Figure 1

MODEL 220

INSTRUCTION MANUAL

SEMICONDUCTOR ANALYZER

PUBLICATION NO. 2490-652

The Hickok Electrical Instrument Company

10514 DUPONT AVENUE • CLEVELAND, OHIO 44108 • (216) 541-8060 • TWX: 810-421-8286

HICKOK

WARRANTY

IMPORTANT

The following warranty shall be void if the registration card is not properly completed and returned to the Hickok factory, post marked within ten days after date of purchase.

The Hickok Electrical Instrument Co. warrants this instrument of its manufacture to be free from defects in material and workmanship for a period of two years (24 months) from the date of original purchase, subject to the following conditions.

a. Any instrument found to be defective during the first twelve month period after date of purchase may be returned, transportation prepaid, to the factory for repair or, at our option, replacement without charge.

b. Any instrument found to be defective during the second twelve month period after date of purchase may be returned, transportation prepaid, to the factory for repair subject to a minimal handling charge for each time the instrument is returned. Contact the Hickok factory for information regarding this service charge.

This warranty does not apply to any of our products which have been repaired or altered by unauthorized persons, or which have been subject to misuse, negligence, or accident, or which have had the serial number altered, effaced or removed. Neither shall the warranty apply where a warranty registration card has not been properly completed and returned to us promptly after purchase. This warranty is in lieu of all other warranties whether expressed or implied.

RETURNING EQUIPMENT FOR REPAIR

Before returning any equipment for service, the factory must first be contacted, giving the nature of the trouble. Instructions will then be given for either correcting the trouble or returning the equipment. Upon authorization, this equipment should be forwarded directly either to the Hickok factory address at 10514 Dupont Avenue, Cleveland, Ohio, 44108, or to a designated service station in your locality.

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SECTION 1
GENERAL INFORMATION

1-1. DESCRIPTION

The Hickok Model 220 Semiconductor Analyzer is a completely solid state tester that provides in or out of circuit tests on all types of semiconductors.

The Model 220 has a bright LED display for fast and easy GOOD/BAD indication and lead identification. There is no need to search for data sheets to determine device type or lead configuration. The Model 220 indicates the proper leads for you.

The Model 220 will also indicate the beta of a transistor in or out of circuit, the transconductance of a FET in or out of circuit, and the leakage of diodes or transistors out of circuit.

The test leads and line cord are stored under the hinged top cover.

1-2. SPECIFICATIONS

a. Ranges and Functions

BETA:	1-100, 10-1000, 100-10,000 (Beta test collector current - 1mA)
OHMS:	100Ω, 1000Ω, 10,000Ω center scale (10mV open circuit voltage)
FET:	0-250, 0-2500, 0-25,000μmhos
IF,IR:	0-10μA, 0-100μA, 0-1mA
DIODE:	Qualitative with parallel load ≥ 500 ohms
SCR, UJT, TRIAC:	Qualitative

b. Accuracies

BETA:	±5% of arc, in or out of circuit except highest beta range = 30% of arc in circuit (parallel load ≥ 500 ohms), 10% out of circuit.
OHMS:	±3% of arc in or out of circuit.
FET:	±5% of range out of circuit, ±15% of range in circuit (Parallel load G-S ≥ 100 ohms, D-S ≥ 4K ohms) except lowest range accuracy is 25% of arc.
IF,IR:	±5% of range, out of circuit.

c. Power Requirements

105 to 125V AC, or 210 to 250V AC, 50-400Hz.

d. Size

8"W x 7"H x 6"D (20.3 cm x 17.8 cm x 15.2 cm)
Weight: 6-1/2 lbs (2.95 kg).

1-3. CONTROLS, CONNECTORS AND THEIR FUNCTIONS

POWER - ON-OFF switch controls line input power to tester.

METER ZERO - electrically zeroes the indicating meter.

OHMS ADJ - used to set the indicating meter to ∞ (infinity) in the OHMS function.

POLARITY - used to select device type in BETA and FET functions and lead configuration in OHMS function.

FUNCTION - selects the type of test to be performed.

RANGE - selects the scale factor for the indicating meter.

SCR, TRIAC, UJT switch - latching type pushbutton used in conjunction with qualitative testing of these devices (See Section 4 for further explanation).

TEST MODE switch - selects mode of operation - either GOOD/BAD or PARAMETER.

XSTR/DIODE switch - selects device type to be checked in GOOD/BAD mode.

BASE switch - used to correctly position the base lead when transferring the device under test from GOOD/BAD mode to PARAMETER mode.

COLLECTOR switch - same as BASE except it transfers the collector lead. Set for highest beta indication.

LED indicators - the top row indicates whether the device is GOOD or BAD. In addition, if GOOD, it also automatically indicates device polarity. If the device is GOOD, the middle row of LED's will indicate the position of the control element. The bottom row of LED's is used in conjunction with the COLLECTOR switch to indicate the position of the collector lead.

SOCKET - used for out of circuit testing of smaller devices.

1, 2, 3 BANANA JACKS - used in conjunction with test leads for either in circuit testing or for large devices, such as TO-3 transistors, out of circuit.

SECTION 2
OPERATING INSTRUCTIONS

CAUTION

When making in circuit measurements, be sure no circuit voltages are present. Otherwise, damage to the Model 220 equipment may result.

2-1. GOOD/BAD TESTING OPERATION

The Model 220 Semiconductor Analyzer is one of the simplest test equipment to operate ever developed. For testing most semiconductor devices, it is only necessary for the operator to determine whether it is a three lead or two lead device and select the appropriate test by means of the XSTR-DIODE switch.

Set the TEST MODE switch in the GOOD/BAD position, the PWR switch to ON and connect the device under test to the socket or jacks in any convenient manner. The Model 220 will do the rest. It will determine if the device is good or bad. If it is good, the Model 220 will light the appropriate LED indicating whether the device is a P (PNP or P channel) or an N type (NPN or N channel). It will also identify the control electrode. In the case of a two lead device, it will identify the anode and cathode of the device connected to the tester.

NOTE

In the GOOD/BAD mode of operation, the tester will cycle through approximately once every 2 to 3 seconds. The proper indication is obtained at the end of each cycle.

2-2. PARAMETER OPERATION

a. Beta Measurement

The Model 220 will accurately determine the beta of a transistor either in or out of circuit. It is not necessary for the user to know the device type or the lead configuration as this will all be determined automatically by the Model 220.

Simply connect the device under test to the Model 220 test socket or banana jacks in any convenient manner. Place the TEST MODE switch in the GOOD/BAD position. If the transistor is good, the LED display will cycle through once every 2 to 3 seconds, indicate the device type and also the location of the base lead.

At the end of one of the cycles place the TEST MODE switch in the SET position. NOTE: The test mode switch must be changed only while the LED display is indicating device type. Set the BASE switch to correspond with the particular base LED that is lit.

If the transistor is in circuit and the circuit loading is not known, it will be necessary to measure the load. Refer to the section on ohms measurement. Accurate beta measurements can be made with circuit loads as low as 500 ohms.

If the transistor is out of circuit or the in circuit loading is acceptable (500 ohms or more), proceed as follows. Set the POLARITY switch to the type indicated by the LED's. Set the FUNCTION switch to BETA. Electrically zero the meter using the METER ZERO. Now set the TEST MODE switch in the PARAMETER position. Rotate the RANGE switch to obtain an on scale reading. Set the COLLECTOR switch in the position that gives the highest beta indication. Note that high beta is down scale on the meter. The meter now indicates the correct beta of the device.

By using the Model 220 you have now determined almost everything you want to know about the device. You know the beta (from the meter reading), the device type and the complete lead configuration (from the LED indicators).

b. Ohms Measurement

Set the Model 220 controls as follows: TEST MODE switch to PARAMETER, FUNCTION switch to OHMS, BASE switch to 2 and the COLLECTOR switch to the right. The banana jacks now correspond to the POLARITY switch as follows: EMITTER = 1, BASE = 2, COLLECTOR = 3. (E-B = 1-2, C-B = 3-2, C-E = 3-1).

Rotate the RANGE switch to the desired range. Rotate the POLARITY switch to the desired jacks (E-B, C-B, C-E). Adjust the meter pointer to ∞ with the OHMS ADJ control. Short the two banana jacks being used. Set the meter pointer to zero using the METER ZERO control. Repeat the above procedure until ∞ and zero are properly set.

Connect the unknown circuit to the test jacks and read the value indicated on the meter. Be sure to apply the proper scale factor as indicated by the RANGE switch.

The ohms measuring circuit uses a very low voltage source (10mV) such that resistors may be accurately measured in circuit without regard to the semiconductor devices present. Semiconductor junctions in parallel with the resistor being measured will have no affect on ohms accuracy unless they are shorted.

c. FET Measurement

The Model 220 is capable of measuring the transconductance of N or P channel FET's with G_M as high as 25000μmhos. As with bipolar

transistors, it will be necessary to know the circuit loading if the device is being checked in circuit. The Model 220 will give correct indications with a drain-source load as low as 4000 ohms and with gate-source loads as low as 100 ohms. Refer to OHMS measurement section to make these checks.

If the in circuit loading is greater than the minimum values specified above, you may proceed. If the circuit impedances are too low, it will be necessary to remove the device and check it out of circuit.

Place the TEST MODE switch in the GOOD/BAD position. Place the FET in the test socket or connect it to the banana jacks in any convenient configuration. Make sure the XSTR/DIODE switch is in the XSTR position. If the FET is good the LED display will cycle through once every 2 to 3 seconds and indicate the device type and also the location of the gate lead.

NOTE

> The Model 220 may not give a correct indication in the GOOD/BAD mode on some low G_M FET's. This is due to the low "ON" resistance of these devices. The device can still be properly checked using the PARAMETER mode. Simply connect the gate lead to position 2, set the BASE switch at 2 and proceed with the normal parameter measurement.

At the end of one of the cycles of the LED display move the TEST MODE switch to the SET position. Set the BASE switch to correspond with the particular base LED that is lit.

Turn the POLARITY switch to the type indicated by the GOOD LED's. Set the FUNCTION switch to FET and electrically zero the meter. Set the TEST MODE switch in the PARAMETER position. Rotate the RANGE switch to obtain an on scale meter indication. The G_M of the FET can now be read directly from the meter by applying the scale factor indicated by the RANGE switch.

You will note that the only lead determination made was that of the gate lead. This is done because on the vast majority of FET's the drain and source leads are interchangeable. In the very few cases where drain and source are not interchangeable, merely set the BASE switch to 2 and the COLLECTOR switch to the right. Now connect the source to 1, gate to 2, drain to 3, and proceed with a normal parameter measurement.

d. I_F, I_R Measurements

The I_F, I_R function of the Model 220 is mainly used to determine the leakage currents of various devices. The Model 220 is capable of measuring current from 10μA to 1mA full scale. On the 10μA range this gives a resolution of 200 nanoamperes per division.

The I_F, I_R function is also used in conjunction with the SCR, TRIAC, UJT switch for certain special tests. Refer to the separate instructions in paragraph e dealing with these special tests.

For standard current measurements set the TEST MODE switch to PARAMETER, BASE switch to 2, COLLECTOR switch to the left, SCR, TRIAC, UJT switch out, FUNCTION switch to I_F, I_R and use banana jacks 1 and 2. With the POLARITY switch set for N type, there will be approximately + 5 volts at jack 1 with respect to jack 2. With the POLARITY set for P type, jack 1 will be approximately - 5 volts with respect to jack 2. These supplies are current limited at just over 1mA so the possibility of damage to the device under test is eliminated.

Either polarity may be used. The only consideration is how the device under test is connected to the jacks and whether you want to measure forward or reverse current.

e. Special Tests

NOTE: All special tests are out-of-circuit only.

1. I_{CBO}, I_{CES}

Set the Model 220 controls as follows: TEST MODE switch to PARAMETER, BASE switch to 2, COLLECTOR switch to the right, FUNCTION switch to I_F, I_R, SCR, TRIAC, UJT latching pushbutton in "out" position, and POLARITY switch to the type of device being tested. Zero the meter.

Connect the base of the device under test to jack 2, the emitter to 3, and the collector to 1. Set the RANGE switch to obtain the best on scale reading. The meter now indicates the I_{CBO} (leakage from collector to base with the emitter open) of the device.

Depress the SCR, TRIAC, UJT switch to the "in" position. The meter now reads the I_{CES} of the device. (Leakage from collector to emitter with the emitter shorted to base.)

2. SCR

Set the Model 220 controls as follows: POLARITY switch to N type, FUNCTION to I_F, I_R, RANGE to X10, TEST MODE to PARAMETER, BASE switch to 2 and COLLECTOR switch to the right. Depress the pushbutton switch and zero the meter. (Leave switch depressed.)

Connect the SCR as follows: Gate to jack 1, Cathode to 2, and Anode to 3. The pushbutton being depressed prevents false triggering. Any meter deflection at this point indicates leakage.

Release the pushbutton switch and momentarily short 1 to 3. This turns the SCR "ON". A good SCR will cause the meter pointer to deflect upscale.

3. TRIAC

Follow the same set up procedure as for SCR except leave the pushbutton switch out. Connect the TRIAC Gate to jack 1, Main Terminal 2 to 2, and Main Terminal 1 to 3.

Any meter deflection at this point indicates device leakage. Depress the pushbutton. A good TRIAC will cause the meter pointer to deflect upscale. Release the pushbutton. Change the POLARITY switch to P type. Depress the pushbutton. A good TRIAC will cause the meter pointer to deflect upscale.

This test checks out the ability of the TRIAC to conduct in both directions.

4. UJT

Follow the same set up procedure as for SCR. Two parameters can be checked on the UJT - Ieb_2s and Ib_2b_1s.

Ieb_2s - This is the measurement of the leakage current between the emitter and base 2 with the base 1 shorted to base 2. Connect base 1 of the UJT to jack 1, base 2 to 2 and the emitter to 3. The meter now indicates Ieb_2s. This is typically 1 μA or less.

Ib_2b_1s - This is the measurement of the forward current from base 2 to base 1 with the emitter shorted to base 1.

Connect base 1 of the UJT to jack 1, base 2 to 3 and the emitter to 2. The meter will now indicate Ib_2b_1s. This reading can be converted to Rbb by using the following equation: $Rbb = 5V/Ib_2b_1s$. Rbb is the inter-base resistance or the resistance between base 1 and base 2.

SECTION 3
CALIBRATION AND MAINTENANCE

3-1. CALIBRATION

a. Test Equipment Required:

1. A GOOD PNP transistor.
2. A GOOD NPN transistor.
3. A dc milliammeter, range 1mA full scale.
4. A dc millivoltmeter, range 100mV full scale.
5. A dc voltmeter, range 10V full scale.
6. Standard resistance, 460 ohms ± 1%.

NOTE

A multimeter having suitable ranges may be substituted for items 3, 4, and 5 above.

b. Precalibration Adjustments

Using the dc voltmeter check the output of the + 5 volt supply at the + terminal of capacitor C14 and the - 5 volt supply at the - terminal of C16. The outputs should measure between 4.70 and 5.50 volts. Check the +7 volt and - 7 volt supplies at the + and - terminals of C18 respectively. These outputs should measure between 6 and 8 volts.

c. Beta Calibration

1. Set the Model 220 controls as follows:

FUNCTION switch, set to BETA.
POLARITY switch, set to N.
RANGE switch, set to X0.1.
MODE switch, set to PARAMETER.
BASE switch, set to 2.
COLLECTOR switch, set to right hand position.

2. Connect the GOOD NPN transistor and the milliammeter to the test jacks of the Model 220 Analyzer as shown in Figure 2. (Emitter to jack 1, Base to jack 2 and Collector through the meter to jack 3.)

3. Adjust variable resistor R39 until the meter reads 1mA.

4. With all other controls set as in paragraph C1 above, set the POLARITY switch to P and replace the NPN transistor (Figure 2) with the GOOD PNP transistor.

5. Adjust R38 for a reading of 1mA.

d. Offset Adjustment

1. Remove the milliammeter and connect the GOOD PNP transistor directly into the Model 220.

2. Connect the millivoltmeter between jacks 1 and 3 (emitter and collector) and monitor the voltage while adjusting R40 to obtain a meter reading of zero volts.

3. Connect the millivoltmeter between jacks 1 and 2 (emitter and base) and adjust R50 for a meter reading of zero volts.

4. Repeat Steps 3 and 4 above and readjust R40 and R50 as necessary to obtain zero readings.

e. GM Scale Calibration

1. Set the Model 220 Controls as follows:

FUNCTION switch, set to FET.
POLARITY switch, set to N or P.
RANGE switch, set to X1.0.

2. Connect a 460 ohm resistance between jacks 2 and 3.

3. Adjust R44 for center scale deflection on the GM scale of the Model 220 Analyzer.

This completes the calibration procedure.

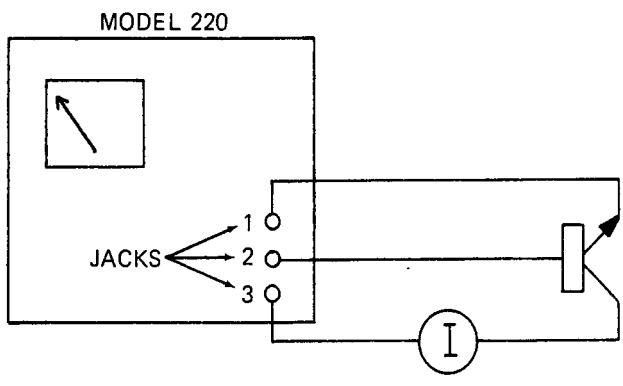

Figure 2. Beta Calibration Test

3-2. MAINTENANCE

Your Model 220 Semiconductor Analyzer has been constructed using the latest components and techniques that the electronic technology has to offer. It has been designed for long reliable service as indicated by your two (2) year warranty.

A troubleshooting procedure is not presented in this manual. The experienced electronic technician can easily interpret the Schematic and Parts Location diagrams for routine troubleshooting; however, it should be noted that the semiconductor devices used in this equipment are of such sophistication that they are not in general distribution. In addition the necessary test equipment for adjustment and repair of this instrument is not generally available.

Should difficulty be encountered with your Semiconductor Analyzer the Hickok Electrical Instrument Co. maintains a complete service facility for reliable and timely service of our products.

SECTION 4

PARTS LIST

MODEL 220 SEMICONDUCTOR ANALYZER

When ordering parts be sure to give the reference designation, description, and the Hickok part number as listed in the following table. Also include the model and serial number of the equipment. There is a minimum billing charge of $5.00 for all parts orders.

REF DESIG.	NOTES	DESCRIPTION	HICKOK PART NO.
AR1		INTEGRATED CIRCUIT: dual op amp, RC4558DN	9800-136
AR2		Same as AR1	
AR3		INTEGRATED CIRCUIT: LM741CN	9800-57
AR4		Same as AR3	
AR5		Same as AR3	
AR6		Same as AR3	
C1		CAPACITOR, FIXED, CERAMIC: 470 pf	3110-339
C2		CAPACITOR, FIXED, ELECTROLYTIC TANTALUM: 4.7 uf, 35 volts	3085-481
C3		Same as C2	
C4		CAPACITOR, FIXED, ELECTROLYTIC TANTALUM: 47 uf, 6 volts	3085-492
C5		Same as C4	
C6		Same as C1	
C7		Same as C4	
C8		CAPACITOR, FIXED, METALLIZED MYLAR: .047 uf, 10%, 250 volts	3090-102

REF DESIG.	NOTES	DESCRIPTION	HICKOK PART NO.
C9		CAPACITOR, FIXED, ELECTROLYTIC: 680 uf, +50% -10%, 16 volts	3085-446
C10 thru C14		Same as C4	
C15		Same as C9	
C16		Same as C4	
C17		Same as C9	
C18		Same as C2	
C19		Same as C1	
C20 thru C29		Same as C4	
C30		Not used	
C31		Same as C1	
C32		Same as C1	
CR1 thru CR4		SEMICONDUCTOR DEVICE: diode 1N914	3870-175
CR5		SEMICONDUCTOR DEVICE: diode 5%, 5.1 volt, 1N5729B	3870-320
CR6		Same as CR5	
CR7 thru CR24		Same as CR1	
CR25		SEMICONDUCTOR DEVICE: diode 1N5740B	3870-309
CR26 thru CR31		Same as CR1	
CR32		SEMICONDUCTOR DEVICE: zener diode, ±5%, 6.2 volt, 400 MW 1N5731B	3870-302
CR33		SEMICONDUCTOR DEVICE: diode 1N2069	3870-62

REF DESIG.	NOTES	DESCRIPTION	HICKOK PART NO.
CR34		Same as CR32	
CR35		Same as CR33	
CR36 thru CR42		Same as CR1	
DS1 thru DS9		LAMP: LED, LSL-6L red diffused	12270-125
J1		JACK: red	10300-88
J2		JACK: black	10300-89
J3		JACK: yellow	10300-90
M1		METER: 0-100μa, Model 34N	340-034
Q1		TRANSISTOR: NPN, 2N5133	20861-210
Q2		Same as Q1	
Q3		Same as Q1	
Q4		Same as Q1	
Q5		TRANSISTOR: 2N5138	20861-221
Q6		Same as Q1	
Q7		TRANSISTOR: MPSA14, NPN Darlington	20861-372
Q8		TRANSISTOR: MPSA65, PNP Darlington	20861-373
Q9		Same as Q7	
R1		RESISTOR, FIXED, DEPOSITED CARBON: 330 ohms, 5%, 1/4 watt	18470-331
R2		RESISTOR, FIXED, DEPOSITED CARBON: 1 megohm, 5%, 1/4 watt	18470-105
R3		RESISTOR, FIXED, DEPOSITED CARBON: 11K ohms, 5%, 1/4 watt	18470-113
R4		RESISTOR, FIXED, DEPOSITED CARBON: 22K ohms, 5%, 1/4 watt	18470-223

REF DESIG.	NOTES	DESCRIPTION	HICKOK PART NO.
R5		Same as R2	
R6		RESISTOR, FIXED, DEPOSITED CARBON: 100K ohms, 5%, 1/4 watt	18470-104
R7		RESISTOR, FIXED, DEPOSITED CARBON: 1K ohms, 5%, 1/4 watt	18470-102
R8		Same as R7	
R9		Same as R2	
R10		Same as R4	
R11		RESISTOR, FIXED, DEPOSITED CARBON: 3K ohms, 5%, 1/4 watt	18470-302
R12		Same as R4	
R13		RESISTOR, FIXED, DEPOSITED CARBON: 1.5K ohms, 5%, 1/4 watt	18470-152
R14		Same as R6	
R15		Same as R6	
R16		Same as R6	
R17		Same as R2	
R18		Same as R13	
R19		Same as R6	
R20		Same as R6	
R21		Same as R6	
R22		Same as R2	
R23		Same as R2	
R24		RESISTOR, FIXED, DEPOSITED CARBON: 82K ohms, 5%, 1/4 watt	18470-823
R25		Same as R6	
R26		RESISTOR, FIXED, DEPOSITED CARBON: 1.5 megohms, 5%, 1/4 watt	18470-155
R27		Same as R13	

REF DESIG.	NOTES	DESCRIPTION	HICKOK PART NO.
R28		RESISTOR, FIXED, DEPOSITED CARBON: 33K ohms, 5%, 1/4 watt	18470-333
R29		RESISTOR, FIXED, DEPOSITED CARBON: 820 ohms, 5%, 1/4 watt	18470-821
R30		RESISTOR, FIXED, DEPOSITED CARBON: 24K ohms, 5%, 1/4 watt	18470-243
R31		RESISTOR, FIXED, DEPOSITED CARBON: 10K ohms, 5%, 1/4 watt	18470-103
R32		Same as R31	
R33		Same as R6	
R34		Same as R4	
R35		RESISTOR, FIXED, DEPOSITED CARBON: 390 ohms, 5%, 1/4 watt	18470-391
R36		RESISTOR, FIXED, DEPOSITED CARBON: 100 ohms, 5%, 1/4 watt	18470-101
R37		RESISTOR, VARIABLE: 1K ohms, 30%, 1/4 watt	16925-747
R38		Same as R37	
R39		RESISTOR, FIXED DEPOSITED CARBON: 4.7K ohms, 5%, 1/4 watt	18470-472
R40		RESISTOR, VARIABLE: 10K ohms, 30%, 1/4 watt	16925-827
R41		Same as R29	
R42		Same as R29	
R43		Same as R31	
R44		RESISTOR, VARIABLE: 100 ohms, .25 watt	16925-783
R45		RESISTOR, FIXED, DEPOSITED CARBON: 200 ohms, 5%, 1/4 watt	18470-201

REF DESIG.	NOTES	DESCRIPTION	HICKOK PART NO.
R46		RESISTOR, FIXED, DEPOSITED CARBON: 470 ohms, 5%, 1/4 watt	18470-471
R47		Same as R2	
R48		RESISTOR, FIXED, DEPOSITED CARBON: 2.2K ohms, 5%, 1/4 watt	18470-222
R49		Same as R7	
R50		Same as R40	
R51		RESISTOR, FIXED, DEPOSITED CARBON: 5.1K ohms, 5%, 1/4 watt	18470-512
R52		Same as R31	
R53		Same as R31	
R54		RESISTOR, FIXED, DEPOSITED CARBON: 6.2 ohms, 5%, 1/4 watt	18555-209
R55		Same as R31	
R56		Same as R7	
R57		RESISTOR, FIXED, DEPOSITED CARBON: 91 ohms, 5%, 1/4 watt	18470-910
R58		RESISTOR, VARIABLE: 10K ohms, 20%, linear taper	16925-829
R59		RESISTOR, FIXED, DEPOSITED CARBON: 47 ohms, 5%, 1/4 watt	18470-470
R60		Same as R3	
R61		RESISTOR, FIXED, DEPOSITED CARBON: 1.8K ohms, 5%, 1/4 watt	18470-182
R62		RESISTOR, VARIABLE: 2K ohms, 20%, linear taper	16925-828
R63		RESISTOR, FIXED, DEPOSITED CARBON: 100 ohms, 5%, 1/4 watts	18470-101
R64		Same as R59	

REF DESIG.	NOTES	DESCRIPTION	HICKOK PART NO.
R65		RESISTOR, FIXED, DEPOSITED CARBON: 4.3K ohms, 5%, 1/4 watt	18470-432
R66		RESISTOR, FIXED, DEPOSITED CARBON: 430 ohms, 5%, 1/4 watt	18470-431
R67		Same as R48	
S1		SWITCH: slide, 6p 3t	19911-155
S2		Same as S1	
S3		Same as S1	
S4		SWITCH: rotary, function, 5 section, 4 position	19912-698
S5		SWITCH: rotary, polarity, 4 section, 5 position	19912-697
S6		SWITCH: rotary, range, 2 section, 3 position	19912-696
S7		SWITCH: toggle, dpdt	19911-154
S8		SWITCH: pushbutton, basic 2 pole module, push-push action, mtg bracket without ears	19910-244
S9		SWITCH: slide, dpdt	19911-156
T1		TRANSFORMER	20800-423
W1		CORD: line, 6 ft long, grey	3675-49
X1		SOCKET: transistor	19350-518
Z1		INTEGRATED CIRCUIT: 1NS4016C	9800-141
Z2		Same as Z1	
Z3		Same as Z1	
Z4		INTEGRATED CIRCUIT: 4001 CMOS quad 2-input positive NOR	9800-96
Z5		Same as Z4	
Z6		INTEGRATED CIRCUIT: octal counter/driver, MC14022CP	9800-128
Z7		Same as Z4	
Z8		Same as Z1	

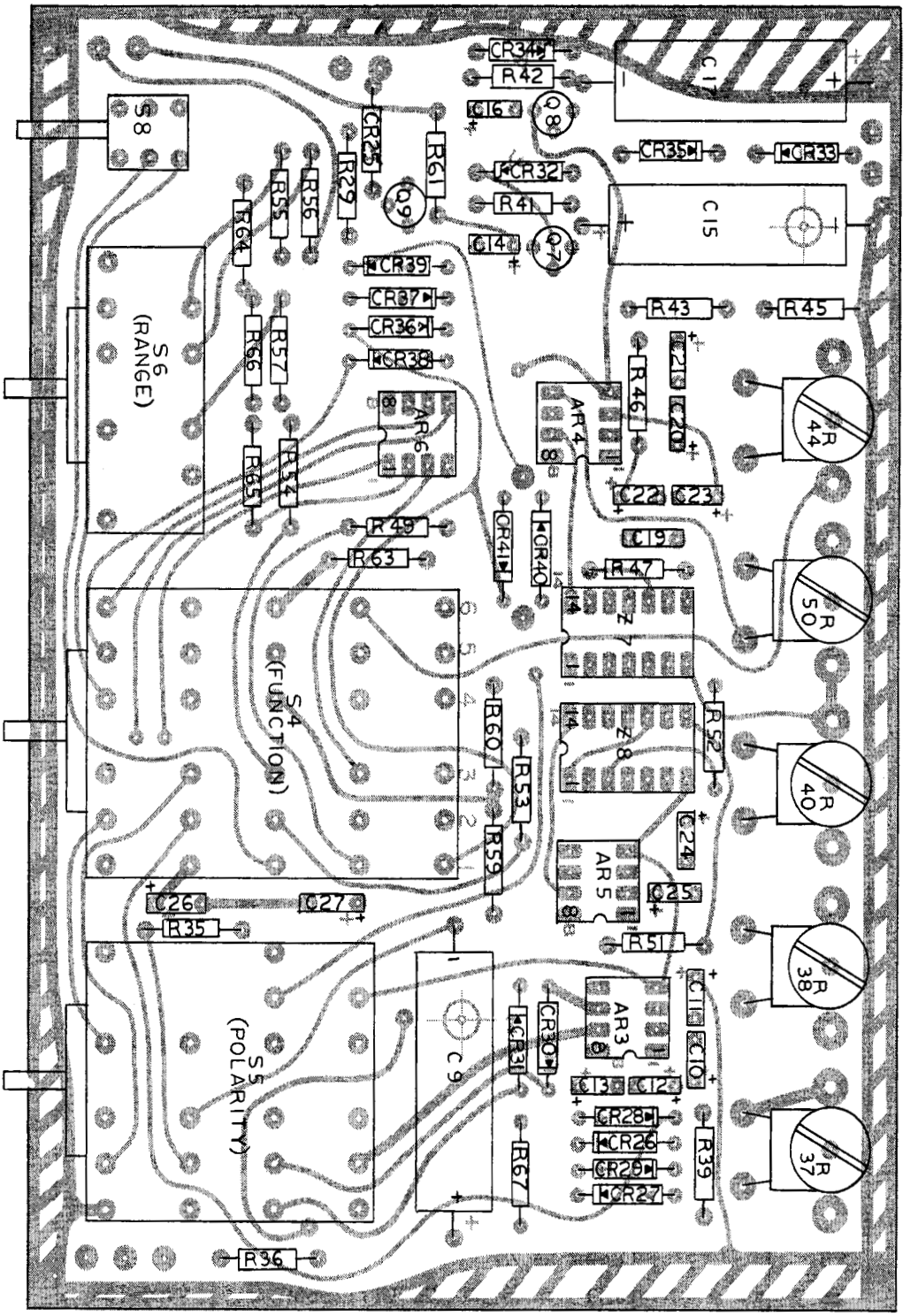

Figure 3. Parts Location Diagram,
Model 220 Main PC Board Assembly

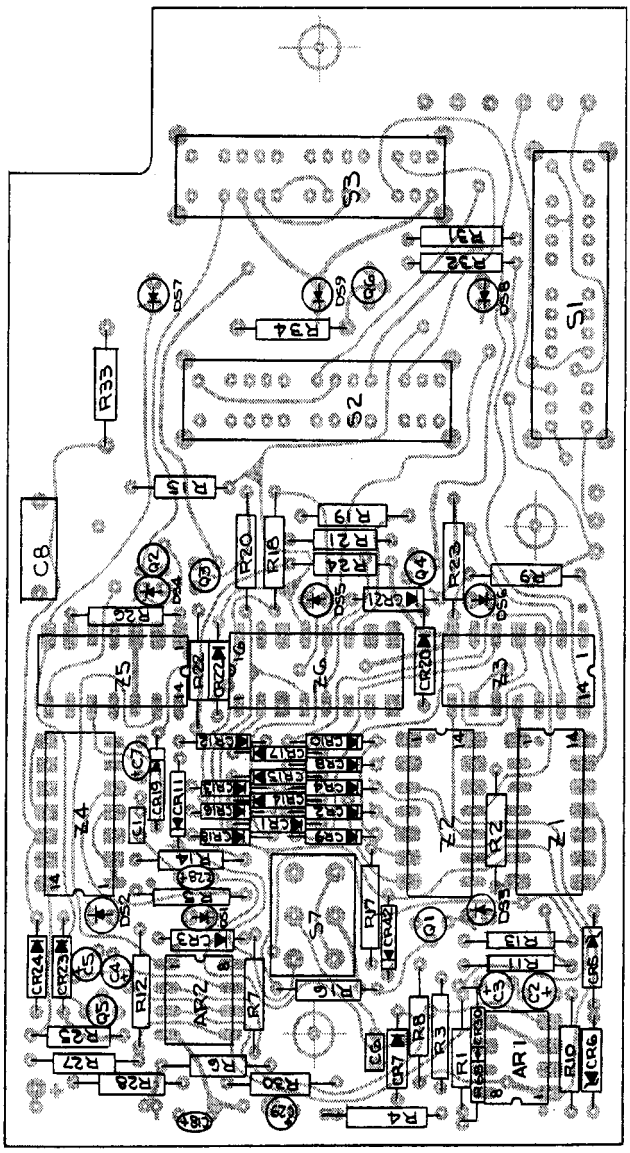

Figure 4. Parts Location Diagram,
Model 220 Go - No - Go PC Board Assembly

ALT	DRAWING NUMBER
BA	902-508W

S1	TEST MODE
S2	BASE SELECT
S3	COLLECTOR
S4	FUNCTION
S5	POLARITY
S6	RANGE
S7	XSTR-DIODE
S8	SCR-TRIAC-UJT
S9	POWER

SYMBOLS	
LAST USED	NOT USED
AR6	C30
C32	
CR42	
DS9	
J3	
Q9	
R67	
S9	
X1	
Z8	
T1	
M1	
W1	

SHOWN WIRED FOR 115V OPERATION.
FOR 230V OPERATION DISCONNECT
#1 & #2, #3 & #4 CONNECT
#2 TO #3.

NOTES:

1) UNLESS OTHERWISE SPECIFIED, ALL RESISTORS ARE IN OHMS, 1/4 W, 5%.
2) UNLESS OTHERWISE SPECIFIED, ALL CAPACITORS ARE IN MICROFARADS.

FIG. 5 - SCHEMATIC WIRING DIAGRAM
Model 220 in Circuit Transistor Tester

THE HICKOK ELECTRICAL INSTRUMENT COMPANY
CLEVELAND, OHIO 44108

TITLE
SCHEMATIC WIRING DIAGRAM
MODEL 220 IN-CKT TRANS. TESTER