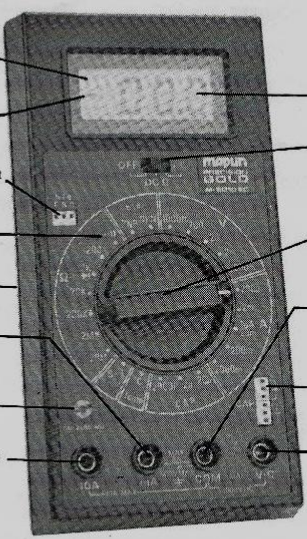
Digital Multimeter
Model M-5010EC
Operator's Manual

MAPLIN ELECTRONIC SUPPLIES

RELIABLE, ACCURATE MEASUREMENTS

0.25% BASIC DC ACCURACY. 10 AMP, AC/DC.
TEMPERATURE AND CAPACITANCE MEASUREMENT

AMAZING QUALITY AT LOW COST!



SAFETY SYMBOLS

The symbol ⚠ on the instrument denotes that the user should refer to the operating instructions.
The symbol ⚡ on the instrument denotes that a high voltage may be present on the terminal(s).

MODEL M-5010EC SPECIFICATIONS

GENERAL

DISPLAY: 3½ digit LCD. 0.5" height with polarity and LO BAT indication.
OVERRANGE INDICATION: 3 least significant digits blanked.
MAXIMUM COMMON MODE VOLTAGE: 500V peak.
OPERATING ENVIRONMENT: 0° to 50°C; less than 80% relative humidity up to 35°C, less than 70% relative humidity from 35°C to 50°C.
STORAGE ENVIRONMENT: −15°C to 50°C.
TEMPERATURE COEFFICIENT (0° to 18°C and 28° to 50°C): Less than 0.1 x applicable accuracy specification per °C.
POWER: 9V alkaline or carbon-zinc battery (PP3).
BATTERY LIFE: 100 hours typical with carbon-zinc cells; 200 hours with alkaline cells.
BATTERY INDICATOR: Display indicates "LO BAT" when less than 20% of life remains.
DIMENSIONS, WEIGHT: 170mm x 87mm x 42mm. 343 grams.

DC VOLTAGE

RANGE	RESOLUTION	ACCURACY
200mV	100μV	
2V	1mV	
20V	10mV	± (0.25% of reading + 1 digit)
200V	100mV	
1000V	1V	

Input Impedance: 10M on all ranges.
Normal Mode Noise Rejection: 46dB at 60Hz (1k unbalance)
Common Mode Noise Rejection: 100dB at 60Hz.
Overload Protection: 1000V DC or peak on all ranges.
Response Time: <1 sec.

DC CURRENT

RANGE	RESOLUTION	ACCURACY	MAX. F.S. VOLTAGE DROP
200μA	100nA	± (0.5% rdg + 1d)	0.25V
2mA	1μA	± (0.5% rdg + 1d)	0.25V
20mA	10μA	± (0.5% rdg + 1d)	0.25V
200mA	100μA	± (0.75% rdg + 1d)	0.25V
2000mA	1mA	± (1.5% rdg + 5d)	0.75V
10A	10mA	± (1.5% rdg + 5d)	0.30V

Overload Protection : mA Input; 2A/250V fuse
10A Input; unfused up to 15A for 15 seconds.

AC VOLTAGE

RANGE	RESOLUTION	ACCURACY	FREQ. RANGE
200mV	100μV		
2V	1mV	± (0.5% rdg + 5d)	45Hz – 500Hz
20V	10mV	On all ranges	On all ranges
200V	100mV		
750V	1V	± (1% rdg + 5d)	

Conversion: Calibrated for rms of sine wave.
Input Impedance: 10M shunted by 100pF on all ranges except 200mV range.
Common Mode Noise Rejection: 60dB, 50Hz - 60Hz (1kΩ unbalanced).
Overload Protection: 1000V DC or 750V rms AC continuous, except 15 sec max above 300V on 200mV range.
Response Time: 1 sec.

AC CURRENT

RANGE	RESOLUTION	ACCURACY	MAX. F.S. VOLTAGE DROP
200μA	100nA	± (0.75% rdg + 5d)	0.25V rms
2mA	1μA	± (0.75% rdg + 5d)	0.25V rms
20mA	10μA	± (0.75% rdg + 5d)	0.25V rms
200mA	100μA	± (0.75% rdg + 5d)	0.25V rms
2000mA	1mA	± (1.5% rdg + 5d)	0.76V rms
10A	10mA	± (2% rdg + 5d)	0.3V rms

Overload Protection : mA Input; 2A/250V fuse
10A Input; unfused up to 15A for 15 seconds.

RESISTANCE

RANGE	RESOLUTION	ACCURACY	MAX OPEN CIRCUIT V
200Ω	100mΩ	± (0.5% rdg + 3d)	2.8V
2kΩ	1Ω	± (0.3% rdg + 1d)	2.8V
20kΩ	10Ω	± (0.3% rdg + 1d)	500mV
200kΩ	100Ω	± (0.3% rdg + 1d)	500mV
2MΩ	1kΩ	± (0.75% rdg + 2d)	500mV
20MΩ	10kΩ	± (1.5% rdg + 2d)	500mV

Max Allowable Input: 500V DC or rms.

CONTINUITY TEST (•))))

Resistance Range: Buzzer sounds at less than 200Ω approximately.
Response Time: Less than 100m sec.

DIODE TEST (⊣◀)

Test Voltage: 2.8 Volts.
Maximum Test Current: 3mA.

TEMPERATURE MEASUREMENT

RANGE	RESOLUTION	ACCURACY
−20°C to 1370°C	1°C	± (0.25% rdg + 1d)

Sensor: Type K (NiCr - NiAl)

CONDUCTANCE MEASUREMENT

RANGE	RESOLUTION	ACCURACY
200nS	0.1nS	± (1.5% rdg + 10d)

(Equivalent to 5MΩ to 10,000MΩ).

CAPACITANCE MEASUREMENT

RANGE	RESOLUTION	ACCURACY
2000pF	1pF	± (1.5% rdg + 5d)
2μF	0.001μF	± (2% rdg + 5d)
20μF	0.01μF	± (2% rdg + 5d)

h_{FE} TEST

Test Condition: 10μA, 2.8V
h_{FE} Gain 0 – 1000 (NPN/PNP)

FULLY OVERLOAD PROTECTED, UL 1244

Overload protection is accomplished on all ranges. For over-voltage protection, a selected sparkgap with low capacitance is used which proved superior in performance than the varistors used on other instruments. An inrush current limiter combination protects up to 500V DC or rms AC on all resistance ranges.

Also, a pair of fast switching high current silicon diodes plus a fuse provide excellent protection on all current ranges.

Furthermore, the input of the A/D converter is protected against over-voltage.

SAFETY INPUT SOCKET AND PROTECTED TEST LEADS

The 4mm input sockets are fully recessed and protected against accidental contacts. The test leads supplied with the equipment give added safety to the user since the jacks are shrouded, thus avoiding dangerous connections to potential high voltages. The prods supplied have finger stops to keep fingers away from the naked end. The prod terminals are sufficiently long and slender to reach any test points found on actual boards.

OPERATOR SAFETY

Plastic ABS casing intrinsically insulated, deeply recessed sockets and safety test leads ensure a high degree of protection to the user. In the event of accidental or erroneous connection to a power source giving large current, a fuse will blow and there will be no damage to the operator or equipment. (There is no arc in the fuse and therefore, no danger of combustion in the meter).

OPERATING INSTRUCTIONS

GENERAL

The M5010EC DMM is a completely portable, pocket-sized 3½ digit multimeter designed for use by engineers, technicians and hobbyists who demand an instrument that is accurate, reliable and always ready for use.

The meter is equipped with eleven functions and 36 ranges, each test position being quickly and easily selected with a simple turn of the single selector switch. Small enough to fit in most attaché cases, it is equipped with a multi-position tilt stand. This instrument is equally suited for design engineering, production testing, field servicing, or industrial maintenance applications.

WARNINGS

1. To avoid electrical shock and/or damage to the instrument, do not measure voltages that might exceed 500V above earth ground.
2. Before using the instrument, inspect test leads, connectors, and prods for cracks, breaks or any crazes in the insulation.

DC VOLTAGE MEASUREMENT

1. Connect red test lead to "V.Ω" input connector and black lead to "COM".
2. Slide the POWER/FUNCTION switch to "DC.Ω" (mid position).
3. Set RANGE switch to desired "V" position. If magnitude not known, set switch to highest range and reduce until a satisfactory reading is obtained. This applies to all measurements on any function.
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.

DC CURRENT MEASUREMENT

1. Connect the red lead to "mA" jack for measurements up to 2A and black lead to "COM" jack.

NOTE

For measurements between 2 Amps and 10 Amps, connect red lead to "10A" jack and ensure it is fully pressed home.

2. Set the POWER/FUNCTION switch to "DC.Ω", and RANGE switch to desired "A" position.
3. Open the circuit to be measured and connect test leads IN SERIES with the load in which current is to be measured.
4. Read current value on digital display.

AC VOLTAGE MEASUREMENTS

1. Connect the red lead to "V.Ω", black lead to "COM".
2. Set the POWER/FUNCTION switch to "AC", and RANGE switch to desired "V" position.
3. Connect test leads to device or circuit being tested.
4. Read voltage value on digital display.

AC CURRENT MEASUREMENTS

1. Connect the red lead to "mA", and black lead to "COM". (For measurements between 2 Amps and 10 Amps, red lead should be connected to "10A" jack.)
2. Set the POWER/FUNCTION switch to "AC", and RANGE switch to desired "A" position.
3. Open the circuit to be measured and connect test leads IN SERIES with the load being measured.
4. Read current value on digital display.

RESISTANCE MEASUREMENTS

1. Connect the red lead to "V.Ω" and black lead to "COM".
2. Set the POWER/FUNCTION switch to "DC.Ω", and RANGE switch to desired "OHM" position.
3. If the resistance being measured is connected to a circuit, turn off power and discharge all capacitors before applying test prods.
4. Connect test leads to circuit being measured.
5. Read resistance value on digital display.

DIODE TESTS

1. Connect the red lead to "V.Ω" and black lead to "COM".
2. Set the POWER/FUNCTION switch to "DC.Ω", and RANGE switch to the 2kΩ (⊣◀) position.
3. If the semiconductor junction being measured is connected to a circuit, turn off power and discharge all capacitors.
4. Connect test leads to device.
5. For forward bias, connect the red test lead to anode and black to cathode. For a good diode, the meter will show a value. If the diode under test is defective, "000" (shorted), or "1" (open circuit) will be displayed. When the test leads are connected in reverse (red to cathode, black to anode), a good diode will show "1" or, if it is defective, "000" or other figures.

CONTINUITY CHECKS

1. Connect the red lead to "V.Ω" and black lead to "COM".
2. Set the POWER/FUNCTION switch to "DC.Ω", and RANGE switch to Buzzer (•))) position.
3. Connect test leads to the circuit under test.
4. Built-in buzzer sounds if the circuit under test is low resistance.

TEMPERATURE MEASUREMENT

The meter can be used for making temperature measurements by connecting the thermocouple to "V.Ω" and "COM" jacks.

1. Connect the type K (NiCr-NiAl) thermocouple to the jacks on the instrument.

CAUTION

Do not exceed 150V continuous or 300V momentary (i.e. no more than 10 seconds) to avoid any damage between the "V.Ω" and "COM" jack on the meter.

2. Set the POWER/FUNCTION switch to "DC.Ω", and RANGE switch to "TEMP" position.
3. Place the probe or thermocouple tip on or in the material to be measured and take the temperature reading directly from the display. The reading is in °C.

NOTE

The meter is designed to show temperature automatically when a thermocouple is plugged into the jacks, but the display will show "1" when no thermocouple is connected.

CONDUCTANCE MEASUREMENT

1. Connect the red lead to "V.Ω" and black lead to "COM".
2. Set the POWER/FUNCTION switch to "DC.Ω" and RANGE switch to "S = 1/Ω".

3. Connect test leads to the measuring point and read the value on the display.

NOTE

1. a. SIEMENS(S) = 1/Ohm = international unit of conductance formerly known as the mho (℧).
   b. The readout is in terms of conductance with unit nS (10^{-9} S). If resistance readings are required, then divide 1 by the readout, and multiply by 10,000. The result is in MΩ.
2. The conductance range can be used for leakage testing. The S conductance range effectively extends the resistance measurement capability of this DMM up to 10,000M ohm and thus it can be used to provide useful leakage measurements on various components, diodes, cables, connectors, printed circuit boards, etc. In all cases, the test voltage is <5V DC.

$$\frac{10{,}000}{\text{Readout}} = \text{Resistance (M}\Omega\text{)}$$

Examples

If the measurement result is 10, the resistance reading is:

$$\frac{10{,}000}{10} = 1{,}000\ \text{M}\Omega$$

If the measurement result is 1000:

$$\frac{10{,}000}{1000} = 10\ \text{M}\Omega$$

CAPACITANCE MEASUREMENT

1. Set the POWER/FUNCTION switch to "DC.Ω", and RANGE switch to desired "CAP" position.
2. Before measurement, on any capacitance range, the meter should be zeroed. With nothing connected to the meter, turn the "CAP ZERO ADJ" so that the display reads zero.
3. Insert the capacitor in the CAP sockets. (To measure polarised capacitors, ensure that the polarities of the CAP socket agrees with those on the capacitor.)
4. Read capacitance value on the digital display.

h_{FE} MEASUREMENT

1. Set POWER/FUNCTION switch to "DC.Ω", and RANGE switch to "PNP" or "NPN" position according to type of transistor.
2. Insert the transistor's emitter, base and collector leads into the appropriate pin in the socket marked EBC.
3. The display will now show the value of transistor gain (h_{FE}) between 0 and 1000.

BATTERY REPLACEMENT

CAUTION

Before attempting to remove or replace the battery, disconnect the test leads from any energised circuit to avoid possibility of electrical shock.

1. It is necessary to replace battery when the words "LO BAT" appear in the upper left corner of the display.
2. Slide the battery cover upward by pressing it inward.
3. Unsnap the battery connector and replace with a new 9 volt battery. For maximum life alkaline cells are recommended although any standard PP3 9 volt battery is suitable.
4. Replace the battery cover.

FUSE REPLACEMENT

1. This instrument is provided with a 2A/250V fuse to protect the current measuring circuits which measure up to 2000mA.
2. To replace the fuse, slide the battery cover upward by pressing it inward.
3. Replace blown fuse with new 2A/250V fuse. To prevent fire, do not use a fuse which has a higher rated value than specified.

CALIBRATION

1. GENERAL

1-1. Calibration should be carried out 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.

1-2. Remove the rear cover from the instrument by removing three screws and then lifting off the cover.

2. DC CALIBRATION

2-1. Slide POWER/FUNCTION switch to "DC.Ω", and the RANGE switch to 200mV position.

2-2. Set the output of the calibrator to 190mV ± 0.02% and connect it to the "V.Ω" and "COM" input connectors of the instrument.

2-3. Using a small flat-tipped screw driver, adjust potentiometer VR1 (DC ADJ) until display reads exactly 190.0.

3. AC CALIBRATION

3-1. Slide POWER/FUNCTION switch to "AC".

3-2. Set the output of the AC calibrator for 190mV ± 0.05% pure sine wave at a frequency between 45 and 500Hz and connect it to the "V.Ω" and "COM" input connectors of the multimeter.

3-3. Adjust potentiometer VR2 (AC ADJ) until display reads exactly 190.0.

4. CAPACITANCE CALIBRATION

4-1. 2000pF

Slide POWER/FUNCTION switch to "DC.Ω", and RANGE switch to 2000p position. Turn the "CAP ZERO ADJ" control until the display reads zero. Insert a 1000pF standard capacitor into the CAP test sockets and turn VR3 until the display reads 1000.

4-2. 2μF

Set the RANGE switch to 2μ position and turn the "CAP ZERO ADJ" until the display reads zero. Insert a 1μF standard capacitor into the CAP test sockets and turn VR6 until the display reads 1.000.

4-3. 20μF

Set the RANGE switch to 20μ position and turn the "CAP ZERO ADJ" control until the display reads zero. Insert a 10μF standard capacitor into the CAP test sockets and turn VR5 until the display reads 10.00.

5. TEMPERATURE CALIBRATION

5-1. Slide POWER/FUNCTION switch to "DC.Ω" and RANGE switch to Temp position. Set the output of the calibrator to DC 0.798mV ± 0.02% and connect it to the "V.Ω" and "COM" input connectors. Adjust VR7 until display reads exactly 20 + ambient temperature.

E.g. ambient temperature is 25°C

20 + 25 = 45

6. AFTER CALIBRATION

6-1. Replace the rear cover on the meter by tightening the three screws.

CAUTION

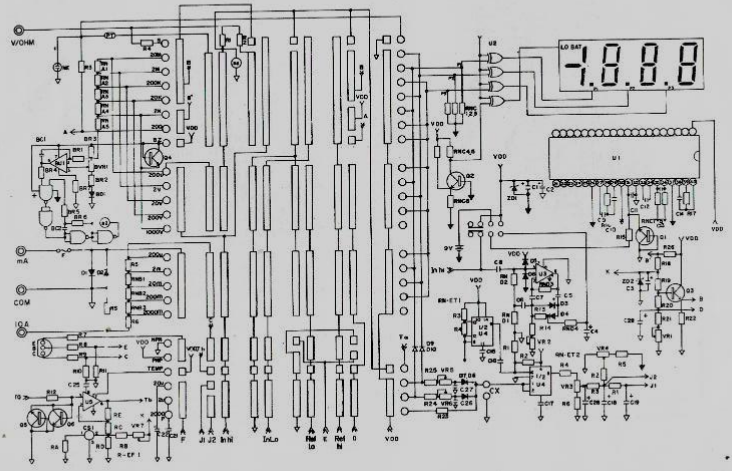
The calibration procedures must be carried out in the sequence shown. DC voltage must always be adjusted prior to AC voltage adjustment.

NOTICE: Specifications are subject to change without notice to ensure that the highest possible quality is maintained at all times.

PARTS LIST

PART	DESCRIPTION	PART	DESCRIPTION
U1	A/D CONVERTER ICL 7106	R11	RESISTOR 2M ¼W F METAL
U2	EX OR GATE CD 4070	R12, 13	RESISTOR 10K ¼W F METAL
U3	OP AMP TL 061	R14	RESISTOR 4.5K ¼W F METAL
U4	DUAL TIMER NE 556	R15	RESISTOR 1M ½W J CARBON
U5	OP AMP LM 308A	R16	RESISTOR 400K ¼W F METAL
US1	CURRENT SOURCE LM 334	R17	RESISTOR 100K ¼W F METAL
Q1, 2, 3, 5, 6	TR NPN SI 2N 3904	R18	RESISTOR 5K ¼W J CARBON
Q4	TR NPN SI GES 5818	R19	RESISTOR 8.2K ¼W F METAL
SG	SPARK GAP 1200V 20%	R20	RESISTOR 20K ¼W F METAL
PT	CURRENT LIMITTER 1K 8mA 500V 20%	R21	RESISTOR 2.3K ¼W F METAL
NE	NEON LAMP 80V	R22	RESISTOR 50K ¼W F METAL
ZD1	ZENER DIODE 12V 1N 963	R23	RESISTOR 995K ¼W F METAL
ZD2	ZENER DIODE 1.2V 1N 9491B	R24	RESISTOR 510 ¼W F METAL
D1, 2	DIODE 50V 3A 1N 5400	R25	RESISTOR 230 ¼W F METAL
D3-10	DIODE SI SWTCHING 1N 4148	R26	RESISTOR 3.3K ¼W F METAL
C1, 2, 3	CAPACITOR 10μF 16V ELECTRIC	RS	SHUNT Mn φ2 0.01Ohm WIRE
C4	CAPACITOR 1μF TANTAL 16V	VR1,2,5,6	SEMI VR 500 CET-091 TYPE
C5, 6	CAPACITOR 4.7μF TANTAL 16V	VR3, 7	SEMI VR 5K CET-091 TYPE
C6,7,11,12,13	CAPACITOR 0.1μF METALIZED 63V	VR4	SEMI VR 2.2K CET-092A TYPE
C8	CAPACITOR 0.022μF MICA 630V	RNA	RESISTOR NET WORK HC DMM-V
C9	CAPACITOR 0.047μF METALIZED 63V	RNB	RESISTOR NET WORK HC DMM-S
C10, 22	CAPACITOR 0.22μF METALIZED 63V	RNC	RESISTOR NET WORK HC 501-C
C14	CAPACITOR 100pF MICA 50V	RND	RESISTOR NET WORK HC 501-D
C15, 17	CAPACITOR 0.01μF CERAMIC 50V	RNE	RESISTOR NET WORK HC 5010 EC OR EF
C16	CAPACITOR 30pF CERAMIC 50V	RNF	RESISTOR NET WORK RN 5010-ET1
C18, 19, 28	CAPACITOR 0.33μF TANTAL 16V	RNG	RESISTOR NET WORK RN 5010-ET2
C21, 26, 27	CAPACITOR 0.022μF MYLAR 50V	IU1	OP AMP TL 061
C25	CAPACITOR 100pF CERAMIC 50V	IU2	QUAD NAND GATE CD 4011
R1	RESISTOR 100½W J CARBON	PBZ	PIEZO BUZZER 21 PA
R2	RESISTOR 910K ¼W J CARBON	BD1	DIODE SI 1N 4148 OR 914
R3	RESISTOR 100½W C METAL	BVR1	SEMI VR 200K SR-085
R4	RESISTOR 10M ½W C METAL	BR1	RESISTOR 220K ¼W J CARBON
R5	RESISTOR 900½W C METAL	BR2	RESISTOR 680K ¼W J CARBON
R6	RESISTOR 0.09 ½W C WIRE	BR3-6	RESISTOR 1M ¼W J CARBON
R7, 9	RESISTOR 270 ¼W F METAL	BR7	RESISTOR 1K ¼W J CARBON
R8	RESISTOR 180K ¼W F METAL	BC1, 2	CAPACITOR 220pF CARAMIC 50V
R10	RESISTOR 2K ¼W F METAL		

SCHEMATIC DIAGRAM



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