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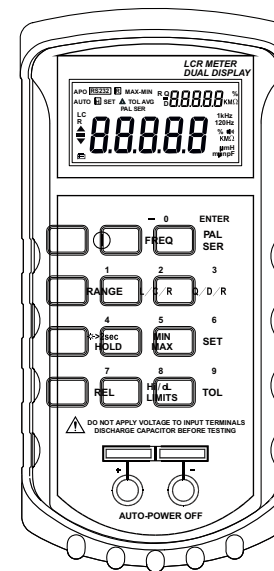**Email :** kusam_meco@vsnl.net
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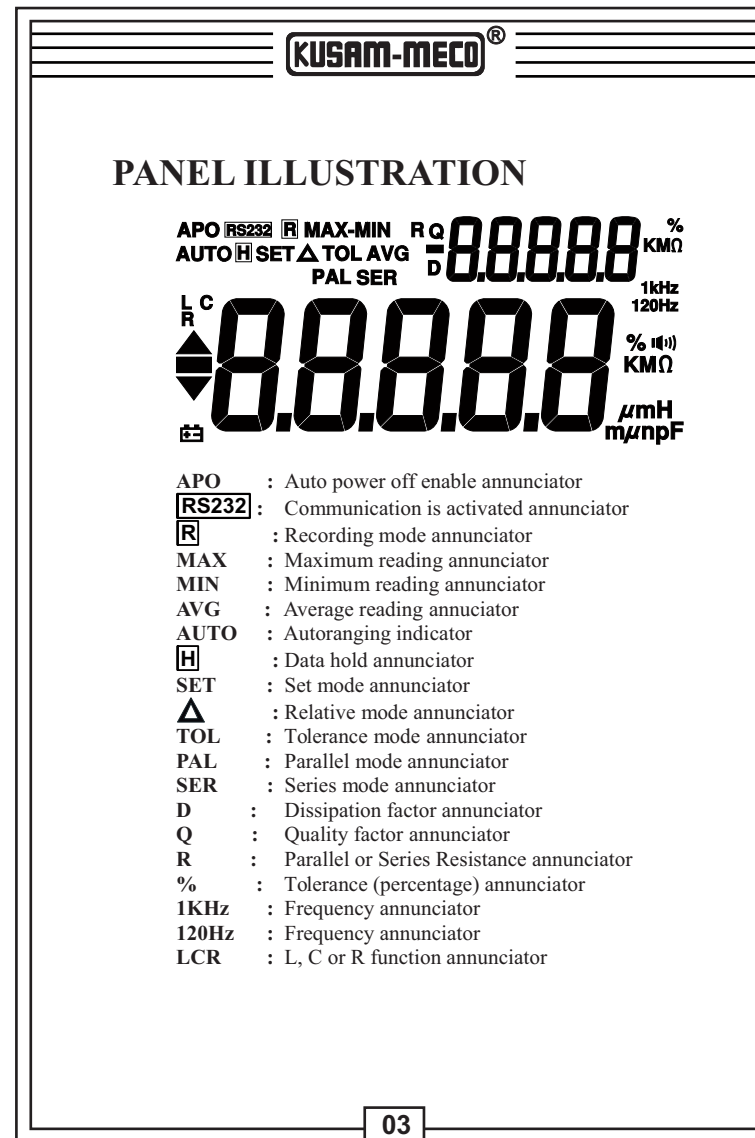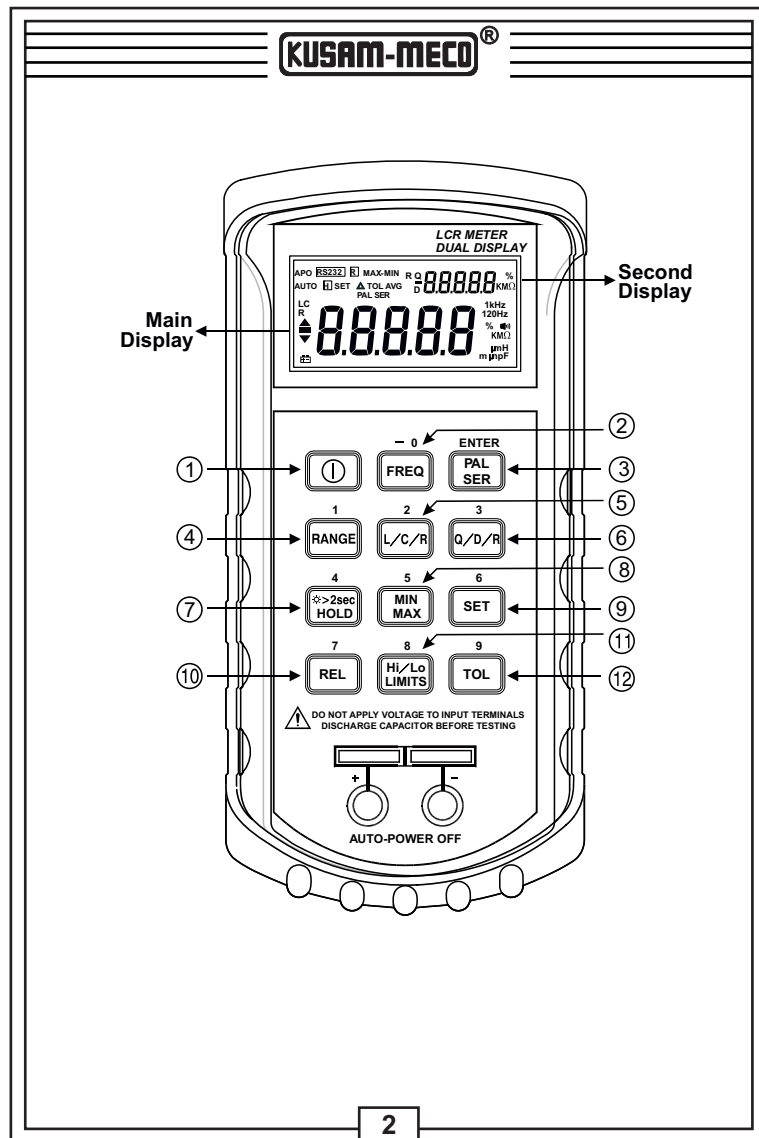**KUSAM-MECO®**

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MODEL KM-459

OPERATION MANUAL

CONTENTS

GENERAL SPECIFICATION

Display:	• 4½ digit liquid crystal display (LCD).
Overload indication:	• "OL" display.
Low battery indication:	• The "⊟" is displayed when the battery voltage drops below the operating level, and cancel all the memorized values to store into EEPROM. (included SET values)
Measurement rate:	• One time per second, nominal.
Operating environment:	• 0°C to 50°C at < 80% RH.
Storage environment:	• -20°C to 60°C at 0 to 80% RH. with battery removed from meter.
Power:	• Single standard 9-volt battery, NEDA 1604, JIS 006P, IEC 6F22.
External power:	• Minimum 12V, maximum 15V, and at least minimum 50mA.
Auto-power:	• As the "APO" is displayed on the LCD, the meter will shut down by itself if unused for about 10 minutes, press the power key to resume power-on mode. The meter will cancel auto power off function when RS232, Max, and external power are used.
FUSE warning:	• Damaged or open fuse indicator.
Note:	• The microprocessor of the meter can self detect if its fuse is either open or damaged. The LCD will display the symbol "FUSE" and an audible beep will sound continuously.
Dimensions:	• 19.2cm (Height), 9.1cm (width), and 5.25cm (thickness).
Weights:	• About 365g (including battery and holster).
Accessories:	• A pair of test leads, manual instruction, (9V battery and spare fuse in the meter).
Protective Fuse:	• 0.1A fast-blow 250V AC.

Main Display

Second Display

LCR METER
DUAL DISPLAY

PANEL ILLUSTRATION

APO	:	Auto power off enable annunciator
RS232	:	Communication is activated annunciator
R	:	Recording mode annunciator
MAX	:	Maximum reading annunciator
MIN	:	Minimum reading annunciator
AVG	:	Average reading annunciator
AUTO	:	Autoranging indicator
H	:	Data hold annunciator
SET	:	Set mode annunciator
△	:	Relative mode annunciator
TOL	:	Tolerance mode annunciator
PAL	:	Parallel mode annunciator
SER	:	Series mode annunciator
D	:	Dissipation factor annunciator
Q	:	Quality factor annunciator
R	:	Parallel or Series Resistance annunciator
%	:	Tolerance (percentage) annunciator
1KHz	:	Frequency annunciator
120Hz	:	Frequency annunciator
LCR	:	L, C or R function annunciator

▲   : Hi limits annunciator, Tolerance high annunciator
▼   : Lo limits annunciator, Tolerance low annunciator
🔋   : Indicates the battery power is weakening
•)))   : Beeper tone indicator for tolerance mode
MKΩ   : Resistance (O) mhannunciator
umH   nduIctance (Henry) annunciator
munpF   : Capacitance(ara) annunciator

SPECIFICATIONS

CAPACITANCE:

Range	Min. F	Max.	Test Frequency 120Hz Cx	DF	Note
10mF	F	10.000mF	±(5.0% rdg + 5 counts) DF<0.1	±(10% rdg + 100/Cx + 5 counts) DF<0.1	after short cal.
2000 F	100nF	1999.9μF	±(1.0% rdg + 5 counts) DF<0.1	±(2.0% rdg + 100/Cx + 5 counts) DF<0.1	after short cal.
200 F	10nF	199.99μF	±(0.7% rdg + 3 counts) DF<0.5	±(0.7% rdg + 100/Cx + 5 counts) DF<0.5	-
20 F	1nF	19.999μF	±(0.7% rdg + 3 counts) DF<0.5	±(0.7% rdg + 100/Cx + 5 counts) DF<0.5	-
2000nF	100pF	1999.9nF	±(0.7% rdg + 3 counts) DF<0.5	±(0.7% rdg + 100/Cx + 5 counts) DF<0.5	-
200nF	10pF	199.99nF	±(0.7% rdg + 5 counts) DF<0.5	±(0.7% rdg + 100/Cx + 5 counts) DF<0.5	after open cal.
20nF	1pF	19.999nF	±(1.0% rdg + 5 counts) DF<0.1	±(2.0% rdg + 100/Cx + 5 counts) DF<0.1	after open cal.

Test Frequency 1KHz

Range	Min.	Max.	Cx	DF	Note
2000 F	100nF	1000.0μF	± (5.0% rdg + 5 counts) DF<0.1	± (10% rdg + 100/Cx + 5 counts) DF<0.1	after short cal.
200 F	10nF	199.99μF	± (1.0% rdg + 3 counts) DF<0.5	± (2.0% rdg + 100/Cx + 5 counts) DF<0.5	after short cal.
20 F	1nF	19.999μF	± (0.7% rdg + 3 counts) DF<0.5	± (0.7% rdg + 100/Cx + 5 counts) DF<0.5	-
2000nF	100pF	1999.9nF	± (0.7% rdg + 3 counts) DF<0.5	± (0.7% rdg + 100/Cx + 5 counts) DF<0.5	-
200nF	10pF	199.99nF	± (0.7% rdg + 5 counts) DF<0.5	± (0.7% rdg + 100/Cx + 5 counts) DF<0.5	-
20nF	1pF	19.999nF	± (0.7% rdg + 5 counts) DF<0.1	± (0.7% rdg + 100/Cx + 5 counts) DF<0.1	after open cal.
2000pF	0.1pF	1999.9pF	± (1.0% rdg + 5 counts) DF<0.1	± (2.0% rdg + 100/Cx + 5 counts) DF<0.1	after open cal.

INDUCTANCE:

Test Frequency 120Hz

Range	Min.	Max.	Lx (DF<0.5)	DF(DF<0.5)	Note
10000H	1H	10000H	Not specified	Not specified	-
2000H	100mH	1999.9H	± (1.0% rdg + Lx/10000 + 5 counts)	± (2.0% rdg + 100/Lx + 5 counts)	after open cal.
200H	10mH	199.99H	± (0.7% rdg + Lx/10000 + 5 counts)	± (1.2% rdg + 100/Lx + 5 counts)	-
20H	1mH	19.999H	± (0.7% rdg + Lx/10000 + 5 counts)	± (1.2% rdg + 100/Lx + 5 counts)	-
2000mH	100μH	1999.9mH	± (0.7% rdg + Lx/10000 + 5 counts)	± (1.2% rdg + 100/Lx + 5 counts)	-
200mH	10 H	199.99mH	± (1.0% rdg + Lx/10000 + 5 counts)	± (3.0% rdg + 100/Lx + 5 counts)	after short cal.
20mH	1 H	19.999mH	± (2.0% rdg + Lx/10000 + 5 counts)	± (10% rdg + 100/Lx + 5 counts)	after short cal.

Test Frequency 1KHz

Range	Min.	Max.	Lx (DF<0.5)	DF(DF<0.5)	Note
2000H	100mH	1000.0H	Not specified	Not specified	-
200H	10mH	199.99H	± (1.0% rdg + Lx/10000 + 5 counts)	± (1.2% rdg + 100/Lx + 5 counts)	after open cal.
20H	1mH	19.999H	± (0.7% rdg + Lx/10000 + 5 counts)	± (1.2% rdg + 100/Lx + 5 counts)	-
2000mH	100μH	1999.9mH	± (0.7% rdg + Lx/10000 + 5 counts)	± (1.2% rdg + 100/Lx + 5 counts)	-
200mH	10 H	199.99mH	± (0.7% rdg + Lx/10000 + 5 counts)	± (1.2% rdg + 100/Lx + 5 counts)	-
20mH	1 H	19.999mH	± (1.2% rdg + Lx/10000 + 5 counts)	± (5.0% rdg + 100/Lx + 5 counts)	after short cal.
2000 H	0.1μH	1999.9μH	± (2.0% rdg + Lx/10000 + 5 counts)	± (10% rdg + 100/Lx + 5 counts)	after short cal.

RESISTANCE:

Range	Min.	Max.	Test Freq. 120Hz	Test Freq. 1KHz	Note
10M	1KΩ	10.000MΩ	± (2.0% rdg + 8 counts)	± (2.0% rdg + 8 counts)	after open cal.
2M	100Ω	1.9999MΩ	± (0.5% rdg + 5 counts)	± (0.5% rdg + 5 counts)	after open cal.
200K	10Ω	199.99KΩ	± (0.5% rdg + 3 counts)	± (0.5% rdg + 3 counts)	-
20K	1Ω	19.999KΩ	± (0.5% rdg + 3 counts)	± (0.5% rdg + 3 counts)	-
2K	100mΩ	1.9999KΩ	± (0.5% rdg + 3 counts)	± (0.5% rdg + 3 counts)	-
200	10mΩ	199.99Ω	± (0.8% rdg + 5 counts)	± (0.8% rdg + 5 counts)	after short cal.
20	1mΩ	19.999Ω	± (1.2% rdg + 8 counts)	± (1.2% rdg + 8 counts)	after short cal.

Note : In 20Ω range, effective readings must over 20 counts.

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Remark

1. Q value is the reciprocal of DF.
2. The specification is based on the testing sockets (clips) performed on the meter.
3. L(C) x indicates the readings of inductance (capacitance) on the display.
   E.g.: inductance (capacitance)=18.888H(F) then L (C) x=18888.

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OPERATION INSTRUCTION

Cautions:

It is recommended that you read the safety and operation instructions before using the meter.

WARNING
Before taking any measurements, please isolate the DUT(Device Under Test) from the power supply. To avoid electric shock, plug off the test leads from the meter before opening case and battery hatch. Do not use the meter if test leads, alligator's clips and appearance look cracked and damaged, Please check periodically. To avoid electric shock, discharge the circuits completely, before taking any measurements.

CAUTION

When it appears to have abnormal situations, such as you cannot turn on the meter to operate.
1. It is normal situation when you cannot turn on the meter after turning off the meter just for few seconds. Please wait a moment to turn it on again.
2. When you cannot operate the meter normally, please turn off it and restart the meter.
3. There are two measuring concerns when it comes to measure under 0.5 ohms.
  i. Use tidy alligator clips to clip the DUT(Device Under Test) reliably. Before taking any measurements, please make short-zeroing calibration to make sure impedance between test leads.
  ii. The DUT(Device Under Test) must keep clean and should not have any oxidization existed or untidy phenomenon, which will affect accuracy.

(1) AUTO POWER-DOWN

If unused for about 10 minutes, the meter will power-down automatically. Press ① button switches to resume power-on mode. When the power is down, press ① button to turn on the meter. The operating condition return to what they were before the power was last turned off.

In the MIN MAX record mode, RS-232 communication mode or using DC power-adaptor auto-power down function is disabled automatically.

Continuous Measurement

In the power down mode, push ① button 2 sec. Until the APO OFF annunciator appears. Will put the meter into the continuous measurement mode.

Power Switch

The ① button turns the meter on or off. In the microcomputer failure status press ① button until the meter off.

(2) FREQUENCY SELECT

Set the "FREQ" button switch to 120Hz or 1KHz according to the specimen to be test. Generally, the electrolytic capacitor is set to 120Hz. Others are set to 1KHz in general.

(3) PARALLEL / SERIES MODE

Set the "PAL SER" button switch to parallel or series measuring circuit mode. However, in the specimen having a high impedance in general, measurement is made in parallel equivalent circuit mode "PAL", while in the specimen having a low impedance, measurement is made in series equivalent circuit mode "SER".

---

(4) RANGE BUTTON

Press (RANGE) button to select the Manual Range mode and turn off the "AUTO" annunciator. (The meter remains in the range it was in when manual ranging was selected). In the Manual Range mode. Each time you press (RANGE) button, the range (and the input range annunciator) increments, and a new value is displayed. To exit the Manual Range mode and return to autoranging, press and hold down (RANGE) button for 2 seconds. The "AUTO" annunciator turns back on.

(5) L/C/R FUNCTION BUTTON (ONLY MAIN DISPLAY)

The L/C/R key switch the measurement parameter in sequence L - C - R - L ..., the annunciator is indicated on LCD. When the meter is turned on, it is set to the measurement parameter selected that was in use when the meter was last turned off.

(6) Q/D/R FUNCTION BUTTON (ONLY SECOND DISPLAY)

The Q/D/R key switch the measurement parameter in sequence Q - D - R - Q ..., the annunciator is indicated on LCD. When the meter is turned on, it is set to the measurement parameter selected that was in use when the meter was last turned off.

(7) HOLD. ☼>2SEC

Press the "HOLD" key to enter the data hold mode, the "HOLD" annunciator is displayed. When Hold mode is selected, the meter stops all further measurements. Press "HOLD" 2 sec to start backlit function, press this key for 2 sec to exit the Backlit function. After starting the backlit for 1 minute, the Backlit function will exit by itself.

(8) MIN/MAX BUTTON

Press "Min/Max" to enter the Min/Max/Avg mode, and stop the auto shut down function, In Addition to power and hold key, the other keys cannot be activated. When the meter samples about 6 times, and then beeper will emit a sound. When a new Max/Min data being recorded and then beeper will emit 2 sounds.

Main display value (second display value) cycles through (Min/ Max key) present value (parameter value) → Max value (parameter value) → Min value (parameter value) → Max value minus Min value (times to test) → The Average Value's display (times to test). The meter will ignore and not to record if overload ("OL") situation happens in the comparative processes or in the capacitance range ≤50 counts.

The Average Value's display is true average recording. It can save up to 3000 times, the "Avg" annunciator will flash when recording times reaching 2991 to 3000 times. When recording over 3000 times the Avg will stop to record and it will also display the average value on the LCD. The meter continues to record the Max/Min value.

Under the Max/Min function, press "HOLD" key to stop recording temporarily but store the former recording value in advance, press "HOLD" again to go on recording. In order to prevent any mistakes or losses taken, you have to press 2 sec to exit the Max/Min function and cancel the original recordings.

(9) SET

1. The "SET" can only be activated only before you have not used any other functions.
2. Press "SET" to enter the SET mode, and change to manual range mode automatically.
3. While in the SET function, the main display is cleared, the second display shows "SET" annunciators, LCD shows Δ, TOL, ▲, ▼, flashing. There are only 5 keys that you can use "Power", "SET", "REL", "Hi/Lo", "TOL" in this moment.

4. OPEN, SHORT calibration:

Press "SET", LCD will display CAL OPEn, and press PAL/SER(ENTER), the program enters "OPEN" calibration, after completing the open. The LCD displays CAL SHrt, press PAL/SER (ENTER). The program enters Short calibration. If you do not want to proceed Short calibration, and press "SET" to exit. When LCD shows CAL SHrt, press PAL/SER (ENTER) key. The program enters "SHORT" calibration. And then back to normal situation.

5. Hi/Lo Limits setting:

Press "Hi/Lo", LCD only shows ▲ flashing. The previous setting Hi will also appear and let user to do the modifications. When you input Lo setting value, the annunciator ▼ is flashing. The previous setting Lo will also appear and let user to do the modifications. When the Lo setting value is greater than the Hi setting value, the LCD shows Err and back to the Hi setting mode. Please to enter the new Hi/Lo setting value.

6. TOL Hi/Lo Limits setting:

Press "TOL", LCD shows TOL flashing. The previous setting standard value will also appear and let user to do the modifications. When you input +TOL setting value, the annunciators "TOL" "▲" are flashing. The previous setting +TOL will also appear and let user to do the modifications. When you input -TOL setting value, the annunciators "TOL" "▼" are flashing. The previous setting -TOL will also appear and let user to do the modifications.

7. REL setting:

Press "REL", LCD shows D flashing. The previous standard setting value will also appear and let user to do the modifications.

8. Data setting:

When using the character on the nameplate to input data, the previous setting will appear, and the place that waits to be entered will flash. INPUT starts from the largest digit to enter, the largest digit only 1, In that case the original setting will flash. The original setting is 0, and the bottom part of seven segments will flash. Press "1" is 1, press any keys is 0, press "ENTER" to exit without change. TOL Hi/Lo Limits setting without largest digit. There is no annunciator flashing After entering 5 digits, In the mean time enters +/- symbols, press "0" to change +/- symbols, press other keys to input + symbol.

*Caution: Press "ENTER", emit two beeps, the data store in volatile storage. The data will store in nonvolatile storage region while the meter power off. In this mode the automatic power-off feather is disabled.

(10) REL RELATIVE MODE (ONLY MAIN DISPLAY)

Press "REL" key to the Relative mode. The displayed reading is stored as a reference value, the display is zeroed and annunciator "Δ" is displayed. Press REL key again to exit the Relative mode.

For example: the displayed reading is 100.0, then press REL to store as a reference value, and the display become zero, to store 100.0 as a standard reference value, if our input signal is 99.5, then the reading will be 99.5-100.0 that equals -0.5. The user (see "SET" in this manual can also set the relative value). When the desired relative value has been entered, press REL key to enter the Relative mode, and press SET key to use Relative value as a reference value. Press REL again to exit the relative Mode.

---

(11) HI/LO LIMITS (ONLY MAIN DISPLAY)

Press "Hi/Lo LIMITS" to enter the Hi/Lo LIMITS mode, and change to manual range mode, the original Hi/LO LIMITS value and annunciators "▲" "▼" appear in the same time individually. When the input exceeds Hi limits, the "▲" is blinking and emits a continuous tone. When the input goes below the Lo limits, the "▼" is blinking and the beeper emits a pulse tone. This warns users that out of setting ranges, press "Hi/Lo LIMITS" again to exit this mode. In additions, the meter will ignore and not to record if overload ("OL") situation happens in the comparative processes or in the capacitance range ≤50 counts.

(12) TOL

Press "TOL" to enter the tolerance mode, and change to manual range mode automatically, the original preset standard value and annunciators "TOL" appear in the same time individually. How to set standard value please refer to SET in this manual. When entering TOL mode, the Main display is the present value and the second display is tolerance value.

There are 4 preset values in the TOL mode for instant use, just to press TOL again to cycle through 1%, 5%, 10%, 20%, then back to the present. When entering the TOL mode, and the annunciator "▲" "▼" will appear in the same time, when the input exceeds Hi limits, the "▲" is blinking and also emits a continuous tone. When the input goes below the LO limits, the "▼" is blinking and the beeper emits a pulse tone. This warns users that out of setting ranges.

The standard value can be set by SET function, please refer to SET setting in this manual. When standard value have set, and press "TOL" then press "SET" to use preset TOL setting. In additions, the meter will ignore and not to record if overload ("OL") situation happens in the comparative processes or in the capacitance range ≤50 counts. Press "TOL" 2 sec to exit this function.

MAINTENANCE

> **WARNING**
> Remove test leads before changing battery or fuse or performing any servicing.

Battery Replacement
Power is supplied by a 9 volt "transistor" battery. (NEDA 1604, IEC 6F22). The " ⊞ " appears on the LCD display when replacement is needed. To replace the battery, remove the two screws from the back of the meter and lift off the battery case. Remove the battery from battery contacts.

Fuse Replacement
The LCD display the symbol "FUSE" and an audible beep will sound. Replace fuse only with the original type 0.1A/250V, fast acting fuse.

Cleaning
Periodically wipe the case with a damp cloth and detergent, do not use abrasives or solvents.

RS-232 COMMAND TABLE

Use IR as the interface of Data transmission, and use external computer to start RS-232 functions.

RS-232 Interface Parameter:
Baud rate: 1200
Parity check: EVEN
Data buts: 7
Stop bits: 1

(1) Setup Selections
    a. Command S: Meter will enter the Setup mode and return "SETUP READY_x". (x: firmware version)

    b. Command
    [E(L/C/R)(Q/D/R)(P/S)(A/B)(A/M)(0~6)]:
    Main function change

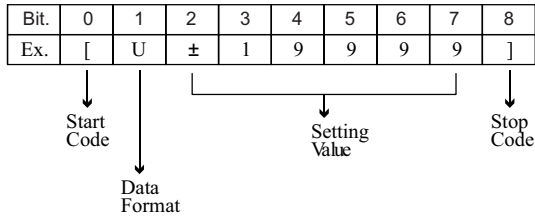|	
(L/C/R)	: L, C or R test function
(Q/D/R)	: Q, D or R
(P/S)	: P-PAL / S-SER
(A/B)	: A - 1KHz / B - 120Hz
(A/M)	: A - AUTO / M - MANUAL
(0~6)	: Manual range

Bit.	0	1	2	3	4	5	6	7	8
Ex.	[	U	±	1	9	9	9	9	]

Start Code   Data Format   Setting Value   Stop Code

[U±19999]   **:** REL SET setting value
[V±19999]   **:** Limits Hi setting value
[W±19999]   **:** Limits Lo setting value
[X±19999]   **:** TOL SET setting value
[Y±19999]   **:** TOL SET Hi setting value
[Z±19999]   **:** TOL SET Lo setting value

After receiving of setting data from PC (U/V/W/X/Y/Z), and will send out the receiving data again then it is convenient for PC to check the accuracy of data output are total 7 digits.

  c. Command [BXXXXXX]: Exit the SETUP mode

(2) Read Data
  Command N: Read Meter current data and status. Data format: There are 39 ASCII code.
  The Main Display data just send L/C/R data that don't process before (like the data before REL). The Second Display data is the same as Main.

1.   L / C / R
2.   Q / D / R
3.   A(1KHz) / B(120Hz)
4.   P(PAL) / S(SER)
5.   A(AUTO) / M(MENU)
6.   0 / 1: Main Display MSD,
     8: while changing range ,
     9: OL
7.   6~10: Main Display Data
8.
9.
10.   LSD
11.   Main Display Range
12.   MSD
13.   12~15: Second Display Data
14.
15.   LSD
16.   Second Display Range , 9: OL
17.   Sequence 0~9 cycling
18.   MSD
19.   18~21: D value
20.
21.   LSD
22.   Range for D value , 9: OL
23.   MSD
24.   23~26: Q value
25.

26. LSD
27. Range for Q value , 9 : OL
28. S(SET) / _(normal)
29. F(FUSE) / _(normal)
30. H(HOLD) / _(normal)
31. R(Present value) / M(Maximum value) /I(Minimum value) / X(Max-Min value) / A(Average value) / _(normal)
32. R(REL) / S(REL SET) / _(normal)
33. L(LIMITS) / _(normal)
34. T(TOL) / S(TOL SET) / _(normal)
35. B(Backlight) / _(normal)
36. A(Adapter insert) / _(normal)
37. B(Low Battery) / _(normal)
38. CR (ASCII : 0DH)
39. nl(LF) (ASCII : 0AH)

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(3) RS-232 Output Chart for Main Display:

Range	Rs	R 1KHz/120Hz	L 1KHz	L 120Hz	RS	C 1KHz	C 120Hz
0	100Ω	20.000Ω	2000.0µH	20.000mH	100KΩ	2000.0pF	20.000nF
1	100Ω	200.00Ω	20.000mH	200.00mH	100KΩ	20.000nF	200.00nF
2	100Ω	2000.0Ω	200.00mH	2000.0mH	10KΩ	200.00nF	2000.0nF
3	1KΩ	20.000KΩ	2000.0mH	20.000H	1KΩ	2000.0nF	20.000µF
4	10KΩ	200.00KΩ	20.000H	200.00H	100Ω	20.000µF	200.00µF
5	100KΩ	2000.0KΩ	200.00H	2000.0H	100Ω	200.00µF	2000.0µF
6	100KΩ	10.000MΩ	1000.0H	10000H	100Ω	2000.0µF	10.000mF

(4) RS-232 Output Chart for Second Display:

Range	Q/D	R (Rs=100)	R (Rs=1K, 10K)	R (Rs=100K)
1	999.9	99.99Ω	99.99Ω	X
2	99.99	999.9Ω	999.9Ω	999.9Ω
3	9.999	9.999KΩ	9.999KΩ	9.999KΩ
4	.9999	99.99KΩ	99.99KΩ	99.99KΩ
5	X	X	999.9KΩ	999.9KΩ

(5) FORMULA:

$R_P = R_S(1+Q^2)$
$C_P = C_S[1/(1+D^2)]$
$C_S = C_P(1+D^2)$
$L_P = L_S[1+(1/Q^2)]$
$L_S = L_P[Q^2/(1+Q^2)]$