MODEL 3000
DIGITAL CAPACITANCE METER

Operation and Calibration Manual

Serial Numbers

This manual applies directly to instruments with serial numbers 30010 and up, PCB Assembly 8503000-0-3, revision 3.

Serial Number: _____

For technical assistance, contact
GLK INSTRUMENTS
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I. WARRANTY

GLK Instruments products are warranted against defects in workmanship and materials under normal use and service for one year from date of their shipment by GLK Instruments, except that components obtained from others are warranted only to the extent of the original manufacturers' warranties, if any. This warranty does not extend to any products that have been repaired or altered by others. GLK Instruments' sole liability and the Purchaser's sole remedy under this warranty are limited to repairing or replacing defective products. The repair or replacement of defective products does not extend the warranty period. This warranty does not apply to components or products which by the nature of the applications are consumed in operation or which have a normal life inherently shorter than one year. Examples of this are batteries, components or products exposed to nuclear radiation, or used in the measurement of detection of explosions. GLK Instruments shall not be liable for consequential damages under any circumstances.

THE FOREGOING WARRANTY AND REMEDY ARE IN LIEU OF ALL OTHER REMEDIES AND ALL OTHER WARRANTIES, WRITTEN OR ORAL, STATUTORY, EXPRESS, OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

II. PRODUCT USE RESTRICTIONS

GLK Instruments does not recommend the use of any of its products or the incorporation of any of its products by second parties in their products in (a) life support applications where failure or malfunction of the product can be reasonably expected to cause failure of the life support device or to significantly affect its safety or effectiveness, (b) any nuclear facility applications which including nuclear reactors and devices designed or used in connection with the handling, processing packaging, preparation, utilization, fabricating, alloying, storing, or disposal of fissionable material or waste products, (c) consumer applications where failure or malfunction of the product can be reasonably expected to cause injury, and (d) applications where failure or malfunction of the product can reasonably be expected to place the health and safety of the general public in jeopardy. GLK Instruments will not knowingly sell its products for use in such applications unless GLK Instruments receives in writing satisfactory assurances that (a) the risks of injury or damage have been minimized, (b) the customer assumes all such risks, and (c) the liability of GLK Instruments is adequately protected under the circumstances.

III. RETURN MATERIAL AUTHORIZATION

In the unlikely event that any of the products of GLK Instruments need repair, contact GLK Instruments for a return material authorization (RMA) number.

IV. SPECIFICATIONS

(25 ^{o}C unless specified otherwise)

Electrical

Capacitance range:	2.000 pF to 200.0 nF
Resolution:	0.001 pF to 0.1 nF
Display:	3 1/2 digit LCD
Accuracy with or without probes:	± (0.1% of reading + 2 digits)
Measurement frequencies:	24 kHz (2 pF, 20 pF, 200 pF, 2 nF) 2.4 kHz (20 nF) 240 Hz (200 nF)
Charging voltage:	5 V (all ranges)
Offset adjustment:	1.5 pF
Signal output voltage:	0 - 200 mV DC
Source resistance:	1000 ohms (1%)
Reference output voltage:	5.000 V DC
Source resistance:	1000 ohms (1%)
Battery:	9 V alkaline (NEDA 1604A)
Auxiliary power:	9 - 28 V DC, 50 mA supply with 2.1 mm DC power jack

Environmental

Operating Temperature:	0 ^{o}C to +50 ^{o}C
Storage Temperature:	-20 ^{o}C to +70 ^{o}C
Operating relative humidity:	80% (noncondensing)

Mechanical

Package:	Bench top, portable instrument case with tilt bail
Dimensions:	8.50 x 9.52 x2.44 inches
Net Weight:	2 lbs

Accessories Supplied

Two miniature shielded probes and probe accessories (PN 2110112)
9 V battery (NEDA 1604A)
Operation and Calibration Manual
100 nF Chip Capacitor
Battery eliminator (PN 4001200): input 120 VAC, 60 Hz, 6 W; output 9 VDC, 200 mA, 2.1 mm Plug

Optional Accessories

International battery eliminator (PN 4001201): input 90 to 264 VAC, 47 to 63 Hz, 18 W, IEC 320 connector; output 12 VDC, 1.5 A, 2.1 mm Plug. Customer supplies AC cord set, 3-prong IEC 320 to local connection

V. DESCRIPTION

The Model 3000 Digital Capacitance Meter is the first commercially available low cost, high accuracy instrument designed exclusively for the measurement of very small value capacitors and capacitors whose size and shape are not conveniently handled by conventional sockets, clamp fixtures, or alligator clip leads. This instrument is particularly useful for the measurement chip capacitors whose small size precludes the use of identifying marks.

The Model 3000 employs a unique and patented (U.S. Patent No. 4806846) switched capacitor circuit and a ratio metric measurement technique that eliminates errors due to stray capacitance to ground. The patented circuit has high common-mode rejection and eliminates errors due to changes in the reference voltage from temperature, aging, etc. This unique circuit allows the capacitor under measurement to be remotely connected to the meter via two, miniature, shielded probes without affecting the accuracy or resolution of the instrument.

The convenience of using miniature probes solves the costly problem of constructing special test fixtures and shielded boxes for the determination of the capacitance of a variety of objects. For example, the Model 3000 with its standard probes can easily determine the capacitance between the pins of a connector, the large signal gate capacitance of power MOSFETs, the depletion capacitance of diodes, the capacitance between the traces on a printed circuit board, or even the static capacitance of microstrip or stripline microwave circuits. Using ultra-miniature, shielded probes, very accurate wafer level, large signal measurements of MOS capacitors are easily obtained.

Miniature, shielded probes are normally supplied with the instrument; however, the Model 3000, due to its unique circuitry, can accommodate a large variety of custom built shielded probes, special shielded connectors, or test fixtures. Coarse and fine offset adjustment potentiometers are provided on the front panel of the instrument to compensate for test fixture capacitances up to 1.5 pF. The Model 3000 maintains its accuracy and resolution with or without probes.

Auxiliary analog outputs of the meter reading and 5V reference voltage are available on the back panel. These outputs can be connected to digital voltmeters, plotters, data loggers, computer data acquisition systems, etc.

A 9 V alkaline battery powers the Model 3000. Battery life is approximately 200 hours. An auxiliary DC power jack is provided for powering the instrument from the battery eliminator (US version PN 4001200 or optional, international version PN 4001201).

VI. INITIAL PREPARATION

The Model 3000 (PN 2903000-112) is supplied ready for use with a battery, battery eliminator, two probes, and probe accessories. If the 9 V battery is not installed, open the battery compartment cover on the back of the instrument and connect the 9 V battery to the polarized snap lead. If the instrument is to be stored for an extended period, remove the battery to prevent damage from leakage.

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ALWAYS DISCONNECT THE BATTERY ELIMINATOR AND ANY TEST FIXTURES OR PROBES FROM THE INSTRUMENT WHEN REPLACING THE BATTERY. BEWARE OF STATIC ELECTRICITY

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The instrument is now ready for use; however, it is recommended to perform the following initial checkout to become more familiar with the instrument. Select the 2.000 pF range by depressing the respective front panel switch. Turn on the instrument by pressing the ON switch. The LCD display should appear and settle to a stable reading of ± 0.002 within a few seconds. The instrument was adjusted at the factory to read ± 0.002 pF. If the display is not within ± 0.002 pF, then adjust the OFFSET COARSE or FINE potentiometers on the front panel of the instrument. Unpack the two probes, and connect each probe to the front panel BNC connectors. Hold probes at least 6 inches apart and observe the display. The display should read ± 0.002 pF provided the probes are held stationary. If necessary, adjust the OFFSET FINE potentiometer to zero the display. Hold the probes tips about 1/10 inch apart. You should observe a reading of approximately 0.015 pF or 15 femtofarads. Place the probes at least 6 inches apart again and check the zero on the other ranges by depressing each range switch while observing the display. Next, measure a 100 nF chip capacitor supplied with the unit. First select the 200 nF range; second touch each of the metalized ends of the chip capacitor with the probe tips; and third, read the display. The 100 nF chip capacitor has tolerance of ± 20%.

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CAUTION - ALWAYS DISCHARGE HIGH VOLTAGE CAPACITORS BEFORE MEASURING TO AVOID DAMAGE TO INSTRUMENT

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You should now be familiar with the general use of the Model 3000 Digital Capacitance Meter. For a more detailed discussion of the operation of the Model 3000 refer to the following section.

VII. OPERATING INSTRUCTIONS

A detailed description of each function of the instrument is given in this section. The basic functions of the Model 3000 are listed below.

Front Panel:
1) Display, 3 1/2 digit LCD
2) Range switch, 2 pF to 200 nF, push-to-select
3) Power switch, push-ON, push-OFF
4) C_X HIGH input BNC (positive connection)
5) C_X LOW input BNC (negative connection)
6) OFFSET COARSE and FINE potentiometers

Rear panel:
7) 9 V battery compartment
8) Auxiliary DC power jack
9) Analog output jacks, 0 - 200 mV DC
10) Reference voltage output jacks, 5 V DC

1) The display is a self-contained 3 1/2 digit LCD digital voltmeter with polarity and decimal point indication. The decimal point is automatically selected when the desired range switch is pushed.

2) The range switch is a push-to-select interlocking assembly. Ranges are 2 pF, 20 pF, 200 pF, 2 nF, 20 nF, and 200 nF. A resolution of 0.001 pF or 1 femofarad can be achieved on the 2 pF range.

3) The power switch is a push-ON and push-OFF type with also only 300 gram-force required for actuation.

4 & 5) Connection to the Model 3000 is via the BNC's on the front panel. Normally the probes supplied with the instrument will be connected to these terminals. However, custom-built shielded probes, connectors, or other special test fixtures can be connected to these terminals without affecting the accuracy of the instrument. The terminal marked (+) or HIGH is the positive drive or charging terminal and should be connected to the positive terminal of polarized capacitors. Likewise, the negative terminal (-) or LOW input should be connected to the negative terminal of polarized capacitors. The HIGH terminal should always be connected to the outer foil, plate, or larger electrode of the capacitor under measurement and the LOW terminal to its other electrode to minimize noise pickup. In the case of 3-terminal capacitors, such as calibration standards, the shield of the capacitor (i.e. its third electrode) should be connected to the ground shield of the probes. An alternative is to connect a 3-terminal capacitor to the instrument using coaxial cables. In electrically noisy environments the capacitor under test may require shielding to obtain a stable reading. To maintain accuracy and low noise readings, connect

external shielding to both probe shields.

The Model 3000 uses a combination of CMOS and JFET devices to charge and discharge the capacitor under test; consequently, voltage transients can damage these devices and will cause the instrument to malfunction. All capacitors, but specifically high voltage and high capacitance capacitors, must be discharged first before measurement to avoid damage to the instrument.

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DISCHARGE ALL CAPACITORS BEFORE MEASUREMENT TO PREVENT DAMAGE TO THE INSTRUMENT AND TO PREVENT PERSONAL INJURY

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The drive level that is presented to the capacitor under test from the (+) or HIGH connection is +5.0 V peak with respect to the (-) or LOW connection; thus, a wide range of capacitors that have breakdown voltages as low as 5 V can be measured with the Model 3000 without damaging the capacitor under test. Avoid capacitors that have leaky dielectric or high conductance. The Model 3000 cannot measure conductance. Depending on the range, leaky dielectric capacitors can produce large erroneous readings. Likewise, the depletion capacitance of diodes must be measured under reverse bias conditions, i.e. HIGH terminal is connected to the cathode, and the LOW terminal is connected to the anode to reverse bias the diode.

6) The OFFSET COARSE and FINE potentiometers on the front panel of the instrument are used primarily to compensate for the capacitance between the unshielded terminals of test fixtures used to measure axial and radial leaded capacitors. The OFFSET potentiometers can subtract up to 1.5 pF of test fixture capacitance. The OFFSET potentiometers are used also to zero the instrument on the 2 pF scale and may be required occasionally due to amplifier drift, component replacement, or operation at elevated temperatures.

7) The 9 V battery is housed in a compartment on the rear of the instrument. The Model 3000 will operate for approximately 200 hours on a 9 V alkaline battery. A low dropout voltage regulator allows extended use of the battery down to a voltage of about 5.2 V before replacement.

8) The auxiliary DC power jack provides the capability of operating the instrument continuously from an external power source such as the optional battery eliminator (PN 4001200). The internal 9 V battery is automatically disconnected from the instrument when the battery eliminator is connected.

9) The analog output provides a 0 - 200 mV DC signal proportional to the capacitor under test and also to the instrument's internal reference voltage. The source resistance is 1000 ohms.

10) The instrument's internal 5.000 V DC reference voltage is available at the reference output jacks. Its source resistance is 1000 ohms. The reference output voltage is used to provide external ratio metric capability to remove errors in the analog output signal due to changes in the reference voltage from temperature and long term drift. For ratio metric measurements, connect the 5 V reference output to the external reference input on digital voltmeters, data loggers, etc. that provide for this option. Alternatively, errors from variations in the reference voltage can be removed from the analog output signal by calculating the ratio of analog output to the 5 V reference output and multiplying by the appropriate scale factor. Using the external outputs of the Model 3000 with precision digital voltmeters or data acquisition systems, capacitors can be measured to 0.05% accuracy and to a resolution of 10 ppm.

VIII. SERVICING INFORMATION

For service on your Model 3000 Digital Capacitance Meter contact GLK Instruments directly. Complete repair and calibration services are maintained by GLK Instruments; however, minor repair and calibration can generally be performed in the field if you have access to a precision 3-terminal capacitor standard.

IX. CALIBRATION

Field calibration of the Model 3000 Digital Capacitance Meter can be accomplished using only a single 1000 pF, 3-terminal standard capacitor such as General Radio Model 1404-A standard reference capacitor. To calibrate the Model 3000, first remove the top half of the instrument case by removing the four screws located in the bottom half of the case. If operating in battery mode, check the battery voltage at TP1. If its voltage is below 7 V, replace the battery with a fresh 9 V alkaline cell. The Model 3000 will function correctly down to a battery voltage of approximately 5.2 V.

Turn on the instrument, measure the voltage at TP2, and adjust the 5 V potentiometer, R5, to set the voltage at TP1 to +5.000 ± 0.002 V. Select the 2.000 pF range and adjust the OFFSET COARSE and FINE potentiometers to zero the display. The display should read ± 0.000 pF after zero adjustment. Select the 2.000 nF range and connect the 1000 pF standard capacitor to the instrument using coaxial cables. Adjust the CAL potentiometer, R11, for a display reading of 1.000 nF ± 0.000 nF. Connect a high impedance voltmeter to the ANALOG OUTPUT terminals on the back of the instrument. Adjust the AUX CAL potentiometer, R27, for a reading of 0.1000 V ± 0.0001 V.

This completes the basic calibration of the instrument. All of the other ranges will track the calibration on the 2.000 nF range to within ± (0.1% of reading + 2 digits).

Remove the standard capacitor and replace the cover. The Model 3000 is now ready for use as precision capacitance meter.

X. REVISIONS

The following changes are effective for instruments with serial numbers 30000 and up (PCB Assembly 8503000-0-3 Rev 3).

No revisions at this time. This manual and any future revisions will be posted on our website: www.glkinst.com