BECKMAN

TECH 300, TECH 310, and TECH 330

Digital Multimeters

Beckman Instructions 3000-940-100-B

BECKMAN

TECH 300, TECH 310, AND TECH 330 DIGITAL MULTIMETERS OPERATOR'S MANUAL

BECKMAN INSTRUMENTS, INC. • ADVANCED ELECTRO-PRODUCTS DIVISION • FULLERTON, CALIFORNIA

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WARRANTY

ONE-YEAR LIMITED WARRANTY

The Series 300 Digital Multimeter is warranted in its entirety against any defects of material or workmanship which develop for any reason whatsoever, except abuse, within a period of one (1) year following the date of purchase of the Multimeter by the original purchaser. This warranty is extended by Beckman Instruments, Inc. (Beckman), only to the original purchaser or original user of the Multimeter, who must, as a CONDITION PRECEDENT TO WARRANTY COVERAGE AND PERFORMANCE THEREUNDER BY BECKMAN, complete and return the Warranty Registration Card, received on purchase of the Multimeter.

In the event a defect develops during the warranty period, Beckman will, at Beckman's election, repair or replace the Multimeter with a new or reconditioned model of equivalent quality. In order to obtain performance of any obligation of Beckman under the warranty, the original purchaser or original user must return the defective Multimeter, postage prepaid, along with a handling charge of $3.00* to:

Beckman Instruments, Inc.
2550 Harbor Boulevard
Fullerton, CA 92634
Attention: Customer Service

or to any other Beckman Service Center.

In the event of replacement with a new or reconditioned model, the replacement unit will continue the warranty period of the original Multimeter. Replacement units will be returned by air, typically with only one (1) working day turnaround at the Service Center.

ANY IMPLIED WARRANTIES ARISING OUT OF THE SALE OF THE SERIES 300 MULTIMETER, INCLUDING BUT NOT LIMITED TO IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE LIMITED IN DURATION TO THE ABOVE-STATED ONE (1) YEAR PERIOD. BECKMAN SHALL NOT BE LIABLE FOR LOSS OF USE OF THE MULTIMETER OR OTHER INCIDENTAL OR CONSEQUENTIAL DAMAGES, EXPENSES, OR ECONOMIC LOSS OR FOR ANY CLAIM OR CLAIMS FOR SUCH DAMAGE, EXPENSES OR ECONOMIC LOSS.

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This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

*Prices subject to change without notice.

BECKMAN INSTRUMENTS, INC.
Fullerton, California

Dear Customer:

Congratulations on the purchase of your new Beckman Digital Multimeter! Beckman Instruments, Inc., a leading international manufacturer of laboratory analytical instruments, process instruments and precision components, has extended its knowledge and skills into the production of the Series 300 Digital Multimeter. Because of the time and care taken in the design and manufacture of your Multimeter, we are sure that you will enjoy the use of it for many years to come.

Beckman Instruments, Inc.

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SECTION ONE — INTRODUCTION

The Series 300 Digital Multimeters are completely portable, hand-held 3½-digit multimeters designed for use by the engineer, technician, and hobbyist who demands an instrument that is accurate, reliable, and always ready for use. Equipped with seven functions and 29 ranges (27 ranges on the TECH 300); each test position is quickly and easily selected with a simple turn of the single selector switch. Small enough to fit in most attache cases and equipped with a multi-position tilt stand, these instruments are equally suited for design engineering, production testing, field servicing, and industrial maintenance applications.

In addition to the features described above, the TECH 310 and TECH 330 offer two particularly useful, yet uncommon digital multimeter features—Insta-Ohms™ Quick Continuity Indicator and 10-ampere AC/DC current measurement capability. With Insta-Ohms, circuit shorts can be traced and other continuity checks can be made more quickly and easily than ever before with a digital multimeter! It also can be used for troubleshooting small-value capacitors.

The TECH 330 has the added capability of measuring both ac voltage and current in true rms. True rms permits accurate measurement of even the nonsinusoidal waveforms typically found in switching power supplies, motor speed controllers, SCR regulators, and digital systems. The direct-coupled inputs of the RMS 3030 permit direct measurement of the total (ac + dc) rms value of complex or simple ac waveforms.

The TECH 300, the TECH 310, and the TECH 330 include all of the following features as standard:

SUPERIOR RELIABILITY

To ensure high instrument reliability, Beckman designed a custom CMOS large-scale integrated circuit to eliminate most discrete components. Since all active multimeter functions are performed by this one integrated circuit, the total number of electronic parts in each instrument has been reduced to less than 40 (less than 50 in the TECH 330) —far fewer than in comparable multimeters. Reliability is further enhanced by 100 percent burn-in of each instrument and complete factory test of every function and range.

GUARANTEED LONG-TERM ACCURACY

Specified accuracies are guaranteed for a full year with a single calibration adjustment on the TECH 300 and TECH 310, and only four adjustments on the Tech 330. Long term accuracy is assured through the use of an extremely stable band-gap reference element and Beckman thin-film resistor networks.

RUGGEDNESS

Beckman Multimeters are designed to give years of trouble-free operation under heavy duty use. The instruments can even take a 6-foot fall and still come up working, and still meet specified accuracies. The display and single rotary switch are both recessed to prevent damage while in a tool box or on the job. The case has been designed to keep out dirt, dust, and fluid contaminants that can cause malfunctions in other multimeters.

OVERLOAD PROTECTION

All inputs are protected against continuous overload conditions that may result from the measurement of unknown signals or from operator error. Also all voltages and resistance ranges are protected against voltage transients up to 6kV.

EASE OF USE

Human engineered in every way to make the instruments easy to use, a single switch turns on power, and selects both function and the desired range. The Liquid Crystal Display (LCD) is easy to read both indoors and outdoors — even in direct sunlight.

IN-CIRCUIT RESISTANCE MEASUREMENTS

All resistance ranges are low-power ohms which allow accurate measurements of in-circuit resistance. Because test voltages are held to less than 250mV, accurate measurements may be made even in circuits where resistors are directly shunted by typical silicon diodes and transistors.

DIODE TEST FUNCTION

A special diode test function allows accurate measurements of forward voltage drops across diodes and transistor junctions, even in circuits where semiconductors are shunted directly by resistors.

BATTERY LIFE

One standard 9-volt transistor battery provides up to *2000* hours of continuous instrument operation. Under typical use, a battery should last two years.

LOW BATTERY INDICATOR

The decimal point begins to blink when approximately 200 hours of battery life remains.

VERSATILE

Perfect for field, lab, or home use. Small, lightweight, and completely portable. It has a handy tilt bail for easy positioning and anti-skid pads to keep it in place.

COMPLETE AND READY TO USE

Instruments are shipped with battery and fuse installed. Just remove it from the box and it is ready to use. Also included with each instrument is a spare fuse, test leads, and a complete operator's manual.

1.1 TECH 300

The TECH 300 has all of the features just described and is capable of making current measurements up to 2 amperes. It has an accuracy of ±0.5% of reading in dc volts.

1.2 TECH 310

The TECH 310 has all of the features just described, including the Insta-Ohms Quick Continuity Indicator and 10- ampere current range. The accuracy of the TECH 310 is ±0.25% of reading in dc volts.

1.3 TECH 330

The TECH 330 has all the features just described, including the Insta-Ohms Quick Continuity test function and 10 ampere current ranges plus the capability of measuring ac signals in true rms, and has an accuracy of ±0.1% of reading in dc volts.

NOTE

The symbol ⚠ on the front panel of the instrument is an international symbol meaning "REFER TO OPERATING INSTRUCTIONS." Warnings and precautions to avoid personal injury and instrument damage are listed in Paragraph 4.1.

Specifications are subject to change without notice.

2.1 GENERAL

The following specifications apply to the TECH 300, the TECH 310, and the TECH 330.

OPERATING TEMPERATURE RANGE
0°C to +50°C.

STORAGE TEMPERATURE RANGE
−40°C to +65°C with battery removed.

DISPLAY
3½-digit liquid crystal display (LCD) with a maximum reading of 1999.

POWER
Single, standard 9-volt transistor battery, NEDA 1604.

BATTERY LIFE
Alkaline: 2000 continuous hours, nominal.
Zinc-Carbon: 1600 continuous hours, nominal.
Under typical usage, 2 years.

LOW BATTERY INDICATOR
Decimal point blinks when 200 hours battery life remain.

SHOCK AND VIBRATION
Meets MIL-T-28800 Specifications.

RELATIVE HUMIDITY
0% to 80%, 0°C to 35°C; 0% to 70%, 35°C to 50°C.

TEMPERATURE COEFFICIENT (0°C to 20°C, 30°C to 50°C)
Less than 15% of applicable accuracy specifications per °C.

MAXIMUM COMMON-MODE VOLTAGE
1500Vdc or peak ac.

DIMENSIONS
6.85 inches (17.4cm) long x 3.65 inches (9.3cm) wide x 1.8 inches (4.6cm) high.

WEIGHT
16 ounces (453 grams) including battery.

CALIBRATION
Accuracy specifications guaranteed for one (1) year, 20°C to 30°C.

MEASUREMENT RATE
Four measurements per second nominal.

CASE
High-impact ABS plastic, recessed switch and display.

INSTRUMENT INCLUDES:
1. 9-volt battery.
2. Spare fuse.
3. Safety test leads.
4. Operator's manual.

2.2 DC VOLTS

The following specifications apply to the TECH 300, the TECH 310, and the TECH 330 unless otherwise indicated.

GENERAL
Automatic polarity indication (+ and − indicated).

		ACCURACY (1 YEAR, 20°C to 30°C)		
RANGE	RESOLUTION	TECH 300	TECH 310	TECH 330
±200mV ±2V ±20V ±200V ±1500V	100μV 1mV 10mV 0.1V 1V	±(0.5% reading + 1 digit)	±(0.25% reading + 1 digit)	±(0.1% reading + 1 digit)

INPUT IMPEDANCE (ALL RANGES)
22MΩ.

NORMAL-MODE REJECTION
Greater than 60dB above 49Hz.

COMMON-MODE REJECTION
Greater than 160dB up to 1500Vdc.

RESPONSE TIME
Less than 1 second.

OVERVOLTAGE PROTECTION
1500Vdc or peak ac, any range.

2.3 AC VOLTS

The following specifications apply to the TECH 300, the TECH 310, and the TECH 330 unless otherwise indicated.

TECH 300

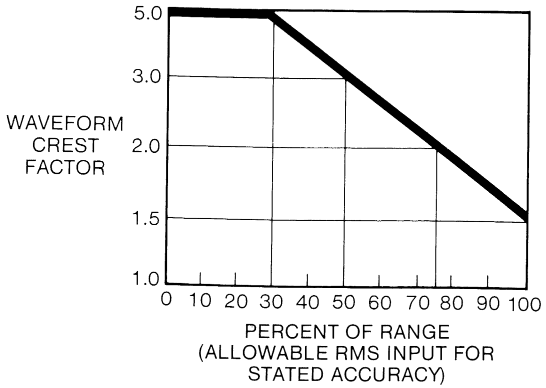
		ACCURACY (1 YEAR, 20°C to 30°C)		
RANGE	RESOLUTION	45Hz to 2kHz	2kHz to 5kHz	5kHz to 10kHz
200mV 2V 20V 200V 1000V	100μV 1mV 10mV 0.1V 1V	±(1.5% reading + 4 digits)	±(2.0% reading + 5 digits)	±(3.0% reading + 9 digits)

TECH 310

		ACCURACY (1 YEAR, 20°C to 30°C)		
RANGE	RESOLUTION	45Hz to 2kHz	2kHz to 5kHz	5kHz to 10kHz
200mV 2V 20V 200V 1000V	100μV 1mV 10mV 0.1V 1V	±(0.75% reading + 3 digits)	±(1.5% reading + 5 digits)	±(2.5% reading + 9 digits)

TECH 330		ACCURACY (1 YEAR, 20°C to 30°C)				
RANGE	RESOLUTION	45Hz to 2kHz	2kHz to 5kHz	5kHz to 10kHz	10kHz to 20kHz	20kHz to 40kHz
200mV 2V 20V 200V 1000V	100μV 1mV 10mV 0.1V 1V	±(0.8% reading + 3 digits)	±(1.0% reading + 4 digits)	±(1.5% reading + 5 digits)	±(2% reading + 7 digits)	±(5% reading + 15 digits) Not Specified

EXTENDED FREQUENCY RESPONSE (RMS 3030)
Typically, ±3dB at 100kHz
CREST FACTOR (TECH 330)
Allowable crest factor (peak/rms ratio) varies from 1.0 to 5.0.



CONVERSION TECHNIQUE
TECH 300 and TECH 310: Average sensing, calibrated to display rms value of sine wave.
TECH 330: True rms responding (ac + dc).

INPUT IMPEDANCE (ALL RANGES)
2.2 megohms, shunted by less than 75pF.

RESPONSE TIME
Less than 2 seconds. (On TECH 330, above 10% of full-scale.)

OVERVOLTAGE PROTECTION
TECH 300 and TECH 310: 1000Vrms ac (1500V peak) or 250Vdc (5 seconds maximum above 450Vrms on 200mV range).
TECH 330: 1000Vrms ac (1500V peak) or 1500Vdc (200mV range, 500Vrms or dc maximum).

2.4 DC CURRENT

The following specifications apply to the TECH 300, the TECH 310, and the TECH 330 unless otherwise indicated.

GENERAL
Automatic polarity indication (+ and − indicated).

		ACCURACY (1 YEAR, 20°C to 30°C)		
RANGE	RESOLUTION	TECH 300	TECH 310	TECH 330
±200µA	100nA			
±2mA	1µA	±(1.0% reading + 1 digit)	±(0.75% reading + 1 digit)	±(0.35% reading + 1 digit)
±20mA	10µA			
±200mA	100µA			
±2A	1mA			
±10A* (TECH 330, 310 only)	10mA		±(1.5% reading + 1 digit)	±(1.0% reading + 1 digit)

*Continuous measurements up to 10 amperes, 30 seconds maximum from 10 to 19.99 amperes.

RESPONSE TIME
Less than 1 second.

VOLTAGE BURDEN
200µA to 200mA ranges: 250mV maximum at fullscale.
2A and 10A ranges: 700mV maximum at fullscale.

OVERCURRENT PROTECTION — A INPUT
2 amperes, 250V (fused).

OVERCURRENT PROTECTION — 10A INPUT
(TECH 310 and TECH 330 only).
Up to 20 amperes for 30 seconds (unfused).

2.5 AC CURRENT

The following specifications apply to the TECH 300, the TECH 310, and the TECH 330 unless otherwise indicated.

CONVERSION TECHNIQUE
TECH 300 and TECH 310:
Average sensing, calibrated to display rms value of sine wave.
TECH 330: True rms responding (ac + dc).

RESPONSE TIME
Less than 2 seconds (on TECH 330, above 10% of fullscale).

VOLTAGE BURDEN
200µA to 200mA ranges: 250mV maximum at fullscale.
2A and 10A ranges: 700mV maximum at fullscale.

OVERCURRENT PROTECTION — A INPUT
2 amperes, 250V (fused).

OVERCURRENT PROTECTION — 10A INPUT
(TECH 310 and TECH 330 only.)
Up to 20 amperes for 30 seconds (unfused).

		ACCURACY (1 YEAR, 20°C to 30°C)						
		45Hz to 400Hz			400Hz to 2kHz			2kHz to 5kHz
RANGE	RESOLUTION	TECH 300	TECH 310	TECH 330	TECH 300	TECH 310	TECH 330	TECH 330
200µA	100nA	±(2.0% reading + 4 digits)	±(1.5% reading + 3 digits)	±(0.9% reading + 3 digits)	±(2.0% reading +3 digits)	±(1.5% reading +3 digits)	±(0.9% reading + 3 digits)	±(1.5% reading +3 digits)
2mA	1µA							
20mA	10µA							
200mA	100µA							
2A	1mA							
10A* (TECH 330, 310 only)	10mA		±(2.0% reading + 3 digits)	±(1.5% reading + 3 digits)				

*Continuous measurements up to 10 amperes, 30 seconds maximum from 10 to 19.99 amperes

2.6 RESISTANCE

The following specifications apply to the TECH 300, the TECH 310, and the TECH 330 unless otherwise indicated.

GENERAL
Low-power ohms on all ranges, no need for zero adjustment.

			ACCURACY (20°C to 30°C)		
RANGE	RESOLUTION	MAX. TEST CURRENT	TECH 300	TECH 310	TECH 330
200Ω	0.1Ω	2.5mA	±(0.75% reading + 1 digit)	±(0.5% reading + 1 digit)	±(0.2% reading + 1 digit)
2kΩ	1Ω	250µA			
20kΩ	10Ω	25µA			
200kΩ	100Ω	2.5µA			
2MΩ	1000Ω	250nA	±(1.5% reading + 1 digit)		±(1.0% reading + 1 digit)
20MΩ	10kΩ	25nA			

MAXIMUM OPEN CIRCUIT VOLTAGE
0.5V, all ranges.

MAXIMUM IN-RANGE VOLTAGE (Low-Power Ohms)
250mV, all ranges.

RESPONSE TIME
Less than 1 second, except on 20MΩ range, less than 4 seconds.

OVERLOAD PROTECTION
300Vdc or rms ac, any range.

2.7 DIODE TEST

The following specifications apply to the TECH 300, the TECH 310, and the TECH 330 unless otherwise indicated.

RANGE
0V to 2V.

RESOLUTION
1mV.

ACCURACY
TECH 300: ±(0.5% reading + 2 digits).
TECH 310: ±(0.25% reading + 2 digits).
TECH 330: ±(0.1% reading + 2 digits).

ACCURACY CONDITIONS
1 year, 20°C to 30°C.

TEST CURRENT
5mA ±10%.

RESPONSE TIME
Less than 1 second.

OVERLOAD PROTECTION
300Vdc or rms ac.

2.8 INSTA-OHMS QUICK CONTINUITY INDICATOR (TECH 310 and TECH 330 Only)

RESPONSE TIME
Less than 100 milliseconds.

SECTION THREE PREPARATION FOR USE

This section contains paragraphs that describe the following: unpacking and inspection; installation; controls, indicators, and connectors; and initial checkout procedure.

3.1 UNPACKING AND INSPECTION

Remove the Multimeter from the shipping container. The box should contain the following items:

1. Multimeter
2. Test lead set (one black, one red)
3. Operator's manual for TECH 300, TECH 310, and TECH 330 instruments
4. Nine-volt battery (installed).
5. Two fuses (one installed and one spare inside the case). To gain access to inside of instrument, see Paragraph 6.2.3.

Account for and inspect all of the above items. If any of the items are damaged or are missing, *immediately return the complete package to the place of purchase for an exchange.*

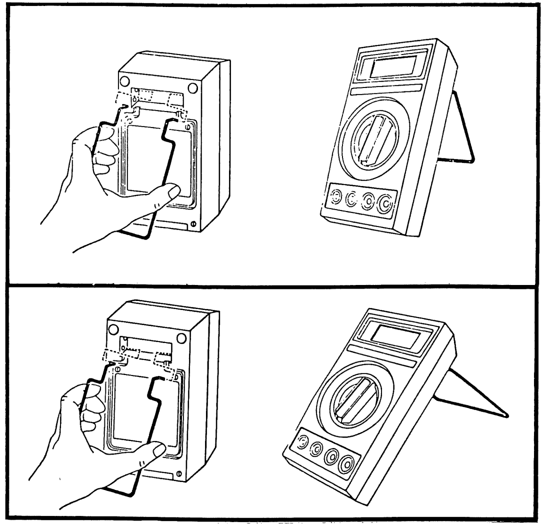
NOTE
Retain the shipping container for use if instrument must be returned for exchange or repair.

3.2 INSTALLATION

The Multimeter is shipped ready for use. The only action required by the user is to place the tilt bail in the desired position. Figure 1 shows the various positions that the tilt bail may be placed in. The tilt bail is moved from one position to another by squeezing the two sides of the bail together and then reinserting the tips in the desired positions.

3.3 INSTRUMENT FAMILIARIZATION

It is HIGHLY RECOMMENDED that the user become familiar with the controls, indicators, and connectors of the Multimeter shown and described in Figure 2 before operating the device.



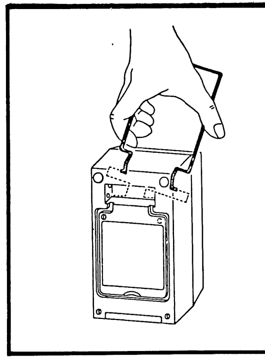


Figure 1. Positioning the Tilt Bail

1. Digital Display
   A 3½-digit LCD readout (maximum reading 1999) with automatic decimal point placement, automatic polarity indication, overrange indication, low battery indication (blinking decimal point) and on TECH 310 and TECH 330, the InstaOhm Quick Continuity Indicator (Ω). Indicates measured input value in volts, amperes, or ohms as selected by the Function/Range Switch.
2. Function/Range Switch
   This is the only control on the Multimeter and greatly simplifies the operation of the instrument. The one switch turns the instrument off and on, selects the function, and selects the desired range. Six functions can be selected by directing the pointer on the center bar to: DCV, ACV, DCA, ACA, Ω (ohms), or Diode Test (diode symbol).
   The DCV function provides 5 ranges from 200mV to 1500 volts dc. The ACV function provides 5 ranges from 200mV to 1000 volts rms ac. The DCA and ACA functions each provide five ranges of current measurements from 200μA to 2A fullscale. On the TECH 310 the $\frac{20m}{10A}$ positions in the DCA and ACA functions serve two purposes. When using the "A" Input

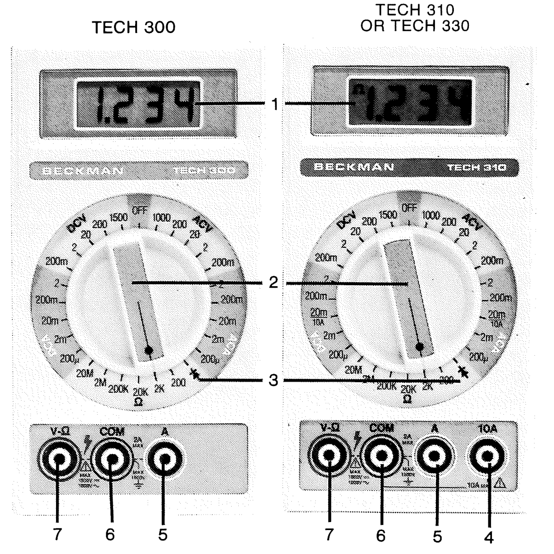


Figure 2. Operating Controls, Indicators and Connectors

Connector, the $\frac{20m}{10A}$ position serves as the 20mA range. When using the "10A" Input Connector, the $\frac{20m}{10A}$ position serves as the 10A range. The TECH 310 thus provides a total of six current ranges for both dc and ac current. The (Ω) function provides six ranges of resistance measurements from 200Ω to 20MΩ. The continuity test function operates in any resistance range of the TECH 310 or the TECH 330.

3. Diode Test Function
   Diode test position is used for checking diodes and other semiconductor junctions.
4. 10A Input Connector (TECH 310 and TECH 330 Only)
   Banana jack connector used for continuous current meaurements from 0 to 10A. Measurements between 10 and 20 amperes for a duration of 30 seconds maximum also may be made using this terminal. Inputs beyond this maximum may cause damage to the instrument.
5. A Input Connector
   Banana jack connector used for current measurements up to 2 amperes. The instrument is protected by a fuse against inputs over 2 amperes.
6. COM Input Connector (Black)
   Banana jack connector used as the common or low input for all measurements.
7. V·Ω Input Connector
   Banana jack connector used as the high input for all voltage and resistance measurements.

3.4 INITIAL CHECKOUT

Before placing the Multimeter into use, a simple checkout procedure will ensure that the device is working properly. The only equipment required is the test leads.

1. Be certain that battery and fuse are installed properly, see Paragraphs 6.2.2 and 6.2.3.
2. Connect the red test lead to the V·Ω Input Connector and the black test lead to the COM Input Connector.
3. Place the Function/Range Switch in the 1500 DCV position.
4. Touch the red test lead and black test lead together. Observe the Digital Display; it should read 000 ±1.
5. Turn the Function/Range Switch counterclockwise to each DCV position while observing the Digital Display. With the test lead tips in contact, the Digital Display should read zero plus or minus one digit and the decimal point positioned as follows:

200V	00.0
20V	0.00
2V	.000
200mV	00.0

6. Turn the Function/Range Switch to the 20MΩ position. With the two test lead tips separated, the Digital Display should read OL (overload).
7. Touch the test lead tips together and observe the Digital Display; it should read 0.00 or 0.01.
8. Turn the Function/Range Switch to each Ω position while observing the Digital Display. With the test lead tips in contact, the Digital Display should read zero in each position. In the 200Ω position, the Digital Display may read 000.1 or 000.2 because of test lead resistance. The decimal point should be positioned as follows:

20MΩ	0.00
2MΩ	.000
200kΩ	00.0
20kΩ	0.00
2KΩ	.000
200Ω	00.0

9. Turn the Function/Range Switch to the 1000 ACV position.

WARNING

The next step requires the measurement of the local ac line (mains) voltage. Be careful not to touch the test lead tips with fingers and do not allow the tips to contact each other.

10. Measure the local line (mains) voltage at a convenient ac power outlet. The Digital Display should show the appropriate voltage with a resolution of one volt.
11. Remove both probes from the ac outlet.
12. If the instrument has performed properly during this checkout procedure, it is fully operational and ready to use.

NOTE

When using the 10A Input Connector for current measurements, the test lead jack must be ***fully*** *depressed into the input connector. This engages a microswitch which enables the 10-ampere current shunt.*

SECTION FOUR — OPERATING INSTRUCTIONS

This section of the manual describes the various operating modes of the Multimeters as well as a summary of warnings and precautions.

4.1 WARNINGS AND PRECAUTIONS

The following warnings and precautions are mentioned to protect the user from injury and the instrument from damage.

4.1.1 WARNINGS

1. *Use extreme caution when working near high voltage sources. This includes any voltage measurements requiring the use of 200Vac, 1000Vac, 200Vdc, and 1500Vdc Ranges.*
2. *To avoid electrical shock hazard and/or damage to the instrument, do not measure voltages that might exceed 1500 volts above earth ground.*
3. *During current measurements using the A input connector, operator injury or damage to the instrument may occur if the fuse blows in a circuit which exhibits an open circuit voltage greater than 250 volts.*
4. *Before each instrument use, inspect test leads, connectors, and prods for cracks, breaks, or crazes in the insulation. If any defects are found, replace item immediately.*
5. *To avoid electrical shock hazard, do not touch test lead tips, or the circuit being tested, while power is applied to the circuit.*

4.1.2 PRECAUTIONS

1. Exceeding the maximum input overload limits can damage the Multimeter.
2. When making current measurements, make sure that the Multimeter is connected in series with the load in which the current is to be measured. NEVER connect the Multimeter ACROSS a voltage source. If this is done, it may either blow the overload protection fuse or damage the device being tested.

4.2 OVERLOAD INDICATION

The Multimeters are equipped with automatic overload protection. This means that whenever an input signal is larger than the range selected, an overload symbol (OL) will appear in the Digital Display, see Figure 6. This feature allows the user to test devices with unknown circuitry where an overload condition might exist. See Section Five for a complete description of overload protection.

4.3 VOLTAGE MEASUREMENTS

4.3.1 DC VOLTAGE

1. Connect red test lead to V·Ω Input Connector and black test lead to COM Input Connector.
2. Set Function/Range Switch to desired DCV position. If magnitude of voltage is not known, set switch to highest range and reduce until satisfactory reading is obtained.
3. Turn off power to device or circuit being tested and discharge all capacitors.

WARNING

To avoid electrical shock hazard and/or damage to the instrument, do not attempt to measure voltages that might exceed 1500 volts.

4. Connect test leads to device or circuit being measured.
5. Turn on power to device or circuit being measured. Voltage value will appear on Digital Display along with the voltage polarity.
6. Turn off power to device or circuit being tested and discharge all capacitors before disconnecting test leads from device or circuit being tested.

4.3.2 AC VOLTAGE

1. Connect red test lead to V·Ω Input Connector and black test lead to COM Input Connector.
2. Set Function/Range Switch to desired ACV position. If magnitude of voltage is not known, set switch to highest range and reduce until satisfactory reading is obtained.
3. Turn off power to device or circuit being tested and discharge all capacitors.

WARNING

To avoid electrical shock hazard and/or damage to instrument, do not attempt to measure voltage that might exceed 1000 volts rms or 1500 volts peak ac.

4. Connect test leads to device or circuit being measured.
5. Turn on power to device or circuit being measured. Voltage value will appear on Digital Display.
6. Turn off power to device or circuit being tested and discharge all capacitors before disconnecting test leads from device or circuit being tested.

4.3.3 TRUE RMS MEASUREMENTS (TECH 330)

The TECH 330 permits the direct measurement of the total rms (ac + dc) value of a signal. This is particularly useful in measuring the output of power-control circuits and switching power supplies. Occasionally, however, one may want to know only the ac component, such as in measuring the ripple on a power supply output. This can be accomplished by placing a capacitor (0.047μF to 0.22μF) in series with the test leads to block the dc component of the signal. The capacitor should have a voltage rating exceeding the magnitude of the dc voltage to be blocked. Selection of an appropriate ACV range then gives a direct reading of the signals rms ac component.

4.3.4 APPLICATION NOTE

Understanding the ac conversion process in your Multimeter will help you to more fully utilize its measurement capability.

The ac converter used in the TECH 300 and TECH 310 is "average-responding." An rms value is determined by first rectifying and filtering the signal to obtain the average value. The average value is then scaled upward by a factor of 1.11 to obtain the rms value. The scaling factor of 1.11 is accurate in the measurement of sine wave signals for which the relationship between the average and rms values is as follows:

$$\text{Vrms} = \frac{2\sqrt{2}\,\text{Vavg}}{\pi} = 1.11\ \text{Vavg}$$

In measuring non-sinusoidal waveforms, however, significant errors can be introduced because of different scaling factors relating average to rms values. Rough correction factors can be sometimes calculated for standard waveforms that are free from significant noise and distortion but accurate measurements of complex waveforms can be difficult to achieve.

RMS values of non-sinusoidal ac signals can be measured directly and more accurately with the TECH 330 which features a "true-rms responding" ac converter. True rms ac response can be particularly useful in measuring complex or noisy signals for which even rough correction factors cannot be easily computed.

Ac converters of all types are limited by their frequency response and input dynamic range. Bandwidth defines the range of frequencies in which the conversion accuracy is within 3dB. The bandwidth of the TECH 330 is 100kHz.

Measurements of complex signals will not be affected by converter bandwidth limitations unless there are significant harmonic components beyond 100kHz.

Crest factor is a measure of the input dynamic range of a true-rms responding ac converter. It expresses the ability of the ac converter to handle a signal that has large peak values compared to its rms value without saturating the converter circuitry and degrading the specified accuracy.

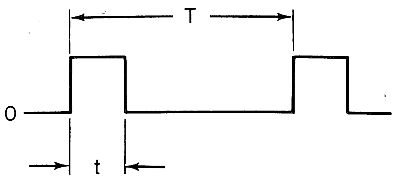
For the TECH 330, crest factor is defined as the ratio of the peak voltage to the total rms. (ac + dc) voltage.

$$\text{Crest Factor} = \frac{\text{V peak}}{\text{Vrms}}$$

Crest factor for a pulse train is also related to duty cycle (D) as follows:

$$\text{Crest Factor} = \sqrt{\frac{1}{D}}$$

$$\text{where } D = \frac{t}{T}$$



Crest factor for the TECH 330 ranges from 1.0 to 5.0 on each voltage scale depending on the rms value of the signal being measured. At fullscale (1999 counts), signals with crest factor between 1.0 to 1.5 can be measured. Signals with crest factor of 1.0 include a square wave or pure dc (peak voltage equals rms voltage). An undistorted sine wave signal (crest factor = 1.414) can also be measured at fullscale. Even a sine wave with considerable harmonic distortion can still be accurately measured at fullscale.

At half scale (1000 counts), signals with crest factor between 1.0 and 3.0 can be measured without performance degradation. At 600 counts and below, signals with crest factors up to 5.0 can be measured. If the crest factor of a waveform is not known, it can be determined by measuring the peak voltage with an oscilloscope and dividing by the rms voltage measured by the Multimeter. The crest factor of some typical waveforms are shown in Figure 3.

4.4 CURRENT MEASUREMENTS

4.4.1 DC CURRENT

1. Connect red test lead to the A Input Connector for current measurements up to 2 amperes. For current measurements between 2 and 10 amperes, connect red test lead to the 10A Input Connector (TECH 310 and TECH 330 only). Connect black test lead to COM Input Connector.

NOTE

When using the 10A Input Connector for current measurements, the test lead jack must be fully depressed into the input connector.

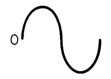
Waveform		Crest Factor
Sine Wave		1.414
Sawtooth		1.732
Half-Wave Rectified Sine Wave		2.0
SCR Output 100% to 10%		1.414 to 3.0
Rectangular Pulse 50% ≥ D ≥ 10%		1.414 to 3.16

Figure 3. Typical Waveform Crest Factors

2. Set Function/Range Switch to desired DCA position. If magnitude of current is not known, set switch to highest range and reduce until satisfactory reading is obtained. When the 10A Input Connector is used, the Function/Range Switch should be placed in the $\frac{20m}{10A}$ position.
3. Turn off power to device or circuit being tested and discharge all capacitors.
4. Open circuit in which current is to be measured. Now securely connect test leads in series with the load in which the current is to be measured.
5. Turn on power to circuit being tested.
6. Read current value on Digital Display.
7. Turn off all power to circuit being tested and discharge all capacitors.
8. Disconnect test leads from circuit and reconnect circuit that was being tested.

4.4.2 AC CURRENT

1. Connect red test lead to A Input Connector for measurements up to 2 amperes. For current measurements between 2 and 10 amperes, connect red test lead to 10A Input Connector (TECH 310 and TECH 330 only). Connect black test lead to COM Input Connector.

NOTE

When using the 10A Input Connector for current measurements, the test lead jack must be fully depressed into the input connector.

2. Set Function/Range Switch to desired ACA position. If magnitude of current is not known, set switch to highest range and reduce until satisfactory reading is obtained. When the 10A Input Connector is used, the Function/Range Switch should be placed in the $\frac{20m}{10A}$ position.
3. Turn off power to device or circuit being tested and discharge all capacitors.
4. Open circuit in which current is to be measured. Now securely connect test leads in series with the load in which the current is to be measured.
5. Turn on power to circuit being tested.
6. Read current value on Digital Display.

7. Turn off all power to circuit being tested and discharge all capacitors.
8. Disconnect test leads from circuit and reconnect circuit that was being tested.

4.5 RESISTANCE MEASUREMENTS

All resistance ranges on the Multimeter are low-power ohms which allow accurate measurements of in-circuit resistance. (Use Diode Test Function for checking diode and other semiconductor junctions.)

1. Connect red test lead to V·Ω Input Connector and black test lead to COM Input Connector.
2. Set Function/Range Switch to desired Ω position. If magnitude of resistance is not known, set switch to highest range and reduce until satisfactory reading is obtained.
3. If the resistance being measured is connected to a circuit, turn off power to circuit being tested and discharge all capacitors.
4. Connect test leads to circuit being measured. When measuring high resistance be careful not to contact adjacent points, even if insulated, because some insulators have a relatively low insulation resistance, which may affect the resulting measurement.
5. Read resistance value on Digital Display. If a high resistance value is shunted by a large value of capacitance, allow Digital Display to stabilize.

4.6 DIODE AND TRANSISTOR TEST MEASUREMENTS

The special diode test function allows accurate measurements of forward voltage drops across diodes and transistor junctions. A constant-current source forces 5mA of current into the semiconductor junction under test which results in the voltage drop being displayed on the Digital Display. This function also permits measurement of in-circuit semiconductor junctions with as little as 200Ω in parallel with the transistor or diode. The limited current produced by the instrument in the Diode Test Function minimizes the possibility of damage to low-power semiconductor junctions, a common problem when using many analog meters.

4.6.1 DIODE TESTS

To perform diode test measurements, use the following procedure:

1. Connect red test lead to V·Ω Input Connector and black test lead to COM Input Connector.
2. Set Function/Range Switch to the Diode Test (—▶|—) position.
3. If the semiconductor junction being measured is connected to a circuit, turn off power to circuit being tested and discharge all capacitors.
4. Connect test leads to device.
5. Read forward voltage drop on Digital Display.

If the Digital Display reads OL, reverse the lead connections. The placement of the leads when the forward voltage is displayed (normally 600 to 900mV) indicates the orientation of the diode. The red lead is then connected to the anode and the black lead is connected to the cathode as shown in Figure 4.

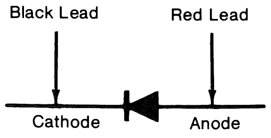


Figure 4. Placement of Leads in Respect to Anode and Cathode

If OL is displayed with both lead connections, the junction is open.

If a low reading (less than 1 volt) is obtained with both lead connections, the junction is shorted internally or (if the junction is measured in a circuit) the junction is shunted by a resistance less than 200 ohms. In the latter case, the junction must be disconnected from the circuit in order to verify its operation.

4.6.2 TRANSISTOR JUNCTION TESTS

Transistors can be tested in the same manner as diodes by checking the two diode junctions formed between the base and emitter and the base and collector of the transistor. Figure 5 shows the orientation of these effective diode junctions for PNP and NPN transistors.

To complete the transistor tests, check for shorts between the collector and emitter.

4.6.3 TRANSISTOR BETA TEST

With a simple test fixture the Diode Test Function can be used to determine the dc current gain (Beta) of a transistor. Beta is measured using a collector-to-emitter voltage (VCE) of about 1 volt and a collector current (IC) of about 5mA.

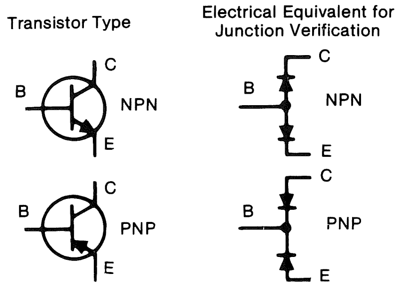


Figure 5. Orientation of Effective Diode Junctions for PNP and NPN Transistors

The transistor Beta test setup is shown in Figure 6 for an NPN transistor. For PNP transistors, the connections to the Multimeter should be reversed.

$$\text{Beta} = \frac{5000}{\text{Display Change in Digits}}$$

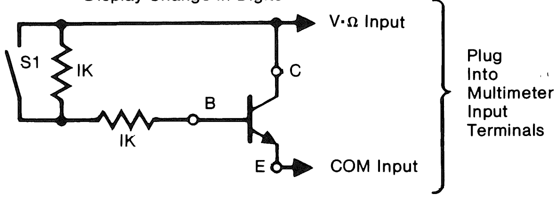


Figure 6. Test Fixture for Beta Measurements

To determine transistor Beta, use the following procedure:

1. With all the connections made as shown in Figure 6 and with switch S1 open, record the displayed reading (ignore decimal point).

NOTE

If an overload indication is obtained, reverse the connections to the Multimeter.

If an overload indication is obtained regardless of meter orientation, or if a reading less than 0.200 is obtained, the transistor is probably defective.

2. Close switch S1 and record the new displayed reading (ignore decimal point).
3. Divide 5000 by the difference in digits between the readings obtained in Steps 1 and 2. The resulting number is the transistor dc Beta.

4.7 CONTINUITY AND CAPACITOR CHECKS (TECH 310 and TECH 330 ONLY)

Before the Beckman Digital Multimeter, quick continuity checks using a digital multimeter were not possible. Now they can be done just as quickly and as easily as with an analog meter. This feature is particularly useful in circuit and cable tracing, but also may be used for troubleshooting small-value capacitors.

4.7.1 CONTINUITY CHECKS

1. Place Function/Range Switch in any Ω range.
2. Connect red test lead to the V·Ω connector and the black test lead to the COM connector. With the test leads separated or measuring an out-of-range resistance, the Digital Display will indicate OL (overload), Figure 7.
3. Place one test lead probe at one end of cable or circuit to be tested. Use the other test lead to trace the circuit or cable until the circuit is complete. When continuity is established, an Ω symbol will appear in the upper left-hand corner of the Digital Display, Figure 8. If contact in the cable or circuit is maintained long enough (about 1/4 of a second) the OL will disappear and the resistance value of the cable or circuit will appear next to the Ω, Figure 9.

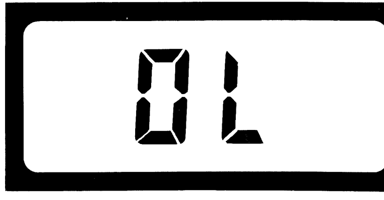


Figure 7. Display of Overload Symbol

Figure 8. Display of Insta-Ohms Quick Continuity Indicator Symbol (Ω)

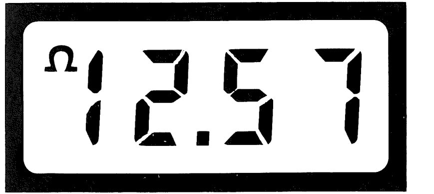


Figure 9. Display of Insta-Ohms Quick Continuity Indicator Symbol (Ω) and Resistance Value

NOTE

The continuity indicator is triggered by any resistance less than double the maximum resistance measurable on the selected range. For example, on the 200Ω range, the Ω symbol will appear when less than 400Ω is detected by the instrument.

4.7.2 CAPACITOR CHECKS

The Insta-Ohms Quick Continuity Indicator also can be used as rough check of capacitors with a value greater than or equal to 0.01μF. This feature can be a great aid in troubleshooting circuits in which an open or shorted bypass capacitor is suspected. Use the following procedure to check capacitors:

1. Place Function/Range Switch in 20MΩ range position.
2. Connect red test lead to V·Ω connector and the black test lead to the COM connector. With the test leads separated, the Digital Display will indicate OL (overload), Figure 6.
3. Discharge the capacitor to be checked by briefly shorting the ends together.
4. Place red test lead probe at one end of capacitor. Place the black test lead at other end of capacitor.

NOTE

Do not touch capacitor leads or test probe ends during capacitor check because proper operation of Insta-Ohms feature could be affected.

5. If the Insta-Ohms symbol (Ω) appears briefly and then disappears, the capacitor is accepting a charge. If the Insta-Ohms symbol does not appear, reverse the test leads. If the Insta-Ohms symbol still does not appear, the capacitor is probably open. If the capacitor is shorted, a low resistance value will be displayed.

NOTE

Insta-Ohms can only be used to check capacitors with a value of 0.01 µF or greater.

4.8 DECIBEL MEASUREMENTS

In addition to its normal functions, the Multimeter can be used to measure decibels. The value obtained from this measurement can be used to indicate the gain and accuracy of electronic devices. The decibel (dB) is the logarithm of the ratio of two electrical signals; usually a certain amount of power across a fixed resistance is used as a reference and denoted as 0 (zero) decibels. In our example, OdB is defined as 1 milliwatt into 600 ohms. Use the procedure of Paragraph 4.3.2 to determine ac voltage and the graph of Figure 10 to determine decibel value.

2V Range – Add 20dB
20V Range – Add 40dB
200V Range – Add 60db
1000V Range – Add 80dB

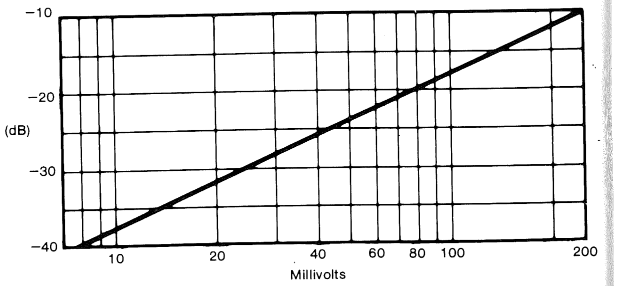


Figure 10. Decibel Conversion Chart

5.1 GENERAL

The central part of the Beckman Digital Multimeter is the custom-designed CMOS LSI multiprocessor chip, U4; for the TECH 330,(U7). *Please note in the following text that where the TECH 330 has a different identification for the electronic component, the term will appear in parentheses; i.e., (U7).* To increase instrument reliability, much of the necessary electronic circuitry is incorporated on the multiprocessor chip. The chip contains an active input filter, an averaging ac-to-dc converter, the Insta-Ohms detection and resistance measurement circuitry, an analog-to-digital converter with ±200mVdc fullscale ratiometric inputs, and all necessary digital and LCD display drive circuitry.

Peripheral components are used with this chip to perform a range of voltage, current, resistance, and semiconductor measurements, and to provide overall instrument protection.

Included in these peripheral circuits are the Function/Range Switch, 3 resistor networks, a voltage reference diode, several circuit protection components, the battery, and the display. The TECH 330 also contains an additional LSI chip which performs true rms conversion of the ac signals.

5.2 OVERALL FUNCTIONAL DESCRIPTION

Simplified block diagrams are shown in Figures 11 and 12. The schematic wiring diagrams are shown in Figures 13, 14, and 15.

The Function/Range Switch routes the input signal to an appropriate Input Conditioning Circuit which converts the input signal to a dc voltage between −200mV and +200mV.

This signal can then be processed by the multiprocessor chip. After being passed through an active filter for normal-mode rejection of interfering powerline and audio frequency signals, the on-chip A/D converter digitizes the signal into display segment driving signals, resulting in an accurate digital display of the applied input signal.

Decimal point positions on the display are determined automatically by the multiprocessor chip, based upon the Function/Range Switch settings.

5.3 BLOCK DIAGRAM ANALYSIS

5.3.1 INPUT PROTECTION CIRCUITRY

Input protection circuitry has been provided to protect the instrument from normally encountered overloads and range selection errors.

In the dc voltage ranges, primary over-voltage protection is provided by a 2MΩ series resistor R8* (R9) working into voltage limiters included in the converter chip. 1500 volts dc continuous overload and energy-limited transients of much higher voltage can be accepted. Secondary protection from high voltages is provided by a 2-kilovolt spark gap SG1. On all resistance ranges and the diode test function, a positive temperature coefficient resistor RT1 and zener diodes VR2, VR3 (VR1, VR3) provide isolation from the application of external voltages.

In the current mode, protection is provided by a combination of a diode limiter bridge (BR1) and a 2 amp/250V fuse (F1). The fuse will blow for long-term overloads and the diodes divert overloads from the current measurement resistors.

*Resistance reference numbers for TECH 300 are one number lower than those given for TECH 310.

Although not fuse-protected, the 10A current input connects directly into a durable 10MΩ current shunt R1 that can withstand 10 amps continuously and up to 20 amps for less than 30 seconds (TECH 310 and TECH 330 only).

5.3.2 INPUT CONDITIONING CIRCUITS

The A/D converter on the multiprocessor chip accurately converts an unknown voltage within the range of −200mV to +200mV dc to a digital equivalent which is displayed on the digital display. If the signal being measured is other than a dc voltage in the ±0.2V range, the signal must be converted to a dc voltage and scaled down before being presented to the A/D converter. This is the function of the input conditioning circuits.

Voltage Measurements

A precision-ratio resistor network is used as the voltage divider for both ac and dc voltage ranges. The voltage divider is part of a Beckman Thin Film Resistor network U1. Thin film resistor networks exhibit exceptionally good long-term stability and contribute significantly to the long-term accuracy of Beckman Multimeters.

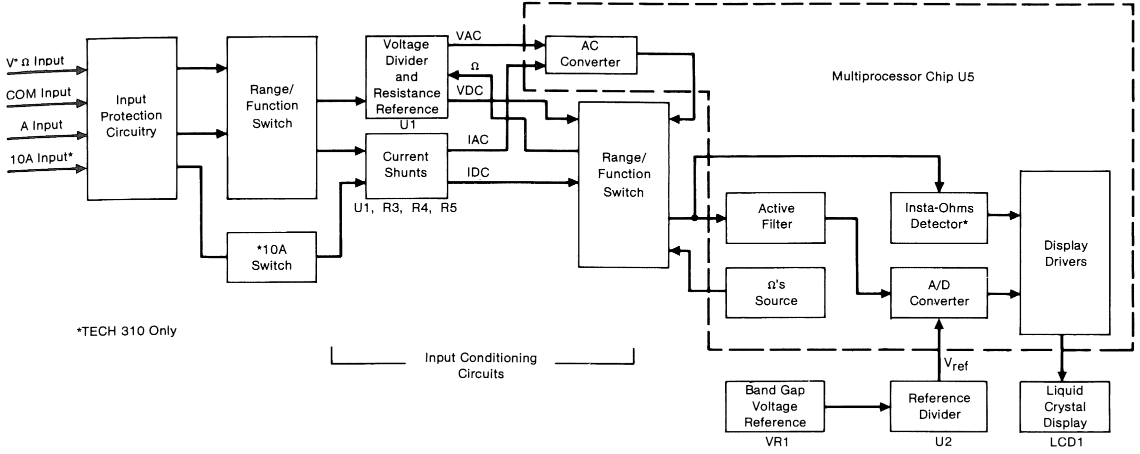


Figure 11. Simplified Block Diagram TECH 300 and TECH 310

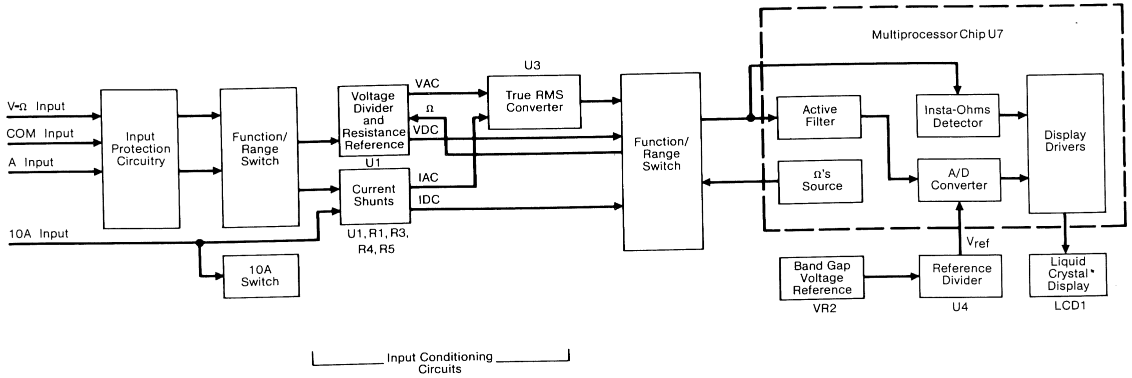


Figure 12. Simplified Block Diagram TECH 330

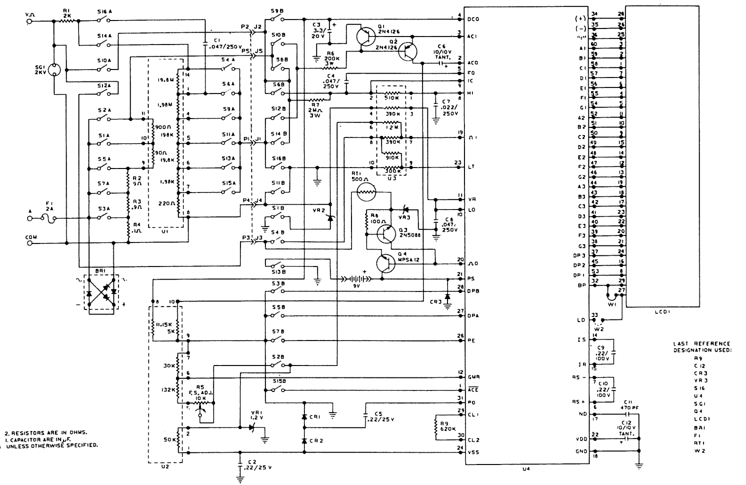


Figure 13. Schematic Wiring Diagram of TECH 300

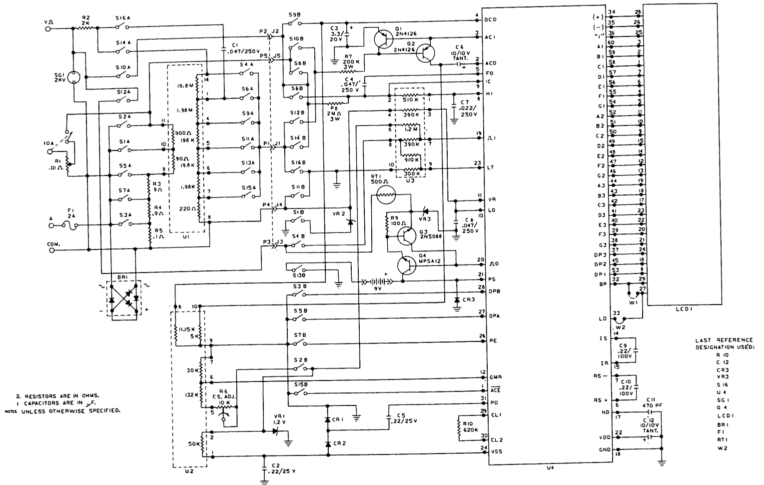


Figure 14. Schematic Wiring Diagram of TECH 310

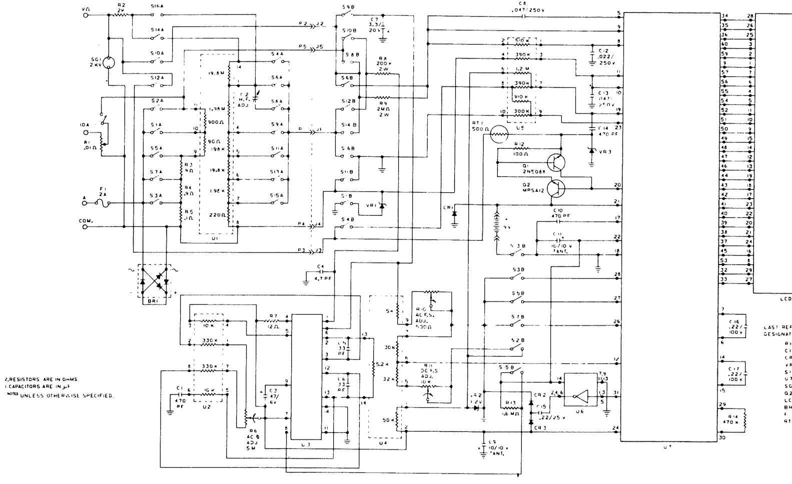


Figure 15. Schematic Wiring Diagram of TECH 330

If the ±200mV dc range is selected, the input signal feeds directly into the multiprocessor chip. On all other higher dc voltage ranges, a precise power-of-ten voltage is selected from the voltage divider as the multiprocessor input. If a ACV range is selected, the voltage divider output is coupled to an ac converter which in turn provides a proportional dc output to the active filter input to the multiprocessor chip.

On the TECH 300 and TECH 310, the ac converter is an *averaging* converter, a precision half wave rectifier whose output is a dc voltage calibrated to equal the rms value of a sine wave input. The ac converter is located on the multiprocessor chip and is separately powered to save battery drain except during ac voltage and ac current measurements.

On the TECH 330, the ac conversion process is accomplished in the true rms converter chip (U3). The TECH 330 calculates the rms value of an input voltage by performing the electronic equivalent of the actual mathematical function:

$$V_{rms} = \sqrt{\frac{1}{T}\int_0^T V_{IN}^2(t)\,dt}$$

A block diagram of the true rms converter chip is shown in Figure 16.

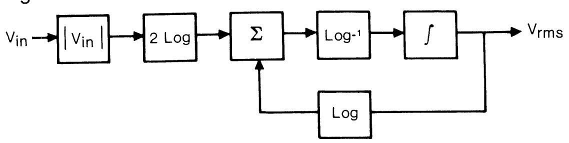


Figure 16. True RMS Converter Block Diagram

Resistance Measurements

Resistance measurements are made using a ratio technique where the unknown resistance is compared against an internal standard. As shown in Figure 17, the unknown resistance is connected in series with a selected reference resistor to a bias voltage generated by the multiprocessor chip.

The reference resistor is selected to be equal to the full-scale range of the unknown resistor being measured; e.g., if the 20KΩ range is selected, a precision 20KΩ resistor is switched across the reference input. Reference resistors are selected from the same thin film resistor network U1 used as the voltage divider for voltage measurements.

Because of negligible loading at the sensing terminals by the multiprocessor chip, the ratio of the two resistors is equal to the ratio of their respective voltage drops.

$$\frac{V_x}{R_x} = \frac{V_{ref}}{R_{ref}}$$

The A/D converter on the multiprocessor chip uses a ratiometric conversion technique which relies solely on the ratio of the unknown voltage, V_x, to a reference voltage, V_{ref}. Choosing a low bias voltage assures that the voltage developed across the unknown resistance is 0.25 volt maximum. This allows low voltage testing of resistors in circuits where the presence of semiconductor junctions could otherwise affect the measurement accuracy.

Current Measurements

Current is converted to a dc voltage by passing the current through a selected shunt resistor, resulting in a voltage drop (I·R) within the ±200mV range required by the multiprocessor chip. This process assures that the maximum voltage burden or voltage dropped through the current sense resistor is less than 0.25V.

The resistors that are switched in series to make current shunt values from 0.1Ω to 1KΩ are part of the thin film

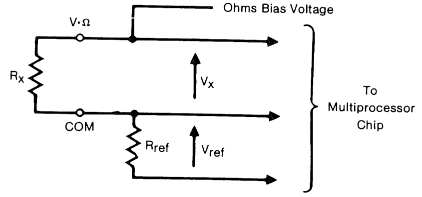


Figure 17. Input Conditioning Circuit for Resistance Measurements

network U1 and wire wound resistors R3, R4, and R5. The 0.01Ω shunt for the 10 amp current range is a separate component R1 switched in automatically when a test lead is fully inserted into the 10A input.

The voltage drop from a dc current measurement is routed directly to the multiprocessor chip. In ac current ranges, the shunt voltage drop is routed to the same ac converter used in the conversion of ac voltages.

Diode Measurements

The diode test operating mode provides a repeatable and easily understandable means to check semiconductor junctions. In this mode, the Multimeter operates with a

±2 volt fullscale dc measurement range. A 5mA constant test current is supplied via the V-Ω terminal. The resulting junction forward voltage drop is scaled to within ±200mV by the voltage divider, converted in the multiprocessor chip and displayed. Reverse connection (checking diode blocking) will normally read OL.

5.3.3 MULTIPROCESSOR CHIP

The multiprocessor chip contains the averaging ac converter, an active input filter, the Insta-Ohms detector, the A/D converter, circuits for controlling the voltage polarity signs, the overload indicator and the low battery indicator, and all display drivers.

Active Filter

A second order Bessel filter is incorporated in the multiprocessor chip to insure broadband normal-mode rejection of interfering powerline and audio frequencies. This, combined with the usual 6dB per octave rejection of the integrating converter, provides more than 60dB rejection at powerline frequencies.

Insta-Ohms Quick Continuity Indicator (TECH 310 and TECH 330 Only)

The Insta-Ohms Quick Continuity Indicator allows a very quick determination of circuit continuity. The Insta-Ohms detector consists of a single-bit analog-to-digital converter that triggers at approximately twice fullscale input in any ohms range. Because it is separate from the main analog-to-digital conversion circuitry, normal conversion time is not required and indication in the Digital Display occurs almost immediately (within 0.1 second).

A/D Converter

The A/D converter performs a true ratio voltage conversion between two input ports. One input to the A/D converter is the unknown input voltage. For all voltage and current measurements, the reference or second port is connected to a precision voltage reference generated by a band-gap diode VR1 (VR2), and a voltage divider network U2 (U4). The reference voltage is set by an adjustment of trimmer R6 (R11). In the TECH 300 and TECH 310, this one trimmer comprises the only adjustment required for calibration.

When the unknown input voltage exactly equals the reference voltage, a fullscale reading results from the A/D converter. As the ratio of the unknown input voltage to the reference voltage declines, proportionally lower readings result from the main converter.

In the resistance ranges, the reference input is supplied by the voltage drop across a reference resistor connected in series with the unknown resistance.

SECTION SIX MAINTENANCE

This section of the manual describes maintenance procedures, calibration, and troubleshooting. In addition, a general statement on service policy is included. Any questions regarding warranty repair or instrument servicing should be directed to Beckman Instruments, Inc., at (714) 871-4848.

6.1 WARRANTY STATEMENT

The warranty statement for the Beckman Multimeters appears on the inside front cover of this manual. Read it carefully before requesting warranty repairs.

6.1.1 WARRANTY REPLACEMENT

Any Series 300 instrument claimed to be defective should be returned to Beckman Instruments, Inc., with a $3.00 handling fee within the continental USA and $12.00 elsewhere.* Follow the shipping instructions of Paragraph 6.1.3.

Warranty replacement will be made typically within one (1) working day after receipt of defective unit.

6.1.2 NON-WARRANTY REPLACEMENT

Any out-of-warranty instrument that is defective, but repairable, can be exchanged for a reconditioned instrument at a flat rate contained on Beckman's current price list. The replacement unit carries a three (3) month warranty. Contact any authorized Beckman distributor or Beckman Instruments, Inc., for the current non-warranty replacement rates.

6.1.3 SHIPPING INSTRUCTIONS

Instruments returned for calibration or repair should be shipped with the following information or items: Company name, customer's name, address, customer's telephone number, proof of purchase (warranty repairs), a description of the problem encountered or service required, and the appropriate service charge.

Service charges should be remitted in either the form of a check, money order, or purchase order made payable to Beckman Instruments, Inc.

*Prices subject to change without notice.

Instruments should be shipped with transportation charges prepaid to the following address:

Beckman Instruments, Inc.
2550 Harbor Boulevard
Fullerton, CA 92634
Attn: Customer Service

Instruments will be returned to the customer by UPS Blue (airmail) or equivalent with transportation charges paid by Beckman Instruments, Inc.

6.2 MAINTENANCE PROCEDURES

Regular operator maintenance of the Multimeters consists of: cleaning case and window, battery replacement, and fuse replacement. All other repairs should be performed by the Beckman Service Center or other qualified instrument service personnel.

6.2.1 CLEANING CASE AND WINDOW

CAUTION

Do not use aromatic hydrocarbons or chlorinated solvents for cleaning. These chemicals will react with plastics used in construction of case.

The front panel and case should be cleaned with a mild solution of detergent and water. Apply sparingly with a soft cloth and allow to dry completely before using.

6.2.2 BATTERY REPLACEMENT

WARNING

To prevent electrical shock hazard, turn off Multimeter and disconnect test leads before removing back cover.

1. After disconnecting test leads and turning off Multimeter, remove back cover by removing four screws (see Figure 18), and then lift off back cover.

CAUTION

Failure to turn off the instrument before installing the battery could result in damage to the battery if it is connected to the battery terminal incorrectly.

2. The battery is located in the front part of the case as shown in Figure 19. Disconnect battery from instrument and replace with a standard 9-volt transistor battery.

Figure 18. Rear View of Multimeter

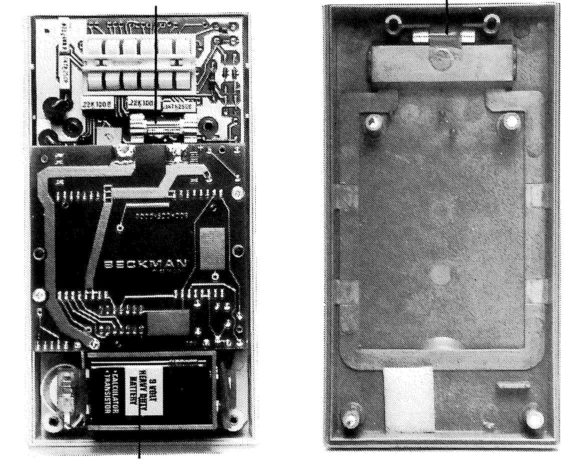


Figure 19. Multimeter with Back Cover Removed

3. Replace back cover and secure with four screws.

WARNING

Do not operate Multimeter with back cover removed (except during calibration).

6.2.3 FUSE REPLACEMENT

WARNING

To prevent electrical shock hazard, turn off Multimeter and disconnect test leads before removing back cover.

1. After disconnecting test leads and turning off Multimeter, remove back cover by removing four screws, see Figure 18, and then lift off cover.
2. The fuse is located in the upper half of the instrument (see Figure 19). Remove old fuse and replace with spare fuse attached to the inside of the back cover.

WARNING

To prevent fire, use Type AGX 2A/250V fuse only.

3. Replace back cover and secure with four screws.

WARNING

Do not operate Multimeter with back cover removed (except during calibration).

6.3 CALIBRATION*

In order to maintain the specifications described in Section Two of this manual, it is recommended that the Multimeter be calibrated once each year and/or after it is repaired.

The equipment required for calibration is listed in Figure 20.

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*If the necessary equipment is not available, calibration service is available from the Beckman Service Center for $15.00 in the Continental U.S.A. and $25.00 elsewhere. (Prices are subject to change without notice.) Instrument calibration performed at Beckman is traceable to the National Bureau of Standards (NBS). For this service, send the unit and appropriate service charge following the shipping instructions of Paragraph 6.1.3.

Instrument Type	Required Characteristics	Recommended Models
dc calibrator	Voltage Range: 0 to 1000Vdc Accuracy: ±0.025%	Rotek 600 or Equivalent
ac calibrator (For use with TECH 330 only)	Voltage Range: 0 to 110Vac Frequency Range: 400Hz to 20kHz Voltage Accuracy: 0.05% at 400Hz; 0.5% at 20kHz	Rotek 600, HP 745A, or Equivalent

Figure 20. Equipment Required for Calibration.

6.3.1 CALIBRATION OF TECH 300 and TECH 310

1. Perform calibration at an ambient temperature of 25 ±2°C and a relative humidity of 80% or less. Allow instrument to stabilize at this temperature for at least 30 minutes.
2. Remove the back cover from the instrument by removing four screws and then lifting off cover.
3. Set the output of the dc calibrator for 190mV ±0.02% and connect it to the V·Ω and COM Input Connectors.
4. Turn the Function/Range Switch on the Multimeter to the 200mV DCV position.
5. Using a small flat-tipped screwdriver, adjust potentiometer R6 (R11 on TECH 330) as identified in Figures 21 and 22, until Multimeter Digital Display reads +190.0 or +190.1
6. Disconnect dc calibrator from Multimeter.
7. Replace back cover and secure with four screws.

6.3.2 CALIBRATION OF TECH 330

1. Use the procedure of Paragraph 6.3.1 through Step 6, and then proceed as follows.
2. Short the input terminals.
3. Turn Function/Range Switch on Multimeter to the 1000V ACV position.
4. Adjust potentiometer R6, as identified in Figure 23, until the Digital Display reads 000 or 001. Make this adjustment *very slowly* to allow the instrument to stabilize.

5. Turn Function/Range Switch on Multimeter to the 200mV ACV position.
6. Set the output of the dc calibrator to 190mV. Connect the dc calibrator to the V-Ω and COM (polarity is not important) Input Connectors.
7. Adjust potentiometer R10, as identified in Figure 23, until the Digital Display reads 190.0 ±1 digit.
8. Disconnect dc calibrator.

NOTE

The following procedure describes the high frequency adjustment of the true rms converter. At 20kHz, the calibration frequency, the 2Vac Multimeter readings will tend to be higher with the back cover shield removed than with the cover attached. It is, therefore, necessary to adjust the Multimeter to read higher than the calibration standard voltage so that with the cover attached, the desired output is achieved.

9. Place Function/Range switch on Multimeter in the 2V ACV position and set the ac calibrator for an output of 1.900V, 20kHz.
10. Temporarily replace the back cover of the Multimeter.
11. Connect the ac calibrator to the V-Ω and COM Input Connectors, and note the reading. Insure that the COM or "low" side terminal of the AC calibrator is matched with the Multimeter COM terminal.
12. Remove the Multimeter back cover and again note the Digital Display. The difference between the first and second readings is the "error voltage."
13. Adjust trimming capacitor C2, as identified in Figure 23, until the Digital Display reads a number equal to 1.900 plus the "error voltage."
14. Replace Multimeter back cover and secure with the four screws.
15. Verify that the Digital Display reads 1.900 ±20 digits.
16. Disconnect ac calibrator.

6.4 TROUBLESHOOTING

Except for the replacement of the battery and fuse, repair of the Multimeter should be performed only by the Beckman Service Center or by other qualified instrument service personnel.

CAUTION

The CMOS multiprocessor chip U4 is subject to damage created by electrostatic discharge. This component should be handled only by qualified personnel equipped with antistatic grounding devices.

If the instrument is not performing properly, the following steps should be taken before returning the instrument for warranty repair.

1. Check the battery and fuse connections.
2. Check to see that the Function/Range Switch is in the correct position for the type of parameter and range of values being measured, and that the measurement value is within the capability of the instrument.
3. Review and comply with the operating instructions contained in Section Four of this operator's manual.
4. Inspect the test leads for breaks or cracks and ensure that the test leads are inserted fully into the input connectors.
5. Check to see that the ambient environment in which the instrument is being used is within the specifications of the instrument.
6. If the decimal point is blinking, the battery is probably low. Replace battery, using procedure of Paragraph 6.2.2.
7. If the Digital Display is blank with the unit turned on, the battery is probably dead. Replace battery, using procedure of Paragraph 6.2.2
8. If operation is normal in all functions and ranges except ac and dc current, the fuse is probably blown. Replace fuse, using procedure of Paragraph 6.2.3.

If the preceding steps do not remedy the problem, refer to Paragraph 6.1, Warranty and Non-Warranty repair service.

6.4.1 SERVICE MANUAL

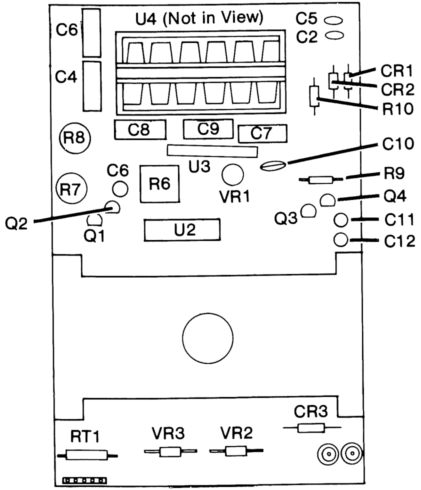
A complete service manual is available from Beckman Instruments, Inc., for those users who desire to service their own instruments. To obtain a copy of this manual, send $3.00* in the form of a check, money order, or a purchase order made payable to Beckman Instruments, Inc. See shipping address in Paragraph 6.1.3.

6.5 INSTRUMENT STORAGE

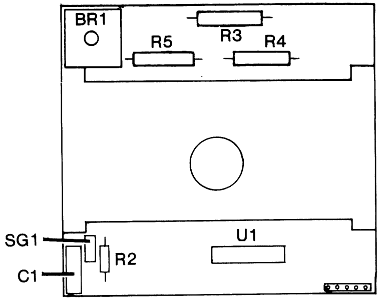
WARNING

If Multimeter is to be stored at temperatures above 122°F (50°C), remove battery.

*Prices are subject to change without notice.



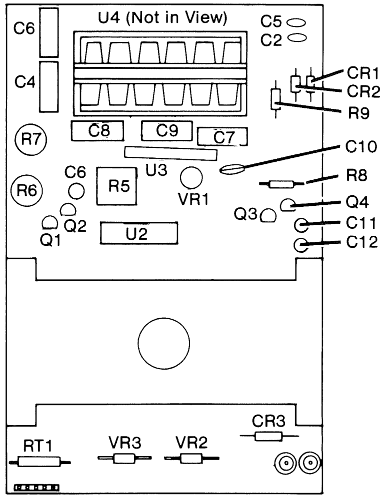
Main Board



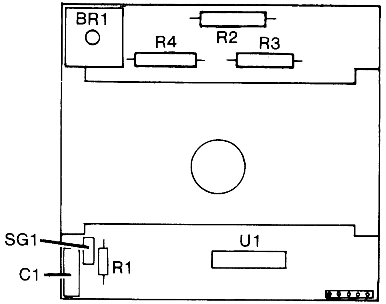
Piggyback Board
(Inside View)

NOTE
R1 is Located
Under the Battery
Cradle.

Figure 21. Components Locator for TECH 310

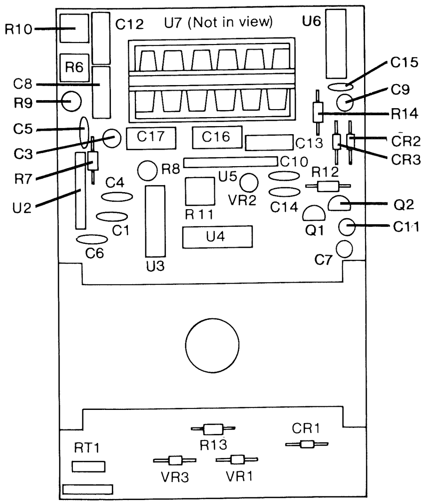


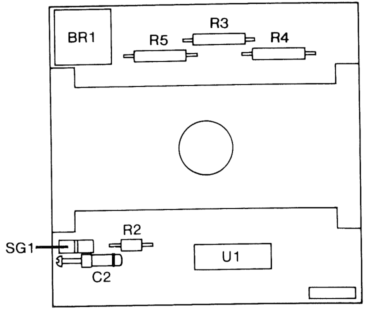
Main Board



Piggyback Board
(Inside View)

Figure 22. Components Locator for TECH 300





Piggyback Board
(Inside View)

NOTE
R1 is Located
Under the Battery
Cradle.

Figure 23. Components Locator for TECH 330

SECTION SEVEN ACCESSORIES

This section provides a description of the accessories and other Multimeter models that are available from Beckman.

7.1 VINYL CARRYING CASE (VC-201)

The vinyl carrying case is constructed of durable, padded vinyl and will accommodate any Beckman Multimeter model. The case has room for the meter, operator's manual, and the test leads without adding any unnecessary bulk. The back of the case has a handy belt loop.

7.2 DELUXE CARRYING CASE (DC-202)

Handsome, yet rugged, this case offers maximum protection for any Beckman Multimeter. Constructed of rigid, leather-grained vinyl, the deluxe case has inside compartments for storing the instrument, test lead set, and the operator's manual.

7.3 HIGH VOLTAGE PROBE (HV-211)

The High Voltage Probe extends the dc voltage measurement capability of any Beckman Multimeter to 50kV. This accessory is essential for television and CRT terminal service where second anode voltages must be measured.

This probe contains a precision 1000:1 resistor divider that scales high voltages down to a level that the Multimeter can handle safely. The high input impedance of the probe minimizes circuit loading and assures accurate measurements.

7.3.1 HIGH VOLTAGE PROBE SPECIFICATIONS

VOLTAGE RANGE
0 to ±50kVDC

INPUT RESISTANCE
1000MΩ

DIVISION RATIO
1000:1

ACCURACY
±2% at 25kV, changes linearly to 8% at 50kV

MAXIMUM INPUT
±50kVDC or peak ac

7.3.2 OPERATION WITH HIGH VOLTAGE PROBE

DANGER

The high voltage probe is used to measure potentially lethal voltages. Always disconnect power and discharge voltage source before connecting or disconnecting the high voltage probe.

When the High Voltage Probe is used, the probe replaces the standard test leads. The probe is connected to the Multimeter in the same manner as the standard test leads and measurements are made as described in Paragraph 4.3.1 except that, because the probe is a precision 1000:1 divider, the Digital Display readings will be in kilovolts. A measured value of 50 000 volts will therefore read +50.0 with the Function/Range Switch in the 200 DCV position.

7.4 RF PROBE (RF-221)

This peak detecting RF probe extends the ac voltage measuring capability of any Beckman Multimeter to 200MHz. The RF probe provides a dc voltage that is calibrated to equal the rms value of a sine wave.

7.4.1 RF PROBE SPECIFICATIONS

FREQUENCY RANGE
2kHz to 200MHz
ACCURACY
± (1% input + 50mV), from 2kHz to 10MHz
±1dB from 10MHz to 100MHz
±6dB from 100MHz to 200MHz
MAXIMUM READING
25Vrms
RESPONSE
Peak sensing, rms calibrated
INPUT IMPEDANCE
1.5MΩ in parallel with 7pF
OVER VOLTAGE PROTECTION
130Vrms at 60Hz or 250Vdc

7.4.2 OPERATION WITH RF PROBE

The RF probe is connected to the Multimeter in the same manner as the standard test leads. Measurements are

made as described in Paragraph 4.3.1. Use appropriate DCV range from 200mV to 200V and read voltage signal directly in volts rms.

7.5 AC CURRENT CLAMP (CT-231)

This accessory extends the ac current measurement capability of any Beckman Multimeter to 150 amperes without breaking the circuit under test. The 1000:1 current transformation allows direct reading in amperes when used with the 200mA ac current range of the Multimeter.

7.5.1 AC CURRENT CLAMP SPECIFICATIONS

RANGE
10A to 150A rms ac
FREQUENCY RANGE
30Hz to 1kHz

ACCURACY
±3% (50Hz to 150Hz)
±4% (150Hz to 1000Hz)
±6% (30Hz to 50Hz)

DIVISION RATIO
1000:1
CIRCUIT-TO-GROUND VOLTAGE
1000 Vrms maximum
MAXIMUM CONDUCTOR SIZE
0.45 inches (11.4mm)

7.5.2 OPERATION WITH 150A AC CURRENT CLAMP

The CT-231 AC Current Clamp is connected to the A and COM Input Connectors of the Multimeter in place of the standard test leads. The jaws of the current clamp are placed around one of the current carrying conductors. With the Multimeter in the 200mA ACI position, current is read directly in amperes.

7.6 AC CURRENT CLAMP (CT-232)

This accessory extends the ac current measurement capability of any Beckman Multimeter to 1000 amperes by use of a 1000:1 current transformer. The clamp-on design permits ac current measurements without breaking the circuit under test.

7.6.1 AC CURRENT CLAMP SPECIFICATIONS

RANGE
10 to 1000A rms ac
FREQUENCY RANGE
30Hz to 1000Hz
ACCURACY
±1% (60Hz)
±2% (30Hz to 1 kHz)
DIVISION RATE
1000:1
CIRCUIT-TO-GROUND VOLTAGE
1000V rms maximum
MAXIMUM CONDUCTOR SIZE
2.125 inches (54mm)

7.6.2 OPERATION WITH 1000A AC CURRENT CLAMP

The CT-232 AC Current Clamp is connected to the A and COM Input Connectors of the Multimeter in place of the standard test leads. The jaws of the current clamp are placed around one of the current carrying conductors. With the Multimeter in the 2A ACI position, the displayed value is multiplied by 1000 to get measured current in amperes.

7.7 DELUXE TEST LEAD KIT (DL-241)

The specially designed Beckman Deluxe Test Lead Kit comes in a handy vinyl case. The kit includes a complete assortment of probe tips for every measurement application. The kit includes the following tips: alligator clips, spade lugs, banana tips, phone tips, and needle tips. All tips will screw into the standard test leads. A set of Beckman Standard Test Leads is also included with the Deluxe Test Lead Kit.