T-79-25

HARRIS

HA-5033

August 1991

Video Buffer

Features

- Differential Phase Error .... 0.1 Degree
- Differential Gain Error 0.1%
- High Slew Rate 1300V/μs
- Wide Bandwidth (Small Signal) 250MHz
- Wide Power Bandwidth .... DC to 65MHz
- Fast Rise Time 3ns
- High Output Drive .... ±8V With 100Ω Load
- Wide Power Supply Range .... ±5V to ±16V
- Replace Costly Hybrids

Applications

- Video Buffer
- High Frequency Buffer
- Isolation Buffer
- High Speed Line Driver
- Impedance Matching
- Current Boosters
- High Speed A/D Input Buffers
- For Further Application Ideas, See App. Note 548

Description

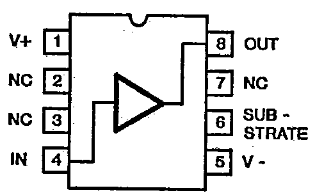
The HA-5033 is a unity gain monolithic I.C. designed for any application requiring a fast, wideband buffer. Featuring a bandwidth of 250MHz and outsanding differential phase/gain characteristics, this high performance voltage follower is an excellent choice for video circuit design. Other features, which include a minimum slew rate of 1000V/μs and high output drive capability, make the HA-5033 applicable for line driver and high speed data conversion circuits.

The high performance of this product is a result of the Harris Dielectric Isolation process. A major feature of this process is that it produces both PNP and NPN high frequency transistors which makes wide bandwidth designs, such as the HA-5033, practical. Alternative process methods typically produce a lower AC performance.

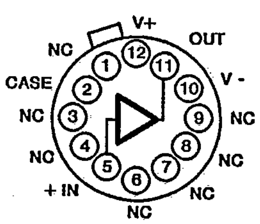
The HA-5033 is available in a 12 pin (TO-8) Metal Can or in 8 pin Plastic Mini-DIP and SOIC packages.

Pinouts

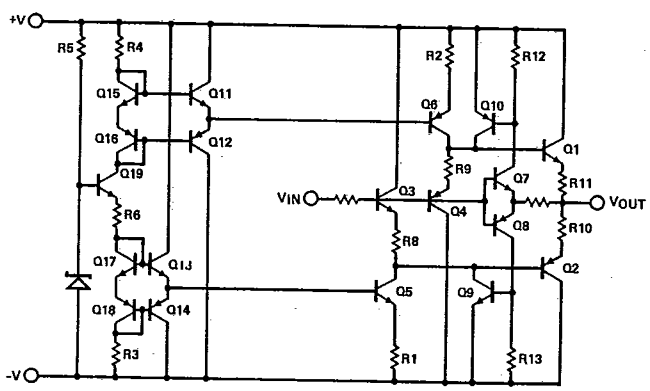
HA3-5033-5 (PLASTIC MINI-DIP)
HA9P5033-5/-9 (SOIC)
TOP VIEW



HA2-5033-2/-5 (TO-8 METAL CAN)
TOP VIEW



Schematic



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

File Number 2924

Absolute Maximum Ratings (Note 1)

Voltage Between V+ and V- Pins 40V
Input Voltage .... Equal to Supplies
Output Current (Peak) (50ms On/1 Second Off) .... ±200mA
Internal Power Dissipation (Note 2)
TO-8 (+25°C) 1.75W
Mini-DIP (+25°C) 1.95W

Operating Temperature Ranges

HA-5033-2 .... $-55^oC \le T_A \le +125^oC$
HA-5033-5 .... $0^oC \le T_A \le +75^oC$
HA-5033-9 .... $-40^oC \le T_A \le +85^oC$
Storage Temperature Range .... $-65^oC \le T_A \le +150^oC$
Maximum Junction Temperature .... +175°C
Maximum Junction Temperature (Plastic Packages) ..... +150°C

Electrical Specifications $V_{SUPPLY} = \pm12V$, $R_S = 50\Omega$, $R_L = 100\Omega$, $C_L = 10pF$, Unless Otherwise Specified.

PARAMETER	TEMP	HA-5033-2 MIN	HA-5033-2 TYP	HA-5033-2 MAX	HA-5033-5 MIN	HA-5033-5 TYP	HA-5033-5 MAX	NOTE 10 HA-5033-9 MAX	UNITS
INPUT CHARACTERISTICS									
Offset Voltage	+25°C	-	5	15	-	5	15	15	mV
	Full	-	6	25	-	6	25	30	mV
Average Offset Voltage Drift	Full	-	33	-	-	33	-	-	µV/°C
Bias Current	+25°C	-	20	35	-	20	35	35	µA
	Full	-	30	50	-	30	50	50	µA
Input Resistance	+25°C	-	1.5	-	-	1.5	-	-	MΩ
Input Capacitance	+25°C	-	1.6	-	-	1.6	-	-	pF
Input Noise Voltage (Note 3)	+25°C	-	20	-	-	20	-	-	µVp-p
TRANSFER CHARACTERISTICS									
Voltage Gain									
$R_L = 100\Omega$	+25°C	0.93	-	-	0.93	-	-	-	V/V
$R_L = 1k\Omega$	+25°C	0.93	0.99	-	0.93	0.99	-	-	V/V
$R_L = 100\Omega$	Full	0.92	-	-	0.92	-	-	-	V/V
-3dB Bandwidth	+25°C	-	250	-	-	250	-	-	MHz
OUTPUT CHARACTERISTICS									
Output Voltage Swing									
$R_L = 100\Omega$	Full	±8	±10	-	±8	±10	-	-	V
$R_L = 1k\Omega$ (Note 4)	Full	±11	±12	-	±11	±12	-	-	V
Output Current	+25°C	±80	±100	-	±80	±100	-	-	mA
Output Resistance	+25°C	-	5	-	-	5	-	-	Ω
Full Power Bandwidth									
(Note 5)	+25°C	-	146	-	-	146	-	-	MHz
(Note 7)	+25°C	15.9	-	-	15.9	-	-	-	MHz
TRANSIENT RESPONSE									
Rise Time (Note 6)	+25°C	-	3	-	-	3	-	-	ns
Propagation Delay	+25°C	-	1	-	-	1	-	-	ns
Overshoot	+25°C	-	10	-	-	10	-	-	%
Slew Rate (Note 7)	+25°C	1	1.3	-	1	1.3	-	-	V/ns
Settling Time to 0.1%	+25°C	-	50	-	-	50	-	-	ns
Differential Phase Error (Note 8)	+25°C	-	0.1	-	-	0.1	-	-	Degree
Differential Gain Error (Note 8)	+25°C	-	0.1	-	-	0.1	-	-	%
POWER SUPPLY CHARACTERISTICS									
Supply Current	+25°C	-	21	25	-	21	25	25	mA
	Full	-	21	30	-	21	30	30	mA
Power Supply Rejection Ratio	Full	54	-	-	54	-	-	-	dB
Harmonic Distortion (Note 9)	+25°C	-	<0.1	-	-	<0.1	-	-	%

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. TO-8: $\theta_{ja} = 101^oC/W$, $\theta_{jc} = 33^oC/W$ Recommended heat sinks for the TO-8: Thermalloy 2240A, $\theta_{sa} = 27^oC/W$, IERC Up-TO-8-48CB, $\theta_{sa} = 10^oC/W$. Mini-DIP: $\theta_{ja} = 91^oC/W$, $\theta_{sa} = 40^oC/W$.
3. 10Hz to 1MHz
4. $\pm V_{SUPPLY} = \pm15V$
5. $V_{OUT} = 1V_{RMS}$, $R_L = 1k\Omega$
6. $V_{OUT} = 500mV$
7. $\pm V_{SUPPLY} = \pm15V$, $V_{OUT} = \pm10V$, $R_L = 1k\Omega$.
8. Differential gain and phase error are non-linear signal distortions found in video systems and are defined as follows: Differential gain error is defined as the change in amplitude at the color subcarrier frequency as the picture signal is varied from blanking to white level. Differential phase error is defined as the change in the phase of the color subcarrier as the picture signal is varied from blanking to white level. Differential gain and phase error were too small to be measured with a Tektronix 520A NTSC Vector Scope.
9. $V_{IN} = 1V_{RMS}$
10. Typical and minimum specification for the -9 version are the same as those for the -5 version.

Operating Instructions

Layout Considerations

The wide bandwidth of the HA-5033 necessitates that high frequency circuit layout procedures be followed. Failure to follow these guidelines can result in marginal performance.

Probably the most crucial of the RF/video layout rules is the use of a ground plane. A ground plane provides isolation and minimizes distributed circuit capacitance and inductance which will degrade high frequency performance. This ground plane shielding can also incorporate the metal case of the HA-5033 since pin #2 is internally tied to the package. This feature allows the user to make metal to metal contact between the ground plane and the package, which extends shielding, provides additional heat sinking and eliminates the use of a socket, IC sockets contribute inter-lead capacitance which limits device bandwidth and should be avoided.

For the plastic Mini-DIP, pin 6 can be tied to either supply, grounded, or simply not used. But to optimize device performance and improve isolation, it is recommended that this pin be grounded.

Other considerations are proper power supply bypassing and keeping the input and output connections as short as possible which minimizes distributed capacitance and reduces board space.

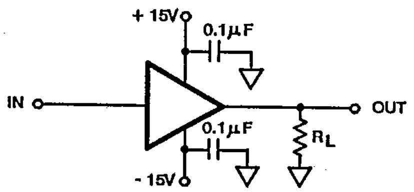
Power Supply Decoupling

For optimum device performance, it is recommended that the positive and negative power supplies be bypassed with capacitors to ground. Ceramic capacitors ranging in value from 0.01 to 0.1μF will minimize high frequency variations in supply voltage. Solid tantalum capacitors 1μF or larger will optimize low frequency performance.

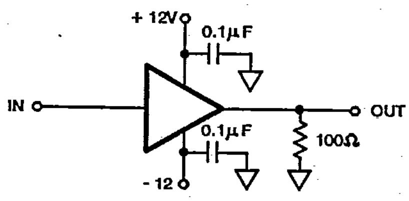
It is also recommended that the bypass capacitors be connected close to the HA-5033 (preferably directly to the supply pins).

Test Circuits

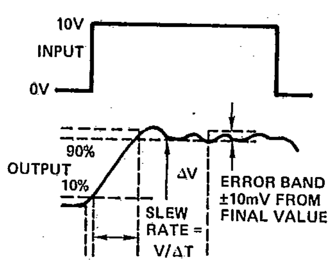
SLEW RATE AND SETTLING TIME



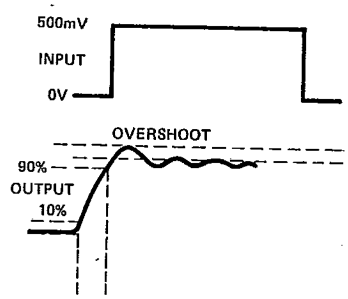
TRANSIENT RESPONSE



SETTLING TIME



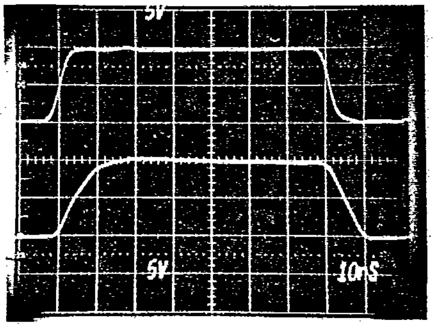
RISE TIME



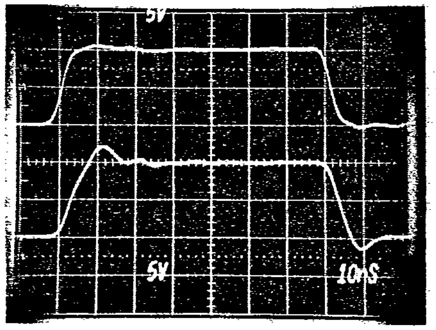
NOTE: Measured on both positive and negative transitions.

Test Circuits (Continued)

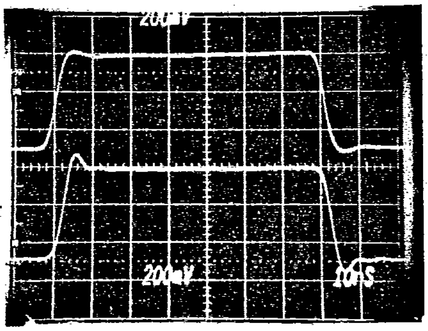
+10V RESPONSE
T_A = +25°C, R_S = 50Ω, R_L = 100Ω



+10V RESPONSE
T_A = +25°C, R_S = 50Ω, R_L = 1kΩ

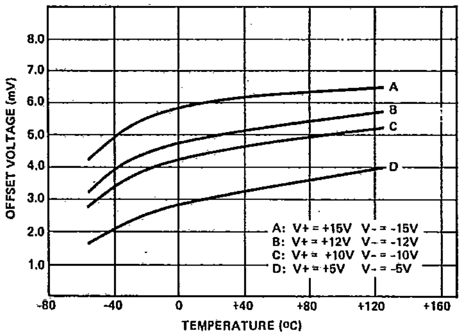


+0.5V PULSE RESPONSE
T_A = +25°C, R_S = 50Ω, R_L = 100Ω

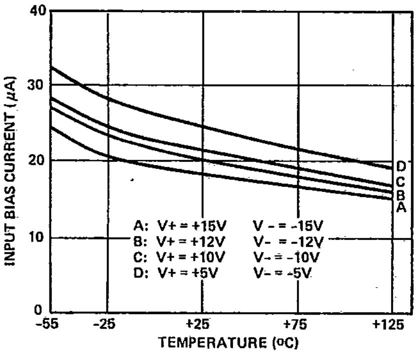


Typical Performance Curves

INPUT OFFSET VOLTAGE vs.
TEMPERATURE vs. SUPPLY VOLTAGE



INPUT BIAS CURRENT vs.
TEMPERATURE vs. SUPPLY VOLTAGE

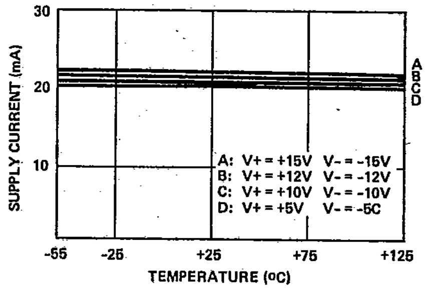


3

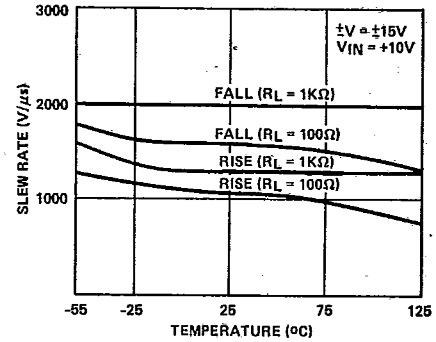
OPERATIONAL AMPLIFIERS

Typical Performance Curves (Continued)

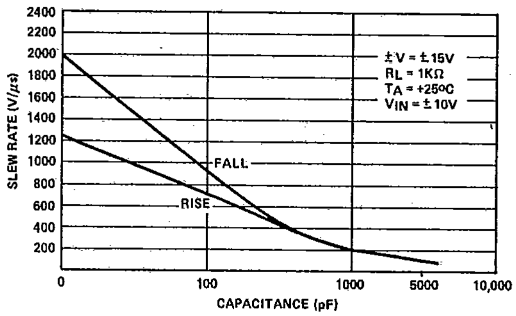
SUPPLY CURRENT vs. TEMPERATURE vs. SUPPLY VOLTAGE



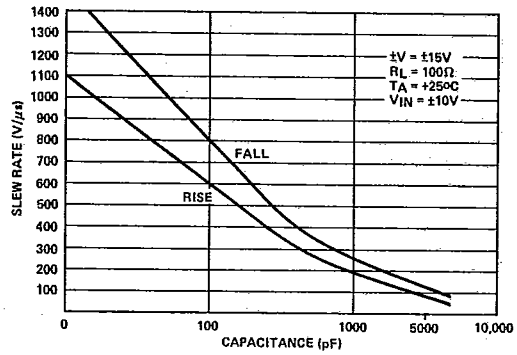
SLEW RATE vs. TEMPERATURE



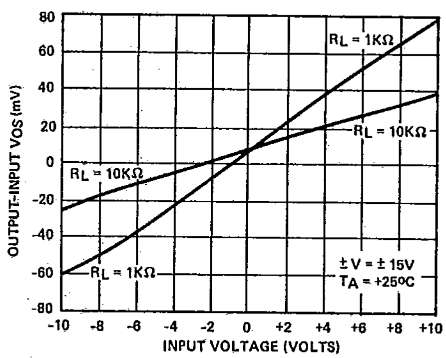
SLEW RATE vs. LOAD CAPACITANCE (R_L = 1kΩ)



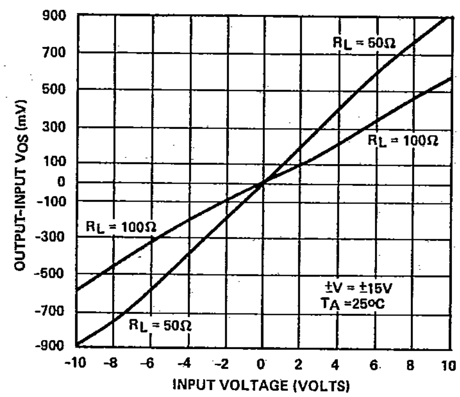
SLEW RATE vs. LOAD CAPACITANCE (R_L = 100Ω)



GAIN ERROR vs. INPUT VOLTAGE

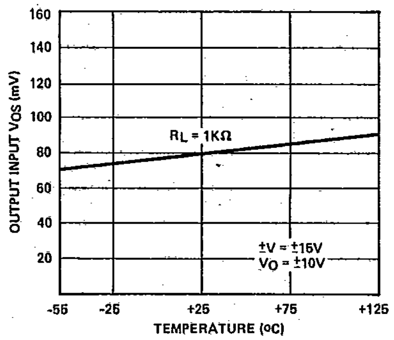


GAIN ERROR vs. INPUT VOLTAGE

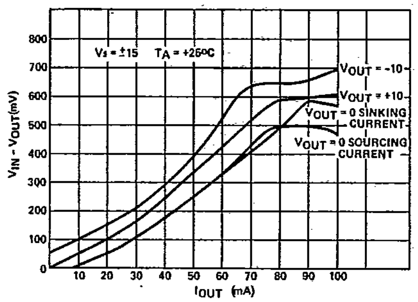


Typical Performance Curves (Continued)

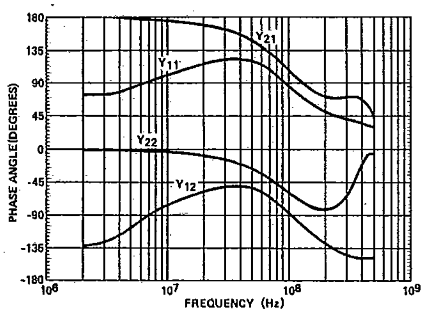
GAIN ERROR vs. TEMPERATURE



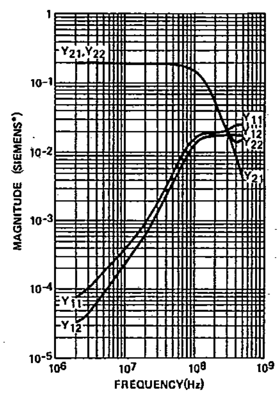
VIN - VOUT vs. IOUT



Y - PARAMETERS PHASE vs. FREQUENCY

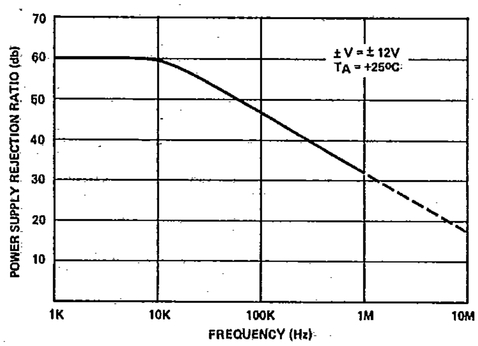


Y - PARAMETER MAGNITUDE vs. FREQUENCY

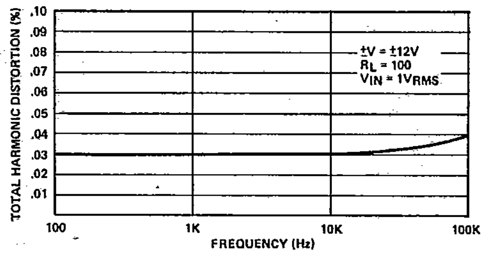


* Siemens = Ω -1

POWER SUPPLY REJECTION RATIO vs. FREQUENCY



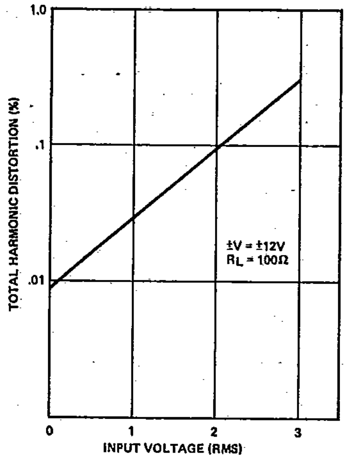
TOTAL HARMONIC DISTORTION vs. FREQUENCY



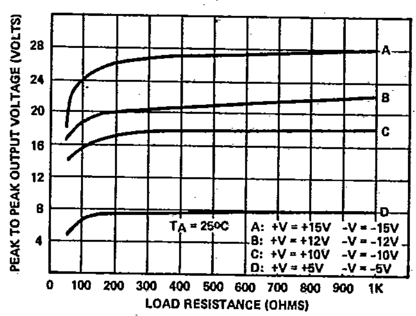
3
OPERATIONAL AMPLIFIERS

Typical Performance Curves (Continued)

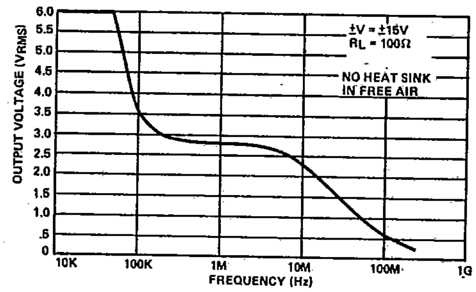
TOTAL HARMONIC DISTORTION vs. RMS INPUT VOLTAGE



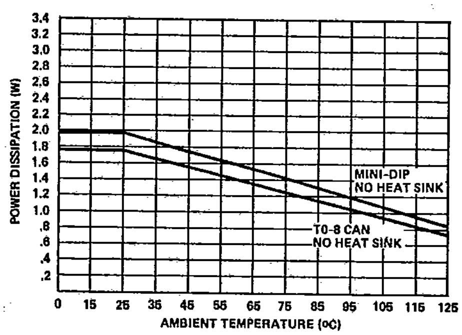
OUTPUT VOLTAGE SWING vs. LOAD RESISTANCE vs. SUPPLY VOLTAGE



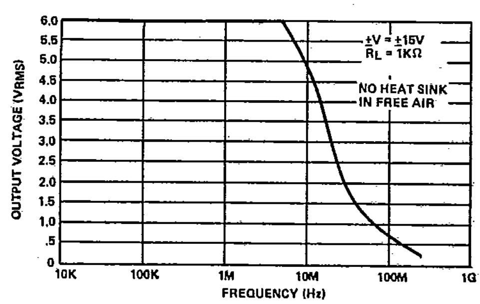
OUTPUT SWING vs. FREQUENCY*



MAXIMUM POWER DISSIPATION vs. AMBIENT TEMPERATURE



OUTPUT SWING vs. FREQUENCY*



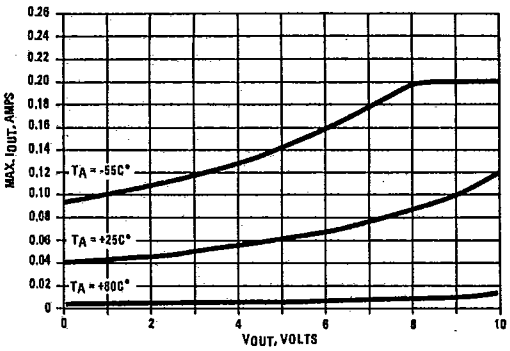
* This curve was obtained by noting the output voltage necessary to produce an observable distortion for a given frequency. If higher distortion is acceptable, then a higher output voltage for a given frequency can be obtained.

However, operating the HA-5033 with increased distortion (to the right of curve shown), will also be accompanied by an increase in supply current. The resulting increase in chip temperature must be considered and heat sinking will be necessary to prevent thermal runaway.

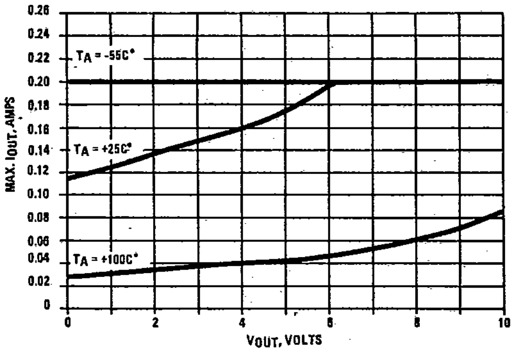
This characteristic is the result of the output transistor operation. If the signal amplitude or signal frequency or both are increased beyond the curve shown, the NPN, PNP output transistors will approach a condition of being simultaneously on. Under this condition, thermal runaway can occur.

Typical Performance Curves (Continued)

HA-5033 SOA, TO-8, NO SINK
T_J = +175, I_{CC} = 30mA, V_{CC} = ±15, θ_{ja} = 101°C/W

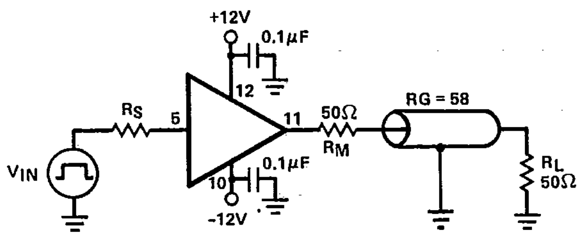


HA-5033, TO-8, AAVID 5792 θ_{sa} = 25°C/W
T_J = +175, I_{CC} = 30mA, V_{CC} = ±15, θ_{jc} = 33°C/W



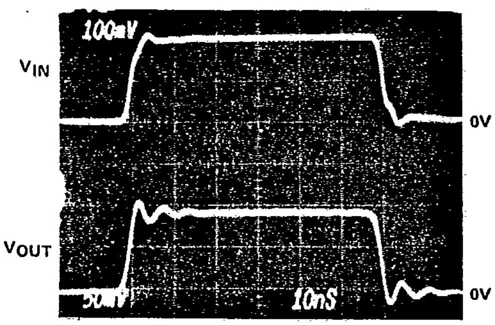
Typical Applications (Also See Application Note 548)

VIDEO COAXIAL LINE DRIVER - 50V SYSTEM



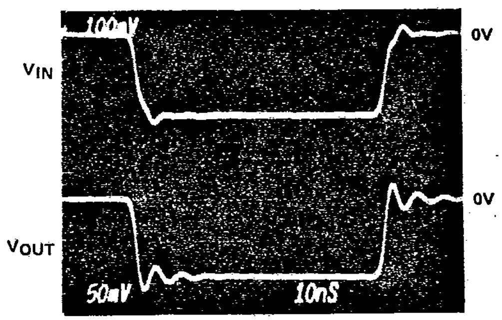
POSITIVE PULSE RESPONSE
T_A = +25°C, R_S = 50Ω, R_M = R_L = 50Ω

$$V_O = V_{IN}\left(\frac{R_L}{R_L + R_M}\right) = \frac{1}{2} V_{IN}$$



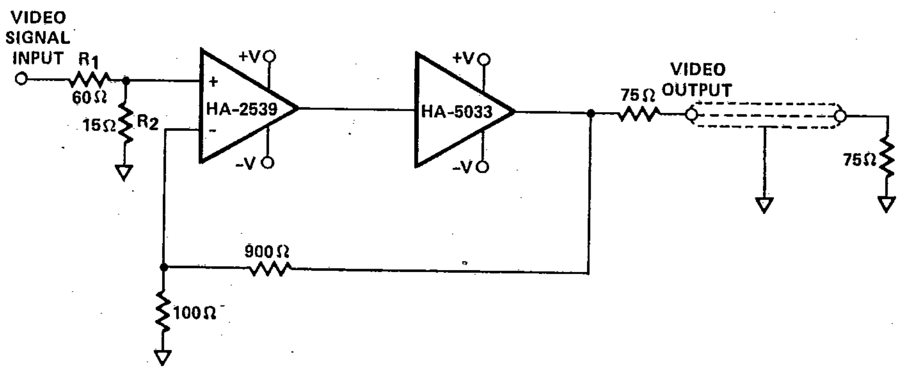
NEGATIVE PULSE RESPONSE
T_A = +25°C, R_S = 50Ω, R_M = RL = 50Ω

$$V_O = V_{IN}\left(\frac{R_L}{R_L + R_M}\right) = \frac{1}{2} V_{IN}$$



Typical Applications (Continued)

VIDEO GAIN BLOCK



Die Characteristics

Transistor Count 20
Die Dimensions .... 50 x 66 x 19mils (1270 x 1660 x 480μm)
Substrate Potential* .... V-
Process .... High Frequency Bipolar-DI
Passivation .... Nitride

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