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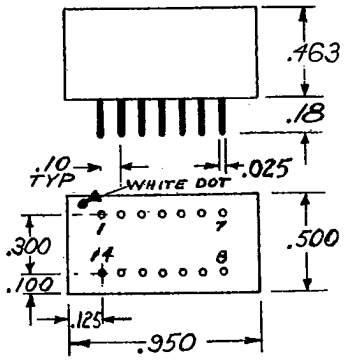
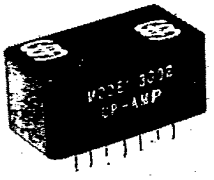
MODEL 3002 SOLID STATE SILICON

DIFFERENTIAL OPERATIONAL DC AMPLIFIER

FOR LOW-LEVEL INSTRUMENTATION & BRIDGE APPLICATIONS



THIS UNIT PLUGS INTO A STANDARD 14 PIN DUAL-IN-LINE (DIP) SOCKET, OR IT CAN BE WIRED OR SOLDERED DIRECTLY TO A PRINTED WIRING BOARD.



ACTUAL SIZE

- 0.6 MICROVOLT/°C. TEMPERATURE DRIFT
- 5 MICROVOLT/ WEEK OFFSET VOLTAGE DRIFT
- 2 PICOAMP/°C. OFFSET CURRENT DRIFT
- 300 MEGOHM INPUT IMPEDANCE
- WIDE COMMON MODE RANGE
- NO FREQUENCY COMPENSATION REQUIRED
- SHORT CIRCUIT PROTECTION
- ZERO OFFSET VOLTAGE NULL CAPABILITY
- NO LATCH-UP

ADDITIONAL FEATURES

- Completely Solid State Silicon Design
- Hybrid Integrated Circuit
- DC and AC operation
- Differential or Single-Ended Input
- Inverted and Non-Inverted Operation
- Large Differential Voltage Range
- High Gain-Bandwidth Product
- Differential Input, Single Ended Output
- Versatile, Precise Transfer Functions
- High Linearity, Low Distortion, Now Noise
- Wide Temperature Range
- Solid Encapsulation
- Small Size, Light Weight, Rugged

TYPICAL APPLICATIONS

- Precision Differential Operational Amplifier For Analog Computers
- Thermocouple, Strain Gage and Transducer Bridges
- Low Level Instrumentation
- Log Period Integrators
- Summation, Subtraction, Differentiation
- High Performance Voltage Followers
- High Input Impedance Isolation Amplifiers
- Precision Comparators, Regulators, Simulators
- Reference Voltage and Power Supply Regulators
- Active Filters

TYPICAL OPERATING CHARACTERISTICS (25°C)

Open-Loop Voltage Gain	20×10^6 (146 db)
Common Mode Rejection	100 db
Output Voltage Range ($R_L > 10K$)	±14 volts
Output Current Range	±5 milliamperes
Gain-Bandwidth Product	2 mcps
Differential Input Resistance	300 megohms
Common Mode Input Resistance	1000 megohms
Output Impedance	100 ohms
Frequency Response (Gain = 1000)	10 kcps
Operating Temperature Range	−55°C. to +125°C.
Supply Voltages and Currents	±15 volts
Supply Currents	To +28 ma, − 17ma
Power Consumption	200 milliwatts

MECHANICAL-ENVIRONMENTAL CHARACTERISTICS

DIMENSIONS:
0.50 x 0.95 x 0.47 inches

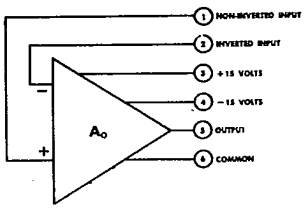
WEIGHT:
Nominal 8 grams.

ENCLOSURE:
Solid epoxy encapsulated plug-in unit

SHOCK:
10,000 G.

VIBRATION:
100 G, zero to 2000 cps.

ACCELERATION:
5,000 G.



CONNECTIONS

GENERAL DESCRIPTION

The Model 3002 is a variable high gain, differential input, single-ended output DC operational amplifier suitable for low level instrumentation and bridge input applications. The differential input capability and the extremely high open-loop gain allows versatile utilization of external networks and closed-loop negative feedback to achieve exceptional stability, high linearity and precise predictable transfer functions.

The design is completely solid state and uses only silicon semiconductors and integrated circuits. An active internal low power temperature regulator isolated within a high thermal resistance package, is used to maintain a constant substrate temperature above the highest ambient up to 125°C. This provides very stable DC amplification, thereby replacing complex chopper stabilized amplifiers. Typical stability is 0.6 microvolts per degree C. and 5 microvolts per week, ideal for analog application with thermocouple bridges, strain gage transducers, long time constant integrators, comparators, precision analog computers, analog-to-digital and digital-to-analog converters. A wide common mode voltage range and elimination of "latch-up" make the Model 3002 useful as a voltage follower.

High gain (20 million open-loop, 1000 closed-loop) and a wide range of operating voltages assures excellent performance in integrator, summing amplifier and all feedback applications. Additional features include output short-circuit protection of indefinite duration and no requirement for external frequency compensation. Internal 6db/octave roll-off provides stability in closed-loop applications.

The solid state miniature design assures stable operation through severe modes of shock, vibration and acceleration. Its reliable performance makes it particularly suited for aerospace, military, industrial and medical applications.

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ABSOLUTE MAXIMUM RATINGS

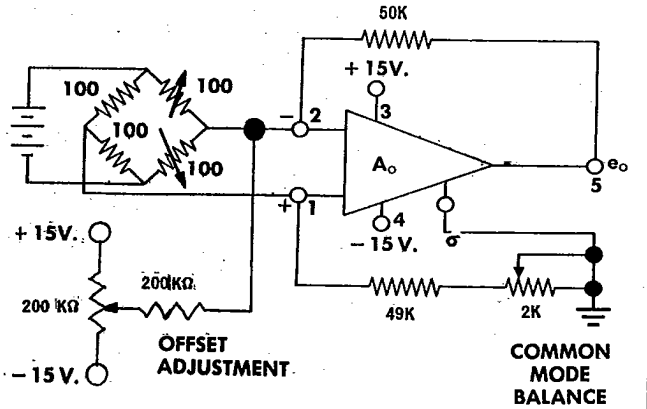
Supply Voltage	±18 Volts
Differential Input Voltage	±10 Volts
Output Current	±5 milliamperes
Common Mode Input Voltage	±15 volts
Differential Input Voltage	±10 volts
Operating Temperature	−55°C. to +125°C.
Storage Temperature	−65°C. to +150°C.
Lead Temperature (Soldering, 60 sec.)	300°C.
Output Short-Circuit Duration (Ground or Supplys, 75°C.)	Indefinite

TYPICAL ELECTRONIC CHARACTERISTICS AT 25°C.

SYMBOL	CHARACTERISTIC	MAGNITUDE	UNITS
A_O	NON-INVERTED OPEN-LOOP VOLTAGE GAIN	20×10^6	—
(CMR)	COMMON MODE REJECTION	100	decibels
E_{CM}	COMMON MODE INPUT VOLTAGE RANGE	±15	volts
R_{ID}	DIFFERENTIAL INPUT RESISTANCE.	300	megohms
R_{CM}	COMMON MODE INPUT RESISTANCE.	1000	megohms
Z_O	OUTPUT IMPEDANCE.	100	ohms
E_O	OUTPUT VOLTAGE RANGE (R_L>2K ohms)	±13	volts
I_O	OUTPUT CURRENT RANGE	±5	milliamps
$\frac{\Delta A}{\Delta T}$	CLOSED-LOOP DC VOLTAGE GAIN STABILITY VS TEMPERATURE CHANGE	A=1000; R_I=50Ω; R_F=50KΩ	.0005%/°C.
$\frac{\Delta A_O}{\Delta V_s}$	OPEN-LOOP DC VOLTAGE GAIN CHANGE VS SUPPLY VOLTAGE CHANGE.	ΔV_s=±3 Volts	0.1%/volt
$\frac{\Delta A}{\Delta V_s}$	CLOSED-LOOP DC VOLTAGE GAIN CHANGE VS SUPPLY VOLTAGE CHANGE.	A=1000; R_F=50KΩ; R_I=50Ω	.001%/volt
E_{OF}	OUTPUT VOLTAGE OFFSET, REFERRED TO INPUT (OR DC INPUT VOLTAGE OFFSET)	2 000	microvolts
$\frac{\Delta E_{OF}}{\Delta T}$	OUTPUT VOLTAGE OFFSET CHANGE VS TEMPERATURE CHANGE REFERRED TO INPUT.	0.6	microvolts/°C.
$\frac{\Delta E_{OF}}{\Delta V_s}$	OUTPUT VOLTAGE OFFSET CHANGE VS SUPPL VOLTAGE CHANGE, REFERRED TO INPUT (R_s<100K ohms)	80	microvolts/volt
I_{OF}	OUTPUT CURRENT OFFSET. REFERRED TO INPUT.	30	nanoamps
$\frac{\Delta I_{OF}}{\Delta T}$	OUTPUT CURRENT OFFSET CHANGE VS TEMPERATURE CHANGE, REFERRED TO INPUT.	2	picoamps/°C.
E_N	OUTPUT NOISE VOLTAGE. REFERRED TO THE INPUT. (BW=10 to 500 cps. R_s<50 ohms)	3	microvolts rms
E_D	LONG TERM OUTPUT VOLTAGE DRIFT REFERRED TO INPUT (R_s<50 ohms)	5	microvolts/week
A_{OfC}	OPEN-LOOP GAIN-BANDWIDTH PRODUCT.	2	megacycle/sec.
$f_{C(1)}$	UNITY-GAIN FREQUENCY RESPONSE.	20	kilocycles/sec.
$f_{C(100)}$	FREQUENCY RESPONSE AT GAIN OF 100.	20	kilocycles/sec.
I_B	INPUT BIAS CURRENT	12	nanoamperes
$\frac{\Delta I_B}{\Delta T}$	INPUT BIAS CURRENT CHANGE VS TEMPERATURE CHANGE.	15	picoamperes/°C.
t_R	TRANSIENT RESPONSE RISETIME (UNITY GAIN, 5% OVERSHOOT).	0.3	microseconds
$\frac{\Delta E_O}{\Delta t}$	SLEW RATE (UNITY GAIN)	0.5	volts/microsecond
R_L	LOAD RESISTANCE, MINIMUM RECOMMENDED.	2	kilohms
V_s	SUPPLY VOLTAGES	+15 & −15	volts
I_s	NOMINAL SUPPLY CURRENT (each supply).	+28, −17	milliamperes
P_C	POWER CONSUMPTION:	200	milliwatts

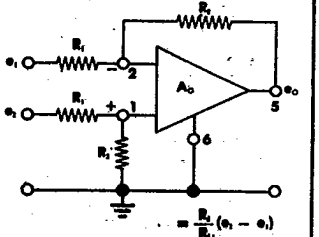
APPLICATION CIRCUITS

BRIDGE AMPLIFIER



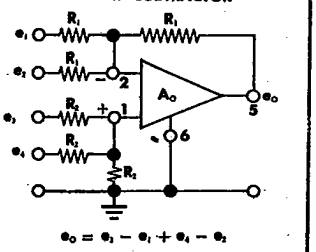
$$\text{GAIN} = \frac{2\,(50K)}{100} = 1000$$

COMPARATOR OR SUBTRACTOR (DIFFERENTIAL AMPLIFIER)



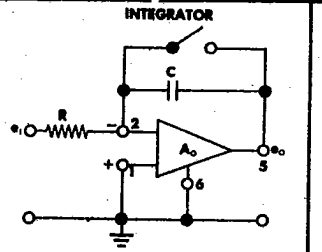
$$= \frac{R_2}{R_1}(e_2 - e_1)$$

ADDER - SUBTRACTOR



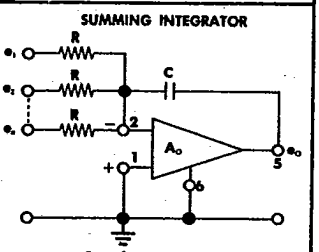
$$e_o = e_1 - e_2 + e_3 - e_4$$

INTEGRATOR



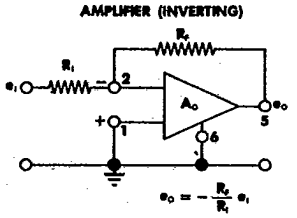
$$e_o = -\frac{1}{RC}\int e_i\,dt$$

SUMMING INTEGRATOR



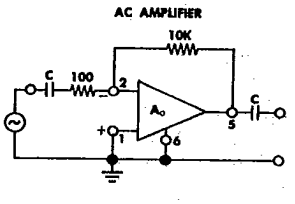
$$e_o = -\frac{1}{RC}\int (e_1 + e_2 + \ldots + e_n)\,dt$$

AMPLIFIER (INVERTING)

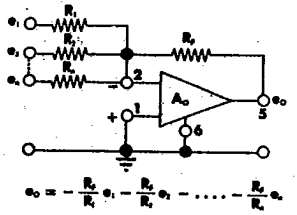


$$e_o = -\frac{R_2}{R_1}e_i$$

AC AMPLIFIER



ADDER (MIXER)



$$e_o = -\frac{R_2}{R_1}e_1 - \frac{R_2}{R_2}e_2 - \ldots - \frac{R_2}{R_n}e_n$$

VOLTAGE FOLLOWER