack.
CALIBRATION	
DC CAL pot at limit.	VR1, Z2, or R5.
AC CAL pot at limit.	Z5, CR3, CR4, R9, AR1, dc calibration incorrect.
HF adjust at limit.	S3D, Z1, C2, shield not installed.

Section 5
List of Replaceable Parts

5-1. INTRODUCTION

5-2. This section contains an illustrated parts breakdown of the instrument. A similar parts listing for each of the options will be found in Section 6. Components are listed alphanumerically by assembly. Both electrical and mechanical components are listed by reference designation. Each listed part is shown in an accompanying illustration.

5-3. Parts lists include the following information:

1. Reference Designation.

2. Description of each part.

3. FLUKE Stock Number.

4. Federal Supply Code for Manufacturers. (See Table 5-4 for Code-to-Name list.)

5. Manufacturer's Part Number.

6. Total Quantity per assembly or component.

7. Recommended Quantity: This entry indicates the recommended number of spare parts necessary to support one to five instruments for a period of two years. This list presumes an availability of common electronic parts at the maintenance site. For maintenance for one year or more at an isolated site, it is recommended that at least one of each assembly in the instrument be stocked. In the case of optional subassemblies, plug-ins, etc., that are not always part of the instrument, or are deviations from the basic instrument model, the REC QTY column lists the recommended quantity of the item in that particular assembly.

5-4. HOW TO OBTAIN PARTS

5-5. Components may be ordered directly from the manufacturer by using the manufacturer's part number, or from the John Fluke Mfg. Co., Inc. factory or authorized representative by using the FLUKE STOCK NUMBER. In the event the part you order has been replaced by a new or improved part, the replacement will be accompanied by an explanatory note and installation instructions if necessary.

5-6. To ensure prompt and efficient handling of your order, include the following information.

1. Quantity
2. FLUKE Stock Number
3. Description
4. Reference Designation
5. Printed Circuit Board Part Number
6. Instrument Model and Serial Number

CAUTION

Indicated devices are subject to damage by static discharge.

Table 5-1. 8020B Final Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
	(SEE FIGURE 5-1.)						
A 1	8020B MAIN PCB ASSEMBLY				1		1
A 2	ANNUNCIATOR PCB ASSEMBLY	613943	89536	613943	1		
BT 1	BATTERY,PRIMARY,9V,0-15MA	446823	83740	NEDA #1604	1		
F 1	FUSE,1/4 X 1,FAST,2A,250V	376582	71400	AGX2	2		2
F 2	FUSE,13/32 X 1-3/8,FAST,3A,600V	475004	71400	BBS-3	1	1	
H 1	SCREW,THD FORM,PHP,STL,4-14X3/8	448456	89536	448456	2	5	
H 2	SCREW,MACH,PHP,STL,4-40X3/16	129882	73734	19022	1		
H 3	SCREW,THD FORM,PHP,STL,7-19X3/4	447953	89536	447953	3		
MP 1	LENS,DISPLAY	650655	89536	650655	1	10	
MP 2	BUTTON,FUNCTION SWITCH-DK PEWTER	606889	89536	606889	2		
MP 3	BUTTON,FUNCTION SWITCH-DK PEWTER	606863	89536	606863			
MP 4	BUTTON,RANGE SWITCH-DK UMBER	606871	89536	606871	6		
MP 5	BUTTON,RANGE SWITCH-DK UMBER	606855	89536	606855			
MP 6	BEZEL,WINDOW	682997	89536	682997	1	1	
MP 7	BRACKET LCD MOUNTING	531657	89536	531657	1		
MP 8	PLATE LCD MOUNTING BRACKET	531665	89536	531665	1		
MP 9	CASE BOTTOM	652727	89536	652727	1		
MP 10	COVER, BATTERY	637686	89536	637686	1		
MP 11	BAIL	616961	89536	616961	1		
MP 12	FLANGE, SWITCH	455881	89536	455881	1		
MP 13	SHIELD	604389	89536	604389	1		
MP • 14	CASE, TOP	542027	89536	542027	1		
MP 15	SPACER, CASE	458588	89536	458588	2		
MP 16	DECAL, CASE TOP	604405	89536	604405	1		
MP 17	SHOCK ABSORBER	428441	89536	428441	1		
MP 18	FOOT, NON-SKID	604397	89536	604397	4		
MP 19	BUTTON, POWER SWITCH	456491	89536	456491	1		
MP 20	* TEST LEADS AND PROBE	516666	89536	516666	1		
MP 21	CONNECTOR, ELASTOMERIC	520858	89536	520858	1		
TM 1	8020B INSTRUCTION MANUAL (NOT SHOWN)	616029	89536	616029	1		
TM 2	8020B OPERATOR GUIDE (NOT SHOWN)	616730	89536	616730	1		
U 1	* IC,CMOS,3.5 DIGIT ADC,CUSTOM	429100	89536	429100	1		
U 3	* LCD,3.5 DIGIT,DIRECT DRIVE	504324	89536	504324	1		

NOTE 1 = REPLACE AT COMPONENT LEVEL ONLY
NOTE 2 = F1 FUSE, EUROPEAN USAGE: P/N 460972

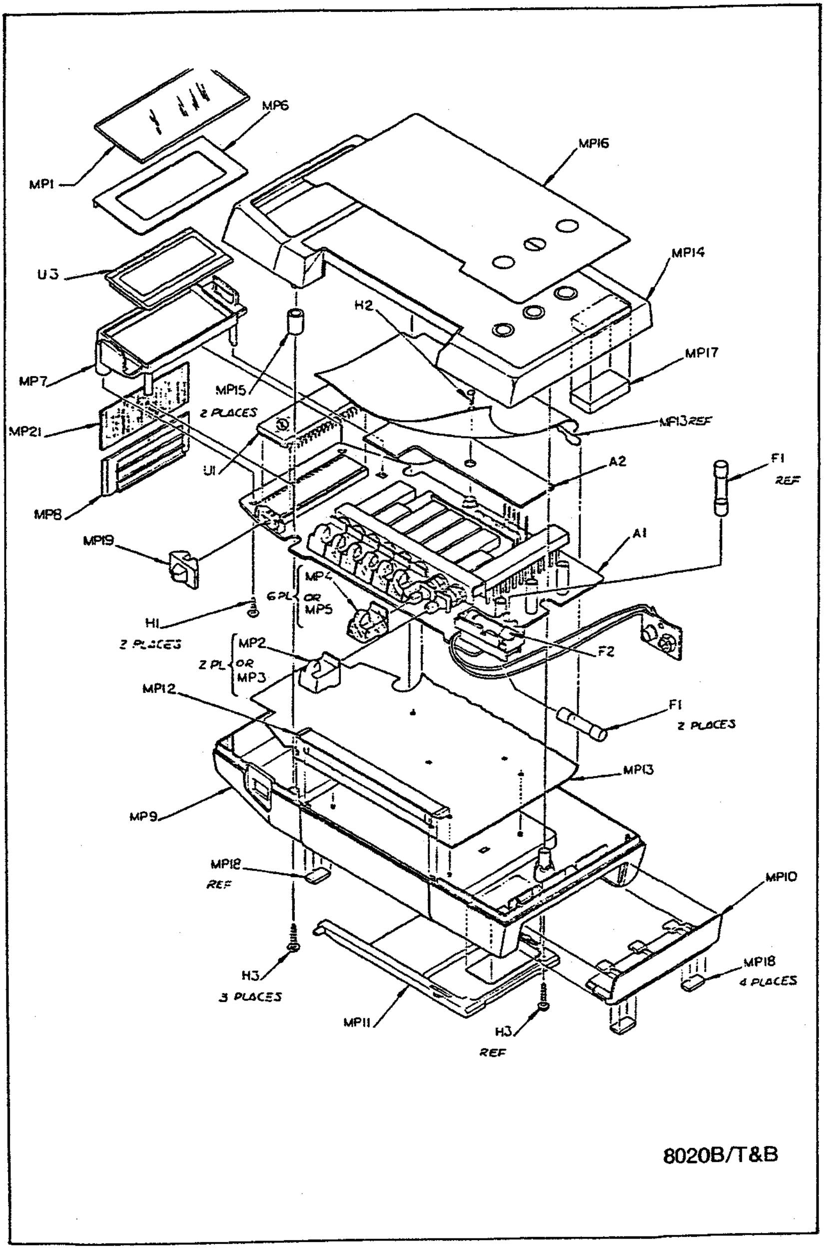


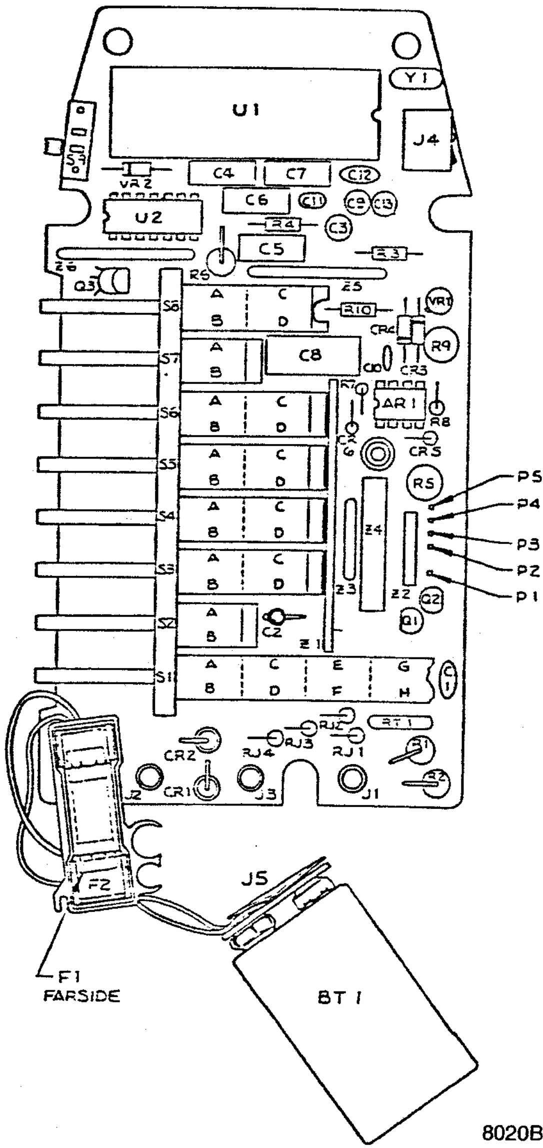
Figure 5-1. 8020B Final Assembly

Table 5-2. A1 Main PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
	(SEE FIGURE 5-2.)						
AR 1	* IC,OP AMP,SELECTED GBW 600KHZ	418566	12040	LM358N	1		
C 1, 12	CAP,CER,500PF,+-10%,1000V,X5R	105692	71590	2DDH60N501K	2		
C 2	CAP,VAR,0.25-1.5PF,1700V,TEFLON	218206	72982	530-000	1		
C 3, 9	CAP,AL,22UF,+-20%,16V	614750	89536	614750	2		
C 4, 7	CAP,POLYPR,0.047UF,+-10%,100V	446773	89536	446773	2		
C 5	CAP,POLYPR,0.1UF,+-10%,100V	446781	89536	446781	1		
C 6	CAP,POLYES,0.22UF,+-10%,100V	436113	73445	C280MAH1A220K	1		
C 8	CAP,POLYES,0.022UF,+-10%,1000V	448183	55112	0.22/10/1000-7	1		
C 10	CAP,CER,27PF,+-2%,100V,COG	362749	51406	RPE121	1		
C 11	CAP,CER,0.22UF,+-20%,50V,Z5U	519157	51406	RPE111Z5U224M50V	1		
CR 1, 2	* DIODE,SI, 50 PIV, 2.0 AMP	707869	89536	707869	2	1	
CR 3- 6	* DIODE,SI,BV= 75.0V,IO=150MA,500 MW	203323	07910	1N4448	4	1	
J 4	JACK,PWB	423897	89536	423897	1		
J 5	CONTACT ASSY TERMINATION	651653	89536	651653	1		
MP 1	RECEPTACLE	508606	89536	508606	3		
MP 1	FUSE CAP	540716	89536	540716	1		
MP 2	FUSE CLIP	534925	89536	534925	1		
MP 2	SPACER	604371	89536	604371	1		
MP 3	SPRING	535211	89536	535211	1		
MP 4	FUSE CLIP	535203	89536	535203	1		
P 1- 5	PIN,SINGLE,PWB,0.025 SQ	603910	89536	603910	5		
Q 1- 3	* TRANSISTOR,SI,NPN,SMALL SIGNAL	218396	04713	2N3904	3	1	
R 1	RES,CC,100K,+-10%,1W	109397	01121	GB1041	1		
R 2	RES,WW,FUSIBLE,1K,+-10%,2W	474080	89536	474080	1		
R 3	RES,CF,200K,+-5%,0.25W	441485	80031	CR251-4-5P200K	1		
R 4	RES,CF,220K,+-5%,0.25W	348953	80031	CR251-4-5P220K	1		
R 5	RES,VAR,CERM,1K,+-20%,0.3W	614065	51406	RVS0707-V-100-3-10	1	1	
R 6	RES,CC,1M,+-10%,1W	109793	01121	GB1051	1		
R 7	RES,CF,10K,+-5%,0.25W	348839	80031	CR251-4-5P10K	1		
R 8	RES,CF,2.2M,+-5%,0.25W	342659	80031	CR251-4-5P2M2	1		
R 9	RES,VAR,CERM,300,+-20%,0.3W	614040	51406	RVS0707-V-100-3-30	1		
R 10	RES,CF,100K,+-5%,0.25W	348920	80031	CR251-4-5P100K	1		
RJ 1- 4	VARISTOR,430V,+-10%,1.0MA	447672	09214	V430MA7B	4		
RT 1	THERMISTOR,RECT.,POS.,1K,+-40%,25C	446849	50157	180010200	1		

Table 5-2. A1 Main PCB Assembly (cont)

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
	(SEE FIGURE 5-2.)						
S 1- 8	SWITCH, ASSEMBLY, PUSHBUTTON	453647	89536	453647	1		
S 9	SWITCH,SLIDE,SPDT	453365	34828	G1-116-0001-G20-52	1		
U 2	* IC,CMOS,QUAD XOR GATE	355222	02735	CD4030AE	1	1	
VR 1	* IC, 1.22V,50 PPM T.C.,BANDGAP REF	508259	32293	ITS 6935-2	1	1	
VR 2	* ZENER,UNCOMP, 12.0V,10%, 10.5MA, 0.4W	113456	04713	1N963A	1	1	
XU 1	SOCKET,IC,40 PIN	429282	09922	DILB40P-108	1		
Y 1	* CRYSTAL,3.2MHZ,+-0.05%,HC-18/U	513937	89536	513937	1	1	
Z 1	* RES NET ASSY TESTED A GRD (8020 DIV)	515874	89536	515874	1	1	
Z 2	RES,NET,CERM,CUSTOM,TOL,TC,MATCH	447680	89536	447680	1		
Z 3	RES,NET,CERM,CUSTOM	447706	89536	447706	1		
Z 4	* RES,NET,WW,TOL,MATCHED	435727	89536	435727	1		
Z 5	RES,NET,CERM,CUSTOM,TOL,TC,MATCH	447698	89536	447698	1		
Z 6	RES,NET,CERM,CUSTOM	447714	89536	447714	1		



8020B-1601

Figure 5-2. A1 Main PCB Assembly

Table 5-3. A2 Annunciator PCB Assembly

REF DES	DESCRIPTION	FLUKE STOCK NO.	MFG SPLY CODE	MFG PART NO.	TOT QTY	REC QTY	NOTE
	(SEE FIGURE 5-3.)						
AR 20	* IC,OP AMP,SELECTED BIAS CURRENT=100PA	604363	89536	604363	1	1	
C 20	CAP,CER,0.22UF,+80-20%,50V,Z5U	649939	89536	649939	1		
C 21	CAP,CER,150PF,+-10%,50V,X7R	682377	89536	682377	1		
J 20	SOCKET,SINGLE,PWB,FOR 0.025 PIN	614396	22526	75377-001	1		
J 21	SOCKET,1 ROW,PWB,0.100CTR,4 POS	417311	30035	SS-109-1-04	1		
LS 1	AF TRANSD,PIEZO,24 MM	602490	51406	EFB-RD24C01	1		
R 21, 22	RES,CF,200K,+-5%,0.25W	573634	80031	CR251-4-5P200K	2	1	
R 22	RES,CF,18K,+-5%,0.25W	681858	89536	681858	1		
R 23, 26	RES,CF,200K,+-5%,0.25W	681841	89536	681841	2		
R 24	RES,CF,100K,+-5%,0.25W	658963	89536	658963	1		
R 27	RES,CC,10M,+-5%,0.25W	572842	01121	CB1065			
R 27	RES,CF,10M,+-5%,0.25W	696971	89536	696971	1		
R 28	RES,CF,1M,+-5%,0.25W	649970	89536	649970	1		
U 10	* IC,CMOS,QUAD 2 INPUT NAND GATE	418509	12040	MM74C00N	1		

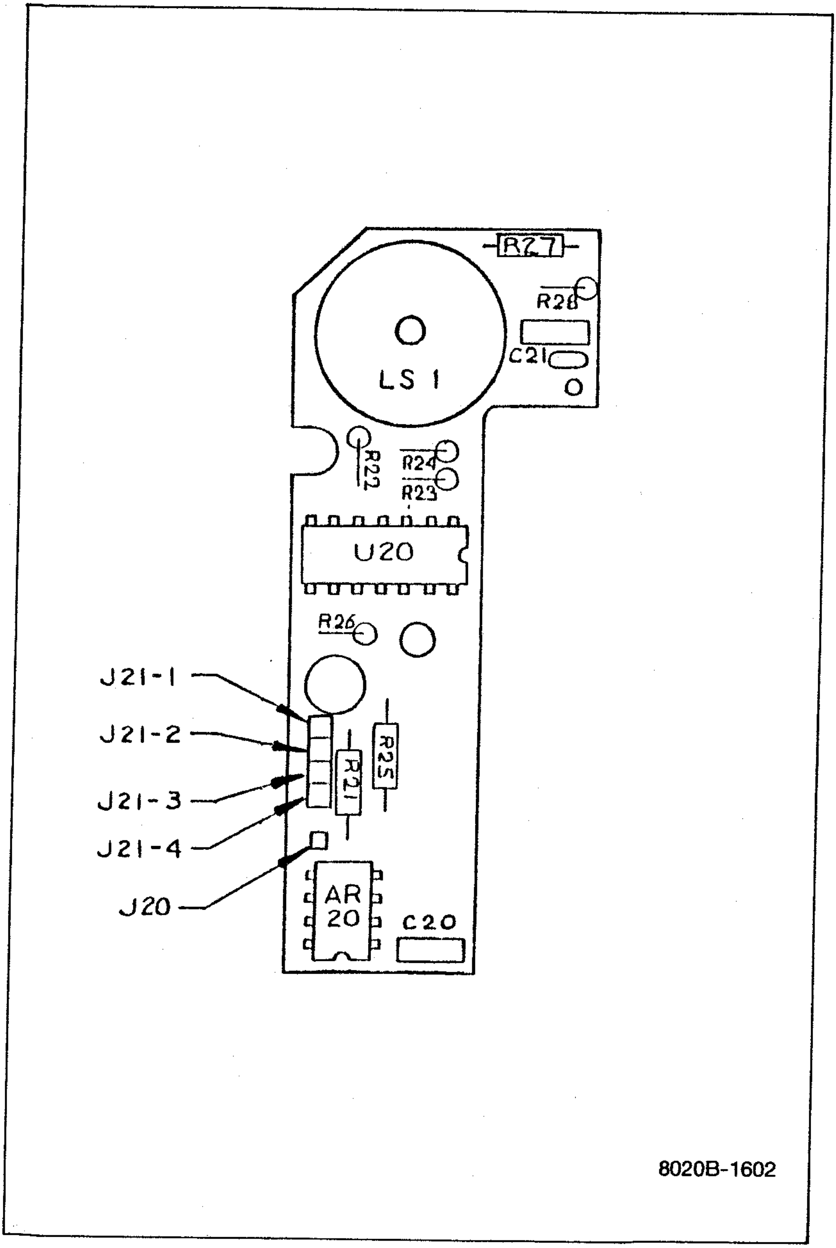


Figure 5-3. A2 Annunciator PCB Assembly

Table 5-5. Federal Supply Codes for Manufacturers

01121
Allen-Bradley Co.
Milwaukee, Wisconsin

02735
Replaces 18725
RCA - Solid State Div.
Somerville, New Jersey

04713
Motorola Inc.
Semiconductor Group
Phoenix, Arizona

05277
Westinghouse Electric Corp.
Semiconductor Division
Youngwood, Pennsylvania

07263
Fairchild Camera & Instrument Corp.
Semiconductor Division
Mountain View, California

07910
Replaced by 15818

09214
General Electric Co.
Semiconductor Products
Power Component Operation
Auburn, New York

09922
Burndy Corp.
Norwalk, Connecticut

12040
National Semiconductor Corp.
Danbury, Connecticut

14099
Semtech Corp.
Newbury Park, California

15818
Teledyne Semiconductors
Formerly Amelco Semiconductor
Mountain View, California

18736
Voltronics Corp.
Hanover, New Jersey

19647
Caddock Electronics Inc.
Riverside, California

22526
DuPont, El DeNemours & Co. Inc.
Berg Electronics Div.
New Cumberland, Pennsylvania

30035
Jol Industries Inc.
Garden Grove, California

50157
Midwest Components Inc.
Muskegon, Mississippi

51404
Corning Glass Works
Medical & Scientific Instruments
Medfield, Maryland

51406
Murata Corporation of America
Marietta, Georgia

52763
Stettner-Trush Inc.
Cazenovia, New York

56289
Sprague Electric Co.
North Adams, Massachusetts

71400
Bussman Manufacturing
Div. of McGraw-Edison Co.
St. Louis, Missouri

71590
Centrelab Electronics
Div. of Globe Union Inc.
Milwaukee, Wisconsin

72136
Electro Motive Mfg. Co.
Florence, South Carolina

72982
Erie Technical Products Inc.
Erie, Pennsylvania

73445
Amperex Electronic Corp.
Hicksville, New York

75915
Littlefuse Inc.
Des Plaines, Illinois

Table 5-5. Federal Supply Codes for Manufacturers (cont)

79727
C - W Industries
Warminster, Pennsylvania

80031
Mepco/Electra Corp.
Morristown, New Jersey

84411
TRW Electronic Components
TRW Capacitors
Ogallala, Nebraska

89536
John Fluke Manufacturing Co., Inc.
Everett, Washington

Section 6
Schematic Diagrams

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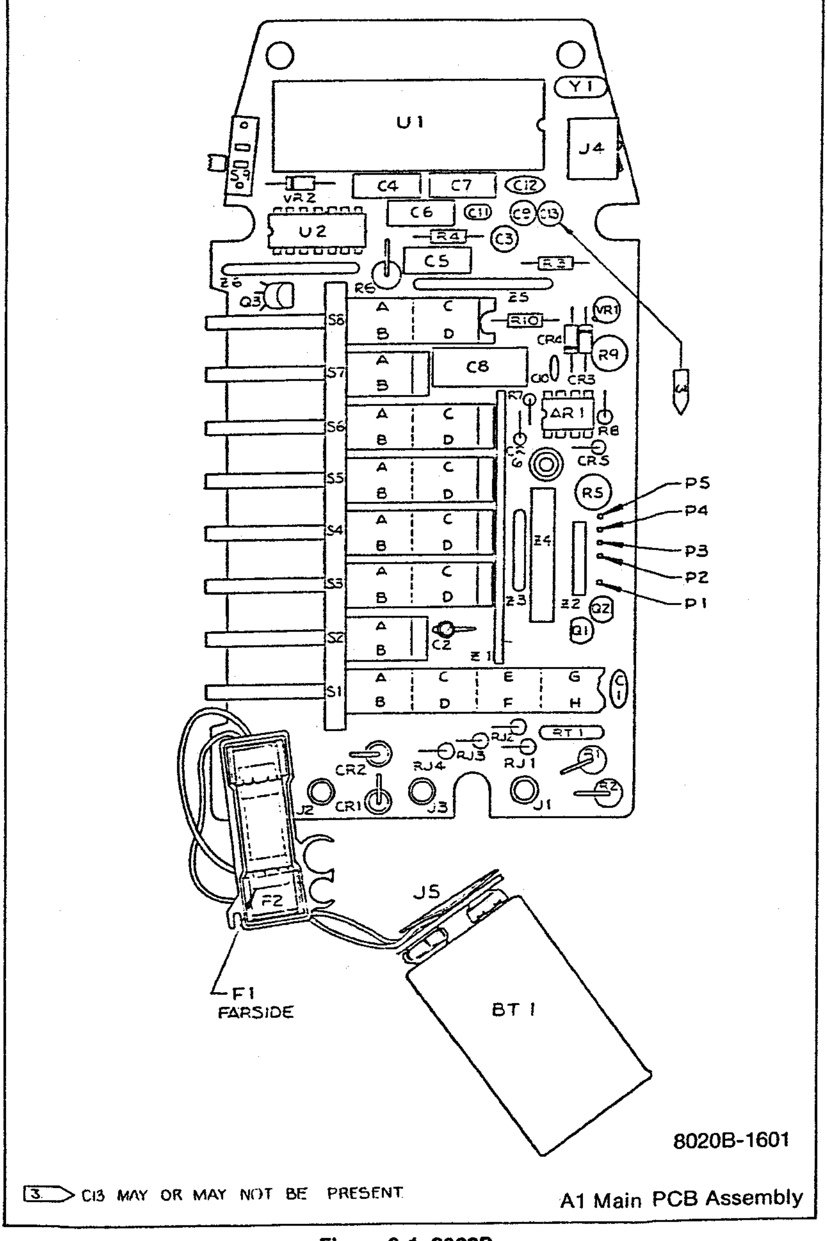
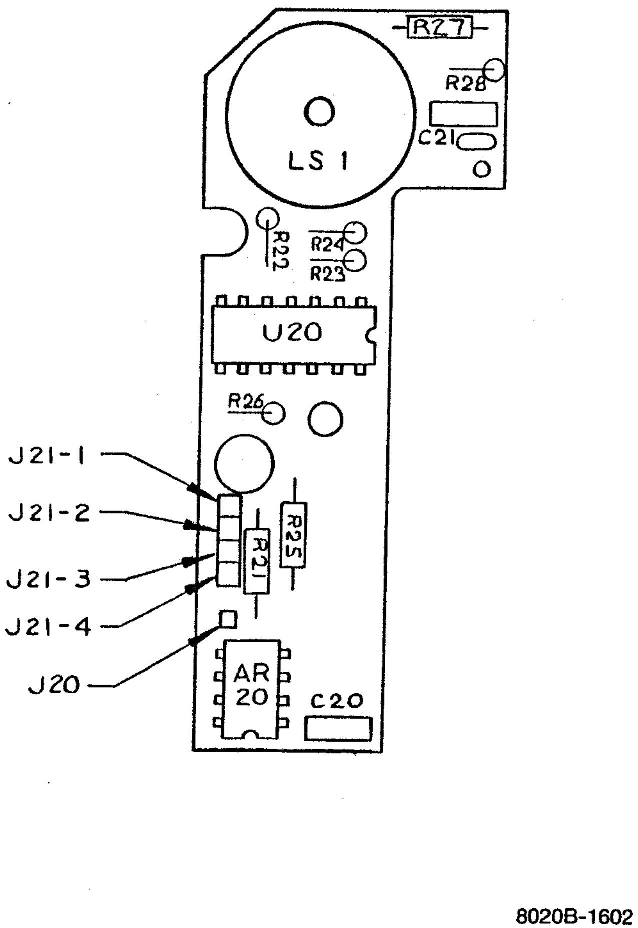
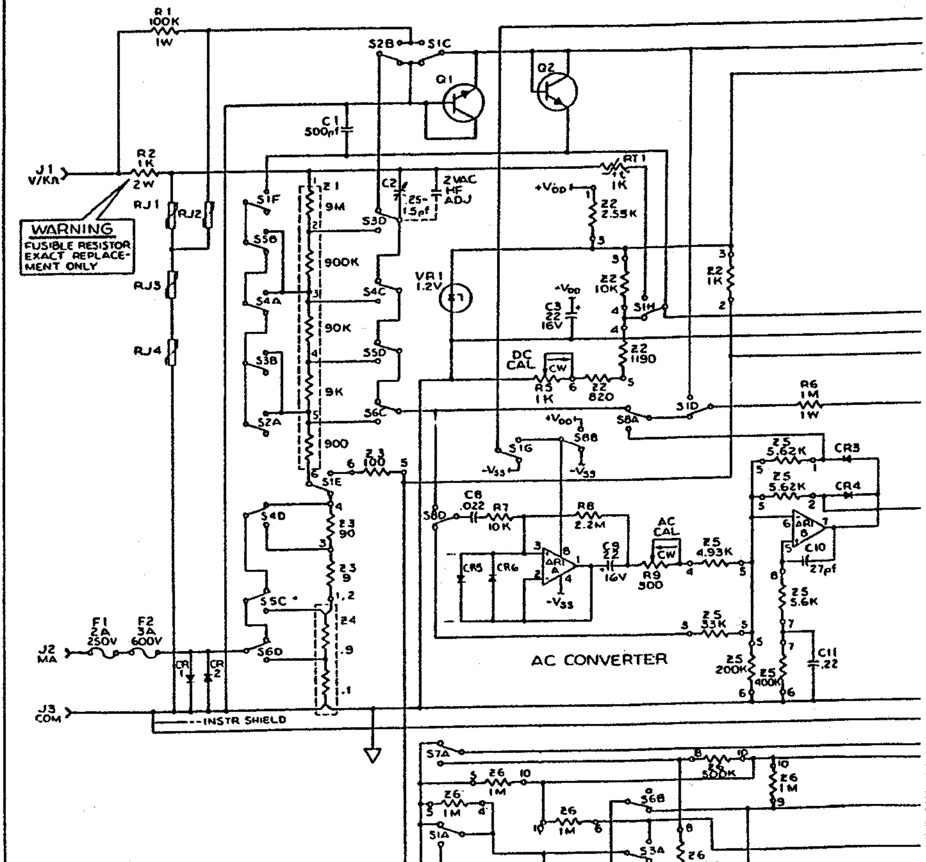


Figure 6-1. 8020B



A2 Annunciator PCB Assembly

Figure 6-1. 8020B (cont)



NOTES: UNLESS OTHERWISE SPECIFIED

1. ALL RESISTOR VALUES ARE IN OHMS (Ω). ALL CAPACITOR VALUES ARE IN MICROFARADS. (μF)

2. REFERENCE DESIGNATIONS

HIGHEST	NOT USED
S9, F2, CR5, U20, AR 20, Y1, C21, VR2, BT1, J21, Q3, RJ4, RT1, R28, Z6, P5.	AR2-19 C13-19 R11-20 U4-19 J6-19

3. S1=KΩ S2=.2 S3=2 S4=20 S5=200 S6=2K S7=20MEG S8=AC-DC S9=POWER ON-OFF

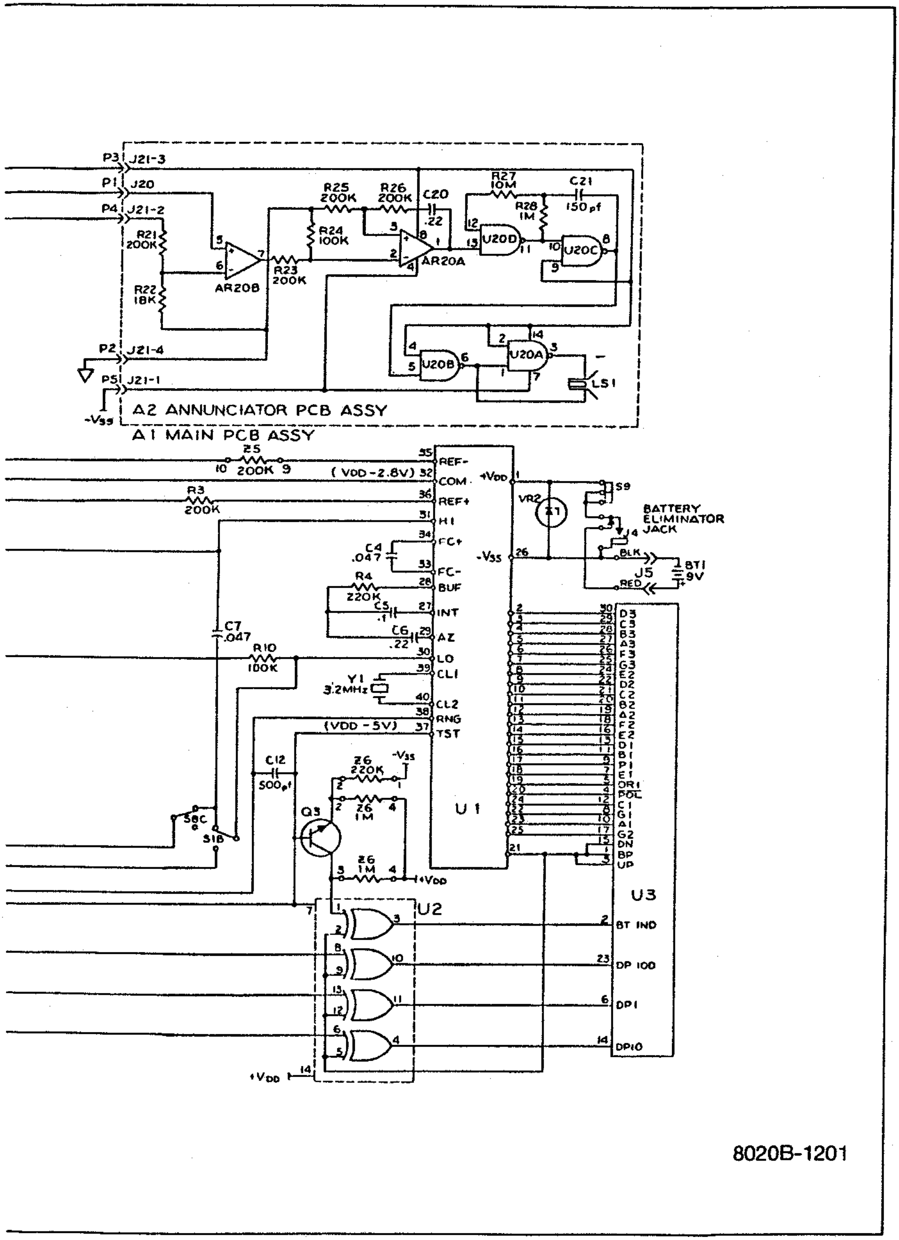
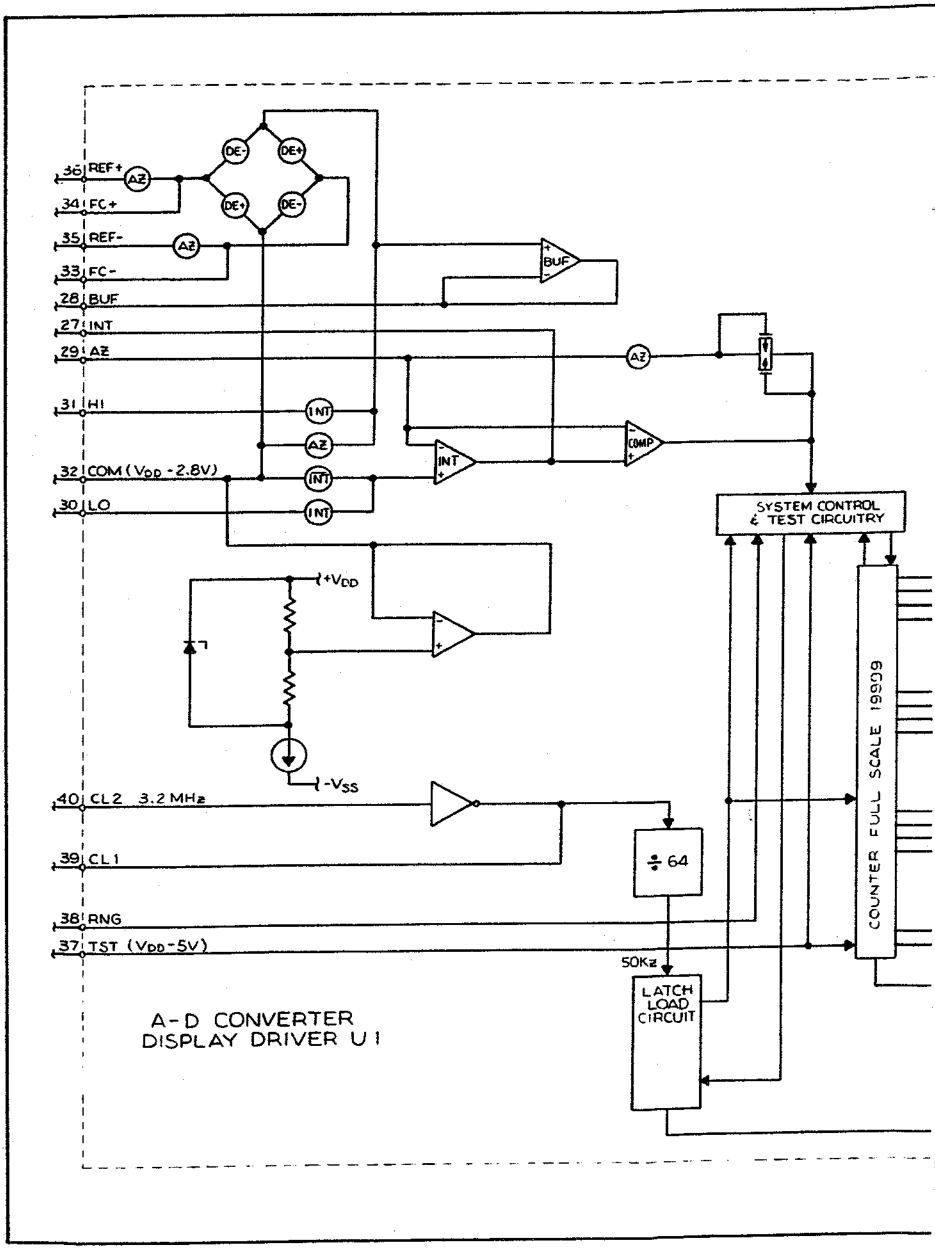
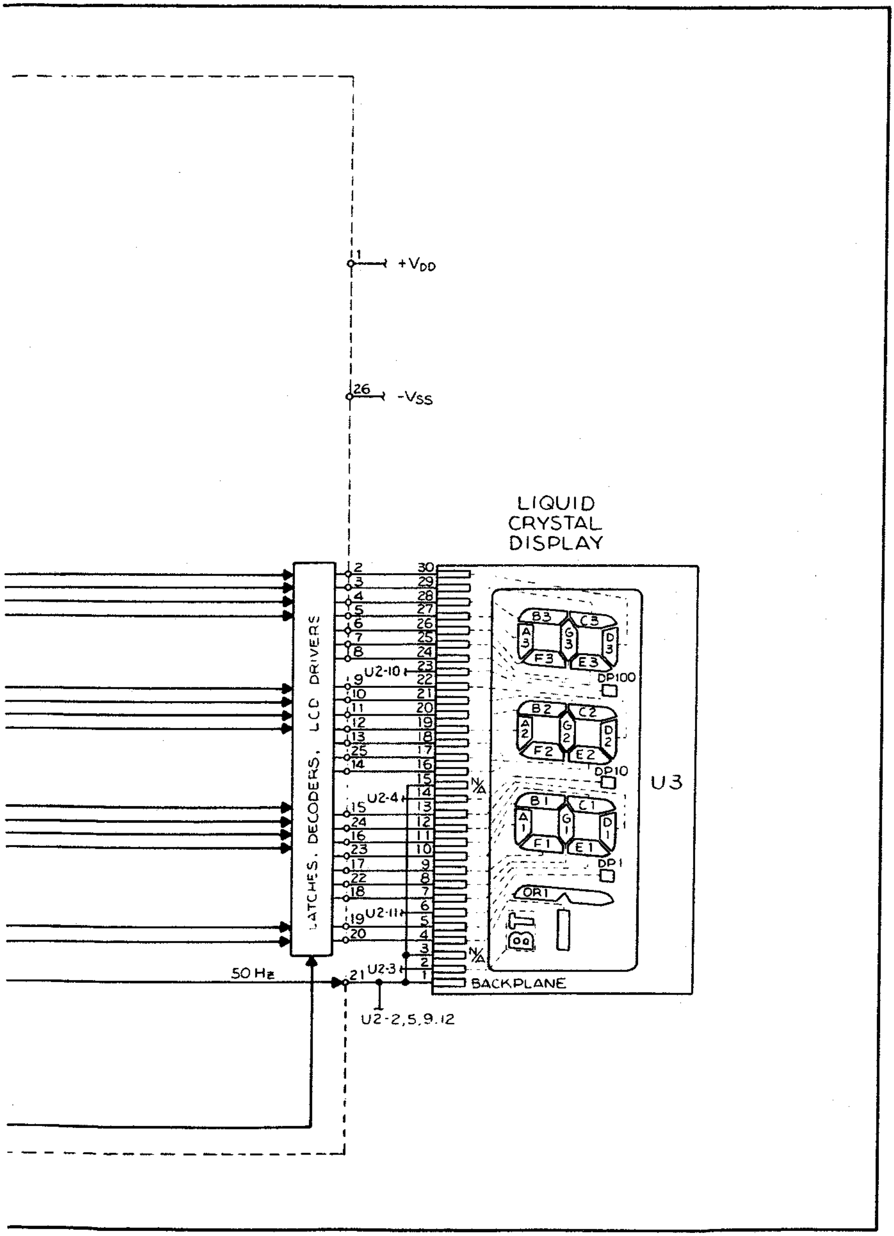


Figure 6-1. 8020B (cont)


36 REF+
34 FC+
35 REF-
33 FC-
28 BUF
27 INT
29 AZ
31 HI
32 COM (VDD -2.8V)
30 LO
40 CL2 3.2 MHz
39 CL1
38 RNG
37 TST (VDD-5V)
DE-
DE+
AZ
INT
BUF
COMP
+VDD
-VSS
SYSTEM CONTROL & TEST CIRCUITRY
COUNTER FULL SCALE 19999
÷ 64
50Kz
LATCH LOAD CIRCUIT
A-D CONVERTER
DISPLAY DRIVER U1



igure 6-2. U1 and U3, A/D Converter and Display

Appendix A
Manual Change and Backdating Information

INTRODUCTION

This appendix contains information necessary to backdate the manual to conform with earlier pcb configuations. To identify the configuration of the pcbs used in your instrument, refer to the revision letter (marked in ink) on the component side of each pcb assembly. Table A-1 defines the assembly revision levels documented in this manual.

NEWER INSTRUMENTS

As changes and improvements are made to the instrument, they are identified by incrementing the revision letter marked on the affected pcb assembly. These changes are documented on a supplemental change/errata sheet which, when applicable, is inserted at the front of the manual.

CHANGES

The following design changes unless otherwise noted, affect only section 5 and section 6 of this manual.

- Section 5, parts list and component location drawings.
- Section 6, schematic and component location drawings.

Table A-1. Manual Status and Backdating Information

Ref Or Option No.	Assembly Name	Fluke Part No.	* To adapt manual to earlier rev configurations perform changes in desending order (by no.), ending with change under desired rev letter														
			–	A	B	C	D	E	F	G	H	J	K	L	M	N	P
A1	MAIN PCB ASSEMBLY	613919	●	●	+	+	X	+	+	+	+	+	X				
A2	ANNUNCIATOR PCB ASSEMBLY	613943	●	+	+	+	+	X									

* X = The PCB revision levels documented in this manual.
● = These revision letters were never used in the instrument.
– = No revision letter on the PCB.
+ = Change not documented in this manual.

WARRANTY

Notwithstanding any provision of any agreement the following warranty is exclusive:

The JOHN FLUKE MFG. CO. INC., warrants each instrument is manufactures to be free from defects in material and workmanship under normal use and service for the period of 2 years from date of purchase. This warranty extends only to the original purchaser. This warranty shall not apply to fuses, disposable batteries (rechargable type batteries are warranted for 90 days), or any product or parts which have been subject to misuse, neglect, accident, or abnormal conditions of operations.

In the event of failure of a product covered by this warranty, John Fluke Mfg. Co. Inc., will repair and calibrate an instrument returned to an authorized Service Facility within 2 years from date of purchase; provided the warrantor's examination discloses to its satisfaction that the product was defective. The warrantor may, at its option, replace the product in lieu of repair. With regard to any instrument returned within 2 years of the original purchase, said repairs or replacement will be made without charge. If the failure has been caused by misuse, neglect, accident, or abnormal conditions of operations, repairs will be billed at a nominal cost. In such case, an estimate will be substituted before work is started, if requested.

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2. On receipt of the shipping instructions, forward the instrument, transportation prepaid. Repairs will be made at the Service Facility and the instrument returned, transportation prepaid.

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The instrument should be thoroughly inspected immediately upon original delivery to purchaser. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument is damaged in any way, a claim should be filed with the carrier immediately. (To obtain a quotation to repair shipment damage, contact the nearest Fluke Technical Center.) Final claim and negotiations with the carrier must be completed by the customer.

The JOHN FLUKE MFG. CO. INC., will be happy to answer all applications or use questions, which will enhance your use of this instrument. Please address your requests or correspondence to: JOHN FLUKE MFG. CO. INC., P.O. BOX C9090, EVERETT, WASHINGTON 98206, ATTN: Sales Dept. For European Customers: Fluke (Holland) B.V., P.O. Box 5053, 5004 EB, Tilburg, The Netherlands.

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