I-CAN User Manual

Picture Perfect Measurements™

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Geodetic Services

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I-CAN Equipment List

The I-CAN system consists of: -

- One I-CAN canister
- One I-CAN canister controller
- One internal (chamber) cable
- One external cable
- One chamber wall penetration cable (interface through chamber plate)*
- One I-CAN temperature interface cable*
- One I-CAN temperature monitor*
- One I-CAN manual

*** Optional Items**

Important Precautions

- NEVER touch or handle the glass portion of the canister.
- Ensure the INCA camera is switched on before sealing it in the canister. The power can be cycled from the control box as required.
- Always cover the canister window when not in use.
- Monitor the internal temperature of the canister when in use.
- Ensure power to the controller and camera is OFF before attaching cables.
- Never force cable connections together. The cables are slotted and will fit easily together provided they are correctly aligned.
- Upon closing ensure that all canister bolts are tightened. Use the slip washers provided with the canister.
- Purge the internal canister environment after sealing.
- Ensure the canister is thermally wrapped for cold tests.
- Ensure the canister is GN_2 cooled for all tests. The camera itself will generate heat and this will naturally raise the internal canister temperature.
- Thermally shield the internal chamber cable for cold tests.
- Out gas all chamber components prior to use.

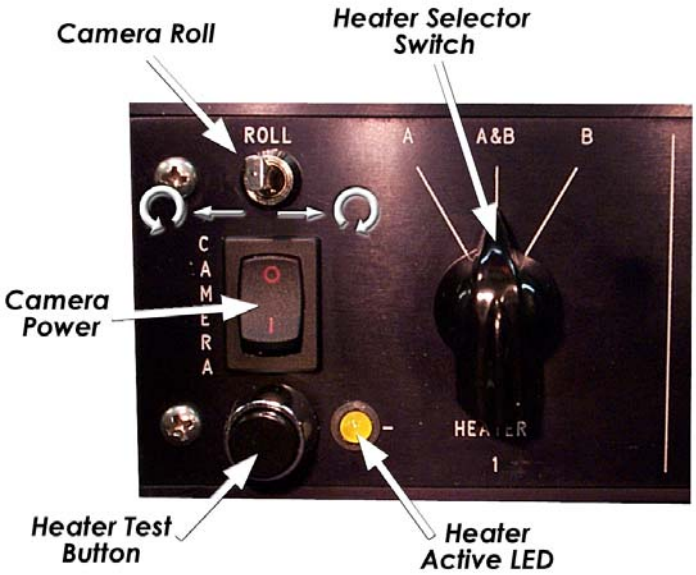
I-CAN Components

The diagrams below show the location of the primary I-CAN controls. The controls for camera 1 and 2 are identical.

Front Face of Controller.

Camera Power – Push down to power up the camera.

Camera Roll – Push left to roll the camera anti clockwise. Push right to roll the camera clockwise. The canister is equipped with limit switches that will prevent the camera from being rolled 360°. This is to protect the wiring from damage due to twisting.



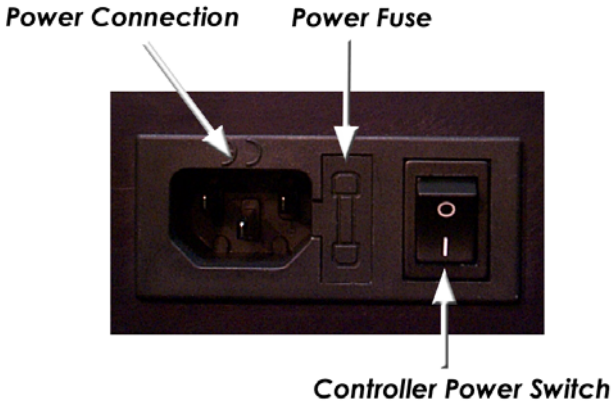
Heater Selector Switch – The canister is equipped with two internal heaters (A&B). These heaters are selected using the heater selector switch. The heaters are activated automatically once the temperature in the canister drops below 10°C. When active the heater active LED will be lit. Select "A&B" if the Heater Active LED is lit greater than 50% of the time.

Heater Test Button – The heaters in the canister can be tested using the heater test button. If operational the heater LED will be lit up. If LED fails to light then check the Heater Fuses located on the rear panel

Heater Active LED – This LED is lit when either or both of the heaters is active.

Rear Face of Controller

Power Connection – Power cord connection socket.

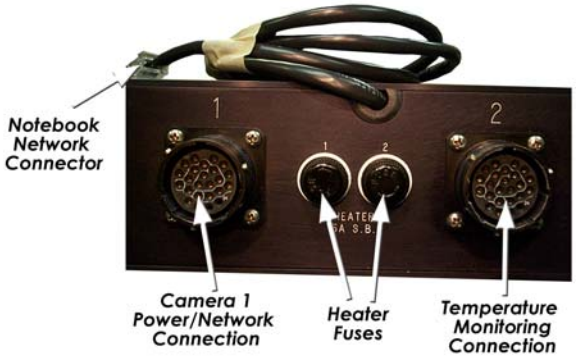


Power Fuse – Check and replace if unit will not power up. Ensure that any replacement fuses used match blown fuse precisely. The fuse of your AC supply should be 250VAC 6.3A(110V) or a 250VAC 3.15A(220V). Before exchanging a blown fuse switch off the unit and remove the mains cable. If the new fuse blows immediately upon reconnection contact GSI for further assistance.

Controller Power Switch– Push down to power up the I-CAN controller.

Notebook Network Connector – Connect to notebook network card.

Camera 1 Power/Network Connection – Supplies the camera with power and network.

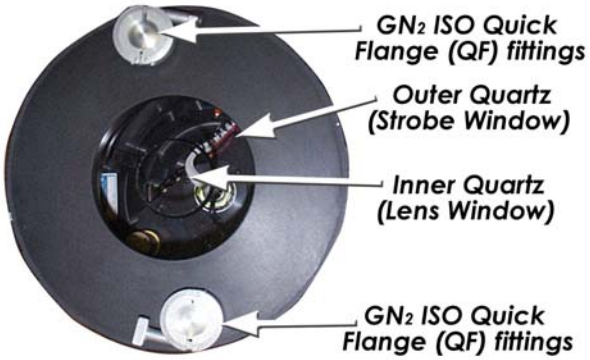


Heater Fuses – Check and replace if heaters will not function when tested. Ensure that any replacement fuses used match blown fuse precisely. The fuse should be a 250V 6.3A Slow Blo. Before exchanging a blown fuse switch off the unit and remove the mains cable. If the new fuse blows immediately upon reconnection contact GSI for further assistance.

Temperature Monitoring Connection* – Connect the supplied cable to this connection to monitor the internal temperature of the canister. (Note – Camera ports 1 and 2 are identical and can be used interchangeably)

(* Optional item)

I-CAN Front Face



GN2 ISO Quick Flange (QF) fittings– Connection point for optional supply of gaseous nitrogen. The nitrogen should be used for cooling the canister in cases where the internal temperature exceeds the prescribed range.

Outer Quartz – Portion of the I-CAN window that the strobe flashes through.

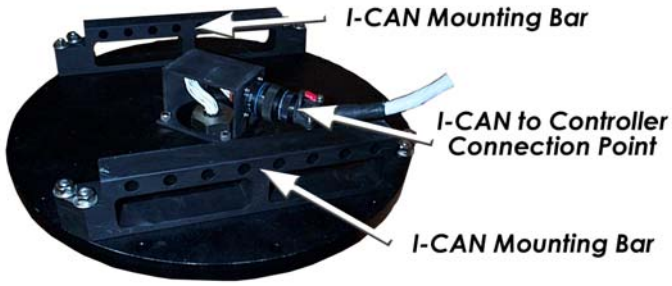
Inner Quartz – Portion of the I-CAN window that the camera looks through.

Solid Quartz – One-piece window that has replaced original two-piece design.

I-CAN Rear Face

I-CAN Mounting Bar – Used to mount I-CAN to external structure

I-CAN to Controller Connection Point– Internal chamber cable is connected here.



I-CAN Internal

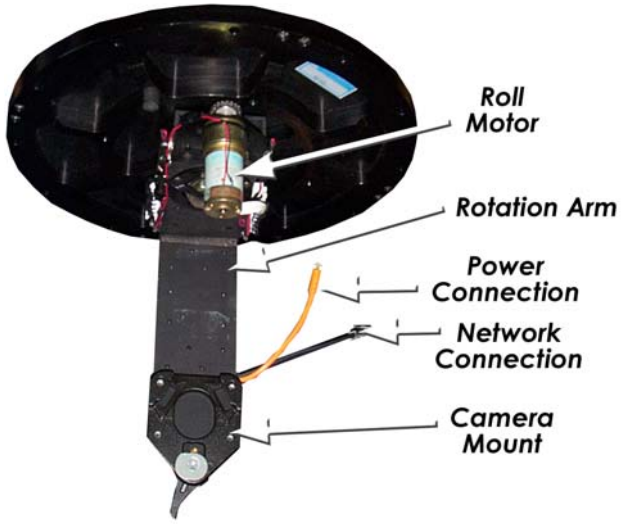
Roll Motor – Used to rotate camera arm

Rotation Arm – Arm that supports camera

Power Connection – Connects I-CAN to INCA camera power.

Network Connection – Connects I-CAN to INCA camera network

Camera Mount – Connects INCA camera to rotation arm



NOTE – If the canister is being used with an INCA2 then the power and network connection will be combined into one connector.

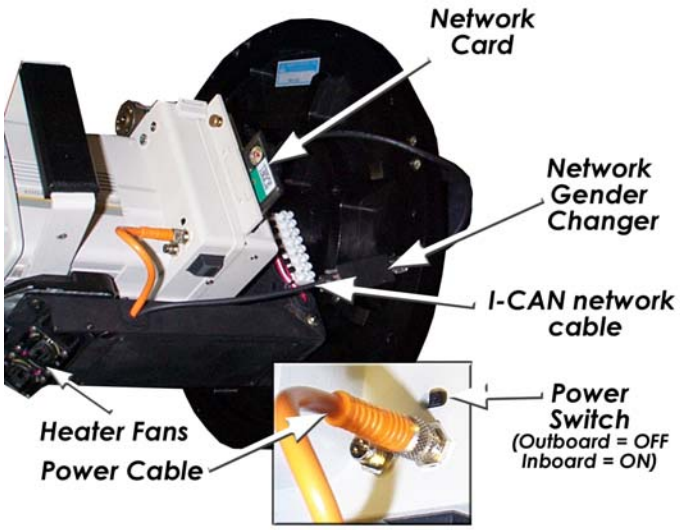
I-CAN Assembly

The system assembly can be broken down into the following tasks.

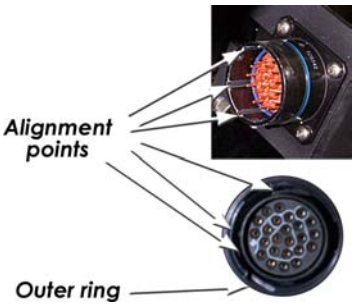
1. Camera attachment and setup
2. Controller connections
3. System test
4. Closing I-CAN
5. Purging the canister

Camera attachment and setup

1. The I-CAN rotation arm has a standard hexagonal mount that is compatible with the mount on the base of the INCA.
2. Ensure the mount quick lock mechanism is in the open position. (Refer to the adjacent diagram).
3. Remove the INCA from its box and carefully align the hexagonal base. The camera should be orientated so the lens faces out.
4. Ensure the quick lock mechanism is secure before releasing the camera.
5. Plug the network card into the rear slot of the INCA camera.
6. Plug the end of the network card cable into the network gender changer.
7. Plug the I-CAN network cable into the changer.
8. Plug in the orange power cable into the outer 4-pin plug on the INCA. Make sure that it is securely attached.
9. Slide the INCA power switch to the ON position.



Cable connections



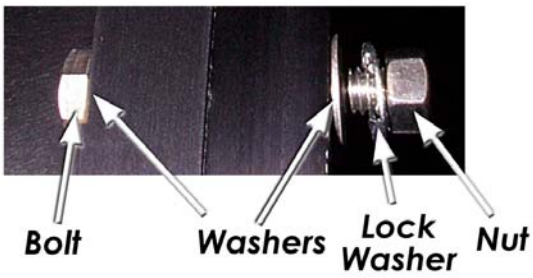
1. Connect the internal chamber cable to the rear of the canister. The connections have slots and must be correctly aligned before connection. Do not force the connection, as this will damage the cable pins. Once aligned turn the outer ring. If aligned correctly the cable end will join.
2. Connect the external chamber cable to the "Camera 1" connection on the rear of the I-CAN controller. Once again, ensure the plugs are aligned when attempting to connect them.
3. Connect the temperature monitor plug to the Camera 2 connection.
4. Plug the ends of the temperature monitoring cable into the supplied temperature monitor.
5. Connect the power cable to the rear of the controller.
6. Connect the external and internal cables to the corresponding customer designed chamber penetration interface using the supplied 1m cable.
7. Connect the controller network cable to the laptop network card.

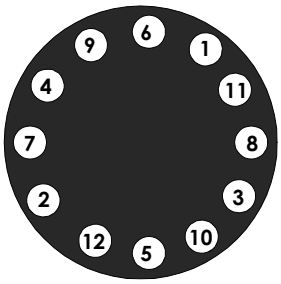
System Test

1. It is strongly advisable to perform a system test prior to sealing the canister.
2. Switch on the power to the I-CAN controller. The controller unit fans will start.
3. Switch on the power to camera 1 on the controller. Verify that the camera is booting. If it isn't, check to make sure that the camera is switched on.
4. Push the rotation controller to the left and verify that the camera is rotating anti-clockwise. Keep rotating the camera until it reaches the limit switch. Verify the camera stops rotating when it reaches the limit.
5. Push the rotation controller to the right and verify that the camera is rotating clockwise. Keep rotating the camera until it reaches the limit switch. Once again verify that the camera stops rotating when it reaches the limit.
6. Switch the heater selector to "A" and press the test switch. Verify that the LED lights.
7. Switch the heater selector to "B" and press the test switch. Verify that the LED lights.
8. Switch on the Temperature monitor and verify that it is recording the room temperature. Use an independent thermometer to check this.
9. Start a new project in V-STARS and verify that photos can be taken online.

Closing I-CAN

1. Ensure the lens cap has been removed from the camera.
2. Check that all the components have been correctly assembled.
3. Power up the camera.
4. Take the canister shell and carefully lower it over the canister. Ensure that none of the cables are trapped between the base and the seal of the canister shell.
5. Rotate the shell until the hole patterns correctly align. If the ISO Quick Flange (QF) fittings are being used then ensure that they are on the left and right sides of the camera. This will ensure that the connection tubes don't obscure the camera.
6. Take a washer and pass it through the shaft of one of the canister seal bolts. Pass the bolt through the hole. The head of the bolt is at the front of the canister.
7. Add the second washer, a lock washer and then the nut. Refer to the adjacent diagram.
8. Finger tighten the nut.
9. Add the remaining 11 bolts in the same manner.
10. Once all the bolts are in place, tighten the first bolt using a torque spanner to 5ft/lbs (6Nm).
11. Move through the sequence of bolts shown in the adjacent diagram and tighten these to 5ft/lbs (6Nm).
12. Move back to the first bolt and tighten it to 10ft/lbs (14Nm). Repeat the pattern until all the bolts have been tightened to 10ft/lbs (14Nm.
13. Move back to the first bolt and tighten it to 15ft/lbs (20Nm). Repeat the pattern until all the bolts have been tightened.





Purging the canister

Follow all the safety instructions associated with the use of GN_2 when completing the following instructions.

1. Once sealed it is necessary to purge the atmosphere in the canister. This will remove all the water vapor and hence prevent condensation on the glass or lens surface. Typically GN2 is used.
2. Remove the two flange covers on the front of the canister.
3. Connect the GN_2 hose to one of the flanges.
4. Commence pumping the gas into the canister.
5. The amount of time required to purge the canister will depend on the pressure the GN_2 is flowing at.
6. When the air has been purged seal the first flange.
7. Remove the hose and seal the second flange.

I-CAN Operation

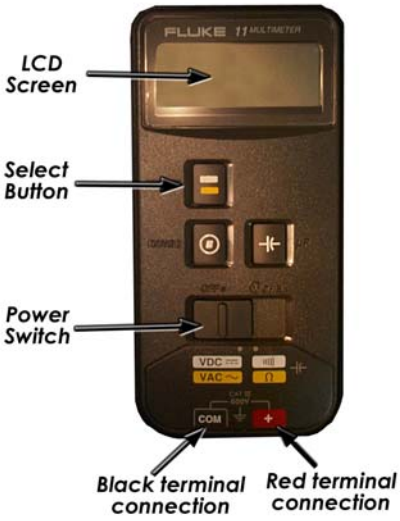
Once correctly assembled the system is ready for use. The following describes some of the features of the I-CAN system.

Canister Internal Temperature (Optional item)

The canister is fitted with a thermistor. The resistance of the thermistor changes with temperature and hence the temperature can be determined by measuring the resistance.

To determine the temperature within the canister:

1. Attach the interface cable to the rear of the canister.
2. Plug in the connectors at the end of the plug into the multimeter. Use the adjacent diagram as a guide. Refer to Appendix A for further instructions
3. Switch on the meter by sliding the switch all the way over to the right. Refer to adjacent diagram.
4. Press the "Select" button once to select resistance.
5. Read the resistance and use the supplied table to determine the corresponding temperature. The table is shown below.



Resistance (kΩ)	*Temperature (°C)*	*Temperature (°F)*
9.83	0	32
7.64	5	41
5.98	10	50
4.72	15	59
3.15	20	68
3.00	25	77
2.41	30	86
1.96	35	95
1.60	40	104

To use the table, simply read off the temperature at the measured resistance value. Please note that the acceptable operation range of the camera is 0°C to 40°C.

6. To reset the meter simply switch it off and on
7. Refer to Appendix A for further instructions on the Fluke Multimeter.

Heaters

The canister comes with two independently wired heaters. This redundancy provides the canister with a fail safe if one heater fails. In addition, the two heaters can operate simultaneously and thus double the heat output. The heaters commence operation when the contacts of two series thermostats close. These contacts close @ 50F +/- 7F degrees, and open at 70F +/-5F degrees (10C +/- 4C close; 21C +/- 3C open). Two fans within the canister help circulate the heat down the hollow arm bracket and over the lens of the camera.

The selection of which heater to use is completely arbitrary. During normal operation the heater should cycle between on and off. If the heater light is on continuously switch the selector to the "A & B" option. This will effectively double the heat output. Use the Temperature monitor as a guide.

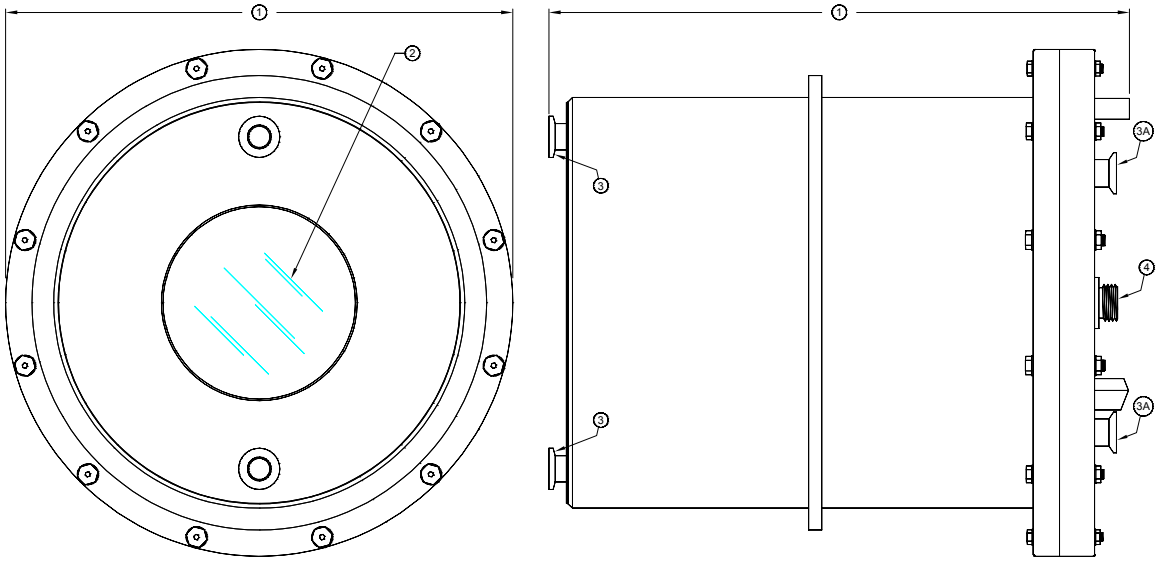
Camera Rotation

The camera can be rotated using the toggle switch on the controller. Pushing the switch left will rotate the camera anti clockwise. Pushing the switch right will rotate the controller clockwise.

Limit switches prevent the camera rolling the full 360°. This is to protect the wiring from damage due to twisting. The camera is capable of 315°.

Specifications

I-CAN Canister



ENVIRONMENTAL CHAMBER CAMERA PHYSICAL SPECIFICATIONS

1. DIAMETER=37 cm, LENGTH=46 cm
2. FUSED QUARTZ WINDOW, 14 cm DIAMETER
3. ISO-QF FITTINGS FOR DRY NITROGEN PURGE
3A. OPTIONAL ISO-QF FITTINGS
4. ELECTRICAL CONNECTOR

GROSS WEIGHT WITH CAMERA INSTALLED: 25 kg

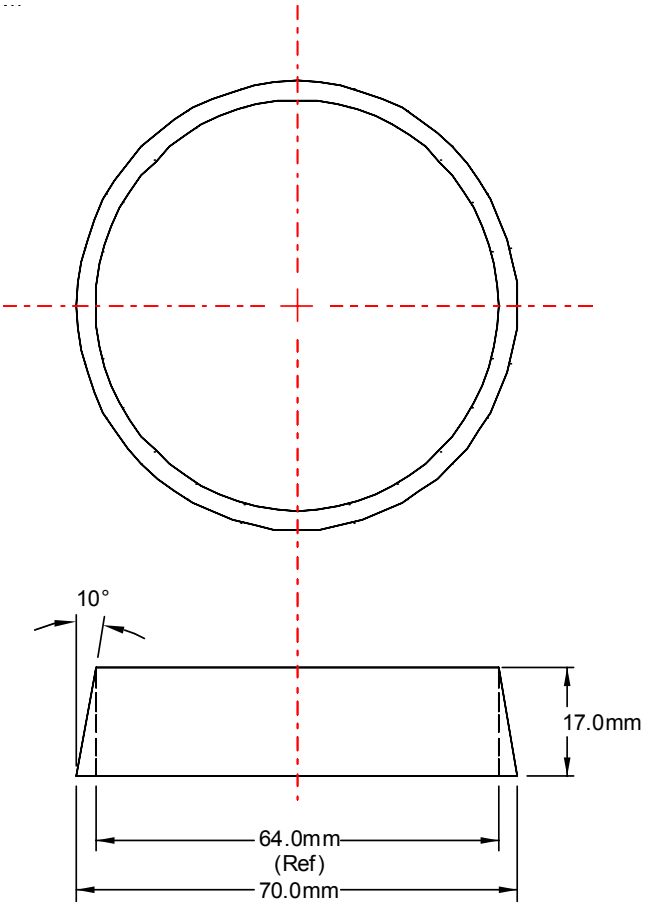
OPERATIONAL SPECIFICATIONS

PRESSURE: 3×10^{-8} TO 765 TORR, EXTERNAL
765 TORR, INTERNAL (NOMINAL)

EXTERNAL TEMPERATURE: -200°C TO +100°C
INTERNAL OPERATING TEMPERATURE: 15°C TO 30°C
(WITH THERMAL WRAP AND NITROGEN PURGE)

EXTERNAL POWER: 230v, 50Hz OR 120v, 60Hz

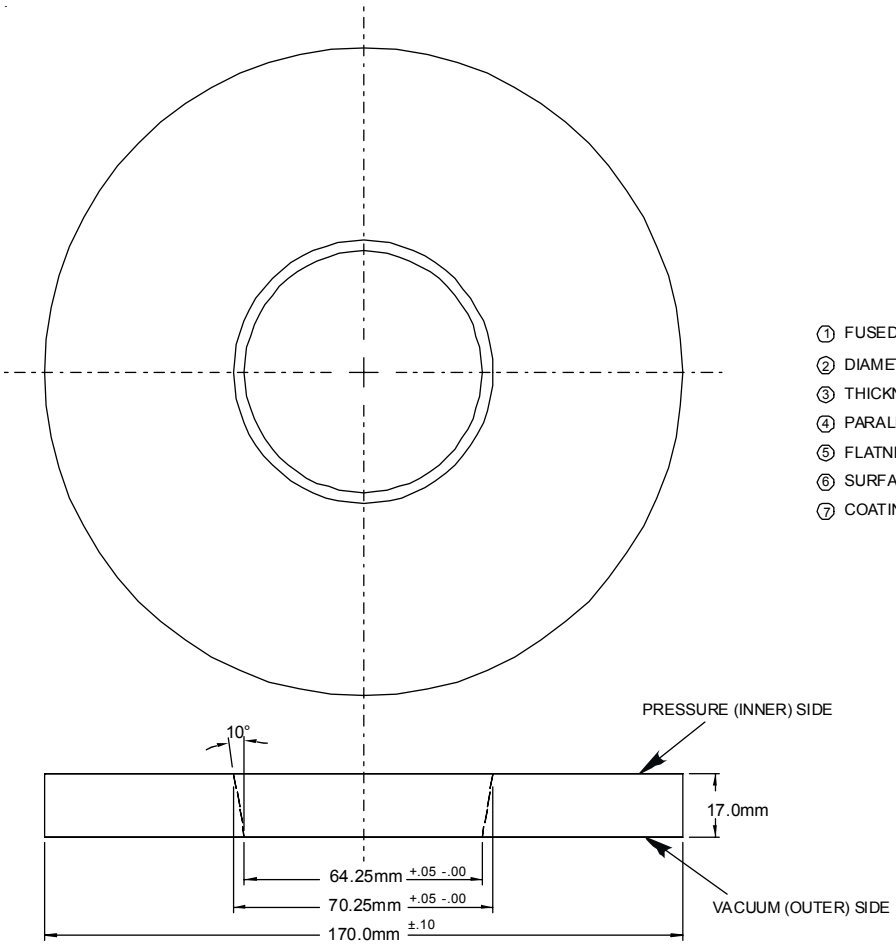
I-CAN Canister Fused Silica Window (Inner Lens Portion)



NOTES

1. MATERIAL: FUSED SILICA, GRADE A1 OPTICAL OR BETTER.
2. DIAMETER TOLERANCES: +0.00, -0.05mm
3. THICKNESS TOLERANCES: ±0.05mm
4. PARALLELISM: 5 arc sec.
5. FLATNESS: 1/10 [redacted] @ .63 [redacted]m, BOTH SIDES
6. SURFACE QUALITY: 10-5 (SCRATCH-DIG)
7. COATING: NONE

I-CAN Canister Annular Window (Outer Flash Portion)

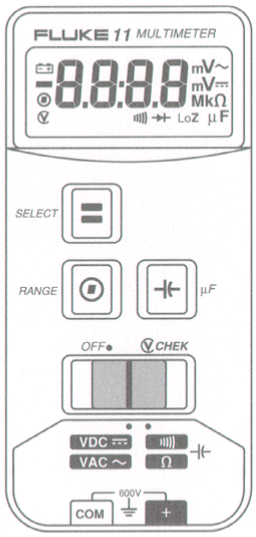


NOTES:

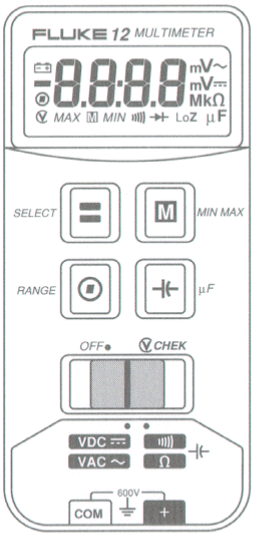
① FUSED QUARTZ, COMMERCIAL GRADE.
② DIAMETER: AS SHOWN.
③ THICKNESS: ±.10mm.
④ PARALLELISM: 1 min.
⑤ FLATNESS: 10 ▌/ INCH @ 0.63 m_m
⑥ SURFACE QUALITY 20-10 (SCRATCH DIG)
⑦ COATING: NONE.

Appendix – Fluke 11 Multimeter

FLUKE 11



FLUKE 12



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11/12
MULTIMETER

USERS MANUAL

PN 900191
July 1991 Rev. 1 12/93

FLUKE®

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READ FIRST: SAFETY INFORMATION

This meter has been designed and tested in accordance with IEC Publication 1010. To ensure that the meter is used safely, follow all safety and operating instructions in this manual. If the meter is not used as described in this manual, the safety features of the meter might be impaired.

- Do not use the meter if the meter or test leads look damaged, or if you suspect that the meter is not operating properly.
- Turn off power to the circuit under test before cutting, unsoldering, or breaking the circuit. Small amounts of current can be dangerous.
- Do not apply more than 600V rms between a terminal and earth ground.
- Use caution when working above 60V dc or 30V ac rms. Such voltages pose a shock hazard.
- When using the probes, keep your fingers behind the finger guards on the probes.
- Disconnect the live test lead before disconnecting the common test lead.

SYMBOLS

The following international electrical symbols are used in this manual:

- ⚠ Important Safety Information in Manual
- ⊘ Not Applicable to Identified Model
- ~ AC
- ⎓ DC
- ⊣▶ Diode
- ⊣(Capacitor
- ⏚ Ground
- ⧈ Double Insulation

DISPLAY

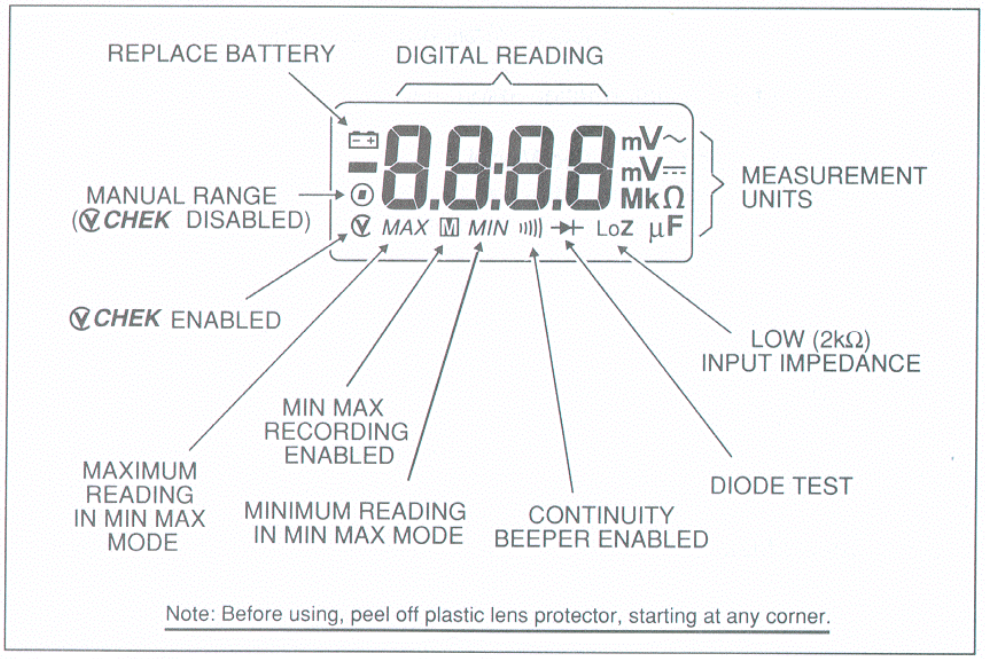

Figure 1. Display

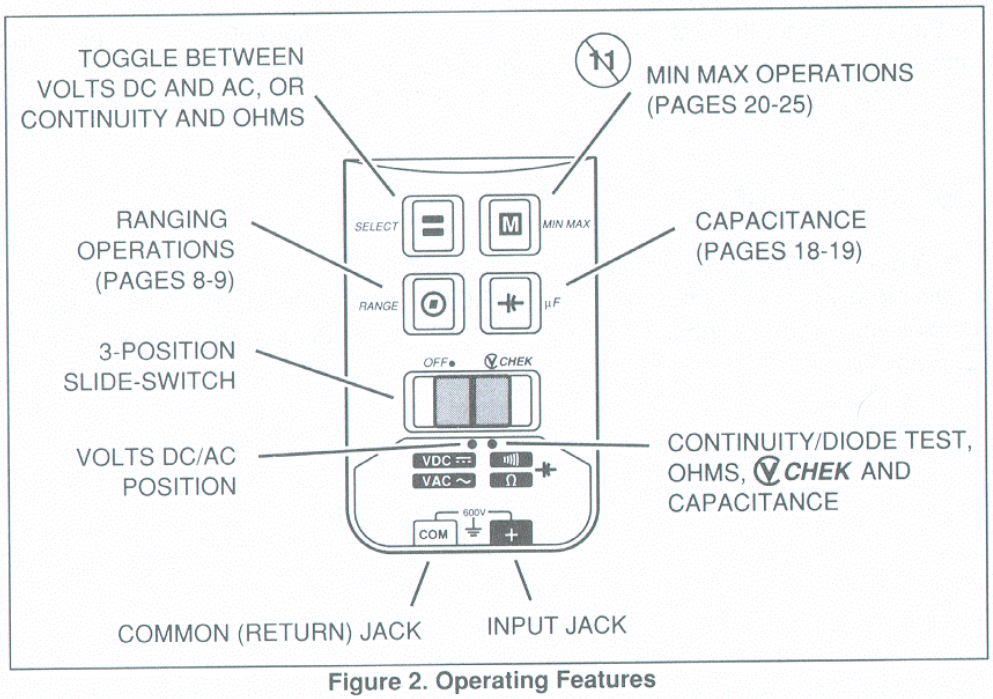

Figure 2. Operating Features

STANDBY MODE

In Standby mode, the display goes blank to preserve battery life. The meter beeps and enters Standby if it is ON but inactive for more than 45 minutes. Press any pushbutton to resume operation. Standby is not allowed if the meter is in the MIN MAX mode.

[⊙] INPUT RANGES

The input range determines the highest value the meter will measure. Most functions have more than one range (see SPECIFICATIONS). If the range is too low, the display shows OL (overload). If the range is too high, the display will show fewer digits of resolution.

Autoranging

The meter defaults to autorange when you turn it on. In autorange, the meter selects the range automatically.

Manually Selecting a Range

The meter also has a manual range mode. In manual range, you select and lock the meter in a range. To manually select a range:

1. Press [⊙]. The meter is locked in the range it is in, and ⊙ is displayed. In manual range, ⓥCHEK is disabled.
2. Press [⊙] to step through the ranges. NOTE: The 4000 mV range, which can only be entered in manual range, is convenient when using accessories.
3. To return to autorange, press [⊙] for 2 seconds (until ⊙ is no longer displayed), or change the measurement function.

MEASURING VOLTAGE

1. Insert the test leads in the jacks.
2. To select a voltage function, put the slide-switch in the middle position. See Figure 3.

   To toggle between dc and ac, press [⎓].
3. Touch the probes to the test points, and read the display. The meter beeps an Overload Alert™ when OL (overload) is displayed.

In manual range, you can toggle the meter between a high or low input impedance mode by moving the slide-switch between the voltage and continuity/ohms positions. (See "ⓥCHEK AND HOW TO USE IT".) In the continuity/ohms position, the input impedance of the meter is 2 kΩ, and LoZ is displayed to indicate that the meter is in the low input impedance mode. In the volts position, the input impedance is 5 MΩ in ac and 10 MΩ in dc.

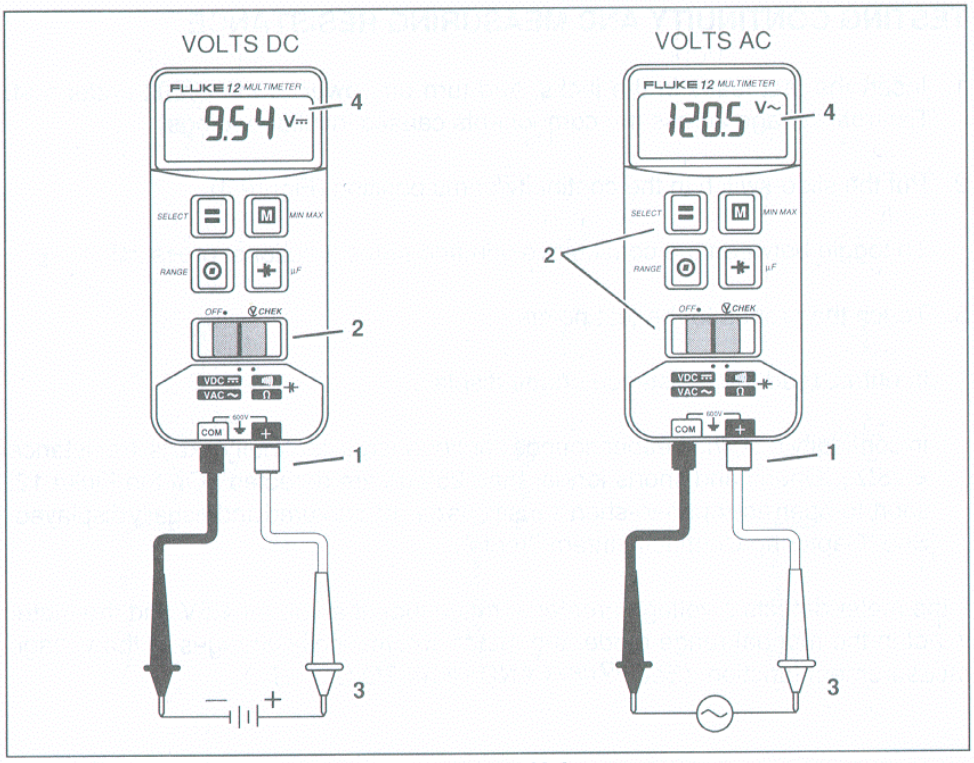

Figure 3. Measuring Voltage

TESTING CONTINUITY AND MEASURING RESISTANCE

1. Insert the test leads in the jacks, and turn off power to the circuit under test. External voltage across the components causes invalid readings.

2. Put the slide-switch in the continuity/ohms position (Figure 4).

   To toggle between the continuity/diode and ohms functions, press [=].

3. Touch the probes to the test points.

   In ohms, read the resistance on the display.

   In continuity test, the beeper sounds continuously if continuity exists (resistance < 25Ω.). Opens and shorts longer than 250 µs are detected. On the Fluke 12, short-to-open and open-to-short transitions can be captured and visually displayed. See "Capturing Continuity Intermittents".

If the meter detects a voltage greater in magnitude than about 4.5V and the meter is not in the manual range mode, the meter automatically changes to the voltage measurement function. (See "CHEK AND HOW TO USE IT".)

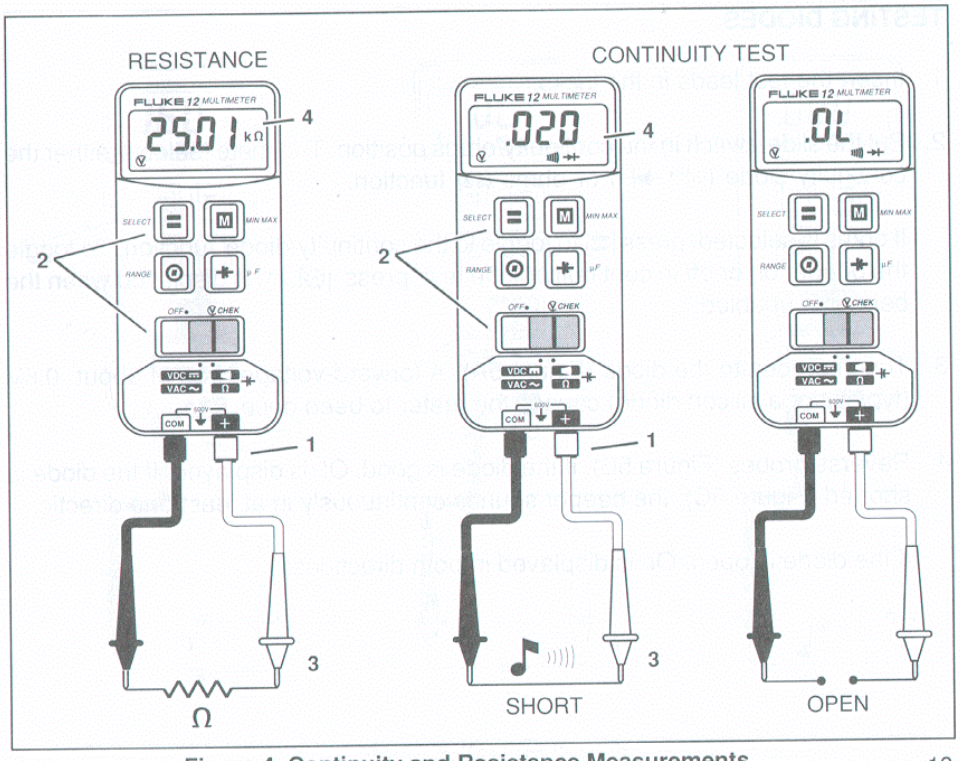

Figure 4. Continuity and Resistance Measurements 13

TESTING DIODES

1. Insert the test leads in the jacks.

2. Put the slide-switch in the continuity/ohms position. The meter selects either the continuity/diode (•))) →▶|—) or ohms (Ω) function.

   If ohms is selected, press [=] to toggle to the continuity/diode function. To toggle the beeper on or off in continuity/diode test, press [⊙]. •))) is displayed when the beeper is enabled.

3. Touch probes to the diode (Figure 5A). A forward-voltage drop of about 0.6V (typical for a silicon diode) causes the meter to beep once.

4. Reverse probes (Figure 5B). If the diode is good, OL is displayed. If the diode is shorted (Figure 5C), the beeper sounds continuously in at least one direction.

   If the diode is open, OL is displayed in both directions.

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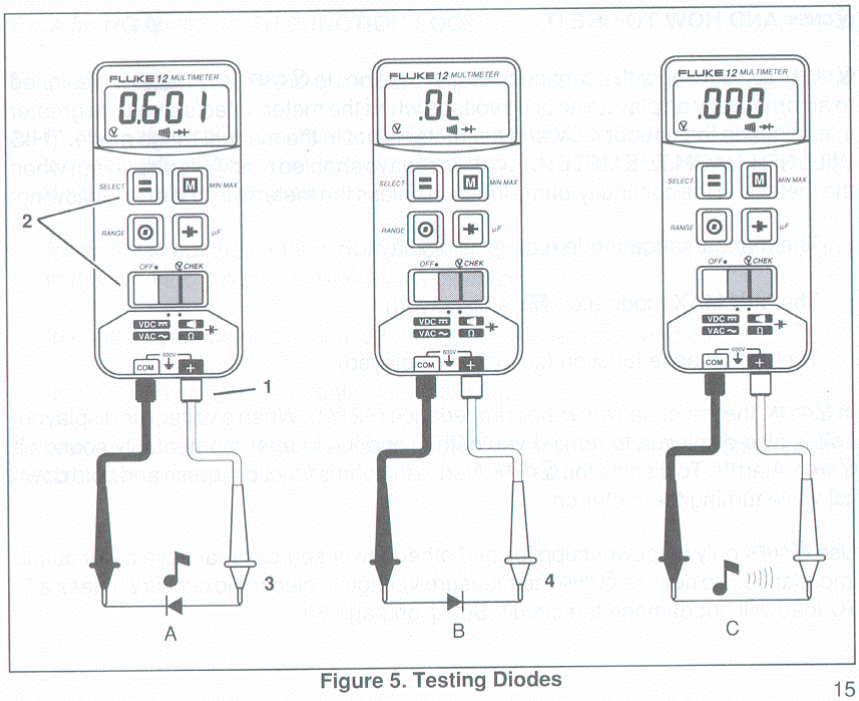

Figure 5. Testing Diodes

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ⓋCHEK AND HOW TO USE IT

ⓋCHEK is a subset of the continuity/ohms function. In ⓋCHEK, the meter is designed to automatically display an ac or dc voltage when the meter detects a voltage greater in magnitude than about 4.5V and the meter is not in the manual range mode. THIS WILL NOT HARM THE METER. ⓋCHEK is always enabled (and Ⓥ is displayed) when the meter is in the continuity/ohms function unless the meter is in one of the following:

- The manual range mode (i.e., ⊙ is displayed)
- The MIN MAX mode (i.e., M is displayed)
- The capacitance function (i.e., µF is displayed)

In ⓋCHEK, the meter has a low input impedance (~2 kΩ). When a voltage is displayed, LoZ is also displayed to remind you of this, and the beeper momentarily sounds a ⓋCHEK Alert™. To disable the ⓋCHEK Alert in the ohms function, press and hold down [=] while turning the meter on.

Use ⓋCHEK only on power supplies and other power sources that have a low output impedance. Do not use ⓋCHEK to measure voltage in electronic circuitry unless a 2-kΩ load will not damage the circuit. See † on page 30.

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DISABLING ⓥCHEK WITH FUNCTION LOCK

To lock the meter in either the continuity/diode or ohms function, and disable ⓥCHEK:

1. Put the slide-switch in the continuity/ohms position. The meter selects the continuity/diode or ohms function. Press [⏤] to toggle between the continuity/diode and ohms functions.

2. Press [⊙] to put the meter in manual range. ⊙ is displayed. The meter is locked in the selected function and ⓥCHEK is disabled.

   In continuity/diode test, press [⊙] to toggle the beeper on and off.

   In ohms, press [⊙] to manually select a range.

To remove the function lock and reenable ⓥCHEK, press [⊙] for 2 seconds, press [⏤], or move the slide-switch.

[⊣⊢] MEASURING CAPACITANCE

First, turn off power to the circuit, and disconnect and discharge the capacitor.

1. Insert test leads, and move the slide-switch to ⊣⊢. (See Figure 6.)

2. Press [⊣⊢]. The capacitance function is selected and µF is displayed.

3. Touch the probes to the capacitor. When measuring polarized capacitors, be sure to connect the positive to ⊞ and the negative to COM. Capacitor dielectric absorption can cause measurement errors. If more discharge is necessary, the meter displays "dISC" while the capacitor is discharging.

To exit capacitance, Press [⊣⊢] or [⏤], or move the slide-switch to another position.

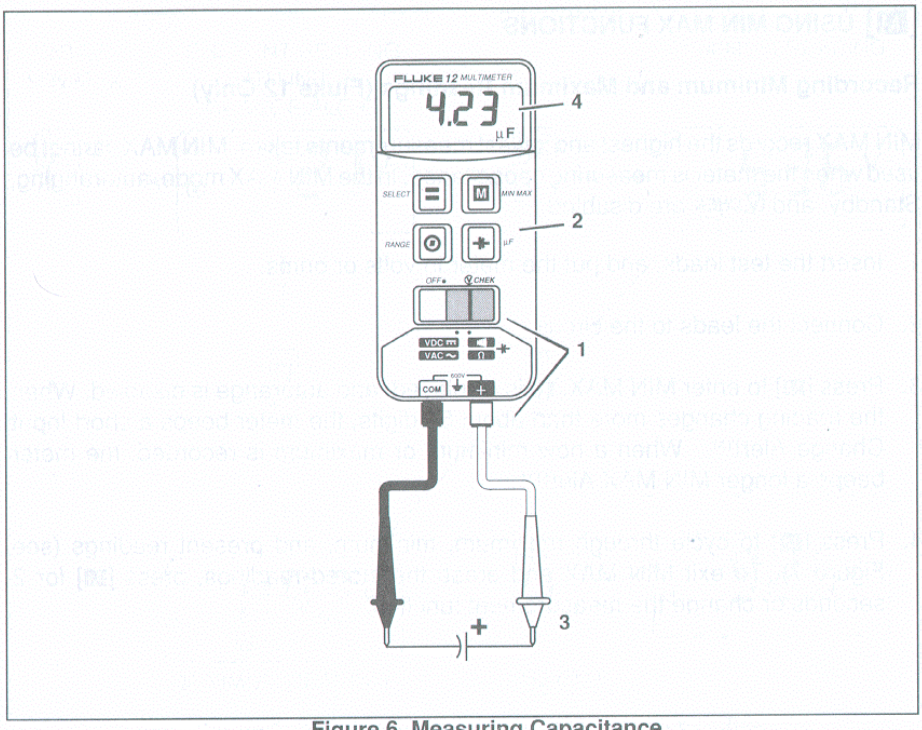

Figure 6. Measuring Capacitance

[M] USING MIN MAX FUNCTIONS

Recording Minimum and Maximum Readings (Fluke 12 Only)

MIN MAX records the highest and lowest measurements taken. MIN MAX cannot be used when the meter is measuring capacitance. In the MIN MAX mode, autoranging, Standby, and CHEK are disabled.

1. Insert the test leads, and put the meter in volts or ohms.
2. Connect the leads to the circuit.
3. Press [M] to enter MIN MAX. M is displayed, and autorange is disabled. When the reading changes more than about 50 digits, the meter beeps a short Input Change Alert™. When a new minimum or maximum is recorded, the meter beeps a longer MIN MAX Alert™.
4. Press [M] to cycle through maximum, minimum, and present readings (see Figure 7). To exit MIN MAX and erase the stored readings, press [M] for 2 seconds or change the measurement function.

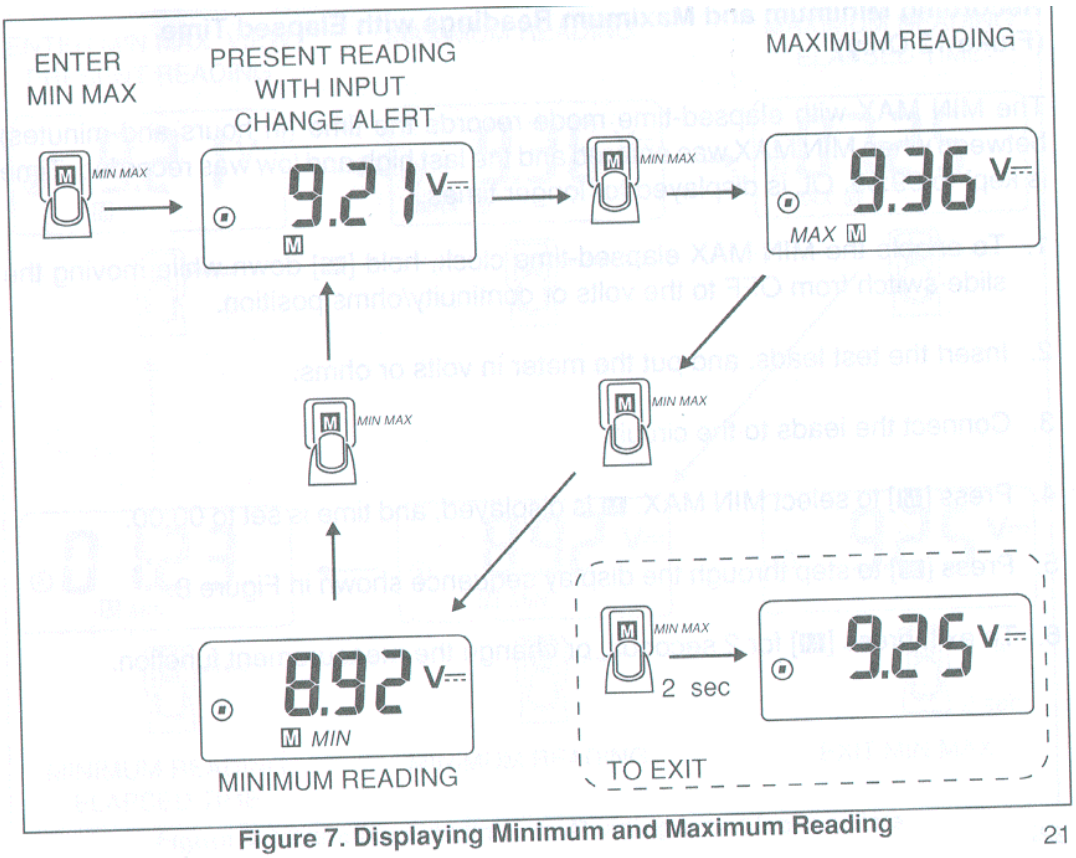

Figure 7. Displaying Minimum and Maximum Reading

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Recording Minimum and Maximum Readings with Elapsed Time (Fluke 12 Only)

The MIN MAX with elapsed-time mode records the time (in hours and minutes) between when MIN MAX was entered and the last high and low was recorded. Time is kept to 99:59. OL is displayed for longer times.

1. To enable the MIN MAX elapsed-time clock, hold [M] down while moving the slide-switch from OFF to the volts or continuity/ohms position.
2. Insert the test leads, and put the meter in volts or ohms.
3. Connect the leads to the circuit.
4. Press [M] to select MIN MAX. M is displayed, and time is set to 00:00.
5. Press [M] to step through the display sequence shown in Figure 8.
6. To exit, press [M] for 2 seconds, or change the measurement function.

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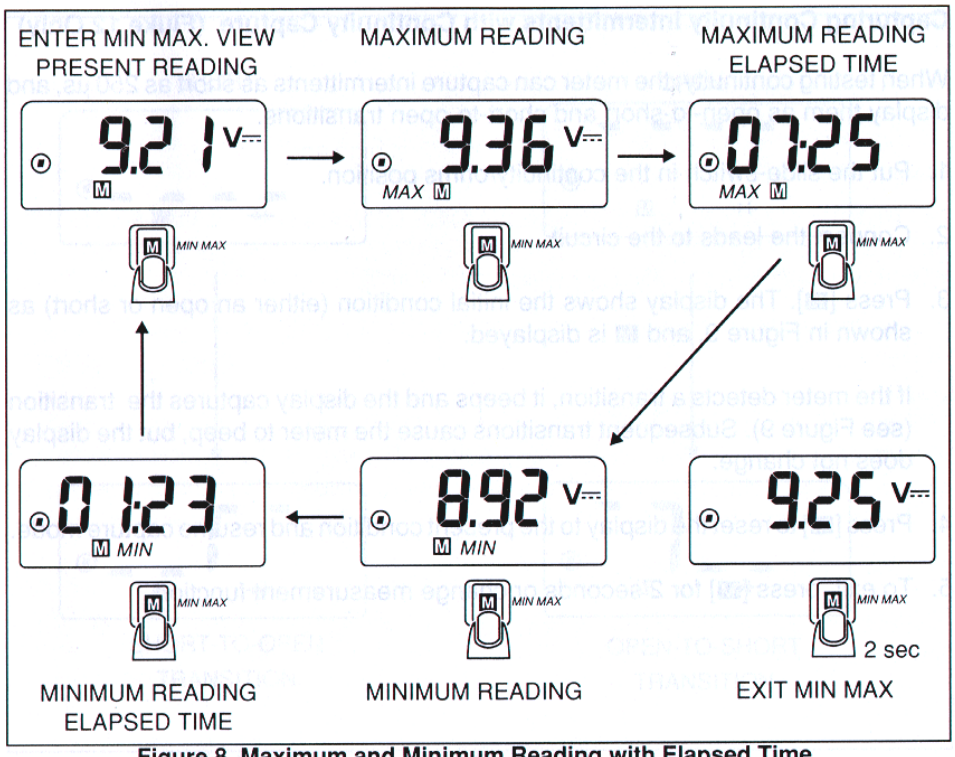

Figure 8. Maximum and Minimum Reading with Elapsed Time

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Capturing Continuity Intermittents with Continuity Capture (Fluke 12 Only)

When testing continuity, the meter can capture intermittents as short as 250 µs, and display them as open-to-short and short-to-open transitions.

1. Put the slide-switch in the continuity/ohms position.
2. Connect the leads to the circuit.
3. Press [M]. The display shows the initial condition (either an open or short) as shown in Figure 9, and M is displayed.

   If the meter detects a transition, it beeps and the display captures the transition (see Figure 9). Subsequent transitions cause the meter to beep, but the display does not change.
4. Press [M] to reset the display to the present condition and resume capture mode.
5. To exit, press [M] for 2 seconds or change measurement function.

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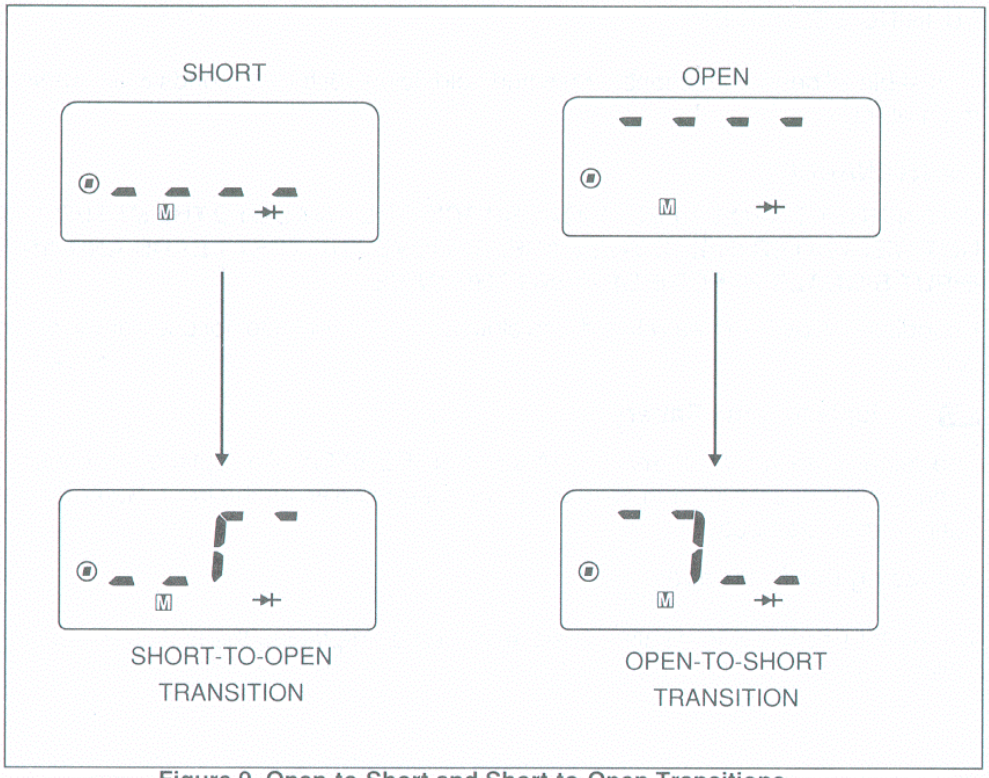

Figure 9. Open-to-Short and Short-to-Open Transitions

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TURNING BEEPER OFF

To disable all beeper functions, press and hold down [⊙] for 2 seconds while turning the meter on.

MAINTENANCE

WARNING: TO AVOID ELECTRICAL SHOCK OR DAMAGE TO THE METER, DO NOT GET WATER INSIDE THE CASE. REMOVE THE TEST LEADS AND ANY INPUT SIGNALS BEFORE OPENING THE CASE.

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

Replacing the Battery

The meter uses a 9V battery (NEDA 1604 or IEC 6F22). To replace the battery, remove the four screws from the back of the meter and lift off the front. Remove the battery from case bottom.

Replacing the Test Leads

The meter uses double-insulated test leads. When replacing the test leads, order Fluke TL-75 PN 855705 only.

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Service and Parts

This meter should be serviced only by a qualified service technician. To order the service manual (PN 900824) and other parts or for service information, in the USA call 1-800-825-9810. Outside the USA, contact the nearest Fluke service center (see back of manual).

Accessories

When using accessories, put the slide-switch in the volts position, and manually select the 4000 mV range for ease of reading.

SPECIFICATIONS

This meter complies with Part 15 of FCC Rules. Operation is subject to the following conditions: (1) This meter may not cause harmful interference, and (2) this meter must accept any interference received, including interference that may cause undesired operation.

Accuracy is specified for a period of one year after calibration, at 18°C to 28°C (64°F to 82°F) with relative humidity to 90%. AC conversions are ac-coupled, average responding, and calibrated to the rms value of a sine wave input. Accuracy Specifications are given as:

±([% of reading] + number of least significant digits])

Maximum Voltage Between any Terminal and Earth Ground	600V rms
Display	3 3/4-digits, 4000 counts, updates 4/sec
Operating Temperature	-10°C to 50°C
Storage Temperature	-30°C to 60°C indefinitely (to -40°C for 100 hrs)
Temperature Coefficient	0.1 x (specified accuracy)/°C (<18°C or >28°C)
Relative Humidity	0% to 90% (-10°C to 35°C) 0% to 70% (35°C to 50°C)
Battery Type	9V, NEDA 1604 or IEC 6F22
Battery Life	650 continuous hours with alkaline 450 continuous hours with carbon-zinc
Shock, Vibration	1 meter shock. Per MIL-T-28800D for a Class 3 Instrument
Size (HxWxL)	1.35 in x 2.75 in x 5.55 in (3.46 cm x 7.05 cm x 14.23 cm)
Weight	10 oz (286 g)
Safety	Designed to Protection Class II requirement of UL1244, ANSI/ISA-S82, CSA C22.2 No 231, and VDE 0411, and IEC 1010 overvoltage category III.
EMI Regulations	Complies with FCC Part 15, Class B, and VDE 0871B.

Function	Range	Resolution	Accuracy (50 to 400 Hz)
V~	4000mV*	1mV	±(1.9%+3)
	4.000V	0.001V	±(1.9%+3)
	40.00V	0.01V	±(1.9%+3)
	400.0V	0.1V	±(1.9%+3)
	600V	1V	±(1.9%+3)
V⎓	4000mV*	1mV	±(0.9%+2)
	4.000V	0.001V	±(0.9%+2)
	40.00V	0.01V	±(0.9%+1)
	400.0V	0.1V	±(0.9%+1)
	600V	1V	±(0.9%+1)
Ω	400.0 Ω	0.1 Ω	±(0.9%+2)
	4.000 kΩ	0.001 kΩ	±(0.9%+1)
	40.00 kΩ	0.01 kΩ	±(0.9%+1)
	400.0 kΩ	0.1 kΩ	±(0.9%+1)
	4.000 MΩ	0.001 MΩ	±(0.9%+1)
	40.00 MΩ	0.01 MΩ	±(1.5%+3)
⊣⊢	1.000 µF	0.001 µF	±(1.9%+2)
	10.00 µF	0.01 µF	±(1.9%+2)
	100.0 µF	0.1 µF	±(1.9%+2)
	10000 µF	1 µF	≤1000 µF ±(1.9% + 2) >1000 µF ±(10% + 90) Typical
))))) →|←	2.000V	0.001V	±(0.9%+2)†

* The 4000 mV range can only be entered in manual range mode. Use the 4000 mV range with accessories.
† The beeper is guaranteed to come on at <25Ω and turn off at >250Ω. The meter detects opens or shorts of 250 µs or longer.

Function	Overload Protection*	Input Impedance (Nominal)	Common Mode Rejection Ratio (1 kΩ Unbalance)	Normal Mode Rejection
V⎓	600V dc	>10 MΩ <100 pF †V CHEK & LoZ = >2 kΩ <200 pF	>100 dB at dc, 50 Hz, or 60 Hz	>50 dB at 50 Hz or 60 Hz
V~	600V rms	>5 MΩ <100 pF †V CHEK & LoZ = >2 kΩ <200 pF (ac-coupled)	>60 dB at dc 50 or 60 Hz	

Ω		Open Circuit Test Voltage	Full Scale Voltage To 4.0 MΩ	Full Scale Voltage 40 MΩ	Short Circuit Current
	600V rms	<1.5V dc	<450 mV dc	<1.5V dc	<500 µA
→|←	600V rms	2.4-3.0V dc	2.400V dc		0.95 mA(typical)

*3 x 10^6 V Hz Maximum

† ≈2kΩ with input voltage up to 50V. Impedance will increase with input voltage to >300 kΩ at 600V.

MIN MAX Recording Accuracy and Response Time
Specified accuracy of the measurement function ± 12 digits for changes >200 ms in duration (±40 digits in ac). Typical 100 ms response to 80%.

MIN MAX Recording with Elapsed Time

Elapsed Time	Resolution	Accuracy
0 to 100 hours (99:59)	1 minute	0.3% typical

Continuity Capture
Detects opens or shorts of 250 µs or longer

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Warranty Information

Congratulations on your purchase of a Fluke Multimeter, which is designed to give you years of troublefree service. Enclosed is our two year warranty and product information card. Please take a few minutes to complete the requested information so that it is possible to send you product safety information and better serve the needs of you, our customer.

Statement of Calibration

Fluke Corporation has calibrated this meter using standards and instruments the accuracy of which is traceable to the National Institute of Standards in the USA or to nationally accepted measuring systems. The standards and instruments used in calibration are supported by a calibration system which meets or exceeds the requirements of MIL-STD-45662.

A serialized and dated Certificate of Calibration for any individual instrument can be obtained by sending the meter to any Fluke Technical Service Center listed in the manual. A nominal calibration fee will be charged.

Corporate Quality Assurance