

## 6-Channel Buffer with High Power $V_{COM}$

The EL5624A integrates six gamma reference buffers with a single high power  $V_{COM}$  amplifier. Each gamma buffer has a bandwidth of 12MHz and features a slew rate of 15V/ $\mu$ s. The output current is rated at 30mA continuous, 140mA peak.

The  $V_{COM}$  amplifier is rated for 260mA peak output current and also features higher slew rate (70V/ $\mu$ s) and bandwidth (35MHz) for use in error cancellation circuits.

The EL5624A is available in the 20-pin HTSSOP package and is specified for operation over the -40°C to +85°C temperature range.

## Ordering Information

PART NUMBER (See Note)	PACKAGE (Pb-Free)	TAPE & REEL	PKG. DWG. #
EL5624AIREZ (See Note)	20-Pin HTSSOP (Pb-free)	-	MDP0048
EL5624AIREZ-T7 (See Note)	20-Pin HTSSOP (Pb-free)	7"	MDP0048
EL5624AIREZ-T13 (See Note)	20-Pin HTSSOP (Pb-free)	13"	MDP0048

NOTE: Intersil Pb-free products employ special Pb-free material sets; molding compounds/die attach materials and 100% matte tin plate termination finish, which are RoHS compliant and compatible with both SnPb and Pb-free soldering operations. Intersil Pb-free products are MSL classified at Pb-free peak reflow temperatures that meet or exceed the Pb-free requirements of IPC/JEDEC J STD-020.

## Features

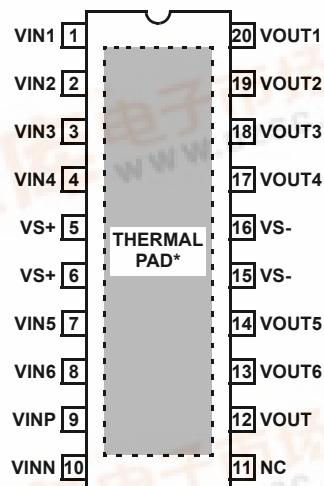
- 6 x gamma buffers
- Single high power  $V_{COM}$  amplifier
- 260mA peak  $V_{COM}$  output current
- Low power - just 8.5mA
- Pb-free available (RoHS compliant)

## Applications

- TFT-LCD displays
- Flat panel monitors
- Notebook displays
- LCD-TVs

## Pinout

**EL5624A**  
**(20-PIN HTSSOP)**  
**TOP VIEW**



\* THERMAL PAD CONNECTED TO PIN 15 or 16 ( $V_{S-}$ )

## EL5624A

### Absolute Maximum Ratings (T<sub>A</sub> = 25°C)

Supply Voltage between V <sub>S+</sub> and V <sub>S-</sub> .....	+18V	Power Dissipation .....	See Curves
Input Voltage .....	V <sub>S-</sub> -0.5V, V <sub>S+</sub> +0.5V	Maximum Die Temperature .....	+125°C
Maximum Continuous Output Current (Buffer) .....	30mA	Storage Temperature .....	-65°C to +150°C
Maximum Continuous Output Current (V <sub>COM</sub> ) .....	60mA	Operating Conditions .....	-40°C to +85°C

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

NOTE: All parameters having Min/Max specifications are guaranteed. Typ values are for information purposes only. Unless otherwise noted, all tests are at the specified temperature and are pulsed tests, therefore: T<sub>J</sub> = T<sub>C</sub> = T<sub>A</sub>

### Electrical Specifications V<sub>S+</sub> = +15V, V<sub>S-</sub> = 0, R<sub>L</sub> = 10kΩ, C<sub>L</sub> = 10pF to 0V, Gain of V<sub>COM</sub> = 1, RLV<sub>COM</sub> = 1kΩ and T<sub>A</sub> = 25°C, unless otherwise specified

PARAMETER	DESCRIPTION	CONDITIONS	MIN	TYP	MAX	UNIT
<b>INPUT CHARACTERISTICS (REFERENCE BUFFERS)</b>						
V <sub>OS</sub>	Input Offset Voltage	V <sub>CM</sub> = 0V		2	14	mV
TCV <sub>OS</sub>	Average Offset Voltage Drift	(Note 1)		5		μV/°C
I <sub>B</sub>	Input Bias Current	V <sub>CM</sub> = 0V		2	50	nA
R <sub>IN</sub>	Input Impedance			1		GΩ
C <sub>IN</sub>	Input Capacitance			1.35		pF
A <sub>V</sub>	Voltage Gain	1V ≤ V <sub>OUT</sub> ≤ 14V	0.992		1.008	V/V
<b>INPUT CHARACTERISTICS (V<sub>COM</sub> AMPLIFIER)</b>						
V <sub>OS</sub>	Input Offset Voltage	V <sub>CM</sub> = 7.5V		1	15	mV
TCV <sub>OS</sub>	Average Offset Voltage Drift	(Note 1)		5		μV/°C
I <sub>B</sub>	Input Bias Current	V <sub>CM</sub> = 7.5V		2	50	nA
R <sub>IN</sub>	Input Impedance			1		GΩ
C <sub>IN</sub>	Input Capacitance			1.35		pF
V <sub>REG</sub>	Load Regulation	V <sub>COM</sub> = 1.5V, -60mA < I <sub>L</sub> < 60mA	-20		+20	mV
A <sub>VOL</sub>	Open Loop Gain	R <sub>L</sub> = 1kΩ	55	75		dB
CMRR	Common Rejection Ratio		45	70		dB
<b>OUTPUT CHARACTERISTICS (REFERENCE BUFFERS)</b>						
V <sub>OL</sub>	Output Swing Low	I <sub>L</sub> = 7.5mA		50	150	mV
V <sub>OH</sub>	Output Swing High	I <sub>L</sub> = 7.5mA	14.85	14.95		V
I <sub>SC</sub>	Short Circuit Current	R <sub>L</sub> = 10Ω	±200	±250		mA
<b>OUTPUT CHARACTERISTICS (V<sub>COM</sub> AMPLIFIER)</b>						
V <sub>OL</sub>	Output Swing Low	I <sub>L</sub> = -7.5mA		50	150	mV
V <sub>OH</sub>	Output Swing High	I <sub>L</sub> = +7.5mA	14.85	14.95		V
I <sub>SC</sub>	Short Circuit Current	R <sub>L</sub> = 10Ω	±220	±260		mA
<b>POWER SUPPLY PERFORMANCE</b>						
PSRR	Power Supply Rejection Ratio	Reference buffer V <sub>S</sub> from 4.5V to 15.5V	55	80		dB
		V <sub>COM</sub> buffer, V <sub>S</sub> from 4.5V to 15.5V	55	80		dB
I <sub>S</sub>	Total Supply Current	No load		8.5	10	mA
<b>DYNAMIC PERFORMANCE (BUFFER AMPLIFIERS)</b>						
SR	Slew Rate (Note 2)	-4V ≤ V <sub>OUT</sub> ≤ 4V, 20% to 80%	50	70		V/μs
t <sub>S</sub>	Settling to +0.1% (A <sub>V</sub> = +1)	(A <sub>V</sub> = +1), V <sub>O</sub> = 2V step		250		ns
BW	-3dB Bandwidth	R <sub>L</sub> = 10kΩ, C <sub>L</sub> = 10pF		12		MHz

## EL5624A

**Electrical Specifications**  $V_{S+} = +15V$ ,  $V_{S-} = 0$ ,  $R_L = 10k\Omega$ ,  $C_L = 10pF$  to 0V, Gain of  $V_{COM} = 1$ ,  $RLV_{COM} = 1k\Omega$  and  $T_A = 25^\circ C$ , unless otherwise specified **(Continued)**

PARAMETER	DESCRIPTION	CONDITIONS	MIN	TYP	MAX	UNIT
GBWP	Gain-Bandwidth Product	$R_L = 10k\Omega$ , $C_L = 10pF$		8		MHz
PM	Phase Margin	$R_L = 10k\Omega$ , $C_L = 10pF$		50		°
CS	Channel Separation	$f = 5MHz$		75		dB
<b>DYNAMIC PERFORMANCE (<math>V_{COM}</math> AMPLIFIERS)</b>						
SR	Slew Rate (Note 2)	$-4V \leq V_{OUT} \leq 4V$ , 20% to 80%	60	70		V/ $\mu s$
$t_S$	Settling to $\pm 0.1\%$ ( $A_V = +1$ )	( $A_V = +1$ ), $V_O = 6V$ step		150		ns
BW	-3dB Bandwidth	$R_L = 1k\Omega$ , $C_L = 2pF$		35		MHz
GBWP	Gain-Bandwidth Product	$R_L = 1k\Omega$ , $C_L = 2pF$		20		MHz
PM	Phase Margin	$R_L = 1k\Omega$ , $C_L = 2pF$		50		°

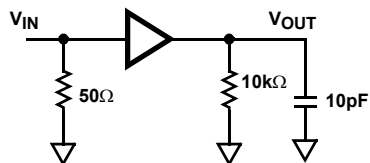
NOTES:

1. Measured over operating temperature range
2. Slew rate is measured on rising and falling edges

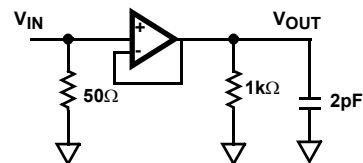
## Pin Descriptions

PIN NUMBER	PIN NAME	PIN FUNCTION
1	VIN1	Input
2	VIN2	Input
3	VIN3	Input
4	VIN4	Input
5, 6	VS+	Positive supply
9	VINP	Positive input - $V_{COM}$
10	VINN	Negative input - $V_{COM}$
11	NC	Not connected
12	VOUT	Output for $V_{COM}$
15, 16	VS-	Negative supply
17	VOUT4	Output
18	VOUT3	Output
19	VOUT2	Output
20	VOUT1	Output
7	VIN5	Input
8	VIN6	Input
14	VOUT5	Output
13	VOUT6	Output

## Test Circuits



FOR BUFFERS



FOR  $V_{COM}$

## Typical Performance Curves

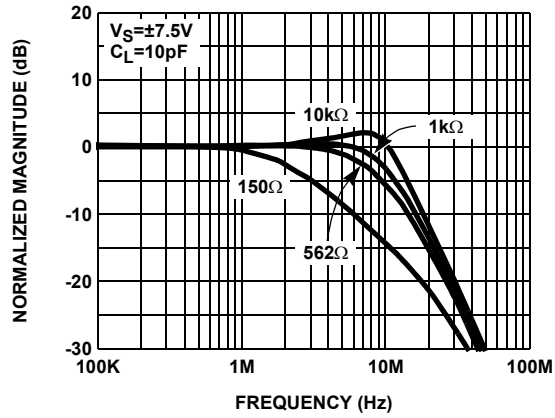


FIGURE 1. FREQUENCY RESPONSE FOR VARIOUS  $R_L$  (BUFFER)

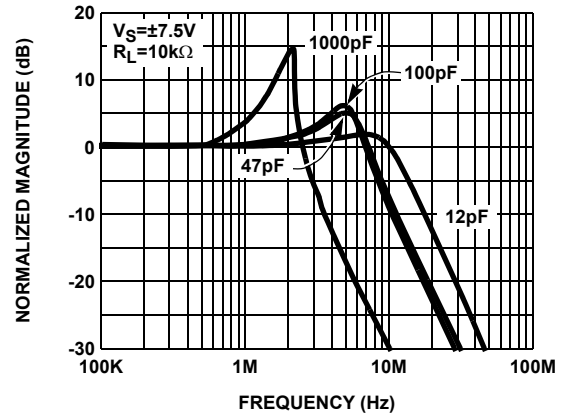


FIGURE 2. FREQUENCY RESPONSE FOR VARIOUS  $C_L$  (BUFFER)

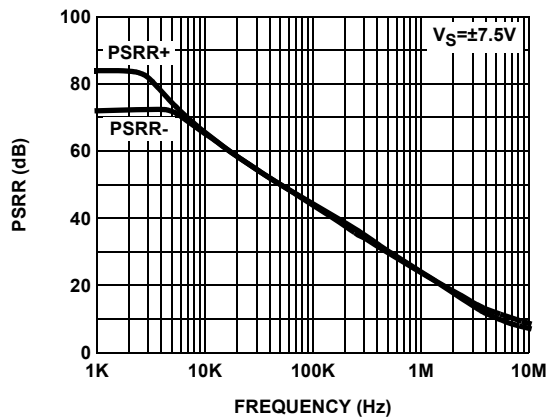


FIGURE 3. PSRR vs FREQUENCY (BUFFER)

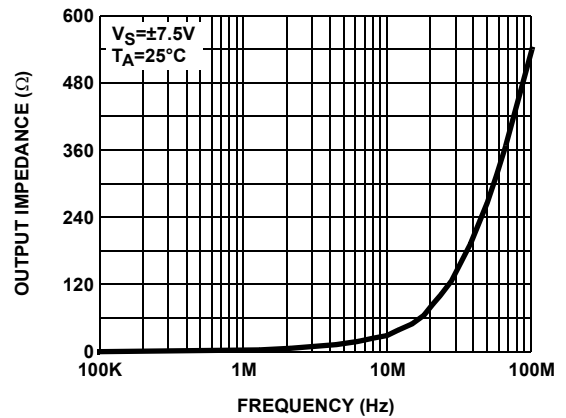


FIGURE 4. OUTPUT IMPEDANCE vs FREQUENCY (BUFFER)

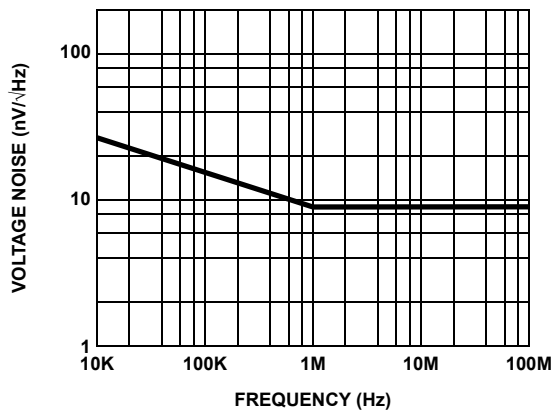


FIGURE 5. INPUT NOISE SPECIAL DENSITY vs FREQUENCY (BUFFER)

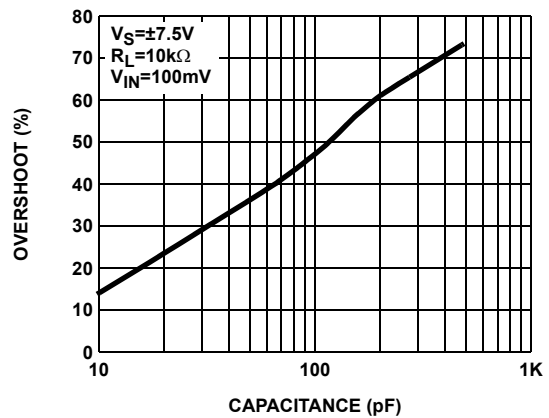


FIGURE 6. OVERSHOOT vs LOAD CAPACITANCE (BUFFER)

Typical Performance Curves (Continued)

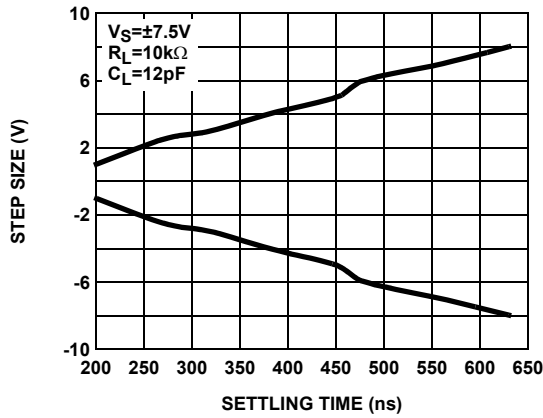


FIGURE 7. SETTLING TIME vs STEP SIZE (BUFFER)

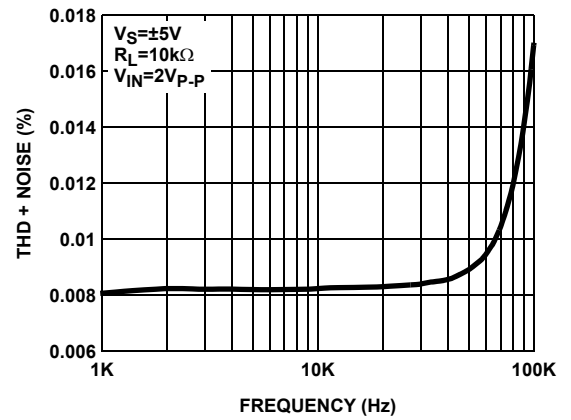


FIGURE 8. TOTAL HARMONIC DISTORTION + NOISE vs FREQUENCY (BUFFER)

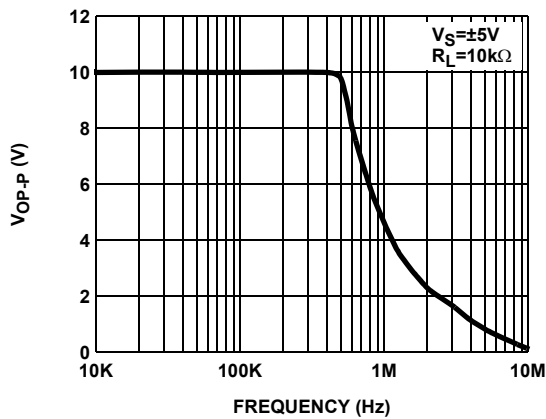


FIGURE 9. OUTPUT SWING vs FREQUENCY (BUFFER)

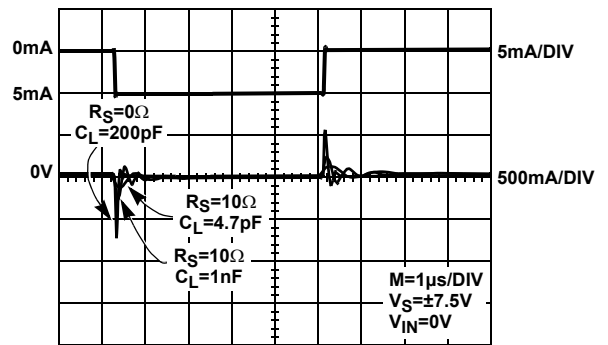


FIGURE 10. TRANSIENT LOAD REGULATION - SOURCING (BUFFER)

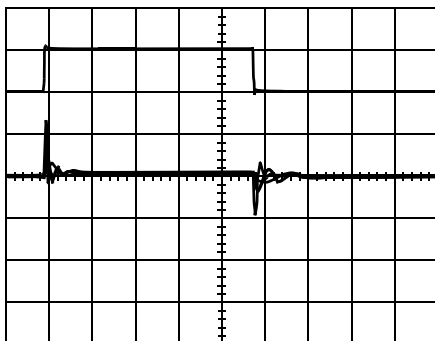


FIGURE 11. TRANSIENT LOAD REGULATION -SINKING (BUFFER)

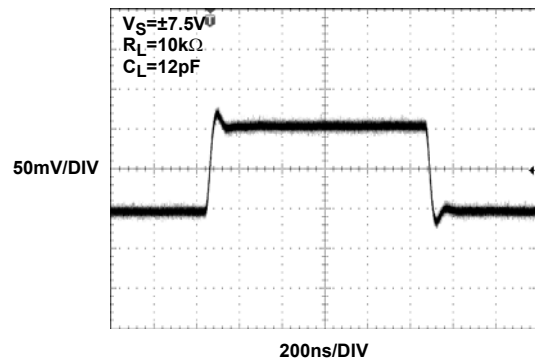


FIGURE 12. SMALL SIGNAL TRANSIENT RESPONSE (BUFFER)

Typical Performance Curves (Continued)

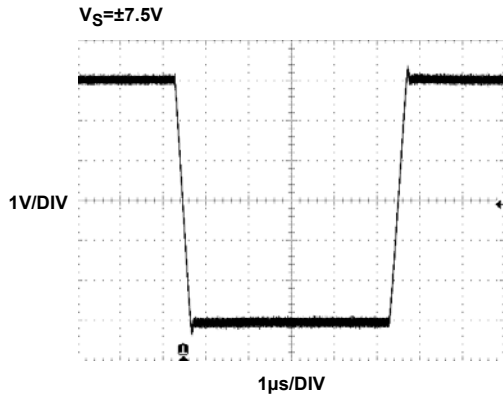


FIGURE 13. LARGE SIGNAL TRANSIENT RESPONSE (BUFFER)

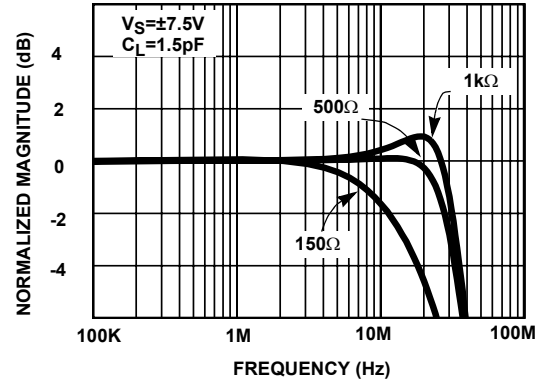


FIGURE 14. FREQUENCY RESPONSE FOR VARIOUS  $R_L$  ( $V_{COM}$ )

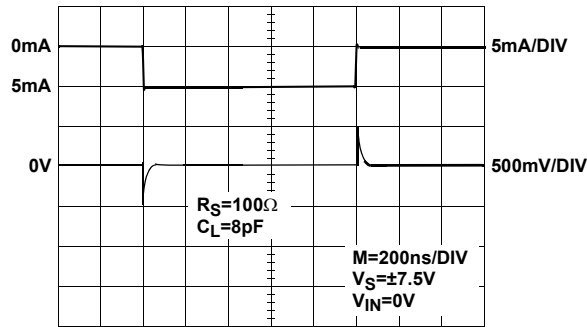


FIGURE 15. TRANSIENT LOAD REGULATION - SOURCING ( $V_{COM}$ )

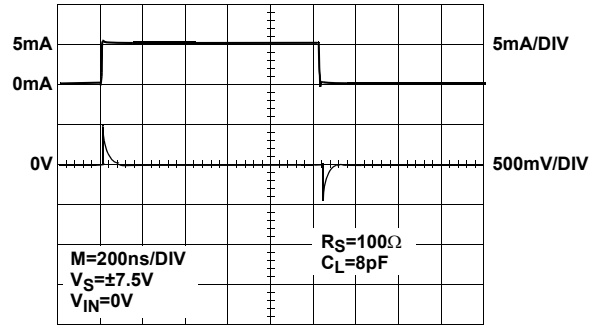


FIGURE 16. TRANSIENT LOAD REGULATION - SINKING ( $V_{COM}$ )

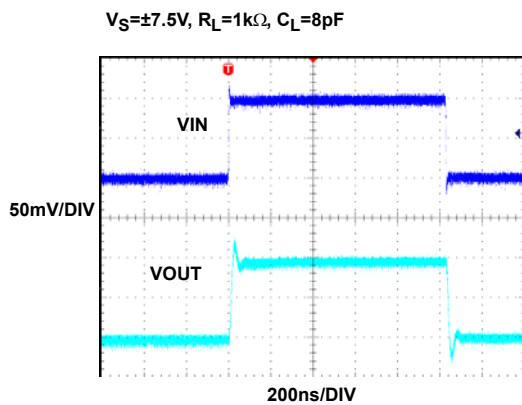


FIGURE 17. SMALL SIGNAL TRANSIENT RESPONSE ( $V_{COM}$ )

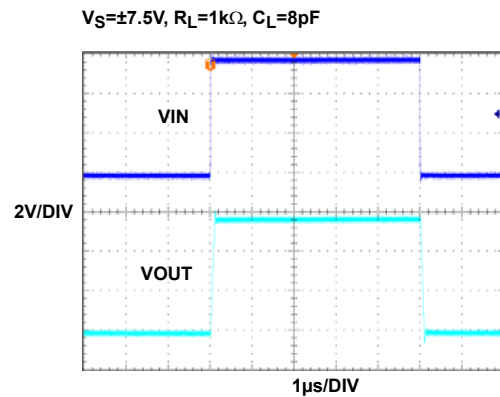


FIGURE 18. LARGE SIGNAL TRANSIENT RESPONSE ( $V_{COM}$ )

### Typical Performance Curves (Continued)

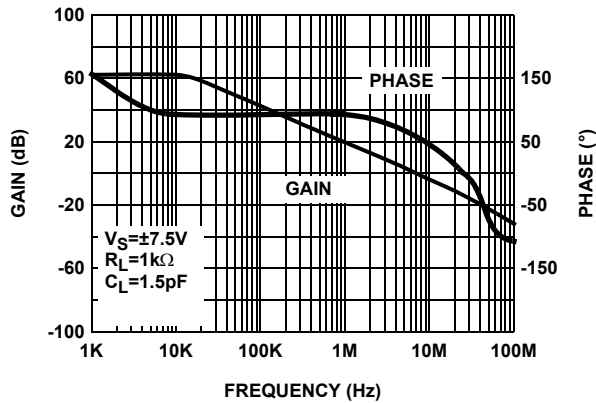


FIGURE 19. OPEN LOOP GAIN AND PHASE vs FREQUENCY

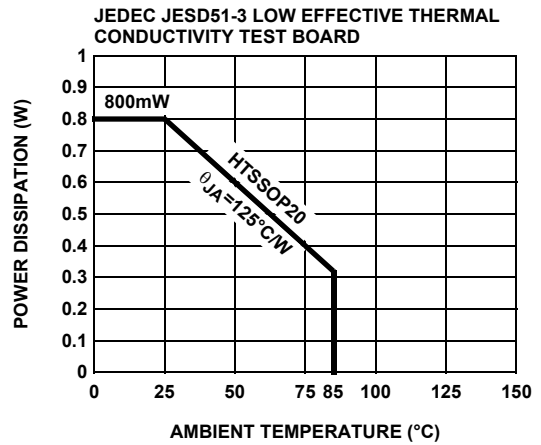


FIGURE 20. PACKAGE POWER DISSIPATION vs AMBIENT TEMPERATURE

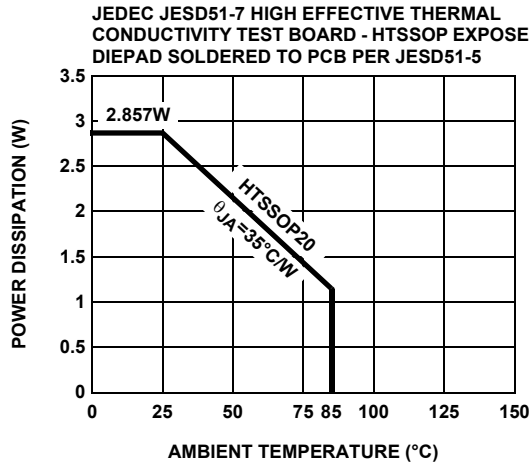


FIGURE 21. PACKAGE POWER DISSIPATION vs AMBIENT TEMPERATURE

## Description of Operation and Application Information

### Product Description

The EL5624A is fabricated using a high voltage CMOS process. It exhibits rail to rail input and output capability and has very low power consumption. When driving a load of 10K and 12pF, this buffer has a -3dB bandwidth of 12MHz and exhibit 18V/μs slew rate. The  $V_{COM}$  amplifier has a -3dB bandwidth of 35MHz and exhibit 70V/μs slew rate.

### Input, Output, and Supply Voltage Range

The EL5624A is specified with a single nominal supply voltage from 5V to 15V or a split supply with its total range from 5V to 15V. Correct operation is guaranteed for a supply range from 4.5V to 16.5V.

The input common-mode voltage range of the EL5624A extends 500mV beyond the supply rails. The output swings of the buffers and  $V_{COM}$  amplifier typically extend to within 100mV of the positive and negative supply rails with load currents of 5mA. Decreasing load currents will extend the output voltage even closer to each supply rails.

### Output Phase Reversal

The EL5624A is immune to phase reversal as long as the input voltage is limited from  $V_S - 0.5V$  to  $V_S + 0.5V$ . Although the device's output will not change phase, the input's overvoltage should be avoided. If an input voltage exceeds supply voltage by more than 0.6V, electrostatic protection diode placed in the input stage of the device begin to conduct and overvoltage damage could occur.

### Choice of Feedback Resistor and Gain Bandwidth Product for $V_{COM}$ Amplifier

For applications that require a gain of +1, no feedback resistor is required. Just short the output pin to the inverting input pin. For gains greater than +1, the feedback resistor forms a pole with the parasitic capacitance at the inverting input. As this pole becomes smaller, the amplifier's phase margin is reduced. This causes ringing in the time domain and peaking in the frequency domain. Therefore,  $R_F$  has some maximum value that should not be exceeded for optimum performance. If a large value of  $R_F$  must be used, a small capacitor in the few Pico farad range in parallel with  $R_F$  can help to reduce the ringing and peaking at the expense of reducing the bandwidth.

As far as the output stage of the amplifier is concerned, the output stage is also a gain stage with the load.  $R_F$  and  $R_G$  appear in parallel with  $R_L$  for gains other than +1. As this combination gets smaller, the bandwidth falls off. Consequently,  $R_F$  also has a minimum value that should not be exceeded for optimum performance. For gain of +1,  $R_F = 0$  is optimum. For the gains other than +1, optimum response is obtained with  $R_F$  between  $1k\Omega$  to  $5k\Omega$ .

The  $V_{COM}$  amplifier has a gain bandwidth product of 20MHz. For gains  $\geq 5$ , its bandwidth can be predicted by the following equation:

$$\text{Gain} \times \text{BW} = 20\text{MHz}$$

### Output Drive Capability

The EL5624A does not have internal short-circuit protection circuitry. The buffer will limit the short circuit current to over 250mA and the  $V_{COM}$  amplifier will limit the short circuit current to  $\pm 200\text{mA}$  if the outputs are directly shorted to the positive or the negative supply. If the output is shorted indefinitely, the power dissipation could easily increase such that the part will be destroyed. Maximum reliability is maintained if the output continuous current never exceeds  $\pm 30\text{mA}$  for the buffers and  $\pm 60\text{mA}$  for the  $V_{COM}$  amplifier. These limits are set by the design of the internal metal interconnections.

### The Unused Buffers

It is recommended that any unused buffers should have their inputs tied to ground plane.

### Power Dissipation

With the high-output drive capability of the EL5624A, it is possible to exceed the  $125^\circ\text{C}$  "absolute-maximum junction temperature" under certain load current conditions. Therefore, it is important to calculate the maximum junction temperature for the application to determine if load conditions need to be modified for the buffer to remain in the safe operating area.

The maximum power dissipation allowed in a package is determined according to:

$$P_{D\text{MAX}} = \frac{T_{J\text{MAX}} - T_{A\text{MAX}}}{\theta_{JA}}$$

where:

- $T_{J\text{MAX}}$  = Maximum junction temperature
- $T_{A\text{MAX}}$  = Maximum ambient temperature
- $\theta_{JA}$  = Thermal resistance of the package
- $P_{D\text{MAX}}$  = Maximum power dissipation in the package

The maximum power dissipation actually produced by an IC is the total quiescent supply current times the total power supply voltage, plus the power in the IC due to the loads, or:

$$P_{D\text{MAX}} = V_S \times I_S + \sum_i [(V_{S^+} - V_{OUT^i}) \times I_{LOAD^i}] + (V_{S^+} - V_{OUT}) \times I_{LA}$$

when sourcing, and:

$$P_{D\text{MAX}} = V_S \times I_S + \sum_i [(V_{OUT^i} - V_{S^-}) \times I_{LOAD^i}] + (V_{OUT} - V_{S^-}) \times I_{LA}$$

when sinking.

where:

- $i = 1$  to total number of buffers
- $V_S$  = Total supply voltage of buffer and  $V_{COM}$
- $I_{S\text{MAX}}$  = Total quiescent current
- $V_{OUT^i}$  = Maximum output voltage of the application
- $V_{OUT}$  = Maximum output voltage of  $V_{COM}$
- $I_{LOAD^i}$  = Load current of buffer
- $I_{LA}$  = Load current of  $V_{COM}$

If we set the two  $P_{D\text{MAX}}$  equations equal to each other, we can solve for the  $R_{LOAD}$ 's to avoid device overheat. The package power dissipation curves provide a convenient way to see if the device will overheat. The maximum safe power dissipation can be found graphically, based on the package type and the ambient temperature. By using the previous equation, it is a simple matter to see if  $P_{D\text{MAX}}$  exceeds the device's power derating curves.

### Power Supply Bypassing and Printed Circuit Board Layout

As with any high frequency device, good printed circuit board layout is necessary for optimum performance. Ground plane construction is highly recommended, lead lengths should be as short as possible, and the power supply pins must be well bypassed to reduce the risk of oscillation. For normal single supply operation, where the  $V_S$ - pin is connected to ground, one  $0.1\mu\text{F}$  ceramic capacitor should be

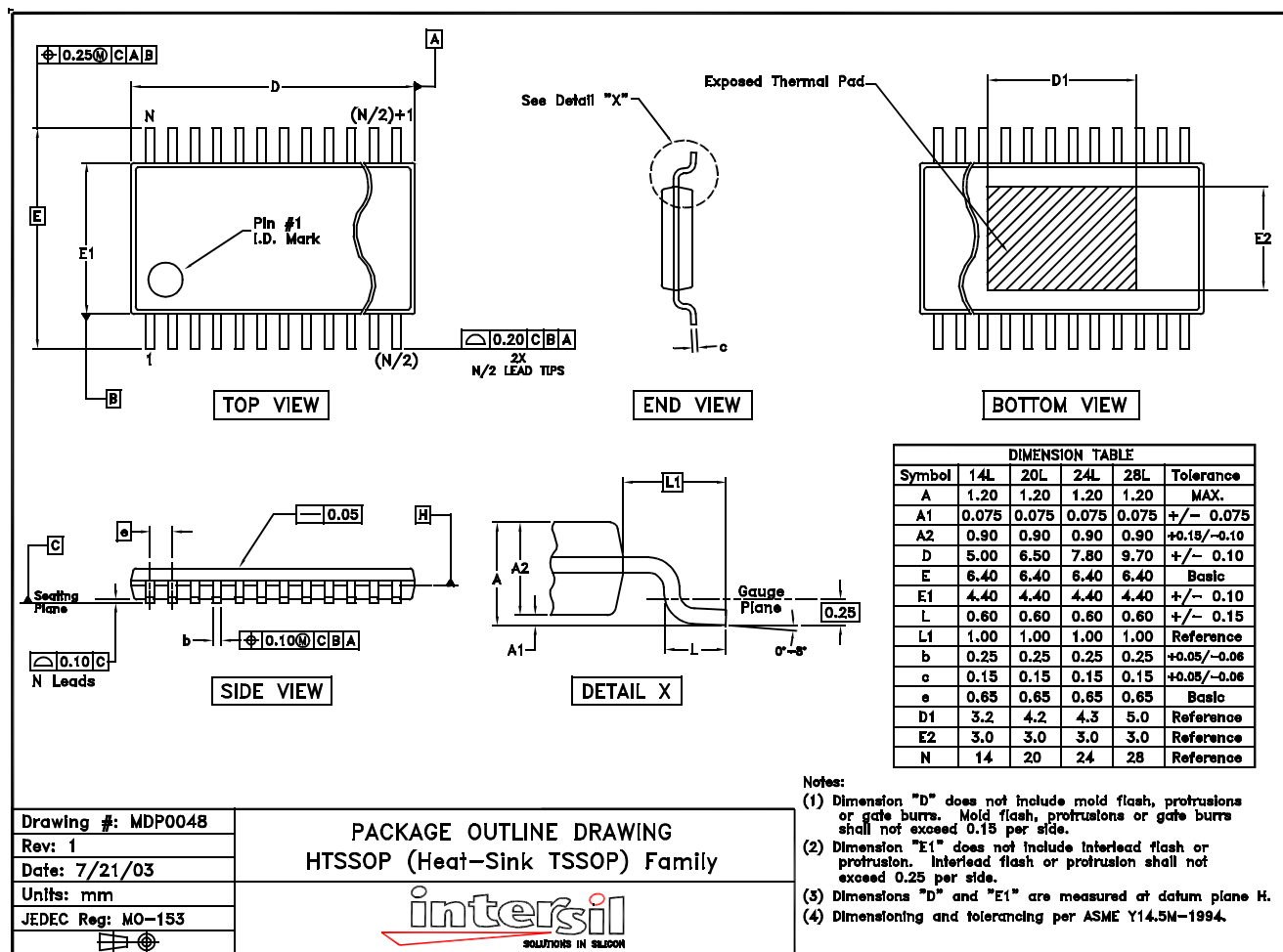


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placed from the  $V_{S+}$  pin to ground. A 4.7 $\mu$ F tantalum capacitor should then be connected from the  $V_{S+}$  pin to ground. One 4.7 $\mu$ F capacitor may be used for multiple devices. This same capacitor combination should be placed at each supply pin to ground if split supplies are to be used.

**Important Note:** The metal plane used for heat sinking of the device is electrically connected to the negative supply potential ( $V_{S-}$ ). If  $V_{S-}$  is tied to ground, the thermal pad can be connected to ground. Otherwise, the thermal pad must be isolated from any other power planes.

### Package Outline Drawing



NOTE: The package drawings shown here may not be the latest versions. For the latest revisions, please refer to the Intersil website at [www.intersil.com/design/packages/elantec](http://www.intersil.com/design/packages/elantec)

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