Low Power, High Speed Operational Amplifier

FEATURES

- Gain-Bandwidth Product 50MHz
- Unity-Gain Stable
- Slew Rate 165V/µs
- Output Current ±20mA
- Low Supply Current 12mA
- High Open-Loop Gain 7.5V/mV
- Low Cost
- Single Supply 5V Operation
- Industry Standard Pinout
- Output Shutdown

APPLICATIONS

- Video Cable Drivers
- Video Signal Processing
- Fast Peak Detectors
- Fast Integrators
- Video Cable Drivers
- Pulse Amplifiers

DESCRIPTION

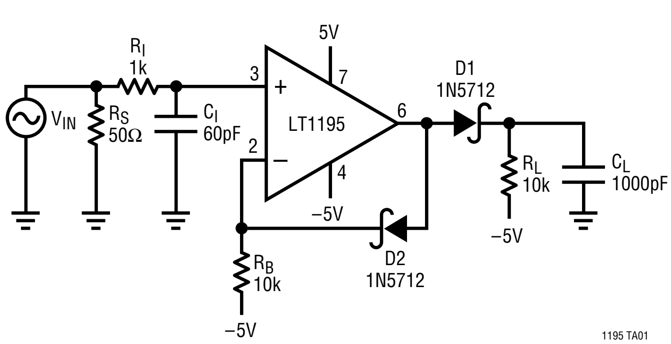
The LTC1195 is a video operational amplifier optimized for operation on single 5V and ±5V supply. Unlike many high speed amplifiers, the LT1195 features high open-loop gain, over 75dB, and the ability to drive heavy loads to a full power bandwidth of 8.5 MHz at $6V_{P-P}$. The LT1195 has a unity-gain stable bandwidth of 50MHz, and a 60° phase margin, and consumes only 12mA of supply current, making it extremely easy to use.

Because the LT1195 is a true operational amplifier, it is an ideal choice for wideband signal conditioning, fast integrators, peak detectors, active filters, and applications requiring speed, accuracy, and low cost.

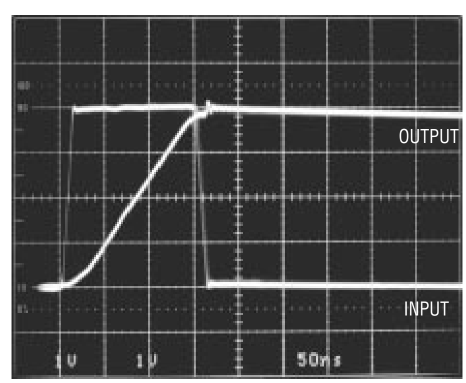
The LT1195 is a low power version of the popular LT1190, and is available in 8-pin miniDIPs and SO packages with standard pinouts. The normally unused pin 5 is used for a shutdown feature that shuts off the output and reduces power dissipation to a mere 15mW.

TYPICAL APPLICATION

Fast Pulse Detector



Pulse Detector Response



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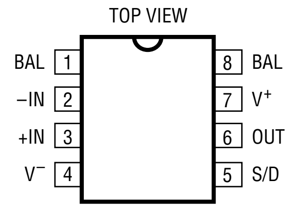
ABSOLUTE MAXIMUM RATINGS

Total Supply Voltage (V^+ to V^-) 18V
Differential Input Voltage .... ±6V
Input Voltage .... $\pm V_S$
Output Short-Circuit Duration (Note 1) .... Continuous
Operating Temperature Range
  LT1195M .... –55°C to 125°C
  LT1195C .... 0°C to 70°C
Junction Temperature (Note 2)
  Plastic Package (CN8, CS8) .... 150°C
  Ceramic Package (CJ8, MJ8) .... 175°C
Storage Temperature Range .... –65°C to 150°C
Lead Temperature (Soldering, 10 sec) .... 300°C

PACKAGE/ORDER INFORMATION



J8 PACKAGE 8-LEAD CERAMIC DIP
N8 PACKAGE 8-LEAD PLASTIC DIP
S8 PACKAGE 8-LEAD PLASTIC SOIC

T_{JMAX} = 175°C, θ_{JA} = 100°C/W (J8)
T_{JMAX} = 150°C, θ_{JA} = 100°C/W (N8)
T_{JMAX} = 150°C, θ_{JA} = 150°C/W (S8)

ORDER PART NUMBER
LT1195MJ8 LT1195CJ8 LT1195CN8 LT1195CS8
S8 PART MARKING
1195

±5V ELECTRICAL CHARACTERISTICS T_A = 25°C

V_S = ±5V, $C_L \le$ 10pF, pin 5 open circuit, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS	LT1195M/C MIN	TYP	MAX	UNITS
V_{OS}	Input Offset Voltage	J8, N8 Package		3.0	8.0	mV
		S8 Package		3.0	10.0	mV
I_{OS}	Input Offset Current			0.2	1.0	µA
I_B	Input Bias Current			±0.5	±2.0	µA
e_n	Input Noise Voltage	f_O = 10kHz		70		nV/√Hz
i_n	Input Noise Current	f_O = 10kHz		2.0		pA/√Hz
R_{IN}	Input Resistance – Differential Mode			230		kΩ
	Input Resistance – Common Mode			20		MΩ
C_{IN}	Input Capacitance	A_V = 1		2.2		pF
	Input Voltage Range	(Note 3)	–2.5		3.5	V
CMRR	Common-Mode Rejection Ratio	V_{CM} = –2.5 to 3.5V	60	85		dB
PSRR	Power Supply Rejection Ratio	V_S = ±2.375V to ±8V	60	85		dB
A_{VOL}	Large-Signal Voltage Gain	R_L = 1k, V_{OUT} = ±3V	2.0	7.5		V/mV
		R_L = 150Ω, V_{OUT} = ±3V	0.5	1.5		V/mV
		V_S = ±8V, R_L = 1k, V_{OUT} = ±5V		11.0		V/mV
V_{OUT}	Output Voltage Swing	V_S = ±5V, R_L = 1k	±3.8	±4.0		V
		V_S = ±8V, R_L = 1k	±6.7	±7.0		V
SR	Slew Rate	A_V = –1, R_L = 1k, (Note 4, 9)	110	165		V/µs
FPBW	Full Power Bandwidth	V_{OUT} = 6V_{P-P}, (Note 5)		8.75		MHz
GBW	Gain-Bandwidth Product			50		MHz
t_{r1}, t_{f1}	Rise Time, Fall Time	A_V = 50, V_{OUT} = ±1.5V, 20% to 80%, (Note 9)	125	170	250	ns
t_{r2}, t_{f2}	Rise Time, Fall Time	A_V = 1, V_{OUT} = ±125mV, 10% to 90%		3.4		ns
t_{PD}	Propagation Delay	A_V = 1, V_{OUT} = ±125mV, 50% to 50%		2.5		ns
	Overshoot	A_V = 1, V_{OUT} = ±125mV		22		%
t_S	Settling Time	3V Step, 0.1%, (Note 6)		220		ns
Diff A_V	Differential Gain	R_L = 150Ω, A_V = 2, (Note 7)		1.25		%
Diff Ph	Differential Phase	R_L = 150Ω, A_V = 2, (Note 7)		0.86		DEG_{P-P}

LINEAR TECHNOLOGY

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±5V ELECTRICAL CHARACTERISTICS $T_A = 25°C$

$V_S = ±5V$, $C_L \le 10pF$, pin 5 open circuit, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS	LT1195M/C MIN	TYP	MAX	UNITS
I_S	Supply Current			12	16	mA
	Shutdown Supply Current	Pin 5 at V^-		0.8	1.5	mA
$I_{S/D}$	Shutdown Pin Current	Pin 5 at V^-		5	25	µA
t_{ON}	Turn-On Time	Pin 5 from V^- to Ground, $R_L = 1k$		160		ns
t_{OFF}	Turn-Off Time	Pin 5 from Ground to V^-, $R_L = 1k$		700		ns

5V ELECTRICAL CHARACTERISTICS $T_A = 25°C$

$V_S^+ = 5V$, V_S^-, = 0V, $V_{CM} = 2.5V$, $C_L \le 10pF$, pin 5 open circuit, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS		LT1195M/C MIN	TYP	MAX	UNITS
V_{OS}	Input Offset Voltage	J8, N8 Package S8 Package			3.0 3.0	9.0 11.0	mV mV
I_{OS}	Input Offset Current				0.2	1.0	µA
I_B	Input Bias Current				±0.5	±2.0	µA
	Input Voltage Range	(Note 3)		2.0		3.5	V
CMRR	Common-Mode Rejection Ratio	$V_{CM} = 2V$ to $3.5V$		60	85		dB
A_{VOL}	Large-Signal Voltage Gain	$R_L = 150\Omega$ to Ground, $V_{OUT} = 1V$ to $3V$		0.5	3.0		V/mV
V_{OUT}	Output Voltage Swing	$R_L = 150\Omega$ to Ground	V_{OUT} High	3.5	3.8		V
			V_{OUT} Low		0.25	0.4	V
SR	Slew Rate	$A_V = –1$, $V_{OUT} = 1V$ to $3V$			140		V/µs
GBW	Gain-Bandwidth Product				45		MHz
I_S	Supply Current				11	15	mA
	Shutdown Supply Current	Pin 5 at V^-			0.8	1.5	mA
$I_{S/D}$	Shutdown Pin Current	Pin 5 at V^-			5	25	µA

±5V ELECTRICAL CHARACTERISTICS $–55°C \le T_A \le 125°C$, (Note 10)

$V_S = ±5V$, pin 5 open circuit, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS	LT1195M MIN	TYP	MAX	UNITS
V_{OS}	Input Offset Voltage			3.0	15.0	mV
$\Delta V_{OS}/\Delta T$	Input V_{OS} Drift			17		µV/°C
I_{OS}	Input Offset Current			0.2	2.0	µA
I_B	Input Bias Current			±0.5	±2.5	µA
CMRR	Common-Mode Rejection Ratio	$V_{CM} = –2.5V$ to $3.5V$	55	85		dB
PSRR	Power Supply Rejection Ratio	$V_S = ±2.375V$ to $±8V$	55	80		dB
A_{VOL}	Large-Signal Voltage Gain	$R_L = 1k$, $V_{OUT} = ±3V$ $R_L = 150\Omega$, $V_{OUT} = ±3V$	1.50 0.25	5.0 0.8		V/mV V/mV
V_{OUT}	Output Voltage Swing	$R_L = 1k$	±3.7	±3.9		V
I_S	Supply Current			12	18	mA
	Shutdown Supply Current	Pin 5 at V^-, (Note 8)		0.8	2.5	mA
$I_{S/D}$	Shutdown Pin Current	Pin 5 at V^-		5	25	µA

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±5V ELECTRICAL CHARACTERISTICS $0°C \le T_A \le 70°C$

V_S = ±5V, pin 5 open circuit, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS	LT1195C MIN	TYP	MAX	UNITS
V_{OS}	Input Offset Voltage	J8, N8 Package S8 Package		3.0 3.0	10.0 15.0	mV mV
$\Delta V_{OS}/\Delta T$	Input V_{OS} Drift			12		μV/°C
I_{OS}	Input Offset Current			0.2	1.7	μA
I_B	Input Bias Current			±0.5	±2.5	μA
CMRR	Common-Mode Rejection Ratio	V_{CM} = –2.5V to 3.5V	60	85		dB
PSRR	Power Supply Rejection Ratio	V_S = ±2.375V to ±5V	60	90		dB
A_{VOL}	Large-Signal Voltage Gain	R_L = 1k, V_{OUT} = ±3V R_L = 150Ω, V_{OUT} = ±3V	2.0 0.3	7.5 1.5		V/mV V/mV
V_{OUT}	Output Voltage Swing	R_L = 1k	±3.7	±3.9		V
I_S	Supply Current			12	17	mA
	Shutdown Supply Current	Pin 5 at $V^–$, (Note 8)		0.9	2.0	mA
$I_{S/D}$	Shutdown Pin Current	Pin 5 at $V^–$		5	25	μA

5V ELECTRICAL CHARACTERISTICS $0°C \le T_A \le 70°C$

V_S^+ = 5V, $V_S^–$ = 0V, V_{CM} = 2.5V, pin 5 open circuit, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS		LT1195C MIN	TYP	MAX	UNITS
V_{OS}	Input Offset Voltage	J8, N8 Package S8 Package			1.0 1.0	10.0 15.0	mV mV
$\Delta V_{OS}/\Delta T$	Input V_{OS} Drift				15		μV/°C
I_{OS}	Input Offset Current				0.2	1.7	μA
I_B	Input Bias Current				±0.5	±2.5	μA
	Input Voltage Range	(Note 3)		2.0		3.5	V
CMRR	Common-Mode Rejection Ratio	V_{CM} = 2V to 3.5V		60	85		dB
V_{OUT}	Output Voltage Swing	R_L = 150Ω to Ground	V_{OUT} High	3.5	3.75		V
			V_{OUT} Low		0.15	0.4	V
I_S	Supply Current				12	16	mA
	Shutdown Supply Current	Pin 5 at $V^–$, (Note 8)			0.9	2.0	mA
$I_{S/D}$	Shutdown Pin Current	Pin 5 at $V^–$			5	25	μA

Note 1: A heat sink may be required to keep the junction temperature below absolute maximum when the output is shorted continuously.

Note 2: T_J is calculated from the ambient temperature T_A and power dissipation P_D according to the following formats:

LT1195MJ8, LT1195CJ8: $T_J = T_A + (P_D \times 100°C/W)$

LT1195N: $T_J = T_A + (P_D \times 100°C/W)$

LT1195CS: $T_J = T_A + (P_D \times 150°C/W)$

Note 3: Exceeding the input common-mode range may cause the output to invert.

Note 4: Slew rate is measured between ±1V on the output, with ±3V input step.

Note 5: Full power bandwidth is calculated from the slew rate measurement: $FPBW = SR/2\pi V_P$.

Note 6: Settling time measurement techniques are shown in "Take the Guesswork Out of Settling Time Measurements," EDN, September 19, 1985.

Note 7: NTSC (3.58MHz). For R_L = 1k, Diff A_V = 0.3%, Diff Ph = 0.35°.

Note 8: See Applications Information section for shutdown at elevated temperatures. Do not operate the shutdown above T_J > 125°C.

Note 9: AC parameters are 100% tested on the ceramic and plastic DIP packaged parts (J8 and N8 suffix) and are sample tested on every lot of the SO packaged parts (S8 suffix).

Note 10: Do not operate at A_V < 2 for T_A < 0°C.

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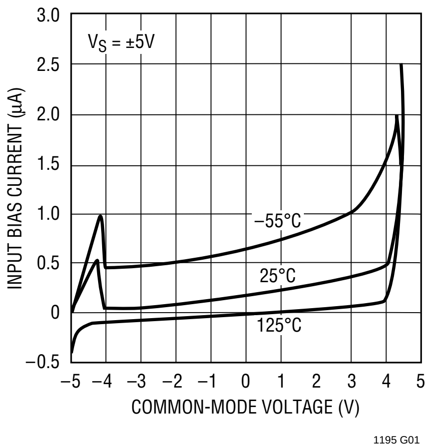
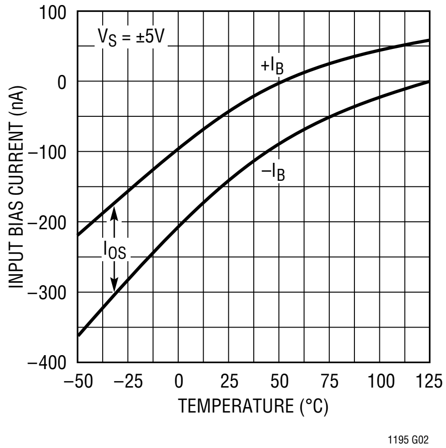
TYPICAL PERFORMANCE CHARACTERISTICS

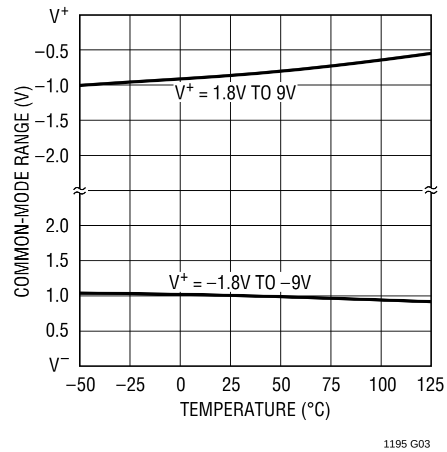
Input Bias Current vs Common-Mode Voltage



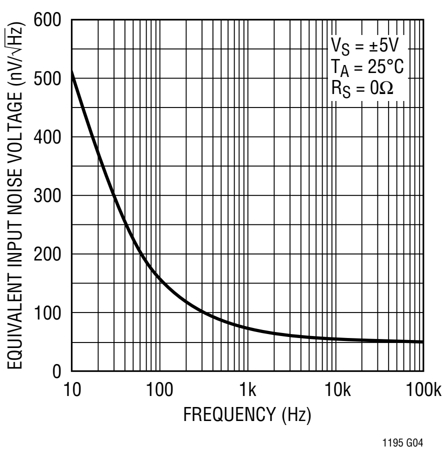
Input Bias Current vs Temperature



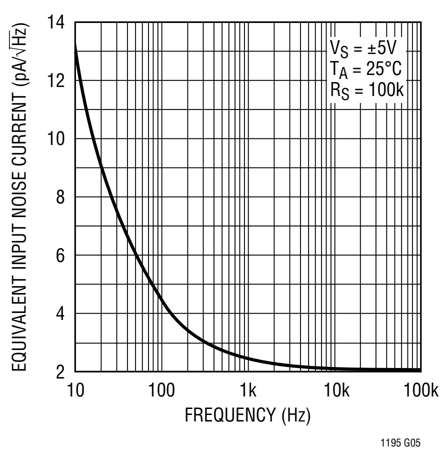
Common-Mode Voltage vs Temperature



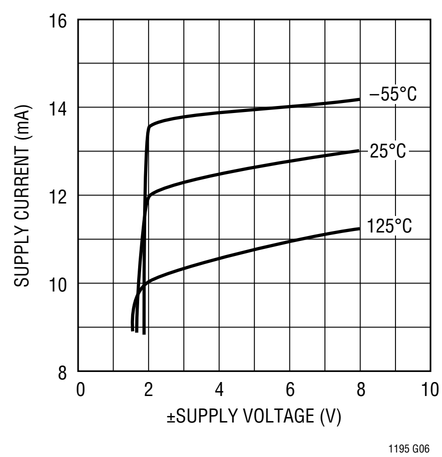
Equivalent Input Noise Voltage vs Frequency



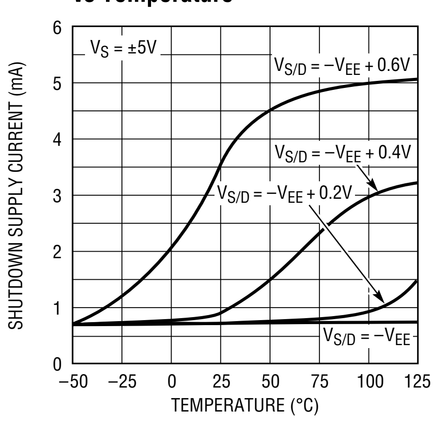
Equivalent Input Noise Current vs Frequency



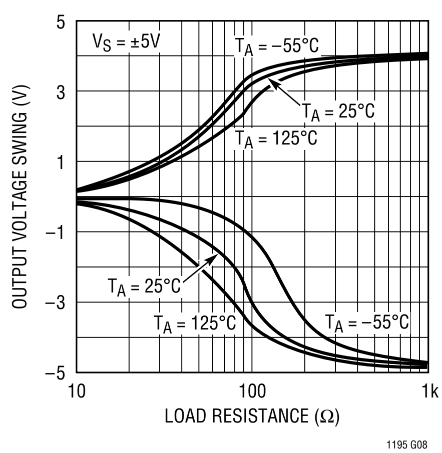
Supply Current vs Supply Voltage



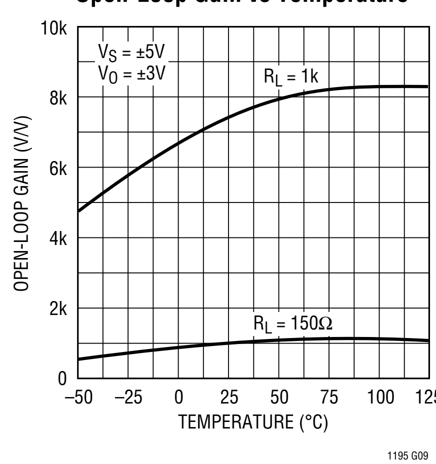
Shutdown Supply Current vs Temperature



Output Voltage Swing vs Load Resistance



Open-Loop Gain vs Temperature



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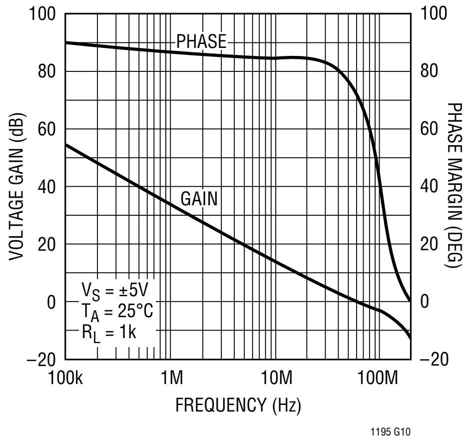
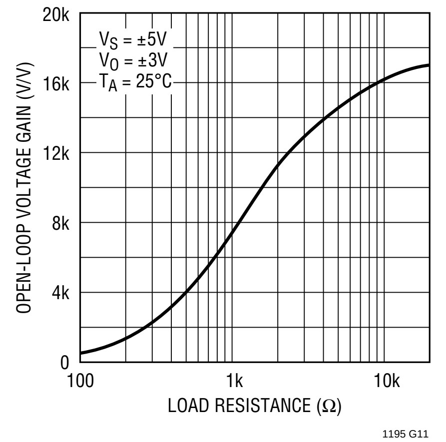
TYPICAL PERFORMANCE CHARACTERISTICS

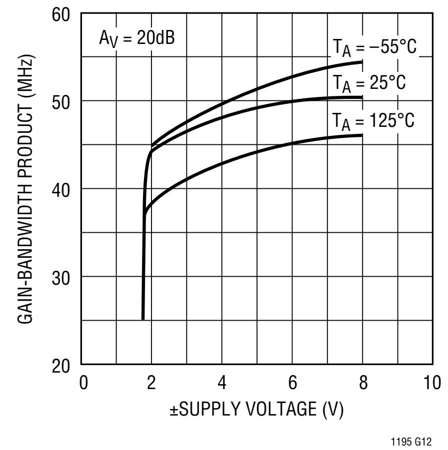
Gain and Phase vs Frequency



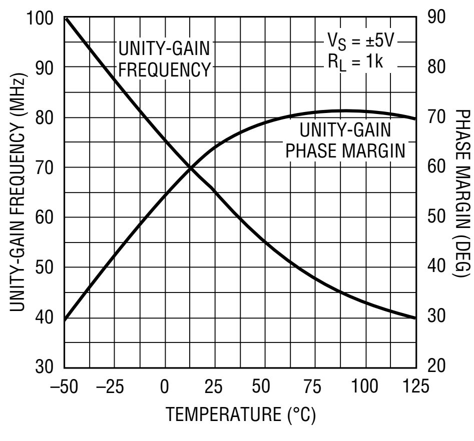
Open-Loop Voltage Gain vs Load Resistance



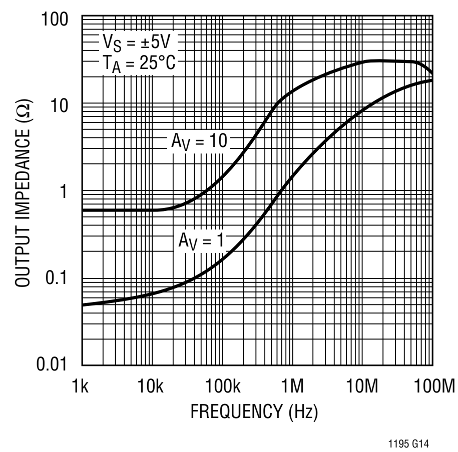
Gain-Bandwidth Product vs Supply Voltage



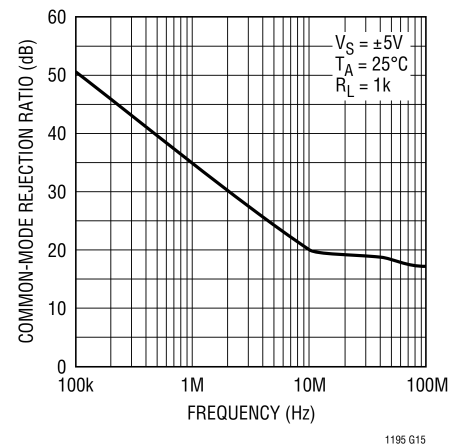
Unity-Gain Frequency and Phase Margin vs Temperature



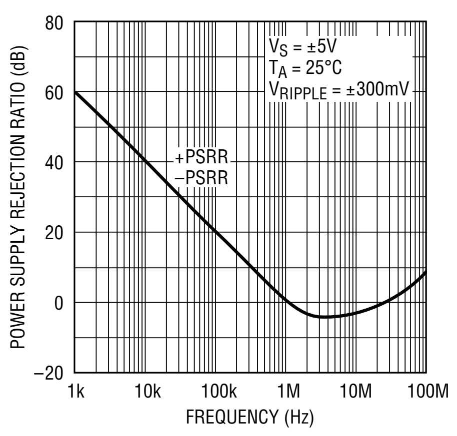
Output Impedance vs Frequency



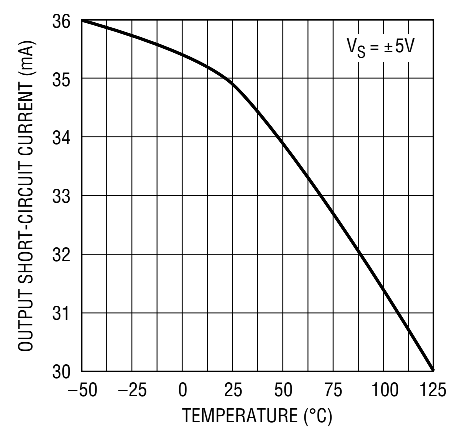
Common-Mode Rejection Ratio vs Frequency



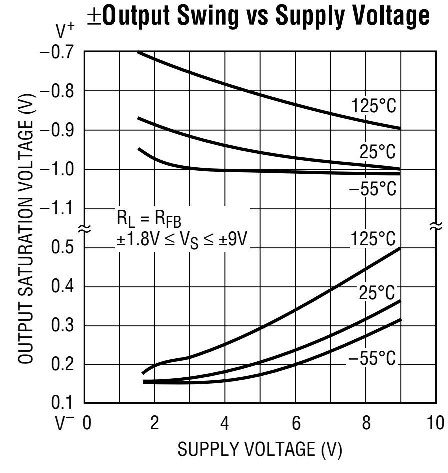
Power Supply Rejection Ratio vs Frequency



Output Short-Circuit Current vs Temperature



±Output Swing vs Supply Voltage



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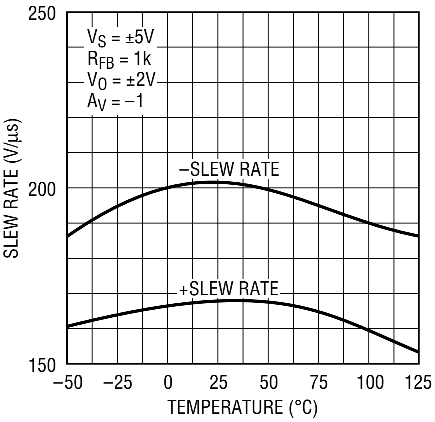
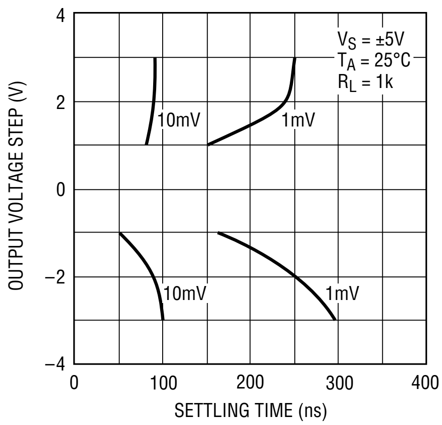
TYPICAL PERFORMANCE CHARACTERISTICS

Slew Rate vs Temperature



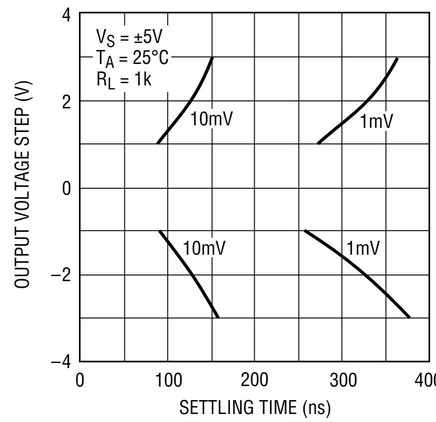
1195 G19

Output Voltage Step vs Settling Time, A_V = –1



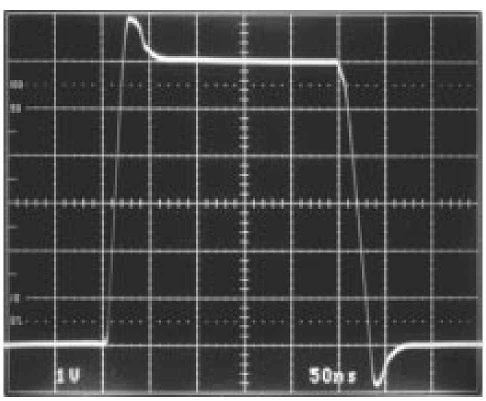
1195 G20

Output Voltage Step vs Settling Time, A_V = 1



1195 G21

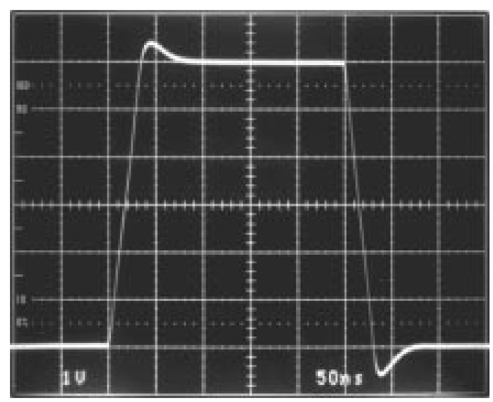
Large-Signal Transient Response



A_V = 1, R_L = 1k

1195 G22

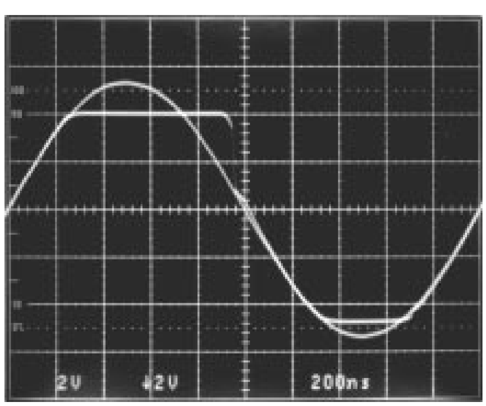
Large-Signal Transient Response



A_V = –1, R_L = 1k

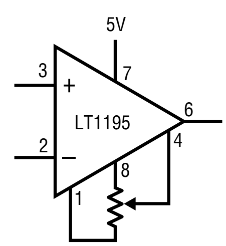
1195 G23

Overload Recovery



A_V = 1, V_{IN} = 11V_{P-P}

1195 G24



INPUT OFFSET VOLTAGE CAN BE ADJUSTED OVER A ±150mV RANGE WITH A 1k to 10k POTENTIOMETER.

1195 G25

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APPLICATIONS INFORMATION

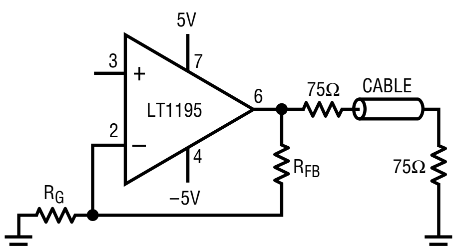
Power Supply Bypassing

The LT1195 is quite tolerant of power supply bypassing. In some applications a 0.1μF ceramic disc capacitor placed 0.5 inches from the ampifier is all that is required. In applications requiring good settling time, it is important to use multiple bypass capacitors. A 0.1μF ceramic disc in parallel with a 4.7μF tantalum is recommended.

Cable Terminations

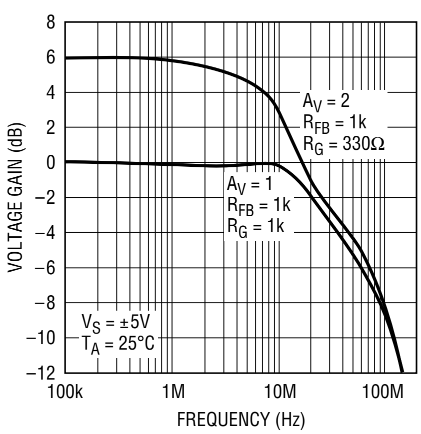
The LT1195 operational amplifier has been optimized as a low cost video cable driver. The ±20mA guaranteed output current enables the LT1195 to easily deliver $6V_{P-P}$ into 150Ω, while operating on ±5V supplies.

Double-Terminated Cable Driver



1195 AI01

Cable Driver Voltage Gain vs Frequency



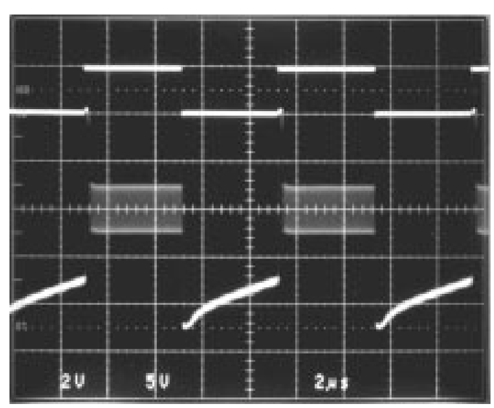
1195 AI02

When driving a cable it is important to terminate the cable to avoid unwanted reflections. This can be done in one of two ways: single termination or double termination. With single termination, the cable must be terminated at the receiving end (75Ω to ground) to absorb unwanted energy. The best performance can be obtained by double termination (75Ω in series with the output of the amplifier, and 75Ω to ground at the other end of the cable). This termination is preferred because reflected energy is absorbed at each end of the cable. When using the double termination technique it is important to note that the signal is attenuated by a factor of 2, or 6dB. This can be compensated for by taking a gain of 2, or 6dB in the amplifier.

Using the Shutdown Feature

The LT1195 has a unique feature that allows the amplifier to be shut down for conserving power, or for multiplexing several amplifiers onto a common cable. The amplifier will shutdown by taking pin 5 to V^-. In shutdown, the amplifier dissipates 15mW while maintaining a true high impedance output state of 15k in parallel with the feedback resistors. The amplifiers must be used in a noninverting configuration for MUX applications. In inverting configurations the input signal is fed to the output through the feedback components. The following scope photos show that with very high R_L, the output is truly high impedance; the output slowly decays toward ground. Additionally, when the output is loaded with as little as 1k the amplifier shuts off in 700ns. This shutoff can be under the control of HC CMOS operating between 0V and –5V.

Output Shutdown



1MHz SINE WAVE GATED OFF WITH SHUTDOWN PIN
$A_V = 1$, R_L = SCOPE PROBE

1195 AI03

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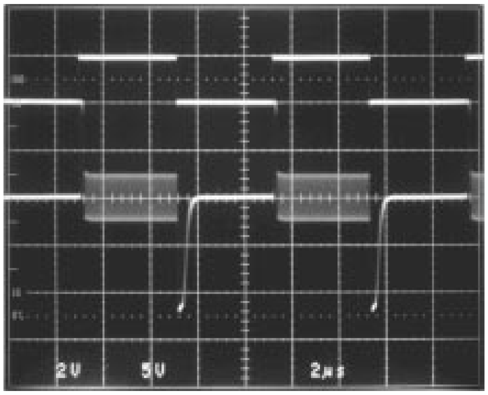
APPLICATIONS INFORMATION

Output Shutdown



1MHz SINE WAVE GATED OFF WITH SHUTDOWN PIN
$A_V = 1$, $R_L = 1k$

1195 AI04

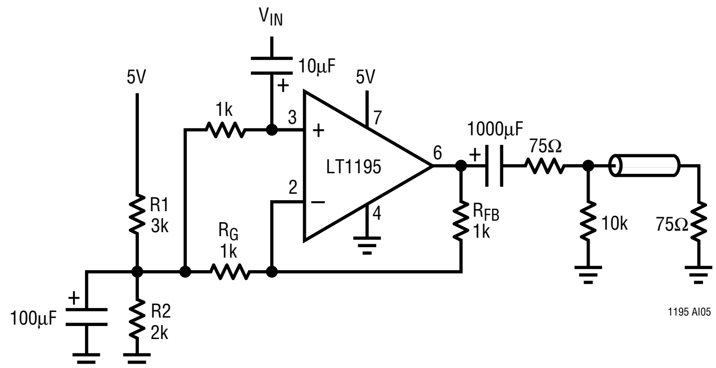
Detecting Pulses

The front page shows a circuit for detecting very fast pulses. In this open-loop design, the detector diode is D1 and a level shifting or compensating diode is D2. A load resistor R_L is connected to –5V, and an identical bias resistor R_B is used to bias the compensating diode. Equal value resistors ensure that the diode drops are equal. A very fast pulse will exceed the amplifier slew rate and cause a long overload recovery time. Some amount of dV/dt limiting on the input can help this overload condition, however too much will delay the response. Also shown is the response to a $4V_{P-P}$ input that is 150ns wide. The maximum output slew rate in the photo is 30V/μs. This rate is set by the 30mA current limit driving 1000pF.

Operation on Single 5V Supply

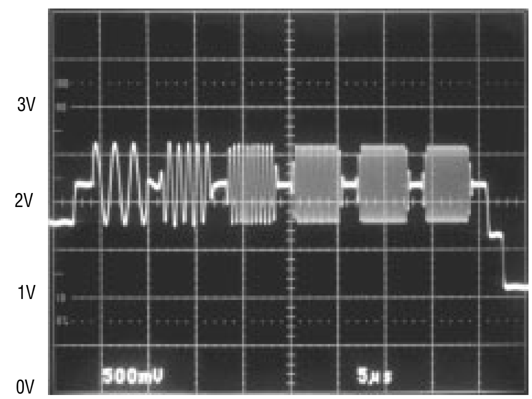
The LT1195 has been optimized for a single 5V supply. This circuit amplifies standard composite video ($1V_{P-P}$ including sync) by 2 and drives a double-terminated 75Ω cable. Resistors R1 and R2 bias the amplifier at 2V, allowing the sync pulses to stay within the common-mode range of the amplifier. Large coupling capacitors are required to pass the low frequency sidebands of the composite signal. A multiburst response and vector plot standard color burst are shown.

Single 5V Video Amplifier



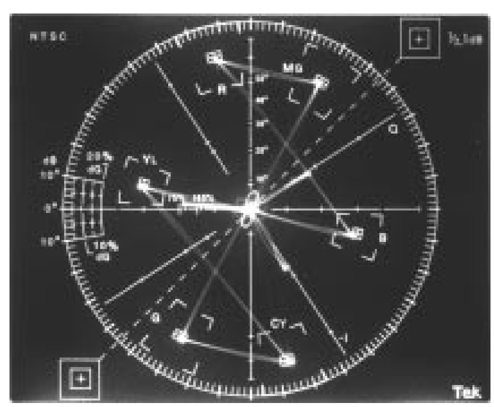
1195 AI05

Video Multiburst at Pin 6 of Amplifier



1195 AI06

Vector Plot of Standard Color Burst



1195 AI07

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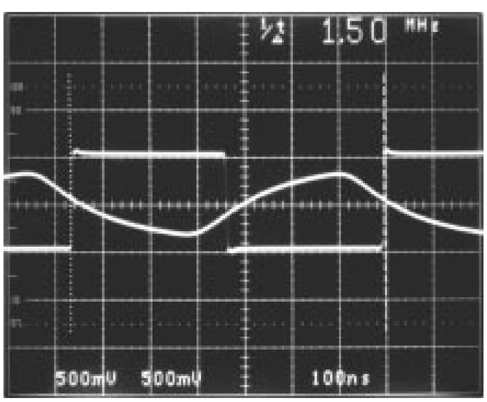
APPLICATIONS INFORMATION

Send Color Video Over Twisted-Pair

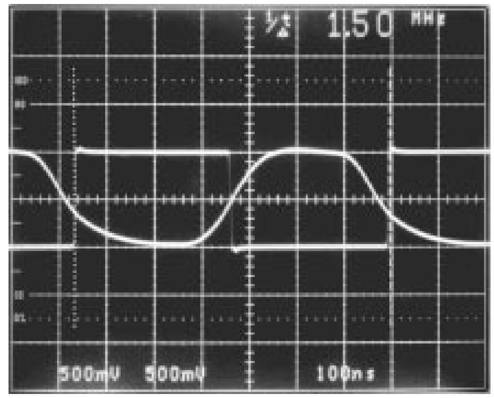
With an LT1195 it is possible to send and receive color composite video signals more than 1000 feet on a low cost twisted-pair. A bidirectional “video bus” consists of the LT1195 op amp and the LT1187 video difference amplifier. A pair of LT1195s at TRANSMIT 1, is used to generate differential signals to drive the line which is back-terminated in its characteristic impedance. The LT1187, twisted-pair receiver, converts signals from differential to single-ended. Topology of the LT1187 provides for cable compensation at the amplifier’s feedback node as shown. In this case, 1000 feet of twisted-pair is compensated with 1000pF and 50Ω to boost the 3dB bandwidth of the system from 750kHz to 4MHz. This bandwidth is adequate to pass a 3.58MHz chrome subcarrier, and the 4.5MHz sound subcarrier. Attenuation in the cable can be compensated by lowering the gain set resistor R_G. At TRANSMIT 2, another pair of LT1195s serve the dual function to provide cable termination via low output impedance, and generate differential signals for TRANSMIT 2. Cable termination is made up of 15Ω and 33Ω attentuator to reduce the differential input signal to the LT1187. Maximum input signal for the LT1187 is $760mV_{P-P}$.

1.5MHz Square Wave Input and Unequalized Response Through 1000 Feet of Twisted-Pair



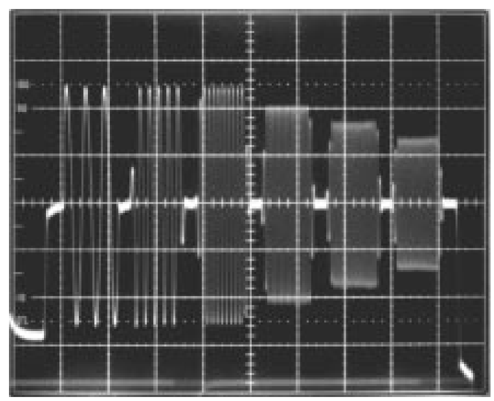
1195 A108

1.5MHz Square Wave Input and Equalized Response Through 1000 Feet of Twisted-Pair

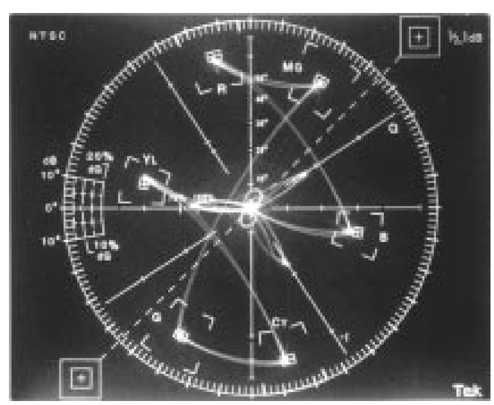


1195 A109

Multiburst Pattern Passed Through 1000 Feet of Twisted-Pair


1195 A110

Vector Plot of Standard Color Burst Through 1000 Feet of Twisted-Pair



1195 A111

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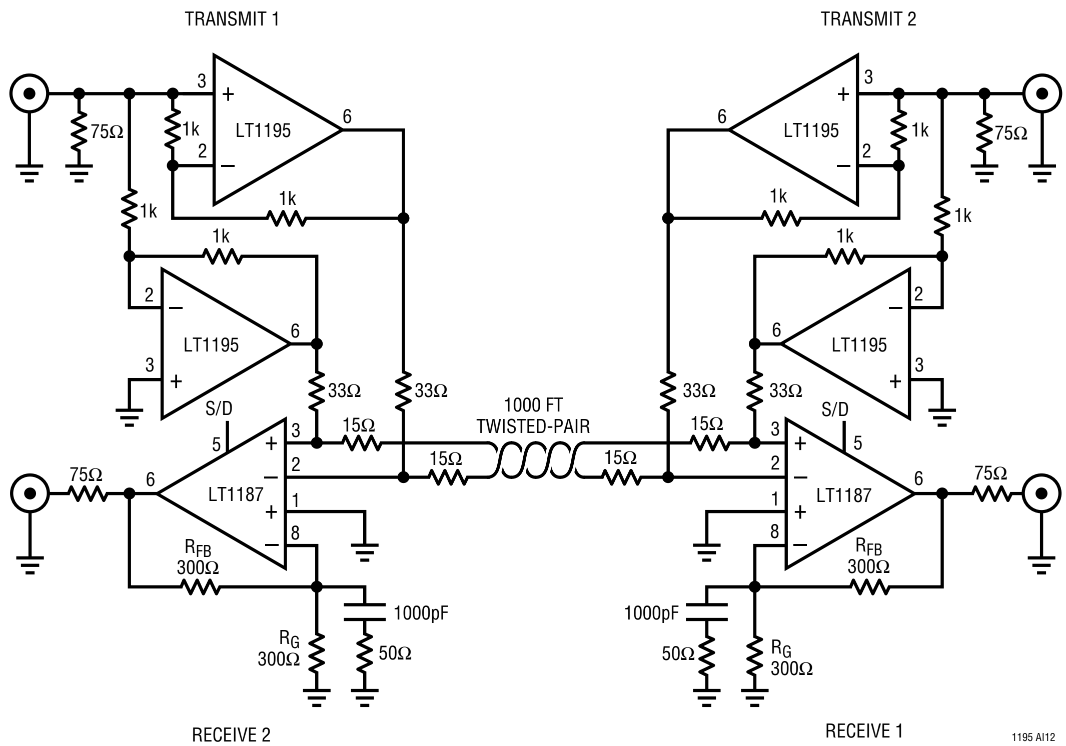
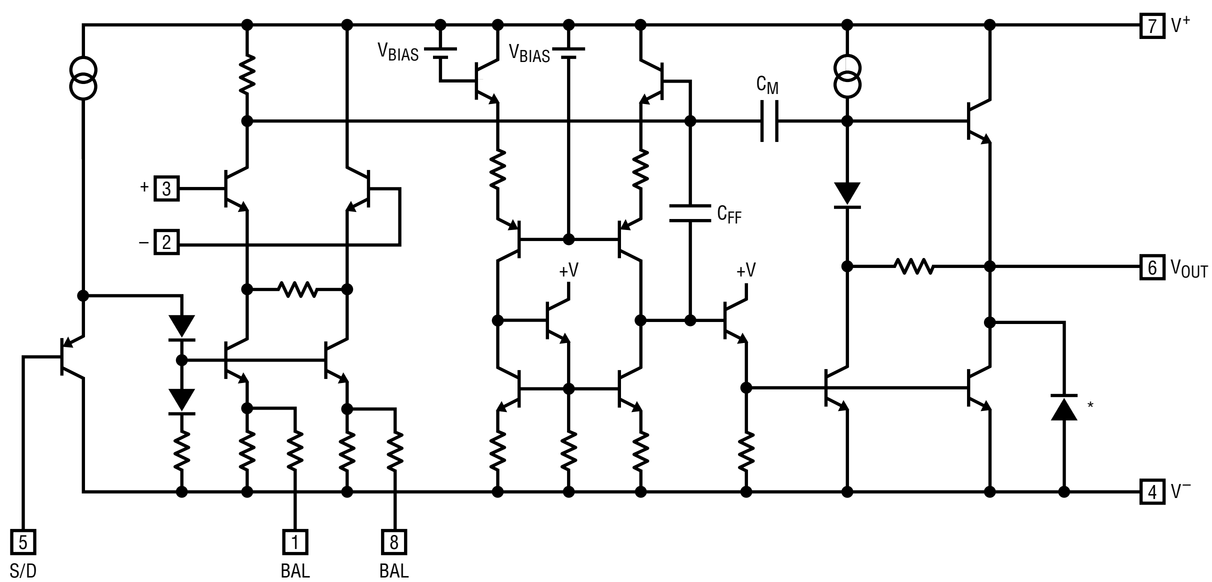
APPLICATIONS INFORMATION

Bidirectional Video Bus



SIMPLIFIED SCHEMATIC



* SUBSTRATE DIODE, DO NOT FORWARD BIAS

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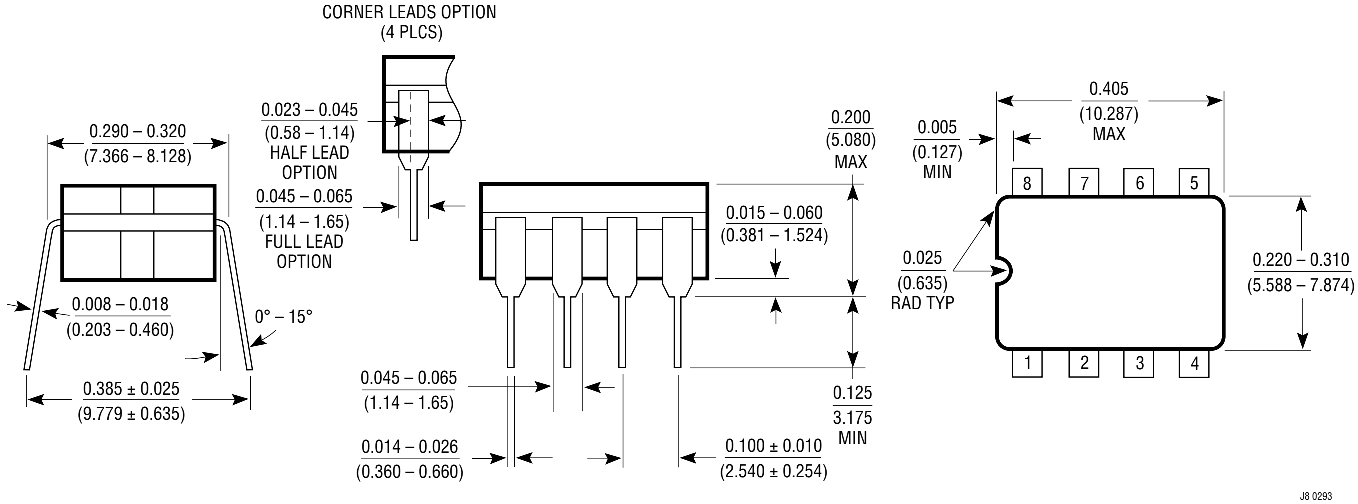
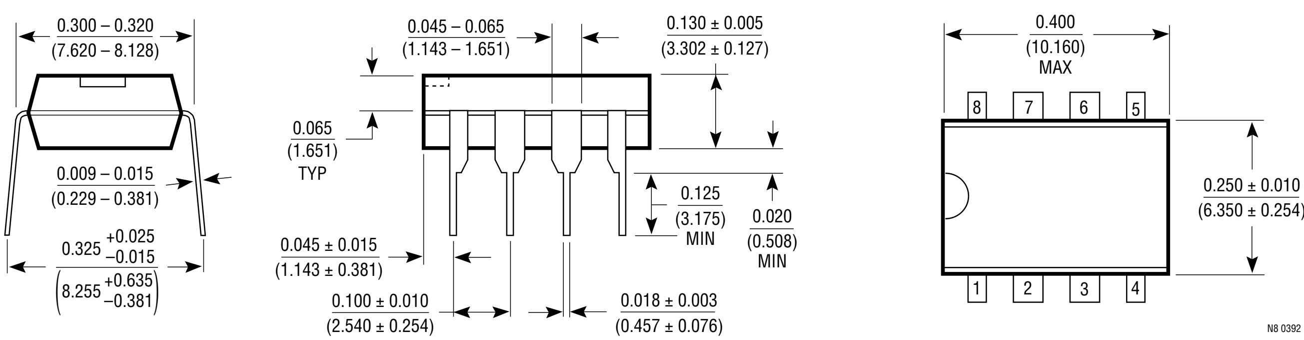
PACKAGE DESCRIPTION

Dimensions in inches (millimeters) unless otherwise noted.

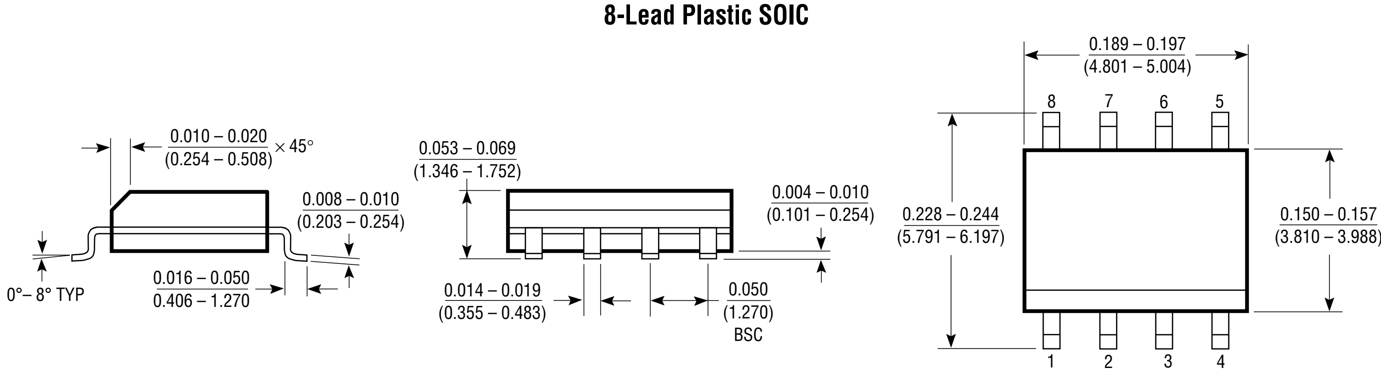
J8 Package
8-Lead Ceramic DIP



N8 Package
8-Lead Plastic DIP



S8 Package
8-Lead Plastic SOIC



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