EVM User's Guide: DP83TC812-IND-SPE
DP83TC812-IND-SPE Evaluation Module

TEXAS INSTRUMENTS

Description

The DP83TC812-IND-SPE daughter card is a compact, two port, peripheral device designed to seamlessly integrate with the AM64x Evaluation Board. Engineered to enhance the evaluation process, the direct plug-in compatibility of DP83TC812-IND-SPE offers ease of integration and rapid deployment due to evaluate Single Pair Ethernet.
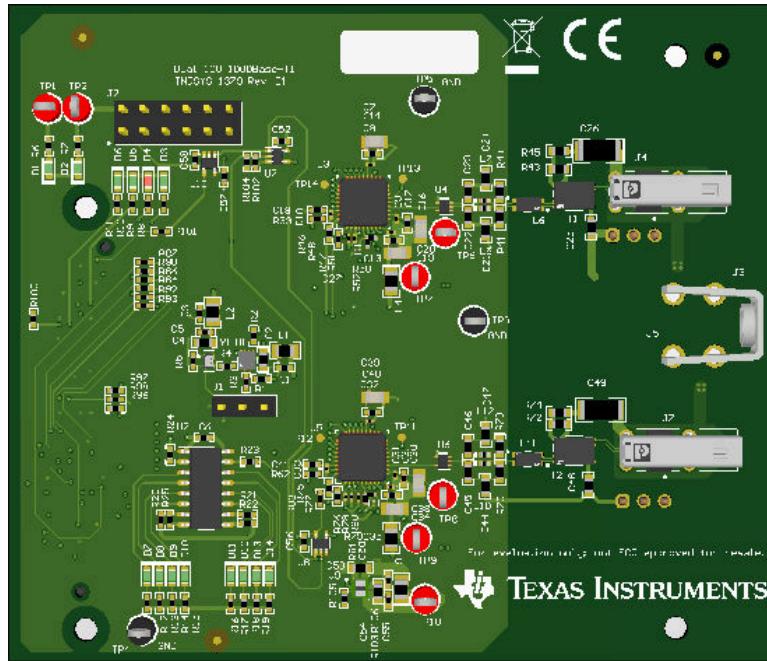
1 Features

The Sitara™ AM64x EVM Industrial Single-pair Ethernet PHY add-on board has the following features:

- 2x DP83TC812 gigabit SPE PHYs with RGMII interface
- 2x jack modular connector 2P2C single-pair Ethernet (SPE) 90° angle (right) shielded category B connector

Hardware Board

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2 Evaluation Module Overview

This user guide details how to properly operate and configure the DP83TC812-IND-SPE daughter card.

Preface: Read This First

2.1 Sitara MCU+ Academy

Texas Instruments offers the *MCU+ Academy* as a resource for designing with the MCU+ software and tools on supported devices. The MCU+ Academy features easy-to-use training modules that range from the basics of getting started to advanced development topics.

2.2 If You Need Assistance

If you have any feedback or questions, support for AM64x Sitara MCUs and the AM64x EVM industrial Ethernet PHY add-on board development kit is provided by the TI product information center (PIC) and the TI E2E™ Forum. Contact information for the PIC can be found on the TI website.

2.1 Introduction

The DP83TC812-IND-SPE daughter card was developed to enable additional Ethernet peripheral support on the AM64x Evaluation Board and allow for rapid prototyping of the Single Pair Ethernet for industrial Ethernet applications. This user guide details the design of the add-on board and how to properly use the interface.

2.2 Kit Contents

The DP83TC812-IND-SPE daughter card kit contains the following items:

• DP83TC812-IND-SPE daughter card

Not included:

• AM64x Evaluation Board

2.3 Specifications

The DP83TC812-IND-SPE daughter card serves as a tool to evaluate 1000Base-T1. Consult the DP83TC812 data sheet for more information.

2.4 Device Information

The DP83TC812-Q1 device is an IEEE 802.3bw compliant automotive PHYTER™ Ethernet physical-layer transceiver, which can work with an unshielded twisted-pair cable. The PHY supports TC10 sleep and wake features. PHY provides all physical layer functions necessary for transmitting and receiving data over unshielded, single, twisted-pair cables. The device provides xMII flexibility with support for standard MII, RMII, RGMII, and SGMII MAC interfaces. The PHY also integrates a low-pass filter on the MDI side to reduce emissions.

This device includes the Diagnostic Tool Kit, providing an extensive list of real-time monitoring tools, debug tools, and test modes. Within the tool kit is the first integrated electrostatic discharge (ESD) monitoring tool. The tool is capable of counting ESD events on MDI, as well as providing real-time monitoring through the use of a programmable interrupt. Additionally, the DP83TC812-Q1 includes a pseudo random binary sequence (PRBS) frame generation tool, which is fully compatible with internal loopbacks, to transmit and receive data without the use of a MAC. The device is housed in a 6.00mm × 6.00mm, 36-pin VQFN wettable flank package. This device is pin-to-pin compatible with DP83TG720 (1000BASE-T1). The device is also form factor compatible with DP83TC811. This allows for using a single PCB layout for DP83TC811, DP83TC812, DP83TC814, and DP83TG720.

For additional information, refer to the DP83TC812x-Q1 data sheet.

3 Hardware

3.1 Power Tree

The DP83TC812-IND-SPE AM64x daughter card is powered from a 3.3V input from the Samtec®
SEAM-30-02.0-S-04-2-A-K-TR 150-pin connector that interfaces the DP83TC812-IND-SPE daughter card with
the main AM64x EVM.

3.2 Test Points

The DP83TC812-IND-SPE is equipped with multiple test points for hardware debug and bench testing. Table 3-1
shows the test points on the board and the associated signal net.

Table 3-1. DP83TC812-IND-SPE Test Points

Test Point	Signal	Description
TP1	3V3_S	3.3V board supply
TP2	1V8_S	1.8V board supply
TP3	GND	Ground
TP4	GND	Ground
TP5	GND	Ground
TP6	3V3_FB_ETH0	3.3V supply to ETH0 PHY with ferrite bead and decoupling capacitors
TP7	1V0_XTIDA_FB_ETH0	1.0V supply to ETH0 PHY with ferrite bead and decoupling capacitors
TP8	3V3_FB_ETH1	3.3V supply to ETH1 PHY with ferrite bead and decoupling capacitors
TP9	1V0_XTIDA_FB_ETH1	1.0V supply to ETH1 PHY with ferrite bead and decoupling capacitors
TP10	1V0_XTIDA	1.0V output from step-down module
TP11	ETH1_RGMII_RX_CTL	RX_CTRL signal from ETH1
TP12	ETH1_RGMII_TX_CTL	TX_CTRL signal from ETH1
TP13	ETH0_RGMII_RX_CTL	RX_CTRL signal from ETH0
TP14	ETH0_RGMII_TX_CTL	TX_CTRL signal from ETH0

4 Hardware Design Files

4.1 Schematics

Figure 4-1 through Figure 4-4 show the EVM schematics.

Figure 4-1. ETH0

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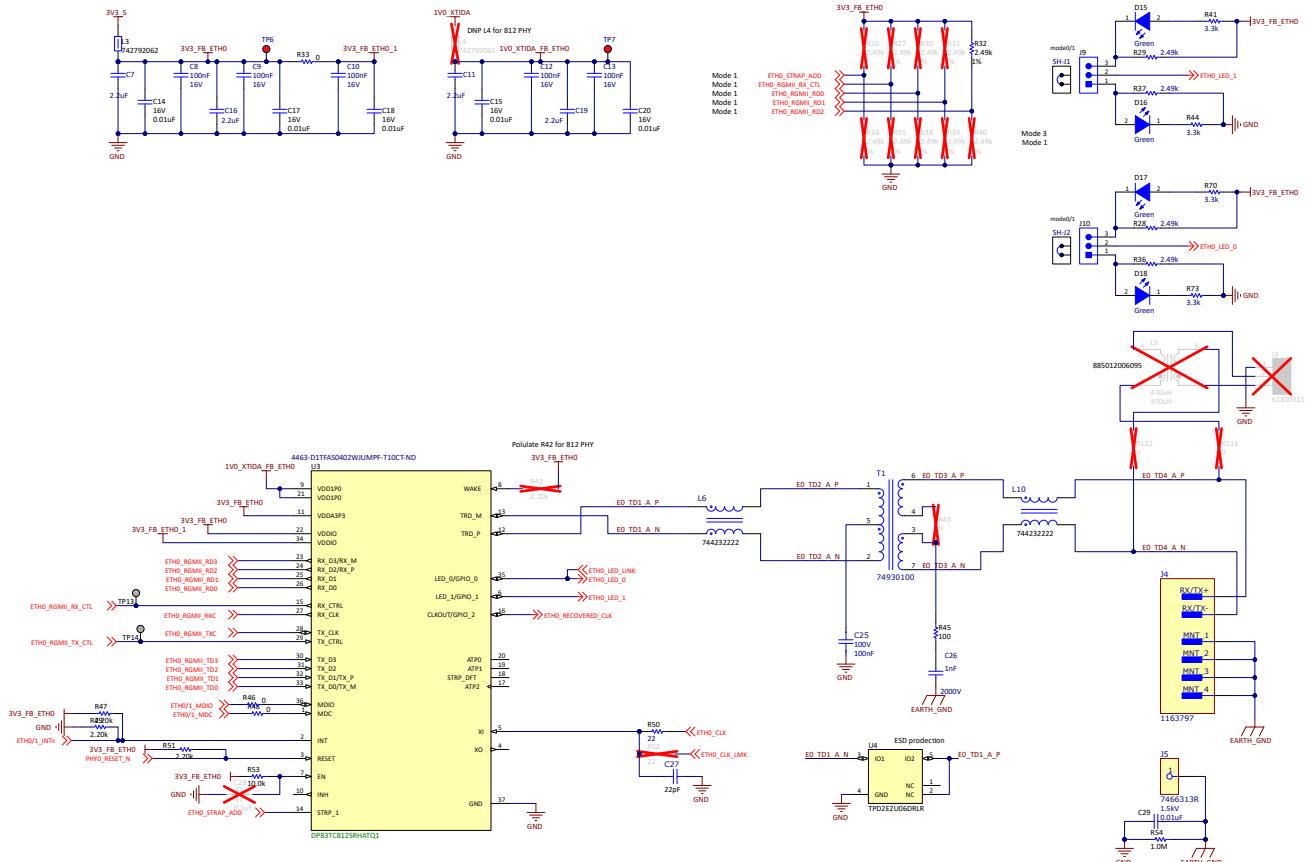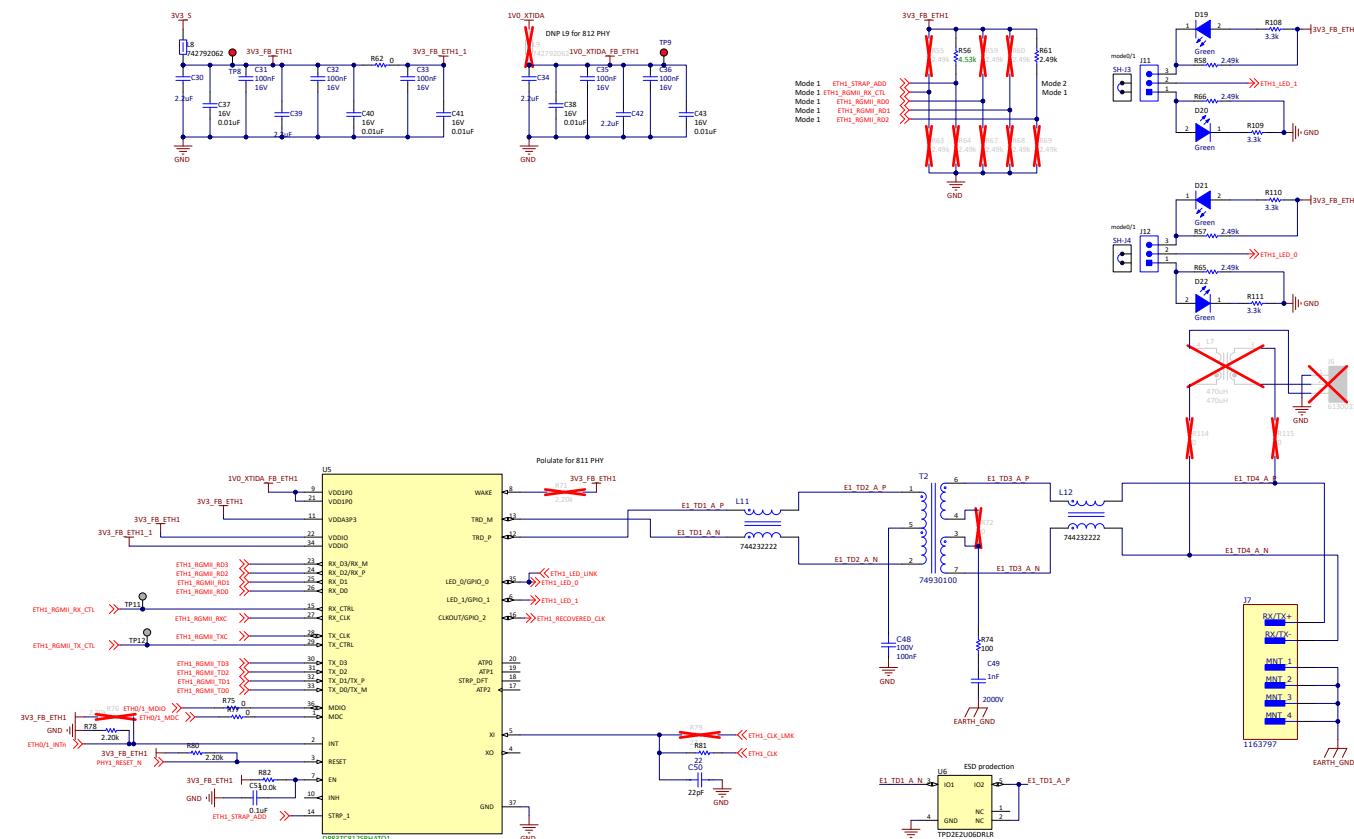
Figure 4-2. ETH1
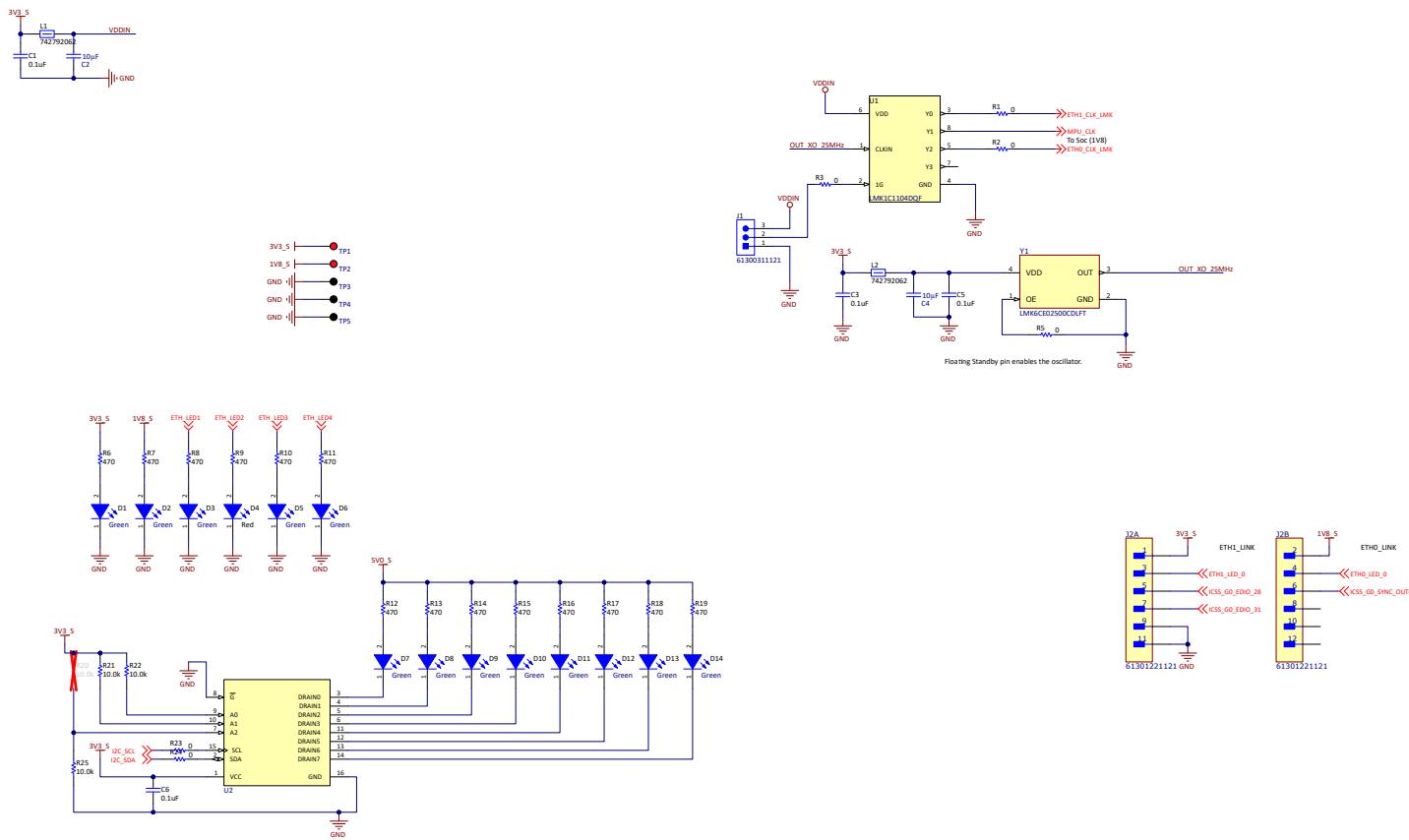
Figure 4-3. CLK_CFG
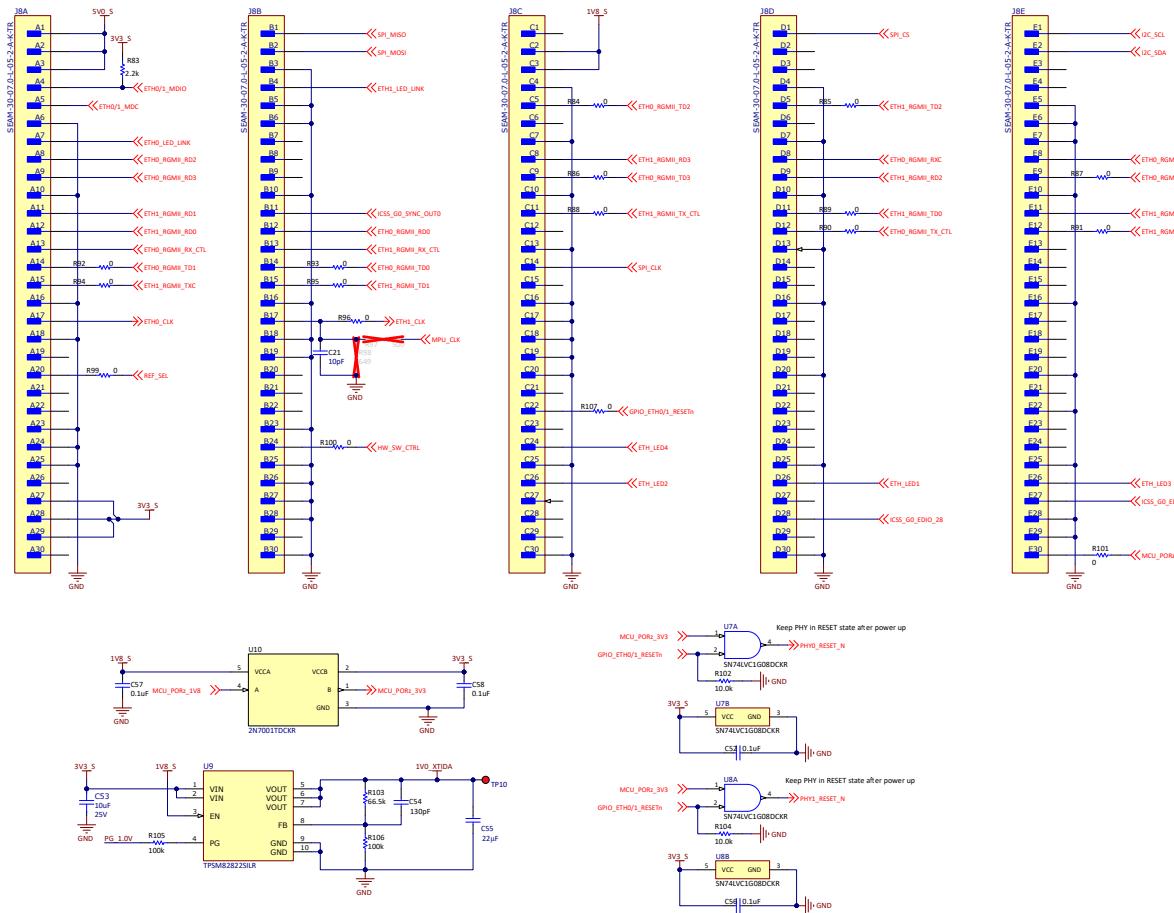
**Figure 4-4. Interface**

4.2 PCB Layout

through show the design of the DP83TC812-IND-SPE EVM using a six-layer PCB with 2oz copper thickness.
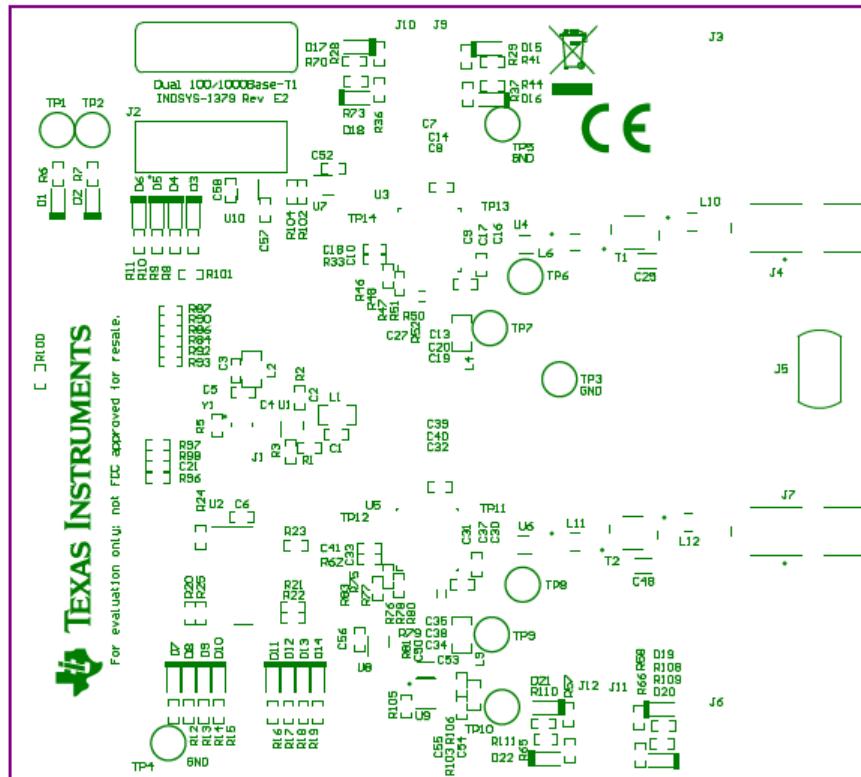
| ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: INDSYS-1379	REV: E2	SVN REV: Not in version control
LAYER NAME = Top Overlay	TID #: N/A		
PLOT NAME = Top Overlay	GENERATED : 9/30/2024 1:49:52 PM		TEXAS INSTRUMENTS

Figure 4-5. Top Overlay
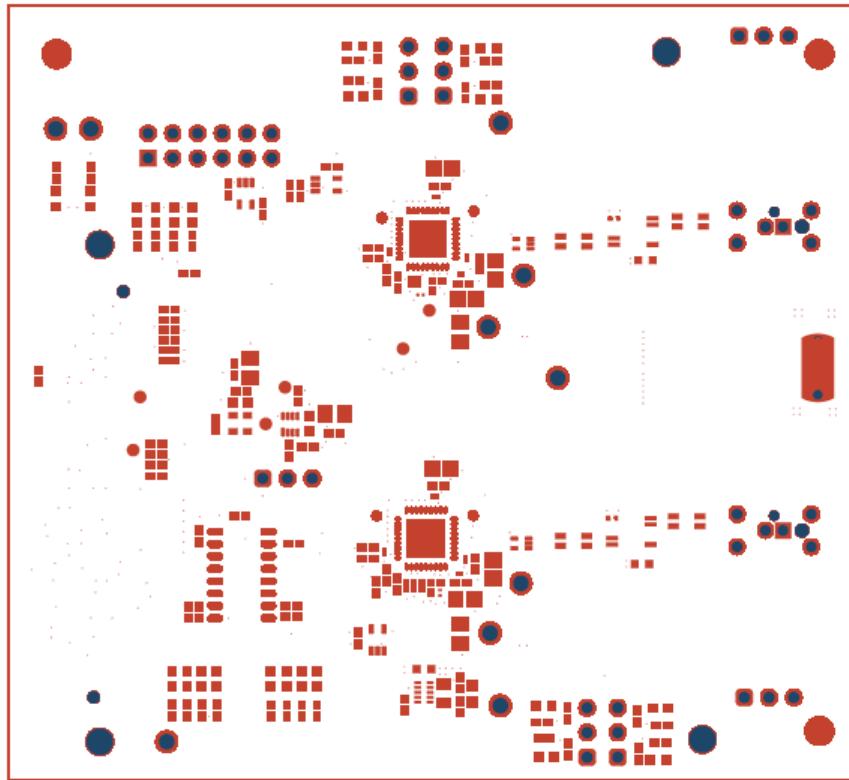
ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: INDSYS-1379	REV: E2	SVN REV: Not in version control
LAYER NAME = Top Solder	TID #: N/A		
PLOT NAME = Top Solder Mask	GENERATED : 9/30/2024 1:49:52 PM		TEXAS INSTRUMENTS

Figure 4-6. Top Solder
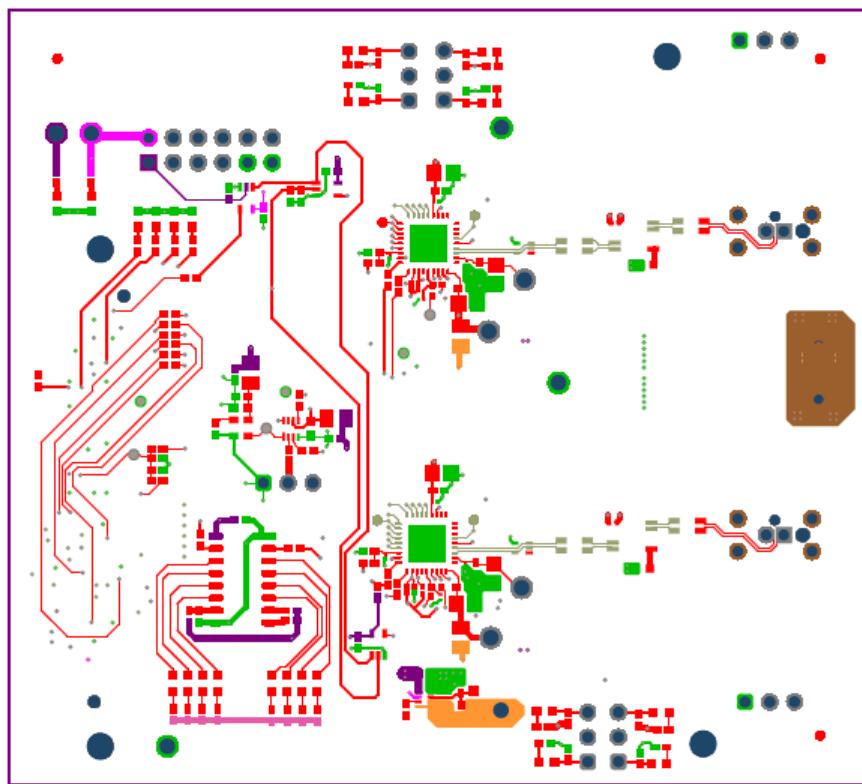
ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: INDSYS-1379	REV: E2	SVN REV: Not in version control
LAYER NAME = Layer 1	TID #: N/A		
PLOT NAME = Top Layer	GENERATED : 9/30/2024 1:49:52 PM		TEXAS INSTRUMENTS

Figure 4-7. Layer 1
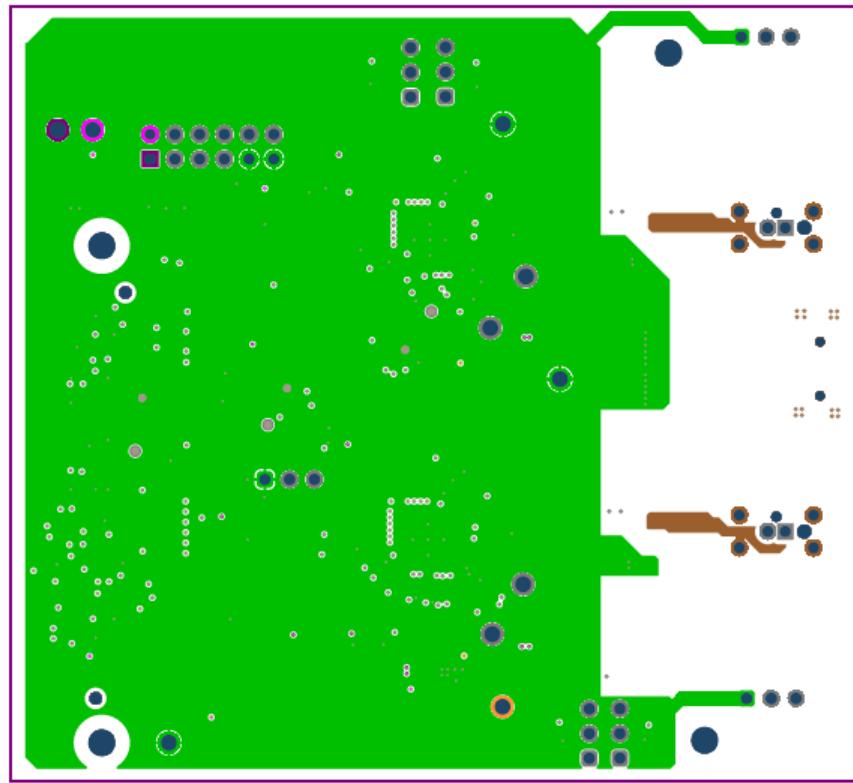
ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: INDSYS-1379	REV: E2	SVN REV: Not in version control
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PLOT NAME = Signal Layer 1	GENERATED : 9/30/2024 1:49:52 PM		TEXAS INSTRUMENTS

Figure 4-8. Layer 2
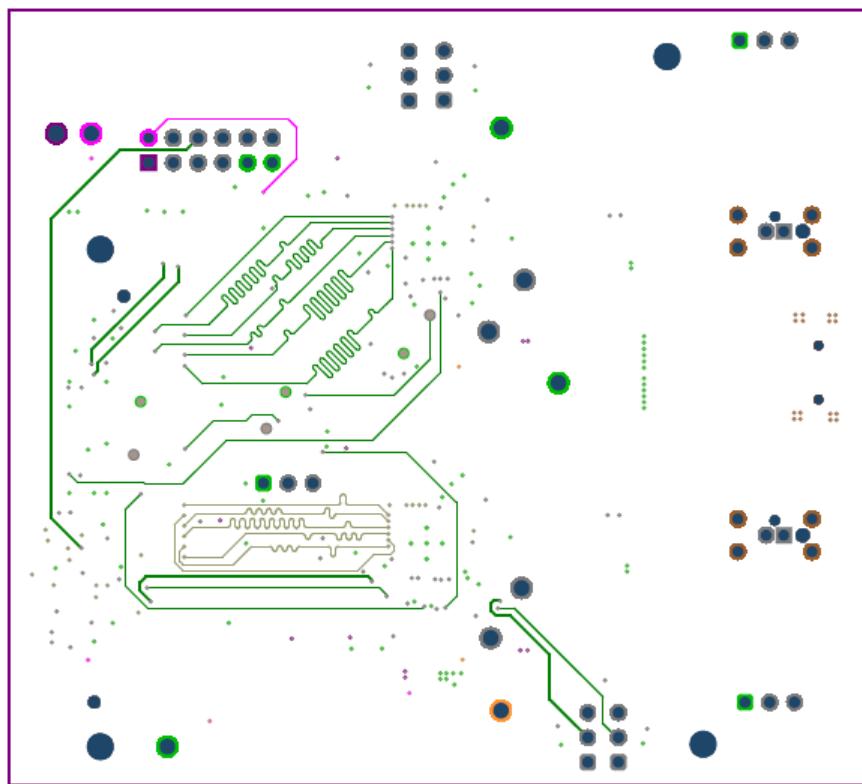
ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: INDSYS-1379	REV: E2	SVN REV: Not in version control
LAYER NAME = Layer 3	TID #: N/A		
PLOT NAME = Signal Layer 2	GENERATED : 9/30/2024 1:49:52 PM		TEXAS INSTRUMENTS

Figure 4-9. Layer 3
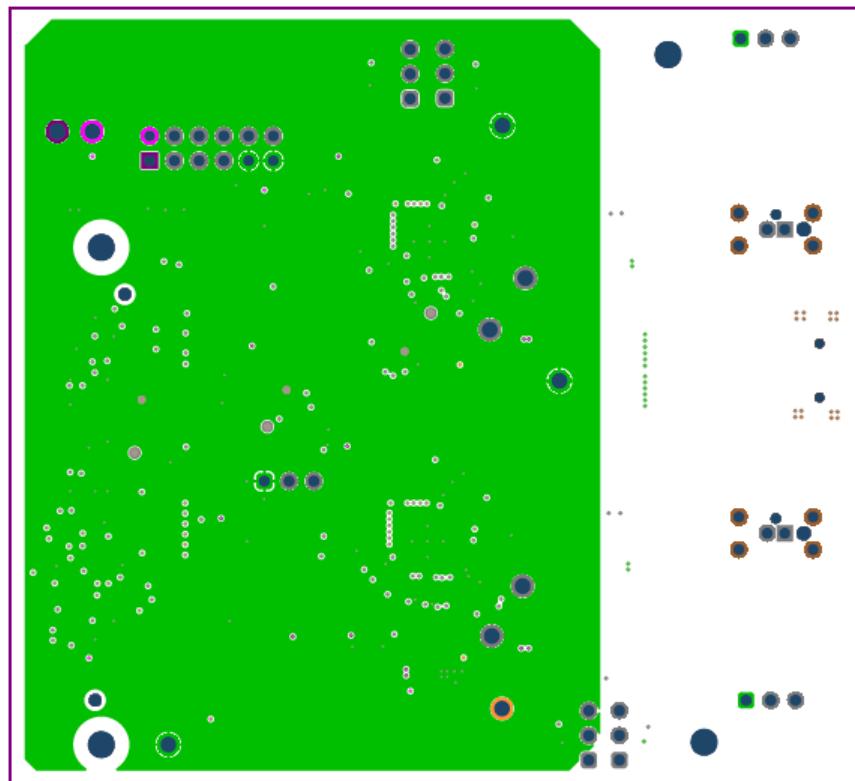
ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: INDSYS-1379	REV: E2	SVN REV: Not in version control
LAYER NAME = Layer 4	TID #: N/A		
PLOT NAME = Signal Layer 3	GENERATED : 9/30/2024 1:49:52 PM		TEXAS INSTRUMENTS

Figure 4-10. Layer 4
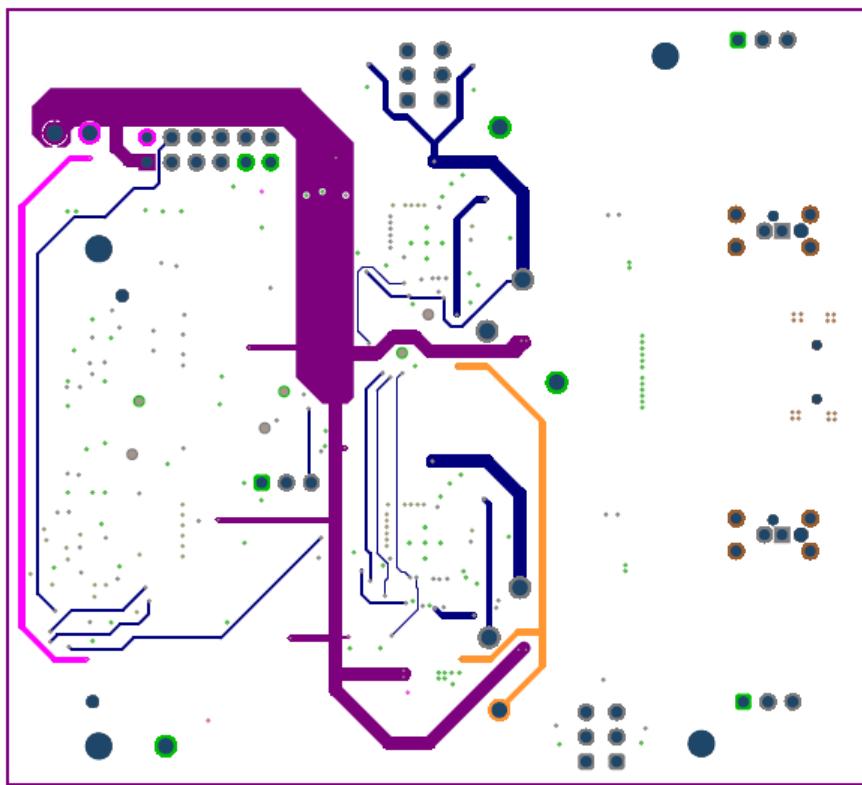
ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: INDSYS-1379	REV: E2	SVN REV: Not in version control
LAYER NAME = Layer 5	TID #: N/A		
PLOT NAME = Signal Layer 4	GENERATED : 9/30/2024 1:49:52 PM		TEXAS INSTRUMENTS

Figure 4-11. Layer 5
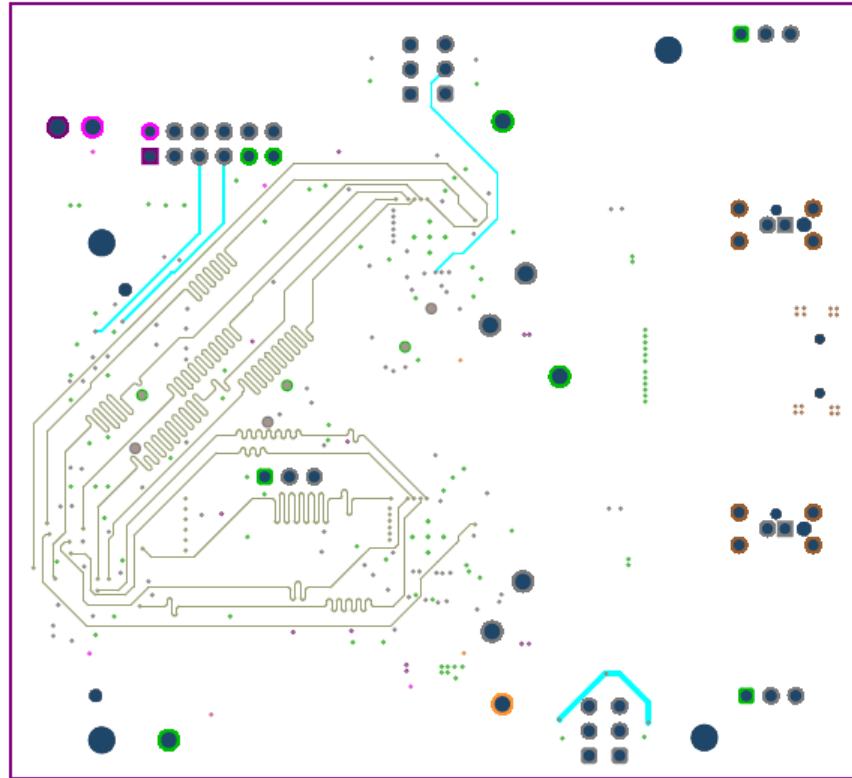
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ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: INDSYS-1379	REV: E2	SVN REV: Not in version control
LAYER NAME = Layer 6	TID #: N/A		
PLOT NAME = Signal Layer 5	GENERATED : 9/30/2024 1:49:52 PM		TEXAS INSTRUMENTS

Figure 4-12. Layer 6
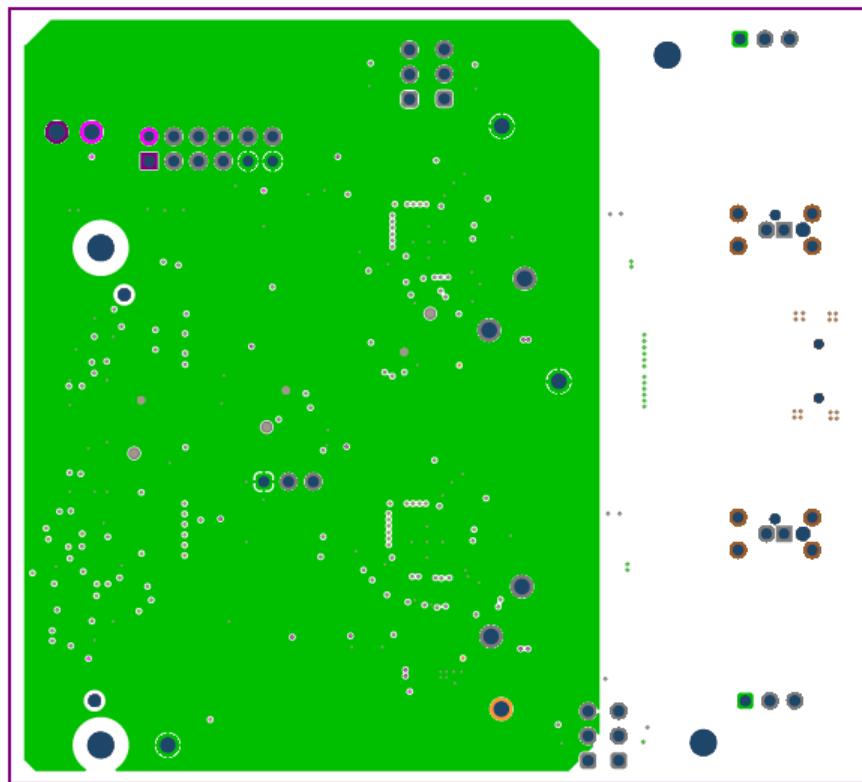
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LAYER NAME = Layer 7	TID #: N/A		
PLOT NAME = Signal Layer 6	GENERATED : 9/30/2024 1:49:52 PM		TEXAS INSTRUMENTS

Figure 4-13. Layer 7
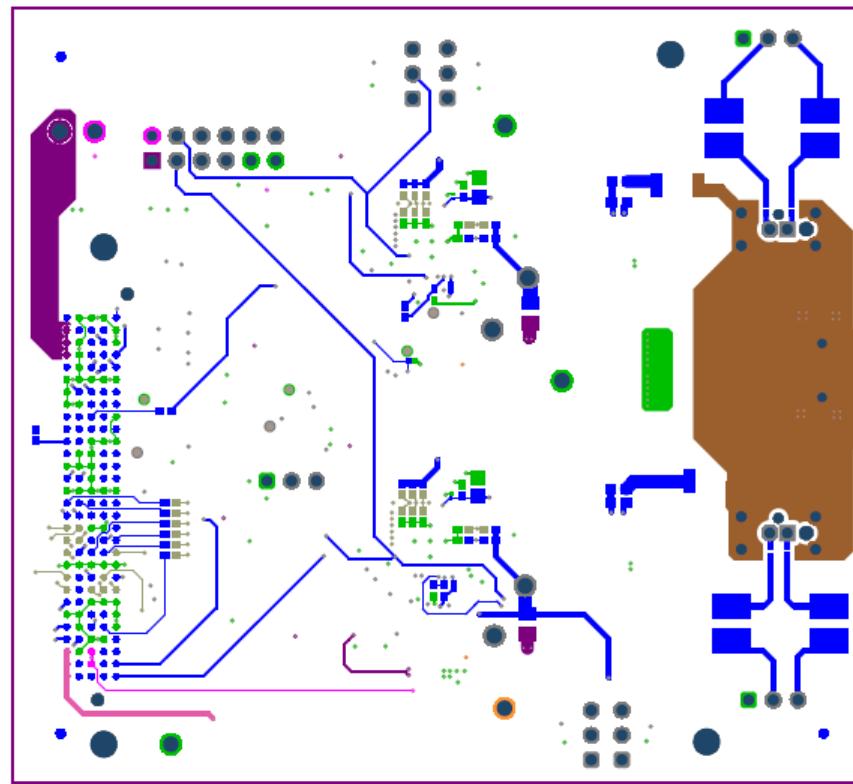
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LAYER NAME = Layer 8	TID #: N/A		
PLOT NAME = Bottom Layer	GENERATED : 9/30/2024 1:49:52 PM		TEXAS INSTRUMENTS

Figure 4-14. Layer 8
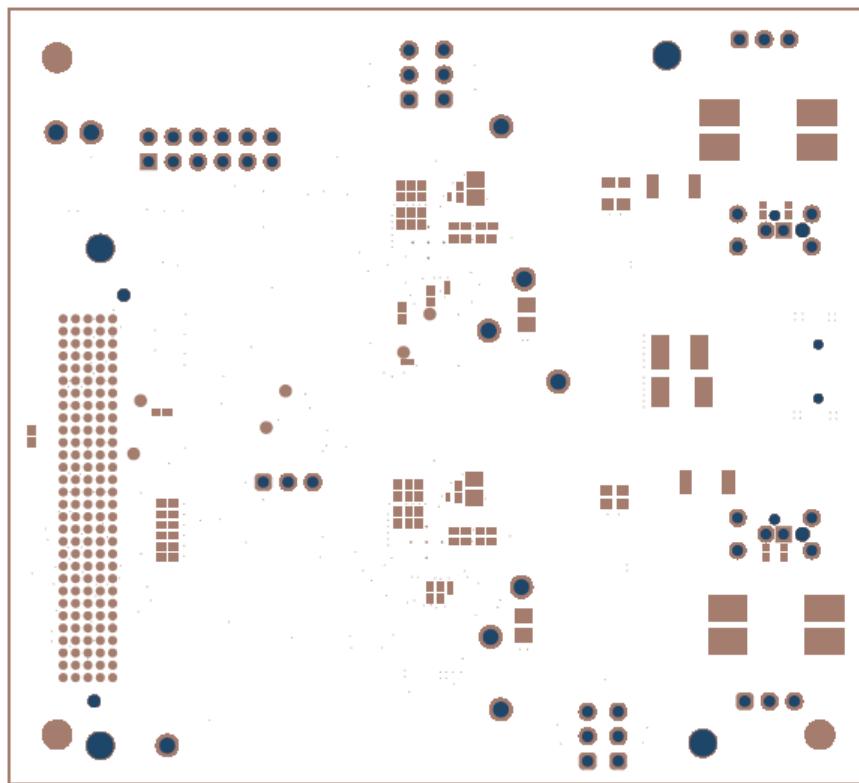
ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: INDSYS-1379	REV: E2	SVN REV: Not in version control
LAYER NAME = Bottom Solder	TID #: N/A		
PLOT NAME = Bottom Solder Mask	GENERATED : 9/30/2024 1:49:52 PM		TEXAS INSTRUMENTS

Figure 4-15. Bottom Solder

ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: INDSYS-1379	REV: E2	SVN REV: Not in version control
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PLOT NAME = Bottom Overlay	GENERATED : 9/30/2024 1:49:52 PM		TEXAS INSTRUMENTS

Figure 4-16. Bottom Overlay
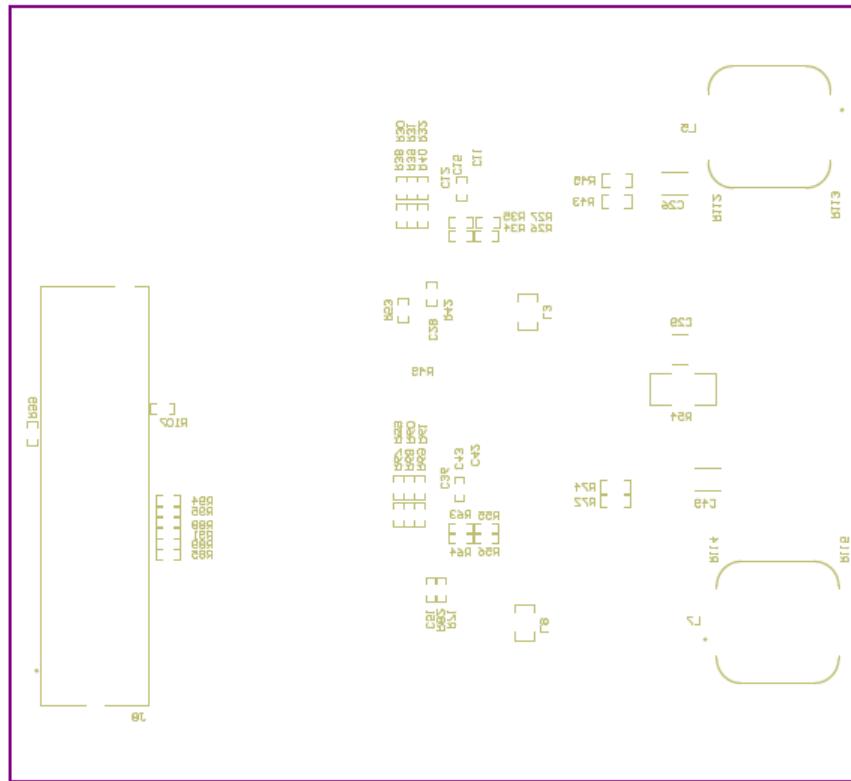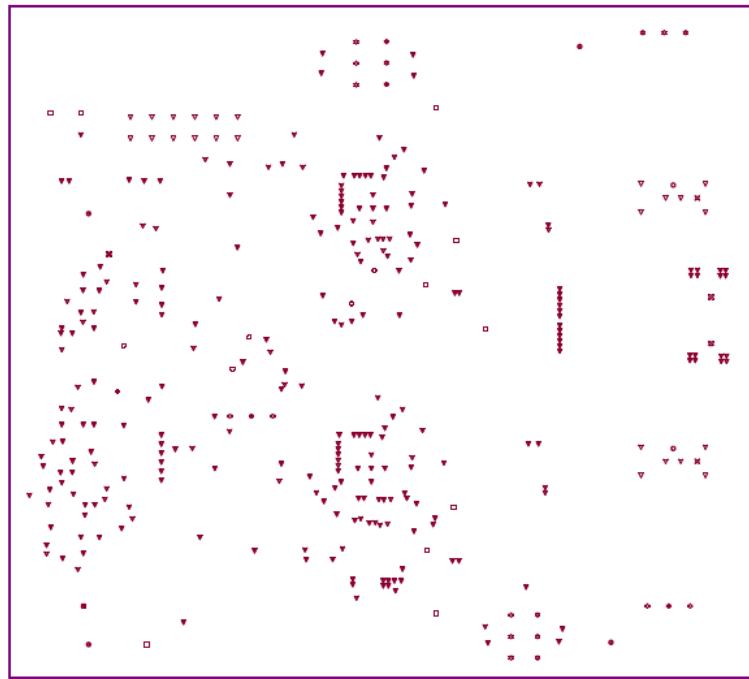
Symbol	Quantity	Finished Hole Size	Plated	Hole Type	Drill Layer Pair	Hole Tolerance
○	2	41.34mil (1.050mm)	NPTH	Round	Layer 1 - Layer 8	
✲	2	50.00mil (1.270mm)	NPTH	Round	Layer 1 - Layer 8	
⋈	2	55.91mil (1.420mm)	NPTH	Round	Layer 1 - Layer 8	
⊕	4	108.00mil (2.743mm)	NPTH	Round	Layer 1 - Layer 8	+/-3.00mil
▼	263	7.87mil (0.200mm)	PTH	Round	Layer 1 - Layer 8	
○	6	32.00mil (0.813mm)	PTH	Round	Layer 1 - Layer 8	
⋈	2	38.19mil (0.970mm)	PTH	Round	Layer 1 - Layer 8	
▽	24	43.31mil (1.100mm)	PTH	Round	Layer 1 - Layer 8	
✿	21	45.28mil (1.150mm)	PTH	Round	Layer 1 - Layer 8	
□	10	63.00mil (1.600mm)	PTH	Round	Layer 1 - Layer 8	
	336 Total					

ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: INDSYS-1379	REV: E2	SVN REV: Not in version control
LAYER NAME = Drill Drawing	TID #: N/A	
PLOT NAME = Drill Drawing	GENERATED : 9/30/2024 1:49:52 PM	TEXAS INSTRUMENTS

Figure 4-17. Drill Drawing
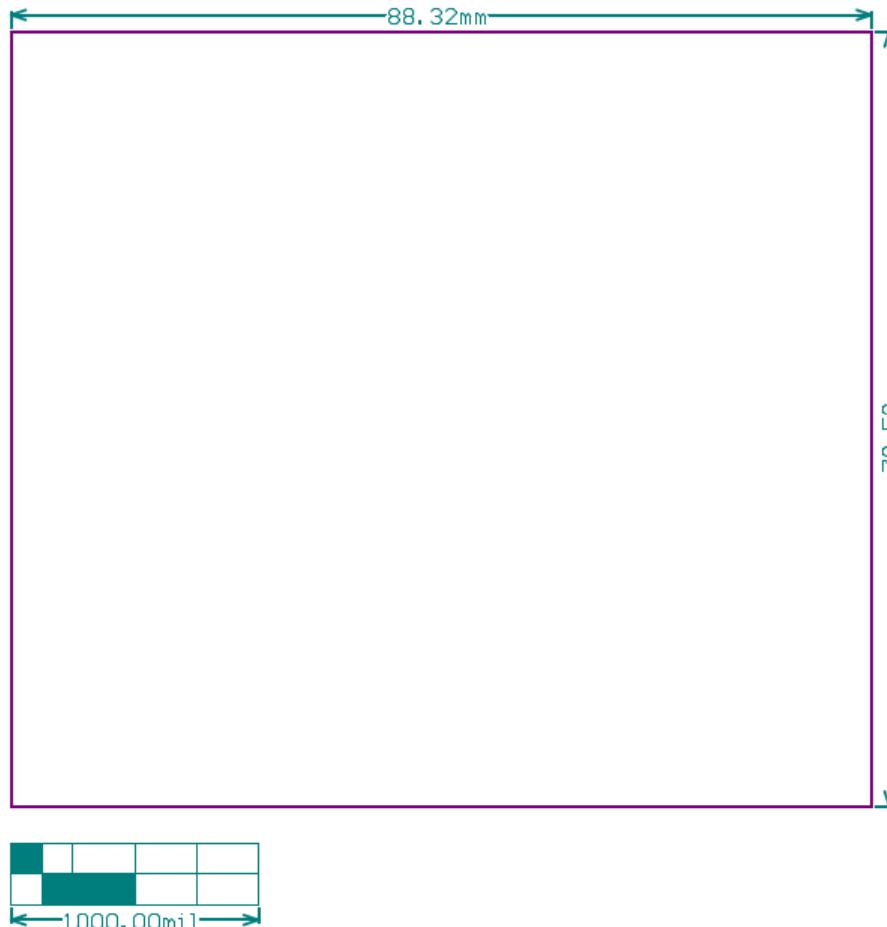
Figure 4-18. M2 Board Dimensions

4.3 Bill of Materials (BOM)

Item Number	Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
1	!PCB1	1		Printed circuit board		INDSYS-1379	Any		
2	C1, C3, C5, C6, C51, C52, C56, C57, C58	9	0.1µF	CAP, CERM, 0.1µF, 10V, ±20%, X5R, 0402	402	8.85012E+11	Wurth Elektronik		
3	C2, C4	2		WCAP-CSGP multilayer ceramic chip capacitor, general purpose, size 0603, X5R, 10µF, 25VDC		8.85012E+11	Wurth Elektronik		
4	C7, C11, C16, C19, C30, C34, C39, C42	8	2.2µF			GRM21BR71C225KA12L	Murata		
5	C8, C9, C10, C12, C13, C31, C32, C33, C35, C36	10		WCAP-CSGP multilayer ceramic chip capacitor, general purpose, size 0201, X5R Class II, 100nF, 16VDC		8.85012E+11	Wurth Elektronik		
6	C14, C15, C17, C18, C20, C37, C38, C40, C41, C43	10	0.01µF	CAP, CERM, 0.01µF, 16V, ±10%, X7R, 0402	402	8.85012E+11	Wurth Elektronik		
7	C21	1	10pF	CAP, CERM, 10pF, 50V, ±1%, C0G/NP0, 0402	402	GRM1555C1H100FA01D	MuRata		
8	C25, C48	2	100nF	0.1µF ±10% 100V ceramic capacitor X7R 0603 (1608 Metric)	603	8.85012E+11	Wurth Electronics		
9	C26, C49	2		WCAP-CSMH multilayer ceramic chip capacitor, mid and high voltage, size 1808, X7R Class II, 1nF, 2000VDC		8.85342E+11	Wurth Elektronik		
10	C27, C50	2	22pF	Cap ceramic 22pF 25V C0G 5% pad SMD 0201 125°C automotive T/R	201	CGA1A2C0G1E220J030BA	TDK		
11	C29	1	0.01µF	CAP, CERM, 0.01µF, 1500V, ±10%, X7R, 1812	1812	1812SC103KAT1A	AVX		
12	C53	1	10µF	10µF ±20% 25V ceramic capacitor X5R 0603 (1608 Metric)	603	8.85012E+11	Wurth		
13	C54	1	130pF	CAP, CERM, 130pF, 50V, ±5%, C0G/NP0, 0603	603	GRM1885C1H131JA01D	MuRata		

Item Number	Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
14	C55	1		WCAP-CSGP multilayer ceramic chip capacitor, general purpose, size 0805, X5R, 22µF, 10VDC		8.85012E+11	Wurth Elektronik		
15	D1, D2, D3, D5, D6, D7, D8, D9, D10, D11, D12, D13, D14, D15, D16, D17, D18, D19, D20, D21, D22	21	Green	LED, Green, SMD	LED_0603	150060VS75000	Wurth Elektronik		
16	D4	1	Red	LED, Red, SMD	LED_0603	150060RS75000	Wurth Elektronik		
17	FID1, FID2, FID3, FID4, FID5, FID6	6		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A		
18	J1, J9, J10, J11, J12	5		Header, 2.54mm, 3x1, gold, TH	Header, 2.54mm, 3x1, TH	61300311121	Wurth Elektronik		
19	J2	1		THT vertical pin header WR-PHD, pitch 2.54mm, dual row, 12 pins	HDR12	61301221121	Wurth Electronics		
20	J4, J7	2		Jack modular connector 2P2C single pair Ethernet (SPE) 90° angle (Right) shielded CatB	PTH_ETHERNET_CONNECTOR	1163797	Phoenix Contact		
21	J5	1		2 Pin screw terminal, power tap M3 surface mount, right angle	SMT_REDCUBE_7MM00_4MM33	7466313R	Wurth Electronics		
22	J8	1		150 position connector high density array, male surface mount gold	HDR150	SEAM-30-07.0-L-05-2-A-K-TR	Samtec		
23	L1, L2, L3, L8	4	80Ω	Ferrite bead, 80Ω at 100MHz, 0.5A, 0805	805	742792062	Wurth Elektronik		
24	L6, L10, L11, L12	4		2 Line common mode choke surface mount 200mA DCR 1.2Ω	SMT4_3MM2_1MM6	744232222	Wurth		
25	LBL1	1		Thermal transfer printable labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650 x 0.200 inch	THT-14-423-10	Brady		

Item Number	Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
26	R1, R2, R3, R5, R23, R24, R33, R46, R48, R62, R75, R77, R84, R85, R86, R87, R88, R89, R90, R91, R92, R93, R94, R95, R96, R99, R100, R101, R107	29	0	RES, 0, 5%, 0.063W, AEC-Q200 Grade 0, 0402	402	CRCW04020000Z0ED	Vishay-Dale		
27	R6, R7, R8, R9, R10, R11, R12, R13, R14, R15, R16, R17, R18, R19	14	470	RES, 470, 5%, 0.063W, AEC-Q200 Grade 0, 0402	402	CRCW0402470RJNED	Vishay-Dale		
28	R21, R22, R25, R53, R82, R102, R104	7	10.0k	RES, 10.0k, 1%, 0.063W, AEC-Q200 Grade 0, 0402	402	CRCW040210K0FKED	Vishay-Dale		
29	R28, R29, R32, R36, R37, R57, R58, R61, R65, R66	10	2.49k	RES, 2.49k, 1%, 0.063W, AEC-Q200 Grade 0, 0402	402	CRCW04022K49FKED	Vishay-Dale		
30	R41, R44, R70, R73, R108, R109, R110, R111	8	3.3k	RES, 3.3k, 5%, 0.063W, AEC-Q200 Grade 0, 0402	402	CRCW04023K30JNED	Vishay-Dale		
31	R45, R74	2	100	RES, 100, 1%, 0.25W, AEC-Q200 Grade 0, 0603	603	CRCW0603100RFKEAHP	Vishay-Dale		
32	R47, R49, R51, R78, R80	5	2.20k	RES, 2.20k, 1%, 0.05W, 0201	201	CRCW02012K20FKED	Vishay-Dale		
33	R50, R81	2	22	RES, 22, 5%, 0.063W, AEC-Q200 Grade 0, 0402	402	CRCW040222R0JNED	Vishay-Dale		
34	R54	1	1.0Meg	RES, 1.0M, 5%, 0.75W, AEC-Q200 Grade 0, 2010	2010	CRCW20101M00JNEF	Vishay-Dale		
35	R56	1	4.53k	RES, 4.53k, 1%, 0.063W, AEC-Q200 Grade 0, 0402	402	CRCW04024K53FKED	Vishay-Dale		
36	R83	1	2.2k	RES, 2.2k, 5%, 0.063W, AEC-Q200 Grade 0, 0402	402	CRCW04022K20JNED	Vishay-Dale		
37	R103	1	66.5k	RES, 66.5k, 1%, 0.063W, AEC-Q200 Grade 0, 0402	402	CRCW040266K5FKED	Vishay-Dale		
38	R105, R106	2	100k	RES, 100k, 1%, 0.063W, AEC-Q200 Grade 0, 0402	402	CRCW0402100KFKED	Vishay-Dale		

Item Number	Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
39	SH-J1, SH-J2, SH-J3, SH-J4	4		Shunt, 2.54mm, Gold, Black	Shunt, 2.54mm, Black	60900213421	Wurth Elektronik		
40	T1, T2	2		120µH Pulse Transformer 1:1 Surface Mount	SMT_XFRMR_4MM70_3MM22	74930100	Wurth		
41	TP1, TP2, TP6, TP7, TP8, TP9, TP10	7		Test Point, Compact, Red, TH	Red Compact Testpoint	5005	Keystone		
42	TP3, TP4, TP5	3		Test Point, Compact, Black, TH	Black Compact Testpoint	5006	Keystone		
43	U1	1		3.3V and 2.5V LVCMOS high-performance Clock Buffer Family, DQF0008A (WSON-8)	DQF0008A	LMK1C1104DQF	Texas Instruments		Texas Instruments
44	U2	1		8-Bit LED Driver with I2C Interface, D0016A, TUBE	D0016A	TPIC2810D	Texas Instruments		
45	U3, U5	2		Low Power Auto PHY 1000BASE-T1 Automotive Ethernet Physical Layer Transceiver, RND0036A (VQFNP-36)	RND0036A	DP83TC812SRHATQ1	Texas Instruments	DP83TC812SRHATQ1	Texas Instruments
46	U4, U6	2		Dual-Channel High-Speed ESD Protection, DRL0005A (SOT-OTHER-5)	DRL0005A	TPD2E2U06DRLR	Texas Instruments		Texas Instruments
47	U7, U8	2		Single 2-Input Positive-AND Gate, DCK0005A, LARGE T&R	DCK0005A	SN74LVC1G08DCKR	Texas Instruments		
48	U9	1		Non-Isolated PoL Module DC DC Converter 1 Output 0.6 ~ 4V 2A 2.4V - 5.5V Input	uSIP10	TPSM82822SILR	Texas Instruments		
49	U10	1		1-Bit Dual-Supply Buffered Voltage Signal Converter, DCK0005A (SOT-SC70-5)	DCK0005A	2N7001TDCKR	Texas Instruments		
50	Y1	1		High-Performance BAW Oscillator	VSON4	LMK6CE02500CDLFT	Texas Instruments		

Item Number	Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer	Alternate Part Number	Alternate Manufacturer
51	C28	0	0.1µF	CAP, CERM, 0.1µF, 10V, ±20%, X5R, 0402	402	8.85012E+11	Wurth Elektronik		
52	J3, J6	0		Header, 2.54mm, 3x1, Gold, TH	Header, 2.54mm, 3x1, TH	61300311121	Wurth Elektronik		
53	L4, L9	0	80Ω	Ferrite Bead, 80Ω at 100MHz, 0.5A, 0805	805	742792062	Wurth Elektronik		
54	L5, L7	0	470µH	Coupled inductor, 470µH, 0.9A, 1Ω, SMD	SMD, 12.5x12.5mm	744870471	Wurth Elektronik		
55	R20	0	10.0k	RES, 10.0k, 1%, 0.063W, AEC-Q200 Grade 0, 0402	402	CRCW040210K0FKED	Vishay-Dale		
56	R26, R27, R30, R31, R34, R35, R38, R39, R40, R55, R59, R60, R63, R64, R67, R68, R69	0	2.49k	RES, 2.49k, 1%, 0.063W, AEC-Q200 Grade 0, 0402	402	CRCW04022K49FKED	Vishay-Dale		
57	R42, R71, R76	0	2.20k	RES, 2.20k, 1%, 0.05W, 0201	201	CRCW02012K20FKED	Vishay-Dale		
58	R43, R72	0	0	RES, 0, 5%, 0.1W, AEC-Q200 Grade 0, 0603	603	CRCW06030000Z0EA	Vishay-Dale		
59	R52, R79	0	22	RES, 22, 5%, 0.063W, AEC-Q200 Grade 0, 0402	402	CRCW040222R0JNED	Vishay-Dale		
60	R97	0	500	RES, 500, 0.1%, 0.05W, 0402	402	PNM0402E5000BST1	Vishay Thin Film		
61	R98	0	649	RES, 649, 1%, 0.063W, AEC-Q200 Grade 0, 0402	402	CRCW0402649RFKED	Vishay-Dale		
62	R112, R113, R114, R115	0	0	RES, 0, 5%, 0.063W, AEC-Q200 Grade 0, 0402	402	CRCW04020000Z0ED	Vishay-Dale		

5 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

DATE	REVISION	NOTES
October 2024	*	Initial Release