ISL1557A

12V xDSL Differential Line Driver with Enhanced Output Protection

FN6568
Rev 3.00
Mar 2, 2018

The ISL1557A is a dual operational amplifier designed for VDSL2 and ADSL line driving in DMT based solutions. This device features a high drive capability of 750mA while consuming only 6mA of supply current per amplifier and operating from a single 4.5V to 12V supply. The driver achieves a typical distortion of -80dBc at 150kHz into a 25Ω load. The ISL1557A is designed with stronger output clamps to enhance protection against lightning transients.

The ISL1557A is available in the thermally-enhanced 16 Ld QFN and 10 Ld HMSOP package and is specified for operation over the full -40°C to +85°C temperature range. The ISL1557A has two control pins (C_0 and C_1) for controlling the bias and enable/disable of the outputs. These controls allow for lowering the power to fit the performance/power ratio for the application.

The ISL1557A is ideal for ADSL2+, SDSL, HDSL2, and VDSL line driving applications, including both 14.5dBm and 21dBm applications.

Related Literature

For a full list of related documents, visit our website

- ISL1557A product page

Features

- 21dBm output power capability
- Drives up to 750mA from a +12V supply
- $20V_{P-P}$ differential output drive into 21Ω
- -80dBc typical driver output distortion at full output at 150kHz
- -75dBc typical driver output distortion at 4MHz
- -82dBc typical driver output distortion at 10MHz
- -79dBc typical driver output distortion at 17MHz
- Low quiescent current of 6mA per amplifier
- Supply range
  - ISL1557AIUEZ . . . . 4.5V to 12V
  - ISL1557AIRZ . . . . ±2.25V to ±6V, 4.5V to 12V
- 300MHz bandwidth
- Thermal shutdown
- Pb-free (RoHS compliant)

Applications

- VDSL2 line drivers
- ADSL2+ CPE line driving
- G.SHDSL and HDSL2 line drivers

Ordering Information

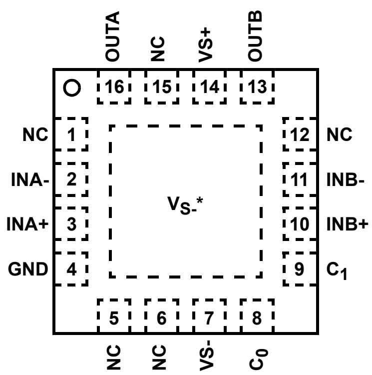
PART NUMBER (Notes 2, 3)	PART MARKING	TEMP. RANGE (°C)	TAPE AND REEL (UNITS)	PACKAGE (Pb-Free)	PKG. DWG. #
ISL1557AIRZ	155 7AIRZ	-40 to +85	-	16 Ld 4x4 QFN	L16.4x4H
ISL1557AIRZ-T7 (Note 1)	155 7AIRZ	-40 to +85	1k	16 Ld 4x4 QFN (Tape and Reel)	L16.4x4H
ISL1557AIUEZ (No longer available or supported)	BBBGA	-40 to +85	-	10 Ld HMSOP	MDP0050

NOTES:

1. Refer to TB347 for details about reel specifications.
2. These 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. 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), refer to the ISL1557A product information page. For more information about MSL, refer to TB363.

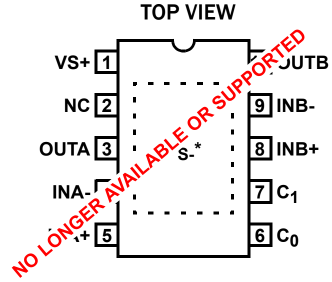
Pin Configurations

ISL1557A
(16 LD QFN)
TOP VIEW



*THERMAL PAD MUST BE CONNECTED TO NEGATIVE SUPPLY: V_{S-}. QFN PACKAGE CAN BE USED IN SINGLE AND DUAL SUPPLY APPLICATIONS.

ISL1557A
(10 LD HMSOP)
TOP VIEW



*THERMAL PAD MUST BE CONNECTED TO NEGATIVE SUPPLY: V_{S-}. HMSOP PACKAGE CAN BE USED IN SINGLE SUPPLY APPLICATIONS ONLY.

Pin Descriptions

16 LD QFN	10 LD HMSOP	PIN NAME	FUNCTION
1, 5, 6, 12, 15	2	NC	No connect
2	4	INA-	Inverting input of Amplifier A
3	5	INA+	Non-inverting input of Amplifier A
4	Thermal Pad	GND	Ground connect
7	Thermal Pad	VS-	Negative supply
8	6	C_0 (Note 4)	Current control bias pin
9	7	C_1 (Note 4)	Current control bias pin
10	8	INB+	Non-inverting input of Amplifier B
11	9	INB-	Inverting input of Amplifier B
13	10	OUTB	Output of Amplifier B
14	1	VS+	Positive supply
16	3	OUTA	Output of Amplifier A

Pin Descriptions

16 LD QFN	10 LD HMSOP	PIN NAME	FUNCTION

NOTE:

4. The single DSL port is made of Amplifiers A and B. C_0 and C_1 control I_S settings for the DSL port.

Absolute Maximum Ratings (T_A = +25°C)

V_S+ Voltage to Ground . . . . -0.3V to +13.2V
V_{IN}+ Voltage . . . . GND to V_S+
Current into any Input 8mA
Continuous Output Current 75mA
C0, C1 to Ground . . . . +6.6V
ESD Rating
  Human Body Model 1kV
  Machine Model 1.5kV

Thermal Information

Ambient Operating Temperature Range . . . . -40°C to +85°C
Storage Temperature Range . . . . -60°C to +150°C
Operating Junction Temperature . . . . +150°C
Power Dissipation . . . . see Figure 23 on page 8
Pb-Free reflow profile . . . . see TB493

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.

Electrical Specifications

V_S = 12V, R_F = 750Ω, R_{L-DIFF} = 50Ω, C_0 = C_1 = 0V, T_A = +25°C, unless otherwise specified.

PARAMETER	DESCRIPTION	CONDITIONS	MIN	TYP	MAX	UNIT
AC PERFORMANCE						
BW	-3dB Bandwidth	R_F = 499Ω, A_V = +5		300		MHz
		R_F = 750Ω, A_V = +5		250		MHz
		R_F = 750Ω, A_V = +10		200		MHz
THD	Total Harmonic Distortion, Differential	f = 4MHz, V_O = $4V_{P-P\_DIFF}$, R_{L-DIFF} = 100Ω		-75		dBc
		f = 10MHz, V_O = $4V_{P-P\_DIFF}$, R_{L-DIFF} = 100Ω		-82		dBc
		f = 17MHz, V_O = $4V_{P-P\_DIFF}$, R_{L-DIFF} = 100Ω		-79		dBc
SR	Slew Rate, Single-ended	V_{OUT} from -3V to +3V	750	1200		V/µs
DC PERFORMANCE						
V_{OS_CM}	Offset Voltage Common Mode		-40		+40	mV
V_{OS_DM}	Offset Voltage Differential Mode		-7.5		+7.5	mV
R_{OL}	Differential Transimpedance	V_{OUT} = $12V_{P-P}$ differential, unloaded		3.0		MΩ
INPUT CHARACTERISTICS						
I_B+	Non-Inverting Input Bias Current		-7.0		+7.0	µA
I_{B^-} DM	Inverting Input Bias Current Differential Mode		-75	3	+75	µA
e_N	Input Noise Voltage	f = 10kHz		8.2		$nV/\sqrt{Hz}$
i_N	Input Noise Current	f = 10kHz		25		$pA/\sqrt{Hz}$
OUTPUT CHARACTERISTICS						
V_{OUT}	Loaded Output Swing (Single- ended)	V_S = ±6V, R_{L-DIFF} = 50Ω	±4.85	±5.0		V
		V_S = ±6V, R_{L-DIFF} = 20Ω	±4.4	±4.7		V
I_{OUT}	Output Current	R_L = 0Ω		1000		mA
SUPPLY						
V_S	Supply Voltage	Single supply	4.5		13.2	V
I_S+ (Full Bias)	Positive Supply Current per Amplifier	All outputs at 0V, C_0 = C_1 = 0V	12	15	21.5	mA
I_S+ (Medium Bias)	Positive Supply Current per Amplifier	All outputs at 0V, C_0 = 5V, C_1 = 0V		11		mA
I_S+ (Low Bias)	Positive Supply Current per Amplifier	All outputs at 0V, C_0 = 0V, C_1 = 5V		6.0		mA
I_S+ (Power down)	Positive Supply Current per Amplifier	All outputs at 0V, C_0 = C_1 = 5V		0.6	1.0	mA
I_{INH}, C_0 or C_1	C_0, C_1 Input Current, High	C_0, C_1 = 6V	100	175	250	µA
I_{INL}, C_0 or C_1	C_0, C_1 Input Current, Low	C_0, C_1 = 0V	-5		+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

Typical Performance Curves

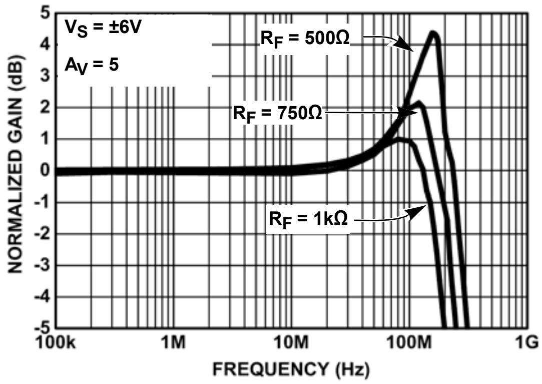


FIGURE 1. DIFFERENTIAL FREQUENCY RESPONSE WITH VARIOUS R_F (FULL BIAS MODE)

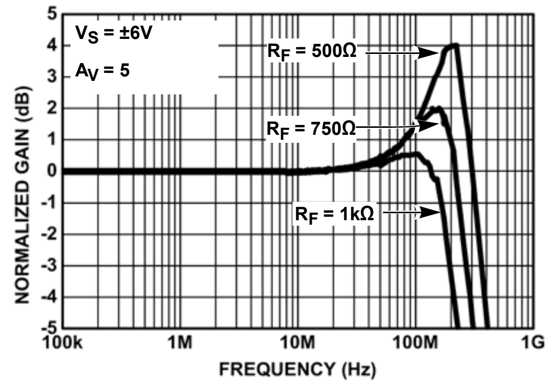


FIGURE 2. DIFFERENTIAL FREQUENCY RESPONSE WITH VARIOUS R_F (MEDIUM BIAS MODE)

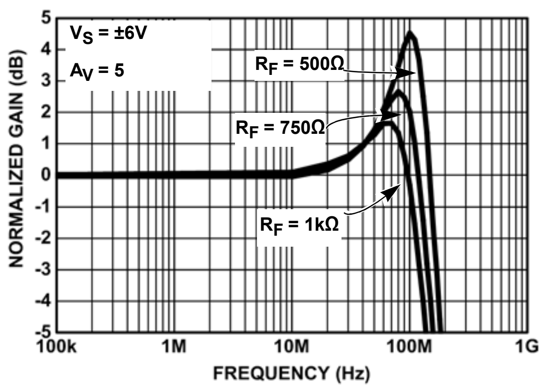


FIGURE 3. DIFFERENTIAL FREQUENCY RESPONSE WITH VARIOUS R_F (LOW BIAS MODE)

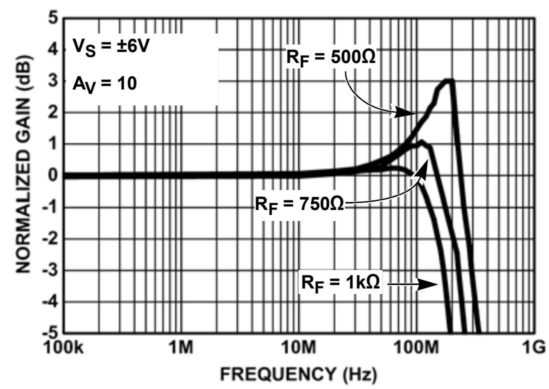


FIGURE 4. DIFFERENTIAL FREQUENCY RESPONSE WITH VARIOUS R_F (FULL BIAS MODE)

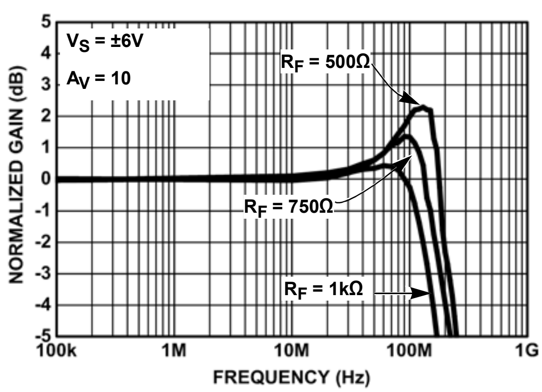


FIGURE 5. DIFFERENTIAL FREQUENCY RESPONSE WITH VARIOUS R_F (MEDIUM BIAS MODE)

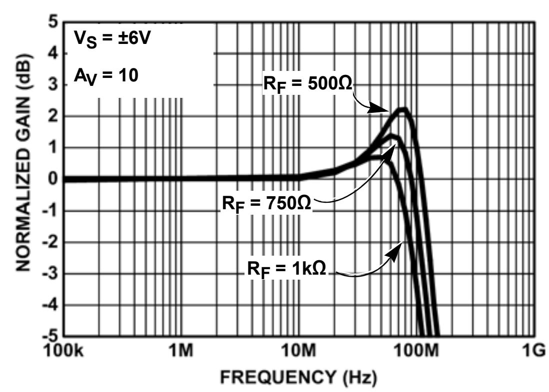


FIGURE 6. DIFFERENTIAL FREQUENCY RESPONSE WITH VARIOUS R_F (LOW BIAS MODE)

Typical Performance Curves (Continued)

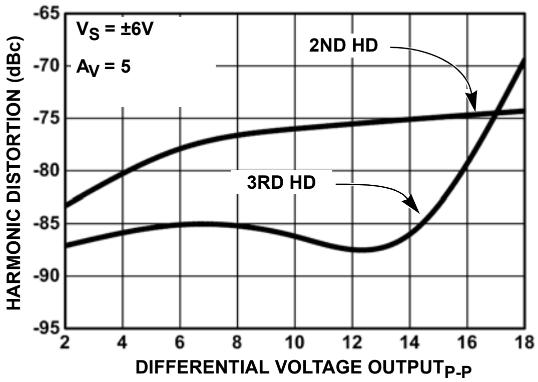


FIGURE 7. HARMONIC DISTORTION at 2MHz

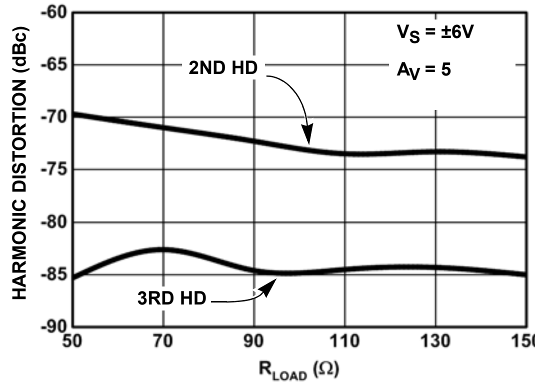


FIGURE 8. 2ND AND 3RD HARMONIC DISTORTION vs R_{LOAD} at 2MHz

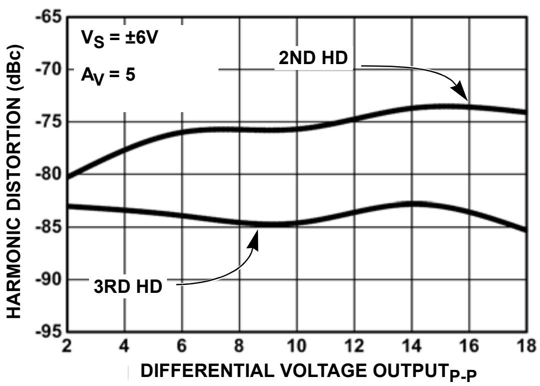


FIGURE 9. HARMONIC DISTORTION at 3MHz

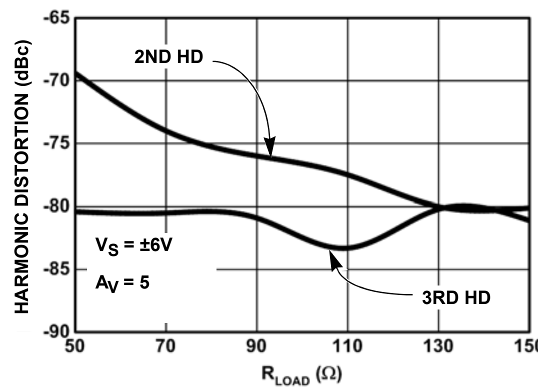


FIGURE 10. 2ND AND 3RD HARMONIC DISTORTION vs R_{LOAD} at 3MHz

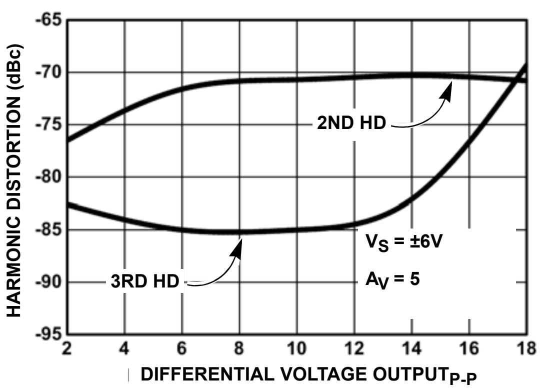


FIGURE 11. HARMONIC DISTORTION at 5MHz

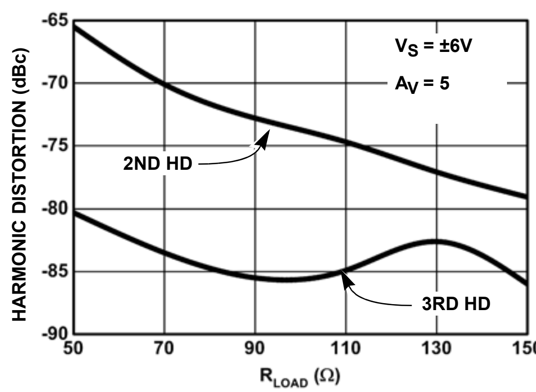


FIGURE 12. 2ND AND 3RD HARMONIC DISTORTION vs R_{LOAD} at 5MHz

Typical Performance Curves (Continued)

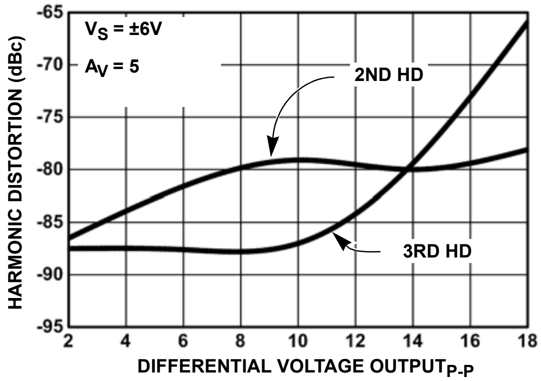


FIGURE 13. HARMONIC DISTORTION at 10MHz

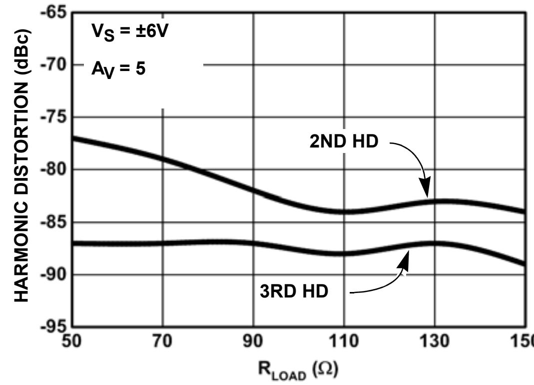


FIGURE 14. 2ND AND 3RD HARMONIC DISTORTION vs R_{LOAD} at 10MHz

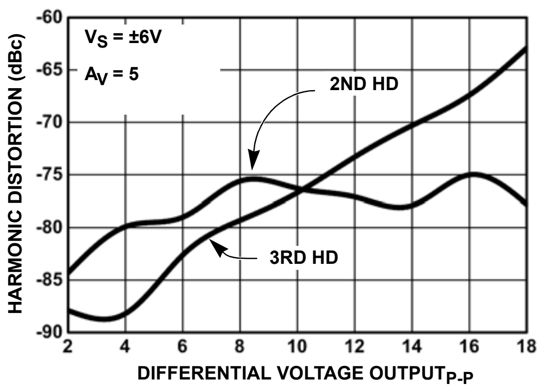


FIGURE 15. HARMONIC DISTORTION at 17MHz

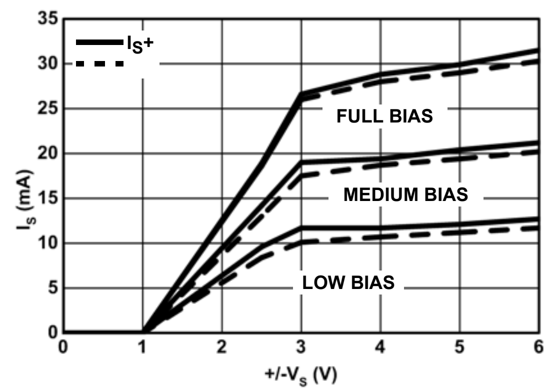


FIGURE 16. SUPPLY CURRENT vs SUPPLY VOLTAGE

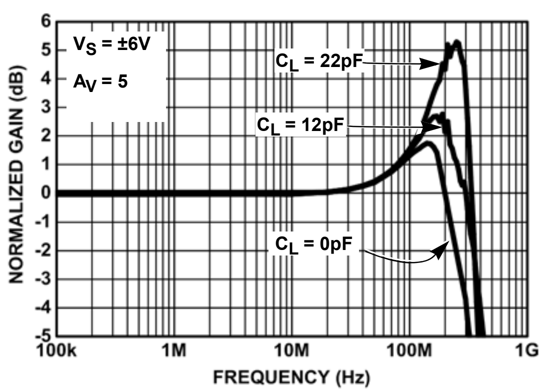


FIGURE 17. FREQUENCY RESPONSE WITH VARIOUS C_L (FULL BIAS MODE)

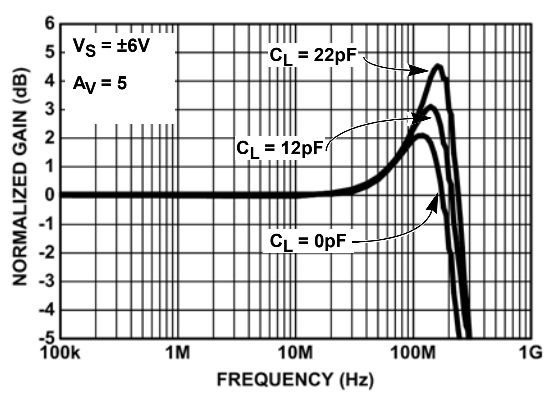


FIGURE 18. FREQUENCY RESPONSE vs VARIOUS C_L (MEDIUM BIAS MODE)

Typical Performance Curves (Continued)

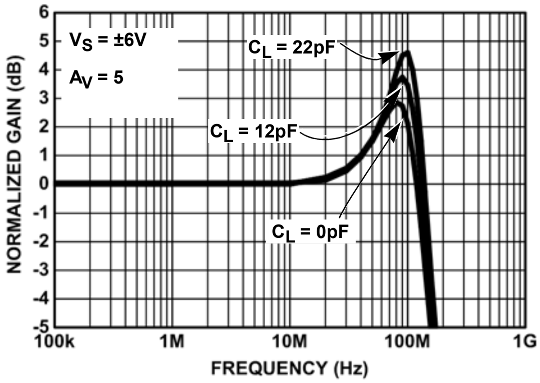


FIGURE 19. FREQUENCY RESPONSE WITH VARIOUS C_L (LOW BIAS MODE)

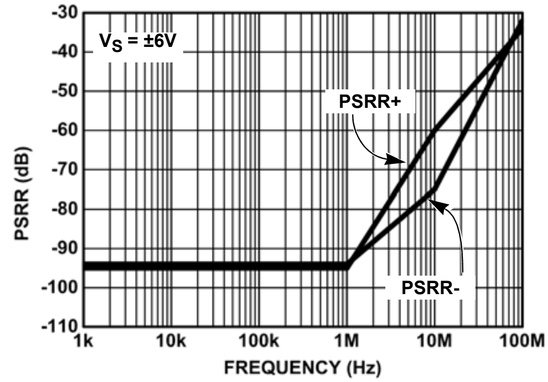


FIGURE 20. PSRR vs FREQUENCY

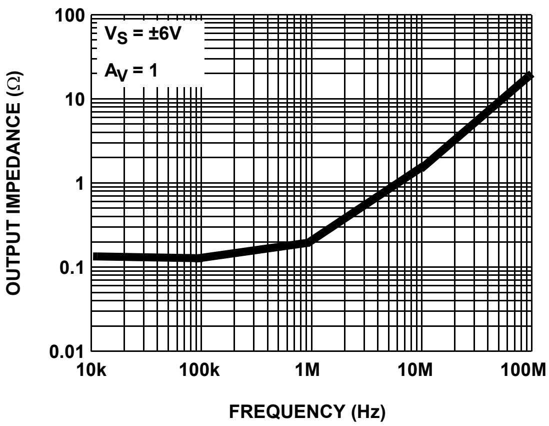


FIGURE 21. OUTPUT IMPEDANCE vs FREQUENCY

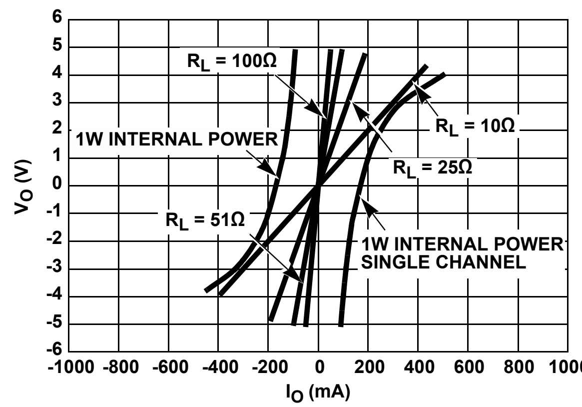


FIGURE 22. OUTPUT VOLTAGE AND CURRENT LIMITATIONS

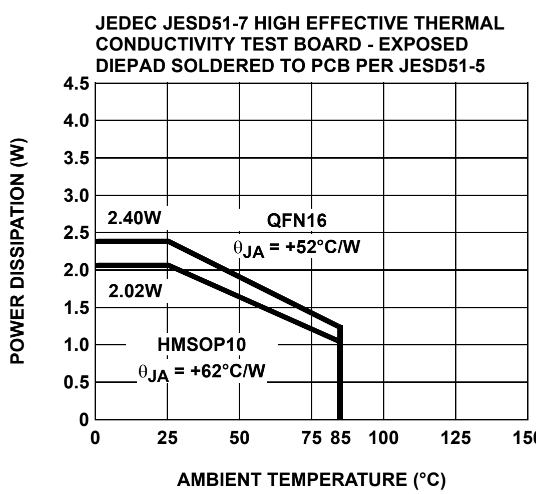


FIGURE 23. PACKAGE POWER DISSIPATION vs AMBIENT TEMPERATURE

Applications Information

Product Description

The ISL1557A is a dual operational amplifier designed for line driving in DMT ADSL2+ and VDSL solutions. It is a dual current mode feedback amplifier with low distortion that draws a moderately low supply current. It is built using proprietary Renesas complimentary bipolar process and is offered in industry standard pinouts. Due to the current feedback architecture, the ISL1557A closed-loop 3dB bandwidth is dependent on the value of the feedback resistor. First, select the desired bandwidth by choosing the feedback resistor, R_F, then set the gain by choosing the gain resistor, R_G. The curves at the beginning of the "Typical Performance Curves" on page 5 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 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 within 1V/µs. If the power supply rising time is undetermined, a series 10Ω resistor on the power supply line 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 resistors are acceptable, but avoid using wire-wound resistors because of their parasitic inductance. Similarly, capacitors should be low inductance for the best performance.

Capacitance at the Inverting Input

Due to the topology of the current feedback amplifier, stray capacitance at the inverting input will effect the AC and transient performance of the ISL1557A when operating in the non-inverting configuration.

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

Feedback Resistor Values

The ISL1557A has been designed and specified with R_F = 750Ω for A_V = +5. This value of feedback resistor yields extremely flat frequency response with 1dB peaking out to 250MHz. As 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 starting on page 5, which show 3dB bandwidth and peaking vs frequency for various feedback resistors and various supply voltages.

Bandwidth vs Temperature

Although many amplifiers’ supply current and consequently 3dB bandwidth drop off at high temperatures, the ISL1557A is designed to have little supply current variations with temperature. An immediate benefit is that the 3dB bandwidth does not drop off drastically with temperature.

Supply Voltage Range

The ISL1557A is designed to operate with supply voltages from ±2.25V to ±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 +4.5V to +12V nominal can be used as long as the input common mode range is not exceeded. When using a single supply, be sure to either:

- DC bias the inputs at an appropriate common mode voltage and AC couple the signal, or:
- Ensure the driving signal is within the common mode range of the ISL1557A. The ISL1557AIUEZ must be used in single supply applications.

ADSL CPE Applications

The ISL1557A is designed as a line driver for ADSL CPE modems. It is capable of outputting 450mA of output current with a typical supply voltage headroom of 1.3V. It can achieve -85dBc of distortion at low 7.1mA of supply current per amplifier.

The average line power requirement for the ADSL CPE application is 14.5dBm (28mW) into a 100Ω line. The average line voltage is $1.67V_{RMS}$. 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 1:2 is selected. The circuit configuration is shown in Figure 24.

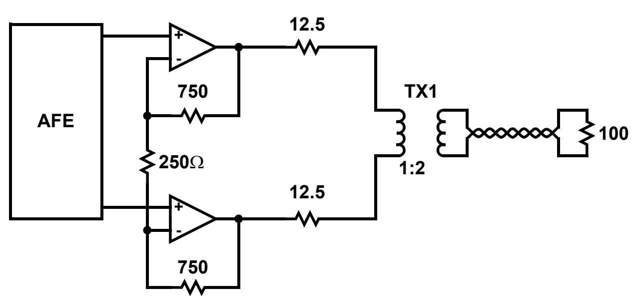


FIGURE 24. CIRCUIT CONFIGURATION

Revision History

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

DATE	REVISION	CHANGE
Mar 2, 2018	FN6568.3	-Added Related Literature section on page 1. -Added Notes 1, 2, and 3 on page 2. -Updated package outline drawing on page 10. -Removed About Intersil section and added Renesas disclaimer.

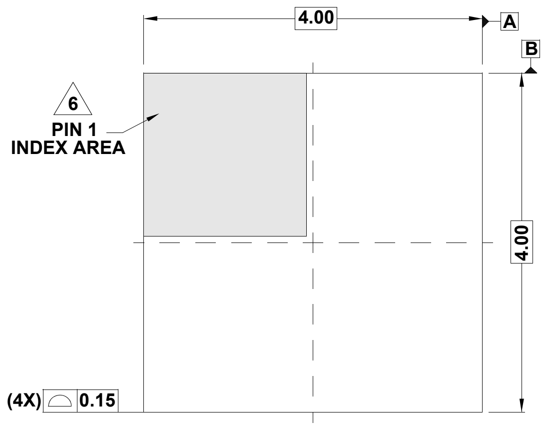
Package Outline Drawings

For the most recent package outline drawing, see L16.4x4H.

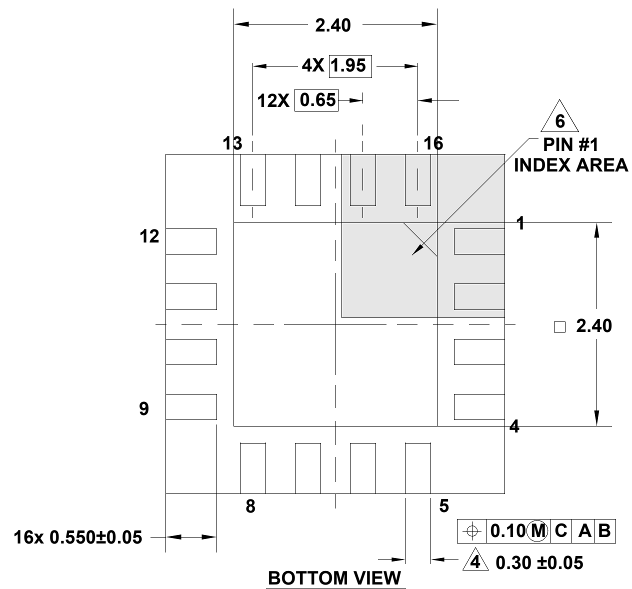
L16.4x4H

16 LEAD QUAD FLAT NO-LEAD PLASTIC PACKAGE

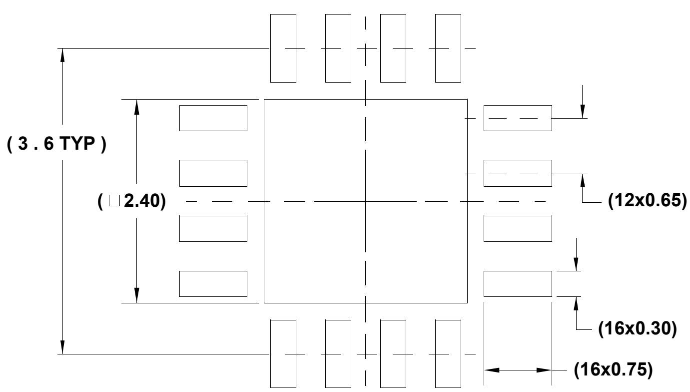
Rev 0, 1/12



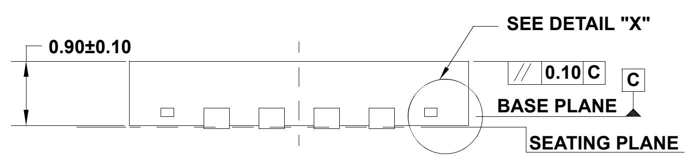
TOP VIEW



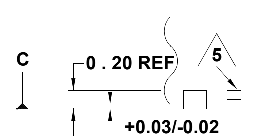
BOTTOM VIEW



TYPICAL RECOMMENDED LAND PATTERN



SIDE VIEW

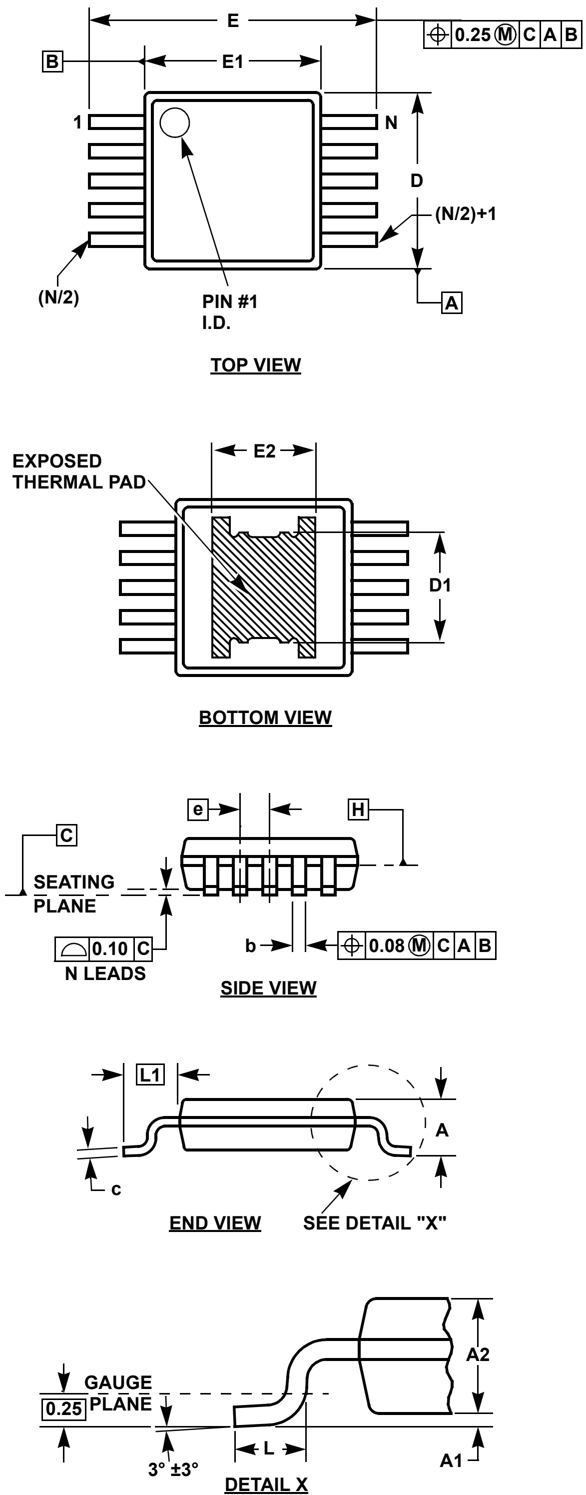


DETAIL "X"

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.

HMSOP (Heat-Sink MSOP) Package Family



MDP0050

HMSOP (HEAT-SINK MSOP) PACKAGE FAMILY

SYMBOL	MILLIMETERS HMSOP8	MILLIMETERS HMSOP10	TOLERANCE	NOTES
A	1.00	1.00	Max.	-
A1	0.075	0.075	+0.025/-0.050	-
A2	0.86	0.86	±0.09	-
b	0.30	0.20	+0.07/-0.08	-
c	0.15	0.15	±0.05	-
D	3.00	3.00	±0.10	1, 3
D1	1.85	1.85	Reference	-
E	4.90	4.90	±0.15	-
E1	3.00	3.00	±0.10	2, 3
E2	1.73	1.73	Reference	-
e	0.65	0.50	Basic	-
L	0.55	0.55	±0.15	-
L1	0.95	0.95	Basic	-
N	8	10	Reference	-

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NOTES:

1. Plastic or metal protrusions of 0.15mm maximum per side are not included.
2. Plastic interlead protrusions of 0.25mm 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.

For the most recent package outline drawing, see MDP0050.

SALES OFFICES Renesas Electronics Corporation http://www.renesas.com

Refer to "http://www.renesas.com/" for the latest and detailed information.

Renesas Electronics America Inc.
1001 Murphy Ranch Road, Milpitas, CA 95035, U.S.A.
Tel: +1-408-432-8888, Fax: +1-408-434-5351

Renesas Electronics Canada Limited
9251 Yonge Street, Suite 8309 Richmond Hill, Ontario Canada L4C 9T3
Tel: +1-905-237-2004

Renesas Electronics Europe Limited
Dukes Meadow, Millboard Road, Bourne End, Buckinghamshire, SL8 5FH, U.K
Tel: +44-1628-651-700, Fax: +44-1628-651-804

Renesas Electronics Europe GmbH
Arcadiastrasse 10, 40472 Düsseldorf, Germany
Tel: +49-211-6503-0, Fax: +49-211-6503-1327

Renesas Electronics (China) Co., Ltd.
Room 1709 Quantum Plaza, No.27 ZhichunLu, Haidian District, Beijing, 100191 P. R. China
Tel: +86-10-8235-1155, Fax: +86-10-8235-7679

Renesas Electronics (Shanghai) Co., Ltd.
Unit 301, Tower A, Central Towers, 555 Langao Road, Putuo District, Shanghai, 200333 P. R. China
Tel: +86-21-2226-0888, Fax: +86-21-2226-0999

Renesas Electronics Hong Kong Limited
Unit 1601-1611, 16/F., Tower 2, Grand Century Place, 193 Prince Edward Road West, Mongkok, Kowloon, Hong Kong
Tel: +852-2265-6688, Fax: +852 2886-9022

Renesas Electronics Taiwan Co., Ltd.
13F, No. 363, Fu Shing North Road, Taipei 10543, Taiwan
Tel: +886-2-8175-9600, Fax: +886 2-8175-9670

Renesas Electronics Singapore Pte. Ltd.
80 Bendemeer Road, Unit #06-02 Hyflux Innovation Centre, Singapore 339949
Tel: +65-6213-0200, Fax: +65-6213-0300

Renesas Electronics Malaysia Sdn.Bhd.
Unit 1207, Block B, Menara Amcorp, Amcorp Trade Centre, No. 18, Jln Persiaran Barat, 46050 Petaling Jaya, Selangor Darul Ehsan, Malaysia
Tel: +60-3-7955-9390, Fax: +60-3-7955-9510

Renesas Electronics India Pvt. Ltd.
No.777C, 100 Feet Road, HAL 2nd Stage, Indiranagar, Bangalore 560 038, India
Tel: +91-80-67208700, Fax: +91-80-67208777

Renesas Electronics Korea Co., Ltd.
17F, KAMCO Yangjae Tower, 262, Gangnam-daero, Gangnam-gu, Seoul, 06265 Korea
Tel: +82-2-558-3737, Fax: +82-2-558-5338