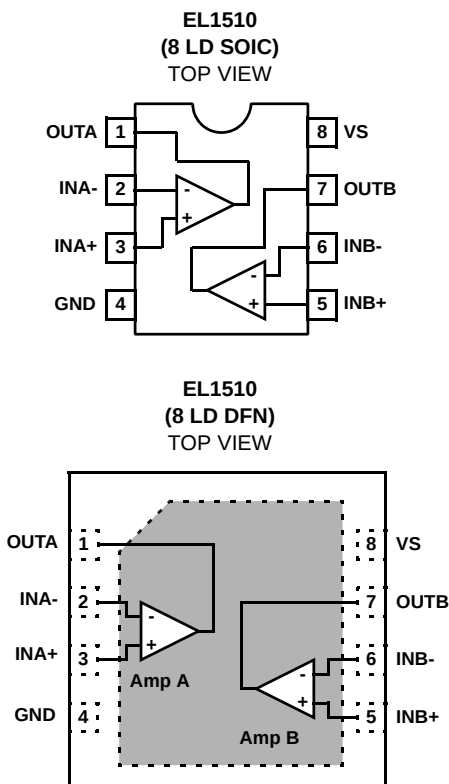


## Medium Power Differential Line Driver

The EL1510 is a dual operational amplifier designed for central office and customer premise line driving in both SDSL and ADSL solutions. This device features a high drive capability of 250mA while consuming only 7.5mA of supply current per amplifier, operating from  $\pm 12\text{V}$  supplies. This driver achieves a typical distortion of less than -85dBc, at 150kHz into a  $25\Omega$  load. The EL1510 is available in the power 8 Ld DFN package and is specified for operation over the full  $-40^\circ\text{C}$  to  $+85^\circ\text{C}$  temperature range. The DFN package has the potential for a very low junction to ambient thermal resistance of  $43^\circ\text{C/W}$ , making it suitable for high power applications. The EL1510 is in the 8 Ld SOIC package and thus is limited to applications where the power dissipation in the device is less than 781mW.

The EL1510 is ideal for CPE modem applications in ADSL, HDSL2, G.SHDSL, and VDSL.

## Pinouts



## Features

- $40\text{V}_{\text{P-P}}$  differential output drive into  $100\Omega$
- -85dBc typical driver output distortion at full output at 150kHz
- Low quiescent current of 7.5mA per amplifier
- Pb-free plus anneal available (RoHS compliant)

## Applications

- ADSL G.lite CO line driving
- G.SHDSL, HDSL2 line drivers
- ADSL full rate CPE line driving
- Video distribution amplifiers
- Video twisted-pair line drivers

## Ordering Information

| PART NUMBER                 | PART MARKING | TAPE & REEL | PACKAGE                | PKG. DWG. # |
|-----------------------------|--------------|-------------|------------------------|-------------|
| EL1510CS                    | 1510CS       | -           | 8 Ld SOIC              | MDP0027     |
| EL1510CS-T7                 | 1510CS       | 7"          | 8 Ld SOIC              | MDP0027     |
| EL1510CS-T13                | 1510CS       | 13"         | 8 Ld SOIC              | MDP0027     |
| EL1510CSZ<br>(See Note)     | 1510CSZ      | -           | 8 Ld SOIC<br>(Pb-Free) | MDP0027     |
| EL1510CSZ-T7<br>(See Note)  | 1510CSZ      | 7"          | 8 Ld SOIC<br>(Pb-Free) | MDP0027     |
| EL1510CSZ-T13<br>(See Note) | 1510CSZ      | 13"         | 8 Ld SOIC<br>(Pb-Free) | MDP0027     |
| EL1510CL                    | 1510CL       | -           | 8 Ld DFN               | MDP0047     |
| EL1510CL-T7                 | 1510CL       | 7"          | 8 Ld DFN               | MDP0047     |
| EL1510CL-T13                | 1510CL       | 13"         | 8 Ld DFN               | MDP0047     |

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-020C.

**Absolute Maximum Ratings** ( $T_A = +25^\circ\text{C}$ )

$V_{S+}$  Voltage to Ground ..... -0.3V to +26.4V  
 $V_{IN+}$  Voltage ..... GND to  $V_{S+}$   
 Current into any Input ..... 8mA  
 Continuous Output Current ..... 75mA

Ambient Operating Temperature Range .....  $-40^\circ\text{C}$  to  $+85^\circ\text{C}$   
 Storage Temperature Range .....  $-60^\circ\text{C}$  to  $+150^\circ\text{C}$   
 Operating Junction Temperature .....  $-40^\circ\text{C}$  to  $+150^\circ\text{C}$   
 Power Dissipation ..... See Curves

**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.

**IMPORTANT NOTE:** All parameters having Min/Max specifications are guaranteed. Typical values are for information purposes only. Unless otherwise noted, all tests are at the specified temperature and are pulsed tests, therefore:  $T_J = T_C = T_A$

**Electrical Specifications**  $V_S = \pm 12\text{V}$ ,  $R_F = 1.5\text{k}\Omega$ ,  $R_L = 100\Omega$  to mid supply,  $T_A = 25^\circ\text{C}$  unless otherwise specified.

| PARAMETER                     | DESCRIPTION                      | CONDITIONS                                               | MIN        | TYP        | MAX | UNIT                   |
|-------------------------------|----------------------------------|----------------------------------------------------------|------------|------------|-----|------------------------|
| <b>AC PERFORMANCE</b>         |                                  |                                                          |            |            |     |                        |
| BW                            | -3dB Bandwidth                   | $A_V = +4$                                               |            | 70         |     | MHz                    |
| HD                            | Total Harmonic Distortion        | $f = 1\text{MHz}$ , $V_O = 16V_{P-P}$ , $R_L = 50\Omega$ |            | -75        |     | dBc                    |
| dG                            | Differential Gain                | $A_V = +2$ , $R_L = 37.5\Omega$                          |            | 0.17       |     | %                      |
| d $\theta$                    | Differential Phase               | $A_V = +2$ , $R_L = 37.5\Omega$                          |            | 0.1        |     | °                      |
| SR                            | Slewrate                         | $V_{OUT}$ from -4.5V to +4.5V                            | 350        | 500        |     | V/ $\mu\text{s}$       |
| <b>DC PERFORMANCE</b>         |                                  |                                                          |            |            |     |                        |
| $V_{OS}$                      | Offset Voltage                   |                                                          | -17        |            | 17  | mV                     |
| $\Delta V_{OS}$               | $V_{OS}$ Mismatch                |                                                          | -10        |            | 10  | mV                     |
| $R_{OL}$                      | Transimpedance                   | $V_{OUT}$ from -4.5V to +4.5V                            | 1          | 2          | 3.5 | M $\Omega$             |
| <b>INPUT CHARACTERISTICS</b>  |                                  |                                                          |            |            |     |                        |
| $I_{B+}$                      | Non-Inverting Input Bias Current |                                                          | -5         |            | 5   | $\mu\text{A}$          |
| $I_{B-}$                      | Inverting Input Bias Current     |                                                          | -30        |            | 30  | $\mu\text{A}$          |
| $\Delta I_{B-}$               | $I_{B-}$ Mismatch                |                                                          | -20        |            | 20  | $\mu\text{A}$          |
| $e_N$                         | Input Noise Voltage              |                                                          |            | 2.8        |     | nV/ $\sqrt{\text{Hz}}$ |
| $i_{N+}$                      | +Input Noise Current             |                                                          |            | 1.8        |     | pA/ $\sqrt{\text{Hz}}$ |
| $i_{N-}$                      | -Input Noise Current             |                                                          |            | 19         |     | pA/ $\sqrt{\text{Hz}}$ |
| <b>OUTPUT CHARACTERISTICS</b> |                                  |                                                          |            |            |     |                        |
| $V_{OUT}$                     | Loaded Output Swing Single Ended | $R_L = 100\Omega$ to GND                                 | $\pm 10.3$ | $\pm 10.9$ |     | V                      |
| $V_{OUT P}$                   | Loaded Output Swing Single Ended | $R_L = 25\Omega$ to GND                                  | 9.5        | 10.2       |     | V                      |
| $V_{OUT N}$                   | Loaded Output Swing Single Ended | $R_L = 25\Omega$ to GND                                  | -8.2       | -9.8       |     | V                      |
| $I_{OUT}$                     | Output Current                   | $R_L = 0\Omega$                                          |            | 500        |     | mA                     |
| <b>SUPPLY</b>                 |                                  |                                                          |            |            |     |                        |
| $V_S$                         | Supply Voltage                   | Single Supply                                            | 5          |            | 24  | V                      |
| $I_S$                         | Supply Current per Amplifier     | All Outputs at 0V                                        |            | 7.5        | 9   | mA                     |

## Typical Performance Curves

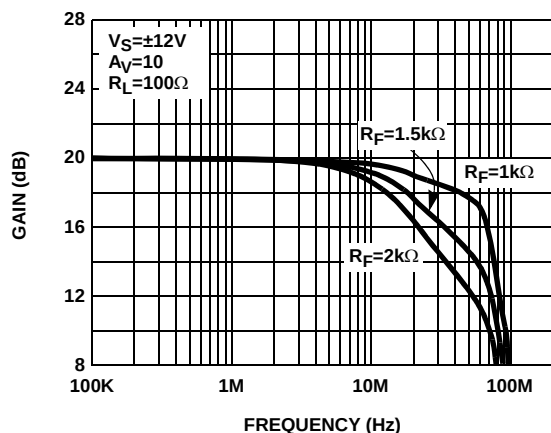
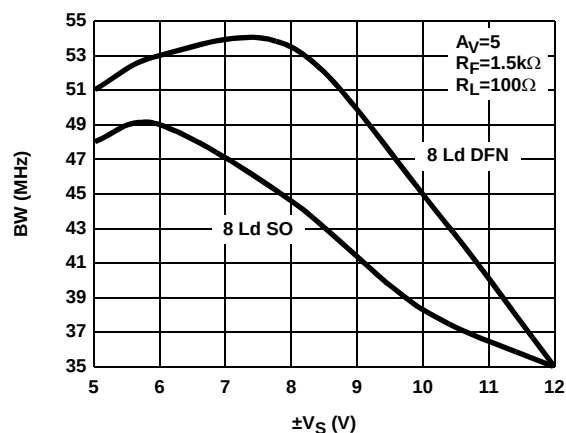
FIGURE 1. DIFFERENTIAL FREQUENCY RESPONSE vs  $R_F$ 

FIGURE 2. DIFFERENTIAL BANDWIDTH vs SUPPLY VOLTAGE

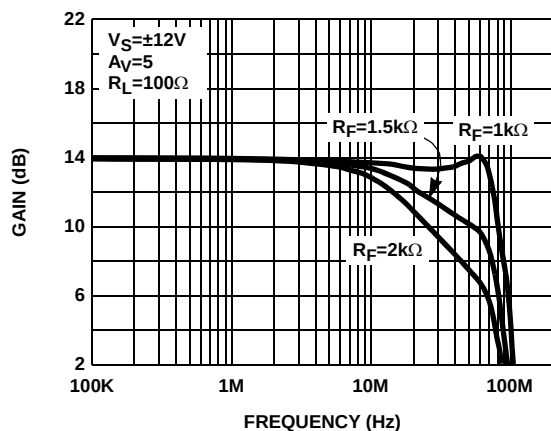
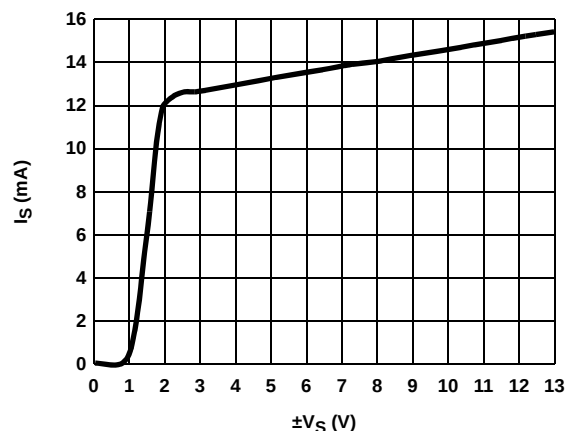
FIGURE 3. DIFFERENTIAL FREQUENCY RESPONSE vs  $R_F$ 

FIGURE 4. SUPPLY CURRENT vs SUPPLY VOLTAGE

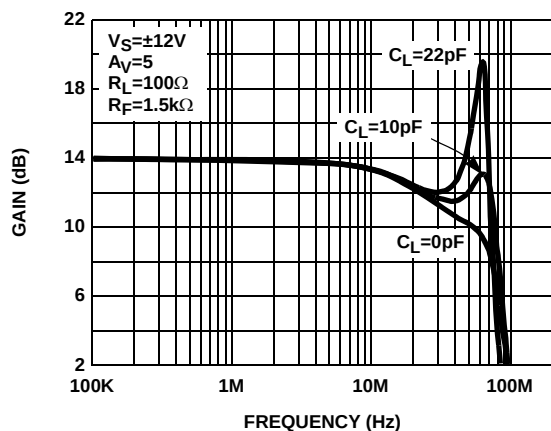
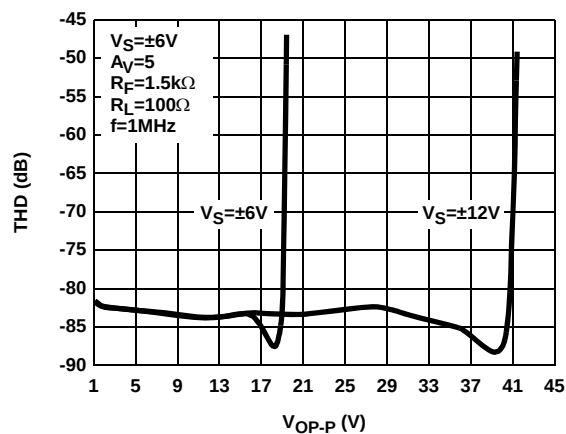
FIGURE 5. DIFFERENTIAL FREQUENCY RESPONSE vs  $C_L$ 

FIGURE 6. DIFFERENTIAL TOTAL HARMONIC DISTORTION vs DIFFERENTIAL OUTPUT VOLTAGE - ALL PACKAGES

## Typical Performance Curves (Continued)

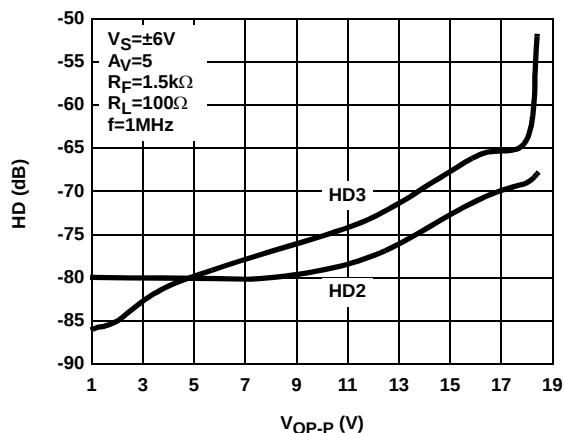


FIGURE 7. DIFFERENTIAL HARMONIC DISTORTION vs DIFFERENTIAL OUTPUT VOLTAGE - ALL PACKAGES

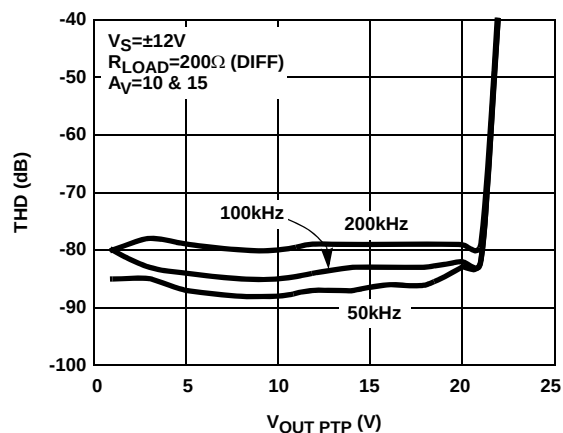


FIGURE 8. DISTORTION RESULTS

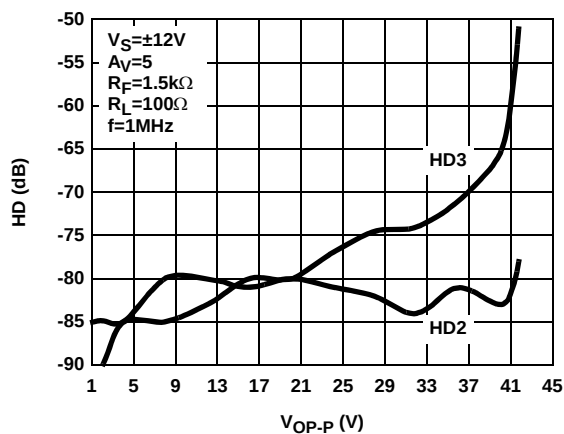


FIGURE 9. DIFFERENTIAL HARMONIC DISTORTION vs DIFFERENTIAL OUTPUT VOLTAGE - ALL PACKAGES

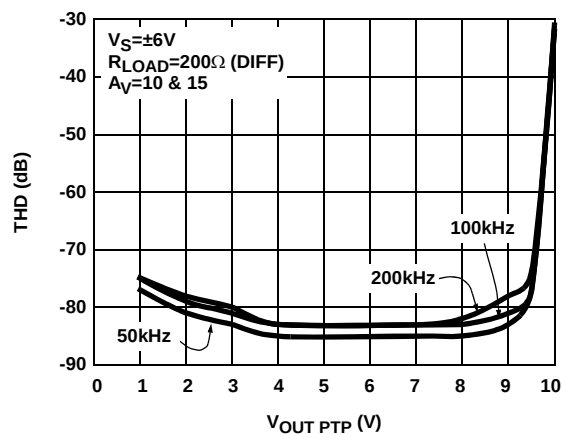


FIGURE 10. DISTORTION RESULTS

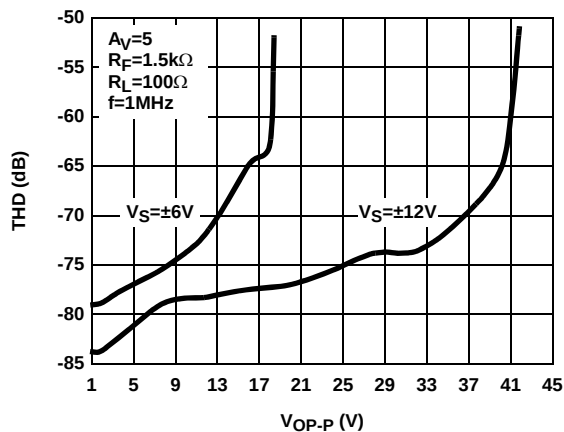


FIGURE 11. DIFFERENTIAL TOTAL HARMONIC DISTORTION vs DIFFERENTIAL OUTPUT VOLTAGE - ALL PACKAGES

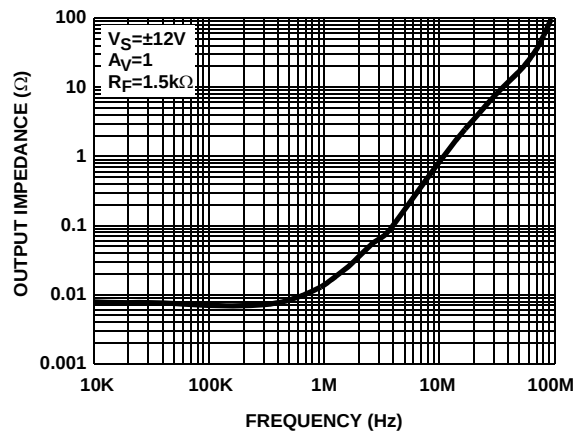


FIGURE 12. OUTPUT IMPEDANCE vs FREQUENCY

Typical Performance Curves (Continued)

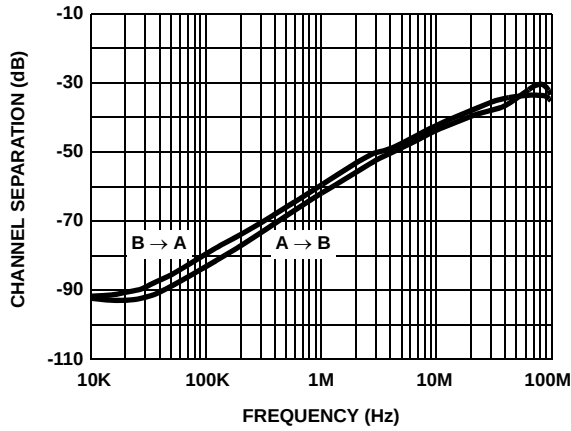


FIGURE 13. CHANNEL SEPARATION vs FREQUENCY

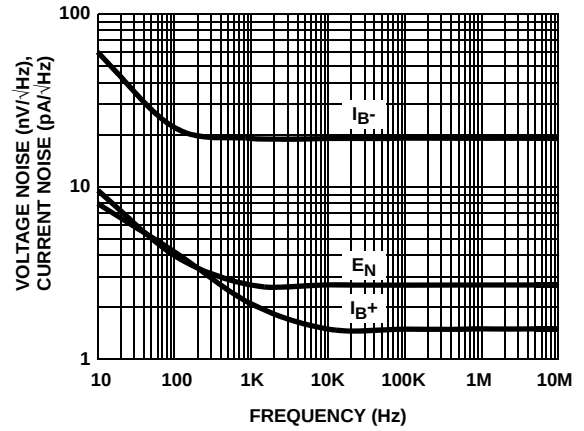


FIGURE 14. VOLTAGE AND CURRENT NOISE vs FREQUENCY

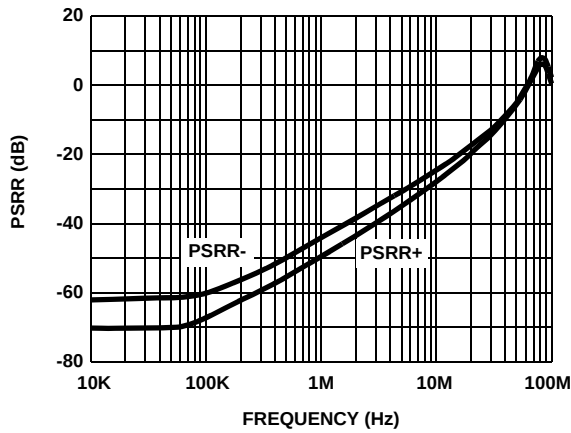


FIGURE 15. PSRR vs FREQUENCY

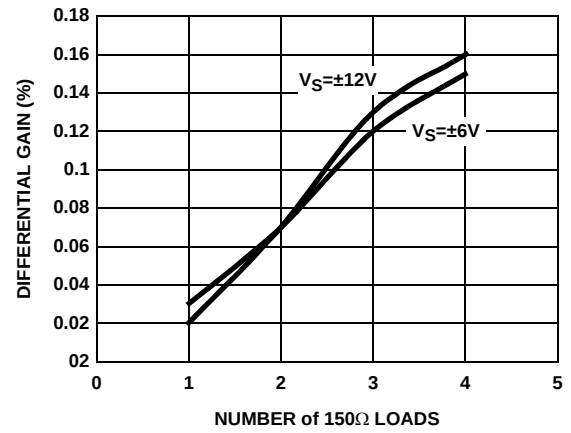


FIGURE 16. DIFFERENTIAL GAIN

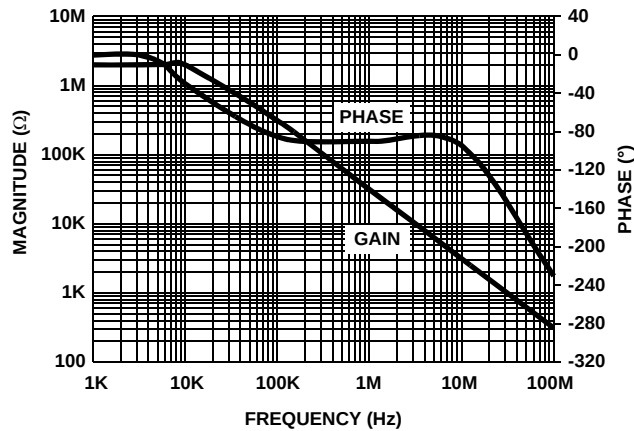


FIGURE 17. TRANSIMPEDANCE (ROL) vs FREQUENCY

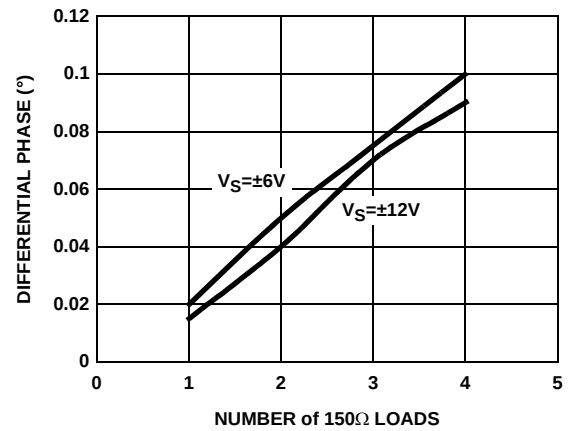


FIGURE 18. DIFFERENTIAL PHASE

# Typical Performance Curves (Continued)

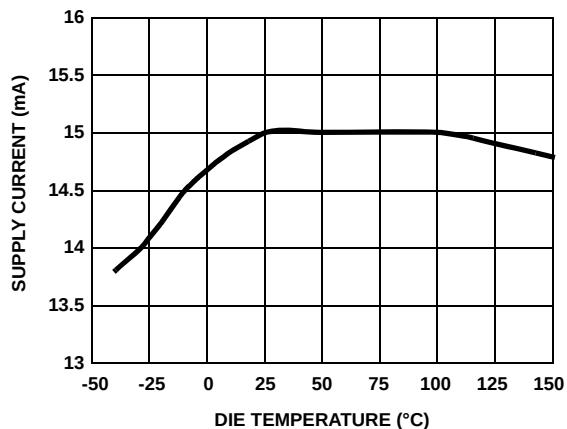


FIGURE 19. SUPPLY CURRENT vs TEMPERATURE

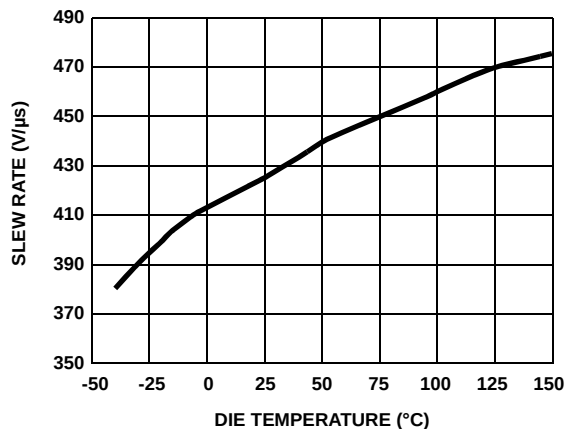


FIGURE 20. SLEW RATE vs TEMPERATURE

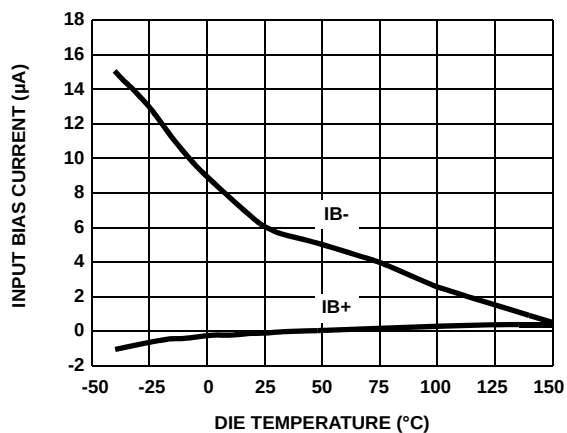


FIGURE 21. INPUT BIAS CURRENT vs TEMPERATURE

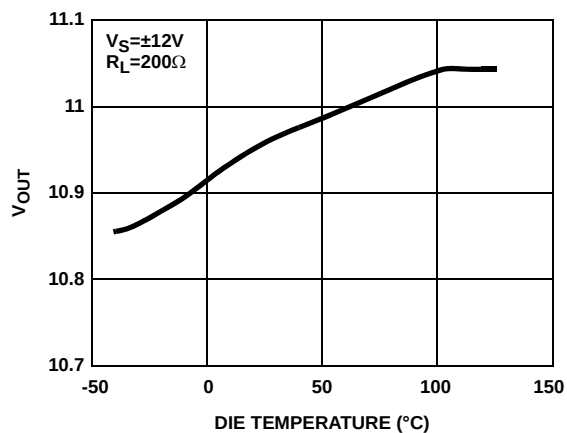


FIGURE 22. OUTPUT VOLTAGE vs TEMPERATURE

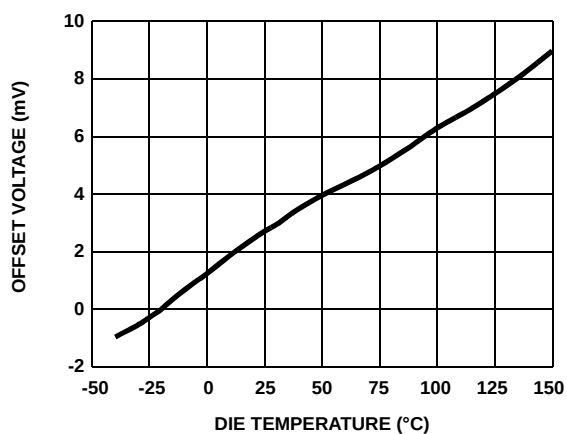


FIGURE 23. OFFSET VOLTAGE vs TEMPERATURE

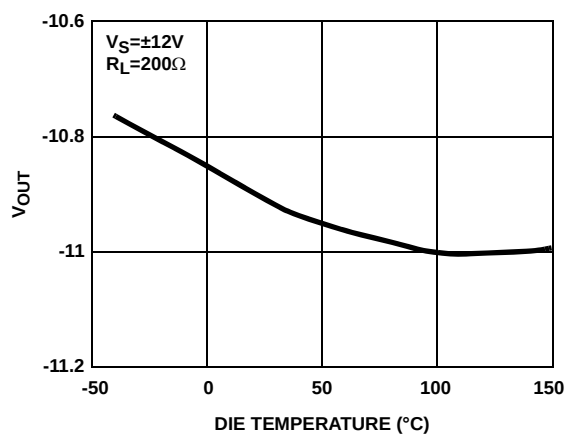


FIGURE 24. OUTPUT VOLTAGE vs TEMPERATURE

## Typical Performance Curves (Continued)

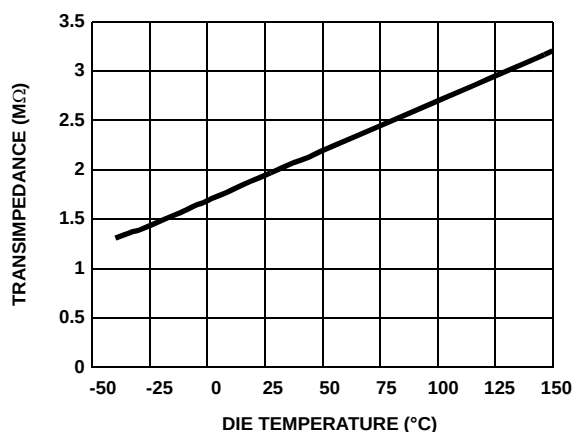


FIGURE 25. TRANSIMPEDANCE vs TEMPERATURE

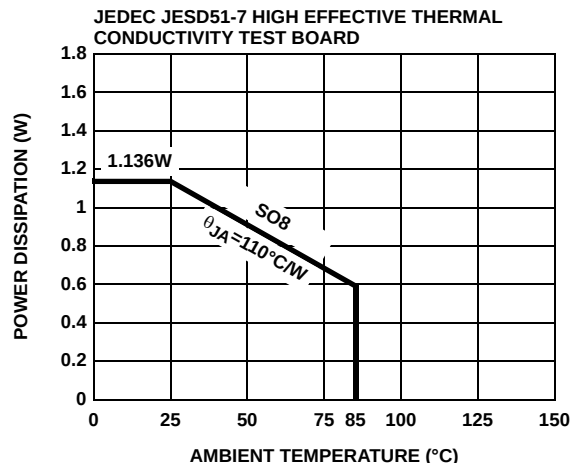


FIGURE 26. PACKAGE POWER DISSIPATION vs AMBIENT TEMPERATURE

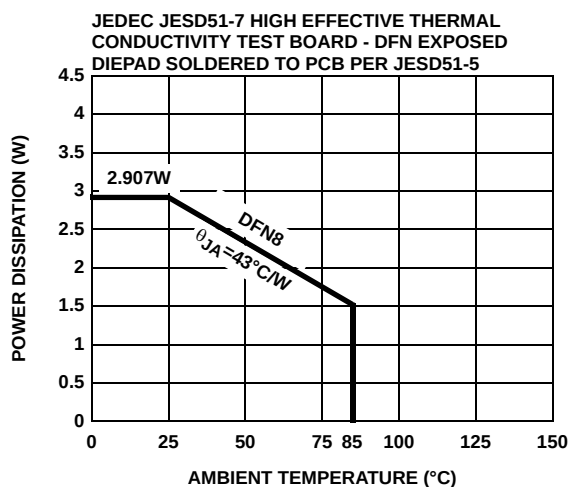


FIGURE 27. PACKAGE POWER DISSIPATION vs AMBIENT TEMPERATURE

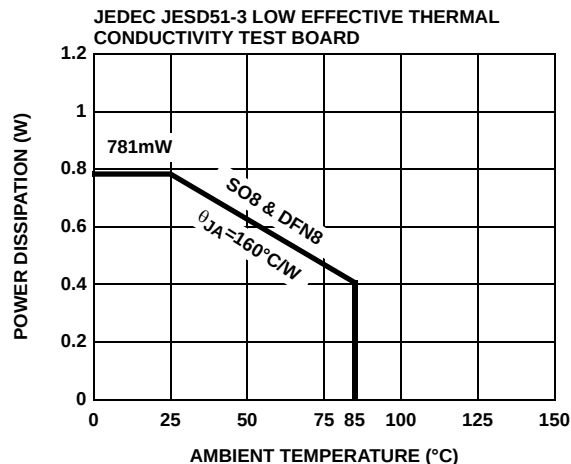


FIGURE 28. PACKAGE POWER DISSIPATION vs AMBIENT TEMPERATURE

## Applications Information

### Product Description

The EL1510 is a dual operational amplifier designed for line driving in DMT ADSL solutions. It is a dual current mode feedback amplifier with low distortion while drawing moderately low supply current. It is built using Elantec's proprietary complimentary bipolar process and is offered in industry standard pin-outs. Due to the current feedback architecture, the EL1510 closed-loop 3dB bandwidth is dependent on the value of the feedback resistor. First the desired bandwidth is selected by choosing the feedback resistor,  $R_F$ , and then the gain is set by picking the gain resistor,  $R_G$ . The curves at the beginning of the Typical Performance Curves section show the effect of varying both  $R_F$  and  $R_G$ . The 3dB bandwidth is somewhat dependent on the power supply voltage.

### 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, below  $\frac{1}{4}$ ". The power supply pins must be well bypassed to reduce the risk of oscillation. A 1.0μF tantalum capacitor in parallel with a 0.01μF ceramic capacitor is adequate for each supply pin.

For good AC performance, parasitic capacitances should be kept to a minimum, especially at the inverting input. This implies keeping the ground plane away from this pin. Carbon resistors are acceptable, while use of wire-wound resistors should not be used because of their parasitic inductance. Similarly, capacitors should be low inductance for best performance.

### Capacitance at the Inverting Input

Due to the topology of the current feedback amplifier, stray capacitance at the inverting input will affect the AC and transient performance of the EL1510 when operating in the non-inverting configuration.

In the inverting gain mode, added capacitance at the inverting input has little effect since this point is at a virtual ground and stray capacitance is therefore not “seen” by the amplifier.

### Feedback Resistor Values

The EL1510 has been designed and specified with  $R_F=1.5k\Omega$  for  $A_V=+5$ . This value of feedback resistor yields extremely flat frequency response with no peaking out to 40MHz. As is the case with all current feedback amplifiers, wider bandwidth, at the expense of slight peaking, can be obtained by reducing the value of the feedback resistor. Inversely, larger values of feedback resistor will cause rolloff to occur at a lower frequency. See the curves in the Typical Performance Curves section which show 3dB bandwidth and peaking vs frequency for various feedback resistors and various supply voltages.

### Bandwidth vs Temperature

Whereas many amplifiers' supply current and consequently 3dB bandwidth drop-off at high temperature, the EL1510 was designed to have little supply current variations with temperature. An immediate benefit from this is that the 3dB bandwidth does not drop off drastically with temperature.

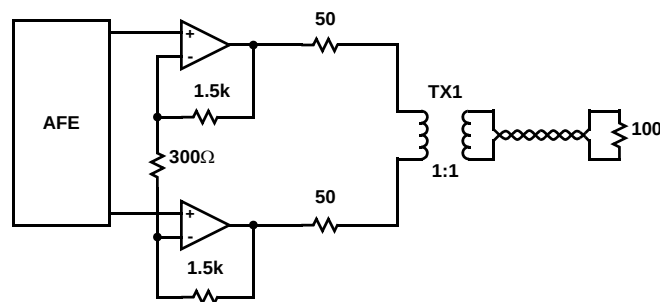
### Supply Voltage Range and Operation

The EL1510 has been designed to operate with supply voltages from  $\pm 2.5V$  to  $\pm 12V$ . If a single supply is desired, values from  $+5V$  to  $+24V$  can be used as long as the input common mode range is not exceeded. When using a single supply, be sure to either 1) DC bias the inputs at an appropriate common mode voltage and AC couple the signal, or 2) ensure the driving signal is within the common mode range of the EL1510.

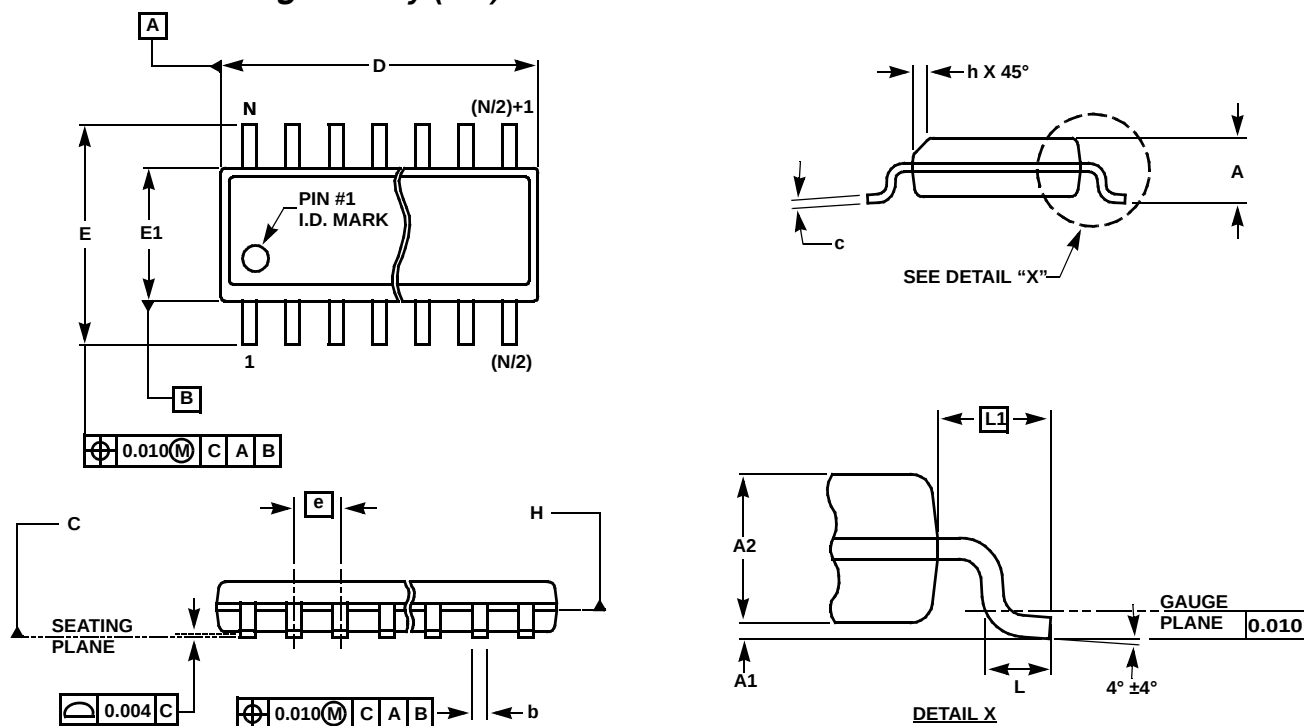
### ADSL CPE Applications

The EL1510 is designed as a line driver for ADSL CPE modems. It is capable of outputting 400mA of output current with a typical supply voltage headroom of 1.8V. It can achieve -85dBc of distortion at low 7.5mA of supply current per amplifier.

The average line power requirement for the ADSL CPE application is 13dBm (20mW) into a  $100\Omega$  line. The average line voltage is  $1.41V_{RMS}$ . The ADSL DMT peak to average ratio (crest factor) of 5.3 implies peak voltage of 7.5V into the line. Using a differential drive configuration and transformer coupling with standard back termination, a transformer ratio of 1:1 is selected. The circuit configuration is as shown below.



## Small Outline Package Family (SO)



### MDP0027

#### SMALL OUTLINE PACKAGE FAMILY (SO)

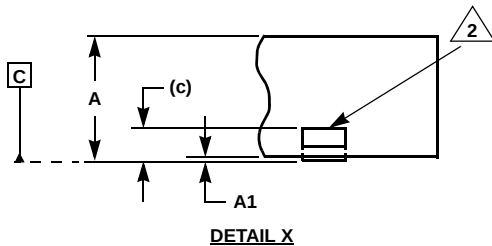
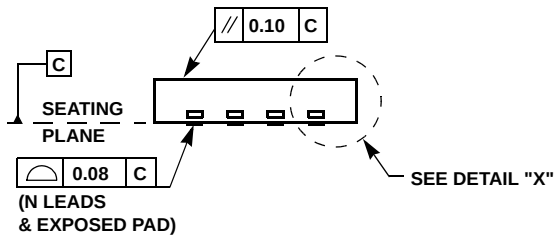
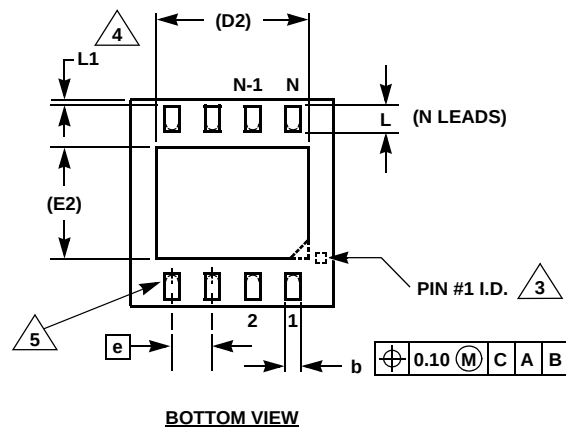
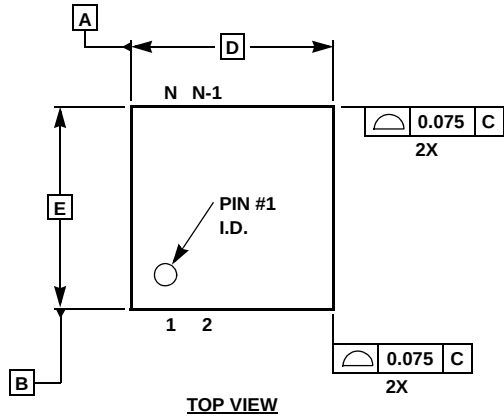
| SYMBOL | INCHES |       |                  |                           |                  |                  |                  | TOLERANCE | NOTES |
|--------|--------|-------|------------------|---------------------------|------------------|------------------|------------------|-----------|-------|
|        | SO-8   | SO-14 | SO16<br>(0.150") | SO16 (0.300")<br>(SOL-16) | SO20<br>(SOL-20) | SO24<br>(SOL-24) | SO28<br>(SOL-28) |           |       |
| A      | 0.068  | 0.068 | 0.068            | 0.104                     | 0.104            | 0.104            | 0.104            | MAX       | -     |
| A1     | 0.006  | 0.006 | 0.006            | 0.007                     | 0.007            | 0.007            | 0.007            | ±0.003    | -     |
| A2     | 0.057  | 0.057 | 0.057            | 0.092                     | 0.092            | 0.092            | 0.092            | ±0.002    | -     |
| b      | 0.017  | 0.017 | 0.017            | 0.017                     | 0.017            | 0.017            | 0.017            | ±0.003    | -     |
| c      | 0.009  | 0.009 | 0.009            | 0.011                     | 0.011            | 0.011            | 0.011            | ±0.001    | -     |
| D      | 0.193  | 0.341 | 0.390            | 0.406                     | 0.504            | 0.606            | 0.704            | ±0.004    | 1, 3  |
| E      | 0.236  | 0.236 | 0.236            | 0.406                     | 0.406            | 0.406            | 0.406            | ±0.008    | -     |
| E1     | 0.154  | 0.154 | 0.154            | 0.295                     | 0.295            | 0.295            | 0.295            | ±0.004    | 2, 3  |
| e      | 0.050  | 0.050 | 0.050            | 0.050                     | 0.050            | 0.050            | 0.050            | Basic     | -     |
| L      | 0.025  | 0.025 | 0.025            | 0.030                     | 0.030            | 0.030            | 0.030            | ±0.009    | -     |
| L1     | 0.041  | 0.041 | 0.041            | 0.056                     | 0.056            | 0.056            | 0.056            | Basic     | -     |
| h      | 0.013  | 0.013 | 0.013            | 0.020                     | 0.020            | 0.020            | 0.020            | Reference | -     |
| N      | 8      | 14    | 16               | 16                        | 20               | 24               | 28               | Reference | -     |

Rev. M 2/07

#### NOTES:

1. Plastic or metal protrusions of 0.006" maximum per side are not included.
2. Plastic interlead protrusions of 0.010" maximum per side are not included.
3. Dimensions "D" and "E1" are measured at Datum Plane "H".
4. Dimensioning and tolerancing per ASME Y14.5M-1994

## Dual Flat No-Lead Package Family (DFN)



## MDP0047

DUAL FLAT NO-LEAD PACKAGE FAMILY (JEDEC REG: MO-229)

| SYMBOL | MILLIMETERS |       | TOLERANCE   |
|--------|-------------|-------|-------------|
|        | DFN8        | DFN10 |             |
| A      | 0.85        | 0.90  | ±0.10       |
| A1     | 0.02        | 0.02  | +0.03/-0.02 |
| b      | 0.30        | 0.25  | ±0.05       |
| c      | 0.20        | 0.20  | Reference   |
| D      | 4.00        | 3.00  | Basic       |
| D2     | 3.00        | 2.25  | Reference   |
| E      | 4.00        | 3.00  | Basic       |
| E2     | 2.20        | 1.50  | Reference   |
| e      | 0.80        | 0.50  | Basic       |
| L      | 0.50        | 0.50  | ±0.10       |
| L1     | 0.10        | 0     | Maximum     |

Rev. 2 2/07

## NOTES:

1. Dimensioning and tolerancing per ASME Y14.5M-1994.
2. Exposed lead at side of package is a non-functional feature.
3. Bottom-side pin #1 I.D. may be a diepad chamfer, an extended tiebar tab, or a small square as shown.
4. Exposed leads may extend to the edge of the package or be pulled back. See dimension "L1".
5. Inward end of lead may be square or circular in shape with radius (b/2) as shown.
6. N is the total number of leads on the device.

All Intersil U.S. products are manufactured, assembled and tested utilizing ISO9000 quality systems.

Intersil Corporation's quality certifications can be viewed at [www.intersil.com/design/quality](http://www.intersil.com/design/quality)**elantec**

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