

Description

The ISL29501-ST-EV1Z is a distance measurement reference design. It combines the [ISL29501](#) chip with an OSRAM SFH 4550 IR emitting LED and OSRAM SFH 213FA photodiode. The circuit board is enclosed in an opaque plastic chassis designed to optically isolate components. Included is a USB flash drive containing the evaluation software for a PC and related technical documents.

The ISL29501-ST-EV1Z board also allows quick evaluation of the ISL29501 performance for a 2m sensing system.

Specifications

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

- Micro USB 2.0 connection
- $V_{IN} = 5V$ (USB Power)
- I_{DD} maximum = 225mA
- P optical maximum = 70mW
- Wavelength = 860nm
- Optical duty cycle maximum = 50%
- Emission angle = $\pm 3^\circ$
- Coherent light - No

Key Features

- Self contained measurement system
- Enables proximity detection and distance measurement
- Emitter DAC with programmable current up to 255mA
- Operates in continuous or single shot mode
- On-chip active ambient light rejection
- Regulated power 2.7V to 3.3V USB or external supply
- I²C interface supporting 1.8V and 3.3V bus

References

- [ISL29501](#) Datasheet
- [AN1966](#), "ISL29501 Sand Tiger Optics Application Note"
- [AN1917](#), "ISL29501 Layout Design Guide"
- [UG054](#), "ISL29501 Evaluation Software User Guide"
- [AN1967](#), "Temperature and Ambient Light Data Collection"

Ordering Information

PART NUMBER	DESCRIPTION
ISL29501-ST-EV1Z	ISL29501 Sand Tiger demonstration kit, (EVB, USB cable, software, technical documentation)

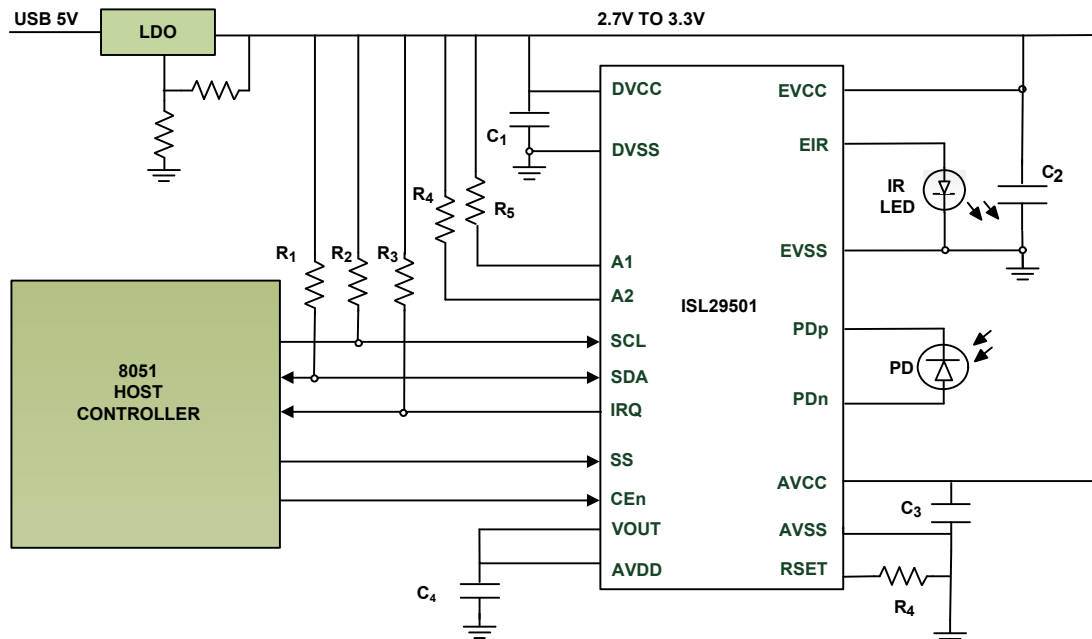


FIGURE 1. SAND TIGER BLOCK DIAGRAM

Functional Description

The ISL29501-ST-EV1Z is both a reference design and demonstration board that provides a single platform to demonstrate the features of the ISL29501. The ISL29501-ST-EV1Z circuit board and supplied enclosure have been designed to deliver maximum electrical and optical performance.

The system sends out light pulses through the emitter LED and receives returned light pulses that reflected off a target. The difference in phase of the emitted signal and the return signal is converted to distance by the ISL29501 and is graphed in the evaluation software. The magnitude of the return signal is graphed as well. This and additional data is available in chip registers, see UG054, "ISL29501 Evaluation Software User Guide" for additional details.

Operating Features

The ISL29501-ST-EV1Z demonstration board is shown in [Figures 4](#) and [5](#). The hardware enable function is controlled by a software switch, which can be overridden shorting J9 pins 1 and 2. See the schematic for details. A Power-Good (PG) LED indicates that the LDO is regulating properly.

External Power Supply

For high current/high duty cycle setups USB power may not be able to power the board. In the default condition, jumper J10 shorts pins 1 and 2 to connect to USB power to the LDO. To power the board with an external power supply, remove this jumper and connect the positive (+) terminal to J10-2 and the negative (-) to J10-4.

If you want to bypass the LDO and power the ISL29501 directly with a power supply, remove the jumper on J10. Use J10-4 for your ground connection and apply the positive voltage to TP7.

External Microprocessor

For debug of customer written software, it might be useful to connect the Sand Tiger to a different microprocessor. The I²C pins SCL and SDA are available on pins J4-4 and J4-3 respectively. The remaining support pins are available on J5: SS - J5-4, IRQ - J5-3 and CEn - J5-2. The support pins are generally connected to GP pins on the microprocessor. SCL and SDA are compatible with 1.8V microprocessors but unfortunately the support pins require 3V signaling.

System Calibration

Before meaningful measurements can be made the calibration registers in the chip need to be loaded. This can be done in two ways. The first is to load a profile that contains data into the GUI. This could be one of the Intersil provided profiles or one that was saved previously by the user. See UG054, "ISL29501 Evaluation Software User Guide" for further details. The second is to calibrate the board directly.

Calibrating Sand Tiger

There are 3 separate standard calibrations that need to be executed in order to calibrate the system. These are magnitude, crosstalk and distance calibrations.

MAGNITUDE CALIBRATION

Magnitude calibration is done after the emitter current and duty cycle settings are programmed. It is a dark (no light) calibration that takes less than 1s to run. Run this calibration from the GUI.

CROSSTALK CALIBRATION

Crosstalk is defined as a signal that reaches the ISL29501 chip directly without bouncing off the target. This can be electrical or optical. At close range and large return signal values, crosstalk has a minor impact on distance measurements. At the far end of the distance range the crosstalk might exceed the signal, adding error to measurements.

For this calibration the user makes a distance measurement with the return signal blocked from reaching the photodiode. This can be done in two ways. The first is to cover the emitter or photodiode optically preventing any of the emitted signal from reaching the photodiode. The second is to point the board toward infinity so there is no return signal. Care must be taken since small amounts of signal will be returned by objects up to 4 meters away. The emitting angle of the light is $\pm 3^\circ$ so you must be sure that there are no objects within this cone when doing this calibration.

Since the chip sees none of the emitted signal anything received is crosstalk. Run this calibration from the GUI after running Magnitude calibration.

DISTANCE CALIBRATION

Variation in delay of emitters, photodiodes and the ISL29501 will change the signal path delay. To compensate for this a reference point at a known distance needs to be established. This reference is calculated during distance calibration. The process involves making a distance measurement at a known distance. While it is not critical it is best to use a reference distance about 25% of the intended range. The GUI will write the correct registers that establish the reference distance inside the chip.

It is important that there are no objects inside the $\pm 3^\circ$ emitting angle other than the target.

Once these calibration registers are written, all succeeding distance will have this value subtracted real time from the measured value. Run this calibration from the GUI after running crosstalk calibration. See UG054, "ISL29501 Evaluation Software User Guide" for details on how to run the calibrations in the GUI.

Operating Range

The circuit board contains an LDO to convert the input voltage to the ISL29501 operating voltage range, 2.7V - 3.3V. By default the board is configured for USB power but can be alternately powered by an external power supply. The LDO resistors are ratioed to create a 3.0V power rail. All other set-up conditions can be configured through the chip registers and evaluation software.

PCB Layout Guidelines

The ISL29501-ST-EV1Z PCB layout has been optimized for electrical and thermal performance. Care needs to be placed in decoupling circuits and noise isolation. Sand Tiger follows good design techniques but additional suggestions are available in AN1917, "ISL29501 Layout Design Guide".

Quick Start Guide

To start making distance measurements follow these simple steps.

1. Plug the USB cable into the reference design and the PC.
2. Point the emitter toward the desired target.
3. Double click "TOF.exe" to start the GUI.
4. From the GUI do a File -> Load Profile -> filename to load safe initial register settings and calibration data.
5. Click either "Start" or "Step" to begin making distance measurements.

Changing Settings

Once the board is running and making measurements, the user may want to change settings. The user has the ability to change any of the chip registers with the evaluation software, see UG054, "ISL29501 Evaluation Software User Guide" for details. It is important to note that if the pulse duty cycle or the emitter current is changed, the user must redo the standard calibrations. This process is described in the sections under ["Calibrating Sand Tiger"](#).

Sand Tiger Enclosure

The Sand Tiger chassis is designed to allow easy handling of the board to make distance measurements. The threaded hole fits most camera tripod screws, which create a stable mount for precision measurements and characterization. The holes in the top isolate the emitter and photodiode to minimize optical crosstalk. The chassis top connects to the bottom with an interference fit. It is snug but the two can be easily separated by hand. Two threaded 4-40 holes are provided to allow attachment of glass. Shown on the side are a micro USB that connects to a PC to run the evaluation software and the power-good LED.



FIGURE 2. SAND TIGER CHASSIS



FIGURE 3. SAND TIGER CHASSIS WITH GLASS

ISL29501-ST-EV1Z Demonstration Board

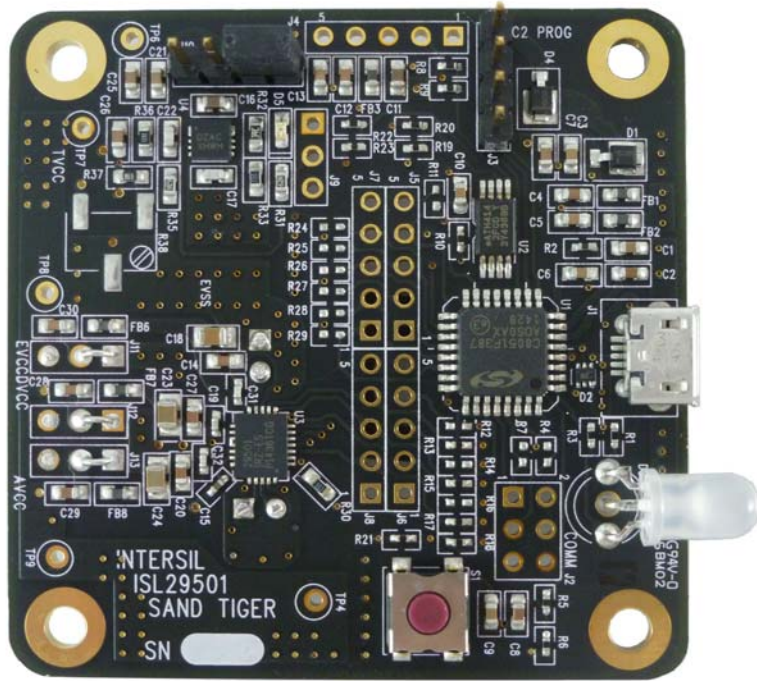


FIGURE 4. SAND TIGER BOARD TOP SIDE



FIGURE 5. SAND TIGER BOARD BOTTOM SIDE

NOTE: Visible on the bottom side of the board are the emitter LED and photodiode. Each is surrounded by a brass tube. These tubes are grounded and serve as terminators for any electric fields. They prevent crosstalk from the emitter to the photodiode.

ISL29501-ST-EV1Z Circuit Schematics

PCB TO HAVE BLACK MATTE SOLDERMASK ON BOTH SIDES.

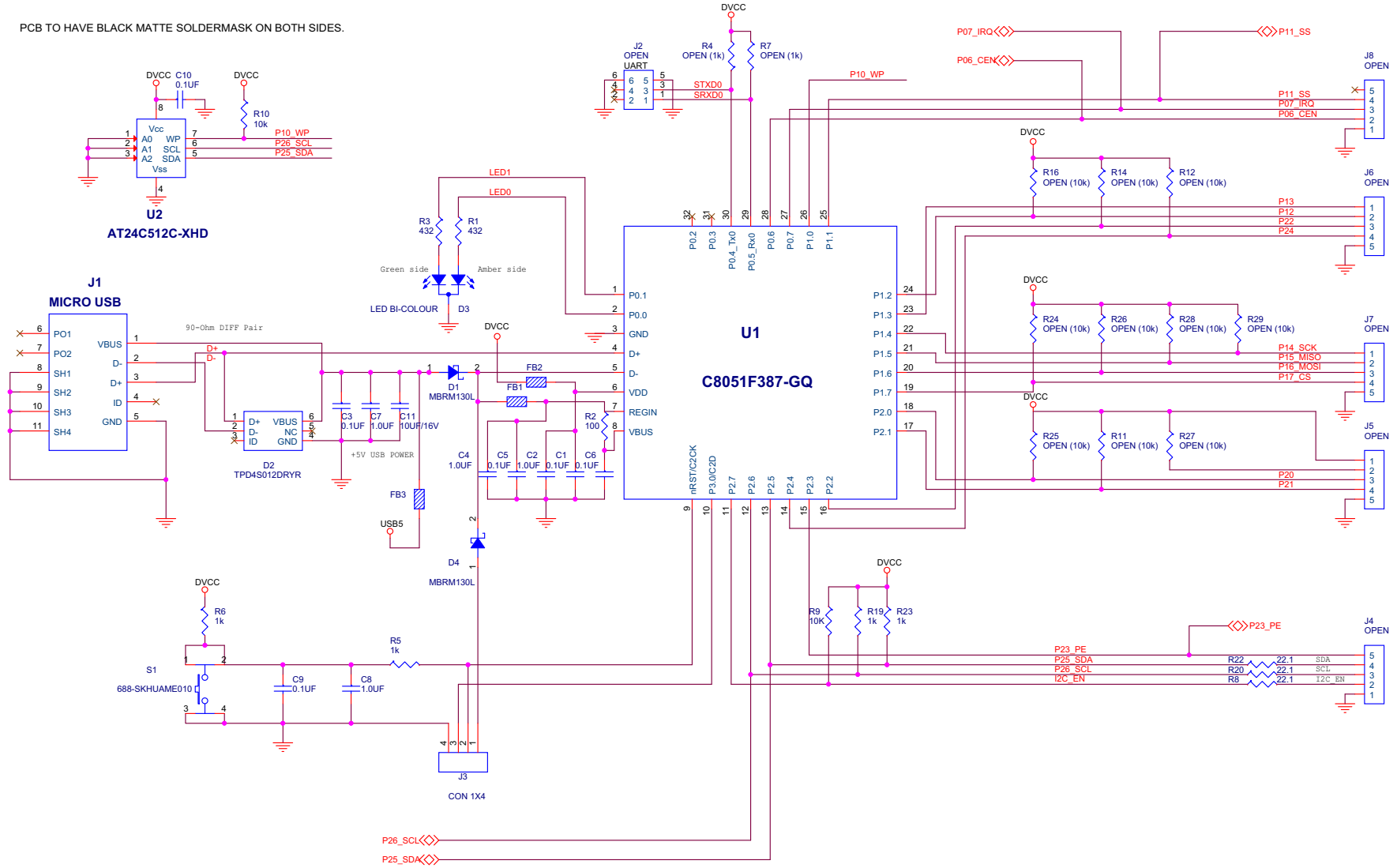


FIGURE 6. SAND TIGER SCHEMATIC CONTROL SHEET

ISL29501-ST-EV1Z Circuit Schematics (Continued)

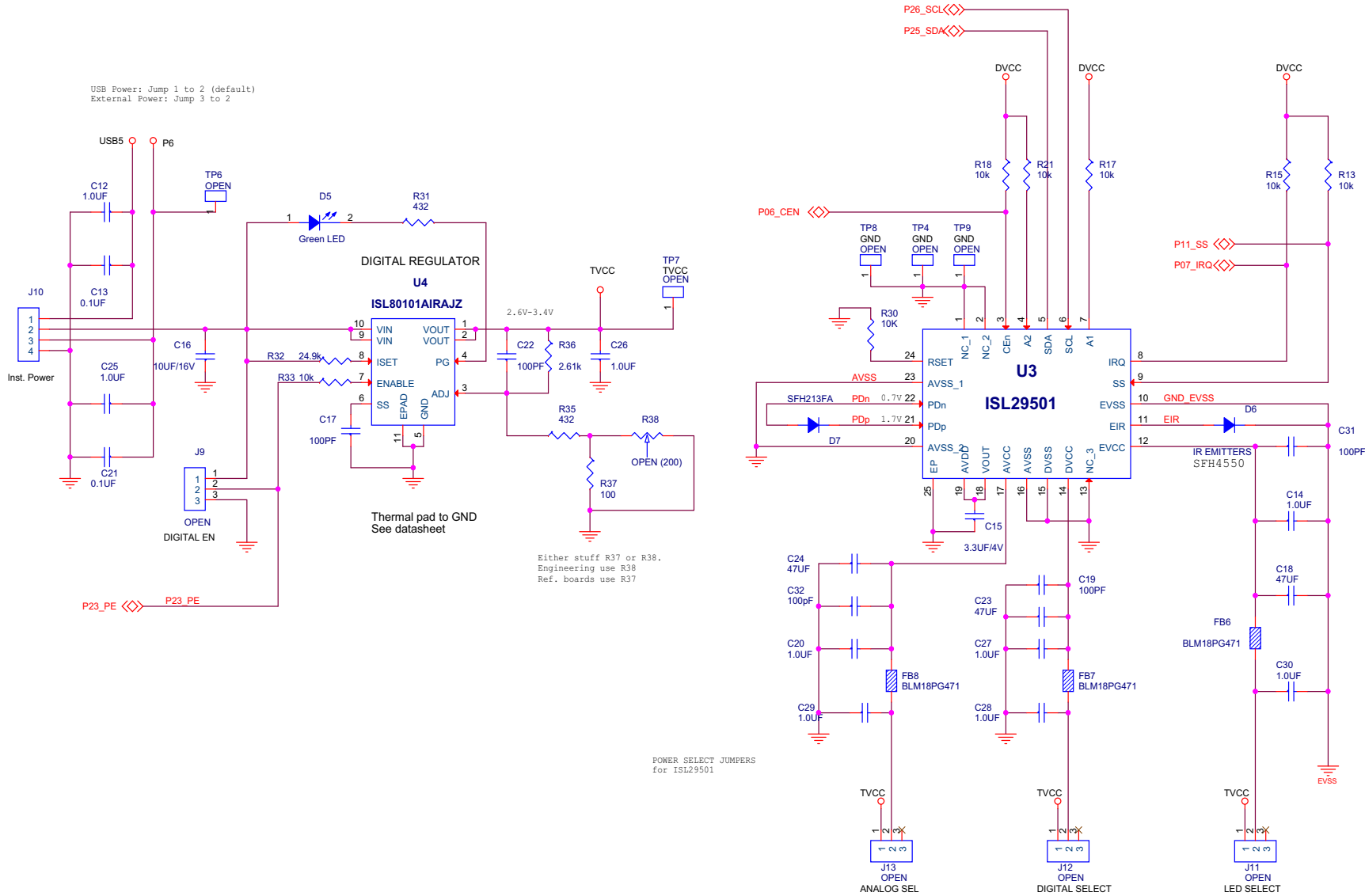


FIGURE 7. SAND TIGER SCHEMATIC - ISL29501 AND POWER

ISL29501-ST-EV1Z Bill of Materials

MANUFACTURER PART	QTY	UNIT	REFERENCE DESIGNATOR	DESCRIPTION	MANUFACTURER
ISL29501-ST-EV1ZREVCPCB	1	ea.		PWB-PCB-ISL29501-ST-EV1Z, REVC, ROHS	TBD
0402YA101KAT2A	3	ea.	C19, C31, C32	CAP, SMD, 0402, 100pF, 16V, 10%, NPO, ROHS	AVX
AMK105BJ335MV-F	1	ea.	C15	CAP, SMD, 0402, 3.3μF, 4V, 20%, X5R, ROHS	TAIYO YUDEN
ECJ-1VC1H101J	2	ea.	C17, C22	CAP, SMD, 0603, 100pF, 50V, 5%, C0G, ROHS	PANASONIC
GRM188R71E104KA01D	8	ea.	C1, C3, C5, C6, C9, C10, C13, C21	CAP, SMD, 0603, 0.1μF, 25V, 10%, X7R, ROHS	MURATA
0603ZC105KAT2A	13	ea.	a) C2, C4, C7, C8, C12, C14, C20, C25, C26, C27, C28, C29, C30	CAP, SMD, 0603, 1.0μF, 10V, 10%, X7R, ROHS	AVX
GRM188R61C106KAALD	2	ea.	C11, C16	CAP, SMD, 0603, 10μF, 16V, 10%, X5R, ROHS	MURATA
C2012X5R1A476M125AC	3	ea.	C18, C23, C24	CAP, SMD, 0805, 47μF, 10V, 20%, X5R, ROHS	TDK
1050170001	1	ea.	J1	CONN-RECEPTACLE, USB-MICRO B, SMD, 5 CONTACT, R/A, ROHS	MOLEX
68000-236HLF	2	ea.	J3, J10	CONN-HEADER, 1x4, BRKAWY 1x36, 2.54mm, ROHS	BERG/FCI
	3	ea.	J11-Pins1-2, J12-Pins1-2, J13-Pins1-2 ONLY	CONN-JUMPER, SOLDER SHORT,	
SPC02SYAN	1	ea.	J10-Pins 1-2	CONN-JUMPER, SHORTING, 2PIN, BLACK, GOLD, ROHS	SULLINS
MBRM130LT1G	2	ea.	D1, D4	DIODE-SCHOTTKY, 30V, 1A, SMD, 2P, DO-216AA, ROHS	ON SEMICONDUCTOR
LTST-C191KGKT	1	ea.	D5	LED, SMD, 0603, GREEN CLEAR, 2V, 20mA, 574nm, 35mcd, ROHS	LITEON/VISHAY
SFH4550	1	ea.	D6	LED-EMITTER IR, TH, T1 3/4, 1.5V, 100mA, 850nm, ROHS	OSRAM
SPR-54MVWF	1	ea.	D3 - *Leads should stand approximately two tenths off board and part is bent to right side before being soldered.	LED, TH, RND, 5mm, GREEN/RED, 2.1V/2V, 10mA, 10mcd/6.3mcd, ROHS	ROHM
BLM18PG471SN1D	6	ea.	FB1, FB2, FB3, FB6, FB7, FB8	FERRITE BEAD, SMD, 0603, 470Ω, 1A, 200mΩ, ROHS	MURATA
AT24C512C-XHD	1	ea.	U2	IC-2-WIRE SERIAL EEPROM, 8P, TSSOP, 1MHz, 512kBIT, ROHS	ATMEL
C8051F387-GQ	1	ea.	U1	C-USB MICROCONTROLLER, 32P, LQFP, 8BIT, 48MIPS, ROHS	SILICON LABORATORIES
ISL29501IRZ-T7	1	ea.	U3	IC-TOF SIGNAL PROCESSOR, 24P, QFN, ROHS	INTERSIL

ISL29501-ST-EV1Z Bill of Materials (Continued)

MANUFACTURER PART	QTY	UNIT	REFERENCE DESIGNATOR	DESCRIPTION	MANUFACTURER
ISL80101AIRAJZ	1	ea.	U4	IC-1A LDO ADJ.VOLT REGULATOR, 10P, DFN, 3x3, ROHS	INTERSIL
TPD4S012DRYR	1	ea.	D2	IC-TVS, 4-CHANNEL ESD SOLUTION, 6P, SON6, ROHS	TEXAS INSTRUMENTS
CR0402-16W-1000FT	1	ea.	R2	RES, SMD, 0402, 100Ω, 1/16W, 1%, TF, ROHS	VENKEL
CR0402-16W-102JT	4	ea.	R5, R6, R19, R23	RES, SMD, 0402, 1k, 1/16W, 1%, TF, ROHS	VENKEL
ERJ-2RKF1002X	7	ea.	R9, R10, R13, R15, R17, R18, R21	RES, SMD, 0402, 10k, 1/16W, 1%, TF, ROHS	PANASONIC
RC0402FR-0722R1L	3	ea.	R8, R20, R22	RES, SMD, 0402, 22.1Ω, 1/16W, 1%, TF, ROHS	YAGEO
CR0402-16W-4320FT	2	ea.	R1, R3	RES, SMD, 0402, 432Ω, 1/16W, 1%, TF, ROHS	VENKEL
	0	ea.	a) R4, R7, R11, R12, R14, R16, R24, R25, R26,	RES, SMD, 0402, DNP, DNP, DNP, TF, ROHS	
	0	ea.	b) R27, R28, R29	RES, SMD, 0402, DNP, DNP, DNP, TF, ROHS	
CR0603-10W-1000FT	1	ea.	R37	RES, SMD, 0603, 100Ω, 1/10W, 1%, TF, ROHS	VENKEL
CR0603-10W-1002FT	2	ea.	R30, R33	RES, SMD, 0603, 10k, 1/10W, 1%, TF, ROHS	VENKEL
ERJ-3EKF2492V	1	ea.	R32	RES, SMD, 0603, 24.9k, 1/10W, 1%, TF, ROHS	PANASONIC
CR0603-10W-2611FT	1	ea.	R36	RES, SMD, 0603, 2.61k, 1/10W, 1%, TF, ROHS	VENKEL
RC0603FR-07432RL(PbFREE)	2	ea.	R31, R35	RES, SMD, 0603, 432Ω, 1/10W, 1%, TF, ROHS	YAGEO
SKHUAME010	1	ea.	S1	SWITCH-TACTILE, SMD, 6.3x6.2, 12V, 50mA, 2.6N, 260gf, ROHS	ALPS ELECTRIC INC
3025010-03	1	ea.	BAG & SHIP W/BOARD	CABLE-USB TYPE A MALE to TYPE MICRO-B MALE, 3FT, ROHS	QUALTEK ELECTRONICS
ISL29501-ST-EZCHASSISBOM	1	ea.	COMPLETED ASSEMBLY	PWB-ASSY, ISL29501-ST-EV1ZCHASSIS, ROHS	INTERSIL
212403-013	1	ea.	Place assy in bag	BAG, STATIC, 5x8, ZIPLOC, ROHS	INTERSIL
	0	ea.	J2, J4, J5, J6, J7, J8, J9	DO NOT POPULATE OR PURCHASE	
	0	ea.	R38	DO NOT POPULATE OR PURCHASE	
	0	ea.	TP4, TP6, TP7, TP8 (5001)	DO NOT POPULATE OR PURCHASE	
LABEL-DATE CODE	1	ea.	AFFIX TO BACK OF PCB	LABEL-DATE CODE_LINE 1: YRWK/REV#, LINE 2: BOM NAME	INTERSIL
SFH213-FA	1	ea.	D7	IC-PHOTODIODE, RADIAL, 2P, 5mm, 50V, 900nm, 1nA, ROHS	OSRAM

Chassis Bill of Materials

MANUFACTURER PART	QTY	UNIT	REFERENCE DESIGNATOR	DESCRIPTION	MANUFACTURER
ISL29501-ST-EV1ZFG	1	ea.	ASSY INSTRUCTIONS	PWB-FG, ISL29501-ST-EV1Z, ROHS	INTERSIL
92185A105	2	ea.	PCB TO CHASSIS BOTTOM	SCREW, 4-40x3/16in, SOCKET HEAD, CAP, SS, ROHS	MCMaster-CARR
29501-01-08	1	ea.	SANDTIGER-CHASSISBOTTOM	CHASSIS BOTTOM, 2.5x2.5, ACETAL HOMOPOLYMER, BLK, ROHS	PROTOLABS
29501-02-05	1	ea.	SANDTIGER-CHASSISTOP	CHASSIS TOP, 2.5x2.5, ACETAL HOMOPOLYMER, BLK, ROHS	PROTOLABS
4701-60-20031-04	1	ea.	D6, D7 (PCB) GASKET	GASKET-URETHANE FOAM, VERY FIRM, BLK, CUSTOM CUT 28.5x14.6mm	ROGERS CORP.
6035-04BR219	4	ea.	a) CHASSIS TOP	HARDWARE, ULTRASERT II-LONG, 4-40, 0.219x0.172, BRASS, ROHS	DODGE INSERTS
6035-04BR219	0	ea.	b) CHASSIS BOTTOM	HARDWARE, ULTRASERT II-LONG, 4-40, 0.219x0.172, BRASS, ROHS	DODGE INSERTS
6035-4BR300	1	ea.	CHASSIS BOTTOM SIDE HOLE	HARDWARE, ULTRASERT II-SHORT, 1/4-20, 0.30x0.375, BRASS, ROHS	DODGE INSERTS
ASSEMBLY INSTRUCTIONS	0	ea.	a) Ensure J1 (USB connector) and D5 (LED) are facing the side opening in CHASSIS BOTTOM when PCB is mounted face down.	Instructions for assembly.	INTERSIL
90145A473	2	ea.	CHASSIS BOTTOM TO PCB	HARDWARE, DOWEL PIN, 3/4x1/8, STAINLESS, ROHS	MCMaster-CARR
SANDTIGER-BRASSTUBE	2	ea.	D6, D7 (PCB)	TUBE-BRASS, Alloy#260/270, 1/2-3/4, Length 0.275, 0.250D, 0.238ID	K&S Precision Metals

Board Layout - 4 Layers

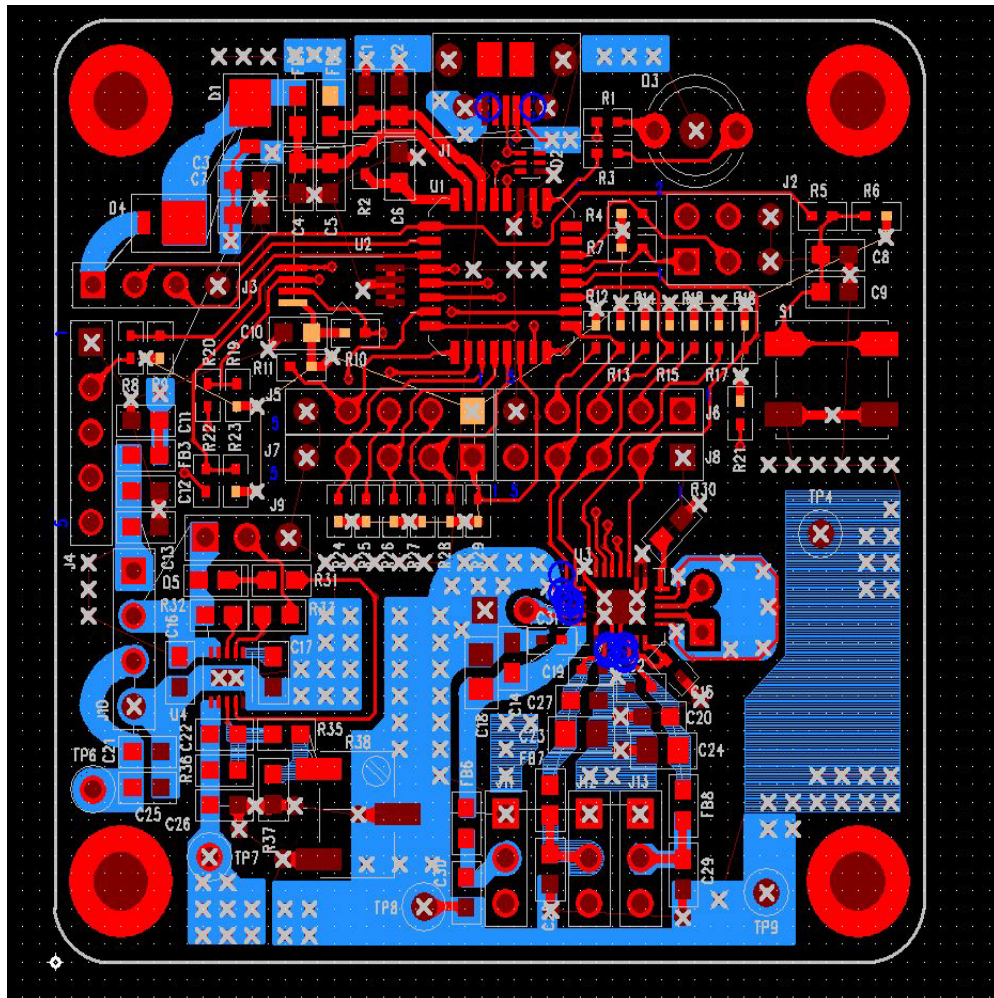


FIGURE 8. TOP LAYER

Board Layout - 4 Layers (Continued)

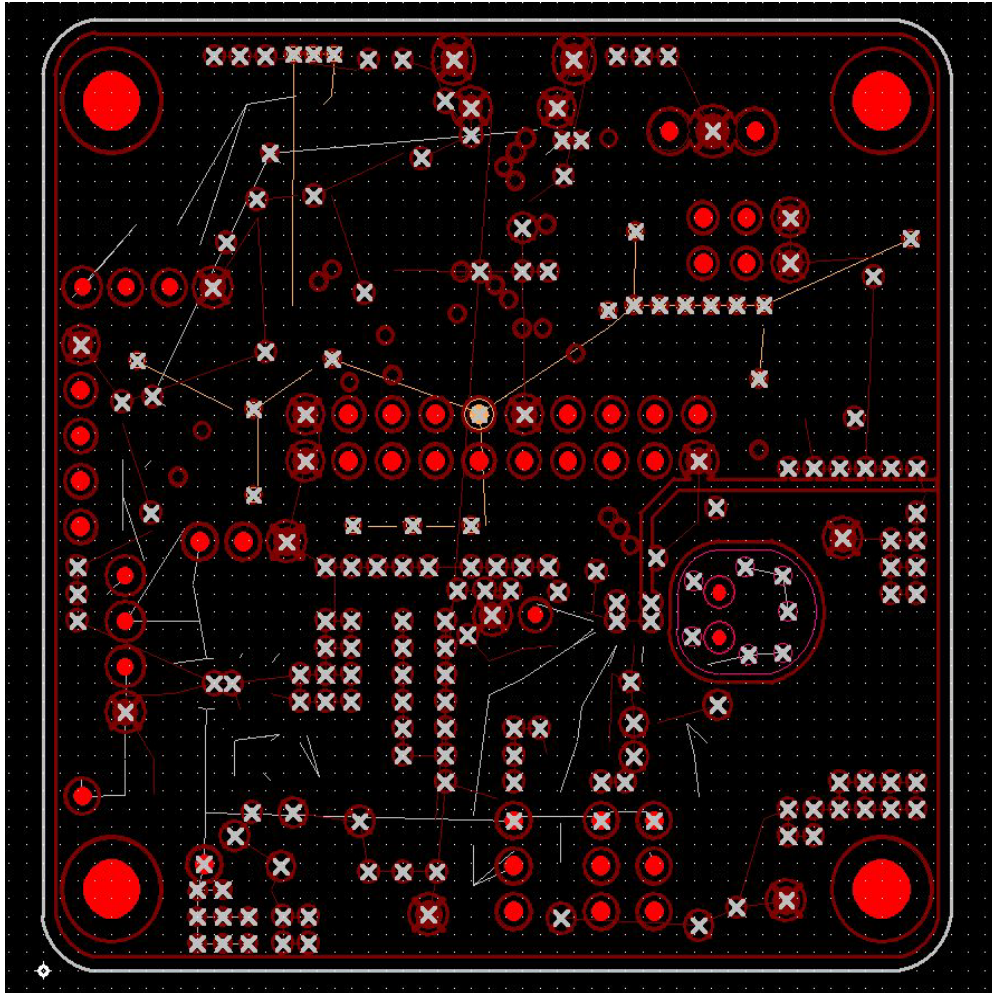


FIGURE 9. PCB - LAYER 2 (VIEWED FROM TOP)

Board Layout - 4 Layers (Continued)

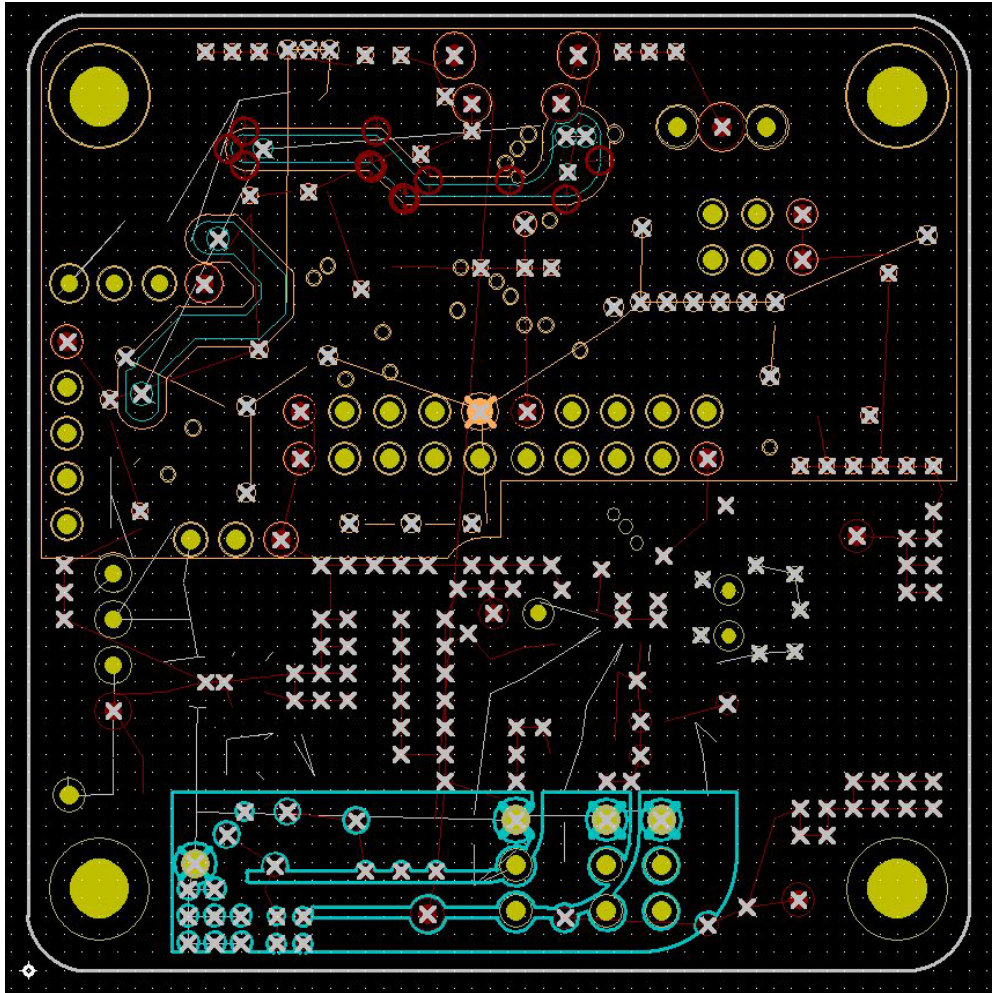


FIGURE 10. PCB - LAYER 3 (VIEWED FROM TOP)

Board Layout - 4 Layers (Continued)

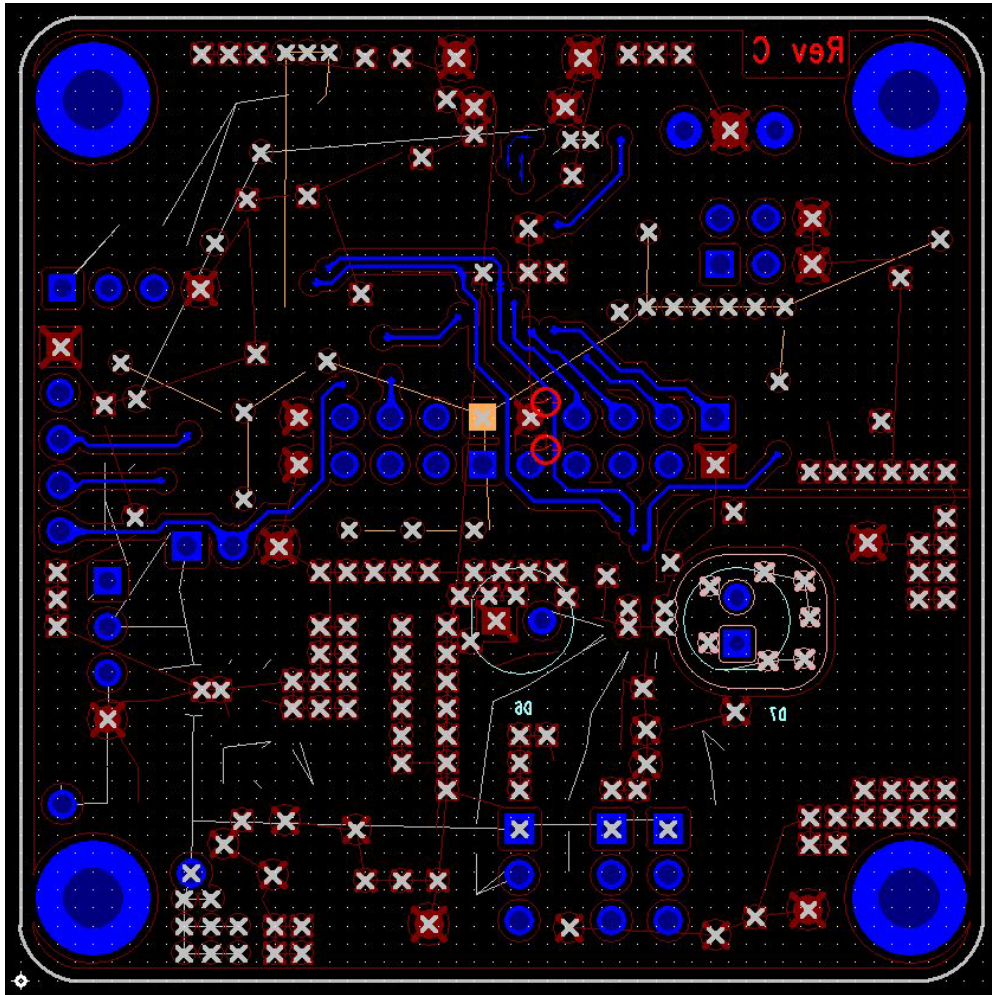


FIGURE 11. PCB - BOTTOM LAYER (VIEWED FROM TOP)

The measured distance will drift with changes in temperature as shown in [Figure 14 on page 14](#). The ISL29501 has temperature compensation built into the chip. This is an advanced calibration, which involves collecting temperature vs. distance data and programming the compensation registers. Initially Intersil will generate these coefficients from customer collected data. The process for collecting data is described in AN1967, "Temperature and Ambient Data Collection".

It is strongly recommended that customers should evaluate these parameters as a last step in their evaluation. To avoid temperature effects low integration times, reg 0x10 < 0x06 should be used.

Typical Performance Curves

USB Powered $V_{IN} = 5V$, $V_{reg} = 3.3V$, $T_A = +25^\circ C$, Sample size = 5, integration time = 140ms.



FIGURE 12. MEASURED vs ACTUAL DISTANCE

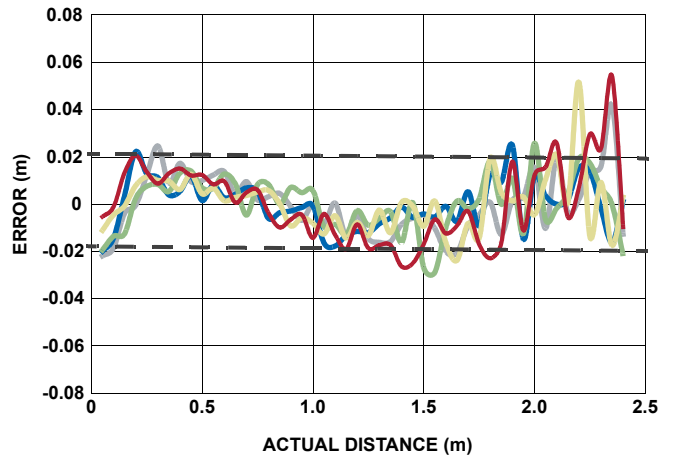


FIGURE 13. ERROR vs ACTUAL DISTANCE

Temperature Performance

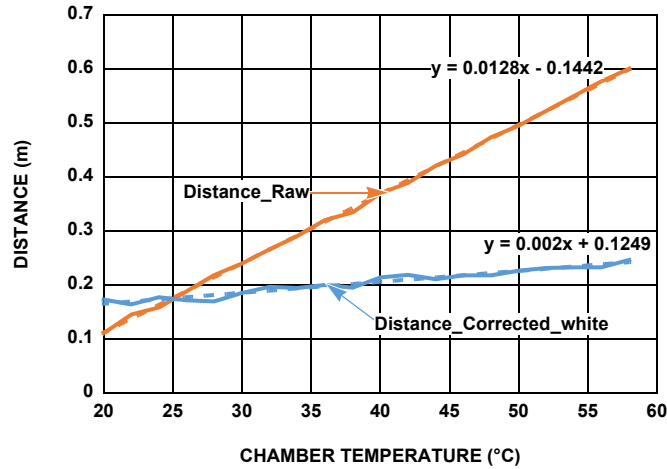


FIGURE 14. TEMPERATURE PERFORMANCE BEFORE AND AFTER CORRECTION

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