Features

- Slew rate—1500 V/μs
- Output drive—100 mA
- Rise and fall times—2.9 ns
- Input resistance—$10^{11}\Omega$
- Power bandwidth—100 MHz
- MIL-STD-883 devices 100% manufactured in U.S.A.

Advantages

- Excellent phase linearity
- Driver cables and other capacitive loads
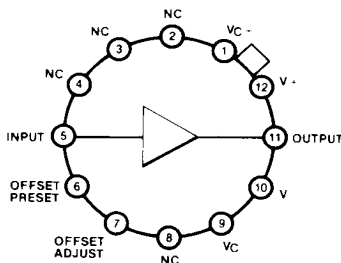- Wide supply range, single or split

Ordering Information

Part No.	Temp. Range	Package Outline #
ELH0033G/883B	55°C to +125°C	TO-8 MDP0002

8001401ZX is the SMD version of this device.

Connection Diagram

12-Pin TO-8

0033-1

Top View

Note: Case is electrically isolated.

General Description

The ELH0033 is a high-speed, FET input voltage follower buffer designed to provide high output currents from DC to over 100 MHz. The ELH0033 slews at 1500 V/μs and will drive 100Ω loads. Phase linearity is excellent to 20 MHz, allowing the buffer to be included in op amp loops.

The ELH0033 is intended to fulfill a wide range of buffer applications such as high-speed line drivers, video impedance transformation, nuclear instrumentation amplifiers, op amp isolation buffers for driving reactive loads and high impedance input buffers for high-speed A to D's and comparators.

These devices are constructed using specially selected junction FETs and active laser trimming to achieve guaranteed performance specifications. The ELH0033 is specified for operation from −55°C to +125°C.

Elantec facilities comply with MIL-I-45208A and other applicable quality specifications. Elantec's Military devices are 100% fabricated and assembled in our rigidly controlled, ultra-clean facilities in Milpitas, California. For additional information on Elantec's Quality and Reliability Assurance policy and procedures request brochure QRA-1.

Equivalent Schematic

0033-2

2

July 1992 Rev H
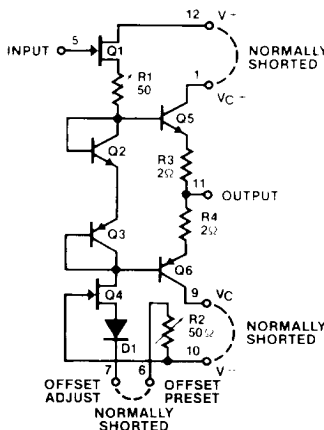
ELH0033G/883/8001401ZX
Fast Buffer Amplifier

Absolute Maximum Ratings

V_S	Supply Voltage (V+ − V−)	40V	T_A	Operating Temperature Range	
V_{IN}	Input Voltage	40V		ELH0033	−55°C to +125°C
P_D	Power Dissipation (See Curves)	1.5W	T_J	Operating Junction Temperature	175°C
I_{OC}	Continuous Output Current	±100 mA	T_{ST}	Storage Temperature	−65°C to +150°C
I_{OP}	Peak Output Current	±250 mA		Lead Temperature	
				(Soldering, 10 seconds)	300°C

Important Note:

All parameters having Min/Max specifications are guaranteed. The Test Level column indicates the specific device testing actually performed during production and Quality inspection. Elantec performs most electrical tests using modern high-speed automatic test equipment, specifically the LTX77 Series system. Unless otherwise noted, all tests are pulsed tests, therefore $T_J = T_C = T_A$.

Test Level	Test Procedure
I	100% production tested and QA sample tested per QA test plan QCX0002.
II	100% production tested at T_A = 25°C and QA sample tested at T_A = 25°C, T_{MAX} and T_{MIN} per QA test plan QCX0002.
III	QA sample tested per QA test plan QCX0002.
IV	Parameter is guaranteed (but not tested) by Design and Characterization Data.
V	Parameter is typical value at T_A = 25°C for information purposes only.

DC Electrical Characteristics $V_S = ±15V$, $V_{IN} = 0V$, $T_{MIN} \leq T_A \leq T_{MAX}$

Parameter	Description	Test Conditions	ELH0033				Units
			Min	Typ	Max	Test Level	
V_{OS}	Output Offset Voltage	$R_S \leq 100$ kΩ, $T_J = 25°C$ (Note 1)		5	10	I	mV
		$R_S \leq 100$ kΩ			15	I	mV
$\Delta V_{OS}/\Delta T$	Average Temperature Coefficient of Offset Voltage	$R_S = 100Ω$		50		V	µV/°C
I_B	Input Bias Current	$T_J = 25°C$ (Note 1)			250	I	pA
		$T_A = 25°C$ (Note 2)			2.5	IV	nA
		$T_J = T_A = T_{MAX}$			10	I	nA
A_V	Voltage Gain	$R_S = 100Ω$, $R_L = 1$ kΩ, $V_{IN} = ±10V$	0.97	0.98	1.00	I	V/V
R_{IN}	Input Impedance	$R_L = 1$ kΩ	10^{10}	10^{11}		IV	Ω
		$T_J = 25°C$ (Note 1), $R_L = 1$ kΩ	10^{10}	10^{11}		I	Ω
R_O	Output Impedance	$R_L = 1$ kΩ, $V_{IN} = ±1V$		6	10	I	Ω
V_O	Output Voltage Swing	$V_{IN} = ±14V$, $R_L = 1$ kΩ	±12			I	V
		$V_{IN} = ±10.5V$, $R_L = 100Ω$, $T_A = 25°C$	±9			I	V
I_S	Supply Current		14.5	20	22	I	mA
	Power Consumption			600	660	I	mW

Note 1: Specification is at 25°C junction temperature due to requirements of high-speed automatic testing. Actual values at operating temperature will exceed the value at $T_J = 25°C$. When supply voltages are ±15V, no-load operating junction temperature may rise 40°C−60°C above ambient and more under load conditions. Accordingly, V_{OS} may change one to several mV, and I_B will change significantly during warm-up. Refer to I_B vs temperature graph for expected values.

Note 2: Measured in still air 7 minutes after application of power.
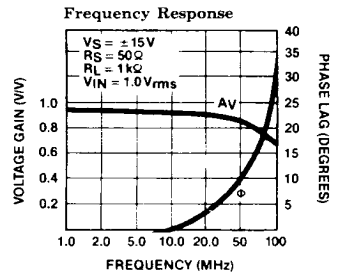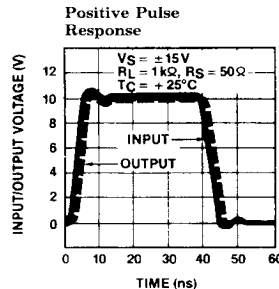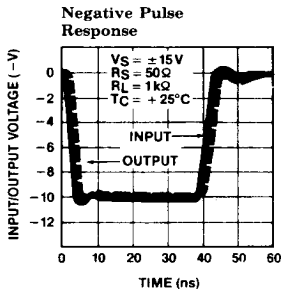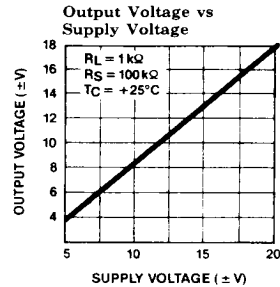
ELH0033G/883/8001401ZX
Fast Buffer Amplifier

AC Electrical Characteristics $T_C = 25°C, V_S = \pm 15V, R_S = 50\Omega, R_L = 1\ k\Omega$

Parameter	Description	Test Conditions	ELH0033			Test Level	Units
			Min	Typ	Max		
SR	Slew Rate	$V_{IN} = \pm 10V$	1000	1500		III	$V/\mu s$
BW	Bandwidth	$V_{IN} = 1\ V_{rms}$		100		V	MHz
	Phase Non-Linearity	BW = 1 MHz to 20 MHz		2		V	°
t_r	Rise Time	$\Delta V_{IN} = 0.5V$		2.9		V	ns
t_p	Propagation Delay	$\Delta V_{IN} = 0.5V$		1.2		V	ns
HD	Harmonic Distortion	f > 1 kHz		< 0.1		V	%
A_V	Voltage Gain	$R_S = 100\Omega$, $V_{IN} = 1\ V_{rms}$, f = 1 kHz	0.97	0.98	1.00	I	V/V
R_O	Output Impedance	$V_{IN} = 1\ V_{rms}$, f = 1 kHz		6	10	I	Ω

Typical Performance Curves

Maximum Power Dissipation

Supply Current vs Supply Voltage

Output Voltage vs Supply Voltage

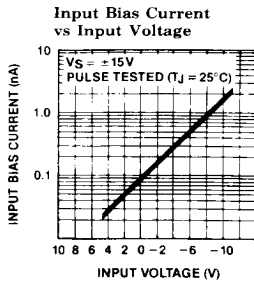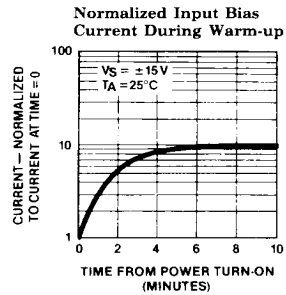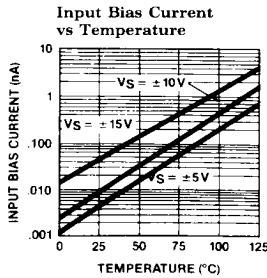### Negative Pulse Response
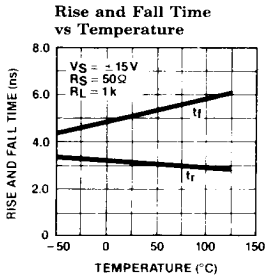

Positive Pulse Response

Frequency Response
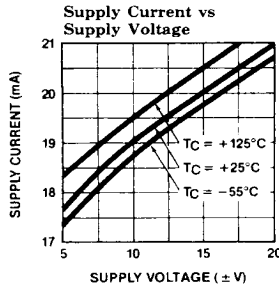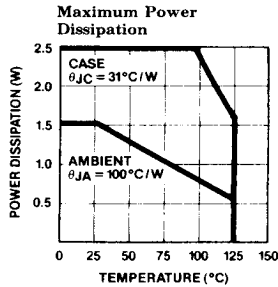
0033-3

ELH0033G/883/8001401ZX
Fast Buffer Amplifier

Typical Performance Curves — Contd.

Rise and Fall Time vs Temperature

$V_S = \pm 15V$
$R_S = 50\Omega$
$R_L = 1k$

Input Bias Current vs Temperature

$V_S = \pm 10V$
$V_S = \pm 15V$
$V_S = \pm 5V$

Normalized Input Bias Current During Warm-up

$V_S = \pm 15V$
$T_A = 25°C$

Input Bias Current vs Input Voltage

$V_S = \pm 15V$
PULSE TESTED $(T_J = 25°C)$

0033-4

Typical Applications

Offset Zero Adjust

INPUT
OFFSET PRESET (OPEN)
OFFSET ADJUST
200Ω
ELH0033
+15V
OUTPUT
−15V

0033-5

Using Resistor Current Limiting

INPUT
ELH0033
V−
R_{LIM} 100Ω
$C \approx 0.1\,\mu F$
OUTPUT
R_{LIM} 100Ω
$C \approx 0.1\,\mu F$
V−

0033-6

Current Limiting Using Current Sources

INPUT
ELH0033
R_{LIM} 10Ω
Q2
Q1
−15V
OUTPUT
39K
0.01 μF
Q3
Q4
R_{LIM} 10Ω
−15V

Q1 = Q2 = 2N2905
Q3 = Q4 = 2N2219

0033-7

Typical Applications — Contd.

High Input Impedance AC Coupled Amplifier

$f_H \geq 100$ MHz
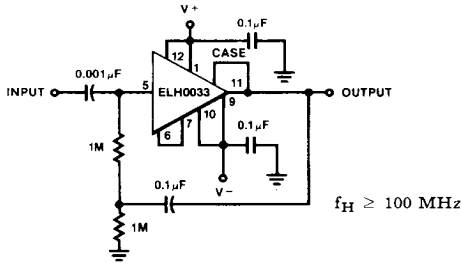
0033-8

Coaxial Cable Driver

*Select C1 for optimum pulse response
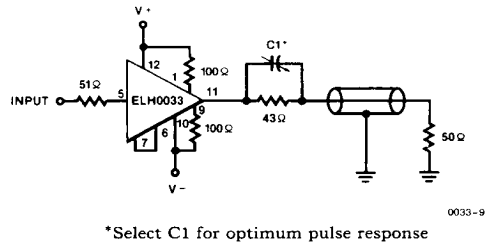
0033-9

Instrumentation Shield/Line Driver
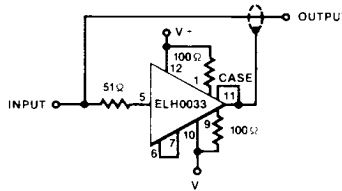
0033-10

Single Supply AC Amplifier
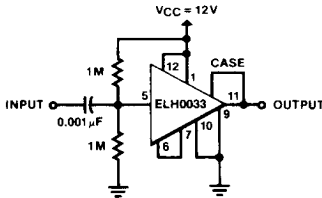
0033-11

4.5 MHz Notch Filter

$$F_O = \frac{1}{2\pi R1 C1}$$

$$R1 = 2\ R2$$

$$C1 = \frac{C2}{2}$$
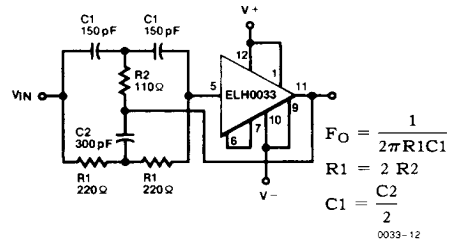
0033-12

High-Speed Sample and Hold

*Polycarbon or teflon

0033-13

2-13
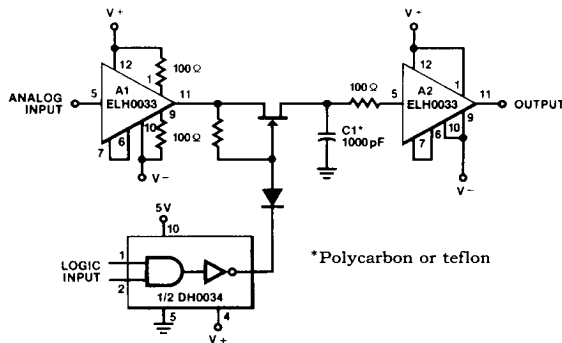
Applications Information

Recommended Layout Precautions

RF/video printed circuit board layout rules should be followed when using the ELH0033 since it will provide power gain to frequencies over 100 MHz. Ground planes are recommended and power supplies should be decoupled at each device with low inductance capacitors. In addition, ground plane shielding may be extended to the metal case of the device since it is electrically isolated from internal circuitry. Alternatively, the case should be connected to the output to minimize input capacitance.

Offset Voltage Adjustment

The ELH0033's offset voltages have been actively trimmed by laser to meet guaranteed specifications when the offset preset pin is shorted to the offset adjust pin. The pre-calibration allows the devices to be used in most DC or AC applications without individually offset nulling each device. If offset null is desirable, it is simply obtained by leaving the offset preset pin open and connecting a trim pot of 100Ω between the offset adjust pin and $V-$.

Operation from Single or Asymmetrical Power Supplies

This device type may be readily used in applications where symmetrical supplies are unavailable or not desirable. A typical application might be an interface to a MOS shift register where $V+ = +5V$ and $V^- = -12V$. In this case, an apparent output offset occurs due to the device's voltage gain of less than unity. This additional output offset error may be predicted by:

$$\Delta V_O \cong (1 - A_V) \frac{(V^+ - V^-)}{2} = 0.005 \, (V^+ - V^-)$$

where: A_V = No load voltage gain, typically 0.99
$V+$ = Positive supply voltage
V^- = Negative supply voltage

For the above example, ΔV_O would be -35 mV. This may be adjusted to zero as described in Section 2. For AC coupled applications, no additional offset occurs if the DC input is properly biased as illustrated in the "typical applications" section.

Short Circuit Protection

In order to optimize transient response and output swing, output current limit has been omitted from the ELH0033. Short circuit protection may be added by inserting appropriate value resistors between $V+$ and V_C+ pins and $V-$ and V_C- pins. Resistor values may be predicted by:

$$R_{LIM} \cong \frac{V^+}{I_{SC}} = \frac{V^-}{I_{SC}}$$

where: $I_{SC} \leq 100$ mA for ELH0033

The inclusion of limiting resistors in the collectors of the output transistors reduces output voltage swing. Decoupling V_C+ and V_C- pins with capacitors to ground will retain full output swing for transient pulses. An alternate active current limit technique that retains full DC output swing uses current sources which are saturated during normal operation thus applying full supply voltage to the V_C pins. Under fault conditions, the voltage decreases as required by the overload.

$$R_{LIM} \cong \frac{V_{BE}}{I_{SC}} = \frac{0.6V}{60 \, mA} = 10\Omega$$

Capacitive Loading

The ELH0033 is designed to drive capacitive loads such as coaxial cables in excess of several thousand picofarads without susceptibility to oscillation. However, peak current resulting from $(C \times d_v/d_t)$ should be limited below absolute maximum peak current ratings for the devices.

Thus:

$$\frac{\Delta V_{IN}}{\Delta t} \times C_L \leq I_{OUT} \leq \pm 250 \, mA$$

In addition, power dissipation resulting from driving capacitive loads plus standby power should be kept below the total package power rating:

$$P_D \, pkg \geq P_{DC} + P_{AC}$$
$$P_D \, pkg \geq (V^+ - V^-) \times I_S + P_{AC}$$
$$P_{AC} \cong (V_{P-P})^2 \times f \times C_L$$

where: V_{P-P} = Peak-to-peak output voltage swing
   f   = Frequency
   C_L = Load Capacitance

Operation within an Op Amp Loop

Both devices may be used as a current booster or isolation buffer within a closed loop with op amps such as the ELH0032 and HA2500 and HA2600 series. An isolation resistor of 47Ω should be used between the op amp output and the input of ELH0033. The wide bandwidth and high slew rates of the ELH0033 assure that the loop has the characteristics of the op amp and that additional rolloff is not required.

Burn-In Circuit
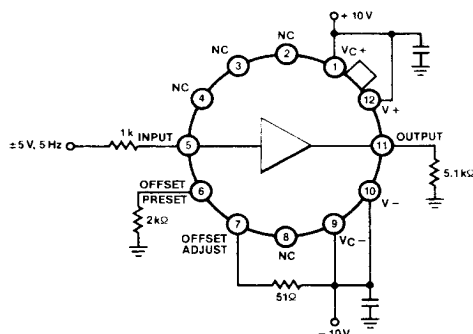
0033-14

Hardware

In order to utilize the full drive capabilities of the ELH0033, it should be mounted with a heatsink, particularly for extended temperature operation. The case is isolated from the circuit and may be connected to system chassis.

IMPORTANT!

Power supply bypassing is necessary to prevent oscillation with the ELH0033 in all circuits. Low inductance ceramic disc capacitors with the shortest practical lead lengths must be connected from each supply lead (within $\frac{1}{4}''$ to $\frac{1}{2}''$ of the device package) to a ground plane. Capacitors should be one or two $0.1\mu F$ in parallel; adding a $4.7\ \mu F$ solid tantalum capacitor will help in troublesome instances.

2

ELH0033G/883/8001401ZX
Fast Buffer Amplifier

ELH0033 Macromodel

```
* Connections:      input
*                     |     V+
*                     |     |    Vc+
*                     |     |     |     V--
*                     |     |     |     |    Vc--
*                     |     |     |     |     |    output
*                     |     |     |     |     |     |
.subckt M0033        5    12     1    10     9    11
* Models
.model qn npn (is = 5e − 14 bf = 150 vaf = 100 re = 1 rb = 5 re = 1 ikf = 200mA
+ cje = 5pF cjc = 5pF mje = .42 mjc = .23 tf = .3nS tr = 200nS br = 5 vtf = 0)
.model qp pnp (is = 5e − 14 bf = 150 vaf = 100 rc = .2 rb = 3 re = 1 ikf = 100mA
+ cje = 5.7pF cjc = 4pF tf = .3nS mje = .32 mjc = .43 tr = 170nS br = 5 vtf = 0)
.model qf njf (vto = − 3V beta = 4.0e − 3 cgd = 4pF cgs = 10pF lambda = 671.0e − 6)
* Resistors
r1 20 21 58.33
r2 27 10 58.33
r3 22 11 2
r4 11 23 2
* Transistors
j1 12 5 20 qf
j4 24 10 26 qf
q2 21 21 25 qn
q3 24 24 25 qp
q5 1 21 22 qn
q6 9 24 23 qp
q7 26 26 27 qn
.ends
```
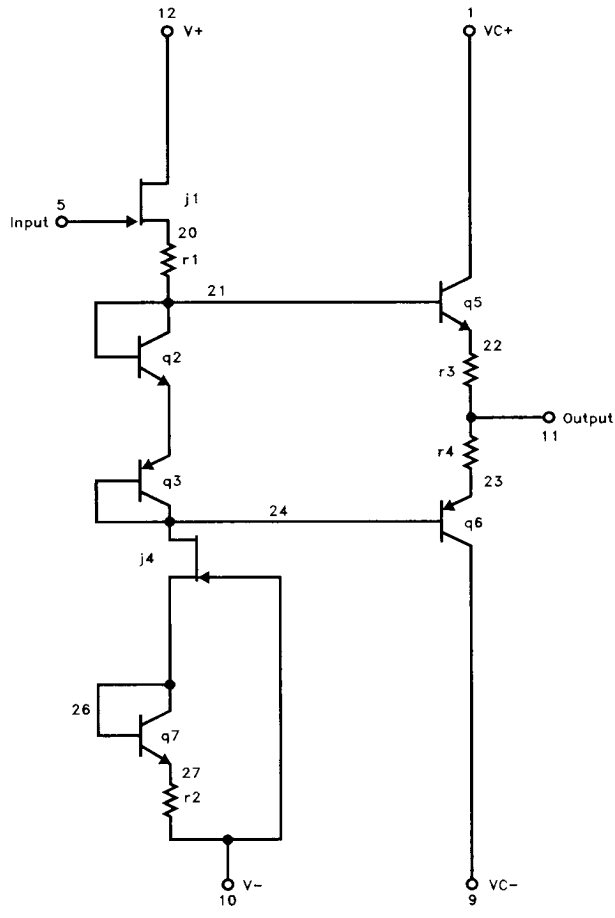
ELH0033 Macromodel — Contd.

0033-16