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OPA633

High Speed
BUFFER AMPLIFIER

FEATURES

● **WIDE BANDWIDTH: 260MHz**
● **HIGH SLEW RATE: 2500V/μs**
● **HIGH OUTPUT CURRENT: 100mA**
● **LOW OFFSET VOLTAGE: 1.5mV**
● **REPLACES HA-5033**
● **IMPROVED PERFORMANCE/PRICE:**
 **LH0033, LTC1010, H0S200**

APPLICATIONS

● **OP AMP CURRENT BOOSTER**
● **VIDEO BUFFER**
● **LINE DRIVER**
● **A/D CONVERTER INPUT BUFFER**

DESCRIPTION

The OPA633 is a monolithic unity-gain buffer ampli-
fier featuring very wide bandwidth and high slew rate.
A dielectric isolation process incorporating both NPN
and PNP high frequency transistors achieves perfor-
mance unattainable with conventional integrated cir-
cuit technology. Laser trimming provides low input
offset voltage.

High output current capability allows the OPA633 to
drive 50Ω and 75Ω lines, making it ideal for RF, IF
and video applications. Low phase shift allows the
OPA633 to be used inside amplifier feedback loops.
OPA633 is available in a low cost plastic DIP package
specified for 0°C to +75°C operation.

PDS-699B
Printed in U.S.A. October, 1993
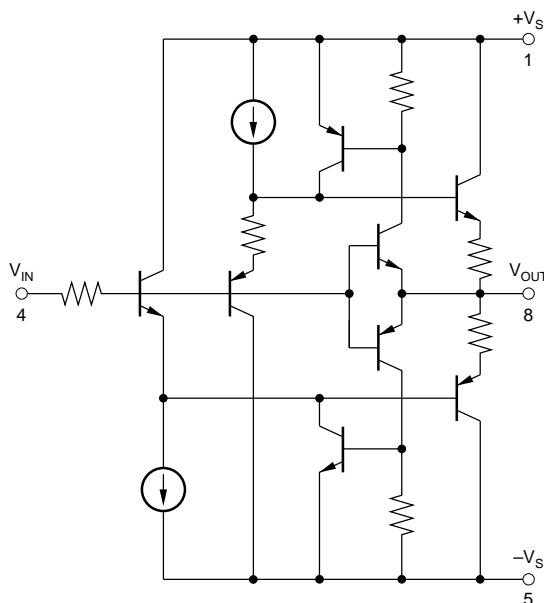
SPECIFICATIONS

ELECTRICAL

At +25°C, $V_S = \pm 12V$, $R_S = 50\Omega$, $R_L = 100\Omega$, and $C_L = 10pF$, unless otherwise specified.

PARAMETER	CONDITIONS	OPA633KP MIN	TYP	MAX	UNITS
FREQUENCY RESPONSE					
Small Signal Bandwidth	$V_O = 1Vrms$, $R_L = 1k\Omega$		260		MHz
Full Power Bandwidth			40		MHz
Slew Rate	$V_O = 10V$, $V_S = \pm 15V$, $R_L = 1k\Omega$	1000	2500		V/µs
Rise Time, 10% to 90%	$V_O = 500mV$		2.5		ns
Propagation Delay			1		ns
Overshoot			10		%
Settling Time, 0.1%			50		ns
Differential Phase Error [1]			0.1		Degrees
Differential Gain Error [1]			0.1		%
Total Harmonic Distortion	$V_O = 1Vrms$, $R_L = 1k\Omega$, $f = 100kHz$		0.005		%
	$V_O = 1Vrms$, $R_L = 100\Omega$, $f = 100kHz$		0.02		%
OUTPUT CHARACTERISTICS					
Voltage	$T_A = T_{MIN}$ to T_{MAX}	±8	±10		V
	$R_L = 1k\Omega$, $V_S = \pm 15V$	±11	±13		V
Current		±80	±100		mA
Resistance			5		Ω
TRANSFER CHARACTERISTICS					
Gain		0.93	0.95		V/V
	$R_L = 1k\Omega$		0.99		V/V
	$T_A = T_{MIN}$ to T_{MAX}	0.92	0.95		V/V
INPUT					
Offset Voltage	$T_A = +25°C$		±5	±15	mV
	$T_A = T_{MIN}$ to T_{MAX}		±6	±25	mV
vs Temperature			±33		µV/°C
vs Supply	$T_A = T_{MIN}$ to T_{MAX}	54	72		dB
Bias Current	$T_A = +25°C$		±15	±35	µA
	$T_A = T_{MIN}$ to T_{MAX}		±20	±50	µA
Noise Voltage	10Hz to 1MHz		20		µVp-p
Resistance			1.5		MΩ
Capacitance			1.6		pF
POWER SUPPLY					
Rated Supply Voltage	Specified Performance		±12		V
Operating Supply Voltage	Derated Performance	±5		±16	V
Current, Quiescent	$I_O = 0$		21	25	mA
	$I_O = 0$, $T_A = T_{MIN}$ to T_{MAX}		21	30	mA
TEMPERATURE RANGE					
Specification, Ambient		0		+75	°C
Operating, Ambient		−25		+85	°C
θ Junction, Ambient			90		°C/W

NOTE: (1) Differential phase error in video transmission systems is the change in phase of a color subcarrier resulting from a change in picture signal from blanked to white. Differential gain error is the change in amplitude at the color subcarrier frequency resulting from a change in picture signal from blanked to white.

PIN CONFIGURATION

Top View

$+V_S$	1	8	Out
NC	2	7	NC
NC	3	6	Substrate (ground)
In	4	5	$-V_S$
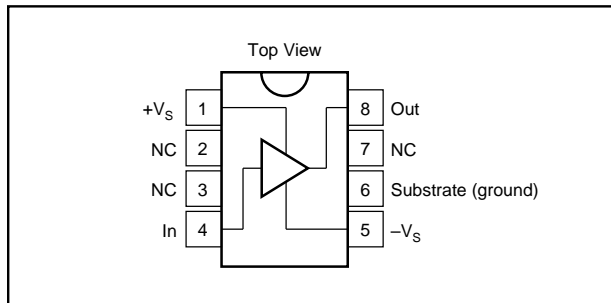
ABSOLUTE MAXIMUM RATINGS

Power Supply, $\pm V_S$ .... ±20V
Input Voltage V_{IN} .... $+V_S + 2V$ to $-V_S - 2V$
Output Current (peak) .... ±200mA
Internal Power Dissipation (25°C) 1.95W
Junction Temperature .... 200°C
Storage Temperature Range .... −40°C to +85°C
Lead Temperature (soldering, 10s) .... 300°C

PACKAGE INFORMATION[1]

MODEL	PACKAGE	PACKAGE DRAWING NUMBER
OPA633KP	8-Pin Plastic DIP	006

NOTE: (1) For detailed drawing and dimension table, please see end of data sheet, or Appendix D of Burr-Brown IC Data Book.
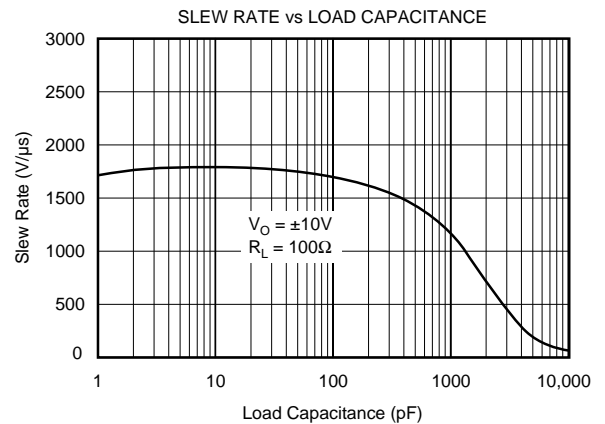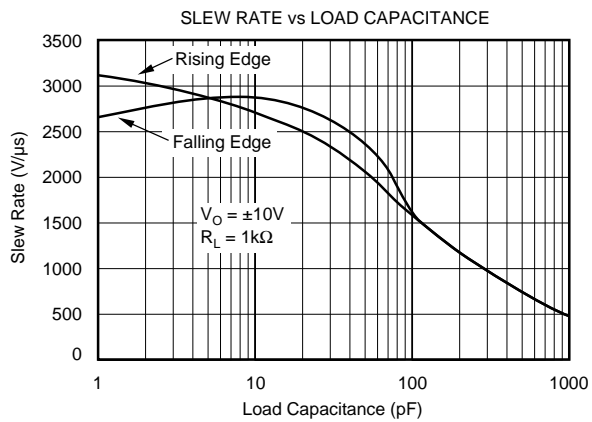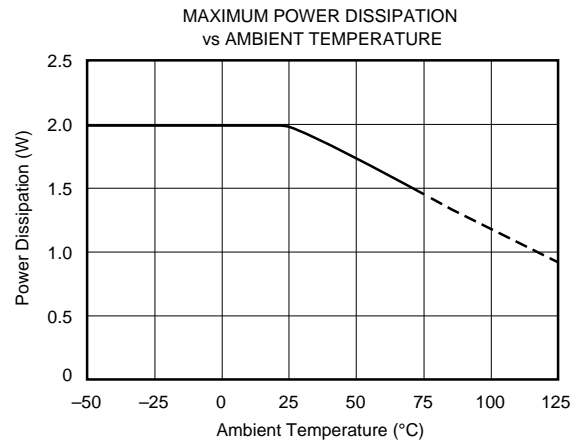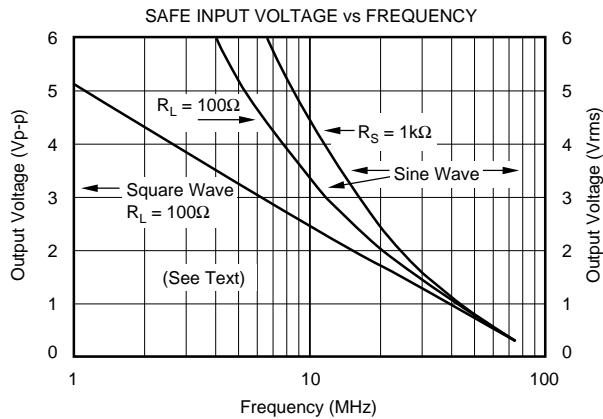
ORDERING INFORMATION

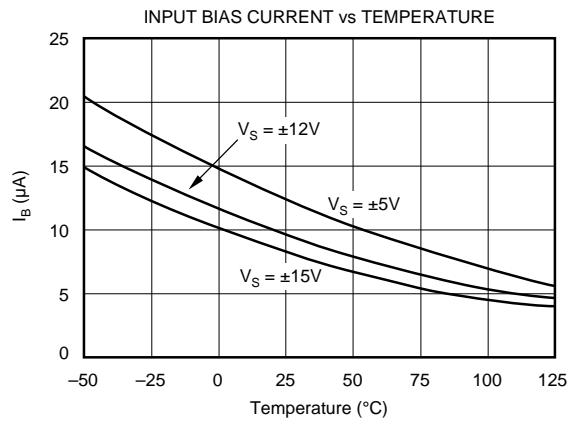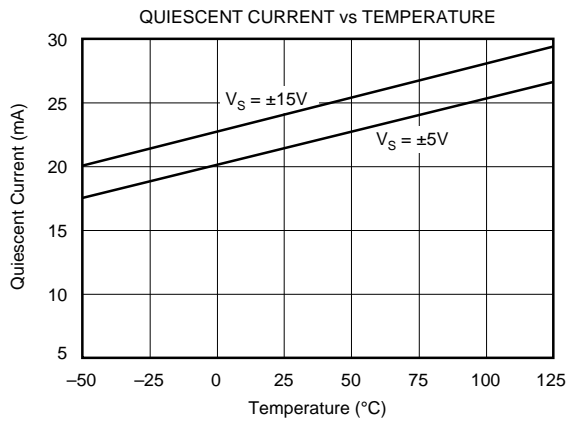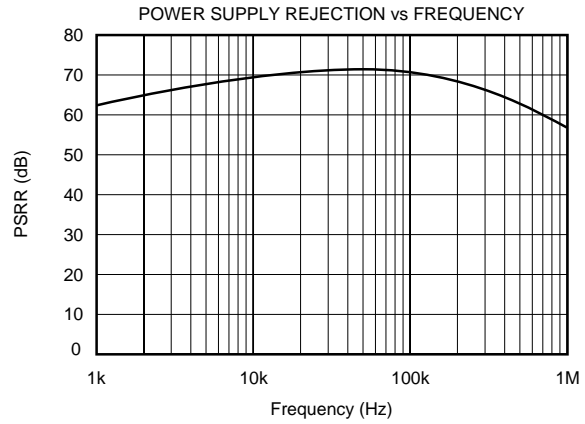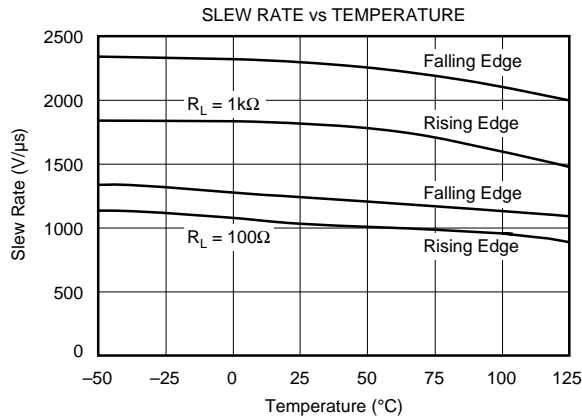| MODEL	PACKAGE	TEMPERATURE RANGE
OPA633KP	8-Pin Plastic DIP	0°C to +75°C

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TYPICAL PERFORMANCE CURVES

At +25°C, $V_S = \pm12V$, $R_S = 50\Omega$, $R_L = 100\Omega$, and $C_L = 10pF$, unless otherwise specified.

GAIN/PHASE vs FREQUENCY

SMALL SIGNAL BANDWIDTH vs TEMPERATURE

SAFE INPUT VOLTAGE vs FREQUENCY

MAXIMUM POWER DISSIPATION
vs AMBIENT TEMPERATURE

SLEW RATE vs LOAD CAPACITANCE

SLEW RATE vs LOAD CAPACITANCE

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TYPICAL PERFORMANCE CURVES (CONT)

At +25°C, V_S = ±12V, R_S = 50Ω, R_L = 100Ω, and C_L = 10pF, unless otherwise specified.

SLEW RATE vs TEMPERATURE

POWER SUPPLY REJECTION vs FREQUENCY

QUIESCENT CURRENT vs TEMPERATURE

INPUT BIAS CURRENT vs TEMPERATURE

OUTPUT VOLTAGE SWING vs LOAD RESISTANCE

$V_{IN} - V_{OUT}$ vs OUTPUT CURRENT

TYPICAL PERFORMANCE CURVES (CONT)

At +25°C, $V_S = \pm12V$, $R_S = 50\Omega$, $R_L = 100\Omega$, and $C_L = 10pF$, unless otherwise specified.

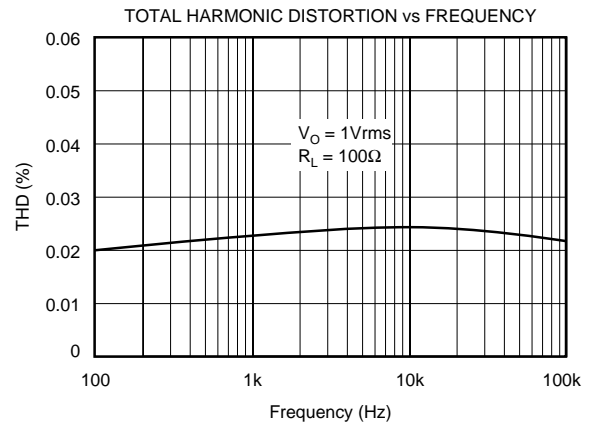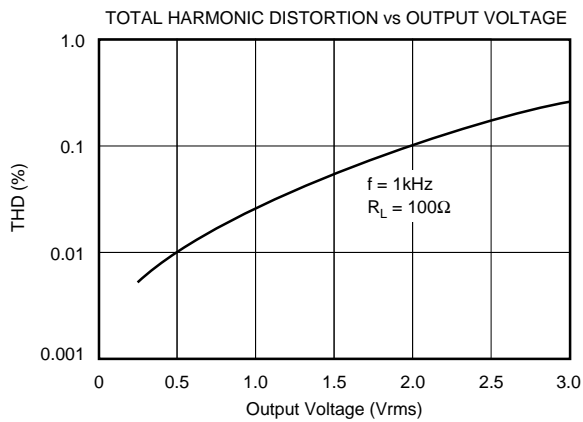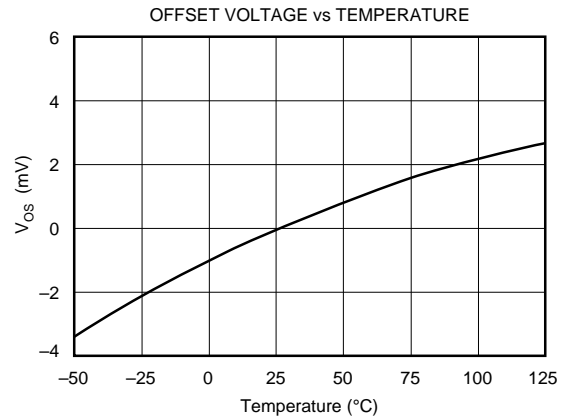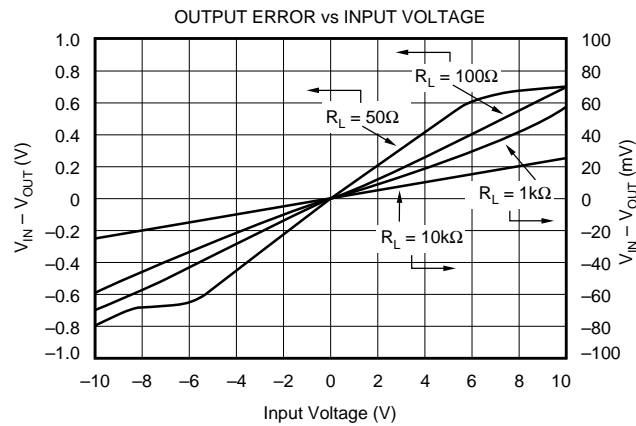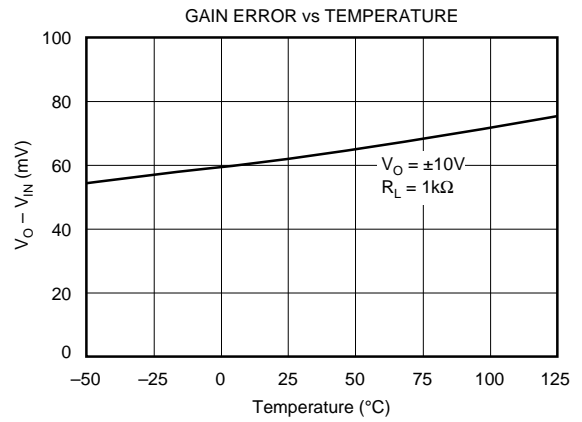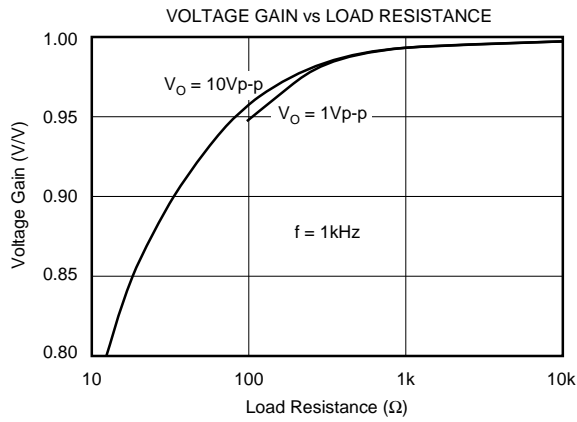VOLTAGE GAIN vs LOAD RESISTANCE

V_O = 10Vp-p

V_O = 1Vp-p

f = 1kHz

GAIN ERROR vs TEMPERATURE

V_O = ±10V
R_L = 1kΩ

OUTPUT ERROR vs INPUT VOLTAGE

R_L = 100Ω

R_L = 50Ω

R_L = 1kΩ

R_L = 10kΩ

OFFSET VOLTAGE vs TEMPERATURE

TOTAL HARMONIC DISTORTION vs OUTPUT VOLTAGE

f = 1kHz
R_L = 100Ω

TOTAL HARMONIC DISTORTION vs FREQUENCY

V_O = 1Vrms
R_L = 100Ω

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APPLICATIONS INFORMATION

As with any high frequency circuitry, good circuit layout technique must be used to achieve optimum performance. Power supply connections must be bypassed with high frequency capacitors. Many applications benefit from the use of two capacitors on each power supply—a ceramic capacitor for good high frequency decoupling and a tantalum type for lower frequencies. They should be located as close as possible to the buffer's power supply pins. A large ground plane is used to minimize high frequency ground drops and stray coupling.

Pin 6 connects to the substrate of the integrated circuit and should be connected to ground. In principle it could also be connected to $+V_S$ or $-V_S$, but ground is preferable. The additional lead length and capacitance associated with sockets may cause problems in applications requiring the highest fidelity of high speed pulses.

Depending on the nature of the input source impedance, a series input resistor may be required for best stability. This behavior is influenced somewhat by the load impedance (including any reactive effects). A value of 50Ω to 200Ω is typical. This resistor should be located close to the OPA633's input pin to avoid stray capacitance at the input which could reduce bandwidth (see Gain and Phase versus Frequency curve).

OVERLOAD CONDITIONS

The input and output circuitry of the OPA633 are not protected from overload. When the input signal and load characteristics are within the devices's capabilities, no protection circuitry is required. Exceeding device limits can result in permanent damage.

The OPA633's small package and high output current capability can lead to overheating. The internal junction temperature should not be allowed to exceed 150°C. Although failure is unlikely to occur until junction temperature exceeds 200°C, reliability of the part will be degraded significantly at such high temperatures. Since significant heat transfer takes place through the package leads, wide printed circuit traces to all leads will improve heat sinking. Sockets reduce heat transfer significantly and are not recommended.

Junction temperature rise is proportional to internal power dissipation. This can be reduced by using the minimum supply voltage necessary to produce the required output voltage swing. For instance, 1V video signals can be easily handled with ±5V power supplies thus minimizing the internal power dissipation.

Output overloads or short circuits can result in permanent damage by causing excessive output current. The 50Ω or 75Ω series output resistor used to match line impedance will, in most cases, provide adequate protection. When this resistor is not used, the device can be protected by limiting the power supply current. See "Protection Circuits."

Excessive input levels at high frequency can cause increased internal dissipation and permanent damage. See the safe input voltage versus frequency curves. When used to buffer an op amp's output, the input to the OPA633 is limited, in most cases, by the op amp. When high frequency inputs can exceed safe levels, the device must be protected by limiting the power supply current.

PROTECTION CIRCUITS

The OPA633 can be protected from damage due to excessive currents by the simple addition of resistors in series with the power supply pins (Figure 5a). While this limits output current, it also limits voltage swing with low impedance loads. This reduction in voltage swing is minimal for AC or high crest factor signals since only the average current from the power supply causes a voltage drop across the series resistor. Short duration load-current peaks are supplied by the bypass capacitors.

The circuit of Figure 5b overcomes the limitations of the previous circuit with DC loads. It allows nearly full output voltage swing up to its current limit of approximately 140mA. Both circuits require good high frequency capacitors (e.g., tantalum) to bypass the buffer's power supply connections.

CAPACITIVE LOADS

The OPA633 is designed to safely drive capacitive loads up to 0.01μF. It must be understood, however, that rapidly changing voltages demand large output load currents:

$$I_{LOAD} = C_{LOAD} \frac{dV}{dt}$$

Thus, a signal slew rate of 1000V/μs and load capacitance of 0.01μF demands a load current of 10A. Clearly maximum slew rates cannot be combined with large capacitive loads. Load current should be kept less than 100mA continuous (200mA peak) by limiting the rate of change of the input signal or reducing the load capacitance.

USE INSIDE A FEEDBACK LOOP

The OPA633 may be used inside the feedback path of an op amp such as the OPA602. Higher output current is achieved without degradation in accuracy. This approach may actually improve performance in precision applications by removing load-dependent dissipation from a precision op amp. All vestiges of load-dependent offset voltage and temperature drift can be eliminated with this technique. Since the buffer is placed within the feedback loop of the op amp, its DC errors will have a negligible effect on overall accuracy. Any DC errors contributed by the buffer are divided by the loop gain of the op amp.

The low phase shift of the OPA633 allows its use inside the feedback loop of a wide variety of op amps. To assure stability, the buffer must not add significant phase shift to the loop at the gain crossing frequency of the circuit—the frequency at which the open loop gain of the op amp is equal to the closed loop gain of the application. The OPA633 has a typical phase shift of less than 10° up to 70MHz, thus making it useful even with wideband op amps.
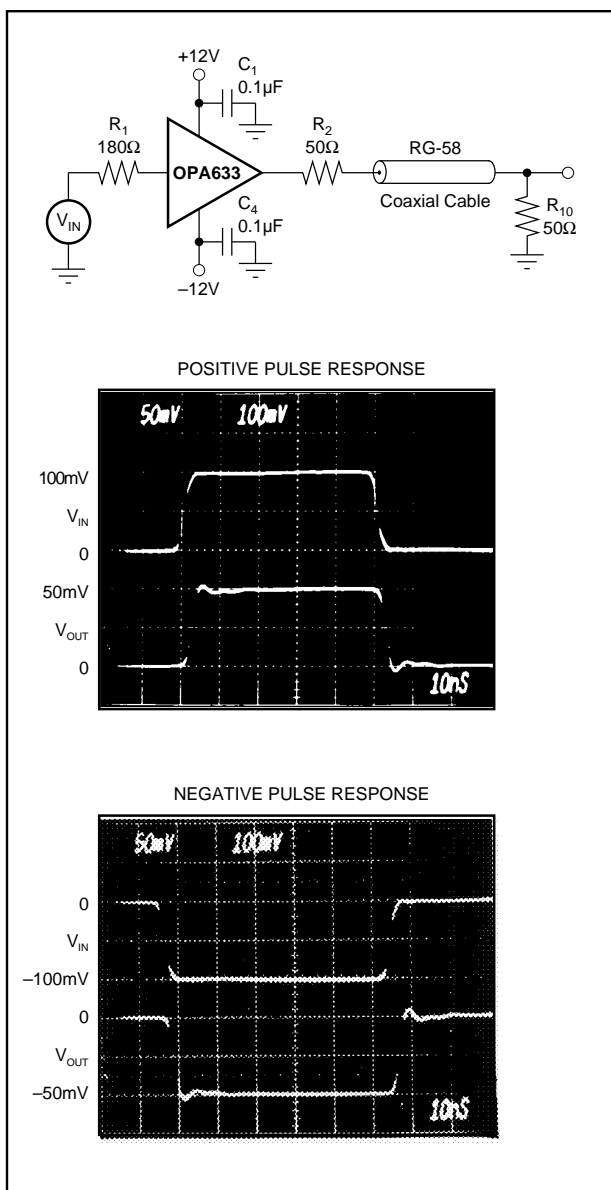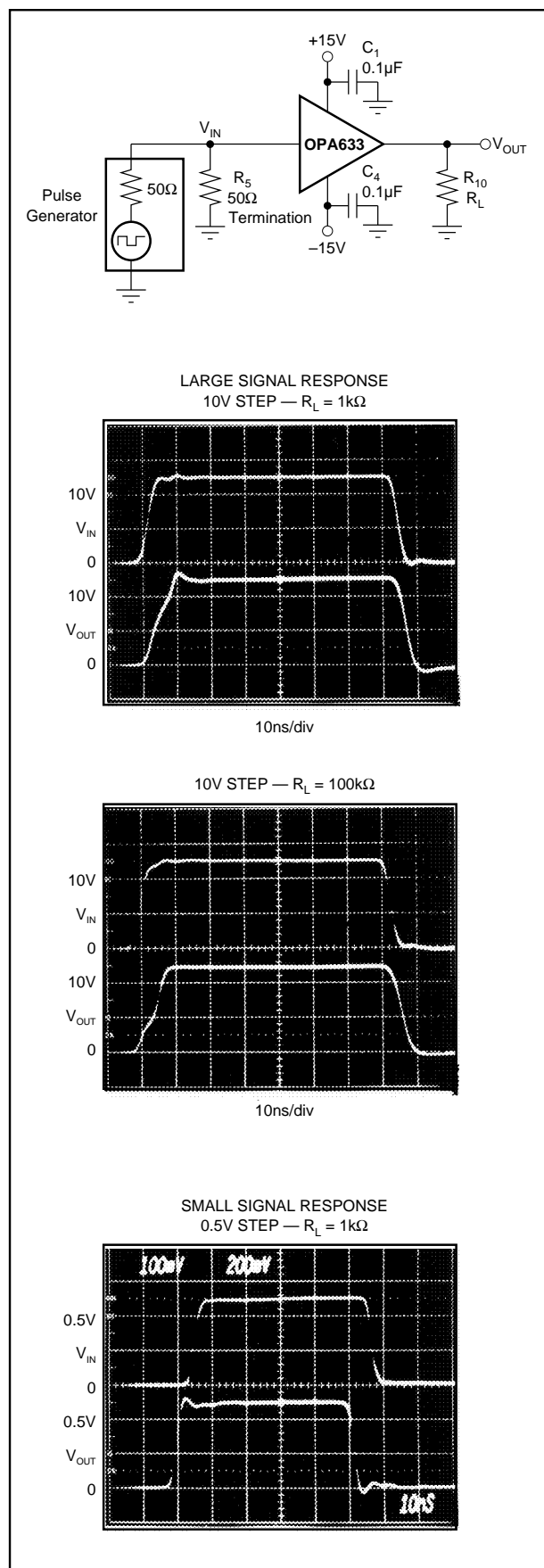
FIGURE 1. Coaxial Cable Driver Circuit.

FIGURE 2. Dynamic Response Test Circuit.
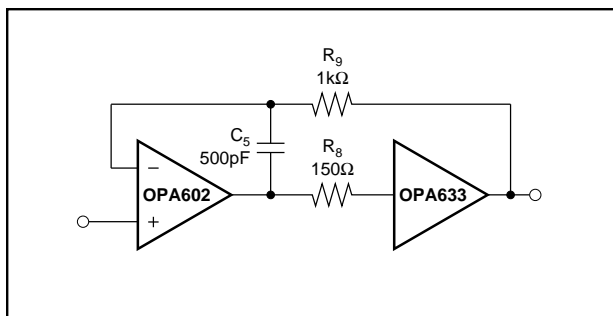
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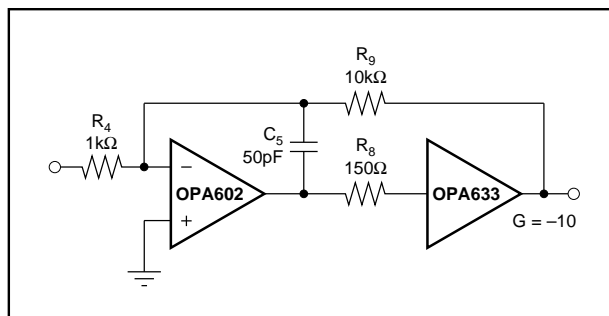
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FIGURE 3. Precision High Current Buffer.

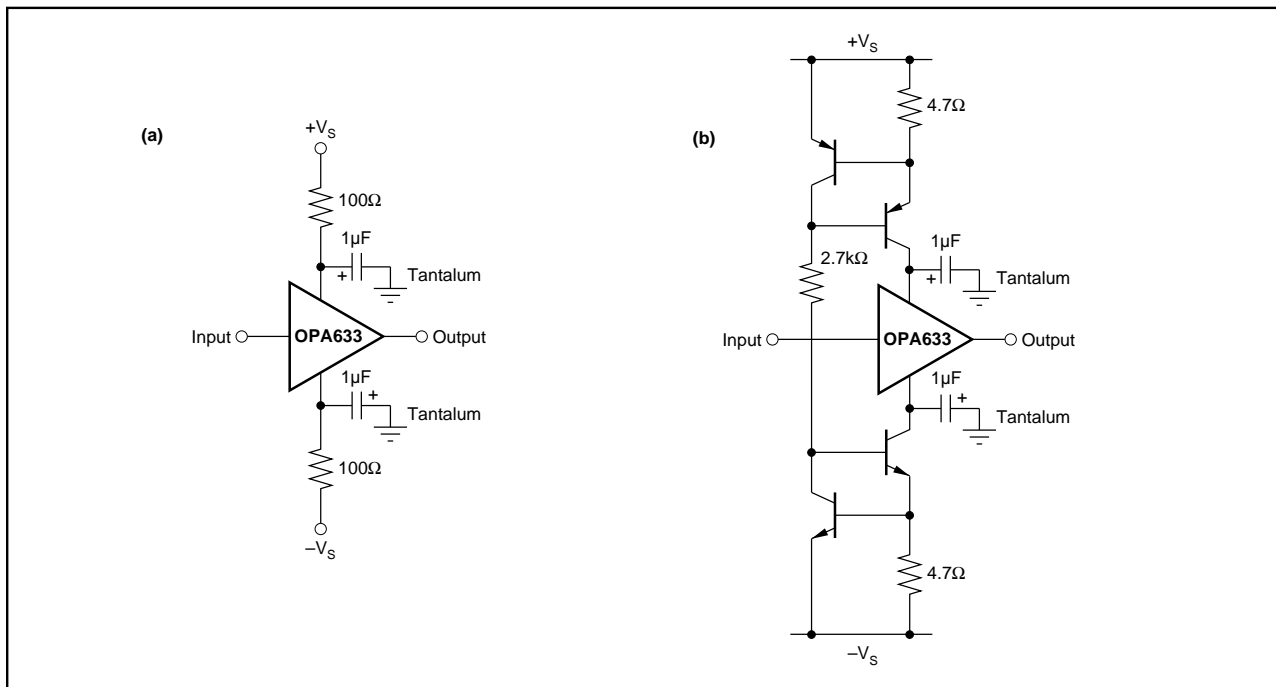FIGURE 4. Buffered Inverting Amplifier.

FIGURE 5. Output Protection Circuits.

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