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8024B
Digital Multimeter

Instruction Manual

P/N 616052
July 1981
Rev. 2, 12/88
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FLUKE

Dear Customer:

Congratulations! We at Fluke are proud to present you with the Model 8024B Multimeter. This instrument represents the very latest in integrated circuit and display technology. As a result, the end product is a rugged and reliable instrument whose performance and design exhibit the qualities of a finely engineered lab instrument.

To fully appreciate and protect your investment, we suggest you take a few moments to read the manual. As always, Fluke stands behind your 8024B with a full 2-year warranty and a worldwide service organization. If the need arises, please don't hesitate to call on us.

Thank you for your trust and confidence.

John Fluke Mfg. Co., Inc.

Table of Contents

SECTION	TITLE	PAGE
1	**INTRODUCTION AND SPECIFICATIONS**	**1-1**
	1-1. INTRODUCTION	1-1
	1-3. SPECIFICATIONS	1-1
2	**OPERATING INSTRUCTIONS**	**2-1**
	2-1. INTRODUCTION	2-1
	2-3. PREPARING FOR OPERATION	2-1
	2-4. Unpacking	2-1
	2-7. Battery or Fuse Installation/Replacement	2-1
	2-9. PHYSICAL FEATURES	2-3
	2-11. OPERATING NOTES	2-6
	2-13. Input Overload Protection	2-6
	2-15. Input Connection to COMMON	2-6
	2-17. Fuse Check	2-7
	2-19. Fuse Replacement	2-7
	2-21. The Display	2-8
	2-26. OPERATION	2-9
	2-28. AC/DC Volts (V) Operation	2-9
	2-30. AC/DC Current (mA) Operation	2-9
	2-32. Resistance (Ω) Operation	2-9
	2-34. Continuity Testing	2-13
	2-36. Diode Testing	2-13
	2-38. Conductance (S) Operation	2-13
	2-40. Temperature (°C) Operation	2-13
	2-43. Level Detector Operation	2-16
	2-45. Peak Hold Operation	2-17
	2-47. INITIAL CHECK-OUT PROCEDURE	2-19
	2-49. MEASUREMENT TECHNIQUES	2-21
	2-51. Temperature Conversion	2-21
	2-53. Conductance-to-Resistance Conversion	2-24
	2-55. AC Measurements	2-24
	2-57. AC/DC/Voltage Measurements	2-24
	2-60. AC/DC Current Measurements	2-24

(continued on page ii)

TABLE OF CONTENTS, *continued*

SECTION	TITLE	PAGE
	2-64. Resistance Measurements	2-27
	2-67. APPLICATIONS	2-29
	2-69. THERMOCOUPLES	2-29
	2-70. Introduction	2-29
	2-73. Monitoring More Than One Thermocouple	2-31
	2-75. Leakage Tester	2-31
3	**THEORY OF OPERATION**	4-1
	3-1. INTRODUCTION	3-1
	3-3. OVERALL FUNCTIONAL DESCRIPTION	3-1
	3-5. A/D Converter	3-1
	3-14. Voltage Measurement Function	3-6
	3-16. Current Measurement Function	3-6
	3-18. Temperature (°C) Measurement Function	3-6
	3-20. Resistance Measurement Function	3-6
	3-23. Conductance Measurement Function	3-11
	3-25. Peak Hold Circuit Level	3-11
	3-27. Level Detector Circuit	3-11
4	**MAINTENANCE**	3-1
	4-1. INTRODUCTION	4-1
	4-3. SERVICE INFORMATION	4-1
	4-7. GENERAL INFORMATION	4-3
	4-8. Access Information	4-3
	4-17. Cleaning	4-5
	4-19. Battery/Backup Fuse Replacement	4-6
	4-21. PERFORMANCE TEST	4-6
	4-23. Initial Procedure	4-6
	4-25. Display Test	4-7
	4-27. Voltage Test	4-8
	4-29. Current Test	4-8
	4-31. Resistance/Conductance Test	4-8
	4-33. Peak Hold Test	4-11
	4-35. Continuity Test	4-11
	4-37. Level Detector Test	4-12
	4-39. BT Test	4-12
	4-41. Temperature Test	4-14
	4-43. CALIBRATION ADJUSTMENTS	4-14
	4-46. TROUBLESHOOTING	4-15
5	**LIST OF REPLACEABLE PARTS**	5-1
	5-1. INTRODUCTION	5-1
	5-4. HOW TO OBTAIN PARTS	5-2

(continued on page iii)

TABLE OF CONTENTS, *continued*

SECTION	TITLE	PAGE
6	**ACCESSORIES INFORMATION**	6-1
	6-1. INTRODUCTION	6-1
	6-3. DELUXE CARRYING CASE (C90)	6-1
	6-5. RUGGED CARRYING CASE (Y8105)	6-1
	6-7. TYPE K SHEATHED THERMOCOUPLE (Y8102)	6-1
	6-8. Introduction	6-1
	6-10. Specifications	6-4
	6-11. TYPE K BEAD THERMOCOUPLE (Y8103)	6-4
	6-12. Introduction	6-4
	6-14. Specifications	6-4
	6-15. THERMOCOUPLE TERMINATION (Y8104)	6-4
	6-17. TEMPERATURE PROBES (80T-150C and 80T-150F)	6-5
	6-18. Introduction	6-5
	6-20. Specifications	6-5
	6-21. HIGH VOLTAGE PROBE (80K-6)	6-5
	6-22. Introduction	6-5
	6-24. Specifications	6-5
	6-25. HIGH VOLTAGE PROBE (80K-40)	6-5
	6-26. Introduction	6-5
	6-28. Specifications	6-6
	6-29. HIGH FREQUENCY PROBE (83RF)	6-6
	6-30. Introduction	6-6
	6-32. Specifications	6-6
	6-33. HIGH FREQUENCY PROBE (85RF)	6-6
	6-34. Introduction	6-6
	6-36. Specifications	6-7
	6-37. CURRENT TRANSFORMER (801-600)	6-7
	6-38. Introduction	6-7
	6-40. Specifications	6-7
	6-41. CURRENT SHUNT (80J-10)	6-7
	6-42. Introduction	6-7
	6-44. Specifications	6-7
	6-45. BATTERY ELIMINATOR (A81)	6-8
	6-47. AC/DC CURRENT PROBE (Y8100)	6-8
	6-48. Introduction	6-8
	6-50. Specifications	6-8
	6-51. AC CURRENT TRANSFORMER (Y8101)	6-9
	6-52. Introduction	6-9
	6-54. Specifications	6-9
	6-55. SAFETY DESIGNED TEST LEAD SET (TL20)	6-9
	6-57. DELUXE TEST LEAD SET (Y8134)	6-10
	6-59. SLIM FLEX TEST LEAD SET (Y8140)	6-10
7	**SCHEMATIC DIAGRAMS**	7-1
A	**MANUAL STATUS INFORMATION**	A-1

List of Tables

TABLE	TITLE	PAGE
1-1.	8024B Accessories	1-2
1-2.	8024B Specifications	1-3
2-1.	Controls, Indicators, and Connectors	2-4
2-2.	Input Overload Limits	2-7
2-3.	Celsius-to-Farenheit Conversion Scale	2-22
2-4.	Voltage/Current Capability of Resistance Ranges	2-29
4-1.	Test Equipment Required	4-2
4-2.	Display Test	4-7
4-3.	Voltage Test	4-9
4-4.	Current Test	4-10
4-5.	Resistance/Conductance Test	4-11
4-6.	Troubleshooting Guide	4-17
5-1.	8024B Final Assembly	5-3
5-2.	A2 Main PCB Assembly	5-8
5-3.	A3 Switch PCB Assembly	5-12
5-4.	Federal Supply Codes for Manufacturers	5-15

List of Illustrations

FIGURE	TITLE	PAGE
2-1.	Removing the Battery Cover	2-2
2-2.	Battery Removal	2-3
2-3.	Controls, Indicators, and Connectors	2-4
2-4.	Display	2-8
2-5.	Abnormal Status Indicators	2-9
2-6.	Volts Operation	2-10
2-7.	Current Operation	2-11
2-8.	Resistance Operation	2-12
2-9.	Conductance Operation	2-14
2-10.	Temperature Operation	2-15
2-11.	Level Detector Operation	2-17
2-12.	Peak Hold Operation	2-18
2-13.	Temperature Correction Factor For K-Type Thermocouples	2-21
2-14.	Conductance-to-Resistance Conversion	2-25
2-15.	Waveform Conversion	2-26
2-16.	Voltage Measurement Error Calculations	2-27
2-17.	Current Measurement Calculations	2-28
2-18.	Thermocouples	2-30
2-19.	Thermocouple Termination Unit	2-32
2-20.	Multipoint Selection	2-32
3-1.	8024B Block Diagram	3-2
3-2.	A/D Converter Functional Diagram	3-4
3-3.	Integrate Capacitor Waveform	3-5
3-4.	Voltage Measurement	3-7
3-5.	Current Measurement	3-8
3-6.	Temperature Measurement	3-9
3-7.	Resistance/Conductance Measurement	3-10
3-8.	Simplified Peak Hold Circuit	3-12
3-9.	Simplified Level Detector Circuit	3-13
4-1.	Calibration Adjustments Location	4-3
4-2.	LCD Display Assembly	4-5

(continued on page vi)

LIST OF ILLUSTRATIONS, *continued*

FIGURE	TITLE	PAGE
4-3.	General Equipment Connection	4-7
4-4.	General Equipment Connection — Current	4-10
4-5.	BT Test	4-13
4-6.	Lag Bath	4-16
5-1.	8024B Final Assembly	5-4
5-2.	A2 Main PCB Assembly	5-11
5-3.	A3 Switch PCB Assembly	5-12
6-1.	8024B Accessories	6-2

Section 1
Introduction & Specifications

1-1. INTRODUCTION

1-2. Your John Fluke Model 8024B is a pocket-size digital multimeter that is ideally suited for application in the field, laboratory, shop, or home. Some of the features of your instrument are:

FUNCTIONS: All standard VOM measurement functions -- ac/dc voltage, ac/dc current, resistance -- plus:

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

Temperature: Used with a K-type thermocouple, this function provides direct display in degrees Celsius for K-type thermocouples.

Peak-Hold: Provides short-term memory for capturing the peak value of transient ac or dc signals such as motor starting current.

Continuity: Provides an immediate visual and audible indication when continuity is detected (use for passive circuit testing).

Level Detector: Senses logic levels and other active signals less than 250V dc or ac rms. Visual and audible indications of the results are provided.

RANGE for each function has:

Full autopolarity

Overrange indication

Effective protection from overloads

Dual slope integration measurement technique to ensure noise-free measurements

OPERATOR CONVENIENCE:

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

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

Lightweight: .482 kg (17 ounces).

Safety Designed Test Leads: Finger guards on the probe and shrouded contacts on connectors reduce the chance of accidental contact with circuit voltages.

POWER:

Up to 100 hours of continuous operation can be expected from a single, inexpensive, 9-volt, alkaline battery (transistor radio/calculator type).

Low battery voltage is automatically detected and displayed. The low battery indication, BT, appears in the display when about 10 hours of operation remain.

Line operation is possible using a Model A81 Battery Eliminator. (See Section 6.)

ACCESSORIES:

A full line of accessories are available to extend the range and scope of your instrument. They are listed in Table 1-1 and described in detail in Section 6.

1-3. SPECIFICATIONS

1-4. Table 1-2 lists the specifications of your 8024B.

Table 1-1. 8024B Accessories

MODEL NO.	DESCRIPTION
C90	Deluxe Carrying Case (Soft Vinyl)
Y8105	Rugged Carrying Case (Molded Plastic)
Y8102	Type K Sheathed Thermocouple
Y8103	Type K Beaded Wire Thermocouple
Y8104	Thermocouple Termination Kit
80T-150C	Temperature Probe °C
80T-150F	Temperature Probe °F
80K-6	High Voltage Probe
80K-40	High Voltage Probe
83RF	High Frequency Probe
85RF	High Frequency Probe

Table 1-1. 8024B Accessories (cont)

MODEL NO.	DESCRIPTION
80I-600	Current Transformer, 2" jaw opening
80J-10	Current Shunt
A81	Battery Eliminator
Y8100	AC/DC Current Probe
Y8101	Current Transformer 7/16" jaw opening
TL70	Safety Designed Test Lead Set
Y8134	Deluxe Test Lead Set
Y8140	Slim Flex Test Lead Set

Table 1-2. 8024B Specifications

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

FUNCTIONS: DC Volts, AC Volts, DC Current, AC Current, Resistance, Diode Test, Conductance, Temperature, Peak-Hold, Continuity, and Level Detection.

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	1 V	

Response Time ..... Less than 1 sec.

Overvoltage Protection ..... 1000V dc or peak ac on all ranges, except 200 mv (15 sec max above 300V dc or rms)

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, 50Hz and 60 Hz

Table 1-2. 8024B Specifications (cont)

AC VOLTS (Average Sensing, RMS Calibrated Sinewave):

RANGE	RESOLUTION	ACCURACY		
		45 Hz to 1 kHz	1 kHz to 2 kHz	2 kHz to 5 kHz
200 mV	100 μ V	±(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	

Response Time ..... Less than 2 seconds

Overload Protection ..... 750V rms or 1000V peak continuous, except 200 mV ac ranges (15 seconds maximum above 300V rms).

Common Mode Rejection Ratio (1 kΩ unbalance) ..... >60 dB at 50 Hz and 60 Hz

Volt-Hz Product ..... 10^7 max (200V at 50 kHz)

Input Impedance ..... 10 MΩ in parallel with <100 pF

DC CURRENT

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

Response Time ..... Less than 1 second

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

Table 1-2. 8024B 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% of reading ±2 digits)	Not Specified	0.3V rms typical
20 mA	10 μA	±(1.5% of reading +2 digits)		
200 mA	100 μA			0.9V rms typical
2000 mA	1 mA			

Response Time ..... Less than 2 seconds

Overload Protection ..... 2A/250V fuse in series with 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	±(0.15% +1 digit)	<0.25V	0.13 μA
20 MΩ	10 kΩ	±(2% of reading +1 digit)	>.7V	0.13 μA

Overload Protection ..... 500V dc/ac rms on all ranges (15 sec max above 300V dc or rms ac)

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

Diode Test ..... The three ranges—2 kΩ, 200 kΩ, 20 MΩ—have enough open circuit voltage to turn on silicon junctions allowing a diode test. The 2 kΩ range is preferred and is marked with a diode symbol. The three non-diode test ranges — 200Ω, 20 kΩ, and 2000 kΩ — will not turn on silicon junctions when making in-circuit resistance measurements.

Table 1-2. 8024B Specifications (cont)

CONDUCTANCE*

Range	200 nS
Equivalent Resistance Range	5MΩ to 10,000 MΩ
Accuracy	±(2.0% of reading + 10 digits)
Resolution	0.05% of range (10^{-10} S)
Overload Protection	500V dc/rms ac (15 sec max above 300V dc or rms ac)
Diode Test	Will forward bias a typical PN junction

*Conductance is the inverse of ohms (1/Ω) and is expressed in siemens (S). A decrease in conductance is equivalent to an increase in resistance.

PEAK HOLD Use for Measuring Transient Signals

FUNCTIONS, RANGES	AC or DC, VOLTS or CURRENT ALL RANGES
AC	
Accuracy (48 — 450 Hz)	3% of reading + 10 digits, all ranges (except 2 mA, 6% of reading + 10 digits). Average sensing, calibrated to read highest rms value of sine wave.
Acquisition Time	150 ms**
DC	
Accuracy	3% of reading + 10 digits, positive pulses
Acquisition Time	10 ms** square pulse (3 ms square or 8 ms half sine typ.)
Display Decay Rate	<1 digit/sec

**Acquisition Time is the minimum duration of peak or surge for rated accuracy.
Accuracy improves for longer peak duration.

TEMPERATURE (Thermocouple accessory required)

Temperature Sensor	K-Type Thermocouple (Chromel-Alumel) See accessories
Range	-20° C to +1265° C
Resolution	1° C

Table 1-2. 8024B Specifications (cont)

Accuracy	±3° C ±1 digit, -20° to +300° C 3% of reading, +300° C to +1265° C (Accuracy includes NBS conformity, calibration stability, zero, and reference junction but not thermocouple errors.)
Connection	Dual banana isothermal termination provided with FLUKE thermocouple accessories. Use Y8104 termination accessory for any K-Type thermocouple.
Overload Protection	2A/250V fuse in series with 3A/600V fuse.

CONTINUITY Use for Passive Circuit Testing*

Ranges	All Resistance and Conductance ranges
Indication	Open Circuit: " ▲ " Display Continuity: " ▼ " Display + 2 kHz audio tone (selectable)
Response Time (2 kΩ range)	50 μS (Minimum duration of continuity or open to toggle display or audio tone. Pulse stretcher holds display and tone for approx. 100 ms.)
Overload Protection	500V dc or rms ac all ranges (15 sec max above 300V dc or rms ac)

*See section 2 for additional information.

LEVEL DETECTOR Use for Active Circuit Testing

Reference Level	+0.8V dc nominal on 200 kΩ range
Display	" ▲ " for inputs greater than reference " ▼ " for inputs less than reference " ▲ " for inputs toggling above and ▼ below reference Audio tone coincident with " ▼ " (switch selectable)

Table 1-2. 8024B Specifications (cont)

Pulse Response (200 kΩ range)	50 μS (Minimum width of 0 to +3V pulse required to toggle display. Pulse stretcher holds display for approx. 100 ms when short pulses are detected.)
Input Impedance	>100 kΩ in parallel with <100 pF
Overload Protection	500V dc or rms ac (15 sec max above 300V dc or rms ac)

ENVIRONMENTAL

Temperature	
OPERATING	0° C to 50° C (32° F to 122° F)
STORAGE	-35 to +60° C
Relative Humidity	0 to 90% from 0° C to 35° C except 0 to 80% from 0° C to 35° C on 2MΩ, 20MΩ, and 200 nS ranges; 0 to 70% from 35° C to 50° C
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 82.4° F to 122° F), except temperature (<0.02 X accuracy per ° C)

GENERAL:

Protection Class 2	(Relates solely to insulation or grounding properties defined in IEC 348)
Maximum Common Mode Voltage	500V dc or rms
Power Requirements	Single 9V battery, NEDA 1604
BATTERY LIFE	Alkaline: 100 hours typical Zinc carbon: 50 hours typical
BATTERY INDICATOR	"BT" in display illuminates when approximately 20% of life remains
Display	3½ digit LCD (1,999 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	.48 Kg, (17 oz)

Section 2
Operating Instructions

2-1. INTRODUCTION

2-2. To fully utilize the measurement capabilities of your 8024B, a basic understanding of its measurement techniques and limitations is required. This section of the manual provides that information.

2-3. PREPARING FOR OPERATION

2-4. Unpacking

2-5. Your 8024B, this manual, one 9V battery, and two test leads (one red and one black) were shipped to you in a specially designed container. Check the shipment carefully and contact the place of purchase immediately if anything is wrong. If the place of purchase fails to satisfy you, contact the nearest John Fluke Service Center. A list of these service centers is located at the end of this manual.

2-6. 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.

2-7. Battery or Fuse Installation/Replacement

2-8. Your 8024B is designed to operate on a single, inexpensive, 9V battery of the transistor radio/calculator variety (NEDA 1604). When you receive your 8024B, the battery will not be installed in the DMM. Once the battery is installed, you can expect a typical operating life of up to 100 hours with an alkaline battery or 50 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 8024B will operate properly for at least 10 hours on an alkaline battery after BT appears in the display. Use the following procedure to install or replace the battery or fuse:

CAUTION

To ensure 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 a signal input, the battery should be replaced immediately to prevent damage to the LCD.

WARNING

TO AVOID ELECTRICAL SHOCK, BATTERY OR FUSE REPLACEMENT SHOULD ONLY BE PERFORMED AFTER THE INPUT SIGNAL AND TEST LEADS HAVE BEEN REMOVED FROM THE INPUT TERMINALS AND THE POWER SWITCH HAS BEEN SET TO OFF.

1. Set the 8024B POWER switch to OFF.

2. Remove test leads from external circuit connections and from the 8024B input terminals.

3. Open the battery compartment on the bottom of the 8024B as shown in Figure 2-1.

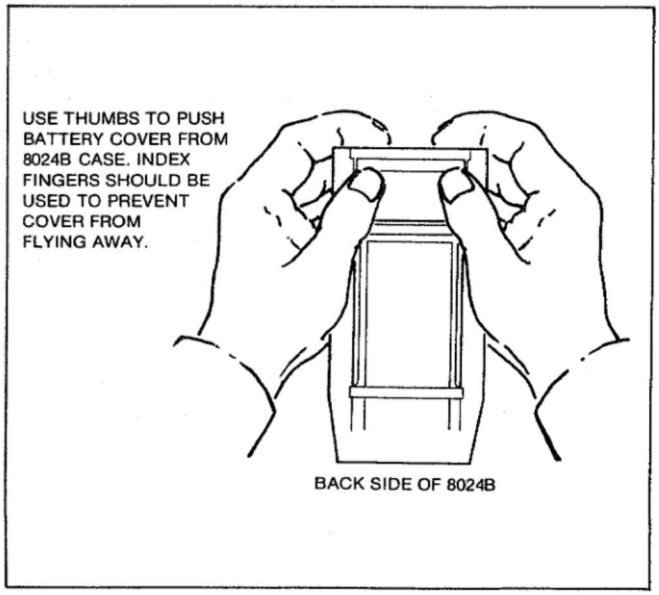


Figure 2-1. Removing the Battery Cover

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

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 type AGX2. (Instruments that accommodate metric fuses use type 171100-2.)

6. Carefully pull the battery clip free from the battery terminals as shown in Figure 2-2.

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

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

WARNING

DO NOT OPERATE THE 8024B UNTIL THE BATTERY COVER IS IN PLACE AND FULLY CLOSED.

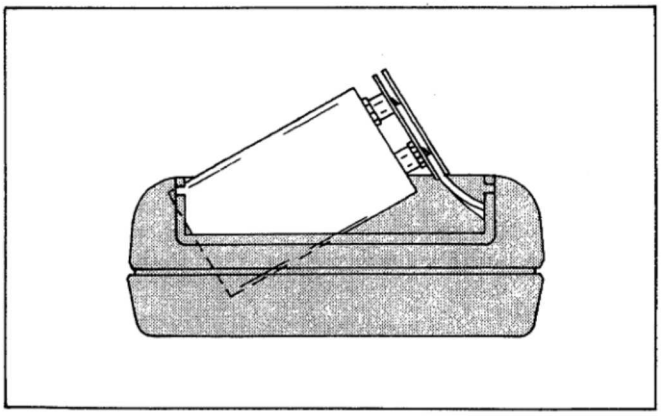


Figure 2-2. Battery Removal

2-9. PHYSICAL FEATURES

2-10. Before you try to use your 8024B, we suggest you take a few minutes to get acquainted with your instrument. All of the externally accessible physical features of your 8024B are shown in Figure 2-3 and described in Table 2-1. Locate each feature on your 8024B as you read the description.

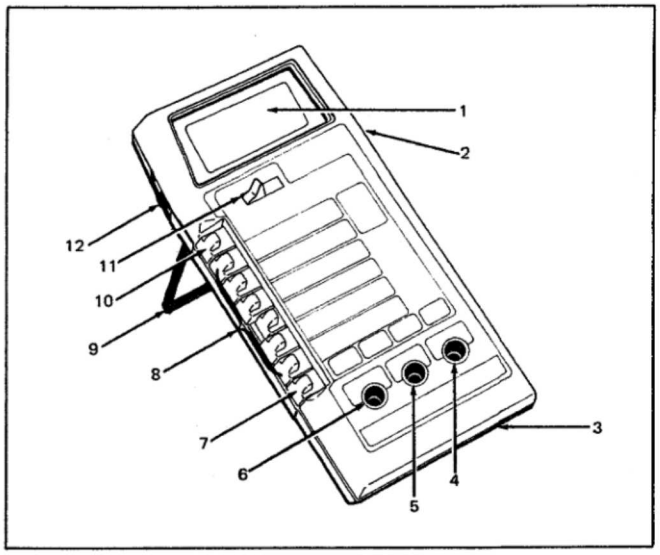


Figure 2-3. Controls, Indicators and Connectors

Table 2-1. Controls, Indicators, and Connectors

ITEM NO.	NAME	FUNCTION
1	Display	A 3½ digit display (1999 max) with decimal point and minus polarity indication. Used to indicate measured input values, overrange condition, low battery condition and level.
2	Battery Eliminator 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.)
3	Battery Compartment and Cover	Cover for the 9V battery and current-protection fuse F1. Refer to figure 2-1 for battery cover removal instructions.

Table 2-1. Controls, Indicators, and Connectors (cont)

ITEM NO.	NAME	FUNCTION
4	V/Ω/S Input Connector	Protected test lead connector used as the high input for all voltage, conductance, continuity, level detector, and resistance measurements. This connector will accept standard banana plugs.
5	COMMON Input Connector	Protected test lead connector used as the low or common input for all measurements. Will accept banana plugs.
6	mA/° C Input Connector	Protected test lead connector used as the high input for all current and temperature.
7	Function Switch mA/° C/V/Ω/S	A push-push switch (push on - push off, do not pull to select a function), which works in conjunction with the high input connectors and the TEMP °C switch to select DMM measurement function.
8	Range Switches	Interlocked push-button switches for selecting ranges, i.e., pressing the desired range switch selects that range and cancels previous switch depressions. Do not pull 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: 200 nS (S = Siemens = 1/Ω = international unit of conductance). Requires simultaneous depression of two range switches. Temperature: °C
9	Tilt Bail	A removable fold-out stand which allows the instrument to be either tilted for bench-top use or hung from a hook in the absence of a work area.

Table 2-1. Controls, Indicators, and Connectors (cont)

ITEM NO.	NAME	FUNCTION
10	DC/AC/Audible tone Switch	A push-push switch (push on - push off, do not pull). When using V or mA functions, the in position selects AC measurement functions and the out position selects the DC measurement function. When used with Ω or S functions, the in position enables the audible tone feature and the out position disables the audible tone feature.
11	PEAK HOLD Switch	A push-push switch (push on - push off, to the right only, do not push or pull to the left), that enables or disables the Peak-Hold function.
12	POWER Switch	A slide switch used to turn the instrument off and on.

2-11. OPERATING NOTES

2-12. The following paragraphs will familiarize you with the capabilities and limitations of your Model 8024B.

2-13. Input Overload Protection

CAUTION

Exceeding the maximum input overload limits can damage your instrument. The transient overload protection circuit is intended to protect against short duration high energy pulses. The components used limit the protection to approximately five pulses per second for 6 kV, 10microsecond pulses, and about 0.6 watts average for lower pulses. Fast rep rate pulses as from a TV set can damage the protection components; RV1 - RV4, R1 and R2*, If replaced, use only Fluke replacement parts to maintain product safety. * R2 is a fusable resistor. Use exact replacement to insure safety.

2-14. 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 2-2.

2-15. Input Connection 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 500V RMS AC ABOVE EARTH GROUND.

Table 2-2. Input Overload Limits

SELECTED FUNCTION	INPUT TERMINALS	MAX. INPUT OVERLOAD
Voltage	V/Ω/S and COMMON	1000V dc or peak ac on all ranges except 200 mV (15 sec max above 300V dc or rms).
Current and Temperature	mA - °C and COMMON	2A maximum, fuse protected to 600V dc/ac rms. DO NOT USE ABOVE 600V.
Resistance, Continuity, Level Detector and Conductance	V/Ω/S and COMMON	500V dc/ac rms.
Any	COMMON	500V dc/ac rms with respect to earth ground.

2-16. The 8024B 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.

2-17. Fuse Check

2-18. The current (mA) function contains two fuses. Check them as follows:

1. Complete the setup 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.

2-19. Fuse Replacement

2-20. 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 2 "Battery or Fuse Installation/Replacement") and (2) F2, 3A/600V battery fuse (see Section 4 "Battery/Backup Fuse Replacement").

WARNING

TO AVOID ELECTRICAL SHOCK DO NOT OPERATE THE 8024B UNTIL THE BATTERY COVER IS IN PLACE AND FULLY CLOSED.

2-21. The Display

2.22 As Figure 2-4 shows, your 8024B has a 3-1/2 digit liquid crystal display. Displayed values can range from 000 through 1999 (1999 is rounded to 2000 for ease of discussion). The decimal point position is determined by the selected range and is independent of selected function, except temperature. When the °C function is selected, the decimal point is not displayed. If the dc voltage or current measurement function is selected, the minus sign indicates that the input signal is negative with respect to the COMMON input terminal. If the °C measurement function is selected, the minus sign indicates that the input temperature is below zero. The absence of a minus sign indicates a positive reading. The minus sign is also used in conjuncton with the up and down ▲▼ arrows when analyzing the input signal using the level detector function.

NOTE

The minus sign (-) may flash momentarily as the 8024B 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 displayed.

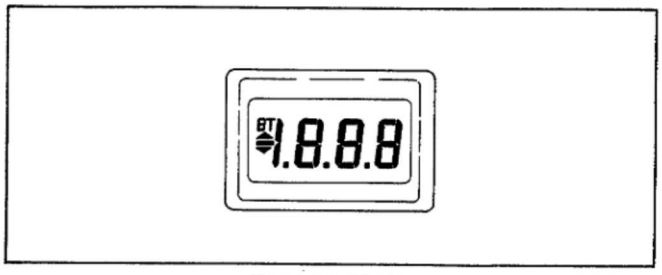


Figure 2-4. Display

2-23. The up and down ▲▼ arrows (above and below the minus sign) are enabled by selecting the resistance or conductance functions. These arrows are visual indicators for the continuity and level detector functions.

2-24. The display has two abnormal status indicators (Figure 2-5), low battery power and instrument overrange. A BT is displayed when approximately 20% of battery life remains (battery replacement is indicated). A 1 followed by three blanked digits is displayed (decimal point may be present) as an overrange indication. It means that the next higher range should be selected. It 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 8024B is powered with the A-81 Battery Eliminator the "BT" indicator may come on. However, instrument operation will be normal.

2-25. The liquid crystal display used in the 8024B 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 multimeter 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. 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.

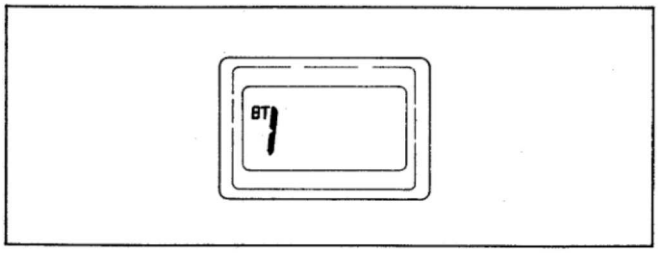


Figure 2-5. Abnormal Status Indicators

2-26. OPERATION

2-27. The following paragraphs describe how to operate your 8024B in each of its nine functions. Proceed to the description for the function you want to use.

2-28. AC/DC Volts (V) Operation

2-29. Figure 2-6 shows operation for the voltage measurement function. Perform each of the steps listed in sequence and comply with the warning.

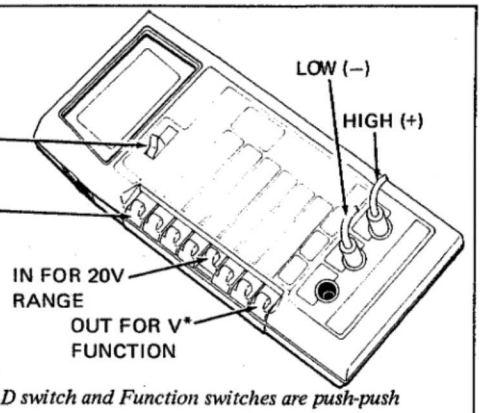
2-30. AC/DC Current (mA) Operation

2-31. Figure 2-7 shows operation for the current measurement function. Perform each of the steps listed in sequence and comply with the warning.

2-32. Resistance (Ω) Operation

2-33. Figure 2-8 shows operation for the resistance measurement function. To make resistance measurements, complete each of the steps listed in the figure sequentially, and comply with the warning.

VOLTS (V)



**NOTE*
The PEAK-HOLD switch and 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 grey 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).

WARNING

TO AVOID ELECTRICAL SHOCK AND/OR INSTRUMENT DAMAGE, DO NOT CONNECT THE 8024B TERMINALS TO SOURCES THAT EXCEED THE FOLLOWING LIMITS WHEN MEASURING VOLTAGES:

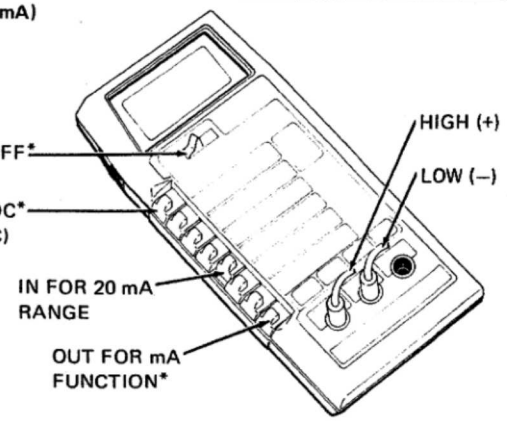
COMMON: 500V DC OR AC RMS WITH RESPECT TO EARTH GROUND.

V-Ω-S: 1000V DC OR 750V AC RMS WITH RESPECT TO THE COMMON TERMINAL (IN THE 200mV RANGE, SOURCES GREATER THAN 300V DC OR AC RMS 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 2-6. Volts Operation

CURRENT (mA)



**NOTE:*
The PEAK-HOLD switch and 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 grey switch beside the range desired (20 mA range shown selected).
- Set the AC/DC switch out for DC or in for AC.
- Insure that all other switches are at the out or OFF positions.

WARNING

TO AVOID ELECTRICAL SHOCK AND/OR INSTRUMENT DAMAGE, DO NOT CONNECT THE 8024B TERMINALS TO SOURCES THAT EXCEED THE FOLLOWING LIMITS WHEN MEASURING CURRENT:

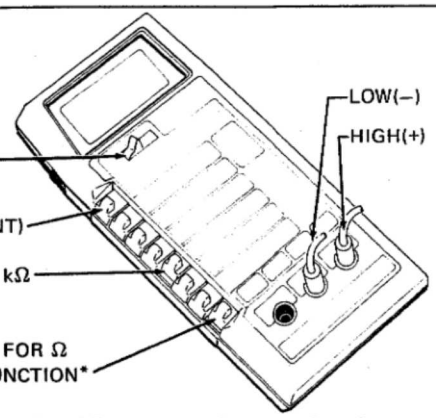
COMMON: 500V DC OR AC RMS WITH RESPECT TO EARTH GROUND.

mA-°C: CURRENT OF 2 AMPS OR OPEN CIRCUIT VOLTAGE OF 600V DC/AC RMS.

- 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-°C terminal is negative with respect to the COMMON terminal.

Figure 2-7. Current Operation

RESISTANCE (Ω)



**NOTE:*
The PEAK-HOLD switch and 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-°C-V-Ω-S switch.
- Depress the grey switch beside the range desired (20k is shown selected.
- Insure 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 8024B TERMINALS TO SOURCES THAT EXCEED THE FOLLOWING LIMITS WHEN MEASURING RESISTANCE OR CONTINUITY:

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

V-Ω-S: 500V DC OR AC RMS WITH RESPECT TO THE COMMON TERMINAL.

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

Figure 2-8. Resistance Operation

2-34. Continuity Testing

2-35. The 2 kΩ range of your 8024B can be used to make fast continuity tests. Select the 2 kΩ range, Ω function, and depress the AC/DC switch (to enable the audible alarm). The ▲ up arrow will appear in the display. If continuity is measured between the test lead tips (touch the tips together momentarily), the audible tone will sound, then the up▲arrow will disappear from the display and the down▼arrow will appear. Typically, 600Ω or less will activate the down▼ arrow and audio tone. Comply with the kΩ warning.

2-36. Diode Testing

2-37. The 2 kΩ, 200 kΩ, and 20 MΩ ranges of the kΩ function will turn on PN junctions. The 2 kΩ is preferred and is marked with a diode symbol on the front panel of your 8024B. The open circuit voltage is less than 3.5V on the 2 kΩ range and less than 1.5V on all other ranges. When testing diodes in conjunction with the audio tone, use the 200 kΩ range.

NOTE

The 200Ω, 20 kΩ, and 2000 kΩ ranges can be used for in-circuit resistance measurements.

2-38. Conductance (S) Operation

2-39. Figure 2-9 shows operation for the conductance measurement function. To make conductance measurements, complete each of the steps listed in the figure sequentially, and comply with the warning. Siemens, the displayed units, is equal to 1/Ω. For the resistance equivalent to the displayed value, refer to the conductance-to-resistance conversion material presented later in this section under Measurement Techniques.

2-40. Temperature (°C) Operation

WARNING

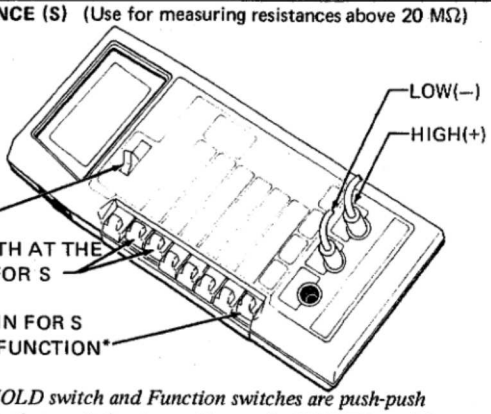
TO AVOID ELECTRICAL SHOCK, DO NOT USE THE THERMOCOUPLE ACCESSORIES WHEN VOLTAGES EXCEEDING 30V AC RMS OR 60V DC ARE PRESENT. THE PROBE TIP MAY BE ELECTRICALLY CONNECTED TO THE ACCESSORY OUTPUT TERMINALS.

2-41. Figure 2-10 describes operation for the temperature measurement function with the thermocouple accessories and with the John Fluke Model 80T-150 Temperature Probe. To find the Fahrenheit equivalent of the °C display, go to the Temperature Conversion portion of the Measurement Techniques material presented later in this section.

NOTE

Thermocouple connections must be made using approved isothermal connectors (such as the Y8104) and thermocouple wire that is the same type as the thermocouple. Failure to use these materials will result in erroneous temperature measurement.

CONDUCTANCE (S) (Use for measuring resistances above 20 MΩ)



**NOTE:*
The PEAK-HOLD switch and 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-°C-V-Ω-S function switch.
- AT THE SAME TIME, depress both of the grey S range switches.
- Insure that all other switches are at the out or OFF positions.
- Insure that the device being measured contains no electrical energy.

WARNING

TO AVOID ELECTRICAL SHOCK AND/OR INSTRUMENT DAMAGE, DO NOT CONNECT THE 8024B TERMINALS TO SOURCES THAT EXCEED THE FOLLOWING LIMITS WHEN MEASURING CONDUCTANCE:

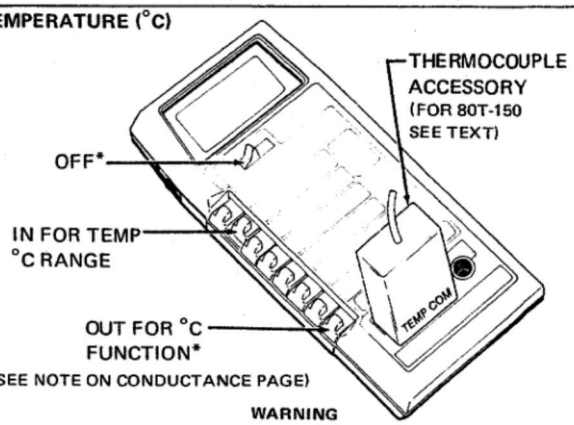
COMMON: 500V DC OR AC RMS WITH RESPECT TO EARTH GROUND.

V-Ω-S: 500V DC OR AC RMS WITH RESPECT TO THE COMMON TERMINAL.

- Connect the test leads across the device being measured (connect the red test lead to the + end of polarized capacitors for leakage measurements.
- Read the measured value in the display.
- See Measurement Techniques section for Conductance-Resistance Conversion chart.

Figure 2-9. Conductance Operation

TEMPERATURE (°C)



*(SEE NOTE ON CONDUCTANCE PAGE)

WARNING

TO AVOID ELECTRICAL SHOCK AND/OR INSTRUMENT DAMAGE, DO NOT EXCEED THE MAXIMUM VOLTAGE AND TEMPERATURE LIMITS FOR THE ACCESSORY USED.

John Fluke Thermocouple ACCESSORIES

- Connect the thermocouple termination across the mA-°C and Common terminals with the TEMP side plugged into the mA-°C terminal,
- Depress the grey TEMP °C range switch.
- Insure that all other switches are at the out or OFF positions.
- Read the measured value in the display. See Measurement Technique section for °F conversion.
- If unit fails to function properly, see FUSE CHECK para. 2-17.

John Fluke 80T-150 ACCESSORY

- Connect the 80T-150 termination across the V-Ω-S and COMMON terminals with the HI side plugged into the V-Ω-S terminal.
- Select the appropriate range (200 mV or 2V).
- Insure that all other switches are at the out or OFF positions.
- Set the 80T-150 POWER switch to the ON position and read the display in units indicated on the accessory label.

Figure 2-10. Temperature Operation

2-42. Not all applications for temperature measurement use just one thermocouple. The applications material at the end of this section describes how to use your 8024B to sequentially measure different thermocouples of the same type. Your 8024B is intended for use with K-type thermocouples. If you use another type of thermocouple, the measurement will be in error. See the Temperature Measurement Techniques material presented later in this section.

2-43. Level Detector Operation

WARNING

TO AVOID ELECTRICAL SHOCK AND/OR INSTRUMENT DAMAGE, DO NOT CONNECT THE 8024B TERMINALS TO SOURCES THAT EXCEED THE FOLLOWING LIMITS WHEN USING THE LEVEL DETECTOR FUNCTION: COMMON: 500V DC OR 500V AC RMS WITH RESPECT TO EARTH GROUND V/Ω/S: 500V DC OR 500V AC RMS WITH RESPECT TO THE COMMON TERMINAL.

2-44. Use the level detector function for sensing logic levels and other active signals less than 250V dc or ac rms in amplitude. Select the 200 kΩ range on the Ω function. The 200 kΩ range is marked with a step function symbol (⌐) on the front panel of your 8024B to indicate its use in the level detector function. The level detector compares the input signal to a +0.8V (nominal) reference. There is both audible and visual indication of the results of the comparison. The audible indication is a 2 kHz tone that can be enabled by depressing the AC/DC switch or disabled by releasing the AC/DC switch. The visual indication is an up and/or down arrow that appears on the display above and/or below the minus sign position. Figure 2-11 shows the indications for some typical input signals. Starting from left to right:

1. The level is above the +0.8V reference so the ▲up arrow appears in the display and the audible tone does not sound.

2. The input level is below the +0.8V reference, but above 0V. The audible tone sounds and the ▼down arrow appears in the display but the minus sign is absent.

3. The input levgl is below both the +0.8V reference and 0V. The ▼down arrow appears, the tone is audible, and the minus sign appears.

4. The input signal is very near 0V. The ▼down arrow appears, the audible tone sounds, and the minus sign flickers off and on.

5. The input is a train of pulses that pass above +0.8V but whose average value is positive. Each time a pulse goes above +0.8V, the ▲up arrow appears and the audible tone is silent. Each time the pulse goes below +0.8V, the ▼down arrow appears and the audible tone sounds. The minus sign does not appear. For a fast pulse train, both arrows will be on.

6. The input signal is a sine wave whose positive peaks pass above +0.8V but whose average value is negative. The audible tone and arrows behave as described in step 5 and the minus sign appears in the display.

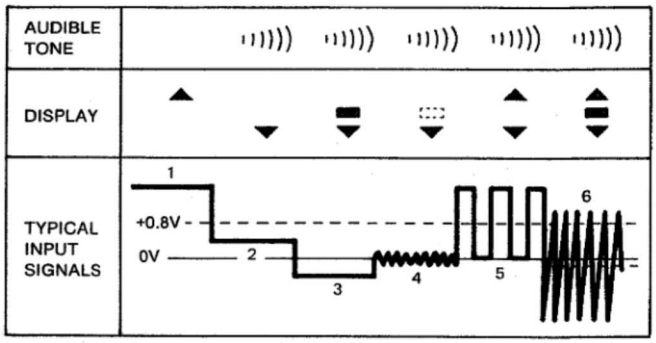


Figure 2-11. Level Detector Operation

7. For short pulses, your 8024B has a pulse stretcher circuit that captures and holds the pulses long enough for the display and tone to respond, typically for 100 ms. The input impedance of the level detector is >100 kΩ so as not to load logic circuits. The level detector is also usable on the 2 kΩ range. On this range, the reference level is +0.4V nominal. See Measurement Techniques for additional information.

2-45. Peak Hold Operation

CAUTION

The PEAK HOLD switch is a push-push type. Operate this switch by pushing to the right only. Do not push or pull the switch to the left (off).

2-46. The peak hold function provides short term memory of the most positive dc or ac rms level (Figure 2-12). The peak hold function is intended to be used for voltage and current measurements. Proceed with the steps of operation for the measurement function being used with the peak hold function. When the test leads have been connected to the circuit to be measured, set the PEAK HOLD switch to ON. For a new reading, set the PEAK HOLD switch to OFF then back to ON. To read negative peak signals, reverse the test connections. An example peak hold operation would be as follows:

1. Set the PEAK HOLD switch to OFF.
2. Select the DC, V (volts) functions.
3. Insert the red test lead into the V/Ω/S input, and select the 20V range.
4. Locate the battery eliminator connector on the right side of the unit.

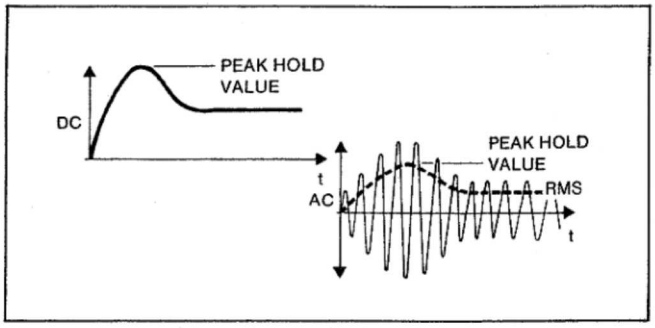


Figure 2-12. Peak Hold Operation

5. Measure the voltage on the side contact (bottom of hole) of the connector (approximately +2.90V).

6. Set the PEAK HOLD switch to ON and momentarily touch the test lead to the side contact.

7. The reading should be the same as step 5, within a few digits.

8. False readings may result if the range or function switches are changed while the PEAK HOLD switch is set to ON. To avoid these errors, reset the PEAK HOLD circuit after each range or function change.

9. Static electricity and noise pickup may cause errors when using the PEAK HOLD function. While the PEAK HOLD switch is ON, avoid touching the probe tips to fingers or other objects which may contain a static charge. The potential for noise pickup is worst whenever the test leads are open circuited. This is particularly true on the 200 mV, 2V and 2 mA ranges. Refer to AC/DC current measurement section of MEASUREMENT TECHNIQUES for additional information.

NOTE

For DC voltages and currents, the peak hold function measures the "most positive" value of the input waveform. If the "most positive" excursion of the waveform is negative with respect to common, a negative sign will be displayed, i.e., when a negative sign is display, the measured value is not the negative peak, but is, instead the least negative (or most positive) portion of the applied waveform.

10. PEAK HOLD accuracy may be affected by mechanical shock. If your 8024B has suffered mechanical shock during a peak measurement, reset the PEAK HOLD circuit and repeat the measurement.

2-47. INITIAL CHECK-OUT PROCEDURE

2-48. Now that you have installed the battery, and know where everything is and how it works, let's make sure that the unit is working properly. We'll run through a simple check-out procedure starting with turn-on. No equipment other than test leads will be required. If a problem is encountered, please check battery, fuse, switch setting, and test lead connection before contacting your nearest 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 Tests 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 between -00.1 and 00.1.

3. Connect the red test lead to the V/Ω/S input terminal. Depress Ω function switch to select Ω function.

4. Touch the red probe tip to the COMMON input terminal, and sequentially depress each of the six dark range switches starting at the top (20 MΩ). The display should read zero ±1 digit and the decimal point should be positioned as follows:

   a. 20 MΩ - 0.00
   b. 2000 kΩ - 000
   c. 200 kΩ - 00.0
   d. 20 kΩ - 0.00
   e. 2 kΩ - .000
   f. 200Ω - 00.0

5. Press the 20V range switch and remove the probe from the COMMON input terminal. Release function switch to select volts function.

6. Look inside the battery eliminator connector on the right side of the 8024B and locate the connector contacts.

7. Touch the red probe to the center post of the battery eliminator connector. The display should read approximately -6.1V dc. (Note: this voltage varies with condition and type of battery.)

8. Touch the probe tip to the side contact of the battery eliminator connector located at the bottom of the hole. 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 eliminator connector.

9. Depress the Ω function switch and the AC/DC switch. The ▲ up arrow will appear in the display. Sequentially depress each of the six range switches. The display will indicate an overrange condition and the decimal point will change position.

10. Touch the red probe tip to the COMMON input terminal, the audible tone will sound and the ▼ down arrow will appear in the display. Sequentially depress each of the grey range switches. 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. Release the AC/DC switch to silence the audio tone.

11. Touch the red probe tip to the mA -°C 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 -°C input connector.

13. Simultaneously depress the two range switches to select 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 terminal. 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 the AC/DC switch and the 750V ac range switch. Set the function switch to the voltage (out) position. (Use 750V range for 230V line.)

WARNING

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

17. Measure the local ac line voltage at a convenient output receptacle.

18. Set the PEAK HOLD switch to the ON position. The value of the line voltage will be locked on the display. The display value should decay no faster than 1 digit per second. Set the PEAK HOLD switch to the OFF position.

19. Remove the test leads from the line power receptacle and set PEAK HOLD to OFF, function to DC, PEAK HOLD to ON, and reinsert probes; observe 1.41 X ac voltage. (This is the instantaneous peak of a single half wave of line voltage.) Set PEAK HOLD to OFF.

20. Select the 200 kΩ range of the Ω function switch (level detector), and depress the AC/DC switch (to enable the audible tone).

21. Connect the test leads to the line voltage receptacle. You will hear the audible tone modulated by the line frequency and see both arrows displayed.

22. Remove the test leads from the line power receptacle.

23. If your 8024B has responded properly to this point, it is operational and ready for use.

2-49. MEASUREMENT TECHNIQUES

2-50. The following paragraphs offer you techniques that can improve the accuracy of measurements made with your 8024B. While most of these techniques are in general use throughout the electronics industry, these paragraphs offer specific information for use with your 8024B. (Figure 2-13 presents a temperature correction factor for K-type thermocouples.) Use this chart for accuracy enhancement above 300°C.

2-51. Temperature Conversion

2-52. The temperature measurements made with your 8024B are displayed in °C. To find the equivalent temperature in °F, either use the conversion tables in Table 2-3 or the formula: 1.8 (°C) + 32° = °F.

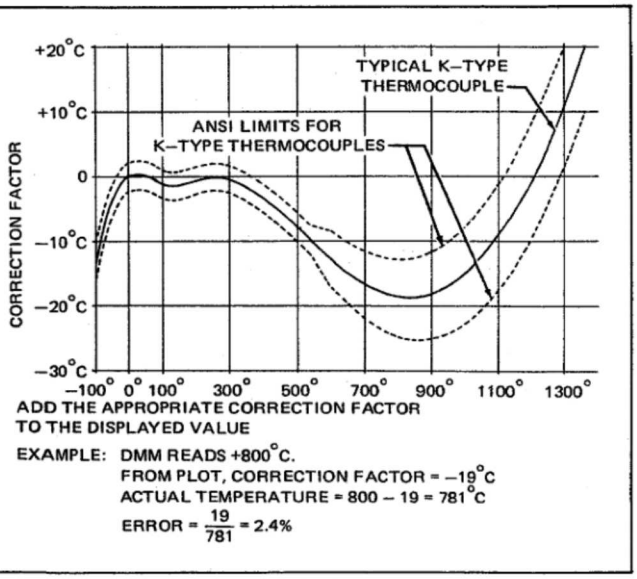


Figure 2-13. Temperature Correction Factor for K-Type Thermocouples

Table 2-3. Celsius-to-Fahrenheit Conversion Scale

°C	°F	°C	°F	°C	°F
−40	−40.0	5	41.0	40	104.0
−38	−36.4	6	42.8	41	105.8
−36	−32.8	7	44.6	42	107.6
−34	−29.2	8	46.4	43	109.4
−32	−25.6	9	48.2	44	111.2
−30	−22.0	10	50.0	45	113.0
−28	−18.4	11	51.8	46	114.8
−26	−14.8	12	53.6	47	116.6
−24	−11.2	13	55.4	48	118.4
−22	−7.6	14	57.2	49	120.2
−20	−4.0	15	59.0	50	122.0
−19	−2.2	16	60.8	55	131.0
−18	−0.4	17	62.6	60	140.0
−17	1.4	18	64.4	65	149.0
−16	3.2	19	66.2	70	158.0
−15	5.0	20	68.0	75	167.0
−14	6.8	21	69.8	80	176.0
−13	8.6	22	71.6	85	185.0
−12	10.4	23	73.4	90	194.0
−11	12.2	24	75.2	95	203.0
−10	14.0	25	77.0	100	212.0
−9	15.8	26	78.8	105	221.0
−8	17.6	27	80.6	110	230.0
−7	19.4	28	82.4	115	239.0
−6	21.2	29	84.2	120	248.0
−5	23.0	30	86.0	125	257.0
−4	24.8	31	87.8	130	266.0
−3	26.6	32	89.6	135	275.0
−2	28.4	33	91.4	140	284.0
−1	30.2	34	93.2	145	293.0
0	32.0	35	95.0	150	302.0
1	33.8	36	96.8	155	311.0
2	35.6	37	98.6	160	320.0
3	37.4	38	100.4	165	329.0
4	39.2	39	102.2	170	338.0

Table 2-3. Celsius-to-Fahrenheit Conversion Scale (cont)

°C	°F	°C	°F	°C	°F
175	347	350	662	750	1382
180	356	355	671	800	1472
185	365	360	680	850	1562
190	374	365	689	900	1652
195	383	370	698	950	1742
200	392	375	707		
205	401	380	716		
210	410	385	725		
215	419	390	734		
220	428	395	743		
225	437	400	752		
230	448	405	761		
235	455	410	770		
240	464	415	779		
245	473	420	788		
250	482	425	797		
255	491	430	806		
260	500	435	815		
265	509	440	824		
270	518	445	833		
275	527	450	842		
280	536	455	851		
285	545	460	860		
290	554	465	869		
295	563	470	878		
300	572	475	887		
305	581	480	896		
310	590	485	905		
315	599	490	914		
320	608	495	923		
325	617	500	932		
330	626	550	1022		
335	635	600	1112		
340	644	650	1202		
345	653	700	1292		

2-53. Conductance-to-Resistance Conversion

2-54. The conductance measurement function of your 8024B displays in siemens. To convert siemens to ohms, use either the conversion scale and interpolation table in Figure 2-14 or the formula: siemens = $1/\Omega$.

2-55. AC Measurements

2-56. The ac ranges of the 8024B 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 2-15 shows the relationship between sine, square, and triangular waveforms, and the required conversion factors. To convert the display reading for a given input waveform to a known measurement value, multiply the reading by the appropriate Display Multiplier.

2-57. AC/DC Voltage Measurements

2-58. The 8024B 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 2-2.

2-59. 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 the circuit does present a problem, the percentage of error can be calculated using the appropriate formula in Figure 2-16.

2-60. AC/DC Current Measurements

WARNING

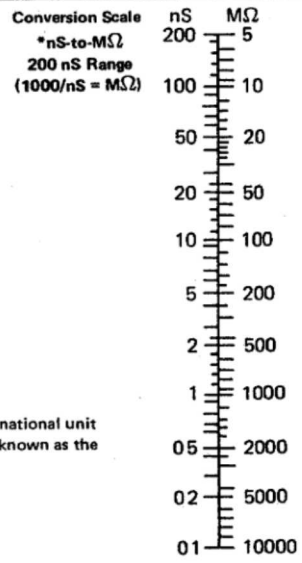
INSTRUMENT DAMAGE AND OPERATOR INJURY MAY RESULT IF THE FUSE BLOWS WHILE CURRENT IS BEING MEASURED IN A CIRCUIT WHICH EXHIBITS AN OPEN CIRCUIT VOLTAGE GREATER THAN 600V. DO NOT ATTEMPT IN-CIRCUIT CURRENT MEASUREMENT WHERE THE POTENTIAL IS GREATER THAN 600V DC OR AC RMS.

2-61. Four ac and four dc current ranges are included on the 8024B; 2 mA, 20 mA, 200 mA, and 2000 mA. Each range is diode protected to 2 amps and fuse protected above 2 amps. If the fuse blows, refer to fuse replacement information given earlier in this section.

2-62. In high electrical noise environments (near ignition switches, fluorescent 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/S connector to the mA connector. This will ensure an accurate measurement. Remove this temporary jumper when the measurement has been completed. This is recommended only for the 2 mA and 20 mA ranges.

CAUTION

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



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

Find the approximate resistance value using the scale above. 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 (1/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 2-14. Conductance-to-Resistance Conversion

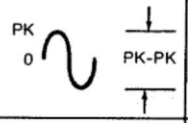
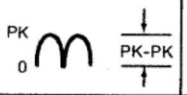
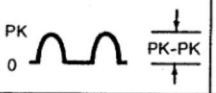
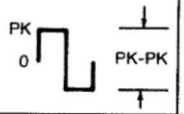
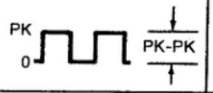
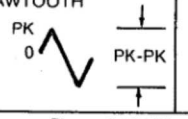
GIVEN INPUT WAVEFORM	8024B DISPLAY MULTIPLIER FOR MEASUREMENT CONVERSION			
	PK-PK	0-PK	RMS	AVG
SINE 	2.828	1.414	1.000	0.900
RECTIFIED SINE (FULL WAVE) 	1.414	1.414	1.000	0.900
RECTIFIED SINE (HALF WAVE) 	2.828	2.828	1.414	0.900
SQUARE 	1.800	0.900	0.900	0.900
RECTIFIED SQUARE 	1.800	1.800	1.272	0.900
RECTANGULAR PULSE D=X/Y 	0.9/D	0.9/D	$0.9/D^{1/2}$	0.9D
TRIANGLE SAWTOOTH 	3.600	1.800	1.038	0.900

Figure 2-15. 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: *

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

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: *

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

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

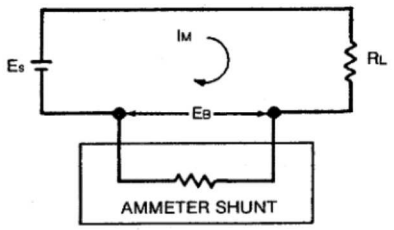
* Vector algebra required.

Figure 2-16. Voltage Measurement Error Calculations

2-63. Full-scale burden voltage (voltage drop across the input terminals) for all ranges except 2000 mA is less than 300 mV. The 2000 mA range has full-scale burden voltage of less than 900 mV. This voltage drop can affect the accuracy of a current measurement if the current is unregulated and the DMM 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 2-17. 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.

2-64. Resistance Measurements

2-65. Six direct reading resistance ranges are provided on the 8024B; 20 MΩ, 2000 kΩ, 200 kΩ, 20 kΩ, 2 kΩ, and 200Ω. All ranges 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 unknown reading. The error is generally on the order of 0.2 to 0.3 ohms for a standard pair of test leads.



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

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% or 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 2-17. Current Measurement Calculations

2-66. Three 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 preferred 2 kΩ range is marked with a diode symbol. The 200Ω, 20 kΩ and 2000 kΩ ranges can be used to make in-circuit resistance measurements. Typical full scale voltage and short circuit current for each resistance range is given in Table 2-4. All values shown are referenced to the COMMON input terminal; i.e., the V/Ω/S terminal is positive.

NOTE

Any changes (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.

Table 2-4. 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

2-67. APPLICATIONS

2-68. The test applications described in the following paragraphs are suggested useful extensions of the 8024B measurement capabilities. However, they are not intended as the equivalent of manufacturer's recommended test methods. They are intended to provide repeatable and meaningful indications which will allow the operator to make sound judgments concerning the condition of the device tested; i.e. good, marginal, or defective.

2-69. THERMOCOUPLES

2-70. Introduction

2-71. In 1821, Seebeck found that when two dissimilar metals are connected at two junctions and the junctions are at different temperatures, a current will flow in the loop (Figure 2-18, Part A) and will continue to flow as long as there is a difference in temperature. This principle is used by your 8024B when making temperature measurements.

2-72. The K-type thermocouple that is used with your 8024B is made from two dissimilar metals, Chromel and Alumel. As long as the same two types of metal are used throughout the loop (Figure 2-18, Part B), there are still only two junctions. The copper conductors of

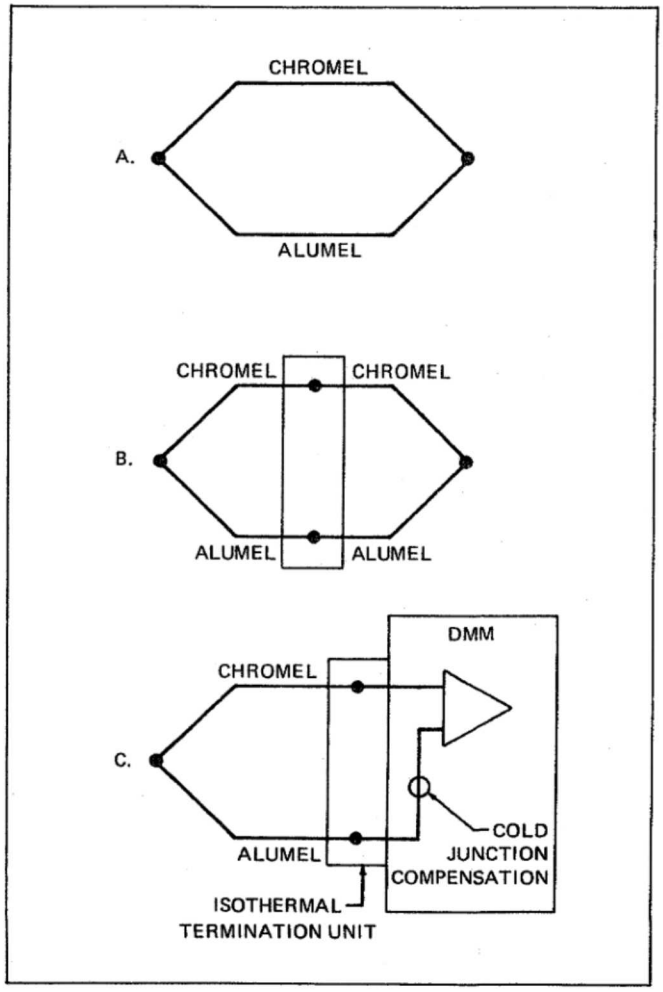


Figure 2-18. Thermocouples

your 8024B are different from both the Alumel and the Chromel (Figure 2-18, Part C) which would seem to add a third junction to the loop. But, remember there is no current or voltage in a thermocouple loop if both junctions are at the same temperature. The isothermal characteristics of the special termination unit for John Fluke thermocouples insures that the two junctions at your DMM are at the same temperature. This leaves the original circuit as shown in Figure 2-18, Part A. If you are going to connect your own K-type thermocouple, use a John Fluke Model Y8104 Thermocouple Termination Unit (see Section 6 for details).

2-73. Monitoring More Than One Thermocouple

2-74. You can use your 8024B to monitor more than one thermocouple -- even thermocouples that are permanently mounted in your system. If your present K-type thermocouples are permanently mounted in a system and have individual remote reading stations, you can attach your present K-type thermocouple quick-connect to a John Fluke Model Y8104 Thermocouple Termination Unit via K-type thermocouple wire (Figure 2-19). Then plug the Y8104 into your 8024B, and carry the meter and thermocouple quick-connect assembly from station to station reading the various temperatures. If your thermocouples are routed to a centralized point (Figure 2-20), use one or more John Fluke Model 2161A Multipoint Selectors. Connect the last 2161A to your 8024B via a Y8104 Thermocouple Termination Unit and select the thermocouple(s) you want to read.

2-75. Leakage Tester

2-76. The 200 nS conductance range effectively extends the resistance measurement capability of the 8024B (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 capacitors, diodes, cables, connectors, printed circuit boards (pcbs), etc. In all cases, the test voltage is <5V dc.

2-77. 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 conductance. If an overrange occurs, select the resistance range that provides on-scale reading.

NOTE

Under high humidity conditions (>80%) conductance measurements may be in error. To ensure accurate measurement, connect clean test leads to the 8024B and (with the leads open) read the residual leakage in nanosiemens. Correct subsequent measurements by subtracting the residual from the readings. (Fingerprints or other contamination on the pcb may also cause residual conductance readings.)

2-78. DIODES

2-79. Diode leakage (IR) tests require that the diode junction be reverse biased when being measured. This is accomplished by connecting the diode's anode 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 the resistance range that provides on-scale reading.

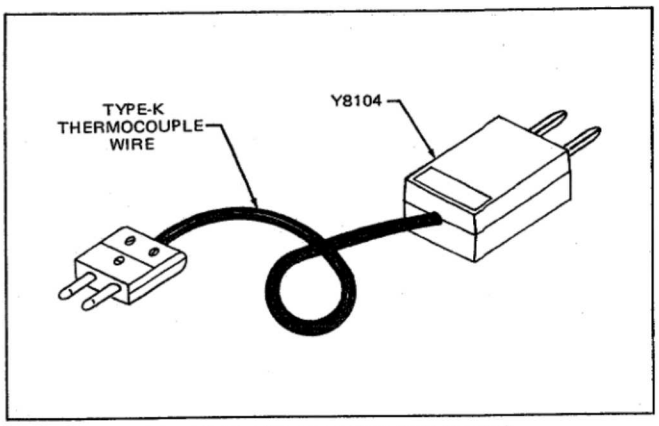
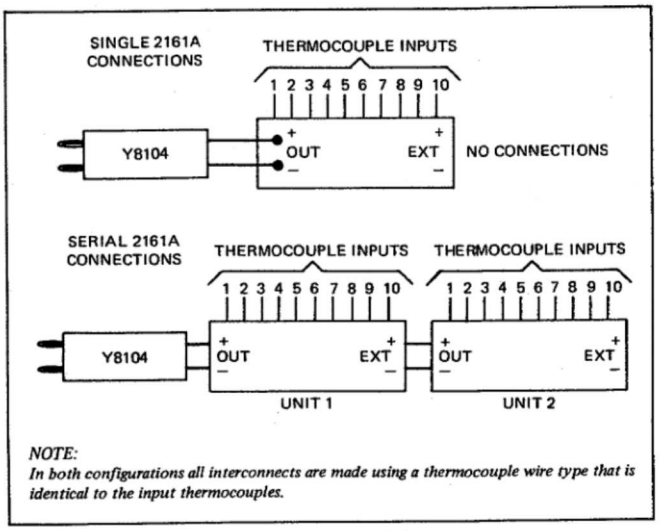


Figure 2-19. Thermocouple Termination Unit



NOTE:
In both configurations all interconnects are made using a thermocouple wire type that is identical to the input thermocouples.

Figure 2-20. Multipoint Selection

Section 3
Theory of Operation

3-1. INTRODUCTION

3-2. This section of the manual describes the theory of operation of your 8024B. The overall function of your 8024B is presented first at an overall functional level. Then the operation of the a/d converter and each function of your 8024B is described in more detail. A detailed schematic of your 8024B can be found in Section 7.

3-3. OVERALL FUNCTIONAL DESCRIPTION

3-4. Figure 3-1 shows the major circuits of your 8024B arranged in a simplified functional block diagram. Input signals are routed by the range and function switches through the appropriate signal conditioners so that a dc analog signal that is proportional to the input signal is applied to the input of the a/d converter if the PEAK HOLD switch is at the OFF position. If the PEAK HOLD switch is at the ON position, the dc analog signal will be stored on a capacitor in the peak hold circuit which will drive the a/d converter with a dc voltage that is the same as the stored charge on the peak hold capacitor until the PEAK HOLD switch is set to the OFF position. The a/d converter will drive the display to a digital display that is numerically the same as the proportional input signal. Decimal point position is determined by the range switch selected. When the Ω function is selected, the input signal is also routed to the level detector circuit. The level detector circuit compares the input signal level to a +0.8V reference (200 kΩ range). If the signal is more positive than the reference, the level detector circuit will cause the ▲up arrow to be displayed (over the minus sign position). If the input signal is less positive than the reference, the level detector will cause the down arrow to be displayed (under the minus sign position). If the audible tone is enabled (AC/DC switch at the AC position) the level detector circuit will cause the audible tone to sound when the input signal is less positive than the reference.

3-5. A/D Converter

3-6. The entire analog-to-digital conversion process is accomplished by a single custom a/d converter and display driver IC, U8. The a/d converter 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 a/d converter IC also contains the display latches, decoders, and drivers.

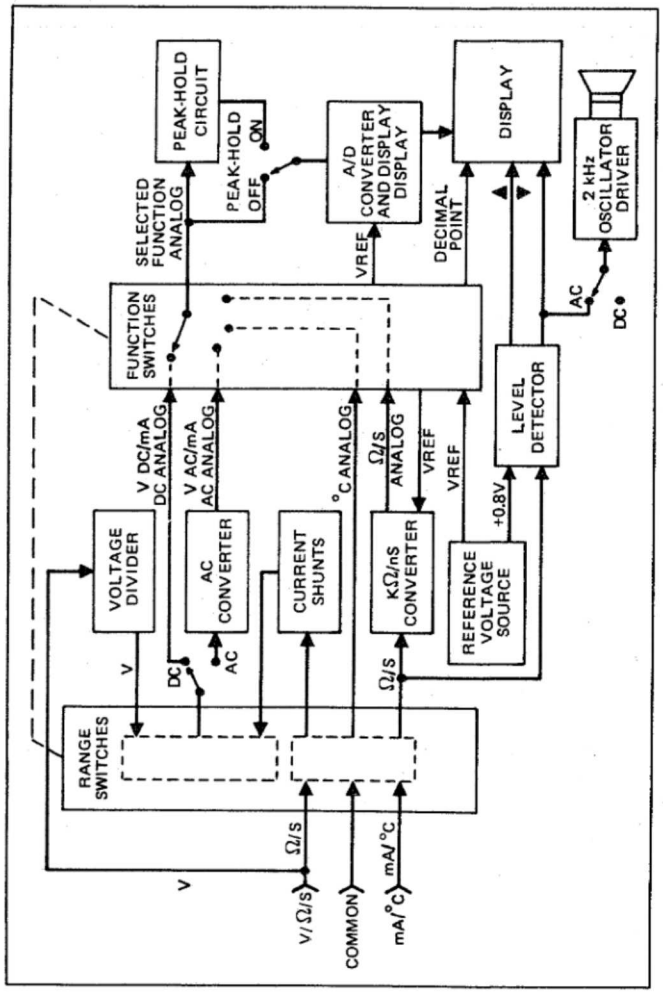


Figure 3-1. 8024B Block Diagram

3-7. The digital control portion of the a/d converter process is an internal function of U8, 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.

3-8. 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. (Sheet 1 of the Schematic also illustrates the a/d converter in a block form.) Basic timing for switch operation and, therefore, a complete measurement cycle is shown in Figure 3-3.

3-9. 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.

3-10. 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.

3-11. 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. At 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.

3-12. 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.

3-13. 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.

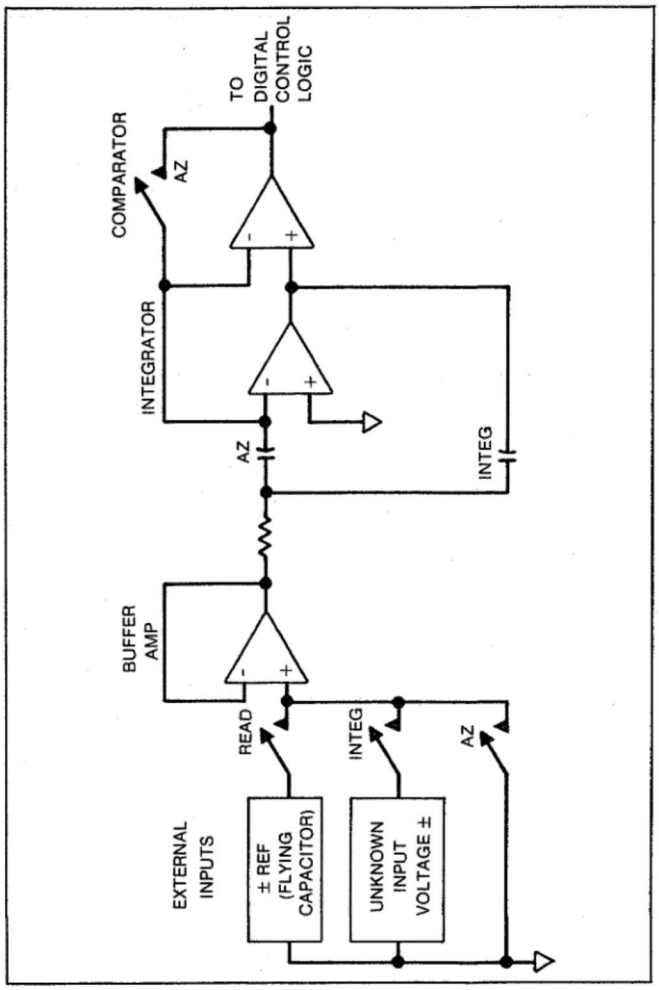


Figure 3-2. A/D Converter Functional Diagram

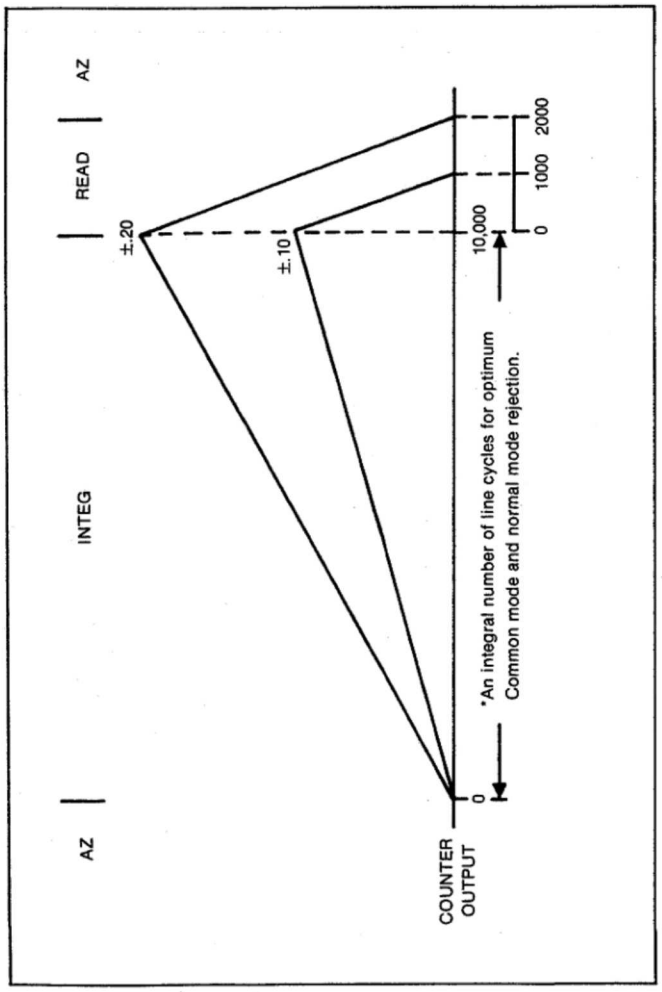


Figure 3-3. Integrate Capacitor Waveform

3-14. Voltage Measurement Function

3-15. Both ac and dc voltage measurement functions use an overvoltage protected 10 MΩ input divider to scale down the input voltage. Under normal conditions (assuming a dc input signal on the proper range) the divider output is a dc voltage that is directly proportional to the input signal level. If the AC function is selected, the output of the divider is ac coupled to an active full-wave rectifier whose dc output is calibrated to equal the rms level of the ac input (for sine wave inputs). If the PEAK HOLD switch is at the OFF position, the dc voltage from the divider or the ac converter is passed through a filter and applied to the a/d converter as the unknown input (Figure 3-4). Peak Hold operation will be covered later.

3-16. Current Measurement Function

3-17. Current measurements are made using a fuse protected, switchable, current shunt (0.1Ω, 1Ω, 10Ω, or 100Ω) to perform the current-to-voltage conversion required by the a/d converter (Figure 3-5). The voltage (IR) drop produced across the selected shunt may be either ac or 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 converter. If the PEAK HOLD switch is at the OFF position, the dc signal from either the ac converter or the current shunt is routed through a filter to the a/d converter. This unknown input voltage to the a/d converter is proportional to the current passing through the current shunt.

3-18. Temperature (°C) Measurement Function

3-19. As Figure 3-6 shows, the input from the thermocouple accessory is applied across the mA and COMMON terminals. If the PEAK HOLD switch is in the OFF position the input will be routed through a filter to the a/d converter unknown input. The COMMON terminal is thermally tied to the collector and base leads of transistor Q3. This provides reference junction temperature compensation. Q3 changes with temperature and provides an offset voltage to counter the thermocouple at the input jacks to ensure the integrity of the reading at the measurement end.

3-20. Resistance Measurement Function

3-21. Resistance measurements are made using a ratio technique as shown in Figure 3-7. When the kΩ function is selected, a simple series of circuits are 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 resistors 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.

3-22. Overall operation of the a/d converter during a resistance measurement is basically as described earlier in this section, with oneexception. 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. The PEAK HOLD switch should always be in the OFF position when making resistance measurements.

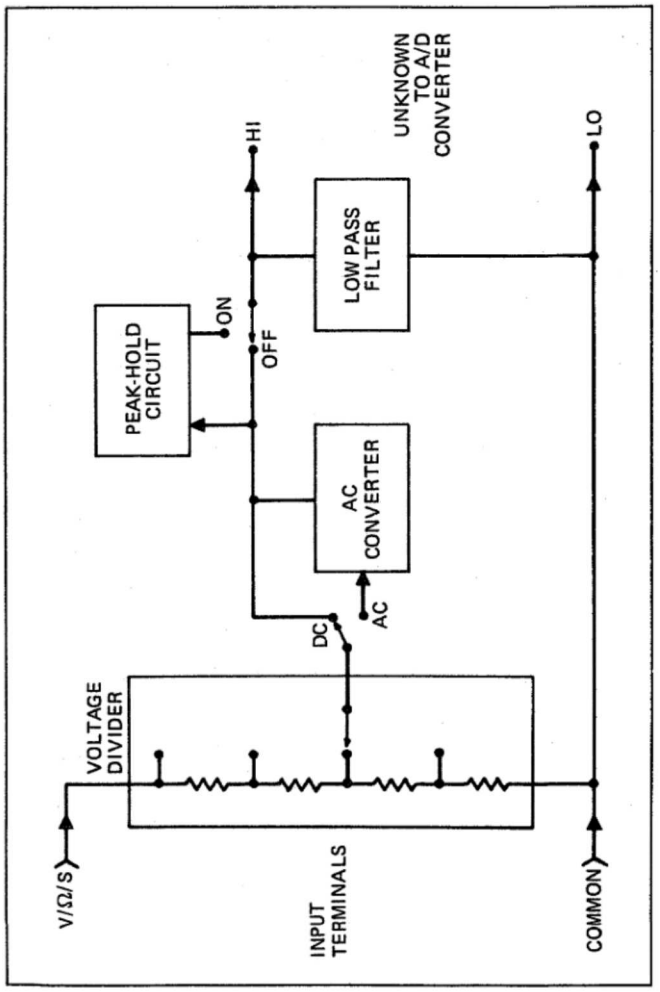


Figure 3-4. Voltage Measurement

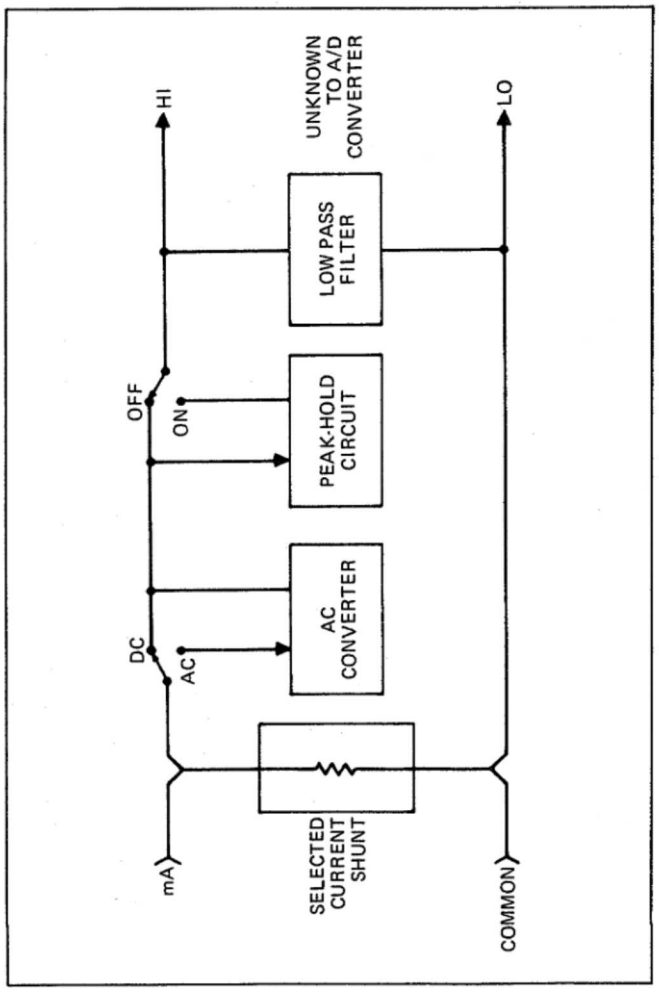


Figure 3-5. Current Measurement

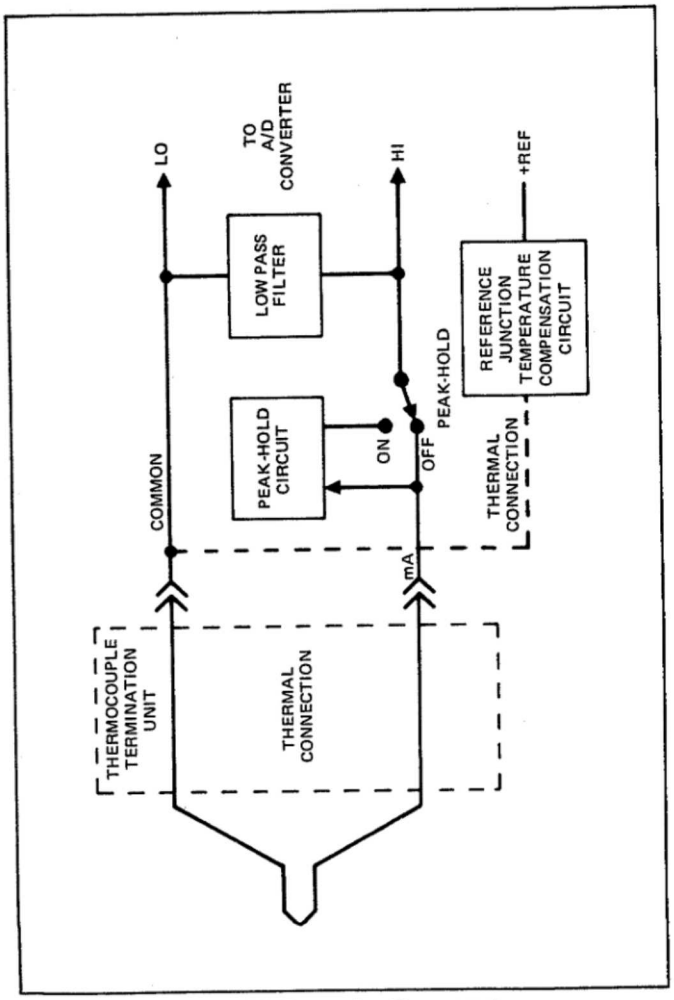


Figure 3-6. Temperature Measurement

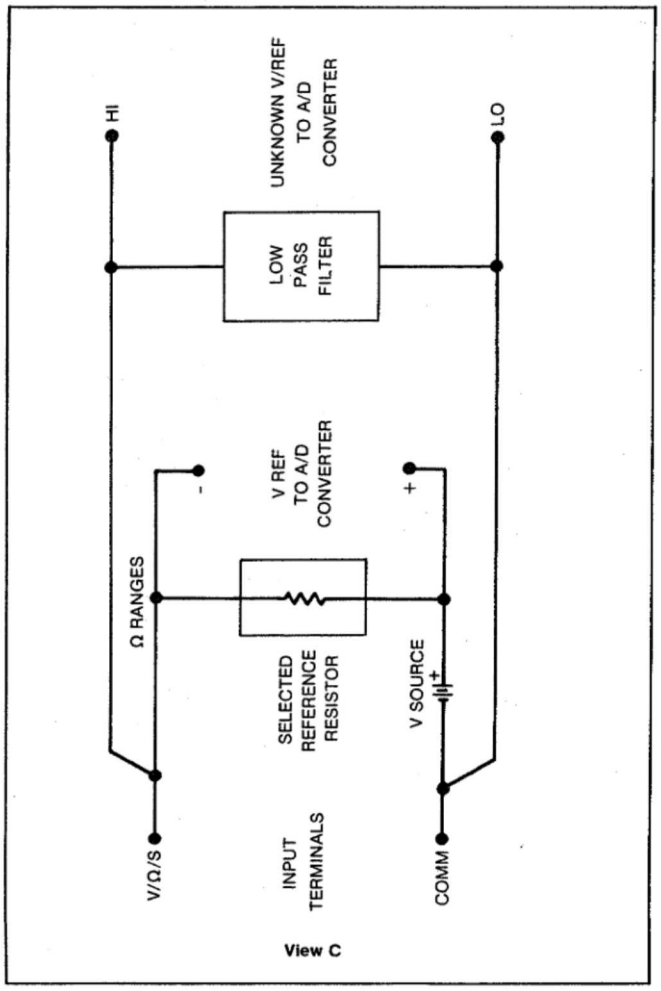


Figure 3-7. Resistance/Conductance Measurement

3-23. Conductance Measurement Function

3-24. Conductance measurements are made using a ratio technique similar to that used in making resistance measurements (Figure 3-7). The main differences are: only one range is provided (200 nS), and the function of the range resistor and the unknown resistor 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 ($1/\Omega$) of the unknown input resistance; i.e., the higher the input resistance, the lower the display reading. The PEAK HOLD switch should always be in the OFF position when making conductance measurements.

3-25. Peak Hold Circuit Level

3-26. As Figure 3-8 shows, the peak hold circuit consists of an operational amplifier (U19) and a capacitor (C19) which is across the a/d converter (U8) input. When the PEAK HOLD switch is set to the ON position, switch action removes the normal input to the a/d converter and routes the output of the signal conditioners to U19. The operational amplifier charges C19 to the peak positive input signal to the DMM. The charge on C19 is the unknown value that the a/d converter reads to determine the displayed value. As the charge on C19 bleeds off through U19, U14, and Q10, the display value will decay. Peak-Hold AC will give the peak rms value of a sine wave since the signal is routed through the AC Converter. Peak-Hold DC should give the positive peak of any input waveform.

3-27. Level Detector Circuit

3-28. As Figure 3-9 shows, when the Ω or S functions are selected, the DMM input is routed both to the resistance/conductance signal conditioner and to the comparator of the level detector circuit. The other input to the comparator is a +0.8V reference level (200 kΩ range). When the DMM input is open circuited or greater than the reference, the level detector circuit causes the ▲up arrow to appear in the display. If the DMM input is less than the reference level, the level detector circuit causes the ▼down arrow to appear in the display and the audible tone to sound if the AC/DC switch is at the AC position.

NOTE

The Peak-Hold switch should be in the OFF position when using the Level Detector Circuit.

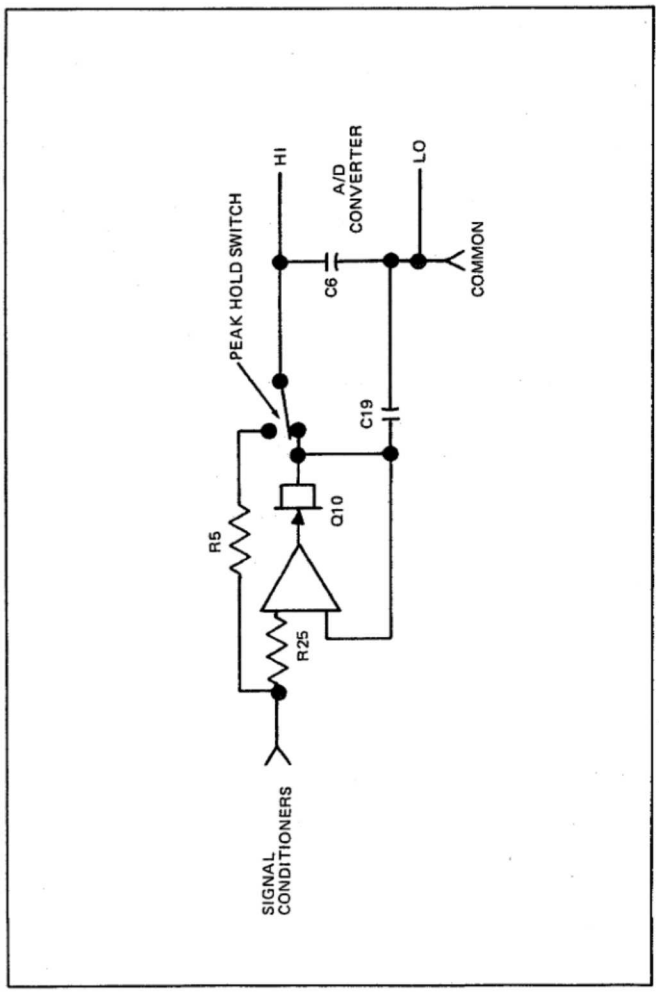


Figure 3-8. Simplified Peak Hold Circuit

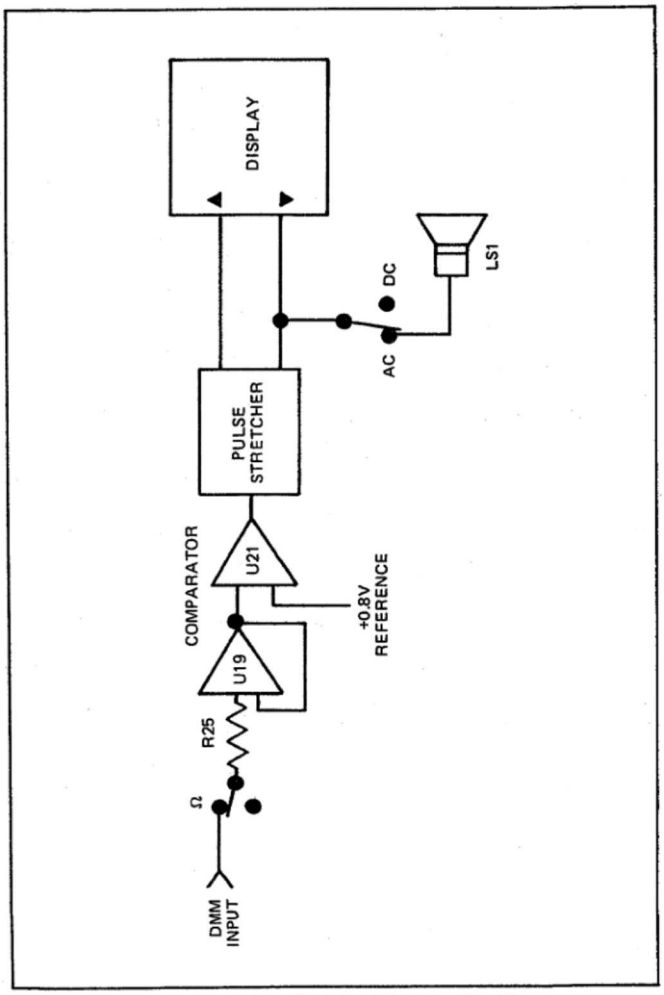
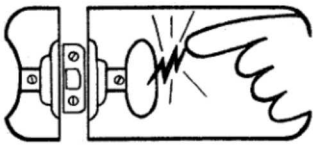


Figure 3-9. Simplified Level Detector Circuit

static awareness

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

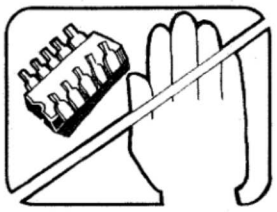


Some semiconductors and custom IC's can be damaged by electrostatic discharge during handling. This notice explains how you can minimize the chances of destroying such devices by:

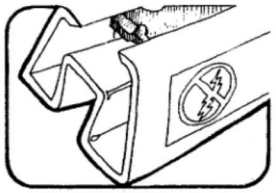
1. Knowing that there is a problem.
2. Learning the guidelines for handling them.
3. Using the procedures, and packaging and bench techniques that are recommended.

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

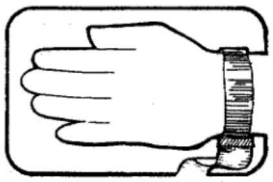
The following practices should be followed to minimize damage to S.S. devices.



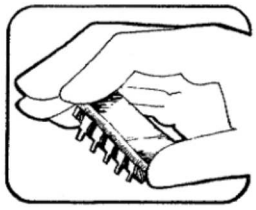
1. MINIMIZE HANDLING



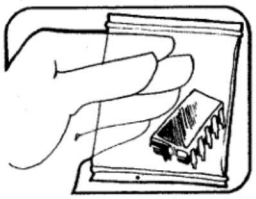
2. KEEP PARTS IN ORIGINAL CONTAINERS UNTIL READY FOR USE.



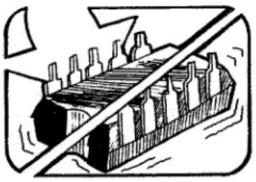
3. DISCHARGE PERSONAL STATIC BEFORE HANDLING DEVICES



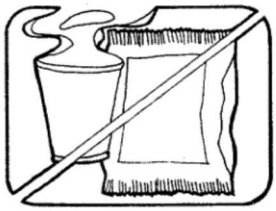
4. HANDLE S.S. DEVICES BY THE BODY



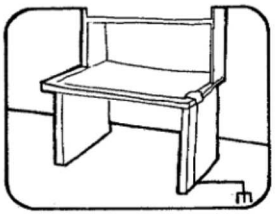
5. USE ANTI-STATIC CONTAINERS FOR HANDLING AND TRANSPORT



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 8024B. This includes service information, general maintenance, performance test, calibration, adjustments, 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 adjustments 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 8024B is warranted for a period of 2 years upon delivery to the original purchaser. Conditions of the warranty are given at the end 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 is provided at the end of this manual. Dated proof-of-purchase will be required for all in-warranty repairs.

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

Table 4-1. Test Equipment Required

INSTRUMENT TYPE	REQUIRED CHARACTERISTICS	RECOMMENDED EQUIPMENT
DMM Calibrator	AC VOLTS: Voltage Range: 0V to 200V to 750V Accuracy Required: ±.1%, ±0.35%, ±0.1% Frequency: 5 kHz to 2 kHz to 1 kHz to 100 Hz, ±0.25% DC VOLTS Voltage Range: 0 to 1000V Accuracy: ±0.025% AC CURRENT: Current Range: 0 to 1900 mA Frequency Range: 100 Hz to 1 kHz Accuracy: ±0.1% DC CURRENT: Current Range: 0 to 1900 mA Accuracy: ±0.1% RESISTANCE: Value: 100Ω Accuracy: ±0.05% Value: 1 kΩ, 10 kΩ, 100 kΩ, 1000 kΩ Accuracy: ±0.025% Value: 10 MΩ Accuracy: ±0.5%	John Fluke Model 5100B
DMM	0 to 12V dc ±.1%	John Fluke Model 8020B
Temperature Reference Monitor	0.4° C resolution at 0° C	PRINCO ASTM 56C
Thermocouple Accessory	8024B compatible	John Fluke Model Y8102 or Y8103
Vacuum Insulated Bottle	1 quart capacity minimum	Thermos
2 Hole Cork	To fit mouth of Vacuum Insulated Bottle	
Pulse Generator	Can generate 25 μsec pulses at 5V p-p	Hewlett Packard Model 8003A

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 ADJUSTMENTS

4-10. Use the following procedure to access F2 and the 8024B calibration adjustments:

1. Set the power switch to OFF.
2. Disconnect test leads and battery eliminator, if attached.
3. Remove the three phillips-head screws from the bottom of the case.
4. 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.
5. All adjustments necessary to complete the calibration procedure are now accessible (see Figure 4-1).

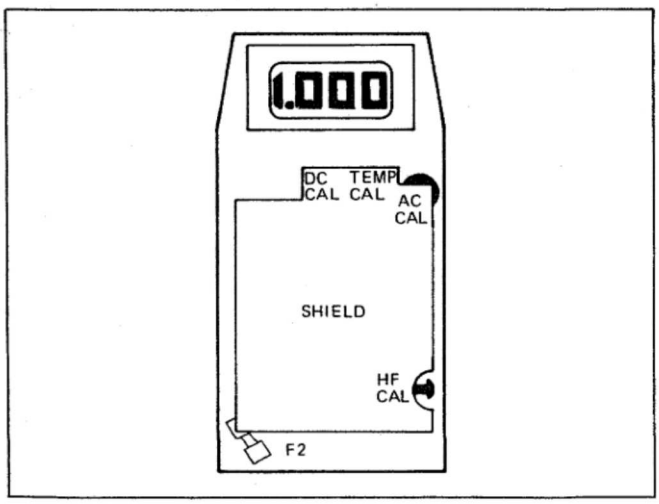


Figure 4-1. Calibration Adjustments Location

4-11. PCB

4-12. There are two PCB assemblies, Main and Switch. Use the following procedure to remove the Main PCB Assembly from the case:

1. Complete the Calibration Adjustments access procedure.

2. Remove the screw from the shield covering the assembly.

3. Using your index finger, lift up the lower right-hand corner of the pcb until it is free. Then pull the pcb to the right until it clears the shelf under the buttons.

4. Reassemble in the logical reverse order.

NOTE

When installing the pcb, route battery-clip wires behind the post on the left-hand side of the bottom case. Also make sure that the removable plastic lip located beneath the range switch pushbuttons is properly installed in the bottom case and that the green power-switch cap is 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 push the lens out of the LCD bracket.

3. Turning LCD bracket upside down gently tap into your palm, LCD shouldfall 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.

4-15. LSI (U8) ACCESS

4-16. Use the following procedure to remove/replace the a/d converter and display driver IC, U8:

1. Remove the pcb assembly using the PCB access procedure.

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

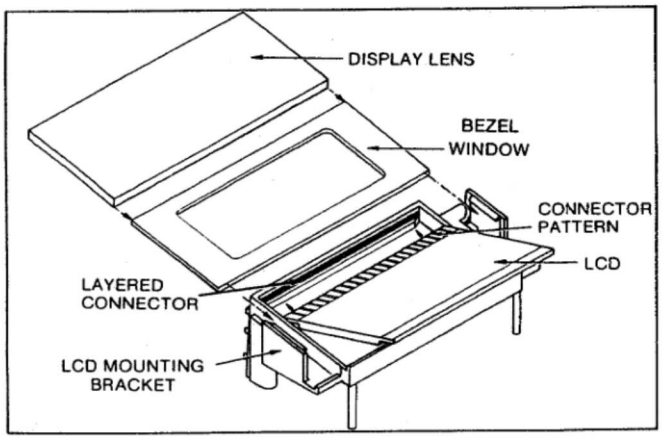


Figure 4-2. LCD Display Assembly

3. Lift the display assembly from the pcb to expose U8.

CAUTION

U8 is a MOS device and is subject to damage by static discharge. Observe the precautions given later in this section under Troubleshooting before attempting to remove or replace U8.

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

5. When installing U8 make sure all pins are lined up in the socket, and then press U8 carefully 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 come in contact with moisture. 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. Contaminants 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 PROCEDURE TO BE PERFORMED BY QUALIFIED SERVICE PERSONNEL ONLY. USE ONLY THE RECOMMENDED REPLACEMENT TYPE.

4-20. Refer to Section 2 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 tests are used to compare the 8024B 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 test, calibration adjustment and/or repair is indicated. The 8024B being tested will be referred to as the UUT (Unit Under Test).

4-23. Initial Procedure

4-24. Each of the performance tests assume that the following conditions exist:

1. The unit has been allowed to stabilize and will be tested at an ambient temperature of 23 ±5°C (73 ± 9°F).
2. The fuse and battery have been checked and, if necessary, replaced.
3. Set the UUT switches to the following positions:

POWER	ON
PEAK HOLD	OFF
All other switches	out

4-25. Display Test

4-26. Use the following procedure to verify the proper operation of all LCD indications except BT.

1. Select the Ω function and connect a short between the COMMON input terminal and the V/Ω/S input terminal. Then for each step in Table 4-2, select the range indicated and verify that the corresponding decimal point position and digit display in the table and the LCD are the same.

2. Select the DC V function, 2.0V range on the UUT.

3. Connect the equipment as shown in Figure 4-3.

Table 4-2. Display Test

STEP	SELECT RANGE	UUT DISPLAY
1	200Ω	00.0*
2	2 kΩ	.000
3	20 kΩ	0.00
4	200 kΩ	00.0
5	2000 kΩ	000
6	20 MΩ	0.00
7	200 nS	1

*One or two digits may appear if a test lead is used to connect the two terminals.

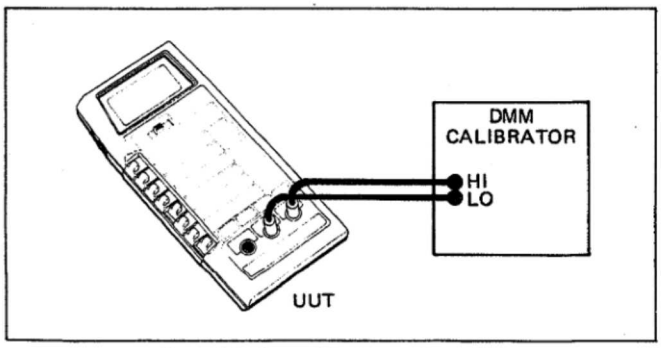


Figure 4-3. General Equipment Connection

4. Program the DMM Calibrator for a UUT input of -1.0V dc and verify that the - sign appears in the UUT display.

5. Program the DMM Calibrator for a UUT display of +1.888 and verify that all segments of each digit appear in the LCD.

6. Program the DMM Calibrator so that each possible number appears in each digit of the display (3-1/2 digit unit).

7. Program the DMM Calibrator for a UUT input of 0V dc.

8. On the UUT, depress the mA-°C-V/Ω/S switch.

9. Verify that the ▼ down arrow appears in the UUT display.

10. Program the DMM Calibrator for a UUT input of +15V dc.

11. Verify that the ▼ down arrow disappears from the UUT display and the ▲ up arrow appears in the UUT display.

4-27. Voltage Test

4-28. Use the following procedure to verify the proper operation of both the AC and DC V measurement functions:

1. Connect the equipment as shown in Figure 4-3 and release the mA-°C-V/Ω/S function switch.

2. For each step of Table 4-3 set the AC/DC switch to the indicated position, select the listed range, program the DMM Calibrator for the corresponding UUT input, and verify that the UUT displayed value is within the limits listed.

4-29. Current Test

4-30. Use the following procedure to verify the proper operation of both the AC and DC mA measurement functions:

1. Connect the equipment as shown in Figure 4-4.

2. For each step of Table 4-4 set the AC/DC switch to the indicatedposition, select the listed range, program the DMM Calibrator for the corresponding UUT input, and verify that the UUT displayed value is within the indicated limits.

4-31. Resistance/Conductance Test

4-32. Use the following procedure to verify the proper operation of both the kΩ and nS measurement functions:

1. On the UUT set the mA-°C-V/Ω/S function switch to the in position (nS).

2. Connect the equipment as shown in Figure 4-3.

3. For each step of Table 4-5 set the AC/DC switch to the indicated position, select the listed range, program the DMM Calibrator for the corresponding UUT input, and verify that the UUT displayed value is within the indicated limits.

Table 4-3. Voltage Test

STEP	UUT SWITCH POSITION		INPUT		DISPLAY LIMITS
	DC/AC	RANGE	LEVEL	FREQ.	
1	DC	200 mV	+190 mV dc	DC	189.7 to 190.3
2			−190 mV dc		−189.7 to −190.3
3		2V	1.9V dc		1.897 to 1.903
4			0.0V dc		0.001 to −0.001
5		20V	19V dc		18.97 to 19.03
6		200V	190V dc		189.7 to 190.3
7		1000V	1000V dc		998 to 1002
8	AC	200 mV	Short	—	00.0 to 00.2
9			190 mV ac rms	100 Hz	188.4 to 191.6
10				2 kHz	186.8 to 193.2
11				5 kHz	180.0 to 199.9
12		2V	1.9V ac rms	100 Hz	1.884 to 1.916
13				2 kHz	1.868 to 1.932
14				5 kHz	1.800 to 1.999
15			190 mV ac rms	5 kHz	0.175 to 0.205
16		20V	19V ac rms	100 Hz	18.84 to 19.16
17				2 kHz	18.68 to 19.32
18				5 kHz	18.00 to 19.99
19		200V	100V ac rms	100 Hz	99.0 to 101.0
20				2 kHz	98.2 to 101.8
21		750V	750V ac rms	100 Hz	740 to 760
22				1 kHz	740 to 760

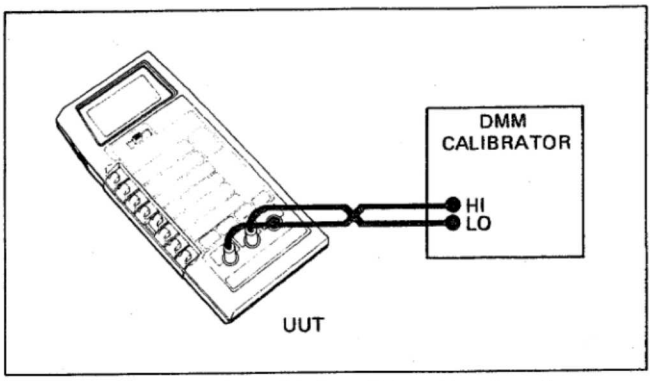


Figure 4-4. General Equipment Connection - Current

Table 4-4. Current Test

STEP	UUT SWITCH POSITION		INPUT		DISPLAY LIMITS
	AC/DC	RANGE	LEVEL	FREQ.	
1	DC	2 mA	+1.9 mA dc		+1.885 to +1.915
2		20 mA	+19 mA dc		+18.85 to +19.15
3		200 mA	+190 mA dc		+188.5 to +191.5
4			−190 mA dc		−188.5 to −191.5
5		2000 mA	+1.9A dc		+1885 to +1915
6	AC	2 mA	Short		0.000 to 0.002
7			1.9 mA ac rms	100 Hz	1.841 to 1.959
8				400 Hz	
9		20 mA	19 mA ac rms	100 Hz	18.69 to 19.31
10				1 kHz	
11		200 mA	190 mA ac rms	100 Hz	186.9 to 193.1
12				1 kHz	
13		2000 mA	1.9A ac rms	100 Hz	1869 to 1931
14				1 kHz	

Table 4-5. Resistance/Conductance Test

STEP	SELECT RANGE	INPUT	DISPLAYED VALUE SHOULD BE	
			NO LESS THAN	NO MORE THAN
1	200Ω	100Ω	99.5	100.5
2	2 kΩ	1 kΩ	0.998	1.002
3	20 kΩ	10 kΩ	9.98	10.02
4	200 kΩ	100 kΩ	99.8	100.2
5	2000 kΩ	1 MΩ	997	1003
6	20 MΩ	10 MΩ	9.79	10.21
7	200 nS	10 MΩ	97.0	103.0

4-33. Peak Hold Test

4-34. Use the following procedure to verify proper operation of the peak hold function:

1. Select the AC V function, 2V range.
2. Connect the equipment as shown in Figure 4-3.
3. Program the DMM Calibrator for a UUT input of 1.9V ac rms at 100 Hz.
4. Push the PEAK HOLD switch to the ON position and verify that the UUT display is between 1.833 and 1.967, ±(3% of rdg + 10 digits).
5. Program the DMM Calibrator for an output of 1.0 mV ac rms at 100 Hz.
6. Verify that the UUT display changes less than 10 digits in 10 seconds.
7. Push the PEAK HOLD switch to the OFF position.

4-35. Continuity Test

4-36. 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/S terminals.
3. When the test leads are open circuited, the ▲ up arrow will be displayed.
4. Short the test leads together and observe that the ▲ up arrow disappears and the ▼ down arrow is displayed.

5. Depress the AC/DC switch to activate the audible tone.

6. Momentarily short the test leads together and observe that the tone sounds coincident with the ▼ down arrow. The ▲ up arrow may or may not be displayed, depending on the duration of the short.

4-37. Level Detector Test

4-38. Use the following procedure to verify the proper operation of the level detector function:

1. Select the Ω functions, 200 kΩ range.

2. Program the pulse generator for a single pulse that is greater than 50 usec wide and 0 to 3V ±0.5% in amplitude.

3. Connect the pulse generator to the UUT: + to the V/Ω/S terminal and - to the COMMON terminal.

4. Cause the pulse generator to output single pulses and verify that the ▲ up arrow appears momentarily in the LCD of the UUT for each single pulse.

5. On the UUT depress the AC/DC switch to enable the audible tone. The audible tone should be on continuously.

6. Cause the pulse generator to output 500 ms pulses and verify that the ▲ up arrow appears in the LCD and the audible tone stops for each pulse.

7. Release the AC/DC switch to disable the audible tone. The ▼ down arrow should appear in the UUT display.

4-39. BT Test

4-40. Complete the following procedure to verify that the BT indicator appears on the LCD at the correct battery level, and that the accuracy of the UTT remains unaffected at this battery voltage level:

1. Connect the equipment as shown in Figure 4-5.

2. Set the UUT switches to the following positions:

200 mV	in
AC/DC	DC (out)

3. Set the DMM controls to the following positions:

20V	in
AC/DC	DC

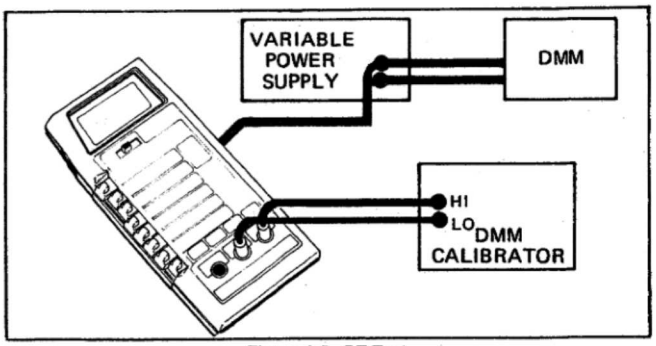


Figure 4-5. BT Test

4. Program the DMM Calibrator for a UUT input of 190.0 mV dc.

5. Adjust the variable power supply for 6.4V dc and adjust R33 until "BT" appears.

6. Re-adjust the power supply for 8V dc and verify that the "BT" extinguishes.

NOTE

The 8024V should draw no more than 2 mA ±.2 mA battery current in this test.

7. Decrease the output of the power supply to +6.0V.

8. Verify that the UUT display is between 189.8 and 190.2 mV dc.

9. Select the 2 kΩ range on the UUT.

10. Program the DMM Calibrator for an input of 1.0 kΩ.

NOTE

The 8024B should draw no more than 4 mA ±.4 mA.

11. Adjust the variable supply for +10V.

12. Verify that the UUT display is between .998 and 1.002 kΩ.

13. Adjust the variable supply for +6V.

14. Verify that the UUT display is between .998 and 1.002 kΩ.

4-41. Temperature Test

WARNING

DO NOT PERFORM THIS PROCEDURE IF THE TIP OF THE THEROMOCOUPLE ACCESSORY HAS BEEN EXPOSED TO TOXIC MATERIALS. INSTEAD USE THE ALTERNATE PROCEDURE DESCRIBED IN THE FOLLOWING CALIBRATION ADJUSTMENTS PROCEDURE.

4-42. The following procedure takes advantage of the inherent stability of human body temperature to verify proper operation of the °C temperature function. If there is any doubt about this procedure, if the thermocouple tip has been exposed to toxic materials, or if extremeaccuracy of measurement is desired, use (as a reference) the lag bath described in the °C Adjustment procedure in the following Calibration portion of this section.

1. Depress the TEMP °C range switch and release the Ω/S switch on the UUT.

2. Connect the John Fluke thermocouple accessory to the UUT.

3. Wipe the tip of the thermocouple accessory clean and place the tip between your thumb and index finger until the UUT display readings stabilize.

NOTE

Normal body temperature of humans is 37° C (98.6° F).

4. Verify that the UUT display is between 34 and 39°C.

4-43. CALIBRATION ADJUSTMENTS

4-44. Under normal operating conditions the 8024B should be calibrated once every two years to maintain the specifications given in Section 1 of this manual. If your 8024B has been repaired or if your 8024B has failed any of the Performance Tests, immediate calibration is indicated. Test equipment needed for the calibration adjustment is listed in Table 4-1. If the test equipment is not available, your nearest John Fluke Service Center will be glad to help. A list of these centers is given in Section 5 of this manual. For verification, complete the Performance Tests after the calibration adjustments are made. The 8024B being calibrated will be referred to as the UUT (Unit Under Test).

4-45. Use the following procedure to perform the calibration adjustments:

1. Allow the UUT to stabilize for at least 30 minutes at an ambient temperature of 21°C to 25°C (70°F to 77°F).

2. Complete the calibration access procedure presented earlier in this section.

3. Select the DC V function, 200 mV range on the UUT.

4. Connect the equipment as shown in Figure 4-3.

5. Program the DMM Calibrator for a UUT input of +190.0 mV dc.

6. Adjust the DC CAL (R6) for a UUT display of exactly 190.0.

7. Connect a jumper across Q10.

8. Push the PEAK HOLD switch to the ON position.

9. Adjust R17 (Peak Hold offset) for a UUT display of exactly 190.0.

10. Remove the jumper from across Q10.

11. Push the PEAK HOLD switch to the OFF position.

12. Connect the equipment as shown in Figure 4-3.

13. On the UUT, depress the AC/DC switch.

14. Program the DMM Calibrator for a UUT input of 190.0 mV ac rms at 100 Hz.

15. Adjust the AC CAL (R4) for a UUT display of exactly 190.0.

16. On the UUT, depress the 2V range.

17. Program the DMM Calibrator for a UUT input of 1.9V ac rms at 5 kHz.

18. Adjust the HF CAL (C1) for a UUT display between 1.805 and 1.995.

19. Establish a lag bath (ice point environment) as shown in Figure 4-6 and allow the lag bath to sit for 30 minutes to reach thermal equilibrium.

20. Connect the Thermocouple Accessory to the UUT.

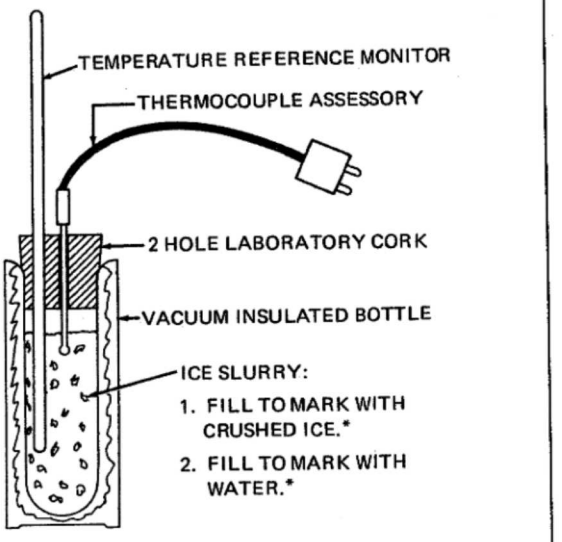
21. Adjust the TEMP CAL (R10) for a UUT display the same as the Temperature Reference Monitor reading.

4-46. TROUBLESHOOTING

CAUTION

Static discharge can damage MOS components contained in the 8024B. Avoid instrument damage by complying with the precautions on the Static Awareness sheet when troubleshooting or repairing the 8024B.

4-47. Never remove, install, or otherwise connect or disconnect components without first turning the 8024B POWER switch to OFF. Table 4-6 is a troubleshooting guide for the 8024B. To properly use the guide, complete the performance tests 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 diagrams in Section 7.



*Both the ice and the water for the ice slurry should be either distilled water or Reagent Grade II DI water.

Figure 4-6. Lag Bath

Table 4-6. Troubleshooting Guide

TEST AND SYMPTOM	POSSIBLE CAUSE
INITIAL PROCEDURE	
BT is displayed when unit is turned on (see BT procedure also). Note, BT will normally be displayed for some line voltages when the A81 line eliminator accessory is used.	Low battery voltage, U18C, U7, U8
Display blank.	Dead battery, POWER switch (S9), VR2 shorted, U8, J5A
DISPLAY TEST	
One or more segments will not light through entire test.	Display interconnection, Display (U9) U8
Decade inoperative or one or more segments always lit.	U8
Improper decimal point indication.	Check signals at U7. Are they OK? YES: Display (U9). NO: Range switches or interconnect.
Minus sign improperly displayed.	U8
Display lit but does not respond to changes in input.	PEAK HOLD switch is at the ON position (if you pushed toward the left to set the PEAK HOLD switch to the OFF position, the switch is still at the ON position), VR1, U8, Y1, C6 shorted, or interconnect.
VOLTAGE TEST	
DC: Display reading is out of tolerance on 200 mV range.	DC CAL (R6) out of calibration, VR1 U5, U8, S8
Display readings out of tolerance on all ranges except 200 mV.	U1, U2, U3
AC: Display reading out-of tolerance on the 2V range with 1.9V ac rms, 5 kHz, input.	AC CAL (R4) out of calibration, AC Converter
Display readings out of tolerance on all ranges except the 200 mV range.	U1

Table 4-6. Troubleshooting Guide (cont)

TEST AND SYMPTOM	POSSIBLE CAUSE
PEAK HOLD TEST	
Value does not appear in the display.	U19, (U14, Q10), C5, C6
Value decays too fast.	U19, C19, U14, Q10
LEVEL DETECTOR TEST	
UP arrow doesn't appear and audible tone doesn't sound when the input is low.	U21, U17, U16, U10, U9, or interconnect.
Down arrow doesn't appear and audible tone doesn't sound when the input is low.	Ω switch (S1E), U21, U17, U16 S8B, or interconnect, U10, U9, LS1 U18 Q8
Down arrow appears, but tone doesn't sound when input is low.	AC/DC switch (S8B), U10, Q8, U18A, LS1
CURRENT TEST	
Input does not affect display.	F1, F2, CR1, CR2
Displayed reading is out of tolerance on one or more ranges..	If 2000 mA and 200 mA ranges are OK, U2 is defective. Otherwise, U3 is defective.
°C TEST	
Display reading out of tolerance.	TEMP COMPENSATION (R10) out of calibration. Room temp should be displayed if °C input and common are shorted together. Check also fuse and battery connector.

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