EVM User's Guide: DP83TG720

DP83TG720-IND-SPE Daughter Card

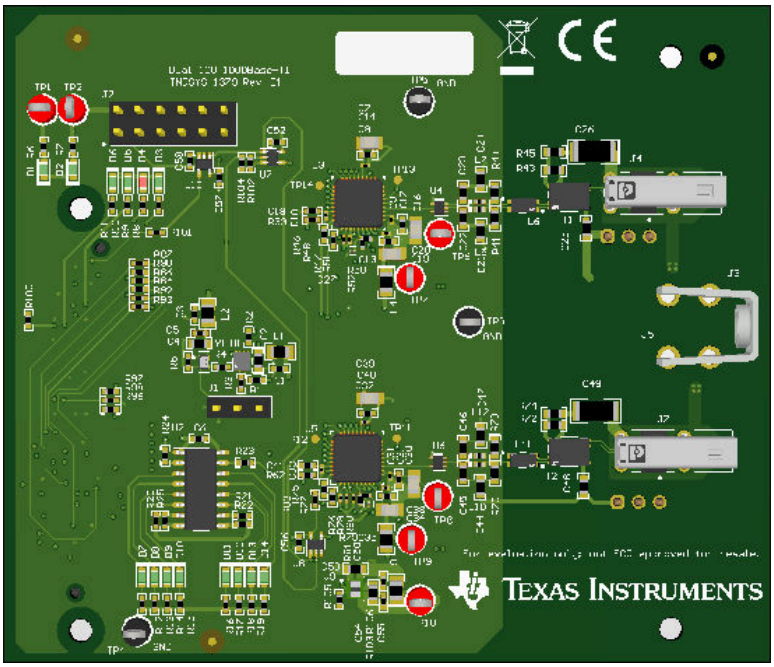
Description

The DP83TG720-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 DP83TG720-IND-SPE offers ease of integration and rapid deployment due to evaluate Single Pair Ethernet.

Features

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

- 2x DP83TG720 gigabit SPE PHYs with RGMII interface
- 2x jack modular connector 2P2C single-pair Ethernet (SPE) 90° angle (right) shielded category B connector



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1 Evaluation Module Overview

This user guide details how to properly operate and configure the DP83TG720-IND-SPE daughter card.

Preface: Read This First

1.1 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.

1.2 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.

1.1 Introduction

The DP83TG720-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.

1.2 Kit Contents

The DP83TG720-IND-SPE daughter card kit contains the following items:

- DP83TG720-IND-SPE daughter card

Not included:

- AM64x Evaluation Board

1.3 Specifications

The DP83TG720-IND-SPE daughter card serves as a tool to evaluate 1000Base-T1. Consult the DP83TG720 data sheet for more information.

1.4 Device Information

The DP83TG720S-Q1 device is compliant with IEEE 802.3bp and *Open Alliance* automotive Ethernet physical layer transceiver specifications. DP83TG720S-Q1 provides all the physical layer functions necessary for transmitting and receiving data over unshielded and shielded, single, twisted-pair cables. The device provides xMII flexibility with support for RGMII and SGMII MAC interfaces.

DP83TG720 is compliant with *Open Alliance* EMC and interoperable specifications over an unshielded twisted cable. DP83TG720 is front-print compatible to TI's 100BASE-T1 PHY, which enables design scalability with a single board for both speeds. This device offers the Diagnostic Tool Kit, with 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 ESD monitoring tool is capable of counting ESD events on both the xMII and MDI, as well as providing real-time monitoring through the use of a programmable interrupt. Additionally, the DP83TG720S-Q1 includes a data generator and checker tool to generate customizable MAC packets and check the errors on incoming packets. This feature allows for system-level data path tests and optimizations without dependency on MAC.

For additional information, refer to the DP83TG720 data sheet

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2 Hardware

2.1 Power Tree

The DP83TG720-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 DP83TG720-IND-SPE daughter card with the main AM64x EVM.

2.2 Test Points

The DP83TG720-IND-SPE is equipped with multiple test points for hardware debug and bench testing. Table 2-1 shows the test points on the board and the associated signal net.

Table 2-1. DP83TG720-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

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3 Hardware Design Files

3.1 Schematics

Figure 3-1 through Figure 3-4 show the EVM schematics.

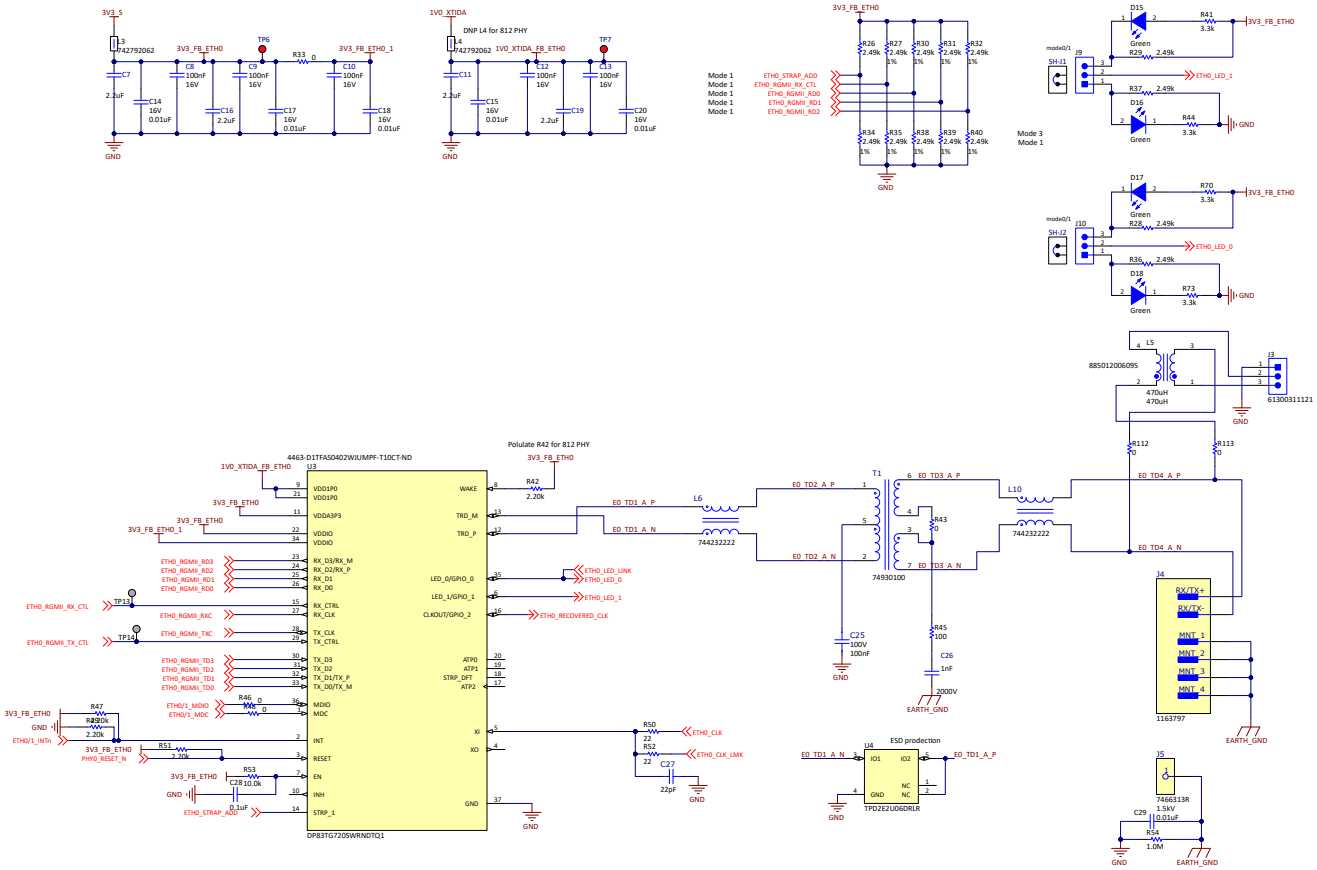

Figure 3-1. ETH0

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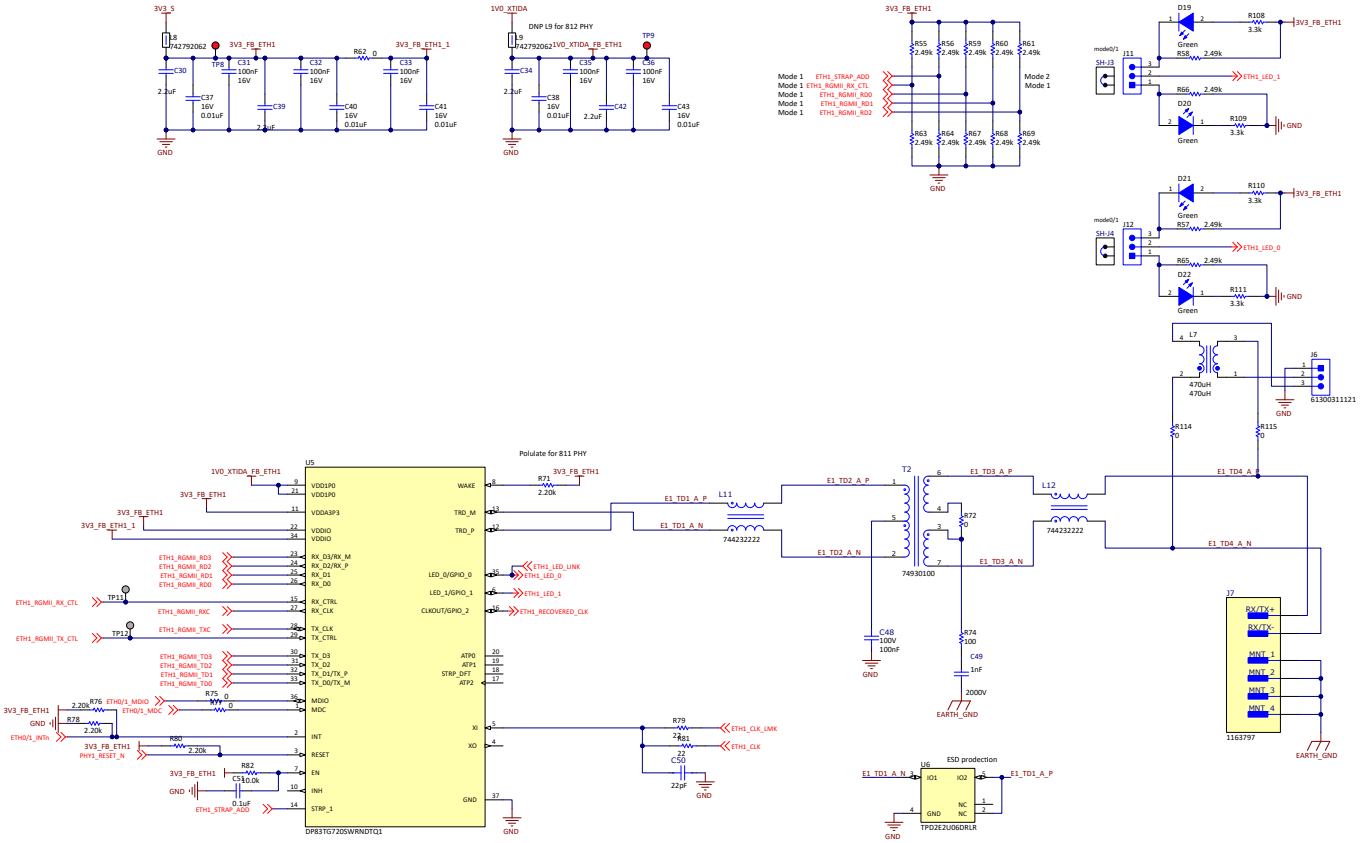

Figure 3-2. ETH1

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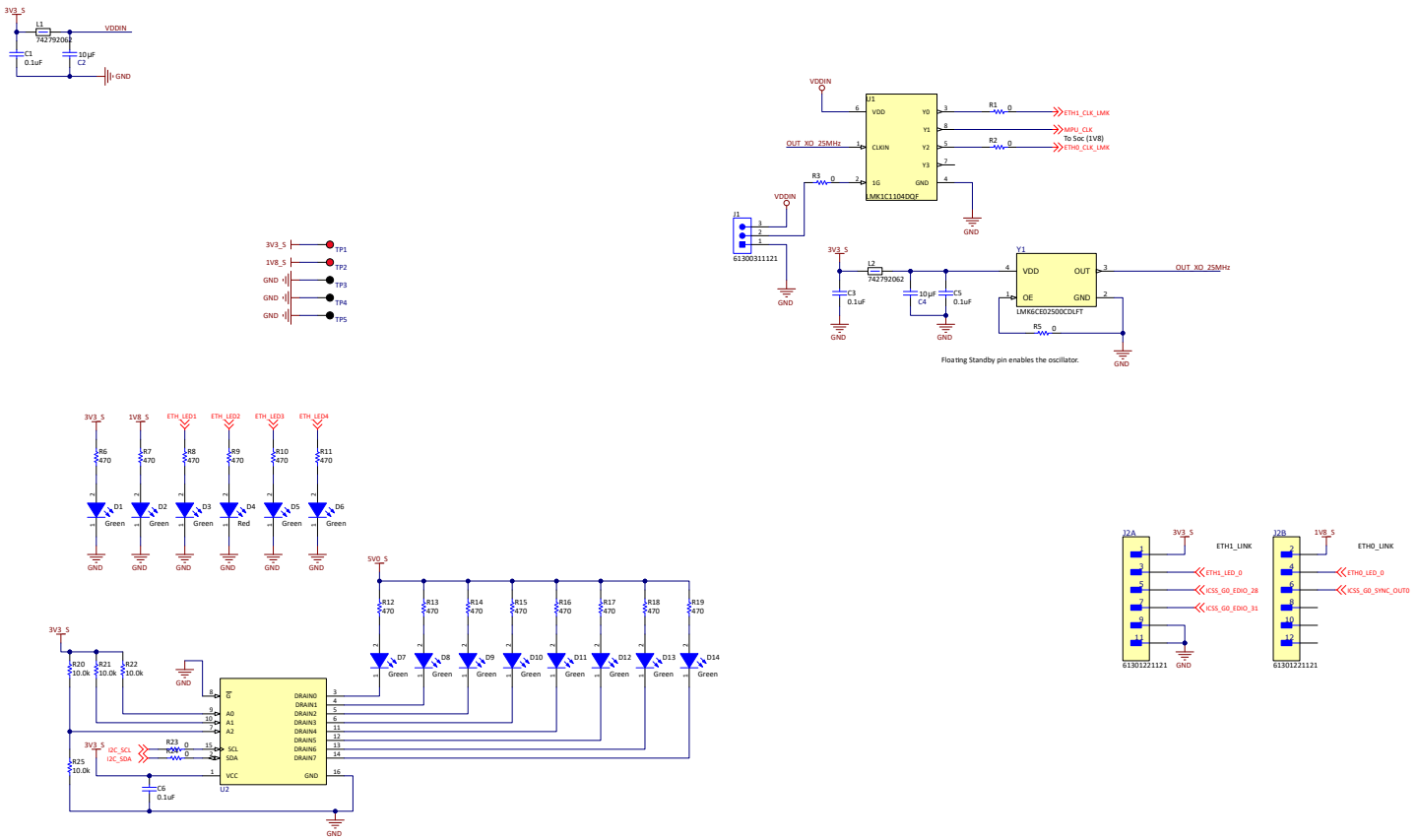

Figure 3-3. CLK_CFG

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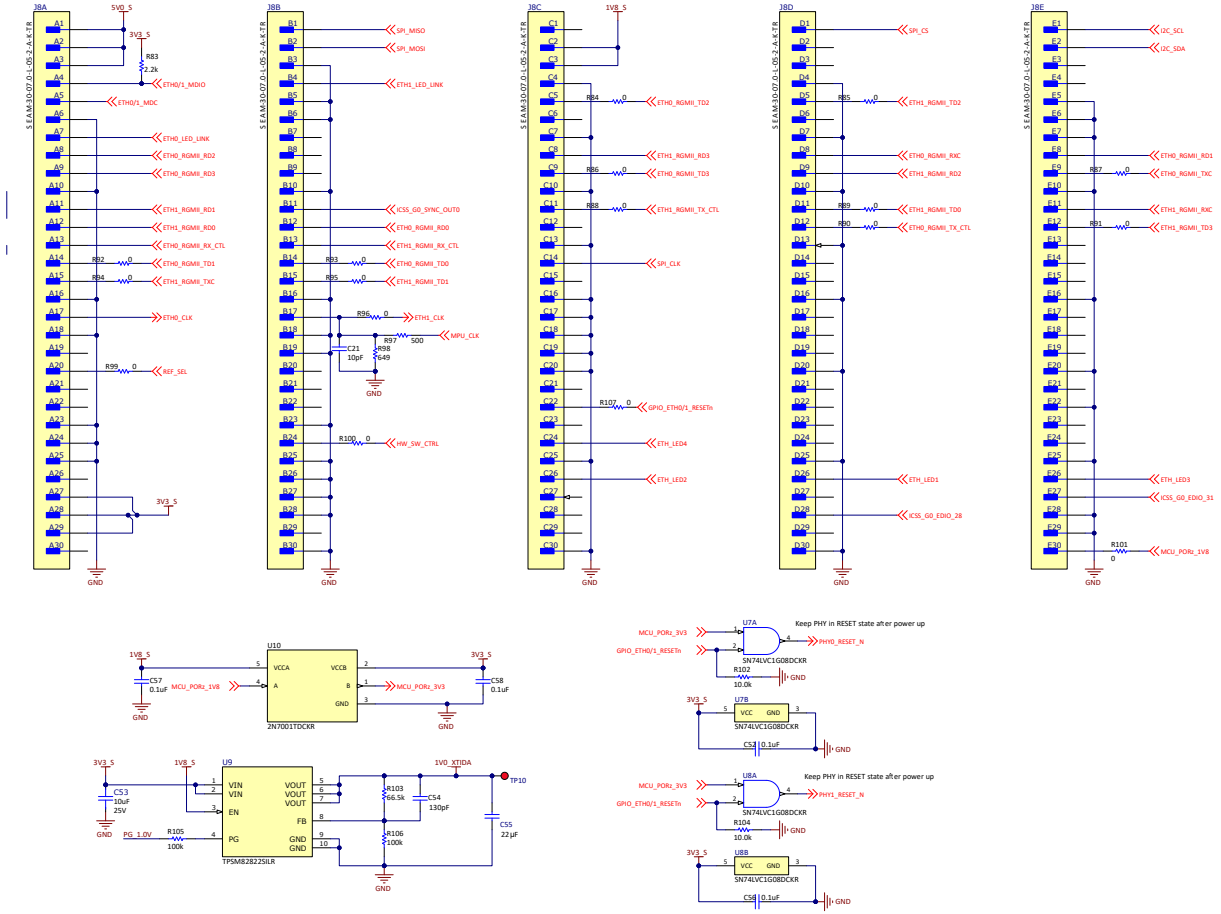

Figure 3-4. Interface

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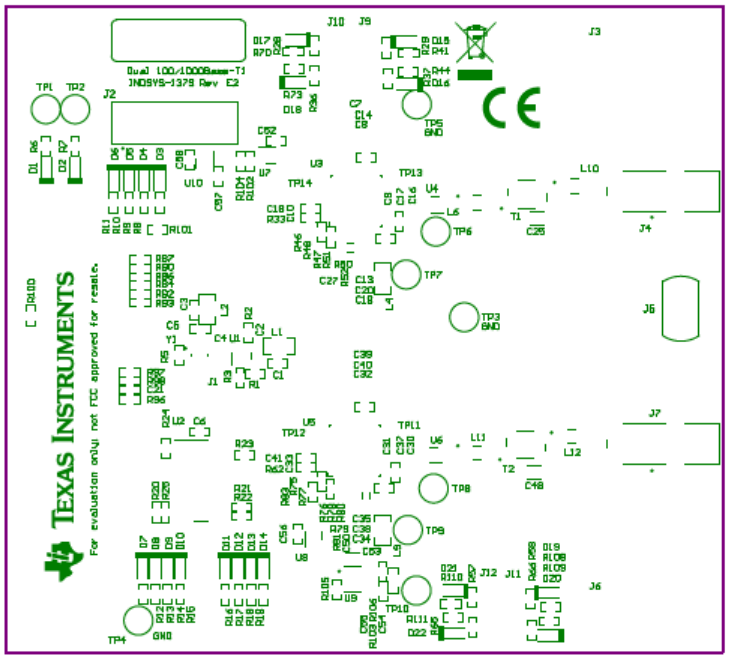
3.2 PCB Layouts

Figure 3-5 through Figure 3-18 show the design of the DP83TG720-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 : 8/22/2024 3:24:24 PM		TEXAS INSTRUMENTS

Figure 3-5. Top Overlay

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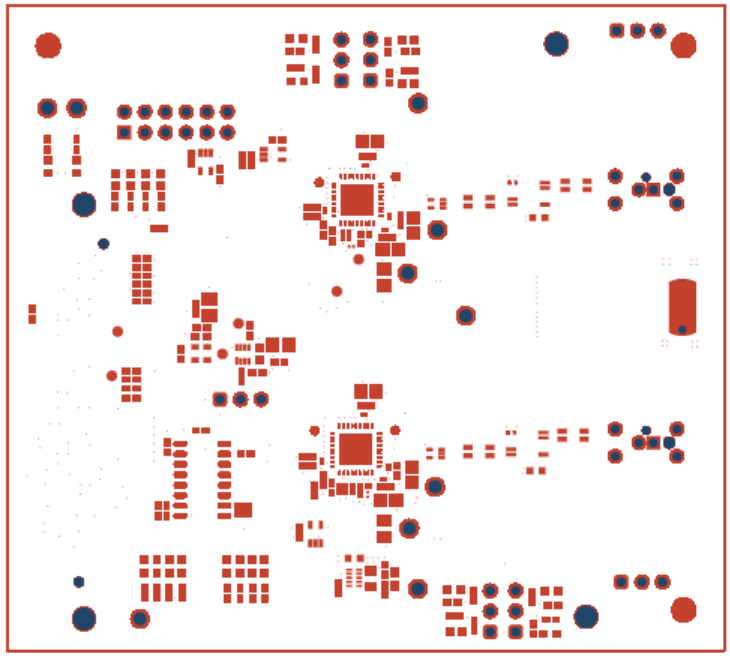

ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: INDSYS-1379	REV: E2	SVN REV: Not in version control
LAYER NAME = Top Solder	TID #: N/A		
PLOT NAME = Top Solder Mask	GENERATED : 8/22/2024 3:24:24 PM		TEXAS INSTRUMENTS

Figure 3-6. Top Solder

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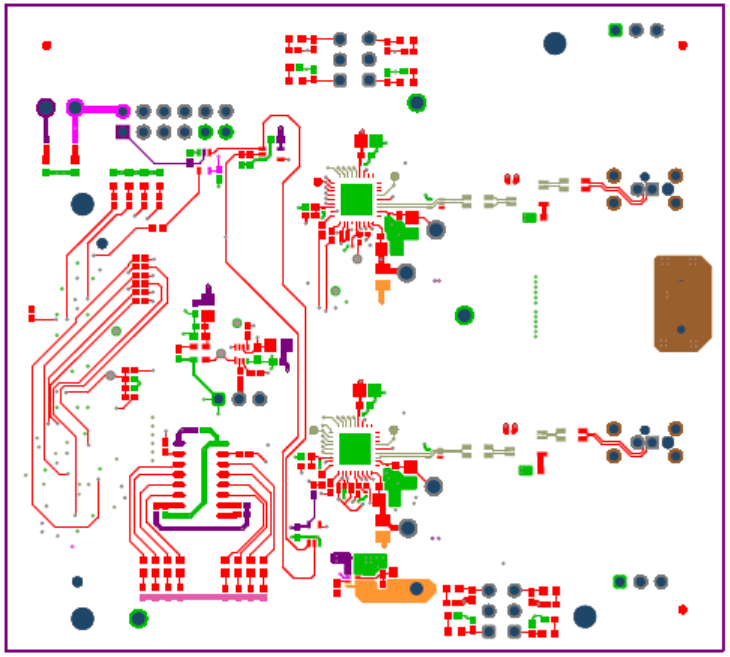

ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: INDSYS-1379	REV: E2	SVN REV: Not in version control
LAYER NAME = Layer 1	TID #: N/A		
PLOT NAME = Top Layer	GENERATED : 8/22/2024 3:24:24 PM		TEXAS INSTRUMENTS

Figure 3-7. Layer 1

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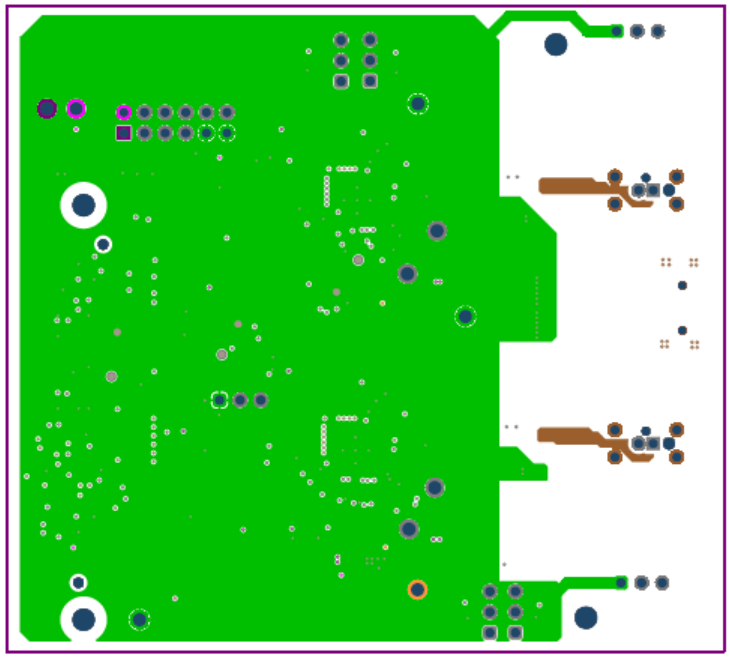

ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: INDSYS-1379	REV: E2	SVN REV: Not in version control
LAYER NAME = Layer 2	TID #: N/A		
PLOT NAME = Signal Layer 1	GENERATED : 8/22/2024 3:24:24 PM		TEXAS INSTRUMENTS

Figure 3-8. Layer 2

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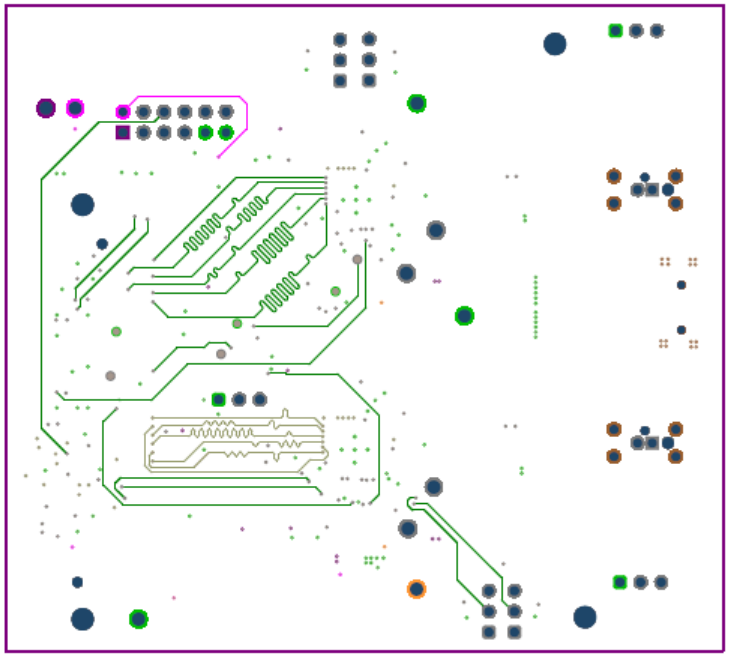

ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: INDSYS-1379	REV: E2	SVN REV: Not in version control
LAYER NAME = Layer 3	TID #: N/A		
PLOT NAME = Signal Layer 2	GENERATED : 8/22/2024 3:24:24 PM		TEXAS INSTRUMENTS

Figure 3-9. Layer 3

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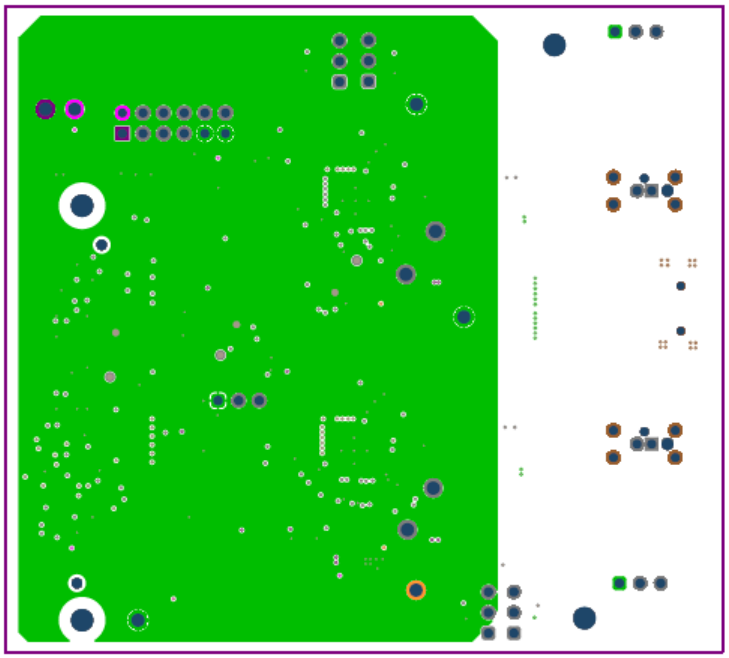

ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: INDSYS-1379	REV: E2	SVN REV: Not in version control
LAYER NAME = Layer 4	TID #: N/A		
PLOT NAME = Signal Layer 3	GENERATED : 8/22/2024 3:24:24 PM		TEXAS INSTRUMENTS

Figure 3-10. Layer 4

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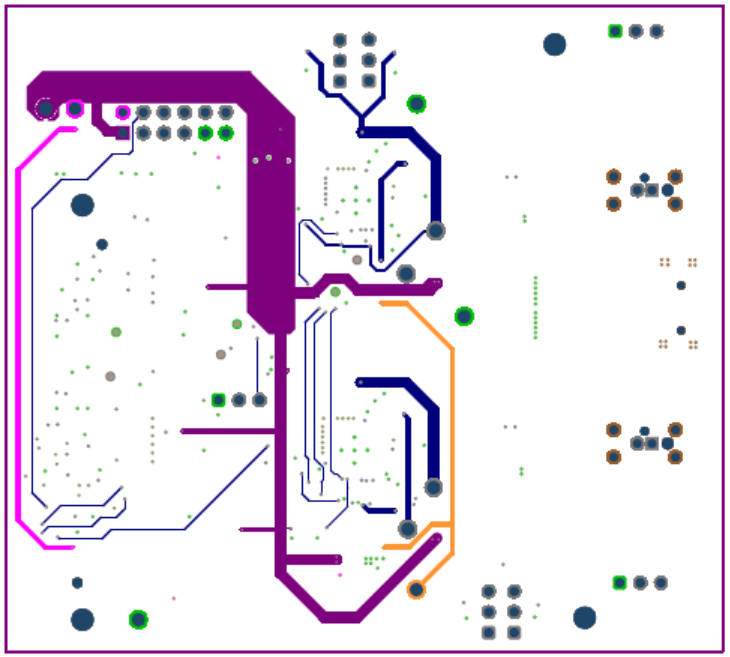

ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: INDSYS-1379	REV: E2	SVN REV: Not in version control
LAYER NAME = Layer 5	TID #: N/A		
PLOT NAME = Signal Layer 4	GENERATED : 8/22/2024 3:24:24 PM		TEXAS INSTRUMENTS

Figure 3-11. Layer 5

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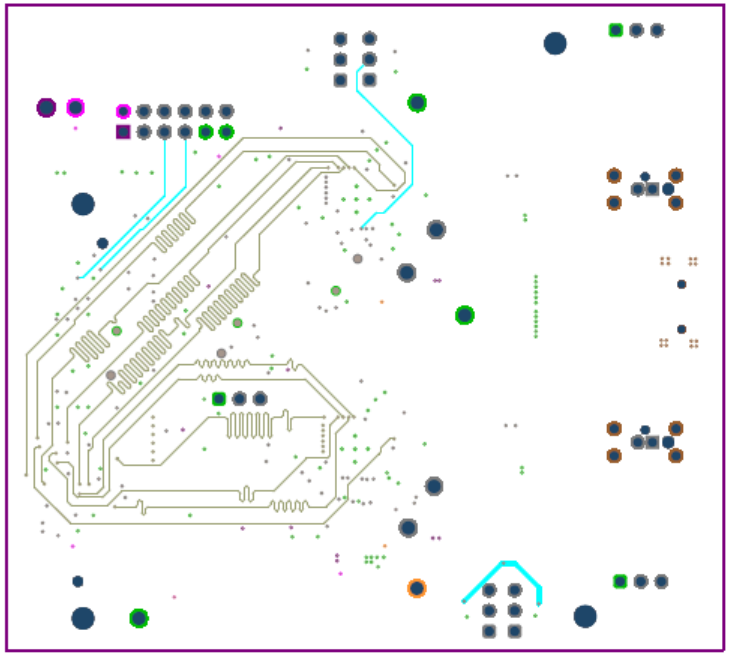

ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: INDSYS-1379	REV: E2	SVN REV: Not in version control
LAYER NAME = Layer 6	TID #: N/A		
PLOT NAME = Signal Layer 5	GENERATED : 8/22/2024 3:24:24 PM		TEXAS INSTRUMENTS

Figure 3-12. Layer 6

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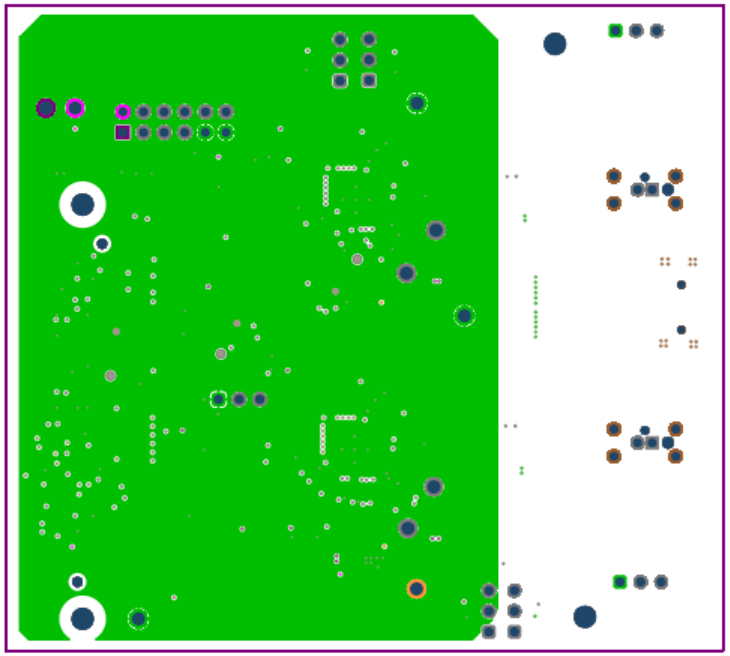

Figure 3-13. Layer 7

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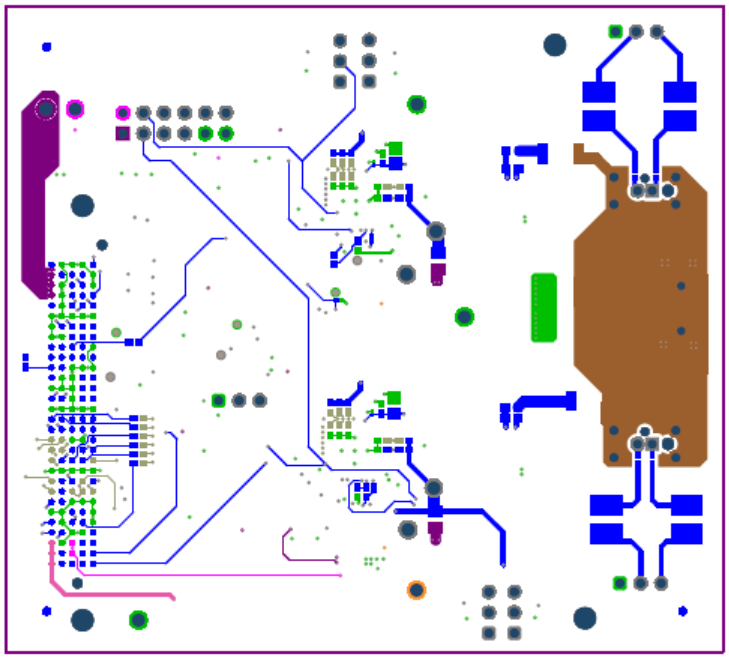

ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: INDSYS-1379	REV: E2	SVN REV: Not in version control
LAYER NAME = Layer 8	TID #: N/A		
PLOT NAME = Bottom Layer	GENERATED : 8/22/2024 3:24:24 PM		TEXAS INSTRUMENTS

Figure 3-14. Layer 8

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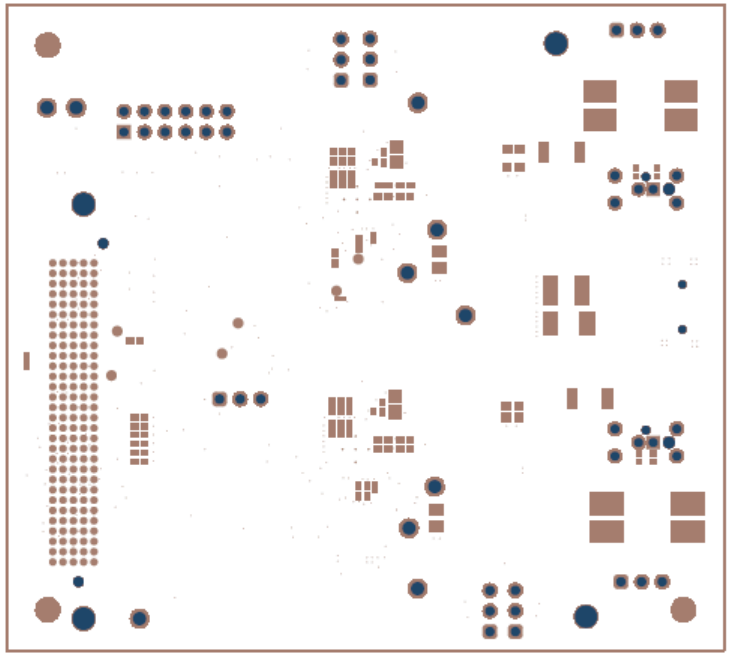

Figure 3-15. Bottom Solder

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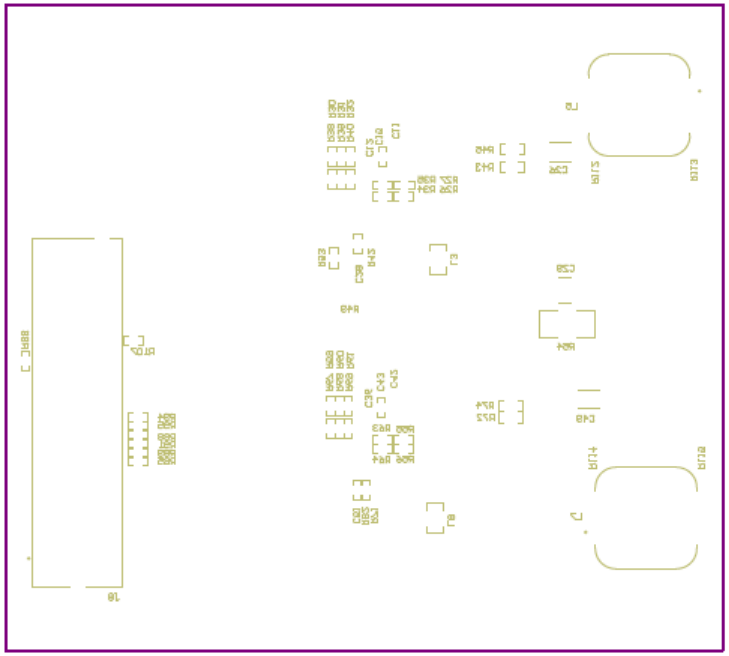

ALL ARTWORK VIEWED FROM TOP SIDE	BOARD #: INDSYS-1379	REV: E2	SVN REV: Not in version control
LAYER NAME = Bottom Overlay	TID #: N/A		
PLOT NAME = Bottom Overlay	GENERATED : 8/22/2024 3:24:24 PM		TEXAS INSTRUMENTS

Figure 3-16. Bottom Overlay

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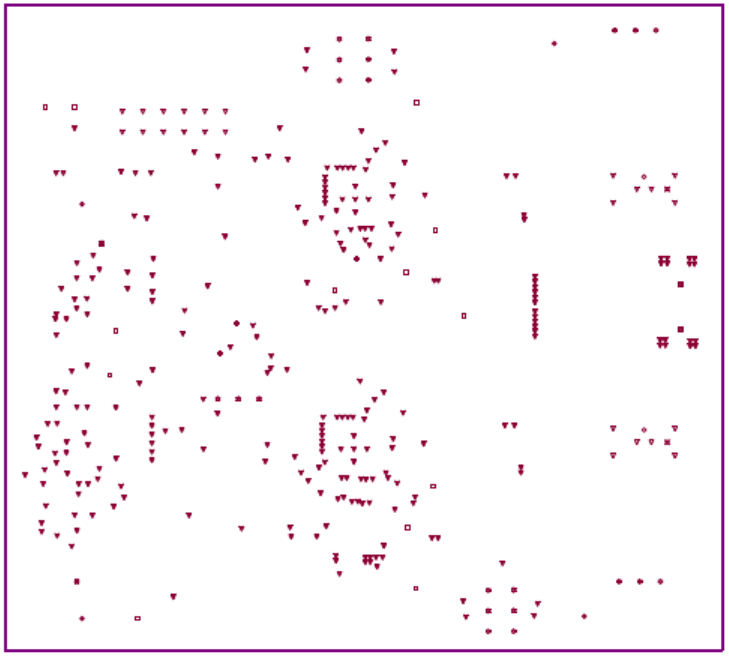

Symbol	Quantity	Finished Hole Size	Plated	Hole Type	Drill Layer Pair	Hole Tolerance
○	2	41.34mil (1.050mm)	NPTH	Round	Layer 1 - Layer 8	
⊠	2	50.00mil (1.270mm)	NPTH	Round	Layer 1 - Layer 8	
⊠	2	55.91mil (1.420mm)	NPTH	Round	Layer 1 - Layer 8	
●	4	108.00mil (2.743mm)	NPTH	Round	Layer 1 - Layer 8	+/-3.00mil
▼	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	SUN REV: Not in version control
LAYER NAME = Drill Drawing	TID #: N/A		
PLOT NAME = Drill Drawing	GENERATED : 8/22/2024 3:24:24 PM		TEXAS INSTRUMENTS

Figure 3-17. Drill Drawing

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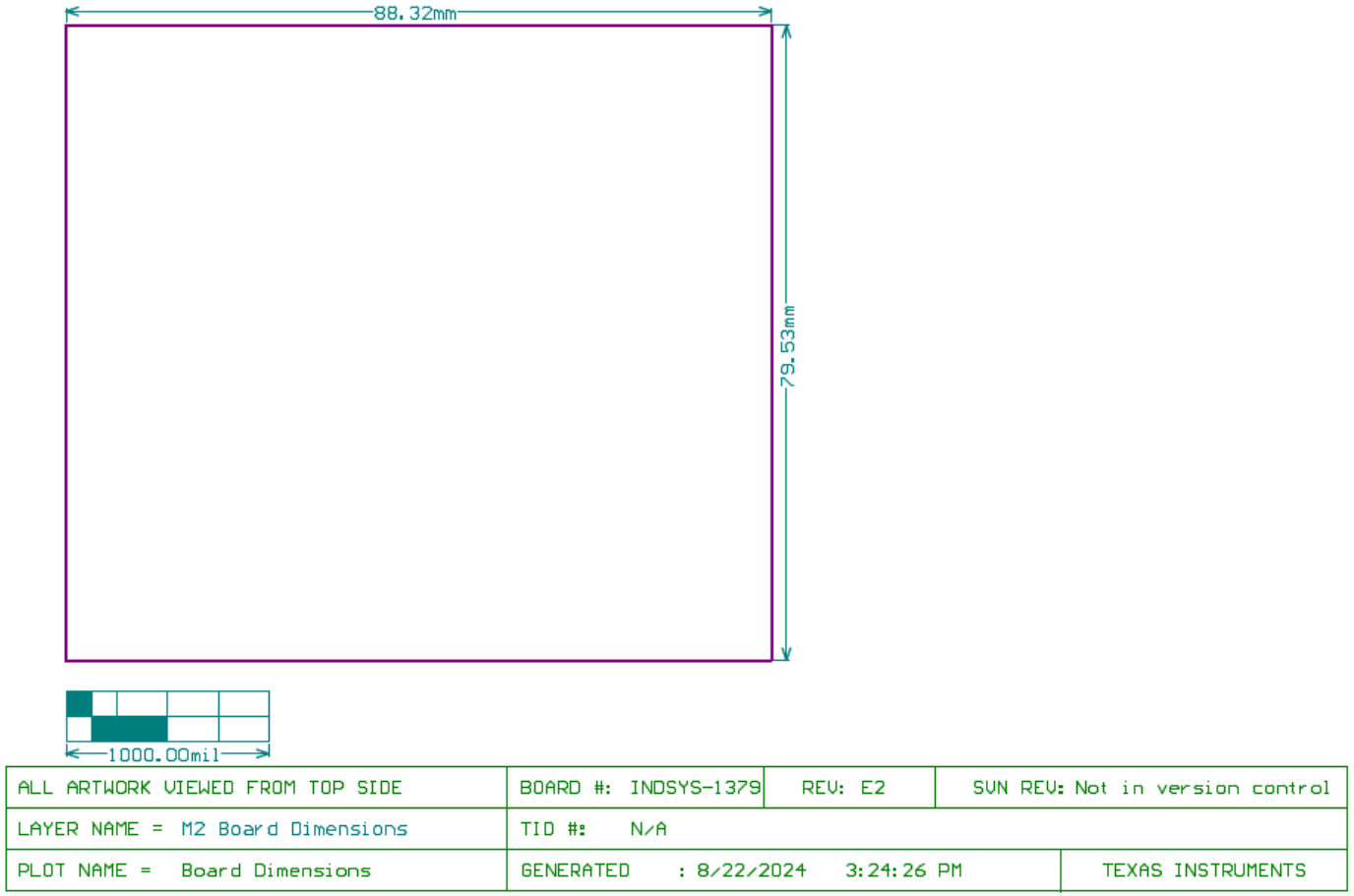

Figure 3-18. M2 Board Dimensions

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3.3 Bill of Materials (BOM)

Table 3-1. Bill of Materials

Item Number	Designator	Quantity	Value	Part Number	Manufacturer	Description	Package Reference
1	!PCB1	1		INDSYS-1379		Printed Circuit Board	
2	C1, C3, C5, C6, C28, C51, C52, C56, C57, C58	10	0.1uF	885012105010	Wurth Elektronik	CAP, CERM, 0.1uF, 10V, ±20%, X5R, 0402	402
3	C2, C4	2		885012106031	Wurth Elektronik	WCAP-CSGP Multilayer Ceramic Chip Capacitor, General Purpose, size 0603, X5R, 10µF, 25VDC	
4	C7, C11, C16, C19, C30, C34, C39, C42	8	2.2uF	GRM21BR71C225KA12L	Murata		
5	C8, C9, C10, C12, C13, C31, C32, C33, C35, C36	10		885012104001	Wurth Elektronik	WCAP-CSGP Multilayer Ceramic Chip Capacitor, General Purpose, size 0201, X5R Class II, 100nF, 16VDC	
6	C14, C15, C17, C18, C20, C37, C38, C40, C41, C43	10	0.01uF	885012205031	Wurth Elektronik	CAP, CERM, 0.01uF, 16V, ± 10%, X7R, 0402	402
7	C21	1	10pF	GRM1555C1H100FA01D	MuRata	CAP, CERM, 10pF, 50V, ± 1%, C0G/NP0, 0402	402
8	C25, C48	2	100nF	885012206120	Wurth Electronics	0.1µF ±10% 100V Ceramic Capacitor X7R 0603 (1608 Metric)	603
9	C26, C49	2		885342210001	Wurth Elektronik	WCAP-CSMH Multilayer Ceramic Chip Capacitor, Mid and High Voltage, size 1808, X7R Class II, 1nF, 2000VDC	
10	C27, C50	2	22pF	CGA1A2C0G1E220J030BA	TDK	Cap Ceramic 22pF 25V C0G 5% Pad SMD 0201 125°C Automotive T/R	201
11	C29	1	0.01uF	1812SC103KAT1A	AVX	CAP, CERM, 0.01uF, 1500V, ± 10%, X7R, 1812	1812
12	C53	1	10µF	885012106031	Wurth	10µF ±20% 25V Ceramic Capacitor X5R 0603 (1608 Metric)	603
13	C54	1	130pF	GRM1885C1H131JA01D	MuRata	CAP, CERM, 130pF, 50V, ± 5%, C0G/NP0, 0603	603

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Table 3-1. Bill of Materials (continued)

Item Number	Designator	Quantity	Value	Part Number	Manufacturer	Description	Package Reference
14	C55	1		885012107011	Wurth Elektronik	WCAP-CSGP Multilayer Ceramic Chip Capacitor, General Purpose, size 0805, X5R, 22µF, 10VDC	
15	D1, D2, D3, D5, D6, D7, D8, D9, D10, D11, D12, D13, D14, D15, D16, D17, D18, D19, D20, D21, D22	21	Green	150060VS75000	Wurth Elektronik	LED, Green, SMD	LED_0603
16	D4	1	Red	150060RS75000	Wurth Elektronik	LED, Red, SMD	LED_0603
17	FID1, FID2, FID3, FID4, FID5, FID6	6		N/A	N/A	Fiducial mark. There is nothing to buy or mount.	N/A
18	J1, J9, J10, J11, J12	5		61300311121	Wurth Elektronik	Header, 2.54mm, 3x1, Gold, TH	Header, 2.54mm, 3x1, TH
19	J2	1		61301221121	Wurth Electronics	THT Vertical Pin Header WR-PHD, Pitch 2.54mm, Dual Row, 12 pins	HDR12
20	J4, J7	2		1163797	Phoenix Contact	Jack Modular Connector 2P2C Single Pair Ethernet (SPE) 90° Angle (Right) Shielded CatB	PTH_ETHERNET_CONNECTOR
21	J5	1		7466313R	Wurth Electronics	2 Pin Screw Terminal, Power Tap M3 Surface Mount, Right Angle	SMT_REDCUBE_7MM00_4MM33
22	J8	1		SEAM-30-07.0-L-05-2-A-K-TR	Samtec	150 Position Connector High Density Array, Male Surface Mount Gold	HDR150
23	L1, L2, L3, L4, L8, L9	6	80Ω	742792062	Wurth Elektronik	Ferrite Bead, 80Ω at 100MHz, 0.5A, 0805	805
24	L6, L10, L11, L12	4		744232222	Wurth	2 Line Common Mode Choke Surface Mount 200mA DCR 1.2Ohm	SMT4_3MM2_1MM6
25	LBL1	1		THT-14-423-10	Brady	Thermal Transfer Printable Labels, 0.650" W x 0.200" H - 10,000 per roll	PCB Label 0.650 x 0.200 inch

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Table 3-1. Bill of Materials (continued)

Item Number	Designator	Quantity	Value	Part Number	Manufacturer	Description	Package Reference
26	R1, R2, R3, R5, R23, R24, R33, R46, R48, R53, R62, R75, R77, R82, R84, R85, R86, R87, R88, R89, R90, R91, R92, R93, R94, R95, R96, R99, R100, R101, R107	31	0	CRCW04020000Z0ED	Vishay-Dale	RES, 0, 5%, 0.063W, AEC-Q200 Grade 0, 0402	402
27	R6, R7, R8, R9, R10, R11, R12, R13, R14, R15, R16, R17, R18, R19	14	470	CRCW0402470RJNED	Vishay-Dale	RES, 470, 5%, 0.063W, AEC-Q200 Grade 0, 0402	402
28	R21, R22, R25, R102, R104	5	10.0k	CRCW040210K0FKED	Vishay-Dale	RES, 10.0k, 1%, 0.063W, AEC-Q200 Grade 0, 0402	402
29	R28, R29, R32, R36, R37, R57, R61, R65	8	2.49k	CRCW04022K49FKED	Vishay-Dale	RES, 2.49k, 1%, 0.063W, AEC-Q200 Grade 0, 0402	402
30	R41, R44, R70, R73, R108, R109, R110, R111	8	3.3k	CRCW04023K30JNED	Vishay-Dale	RES, 3.3k, 5%, 0.063W, AEC-Q200 Grade 0, 0402	402
31	R42, R47, R51, R78, R80	5	2.20k	CRCW02012K20FKED	Vishay-Dale	RES, 2.20k, 1%, 0.05W, 0201	201
32	R43, R72	2	0	CRCW06030000Z0EA	Vishay-Dale	RES, 0, 5%, 0.1W, AEC-Q200 Grade 0, 0603	603
33	R45, R74	2	100	CRCW0603100RFKEAHP	Vishay-Dale	RES, 100, 1%, 0.25W, AEC-Q200 Grade 0, 0603	603
34	R50, R81	2	22	CRCW040222R0JNED	Vishay-Dale	RES, 22, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	402
35	R54	1	1.0Meg	CRCW20101M00JNEF	Vishay-Dale	RES, 1.0M, 5%, 0.75W, AEC-Q200 Grade 0, 2010	2010
36	R56	1	4.53k	CRCW08054K53FKEA	Vishay-Dale	RES, 4.53k, 1%, 0.125W, AEC-Q200 Grade 0, 0805	805
37	R83	1	2.2k	CRCW04022K20JNED	Vishay-Dale	RES, 2.2k, 5%, 0.063W, AEC-Q200 Grade 0, 0402	402
38	R103	1	66.5k	CRCW040266K5FKED	Vishay-Dale	RES, 66.5k, 1%, 0.063W, AEC-Q200 Grade 0, 0402	402

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Table 3-1. Bill of Materials (continued)

Item Number	Designator	Quantity	Value	Part Number	Manufacturer	Description	Package Reference
39	R105, R106	2	100k	CRCW0402100KFKED	Vishay-Dale	RES, 100k, 1%, 0.063W, AEC-Q200 Grade 0, 0402	402
40	SH-J1, SH-J2, SH-J3, SH-J4	4		60900213421	Wurth Elektronik	Shunt, 2.54mm, Gold, Black	Shunt, 2.54mm, Black
41	T1, T2	2		74930100	Wurth	120µH Pulse Transformer 1:1 Surface Mount	SMT_XFMR_4MM70_3MM22
42	TP1, TP2, TP6, TP7, TP8, TP9, TP10	7		5005	Keystone	Test Point, Compact, Red, TH	Red Compact Testpoint
43	TP3, TP4, TP5	3		5006	Keystone	Test Point, Compact, Black, TH	Black Compact Testpoint
44	U1	1		LMK1C1104DQF	Texas Instruments	3.3V and 2.5V LVCMOS High-Performance Clock Buffer Family, DQF0008A (WSON-8)	DQF0008A
45	U2	1		TPIC2810D	Texas Instruments	8-Bit LED Driver with I2C Interface, D0016A, TUBE	D0016A
46	U3, U5	2		DP83TG720SWRNDTQ1	Texas Instruments	Low Power Auto PHY 1000BASE-T1 Automotive Ethernet Physical Layer Transceiver, RND0036A (VQFNP-36)	RND0036A
47	U4, U6	2		TPD2E2U06DRLR	Texas Instruments	Dual-Channel High-Speed ESD Protection, DRL0005A (SOT-OTHER-5)	DRL0005A
48	U7, U8	2		SN74LVC1G08DCKR	Texas Instruments	Single 2-Input Positive-AND Gate, DCK0005A, LARGE T&R	DCK0005A
49	U9	1		TPSM82822SILR	Texas Instruments	Non-Isolated PoL Module DC DC Converter 1 Output 0.6 ~ 4V 2A 2.4V - 5.5V Input	uSIP10

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Table 3-1. Bill of Materials (continued)

Item Number	Designator	Quantity	Value	Part Number	Manufacturer	Description	Package Reference
50	U10	1		2N7001TDCKR	Texas Instruments	1-Bit Dual-Supply Buffered Voltage Signal Converter, DCK0005A (SOT-SC70-5)	DCK0005A
51	Y1	1		LMK6CE02500CDLFT	Texas Instruments	High-Performance BAW Oscillator	VSON4

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4 Revision History

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

DATE	REVISION	NOTES
September 2024	*	Initial Release

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