

MODEL 3000

DIGITAL CAPACITANCE METER

Instruction and Service Manual

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 which have been repaired or altered by others. GLK Instruments' sole liability and the Purchaser's sole remedy under this warranty is 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 °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:	$\pm(0.1\%$ of rdg. + 2 digits)
Measurement frequencies:	24 kHz (2 pF, 20 pF, 200 pF, 2 nF) 2.4 kHz (20 nF) 240 Hz (200 nF)
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:	7 - 28 V dc, 50 mA supply with 2.1 mm DC power jack

Environmental

Operating Temperature:	0 °C to +50 °C
Storage Temperature:	-20 °C to +70 °C
Operating relative humidity:	80% (noncondensing)

Mechanical

Package:	Bench top, portable instrument case with handle
Dimensions:	8.50 x 9.52 x 2.44 inches
Weight:	2 lbs

Accessories Supplied

Two miniature shielded probes and probe accessories (PN 2110112)
9 V battery
Instruction manual
Battery eliminator (PN 4001200), 9 V dc, 50 mA, 2.1 mm Plug, 120 V ac, 60Hz, 6 W

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, patented* switched capacitor circuit and a ratiometric measurement technique to eliminate errors due to stray capacitance to ground. The patented circuit provides high common-mode rejection and eliminate 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 capacitance between the traces on a printed circuit board, or even the static capacitance of microstrip or stripline microwave circuits. Using ultraminiature, 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. An offset adjustment potentiometer is provided on the rear of the instrument to compensate for fixed capacitances up to 1.5 pF between the unshielded electrodes of custom test fixtures. The Model 3000 maintains its accuracy and resolution with or without probes.

The Model 3000 provides auxiliary analog outputs of the meter reading and of the reference voltage for ratiometric measurements. These outputs can be connected to digital voltmeters, plotters, data loggers, computer data acquisition systems, etc.

The Model 3000 is powered by a 9 V alkaline battery which will last approximately 200 hours. An auxiliary DC power jack is provided for powering the instrument from the optional battery eliminator (PN 4001200).

* U.S. Patent No. 4806846

VI. INITIAL PREPARATION

The Model 3000 (PN 2903000-112) is supplied ready for use with a battery, battery eliminator, two probes, and probe accessories. The 9 V battery, however, is not installed. To install the battery, open the battery compartment cover on the rear 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 leakage damage.

***ALWAYS DISCONNECT THE BATTERY ELIMINATOR AND
ANY TEST FIXTURES OR PROBES FROM THE INSTRUMENT
WHEN REPLACING THE BATTERY***

The instrument is now ready for use; however, it is recommended to perform the following initial checkout to become more familiar with the instrument before use.

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 ± 0.001 within a few seconds. The instrument was adjusted at the factory to read ± 0.001 pF. If the display is not within ± 0.001 pF, then adjust the OFFSET potentiometer on the rear of the instrument. Now unpack the two probes and fully, and connect each probe to the front panel BNC connectors. Hold probes about 6 inches apart and observe the display. The display should read ± 0.001 pF provided the probes are held stationary. Hold the probes tips approximately 1/8 inch apart. You should observe a reading of approximately 0.030 pF or 30 femto-farads. 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 the 100 pF chip capacitor supplied with the instrument. First select the 200.0 pF range; second touch each of the metalized ends of the chip capacitor with the probes; and third read the display.

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

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 the operation 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, 2.000 pF to 200.0 nF, push-to-select
- 3) Power switch, push-ON, push-OFF
- 4) Cx HIGH input BNC (positive connection)
- 5) Cx LOW input BNC (negative connection)

Rear panel:

- 6) OFFSET potentiometer
- 7) 9 V battery compartment
- 8) Auxiliary DC power jack
- 9) Analog output jacks, 0 - 200 mV dc
- 10) Reference voltage output jacks, 5.000 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 with only 300 gram-force required to actuate any switch.

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 effecting the accuracy of the instrument. The terminal marked (+) or HIGH is the positive input 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 those used as standards for calibration, 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.

Although the Model 3000 has excellent common-mode rejection, in electrically noisy environments the capacitor under measurement may require shielding to obtain a stable reading. To maintain accuracy and low noise readings, connect the shielding to both probe shields.

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

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

The drive level which is presented to the capacitor under measurement from the HIGH connection is +5.0 V peak with respect to the shield and is current limited to 5 mA. Thus, a wide range of capacitors with breakdown voltages as low as 5 V can be measured with the Model 3000 without damage to the capacitor under measurement.

6) The OFFSET potentiometer located on the rear of the instrument is used primarily to compensate for the capacitance between the unshielded terminals of test fixtures used to measure axial and radial leaded capacitors. The OFFSET potentiometer can subtract up to 1.5 pF of test fixture capacitance. The OFFSET potentiometer is used also to zero the instrument which may be required due to component aging, to component replacement, or to 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.

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 disconnected when the battery eliminator is connected.

9) The analog output provides a 0 - 200 mV dc signal proportional to the capacitor under measurement 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 ratiometric capability to remove errors in the analog output signal due to changes in the reference voltage from temperature and long term drift. The reference output is connected to the external reference input on digital voltmeters, data loggers, etc. which 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 reference output and multiplying by the appropriate scale factor from separate measurements of each voltage. Using the external outputs of the Model 3000 with precision digital voltmeters or data acquisition systems, capacitors can be measured to 0.01% accuracy.

VIII. SERVICING INFORMATION

For service on your Model 3000 Digital Capacitance Meter contact your local GLK Instruments representative or contact the factory directly. Complete repair and calibration services are maintained at the factory; 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 100.00 pF, 3-terminal standard capacitor such as General Radio Model 1403-D. 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. Check the battery voltage at J2. If its voltage is below 7 V, replace the battery with a new 9 V alkaline cell. Turn on the instrument, measure the voltage at TP1, and adjust the 5 V ADJ potentiometer R2 (labeled REF ADJ, R1 on assembly 8503000-0-0) to set the voltage at TP1 to $+5.000 \pm 0.002$ V. Select the 2.000 pF range and adjust the OFFSET potentiometer on the rear of the instrument to zero the display. The display should read ± 0.001 pF after zero adjustment. Select the 200.0 pF range and connect the 100.0 pF standard

capacitor to the instrument using coaxial cables. Adjust the CAL ADJ potentiometer R19 for a display reading of 100.0 pF ± 0.1 pF. Connect a high impedance voltmeter to the ANALOG OUTPUT terminals on the back of the instrument. Adjust the AUX CAL potentiometer R31 for a reading of 0.1000 V ± 0.0001 V. Calibration of the instrument is completed at this point. All of the other ranges will track the calibration on the 200.0 pF range to within $\pm 0.1\%$. Remove the standard capacitor and replace the cover. The Model 3000 is now ready for use as precision instrument for the measurement of capacitance.

X. REVISIONS

The following changes are effective for instruments with serial numbers 10004 and up (Assembly 8503000-0-2 Rev 2):

- 1) R3, REF ADJ, potentiometer has been replaced with R2 labeled 5 V ADJ. R2 is used to set the reference voltage at TP1 to 5.000 Vdc (see Calibration section).
- 2) Potentiometer R31, AUX CAL, has been added to the analog output circuit to allow precise setting of the output voltage. During calibration R31 is adjusted to set the ANALOG OUTPUT to precisely 100.00 mV (see Calibration section).
- 3) The DC power jack is 2.1 mm.
- 4) Average battery life has been extended to about 250 hours for 9 V alkaline and 650 hours for 9 V lithium batteries.

XI. SCHEMATICS AND PARTS LISTS

This section contains the schematics and parts lists for the MODEL 3000 Digital Capacitance Meter. We recommend that repairs whenever possible be performed at the factory. In the event that repairs are needed in the field, replacement parts can be obtained from GLK Instruments. When ordering replacement parts, refer to the parts list for that instrument and specify the circuit number (Ckt. No.), description, and manufacturers' part number. For instruments with serial numbers up to 10003, use parts list for assembly 8503000-0-0 Rev 0. For instruments with serial numbers 10004 and up, use parts list for assembly 8503000-0-2 Rev 2.