INSTRUCTION MANUAL

MODEL 414, 414C

MICRO-MICROAMMETER

WARRANTY

We warrant each of our products to be free from defects in material and workmanship. Our obligation under this warranty is to repair or replace any instrument or part thereof, except tubes, transistors, fuses, and batteries, which, within a year after shipment to the original buyer, proves defective on examination.

DAMAGE IN SHIPMENT

Be sure to include the instrument model number and serial number in all communications.

If the instrument is damaged when received, or fails to operate properly, a claim should be filed with the carrier. Upon receipt of the claim agent's report, we will inform you regarding repair or replacement.

REPAIRS

When returning an instrument for repair or recalibration, it should be securely packed against shipping damage and sent to the factory, freight prepaid. A brief letter describing the difficulty should accompany the instrument.

CONTENTS

SECTION I - INTRODUCTION

Model 414

The Keithley Model 414 Micro-microammeter is a line operated vacuum tube electrometer for measuring currents in the range of 2 micro-microamperes to 10 milliamperes. Features include a response speed of greater than 0.5 seconds on all ranges, an input drop of less than 5 millivolts at full scale, a zero drift of less than 2% per day on any range, good accuracy and calibration stability, negligible noise, and simplicity of operation. For recording, an output signal of five volts at 1 milliampere is available.

Model 414C

This model is identical to the 414 except that a meter-relay replaces the panel meter. An adjustable contact pointer is built into the meter-relay. When the indicating pointer rises to the value set with the adjustable contact, the contacts lock and actuate an internal relay. The relay's SPDT 5-ampere contacts are brought out through an AN connector at the back of the chassis.

A manual reset button is supplied on the front panel. Reset connections are also brought out through the AN connector for remote resetting of the locked-up meter-relay.

SECTION II - SPECIFICATIONS

Ranges:	17 ranges in overlapping 1 and 3 sequence, from 10 milliamperes to 0.1 milli-microamperes full scale.
Accuracy:	Within 3% of full scale on all ranges from 10 milliamperes to 10 milli-microamperes, and within 4% of full scale from 3 milli-microamperes to 0.1 milli-microamperes.
Input Drop:	Less than five millivolts for full scale on any range.
Grid Current:	Negligible.
Zero Drift:	Less than 2% in any eight hour period after a five minute warm-up if the source voltage is not less than one volt.
Response Speed:	Greater than 0.2 second for 67% of full scale on any range with up to 5000 micro-microfarads of input capacity.
Zero Check:	Zero check switch allows zeroing of the instrument without disturbing the test circuit.
Tube Complement:	1 5886, 1 6BR8, 1 6CM6, 1 0B2.
Power Requirements:	100-130 or 200 to 260 volts 50-60 cps, 33 watts.
Accessories Supplied:	Mating connectors, two wire adapter for power cord.
Output:	Five volts at up to one milliampere is developed for full scale deflection.
Noise:	Noise at output and on indicating meter is less than 1% of full scale peak to peak on any range if the source voltage is not less than one volt.
Connectors:	Input: teflon insulated UHF (Amphenol 83-798) Output: binding posts on front panel, Amphenol 80PC2F at rear.
Accessories Available:	Model 6031 end frames for bench mounting.
Cabinet:	Dimensions 19" x 5¼" high by 10" deep. Net weight 16 pounds.

SECTION III - OPERATION

A. OPERATING CONTROLS

1. **Zero Check:** This is a push-button located at the extreme left of the panel. Its function is to allow the zero of the instrument to be checked while the current source is attached. To use, depress and set the zero with ZERO CONTROL. It is a feature of the instrument that the external circuit is not disturbed during the test.

2. **Range Switch:** The RANGE SWITCH is the dial next to and to the right of the ZERO CHECK button. The range in use is always at the top of the dial for convenient operation.

3. **Power, Meter Reverse Switch:** The knob to the right of the RANGE SWITCH is the power and meter polarity switch. This control permits positive or negative meter readings. The output voltage at the recorder terminals is not reversed by this switch.

4. **Zero:** This knob, next to the meter, is used in conjunction with the ZERO CHECK switch as described above to set the instrument zero.

B. OPERATION:

1. **Precautions:** If the instrument is to be used at its extreme sensitivity it is necessary to shield all input leads. The lead-in cable should be polyethylene or teflon insulated coaxial cable; and a low noise, graphite-coated, dielectric cable such as Amphenol 21-537 is recommended. At low sensitivities some of these precautions may be disregarded.

2. **Operation:**

(a) Connect to a power line of proper voltage. The instrument is shipped for 117 volt 50-60 cps operation. For 230 volt operation see circuit diagram at the rear of the manual.

(b) Turn the RANGE SWITCH to 10 milliamperes.

(c) Turn on power. After 30 seconds the instrument is ready to operate.

(d) Depress ZERO CHECK button and set meter to zero. CAUTION: Do not use control to set meter to any other point than zero.

(e) Instrument is now ready to operate. Attach current source and turn RANGE SWITCH to proper range.

3. Special Instructions for Contact Meter Models:

(a) The operation of the instrument is identical to the non-contact meter models with the exception that, on turn-on, the meter pointer will strike the meter contact and lock. Therefore, after the instrument is on for about one minute press RESET button to release pointer and zero the meter. At this point proceed as in Sections 1 and 2.

(b) Special Output Connection: The output connector at the rear of the contact models is an AN connector which contains the output terminals, the control relay contacts and the resetting circuit. It is necessary that contacts A and B in the resetting circuit be shorted if the panel reset button is to be operative. If remote resetting is desired terminals A and B may be connected through a remote normally closed switch. The wiring of this connector is shown in detail in DR1284-9C AT THE REAR of the manual.

(c) The SPDT relay contacts are rated at 5 amperes at 110 volts AC or 24 volts DC.

4. Recording:

The Model 414 is provided with binding posts at the front of the instrument and a connector at the rear for connection to a recorder. A mating plug is provided for the rear connector. The wiring of the connector is shown in the schematics at the rear of the manual and is different for the 414 and the 414C.

The output is five volts and 1 milliampere for full scale meter deflection. The terminals may be connected directly to high impedance recording devices. A series resistor is necessary when driving a milliampere recorder or a mirror galvanometer. The exact value of resistance varies from recorder to recorder. For a one milliampere recorder, approximately 3.8 kilohms is required. The exact sensitivity may be set by means of a potentiometer in series with the output if desired.

5. Speed of Response:

The speed of response of the instrument is specified as not slower than 0.2 seconds for 67% of full scale with 5000 micro-microfarads of input capacity. Capacities greater than 5000 micro-microfarads may cause instability on some ranges. However, the above specifications allows up to 500 feet of 10 mmf per foot coaxial cable.

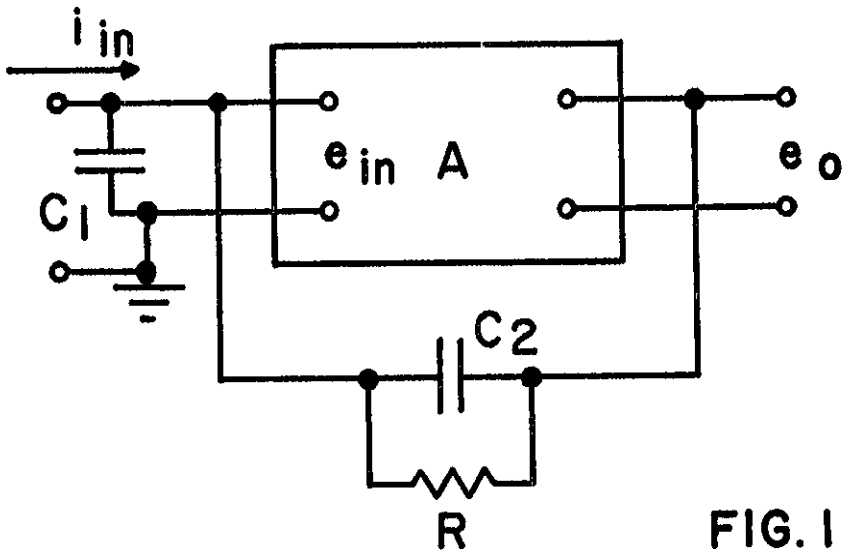


FIG. 1

A. BASIC THEORY:

Figure 1 shows the basic circuit. The input current $\underline{i}$ flows into the input terminal. If we neglect C_1 and C_2 for the moment, the current $\underline{i}$ flows through R the feedback resistor. Since A is an amplifier of gain $\underline{k}$ and the feedback is negative.

$$e_{in} = e_o/k \quad (1)$$

and since all the current must flow through R,

$$i = \frac{-e_o + e_o/k}{R} \quad (2)$$

now if $\underline{k}$, the loop gain is large, the current flowing through the input is e_o/R and may be read from a properly calibrated meter at the output. e_{in} is the input drop of the ammeter.

The input resistance R_{in} is given by e_{in}/i and is,

$$R_{in} = \frac{R}{k+1} \quad (3)$$

Since in the Model 414, the amplifier gain k is about 1000, the input drop, e_{in} will be about 5 millivolts for a five volt output and the effective input resistance R_{in} will be about 1/1000 of the range resistor being used.

If the capacities C_1 and C_2 are considered, the time constant of the circuit is given by,

$$T = RC_1/k + RC_2$$

Thus the input time constant is reduced by a factor equal to the loop gain. Capacitor C_2 is placed across R to damp the response and prevent ringing.

B. CIRCUIT DESCRIPTION: Refer to DR127580 at the rear of the manual:

The input circuit consists of V1, a type 5886 electrometer tube, followed by a 6BH8 and a 6CM6 cathode-follower. This arrangement provides a loop gain of about 1000. A high degree of zero stability is assured by regulation of the filament supply of V1 and B+ supply by V4 the OA2 voltage regulator. The negative bias supply is regulated to the necessary degree by an NE81 neon lamp. The amplifier is a simple single ended direct-coupled amplifier. V1 and V2 are directly coupled and the coupling between V2 and V3 is by means of a NE81 neon lamp. R124, the zero control, operates by varying the screen potential of V1.

The current sensitivity is changed by either changing the feedback resistor (R100 through R113) or by changing the feedback voltage by means of resistors R116 and R117. From 10 milliampers to 10 millimicroamperes a feedback voltage of five volts is used and one resistor is used per range. From 3 millimicroamperes to 0.1 millimicroamperes one resistor is used per decade and the feedback voltage is either one or three volts depending on whether a 3x or 10x range is being used.

The power supply consists of a conventional rectifier-filter circuit for the positive and negative supplies.

SECTION V - MAINTENANCE

Except for occasional tube replacement very little maintenance is required for the model 414. Components are operated well below rating, and high quality components have been used throughout.

1. FACTORY ADJUSTMENTS

Only one factory adjustment is made. This is R132, the meter calibration potentiometer. This adjustment is only necessary if the panel meter is changed. To calibrate set the instrument on the 1 or 10 milliampere range and set the meter to the correct reading with a calibration current sufficient to deflect the panel meter to at least 75% of full scale.

2. TROUBLE SHOOTING

Refer to DR12758-C and the voltage-resistance diagram at the rear of the manual.

Follow this general procedure in trouble shooting if the fault is not apparent from the tabulated list below:

1. Check the B+ and B- potentials: The B+ potential can be measured between the rectifier string and R201 and should be about 320 volts. The ripple should not exceed 3 volts rms. The B- potential may be measured between the negative rectifier string (RF4,5) and R205 and should be about 240 volts. The ripple again should not exceed 3 volts RMS. If either potential is not correct the trouble is probably due to a defective rectifier or filter component although in some cases the transformer may be defective. Refer to the schematic diagram to locate the defective component.

2. SPECIFIC FAULTS

a. Instrument will not balance: If no defect has been found after the inspection suggested in 1., check the voltage at pin 1 or 5 of V4. This should be 150 volts. If the voltage is not 150v, check R203, 202, and 201 for continuity and check V4. If the voltage is correct, check the voltage at pin 3 of V1 (The red dot is next to lead 1) the reading should be 3.2 volts. If the voltage at this point has risen to 150 volts, the filament of V1 is open and this tube should be replaced. If this voltage checks correctly, the following procedure should be started: Short circuit the input to ground with the range switch on 1 microampere full scale. This removes the negative feedback and allows the operating points of the individual tubes to be checked. It will usually be found that the amplifier will become very sensitive and difficult to balance, however it is only necessary that the voltage swing through the correct operating value to confirm that the circuit is operating correctly. Then with the input

shorted, measure the plate potential of V1 with a high impedance VTVM (100 megs or better). This voltage should be setable by means of the ZERO control to 8 volts. If it is not, either the electrometer tube is defective or the potential on the filament or screen is incorrect. We have already measured the potential on lead 3 of V1 and found it correct. Now measure the potential on lead 4. This should be 2.2 volts. If it is not check the value of R122, R123, R124, R208 and R204. Any of these could cause an incorrect voltage. The screen voltage on lead 2 is derived from R124 in the above resistor string. It should be possible to vary the screen voltage from approximately 5.4 to 10 volts. If this cannot be done, but the voltages are correct, R124 is defective or there is a short circuit to some other part of the printed board or harness. Finally remove V2 from its socket. If it is now possible to obtain the correct potential on the plate of V1, V2 is defective.

If it was possible to adjust the electrometer plate to 8 volts, V1 and its associated components are not at fault and it is necessary to proceed to V2, the 6BH8. Check the voltage at pin 2 of V2. This should be the same electrical point as lead 1 of V1 and by moving the zero control it should be possible to vary the potential at V2 precisely as on lead 1 of V1. If this is not possible, check for an open tape on the printed circuit board from V1 to V2. If everything checks to this point, measure the voltage on pin 9 of V2. The voltage should pass through 38 volts by varying the ZERO control. If this does not occur, check the other potentials on V2; if these are not correct look for a defective resistor or an open connection on the board. Finally check for a defective V2.

If no fault has shown up so far, proceed as follows: Check the potential at pin 3, V3, this should be setable with ZERO to about -8.3v. If this is not the case, check to see that GL1, the NE 81 is lit. Then remove V3 from the socket and check to see if now the correct potential can be obtained at pin 3, V3 or the lamp lights. If the potential can now be obtained with the zero control and the lamp lights, V3 may be defective or there may be a short to ground or B- from the cathode of V3. If the lamp does not now light, check R129 and if found good replace GL 1 with a new NE 81. If NE 81's are not available, most NE 2's will work in the circuit.

If the circuit did operate to this point, check V3 as suggested above. Then, if necessary, check for continuity of R130 the cathod load resistor and check to see that the potential at the bottom end of R129 is about -50 volts. Finally, check the potentials on the other electrodes of V3. If now it is possible to swing the output signal through zero volts with the ZERO control, the instrument should operate properly with the short to the input removed. If now this still is not

possible either the feedback connection is open or the circuit is oscillating. To check the feedback connection, check to see that lead 2 indicated on the circuit schematic is connected from the output cathode as shown. If the circuit works properly on some ranges but not on others, check to see if R117 and R116 are defective.

Oscillation in the circuit with the input connector capped (do not confuse with stray pickup) will be caused by a wrong or changed value of C101 or R126. Occasionally if a tube is replaced and the replacement has an unusually high gm, oscillation may occur. If this happens, try another tube or pad C101 so as to double its value.

b. Oscillation: If oscillation occurs, see the paragraph immediately above.

c. Inaccurate reading: For calibration procedure, see Section V 1 on FACTORY ADJUSTMENTS. If this adjustment is insufficient, be sure shielding of input is satisfactory before proceeding. The only other causes of inaccuracy are either insufficient loop gain or inaccurate feedback resistors. If the feedback resistor is at fault, the inaccuracy will be evident only on the range on which the resistor is being used. (CAUTION: when calibrating, using a resistor and a voltage source, the voltage should not be less than 0.1 volts.) The inaccuracy would then involve one of the resistors R100 to R113 or R116 and R117.

To check for low loop gain do the following: Turn the range switch to the 1 millimicroampere scale and connect a voltage source to the input whose impedance is not greater than 10K. The output will become relatively unstable, but with some care it should be possible to determine the DC voltage necessary at the input to cause a full scale meter deflection. If it requires more than about 5 millivolts to achieve full scale deflection, the loop gain is low. If no other symptons of malfunction occur, this can be remedied by replacing tubes.

REPLACEABLE PARTS LIST - MODEL 414 or 414C

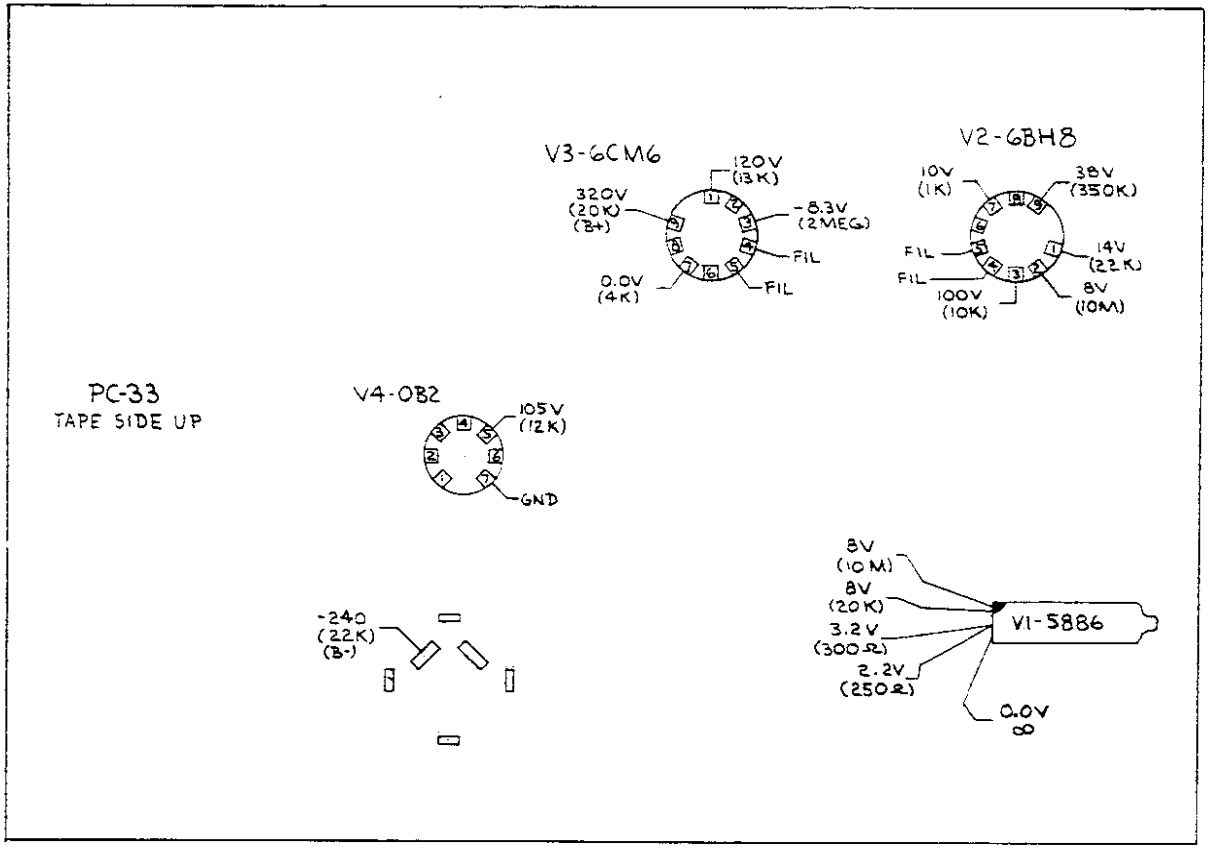
Circuit Desig	Description	Part No.
C100	Capacitor, disc ceramic, 330 mmf, 600 WV, 10%	C22-330
C101	Capacitor disc ceramic. .02 mf, 600 WV, 10%	C22-.02
C102	Capaciotr disc. ceramic, .001 mf, 600 WV. 10%	C22-.001
C103	Same as C100	
C104	Same as C100	
C105	Same as C100	
C106	Same as C100	
C107	Same as C100	
C108	Capacitor disc ceramic, 150 mmf, 600 WV, 10%	C22-150
C109	Capacitor, disc ceramic, 100 mmf, 600 WV, 10%	C22-100
C110	Same as C100	
C111	Capacitor, polystyrene, 500 mmf, 100 WV 25%	C31-500
C112	Capacitor, polystyrene, 50 mmf, 100 WV, 25%	C31-50
C113	Capacitor, polystyrene, 5 mmf, 100 WV, 25%	C31-5
C201A	Capacitor, electrolytic, 20 x 450 WV	C52-20
C201B	Capacitor electrolytic, 20 x 450 WV	C52-2
C202	Capacitor, electrolytic, 20 x 600 WV	C35-20
C203	Capacitor, electrolytic, 20 x 450 WV	C8-20L
C204	Capacitor, ceramic, .002 mf, 600 WV 10%	C22-.02
R100	Resistor.dep. carbon, 500, 1%, $\frac{1}{2}$w	R12-500
R101	Resistor, dep. carbon, 1.67K, 1%, $\frac{1}{2}$w	R12-1.67K
R102	Resistor, dep. carbon, 5K, 1%, $\frac{1}{2}$w	R12-5K
R103	Resistor dep. carbon, 16.7K, 1%, $\frac{1}{2}$w	R12-16.7K
R104	Resistor, dep. carbon, 50K, 1%, $\frac{1}{2}$w	R12-50K
R105	Resistor, dep. carbon, 167K, 1%, $\frac{1}{2}$w	R12-167K
R106	Resistor, dep. carbon, 500K, 1%, $\frac{1}{2}$w	R12-500K
R107	Resistor, dep. carbon, 1.67M, 1%, $\frac{1}{2}$w	R12-1.67M
R108	Resistor, dep. carbon, 5.0M, 1%, $\frac{1}{2}$w	R12-5.0M
R109	Resistor dep. carbon, 16.7M, 1% 1w	R13-16.7M
R110	Resistor, dep. carbon, 50.0M, 1%, 2w	R14-50.0M
R111	Resistor dep. carbon. 100M 1%. 2w	R14-100M
R112	Resistor, High meg., 10^9 ohms 3%	R20-10^9
R113	Resistor, High meg. 10^{10} ohms, 3%	R20-10^{10}
R115	Resistor dep. carbon 1K 1% $\frac{1}{2}$w	R12-1K
R116	Resistor dep. carbon, 2K 1% $\frac{1}{2}$w	R12-2K
R117	Resistor dep. carbon 2K 1%, $\frac{1}{2}$w	R12-2K
R122	Resistor dep. carbon 250 ohms, 1%, $\frac{1}{2}$w	R12-250
R123	Resistor dep. carbon, 250 ohms, 1%, $\frac{1}{2}$w	R12-250
R124	Potentiometer W.W., 70K 4 watt	RP1-70K
R125	Resistor dep. carbon. 10M 1% $\frac{1}{2}$ w	R13-10M
R126	Resistor comp. carbon 1K 10%, $\frac{1}{2}$w	R1-1K
R127	Resistor, comp. carbon, 22K 10%, $\frac{1}{2}$w	R1-22K
R128	Resistor comp. carbon, 330K 10%, $\frac{1}{2}$w	R1-330K
R129	Resistor, comp. carbon 1M 10%, $\frac{1}{2}$w	R1-1M
R130	Resistor, wirewound, 18K, 10% 10w	R5-18K
R131	Resistor dep. carbon, 22K 1%, $\frac{1}{2}$w	R12-22K
R132	Potentiometer W.W., 5K 4 watt	RP3-5K
R133	Same as R100	

REPLACEABLE PARTS LIST - MODEL 414 or 414C

Circuit Desig.	Description	Part No.
R201	Resistor, comp. carbon, 100 ohm, 10%, 2w	R3-100
R202	Resistor, wirewound, 10K, 10%, 10w	R5-10K
R203	Resistor, comp. carbon, 1.2K, 10%, 2w	R3-1.2K
R204	Resistor, wirewound, 10K, 10%, 5w	R4-10K
R205	Resistor, comp. carbon, 47 ohm, 10%, ½w	R1-47
R206	Resistor, comp. carbon, 1K, 10%, 1w	R2-1K
R207	Resistor, comp. carbon, 1M, 10%, ½w	R1-1M
R208	Same as R207.	
RF1	Selenium rectifier, 65 ma, 130 volt input	RF18
RF2	Same as RF1.	
RF3	Same as RF1.	
RF4	Same as RF1.	
RF5	Same as RF1.	
SW1	Meter reversing switch	SW70
SW2	Range switch, ceramic insulated	SW18
TR1	Transformer Primary #1 115v, 50/60 cy Primary #2 115v, 50/60 cy Secondary #1 325v, @ 40 ma Secondary #2 220v, @ 20 mas Secondary #3 6.3v@ 2 a Secondary #3 6.3v @ .6 a	TR23
V1	Electrometer tube, Raytheon CK5886-10	EV5886-10
V2	Vacuum tube, Type 6BH8	EV6BH8
V3	Vacuum tube, Type 6CM6	EV6CM6
V4	Vacuum tube, Type OB2	EVOB2
FU1	Fuse 1.5 amp, Type 3AG	FU-8
ME1	Meter 0 - 200 Microamperes	ME-19
	Connectors On Chassis	
Input Connect.	Connector teflon insulated	CS-12
Output Termin.	Nylon (Two)	BP-13
Output Connect.	Microphone Type	CS-58
	Mating Plugs Furnished With Instruments	
Input Plug	Plug, teflon insulated	CS-49
Output Plug	Microphone Type	CS-33

REPLACEABLE PARTS LIST - MODEL 414C ONLY

Circuit Desig.	Description	Part No.
Output Connect.	Type AN3102A-18-1S	CS-23
C205	Capacitor, electrolytic, 1000 x 15 WV	C11-1000
RE1	SPDT 6 Volt AC Relay	RL7 or RL8
ME1	0-200 ma Model 461-26, Assembly Products	ME-20
RF6	Selenium Rectifier	RF-7
SW3	Pushbutton reset switch	SW-35
Output Plug	Type AN3102A-18-1S	CS-22



VOLTAGE AND RESISTANCE CHART

MEASURMENTS MADE FROM TUBE PIN TO CHASSIS GROUND WITH CONTROLS SET AS FOLLOWS

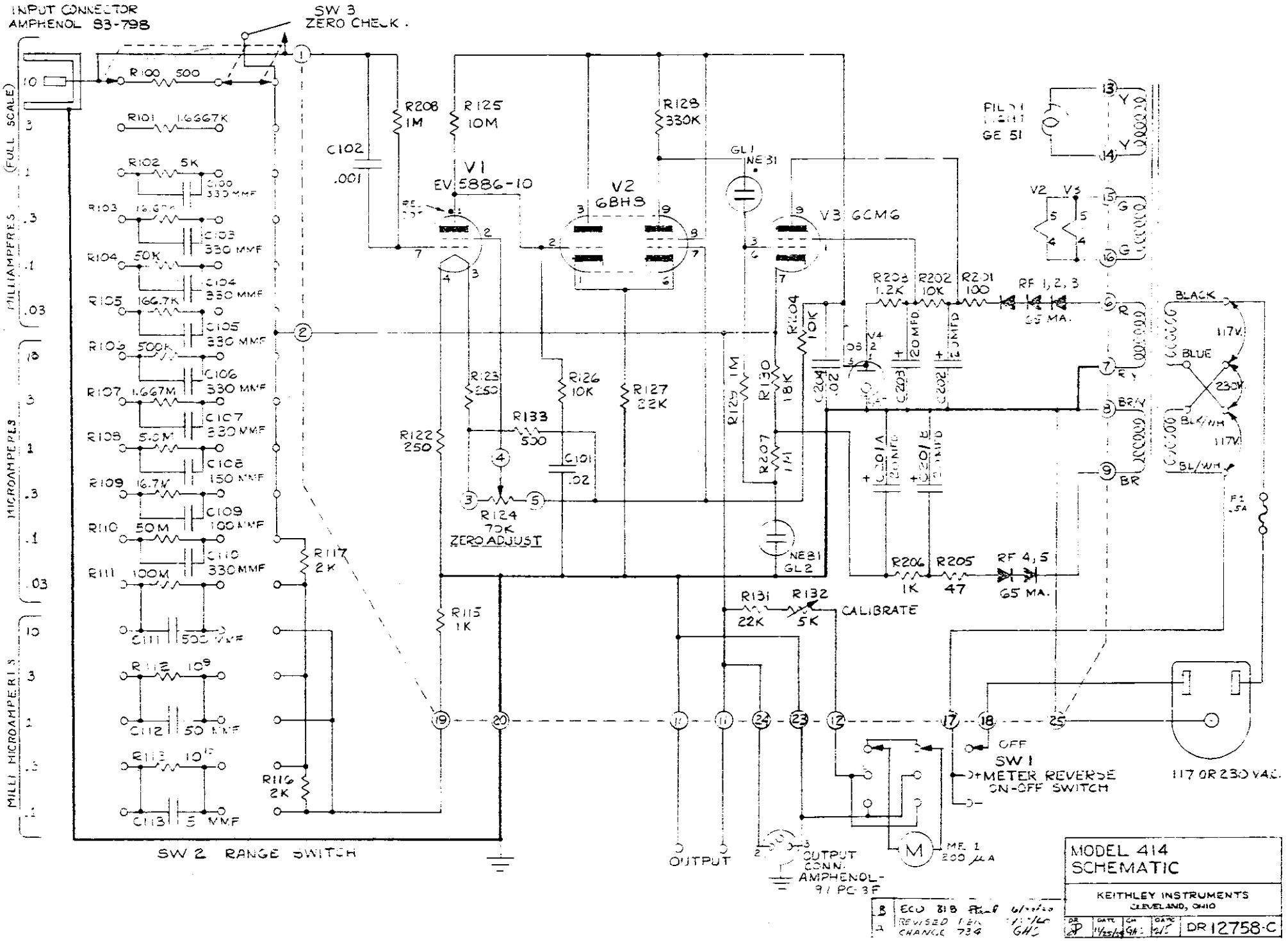
- OUTPUT ON PLUS
- OUTPUT VOLTS ZERO
- RANGE SWITCH AT 1×10^{-2} AMPS

MEASUREMENTS MADE WITH V.T.V.M WITH 100 MEGOHM INPUT IMPEDANCE

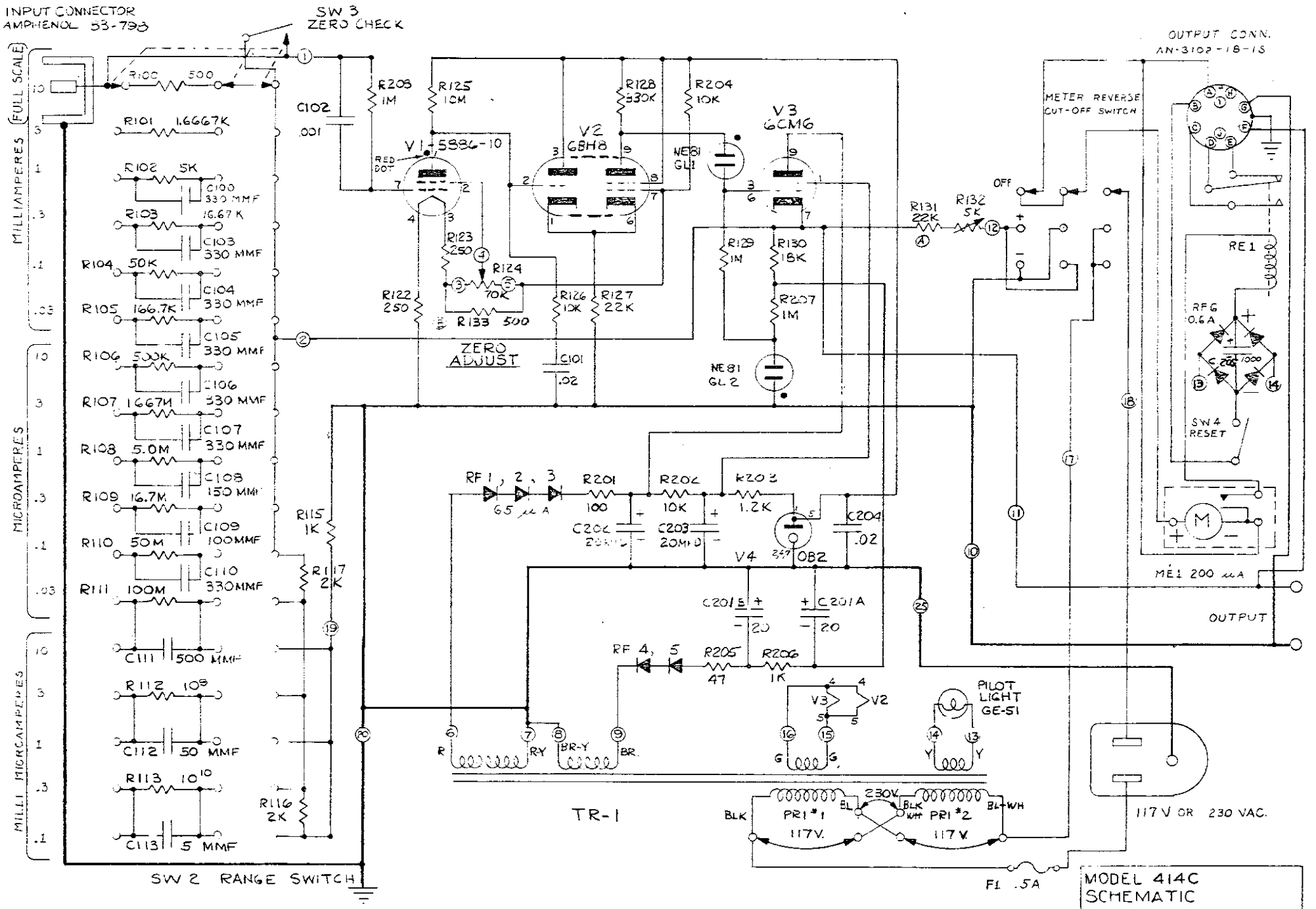
MODEL 414 & 414C
VOLTAGE & RESISTANCE CHART

KEITHLEY INSTRUMENTS
CLEVELAND, OHIO

DR	DATE	CH	DATE	DR 12764 -B
RTF	9/6/59	GHS	10/6/59	



MODEL 414 SCHEMATIC			
KEITHLEY INSTRUMENTS CLEVELAND, OHIO			
B ECO 818 REVISED PER CHANGE 734			
DR	DATE	CH	DATE
DR 12758-C			


INPUT CONNECTOR
AMPHENOL 53-793
SW 3
ZERO CHECK
OUTPUT CONN.
AN-3102-18-1S
MILLIAMPERES (FULL SCALE)
MICROAMPERES
MILLI MICROAMPERES
R100 500
R101 1.6667K
R102 5K
C100 330 MMF
R103 16.67K
C103 330 MMF
R104 50K
C104 330 MMF
R105 166.7K
C105 330 MMF
R106 500K
C106 330 MMF
R107 1667M
C107 330 MMF
R108 5.0M
C108 150 MMF
R109 16.7M
C109 100MMF
R110 50M
C110 330MMF
R111 100M
C111 500 MMF
R112 10^9
C112 50 MMF
R113 10^10
C113 5 MMF
R115 1K
R116 2K
R117 2K
SW 2 RANGE SWITCH
C102 .001
R208 1M
R125 10M
V1 5886-10
RED DOT
V2 6BH8
R128 330K
R204 10K
V3 6CM6
NE81 GL1
R123 250
R124 70K
R133 500
R122 250
R126 10K
R127 22K
ZERO ADJUST
C101 .02
NE81 GL2
R129 1M
R130 18K
R207 1M
R131 22K
R132 5K
OFF
METER REVERSE CUT-OFF SWITCH
RE1
RFG 0.6A
SW4 RESET
ME1 200 μA
OUTPUT
RF 1, 2, 3
65 μA
R201 100
R202 10K
R203 1.2K
C202 20MFD
C203 20MFD
C204 .02
V4 6BZ
C201B 20
C201A 20
RF 4, 5
R205 47
R206 1K
PILOT LIGHT GE-51
TR-1
PRI #1 117V.
PRI #2 117V.
230V
BLK
BL-WH
117 V OR 230 VAC.
F1 .5A
MODEL 414C SCHEMATIC
KEITHLEY INSTRUMENTS
CLEVELAND, OHIO
DR 12849-C

CHANGE NOTICE

May 22, 1969

MODEL 414A PICOAMMETER

Page 19. Change to the following:

Circuit Desig.	Description	Mfg. Code	Keithley Part No.	Fig. Ref.
21850B	MOS FET Input Plug-in Card	80164	23734A	6

Page 20. Change to the following:

Circuit Desig.	Value	Rating	Type	Mfg. Code	Mfg. Part No.	Keithley Part No.	Fig. Ref.
R123	2 kΩ	20%, 0.2 W	CompV	71450	70	RP31-2K	1,7

CHANGE NOTICE

May 22, 1969 MODEL 414S PICOAMMETER

Page 31. Change to the following:

Circuit Desig.	Description	Mfg. Code	Keithley Part No.	Fig. Ref.
21850B	MOS FET Input Plug-in Card	80164	23734A	7

Page 33. Change to the following:

Circuit Desig.	Value	Rating	Type	Mfg. Code	Mfg. Part No.	Keithley Part No.	Fig. Ref.
R131	2 kΩ	20%, 0.2 W	CompV	71450	70	RP31-2K	2,8

CHANGE NOTICE

November 23, 1966 MODEL 414 MICRO-MICROAMMETER

Page 5-2. Change to the following:

Circuit Desig.	Value	Rating	Type	Mfg. Code	Keithley Part No.
C204	0.1 μf	400 v	My	14655	C114-0.1M
C307	0.1 μf	400 v	My	14655	C114-0.1M

CHANGE NOTICE

July 13, 1966

MODELS 414, 414C MICRO-MICRO AMMETER

Page 6-2. Change to the following:

Circuit Desig.	Value	Rating	Type	Mfg. Code	Mfg. Part No.	Keithley Part No.	Loc.
203	20 µf	450 v	ETB	56289	TVA1709	C8-20M	PC

Page 6-3. Change to the following:

Circuit Desig.	Description	Mfg. Code	Keithley Part No.	Loc.
---	Transformer (Mfg. No. K1-226)	80164	TR-57	C

Page 6-5. Change to the following:

Circuit Desig.	Number	Mfg. Code	Keithley Part No.	Loc.
V1	5886	80164	EV-5886-5X	PC

CHANGE NOTICE

February 21, 1966 — MODELS 414, 414C MICRO-MICROAMMETERS

Page 6-2. Change to the following.

D101	Silicon	1N3255	02735	RF-17A	PC
D102	Silicon	1N3255	02735	RF-17A	PC

Page 6-4. Change to the following:

R125	10MΩ	1%, 1/2 w	DCb	79727	CFR-15	R12-10M	PC

MODEL 414-26 MICRO-MICRO AMMETER MODIFICATION NOTICE

The Models 414, 414C Instruction Manual applies to the Model 414-26 with the following Modifications:

1. Instrument low is removed from chassis ground for floating operation of the instrument.

2. Connection of voltages higher than ±200 volts d.c. between chassis ground and instrument low fires a series of Type 9001 regulator tubes triggering the overload protection circuit in the Keithley Model 240 Power Supply. This method protects other monitoring devices connected to the output of the Keithley Model 414.

3. An additional deck switch is added to the range switch SW-2 and 18 wires brought to a connector (Amphenol 165-25) mounted on the rear panel. This circuit is for external use to indicate range switch position.

4. The input connector is changed to an HN Amphenol Type 82-805.

5. Schematic Diagram 19445B at the end of this manual shows these modifications.

Customer - Kanco Inc.
Order No. - 27897
0166 SPECIAL

CHANGE NOTICE

March 15, 1965 MODELS 414, 414C MICRO-MICROAMMETERS

Page 6-2. Change to the following:

C111	510 pf	500 v	Poly	71590	CPR-510J	C138-510P	RS
C112	47 pf	500 v	Poly	71590	CPR-47J	C138-47P	RS
D101	Silicon		1N3255	02735	RF-17	PC	
D102	Silicon		1N3255	02735	RF-17	PC	

71590 is Centralab.

Schematic Diagrams 12758C and 12849C.

Change the values of C111 and C112 to 510P and 47P respectively.

CHANGE NOTICE

December 14, 1964 MODELS 414, 414C MICRO-MICROAMMETERS

Page 5-5.

Change to the following:

RF1	Silicon rectifier, 1N3255	Keithley Part RF-17A
RF2	Silicon rectifier, 1N3255	Keithley Part RF-17A
RF4	Silicon rectifier, 1N3256	Keithley Part RF-22

Remove RF3 and RF5.

Schematic Diagrams 12758C and 12849C.

Remove RF3 and RF5.

REPAIR AND CALIBRATION FORM

For repair or calibration, please fill out this form and return it with your instrument to:

Sales Service Department
Keithley Instruments, Inc.
28775 Aurora Road
Cleveland, Ohio 44139

R-_____
Do not write in this space.

User's Name _____ Telephone _____ Ext. _____
Company _____ Address _____
Division _____ City _____ State _____ Zip _____
Date _____ Model No. _____ Serial No. _____

1. Reason for Return
   - ☐ Repair and Recalibration
   - ☐ Recalibration only (No report, except as specified in item 4 on reverse)*

   *If repairs are necessary to meet specifications, they will be in addition to the calibration.

2. Calibration Report Desired
   - ☐ Report of Calibration Certified Traceable to N.B.S.
   - ☐ Calibration Report
   - ☐ Certificate of Compliance
   - ☐ None

   (for details, see reverse side of this form)

3. To help repair the instrument, briefly describe the problem: _____

4. Is the problem ☐ Constant ☐ Intermittant
   Under what conditions does the problem occur:
   a) Control setting _____
   b) Approx. Temperature _____ °F
   c) Approx. Temperature variation ± _____ °F
   d) Approx. Humidity (high, medium, low) _____
   e) Line voltage _____
   f) Other (such as line transients, line variations, etc.) _____

5. Please draw a block diagram of the system using the Keithley. List any other pertinent data which can help in the repair. Include charts or other data if available.
   Signal Source _____
   Source Impedance _____
   Readout Device:
   - ☐ Recorder
   - ☐ Oscilloscope
   - ☐ Other
   - ☐ None

   Lengths & Types of Connecting Cables _____

6. What repairs or modifications have been made on this instrument which are not on file with the Keithley Repair Department? _____

7. Please enclose any other pertinent data and charts which you feel might help the Repair and Calibration Department

_____ Signature _____ Title

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CALIBRATIONS AVAILABLE AT KEITHLEY INSTRUMENTS.

Listed and defined below are the four types of calibrations and their associated report formats which are presently available at Keithley Instruments. They fall into the following categories:

1. Report of Calibration Certified Traceable to the National Bureau of Standards
2. Calibration Report
3. Certificate of Compliance
4. Recalibration

All calibration and certification performed by Keithley Instruments is in accord with MIL-C-45662A.

Prices shown below are in addition to repair charges for any work necessary to place a customer's unit into first class condition prior to the calibration.

1. Report of Calibration Certified Traceable to the National Bureau of Standards.
This is a completely documented report, including all basic errors or deviations from nominal settings on appropriate ranges, terminals, dials, etc. Work is performed using the primary standards of the company with secondary transfers kept to a minimum. The NBS test numbers for the latest recalibration of the primary standards are furnished.

By definition, the above is performed in our Standards Laboratory so that random operator induced error is minimized and maximum protection to the equipment used is maintained.

This type of calibration is not recommended for instruments with a basic inaccuracy of 1% or greater. The precision involved in this report makes it uneconomical for such instruments. The Calibration Report listed below (No. 2) would be better suited in this case.

As of 12/1/67 the Report of Calibration Certified Traceable to the National Bureau of Standards is available on the following instruments at the prices listed:

Model 140	$325	Model 5155 (Complete Set) . .	$265
Model 260	$220	Model 5155-10^{8}	$ 45
Model 261	$280	Model 5155-10^{9}	$ 45
Model 515	$520	Model 5155-10^{10}	$ 45
Model 630	$250	Model 5155-10^{11}	$ 55
Model 660A	$200	Model 5155-10^{12}	$ 55
Model 662	$250	Model 5155-10^{13}	$ 75

2. Calibration Report.
This report shows only the cardinal range, terminal, dial, etc. errors as determined by production calibration equipment and personnel. The production equipment is maintained traceable by transfer techniques against the primary standards maintained by the company. We attest to this fact and list basic deviations from nominal but the conditions of calibration are not as precisely controlled as the previous report nor are NBS test numbers supplied.

This report is available for any instrument in our line. As of December 1, 1967, only the following price has been established for this report:

Model 261 . . . . . $50

Prices for other units can be estimated upon request.

3. Certificate of Compliance.
This is merely a restatement of the basic guarantee that the instrument was calibrated on equipment that is maintained by our standards personnel against primary standards. No report is issued.

This Certificate of Compliance is available at no charge for any instrument with the exception of the Model 261.

A newly purchased Model 261 or one returned for repair or recalibration is automatically supplied with a Calibration Report (as described in (2) above). The nature of this instrument makes it necessary to complete this report to ascertain specified accuracy. This Calibration Report is forwarded to the customer with the instrument. The $50 charge is incorporated as part of the normal calibration charge of the Model 261.

4. Recalibration.
This is a recalibration of the instrument according to our factory calibration procedures. The prices for this as of December 1, 1967 are as follows:

Model 260	$75	(No report supplied. A Certificate of Compliance can be had at no charge if requested).
Model 261	$50	(Calibration Report as described in (2) above is supplied. See (3) for explanation).

All other instruments are on a time and material basis for the particular unit involved.