

10. *Journal of the American Medical Association*, 2000; 283: 2689-2696.



Revision History

[illegible]

General Specifications of DM-332

Display: 3 3/4 Digit Multimeter**Battery Life:** Typical 200 hours**Operating Temperature:** 0°C ~ 40°C ($\leq 80\%$ RH)**Storage temperature:** -10°C ~ 60°C ($\leq 70\%$ RH)**Accuracy guaranteed temperature:** 23°C \pm 5°C ($\leq 80\%$ RH)**Maximum Reading Rate:** 2 readings / second

Explanation of each part of DM-332

1 LCD Display**1 Power S/W****1 Rotary S/W**

Used for selecting mode and range.

1 Transistor Socket

Used for inserting transistor to measure

1 Terminal Ω -V-mA-Hz

Used for AC/DC voltage, Resistance, frequency and current measure terminal

1 Terminal COM

Used for common terminal

1 Terminal 10A

Used for measuring DC/AC current below 10A

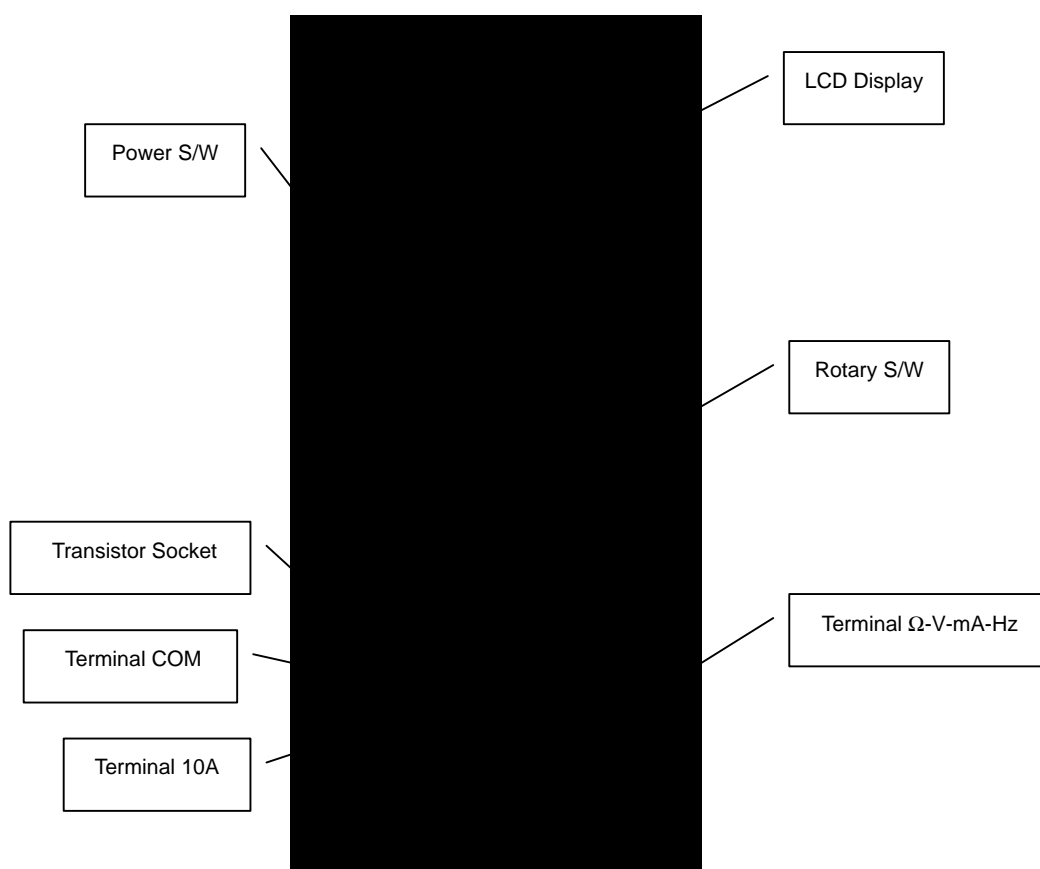


Fig 1 - Front View of DM-332

**Note**

Adjustment and Test of DM-332 should be conducted under proper test environment.

Check operating temperature and relative humidity before adjustment and test.

Accuracy guaranteed temperature: 23°C \pm 5°C (Below 80% RH)

I Test Equipment List

DMM Calibrator: 1set.

Decade Capacitor: 1set.

DC Power Supply (0 ~ 12V) or 9V Battery.

Decade Resistor, Decad Capacitor : Each 1 set

Signal Generator: 1set

DMM (3 3/4 Digit) : 1set

I Calibration Procedure

1. Power On Test

Turn DM-332 on by using power S/W. and check LCD display is turned on.

2. Function Check

2-1. LCD Display Test

Check LCD Display to each range by selecting range with Rotary S/W. Below chart shows correct display

Function	LCD Display to each range
DC VOLTAGE	000.0mV → 0.000V → 00.00V → 000.0V → 0000V
AC VOLTAGE	000.0mV → 0.000V → 00.00V → 000.0V → 0000V
DC CURRENT	0.000mA → 00.00mA → 000.0mA → 00.00A
AC CURRENT	0.000mA → 00.00mA → 000.0mA → 00.00A
BAT	0.000V → 00.00V
HFE	0000
Capacitor	00.00nF → 000.0nF → 0.000uF → 00.00uF
Hz	00.00Hz
Diode	More than 2.400V
Continuity	400.0Ω
Resistor	400.0Ω → 4.000kΩ → 40.00kΩ → 400.0kΩ → 4000kΩ → 40.00MΩ

2-2. MIN/MAX Function Test

Check min/max display is set each time MIN/MAX button is pushed.

2-3. HOLD Function Test

Check display is hold state when HOLD button is pushed.

2-4 Warning System Test

Check Specification	Procedure
Buzzer Sound	Set other range with inserting a probe to 10A terminal on DC 10A range or AC 10A range.
Insertion is not allowable	Insert a probe to 10A terminal on other range except DC 10A range or AC 10A range.

2-5 Auto Power Off Test

DM-332 will be shut down after 30 minutes of no-operation.

2-6. Low Battery Warning Display Test

Check a message, "BATT" on LCD display when Power supply or Battery Voltage goes below 6.4V.

3. Adjustment of DC voltage, AC voltage DC current, Capacitance ,Frequency and Diode.

Function	Adjustment Specification	Adjustment Procedure
Reference Voltage	0.999 ~ 1.000	1. Set Rotary S/W to DC Voltage 400mV range 2. Adjust VR2 to be 1.000V of TP1 voltage.
DC Voltage	389.98~390.02	1. Set Rotary S/W to DC Voltage 400mV range 2. Apply DC 390mV to Terminal COM and Terminal V of DM-332 with a calibrator 3. Adjust VR3 to be displayed 390.00mV on LCD display
AC Voltage	3.895~ 3.905	1. Set Rotary S/W to AC Voltage 4V range 2. Apply AC 3.9V/60Hz to Terminal COM and Terminal V with a calibrator 3. Adjust VR1 to be displayed 3.9V on LCD display
DC Current	9.95 ~ 10.05	1. Set Rotary S/W to DC Current 10A Mode 2. Apply DC 10A current to Terminal COM and Terminal 10A with a calibrator 3. Adjust MN Wire(R39) to be displayed 10.00A on LCD display with a ripper

4. Test

4-1 No Input on DC Voltage Mode

- n Specification : $\pm 0.1\text{mV}$
- n Set Rotary S/W to DC Voltage 400mV range and check DM-332 to meet the above specification.

4-2 No Input on Capacitor Mode

Range	Factory Specification	Test Procedure
40nF	Less than 00.35	Set Rotary S/W to CAP 40nF Range and check displayed value with test specification.
400nF	Less than 001.0	Set Rotary S/W to CAP 400nF Range and check displayed value with test specification.
4uF	Less than 0.010	Set Rotary S/W to CAP 4uF Range and check displayed value with test specification.
40uF	Less than 00.10	Set Rotary S/W to CAP 40uF Range and check displayed value with test specification.

4-3 Short-circuit on DC Voltage Mode

- n Specification : $\pm 0.1\text{ mV}$
- n Set Rotary S/W to DC Voltage 400mV range and Short-circuit between terminal COM and terminal V
- n Check DM-332 to meet the above specification.

4-4 Bar Graph Test

Check bar graph is proportional to measurement value and is displayed correctly.

4-5 DC Voltage Measurement Test

Set Rotary S/W to DC Voltage Mode and Apply below voltage to terminal COM and terminal V to each range with a calibrator

Range	Customer Specification	Factory Specification	Test DC Voltage
DC 400mV	$\pm(0.5\% + 1 \text{dgt})$	$\pm(0.4\% + 1 \text{dgt})$	390mV
DC 4V			3.9V
DC 40V	$\pm(0.5\% + 3 \text{dgt})$	$\pm(0.4\% + 3 \text{dgt})$	39V
DC 400V			390V
DC 1000V	$\pm(0.7\% + 2 \text{dgt})$	$\pm(0.6\% + 2 \text{dgt})$	1000V

4-6 AC Voltage Measurement Test

Set Rotary S/W to AC Voltage Mode and Apply below voltage to terminal COM and terminal V to each range with a calibrator. Check the measurement value to each frequency, 60Hz and 400Hz.

Range	Customer Specification	Factory Specification	Test AC Voltage
AC 400mV	$\pm(1.0\%+3 \text{dgt})$	$\pm(0.9\%+3 \text{dgt})$	390mV/60Hz 390mV/400Hz
AC 4V			3.9V/60Hz 3.9V/400Hz
AC 40V			39V/60Hz 39V/400Hz
AC 400V			390V/60Hz 390V/400Hz
AC 750V			750V/60Hz 750V/400Hz

4-7 DC Current Measurement Test

Set Rotary S/W to DC Current Mode and Apply below DC current to terminal COM and terminal mA to each range with a calibrator. Check the measurement value to each range

Range	Customer Specification	Factory Specification	Test DC Current
DC 4mA	$\pm(1.5\%+2 \text{dgt})$	$\pm(1.4\%+2 \text{dgt})$	3.9mA
DC 40mA			39mA
DC 400mA			390mA



Apply below DC current to **terminal COM and terminal 10A** with a calibrator.

Range	Customer Specification	Factory Specification	Test DC Current
DC 10A	$\pm(2.0\%+5 \text{dgt})$	$\pm(1.9\%+5 \text{dgt})$	9A

4-8 AC Current Measurement Test

Set Rotary S/W to AC Current 20mA Mode and Apply below AC current to terminal COM and terminal mA to each range with a calibrator. Check the measurement value to each range

Range	Customer Specification	Factory Specification	Test AC Current
AC 4mA	$\pm(1.5\%+3\text{dgt})$	$\pm(1.4\%+3\text{dgt})$	3.9mA/60Hz 3.9mA/400Hz
AC 40mA			39mA/60Hz 39mA/400Hz
AC 400mA			390mA/60Hz 390mA/400Hz



Apply below AC current to **terminal COM and terminal 10A** with a calibrator.

Range	Customer Specification	Factory Specification	Test AC Current
AC 10A	$\pm(2.0\%+6\text{dgt})$	$\pm(1.9\%+6\text{dgt})$	9A/60Hz 9A/400Hz

4-9 Resistor Measurement Test

Set Rotary S/W to Resistance Measure Mode and Apply below resistance value to terminal COM and terminal V to each range with decade resistor. Check the measurement value to each range

Range	Customer Specification	Factory Specification	Test Resistance value
400Ω	$\pm(0.7\%+2\text{dgt})$	$\pm(0.6\%+2\text{dgt})$	390Ω
4kΩ			3.9kΩ
40kΩ			39kΩ
400kΩ			390kΩ
4MΩ	$\pm(1.0\%+2\text{dgt})$	$\pm(0.9\%+2\text{dgt})$	3.9MΩ
40MΩ	$\pm(2.5\%+2\text{dgt})$	$\pm(2.4\%+2\text{dgt})$	10MΩ

4-10 Capacitor Measurement Test

Apply below capacitance value between CAP jack with a decade capacitor. In this mode, bar graph is not shown on LCD display.

Range	Customer Specification	Factory Specification	Test Capacitance Value
40nF	$\pm(5.0\%+4\text{dgt})$	$\pm(4.9\%+4\text{dgt})$	39nF
400nF			390nF
4μF			3.9μF
40μF			39μF

4-11 Frequency Measurement Test

Set Rotary S/W to "HZ" mode and apply below frequency value to terminal COM and terminal V with a signal generator

Range	Customer Specification	Factory Specification	Test Frequency Value
Frequency	$\pm(0.3\%+3\text{dgt})$	$\pm(0.3\%+3\text{dgt})$	100Hz/RMS Sine Wave 100mV
			1KHz/RMS Sine Wave 100mV
			10KHz / RMS Sine Wave 100mV
			100KHz / RMS Sine Wave 2V
			900KHz / RMS Sine Wave 4V

4- 12Diode & Continuity Test

Set Rotary S/W to diode test mode and apply a diode to terminal COM and terminal V with forward direction.

Range	Customer Specification	Factory Specification
Diode		Forward Direction : $0.500 \leq$ Reverse Direction : $2.800 \leq$

Set Rotary S/W to continuity test mode and Short-circuit between terminal COM and terminal V.
Buzzer will sound when measurement value is lower than 40Ω .

Range	Customer Specification	Factory Specification
Continuity		Short Circuit : less than 000.3

4- 13 Battery Test

Set Rotary S/W to "BAT" test mode and apply below current to terminal COM and terminal V.

Range	Factory Specification	Test Procedure
1.5V	1.42V ~ 1.58V	Apply DC 110mA on 1.5V range
9V	8.5V ~ 9.5V	Apply DC 9mA on 9V range

4-14 Transistor hFE Measurement Test

Set Rotary S/W to "hFE" mode and insert transistor below to transistor socket

Range	Customer Specification	Factory Specification	Test Transistor
NPN		120 ~ 240	3198Y
PNP			1266Y

4-15 Short-circuit ohm Test

Set Rotary S/W to Resistance 400Ω range and short-circuit to terminal COM and terminal V

Range	Customer Specification	Factory Specification
400Ω		Less than 0.4Ω

Appendix A) Bill of material

LGP P/N	Category	Specification	PCB Find No	Quantity
334-013-1	BUSHING	INPUT CORE BLACK DMM		1
334-013-2	BUSHING	INPUT CORE RED DMM		2
362-035	SPRING	SHIELD SPRING DMM	SP1	1
384-016-1	HOLDER	BAT HOLDER AA(UM-3)X2 UL		1
418-100	FILM VINYL	PPI255 W=65.0 DMM M		1
513-549R5	PCB BARE B/D	DM-332 PCB REV 5		1
521-131	SWITCH	PUSH S.W PS-2216A-L NS		2
531-400	CONNECTOR	HFE SOCKET ESQ-104-23-G-S		1
563-064-2	FUSE	250V 0.5A 50F UL&EU	F1	1
563-066	FUSE	250V 10A H314010 ULE14080	F2	1
563-068	FUSE	125V 1A 22NM MICRO 101L	F3	1
564-015	FUSE HOLDER	FUSE HOLDER FC51A(DMM)		2
564-019	FUSE HOLDER	FUSE HOLDER FC61B 10A		2
571-315	VARIABLE RESISTOR	VR TMC3K B10K (SMD)	VR1	1
571-316	VARIABLE RESISTOR	VR TMC3K B20K (SMD)	VR2,VR3	2
573-119	RESISTOR	M.G 5 MOHM 1/2W 0.25%	R40	1
573-121	RESISTOR	W.W 0.99 OHM 1W 0.25%	R21	1
573-137	RESISTOR	M.G 10 MOHM 1/2W -0.2/0.05%	R9	1
573-138	RESISTOR	M.G 1.11MOHM 1/2W -0.2/0.05%	R16	1
573-139	RESISTOR	M.F 101 KOHM 1/4W -0.2/0.05%	R15	1
573-140	RESISTOR	M.F 10 KOHM 1/4W -0.2/0.05%	R14	1
573-141	RESISTOR	M.F 1 KOHM 1/4W -0.2/0.05%	R13	1
573-142	RESISTOR	M.F 100 -OHM 1/4W -0.2/0.05%	R12	1
574-052-2	PTC	PT05MP-L1K6001	R8	1
574-052-2	PTC	PT05MP-L1K6001	R8A	1
574-055	SPARK GAP	AG15PC 152FS-K2M DAIYOYDEN	SG1	1
581-176	CAPACITOR	ELEC 10UF 16V SRE-TYPE	C7	1
581-195	CAPACITOR	MP 0.1UF 63V J MMY168	C12,C13,C15,C17	4
581-204	CAPACITOR	MP 0.01UF 63V J MMY168	C14	1
581-220	CAPACITOR	MP 0.033UF 63V K MMY168	C10,C11	2
581-221	CAPACITOR	ELEC 0.47UF 50V SRE-TYPE	C4,C5	2
581-222	CAPACITOR	ELEC 2.2UF 35V SRE-TYPE	C8,C9	2
585-154-1	DIODE	RL105	D2,D3,D4,D5	4
585-248	DIODE	KDS226 (SMD) KEC	D1	1
585-262	DIODE	KDS184 (SMD)	D6,D7,D8,D9,D10	5
591-645	IC	NJU9210FD A-D CON NJRC	U1	1
611-664	TRANSISTOR	KSC2328A	Q2,Q3,Q4	3
611-665	TRANSISTOR	KRC110S (SMD)	Q1	1
637-013	BUZZER	BUZZ SBT-11P	B1	1
648-074	CRYSTAL	X-TAL 4MHZ HC-49/U TYPE	Y1	1
873-028R	MN WIRE	MN WIRE CM2 10MOHM	R39	1
873-027	Mn WIRE CM2 DIA 1.6MM	Mn WIRE CM2 DIA1.6MM		1
884-028	PVC TUBE	PVC TUBE VIT-300 27MM ULE843		1

LGP P/N	Category	Specification	PCB Find No	Quantity
CK1HI100D	CAPACITOR	CER 10PF 50V D (2012)	C1	1
CK1HI104M	CAPACITOR	CER 0.1UF 50V M (2012)	C3,C6,C18	3
CK1HI150J	CAPACITOR	CER 15PF 50V J (2012)	c19	1
CK1HI220J	CAPACITOR	CER 22PF 50V J (2012)	C2	1
RD0BP2R2J	RESISTOR	C.F 2.2 -OHM 1/4W 5%	R38	1
RD0CP102J	RESISTOR	C.F 1 KOHM 1/2W 5%	R43	1
RD0CP200J	RESISTOR	C.F 20 -OHM 1/2W 5%	R36	1
RD0CP220J	RESISTOR	C.F 22 -OHM 1/2W 5%	R37	1
RG0CP107J	RESISTOR	M.G 100 MOHM 1/2W 5%	R22,R41	2
RMAH1000J	RESISTOR	M.F 100 -OHM 1/8W 5% (3216)	R5,R42	2
RMAH1001F	RESISTOR	M.F 1 KOHM 1/8W 1% (3216)	R28	1
RMAH1003F	RESISTOR	M.F 100 KOHM 1/8W 1% (3216)	R17,R18	2
RMAH1003J	RESISTOR	M.F 100 KOHM 1/8W 5% (3216)	R4	1
RMAH1004F	RESISTOR	M.F 1 MOHM 1/8W 1% (3216)	R1	1
RMAH1004F	RESISTOR	M.F 1 MOHM 1/8W 1% (3216)	R29	1
RMAH1502J	RESISTOR	M.F 15 KOHM 1/8W 5% (3216)	R26	1
RMAH2202J	RESISTOR	M.F 22 KOHM 1/8W 5% (3216)	R24,R25	2
RMAH3303J	RESISTOR	M.F 330 KOHM 1/8W 5% (3216)	R23	1
RMAH3303J	RESISTOR	M.F 330 KOHM 1/8W 5% (3216)	R27	1
RMAH3602J	RESISTOR	M.F 36 KOHM 1/8W 5% (3216)	R30	1
RMAH43R0F	RESISTOR	M.F 43 -OHM 1/8W 1% (3216)	R3	1
RMAH5100F	RESISTOR	M.F 510 -OHM 1/8W 1% (3216)	R35	1
RMAH6802J	RESISTOR	M.F 68 KOHM 1/8W 5% (3216)	R31	1
RMAH6803J	RESISTOR	M.F 680 KOHM 1/8W 5% (3216)	R32	1
RMBP1000F	RESISTOR	M.F 100 -OHM 1/4W 1%	R11	1
RMBP6803C	RESISTOR	M.F 680 KOHM 1/4W .25%	R33,R34	2
RMBP90R0C	RESISTOR	M.F 90 -OHM 1/4W .25%	R19	1
RMBP9R00C	RESISTOR	M.F 9 -OHM 1/4W .25%	R20	1
RMCP1004F	RESISTOR	M.F 1 MOHM 1/2W 1%	R10	1

Appendix B) Schematic Diagram of DM-332

