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Model K2-W*
Operational Amplifier

OPERATIONAL SYMBOL

APPLICATIONS

In general terms, the field of application of the K2-W is in measurements and active transformations in the range from d-c to over 100 kc. It is primarily intended for use in feedback operations, fidelity of output depending upon the choice of external circuit components and arrangements.

The K2-W is especially useful for the construction of electronic analog computer circuits, such as the GAP/R Analog Components, and for the assembly of operating control circuitry. With appropriate external circuitry, it will readily perform such feedback operations as addition, subtraction, integration, differentiation, multiplication, division, inversion, impedance-conversion, and the injection of current.

A few typical examples of fundamental applications are illustrated in figure 2.
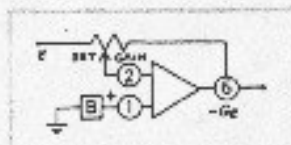
WIDE-RANGE AMPLIFIER
The usual feedback and feed-forward resistors are here embodied in a single potentiometer. A voltage gain of minus one is given by the central setting.
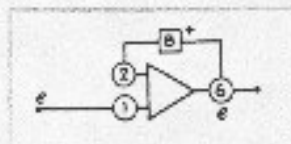
VOLTAGE REPRODUCER
This exceedingly simple arrangement supplies the need for a "follower" without attenuation or distortion, and with an output impedance well below one ohm.
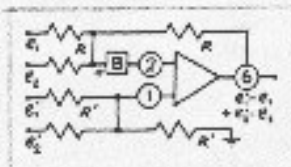
ADDER-SUBTRACTOR
A number of simpler and possibly more familiar circuits are special cases of this one. By using unequal resistors, a more general form of linear combination is made possible.
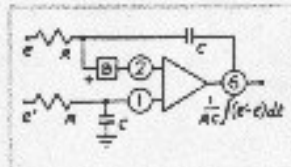
SUBTRACTING INTEGRATOR
A positive or negative integral may be obtained by grounding one input. Unless an integrator is in a stable loop it must be subjected to some sort of "clamping".
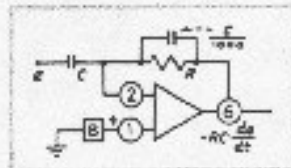
STABLE DIFFERENTIATOR
The smaller shunt capacitor will prevent ringing or sinning, and introduces very little error. In certain difficult cases one might also add a small resistor in series with the input capacitor.

ABSOLUTE-VALUE CIRCUIT
Reversing both diodes will reverse the sign of the output. To the a-c power engineer this is simply a "full wave rectifier", but as a computing device it is useful in a much wider sense.

Figure 2. Typical Applications of the K2-W Operational Amplifier

The values of the various resistance and capacitance elements shown in the above connections may be selected over an extremely wide range. It is suggested that resistors be kept between 50 K and 2 megohms. As for capacitance, a realistic range would be from 100 µµf to 10 µf.

ELECTRICAL CHARACTERISTICS

Gain:
15,000 dc open loop
Response:
½ µsec rise time with bandwidth over 300kc when used as an inverter under ideal circuit conditions
Drift Rate:
±5 mv per day referred to the input
Differential Input Levels:
Voltage (Inputs together):
−50 to +50 volts
Current:
Either input less than 10⁻⁴ amp.
(Insulation leakage and grid current)
Impedance (either input):
Above 100 M (open grid)
Capacitance (Pin 1 grid):
7 µµf
Bias Required for Balance:
Adjustable from 1.0 to 2.0 volts between Pin 1 and 2 (Pin 1 positive with respect to Pin 2).

Output Capabilities:

Output Current (Steady State)

Output Voltage	Design Center	Min.
+50V	+2.0 ma	+1.0 ma
0V	+1.8 ma	
	−2.4 ma	
−50V	−1.8 ma	−1.0 ma

Impedance:
Open loop — below 1K

Max. Power Required (worst case):

Load	Supply Voltage vdc	Output +50V ma	Output −50V ma
No load	+300	+5.4	+4.1
	−300	−4.7	−3.8
Full load (50K)	+300	+6.4	+3.1
	−300	−4.7	−3.8
	6.3*	0.6	0.6

*6.3 vac or vdc amp amp
Typical: Max. rate of output
Swing: ±12V per µsec.

GENERAL CHARACTERISTICS

Temperature:
Max. allowable case temp. (hot spot) +65°C(149°F)
Tube Complement:
2 12AX7A or 7025
Casing:
Molded plastic, sealed unit
Base:
Octal Plug

Dimensions: (Above socket)
1³³⁄₆₄" x 2⁵⁄₆₄" x 4⁹⁄₆₄" h (max)
Weight:
Installed: 3.0 oz.
Packed: 5.6 oz.

GENERAL DESCRIPTION

The Model K2-W Operational Amplifier is a high gain plug-in unit designed and constructed for use as a basic subassembly. With these units, feedback computing devices of all speeds can be assembled with a minimum of external circuitry. A schematic diagram of the K2-W is shown in figure 4.

The K2-W features balanced differential inputs for low drift, high input impedance, low output impedance, high performance, and economy of operation. Its range of operation is from d-c to above 100 kc.

With appropriate feedback connections, the K2-W maintains the two inputs at nearly equal potentials. The residual offset can readily be biased out. (See BIASING METHODS.)
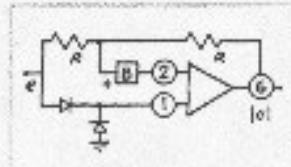
* FEDERAL STOCK NOS. 4935-619-8819 AA
6930-893-2549

BIASING METHODS

The box symbol B used in figure 2 denotes some source of dc voltage and its polarity. For most applications, a bias adjustment is necessary and may be applied in any of several ways. Some recommended methods of biasing are illustrated in figure 3.

When using any of these methods, set the potentiometer for zero d-c error under feedback.

When setting the potentiometer, ground the input of the computing network if possible.
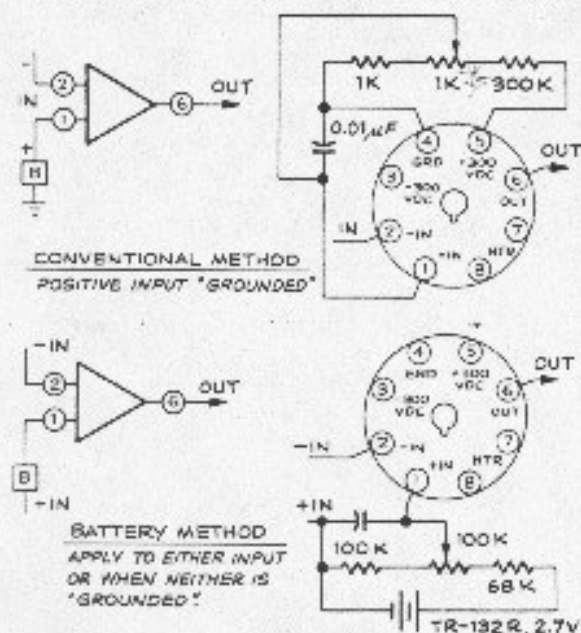

Figure 3. Biasing Methods

CAUTION

Avoid prolonged short-circuiting of the output. The K2-W is designed to tolerate temporary overloads such as output shorted to ground. However, such fault currents, if prolonged, can overheat and thereby shorten the life of K2-W and cause relatively large drifts.

The K2-W and its load may dissipate 8 watts. Unless there is plenty of free air under 30°C (86°F) around the unit, forced ventilation will probably be necessary. The K2-W is not recommended for those applications where either the ventilation is poor or the ambient temperature high. For such applications the MIL. equivalent K2-WJ is recommended.

CAUTION

Do NOT allow the temperature of any part of the case to exceed 65°C (149°F). Avoid severe overloading.

INSTALLATION

Wire the desired external circuitry to an octal socket or GAP/R Manifold. Plug the K2-W into the socket or Manifold. (Information about GAP/R Manifolds is available upon request.)

MAINTENANCE

Preventive Maintenance
1. During operation:
   a. Make sure that tubes are firmly seated.
   b. Make sure that the K2-W is firmly seated.

Trouble Shooting
If trouble in the K2-W is suspected:
1. Check for loose connections, grounds, and/or shorts in the associated circuitry.
2. Check the tubes by substitution.
3. Check the plug-in by substitution.

Corrective Maintenance
1. Replace defective parts.
2. Do NOT open the sealed case.
Opening the case voids the guarantee. The unit should be returned to the factory for repair.
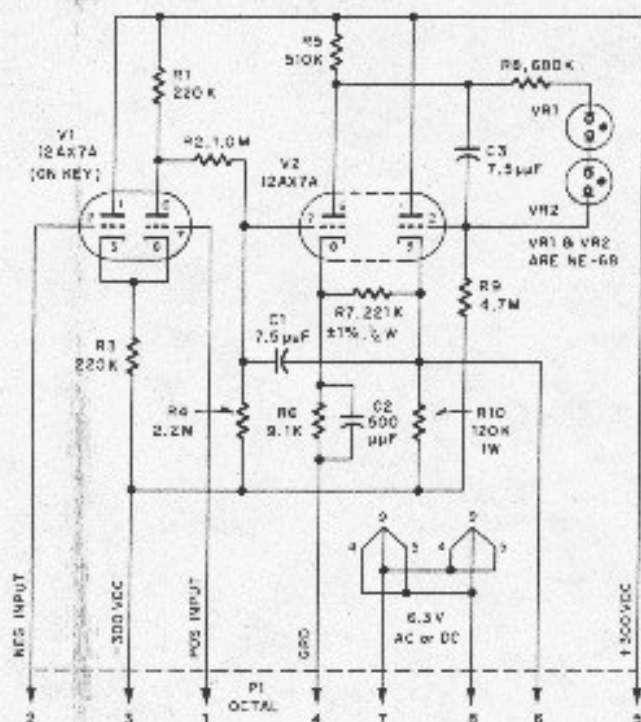
NOTE   UNLESS OTHERWISE STATED RES. ARE ±5%, ½ W

NE 68's contain traces of mildly radioactive material to improve starting characteristics. The resulting radiation is not ordinarily measurable outside the tub.

Figure 4. Schematic Diagram

NOTE: For further information on the utility of Philbrick Plug-ins, refer to the "Applications Manual" available upon request.

NOTE

Operation of tubes for long periods with the cathodes heated and without plate voltage has been known to deactivate the cathodes. Therefore, if equipment is not to be used within a few hours, open the heater circuit.

All K2's made after Nov. 1, 1961 are housed in gray Lexan. The new case can withstand a much higher temperature than the 65°C. recommended max. for the yellow cases. However, longer component life will result, if the case hot-spot temperature can be kept below 45°C. Avoid severe overloading.