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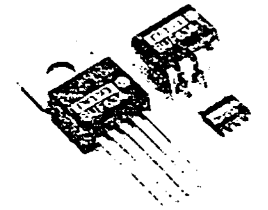
BB

BUF634

AVAILABLE IN DIE



250mA HIGH-SPEED BUFFER

FEATURES

- HIGH OUTPUT CURRENT: 250mA
- SLEW RATE: 2000V/μs
- PIN-SELECTED BANDWIDTH: 30MHz/180MHz
- LOW QUIESCENT CURRENT: 1.5mA (30MHz BW)
- WIDE SUPPLY RANGE: ±2.25 to ±18V
- INTERNAL CURRENT LIMIT
- THERMAL SHUT-DOWN
- 8-PIN DIP, SO-8, 5-PIN TO-220 PACKAGES, DICE

APPLICATIONS

- VALVE DRIVER
- SOLENOID DRIVER
- OP AMP CURRENT BOOSTER
- LINE DRIVER
- HEADPHONE DRIVER
- VIDEO DRIVER
- MOTOR DRIVER
- TEST EQUIPMENT
- ATE PIN DRIVER

DESCRIPTION

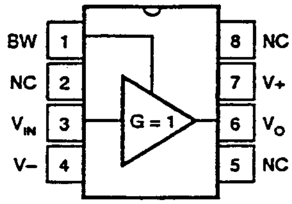
The BUF634 is a high speed unity-gain open-loop buffer recommended for a wide range of applications. It can be used inside the feedback loop of op amps to increase output current, eliminate thermal feedback and improve capacitive load drive.

For low power applications, the BUF634 operates on 1.5mA quiescent current with 250mA output and 2000V/μs slew rate. Bandwidth is increased from 30MHz to 180MHz by connecting pin 1 to V–.

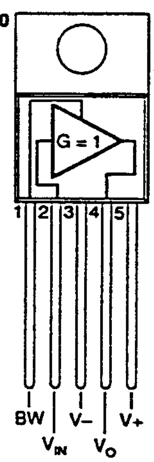
Output circuitry is fully protected by internal current limit and thermal shut-down making it rugged and easy to use.

The BUF634 is available in a variety of packages to suit mechanical and power dissipation requirements. Types include 8-pin DIP, SO-8 surface-mount and 5-pin TO-220. Dice are also available.

8-Pin DIP Package
SO-8 Surface-Mount Package



5-Pin TO-220



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PDS-1206

Printed in U.S.A. July, 1993

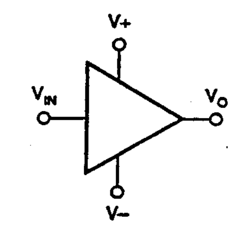
1/100 Stück-Preise:
BUF 634 P DM 12,70/DM 7,10
BUF 634 U DM 12,70/DM 7,10
BUF 634 T DM 16,90/DM 9,50

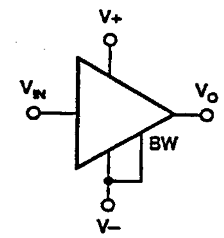
SPECIFICATIONS

ELECTRICAL

T_A = +25°C[1], V_S = ±15V unless otherwise noted.

		BUF634P, U, T						
		LOW QUIESCENT CURRENT MODE			WIDE BANDWIDTH MODE			
PARAMETER	CONDITION	MIN	TYP	MAX	MIN	TYP	MAX	UNITS
INPUT								
Offset Voltage			±30	±100		•	•	mV
vs Temperature	Specified Temperature Range		±100			•		µV/°C
vs Power Supply	V_S = ±2.25V[2] to ±18V		0.1	1		•	•	mV/V
Input Bias Current	V_{IN} = 0V		±0.5	±2		±5	±20	µA
Input Impedance	R_L = 100Ω		80 ‖ 8			8 ‖ 8		MΩ ‖ pF
Noise Voltage	f = 10kHz		4			•		nV/√Hz
GAIN	R_L = 1kΩ, V_O = ±10V	0.95	0.99		•	•		V/V
	R_L = 100Ω, V_O = ±10V	0.85	0.93		•	•		V/V
	R_L = 67Ω, V_O = ±10V	0.8	0.9		•	•		V/V
OUTPUT								
Current Output, Continuous			±250			•		mA
Voltage Output, Positive	I_O = 10mA	(V+) –2.1	(V+) –1.7		•	•		V
Negative	I_O = –10mA	(V–) +2.1	(V–) +1.8		•	•		V
Positive	I_O = 100mA	(V+) –3	(V+) –2.4		•	•		V
Negative	I_O = –100mA	(V–) +4	(V–) +3.5		•	•		V
Positive	I_O = 150mA	(V+) –4	(V+) –2.8		•	•		V
Negative	I_O = –150mA	(V–) +5	(V–) +4		•	•		V
Short-Circuit Current			±350	±550		±400	•	mA
DYNAMIC RESPONSE								
Bandwidth, –3dB	R_L = 1kΩ		30			180		MHz
	R_L = 100Ω		20			160		MHz
Slew Rate	20Vp-p, R_L = 100Ω		2000			•		V/µs
Settling Time, 0.1%	20V Step, R_L = 100Ω		200			•		ns
1%	20V Step, R_L = 100Ω		50			•		ns
Differential Gain	3.58MHz, V_O = 0.7V, R_L = 150Ω		4			0.4		%
Differential Phase	3.58MHz, V_O = 0.7V, R_L = 150Ω		2.5			0.1		°
POWER SUPPLY								
Specified Operating Voltage			±15			•		V
Operating Voltage Range		±2.25[2]		±18	•		•	V
Quiescent Current, I_Q	I_O = 0		±1.5	±2		±15	±20	mA
TEMPERATURE RANGE								
Specification		–40		+85	•		•	°C
Operating		–40		+125	•		•	°C
Storage		–40		+125	•		•	°C
Thermal Shutdown Temperature, T_J			175			•		°C
Thermal Resistance, θ_{JA}	"P" Package[3]		100			•		°C/W
θ_{JA}	"U" Package[3]		150			•		°C/W
θ_{JA}	"T" Package[3]		65			•		°C/W
θ_{JC}	"T" Package		6			•		°C/W



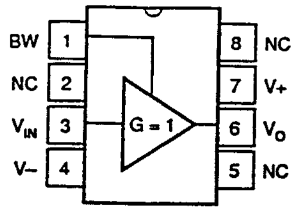


NOTES: (1) Tests are performed on high speed automatic test equipment, at approximately 25°C junction temperature. The power dissipation of this product will cause some parameters to shift when warmed up. See typical performance curves for over-temperature performance. (2) Limited output swing available at low supply voltage. See Output voltage specifications. (3) Typical when all leads are soldered to a circuit board. See text for recommendations.

PIN CONFIGURATION

Top View

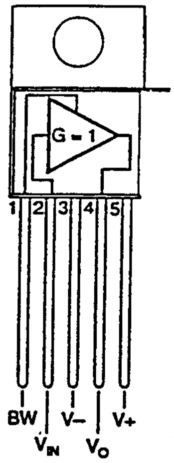
8-Pin Dip Package
SO-8 Surface-Mount Package



NC = No Connection

Top View

5-Pin TO-220



NOTE: Tab electrically connected to V–.

ABSOLUTE MAXIMUM RATINGS

Supply Voltage	±18V
Input Voltage Range	$\pm V_S$
Output Short-Circuit (to ground)	Continuous
Operating Temperature	–40°C to +125°C
Storage Temperature	–40°C to +125°C
Junction Temperature	+150°C
Lead Temperature (soldering,10s)	+300°C

ELECTROSTATIC DISCHARGE SENSITIVITY

Any integrated circuit can be damaged by ESD. Burr-Brown recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet published specifications.

PACKAGE INFORMATION[1]

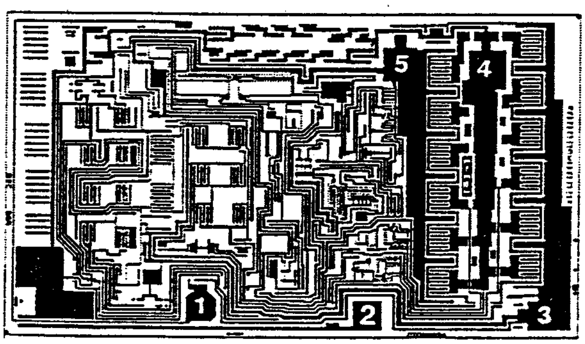
MODEL	PACKAGE	PACKAGE DRAWING NUMBER
BUF634P	8-Pin PDIP	006
BUF634U	SO-8 Surface Mount	182
BUF634T	5-Pin TO-220	315

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	PACKAGE NUMBER
BUF634P	8-Pin Plastic DIP	–40 to +85°C	006
BUF634U	SO-8 Surface-Mount	–40 to +85°C	182
BUF634T	5-Pin TO-220	–40 to +85°C	315
BUF634D	Dice	–40 to +85°C	—

DICE INFORMATION



BUF634 DIE TOPOGRAPHY

PAD	FUNCTION
1	BW
2	V_{IN}
3	V–
4	V_O
5	V+

Substrate Bias: Internally connected to V– power supply.

MECHANICAL INFORMATION

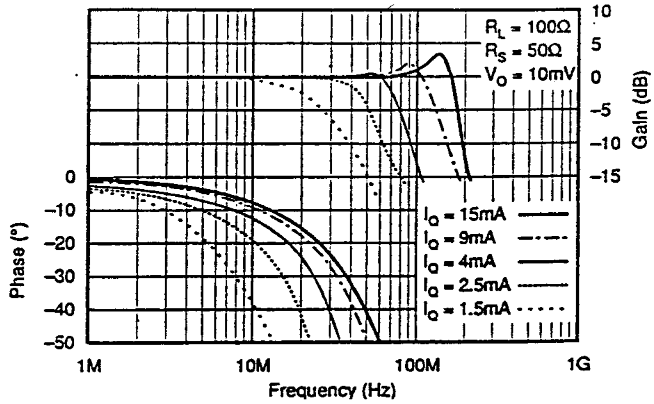
	MILS (0.001")	MILLIMETERS
Die Size	120 x 70 ±5	3.05 x 1.78 ±0.13
Die Thickness	20 ±3	0.51 ±0.08
Min. Pad Size	4 x 4	0.1 x 0.1
Backing		Chromium-Silver

See "DICE PRODUCTS" Appendix C in Burr-Brown IC Data Book, or contact factory for current information.

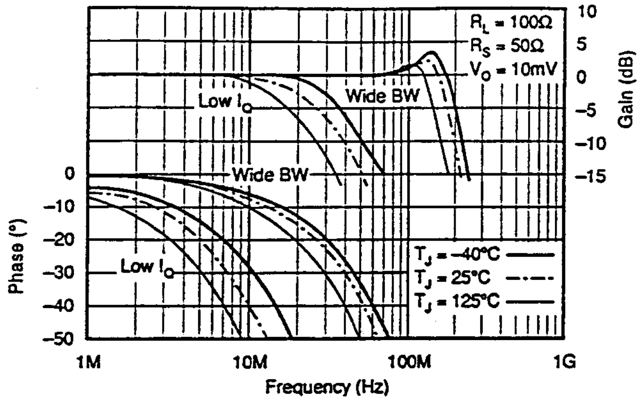
TYPICAL PERFORMANCE CURVES

$T_A = +25°C$, $V_S = ±15V$ unless otherwise noted.

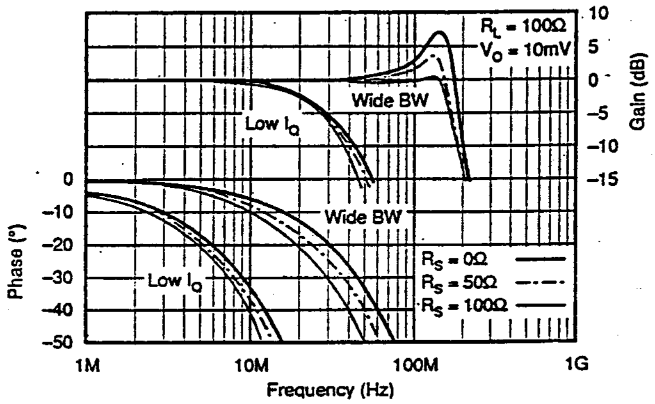
GAIN and PHASE vs FREQUENCY
vs QUIESCENT CURRENT



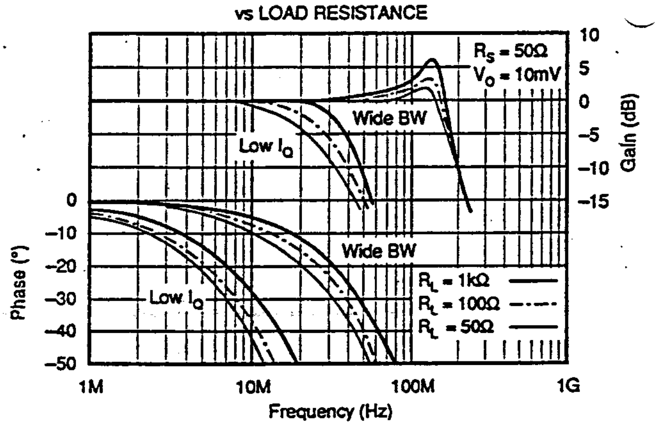
GAIN and PHASE vs FREQUENCY
vs TEMPERATURE



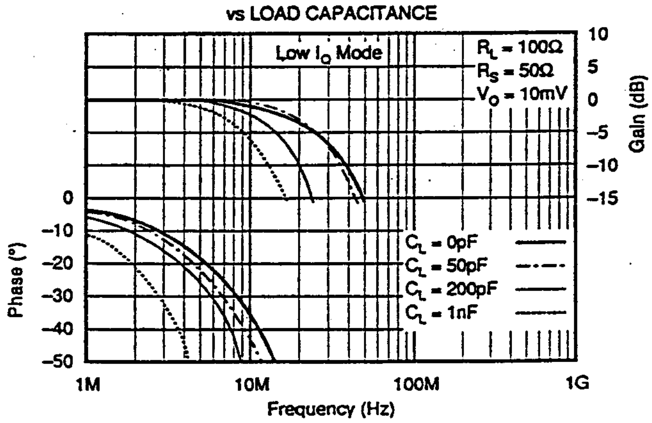
GAIN and PHASE vs FREQUENCY
vs SOURCE RESISTANCE



GAIN and PHASE vs FREQUENCY
vs LOAD RESISTANCE



GAIN and PHASE vs FREQUENCY
vs LOAD CAPACITANCE



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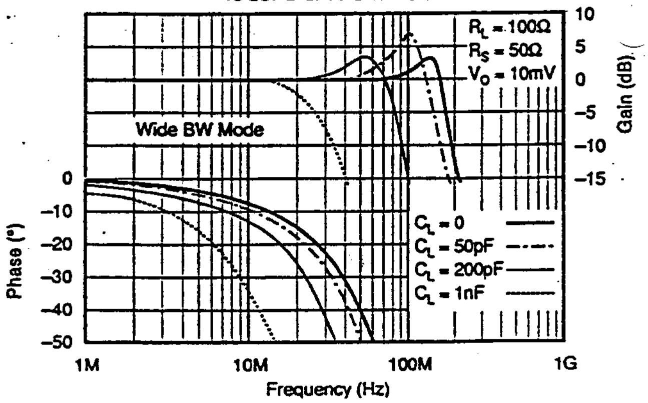
vs LOAD CAPACITANCE



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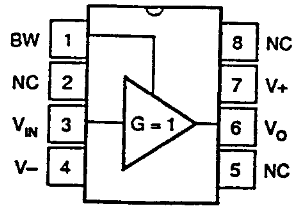

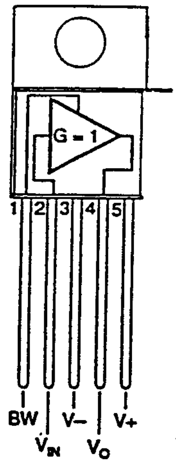

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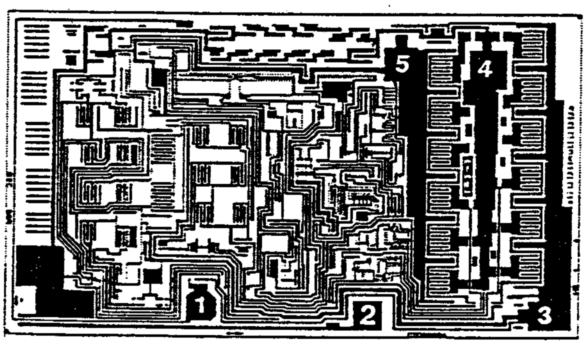

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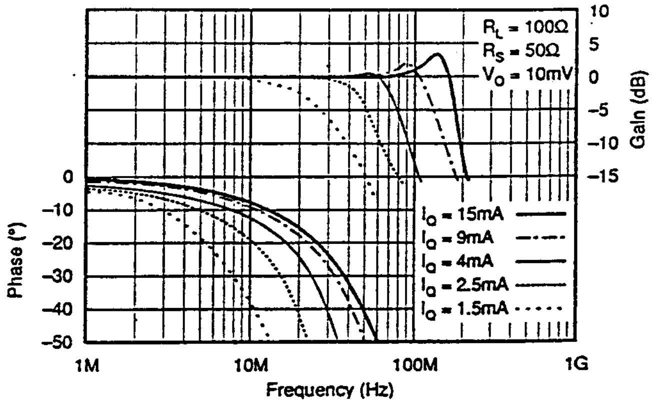
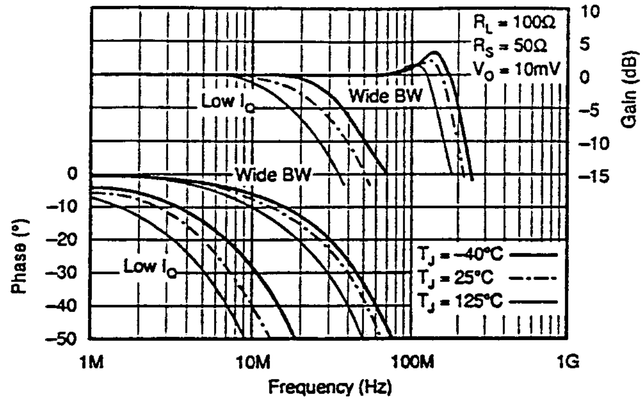
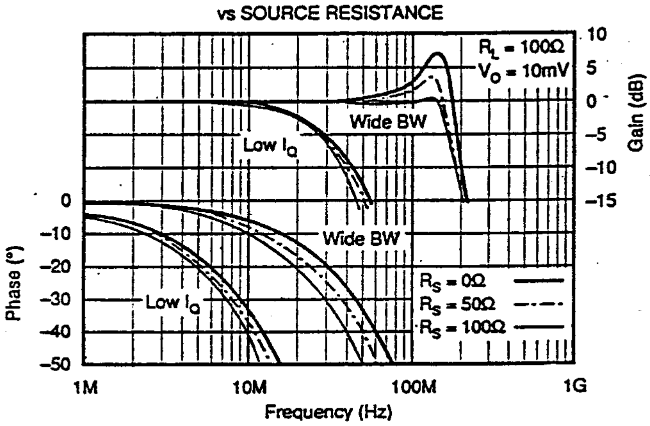
GAIN and PHASE vs FREQUENCY
vs QUIESCENT CURRENT



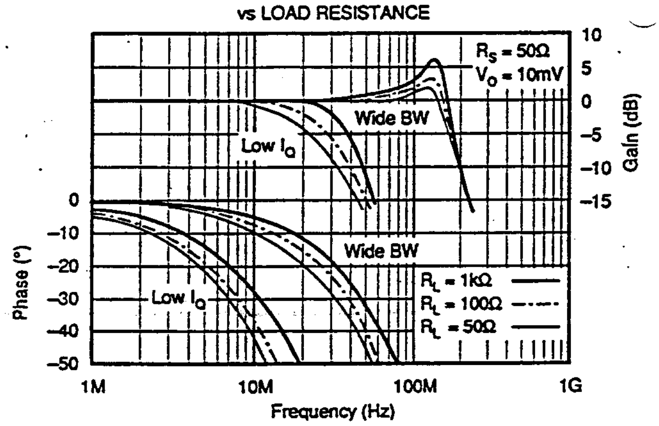
GAIN and PHASE vs FREQUENCY
vs TEMPERATURE



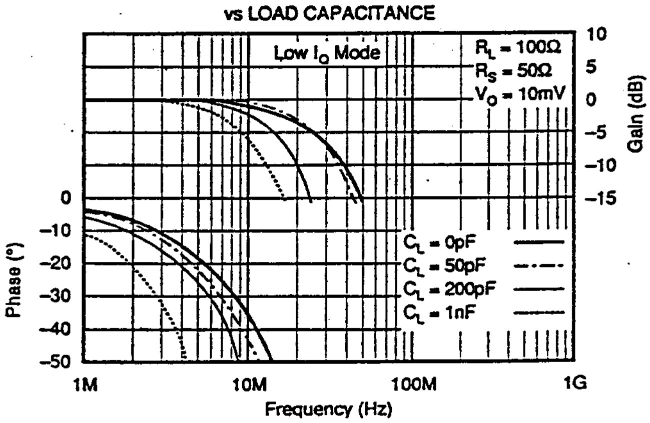
GAIN and PHASE vs FREQUENCY
vs SOURCE RESISTANCE



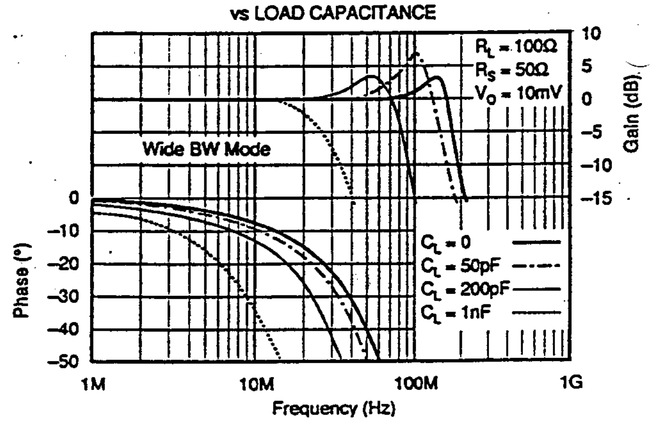
GAIN and PHASE vs FREQUENCY
vs LOAD RESISTANCE



GAIN and PHASE vs FREQUENCY
vs LOAD CAPACITANCE

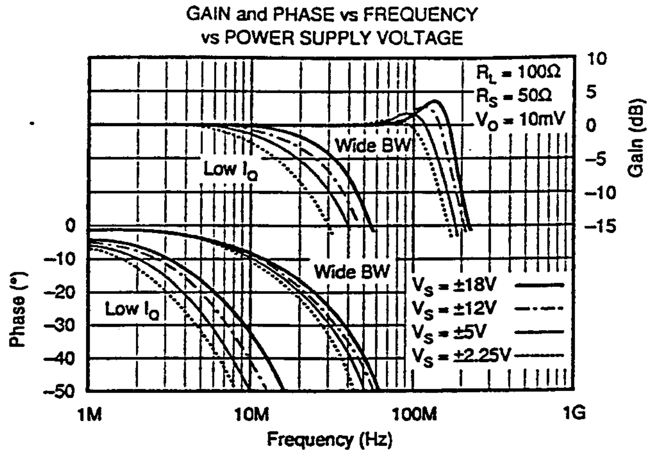


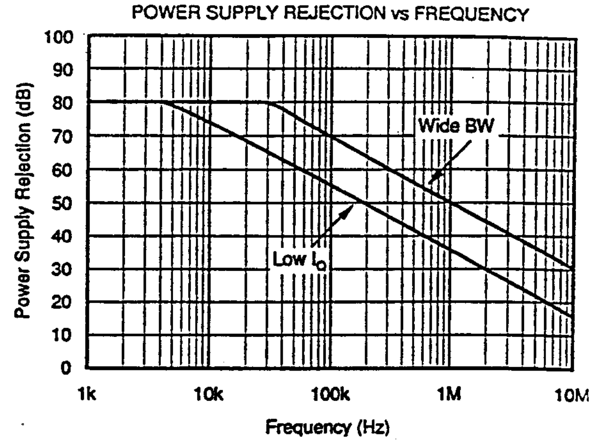
GAIN and PHASE vs FREQUENCY
vs LOAD CAPACITANCE

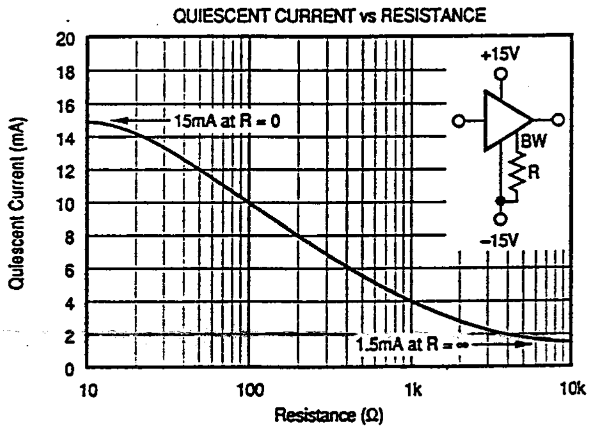


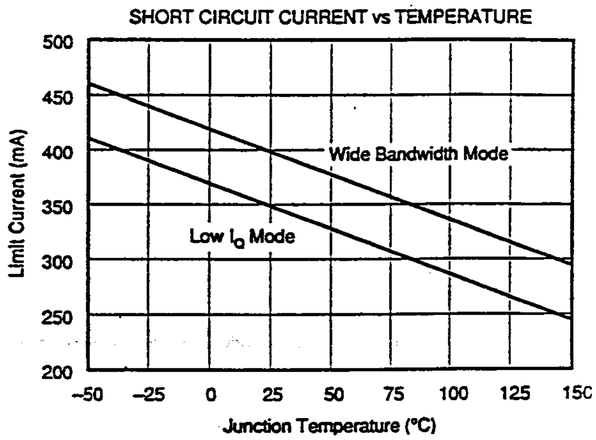
TYPICAL PERFORMANCE CURVES (CONT)

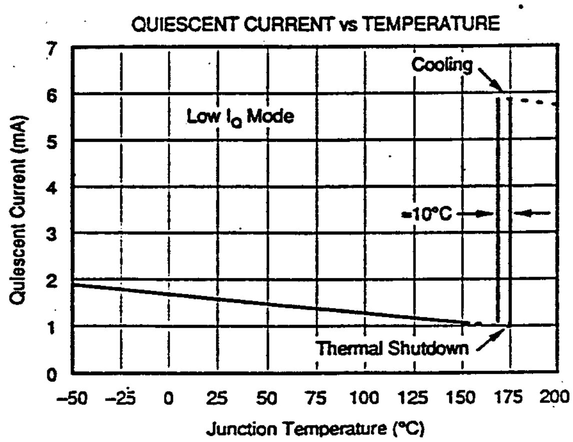
T_A = +25°C, V_S = ±15V unless otherwise noted.

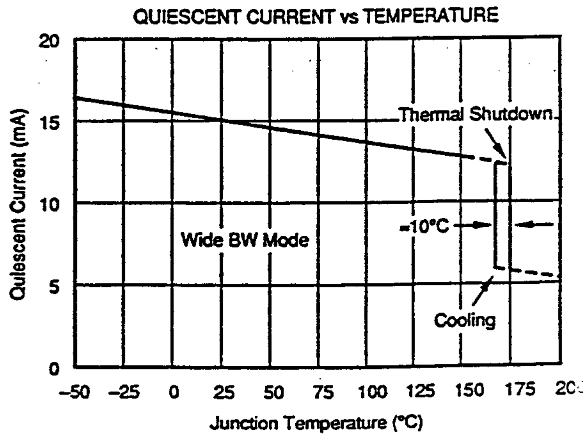






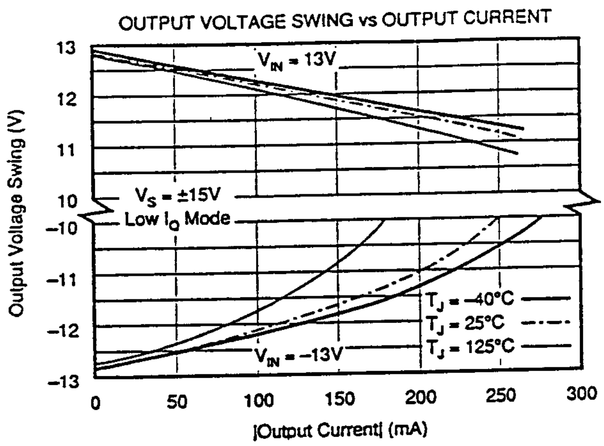


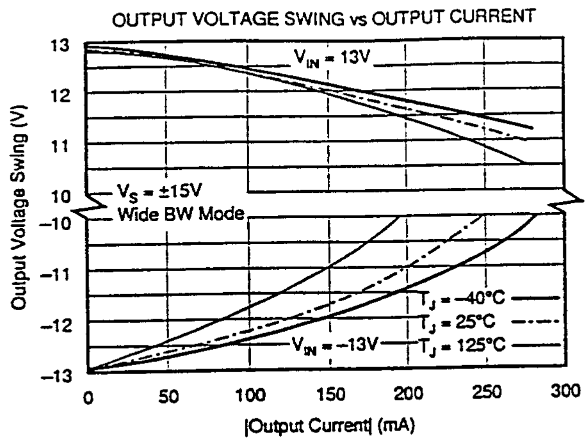


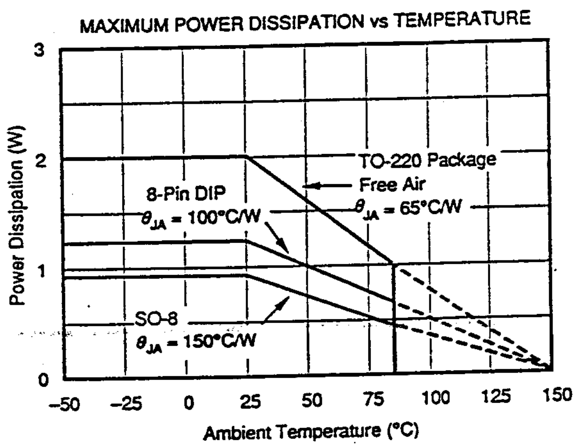


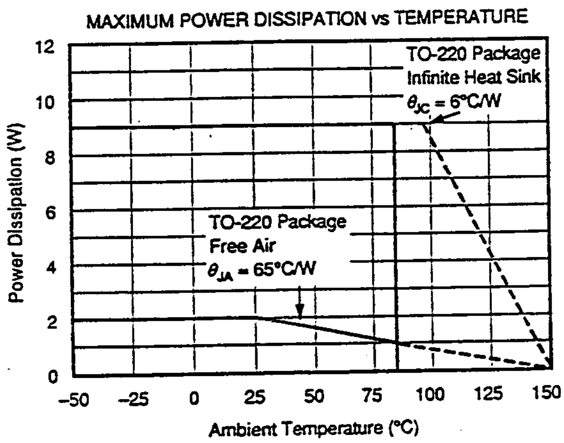
TYPICAL PERFORMANCE CURVES (CONT)

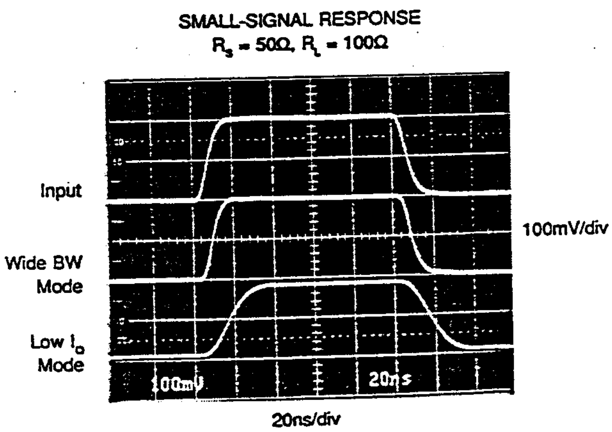
T_A = +25°C, V_S = ±15V unless otherwise noted.

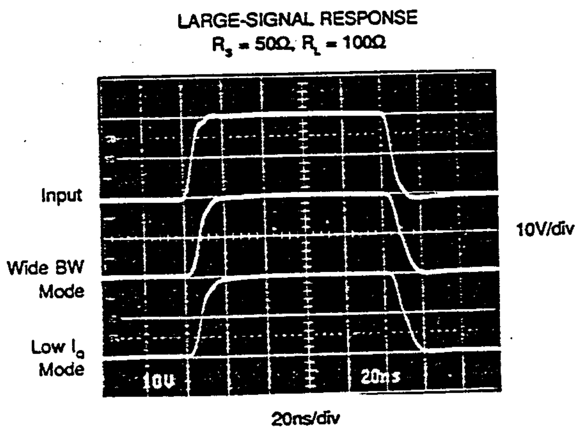












APPLICATION INFORMATION

Figure 1 is a simplified circuit diagram of the BUF634 showing its open-loop complementary follower design.

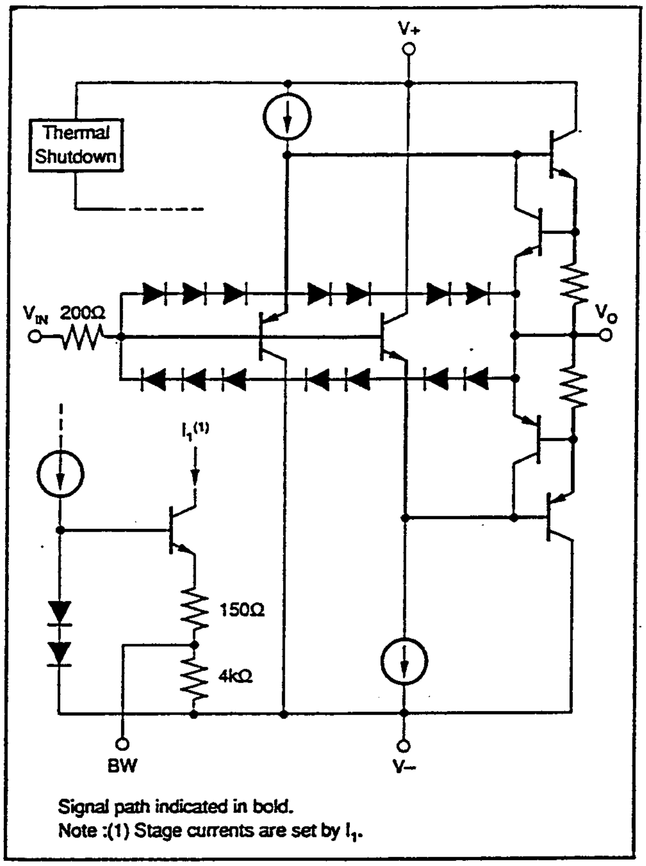


FIGURE 1. Simplified Circuit Diagram.

Figure 2 shows the BUF634 connected as an open-loop buffer. The source impedance and optional input resistor, R_S, influence frequency response—see typical curves. Power supplies should be bypassed with capacitors connected close to the device pins. Capacitor values as low as 0.1µF will assure stable operation in most applications, but high output current and fast output slewing can demand large current transients from the power supplies. Solid tantalum 10µF capacitors are recommended.

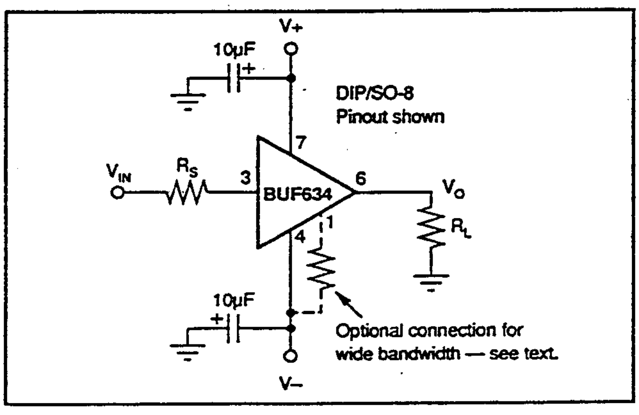


FIGURE 2. Buffer Connections.

High frequency open-loop applications may benefit from special bypassing and layout considerations—see "High Frequency Applications" at end of applications discussion.

OUTPUT CURRENT

The BUF634 can deliver up to ±250mA continuous output current. Internal circuitry limits output current to approximately ±350mA—see typical performance curve "Short Circuit Current vs Temperature". For many applications, however, the continuous output current will be limited by thermal effects.

The output voltage swing capability varies with junction temperature and output current—see typical curves "Output Voltage Swing vs Output Current." Although all three package types are tested for the same output performance using a high speed test, the higher junction temperatures with the DIP and SO-8 package types will often provide less output voltage swing. The TO-220 package can be used with a heat sink to reduce junction temperature, allowing maximum possible output swing.

THERMAL PROTECTION

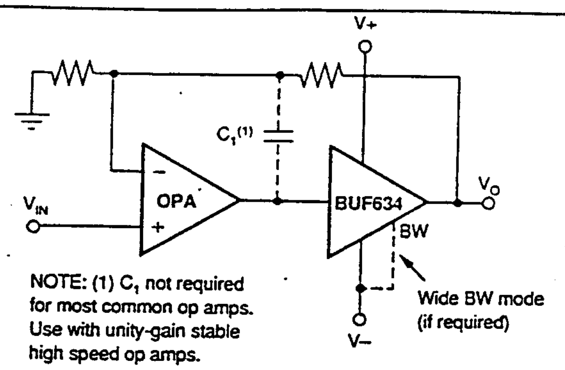
Power dissipated in the BUF634 will cause the junction temperature to rise. A thermal protection circuit in the BUF634 will disable the output when the junction temperature reaches approximately 175°C. When the thermal protection is activated, the output stage is disabled, allowing the device to cool. Quiescent current is approximately 6mA during thermal shutdown. When the junction temperature cools to approximately 165°C the output circuitry is again enabled. This can cause the protection circuit to cycle on and off with a period ranging from a fraction of a second to several minutes or more, depending on package type, signal, load and thermal environment.

The thermal protection circuit is designed to prevent damage during abnormal conditions. Any tendency to activate the thermal protection circuit during normal operation is a sign of an inadequate heat sink or excessive power dissipation for the package type.

The 5-pin TO-220 package provides best thermal performance. When used with a properly sized heat sink, output of the TO-220 version is not limited by thermal performance. See Application Bulletin AB-037 for details on heat sink calculations. The mounting tab of the TO-220 package is electrically connected to the V– power supply.

The DIP and SO-8 surface-mount packages are excellent for applications requiring high output current with low average power dissipation.

To achieve the best possible thermal performance with the DIP or SO-8 packages, solder the device directly to a circuit board. Since much of the heat is dissipated by conduction through the package pins, sockets will degrade thermal performance. Use wide circuit board traces on all the device pins, including pins that are not connected. With the DIP package, use traces on both sides of the printed circuit board if possible.



OP AMP	RECOMMENDATIONS
OPA177, OPA1013 OPA111, OPA2111 OPA121	Use Low I_Q mode. G = 1 stable.
OPA27, OPA2107 OPA602, OPA404	Low I_Q mode is stable. Increasing C_L may cause excessive ringing or instability. Use Wide BW mode.
OPA627, OPA604 OPA2604	Use Wide BW mode, C_1 = 200pF. G = 1 stable.
OPA637, OPA37	Use Wide BW mode. These op amps are not G = 1 stable. Use in G > 4.

FIGURE 3. Boosting Op Amp Output Current.

POWER DISSIPATION

Power dissipation depends on power supply voltage, signal and load conditions. With dc signals, power dissipation is equal to the product of output current times the voltage across the conducting output transistor. Power dissipation can be minimized by using the lowest possible power supply voltage necessary to assure the required output voltage swing.

For resistive loads, the maximum power dissipation occurs at a dc output voltage of one-half the power supply voltage. Dissipation with ac signals is lower. Application Bulletin AB-039 explains how to calculate or measure power dissipation with unusual signals and loads.

Any tendency to activate the thermal protection circuit indicates excessive power dissipation or an inadequate heat sink. For reliable operation, junction temperature should be limited to 150°C, maximum. To estimate the margin of safety in a complete design, increase the ambient temperature until the thermal protection is triggered. The thermal protection should trigger more than 45°C above the maximum expected ambient condition of your application.

INPUT CHARACTERISTICS

Internal circuitry is protected with a diode clamp connected from the input to output of the BUF634—see Figure 1. If the output is unable to follow the input within approximately 3V (such as with an output short-circuit), the input will conduct increased current from the input source. This is limited by the internal 200Ω resistor. If the input source can be damaged by this increase in load current, an additional resistor can be connected in series with the input.

BANDWIDTH CONTROL PIN

The –3dB bandwidth of the BUF634 is approximately 30MHz in the low quiescent current mode (1.5mA typical). To select this mode, leave the bandwidth control pin open (no connection).

Bandwidth can be extended to approximately 180MHz by connecting the bandwidth control pin to V–. This increases the quiescent current to approximately 15mA. Intermediate bandwidths can be set by connecting a resistor in series with the bandwidth control pin—see typical curve "Quiescent Current vs Resistance" for resistor selection. Characteristics of the bandwidth control pin can be seen in the simplified circuit diagram, Figure 1.

The rated output current and slew rate are not affected by the bandwidth control, but the current limit value changes slightly. Output voltage swing is somewhat improved in the wide bandwidth mode. The increased quiescent current when in wide bandwidth mode produces greater power dissipation during low output current conditions. This quiescent power is equal to the total supply voltage, (V+)+|V–|, times the quiescent current.

BOOSTING OP AMP OUTPUT CURRENT

The BUF634 can be connected inside the feedback loop of most op amps to increase output current—see Figure 3. When connected inside the feedback loop, the BUF634's offset voltage and other errors are corrected by the feedback of the op amp.

To assure that the op amp remains stable, the BUF634's phase shift must remain small throughout the loop gain of the circuit. For a G=+1 op amp circuit, the BUF634 must contribute little additional phase shift (approximately 20° or less) at the unity-gain frequency of the op amp. Phase shift is affected by various operating conditions that may affect stability of the op amp—see typical Gain and Phase curves.

Most general-purpose or precision op amps remain unity-gain stable with the BUF634 connected inside the feedback loop as shown. Large capacitive loads may require the BUF634 to be connected for wide bandwidth for stable operation. High speed or fast-settling op amps generally require the wide bandwidth mode to remain stable and to assure good dynamic performance. To check for stability with an op amp, look for oscillations or excessive ringing on signal pulses with the intended load and worst case conditions that affect phase response of the buffer.

HIGH FREQUENCY APPLICATIONS

The BUF634's excellent bandwidth and fast slew rate make it useful in a variety of high frequency open-loop applications. When operated open-loop, circuit board layout and bypassing technique can affect dynamic performance.

For best results, use a ground plane type circuit board layout and bypass the power supplies with 0.1µF ceramic chip capacitors at the device pins. Source resistance will affect high-frequency peaking and step response overshoot and ringing. Best response is usually achieved with a series input resistor of 25Ω to 200Ω, depending on the signal source. Response with some loads (especially capacitive) can be improved with a resistor of 10Ω to 150Ω in series with the output.

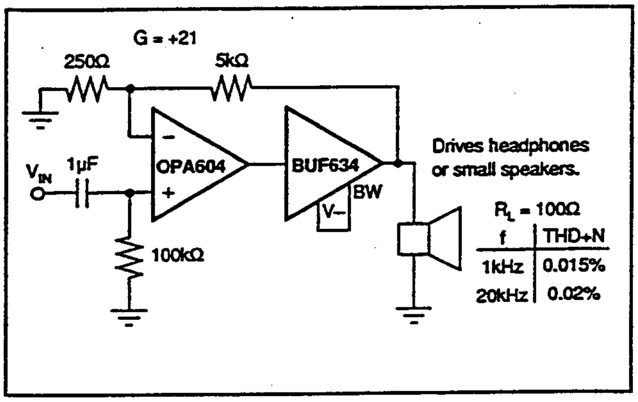


FIGURE 4. High Performance Headphone Driver.

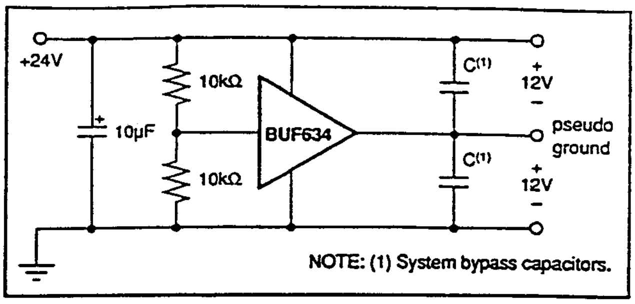


FIGURE 5. Pseudo-Ground Driver.

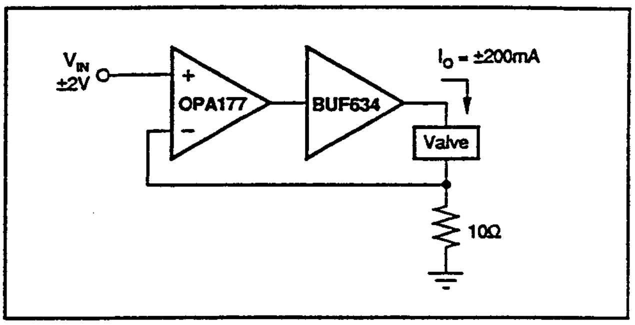


FIGURE 6. Current-Output Valve Driver.

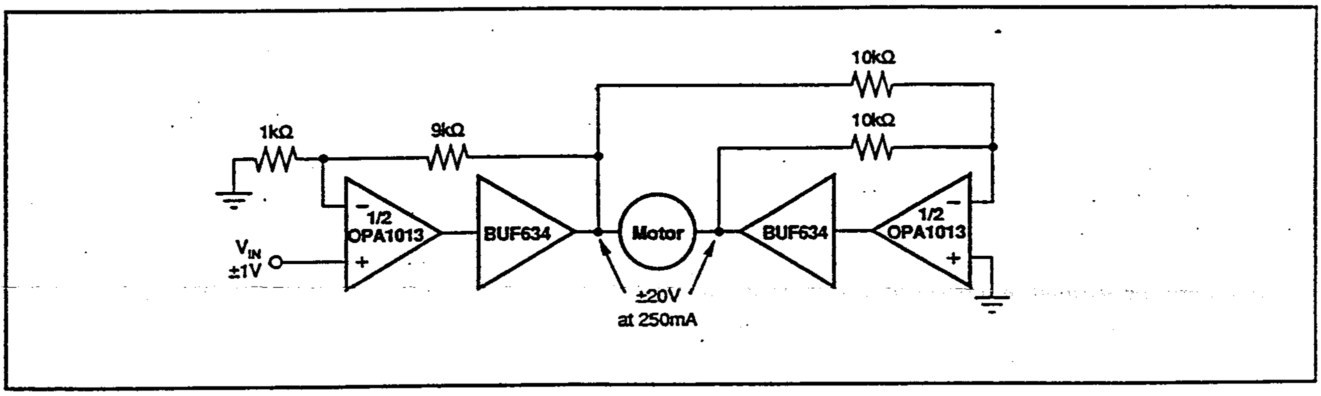


FIGURE 7. Bridge-Connected Motor Driver.

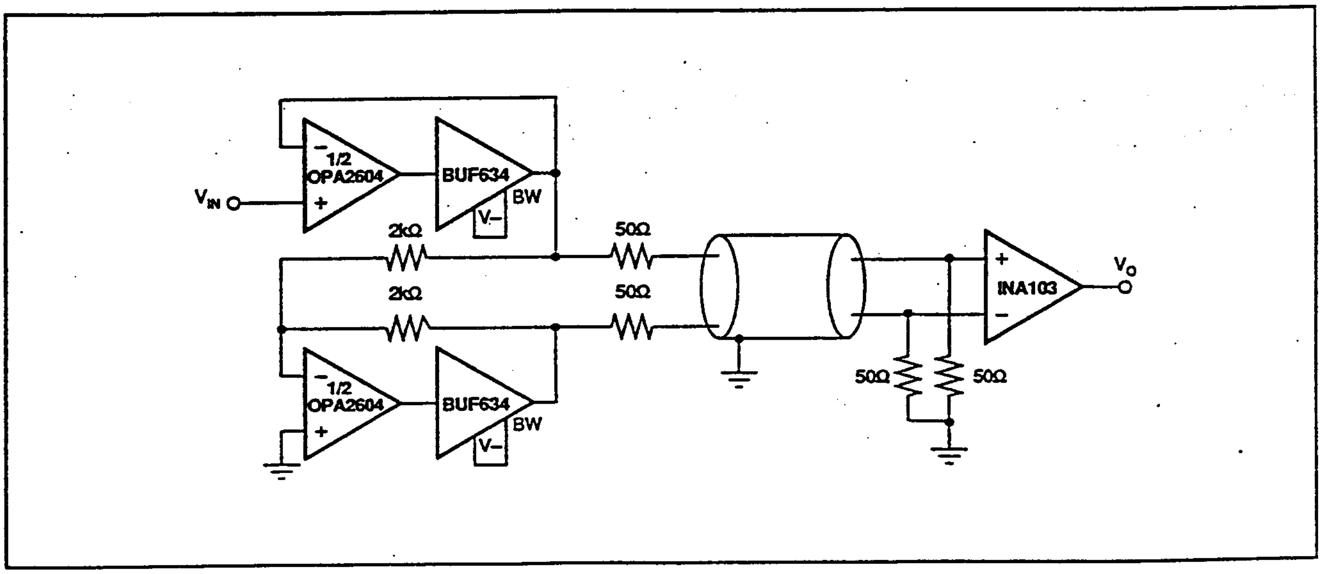
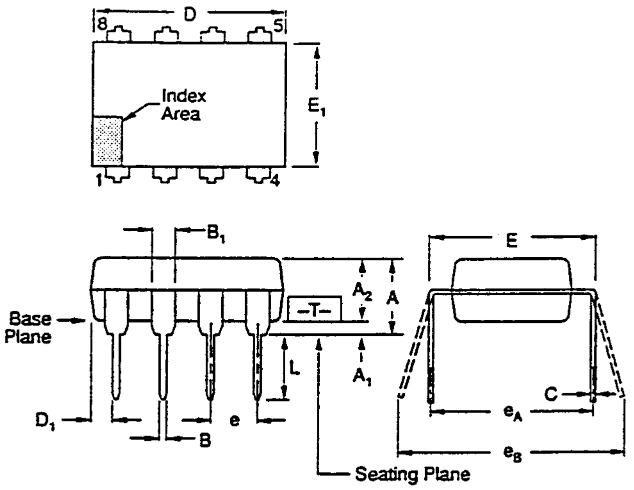


FIGURE 8. Differential Line Driver.

MECHANICALS

Package Number 006 — 8-Pin Plastic Single-Wide DIP



	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A [3]	—	.210	—	5.33
A_1 [3]	.015	—	0.38	—
A_2	.115	.195	2.92	4.95
B	.014	.022	0.36	0.56
B_1	.045	.070	1.14	1.78
C	.008	.015	0.20	0.38
D [4]	.348	.430	8.84	10.92
D_1	.005	—	0.13	—
E [5]	.300	.325	7.62	8.26
E_1 [4]	.240	.280	6.10	7.11
e	.100 BASIC		2.54 BASIC	
e_A [5]	.300 BASIC		7.63 BASIC	
e_B [6]	—	.430	—	10.92
L [3]	.115	.160	2.92	4.06
N [7]	8		8	

(1) Controlling dimension: Inch. In case of conflict between the English and metric dimensions, the inch dimensions control.

(2) Dimensioning and tolerancing per ANSI Y14.5M-1982.

(3) Dimensions A, A_1, and L are measured with the package seated in JEDEC seating plane gauge GS-3.

(4) D and E_1 dimensions for plastic packages do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .010 inch (0.25mm).

(5) E and eA measured with the leads constrained to be perpendicular to plane T.

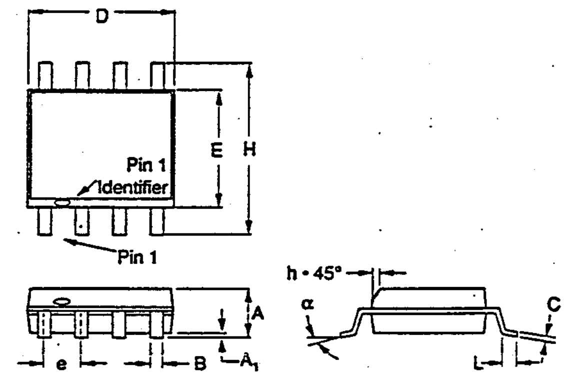
(6) eB is measured at the lead tips with the leads unconstrained.

(7) N is the maximum number of terminal positions.

(8) Corner leads (1, 4, 5, and 8) may be configured as shown in Figure 2.

(9) For automatic insertion, any raised irregularity on the top surface (step, mesa, etc.) shall be symmetrical about the lateral and longitudinal package center-lines.

Package Number 182 — 8-Pin SO-8 Surface Mount

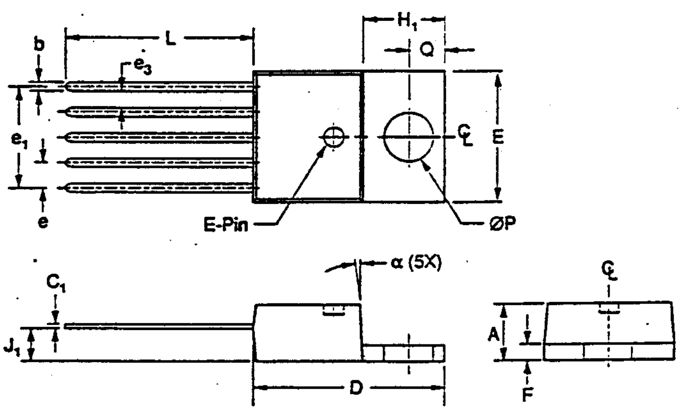


	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	.054	.068	1.37	1.73
A_1	.004	.009	0.10	0.23
B	.014	.019	0.36	0.48
C	.008	.0098	0.20	0.25
D	.189	.196	4.80	4.98
E	.150	.157	3.81	3.99
e	.050 BASIC		1.27 BASIC	
H	.229	.244	5.82	6.20
h	.010	.019	0.25	0.48
L	.016	.050	0.41	1.27
N	8		8	
α	0°	8°	0°	8°

NOTES:

1. Dimensioning and tolerancing per ANSI Y14.5M–1982.
2. "D" and "E" are reference datums and do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.15mm (.086 in.)
3. The chamfer on the body is optional. If it is not present, a visual index feature must be located within the cross-hatched area.
4. "L" is the length of the terminal for soldering to a substrate.
5. "N" is the number of terminal positions.

Package Number 315 — TO-220, 5-Lead



	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	.160	.190	4.06	4.83
b	.025	.040	0.63	1.02
C_1	.014	.022	0.36	0.56
D	.560	.590	14.22	14.99
E	.385	.415	9.78	10.54
e	.062	.072	1.57	1.83
e_1	.263	.273	6.68	6.93
e_3	.030	.040	0.76	1.02
F	.045	.055	1.14	1.40
H_1	.234	.258	5.94	6.55
J_1	.090	.115	2.29	2.92
ØP	.146	.156	3.71	3.96
Q	.103	.113	2.62	2.87
L	.540	.560	13.72	14.22
α	3°	7°	3°	7°