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Single Port, VDSL2 Differential Line Driver

ISL1550

The ISL1550 is a dual operational amplifier intended to be used as a differential line driver. ISL1550's high bandwidth and low distortion performance enables the support of VDSL2 8b, 17a and 30a modem applications.

This device features a high current drive capability of ±750mA required to drive large voltage peaks into heavy loads. In Central Office (CO) applications, the driver achieves a typical Missing Band Power Ratio (MBPR) of -66dBc in VDSL2 8b upstream (US) 1 band and MBPR's of -61dBc and -60dBc in VDSL2 17a US1 and US2 respectively.

The ISL1550 has two bias current control pins (C0, C1) to allow for four power settings (disable, low, medium, high). The VDSL modem DSP configures the line driver's power setting based on the desired mode of operation. The line driver operates on a nominal single +12V or a dual ±6V supplies with bias current in active mode between 15mA to 32mA, depending on its power setting. The ISL1550's gain setting is configurable at the application level by setting the Rf and Rg resistor values. The surge current handling of ISL1550 has been enhanced to allow ITU-T K.20 and GR1089 compliance with minimal external surge protection circuitry.

The ISL1550 is available in the thermally-enhanced, Pb-free RoHS compliant 16 Ld QFN package and is specified for operation over the full -40°C to +85°C temperature range.

Features

- 20dBm output power capability
- Drives up to ±750mA from a +12V supply
- $18V_{P-P}$ differential output drive into 20Ω
- -89dBc typical driver output distortion at full output at 200kHz, $12V_{P-P}$ differential
- -61dBc US1, -60dBc US2 avg. MBPR 17a
- Supply range: ±4.0V to ±6.6V, +8.0V to +13.2V
- Thermal shutdown
- K.20, GR-1089 Surge Robustness Validated

Applications

- VDSL2 Profiles: 8MHz, 17MHz, and 30MHz

Related Literature

- AN1325 "Choosing and Using Bypass Capacitors"

TABLE 1. ALTERNATE SOLUTIONS

PART #	NOMINAL $\pm V_{CC}$ (V)	BANDWIDTH (MHz)	APPLICATIONS
ISL1557	±6,+12	200	VDSL2
ISL1539A	±12,+24	240	VDSL2

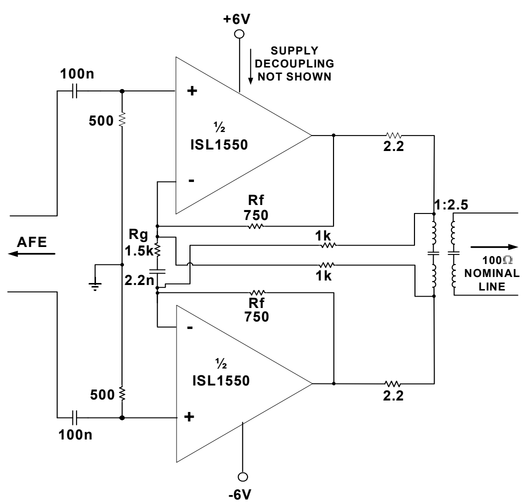


FIGURE 1. TYPICAL APPLICATION CIRCUIT

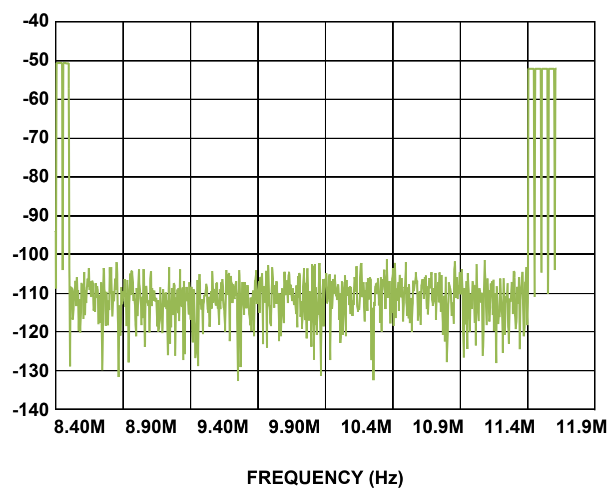


FIGURE 2. US2 MBPR 17a VDSL2 PERFORMANCE

Connection Diagram

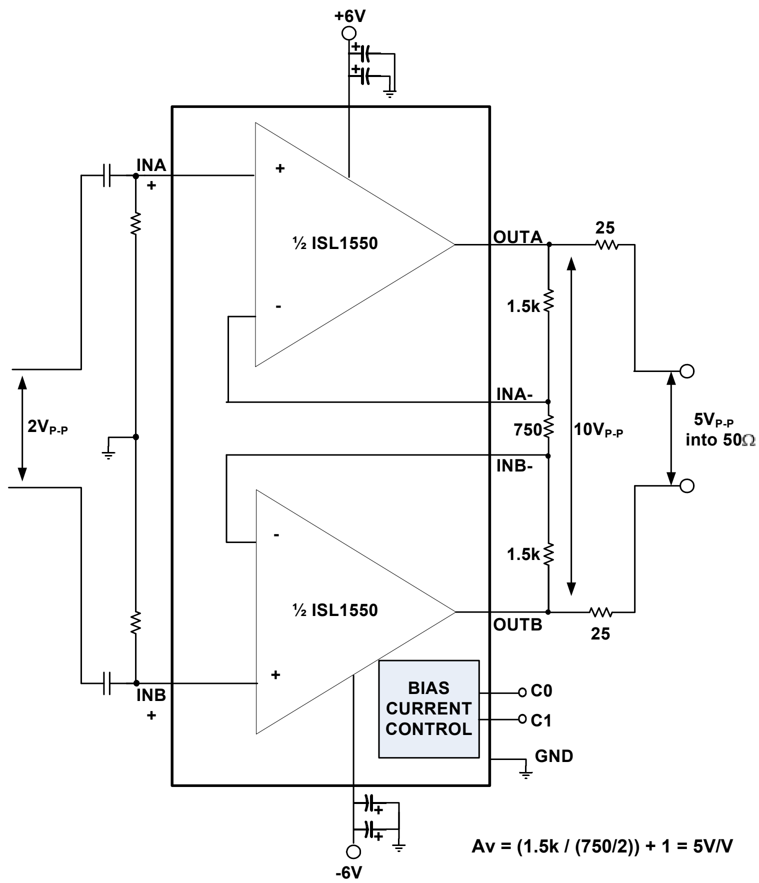
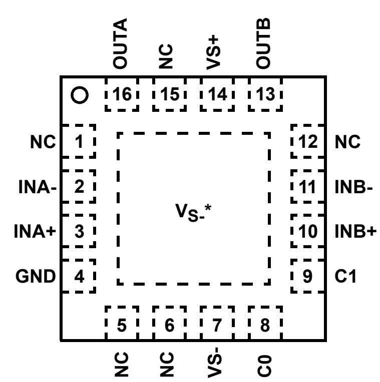


FIGURE 3. TYPICAL DIFFERENTIAL AMPLIFIER I/O

Pin Configuration

ISL1550
(16 LD QFN)
TOP VIEW



*THERMAL PAD CONNECTS TO MOST NEGATIVE SUPPLY

Pin Descriptions

PIN NUMBER	PIN NAME	FUNCTION
1	NC	No Connect
2	INA-	Amplifier A Inverting Input
3	INA+	Amplifier A Non-Inverting Input
4	GND	Ground
5	NC	No Connect
6	NC	No Connect
7	VS-	Negative Supply Voltage
8	C0	Digital Control Pin
9	C1	Digital Control Pin
10	INB+	Amplifier B Non-Inverting Input
11	INB-	Amplifier B Inverting Input
12	NC	No Connect
13	OUTB	Amplifier B Output
14	VS+	Positive Supply Voltage
15	NC	No Connect
16	OUTA	Amplifier A Output

Ordering Information

PART NUMBER (Notes 2, 3)	PART MARKING	TEMP RANGE (°C)	PACKAGE (Pb-free)	PKG. DWG. #
ISL1550IRZ	155 0IRZ	-40 to +85	16 Ld QFN	L16.4x4H
ISL1550IRZ-T7 (Note 1)	155 0IRZ	-40 to +85	16 Ld QFN	L16.4x4H
ISL1550IRZ-T13 (Note 1)	155 0IRZ	-40 to +85	16 Ld QFN	L16.4x4H
ISL1550IRZ-EVALZ	Evaluation Board			

NOTES:

1. Please refer to TB347 for details on reel specifications.
2. These Intersil Pb-free plastic packaged products employ special Pb-free material sets, molding compounds/die attach materials, and 100% matte tin plate plus anneal (e3 termination finish, which is 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.
3. For Moisture Sensitivity Level (MSL), please see device information page for ISL1550. For more information on MSL please see tech brief TB363.

Absolute Maximum Ratings (T_A = +25°C)

V_S+ Voltage to GND . . . . -0.3V to +13.2V
Driver V_{IN}+ Voltage. . . . . GND to +V_S
C_0, C_1 Voltage to GND . . . . -0.3V to +V_S
Current into any Input 8mA
Continuous Output Current for Long Term Reliability. 50mA
ESD Rating
Human Body Model (Tested per JESD22-A114F). 4kV
Machine Model (Tested per JESD22-A115C) 300V
Charge Device Model (Tested per JESD22-C101E). 1.5kV

Thermal Information

Thermal Resistance (Typical)	θ_{JA} (°C/W)	θ_{JC} (°C/W)
16 Ld QFN Package (Notes 4, 5)	53	16.5

Maximum Junction Temperature (Plastic Package) . . . . +150°C
Storage Temperature Range. . . . . -40°C to +150°C
Pb-Free Reflow Profile . . . . see link below
http://www.intersil.com/pbfree/Pb-FreeReflow.asp

Operating Conditions

Ambient Temperature Range . . . . -40°C to +85°C
Junction Temperature Range . . . . -40°C to +150°C

CAUTION: Do not operate at or near the maximum ratings listed for extended periods of time. Exposure to such conditions may adversely impact product reliability and result in failures not covered by warranty.

NOTES:

4. θ_{JA} is measured in free air with the component mounted on a high effective thermal conductivity test board with “direct attach” features. See Tech Brief TB379.
5. For θ_{JC}, the “case temp” location is the center of the exposed metal pad on the package underside.

Electrical Specifications V_S = ±6V, see Figure 1, T_A = +25°C, unless otherwise specified.

PARAMETER	DESCRIPTION	CONDITIONS	MIN (Note 6)	TYP	MAX (Note 6)	UNIT
AC PERFORMANCE						
BW	-3dB Bandwidth	See Figure 1		105		MHz
THD	Total Harmonic Distortion, Differential	f = 200kHz, V_O = 12$V_{P-P\ output}$, R_L = 20Ω		-89		dBc
		f = 4MHz, V_O = 12$V_{P-P\ output}$, R_L = 100Ω		-67		dBc
		f = 10MHz, V_O = 12$V_{P-P\ output}$, R_L = 100Ω		-61		dBc
SR	Slew Rate (20% to 80%)	V_{OUT} from -6V to +6V (differential)	1500	2400		V/µs
DC PERFORMANCE						
V_{OS_CM}	Input Offset Voltage Common Mode		-45		+45	mV
V_{OS_DM}	Input Offset Voltage Differential Mode		-7.5		+7.5	mV
INPUT CHARACTERISTICS						
I_B+	Non-Inverting Input Bias Current		-7.0	-3.0	+7.0	µA
$I_{B^-\ DM}$	Inverting Input Bias Current Differential Mode		-45	±7	+45	µA
e_O	Differential Output Noise	See Figure 1 [at transformer input]		45		nV/√Hz
OUTPUT CHARACTERISTICS						
V_{OUT}	Loaded Output Swing (single-ended)	V_S = ±6V, $R_{L\ DIFF}$ = 100Ω	±4.7	±5.0		V
		V_S = ±6V, $R_{L\ DIFF}$ = 20Ω		±4.5		V
SUPPLY						
+V_S	Supply Voltage	Single supply (-V_S = GND)	8.0	12	13.2	V
I_S+ (Full Bias)	Positive Supply Current	All outputs at 0V, C_0 = C_1 = 0V	27	32	37	mA
I_S+ (Medium Bias)	Positive Supply Current	All outputs at 0V, C_0 = 5V, C_1 = 0V	19	23	26	mA
I_S+ (Low Bias)	Positive Supply Current	All outputs at 0V, C_0 = 0V, C_1 = 5V	12	15	18	mA
I_S+ (Power down)	Positive Supply Current	All outputs at 0V, C_0 = C_1 = 5V	1.3	1.6	2.5	mA
I_{INH}, C_0 or C_1	C_0, C_1 Input Current, High	C_0, C_1 = 6V	100	165	224	µA
I_{INL}, C_0 or C_1	C_0, C_1 Input Current, Low	C_0, C_1 = 0V	-1.5	-1.0	+1.5	µA
V_{INH}, C_0 or C_1	C_0, C_1 Input Voltage, High		2.0			V
V_{INL}, C_0 or C_1	C_0, C_1 Input Voltage, Low				0.8	V

NOTE:

6. Compliance to datasheet limits is assured by one or more methods: production test, characterization and/or design.

Typical Performance Curves

V_{CC} = ±6V, See Figure 1, T_A = +25°C, C0 = C1 = 0V (Full power), Unless otherwise noted.

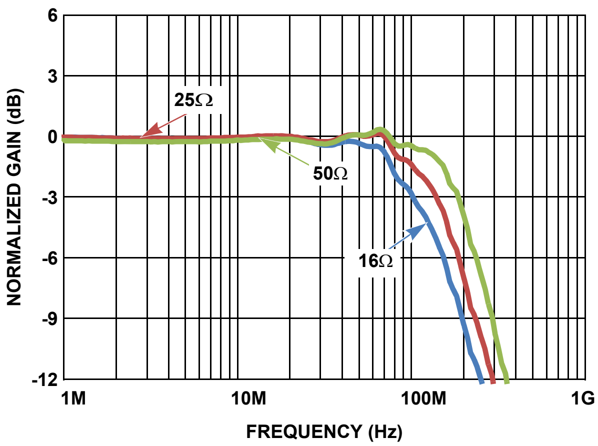


FIGURE 4. SMALL SIGNAL FREQUENCY RESPONSE vs R_{LOAD}

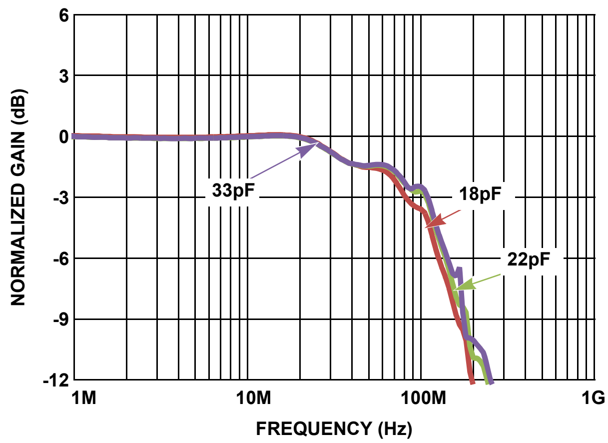


FIGURE 5. SMALL SIGNAL FREQUENCY RESPONSE vs C_{LOAD}

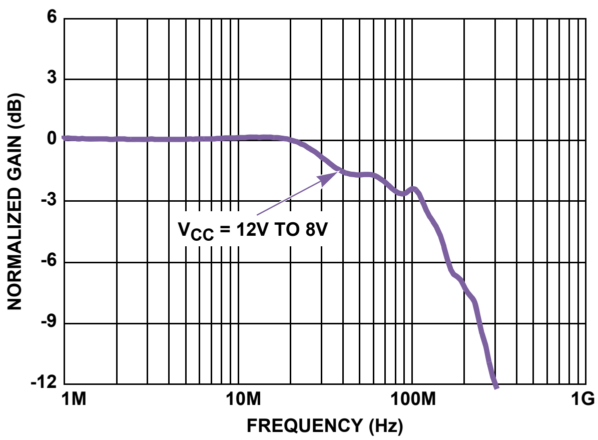


FIGURE 6. SMALL SIGNAL BANDWIDTH vs SUPPLY VOLTAGE

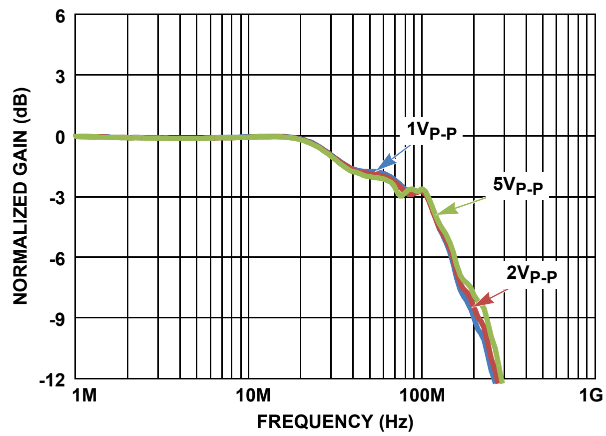


FIGURE 7. LARGE SIGNAL FREQUENCY RESPONSE

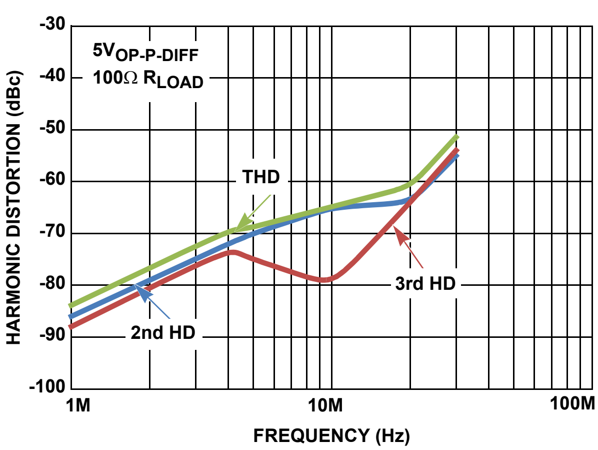


FIGURE 8. HARMONIC DISTORTION vs FREQUENCY

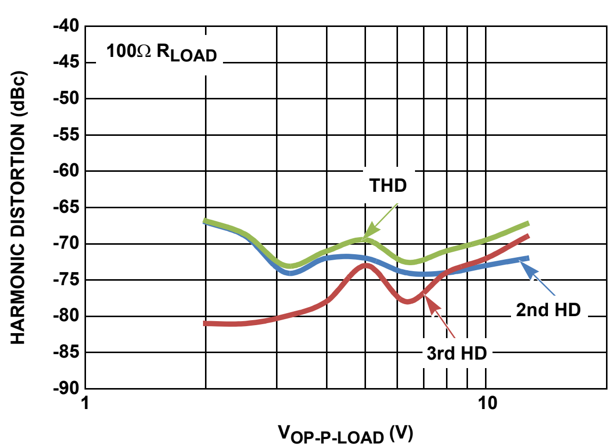


FIGURE 9. 4MHz HARMONIC DISTORTION vs OUTPUT VOLTAGE

Typical Performance Curves

V_{CC} = ±6V, See Figure 1, T_A = +25°C, C0 = C1 = 0V (Full power), Unless otherwise noted. (Continued)

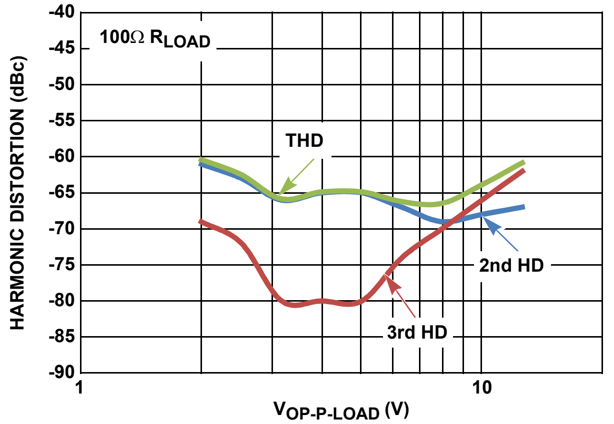


FIGURE 10. 10MHz HARMONIC DISTORTION vs OUTPUT VOLTAGE

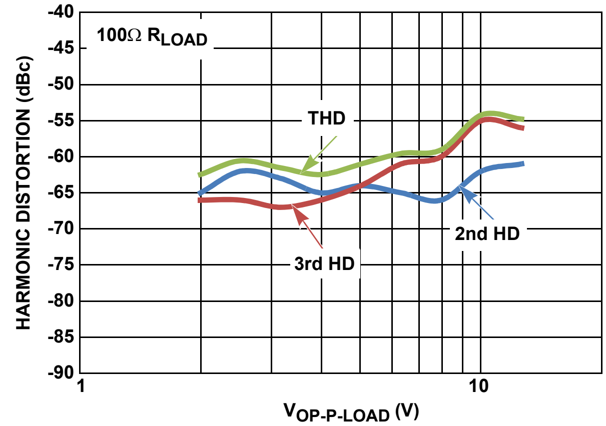


FIGURE 11. 20MHz HARMONIC DISTORTION vs OUTPUT VOLTAGE

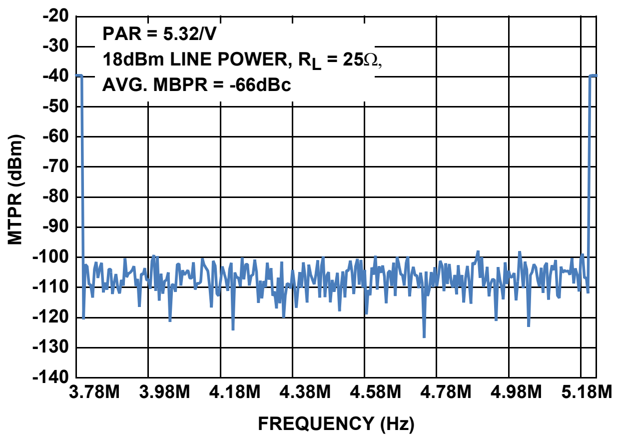


FIGURE 12. MBPR 8b US1

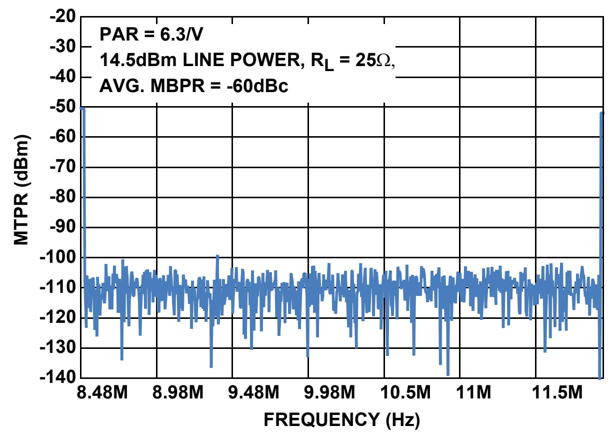


FIGURE 13. MBPR 17a US2

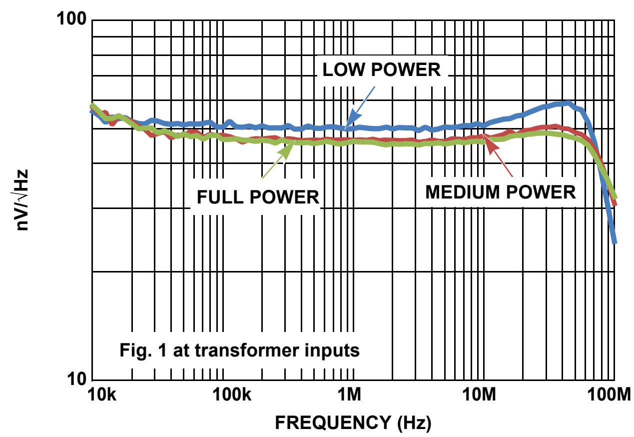


FIGURE 14. DIFFERENTIAL OUTPUT NOISE

Typical Performance Curves

V_{CC} = ±6V, See Figure 1, T_A = +25°C, C0 = 3.3V, C1 = 0V (Medium power), Unless otherwise noted.

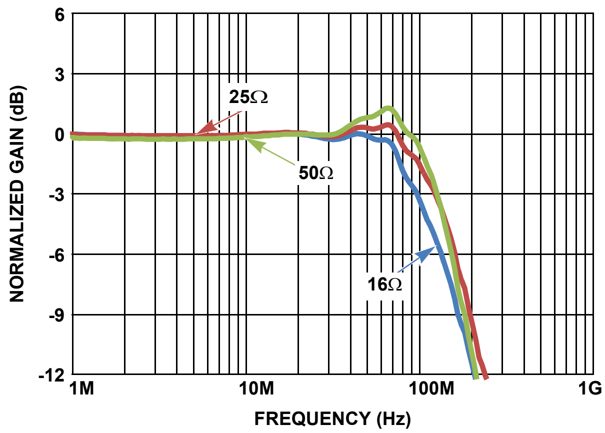


FIGURE 15. SMALL SIGNAL FREQUENCY RESPONSE vs R_{LOAD}

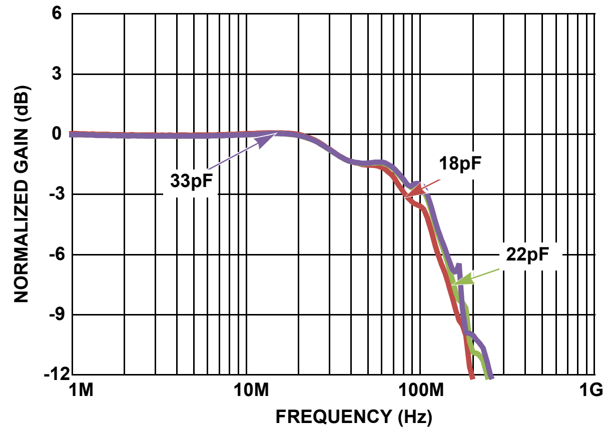


FIGURE 16. SMALL SIGNAL FREQUENCY RESPONSE vs C_{LOAD}

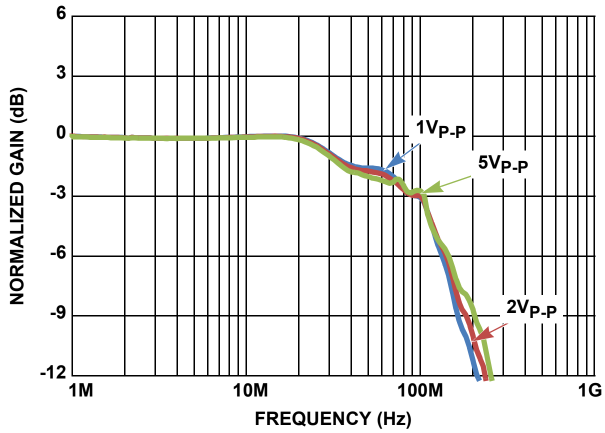


FIGURE 17. LARGE SIGNAL FREQUENCY RESPONSE

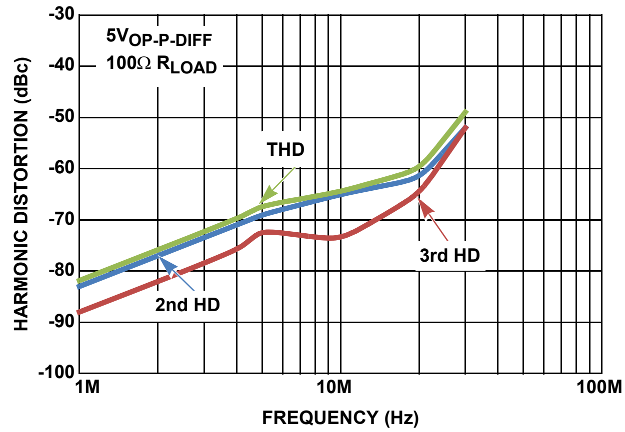


FIGURE 18. HARMONIC DISTORTION vs FREQUENCY

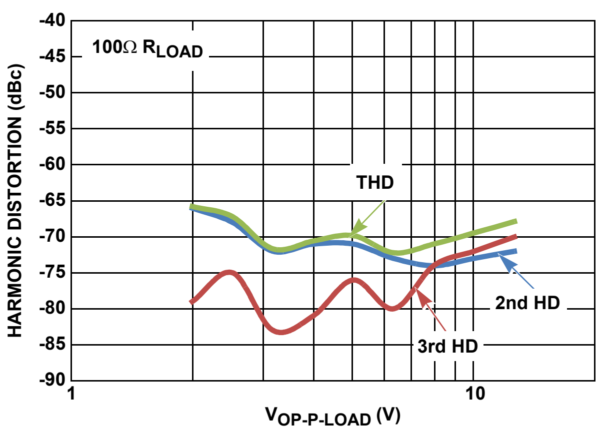


FIGURE 19. 4MHz HARMONIC DISTORTION vs OUTPUT VOLTAGE

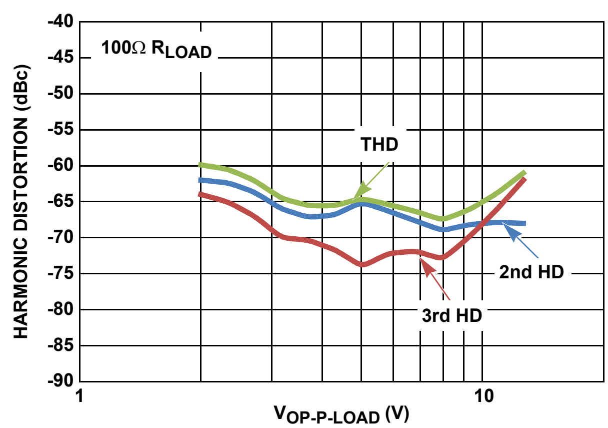


FIGURE 20. 10MHz HARMONIC DISTORTION vs OUTPUT VOLTAGE

Typical Performance Curves

V_{CC} = ±6V, See Figure 1, T_A = +25°C, C0 = 0V, C1 = 3.3V (Low power), unless otherwise noted.

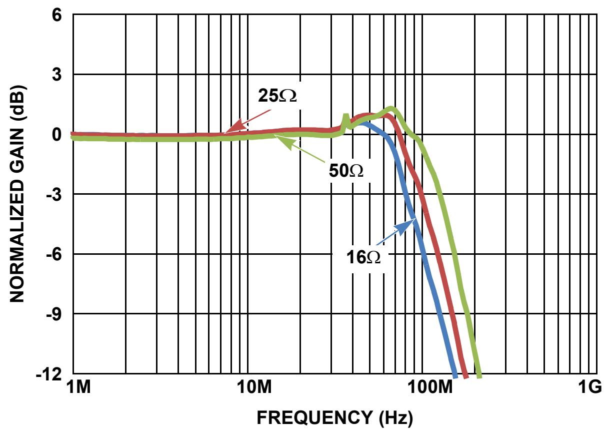


FIGURE 21. SMALL SIGNAL FREQUENCY vs R_{LOAD}

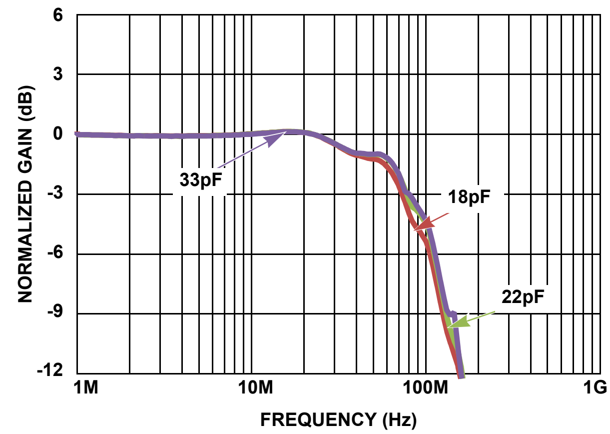


FIGURE 22. SMALL SIGNAL FREQUENCY RESPONSE vs C_{LOAD}

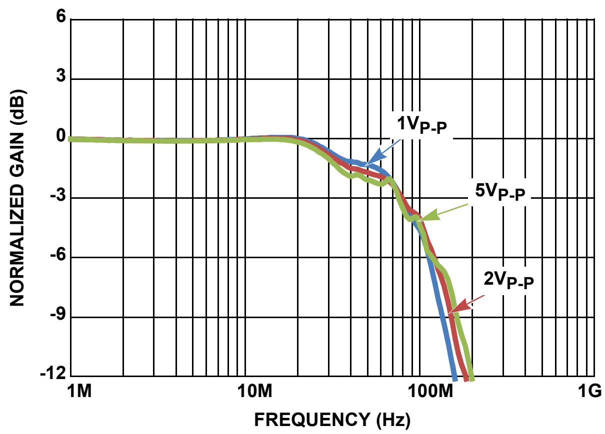


FIGURE 23. LARGE SIGNAL FREQUENCY RESPONSE

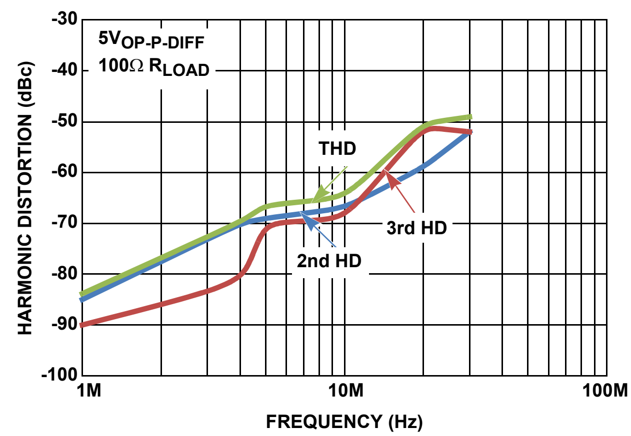


FIGURE 24. HARMONIC DISTORTION vs FREQUENCY

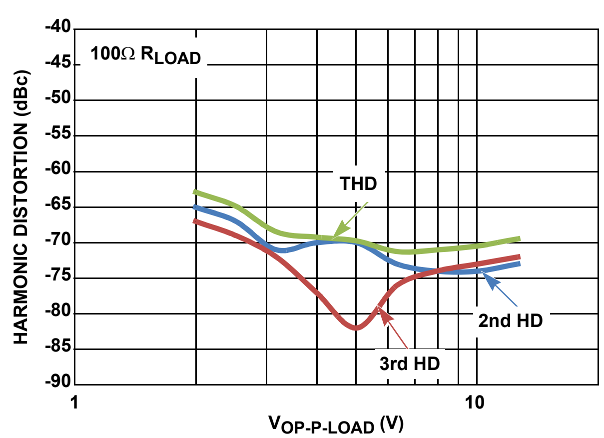


FIGURE 25. 4MHz HARMONIC DISTORTION vs OUTPUT VOLTAGE

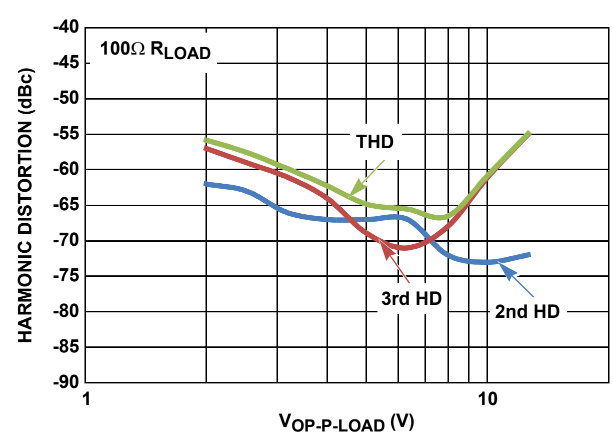


FIGURE 26. 10MHz HARMONIC DISTORTION vs OUTPUT VOLTAGE

Typical Performance Curves

VCC = ±6V, See Figure 3, Gain = 5V/V (Differential), Rf = 1.5kΩ, R_{LOAD} = 100Ω, T_A = +25°C, C0 and C1 Varied, unless otherwise noted.

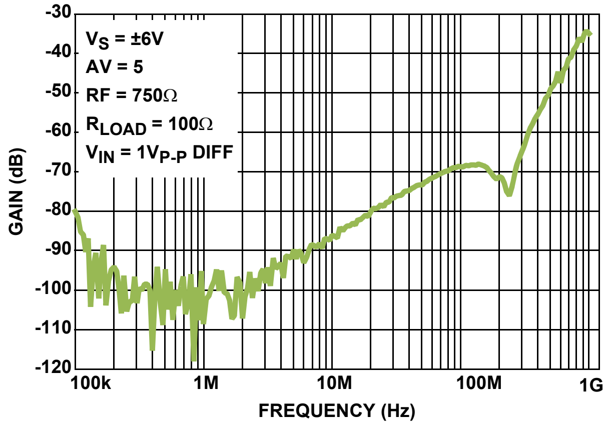


FIGURE 27. OFF-ISOLATION

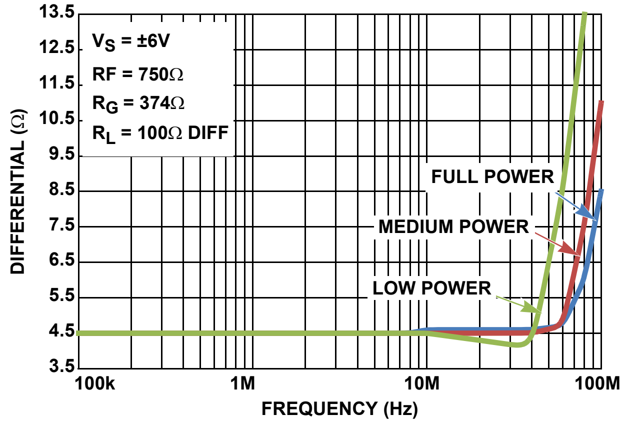


FIGURE 28. DIFFERENTIAL OUTPUT IMPEDANCE

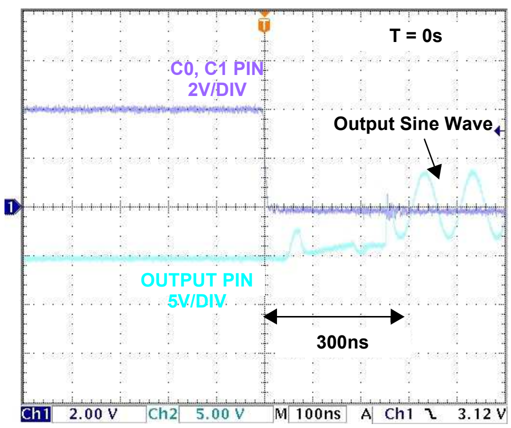


FIGURE 29. POWER ON

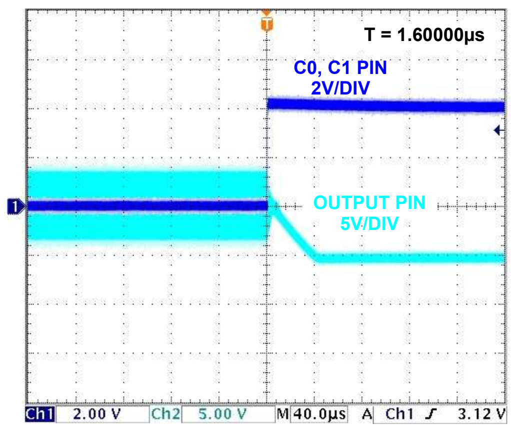


FIGURE 30. POWER OFF

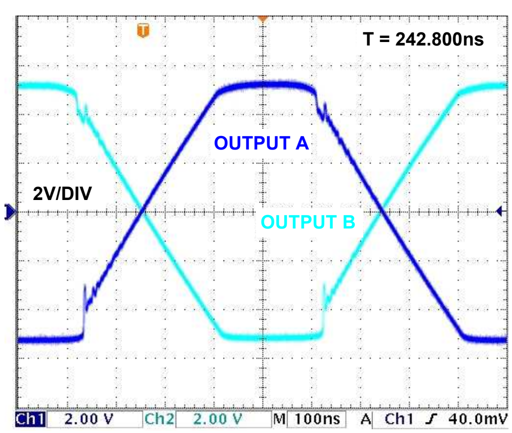


FIGURE 31. OVERDRIVE RECOVERY

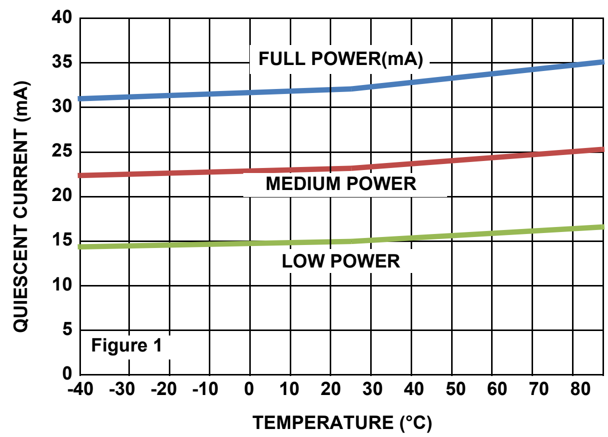


FIGURE 32. QUIESCENT CURRENT vs TEMPERATURE

Typical Performance Curves

VCC = ±6V, See Figure 3, Gain = 5V/V (Differential), Rf = 1.5kΩ, R_{LOAD} = 100Ω, T_A = +25°C, C0 and C1 Varied, unless otherwise noted. **(Continued)**

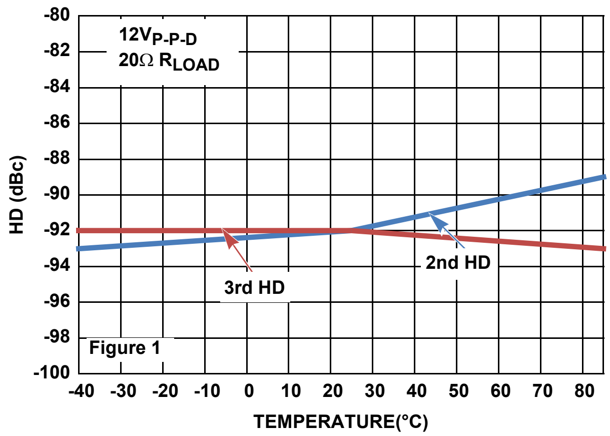


FIGURE 33. 200kHz DISTORTION vs TEMPERATURE

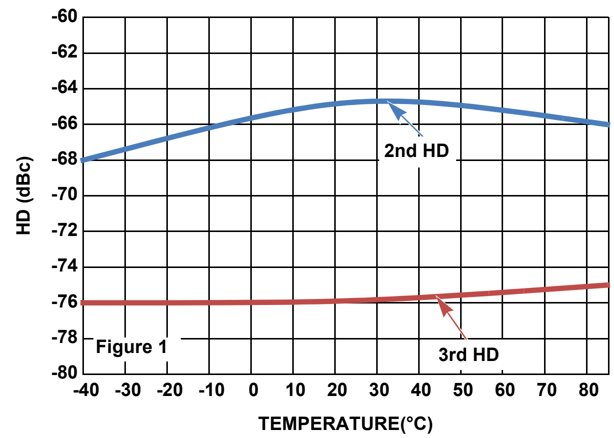


FIGURE 34. 4MHz DISTORTION vs TEMPERATURE

Applications Information

Product Description

The ISL1550 is a dual operational amplifier designed for line driving in DMT VDSL2 8MHz, 12MHz, 17MHz and 30MHz bandplans solutions. It is a current mode feedback amplifier with low distortion drawing moderately low supply current. Due to the current feedback architecture, the ISL1550 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 (Figure 3).

VDSL CO Applications

The ISL1550 is designed as a VDSL line driver for CO. At an output current of ±450mA, the typical supply voltage headroom is 1.5V on each side of the differential output.

The average line power requirement for the VDSL CO application is 20dBm (100mW) into a 100Ω line. The average line voltage is $3.16V_{RMS}$. The VDSL DMT peak-to-average ratio (crest factor) of 5.3 implies peak voltage of $16.8V_P$ into the line. Using a differential drive configuration and transformer coupling with standard back termination, a transformer ratio of 1:2.5 is selected. The active termination technique provides better power efficiency by reducing the backmatch resistor by a factor of K = 5. Positive feedback resistors, RP, can be sized to make the effective backmatch impedance larger. The circuit configuration is shown in Figure 35.

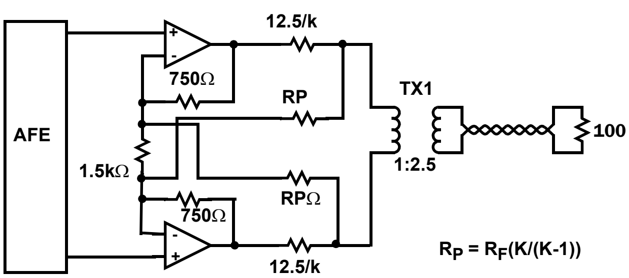


FIGURE 35. CIRCUIT CONFIGURATION

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 0.25”). The power supply pins must be well bypassed to reduce the risk of oscillation. A 4.7µF tantalum capacitor in parallel with a 0.1µF ceramic capacitor is adequate for each supply pin. During power-up, it is necessary to limit the slew rate of the rising power supply to less than 1V/µs. If the power supply rising time is undetermined, a series 10Ω resistor on the power supply line before the decoupling caps can be used to ensure the proper power supply rise time.

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 or metal film resistors are acceptable, while use of wire-wound resistors should be avoided 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 ISL1550 when operating in the non-inverting configuration.

Feedback Resistor Values

The ISL1550 has been designed and specified with R_F = 1.5kΩ for A_V = +5 (Figure 3). 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 the feedback resistor will cause rolloff to occur at a lower frequency.

Quiescent Current vs Temperature

The ISL1550 was designed to slightly increase quiescent current with temperature to maintain good distortion performance at high temperatures. Refer to “Typical Performance Curves” beginning on page 5.

Supply Voltage Range

The ISL1550 has been designed to operate with supply voltages from ±4.0V to ±6.6V nominal. Optimum bandwidth, slew rate, and video characteristics are obtained at higher supply voltages.

Single Supply Operation

If a single supply is desired, values from +8.0V to +13.2V nominal 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 ISL1550.

Revision History

The revision history provided is for informational purposes only and is believed to be accurate, but not warranted. Please go to web to make sure you have the latest revision.

DATE	REVISION	CHANGE
March 16, 2012	FN6795.0	Initial release.

Products

Intersil Corporation is a leader in the design and manufacture of high-performance analog semiconductors. The Company's products address some of the industry's fastest growing markets, such as, flat panel displays, cell phones, handheld products, and notebooks. Intersil's product families address power management and analog signal processing functions. Go to www.intersil.com/products for a complete list of Intersil product families.

For a complete listing of Applications, Related Documentation and Related Parts, please see the respective device information page on intersil.com: ISL1550

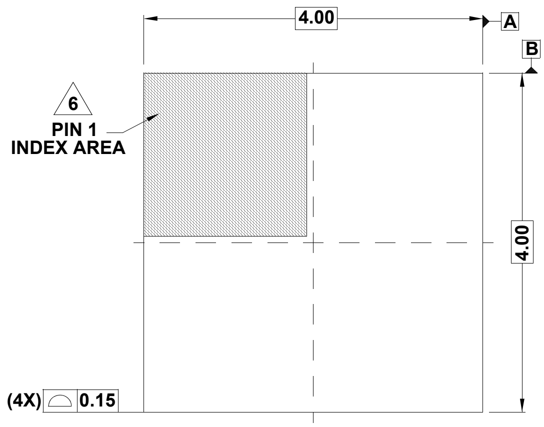
To report errors or suggestions for this datasheet, please go to: www.intersil.com/askourstaff

Package Outline Drawing

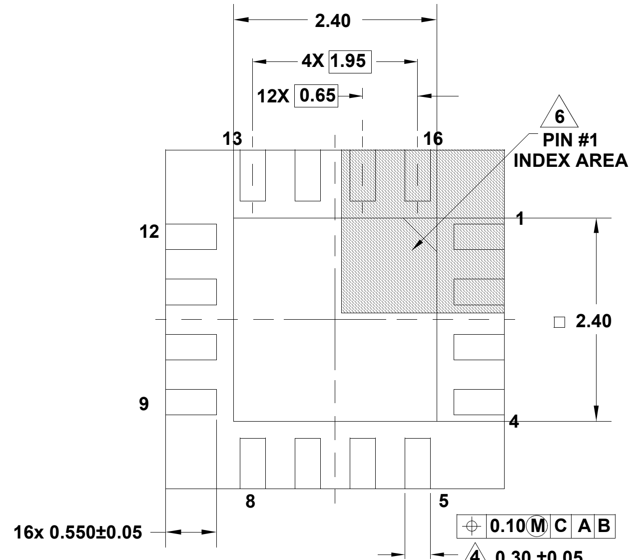
L16.4x4H

16 LEAD QUAD FLAT NO-LEAD PLASTIC PACKAGE

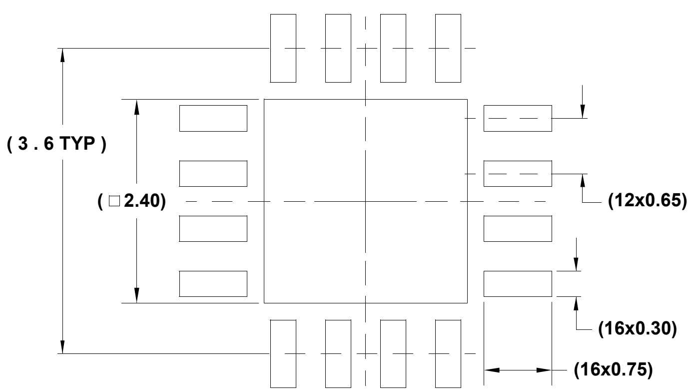
Rev 0, 1/12



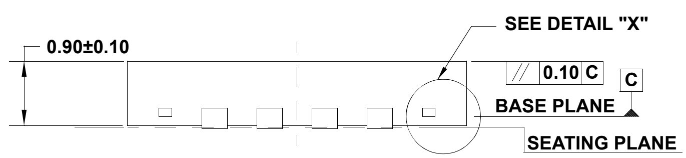
TOP VIEW



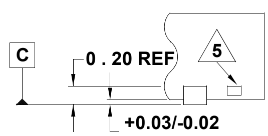
BOTTOM VIEW



TYPICAL RECOMMENDED LAND PATTERN



SIDE VIEW



DETAIL "X"

NOTES:

1. Dimensions are in millimeters.
   Dimensions in ( ) for Reference Only.
2. Dimensioning and tolerancing conform to ASME Y14.5m-1994.
3. Unless otherwise specified, tolerance : Decimal ± 0.05
4. Dimension applies to the metallized terminal and is measured between 0.15mm and 0.30mm from the terminal tip.
5. Tiebar shown (if present) is a non-functional feature.
6. The configuration of the pin #1 identifier is optional, but must be located within the zone indicated. The pin #1 identifier may be either a mold or mark feature.