HA-5190/95

Wideband, Fast Settling Operational Amplifier

Features

- Fast Settling Time (0.1%) 70ns
- Very High Slew Rate 200V/μs
- Wide Gain-Bandwidth ($A_V \geq 5$) 150MHz
- Power Bandwidth 6.5MHz
- Low Offset Voltage 3mV
- Input Noise Voltage ..... 6nV/$\sqrt{Hz}$
- Monolithic Bipolar D.I. Construction

Applications

- Fast, Precise D/A Converters
- High Speed Sample-Hold Circuits
- Pulse and Video Amplifiers
- WideBand Amplifiers
- Replace Costly Hybrids

Description

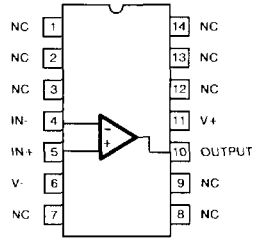
HA-5190/5195 are monolithic operational amplifiers featuring an ultimate combination of speed, precision, and bandwidth. Employing monolithic bipolar construction coupled with Dielectric Isolation, these devices are capable of delivering an unparalleled 200V/μs slew rate with a settling time of 70ns (0.1%, 5V output step). These truly differential amplifiers are designed to operate at gains ≥ 5 without the need for external compensation. Other oustanding HA-5190/5195 features are 150MHz gain-bandwidth-product and 6.5MHz full power bandwidth. In addition to these dynamic characteristics, these amplifiers also have excellent input characteristics such as 3mV offset voltage and 6.0nV/$\sqrt{Hz}$ input voltage noise at 1kHz.

With 200V/μs slew rate and 70ns settling time, these devices make ideal output amplifiers for accurate, high speed D/A converters or the main components in high speed sample/hold circuits. The 5190/5195 are also ideally suited for a variety of pulse and wideband video amplifiers. Please refer to Application Notes 525 and 526 for some of these application designs.

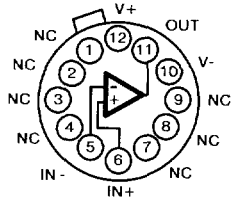
The HA-5190 is specified over the -55°C to +125°C range while the HA-5195 is specified from 0°C to +75°C. The HA-5190/5195 are available in 12 pin Metal Can (TO-8) and 14 pin Ceramic DIP packages. At temperatures above +75°C a heat sink is required for the HA-5190 (see Note 2 and Application Note 556). For military versions, please request the HA-5190/883 Data Sheet.

Pinouts

HA1-5190/5195 (CERAMIC DIP)
TOP VIEW

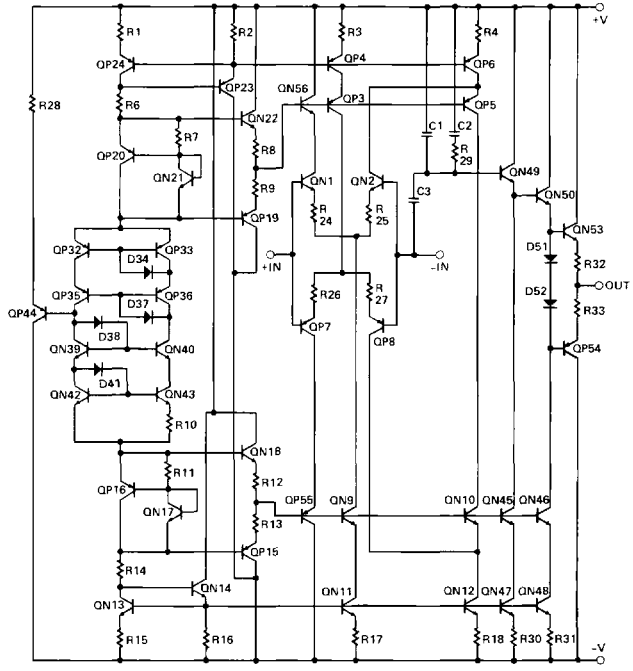


HA2-5190/5195 (TO-8 METAL CAN)
TOP VIEW



Case Tied To V-

Schematic



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

Absolute Maximum Ratings (Note 1)

Voltage Between V+ and V- Terminals 35V
Differential Input Voltage ..... ±6V
Output Current ..... 50mA (Peak)
Internal Power Dissipation (Note 2) ..... 870mW (Cerdip); 1W (TO-8) Free Air
Maximum Junction Temperature (Note 2) ..... +175°C

Operating Temperature Ranges

HA-5190-2 ..... $-55^{\circ}C \leq T_A \leq +125^{\circ}C$
HA-5190-5 ..... $0^{\circ}C \leq T_A \leq +75^{\circ}C$
Storage Temperature Range ..... $-65^{\circ}C \leq T_A \leq +150^{\circ}C$

Electrical Specifications $V_{SUPPLY} = \pm 15V$; $R_L = 200\Omega$, Unless Otherwise Specified.

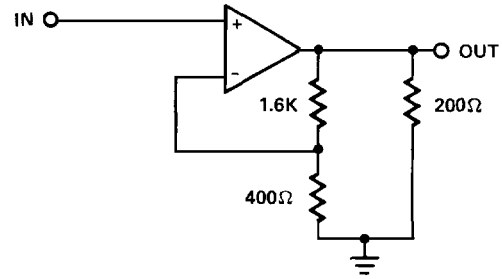
PARAMETER	TEMP	HA-5190-2 -55°C to +125°C			HA-5190-5 0°C to +75°C			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	
INPUT CHARACTERISTICS								
Offset Voltage	+25°C	-	3	5	-	3	6	mV
	Full	-	-	10	-	-	10	mV
Average Offset Voltage Drift	Full	-	20	-	-	20	-	µV/°C
Bias Current	+25°C	-	5	15	-	5	15	µA
	Full	-	-	20	-	-	20	µA
Offset Current	+25°C	-	1	4	-	1	4	µA
	Full	-	-	6	-	-	6	µA
Input Resistance	+25°C	-	10	-	-	10	-	kΩ
Input Capacitance	+25°C	-	1	-	-	1	-	pF
Common Mode Range	Full	±5	-	-	±5	-	-	V
Input Noise Current (f = 1kHz, Rg = 0Ω)	+25°C	-	5	-	-	5	-	$pA/\sqrt{Hz}$
Input Noise Voltage (f = 1kHz, Rg = 0Ω)	+25°C	-	6	-	-	6	-	$nV/\sqrt{Hz}$
TRANSFER CHARACTERISTICS								
Large Signal Voltage Gain (Notes 3)	+25°C	15K	30K	-	10K	30K	-	V/V
	Full	5K	-	-	5K	-	-	V/V
Common Mode Rejection Ratio (Note 4)	Full	74	95	-	74	95	-	dB
Minimum Stable Gain	+25°C	5	-	-	5	-	-	V/V
Gain-Bandwidth-Product (Notes 5 & 6)	+25°C	-	150	-	-	150	-	MHz
OUTPUT CHARACTERISTICS								
Output Voltage Swing (Note 3)	Full	±5	±8	-	±5	±8	-	V
Output Current (Note 3)	+25°C	±25	±30	-	±25	±30	-	mA
Output Resistance	+25°C	-	30	-	-	30	-	Ω
Full Power Bandwidth (Note 3 & 7)	+25°C	5	6.5	-	5	6.5	-	MHz
TRANSIENT RESPONSE (Note 8)								
Rise Time	+25°C	-	13	18	-	13	18	ns
Overshoot	+25°C	-	8	-	-	8	-	%
Slew Rate	+25°C	160	200	-	160	200	-	V/µs
Settling Time:								
5V Step to 0.1%	+25°C	-	70	-	-	70	-	ns
5V Step to 0.01%	+25°C	-	100	-	-	100	-	ns
2.5V Step to 0.1%	+25°C	-	50	-	-	50	-	ns
2.5V Step to 0.01%	+25°C	-	80	-	-	80	-	ns
POWER SUPPLY CHARACTERISTICS								
Supply Current	Full	-	19	28	-	19	28	mA
Power Supply Rejection Ratio (Note 9)	Full	70	90	-	70	90	-	dB

NOTES:

1. Absolute Maximum Ratings are limiting values applied individually beyond which the serviceability of the circuit may be impaired. Functional operation under any of these conditions is not necessarily implied.
2. Recommended heat sinks: For TO-8 Metal Can, Thermalloy #2240A ($\theta_{SA} = 27^{\circ}C/W$) or #2268B ($\theta_{SA} = 24^{\circ}C/W$). For 14 pin Ceramic DIP: AAVID #5602B ($\theta_{SA} = 16^{\circ}C/W$). See Die Characteristics Section for θ_{ja}/θ_{jc} values.
3. $R_L = 200\Omega$, $C_L < 10pF$, $V_{OUT} = \pm 5V$.
4. $\Delta V_{CM} = \pm 5V$.
5. $V_{OUT} = 90mV$.
6. $A_V = 10$.
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 data sheet.
9. $\Delta V_{SUPPLY} = \pm 10V$ D.C. to $\pm 20V$ D.C.

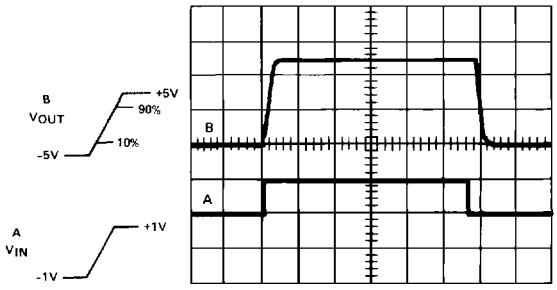
Test Circuits

LARGE AND SMALL SIGNAL RESPONSE TEST CIRCUIT*

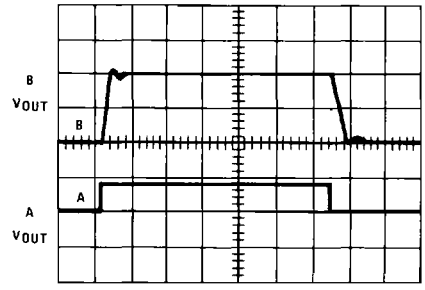


$A_V = 5$
* $C_L < 10pF$

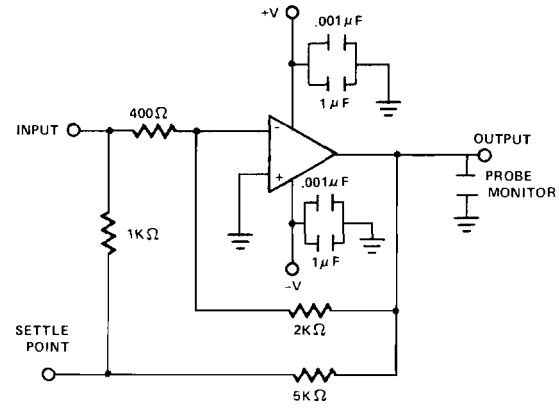
LARGE SIGNAL RESPONSE
Vertical Scale: (Volts: A = 2.0V/Div., B = 4.0/Div.)
Horizontal Scale: (Time: 100ns/Div.)



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



SETTLING TIME TEST CIRCUIT

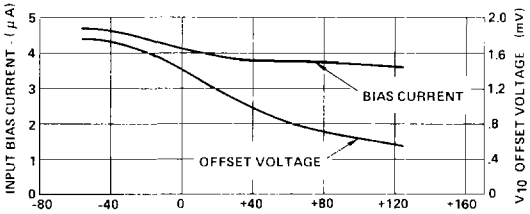


- $A_V = -5$
- Load Capacitance should be less than 10pF.
- It is recommended that resistors be carbon composition and that feedback and summing network ratios be matched to 0.1%.
- Settle Point (Summing Node) capacitance should be less than 10pF. For optimum settling time results, it is recommended that the test circuit be constructed directly onto the device pins. A Tektronix 568 Sampling Oscilloscope with S-3A sampling heads is recommended as a settle point monitor.

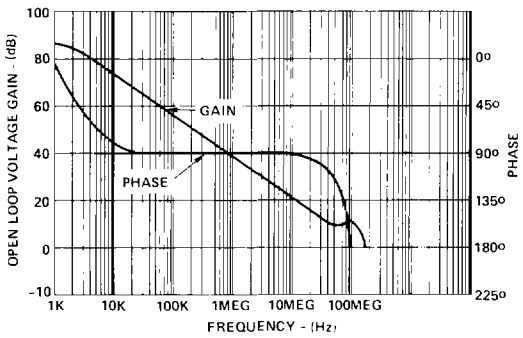
Typical Performance Curves

V+ = +15V, V- = -15V, T_A = +25°C, Unless Otherwise Specified.

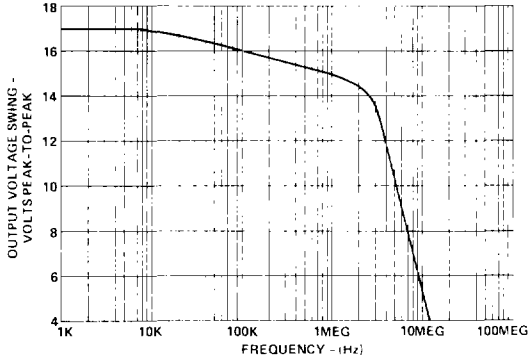
INPUT OFFSET VOLTAGE AND BIAS CURRENT vs. TEMPERATURE



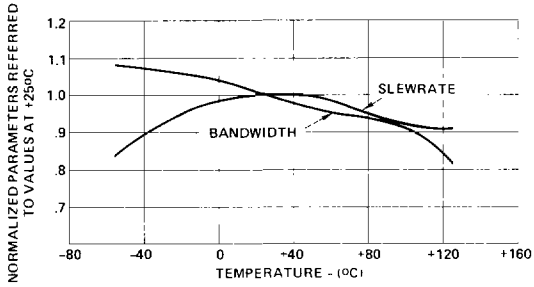
OPEN LOOP FREQUENCY RESPONSE



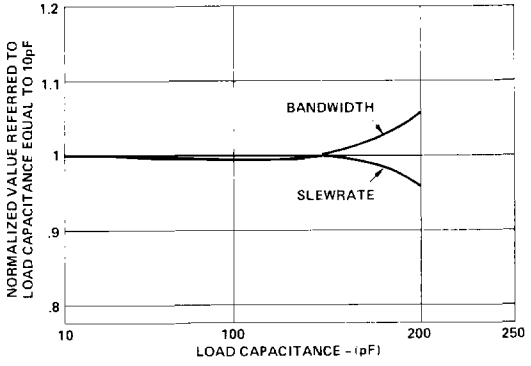
OUTPUT VOLTAGE SWING vs. FREQUENCY



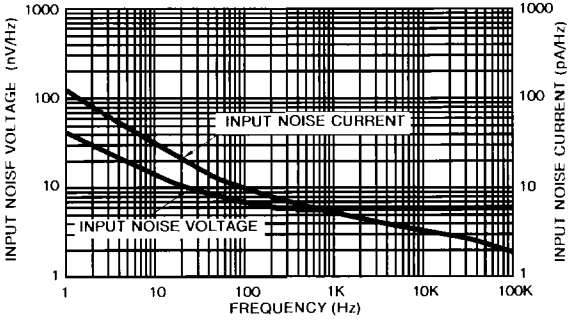
NORMALIZED AC PARAMETERS vs. TEMPERATURE



NORMALIZED AC PARAMETERS vs. LOAD CAPACITANCE

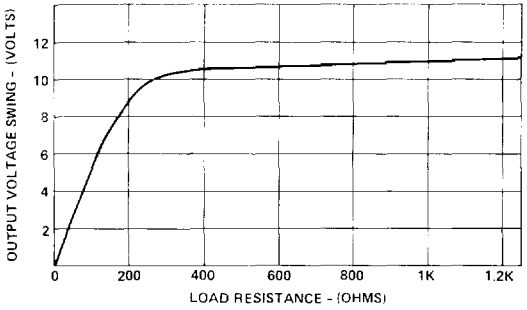


INPUT NOISE VOLTAGE AND NOISE CURRENT vs. FREQUENCY

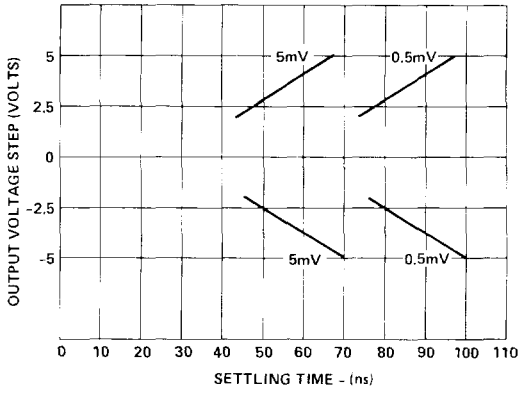


Typical Performance Curves (Continued)

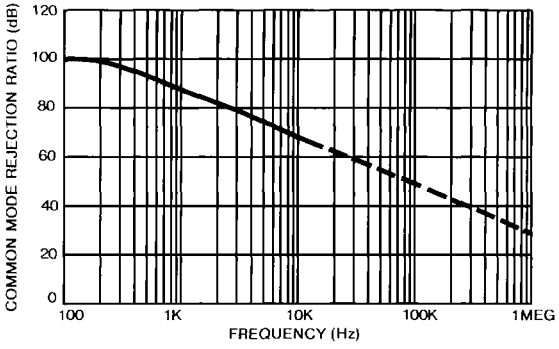
OUTPUT VOLTAGE SWING vs. LOAD RESISTANCE



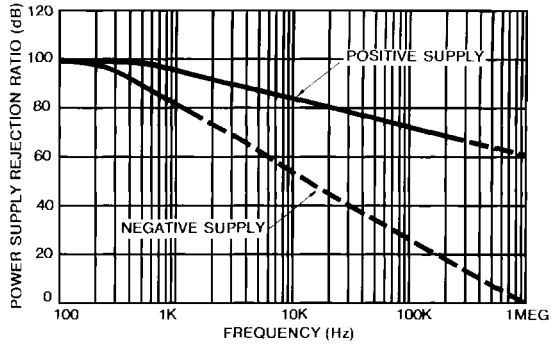
SETTLING TIME FOR VARIOUS OUTPUT STEP VOLTAGES



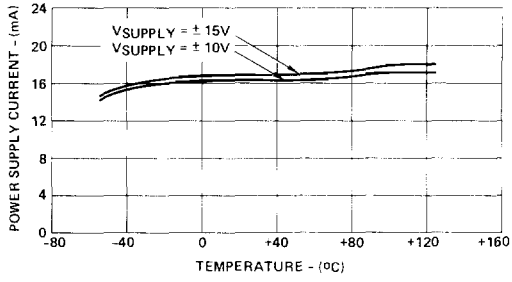
COMMON MODE REJECTION RATIO vs. FREQUENCY



POWER SUPPLY REJECTION RATIO vs. FREQUENCY



POWER SUPPLY CURRENT vs. TEMPERATURE



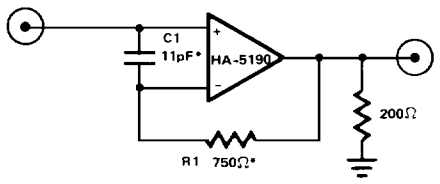
Applying the HA-5190/5195

1. POWER SUPPLY DECOUPLING: Although not absolutely necessary, it is recommended that all power supply lines be decoupled with 0.01μF ceramic capacitors to ground. Decoupling capacitors should be located as near to the amplifier terminals as possible.
2. STABILITY CONSIDERATIONS: HA-5190/5195 is stable at gains ≥ 5. Gains < 5 are covered elsewhere in this data sheet. Feedback resistors should be of carbon composition located as near to the input terminals as possible.
3. WIRING CONSIDERATIONS: Video pulse circuits should be built on a ground plane. Minimum point to point connections directly to the amplifier terminals should be used. When ground planes cannot be used, good single point grounding techniques should be applied.
4. OUTPUT SHORT CIRCUIT: HA-5190/5195 does not have output short circuit protection. Short circuits to ground can be tolerated for approximately 10 seconds. Short circuits to either supply will result in immediate destruction of the device.
5. HEAVY CAPACITIVE LOADS: When driving heavy capacitive loads (≥ 100pF) a small resistor (≈100Ω) should be connected in series with the output and inside the feedback loop.

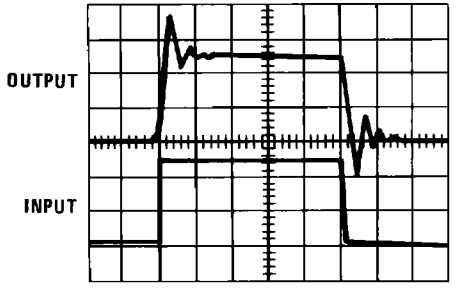
Typical Applications (Also see Application Notes 525 and 526)

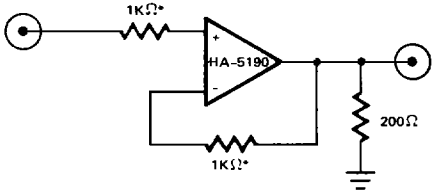
SUGGESTED COMPENSATION FOR UNITY GAIN STABILITY:

NONINVERTING

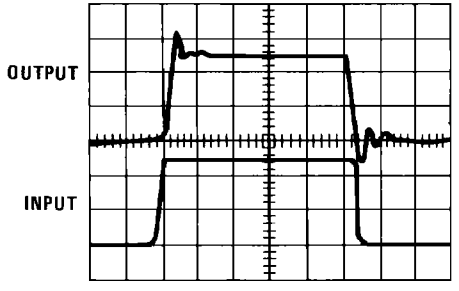


Vertical Scale: (Volts: 2V/Div.)
Horizontal Scale: (Time: 100ns/Div.)



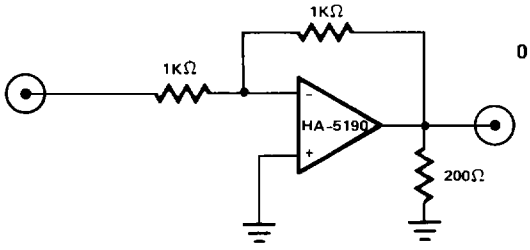


Vertical Scale: (Volts: 2V/Div.)
Horizontal Scale: (Time: 100ns/Div.)

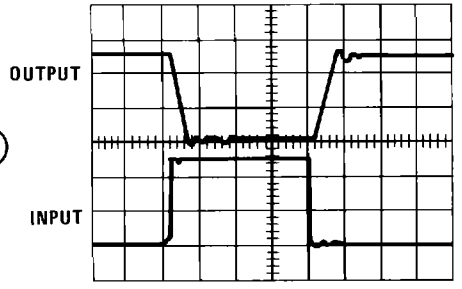


* Values were determined experimentally for optimum speed and settling time. R1 and C1 should be optimized for each particular application to ensure best overall frequency response.

INVERTING

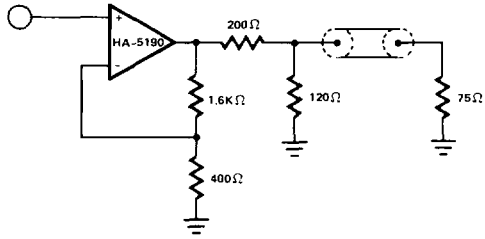


Vertical Scale: (Volts: 2V/Div.)
Horizontal Scale: (50ns/Div.)

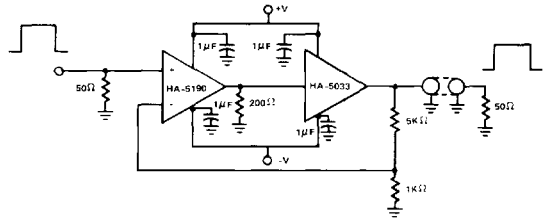


Typical Applications (Continued)

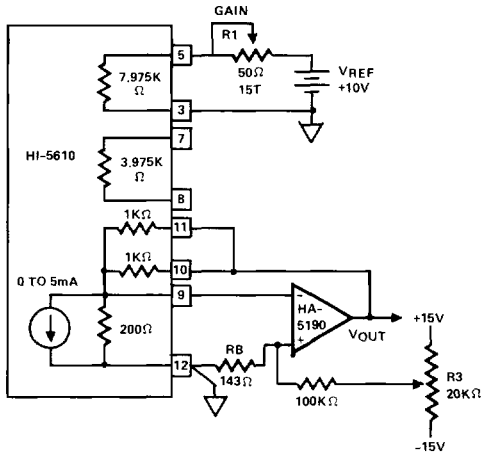
VIDEO PULSE AMPLIFIER/75Ω COAXIAL DRIVER



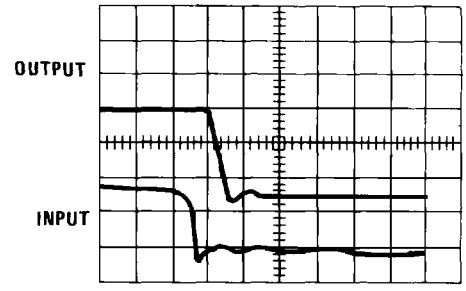
VIDEO PULSE AMPLIFIER COAXIAL LINE DRIVER



FAST DAC OUTPUT BUFFER



Vertical Scale: (Volts: 2V/Div.)
Horizontal Scale: (Time: 50ns/Div.)
B = V_{OUT} C = Digital Input



* Time delay between B and C represents total time delay for 0V to +5V full scale coded change.

Die Characteristics

Transistor Count 49
Die Dimensions ..... 0.087 x 0.052 x 0.019 inches (2210 x 1320 x 483 μm)
Substrate Potential (Powered Up)* ..... V-
Process ..... High Frequency Bipolar Dielectric Isolation
Passivation ..... Nitride

Thermal Constants (°C/W)	θ_{ja}	θ_{jc}
Ceramic DIP	104	48
Metal Can	87	32

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