HARRIS

HA-2541

Wideband, Fast Settling, Unity Gain Stable, Operational Amplifier

Features

- Unity Gain Bandwidth 40MHz
- High Slew Rate 250V/μs
- Low Offset Voltage 0.8mV
- Fast Settling Time (0.1%) 90ns
- Power Bandwidth 4MHz
- Output Voltage Swing (Min) .... ±10V
- Unity Gain Stability
- Monolithic Bipolar Dielectric Isolation Construction

Applications

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

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.

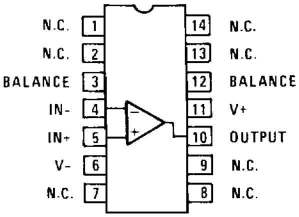
The uniqueness of the HA-2541 is that its slew rate and bandwidth characteristics are specified at unity gain. Historically, high slew rate, wide bandwidth and unity gain stability have been incompatible features for a monolithic operational amplifier. But features such as 250V/μs slew rate and 40MHz 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 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.

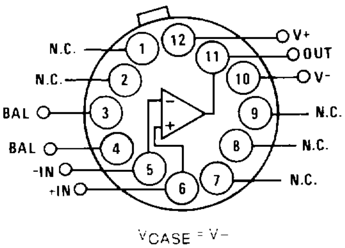
For further application suggestions on the HA-2541, please refer to Applicaton Note 550 (Using the HA-2541), and Application Note 556 (Thermal Safe-Operating-Areas For High Current Operational Amplifiers). Also see Applications' in this data sheet.

Pinouts

HA1-2541 (CERAMIC DIP)
TOP VIEW

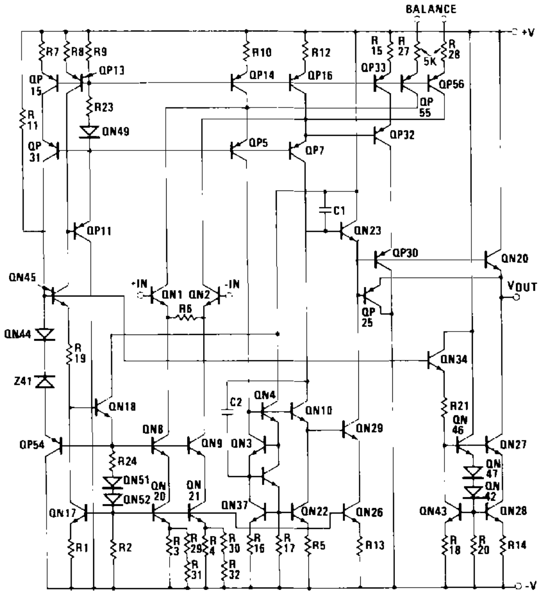


HA2-2541 (TO-8 METAL CAN)
TOP VIEW



V_{CASE} = V-

Schematic



CAUTION: Electronic devices are sensitive to electrostatic discharge. Proper I.C. handling procedures should be followed.

Absolute Maximum Ratings (Note 1)

Voltage Between V+ and V- 35V
Differential Input Voltage .... ±6V
Peak Output Current 50mA
Continuous Output Current 28mArms

Operating Temperature Range:

HA-2541-2 .... $-55^oC \le T_A \le +125^oC$
HA-2541-5 .... $0^oC \le T_A \le +75^oC$
Storage Temperature Range .... $-65^oC \le T_A \le +150^oC$
Maximum Junction Temperature (Note 11) .... +175°C

Electrical Specifications V_{SUPPLY} = ±15 Volts; R_L = 2kΩ, $C_L \le$ 10pF, Unless Otherwise Specified

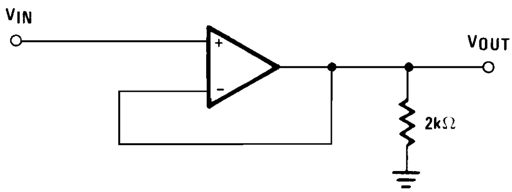
PARAMETER	TEMP	HA-2541-2 -55°C to +125°C MIN	HA-2541-2 TYP	HA-2541-2 MAX	HA-2541-5 0°C to +75°C MIN	HA-2541-5 TYP	HA-2541-5 MAX	UNITS
INPUT CHARACTERISTICS								
Offset Voltage	+25°C		0.8	2		1	2	mV
	Full			6			6	mV
Average Offset Voltage Drift	Full		9			9		μV/°C
Bias Current	+25°C		11	25		11	25	μA
	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		$nV/\sqrt{Hz}$
Input Noise Current (f = 1kHz, R_g = 0Ω)	+25°C		4			4		$pA/\sqrt{Hz}$
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			29		mA
	Full			40			40	mA
Power Supply Rejection Ratio (Note 9)	Full	70	80		70	78		dB

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°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°C with suggested models:
    14 Lead Ceramic DIP:
    Thermalloy #6007 or AAVID #5602B (θ_{sa} = 16°C/W).
    12 Lead Metal Can (TO-8):
    Thermalloy #2240A (θ_{sa} = 27°C/W) or #2268B (θ_{sa} = 24°C/W)

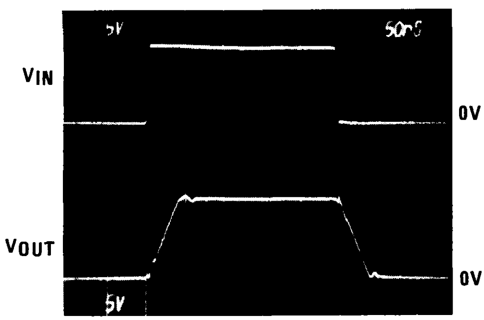
Test Circuits

TEST CIRCUIT

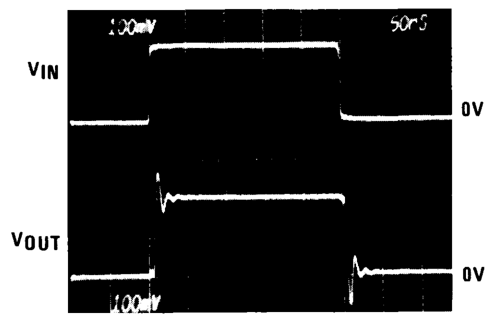


$V_S = \pm 15V$
$A_V = +1$
$C_L \leq 10pF$

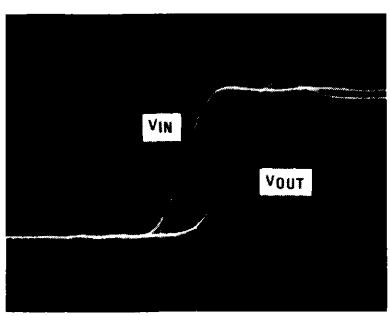
LARGE SIGNAL RESPONSE
Vertical Scale (Volts: 5V/Div.)
Horizontal Scale (Time: 50ns/Div.)



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



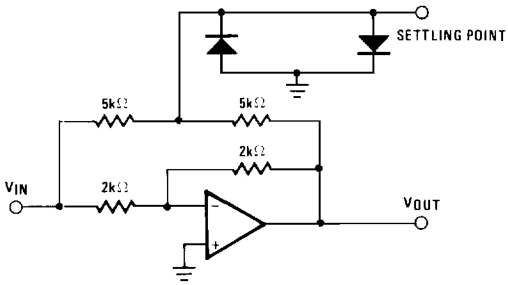
PROPAGATION DELAY
Vertical Scale (Volts: 100mV/Div.)
Horizontal Scale (Time: 5ns/Div.)



$V_S = \pm 15V$, $R_L = 1k\Omega$
T = +25°C
Propagation delay variance is negligible over full temperature range.

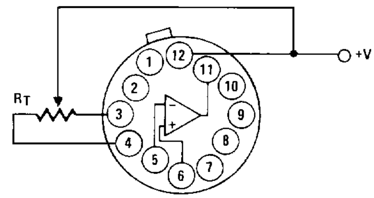
Test Circuits (Continued)

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.

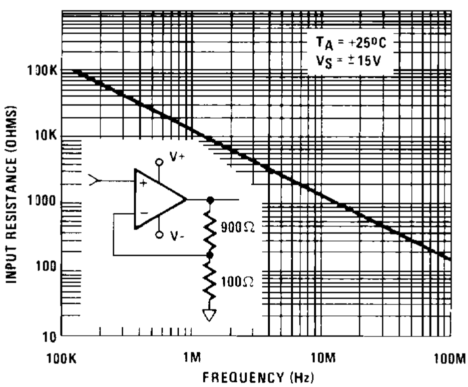
Suggested Offset Voltage Adjustment



Tested Offset Adjustment Range is | V_{OS} +1mV | minimum referred to output. Typical range is ±15mV with R_T = 5kΩ

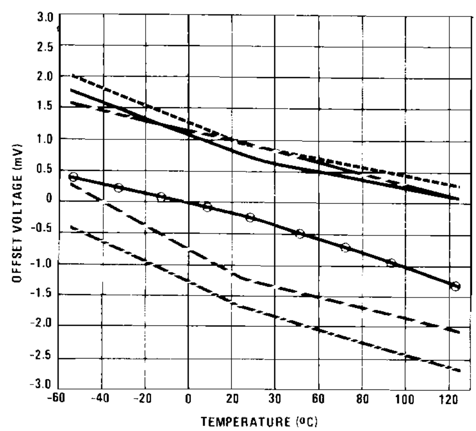
Typical Performance Curves

INPUT RESISTANCE vs. FREQUENCY



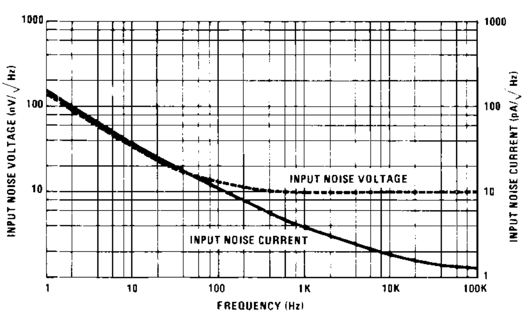
OFFSET VOLTAGE DRIFT WITH TEMPERATURE

Of 6 Representative Units



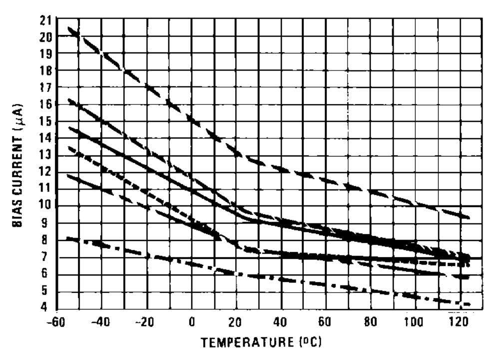
NOISE DENSITY vs. FREQUENCY

T_A = +25°C



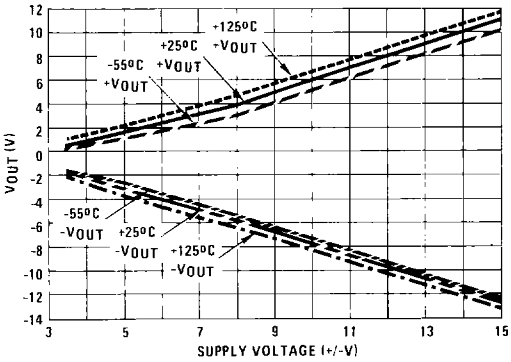
BIAS CURRENT DRIFT WITH TEMPERATURE

Of 6 Representative Units

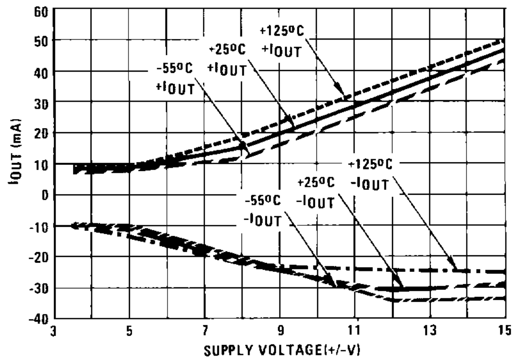


Typical Performance Curves (Continued)

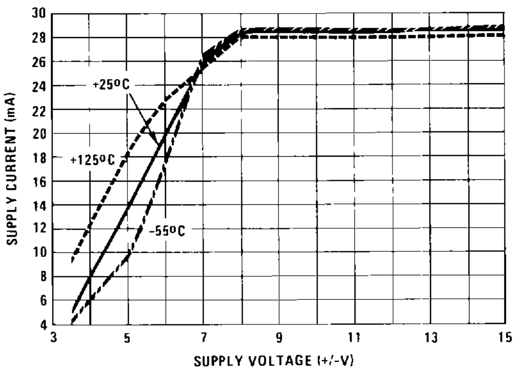
OUTPUT VOLTAGE SWING vs. SUPPLY VOLTAGE
At Various Temperatures



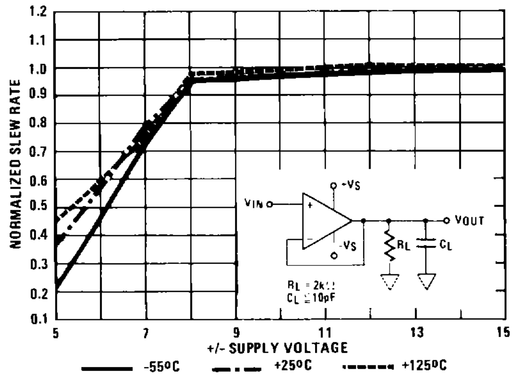
OUTPUT CURRENT vs. SUPPLY VOLTAGE
At Various Temperatures



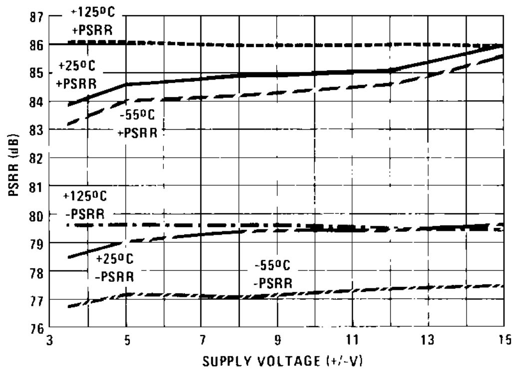
SUPPLY CURRENT vs. SUPPLY VOLTAGE
At Various Temperatures



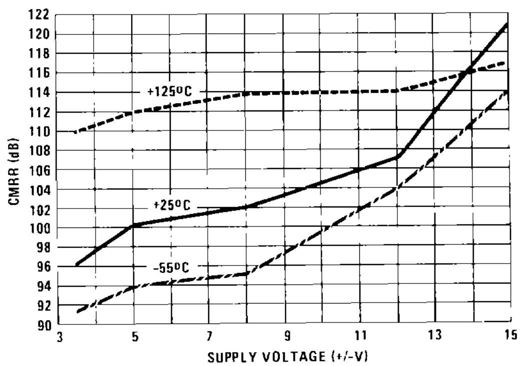
SLEW RATE vs. SUPPLY VOLTAGE
Normalized With $V_S = \pm15V$ at +25°C



PSRR vs. SUPPLY VOLTAGE
Average Of 3 Lots At Various Temperatures

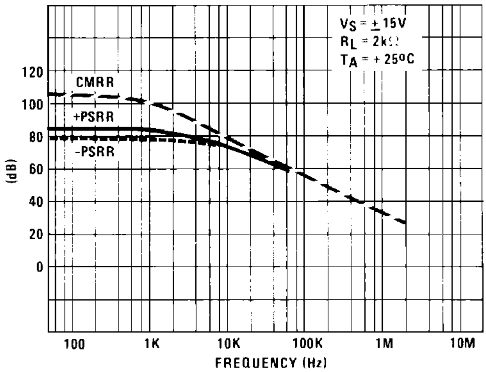


CMRR vs. SUPPLY VOLTAGE
Average of 3 Lots At Various Temperatures



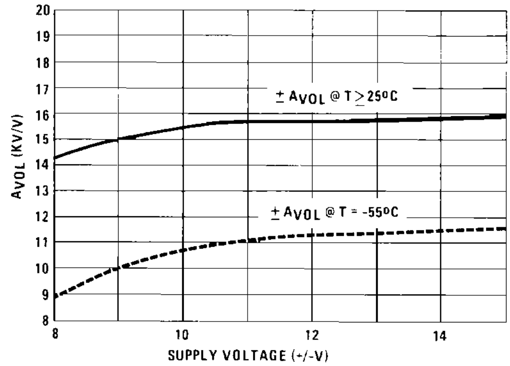
Typical Performance Curves (Continued)

REJECTION RATIOS vs. FREQUENCY



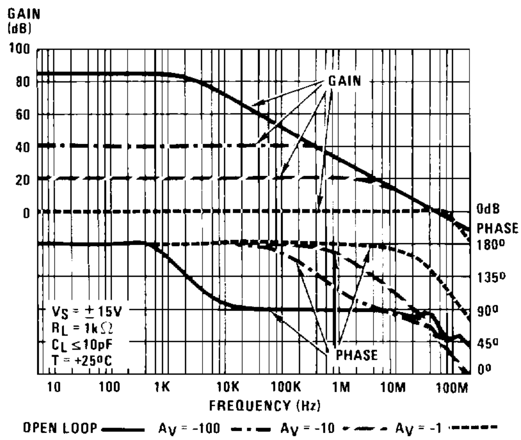
+/– OPEN LOOP GAIN vs. SUPPLY VOLTAGE

Average of 3 Lots Over Temperature



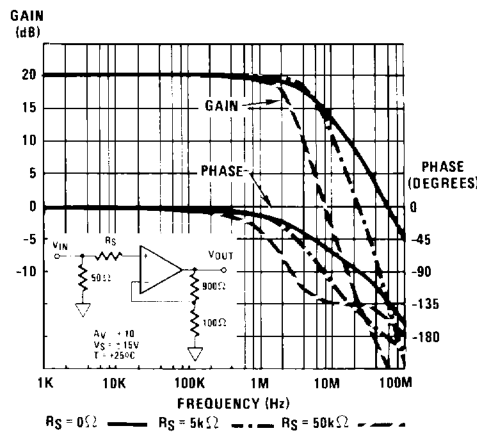
GAIN AND PHASE FREQUENCY RESPONSE

$V_S = \pm15V$, $R_L = 1k$, $C_L \leq 10pF$, $T_A = +25^oC$

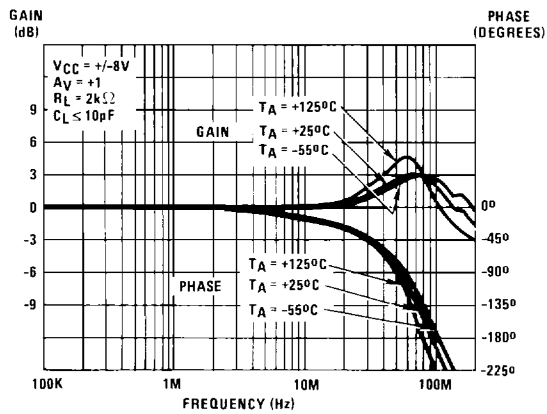


SMALL SIGNAL BANDWIDTH vs. SOURCE RESISTANCE

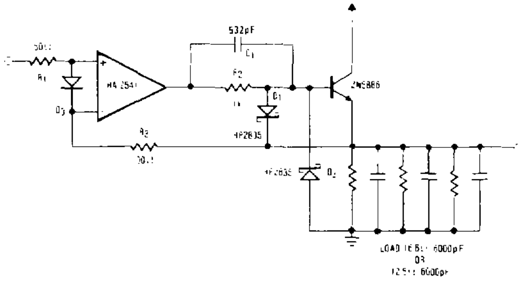
$V_S = \pm15V$, $R_L = 1k\Omega$



CLOSE LOOP FREQUENCY RESPONSE vs. TEMPERATURE



Applications (Also See Application Note 550)



APPLICATION 1. DRIVING POWER TRANSISTORS TO GAIN ADDITIONAL CURRENT BOOSTING

APPLICATION 1

High power amplifiers and buffers are in use in a wide variety of applications. Many times the "high power" capability is needed to drive large capacitive loads as well as low value resistive loads. In both cases the final driver stage is usually a power transistor of some type, but because of their inherently low gain, several stages of pre-drivers are often required. The HA-2541, with its 10mA output rating, is powerful enough to drive a power transistor without additional stages of current amplification. This capability is well demonstrated with the high power buffer circuit in Application 1.

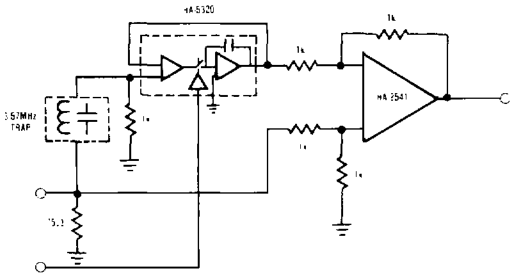
The HA-2541 acts as the pre-driver to the output power transistor. Together, they form a unity gain buffer with the ability to drive three 50 ohm coaxial cables in parallel, each with a capacitance of 2000pF. The total combined load is 16.6 ohms and 6000pF capacitance.

APPLICATION 2

Video

One of the primary uses of the HA-2541 is in the area of video applications. These applications include signal construction, synchronization addition and removal, as well as signal modification. A wide bandwidth device such as the HA-2541 is well suited for use in this class of amplifier. This, however, is a more involved group of applications than ordinary amplifier applications since video signals contain precise DC levels which must be retained.

The addition of a clamping circuit restores D.C. levels at the output of an amplifier stage. The circuit shown in Application 2 utilizes the HA-5320 sample and hold amplifier as the D.C. clamp. Also shown is a 3.57MHz trap in series, which will block the color burst portion of the video signal and allow the D.C. level to be amplified and restored.



APPLICATION 2. VIDEO D.C. RESTORER

Die Characteristics

Transistor Count 41
Die Dimensions .... 89 x 79 x 19 mils
(2250μm x 1990μm x 485μm)
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.