Model K2-W Operational Amplifier

Model K2-W is the same operational amplifier, engineered and designed into this compact form, that has proved so successful in the Philbrick Analog Components. Using these plug-in units as basic subassemblies, feedback computing devices of all speeds may be assembled with only the simplest of wiring. The versatile K2-W is already serving in widespread applications. It features balanced differential inputs for minimum drift and maximum utility, and embodies both high performance and economy of operation in one unit.

This type of high gain amplifier, with appropriate feedback connections, maintains the two inputs at a nearly equal potential. Such properties give rise to a large number of operational applications.

Among the many feedback operations which the K2-W will readily perform are: addition, subtraction, integration, differentiation, multiplication, division, inversion, impedance-conversion, and the injection of current.

OPERATIONAL SYMBOL

BASE PIN CONNECTIONS

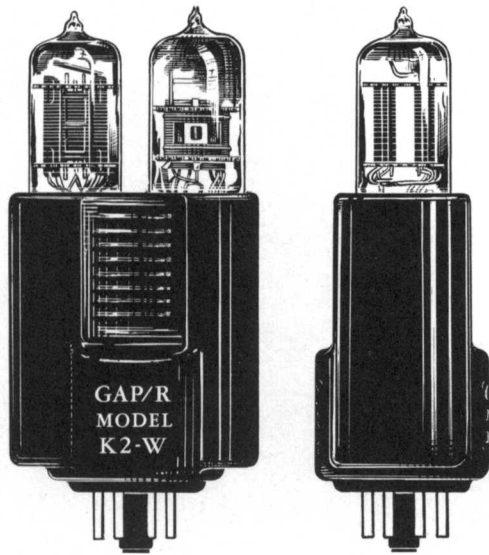|		
1: Pos. Input	4: Ground	7 & 8:
2: Neg. Input	5: Plus 300VDC	Heaters,
3: Minus 300VDC	6: Output	6.3V AC or DC

APPLICATIONS

In general terms, the field of application of the K2-W Amplifier is in measurements and active transformations, in the range from DC to above 100 KC. It is primarily intended for feedback operations, where fidelity is made to depend almost entirely on the external circuit arrangements employed.

There are already more such applications than may readily be presented, and new computing connections are being conjured up every day. The following group of applications is merely typical. The circuits shown have been selected since they are fundamental as well as useful; they should suggest a variety of other forms.
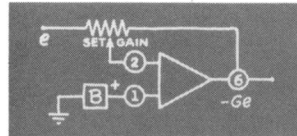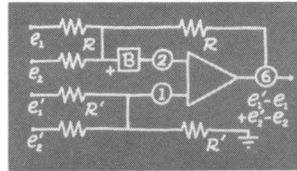
WIDE-RANGE AMPLIFIER
The usual feedback and feedforward resistors are here embodied in a single potentiometer. A voltage gain of minus one is given by the central setting.
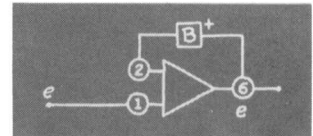
VOLTAGE REPRODUCER
This exceedingly simple arrangement supplies the need for a "follower" without attenuation or distortion, and with an output impedance well below one ohm.

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.
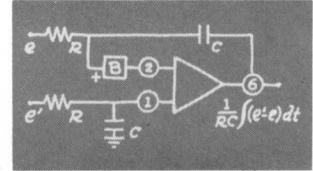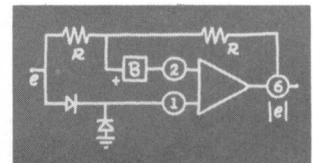
SUBTRACTING INTEGRATOR
A positive or negative integral may be obtained by grounding one input. Unless an integrator is in a stable loop it must be subjected to some sort of "clamping" process.
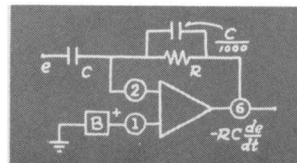
STABLE DIFFERENTIATOR
The smaller shunt capacitor will prevent ringing or singing, and introduces very little error. In certain difficult cases one might also add a small resistor in series with the input capacitor.
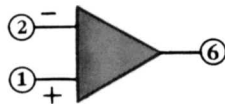
ABSOLUTE-VALUE CIRCUIT
Reversing both diodes will reverse the sign of the output. To the AC Power engineer this is simply a "full wave rectifier", but as a computing device it is useful in a much wider sense.

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 Mmf to 10 Mf.

The box symbol used in the above circuits, marked "B", denotes some source of DC bias. Several recommended methods of applying such bias are shown on the reverse side.

GENERAL SPECIFICATIONS

GAIN:
15,000 DC, open-loop
POWER REQUIREMENTS:
4.5 Milliamps. at +300 VDC
4.5 Milliamps. at −300 VDC
0.6 Amperes at 6.3V
TUBE COMPLEMENT:
2 12AX7
BASING: Octal plug
CASE: Black plastic, molded

INPUT IMPEDANCE:
Above 100 Megohms
OUTPUT IMPEDANCE:
Less than 1 K open-loop; below 1 ohm fully fed back
DRIFT RATE:
5 Millivolts per day, referred to the input
HEIGHT: 4½ Inches overall
WEIGHT: 2.8 ounces

VOLTAGE RANGE:
−50 VDC to +50 VDC, at output and both inputs
INPUT CURRENT:
Less than 0.1 Microamp., for either input
OUTPUT CURRENT:
−1 Milliamp. to +1 Milliamp., driving 50 K load over full voltage range

INPUT BIAS:
Positive input should be made to operate about 1.5 V *high* at balance, normally requiring adjustable external bias
RESPONSE:
2-Microsecond rise time, with band width over 100 KC when used as inverter

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GAP/R MODEL K2-W

IN THE BIASING METHODS SHOWN BELOW, THE POTENTIOMETER IS SET FOR ZERO DC ERROR UNDER FEEDBACK. FOR THIS PURPOSE IT MAY BE ADVISABLE TO GROUND THE INPUT OF THE COMPUTING NETWORK.

Main schematic labels: .22,5% · 1 · 12AX7 · .47 · 12AX7 · 7.5 · .68 · 125v. · 7.5 · .22,5% · 4.7 · .22,5% · .27,5% · .22 5% · 2.2 · 10K · 500

Pin connections:
2 − IN · 7 H 6.3V · 8 H · 1 + IN · 3 −300 VDC · 4 GND (REF) · 6 OUT · 5 +300 VDC

RESISTIVE METHOD OF BIAS
PRINCIPALLY FOR POSITIVE INPUT

10K · 1meg. · .05 · IN 2 · + 1 · B · OUT 6

PRIMARY CELL METHOD
FOR NEGATIVE OR POSITIVE INPUT

IN 2 · B · IN+ 1 · OUT 6 · MALLORY RM1 · 100K · .05

(REVERSE POLARITY IF EMPLOYED IN + INPUT)

GND. · +300vdc · −300 vdc · OUT · NEG. IN · H · POS. IN · H · 6.3v

NOTE THAT FOR MANY APPLICATIONS A BIAS ADJUSTMENT IS UNNECESSARY

ALTERNATIVE METHOD
ILLUSTRATED FOR INVERTER

.25,½% · .25,½% · IN · 1meg. · 2 · 1 · OUT 6 · 100K · .22 · 3 −300 VDC