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* Yellow Change Notice sheet is included only for instrument modifications affecting the Instruction Manual.

SECTION 1. GENERAL DESCRIPTION

1-1. GENERAL. The Keithley Models 108 and 109 are small, 12-ounce X10 gain amplifiers. The Model 108 is tuned for a wideband frequency response; the Model 109 is tuned for pulse response. (See Figures 9 and 10 for illustrations of the two responses.) Both Models require an external power supply, preferably the Keithley Model 1081 Power Supply, which can drive up to three of these units at one time.

a. The Model 108 bandwidth is from 1 kc to 180 Mc (-3db). Response from 2.5 kc to 150 Mc is flat $\pm$0.5 db. Voltage gain is 10 (20 db) when terminated into a 50-ohm load. Up to four Model 108 Amplifiers may be cascaded for gains to 10,000, or one may be used with other amplifiers to increase total gain by 10. The input impedance is 50 ohms. Noise is less than 30 microvolts rms referred to the input.

b. The Model 109 Pulse Amplifier has a rise time of less than 3 nanoseconds (10% to 90%). Overshoot is less than 2%, pulse width for a 10% droop is 30 microseconds. Other specifications are the same as for the Model 108. Four Pulse Amplifiers may be cascaded for gains to 10,000, or one may be used with other amplifiers to increase total gain by 10.

1-2. MODELS 108, 109 DIFFERENCES.

a. The Models 108 and 109 differ only in their tuning. The circuits and the parts are identical. Most of the Instruction Manual applies to both units. Where there are differences – such as application suggestions and calibration – the models are identified.

b. Specifications and operations in this Manual assume using the Keithley Model 1081 Power Supply to power the Amplifier. It is recommended that this Power Supply be used to obtain the maximum benefit from the Amplifier.

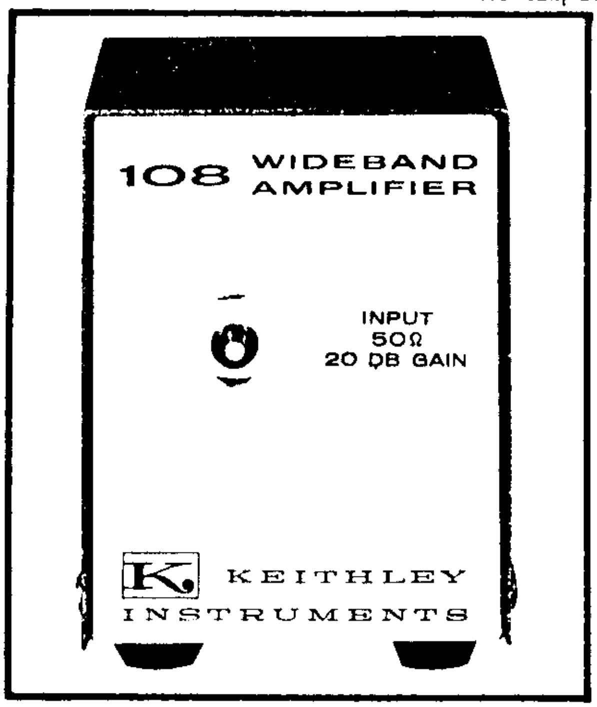


FIGURE 1. Keithley Instruments Model 108 Wideband Amplifier.

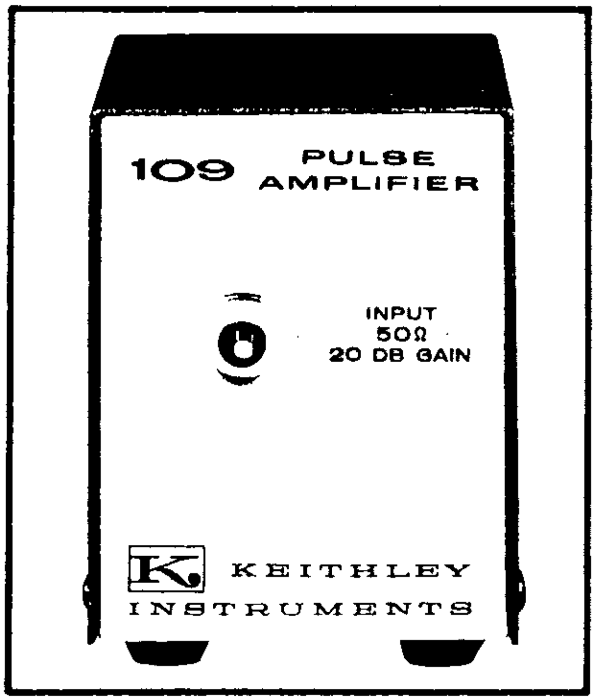


FIGURE 2. Keithley Instruments Model 109 Pulse Amplifier.

1-3. SPECIFICATIONS.

	Model 108 (when powered by the Model 1081 Power Supply)	Model 109 (when powered by the Model 1081 Power Supply)
Frequency[1]: -3db	1 kc and 180 Mc	—
±0.5db	2.5 kc to 150 Mc	—
Rise Time[2] (10% to 90%)	Less than 3 nanoseconds	Less than 3 nanoseconds
Overshoot[3]	—	Less than 2%
Pulse Width for 10% Droop:	—	30 microseconds
Input Impedance:	50 ohms	50 ohms
Voltage Gain (into 50-ohm characteristic impedance)	10 (20 db) ±2% at 10 kc	10 (20 db) ±2% at 10 kc
Maximum rms Noise[4]:	30 microvolts (7 db)	30 microvolts (7 db)
Maximum Output (into 50-ohm characteristic impedance)	1.4 volts peak-to-peak	1.4 volts peak-to-peak
Maximum Overload:	ac, 20 volts peak[5] dc, 2.5 volts	ac, 20 volts peak[5] dc, 2.5 volts
Overload Recovery[6]	Less than 50 nanoseconds	Less than 50 nanoseconds
Delay Time[7]	Less than 5 nanoseconds	Less than 5 nanoseconds
Change in Output Amplitude for a 10% Line Voltage Change (when powered by Model 1081):	Less than ±0.1%	Less than ±0.1%

Notes:

1) db variations add when amplifiers are cascaded.
2) Maximum rise time for 3 amplifiers in cascade is less than 4 nanoseconds.
3) Overshoot for amplifiers in cascade is 3% or less.
4) Noise referred to input measured from 10 cps to 100 Mc. Noise of cascaded amplifiers is equal to noise of first amplifier only.
5) Continuous input power should not exceed 1/8 watt.
6) Using a 100X overload test pulse 100 nanoseconds wide with 5-nanosecond fall time to within 1% of base line. A shorter pulse duration, a slower fall time or less overload shortens recovery time.
7) Delay times add when amplifiers are cascaded.

CONNECTORS: Input and Output: n type. Power: Amphenol 126-214

POWER: +16 volts dc and -12 volts dc; or 28 volts dc floating; ±5% accuracy; 50 milliamperes current (1.4 watts); ±0.1% stability; 2-millivolt peak-to-peak maximum ripple; 100-microfarad filter from each power terminal to ground.

DIMENSIONS, WEIGHT: 3 inches high x 2-1/4 inches wide x 3-3/4 inches deep; net weight, 12 oz

ACCESSORIES SUPPLIED: Mating power connector; mating input and output connectors.

1-4. APPLICATIONS.

a. The Model 108 Wideband Amplifier is used as a general laboratory pre-amplifier in audio, radar, IF, TV and VHF work. It can be used with all types of oscilloscopes. Its low noise permits amplification of signals in the microvolt region at low and high frequencies. Because of its small size, it can be designed into other equipment.

b. The Model 109 Pulse Amplifier is designed to amplify non-sinusoidal wave forms with a fast rise time, minimum overshoot and minimum ringing. Common applications include use with oscilloscopes, high-speed counters, pulse-height analyzers and photo multipliers.

1-5. ACCESSORIES. Refer to Section 6 for complete descriptions of the following Amplifier accessories.

a. Model 1081 Power Supply can power one, two or three Model 108 or 109 Amplifiers. The Power Supply operates from 105-125 or 210-250 volt, 50-400 cps line sources; power rating is 12 watts. Its dimensions are the same as the Amplifiers; net weight is 1-1/2 pounds.

b. Model 1042 Accessory Kit provides useful adapters, terminations and tee for use with the Amplifier. The Kit accessories, contained in a convenient case, are described in Section 6.

c. Model 1082 Mounting Plate adapts the Amplifiers and the Model 1081 for mounting to another surface.

d. Model 1083 Cable allows using the Models 108 and 109 with the Keithley Models 106 and 107 Amplifiers.

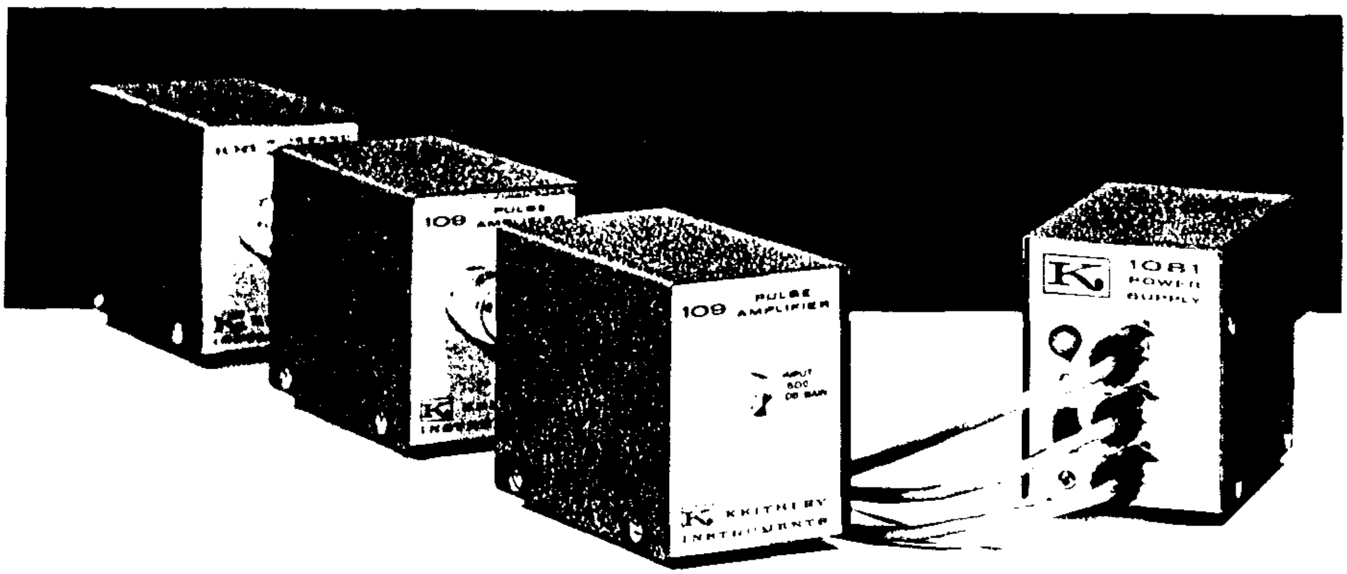


FIGURE 3. Model 1081 Power Supply Used with Three Model 109 Pulse Amplifiers. The Supply will power 1, 2 or 3 Amplifiers. See Sedtion 6 for the Power Supply description.

1-6. EQUIPMENT SHIPPED. The Models 108 and 109 are factory-calibrated and are shipped with all components in place. All units are shipped for bench use. The shipping carton contains the Instruction Manual, a mating power connector and mating input and output plugs.

SECTION 2. OPERATION

2-1. TERMINALS.

a. INPUT and OUTPUT Receptacles. INPUT (front panel) and OUTPUT (rear panel) Receptacles are n-type. Input impedance is 50 ohms. N-type connectros are used for their better impedance characteristics and less leakage at higher frequencies than other popular connectors.

b. POWER Socket. The POWER Socket is a 4-pin connector. It is compatible with the power cable supplied with the Model 1081 Power Supply. Schematic Diagram 17971D shows the pin connections and voltages (refer to J103).

2-2. OPERATING PROCEDURES.

a. No control settings or preliminary adjustments are needed to operate either Amplifier. Both can be used immediately after they are connected to the Model 1081 Power Supply.

NOTE

The Amplifiers have n-type receptacles (Mil. No. 680/U). The Model 1042 Accessory Kit contains adapters to connect other type plugs to the Amplifier. Section 6 describes the Kit.

b. Connect the Power Supply and associated equipment, such as an oscilloscope, on the same power line to avoid ac ground loops. Otherwise, the output signal from the Amplifier may tend to be modulated by the ground loops. To further minimize ground loops, it may be necessary to use isolation plugs on power line plugs of the Power Supply and the associated equipment. If a power supply other than the Model 1081 is used, put 100-μf filter capacitors from + and - to ground.

c. Use coaxial cables for connections, especially if working above 1 Mc. Up to six feet of coaxial cable may be used on the Amplifier input and up to 12 feet on the output, if the output cable is terminated with 50 ohms. Longer cables may be used, but the Amplifier may not meet the flatness or overshoot specifications. All cables used must have a 50-ohm characteristic impedance.

NOTE

The Model 109 has no phase reversal on pulse. If the pulse is positive at the input, it is positive at the output. If it is negative at the input, it is negative at the output.

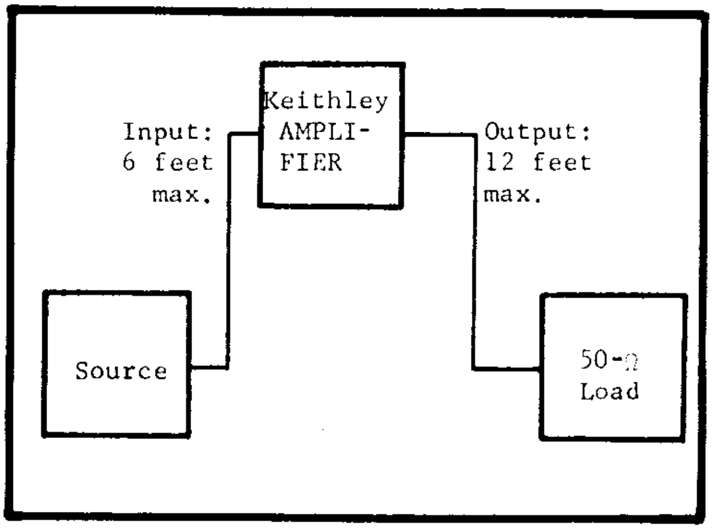


FIGURE 4. Amplifier Cable Connections. Maximum recommended cable length to input is six feet; from output, 12 feet. If longer cables are used, the specified flatness or overshoot may not be achieved. Use only coaxial cables.

2-3. CASCADING.

a. Up to four Amplifiers may be cascaded together for gains of 100, 1000, or 10,000. The final Amplifier output should not exceed 1.4 volts peak-to-peak into a 50-ohm load. Higher outputs exceed the limits of the amplifier stages and distortions will result. A bandpass filter is recommended for 10,000-gain hookups to reduce the noise level.

NOTE

When using the 108 or 109 with the 106 or 107, use the 1083 cable for connection into the 106 and 107 power outlet.

b. Use the n-type male-to-male adapter from the Model 1042 Kit to cascade Amplifiers directly to each other. The Model 108 may also be used in cascade with the Keithley Models 104 and 106 Amplifiers. The Model 109 may also be used in cascade with the Models 105 and 107 Amplifiers.

2-4. GAINS OTHER THAN 10, 100, 1000 AND 10,000. For gains in between the cascaded values, use attenuator pads in series with the Amplifier. When two Amplifiers are cascaded, use the attenuator pad on the last Amplifier OUTPUT Receptacle for input signals below 15 millivolts peak-to-peak for the best signal-to-noise ratio. For example, a 1-millivolt rms input signal is amplified 20 times (26 db) using a 14-db attenuator pad on the last Amplifier output. Maximum input noise of each amplifier is 30 microvolts rms. Noise at the last output is 3 millivolts rms. When the noise is attenuated five times through the 14-db pad, its level is 0.6 millivolt rms. Signal-to-noise ratio is approximately 28:1. If the 14-db attenuator pad were used at the first Amplifier input, the output noise would be 3 millivolts rms. Signal-to-noise ratio would be approximately 6:1, or four times worse than previously.

2-5. OPEN CIRCUIT OPERATION. The specified Amplifier gain is into a 50-ohm load. The gain changes for an open circuit. Output impedance is approximately five ohms below 10 megacycles, increasing as the frequency increases. Below 10 megacycles, therefore, the gain into an open circuit is approximately 10.5 to 11. Above 10 megacycles, the gain increases to approximately 18 (25 db) at 150 megacycles. The Amplifier will not oscillate into an open circuit at any frequency, although standing waves become apparent at the higher frequencies. The magnitude of the waves depends directly on cable length and frequency.

2-6. AMPLIFIER NOISE. The main sources of noise are the transistors and any power supply ripple. Since all noise is referred to the input, the output noise will be the amplifier input noise times the amplifier gain (10). The noise is measured at the output and referred back to the input. When two Amplifiers are cascaded, the noise of the second amplifier is not significant because noise adds as the square root of the sum of the squares.

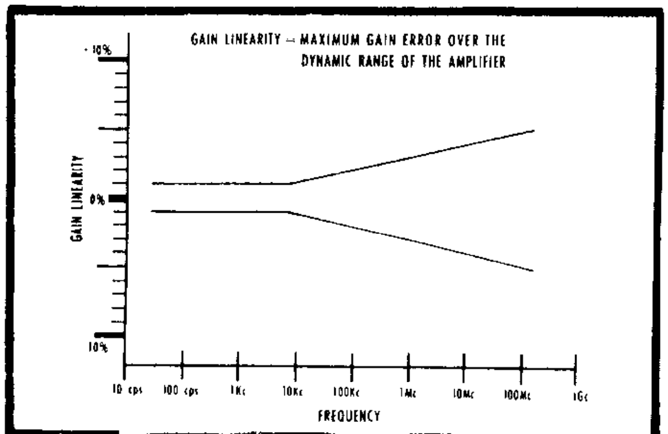


FIGURE 5. Models 108 and 109 Gain Linearity The gain linearity falls within the limits shown above from 2.5 kc to 150 Mc.

2-7. RISE TIME.

a. The rise time is defined as the time needed for a signal to rise from 10% to 90% of its final value. Specifically, for amplifiers, rise time is the time needed for the amplifier to go from 10% to 90% of the final value of the input signal times the amplifier gain. Rise time is measured only with a pulse whose rise time is faster than the amplifier's. When amplifiers are cascaded, the rise times add in quadrature (square root of the sum of the squares).

b. The slight overshoot of a very high frequency pulse can be eliminated in the Model 108 by detuning the high-frequency response slightly. The Model 108 is tuned for maximum gain flatness for a continuous signal. The Model 109 is already tuned for minimum overshoot.

2-8. DELAY TIME. Delay time is the transit time taken by a signal to go from the amplifier input to output. Because delay times are a physical constant, they add for cascaded amplifiers.

2-9. GROUND LOOPS. A common source of errors when amplifying low-level signals is ground loops. This is a current — line or other frequency — flowing in a ground lead impedance, which results in a voltage in addition to the desired signal voltage appearing at the input terminals of the amplifier. Although the origin and mechanism of ground loops are difficult to explain and trace, their effects can be reduced in several ways.

a. Make all ground lead impedances as low as possible.

b. Employ only coaxial hookups wherever possible.

2-10. STRAY FIELDS. Stray fields can induce unwanted emf's in the test system. The inaccuracies due to these fields become more significant as measurements become more sensitive. Induced emf's may be reduced by using coaxial cable having minimum loop area and by using cables of minimum length.

SECTION 3. CIRCUIT DESCRIPTION

3-1. GENERAL.

a. Both Amplifiers are of conventional RC-coupled cascade design, using negative feedback. There is no inductive peaking. The wide bandwidth is achieved by using selected epitaxial mesa transistors with a 1-gigacycle f_t.

b. Careful circuit design allows for maximum performance. Point-to-point wiring minimizes lead inductance. Silver plating on the chassis eliminates ground loops and reduces resistance due to skin effect at high frequencies. Using solid-state components, hermetically sealed tantalum capacitors and metal film resistors insures excellent stability and long, trouble-free operation.

NOTE

Refer to Schematic Diagram 17971D at the back of the Manual for circuit designations.

3-2. AMPLIFIER DESIGN. Each Amplifier uses three high-frequency transistors, two in common emitter cascade configuration and the third being an emitter follower for the output. A high negative feedback loop is used for gain stability.

a. The input is shunted by a 50-ohm metal film resistor (R102), compensated for a nominal 50-ohm input impedance across the band. The input signal is applied to transistor Q101. Transistors Q101 and Q102 amplify the signal and apply it to the emitter follower, transistor Q103, which provides low output impedance and higher power capabilities than the amplifier stages.

b. The feedback loop for the two amplifier stages is through resistor R116 and capacitor C110. The output of transistor Q102 is divided by resistor R116 and the network, resistors R109, R110 and R111. Potentiometer R111 adjusts the gain at the lower frequencies. Trimmers C103, C112, C115 and C118 adjust the feedback at higher frequencies, since the divider becomes primarily capacitive.

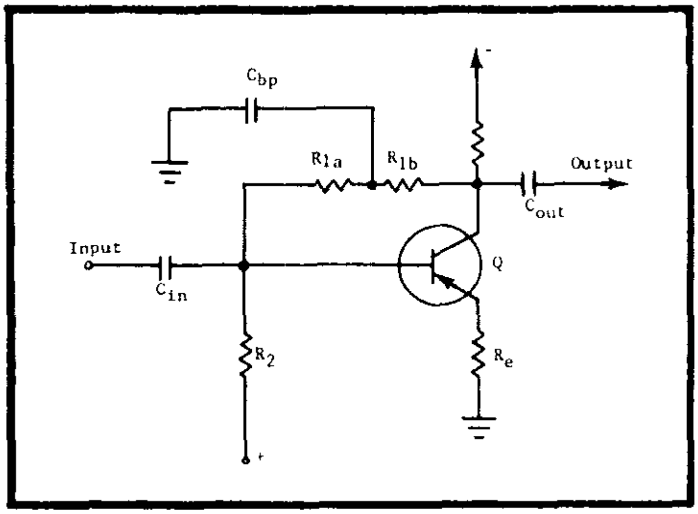


FIGURE 6. Basic Amplifier Stage. The diagram shows the stage design used in the 2-stage amplifier. Resistors R_1 and R_2 and the collector bias voltage drop provide a bias voltage divider, which stabilizes the base voltage. Resistor R_1 supplies dc feedback. To eliminate degeneration caused by the ac feedback, R_1 is divided into two parts, R_{1a} and R_{1b}. Capacitor C_{bp} bypasses the ac from the midpoint to ground.

c. Each stage uses dc feedback from collector to base. The feedback loop for the first stage, transistor Q101, consists of two resistors, R105 and R106. Capacitor C105 is at the midpoint between the two 2.2-kilohm resistors to eliminate ac feedback. Resistors R114 and R115 and capacitor C108 provide the same function for transistor Q102.

SECTION 4. SERVICING

4-1. GENERAL. Section 4 contains the maintenance and troubleshooting procedures for the Models 108 and 109. Follow these as closely as possible to maintain the instrument's specifications.

4-2. SERVICING SCHEDULE. The Models 108 and 109 require no periodic maintenance beyond the normal care required of high-quality electronic equipment. Occasional checks of the frequency or pulse response of the Amplifier should show the need for any adjustment. No part should need frequent replacement under ordinary use.

4-3. PARTS REPLACEMENT.

a. The Replaceable Parts List in Section 7 describes the electrical components of the Amplifiers. Replace components only as necessary. Use only reliable replacements which meet the specifications. Check the frequency or pulse response after any transistor is replaced.

b. The transistors are selected for parameters which allow wide frequency response. Order these parts only from Keithley Instruments, Inc., or its representatives.

NOTE

Physical location of components greatly affects high frequency response. Put replaced parts and their leads in their exact previous position.

4-4. TROUBLESHOOTING.

a. The procedures which follow give instructions for repairing troubles which might occur in the Models 108 and 109. Use the procedures outlined and use only specified replacement parts. Make sure the external circuits are checked. Table 1 lists equipment recommended for troubleshooting. If the trouble cannot be located or repaired, contact the nearest Keithley representative.

Instrument	Use
Keithley Instruments Model 121 True RMS Voltmeter	Measures ac voltages
Keithley Model 153 DC Microvolt-Ammeter, 3% accuracy, 20 megohm input resistance	Measure dc voltages
Simpson Models 260 and 650 Transistor Beta Testers	Check transistors
Tektronix Type 504 Oscilloscope, passband dc to 450 kc	Observe wave forms

TABLE 1. Equipment Recommended for Troubleshooting. Use these instruments or their equivalents.

Trouble	Probable Cause	Remedy
Amplifier will not operate	Faulty transistor	Check Q101, Q102, Q103; replace if faulty
Noise with Amplifier exceeds 30 microvolts rms	Faulty transistor	Check Q101, Q102, Q103; replace if faulty
	Excessive ripple from power supply	Check power supply. Check filters C101, C106, C116, C122, C123 and C124.
Gain is more or less than 10	Potentiometer R111 out of adjustment	Adjust R111 per paragraph 5-3
Model 108 frequency response not flat within specifications	Amplifier out of calibration	Calibrate per paragraph 5-4
Model 109 exceeds overshoot specification	Amplifier out of calibration	Calibrate per paragraph 5-5
Rise time of Amplifier not within specification	Amplifier out of calibration	Adjust Model 108 per paragraph 5-4, Model 109 per paragraph 5-5
Input impedance not 50 ohms	Faulty R102 or C102	Check R102 and C102; replace if faulty

TABLE 2. Models 108 and 109 Troubleshooting. Refer to paragraph 4-4, b, before troubleshooting the Amplifier.

b. Before troubleshooting the Amplifier, check the external circuits, especially the power supply. Make sure the Amplifier output is terminated into a good 50-ohm load. Check the coaxial cables and connections. Check the performance of the signal generator and other instruments. (The Amplifier will faithfully amplify any signal fed to it; a poor input results in a poor output.) Make sure the output signal does not exceed 1.4 volts peak-to-peak. If the external circuits are good, check the Amplifier itself.

c. Table 2 contains troubles which might occure with the instrument. If the repairs indicated in the table do not clear up the trouble, continue to search through a circuit-by-circuit check. Refer to the circuit description in Section 3 to find the more crucial components and to determine their function in the circuit. The complete circuit schematic diagram, 17971D, is in Section 7.

d. If the instrument will not operate, check the power source. If it is satisfactory, continue to isolate the trouble.

e. The Schematic Diagram indicates the transistor terminal voltages referenced to chassis ground. Measure the dc voltages to $\pm$10% of indicated value with a dc voltmeter.

SECTION 5. CALIBRATION

5-1. GENERAL.

a. The following procedures are recommended for calibrating and adjusting the Models 108 and 109. Use the equipment recommended in Table 3. If proper facilities are not available or if difficulty is encountered, contact Keithley Instruments, Inc., or its representative to arrange for factory calibration.

b. Three calibrations are in the procedures: low-frequency calibration, high-frequency wideband calibration and pulse calibration. In addition, paragraph 5-6 outlines test procedures to check response.

c. If the instrument is not within specifications after the calibration, follow the troubleshooting procedures or contact Keithley Instruments, Inc., or its representative.

Instrument	Use
General Radio GR-874 type attenuators, 3 db, 6 db, 10 db and 20 db	High frequency calibration
General Radio GR-874-WM50 50-ohm termination (also found in Keithley Instruments Model 1042 Accessory Kit)	Amplifier termination
Hewlett-Packard Model 202A Audio Oscillator, 20 cps to 40 kc, $\pm 2\%$	Signal generator for low-frequency calibration
Jarrold Electronics Model 900-B Sweep Signal Generator (includes Model D50 Detector), 500 kc to 1200 Mc	Signal generator for Model 108 band response
Keithley Instruments Model 121 True RMS Voltmeter	Measure ac voltages
Tee and adapters (found in Keithley Instruments Model 1042 Accessory Kit)	Hook up calibration circuits
Tektronix Type 111 Pulse Generator, 0.5-nsec rise time, 2 to 20-nsec pulse duration	Check Model 109 pulse response
Tektronix Type 504 Oscilloscope, passband from dc to 450 kc	Check wave form during tuning and view sweep display of Model 108
Tektronix Type 561A Oscilloscope, with dual trace plug-in sampling units, 0.4-nsec rise time	View Model 109 pulse response

TABLE 3. Equipment Recommended for Models 108 and 109 Calibration. Use these instruments or their equivalents.

5-2. CALIBRATION SCHEDULE. Check the Amplifier response yearly or when transistors are changed. Refer to paragraph 5-4 (Model 108) or 5-5 (Model 109) for procedures; recalibrate completely if the response is not correct. Always recalibrate the high-frequency gain if the low-frequency gain is adjusted.

5-3. MODELS 108, 109 LOW-FREQUENCY CALIBRATION

a. Remove the Amplifier cover by removing the four screws. Connect the Amplifier to the Model 1081 Power Supply.

Control	Circuit Desig.	Fig. Ref.	Refer to Paragraph
High Frequency	C103	14	5-4 (108) 5-5 (109)
	C112	14	
	C115	14	
	C118	12	
Low Frequency	R111	14	5-3

TABLE 4. Models 108, 109 Internal Controls. The Table lists all internal controls, the figure picturing the location, and the paragraph describing the adjustment.

b. Connect the Model 202A Oscillator to the Amplifier INPUT. Adjust the oscillator signal for 50 millivolts rms at 10 kc. Connect the Model 121 Voltmeter, Type 504 Oscilloscope and 50-ohm termination to the Amplifier OUTPUT. The output signal should be 500 millivolts rms ±10 millivolts. Adjust potentiometer R111 (Figure 14), if necessary, for this output.

c. Monitor the output signal on the oscilloscope and check for distortion.

NOTE

The low-frequency calibration establishes the base for the high-frequency response. Therefore, tune the Amplifier at the high frequencies after tuning it at the low frequencies.

5-4. MODEL 108 HIGH-FREQUENCY CALIBRATION.

a. Remove the Amplifier by removing the four screws. Connect the Amplifier to the Model 1081 Power Supply. Connect the Model 900-B Sweep Generator to the Amplifier INPUT directly. See Figure 7. Connect the Amplifier OUTPUT to the Model D50 Detector.

b. Adjust the generator signal to 50 millivolts rms and center the frequency at 100 megacycles. Adjust the oscilloscope for a vertical display of 5%/cm.

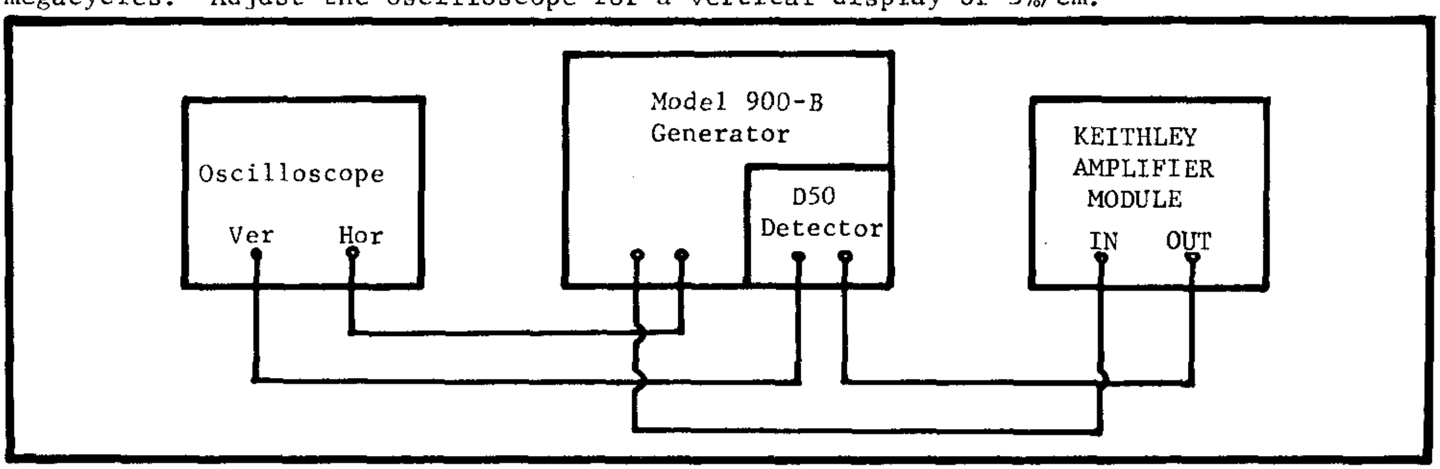


FIGURE 7. Block Diagram for Model 108 High-Frequency Calibration. Refer to Table 3 for equipment.

NOTE

Use only an insulated alignment tool in adjusting the trimmers. Dc biases are present across trimmer C118, and a screwdriver would short out the biases and possibly damage transistor Q102.

c. The low-frequency gain should be previously set (paragraph 5-3). Set trimmers C103, C112 and C115 (Figure 14) to their minimum values. Set trimmer C118 (Figure 12) to minimum by noting when the lowest high-frequency response curve appears on the oscilloscope. Set trimmer C115 to approximately 1/3 of maximum to keep the Amplifier from oscillating into an open circuit at high frequencies. Set trimmer C103 near its maximum. Set trimmer C112 to approximately 1/2 maximum. The response should rise at about 50 to 100 Mc.

d. Increase trimmer C118, watching the response curve on the oscilloscope. When the response looks like a straight line — either rising or descending — stop adjusting C118. Adjust trimmer C112 to bring the high end up or down to the proper gain level. If the mid-range gain (between 50 and 100 Mc) is not flat, alternate adjusting trimmers C103 and C118 until the response is flat. If necessary, re-adjust trimmer C112 to bring the high end in perfectly. Response should be flat to at least 150 Mc (refer to Figure 9).

e. Insert a 3-db pad and re-adjust the oscilloscope for a vertical of 5%/cm. Check for a response of 5%. Using the oscilloscope vertical position control, put the display trace on a reference line. Remove the 3-db pad. The 180-megacycle point should be above the previously set reference line.

5-5. MODEL 109 HIGH-FREQUENCY CALIBRATION.

a. Remove the Amplifier cover by removing the four screws. Connect the Amplifier to the Model 1081 Power Supply.

b. Connect the Type 111 Pulse Generator to the Sampling Oscilloscope. Use attenuators (approximately 26 db) to adjust for a 0.7-volt peak pulse on the oscilloscope. Use the delay cable on the pulse generator to adjust the pulse width to approximately 20 nanoseconds. Set the oscilloscope horizontal sweep to 5 nanoseconds/cm and the vertical sensitivity to 200 millivolts/cm. If necessary, use the pretrigger output of the pulse generator to synchronize the oscilloscope. Note the amount of overshoot and the shape on the pulse's leading edge.

NOTE

The Amplifier is being calibrated at maximum output. Do not put in larger pulses than specified. This will cause overshooting and result in an improperly calibrated amplifier.

c. Add a tee (included in the Model 1042 Kit) and 20-db attenuator; connect the pulse generator to the Amplifier INPUT. See Figure 8. Connect the Amplifier OUTPUT to the oscilloscope's other vertical input. Note the oscilloscope has 50-ohm input impedance, which terminates the Amplifier output.

NOTE

Use only an insulated alignment tool to adjust the trimmers. Dc biases are present across trimmer C118, and a screwdriver would short out the biases and possibly damage transistor Q102.

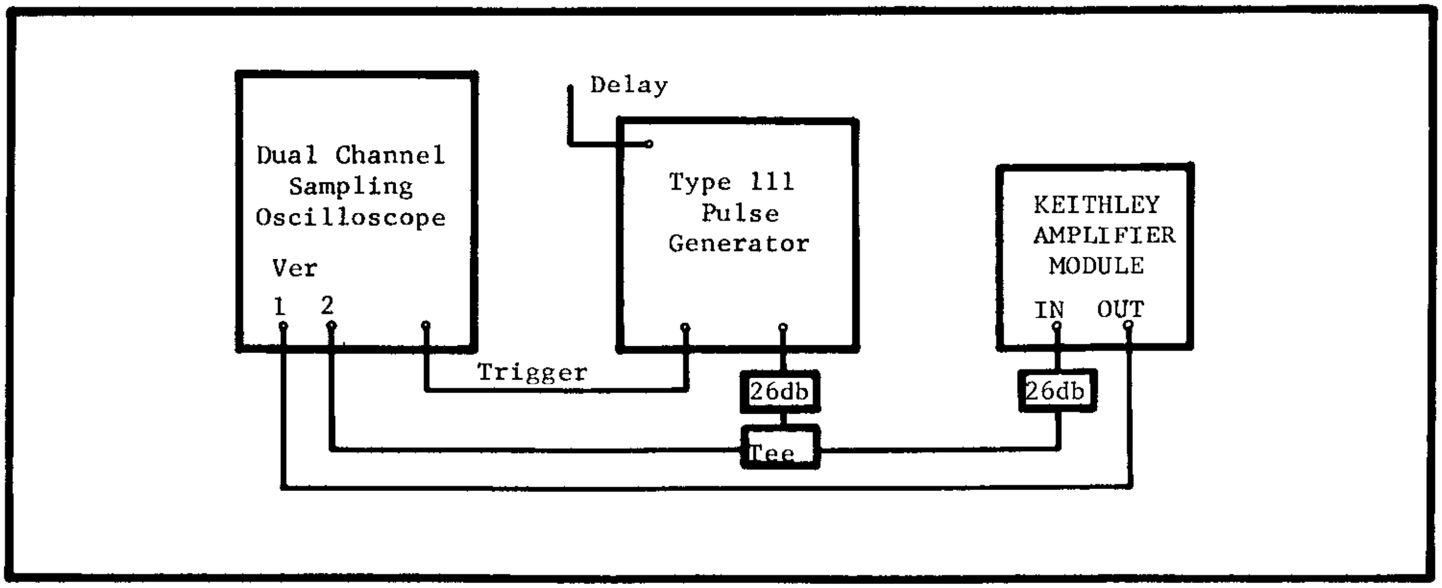


FIGURE 8. Block Diagram for Model 109 High-Frequency Calibration. Refer to Table 3 for equipment.

d. The low-frequency gain should be previously set (paragraph 5-3). Set trimmers C103, C112 and C115 (Figure 14) and C118 (Figure 12) to their minimum values. Set trimmer C115 to approximately 1/3 of its maximum value. Adjust trimmers C103 and C112 so that the output pulse looks exactly like the input pulse (Figure 11). If the input pulse has less than 1% overshoot and ringing, adjust trimmers C103 and C112 for less than 1% overshoot and ringing on the output pulse. Keep trimmer C118 at its minimun value.

e. Increase the oscilloscope sensitivity to 5 millivolts/cm and view the pulse tops. Slight adjustments of trimmer C115 may be necessary to make the output pulse exactly like the input pulse, except for the rise time.

5-6. LOW-FREQUENCY RESPONSE CHECK. Connect the Model 202A Oscillator to the Amplifier INPUT. Adjust the oscillator signal to 50 millivolts rms at 10 kc. Use the Model 121 Voltmeter to monitor the Amplifier output. Terminate the output into 50 ohms. The output voltage at 10 kc should be 500 millivolts rms $\pm 2\%$. Gradually decrease the signal frequency. The output amplitude should not vary more than 5% until 2.5 kc.

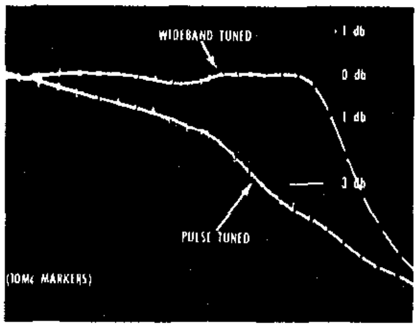


FIGURE 9. Models 108 and 109 Bandwidth Characteristics. The Model 108 is wideband tuned; the Model 109, pulse tuned. The response is from 0 cps (extreme left) to 240 Mc; each pip represents 10 Mc. Display signal of 50 mv rms is from a sweep generator. The excellent flatness of the wideband amplifier is gained at the expense of overshoot and ringing on pulses.

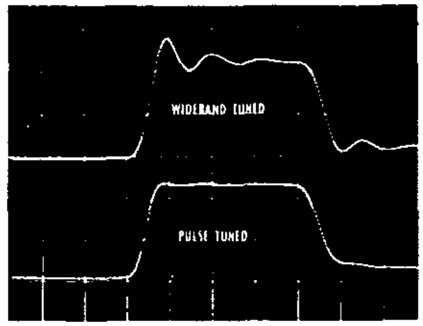


FIGURE 10. Models 108 and 109 Overshoot Characteristics. The Model 108 is wideband tuned; the Model 109, pulse tuned. The oscilloscope is set for 5 nsec/cm horizontal, 0.2 v/cm vertical. The pulse amplifier has minimum pulse distortion at the expense of flatness (see Figure 9).

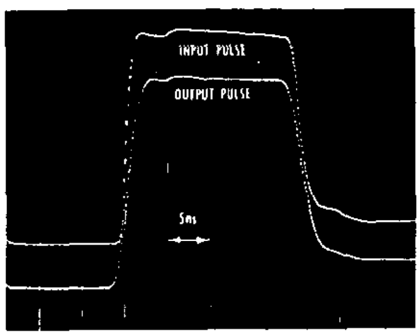


FIGURE 11. Pulse Fidelity of Model 109 Pulse Amplifier. Note how the output pulse follows the input pulse.

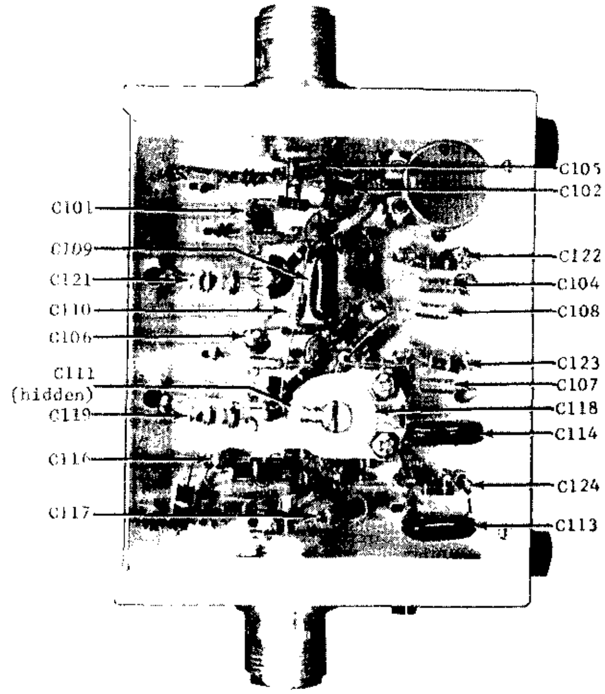


FIGURE 12. Capacitor Locations. The INPUT Receptacle is at the top of the illustration. Both the Models 108 and 109 have the same component locations.

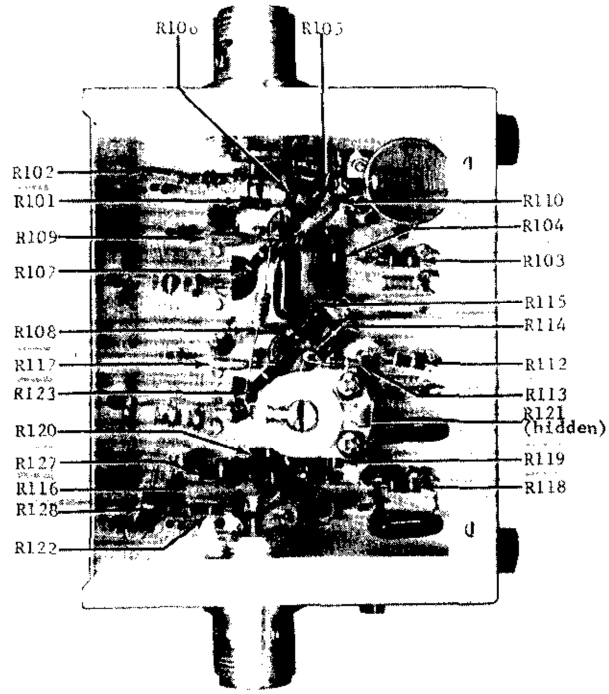


FIGURE 13. Resistor Locations. The INPUT Receptacle is at the top of the illustration. Both the Models 108 and 109 have the same component locations.

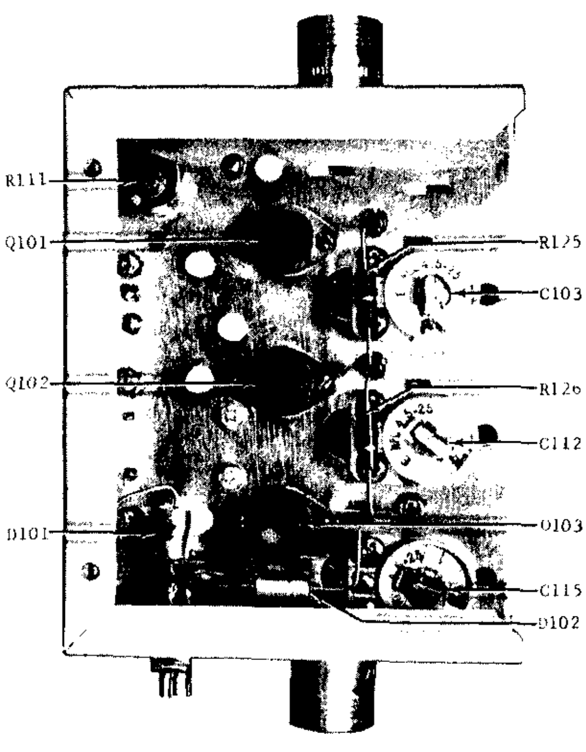


FIGURE 14 (left). Component Locations, Reverse Side. The INPUT Receptacle is at the top of the illustration. Both the Models 108 and 109 have the same component locations.

SECTION 6. ACCESSORIES

6-1. MODEL 1081 POWER SUPPLY.

a. General. The Keithley Model 1081 Power Supply furnishes the power required for one, two or three Models 108 and 109 Amplifiers. No adjustment is necessary. Refer to Section 7 for the Power Supply Replaceable Parts List and Schematic Diagram.

b. Specifications.

Output: As required for 1, 2 or 3 Models 108 and 109 Amplifiers. 28 volts dc floating; $\pm$5% accuracy; 150 milliamperes current; $\pm$0.1% stability; 3-millivolt peak-to-peak maximum ripple.

Power Required: 105-125 or 210-250 volts, 50-400 cps, 12 watts.

Dimensions, Weight: 3 inches high x 2-1/4 inches wide x 3-3/4 inches deep; net weight, 1-1/2 pounds.

Accessories Supplied: Three Power Cables 3 feet long for connecting the Model 1081 to the Model 108 or 109 Amplifier.

c. Operation. Use the Power Cable to connect the Power Supply to the Amplifier. One, two or three Amplifiers can be connected at one time. Connect the Model 1081 to the power line. Snap the front panel slide switch on to turn the instrument on. No warm-up time or adjustment is necessary. For 234-volt power sources, refer to Schematic Diagram 17966C for rewiring the transformer.

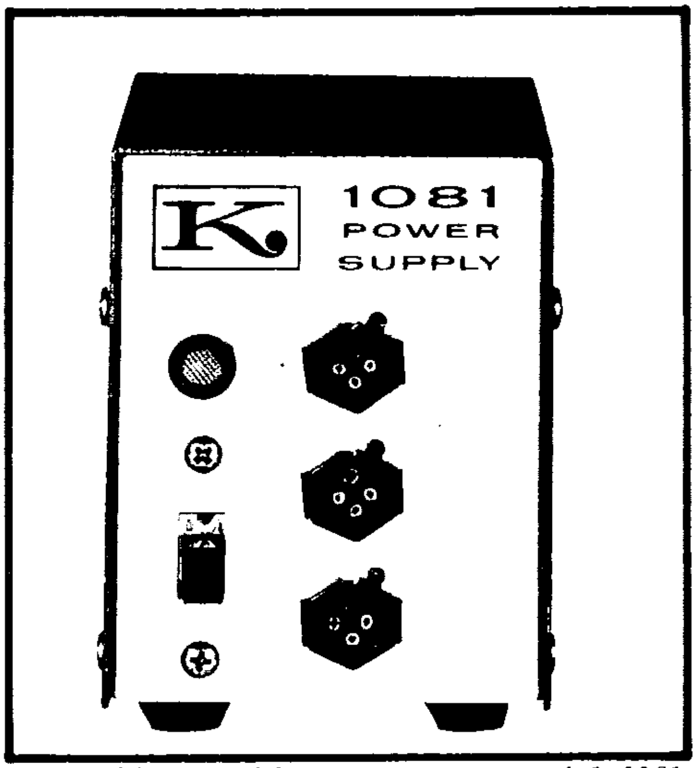


FIGURE 15. Keithley Instruments Model 1081 Power Supply.

d. Circuit. (Refer to Schematic Diagram 17966C.) The Model 1081 is relatively simple for its specifications. Unregulated voltage from the transformer, T1, is rectified by diodes D101 to D104 and filtered by capacitor C101. The voltage is applied to transistor Q1, connected as a series regulator. The output is sampled by resistors R106 and R108 and compared to the voltage across zener reference diode D106. Any voltage difference is amplified by transistors Q2 and Q3, operating as a differential voltage amplifier, and applied to the series regulator. The fuse is in series with the output. If the Power Supply is overloaded, the fuse will blow. Ordinarily, the fuse will not blow, even if Amplifiers are connected or disconnected while the Power Supply is on.

6-2. MODEL 1042 ACCESSORY KIT. The Model 1042 Accessory Kit provides useful adapters, a 50-ohm termination and a tee for use with the Amplifiers. The Kit case is 2 inches high x 12 inches wide x 8 inches deep with polyethylene-foam compartments. It weighs approximately three pounds.

6-3. *MODEL 1082 MOUNTING PLATE. (Refer to Figure 16 for dimensions).*

a. The Model 1082 enables a Model 108, 109 or 1081 to be installed in a system. It provides a mounting surface for O. E. M. applications.

b. *To mount an instrument on the Plate, remove the four feet from the Amplifier or* Power Supply. Attach the Plate to the instrument with the No. 4 flathead screws. Make sure the screw heads are flush with the Plate to avoid interference. The Plate and instrument may be mounted to another surface in any desired position.

Item Fig. 15	Description	Keithley Part No.
1	50-ohm Termination, General Radio Type 874	CS-159
2	Adapter, male n to female uhf	CS-114
3	Adapter, male n to female bnc	CS-116
4	Adapter, male n to male n	CS-158
5	Adapter, male n to General Radio Type 874	CS-109
6	Adapter, n-type tee	CS-157
7	Adapter, male n to General Radio Type 874	CS-109
8	Adapter, male n to male n	CS-158
9	Adapter, male n to female bnc	CS-116
10	Adapter, male n to female uhf	CS-114

TABLE 5. *Contents of Model 1042 Accessory Kit.*

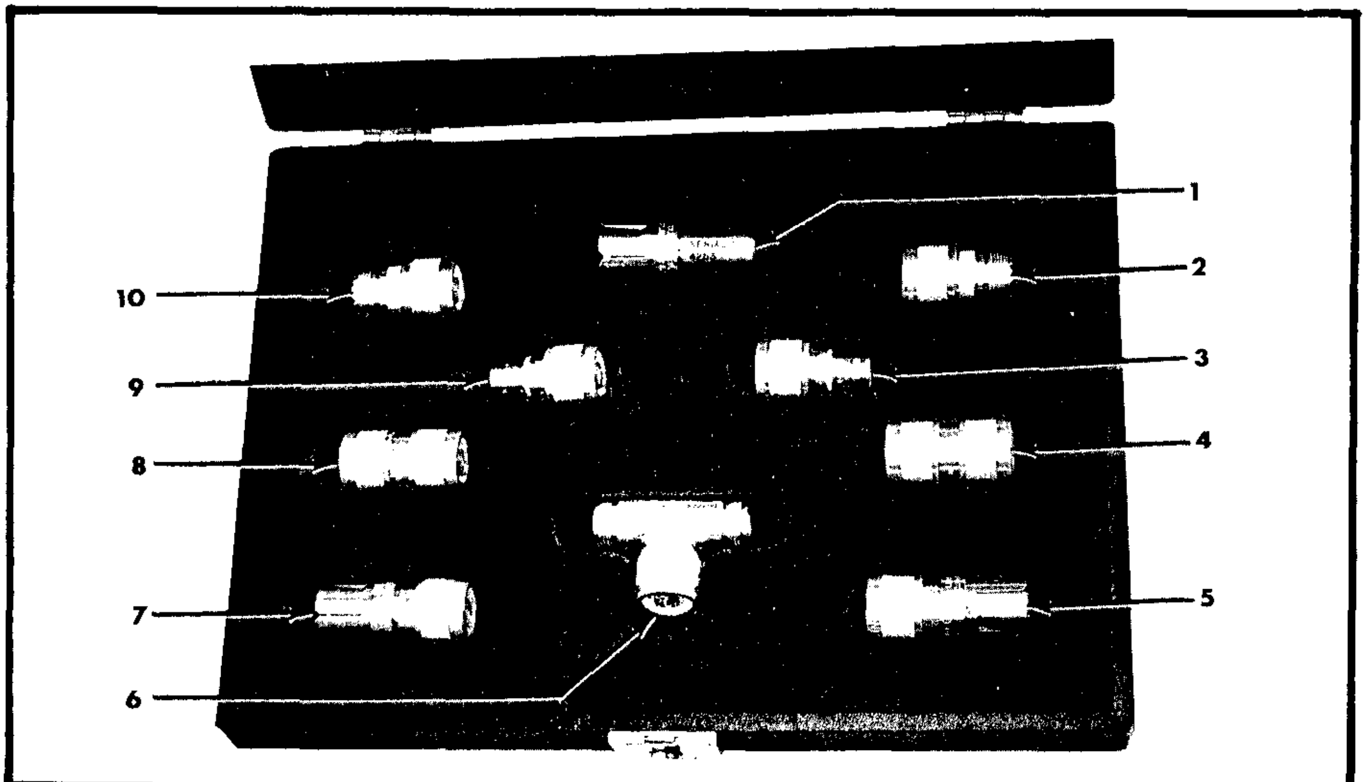


FIGURE 15. Model 1042 Accessory Kit. See Table 5 for contents.

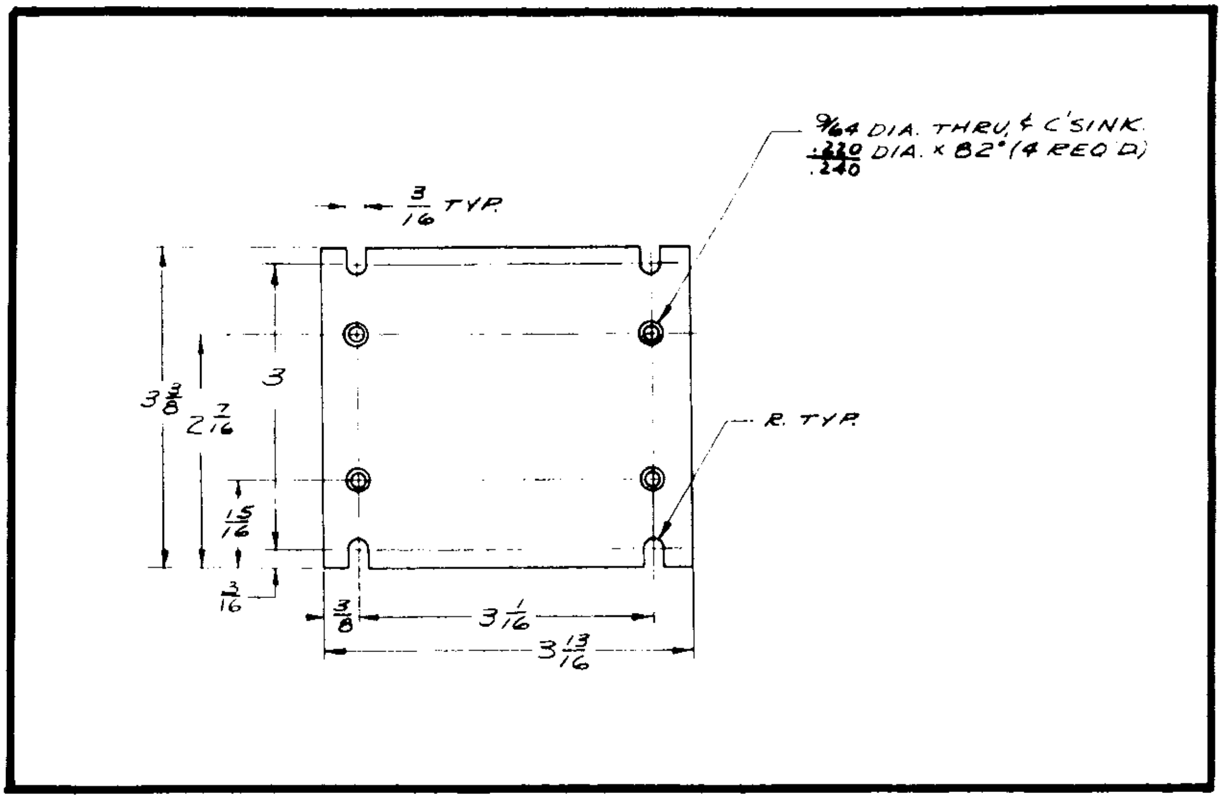


FIGURE 16. Dimensions of the Model 1082 Mounting Plate.

SECTION 7. REPLACEABLE PARTS

7-1. REPLACEABLE PARTS LIST. The Replaceable Parts List describes the components of the Models 108 and 109 Amplifiers and the Model 1081 Power Supply. Both Amplifiers use the same components. The List gives the circuit designation, the part description, a suggested manufacturer, the manufacturer's part number and the Keithley Part Number. The last column indicates the figure picturing the part. The name and address of the manufacturers listed in the "Mfg. Code" column are in Table 7.

7-2. HOW TO ORDER PARTS.

a. For parts orders, include the instrument's model and serial number, the Keithley Part Number, the circuit designation and a description of the part. All structural parts and those parts coded for Keithley manufacture (80164) must be ordered from Keithley Instruments, Inc., or its representive. In ordering a part not listed in the Replaceable Parts List, completely describe the part, its function and its location.

b. Order parts through your nearest Keithley representative or Sales Service Department, Keithley Instruments, Inc.

amp	ampere	M or meg	mega (10^6) or megohms
		m	milli (10^{-3})
CerT	Ceramic, Tubular	Mfg.	Manufacturer
CerTr	Ceramic Trimmer	Mil. No.	Military Type Number
Comp	Composition	MtF	Metal Film
CompV	Composition Variable	My	Mylar
DCb	Deposited Carbon	Ω	ohms
ETB	Electrolytic, Tubular	p	pico (10^{-12})
ETT	Electrolytic, Tantalum		
		Ref.	Reference
f	farad		
Fig.	Figure	μ	micro (10^{-6})
FT	Feed Through		
		v	volt
k	kilo (10^3)	Var	Variable
		w	watt

TABLE 6. Abbreviations and Symbols.

MODELS 108, 109 REPLACEABLE PARTS LIST
(Refer to Schematic Diagram 17971D for circuit designations.)

CAPACITORS

Circuit Desig.	Value	Rating	Type	Mfg. Code	Mfg. Part No.	Keithley Part No.	Fig. Ref.
C101	500 pf	500 v	FT	71590	MFT500	C15-500P	12
C102	1.2 μf	20 v	ETT	05397	K1R2J20K	C80-1.2M	12
C103	4.5-25 pf	500 v	CerTr	71590	822AZ	C76-4.5/25P	14
C104	1.2 μf	20 v	ETT	05397	K1R2J20K	C80-1.2M	12
C105	1.2 μf	20 v	ETT	05397	K1R2J20K	C80-1.2M	12
C106	500 pf	500 v	FT	71590	MFT500	C15-500P	12
C107	1.2 μf	20 v	ETT	05397	K1R2J20K	C80-1.2M	12
C108	1.2 μf	20 v	ETT	05397	K1R2J20K	C80-1.2M	12
C109	0.1 μf	50 v	My	84411	601PE	C41-0.1M	12
C110	1.2 μf	20 v	ETT	05397	K1R2J20K	C80-1.2M	12
C111	1.2 μf	20 v	ETT	05397	K1R2J20K	C80-1.2M	12
C112	4.5-25 pf	500 v	CerTr	71590	822AZ	C76-4.5/25P	14
C113	0.1 μf	50 v	My	84411	601PE	C41-0.1M	12
C114	0.1 μf	50 v	My	84411	601PE	C41-0.1M	12
C115	4.5-25 pf	500 v	CerTr	71590	822AZ	C76-4.5/25P	14
C116	500 pf	500 v	FT	71590	MFT500	C15-500P	12
C117	4.7 μf	20 v	ETT	05397	K4R7J20K	C80-4.7M	12
C118	1.5-3 pf	500 v	CerTr	71590	822DZ	C76-1.5/3P	12
C119	10 pf	600 v	CerT	71590	TCZ	C77-10P	12
C120	10 pf	600 v	CerT	71590	TCZ	C77-10P	
C121	10 pf	600 v	CerT	71590	TCZ	C77-10P	12
C122	500 pf	500 v	FT	71590	MFT500	C15-500P	12
C123	500 pf	500 v	FT	71590	MFT500	C15-500P	12
C124	500 pf	500 v	FT	71590	MFT500	C15-500P	12

DIODES

Circuit Desig.	Type	Number	Mfg. Code	Keithley Part No.	Fig. Ref.
D101	Silicon	1N3253	02735	RF-20	14
D102	Silicon	1N3253	02735	RF-20	14

CONNECTORS

Circuit Desig.	Description	Mfg. Code	Keithley Part No.	Fig. Ref.
J101	Receptacle, n, INPUT, Mil. No. UG-680/U (Mfg. No. 82-811)	02660	CS-95	
J102	Receptacle, n, OUTPUT, Mil. No. UG-680/U (Mfg. No. 82-811)	02660	CS-95	

CONNECTORS (Cont'd)

Circuit Desig.	Description	Mfg. Code	Keithley Part No.	Fig. Ref.
----	(F) Plug, n, Mate of J101 and J102, Mil. No. UG-536/U (Mfg. No. 309-34000)	02660	CS-96	
J103	Receptacle, POWER			
	. Locking Ring (Mfg. No. 126-1430)	02660	CS-165	
	. Receptacle (Mfg. No. 126-1429)	02660	CS-163	
	. Body (Mfg. No. 126-1425)	02660	CS-163	
----	(F) Plug, Mate of J103 (Mfg. No. 126-1427)	02660	CS-162	

RESISTORS

Circuit Desig.	Value	Rating	Type	Mfg. Code	Mfg. Part No.	Keithley Part No.	Fig. Ref.
R101	47 kΩ	10%, 1/4 w	Comp	44655	RC07	R76-47K	13
R102	50 Ω	1%, 1/8 w	MtF	07716	CEA	R88-49.9	13
R103	47 Ω	10%, 1/4 w	Comp	44655	RC07	R76-47	13
R104	470 Ω	10%, 1/4 w	Comp	01121	CB	R76-470	13
R105	2.2 kΩ	10%, 1/4 w	Comp	44655	RC07	R76-2.2K	13
R106	2.2 kΩ	10%, 1/4 w	Comp	44655	RC07	R76-2.2K	13
R107	47 Ω	10%, 1/4 w	Comp	44655	RC07	R76-47	13
R108	47 kΩ	10%, 1/4 w	Comp	44655	RC07	R76-47K	13
R109	60.4 Ω	1%, 1/8 w	MtF	07716	CEA	R88-60.4	13
R110	100 Ω	1%, 1/8 w	MtF	07716	CEA	R88-100	13
R111	1 kΩ	20%, .2 w	CompV	71450	70	RP31-1K	14
R112	47 Ω	10%, 1/4 w	Comp	44655	RC07	R76-47	13
R113	470 Ω	10%, 1/4 w	Comp	01121	CB	R76-470	13
R114	2.2 kΩ	10%, 1/4 w	Comp	44655	RC07	R76-2.2K	13
R115	2.2 kΩ	10%, 1/4 w	Comp	44655	RC07	R76-2.2K	13
R116	1 kΩ	1%, 1/8 w	MtF	07716	CEA	R88-1K	13
R117	50 Ω	1%, 1/8 w	MtF	07716	CEA	R88-49.9	13
R118	47 Ω	10%, 1/4 w	Comp	44655	RC07	R76-47	13
R119	5.6 kΩ	10%, 1/4 w	Comp	01121	CB	R76-5.6K	13
R120	4.7 kΩ	10%, 1/4 w	Comp	01121	CB	R76-4.7K	13
R121	681 Ω	1%, 1 w	MtF	07716	CEC	R94-681	13
R122	1 kΩ	10%, 1/4 w	Comp	44655	RC07	R76-1K	13
R123	10 Ω	10%, 1/4 w	Comp	01121	CB	R76-10	13
R124	Not Used						
R125	10 Ω	10%, 1/2 w	Comp	01121	EB	R1-10	14
R126	10	10%, 1/2 w	Comp	01121	EB	R1-10	14
R127	560	10%, 1 w	Comp	01121	GB	R2-560	13
R128	1 kΩ	10%, 1 w	Comp	01121	GB	R2-1K	13

(F) Furnished accessory.

TRANSISTORS

Circuit Desig.	Number	Mfg. Code	Keithley Part No.	Fig. Ref.
Q101 (108)	SM492-1	80164	TG-17-5	14
Q101 (109)	SM492-1	80164	TG-17-3	14
Q102	SM492-1	80164	TG-17-3	14
Q103 (108)	SM492-1	80164	TG-17-6	14
Q103 (109)	SM492-1	80164	TG-17-3	14

MODEL 1081 REPLACEABLE PARTS LIST
(Refer to Schematic Diagram 17966C for circuit designations.)

CAPACITORS

Circuit Desig.	Value	Rating	Type	Mfg. Code	Mfg. Part No.	Keithley Part No.	Fig. Ref.
C101	75 μf	100 v	ETB	56289	TE14	C60-75M	
C102	75 μf	100 v	ETB	56289	TE14	C60-75M	
C103	0.1 μf	50 v	My	84411	601PE	C41-0.1M	
C104	2.2 μf	20 v	ETT	05397	K2R2J20K	C80-2.2M	
C105	10 μf	35 v	ETT	05397	K10J35KS	C81-10M	
C106	100 μf	25 v	ETT	05079	W100-25C2U1	C96-100M	
C107	100 μf	25 v	ETT	05079	W100-25C2U1	C96-100M	

DIODES

Circuit Desig.	Type	Number	Mfg. Code	Keithley Part No.	Fig. Ref.
D101	Silicon	1N3253	02735	RF-20	
D102	Silicon	1N3253	02735	RF-20	
D103	Silicon	1N3253	02735	RF-20	
D104	Silicon	1N3253	02735	RF-20	
D105	Zener	1N709	12954	DZ-21	
D106	Zener	1N935	04713	DZ-7	

MISCELLANEOUS PARTS

Circuit Desig.	Description	Mfg. Code	Keithley Part No.	Fig. Ref.
DS1	Neon Pilot Lamp (Mfg. No. 2190)	91802	PL-28	
F1 (117 v) F1 (234 v)	Fuse, quick acting, .2 amp, 8 AG (Mfg. No. 361.200)	75915	FU-24	
——	Fuse Holder (Mfg. No. 372001)	75915	FH-8	
J101, J102, J103	Socket	80164	CS-135	

MISCELLANEOUS PARTS (Con't)

Circuit Desig.		Description	Mfg. Code	Keithley Part No.	Fig. Ref.
---	(F)	Cables for J101	80164	18477B	
P1		Cord Set, 6 feet (Mfg. No. 4638-13)	93656	CO-5	
---		Cable Clamp (Mfg. No. SR-5P-1)	28520	CC-4	
S1		Slide Switch, Power (Mfg. No. G326)	79727	SW-45	
T1		Transformer	80164	TR-84	

(F) Furnished Accessory

RESISTORS

Circuit Desig.	Value	Rating	Type	Mfg. Code	Mfg. Part No.	Keithley Part No.	Fig. Ref.
R101	47 kΩ	10%, 1/2 w	Comp	01121	EB	R1-47K	
R102	1.5 kΩ	10%, 1/2 w	Comp	01121	EB	R1-1.5K	
R103	15 Ω	.1%, 1/4 w	WW	01686	7009	R96-15	
R104	3.3 kΩ	10%, 1/2 w	Comp	01121	EB	R1-3.3K	
R105	2.2 kΩ	10%, 1/2 w	Comp	01121	EB	R1-2.2K	
R106	2.2 kΩ	1%, 1/2 w	DCb	79727	CFE-15	R12-2.2K	
R107	33 kΩ	10%, 1/2 w	Comp	01121	EB	R1-33K	
R108	1 kΩ	1%, 1/2 w	DCb	79727	CFE-15	R12-1K	
R109	47 kΩ	10%, 1/2 w	Comp	01121	EB	R76-47K	

TRANSISTORS

Circuit Desig.	Number	Mfg. Code	Keithley Part No.	Fig. Ref.
Q1	2N1183A	02735	TG-31	
Q2	2N1377	01295	TG-30	
Q3	2N1381	01295	TG-8	

MODEL 1083 REPLACEABLE PARTS LIST

Description	Keithley Part No.
Modified Connector, 2 required	18493A
Connector, Body	CS-191
4 Pin Male Receptacle, mate of CS-163	CS-162
4 Pin Female Receptacle, mate of CS-162	CS-163

MODEL 1083 REPLACEABLE PARTS LIST (con't)

Description	Keithley Part No.
Locking Ring, 2 required	CS-165
Shielded Cable	SC-25

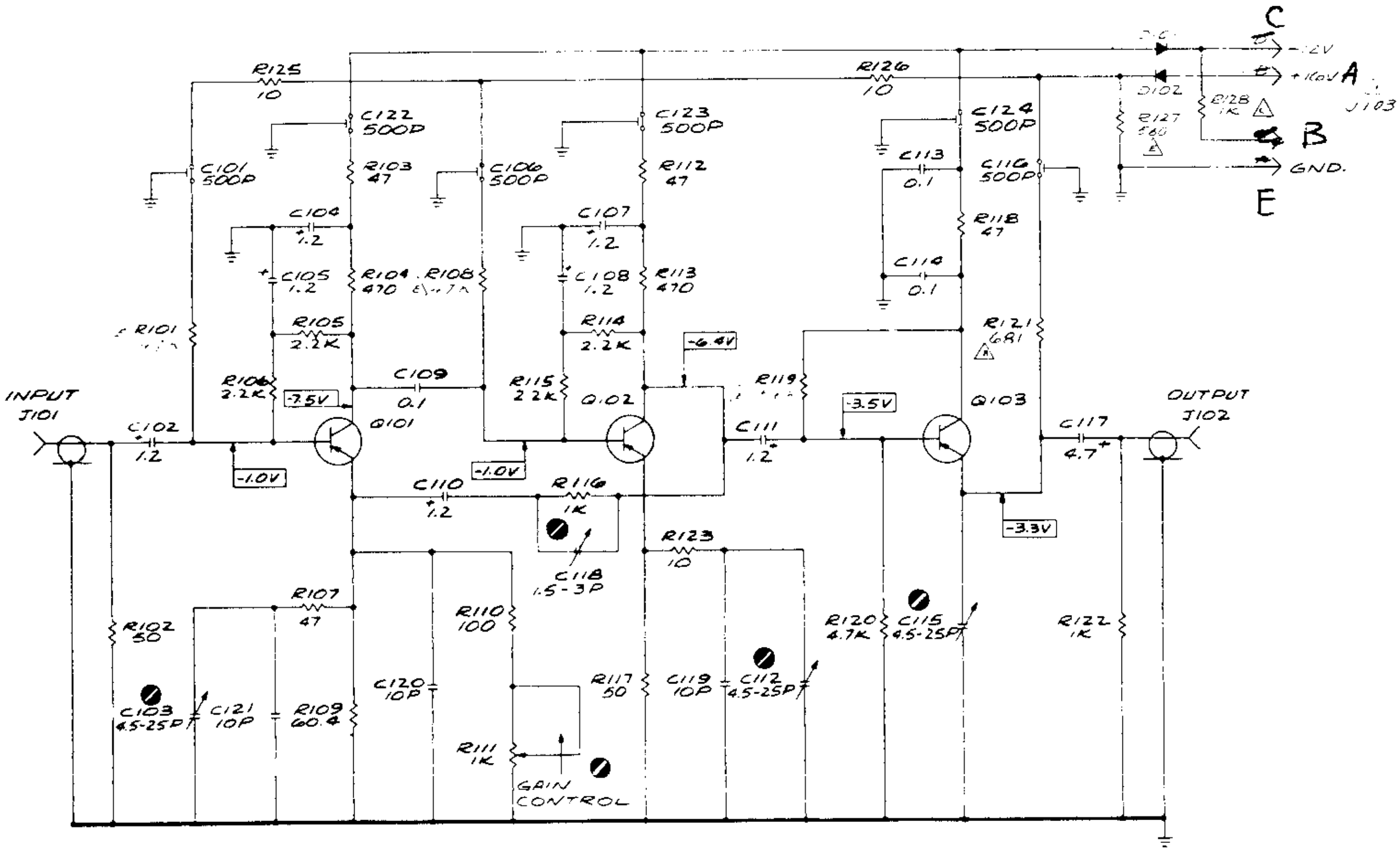
01121	Allen-Bradley Corp. Milwaukee, Wis.	28520	Heyman Mfg. Co. Kenilworth, N. J.
01295	Texas Instruments, Inc. Semiconductor-Components Division Dallas, Texas	44655	Ohmite Mfg. Co. Skokie, Ill.
01686	RCL Electronics, Inc. Riverside, N. J.	56289	Sprague Electric Co. North Adams, Mass.
02660	Amphenol-Borg Electronics Corp. Broadview, Chicago, Illinois	71450	CTS Corp. Elkhart, Ind.
02735	Radio Corp. of America Commerical Receiving Tube and Semiconductor Division Somerville, N. J.	71590	Centralab Division of Globe-Union, Inc. Milwaukee, Wis.
04713	Motorola, Inc. Semiconductor Products Division Phoenix, Arizona	72982	Erie Technological Products, Inc. Erie, Pa.
05397	Union Carbide Corp. Linde Division Kemet Dept. Cleveland, Ohio	75915	Littelfuse, Inc. Des Plaines, Ill.
07716	International Resistance Co. Burlington, Iowa	79727	Continental-Wirt Electronics Corp. Philadelphia, Pa.
12954	Dickson Electronics Corp. Scottsdale, Ariz.	80164	Keithley Instruments, Inc. Cleveland, Ohio
14655	Cornell-Dubilier Electric Corp. Newark, N. J.	84411	Good-All Electric Mfg. Co. Ogallala, Nebr.
		91802	Industrial Devices, Inc. Edgewater, N. J.
		93656	Electric Cord Co. Caldwell, N. J.

TABLE 7. Code List of Suggested Manufacturers. (Based on Federal Supply Code for Manufacturers, Cataloging Handbook H4-1.)

Page 25 Change to the following:

Account Desig.	Description		
[illegible]	[illegible]		
	Landing [illegible]	[illegible]	
	Reception [illegible]	[illegible]	
	Body [illegible] Bldg [illegible]	[illegible]	
	(2) Bldg [illegible] Bldg [illegible]	[illegible]	

[illegible]



NOTE:

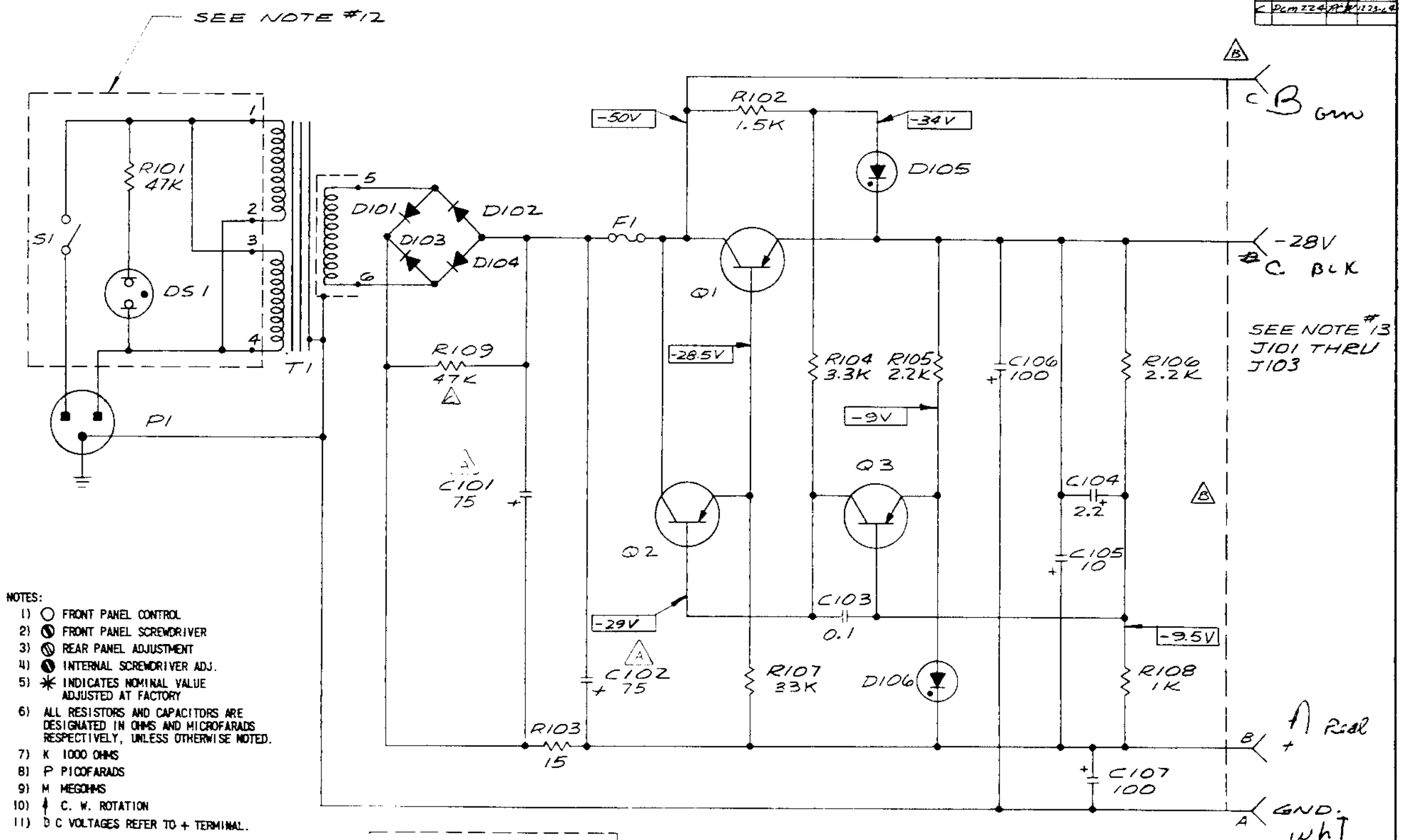
1) ALL RESISTANCE AND CAPACITANCE SHALL BE DESIGNATED IN OHMS AND MICROFARADS RESPECTIVELY, UNLESS OTHERWISE NOTED.
2) ○ FRONT PANEL CONTROL
3) FRONT PANEL SCREWDRIVER ADJ
4) REAR PANEL SCREWDRIVER ADJ.
5) ● INTERNAL SCREWDRIVER ADJ.
6) ↗ = C. W. ROTATION M = MEGOHMS
7) P = PICOFARADS K = 1000 OHMS
8) ✱ INDICATES NOMINAL VALUE ADJUSTED AT FACTORY

KEITHLEY INSTRUMENTS

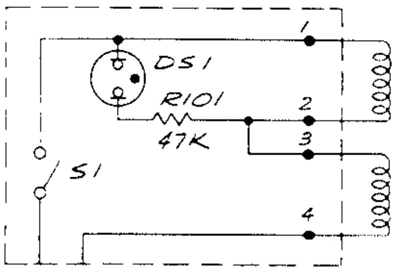
SCHEMATIC, AMPLIFIER

17971D

REVISIONS			
LTR	ECO No.	APPR.	DATE
A	PCM 11R	[illegible]	11-6-64
B	PCM 216	[illegible]	11-16-64
C	PCM 224	[illegible]	1-23-64



NOTES:
1) ○ FRONT PANEL CONTROL
2) FRONT PANEL SCREWDRIVER
3) REAR PANEL ADJUSTMENT
4) INTERNAL SCREWDRIVER ADJ.
5) ✳ INDICATES NOMINAL VALUE ADJUSTED AT FACTORY
6) ALL RESISTORS AND CAPACITORS ARE DESIGNATED IN OHMS AND MICROFARADS RESPECTIVELY, UNLESS OTHERWISE NOTED.
7) K 1000 OHMS
8) P PICOFARADS
9) M MEGOHMS
10) C. W. ROTATION
11) D C VOLTAGES REFER TO + TERMINAL.
12) 117V CONNECTION IS SHOWN ABOVE-SEE BELOW FOR 234V CONNECTION.
13) NOTE 3 IDENTICAL OUTPUT CONNECTORS ARE USED- J101, J102, J103.



234V CONNECTION

Q3	F1					
R109	C107	D106	DS1	S1	T1	P1

HIGHEST REF DESIGNATION USED | REF. DESIGNATION NOT USED

DIMENSIONAL TOLERANCES UNLESS OTHERWISE SPECIFIED

FRAC	DEC	ANG
± 1/64	± .005	± 1°

DO NOT SCALE

DRN M.E. DATE 7-8-64

KEITHLEY INSTRUMENTS CLEVELAND OHIO

TITLE SCHEMATIC, POWER SUPPLY

MODEL 1081 | NEXT ASSEMBLY | QUAN 1

USED ON

PART NUMBER 17966C