INSTRUCTION MANUAL

B+K PRECISION 820

Portable, Digital CAPACITANCE METER

B+K PRECISION DYNASCAN CORPORATION

TABLE OF CONTENTS

SPECIFICATIONS

CAPACITANCE

Range	10 ranges with full scale values from 999.9 pF to 999.9 mF. Reads from 0.1 pF to 999.9 mF.
Accuracy *	0.5% of full scale ± 1 LSD (least significant digit) on 1000 pF to 100 μF ranges. 1% of full scale ±1 LSD on 1000 μF to 1000 mF ranges.
Resolution	0.1 pF on 1000 pF range. .01% of full scale on all ranges.
Reading Time	0.6 SEC max. to 1000 μF, increasing to 35 SEC at 1 Farad.
Overrange	All ranges, bottom segment of all digits light up giving (_ _ _ _) indication.

GENERAL

Display	4-digit LED display.
Front Panel Controls	10-position range switch, zero adjust, on-off switch.
Test Connections	Spring-tensioned slot type capacitor socket and banana jacks for accepting standard test leads.
Power Source	4 standard "C" cells (4.4 to 6 volts). Nicad, alkaline, or zinc carbon, with provision for charger.
Battery Life	At least 6 hours continuous operation. At least 2 weeks of typical intermittent use.
Operating Temperature	0 to 50° C (32 to 100° F).
Dimensions	16 x 11 x 6 cm (6-3/8 x 4-3/8 x 2-3/8").
Weight	675 g (1½ lb.) with batteries.

*1000 pF to 100 nF, 0.5% @ 25°C. Temperature coefficient is .05%/°C.

OPTIONAL ACCESSORIES

BC-28 ADAPTER/CHARGER

Permits use of rechargeable batteries (BP-28 Battery Pack only — not for use with alkaline or zinc-carbon batteries) or operation from 105-130 VAC, 60 Hz AC power. Completely recharges batteries overnight (16 hours). Meter can be operated while batteries are recharging.

BP-28 BATTERY PACK

Includes four Nicad rechargeable batteries. Gives at least 6 hours continuous operation or 2 weeks of typical intermittent use on each charge. Recharges in 16 hours.

LC-28 CARRYING CASE

Offers convenience and protection while transporting the instrument. Sturdy grained leatherette construction, rugged snap fasteners, handle. Cover swings away to permit use of meter while in carrying case. Stowage for test leads and manual.

OPERATING INSTRUCTIONS (refer to Fig. 1)

PROCEDURE

1. Set POWER swith to ON position. A lighted LED display serves as a power on indicator.
2. a. Set RANGE switch to 1000 pF range and zero the meter. Turn the ZERO control until the least significant digit *just changes* from 1 to 0 (see "Considerations", item 2).

   b. If test leads are to be used, connect them to the (+) and (—) jacks before zeroing the meter. *Do not short the leads* together; this will cause an overrange indication on all ranges.
3. a. For all capacitors with leads, insert the capacitor leads directly into the slotted capacitor test socket.

   b. For capacitors which do not have leads, plug test leads into the (+) and (—) jacks and clip the test leads to the capacitor terminals.

OPERATING INSTRUCTIONS (Cont.)

CAUTION

1. Observe polarity when connecting polarized capacitors.
2. Fully discharge any capacitor to be measured.
3. Never apply voltage to the test jacks, serious internal damage may result.

. If the capacitance value is marked, select the appropriate range. For unmarked capacitors, start with the 1000 pF range and keep increasing ranges until the overrange indication goes off and a reading is obtained.

. An overrange indication is given when the bottom segment of each digit is lighted. The display looks like four dashes across the bottom portion of the display: (_ _ _ _). The display may show the dashes continuously, or alternately display dashes and digits. Either condition indicates that the capacitor value is greater than full scale, and a higher range should be selected. The dashes are never displayed during in-range conditions.

6. a. On the 1000 pF to 10 mF ranges, the capacitance reading (or an overrange indication) will be ready in less than a second.

   b. On the 100 mF range, wait 2½ to 5 seconds for the reading.

   c. On the 1000 mF range, the reading will take 10 to 35 seconds, depending upon the size of the capacitor. *Be patient, you will get a reading.* Don't disturb connection to the capacitor or the measurement will start over, further delaying the reading.

   d. Because the capacitor is initially connected to the meter at some random point in the timing cycle, the first reading will probably be innacurate. Wait for the second reading on the 100 mF and 1000 mF ranges. On other ranges, readings occur so often that an incorrect reading is not probable.
7. Read capacitance directly from the LED display. Most schools are currently using the terminology for capacitor values as labeled on the 820 range switch. A conversion chart is provided on the back of

the meter, and on the inside front cover of this manual, for convenience and accuracy in converting nanofarad and millifarad readings into picofarad and microfarad values, in which most capacitors are still marked.

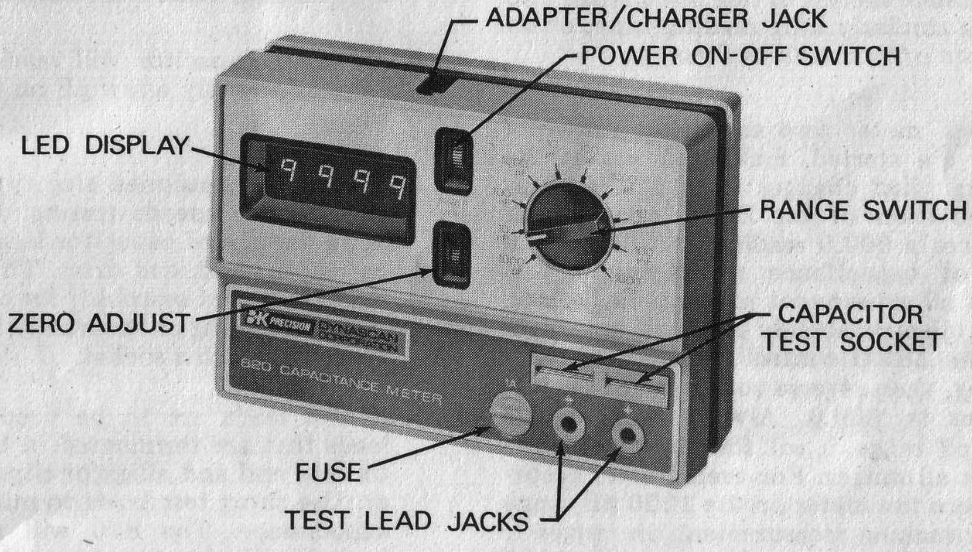


Fig. 1. Operating controls.

OPERATING INSTRUCTIONS (Cont.)

CONSIDERATIONS

1. The 10 to 35 second reading time for the 1000 mF range is normal. Larger capacitors simply charge more slowly. All other capacitance meters in this price range also require similarly long reading time, *or do not even offer a 1000 mF range.*

2. Recheck meter zero each time measurements are started, making sure that the last digit just changes from 1 to 0. Further rotation of the ZERO control still produces a 000.0 reading, but delays the start of capacitance measurement and causes all subsequent readings to be low. If the display already reads all zeros, rotate the ZERO control to obtain a 000.1 reading, then reverse rotation until it just changes to 000.0. Always zero on the 1000 pF range, it will then be very accurate for all ranges. For even greater accuracy, zero the meter on the 1000 pF range before making measurement on ranges 1, 2, and 3. Rezero the meter on the 1000 nF range before making measurements on ranges 4 thru 10.

3. A shorted capacitor will read overrange on all ranges. A capacitor with low voltage leakage will read overrange, or a much higher value than normal.

4. An open capacitor will read zero on all ranges (possibly a few pF on the 1000 pF range).

5. The spring-tensioned slot type capacitor test socket speeds testing. It accepts a wide variety of capacitor lengths, lead dimensions, and lead dress. This eliminates the time spent searching for a socket with correct spacing or accurately bending lead dress to match a socket.

6. If test leads are to be used, select test leads that are terminated in banana plugs on one end and alligator clips on the other. Use short test leads to minimize cable capacitance. The 820 will zero out at least 20 pF of test lead capacitance. Color coded test leads, one red and one black, simplify proper polarity connections.

7. When measuring an assortment of capacitors, where some will require test leads and some will not, leave the test leads connected to the meter throughout the measurements. Otherwise, it is necessary to zero out the test lead capacitance when test leads are connected, and re-zero when they are removed.

8. The meter is protected against damage from charged capacitors by the fuse. If the fuse blows, the meter will read zero for all capacitors checked (a few pF on the 1000 pF range). To remove the fuse, push and turn the cap counter-clockwise. Replace the fuse only with a 1 Amp, type 3AG fuse.

9. To conserve battery life, turn the POWER switch off when not actually making measurements.

10. The optional accessory BC-28 Adapter/Charger is for use with *Nicad rechargeable batteries only*. Do not use the adapter/charger without batteries or when non-rechargeable batteries are installed in the meter.

11. The meter may be operated while the Nicad batteries are being charged. Operation of the meter is unaffected except on the 1000 pF range. On that range only, resolution is reduced by ripple from the adapter/charger causing the least significant digit to vary over a range of 6 to 8 counts.

12. Remove discharged disposable batteries immediately to prevent leakage.

13. The 820 applies a maximum of 2.5 volts to the capacitor being measured. On some ranges, only 0.5 volt is applied. There is no danger of exceeding the voltage rating of any capacitor, nor of retaining a dangerous voltage on the capacitor when it is removed from the meter.

14. Capacitors, especially electrolytics, often have notoriously wide tolerances. Do not be surprised if the measured value is up to 100% greater than the value marked on the capacitor, unless it is a close tolerance type. However, values are seldom drastically below the rated value.

15. A handy reference table, located on the inside rear cover of this manual, summarizes typical characteristics for various types of capacitors.

CIRCUIT DESCRIPTION

INTRODUCTION

The block diagram (Fig. 2, centerfold) gives a functional breakdown of the unit. For detailed curcuit operation, refer to the schematic diagram.

The capacitance meter operates as a time counter to measure the charge time required for the measured capacitor to reach a specific voltage. Circuit design is based upon the RC time constant property. The meter uses a precision constant current source to charge the capacitor and a precision voltage reference to which the capacitor is charged. Charging time then becomes solely dependent upon the value of the capacitor being measured. Each range selects a different combination of precision charging current, clock frequency, and charge voltage reference which permits direct capacitance readings in pF, nF, μF, or mF. A summary of these combinations is listed in Table 1.

CLOCK FREQUENCY GENERATION

The basic clock frequency of the unit is 4MHz, developed by crystal-controlled oscillator IC101B. Crystal CR101 gives a frequency stability of .005% (50 ppm). No tuning adjustment is required during calibration. The 4MHz clock signal is applied to four cascaded decade counters, IC105 and IC106, which provide additional clock frequencies of 400 kHz, 40 kHz, 4 kHz, and 400 Hz. All five clock frequencies are applied to a wafer of the range switch, which selects the appropriate clock frequency (f_o) for each range.

CYCLE CLOCK GENERATION

The 400 Hz clock signal is continuously applied to binary counter IC204. The three outputs of IC204 designated as signals A, B, and C are the ÷128, ÷1024, and ÷4096 outputs. Frequencies are 3.125 Hz for signal A, 0.390625 Hz for signal B, and 0.0976525 Hz for signal C (with no capacitor connected for measurement). Signals A, B, and C are applied to a wafer of the range switch, which selects signal A for the eight lowest ranges, signal B for the 100 mF range, and signal C for the 1000 mF range. The duration of a cycle of this cycle clock signal establishes the discharge time for the capacitor being measured. Thus, a lower frequency, longer duration signal is used on the higher ranges to assure that the capacitor is fully discharged between readings.

THE CAPACITOR CHARGE CYCLE

The capacitor charge cycle starts when binary counter IC204 reaches its full count for signal A, B, or C, whichever is selected by the range switch. The negative-going transition of signal A, B, or C becomes a trigger pulse to flip-flop IC203C-IC203D and causes it to change state. The resulting logic low output of the flip-flop is applied to transistor switch Q203-Q204, turning it off and removing the short from across the capacitor being measured (C_X). This allows C_X to start charging through the selected constant current source. The duration of the capacitor charge cycle depends upon the size of C_X, the magnitude of the constant current source, and the preset voltage to which C_X is charged. Refer to the "Constant Current Source" paragraph for more detail about those factors.

RANGE		CYCLE CLOCK	CLOCK FREQ.	CHARGE VOLTAGE	CONSTANT CURRENT	RESISTANCE	CHARGING TIME (For full scale reading)
1	1000.0 pF	A	4 MHz	2.5 V	1 μA	1 MΩ	2.5 mSEC
2	10.000 nF	A	400 kHz	2.5 V	1 μA	1 MΩ	25 mSEC
3	100.00 nF	A	40 kHz	2.5 V	1 μA	1 MΩ	250 mSEC
4	1000.0 nF	A	4 MHz	2.5 V	1 mA	1 kΩ	2.5 mSEC
5	10.000 μF	A	400 kHz	2.5 V	1 mA	1 kΩ	25 mSEC
6	100.00 μF	A	40 kHz	2.5 V	1 mA	1 kΩ	250 mSEC
7	1000.0 μF	A	40 kHz	2.5 V	10 mA	100Ω	250 mSEC
8	10.000 mF	A	40 kHz	0.5 V	20 mA	50Ω	250 mSEC
9	100.00 mF	B	4 kHz	0.5 V	20 mA	50Ω	2.5 SEC
10	1000.0 mF	C	400 Hz	0.5 V	20 mA	50Ω	25 SEC

Signal A = 3.125 Hz, B = 0.390625 Hz, C = 0.0976525 Hz
Reading Time = Cycle Clock + Charging Time

Table 1. Summary of range selection variables.

CIRCUIT DESCRIPTION (Cont.)

During the capacitor charge cycle, a complementary logic high output from flip-flop IC203C-IC203D is applied to counting interval gate IC203A and the reset input of binary counter IC204. Counting interval gate IC203A allows the selected clock frequency (f_o) to be applied to 4½ decade counter/latch IC102 only during the capacitor charge cycle. The positive-going transition at the beginning of the capacitor charge cycle is the reset pulse for the binary counter, but the continued logic high state at the reset input inhibits counting during the capacitor charge cycle. Thus, the output of the binary counter is a non-symmetrical square wave whenever a capacitor is being measured. The duration of the positive portion of signal A, B, or C is that of the binary counter's full count. The duration of the negative portion is that of the capacitor charge cycle plus the binary counter's full count.

The capacitor charge cycle ends when C_X reaches a preset voltage of 2.5 volts or 0.5 volt, depending upon the selected range. At that point, comparator IC205 produces a pulse to reset flip-flop IC203C-IC203D, and the conditions previously described are reversed.

THE CAPACITOR DISCHARGE CYCLE

The capacitor discharge cycle begins when the charge cycle ends. At that point comparator IC205 produces a pulse to change states of flip-flop IC203C-IC203D. The resulting logic high output is applied to transistor switch Q203-Q204, turning it on. This places an effective short-circuit across capacitor C_X and provides the capacitor discharge path. The complementary logic low output from flip-flop IC203C-IC203D inhibits counting interval gate IC203A and blocks the clock frequency from 4½ decade counter/latch IC102. The logic low state at the reset input of binary counter IC204 allows counting of signal A, B, or C to begin. The transition at the end of a half-cycle of signal A, B, or C (full count of binary counter) has no effect. The transition at the end of a full cycle of signal A, B, or C (second full count of binary counter) ends the capacitor discharge cycle and starts a new capacitor charge cycle.

CONSTANT CURRENT SOURCE

During the capacitor charge cycle, the capacitor being measured (C_X), is charged with a precision constant current. The constant current source circuit consists of IC202B, Q202, the current selection wafer of the range switch, and the resistor and trimpots which determine the precision current value for each range. A 1.0 volt potential is maintained across the resistor network (emitter of Q201 to emitter of Q202). In ranges 1, 2, and 3, the 1.0 volt is applied across resistors R219 and R220 only. This places a 1 megohm resistance in the circuit and results in a precision constant current of 1 microamp when trimpot R220 is properly adjusted. In ranges 4, 5, and 6, resistor R221 and trimpot R222 are added, which drops the total resistance to 1,000 ohms and results in a 1 milliamp constant current. In range 7, R221 and R222 are removed, but resistor network R223/R224/R225 is connected. Total resistance is trimmed to 100 ohms with R224 and a constant current of 10 milliamps is produced. In ranges 8, 9, and 10, the range 7 resistor network is paralleled with another 100-ohm resistor network, R226/R227/-R228, which drops total resistance to 50 ohms and increases the constant current to 20 milliamps.

CHARGE VOLTAGE REFERENCE

On ranges 1 thru 7, the reference voltage for comparator IC205 is 2.5 volts. This is the value to which C_X will charge, because IC-205 ends the capacitor charge cycle when the voltage on the capacitor reaches the reference voltage. The 2.5 volt reference is achieved when resistor R229 is connected in parallel with R230. Network R229/R230 and resistor R231 form a voltage divider which places the reference voltage for IC205 at 2.5 volts. Resistor R229 is removed on ranges 8, 9, and 10, which changes the ratios of the voltage divider and shifts the reference voltage to 0.5 volt.

RANGE SWITCHING SCHEME

Each position of the range switch selects a different combination of constant charging current for C_X, clock frequency for the display circuit counter, and 2.5 or 0.5 volt charge voltage reference for C_X. For example, in the 1000 pF range (range 1), a 1 microamp current is applied to C_X until it is charged to 2.5 volts. During this capacitor charge cycle, the counter in the display circuits is counting a clock frequency of 4 MHz. A full count of 10,000 (999.9 readout) is reached in the time period that a 1000 pF capacitor would require to reach 2.5 volts.

(continued on page 14)

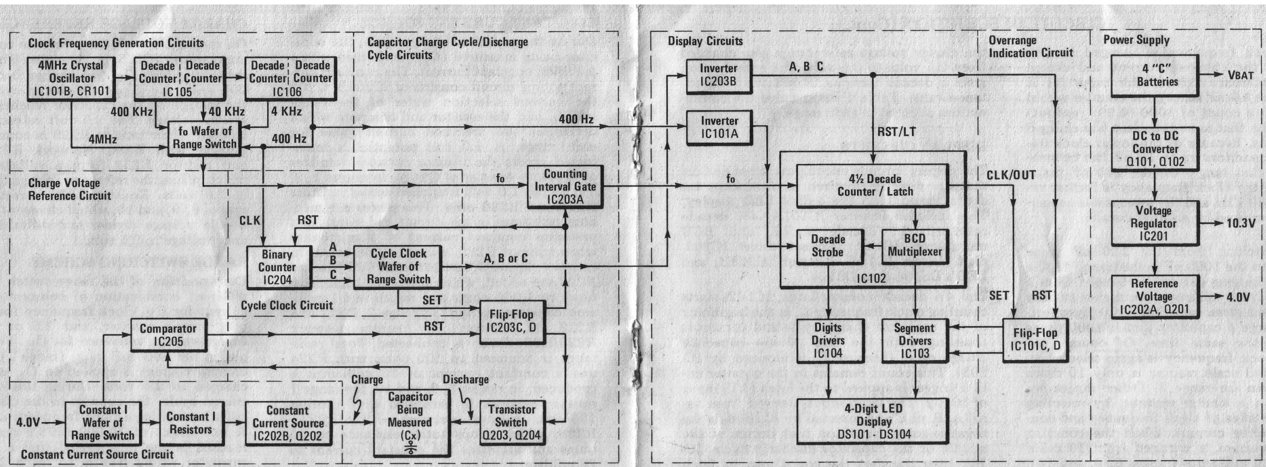


Fig. 2. Block diagram.

If the clock frequency is changed to 400 kHz, but the charging current and charge voltage reference remain the same (as it does in the 10 nF range), the counter would only reach a count of 1000 (0.999 readout) by the time that same capacitor was charged to 2.5 volts. Because of the lower clock frequency, capacitors up to 10 nF can be measured on that range. On the 100 nF range (range 3), the clock frequency is further reduced to 40 kHz and the measurable capacitance is increased by another decade.

When switching from the 100 nF range (range 3) to the 1000 nF range (range 4), the constant charging current is changed from 1 microamp to 1 millamp. The higher current will charge a given capacitor 1000 times faster, or charge a capacitor that is 1000 times larger in the same time. Of course, the 4 MHz clock frequency is again selected so that the full scale reading is only 10 times greater than on range 3. Other ranges are selected in a similar manner, by selecting various decades of clock frequency and constant charging current. When the constant charging current is changed from 10 milliamps to 20 milliamps (ranges 8, 9, and 10), the charge voltage reference is also changed from 2.5 volts to 0.5 volt. The combination gives a decade increase in full scale capacitance value. Table 1 summarizes the combinations selected in each range.

DISPLAY CIRCUITS

The display circuits encompass those devices that are directly involved in producing the digital readout on the 4-digit LED display. This includes inverter IC101A, 4½ decade counter/latch, decade strobe, and BCD multiplexer IC102, segment driver IC103, digit drivers IC104, inverter IC203B, and LED's DS101 thru DS104.

The 4½ decade counter/latch, IC102, starts counting clock frequency f_o at the beginning of the capacitor charge cycle and continues counting until the end of the capacitor charge cycle (because f_o is blocked by IC-203). This count remains in the counter until a trigger is applied to the latch (LT) input of IC102. The latch input, derived from signal A, B. or C and inverted by IC203B, is the negative-going transition that occurs at the middle of the capacitor discharge cycle. IC-102 then transfers the count into its latch circuit. The latched number is converted from binary to BCD and fed out one digit at a time by the BCD multiplexer. Segment driver IC103 converts the BCD signal into segment lighting for the LED's. The decade strobe of IC102 and digit drivers IC104 enable the LED's one at a time, in synchronization with sequenced BCD signals. An inverted 400 Hz clock signal from IC101A refreshes the readout.

The counter is reset at the beginning of each capacitor charge cycle, and takes another count of the capacitor being measured. The readout is updated in the middle of each capacitor discharge cycle when the new count is transferred into the latch circuits.

The decimal points in the LED's are lighted by a direct connection from the range switch. The range switch selects the digit of the display in which the decimal point should appear and routes battery voltage to it.

METER ZERO

Meter zeroing is accomplished by adjusting the RC time constant of a differentiating network (C103, R105, and R106) in the reset input of IC102. The reset signal at this point is a differentiated pulse produced by the positive-going transition of inverted signal A, B, or C. However, it is the trailing edge, or negative-going transition of this pulse that is used to reset the counter. Front panel ZERO control R106 adjusts the width of this pulse and can delay the start of counting to compensate for at least 20 picofarads test lead capacitance. Note that R105 and R106 comprise the only resistance in the circuit on ranges 1, 2, and 3, where a 1 microamp constant current source is used. On all other ranges, Q103 is switched on to shunt R105 and R106 with R107 and R108. This shortens the reset pulse when higher constant current sources are used to assure that the start of counting is not delayed on those ranges. Trimpot R108 is an internal adjustment to zero set the other ranges.

ZERO control R106, or internal adjustment R108, is properly adjusted when it exactly compensates for test socket or test lead capacitance. This is the point where the last digit just changes from 1 to 0. With further rotation, the display still reads 000.0 but counter reset is delayed until the capacitor has already begun charging. Such misadjustment buries part of the capacitor charge cycle count, causing all subsequent readings to be low by the amount of misadjustment.

OVERRANGE INDICATION

If the counter reaches a full count (advances from 9999 to 10000) before the capacitor charge cycle is completed, an overrange indication is given. Upon full count, counter IC102 produces a clock/out signal to trigger flip-flop IC101C-IC101D. An output from the flip-flop inhibits segment driver IC103 to prevent numbers from being displayed. The other output from the flip-flop turns on Q104, which applies power to the bottom segment of the display. As the strobe enables each digit, the bottom segment will light, giving the four dashes readout (____). The output of inverter IC203B is used to reset flip-flop IC101C-IC101D at the beginning of each capacitor charge cycle.

During each display cycle, the latched number from IC102 is displayed until the overrange condition occurs, at which time the numbers are inhibited and the four dashes appear. If a capacitor is only slightly overrange, the numbers and the dashes will alternately flash on the readout. When highly overranged, the dashes are lit so much longer than the numbers that the numbers may be so dim that they are not readily visible.

POWER SUPPLY

The capacitance meter operates from four "C" cells which provide 4.4 to 6 volts, depending upon the degree of battery charge. Raw battery voltage is used to power the display circuits and other points where 4.4- to 6-volt power is used and regulation is not critical. Battery voltage is also applied to a DC-to-DC converter consisting of transistors Q101 and Q102, transformer T101 and diodes D102 and D103. The DC-to-DC converter operates at approximately 15 kHz and converts the battery voltage to a 13- to 20-volt DC output which is applied to regulator IC201. The regulator provides regulated 10.3 volts V_{DD} for most of the digital circuits, and a 4.0-volt reference voltage for IC202A. IC202A compares the actual source voltage of the constant current source circuits with the 4.0-volt reference and controls series pass regulator transistor Q201 to maintain the voltage for the constant current source circuits at 4.0 volts.

PROTECTIVE CIRCUITS

CAUTION

Although the meter is equipped with protective circuits, capacitors should always be discharged before connecting them to the meter for measurement. A high voltage charge or transient could exceed the limitations of the protective circuits and damage the instrument.

Diode D101 gives protection against reverse polarity input at the battery charger jack.

Diodes D201 and D202 and fuse F201 give protection if a charged capacitor is accidentally connected to the meter. If the charged capacitor is connected in the proper polarity, but the potential is greater than the battery voltage, diode D202 allows the battery to act as a filter and absorb the charge. If the charged capacitor is connected with reverse polarity, diode D202 shorts the charge to ground. If the amount of charge is excessive, fuse F201 opens the capacitor's ground return path.

MAINTENANCE AND CALIBRATIONS

MEASURING BATTERY VOLTAGE

Periodically check battery voltage. Measure the DC voltage between the (—) jack and the battery test terminal of the 820 (see Fig. 3). Batteries must be replaced or recharged when voltage drops to 4.4 volts.

BATTERY REPLACEMENT

Loosen the captive screw from the back of the unit and remove the back cover. Install or replace the four "C" cells with polarity shown in the battery compartment. Refer to Fig. 4 for illustrated view.

Alkaline or Ni-Cad batteries are recommended for this product. If Carbon-Zinc or Alkaline types are used, they should be removed immediately when they test low, to prevent instrument damage from battery leakage.

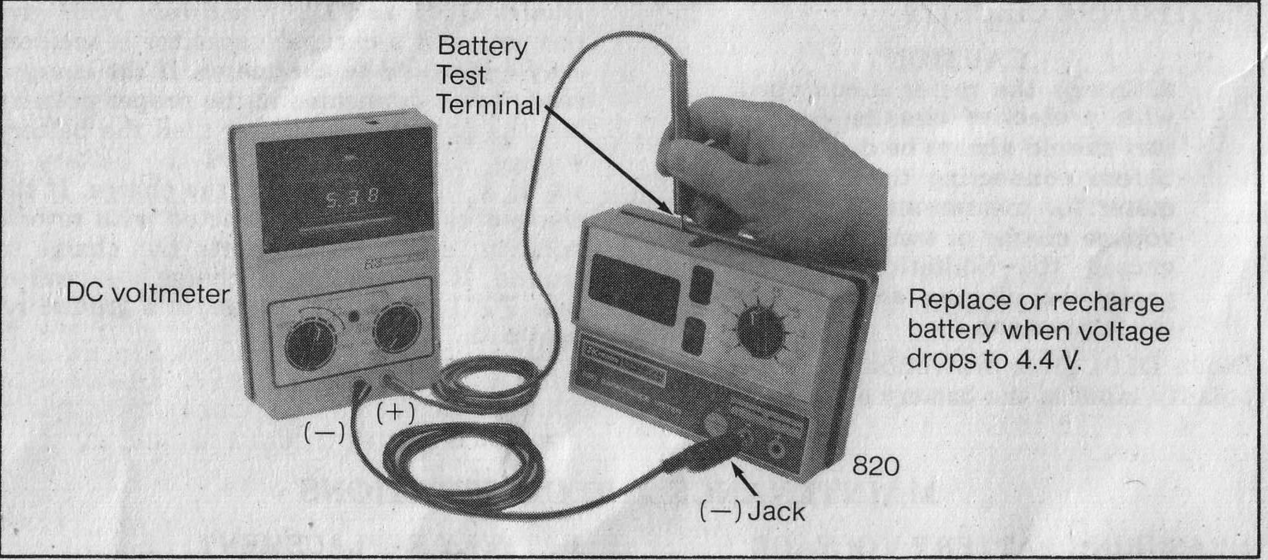


Fig. 3. Measuring battery voltage.

FLASHLIGHT SIZE "C" BATTERIES

Type	NEDA	Burgess	Eveready	Mallory	RCA	Ray-O-Vac
Zinc-Carbon	14F	1	935	M14F	VS035A	1C
Alkaline	14A	AL1	E93	Mn1400	VS1335	814

RECHARGEABLE BATTERIES

Type	Burgess	Eveready	General Electric	Gould	Gulton
Ni-Cad	CD-14	CH 1.5	GCT 1.5 SB	2.0SC	R-190

DISASSEMBLY

For access to the circuit boards for calibration adjustments or servicing, refer to steps 1 thru 4 and Fig. 4. If the circuit boards must be removed from the housing for parts replacement, refer to steps 4 and 5 and Fig. 5.

1. Remove back cover and batteries as for battery replacement.
2. Remove fuse from front panel.
3. Unsolder the connection from the main circuit board to the (+) jack of the front panel.
4. Remove four screws, one from each corner of the inside of the housing, and remove front cover.
5. To remove boards from housing, remove one screw from the approximate center of each board, then compress battery terminals and push them through the slots in the housing. Leave the two boards interconnected.
6. Place boards on insulated work surface if power is to be applied with boards removed from housing.

CALIBRATION ADJUSTMENTS

The unit was carefully checked and calibrated at the factory prior to shipment. Readjustment is recommended only if repairs have been made in a circuit affecting calibration, or if you have reason to believe the unit may be out of calibration. Calibration adjustments should be attempted only if the proper test equipment is available and you are experienced and qualified in its use. If test equipment is less accurate than that specified, the calibration accuracy of the 820 will be degraded proportionately.

Test Equipment Required

DC Voltmeter, 0.5% accuracy (B & K-Precision Model 2810 or 2830 or equivalent).

Four miniature alligator clips and a 1 amp fast blow pigtail fuse wired per Fig. 6.

Precision capacitors (0.1% accuracy): values of approximately 1000 pF, 1.00 μF, and 1000 μF.

Capacitors of any tolerance percentage may be used if the exact value is first measured on a precision capacitor bridge (0.1%). The 820 is then calibrated to read the same value.

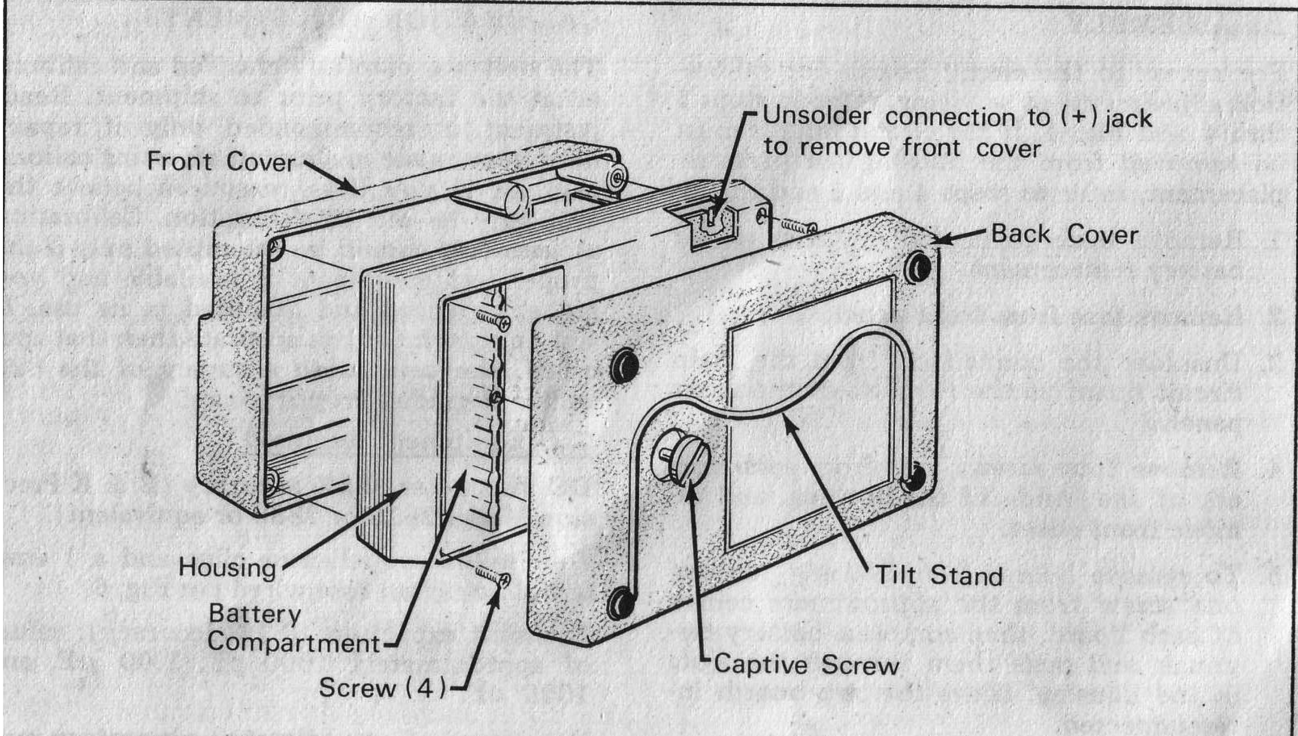


Fig. 4. Disassembly

The capacitor bridge must be operated at its lowest frequency (60 or 120 Hz) for electrolytic capacitors, or any capacitor with high dissipation factor. Since the 820 uses essentially a DC method of measurement and a capacitor bridge uses an AC method of measurement, using the lowest frequency with the bridge method of measurement gives the best correlation of readings.

Procedures

1. Before removing covers, make sure battery voltage exceeds 4.4 volts (Fig. 3).
2. Remove front and back cover and lay unit on a flat surface to hold the batteries in place (do not use a power supply).
3. Measure DC voltage at + side of C204 and adjust R202 for 4.0 volts.
4. Select the 1000 pF range and ZERO the meter.
5. Select the 1000 nF range and adjust R108 to rezero the meter (do not readjust the ZERO control).

NOTE In steps 6 thru 10, the meter may alternately overrange and read 000.0 or slightly higher (first digit not visible). If this occurs, disregard the overrange indication and read the last four digits.

6. Connect 1000 pF precision capacitor to (+) and (—) equivalent points on circuit board as shown in Fig. 6.
7. Select 1000 pF range and adjust R220 so meter reads exact value of precision capacitor.
8. Select 1000 nF range and connect 1.00 µF precision capacitor. Adjust R222 so meter reads exact value of precision capacitor.
9. Select 1000 µF range and connect 1000 µF precision capacitor. Adjust R224 so meter reads exact value of precision capacitor.
10. Select 10 mF range with 1000 µF precision capacitor still connected. Adjust R227 so meter reads exact value of precision capacitor (approximately 1.000).

Field Expedient

The following procedure will not give the factory calibrated accuracy of 0.5%, but should provide accuracy within 2% for ranges 1 thru 6 and within 4% for ranges 7 thru 10. A microammeter/milliammeter with 0.5% accuracy, such as B & K-Precision Model 2830, is required in place of the precision capacitors.

1. Perform steps 1 thru 5 of the standard procedure.
2. Connect meter to measure between the (+) and (—) jack equivalents of the 820 and adjust trimpots as follows:

RANGE	TRIMPOT	METER READING
1000 pF	R220	1.0 µA
1000 nF	R222	1.0 mA
1000 µF	R224	10.0 mA
10 mF	R227	20.0 mA

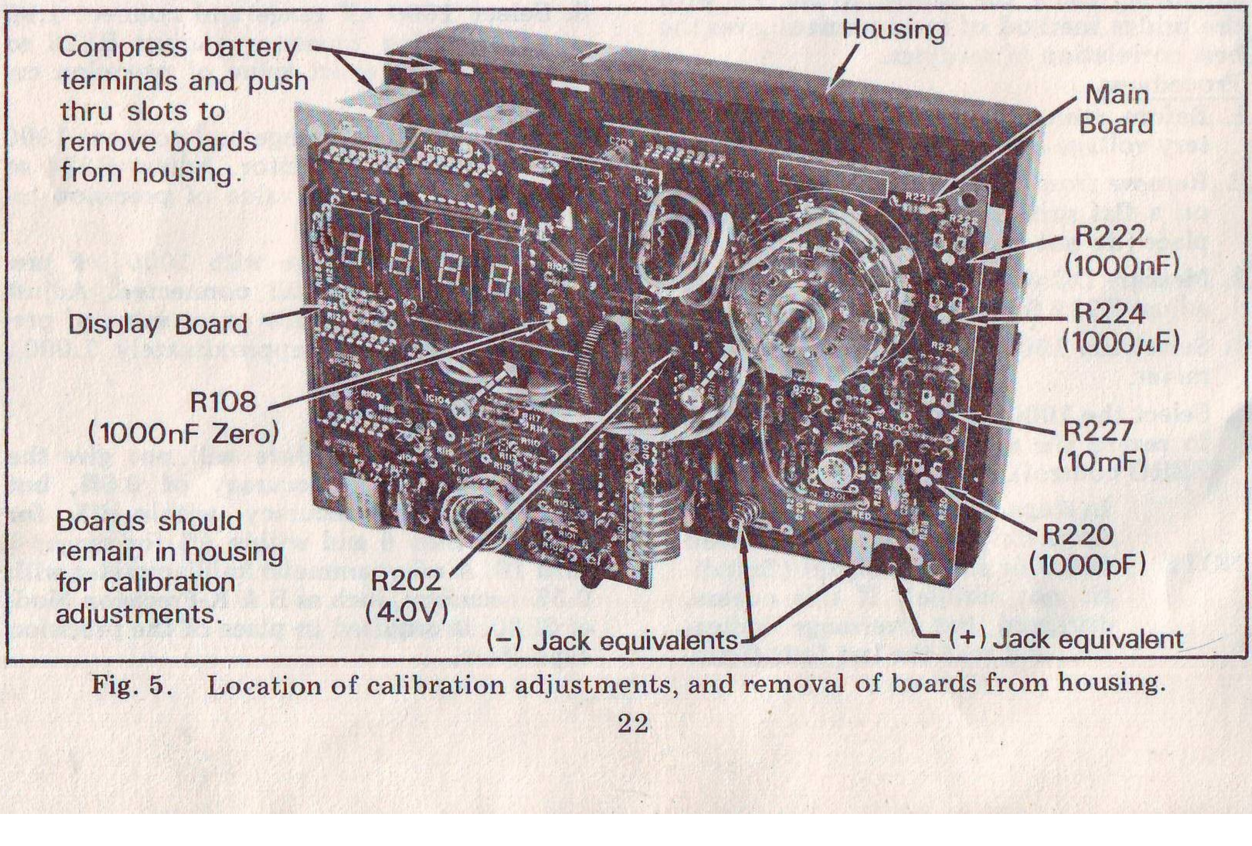


Fig. 5. Location of calibration adjustments, and removal of boards from housing.

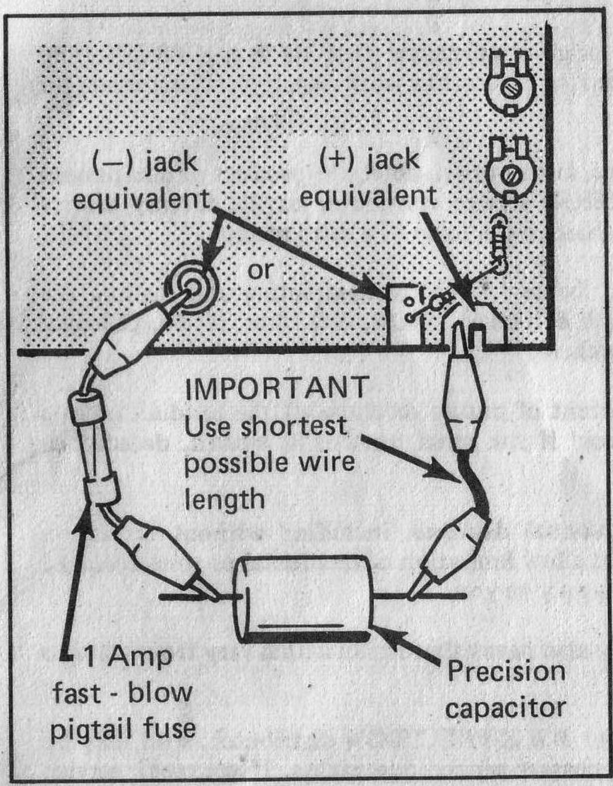


Fig. 6. Connection of precision capacitors during calibration.

WARRANTY SERVICE INSTRUCTIONS

1. Refer to the MAINTENANCE section of your B & K-Precision instruction manual for adjustments that may be applicable.
2. If the above-mentioned procedures do not correct the problem you are experiencing with your unit, pack it securely (preferably in the original carton or double-packed). Enclose a letter describing the problem and include your name and address. Deliver to, or ship PREPAID (UPS preferred) to the nearest B & K-Precision authorized service agency (see list enclosed with unit).

If your list of authorized B & K-Precision service agencies has been misplaced, contact your local distributor for the name of your nearest service agency, or write to:

Service Department
B & K-Precision Product Group
DYNASCAN CORPORATION
2815 West Irving Park Road
Chicago, Illinois 60618

LIMITED ONE-YEAR WARRANTY

DYNASCAN CORPORATION warrants to the original purchaser that its B & K-PRECISION product, and the component parts thereof, will be free from defects in workmanship and materials for a period of one year from the date of purchase.

DYNASCAN will, without charge, repair or replace, at its option, defective product or component parts upon delivery to an authorized B & K-PRECISION service contractor or the factory service department, accompanied by proof of the date of purchase in the form of a sales receipt.

To obtain warranty coverage, this product must be registered by completing and mailing the enclosed warranty registration card to DYNASCAN, B & K-PRECISION, P.O. Box 35080, Chicago, Illinois 60635 within five (5 days) from the date of purchase.

Exclusions: This warranty does not apply in the event of misuse or abuse of the product or as a result of unauthorized alterations or repairs. It is void if the serial number is altered, defaced or removed.

DYNASCAN shall not be liable for any consequential damages, including without limitation damages resulting from loss of use. Some states do not allow limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

This warranty gives you specific rights and you may also have other rights which vary from state to state.

For your convenience we suggest you contact your B & K-PRECISION distributor, who may be authorized to make repairs or can refer you to the nearest service contractor. If warranty service cannot be obtained locally, please send the unit to B & K-PRECISION Service Department, 2815 West Irving Park Road, Chicago, Illinois 60618, properly packaged to avoid damage in shipment.

TYPICAL CAPACITOR CHARACTERISTICS

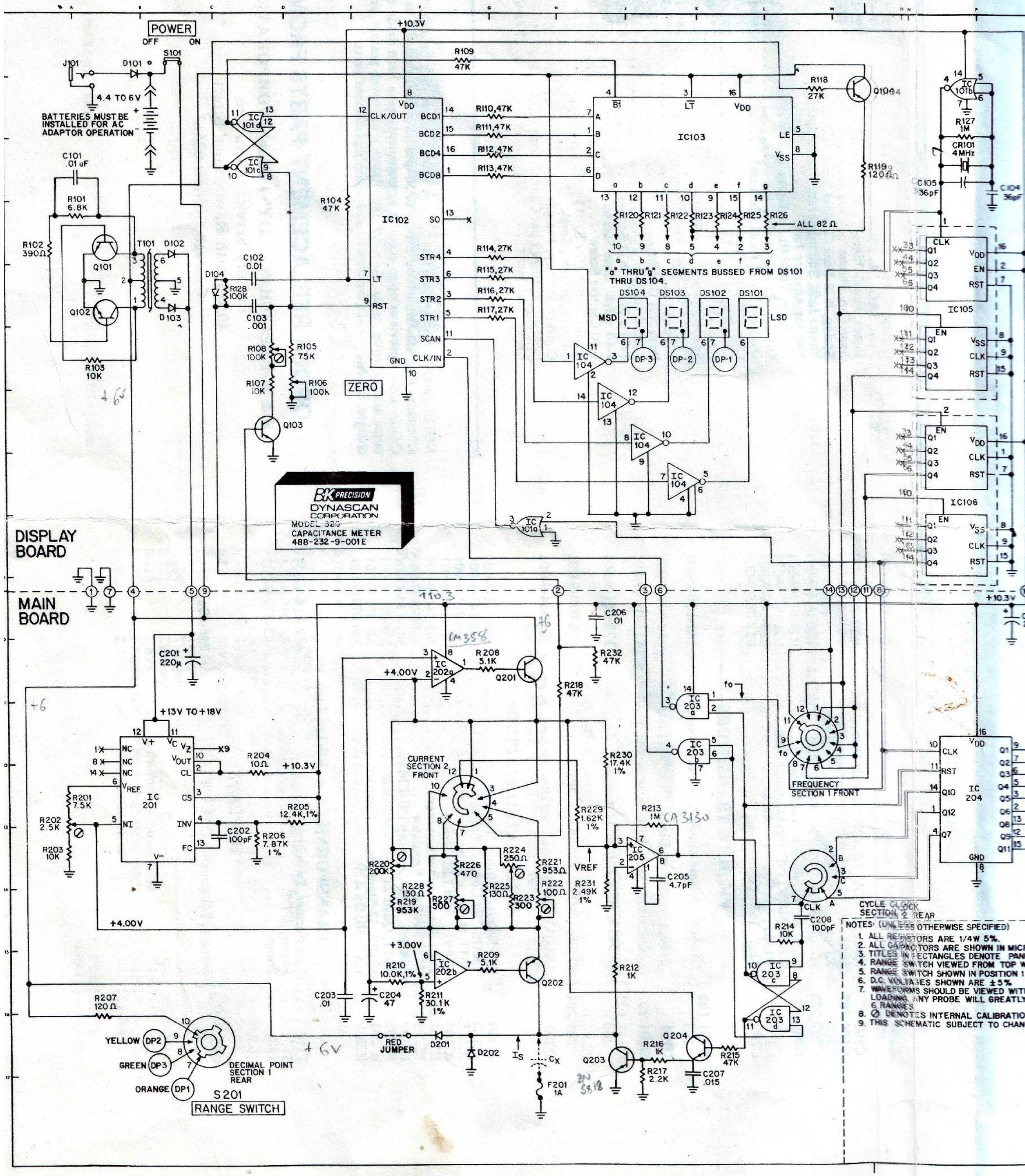
TYPE	VALUE	VOLTAGE	TEMPCO	DF	DA	LEAKAGE
Glass and Mica						
Glass	0.5pF – .01 µF	300 – 1kV	+140 ± 25	.03 – 0.1%		10^9
High K Glass	10 pF – .01 µF	50 – 100	±4500	1 – 3%		10^9
Mica	1 pF – 0.1 µF	100 – 2kV	±500 to ±10	.05 – 0.2%	0.7%	$10^9 - 10^{11}$
Ceramic						
COG	1 pF – 0.1 µF	50 – 600	0±30	0.2%		10^8
COH	1 pF – .01 µF	50 – 600	0±60	0.2%		10^8
COJ	1 pF – .01 µF	50 – 600	0±120	0.2%		10^8
COK	1 pF – .01 µF	50 – 600	0±250	0.2%		10^8
P3K	100 pF – .01 µF	50 – 600	–1500 ±250	0.2%		10^8
S2L	3 – 200 pF	1kV – 6kV	–330 ±500	0.6%		10^7
S3N	3 – 200 pF	1kV – 6kV	–3300 ±2500	0.6%		10^7
U2J	1 pF – .01 µF	50 – 600	–1500 ±250	0.2%		10^8
X5F	100 pF – .01 µF	50 – 600	–500 ±2500	2%		$10^4 - 10^{10}$
X5U	100 pF – .01 µF	50 – 6kV	±2000	2%		$10^4 - 10^{10}$
X7R	10 pF – 2.7 µF	50 – 100	+ 1000 ±3000	2.5%		$10^8 - 10^9$
Y5F	.01 – 2.2 µF	3 – 50	±2500	2 – 10%		$10^5 - 10^8$
Y5R	.01 – 2.2 µF	3 – 50	±3000	2 – 10%		$10^5 - 10^8$
Y5T	.01 – 2.2 µF	3 – 50	+ 1000 ±4000	2 – 10%		$10^5 - 10^8$
Y5V	470 pF – 4.7 µF	50 – 100	±20,000	2.5%		10^9
Z5F	100 pF – .01 µF	50 – 6kV	±2000	2%		$10^4 - 10^{10}$
Z5P	.001 – .01 µF	50 – 6kV	+ 2500 ±2500	2%		$10^4 - 10^{10}$
Z5R	.005 – 0.1 µF	50 – 6kV	+ 2500 ±2500	2%		$10^4 - 10^{10}$
Z5U	.001 – 4.7 µF	50 – 6kV	±10,000	2%		$10^4 - 10^{10}$
Z5V	.001 – 0.1 µF	50 – 600	±10,000	2%		$10^4 - 10^{10}$
Paper and Plastic						
Mylar	.001 – 10 µF	50 – 1600	+ 400 ±200	0.5 – 1%	0.5%	$10^9 - 10^{11}$
Paper	.0005 – 100 µF	200 – 15kV	0±500	0.2 – 1%	2%	$10^9 - 10^{10}$
Parylene	.001 – 1 µF	30 – 100	0±50, –200	0.1 – 0.3%	0.1 – 1%	$10^{10} - 10^{12}$
Polycarbonite	.001 – 25 µF	50 – 400	0±100	0.1 – 0.5%	0.2%	$10^{10} - 10^{11}$
Polystyrene	20 pF – 30 µF	30 – 600	–120 ±30	.01 – 0.1%	.02%	$10^{11} - 10^{12}$
Teflon	.001 – 1 µF	50 – 600	–200	0.1 – 0.2%	0.2%	$10^{11} - 10^{12}$
Electrolytic						
Aluminum Foil	0.5 µF – 1F	3 – 500	+10,000	3 – 50%	10%	.01 – 10µA
Tantalum Foil	0.1 – 10,000 µF	3 – 500	+2500	10 – 20%		.01 – 1µA
Solid Tantalum	.001 – 1000 µF	3 – 125	+1000	1 – 12%	2%	.01 – 10µA

TEMPCO = temperature coefficient in ppm per °C.
DF = dissipation factor @1kHz, except electrolytics @120Hz, Mica @1MHz.
DA = dielectric absorption.
LEAKAGE = ohms x µF, except electrolytics = µA per µFV.

B+K PRECISION DYNASCAN CORPORATION

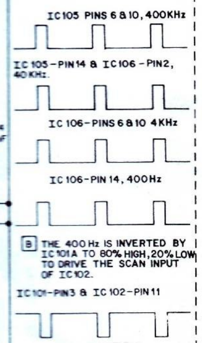
6460 W. Cortland Street, Chicago, Illinois 60635

480-244-9-001 B



NOTE:

A. WAVEFORM OUTPUTS OF IC105 AND IC106 ARE 20% HIGH & 80% LOW DUTY CYCLE.



B. THE 400Hz IS INVERTED BY IC101A TO 80% HIGH, 20% LOW TO DRIVE THE SCAN INPUT OF IC102.

LAST NUMBER	NOT USED
R128	
C105	
D104	
Q104	
IC106	

NUMBERS REPRESENT RIBBON CABLE AND JUMPERS (EXCLUDING DP JUMPERS) VIEWED FROM LEFT TO RIGHT, TOP VIEW, WITH DISPLAY BOARD ABOVE MAIN BOARD.

LAST NUMBER	NOT USED
R232	
C209	
D202	
Q204	
IC205	

NOTES: (UNLESS OTHERWISE SPECIFIED)
1. ALL RESISTORS ARE 1/4W 5%.
2. ALL CAPACITORS ARE SHOWN IN MICROFARADS (μF)
3. TITLES IN RECTANGLES DENOTE PANEL CONTROLS.
4. RANGE SWITCH VIEWED FROM TOP WITH RESPECT TO FRONT PANEL.
5. RANGE SWITCH SHOWN IN POSITION 1, FULLY CCW, 1000pF RANGE.
6. D.C. VOLTAGES SHOWN ARE ±5%
7. WAVEFORMS SHOULD BE VIEWED WITH A 10:1 PROBE TO PREVENT LOADING. ANY PROBE WILL GREATLY LOAD THE C_X IN THE FIRST 6 RANGES.
8. Ø DENOTES INTERNAL CALIBRATION ADJUSTMENT.
9. THIS SCHEMATIC SUBJECT TO CHANGE WITHOUT NOTICE.

SWITCH POSITION	RANGE	COUNT FREQ. (fo)	CURRENT SOURCE (I_S)	V REF.	CYCLE CLK	CHARGING TIME
1 (Fully CCW)	1000.0pf	4MHz	1μA	2.5V	A	2.5ms
2	10.000nf	400KHz	1μA	2.5V	A	25ms
3	100.00nf	40KHz	1μA	2.5V	A	250ms
4	1000.0nf	4MHz	1mA	2.5V	A	2.5ms
5	10.000μf	400KHz	1mA	2.5V	A	25ms
6	100.00μf	40KHz	1mA	2.5V	A	250ms
7	1000.0μf	40KHz	10mA	2.5V	A	250ms
8	10000mf	40KHz	20mA	0.5V	A	250ms
9	100.00mf	4KHz	20mA	0.5V	B	2.5sec.
10 (FULLY CW)	1000.0mf	400Hz	20mA	0.5V	C	25sec.

CYCLE CLK	FREQ.
A	3.125Hz
B	0.390625Hz
C	0.0976525Hz

ALL WAVEFORMS (WITH EXCEPTION OF Cx REFERENCE VOLTAGE) ARE 0 TO 10.3V. RC DECAY WAVEFORMS ABOVE 10.3V AND BELOW 0V MAY BE IGNORED SINCE THEY DO NOT AFFECT OPERATION.