

INSTRUCTION MANUAL
MODEL 710, 711
MILLIVOLT DISCRIMINATOR

TABLE OF CONTENTS

	SECTION
INTRODUCTION.....	I
SPECIFICATIONS.....	II
DESCRIPTION.....	III
OPERATION.....	IV
MAINTENANCE.....	V
Voltage Chart	
Schematic Diagram	
Replaceable Parts List	

SECTION I - INTRODUCTION

A. Models 710 and 711 Millivolt Discriminators

These Millivolt Discriminators are extremely stable, light-modulator dc amplifiers operating a thyatron tube and relay. They are identical except for the method of the trip level adjustments.

Trip level of the 710 and 711 is variable from 0.2 to 10 millivolts. The range may be extended to 1000 volts with an internal resistive divider, or to 10^{-8} ampere with a current shunt. Adjustment of the 710 is made with an external reference and potentiometer located behind the front panel. The 711 is adjusted by means of a calibrated dial in the front panel. Dial setting is accurate within ± 200 uv .

The instruments may be made either locking or non-locking. They are chatter-free on non-locking and locking operation; modification for locking action is easily made by adding a normally open switch.

Long term repeatability of the 710 and 711 is better than 200 microvolts, and the speed of response is between 40 and 60 milliseconds with a signal 50% larger than the trip level. Standard units are wired to trip for signals exceeding the trip point and are fail-safe in that failure of any component causes the alarm condition. On units wired to trip for a signal that decreases below the trip point, the unit is not fail-safe if a loss of reference signal occurs.

Careful shielding, filtering, and guarding permit floating operation up to 500 volts above ground, with excellent rejection to extraneous voltages. Input and output terminals are isolated from each other and from ground.

Immunity to vibration and indefinite life under rigorous environmental conditions are assured by the use of premium subminiature tubes and a Keithley designed photo-resistive modulator having no moving parts. Permissible overload is greater than 10,000 times.

SECTION II - SPECIFICATIONS

Models 710 and 711 are identical except for the means of adjusting the trip level.

TRIP LEVEL: Model 710: Adjustment made with an external reference and potentiometer located behind front panel.
Model 711: Adjustment made with a calibrated dial on the front panel. Dial setting of trip level is accurate within ± 200 uV.

SENSITIVITY: 0.2 to 10 millivolts. Range can be extended to 1000 volts with an internal resistive divider.

MAXIMUM SOURCE IMPEDANCE: 100 K

INPUT IMPEDANCE: From LO to GROUND or INPUT to OUTPUT, over 1000 megohms shunted by .0047 mfd. Across input terminals, greater than 1 megohm. Maximum voltage above ground, 500 volts, dc or peak.

OUTPUT: Relay contacts, DPDT, 5 amps, 110 v, noninductive.

REPEATABILITY OF TRIP POINT: Better than 200 microvolts.

STABILITY OF TRIP POINT: $\pm 0.3\%$ with $\pm 10\%$ line change.

60 CPS REJECTION: 100 millivolts of 60 cps on dc signal will cause less than 1% shift of trip point.

RESPONSE SPEED: As shown in Figure 1, speed depends somewhat on the degree to which the trip point is exceeded. Reclosure time is approximately 30 milliseconds.

TRIP POLARITY: Positive or negative

PERMISSIBLE OVERLOAD: Greater than 10,000 times.

TRIP RESET: Automatic when the standard non-locking mode of operation is used; differential between trip and reset is less than 200 uV. When modified for locking action, a reset switch is added.

TRIP INDICATION: Red light on front panel.

VOLTAGE REFERENCE: One RM401R mercury battery. Battery life is in excess of 10,000 hours.

TUBE, TRANSISTOR COMPLEMENT: 1-6948; 1-6788; 1-5643; 1-2N398

MODULATORS: 2 Keithley Model 1510 Modulators

POWER: 117 v, 60 cps, 12 w; 230 v models on order

ACCESSORIES SUPPLIED: Mating connectors; input, output.

ACCESSORIES AVAILABLE: Model 7101 Case: Model 7102 Rack Frame for mounting up to 7 units.

DIMENSIONS: 8" high x $2\frac{1}{4}$ " wide x $13\frac{1}{2}$ " deep.

SECTION III - DESCRIPTION

The Model 710 and 711 Millivolt Discriminators consist of a three stage vacuum amplifier following a modulator and an input filter. The output of the amplifier is synchronously demodulated and filtered to provide a D.C. signal at the grid of a thyatron. The thyatron controls a relay.

The input contains the D.C. to A.C. modulator, an input filter to reject spurious A.C. signals and the Trip Level reference set.

The modulator used in the Millivolt Discriminator employs two photoconductive cells, PD-101 and PD-102, which operate from the transformer secondary. This action is similar to a single-pole double-throw mechanical chopper with the result that the D.C. input and the D.C. reference are converted to an A.C. signal. With no signal at the input of the amplifier either from the reference or the input, the negative bias cuts off the thyatron and the relay drops out. When a reference signal is fed to the amplifier, the negative bias at the grid of the thyatron is cancelled and the thyatron fires and energizes the relay. This is the normal condition of operation, that is with the relay energized. Operating in this manner the Model 710 and 711 will indicate an alarm condition in the event of any tube failure in the unit or from the loss of this reference signal by any other means. The transistor, Q1 protects against loss of bias on the thyatron. If bias is lost, the transistor opens the cathode circuit of V3 and gives the alarm condition. The modulator compares the input signal to the signal set by the Trip Level. If the input signal is less than the level set by the Trip Level pot., the D.C. voltage to the thyatron grid keeps the thyatron on. If the input signal exceeds the reference signal the thyatron extinguishes and indicates the alarm condition by means of a red light on the front panel.

Spurious A.C. signals are prevented from entering the input by means of a "twin-tee" filter consisting of R-102 through R-106 and C-101 through C-103 which is tuned to line frequency. R-104 and R-106 are set at the factory for maximum rejection to line frequency.

The demodulator circuit employs a four-diode bridge with silicon diodes. A balanced configuration is used so that careful balance of the transformer secondary is not necessary. The demodulator is driven synchronously with the neon lamps which switch the input modulator. The demodulator output is a pulsating D.C. signal which is filtered and fed to the grid of the thyatron.

The basic sensitivity of the instrument is 10 millivolts, however, reduced sensitivity may be obtained by the use of a divider.

The output is obtained as a D.P.D.T. set of contacts from a relay which is used for control.

SECTION IV - OPERATION

A. INPUT CONNECTIONS - The Model 710 and 711 will operate grounded or floating. For grounded operation, one side of the signal source should be grounded.

B. OPERATION - The power is turned on by plugging in the power cord. Be sure that the instrument is wired for the proper line voltage. The Model 710 and 711 will operate satisfactorily on 50 or 60 cps. For method of changing from 115 to 230 volts consult schematic.

The trip point on the Model 710 is set by means of an external reference and a multi-turn wire wound potentiometer located behind the front panel and on the Model 711 by means of a calibrated dial on the front panel. The RELAY OPEN light will go on when the limit is exceeded. No other operating adjustment is necessary.

C. NON-LOCKING OPERATION - The instrument is normally supplied for non-locking operation and the relay will re-close when the signal drops about 200 microvolts below the trip point.

D. LOCKING OPERATION AND CONVERSION TO LOCKING OPERATION - On the output plug at the rear of the instrument, pins (I) and (J) are jumpered. If this jumper is removed, the unit will perform as a locking relay. To reset, pins (I) and (J) must be momentarily shorted after the signal has fallen below the set limit. When units are supplied as locking relays, a reset button, connected across pins (I) and (J), is mounted on the front panel. Remote reset may be obtained by an external control across the reset pins.

E. REVERSE POLARITY OPERATION - If it is desired to operate with negative signals the input signal is merely reversed.

F. OUTPUT CONNECTIONS - The output is obtained as a DPDT set of contacts from a relay. The rating of the relay is 5 amperes NON-INDUCTIVE. If inductive loads or higher currents are to be switched, the output should be followed by a second relay of high enough current capacity.

SECTION V - MAINTENANCE

The only maintenance required is the replacement of the mercury standard cell every 10,000 hours. If the highest reliability is required, it is recommended that the vacuum tubes also be replaced on that schedule.

TROUBLE SHOOTING CHART - MODEL 710 and 711

SYMPTOM	CAUSE OF TROUBLE	REMEDY AND CHECKS
A.C. Power Cord plugged, pilot light does not light and no readings obtained.	Defective Power Cord, Plug or Receptacle Fuse (F-1) blown	Check Power source and connections. Fuse Check (F-1)
No (+) voltage readings obtainable, pilot lamp lights and Relay Open lamp (red) lights.	Defective D201	Check D201. If necessary, replace.
Relay open Lamp (red) on at all times.	Defective V-1, V-2, or V-3. Defective B-1 Open Potentiometer, R-120 Open Relay Coil N/O Relay Contact not making Defective D-102 Jumper on Output Plug	Check Tubes. Replace if necessary. Check Battery. Replace if necessary. Check for continuity. Replace if necessary. Check coil Resistance. 6200 ohms, $\pm 10\%$ Adjust Check D-102, replace if necessary. Check to see if output plug is jumpered between pins (I) and (J)
Lamp (red) off, at all times	Defective DS-2 Defective D-202, D-203, D-204, or D-205 Defective C-110	Check, replace if necessary. Check, replace if necessary. Check, replace if necessary.
Differential is greater than 200 microvolts	Amplifier gain down Defective V-1, V-2, or V-3	Check voltage reading. Check, replace if necessary.

The waveforms in Figure (2) have been prepared to help check for proper operation and localize a possible malfunction.

To obtain the waveforms, short the input leads to chassis. Set the trip level pot for 1 mv and connect an oscilloscope between chassis and the points indicated below:

Figure (1)

- A - V-1, Pin 5
- B - V-2, Pin 1
- C - V-2, Pin 8
- D - Junction of D-103 & D-105 (See Schematic)
- E - V-3, Pin 7

Failure to obtain the desired waveform at any of the above points would indicate the fault to be at that stage or some component preceding it.

Use conventional AC Amplifier trouble-shooting methods to localize fault. Refer to Schematic and Voltage & Resistance Chart.

REPLACEABLE PARTS LIST - MODEL 710

Circuit Desig.	Description	Part No.
B-1	Battery, RM401-R	BA-8
C-101	Capacitor, mylar, .047 mfd. 200 V	C47-.047
C-102	Capacitor, Same as C-101	
C-103	Capacitor, mylar, .1 mfd. 200 V.	C47-.1
C-104	Capacitor, ceramic disc., .01 mfd, 600 V.	C22-.01
C-105	Capacitor, Electrolytic, 4.7 mfd, 15 V	C71-4.7
C-106	Capacitor, Same as C-104	
C-107	Capacitor, Ceramic disc. .02 mfd, 600 V	C22-.02
C-108	Capacitor, Same as C-107	
C-109	Capacitor, Same as C-107	
C-110	Capacitor, Electrolytic, 50 mfd. 6 V.	C17-50
C-111	Capacitor, Same as C-101	
C-112	Capacitor, Ceramic Disc. 47 PF	C22-47
C-113	Capacitor, Ceramic Disc. .0047 mfd., 600 V.	C22-.0047
C-114	Capacitor, Metalized paper tubular, 1 mfd 200V	C18-1.0
C-201	Capacitor, Dry Electrolytic Tubular, 20 mfd. 250 V. DC	C27-20
C-202	Capacitor, Same as C-201	
C-203	Capacitor, Same as C-201	
C-204	Capacitor, Dry Electrolytic Tubular, 1000 mfd. 12 V. DC	C11-1000
thru D-101 D-106	Rectifier, 1N2069	RF-20
thru D-201 D-205	Rectifier, 1N2071	RF-17
F-1	Fuse, .5 A Slow Blow	FU-4
DS-1	Light Assembly, Pilot #47	PL-13G
DS-2	Light Assembly, Pilot #47	PL-13R
J-2	Jack, Input - Cannon XLR-3-32	CS-71
J-1	Jack, Output - Amphenol AN 3102A-18-1S(C)	CS-23
P-1	Plug, Output - Amphenol AN 3106-A-18-1P	CS-22
P-2	Plug, Input - Cannon XLR-3-11	CS-72
R-101	Resistor, Composition, 22M, 10%, $\frac{1}{2}$ watt	R1-22M
R-102	Resistor, Deposited Carbon, 60K, 1%, $\frac{1}{2}$ watt	R12-60K
R-103	Resistor, Deposited Carbon, 23.3K, 1%, $\frac{1}{2}$ watt	R12-23.3K
R-104	Potentiometer, Carbon, 10K	RP2-10K
R-105	Resistor, Deposited Carbon, 40K, 1%, $\frac{1}{2}$ watt	R12-40K
R-106	Potentiometer, Carbon, 20K	RP7-20K
R-107	Resistor, Composition 100K, 10%, $\frac{1}{2}$ watt	R1-100K
R-108	Resistor, Composition 3.3M, 10%, $\frac{1}{2}$ watt	R1-3.3M
R-109	Resistor, Composition 4.7K, 10%, $\frac{1}{2}$ watt	R1-4.7K
R-110	Resistor, Composition 270K, 10%, $\frac{1}{2}$ watt	R1-270K

REPLACEABLE PARTS LIST - MODEL 710

Circuit Desig.	Description	Part No.
R-111	Resistor, Composition 10M, 10%, $\frac{1}{2}$ watt	RL-10M
R-112	Resistor, Composition, 470K, 10%, $\frac{1}{2}$ watt	RL-470K
R-113	Resistor, Same as R-111	
R-114	Resistor, Same as R-107	
R-115	Resistor, Composition, 680K, 10%, $\frac{1}{2}$ watt	RL-280K
R-116	Resistor, Composition, 1K, 10%, $\frac{1}{2}$ watt	RL-1K
R-117	Resistor, Same as R-107	
R-118	Resistor, Same as R-107	
R-119	Resistor, Composition, 47K, 10%, $\frac{1}{2}$ watt	RL-47K
R-120	Potentiometer, Trimpot Wirewound, 1K	RP29-1K
R-121	Resistor, Wirewound, 120K, 1%, $\frac{1}{4}$ watt	R18-21-120K
R-201	Resistor, Composition, 1K, 10%, $\frac{1}{2}$ watt	RL-1K
R-202	Resistor, Same as R-201	
R-203	Resistor, Same as R-119	
R-204	Resistor, Same as R-107	
R-205	Resistor, Composition, 120K, 10%, $\frac{1}{2}$ watt	RL-120K
R-206	Resistor, Composition 10%, $\frac{1}{2}$ watt, 4.7 K	RL-4.7K
R-207	Resistor, Composition, 330 ohms, 10%, $\frac{1}{2}$ watt	RL-330
R-208	Resistor, Wirewound, 25 ohm, 5%, 5 watt	R4A-25
K-1	Relay, P & B - MJ-1287	RL-14
T-1	Transformer (Central K1-176)	TR-43
V-1	Vacuum Tube, Sylvania 6788	EV-6788
V-2	Vacuum Tube, Sylvania 6948	EV-6948
V-3	Vacuum Tube, Sylvania 5643	EV-5643
Q-1	Transistor, RCA EN398	TG-13
PD101	Components of Model 1501 Light Mod. Assembly	13085A
EN101	Components of Model 1501 Light Mod. Assembly	13085A
PD102	Components of Model 1501 Light Mod. Assembly	13085A
EN102	Components of Model 1501 Light Mod. Assembly	13085A

REPLACEABLE PARTS LIST - MODEL 711

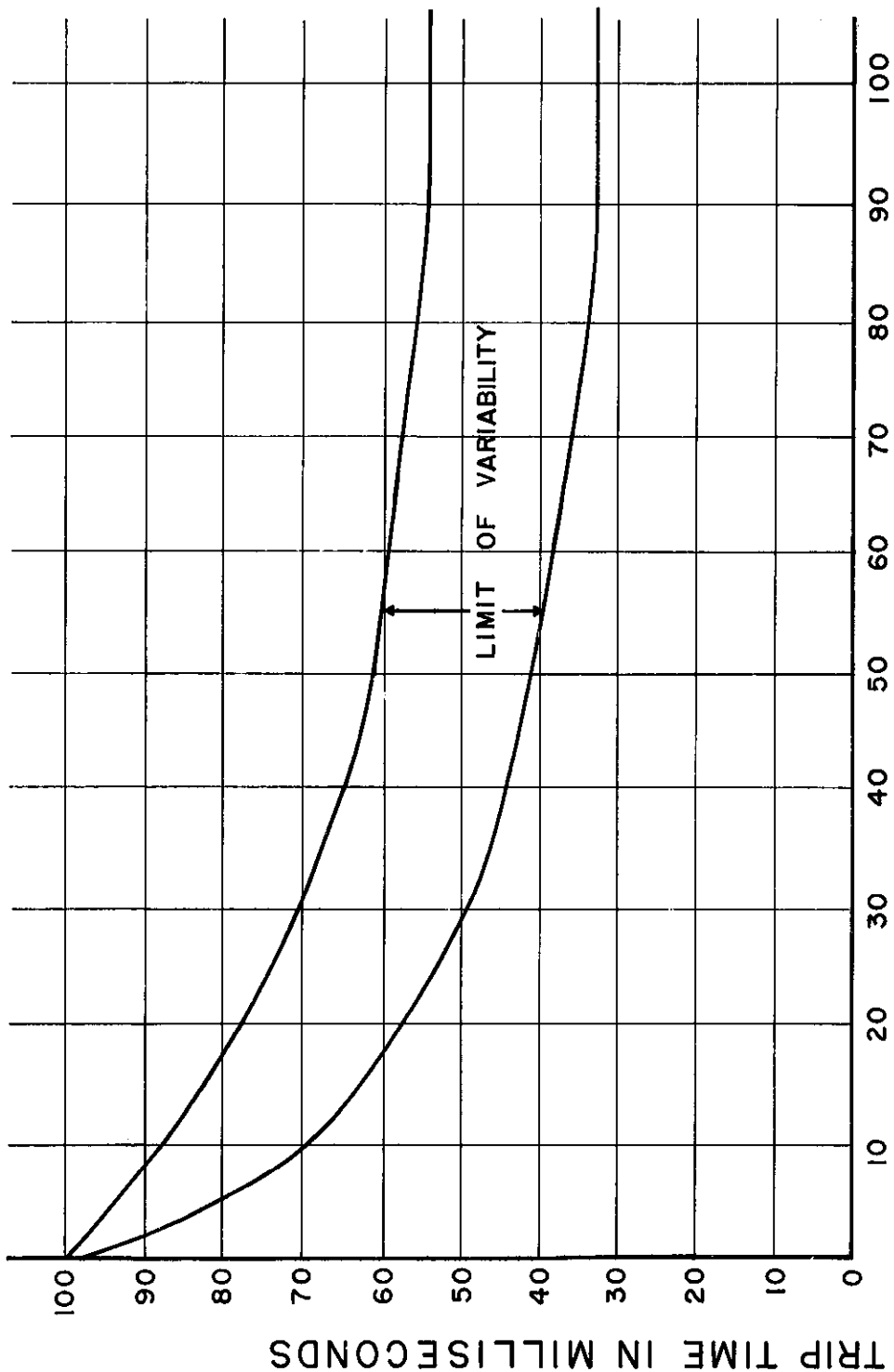
Circuit Desig.	Description	Keithley Part No.
B1	Battery, RM401-R	BA-8
C101	Capacitor, mylar, .047 mfd. 200 V	C47-.047
C102	Capacitor, Same as C101	
C103	Capacitor, Mylar, .1 mfd. 200 V	C47-.1
C104	Capacitor, ceramic disc., .01 mfd. 600 V	C22-.01
C105	Capacitor, Electrolytic, 4.7 mfd. 15 W	C71-4.7
C106	Capacitor, Same as C104	
C107	Capacitor, Ceramic disc. .02 mfd. 600 V	C22-.02
C108	Capacitor, Same as C107	
C109	Capacitor, Same as C107	
C110	Capacitor, Electrolytic, 50 mfd. 6 V	C17-50
C111	Capacitor, Same as C101	
C112	Capacitor, Ceramic disc. 47 PF	C22-47
C113	Capacitor, Ceramic disc. .0047 mfd. 600 V	C22-.0047
C114	Capacitor, Mylar, 1 mfd 200 V	C66-1.0
C201	Capacitor, Dry Electrolytic Tubular, 20 mfd. 250 V DC	C27-20
C202	Capacitor, Same as C201	
C203	Capacitor, Same as C201	
C204	Capacitor, Dry Electrolytic Tubular, 1000 mfd. 12 V DC	C11-1000
D101	Rectifier, 1N2071	RF-17
D102	Rectifier, 1N2071	RF-17
D103	Rectifier	(1)
D104	Rectifier	(2)
D105	Rectifier	(1)
D106	Rectifier	(2)
D201	Rectifier, 1N2071	RF-17
D202 thru D205	Rectifier, 1N2069	RF-20
F1	Fuse, .5 amp, Slow Blow	FU-4
DS1	Light Assmely, Pilot #47	PL-13G
DS2	Light Assmely, Pilot #47	PL-13R

- (1) D103 and D105 are matched, Keithley Part No. 14168A, replace only as a pair.
(2) D104 and D106 are matched, Keithley Part No. 14168A, replace only as a pair.

REPLACEABLE PARTS LIST - MODEL 711 (Cont'd)

Circuit Desig.	Description	Keithley Part No.
J2	Jack, Input - Cannon XLR-3-32	CS-71
J1	Jack, Output - Amphenol AN 3102A-18-1S(C)	CS-23
P1	Plug, Output - Amphenol AN 3106-A-18-1P	CS-22
P2	Plug, Input - Cannon XLR-3-11	CS-72
R101	Resistor, Composition, 2.2M, 10%, 1/2 watt	R1-2.2M
R102	Resistor, Deposited Carbon, 60K., 1%, 1/2 watt	R12-60K
R103	Resistor, Deposited Carbon, 23.3K, 1%, 1/2 watt	R12-23.3K
R104	Potentiometer, Carbon, 10K	RP2-10K
R105	Resistor, Deposited Carbon, 40K, 1%, 1/2 watt	R12-40K
R106	Potentiometer, Carbon, 20K	RP7-20K
R107	Resistor, Composition 100K, 10%, 1/2 watt	R1-100K
R108	Resistor, Composition 3.3M, 10%, 1/2 watt	R1-3.3M
R109	Resistor, Composition 4.7K, 10%, 1/2 watt	R1-4.7K
R110	Resistor, Composition 270K, 10%, 1/2 watt	R1-270K
R111	Resistor, Composition, 10M, 10%, 1/2 watt	R1-10M
R112	Resistor, Composition 470K, 10%, 1/2 watt	R1-470K
R113	Resistor, Same as R111	
R114	Resistor, Same as R107	
R115	Resistor, Composition, 180K, 10%, 1/2 watt	R1-180K
R116	Resistor, Composition, 1K, 10%, 1/2 watt	R1-1K
R117	Resistor, Same as R107	
R118	Resistor, Same as R107	
R119	Resistor, Composition, 47K, 10%, 1/2 watt	R1-47K
R120	Potentiometer, Wirewound, 1K	RP28-1K
R121	Resistor, Wirewound, 120K, 1%, 1/4 watt	R18-6-120K
R122	Potentiometer, Trimpot Wirewound, 10K	RP39-10K
R201	Resistor, Composition, 1K, 10%, 1/2 watt	R1-1K
R202	Resistor, Same as R201	
R203	Resistor, Same as R119	
R204	Resistor, Same as R107	
R205	Resistor, Composition, 120K, 10%, 1/2 watt	R1-120K
R206	Resistor, Composition, 4.7K, 10%, 1/2 watt	R1-4.7K
R207	Resistor, Composition, 330 ohms, 10%, 1/2 watt	R1-330
R208	Resistor, Wirewound, 25 ohm, 5%, 5 watt	R4A-25
K1	Relay, P & B - MF-1287	RL-14
T1	Transformer (Central K1-176)	TR-43

REVISIONS	
SYM	DATE



PERCENT OVER TRIP

FIG. 1

MATERIAL		FINISH	
UNLESS OTHERWISE SPECIFIED			
FRAC.	DEC.	ANG.	
± 1/64	± .005	± 30'	
SCALE	BY	DATE	
1/2" = 1"		6-13-61	
DRAWN	CHECKED	DATE	
APPROVED	DATE		
TITLE		KETHLEY INSTRUMENTS, INC.	
RESPONSE		CLEVELAND, OHIO	
MODEL 710-711		DRAWING NUMBER	
		14331C	

REVISIONS

DESCRIPTION

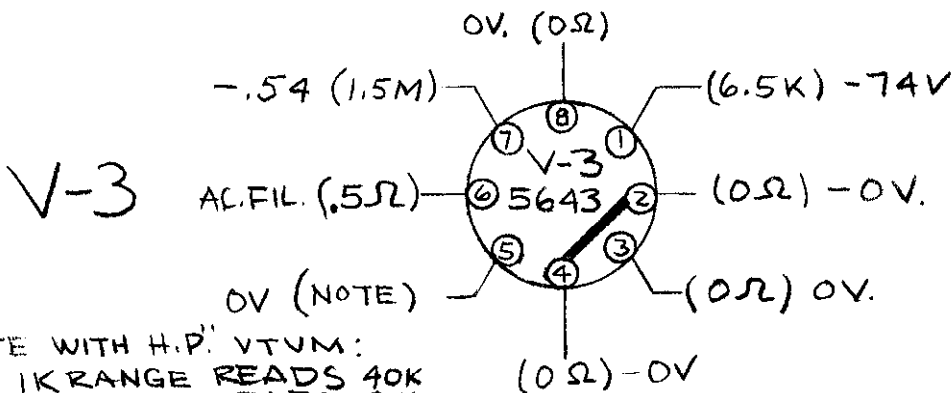
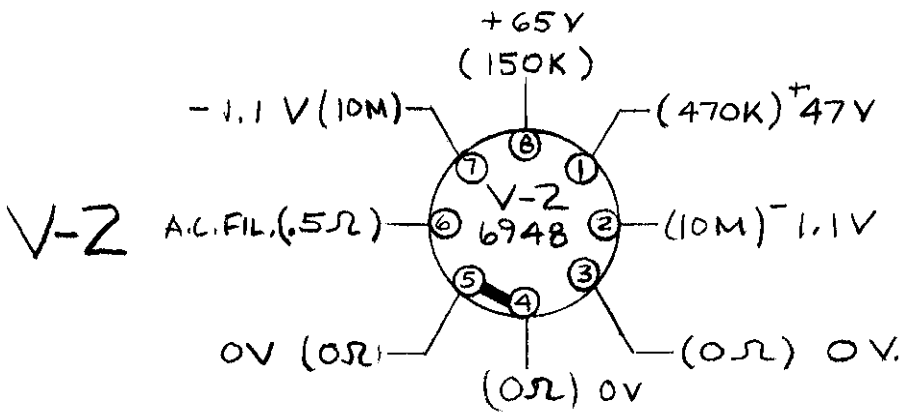
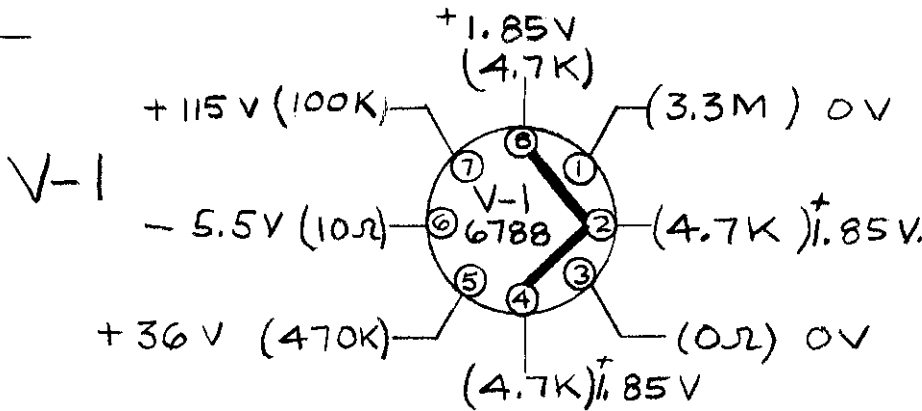
SYM

DATE

MODEL 710-711 VOLTAGE & RESISTANCE CHART

MEASUREMENTS MADE FROM TUBE PIN TO CHASSIS WITH INPUT LEADS SHORTED TO GROUND. AND "TRIP LEVEL" ADJ. FOR MIN. WITH "RELAY OPEN" LIGHT OFF.

USE VTVM FOR MEASUREMENTS



NOTE WITH H.P. VTVM:
 ON 1K RANGE READS 40K
 ON 10K RANGE READS 2K

CONFIDENTIAL
 PROPERTY OF KEITHLEY INSTRUMENTS, INC.
 NOT TO BE USED OR REPRODUCED EXCEPT
 AS AUTHORIZED BY THE COMPANY.

FINISH

MATERIAL

KEITHLEY INSTRUMENTS, INC. CLEVELAND, OHIO		ISSUE	DRAWING NUMBER	SIZE
V & R CHART		DATE 012361	14258A	
		DATE		
TITLE		DRAWN	CHECKED	APPROVED
DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED		cm		
FRAC.	DEC.	ANG.		
± 1/64	± .005	± 30'		
SCALE	N.T.S.	NO. REQ'D		
			NEXT ASSY.	
711	14200M	14200P		
710	14240M	14240P		
MODEL	B/M	NEXT ASSEM.	USED ON	

