

Features

- Unity Gain Bandwidth40MHz
- High Slew Rate250V/ μ s
- Low Offset Voltage0.8mV
- Fast Settling Time (0.1%)90ns
- Power Bandwidth4MHz
- Output Voltage Swing (Min) ± 10 V
- Unity Gain Stability
- Monolithic Bipolar Dielectric Isolation Construction

Description

The HA-2541 is the first unity gain stable monolithic operational amplifier to achieve 40MHz unity gain bandwidth. A major addition to the Harris series of high speed, wideband op amps, the HA-2541 is designed for video and pulse applications requiring stable amplifier response at low closed loop gains.

The uniqueness of the HA-2541 is that its slew rate and bandwidth characteristics are specified at unity gain. Historically, high slew rate, wide bandwidth and unity gain stability have been incompatible features for a monolithic operational amplifier. But features such as 250V/ μ s slew rate and 40MHz unity gain bandwidth clearly show that this is not the case for the HA-2541. These features, along with 90ns settling time to 0.1%, make this

Applications

- Pulse and Video Amplifiers
- Wideband Amplifiers
- High Speed Sample-Hold Circuits
- Fast, Precise D/A Converters
- High Speed A/D Input Buffer

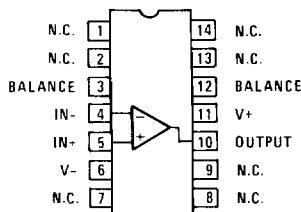
product an excellent choice for high speed data acquisition systems.

Packaged in a metal can (TO-8) or 14 pin ceramic DIP, the HA-2541 is pin compatible with the HA-2540 and HA-5190 op amps. The HA-2541-2 is specified over the temperature range of -55°C to +125°C. The HA-2541-5 is specified over the temperature range of 0°C to +75°C. For the military grade product, refer to the HA-2541 military data sheet.

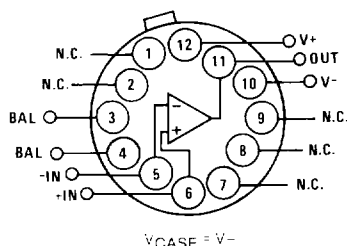
For further application suggestions on the HA-2541, please refer to Application Note 550 (Using the HA-2541), and Application Note 556 (Thermal Safe-Operating-Areas For High Current Operational Amplifiers). Also see Applications' in this data sheet.

Pinouts

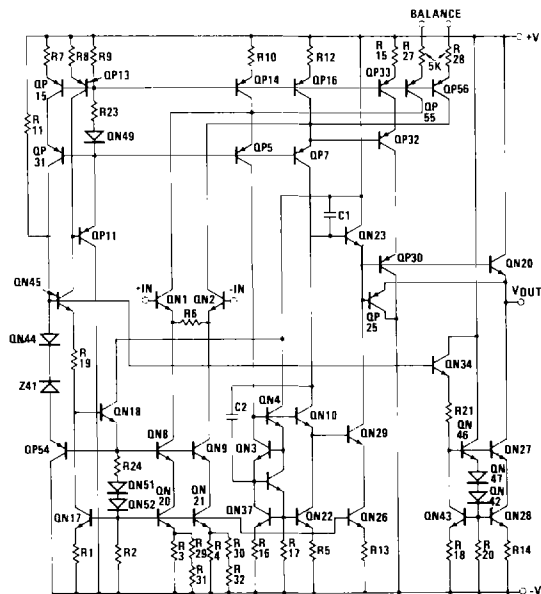
**HA1-2541 (CERAMIC DIP)
TOP VIEW**



**HA2-2541 (TO-8 METAL CAN)
TOP VIEW**



Schematic



Specifications HA-2541

Absolute Maximum Ratings (Note 1)

Voltage Between V+ and V- 35V
Differential Input Voltage $\pm 6V$
Peak Output Current 50mA
Continuous Output Current 28mA rms

Operating Temperature Range:

HA-2541-2 $-55^{\circ}\text{C} \leq T_A \leq +125^{\circ}\text{C}$
HA-2541-5 $0^{\circ}\text{C} \leq T_A \leq +75^{\circ}\text{C}$
Storage Temperature Range $-65^{\circ}\text{C} \leq T_A \leq +150^{\circ}\text{C}$
Maximum Junction Temperature (Note 11) $+175^{\circ}\text{C}$

Electrical Specifications $V_{\text{SUPPLY}} = \pm 15 \text{ Volts}$; $R_L = 2 \text{ k}\Omega$, $C_L \leq 10 \text{ pF}$, Unless Otherwise Specified

PARAMETER	TEMP	HA-2541-2 -55°C to +125°C			HA-2541-5 0°C to +75°C			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
INPUT CHARACTERISTICS								
Offset Voltage	+25°C		0.8	2		1	2	mV
	Full			6			6	mV
Average Offset Voltage Drift	Full		9			9		μV/°C
Bias Current	+25°C		11	25		11	25	μA
	Full			30			30	μA
Average Bias Current Drift	Full		85			85		nA/°C
Offset Current	+25°C		1	7		1	7	μA
	Full			9			9	μA
Input Resistance	+25°C		100			100		kΩ
Input Capacitance	+25°C		1			1		pF
Common Mode Range	Full	±10	±11		±10	±11		V
Input Noise Voltage (f = 1kHz, R _g = 0Ω)	+25°C		10			10		nV/√Hz
Input Noise Current (f = 1kHz, R _g = 0Ω)	+25°C		4			4		pA/√Hz
TRANSFER CHARACTERISTICS								
Large Signal Voltage Gain (Note 3)	+25°C	10k	16k		10k	16k		V/V
	Full	5k			5k			V/V
Common-Mode Rejection Ratio (Note 5)	Full	70	90		70	90		dB
Minimum Stable Gain	+25°C	1			1			V/V
Unity Gain-Bandwidth (Note 6)	+25°C		40			40		MHz
OUTPUT CHARACTERISTICS								
Output Voltage Swing (Note 4)	Full	±10	±11		±10	±11		V
Output Current (Note 4)	+25°C	±10	±15		±10	±15		mA
Output Resistance	+25°C		2			2		Ω
Full Power Bandwidth (Note 3 & 7)	+25°C	3	4		3	4		MHz
Differential Gain (Note 2)	+25°C		0.1			0.1		%
Differential Phase (Note 2)	+25°C		0.2			0.2		Degree
Harmonic Distortion (Note 10)	+25°C		<0.01			<0.01		%
TRANSIENT RESPONSE (Note 8)								
Rise Time	+25°C		4			4		ns
Overshoot	+25°C		40			40		%
Slew Rate	+25°C	200	250		200	250		V/μs
Settling Time:								
10V Step to 0.1%	+25°C		90			90		ns
10V Step to 0.01%	+25°C		175			175		ns
POWER REQUIREMENTS								
Supply Current	+25°C		29	40		29	40	mA
	Full							mA
Power Supply Rejection Ratio (Note 9)	Full	70	80		70	78		dB

HA-2541

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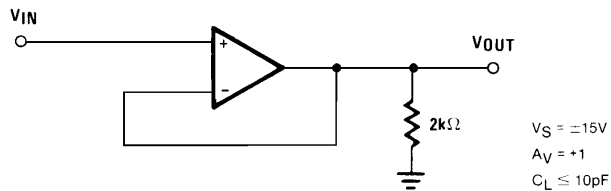
OP AMPS &
COMPARATORS

NOTES:

1. Absolute maximum ratings are limiting values, applied individually, beyond which the serviceability of the circuit may be impaired. Functional operability under any of these conditions is not necessarily implied.
2. Differential Gain and Phase are measured with a 1 Volt differential voltage at 5MHz.
3. $V_O = \pm 10V$
4. $R_L = 1k\Omega$
5. $V_{CM} = \pm 10V$
6. $V_O = 90mV$.
7. Full Power Bandwidth guaranteed based on slew rate measurement using $FPBW = \frac{\text{Slew Rate}}{2\pi V_{PEAK}}$
8. Refer to Test Circuits section of this data sheet.
9. $V_{SUPPLY} = \pm 5VDC$ to $\pm 15VDC$
10. $V_{IN} = 1V_{RMS}$; $f = 10kHz$; $A_V = 10$
11. This value assumes a no load condition: Maximum power dissipation with load conditions must be designed to maintain the maximum junction temperature below $+175^\circ C$. By using Application Note 556 on Safe Operating Area equations, along with the packaging thermal resistances listed in the Die Characteristics section, proper load conditions can be determined. Heat sinking is recommended above $+75^\circ C$ with suggested models:
 - 14 Lead Ceramic DIP: Thermalloy #6007 or AAVID #5602B ($\theta_{SA} = 16^\circ C/W$).
 - 12 Lead Metal Can (TO-8): Thermalloy #2240A ($\theta_{SA} = 27^\circ C/W$) or #2268B ($\theta_{SA} = 24^\circ C/W$)

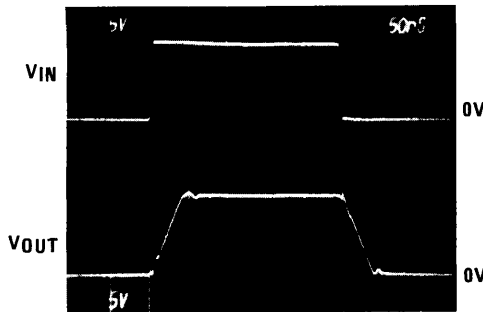
Test Circuits

TEST CIRCUIT



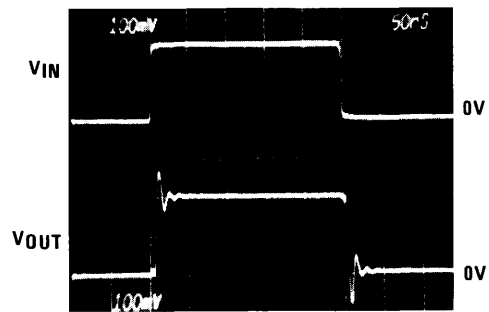
LARGE SIGNAL RESPONSE

Vertical Scale (Volts: 5V/Div.)
 Horizontal Scale (Time: 50ns/Div.)



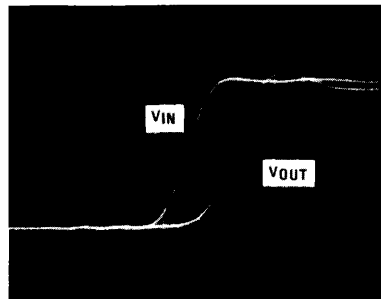
SMALL SIGNAL RESPONSE

Vertical Scale (Volts: 100mV/Div.)
 Horizontal Scale (Time: 50ns/Div.)



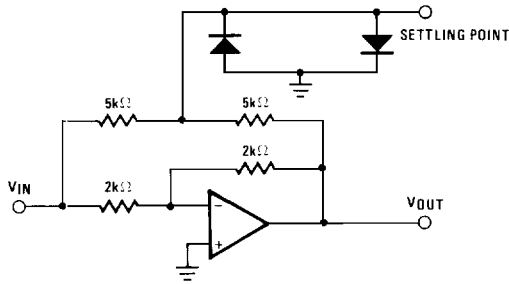
PROPAGATION DELAY

Vertical Scale (Volts: 100mV/Div.)
 Horizontal Scale (Time: 5ns/Div.)

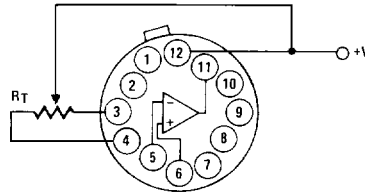


$V_S = \pm 15V$, $R_L = 1k\Omega$
 $T = +25^\circ C$

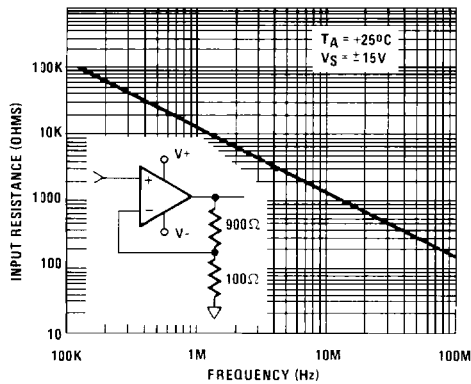
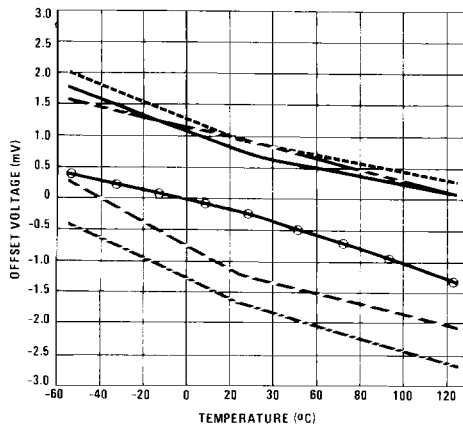
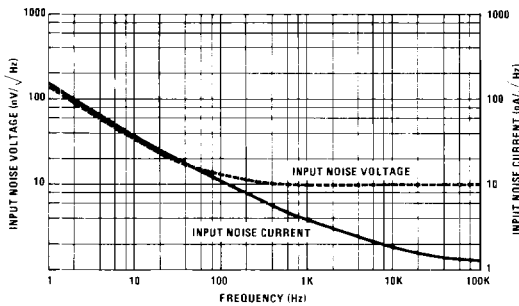
Propagation delay variance is negligible over full temperature range.

Test Circuits (Continued)**SETTLING TIME TEST CIRCUIT**

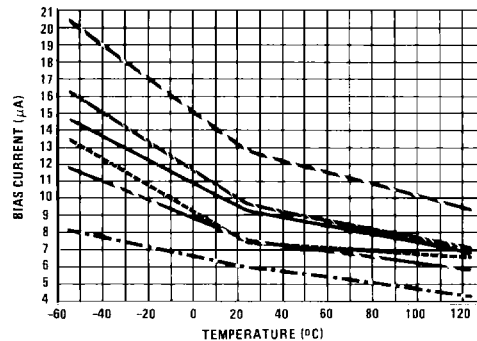
- $A_V = -1$
- Feedback and Summing Resistors Must Be Matched (0.1%)
- HP5082-2810 Clipping Diodes Recommended
- Tektronix P6201 FET Probe Used At Settling Point.

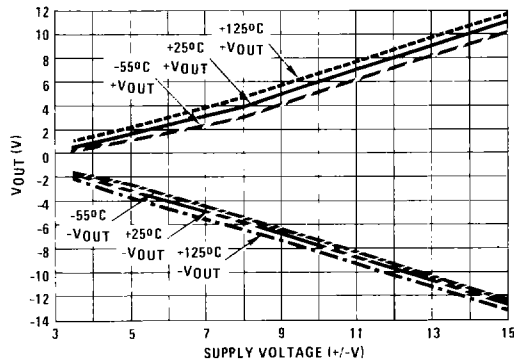
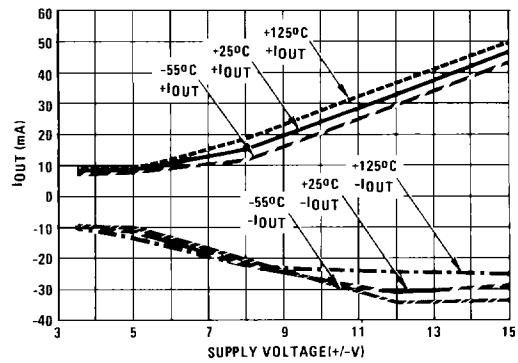
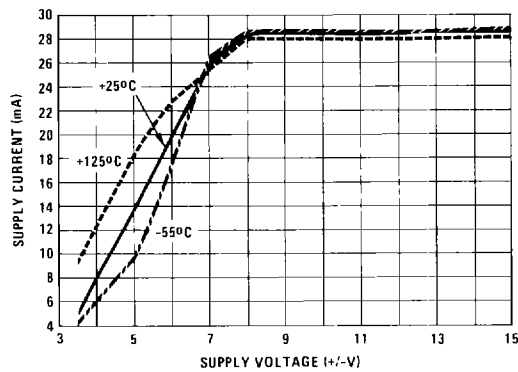
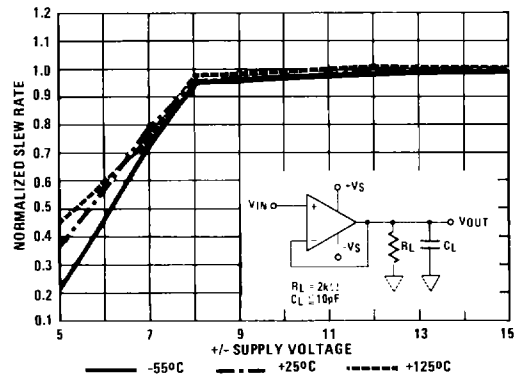
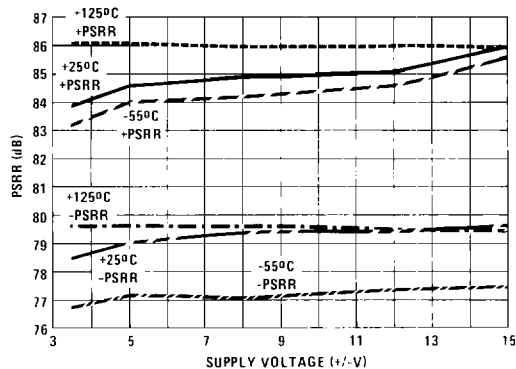
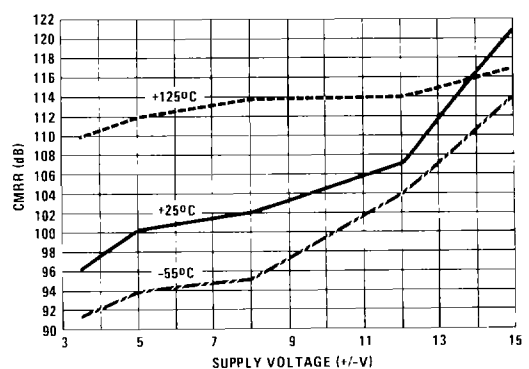
Suggested Offset Voltage Adjustment

Tested Offset Adjustment Range is $|V_{OS}| + 1\text{mV}$ minimum referred to output. Typical range is $\pm 15\text{mV}$ with $R_T = 5\text{k}\Omega$

Typical Performance Curves**INPUT RESISTANCE vs. FREQUENCY****OFFSET VOLTAGE DRIFT WITH TEMPERATURE**
Of 6 Representative Units**NOISE DENSITY vs. FREQUENCY** $T_A = +25^\circ\text{C}$ **BIAS CURRENT DRIFT WITH TEMPERATURE**

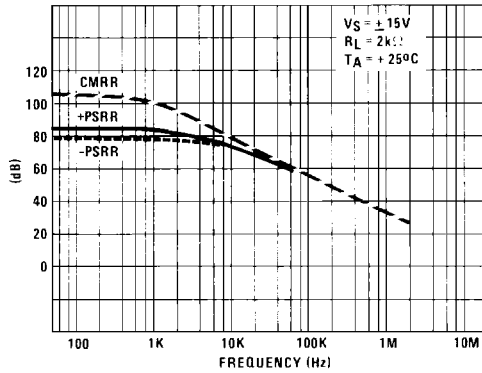
Of 6 Representative Units



Typical Performance Curves (Continued)**OUTPUT VOLTAGE SWING vs. SUPPLY VOLTAGE**
At Various Temperatures**OUTPUT CURRENT vs. SUPPLY VOLTAGE**
At Various Temperatures**SUPPLY CURRENT vs. SUPPLY VOLTAGE**
At Various Temperatures**SLEW RATE vs. SUPPLY VOLTAGE**
Normalized With $V_S = \pm 15V$ at +25°C**PSRR vs. SUPPLY VOLTAGE**
Average Of 3 Lots At Various Temperatures**CMRR vs. SUPPLY VOLTAGE**
Average of 3 Lots At Various Temperatures

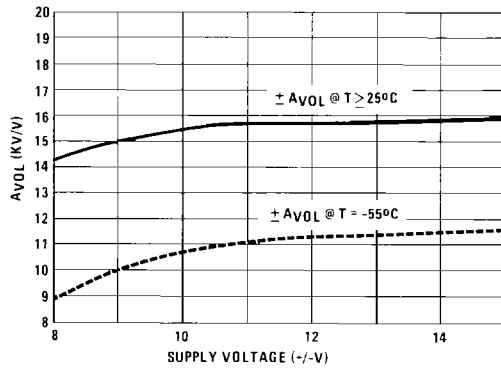
Typical Performance Curves (Continued)

REJECTION RATIOS vs. FREQUENCY

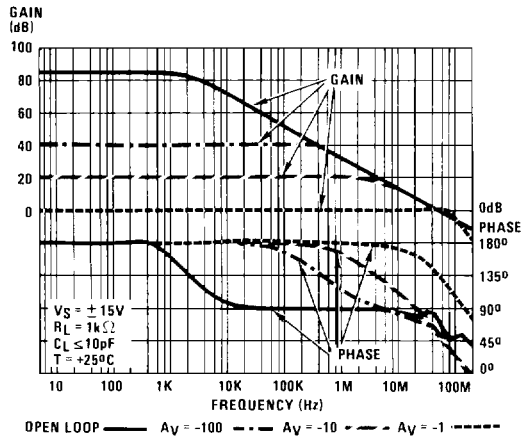


± OPEN LOOP GAIN vs. SUPPLY VOLTAGE

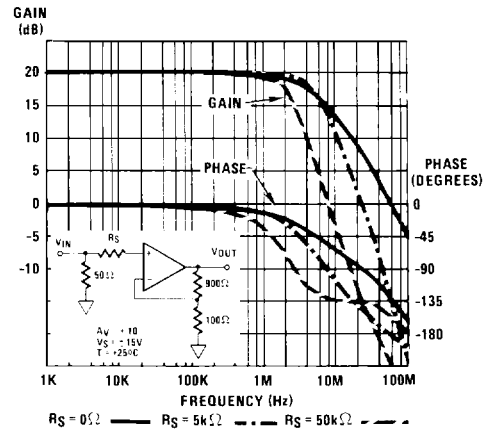
Average of 3 Lots Over Temperature



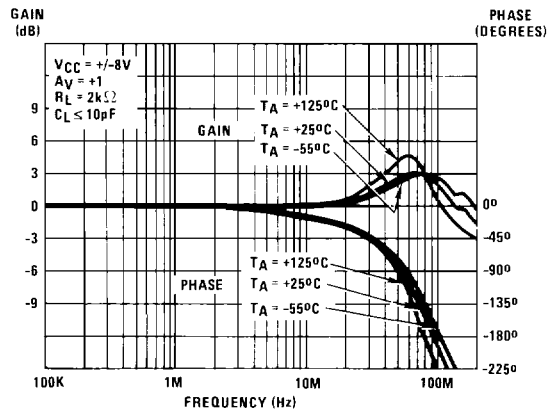
GAIN AND PHASE FREQUENCY RESPONSE

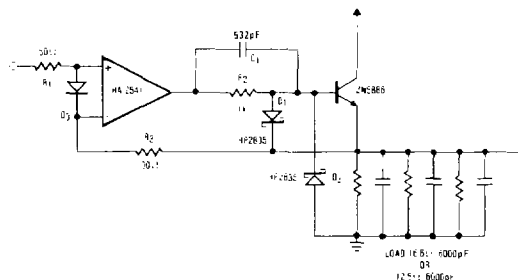
 $V_S = \pm 15V$, $R_L = 1k\Omega$, $C_L \leq 10pF$, $T_A = +25^\circ C$ 

SMALL SIGNAL BANDWIDTH vs. SOURCE RESISTANCE

 $V_S = \pm 15V$, $R_L = 1k\Omega$ 

CLOSE LOOP FREQUENCY RESPONSE vs. TEMPERATURE





APPLICATION 1

This capability is well demonstrated with the high power buffer circuit in Application 1.

The HA-2541 acts as the pre-driver to the output power transistor. Together, they form a unity gain buffer with the ability to drive three 50 ohm coaxial cables in parallel, each with a capacitance of 2000pF. The total combined load is 16.6 ohms and 6000pF capacitance.

APPLICATION 2

Video

The circuit diagram shows a precision rectifier implemented with two operational amplifiers. The first op-amp, labeled '+A 5120', has its non-inverting input connected to ground. Its inverting input is connected to a 5.5MHz TSPF signal source through a 1k resistor. The output of the first op-amp is connected to the inverting input of the second op-amp, which is also labeled '+A 5120'. The non-inverting input of the second op-amp is connected to ground. The output of the second op-amp is connected to a 1k load resistor. A feedback path consisting of a 1k resistor and a diode is connected between the output and the inverting input of the second op-amp. The diode's cathode is towards the output, and its anode is towards the inverting input. A 1k resistor is also connected from the output to ground.

APPLICATION 2. VIDEO D.C. RESTORER

Die Characteristics

Transistor Count.....	41
Die Dimensions.....	89 x 79 x 19 mils (2250 μ m x 1990 μ m x 485 μ m)
Substrate Potential (Powered Up)*.....	V—
Process.....	High Frequency Bipolar Dielectric Isolation
Passivation.....	Silox
Thermal Constants (°C.W)	θ_{ja} θ_{jc}
Ceramic DIP	91 35
Metal Can	66 30

*The substrate may be left floating (Insulating Die Mount) or it may be mounted on a conductor at V- potential.