User's Manual

RENESAS

ISL15102IRZ-EVALZ

User's Manual: Evaluation Board

Industrial Analog and Power

Rev 0.00 Nov 2017

1. Overview

The ISL15102IRZ-EVAL board uses the ISL15102 single port differential line driver for Power Line Communication (PLC) applications. The device is designed to drive heavy line loads while maintaining a high level of linearity required in Orthogonal Frequency Division Multiplexing (OFDM) PLC modem links. The ISL15102IRZ-EVAL board has a disable control switch (DIS). In Disable mode, the line driver goes into Low Power mode and the outputs maintain a high impedance in the presence of high receive signal amplitude, improving TDM receive signal integrity. An internal input CM buffer maximizes the dynamic range and reduces the number of external components in the application circuit.

The ISL15102 is supplied in a thermally-enhanced small footprint (4mmx5mm) 24 Ld QFN package. The ISL15102 is specified for operation across the -40°C to +85°C ambient temperature range.

1.1 Key Features

- Single differential driver
- Internal V_{CM}
- 90MHz signal bandwidth, $A_V = 10$, $R_F = 4.22K$
- Single +8V to +28V supply, absolute maximum 30V
- Supports narrowband and broadband DMT PLC
- Control switch to enable and disable TDM operation
- Fully assembled and tested

1.2 Specifications

This board has been configured and optimized for the following operating conditions:

- Single supply (V_S = 8 to 28V)
- $A_V = 10$
- $R_S = 2.5\Omega$
- AC coupled input and output

1.3 Recommended Equipment

The following materials are recommended to perform testing:

- 0V to 28V power supply with at least 1A source current capability
- Resistive load capable of sinking current up to 1A
- Digital Multimeter (DMM)
- 100MHz differential signal generator
- 100MHz quad-trace oscilloscope

1.4 Ordering Information

Part Number	Description
ISL15102IRZ-EVALZ	Demonstration board with isolated outputs

1.5 Block Diagram

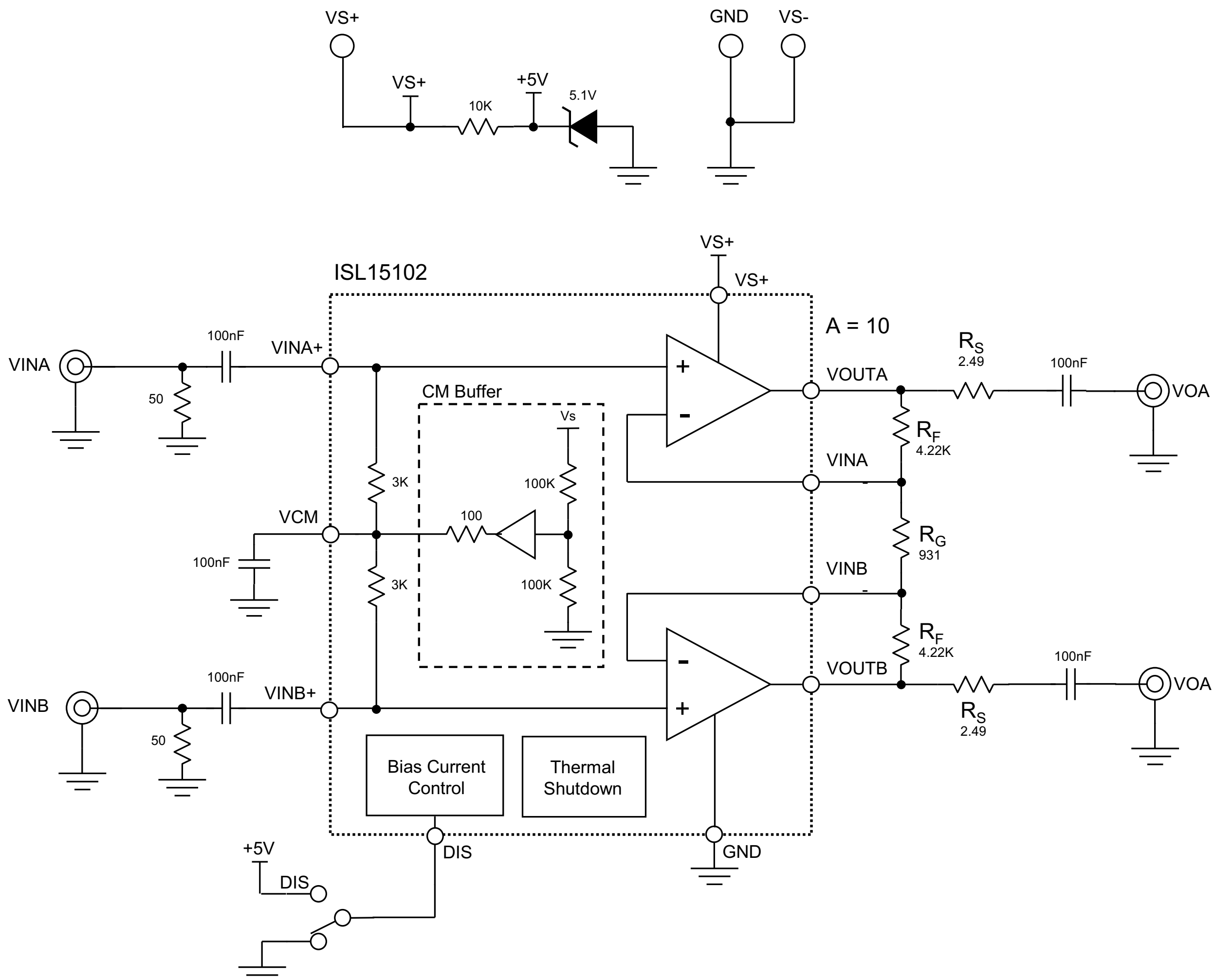

Figure 1. Block Diagram

2. Functional Description

2.1 Quick Setup Guide

(1) Connect +12V to the VS+ plug and ground to the GND plug. The VS- plug is shorted to GND on the PCB and should remain unconnected.

(2) Turn on the power supply and place the DIS switch (SW1) to the GND (chip enabled) position. The supply current should be ~23mA.

(3) Apply a -0.5V to +0.5V (1V_{P-P}) 1MHz differential sine wave signal to the INA and INB ports.

(4) Connect OUTA and OUTB to the high impedance inputs of the oscilloscope.

(5) Verify that the differential signal at OUTA and OUTB is sinusoidal and has an amplitude of -5V to +5V (10V_{P-P}) on the oscilloscope.

2.2 Switch Control

The ISL15102IRZ-EVAL board has a disable control switch (SW1). In Disable mode, the line driver goes into low power mode and the outputs maintain a high impedance in the presence of high receive signal amplitude, improving TDM receive signal integrity. Table 1 summarizes the switch settings.

Table 1. Switch Settings

Switch Position	Function
GND	Driver enabled (DIS=0)
+5V	Driver power-down (DIS=1). Output set to high impedance state
Center	DIS pin controlled by external signal through J1

2.3 Wideband Current Feedback Op Amps as Differential Drivers

A Current Feedback Amplifier (CFA), such as the ISL15102, is particularly suited to the requirements of high output power, high bandwidth, and differential drive. This topology offers a high slew rate on low quiescent power and the ability to hold AC characteristics relatively constant over a wide range of gains. The AC characteristics are principally set by the feedback resistor (R_F) value in simple differential gain circuits as shown in Figure 1 on page 3.

In this differential gain of 10V/V circuit, the 4.22k feedback resistors (R_F) set the bandwidth, while the 931 gain resistor (R_G) controls the gain. The V_o/V_i gain for this circuit is set by (EQ. 1):

$$\frac{V_o}{V_i} = 1 + \left(2 \cdot \frac{R_F}{R_G}\right) = 1 + \left(2 \cdot \frac{4.22k\Omega}{931\Omega}\right) = 10.06 \qquad \text{(EQ. 1)}$$

The effect of increasing or decreasing the feedback resistor value is shown in Figure 13 on page 12. Increasing R_F will tend to roll off the response, while decreasing it will peak the frequency response up, extending the bandwidth. R_G was adjusted in each of these plots to hold a constant gain of 10 (or 20dB). This shows the flexibility offered by the CFA topology—the frequency response can be controlled with the value of the feedback resistor, R_F (R5 and R20), with resistor R_G (R10) setting the desired gain.

The ISL15102 provides two power efficient, high output current CFAs. These are intended to be connected as one differential driver. Power-down control is provided through control pin DIS.

Very low output distortion at low power can be provided by the differential configuration. The high slew rate intrinsic to the CFA topology also contributes to the exceptional performance shown in Figure 16 on page 12. This swept frequency distortion plot shows low distortion at 200kHz holding to very low levels up through 10MHz.

2.4 Input Biasing and Input Impedance

The ISL15102 has internal resistors at the noninverting inputs for mid-rail biasing, so only external AC coupling capacitors are required for input biasing, shown in Figure 1 on page 3. With two 100nF coupling capacitors and an input differential impedance of 6kΩ typical, the first order high-pass cut-off frequency is 530Hz**.**

3. PCB Layout Guidelines

For greatest stability, place the feedback resistors (R_F) as close as possible to the output and inverting input pins to minimize parasitic capacitance in the feedback loop. Keep the gain resistor (R_G) very close to the inverting inputs for its port and minimize parasitic capacitances to ground or power planes as well.

Close placement of the supply decoupling capacitors will minimize parasitic inductance in the supply path. High frequency load currents are typically pulled through these capacitors, so close placement of 0.01µF capacitors on each of the supply pins will improve dynamic performance. Higher valued capacitors, 6.8µF typically, can be placed further from the package because they provide more of the low frequency decoupling.

Connect the thermal pad for the ISL15102 to ground. It is recommended to fill the PCB metal beneath the thermal pad with a 3x3 array of vias to spread heat away from the package. The larger the PCB metal area, the lower the junction temperature of the device.

Although the ISL15102 is relatively robust in driving parasitic capacitive loads, it is always preferred to place any series output resistors (R_S) as close as possible to the output pins. Then trace capacitance on the other side of that resistor will have a much smaller effect on loop phase margin.

Protection devices that are intended to steer large load transients away from the ISL15102 output stage and into the power supplies or ground should have a short trace from their supply connections into the nearest supply capacitor, or they should include their own supply capacitors to provide a low impedance path under fast transient conditions.

3.1 ISL15102IRZ-EVAL Schematic

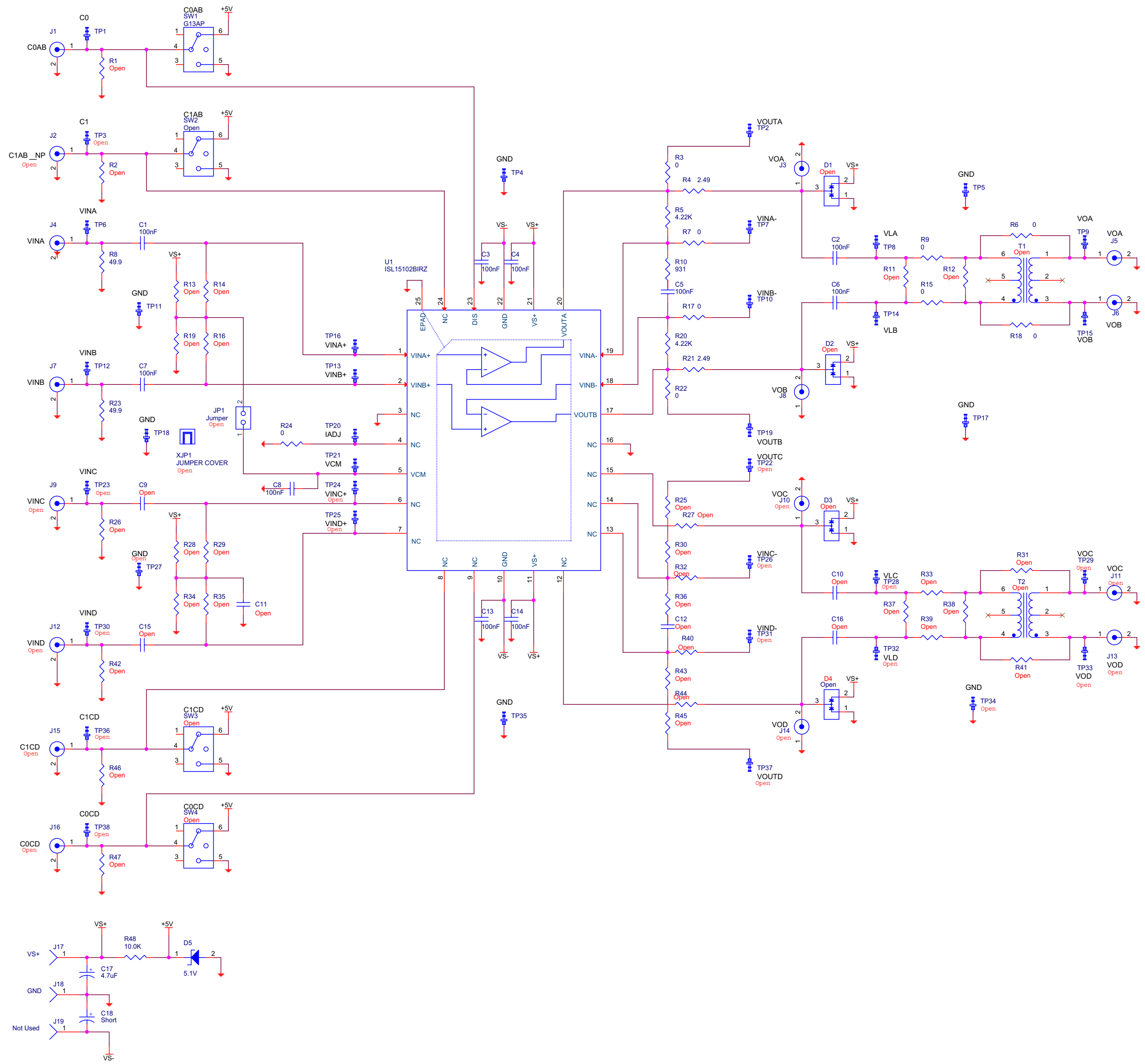

Figure 2. Schematic

3.2 ISL15102IRZ-EVALZ Bill of Materials

Reference Designator	Qty	Manufacturer Part	Assembled	Description	Manufacturer
C1, C2, C5, C6, C7	5	GRM31C5C1E104JA01L	Yes	CAP CER 0.1UF 25V NP0 1206	Murata Electronics North America
C3, C4, C8, C13, C14	5	C1206C104K5RAC7867	Yes	CAP CER 0.1UF 50V X7R 1206	Kemet
C17	1	UMK316AB7475KL-T	Yes	CAP CER 0.1UF 50V X7R 1206	Taiyo Yuden
C18	1	None	Yes	Short	None
D5	1	UDZVTE-175.1B	Yes	Diode Zener 5.1V 200mW UMD2	Rohm Semiconductor
J1, J3, J4, J5, J6, J7, J8	7	112404	Yes	Conn BNC Jack Str 50 ohm PCB	Amphenol-RF Division
J17	1	6095	Yes	Jack Non-insulated Recessed Head	Keystone Electronics
J18	1	6095	Yes	Jack Non-insulated Recessed Head	Keystone Electronics
R3, R6, R7,R9, R15, R17, R18, R22, R24	9	CRCW12060000Z0EA	Yes	RES SMD 0.0 OHM JUMPER 1/4W 1206	Vishay Dale
R4, R21	1	CRCW12062R49FKEA	Yes	RES SMD 2.49 OHM 1% 1/4W 1206	Vishay Dale
R5, R20	2	CRCW12063K01FKEA	Yes	RES SMD 3.01K OHM 1% 1/4W 1206	Vishay Dale
R8, R23	2	CRCW120649R9FKEA	Yes	RES SMD 49.9 OHM 1% 1/4W 1206	Vishay Dale
R10	1	CRCW1206619RFKEA	Yes	RES SMD 619 OHM 1% 1/4W 1206	Vishay Dale
R48	1	CRCW120649R9FKEA	Yes	RES SMD 10K OHM 1% 1/4W 1206	Vishay Dale
SW1	1	G13AP	Yes	SWITCH TOGGLE SPDT 0.4VA 28V	NKK
TP1, TP2, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP14, TP15, TP16, TP17, TP18, TP19, TP20, TP21, TP35	21	1514-2	Yes	Terminal Turret Double 0.109" L	Keystone
U1	1	ISL15102IRZ	Yes		Intersil
C9, C10, C12, C15, C16	5	GRM31C5C1E104JA01L	No	CAP CER 0.1UF 25V NP0 1206	Murata Electronics North America
C11	1	C1206C104K5RAC7867	No	CAP CER 0.1UF 50V X7R 1206	Kemet
D1, D2, D3, D4	4	DDSL01-030SL	No	TVS Diode 30VWM SOT23-3	STMicroelectronics
J2, J9, J10, J11, J12, J13, J14, J15, J16	9	112404	No	Conn BNC Jack Str 50 ohm PCB	Amphenol-RF Division
J19	1	6095	No	Jack Non-insulated Recessed Head	Keystone Electronics
R1, R2, R26, R42, R46, R47	6	CRCW120649R9FKEA	No	RES SMD 49.9 OHM 1% 1/4W 1206	Vishay Dale
R11, R12, R25, R31, R32, R33, R38, R39, R37, R40, R45, R41	10	CRCW12060000Z0EA	No	RES SMD 0.0 OHM JUMPER 1/4W 1206	Vishay Dale
R27, R44	2	CRCW12062R49FKEA	No	RES SMD 2.49 OHM 1% 1/4W 1206	Vishay Dale
R13, R19, R28, R34	4	CRCW120649R9FKEA	No	RES SMD 10K OHM 1% 1/4W 1206	Vishay Dale
R14, R16, R29, R35	4	CRCW12062K00FKEA	No	RES SMD 2K OHM 1% 1/4W 1206	Vishay Dale
R30, R43	2	CRCW12063K01FKEA	No	RES SMD 3.01K OHM 1% 1/4W 1206	Vishay Dale
R36	1	CRCW1206619RFKEA	No	RES SMD 619 OHM 1% 1/4W 1206	Vishay Dale
SW2, SW3, SW4	3	G13AP	No	SWITCH TOGGLE SPDT 0.4VA 28V	NKK
T1, T2	2	TT1-6+	No	RF Transformer 1:1 50R	Mini-Circuit

Reference Designator	Qty	Manufacturer Part	Assembled	Description	Manufacturer
TP3, TP22, TP23, TP24, TP25, TP26, TP27, TP28, TP29, TP30, TP31, TP32, TP33, TP34, TP36, TP37	16	1514-2	No	Terminal Turret Double 0.109" L	Keystone
JP1	1	22284023	No	CONN HEADER 2POS.100 VERT GOLD	Molex, LLC
XJP1	1	969102-0000-DA	No	SHUNT JUMPER 1" BLACK GOLD	3M

3.3 ISL15102IRZ-EVAL Board Layout

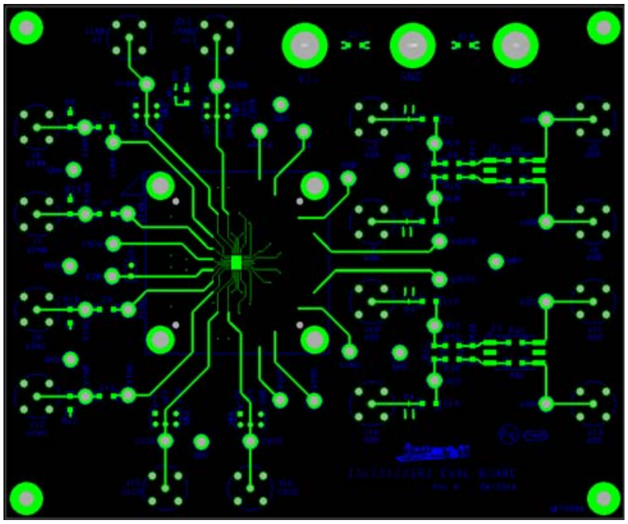

Figure 3. Top Layer

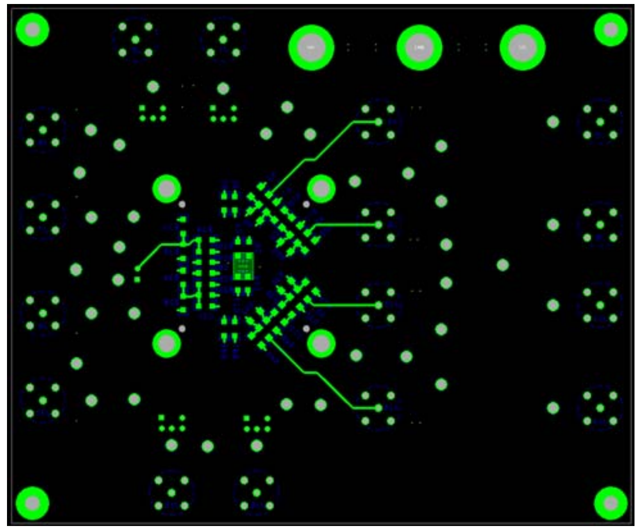

Figure 4. Bottom Layer

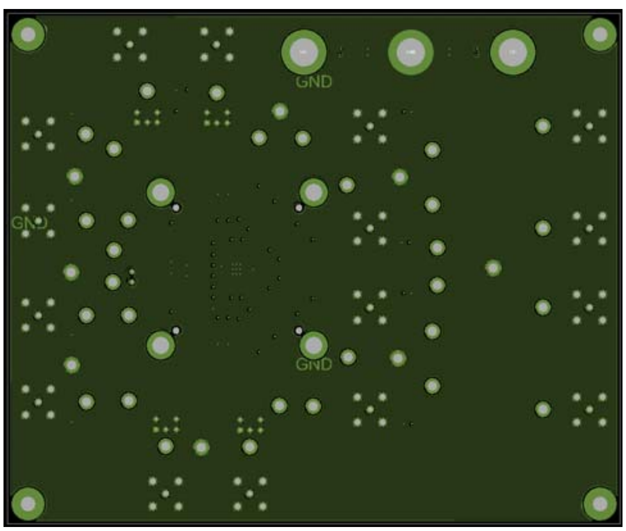

Figure 5. Ground Layer

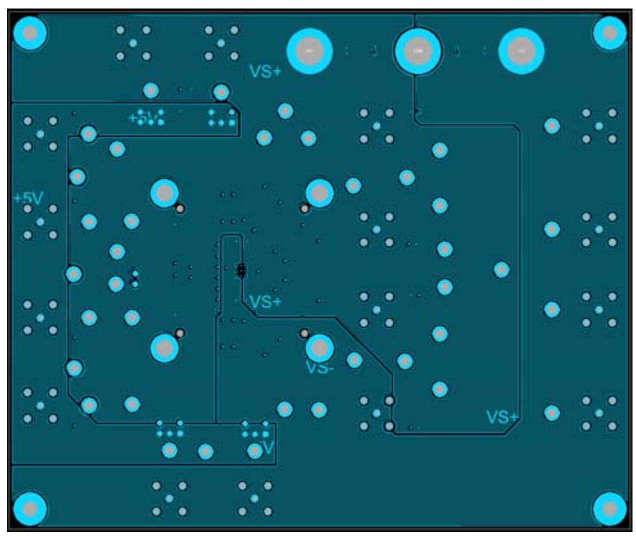

Figure 6. Power Layer

4. Typical Performance Curves

V_S+ = +12V, R_F = 4.22kΩ, A_V = 10V/V differential, R_L = 50Ω differential, TA = +25°C, DIS = 0V

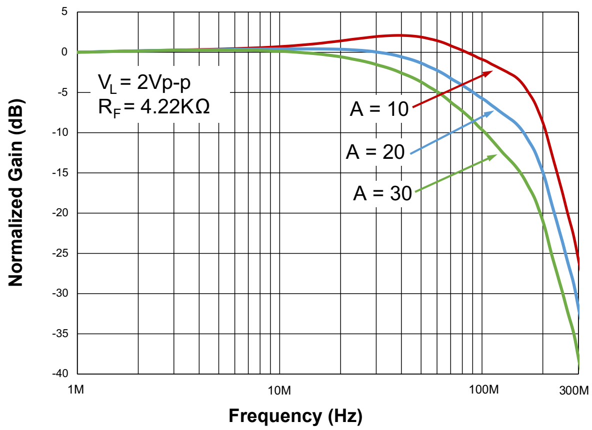

Figure 7. Small Signal Frequency Response vs Gain

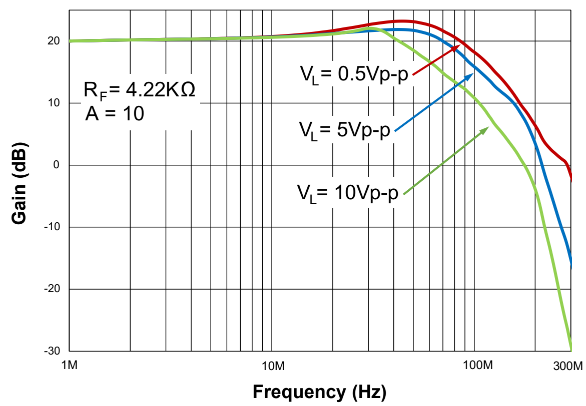

Figure 8. Large Signal Frequency Response

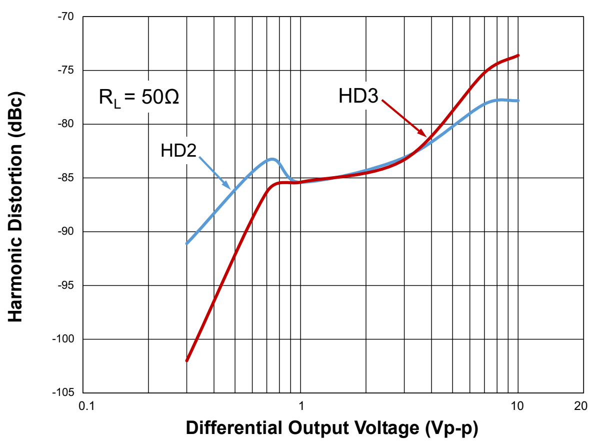

Figure 9. 1MHz Harmonic Distortion vs Output Swing

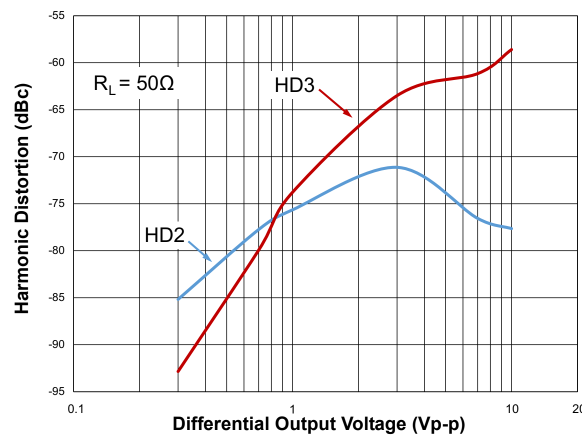

Figure 10. 4MHz Harmonic Distortion vs Output Swing

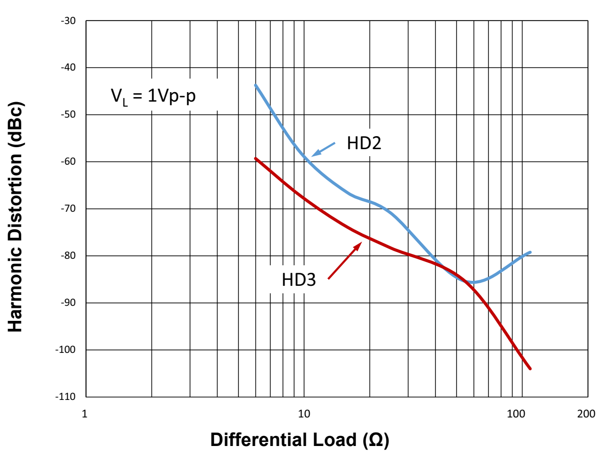

Figure 11. 1MHz Harmonic Distortion vs Load

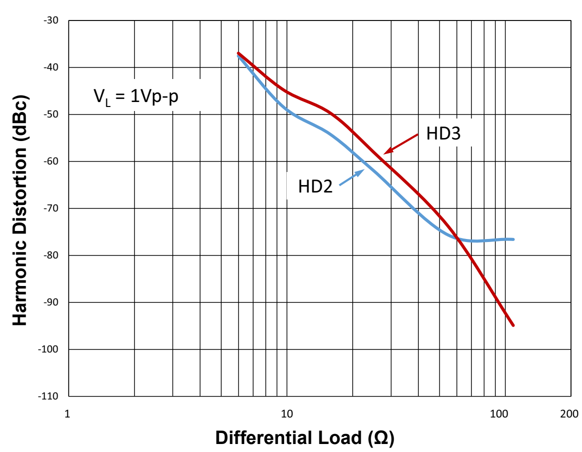

Figure 12. 4MHz Harmonic Distortion vs Load

V_S+ = +12V, R_F = 4.22kΩ, A_V = 10V/V differential, R_L = 50Ω differential, TA = +25°C, DIS = 0V **(Continued)**

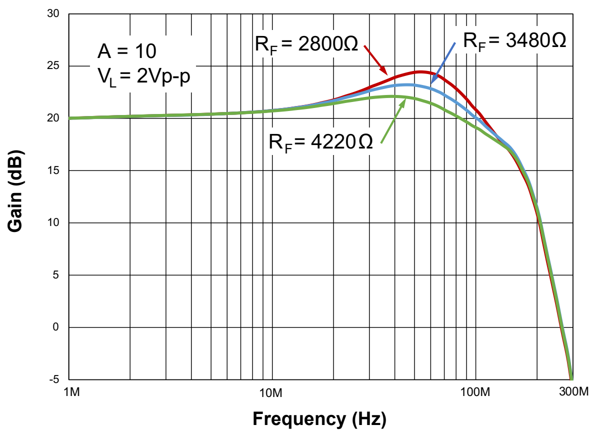

Figure 13. Small Signal Frequency Response vs R_F

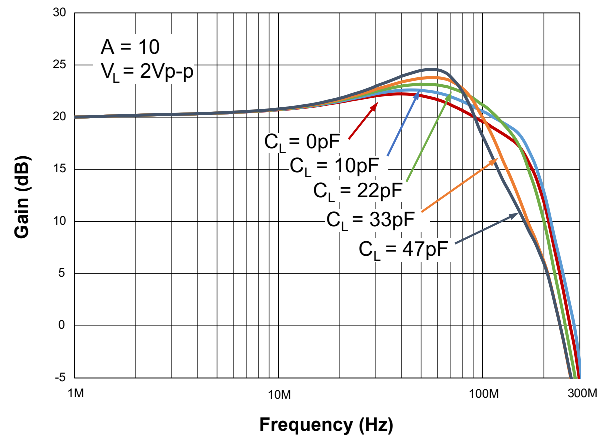

Figure 14. Small Signal Frequency Response vs C_{LOAD}

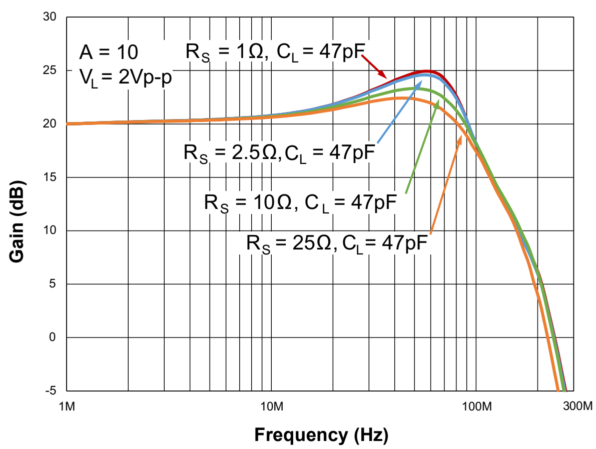

Figure 15. Small Signal Frequency Response vs R_S and C_{LOAD}

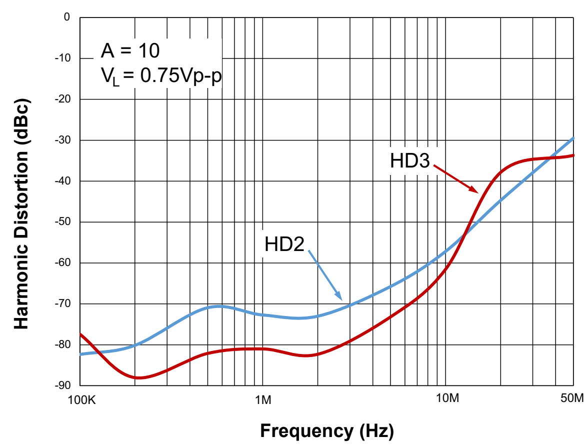

Figure 16. Harmonic Distortion vs Frequency

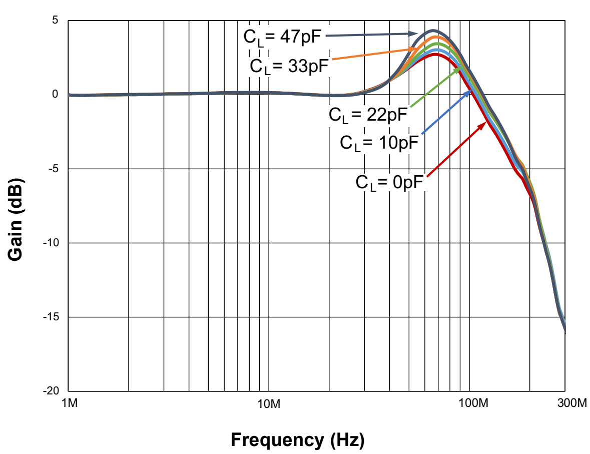

Figure 17. Common-Mode Small Signal Frequency Response vs C_{LOAD}

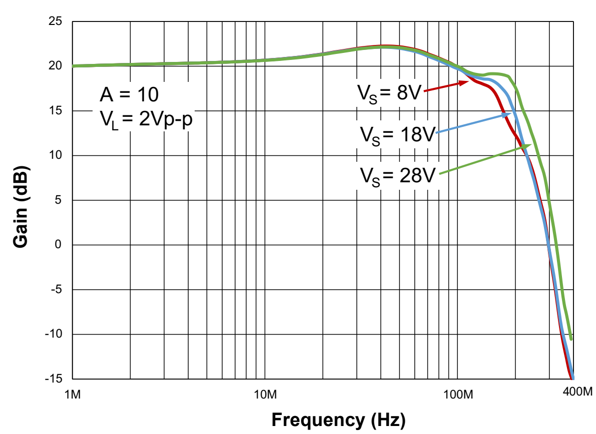

Figure 18. Small Signal Frequency Response vs Supply Voltage

V_S+ = +12V, R_F = 4.22kΩ, A_V = 10V/V differential, R_L = 50Ω differential, TA = +25°C, DIS = 0V **(Continued)**

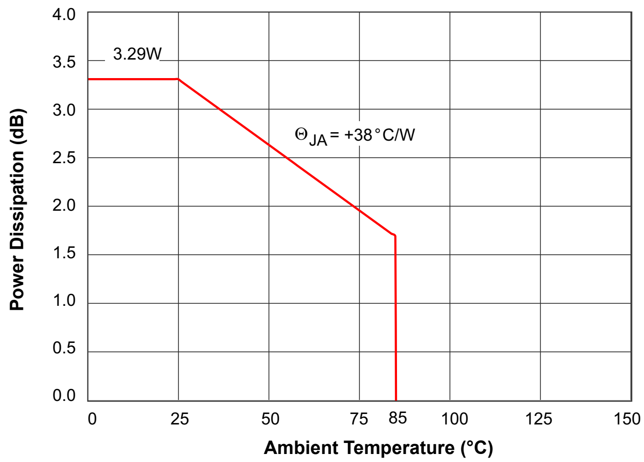

Figure 19. Package Power Dissipation vs Ambient Temperature

5. Revision History

Rev.	Date	Description
0.00	Nov 15, 2017	Initial release

ISL15102IRZ-EVALZ