

# **HICKOK**

Model 215  
POCKET AUTOMATIC  
SEMICONDUCTOR ANALYZER  
INSTRUCTION MANUAL

**HICKOK** THE HICKOK ELECTRICAL INSTRUMENT COMPANY  
10514 Dupont Avenue • Cleveland, Ohio 44108



Figure 1

**Model 215  
POCKET AUTOMATIC  
SEMICONDUCTOR ANALYZER  
INSTRUCTION MANUAL**

PUBLICATION NO. 2490-650

**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.

# TABLE OF CONTENTS

## SECTION 1 DESCRIPTION AND SPECIFICATIONS

	Page
What the Model 215 Does . . . . .	1
Some Unusual Features of the Model 215 . . . . .	1
Front Panel Controls and Readout . . . . .	2
How to Connect the Model 215 to a Device Under Test . . .	4
Specifications and Reference Data . . . . .	4

## SECTION 2 OPERATING INSTRUCTIONS

Introduction . . . . .	7
Special Testing . . . . .	8
Maintenance and Calibration . . . . .	9

PARTS LIST . . . . .	11
----------------------	----

## ILLUSTRATIONS

### Figure

1	MODEL 215 SEMICONDUCTOR ANALYZER . . . . .	Title Page
2	Parts Location Diagram Model 215 . . . . .	10
3	Schematic Wiring Diagram Model 215 . . . . .	15



## HOW TO USE THIS MANUAL

This manual is divided into two sections. Section 1 contains descriptive data, condensed instructions, and specifications. Section 2 contains complete operating instructions. The first section provides general information for testing semiconductor devices. The second section provides operating and special test instructions.

# SECTION 1

## DESCRIPTION AND SPECIFICATIONS

### WHAT THE MODEL 215 DOES

The Model 215 allows in and out of circuit testing of most two- and three-lead semiconductor devices. These include transistors, both NPN and PNP; Junction Field Effect Transistors, both N type and P type; Unijunction Transistors, and diodes. It is entirely solid state. Not only does the Model 215 provide confident testing of semiconductor devices in-circuit, but it also automatically selects the proper leads for testing and runs a complete electrical test on the device. If the device is good, the Model 215 indicates the location of the base/gate lead or, in the case of diodes, the cathode; and indicates the device type, P or N. The Model 215 requires no adjustments and no advance knowledge of the device type being tested or its lead configuration in order to make a valid test. The results of the test are displayed by bright LED readouts which clearly indicate a bad device or, in the case of a good device, indicate the base/gate position and the device type (P or N).

### SOME UNUSUAL FEATURES OF THE MODEL 215

The Model 215 is the most advanced transistor tester available today. It uses the most modern devices available to the electronics industry. It is because of recent advances in electronics that an instrument such as the Model 215 is possible. Essentially the Model 215 contains a small mini-computer which allows it to apply signals to the device under test and from the results of these signals to determine that the device is good or bad and also to determine the device type (P or N) and the location of the control electrode of the device.

Power requirements are minimized by the extensive use of extremely low power, MOS FET integrated circuits. The unit has been designed to provide maximum performance and reliability under widely varying environmental conditions, and to enable measurement of semiconductor devices in-circuit under a wide variety of in-circuit loads. It will accurately test transistors in almost any circuit found in electronic equipment.

In addition, through careful design and construction, the Model 215 is a high-quality piece of sophisticated and reliable test equipment. The front panel has been designed for convenience and versatility in the types of connections which can be made to the device under test. The case is made of high impact polypropylene and includes a cover to protect the instrument when carried in toolboxes, etc.

The Model 215 is constructed entirely of industrial quality components such as glass epoxy printed circuit boards. It has an automatic shut-off feature when the cover is closed to conserve batteries. The unit is designed to accept two standard 9-volt transistor radio batteries which will provide approximately 20 hours of operation.

Rechargeable nickel cadmium batteries can also be used with the Model 215. Hickok offers a charger for use with the Ni-Cad batteries when used with the 215. The recharge jack is already built into the Model 215. Information on battery types and the recharger are contained in the specification section.

### FRONT PANEL CONTROLS AND READOUT

#### BAD

The BAD light will blink when the device under test is bad. It will also blink when no device is connected to the tester and the tester is turned on.

#### TRANSISTOR-PWR OFF-DIODE SWITCH

The TRANSISTOR-PWR OFF-DIODE switch disconnects the batteries without closing the cover and, in addition, allows selection of tests for transistors and diodes. The TRANSISTOR position is used for most three-lead devices and the DIODE position is used for diodes and for special testing of unusual semiconductor devices.

#### GOOD

The GOOD lights will give indication of the device type in the case of a bi-polar transistor, JFET, or unijunction transistor, and give indication of the direction of the diode during a diode test. These lights will blink briefly when a bad device is in the tester. A good indication is obtained when one of the two lights turn on and remain on for 3 to 4 seconds and, for a transistor test, one of the base/gate identifier lights also turns on. The P light, when it is turned on and remains on for 3 to 4 seconds, indicates that the device under test is good and is either a PNP transistor, a P type FET, or a P type unijunction.

In the case of a diode test, if the P light turns on it indicates that the cathode of the diode under test is connected to lead 1 and the anode of the diode under test is connected to lead 3.

The N light, when it is turned on and remains on for 3 to 4 seconds, indicates that the device is good and is either an NPN transistor, an N type FET, or an N type unijunction. In the case of a diode test, it indicates that the diode is connected with the cathode to lead 3 and the anode to lead 1.

## SOCKET

The socket is used for out-of-circuit measurements. The transistor may be plugged into the socket with any one of its three leads going to any one of the three socket holes. The Model 215 will automatically test the transistor, determine its lead configuration and, if it is a good device, turn on the P or the N light and also the appropriate BASE/GATE identifier light. A diode should be placed between leads 1 and 3. If it is a good diode, the P or N light will turn on to indicate the direction of the diode in the socket.

## 1-2-3 LIGHTS

The 1-2-3 lights identify the control electrode of a three-lead device when the device is good. The control electrode would be the "base" in the case of a bi-polar transistor, the "gate" in the case of a junction FET, and the "emitter" in the case of a unijunction transistor. As previously mentioned, the device under test can be plugged into the Model 215 with any lead of the device going to either 1, 2, or 3. The Model 215 will automatically determine if the device is good or bad. If the device is good, the 1-2-3 light will light, indicating which lead is the control electrode.

## 1-2-3 BANANA JACK

The banana jacks below the 1-2-3 lights are for connections of test leads for transistors or diodes which cannot be plugged into the socket, or for in-circuit measurements. The jacks accept a standard banana plug. In the case of a transistor, the transistor can be connected in any configuration to the three leads. The Model 215 will automatically analyze the device and determine whether it is good or bad. If it is good, the P or the N light will light to indicate the device type and the 1-2-3 light, which identifies the control electrode of the device under test, will also light. In the case of the diode measurement, jacks 1 and 3 should be used. The Model 215 will automatically identify the device as GOOD or BAD. If it is good, either the P or the N light will light to indicate the direction of the diode between leads 1 and 3. Test leads are provided with the Model 215 which are compatible with these jacks. In addition, a tri-pointed probe for use in-circuit is available from Hickok. (See SPECIFICATIONS section.)



## HOW TO CONNECT THE MODEL 215 TO A DEVICE UNDER TEST

### THREE-LEAD DEVICES

If the device to be tested is out of circuit and is compatible with the socket on the front panel of the Model 215, simply plug the device to be tested into the Model 215 in any rotation which is convenient. The Model 215 will automatically determine whether the device is good or bad, and indicate the device type and the control electrode. If the device to be tested is either not compatible with the front panel socket or is in circuit, connect the test leads supplied with the tester or the in-circuit probe available from Hickok to the jacks on the Model 215 front panel. Connect the alligator clips of the test leads to the device to be tested and again the Model 215 will automatically determine GOOD or BAD, device type, and control electrode location.

When testing devices in circuit, be sure to consult the SPECIFICATIONS section for limits on in-circuit loading of the device to be tested. Whenever a device is determined to be bad in circuit, it is always best to remove it from the circuit and again recheck it on the Model 215, as hidden in-circuit loads such as shorts could indicate a bad device when in fact the semiconductor device is perfectly good.

### DIODE

Connect the test leads provided with the Model 215 to jacks 1 and 3. Connect the alligator clips in any configuration to the 2 leads of the device to be tested. The Model 215 will automatically determine whether the device is good or bad. On a good device, it will also indicate the direction of the device between leads 1 and 3.

## SPECIFICATIONS AND REFERENCE DATA

CAUTION: FOR IN-CIRCUIT MEASUREMENTS, BE SURE NO VOLTAGE IS PRESENT WHEN TESTING WITH THE MODEL 215. THE MODEL 215 WILL BE DAMAGED BY VOLTAGES IN EXCESS OF 10 VOLTS.

### A. Device types which can be tested:

Bi-polar transistor, both NPN and PNP  
Junction FET's, both N type and P type  
Unijunction transistors, both N type and P type  
Diodes, zener diodes  
SCR's, Triacs (See SPECIAL TESTING section)

## B. Allowable in-circuit loads:

Maximum load, any lead to any other lead,  $500\Omega$  or  $.2\mu F$  or any combination of the two having an equivalent impedance of  $500\Omega$  at 1kHz.

## INDICATIONS

### BAD

The BAD light will blink rapidly. The GOOD lights may blink as well.

### GOOD

With a good device, the tester will light one of the GOOD lights for approximately 3 to 4 seconds and then recycle and again light the GOOD light for 3 to 4 seconds.

### 1-2-3

Will light indicating control electrodes of a three-lead device under test when the device is good (cycles as above every 3 to 4 seconds).

## TEMPERATURE RANGE

Operating	$0^{\circ}\text{C}$ to $50^{\circ}\text{C}$
Storage	$-50^{\circ}\text{C}$ to $+100^{\circ}\text{C}$

## POWER REQUIREMENTS

### BATTERY OPERATED

Two each 9-volt transistor radio batteries: approximate life 20 hours of operation in normal use. Battery life is increased several times by intermittent rather than continuous use. In addition, the batteries will often recover some charge when the unit is turned off for several hours.

#### Battery Types

Non-Rechargeable Batteries (Standard 9-volt transistor radio batteries)

Eveready 216  
Mallory MN1604  
Burgess 2U6

Rechargeable Batteries (approximately 4 hours operation between recharges)

Hickok offers a charger (Part No. 20800-421) for use with rechargeable batteries in the Model 215. The recharge jack is located on the side of all units. The charger provides the proper current and voltage to recharge the Ni-Cad batteries noted below:

Eveready N88

NOTE

The Model 215 may be operated while plugged into the power line; however, the charger supplies insufficient current to charge the batteries and operate the unit. Therefore, the unit must be turned off for recharging.

SIZE:  $5-3/4 \times 3-3/4 \times 1-7/8$  inches

WEIGHT: 12.5 oz.

Hickok offers a tri-pointed probe compatible with the Model 215 specifically designed for in-circuit ease. Hickok Part No. 16970-111.

## SECTION 2

# OPERATING INSTRUCTIONS

### INTRODUCTION

CAUTION: FOR IN-CIRCUIT MEASUREMENTS, BE SURE NO VOLTAGE IS PRESENT WHEN TESTING WITH THE MODEL 215. THE MODEL 215 WILL BE DAMAGED BY VOLTAGES IN EXCESS OF 10 VOLTS.

The Model 215 is among the simplest operating test equipments ever developed. For testing of most semiconductor devices, it only requires the operator to determine whether it is a three-lead or two-lead device and select the appropriate test using the TRANSISTOR-DIODE switch.

The Model 215 does the rest. It will determine whether the device is good or bad and, if it is good, will light the appropriate light indicating whether the device is a P type or an N type device. It will also identify the control electrode. If it is a two-lead device, it will identify the direction that the device is connected into the tester.

The Model 215 will test directly NPN and PNP bi-polar transistors, NPN and PNP bi-polar darlington transistors, P channel and N channel junction FET's, P type and N type unijunction transistors, dual transistors, dual junction FET's, diodes, diode bridges, and zener diodes. A number of other semiconductor devices can be tested by using the diode test and testing for the presence of diode junctions between appropriate leads. The above devices require no knowledge of the device pin out or type; however, in testing with DIODE test, the type of device and pin out must be known. Below is described the testing of several devices which must be tested using the "diode present" method. Most in-circuit semiconductor testers, including the Model 215, will not test MOS FET's, temperature compensated zener diodes, and programmable unijunction transistors.

#### NOTE

The Model 215 may not give a correct indication on some low Gm FET's. This is due to the low "ON" resistance of these devices. If there is some doubt about a particular device, place the toggle switch in DIODE position and check for the presence of a PN junction between the GATE-DRAIN and between the GATE-SOURCE leads.



## SPECIAL TESTING

### SCR-TRIAC

To test an SCR or Triac, place the Model 215 on DIODE test. Connect the test leads to jacks 1 and 3. Connect the test leads to the gate lead and cathode lead of the SCR. The device should read GOOD and should indicate that a diode is present. The gate-cathode leads can be found by simply interchanging the leads of the device between jacks 1 and 3 until a good reading is obtained. The Model 215 will indicate a diode is present and furthermore it will indicate the direction of the diode between leads 1 and 3. The gate of the SCR or Triac is the anode side of the diode. Step 2 is to connect the anode and cathode of the SCR (cathode of the diode indicated when checking for gate/cathode diode) across leads 1 and 3. The BAD light should blink and the N light should blink. If the BAD light and both the P and N lights blink, this indicates a short from anode to cathode on the SCR or Triac. If only the BAD light and the N light blink, it indicates there is an open circuit present and therefore in all likelihood the SCR is good if the previous test has indicated good.

### DUAL TRANSISTORS

When attempting to test dual transistors contained in one package, it is necessary to determine which three leads of the device pertain to a single transistor device. When this is determined, connect the three leads of a single device in any order to the jacks of the Model 215. The tester will perform a normal transistor test with indications of the device qualities.

### GENERAL

In general, any device which can be defined as a series of diodes can be tested by the Model 215, using a step-by-step procedure testing a diode from jacks 1 to 3 to be sure all junctions are present. In most semiconductor devices, if the junctions are present, it is likely that the device is a good device. Most semiconductor failures occur due to opens or shorts within the device rather than device degradation. Most solid state devices can be tested by determining if diodes are present between the proper leads. For devices not described above, the diode testing procedure can usually be applied.

## MAINTENANCE AND CALIBRATION

The Model 215 has been manufactured using the latest semiconductor devices and techniques that electronic technology has to offer. It has been designed for long, reliable and trouble-free service as indicated by our two-year warranty.

Should difficulty be encountered, Hickok maintains a complete service facility to render accurate, timely and reliable service of our products.

A troubleshooting procedure is not presented in this manual due to the complexity of the integrated circuits employed and the fact that test equipment necessary for proper servicing is not generally available in the field.

## PARTS LIST MODEL 215

### POCKET AUTOMATIC 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: RC4558DN dual op amp	9800-136
AR2		Same as AR1	
C1		CAPACITOR, FIXED, CERAMIC: 470 pf	3110-339
C2		CAPACITOR, FIXED, ELECTRO- LYTIC: tantalum, 4.7 uf, 35 volts	3085-481
C3		Same as C2	
C4		CAPACITOR, FIXED, ELECTRO- LYTIC: tantalum, 47 uf, 6 volts	3085-492
C5		Same as C4	
C6		Same as C1	
C7		Same as C4	
C8		CAPACITOR, FIXED, METAL- LIZED MYLAR: .047 uf, 10%, 250 volts	3090-102
C9		Same as C4	
C10		Same as C4	
C11		Same as C2	
CR1 thru CR4		SEMICONDUCTOR DEVICE: diode 1N914	3870-175

REF DESIG.	NOTES	DESCRIPTION	HICKOK PART NO.
CR5		SEMICONDUCTOR DEVICE: diode 1N5729B, 5.1 volt, 5%	3870-320
CR6		Same as CR5	
CR7 thru CR24		Same as CR1	
CR25		SEMICONDUCTOR DEVICE: diode 1N5740B	3870-309
CR26		Same as CR1	
CR27		Same as CR1	
DS1 thru DS6		LAMP: LED LSL-6L red diffused	12270-125
Q1 thru Q4		TRANSISTOR: 2N5133 NPN general purpose	20861-210
Q5		TRANSISTOR: 2N5138	20861-221
R1		RESISTOR, FIXED, DEPOSITED CARBON: 470 ohms, 5%, 1/4 watt	18470-471
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
R5		Same as R2	
R6		RESISTOR, FIXED, DEPOSITED CARBON: 100K ohms, 5%, 1/4 watt	18470-104



REF DESIG.	NOTES	DESCRIPTION	HICKOK PART NO.
R7		RESISTOR, FIXED DEPOSITED CARBON: 2.2K ohms, 5%, 1/4 watt	18470-222
R8		Same as R7	
R9		Same as R2	
R10		Same as R4	
R11		RESISTOR, FIXED, DEPOSITED CARBON: 4.7K ohms, 5%, 1/4 watt	18470-472
R12		Same as R4	
R13		RESISTOR, FIXED, DEPOSITED CARBON: 3K ohms, 5%, 1/4 watt	18470-302
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	

REF DESIG.	NOTES	DESCRIPTION	HICKOK PART NO.
R26		RESISTOR, FIXED, DEPOSITED CARBON: 1.5 megohms, 5%, 1/4 watt	18470-155
R27		RESISTOR, FIXED, DEPOSITED CARBON: 1.5K ohms, 5%, 1/4 watt	18470-152
R28		RESISTOR, FIXED, DEPOSITED CARBON: 33K ohms, 5%, 1/4 watt	18470-333
R29		RESISTOR, FIXED, DEPOSITED CARBON: 100 ohms, 5%, 1/4 watt	18470-101
R30		RESISTOR, FIXED, DEPOSITED CARBON: 24K ohms, 5%, 1/4 watt	18470-243
R31		RESISTOR, FIXED, DEPOSITED CARBON: 3.9K ohms, 5%, 1/4 watt	18470-392
S1		SWITCH: toggle, dpdt, on-off-on, supplied with yellow cap mounted	19911-151
S2		SWITCH: push button, miniature, momentary, N/C	19910-241
Z1		INTEGRATED CIRCUIT: MEM4016P quad bilateral switch	9800-129
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: MC14022CP octal counter/ driver	9800-128

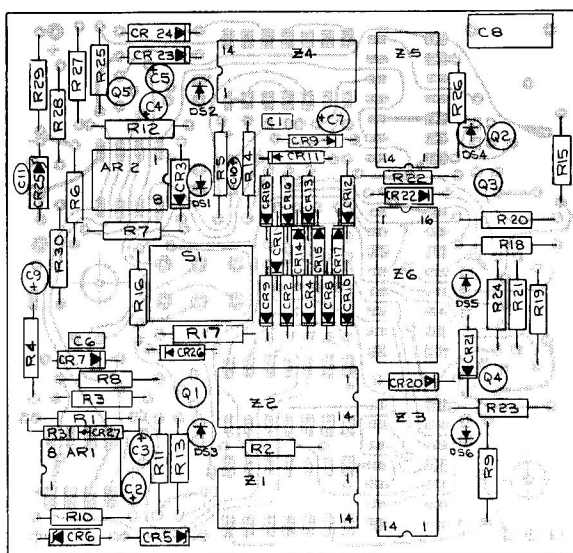
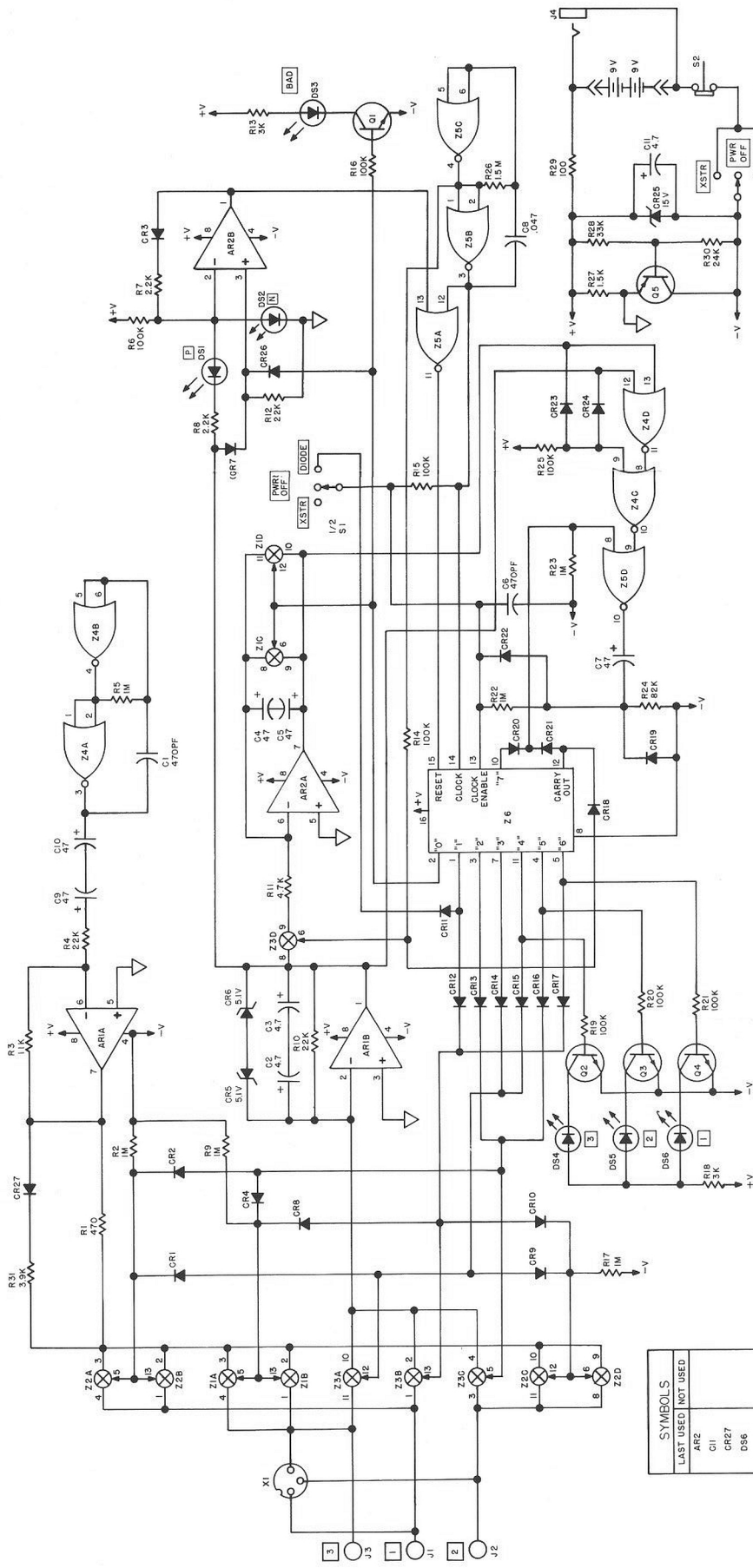


Figure 2. Parts Location Diagram Model 215



SYMBOLS	
AR2	LAST USED NOT USED
C1	
CR27	
DS6	
J3	
Q5	
R31	
S2	
X1	
Z6	

NOTES:  
 1) UNLESS OTHERWISE SPECIFIED, ALL RESISTORS ARE IN OHMS, 1/4 W, 5%.  
 2) UNLESS OTHERWISE SPECIFIED, ALL CAPACITORS ARE IN  $\mu$ F.  
 3)   FRONT PANEL MARKING.

FIG. 3 - SCHEMATIC WIRING DIAGRAM  
 Model 215