

Nikhil Menon

ABSTRACT

This User's Guide discusses how to properly operate and configure the DP83TD510E-EVM. For best layout practices, schematic files, and Bill of Materials, see the associated support documents.

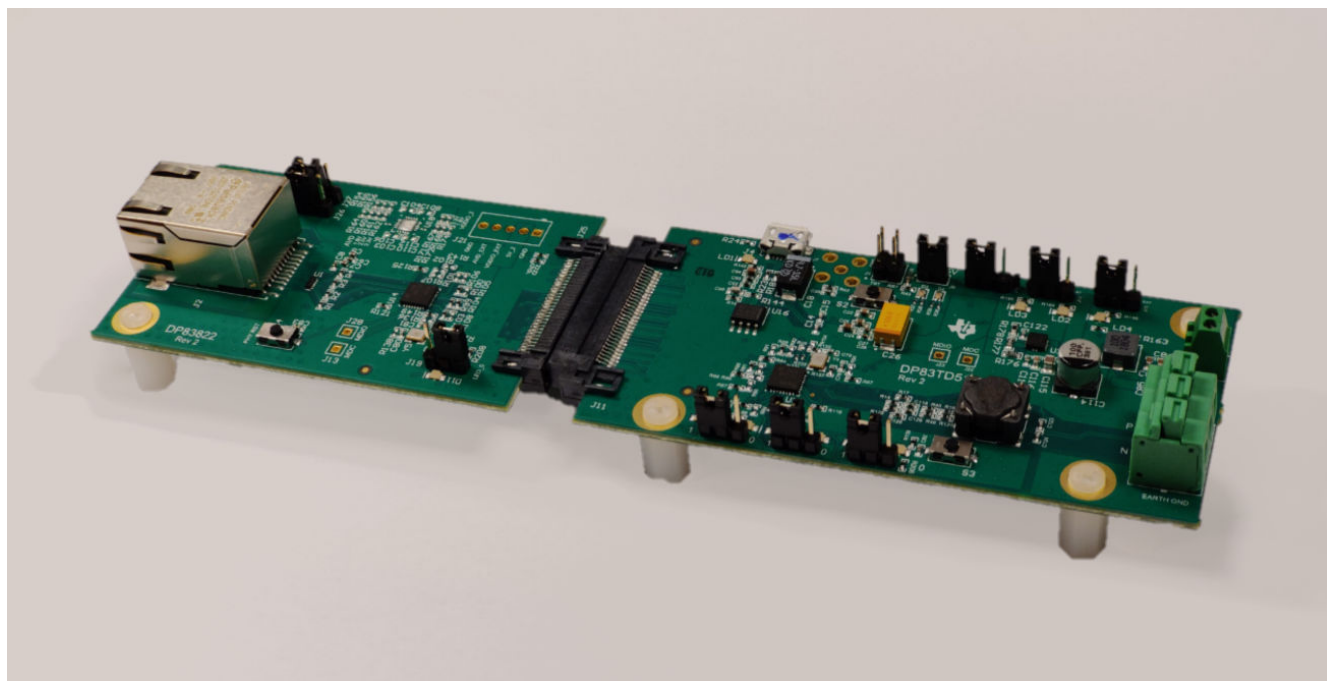


Figure 1-1. DP83TD510E-EVM consists of two PCB's: DP83TD510E Single-Pair-Ethernet board and DP83822I Media-Converter board

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Trademarks

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1 Definitions

Table 1-1. Terminology

ACRONYM	DEFINITION
PHY	Physical Layer Transceiver
MAC	Media Access Controller
SMI	Serial Management Interface
MDIO	Management Data I/O
MDC	Management Data Clock
RGMII	Reduced Gigabit Media Independent Interface
SFD	Start-of-Frame Detection
VDDA	Analog Core Supply Rail
VDDIO	Digital Supply Rail
PD	Pulldown
PU	Pullup
MC	Microcontroller
AFE	Analog Front End

2 Introduction

The DP83TD510E-EVM supports 10-Mbps speed and is IEEE 802.3cg compliant. A DP83822I media converter board is provided for 10BASE-TX Standard Ethernet support and enables bit-error rate testing, interoperability testing, and PMA compliance testing. The EVM also provides on-board tools to configure PHY register using a USB-MDIO graphical user interface tool. The EVM can be powered by a Wide-Vin 5V-36V power supply or through a microUSB cable. Both DP83TD510E and DP83822I can be set to RMII Master or Slave through an on-board 25MHz crystal oscillator or the other's RMII 50MHz clock, respectively.

2.1 Key Features

- Media Converter: 10BASE-T1L to 10BASE-TX
- DP83TD510E IEEE802.3cg Compliant
- 10Base-TX interface for standard Ethernet RJ-45 connection using DP83822H
- RMII Back-to-Back Configuration
- Onboard USB2MDIO to configure PHY
 - USB-2-MDIO Support
 - 4-Pin Dip Switch
- Status LEDs
 - DP83TD510E
 - Link
 - Link + Activity
 - DP83822
 - Link
 - SMI Command
- Variable I/O Voltage Range: 1.8-V, 2.5-V, and 3.3-V
- Bootstraps for Hardware Configuration
- 10BASE-T1L Error Free Data transfer Over 1000 meters
- 10BASE-T1 Error Free Data transfer over 200 meters

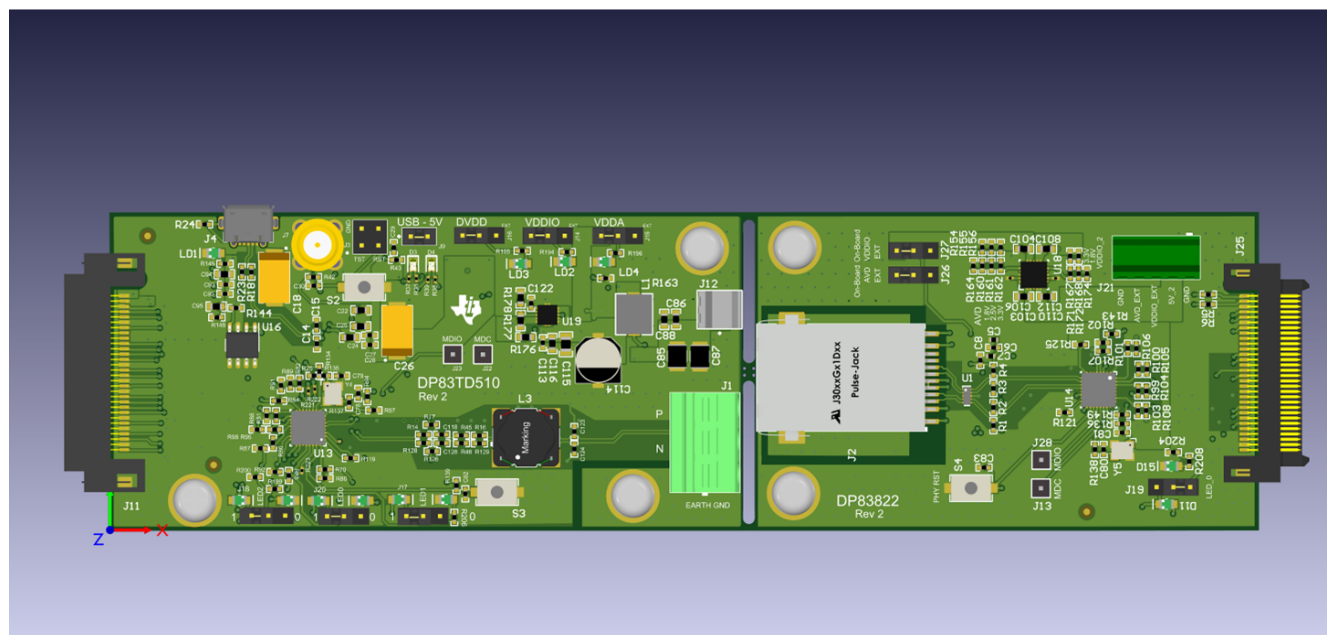


Figure 2-1. DP83TD510E-EVM – Top Side

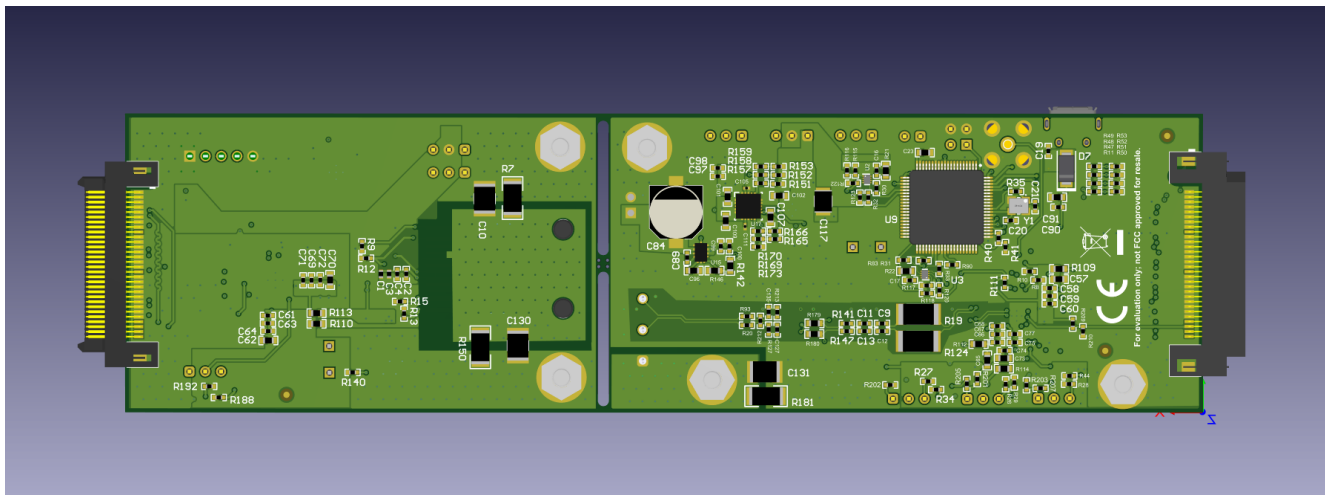


Figure 2-2. DP83TD510E-EVM – Bottom Side

2.2 Block Diagram

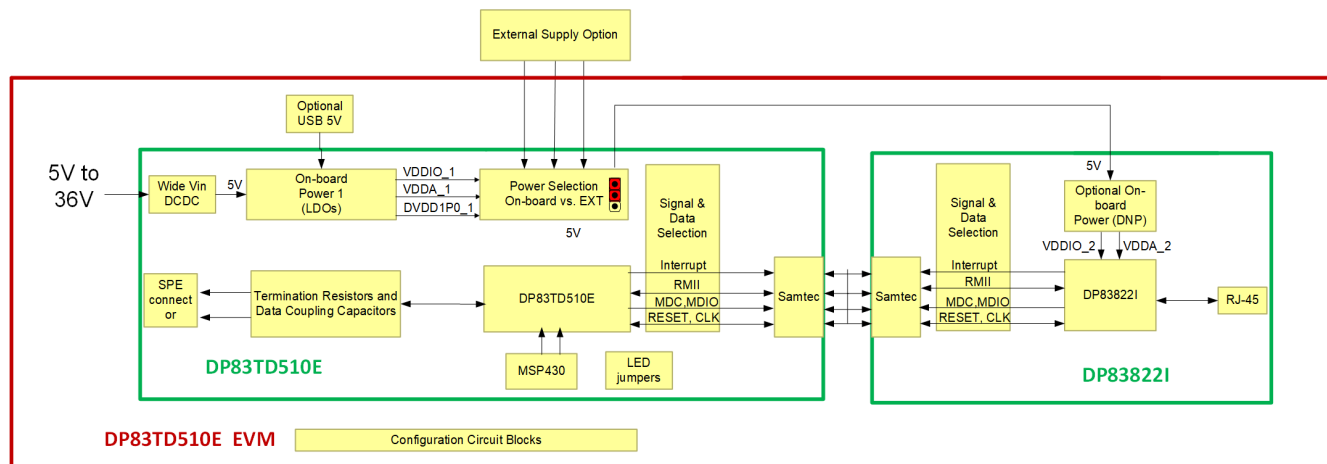
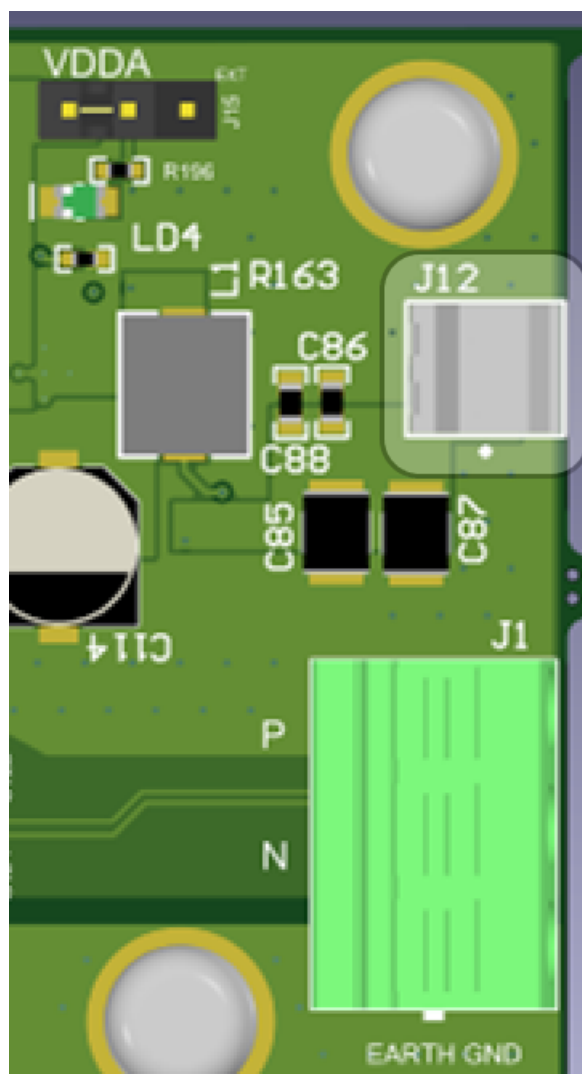


Figure 2-3. DP83TD510E-EVM Block Diagram

The DP83TD510E block of the DP83TD510E-EVM can operate from a single DC supply connected to terminal block J12. The DP83822I media converter board is powered by the VDDIO and VDDA supplies of the DP83TD510E board through the Samtec connector.



- Place shunt at J14 header in the "On-Board" position to connect VDDIO LDO
- Place shunt at J15 header in the "On-Board" position to connect VDDA LDO
- Place shunt at J16 header in the "On-Board" position to connect DVDD LDO
- Remove Shunt at J9 header
- Connect J11 to J25 for Media Converter operation
- **Wide Vin: Connect 36-V to 5-V to pin 1 of J12 and ground to pin 2 of J12**

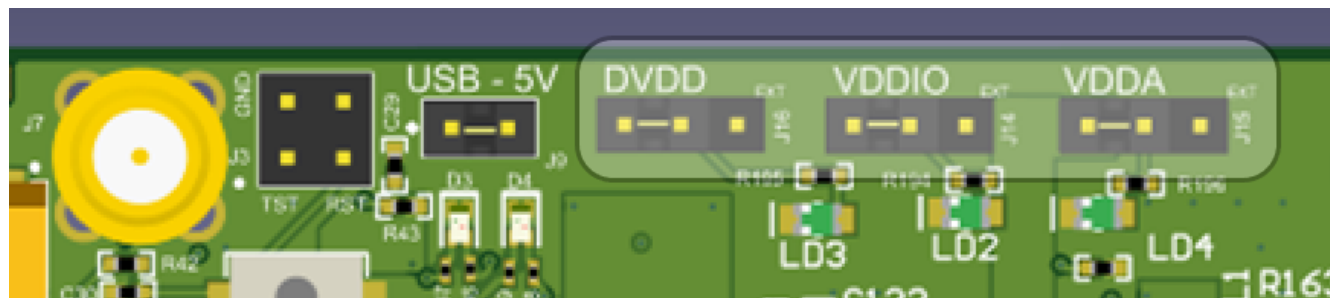


Figure 2-5. DP83TD510E External Supply Connection and Jumpers

3 Board Setup Details

3.1 Power Supply Selection

3.1.1 Onboard Power Supply Operation

- DP83TD510E Onboard Power
 - Place shunt at J14 in the "On-Board" position to enable onboard VDDIO
 - Place shunt at J15 in the "On-Board" position to enable onboard VDDA
 - Place shunt at J16 in the "On-Board" position to enable onboard DVDD
 - Remove shunt at J9
- DP83822I Onboard Power
 - Populate R5, R6 to deliver power through J25 from DP83TD510E board

3.1.2 External Power Supply Operation

- DP83TD510E External Power
 - Place shunt at J14 in the "EXT" position
 - Place shunt at J15 in the "EXT" position
 - Place shunt at J16 in the "EXT" position
 - Connect 1.0V to DVDD-EXT on J16
 - Connect 3.3-V or 1.8V to VDDA-EXT on J15
 - Connect 1.8-V, 2.5-V, or 3.3-V to VDDIO-EXT on J14
 - Connect ground to GND on J12 pin 2
- DP83822I External Power
 - Remove R5, R6 to disconnect VDDA, VDDIO from DP83TD510E board
 - Place shunt at J26 in the "EXT" position to disable onboard VDDA
 - Place shunt at J27 in the "EXT" position to disable onboard VDDIO
 - Connect 3.3-V or 1.8-V to VDDA-EXT on J21 or J26
 - Connect 1.8-V, 2.5-V, or 3.3-V to VDDIO-EXT on J21 or J27
 - Connect ground to GND on J21

3.1.3 USB Power Supply Option

DP83822I block powered by USB.

- Plug in micro-USB to J4
- Place shunt at J9
- Place shunt at J14 in the "On-Board" position
- Place shunt at J15 in the "On-Board" position
- Place shunt at J16 in the "On-Board" position

Note

Only populate J9 when powering over USB.

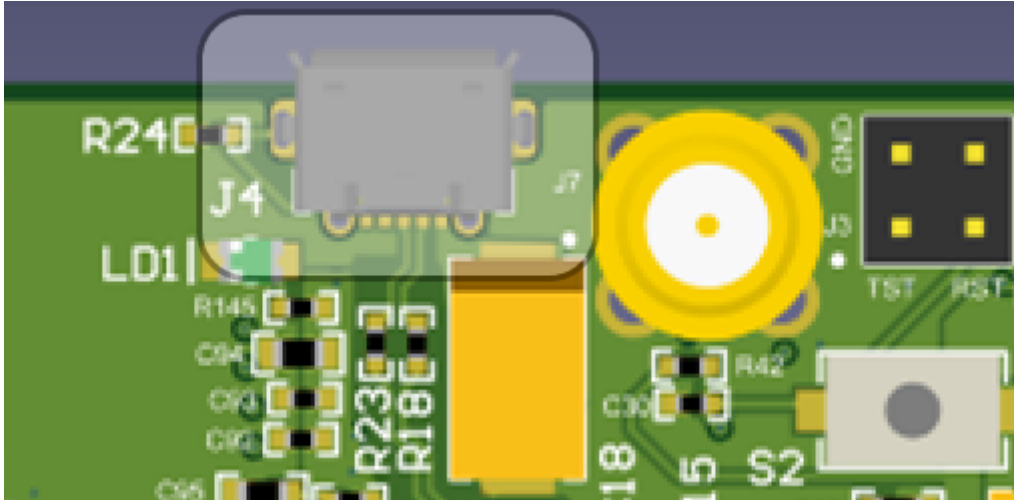


Figure 3-1. DP83TD510E USB Power Supply

3.2 Master and Slave Mode Selection – DP83TD510E

3.2.1 DP83TD510E in RMII Master Mode, DP83822I in RMII Slave Mode (default)

- Populate R149
- Remove R143, R136, R91
- Set the correct hardware straps or perform the correct software write.

Hardware Strapping

- Populate R84, R103 with 2.49k (1%)
- Place shunt on LED_0, J20 in "Mode 0" position

Software Programming

- DP83TD510E
 - Write register 0x0017[5]=1
 - Write register 0x0017[7]=0
- DP83822I
 - Write register 0x0017[5]=1
 - Write register 0x0017[7]=1

3.2.2 DP83TD510E in Slave Mode, DP83822I in Master Mode

- Populate R136, 138, R143, R25
- Remove R135, R137, R149, R91
- Set the correct hardware straps or perform the correct software write.

Hardware Strapping

- Populate R84, R103 with 5.76k (1%), R108 with 2.49k (1%)
- Place shunt on J20 in "Mode 1" position

Software Programming

- DP83822I
 - Write register 0x0017[5]=1
 - Write register 0x0017[7]=0
- DP83TD510E
 - Write register 0x0017[5]=1
 - Write register 0x0017[7]=1

3.3 Clock Selection – DP83TD510E

3.3.1 50 MHz Reference Clock for DP83TD510E in RMII Slave Mode

- Remove R135, R137, R149
- Populate R143, R25

3.3.2 External Clock

- Remove R135
- Populate R134, J7
- Provide External Clock to SMA at J7

3.3.3 On-Board 25 MHz crystal

- Remove R134, R143, R25
- Populate R135, R137

3.4 SMI Connection

In Media Converter configurations, the MDIO/MDC lines of the DP83TD510E and DP83822I are tied together. Both PHYs can be accessed simultaneously. The DP83TD510E has been set to PHY address 00 and the DP83822I has been set to PHY address 05.

- Connect micro-USB to J4
- For direct access to MDIO, MDC lines, populate headers at J22, J23, on DP83TD510E and/or J13, J28 on DP83822I

3.5 Cable Assembly

- Plug a CAT5, CAT5E, or CAT6 cable into the RJ45 connector J2
 - Connect the far-end of the Ethernet cable to a 10BASE-TX capable PHY
- Plug a Single-Pair-Ethernet wires into the terminal block J1 as labeled
 - Connect the far-end of the cable to a 10BASE-T1L capable PHY

3.6 LED Indication

- Look for LED_0 and LED_1 to illuminate when a link is successfully established
- Look for Green LED to illuminate on the RJ45 connector J2 when a link is successfully established (in media convertor mode)
- LED_1 will blink for TX/RX activity

3.7 Serial Management Interface

The DP83TD510E-EVM supports SMI (MDIO/MDC) through J22, J23 and includes an onboard MSP430F5529 for USB-2-MDIO control.

Notes:

- DP83TD510E default PHY_ID is 0
- DP83822 default PHY_ID is 5
- PHY IDs can be changed through bootstrap options found in the data sheet

3.8 Configuration Options

3.8.1 Bootstrap Options

Some DP83TD510E and DP83822 configurations can be done through bootstrap options. Options can be selected with jumpers or resistor population. Refer to the data sheets for bootstrap options and the schematic and layout sections of this User's Guide for resistor locations.

3.8.2

Table 3-1. DP83822 Bootstrap Resistor Designation and Suggested Bootstrap Resistor Values

PIN NAME	PIN NUMBER	STRAP MODE	PU RESISTOR (K Ω)	PU RESISTOR DESIGNATION	PD RESISTOR (K Ω)	PD RESISTOR DESIGNATION
RX_DV	26	1	OPEN	R103	OPEN	R108
		2	10		2.49	
		3	5.76		2.49	
		4	2.49		OPEN	

Table 3-2. DP83TD510E Bootstrap Resistor Designation and Suggested Bootstrap Resistor Values

PIN NAME	PIN NUMBER	STRAP MODE	PU RESISTOR (K Ω)	PU RESISTOR DESIGNATION	PD RESISTOR (K Ω)	PD RESISTOR DESIGNATION
RX_D0	26	0	OPEN	R99	2.49	R104
		1	2.49		OPEN	
RX_D1	25	0	OPEN	R100	2.49	R105
		1	2.49		OPEN	
RX_D2	24	0	OPEN	R101	2.49	R106
		1	2.49		OPEN	
RX_D3	14	0	OPEN	R102	2.49	R107
		1	2.49		OPEN	
RX_DV	15	0	OPEN	R103	2.49	R108
		1	2.49		OPEN	
LED_0	35	0	OPEN	R185	2.49	R201
		1	2.49		OPEN	
LED_2	6	0	OPEN	R187	2.49	R203
		1	2.49		OPEN	

4 Software

The on-board MSP430 comes pre-programmed and ready to use. When using this EVM for the first time on a Windows 7 (or above) PC, MSP430 drivers and USB-2-MDIO software utility will have to be installed. USB-2-MDIO software can be used for accessing the PHY's registers. In the case where an external MSP430 or ezFET is needed, the user may simply connect the TST and RST pins of their device to the DP83TD510E-EVM

4.1 MSP430 Driver

Install the latest MSP430 driver from this website: http://software-dl.ti.com/msp430/msp430_public_sw/mcu/msp430/MSP430_FET_Drivers/latest/index_FDS.html

http://software-dl.ti.com/msp430/msp430_public_sw/mcu/msp430/MSP430_FET_Drivers/latest/index_FDS.html.

4.2 USB-2-MDIO Software

Download the software from <http://www.ti.com/tool/usb-2-mdio> <https://www.ti.com/tool/usb-2-mdio> .

The webpage also contains the User's Guide for installing and using the software. Because the MSP430 is on-board the DP83TD510E-EVM, it is not necessary to purchase a separate MSP430 Launchpad kit and connect to the PHY using wires. In the case the on-board MSP430 cannot be used for some reason, MDIO and MDC pins are also broken out on J23 and J22 pins, respectively. Users can connect an MSP430 launchpad or their own MDIO-MDC utility on J23 and J22 to access the PHY

5 Schematics

Figure 5-1. DP83TD510E-EVM Main Power

5.2 Main Block Schematic

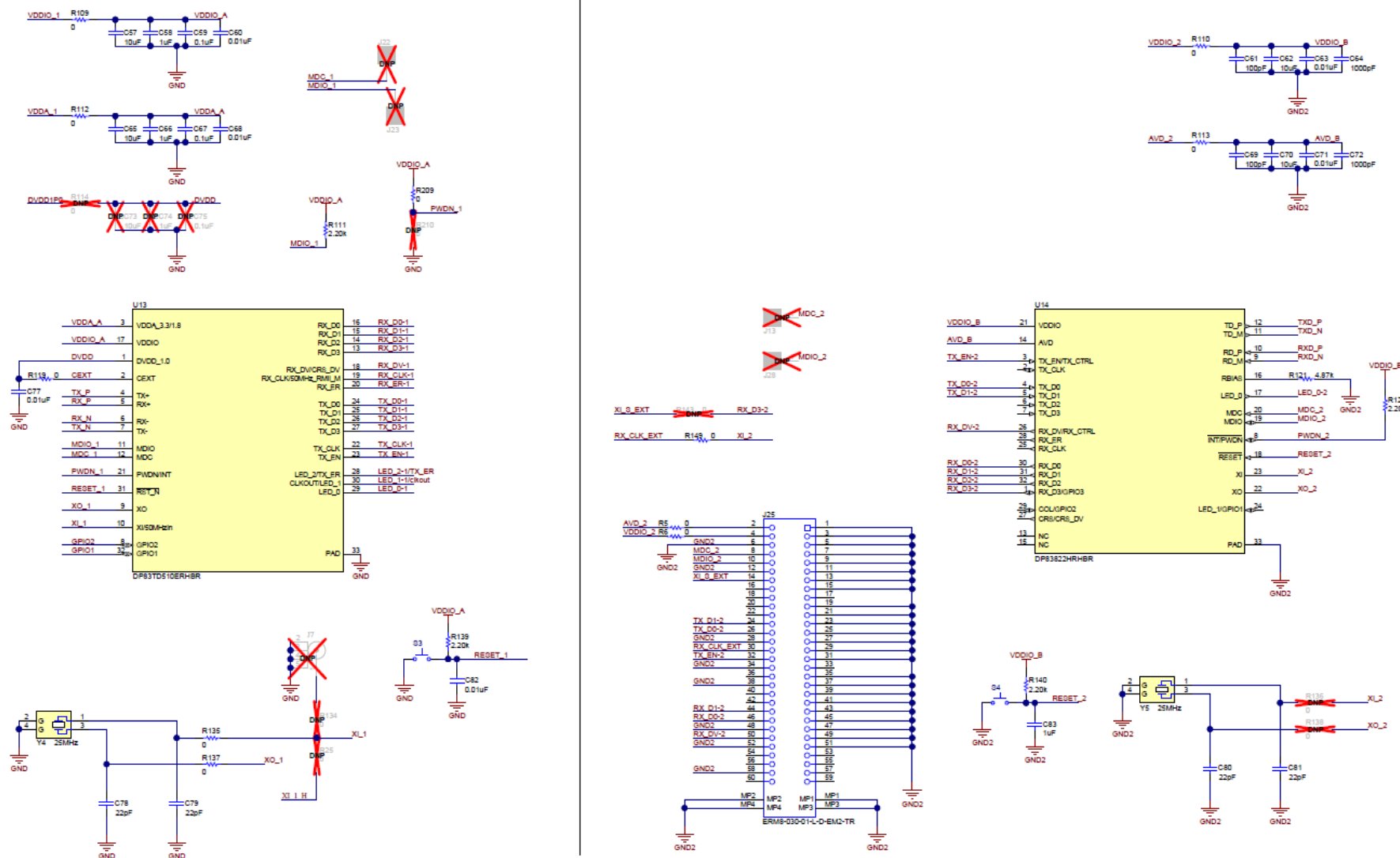


Figure 5-2. DP83TD510E-EVM Main Block

5.3 Interface Schematic

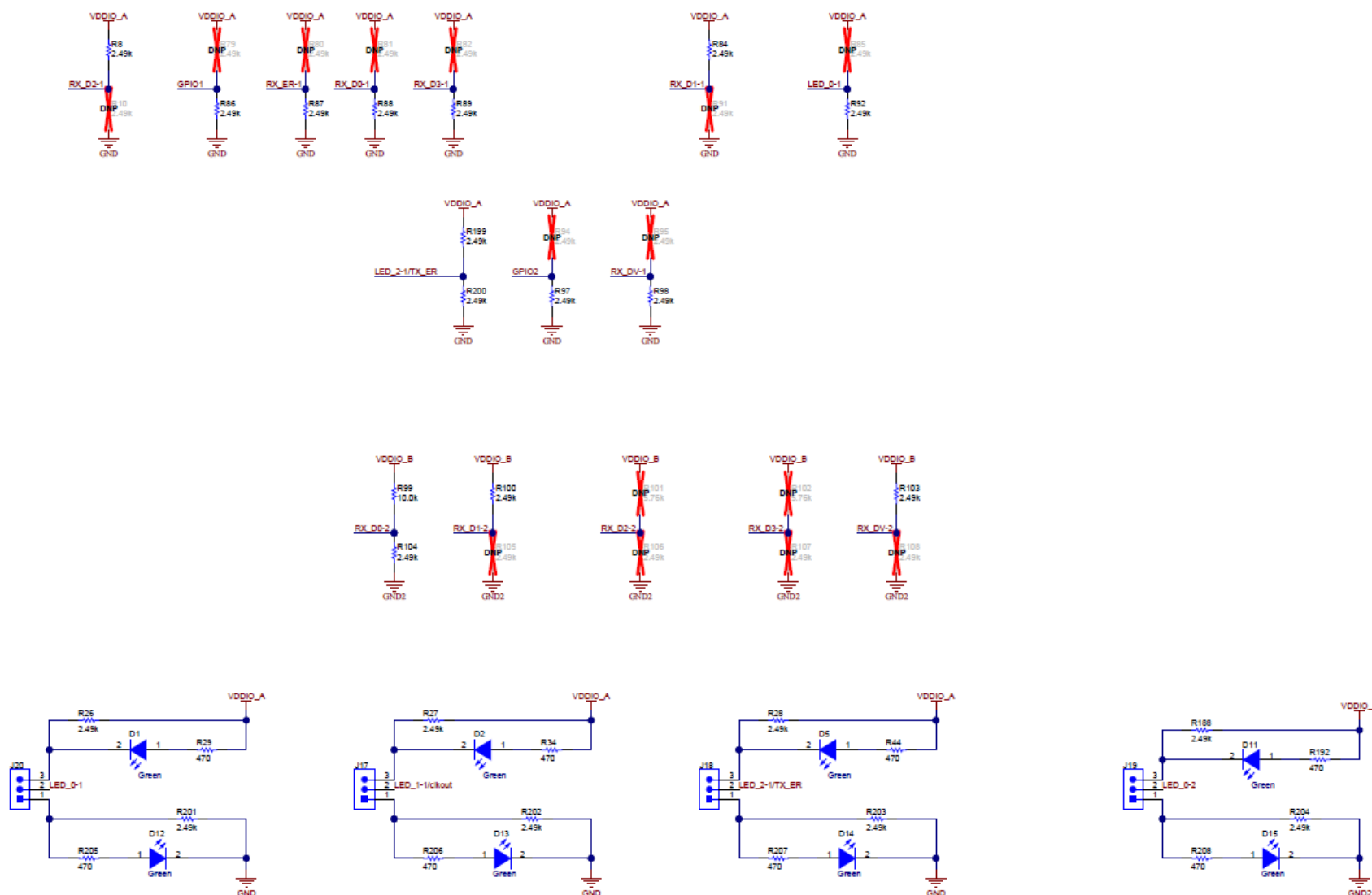


Figure 5-3. DP83TD510E-EVM Interface

5.4 Analog Front End Schematic

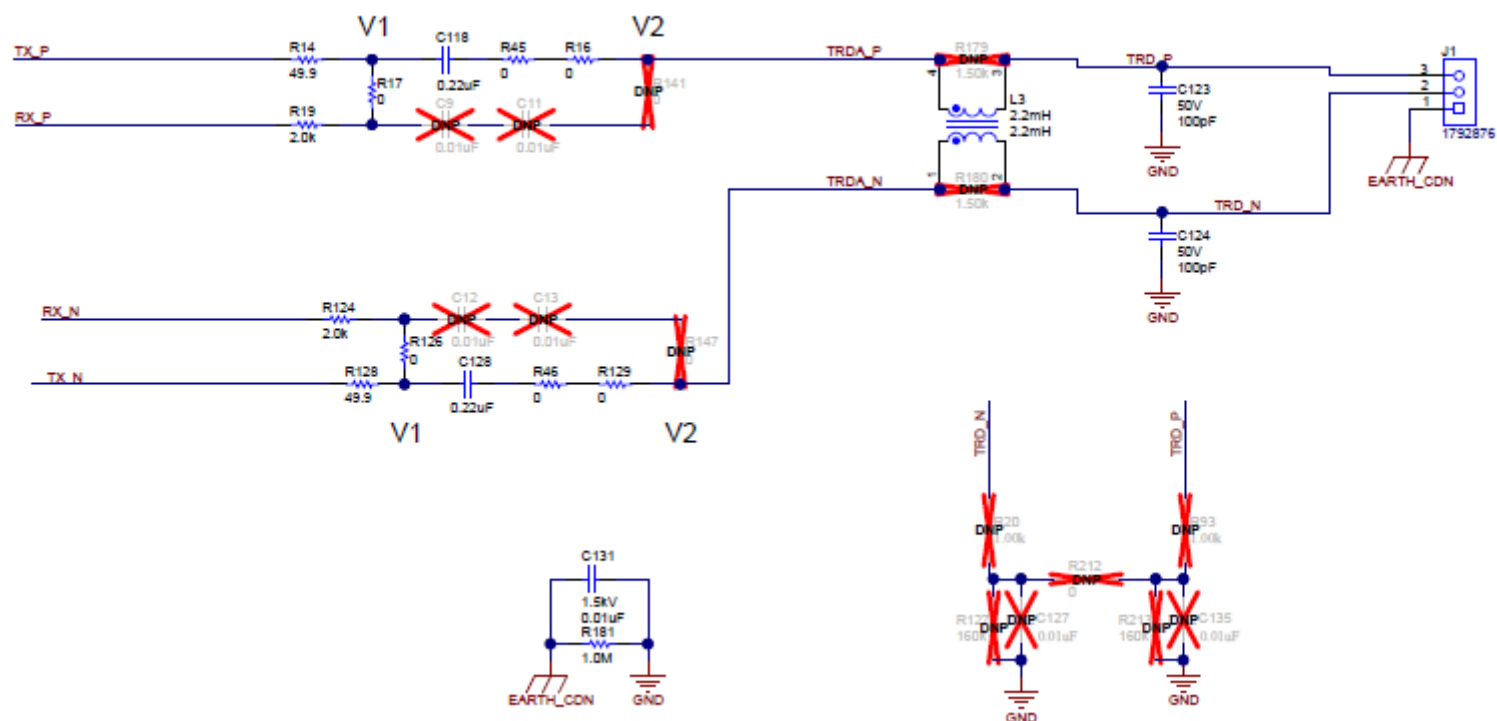


Figure 5-4. DP83TD510E-EVM AFE

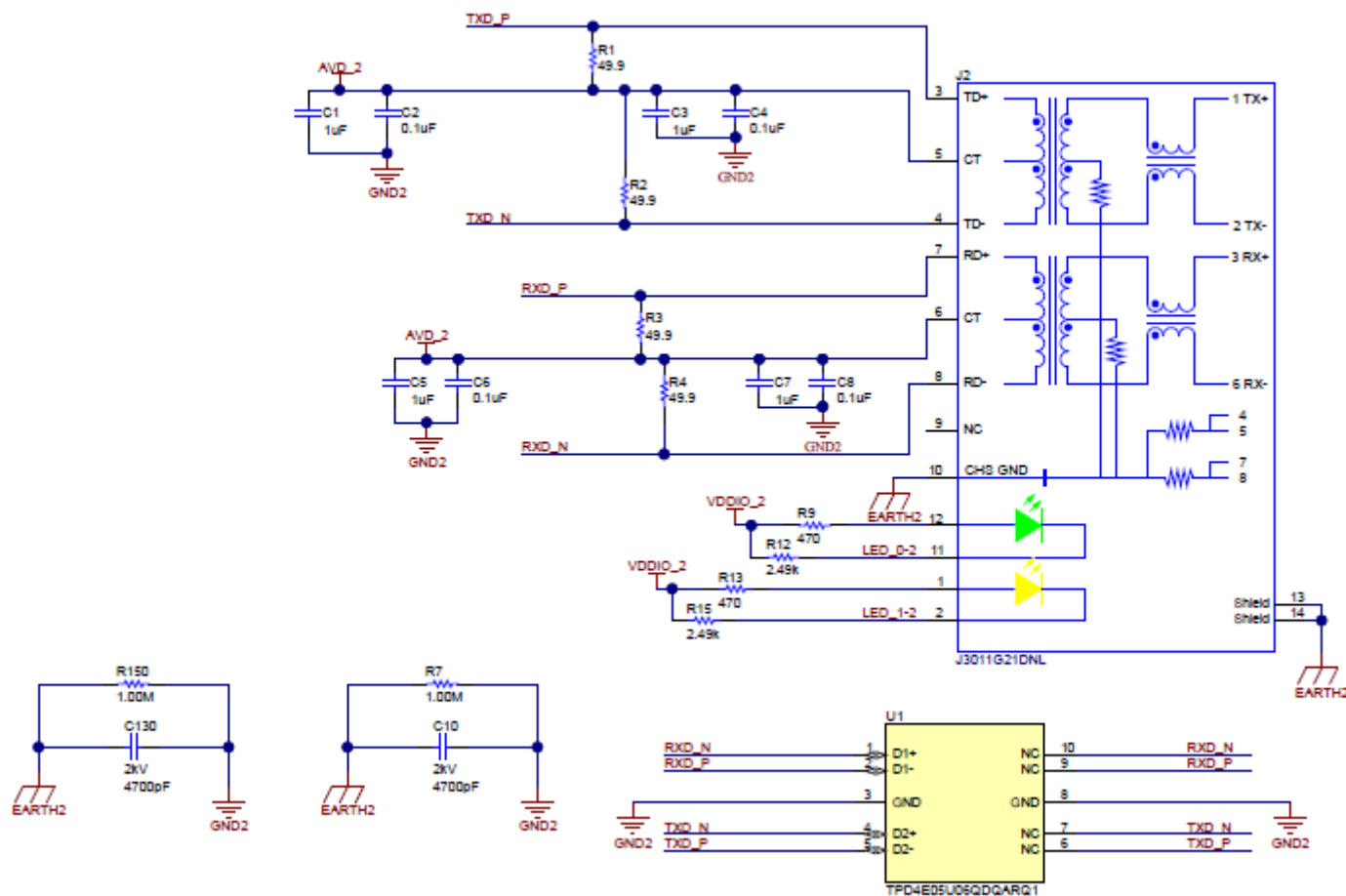


Figure 5-5. DP83822I Media Converter AFE

5.5 COMs Schematic

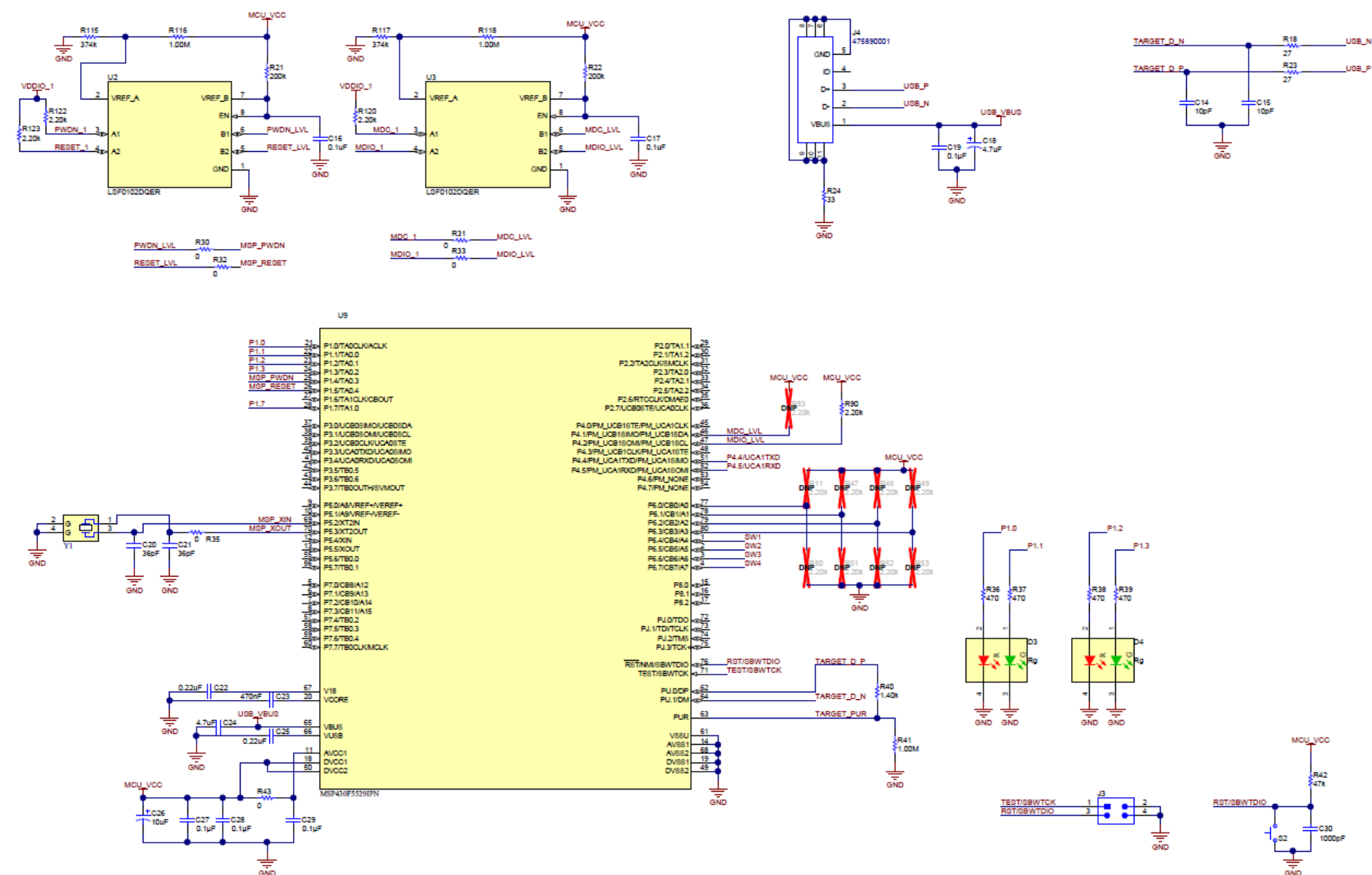


Figure 5-6. DP83TD510E-EVM COMs

5.6 Header Board

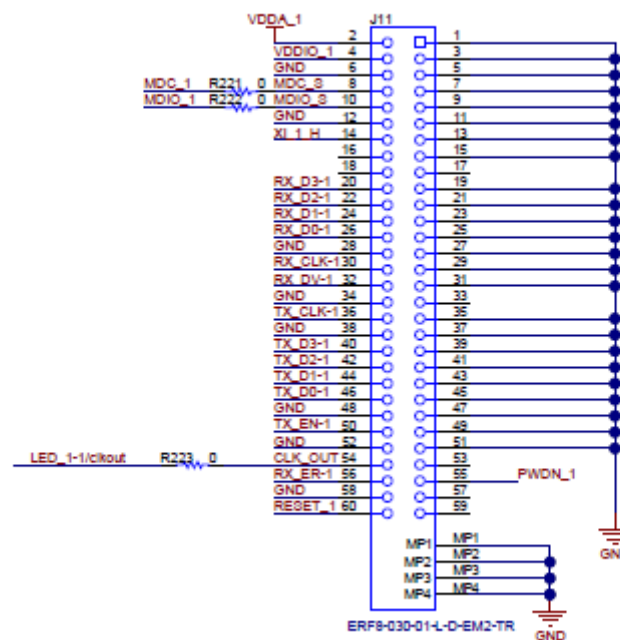
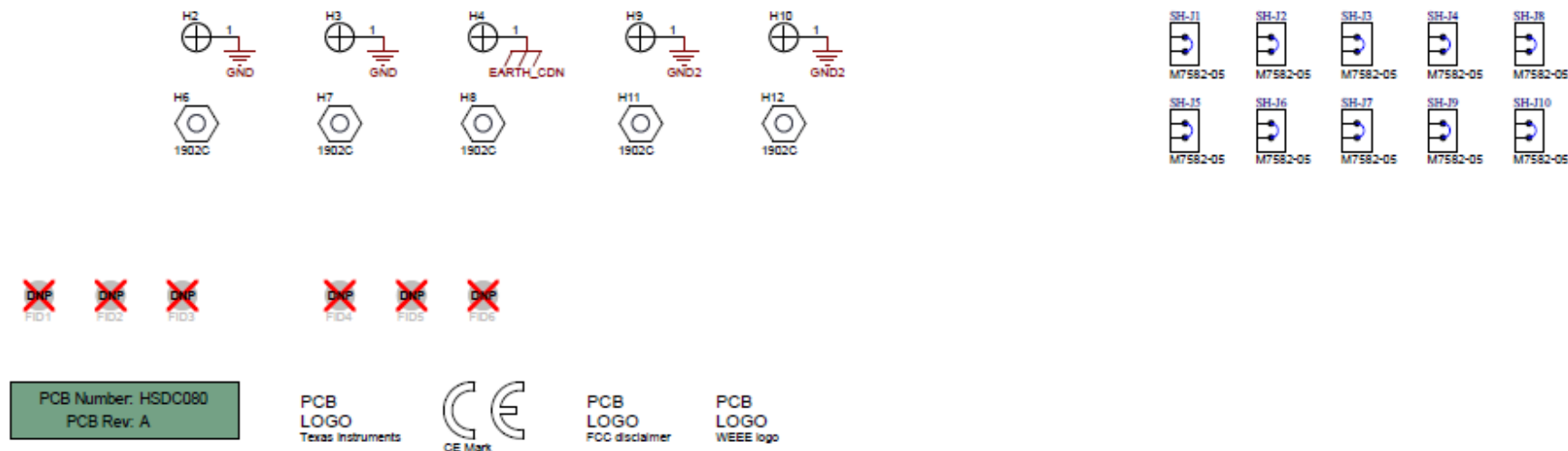


Figure 5-7. DP83TD510E-EVM break-out connector

5.7 Hardware Schematic



ZZ1

Assembly Note

These assemblies are ESD sensitive, ESD precautions shall be observed.

ZZ2

Assembly Note

These assemblies must be clean and free from flux and all contaminants. Use of no clean flux is not acceptable.

ZZ3

Assembly Note

These assemblies must comply with workmanship standards IPC-A-610 Class 2, unless otherwise specified.

6.1 Top Overlay

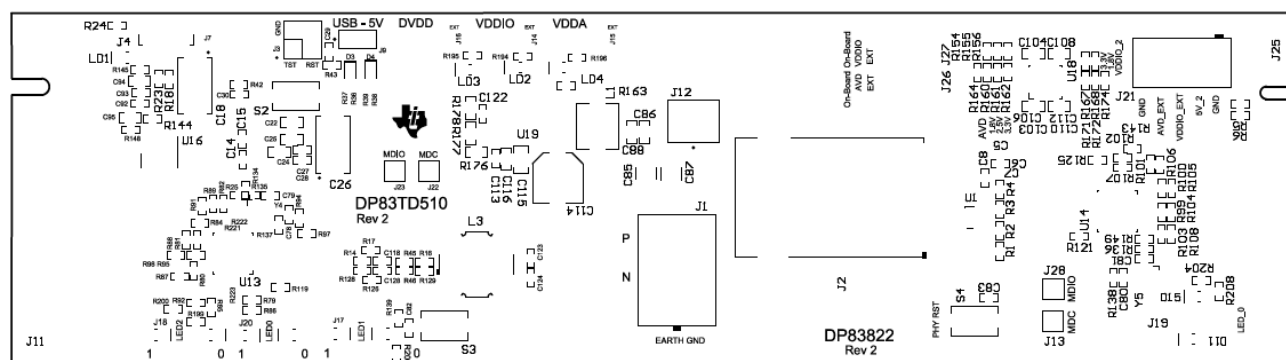


Figure 6-1. Top Overlay

Figure 6-2. Top Layer Mask

Figure 6-3. Top Layer

6.4 Ground Layer 1

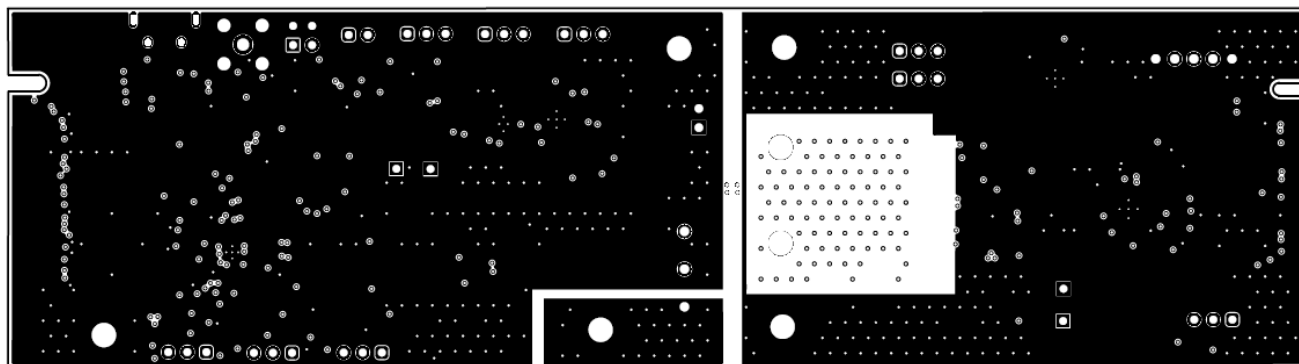


Figure 6-4. Ground Layer 1

6.5 Signal Layer

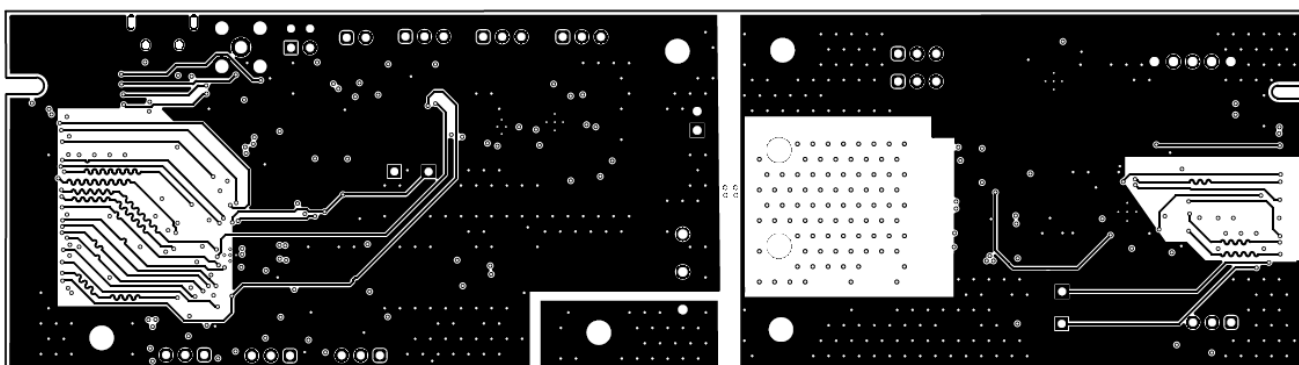


Figure 6-5. Signal Layer

6.6 Power Layer

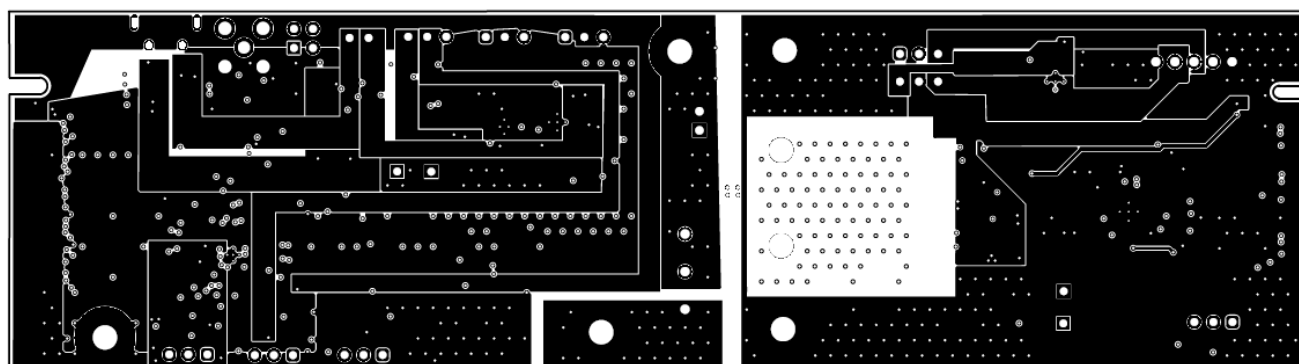


Figure 6-6. Power Layer

6.7 Ground Layer 2

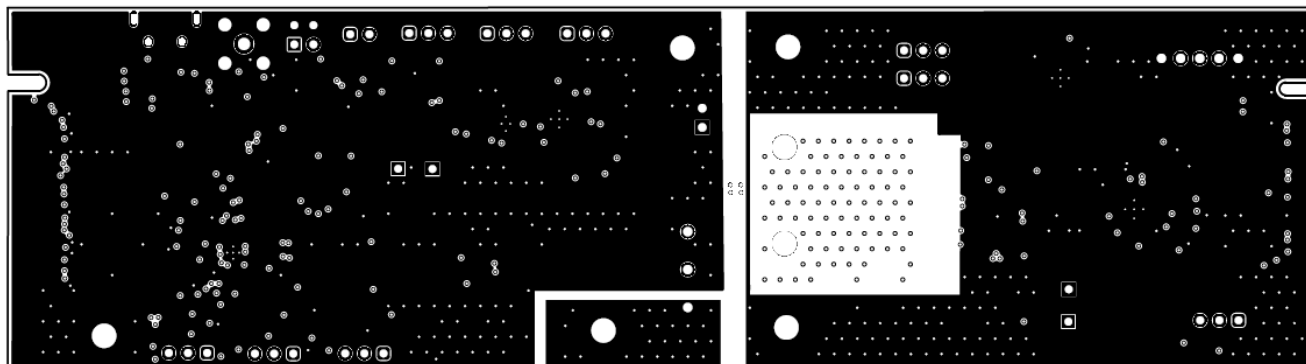


Figure 6-7. Ground Layer 2

6.8 Bottom Layer

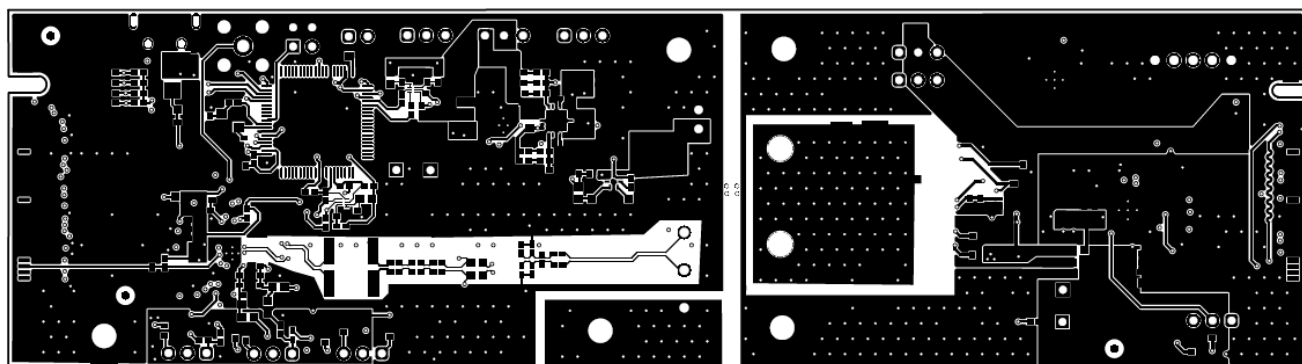


Figure 6-8. Bottom Layer

6.9 Bottom Layer Mask

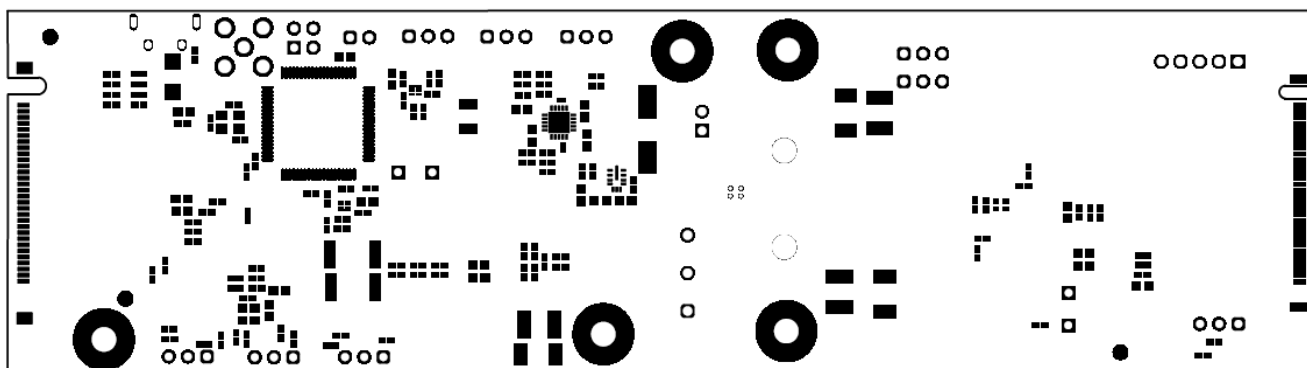


Figure 6-9. Bottom Layer Mask

6.10 Bottom Overlay

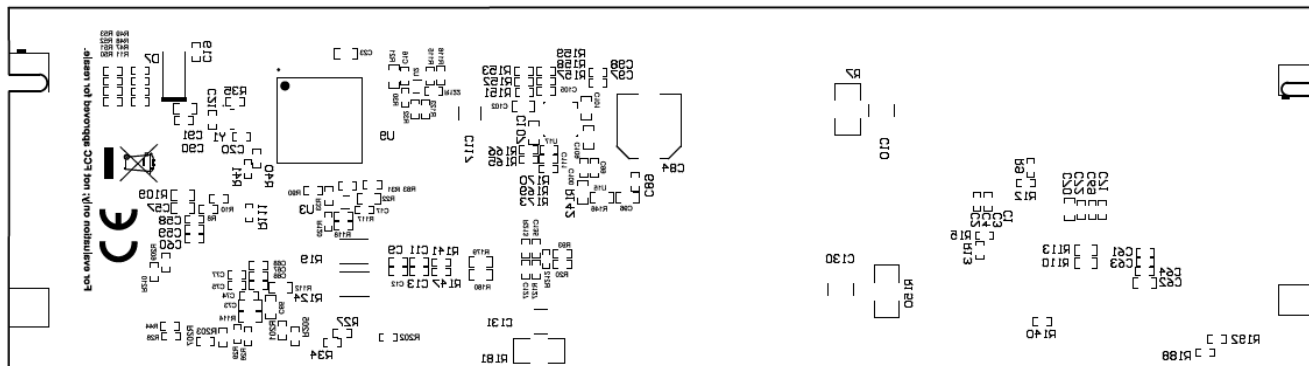
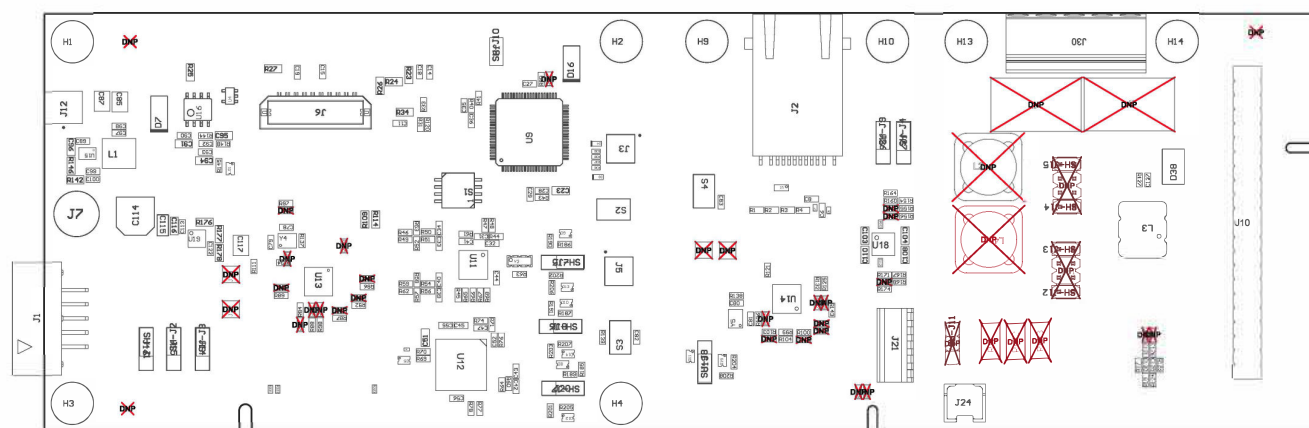


Figure 6-10. Bottom Overlay

6.11 Board Assembly



COMPONENTS MARKED 'DNP' SHOULD NOT BE POPULATED.
ASSEMBLY VARIANT: 001

Figure 6-11. Top Assembly

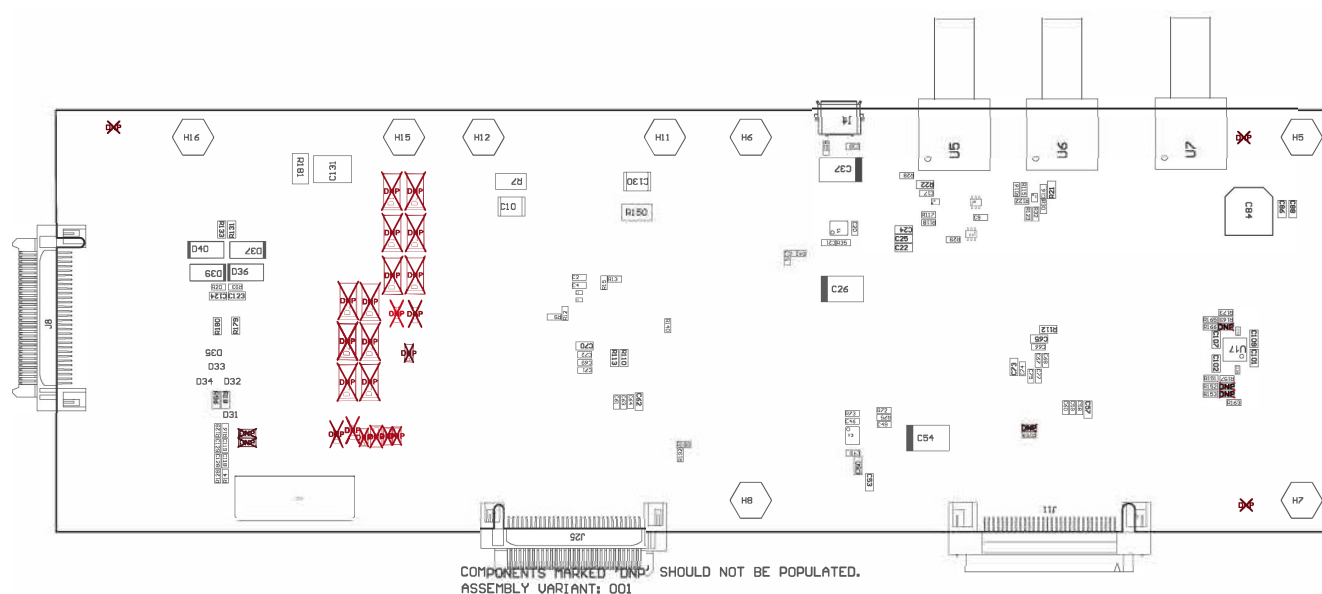


Figure 6-12. Bottom Assembly

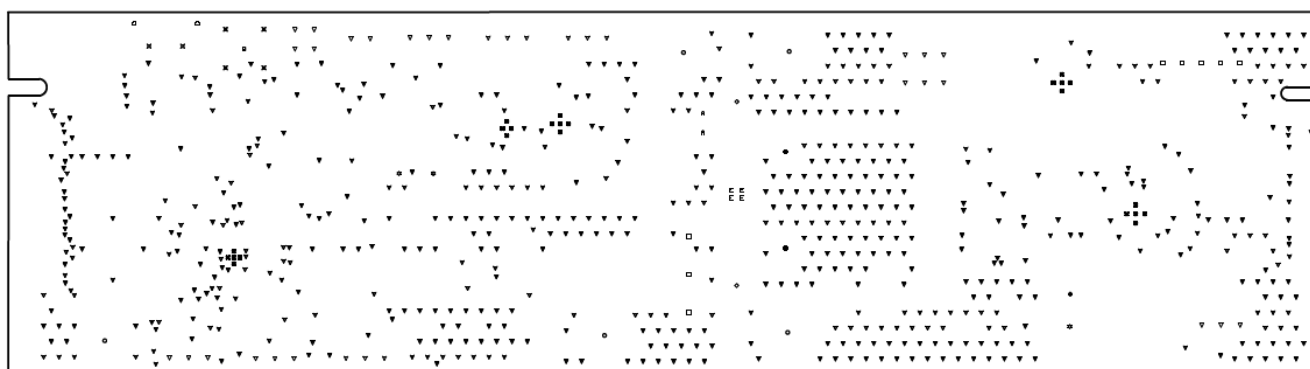


Figure 6-13. Drill Drawing



Figure 6-14. Board Dimensions

7 Bill of Materials

Table 7-1. Bill of Materials

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
C1, C3, C5, C7	4	1uF	CAP, CERM, 1 uF, 10 V, +/- 10%, X7S, AEC-Q200 Grade 1, 0402	0402	GCM155C71A105KE38D	MuRata
C2, C4, C6, C8	4	0.1uF	CAP, CERM, 0.1 uF, 16 V, +/- 10%, X7R, 0402	0402	885012205037	Wurth Elektronik
C10, C130	2	4700pF	CAP, CERM, 4700 pF, 2000 V, +/- 10%, X7R, 1812	1812	1812GC472KAT1A	AVX
C14, C15	2	10pF	CAP, CERM, 10 pF, 16 V, +/- 10%, C0G, 0402	0402	C0402C100K4GACTU	Kemet
C16, C17, C89	3	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0402	0402	GCM155R71H104KE02D	MuRata
C18	1	4.7uF	CAP, TA, 4.7 uF, 35 V, +/- 10%, 1.3 ohm, SMD	7343-31	293D475X9035D2TE3	Vishay-Sprague
C19, C27, C28, C29	4	0.1uF	CAP, CERM, 0.1 uF, 10 V, +/- 10%, X7R, 0402	0402	C0402C104K8RACTU	Kemet
C20, C21	2	36pF	CAP, CERM, 36 pF, 50 V, +/- 5%, C0G/NP0, 0402	0402	CL05C360JB5NNNC	Samsung Electro-Mechanics
C22, C25	2	0.22uF	CAP, CERM, 0.22 uF, 16 V, +80/-20%, Y5V, 0603	0603	C0603C224Z4VACTU	Kemet
C23	1	0.47uF	CAP, CERM, 0.47 uF, 16 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0603	0603	GCM188R71C474KA55D	MuRata
C24	1	4.7uF	CAP, CERM, 4.7 uF, 35 V, +/- 10%, X5R, 0603	0603	C1608X5R1V475K080AC	TDK
C26	1	10uF	CAP, TA, 10 uF, 35 V, +/- 10%, 0.125 ohm, SMD	7343-31	TPSD106K035R0125	AVX
C30, C64, C72	3	1000pF	CAP, CERM, 1000 pF, 50 V, +/- 5%, C0G/NP0, 0402	0402	GRM1555C1H102JA01D	MuRata
C57, C62, C65, C70, C101, C102	6	10uF	CAP, CERM, 10 uF, 10 V, +/- 20%, X7T, 0603	0603	GRM188D71A106MA73D	MuRata
C58, C66, C83, C113	4	1uF	CAP, CERM, 1 uF, 6.3 V, +/- 20%, X7R, 0402	0402	GRM155R70J105MA12D	MuRata
C59, C67	2	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 20%, X7R, AEC-Q200 Grade 1, 0402	0402	CGA2B3X7R1H104M050BB	TDK

Table 7-1. Bill of Materials (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
C60, C63, C68, C71, C77, C82	6	0.01uF	CAP, CERM, 0.01 uF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0402	0402	CGA2B3X7R1H103K050BB	TDK
C61, C69	2	100pF	CAP, CERM, 100 pF, 50 V, +/- 5%, C0G/NP0, AEC-Q200 Grade 1, 0402	0402	CGA2B2C0G1H101J050BA	TDK
C78, C79, C80, C81, C97, C98, C99, C100	8	22pF	CAP, CERM, 22 pF, 50 V, +/- 5%, C0G/NP0, AEC-Q200 Grade 1, 0402	0402	GCM1555C1H220JA16D	MuRata
C84	1	100uF	CAP, AL, 100 uF, 50 V, +/- 20%, SMD	HA0	EMVE500ADA101MHA0G	Chemi-Con
C85, C87, C117	3	4.7uF	CAP, CERM, 4.7 uF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 1210	1210	CGA6P3X7R1H475K250AB	TDK
C86, C88	2	0.22uF	CAP, CERM, 0.22 uF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0603	0603	CGA3E3X7R1H224K080AB	TDK
C90	1	1uF	CAP, CERM, 1 uF, 35 V, +/- 20%, X5R, 0402	0402	GRM155R6YA105ME11D	MuRata
C91, C94	2	10uF	CAP, CERM, 10 uF, 35 V, +/- 20%, X5R, 0603	0603	GRM188R6YA106MA73D	Murata
C92, C93	2	2.2uF	CAP, CERM, 2.2 uF, 16 V, +/- 10%, X6S, 0402	0402	GRM155C81C225KE11D	MuRata
C95	1	470pF	CAP, CERM, 470 pF, 100 V, +/- 5%, X7R, 0603	0603	06031C471JAT2A	AVX
C96	1	1uF	CAP, CERM, 1 uF, 35 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0603	0603	CGA3E1X7R1V105K080AC	TDK
C105, C111	2	0.01uF	CAP, CERM, 0.01 uF, 25 V, +/- 10%, X7R, 0201	0201	GRM033R71E103KE14D	MuRata
C107, C109	2	10uF	CAP, CERM, 10 uF, 6.3 V, +/- 20%, X7S, 0603	0603	C1608X7S0J106M080AC	TDK
C114	1	100uF	CAP, AL, 100 uF, 16 V, +/- 20%, 0.26 ohm, AEC-Q200 Grade 2, SMD	SMT Radial D	EEEF1C101AP	Panasonic
C115	1	10uF	CAP, CERM, 10 uF, 25 V, +/- 10%, X7S, 0805	0805	GRM21BC71E106KE11L	MuRata
C116	1	4.7uF	CAP, CERM, 4.7 uF, 10 V, +/- 10%, X7S, 0603	0603	C1608X7S1A475K080AC	TDK
C118, C128	2	0.22uF	CAP, CERM, 0.22 uF, 10 V, +/- 10%, X5R, 0402	0402	GRM155R61A224KE19D	MuRata

Table 7-1. Bill of Materials (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
C122	1	27pF	CAP, CERM, 27 pF, 50 V, +/- 5%, C0G/NP0, 0402	0402	GJM1555C1H270JB01	MuRata
C123, C124	2	100pF	CAP, CERM, 100 pF, 50 V, +/- 1%, C0G/NP0, 0402	0402	04025A101FAT2A	AVX
C131	1	0.01uF	CAP, CERM, 0.01 uF, 1500 V, +/- 10%, X7R, 1812	1812	1812SC103KAT1A	AVX
D1, D2, D5, D11, D12, D13, D14, D15, LD1, LD2, LD3, LD4	12	Green	LED, Green, SMD	2x1.25mm	QTLF630C4TR	Everlight
D3, D4	2	Rg	LED, Rg, SMD	1.6x0.8mm	HSMF-C165	Avago
D7	1	60V	Diode, Schottky, 60 V, 1 A, AEC-Q101, SMA	SMA	NRVBA160T3G	ON Semiconductor
H2, H3, H4, H9, H10	5		Machine Screw, Round, #4-40 x 1/4, Nylon, Philips panhead	Screw	NY PMS 440 0025 PH	B&F Fastener Supply
H6, H7, H8, H11, H12	5		Standoff, Hex, 0.5"L #4-40 Nylon	Standoff	1902C	Keystone
J1	1		Terminal Block, 5mm, 3x1, R/A, TH	Terminal Block, 5mm, 3x1, R/A, TH	1792876	Phoenix Contact
J2	1		Connector, RJ45 with integrated magnetics, 1x1, Gold, R/A, SMT	Connector, RJ-45 with integrated magnetics, 1x1, R/A, SMT	J3011G21DNL	Pulse Engineering
J3	1		Header, 100mil, 2x2, Gold, TH	2x2 Header	TSW-102-07-G-D	Samtec
J4	1		Connector, Receptacle, Micro-USB Type AB, R/A, Bottom Mount SMT	5.6x2.5x8.2mm	475890001	Molex
J9	1		Header, 100mil, 2x1, Gold, TH	2x1 Header	TSW-102-07-G-S	Samtec
J11	1		Receptacle, 0.8mm, 30x2, Gold, Edge Mount	Receptacle, 0.8mm, 30x2, Edge Mount	ERF8-030-01-L-D-EM2-TR	Samtec
J12	1		Terminal Block, 2x1, 2.54mm, TH	Terminal Block, 2x1, 2.54mm, TH	282834-2	TE Connectivity

Table 7-1. Bill of Materials (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
J14, J15, J16, J17, J18, J19, J20, J26, J27	9		Header, 100mil, 3x1, Gold, TH	3x1 Header	TSW-103-07-G-S	Samtec
J25	1		Receptacle, 0.8mm, 30x2, Tin, Edge mount	Receptacle, 0.8mm, 30x2, Edge mount	ERM8-030-01-L-D-EM2-TR	Samtec
L1	1	10uH	Inductor, Shielded, Ferrite, 10 uH, 2.75 A, 0.128 ohm, SMD	Inductor, 5.7x2.8x5.2mm	SRP5030T-100M	Bourns
L3	1	2.2mH	Coupled inductor, 2.2 mH, 0.75 A, 0.3 ohm, SMD	8.7x10mm	744272222	Würth Elektronik
R1, R2, R3, R4	4	49.9	RES, 49.9, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040249R9FKED	Vishay-Dale
R5, R6, R119, R135, R137, R149, R157, R169, R209	9	0	RES, 0, 5%, 0.063 W, 0402	0402	RC0402JR-070RL	Yageo America
R7, R150	2	1.00Meg	RES, 1.00 M, 1%, 1 W, 2010	2010	HVCB2010FKC1M00	Stackpole Electronics Inc
R8, R12, R15, R26, R27, R28, R84, R86, R87, R88, R89, R92, R97, R98, R100, R103, R104, R188, R199, R200, R201, R202, R203, R204	24	2.49k	RES, 2.49 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04022K49FKED	Vishay-Dale
R9, R13, R145, R194, R195, R196	6	470	RES, 470, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402470RJNED	Vishay-Dale
R14, R128	2	49.9	RES, 49.9, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	RMCF0402FT49R9	Stackpole Electronics Inc
R16, R17, R45, R46, R126, R129	6	0	RES, 0, 0%, 0.2 W, AEC-Q200 Grade 0, 0402	0402	CRCW04020000Z0EDHP	Vishay-Dale
R18, R23	2	27	RES, 27, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040227R0JNED	Vishay-Dale
R19, R124	2	2.0k	RES, 2.0 k, 5%, 1 W, AEC-Q200 Grade 0, 2512	2512	CRCW25122K00JNEG	Vishay-Dale

Table 7-1. Bill of Materials (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
R21, R22	2	200k	RES, 200 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW0603200KJNEA	Vishay-Dale
R24	1	33	RES, 33, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040233R0JNED	Vishay-Dale
R29, R34, R44, R192, R205, R206, R207, R208	8	470	RES, 470, 1%, 0.1 W, AEC-Q200 Grade 0, 0402	0402	ERJ-2RKF4700X	Panasonic
R30, R31, R32, R33	4	0	RES, 0, 5%, 0.1 W, AEC-Q200 Grade 0, 0402	0402	ERJ-2GE0R00X	Panasonic
R35, R43	2	0	RES, 0, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04020000Z0ED	Vishay-Dale
R36, R37, R38, R39	4	470	RES, 470, 5%, 0.05 W, 0201	0201	RC0201JR-07470RL	Yageo America
R40	1	1.40k	RES, 1.40 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04021K40FKED	Vishay-Dale
R41	1	1.00Meg	RES, 1.00 M, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04021M00FKED	Vishay-Dale
R42	1	47k	RES, 47 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040247K0JNED	Vishay-Dale
R90, R111, R120, R122, R123, R125, R139, R140	8	2.20k	RES, 2.20 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04022K20FKED	Vishay-Dale
R99	1	10.0k	RES, 10.0 k, 1%, 0.063 W, 0402	0402	RC0402FR-0710KL	Yageo America
R109, R110, R112, R113	4	0	RES, 0, 5%, 0.1 W, 0603	0603	RC0603JR-070RL	Yageo
R115, R117	2	374k	RES, 374 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402374KFKED	Vishay-Dale
R116, R118	2	1.00Meg	RES, 1.00 M, 1%, 0.1 W, 0402	0402	ERJ-2RKF1004X	Panasonic
R121	1	4.87k	RES, 4.87 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04024K87FKED	Vishay-Dale

Table 7-1. Bill of Materials (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
R142	1	100k	RES, 100 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW0603100KFKEA	Vishay-Dale
R144	1	100k	RES, 100 k, 0.5%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402100KDHEDP	Vishay-Dale
R146	1	24.9k	RES, 24.9 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060324K9FKEA	Vishay-Dale
R148	1	165k	RES, 165 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402165KFKED	Vishay-Dale
R151, R165	2	33.2k	RES, 33.2 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040233K2FKED	Vishay-Dale
R152	1	22.6k	RES, 22.6 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040222K6FKED	Vishay-Dale
R153, R166	2	13.3k	RES, 13.3 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040213K3FKED	Vishay-Dale
R163, R173	2	10.7k	RES, 10.7 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040210K7FKED	Vishay-Dale
R176	1	10.0k	RES, 10.0 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW060310K0FKEA	Vishay-Dale
R177	1	1.13k	RES, 1.13 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW06031K13FKEA	Vishay-Dale
R178	1	4.53k	RES, 4.53 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	0603	CRCW06034K53FKEA	Vishay-Dale
R181	1	1.0Meg	RES, 1.0 M, 5%, 0.75 W, AEC-Q200 Grade 0, 2010	2010	CRCW20101M00JNEF	Vishay-Dale
R221, R222, R223	3	0	RES, 0, 5%, 0.05 W, 0201	0201	CRCW02010000Z0ED	Vishay-Dale
S2, S3, S4	3		Switch, Normally open, 2.3N force, 200k operations, SMD	KSR	KSR221GLFS	C&K Components
SH-J1, SH-J2, SH-J3, SH-J4, SH-J5, SH-J6, SH-J7, SH-J8, SH-J9, SH-J10	10		Single Operation 2.54mm Pitch Open Top Jumper Socket	Single Operation 2.54mm Pitch Open Top Jumper Socket	M7582-05	Harwin

Table 7-1. Bill of Materials (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
U1	1		Automotive 4-Channel ESD Protection Solution for SuperSpeed (up to 5 Gbps) Interface, DQA0010A (USON-10)	DQA0010A	TPD4E05U06QDQARQ1	Texas Instruments
U2, U3	2		Dual Bidirectional Multi-Voltage Level Translator, DQE0008A (X2SON-8)	DQE0008A	LSF0102DQER	Texas Instruments
U9	1		25 MHz Mixed Signal Microcontroller with 128 KB Flash, 8192 B SRAM and 63 GPIOs, -40 to 85 degC, 80-pin QFP (PN), Green (RoHS & no Sb/Br)	PN0080A	MSP430F5529IPN	Texas Instruments
U13	1		802.3cg 10-M Single-Pair Ethernet PHY for 1000 Meter, RHB0032M (VQFN-32)	RHB0032M	DP83TD510ERHBR	Texas Instruments
U14	1		Robust, Low Power 10/100 Ethernet Physical Layer Transceiver Extended Temperature, RHB0032B (VQFN-32)	RHB0032B	DP83822HRHBR	Texas Instruments
U15	1		3.8-V to 36-V 2-A Synchronous Step-Down Voltage Regulator, RNX0012B (VQFN-HR-12)	RNX0012B	LMR33620ARNXT	Texas Instruments
U16	1		Single Output Low Noise LDO, 500 mA, Adjustable 1.3 to 6.5 V Output, 2.5 to 16 V Input, 8-pin SOIC (D), -40 to 125 degC, Green (RoHS & no Sb/Br)	D0008A	TL5209DR	Texas Instruments
U17	1		Dual 500mA Low-Noise (3.8µVRMS) LDO Voltage Regulator, RTJ0020D (WQFN-20)	RTJ0020D	TPS7A8701RTJR	Texas Instruments
U19	1		Single Output LDO, 500mA, Adj. (0.8 to 3.6V), Programmable Soft-Start, DRC0010J (VSON-10)	DRC0010J	TPS74701DRCR	Texas Instruments
Y1	1		Crystal, 24 MHz, 20pF, SMD	3.2x2.5mm	ECS-240-20-33-DU-TR	ECS Inc.
Y4, Y5	2		Crystal, 25 MHz, 12pF, AEC-Q200 Grade 1, SMD	3.2x2.5mm	ABM8AIG-25.000MHZ-12-2Z-T3	Abracon Corporation
C9, C11, C12, C13	0	0.01uF	CAP, CERM, 0.01 uF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0402	0402	CGA2B3X7R1H103K050BB	TDK
C73	0	10uF	CAP, CERM, 10 uF, 10 V, +/- 20%, X7T, 0603	0603	GRM188D71A106MA73D	MuRata
C74	0	1uF	CAP, CERM, 1 uF, 6.3 V, +/- 20%, X7R, 0402	0402	GRM155R70J105MA12D	MuRata

Table 7-1. Bill of Materials (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
C75	0	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 20%, X7R, AEC-Q200 Grade 1, 0402	0402	CGA2B3X7R1H104M050BB	TDK
C103, C104, C108, C110	0	10uF	CAP, CERM, 10 uF, 6.3 V, +/- 20%, X7S, 0603	0603	C1608X7S0J106M080AC	TDK
C106, C112	0	0.01uF	CAP, CERM, 0.01 uF, 25 V, +/- 10%, X7R, 0201	0201	GRM033R71E103KE14D	MuRata
C127, C135	0	0.01uF	CAP, CERM, 0.01 uF, 50 V, +/- 5%, X7R, 0402	0402	C0402C103J5RACTU	Kemet
FID1, FID2, FID3, FID4, FID5, FID6	0		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A
J7	0		Connector, SMA, TH	SMA	142-0701-201	Cinch Connectivity
J13, J22, J23, J28	0		Header, 1x1, Tin, TH	Header, 1x1	PEC01SAAN	Sullins Connector Solutions
J21	0		Terminal Block, 2.54mm, 5 Pos, Tin, Green, R/A, TH	Terminal Block, 2.54mm, 5 Pos, R/A, TH	282834-5	TE Connectivity
R10, R79, R80, R81, R82, R85, R91, R94, R95, R105, R106, R107, R108	0	2.49k	RES, 2.49 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04022K49FKED	Vishay-Dale
R11, R47, R48, R49, R50, R51, R52, R53, R83	0	2.20k	RES, 2.20 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04022K20FKED	Vishay-Dale
R20, R93	0	1.00k	RES, 1.00 k, 1%, 0.1 W, 0402	0402	ERJ-2RKF1001X	Panasonic
R25, R134, R136, R138, R143, R158, R159, R160, R161, R162, R170, R171, R172, R210	0	0	RES, 0, 5%, 0.063 W, 0402	0402	RC0402JR-070RL	Yageo America
R101, R102	0	5.76k	RES, 5.76 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW04025K76FKED	Vishay-Dale
R114	0	0	RES, 0, 5%, 0.1 W, 0603	0603	RC0603JR-070RL	Yageo

Table 7-1. Bill of Materials (continued)

Designator	Qty	Value	Description	Package Reference	Part Number	Manufacturer
R127, R213	0	160k	RES, 160 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW0402160KFKED	Vishay-Dale
R141, R147, R212	0	0	RES, 0, 0%, 0.2 W, AEC-Q200 Grade 0, 0402	0402	CRCW04020000Z0EDHP	Vishay-Dale
R154, R167	0	33.2k	RES, 33.2 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040233K2FKED	Vishay-Dale
R155	0	22.6k	RES, 22.6 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040222K6FKED	Vishay-Dale
R156, R168	0	13.3k	RES, 13.3 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040213K3FKED	Vishay-Dale
R164, R174	0	10.7k	RES, 10.7 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	0402	CRCW040210K7FKED	Vishay-Dale
R179, R180	0	1.50k	RES, 1.50 k, 1%, 0.1 W, 0603	0603	RC0603FR-071K5L	Yageo
U18	0		Dual 500mA Low-Noise (3.8 μ V _{RMS}) LDO Voltage Regulator, RTJ0020D (WQFN-20)	RTJ0020D	TPS7A8701RTJR	Texas Instruments

8 Revision History

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

Changes from Revision * (March 2020) to Revision A (August 2020)	Page
• Initial public release.....	15

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WARNING

Evaluation Kits are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems.

User shall operate the Evaluation Kit within TI's recommended guidelines and any applicable legal or environmental requirements as well as reasonable and customary safeguards. Failure to set up and/or operate the Evaluation Kit within TI's recommended guidelines may result in personal injury or death or property damage. Proper set up entails following TI's instructions for electrical ratings of interface circuits such as input, output and electrical loads.

NOTE:

EXPOSURE TO ELECTROSTATIC DISCHARGE (ESD) MAY CAUSE DEGRADATION OR FAILURE OF THE EVALUATION KIT; TI RECOMMENDS STORAGE OF THE EVALUATION KIT IN A PROTECTIVE ESD BAG.

3 Regulatory Notices:

3.1 United States

3.1.1 Notice applicable to EVMs not FCC-Approved:

FCC NOTICE: This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.

3.1.2 For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:

CAUTION

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

FCC Interference Statement for Class A EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

3.2 Canada

3.2.1 For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210 or RSS-247

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSSs. Operation is subject to the following two conditions:

(1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concernant les EVMs avec appareils radio:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

3.3 Japan

3.3.1 *Notice for EVMs delivered in Japan:* Please see http://www.tij.co.jp/lscs/ti_ja/general/eStore/notice_01.page 日本国内に輸入される評価用キット、ボードについては、次のところをご覧ください。
http://www.tij.co.jp/lscs/ti_ja/general/eStore/notice_01.page

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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1. 電波法施行規則第6条第1項第1号に基づく平成18年3月28日総務省告示第173号で定められた電波暗室等の試験設備でご使用いただく。
2. 実験局の免許を取得後ご使用いただく。
3. 技術基準適合証明を取得後ご使用いただく。

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3.3.3 *Notice for EVMs for Power Line Communication:* Please see http://www.tij.co.jp/lscs/ti_ja/general/eStore/notice_02.page
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3.4 European Union

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive):*

This is a class A product intended for use in environments other than domestic environments that are connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

4 EVM Use Restrictions and Warnings:

4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.

4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.

4.3 Safety-Related Warnings and Restrictions:

4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.

4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.

4.4 User assumes all responsibility and liability to determine whether the EVM is subject to any applicable international, federal, state, or local laws and regulations related to User's handling and use of the EVM and, if applicable, User assumes all responsibility and liability for compliance in all respects with such laws and regulations. User assumes all responsibility and liability for proper disposal and recycling of the EVM consistent with all applicable international, federal, state, and local requirements.

5. *Accuracy of Information:* To the extent TI provides information on the availability and function of EVMs, TI attempts to be as accurate as possible. However, TI does not warrant the accuracy of EVM descriptions, EVM availability or other information on its websites as accurate, complete, reliable, current, or error-free.

6. Disclaimers:

6.1 EXCEPT AS SET FORTH ABOVE, EVMS AND ANY MATERIALS PROVIDED WITH THE EVM (INCLUDING, BUT NOT LIMITED TO, REFERENCE DESIGNS AND THE DESIGN OF THE EVM ITSELF) ARE PROVIDED "AS IS" AND "WITH ALL FAULTS." TI DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, REGARDING SUCH ITEMS, INCLUDING BUT NOT LIMITED TO ANY EPIDEMIC FAILURE WARRANTY OR IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF ANY THIRD PARTY PATENTS, COPYRIGHTS, TRADE SECRETS OR OTHER INTELLECTUAL PROPERTY RIGHTS.

6.2 EXCEPT FOR THE LIMITED RIGHT TO USE THE EVM SET FORTH HEREIN, NOTHING IN THESE TERMS SHALL BE CONSTRUED AS GRANTING OR CONFERRING ANY RIGHTS BY LICENSE, PATENT, OR ANY OTHER INDUSTRIAL OR INTELLECTUAL PROPERTY RIGHT OF TI, ITS SUPPLIERS/LICENSORS OR ANY OTHER THIRD PARTY, TO USE THE EVM IN ANY FINISHED END-USER OR READY-TO-USE FINAL PRODUCT, OR FOR ANY INVENTION, DISCOVERY OR IMPROVEMENT, REGARDLESS OF WHEN MADE, CONCEIVED OR ACQUIRED.

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8. *Limitations on Damages and Liability:*

8.1 *General Limitations.* IN NO EVENT SHALL TI BE LIABLE FOR ANY SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL, OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF THESE TERMS OR THE USE OF THE EVMS , REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. EXCLUDED DAMAGES INCLUDE, BUT ARE NOT LIMITED TO, COST OF REMOVAL OR REINSTALLATION, ANCILLARY COSTS TO THE PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES, RETESTING, OUTSIDE COMPUTER TIME, LABOR COSTS, LOSS OF GOODWILL, LOSS OF PROFITS, LOSS OF SAVINGS, LOSS OF USE, LOSS OF DATA, OR BUSINESS INTERRUPTION. NO CLAIM, SUIT OR ACTION SHALL BE BROUGHT AGAINST TI MORE THAN TWELVE (12) MONTHS AFTER THE EVENT THAT GAVE RISE TO THE CAUSE OF ACTION HAS OCCURRED.

8.2 *Specific Limitations.* IN NO EVENT SHALL TI'S AGGREGATE LIABILITY FROM ANY USE OF AN EVM PROVIDED HEREUNDER, INCLUDING FROM ANY WARRANTY, INDEMNITY OR OTHER OBLIGATION ARISING OUT OF OR IN CONNECTION WITH THESE TERMS, , EXCEED THE TOTAL AMOUNT PAID TO TI BY USER FOR THE PARTICULAR EVM(S) AT ISSUE DURING THE PRIOR TWELVE (12) MONTHS WITH RESPECT TO WHICH LOSSES OR DAMAGES ARE CLAIMED. THE EXISTENCE OF MORE THAN ONE CLAIM SHALL NOT ENLARGE OR EXTEND THIS LIMIT.

9. *Return Policy.* Except as otherwise provided, TI does not offer any refunds, returns, or exchanges. Furthermore, no return of EVM(s) will be accepted if the package has been opened and no return of the EVM(s) will be accepted if they are damaged or otherwise not in a resalable condition. If User feels it has been incorrectly charged for the EVM(s) it ordered or that delivery violates the applicable order, User should contact TI. All refunds will be made in full within thirty (30) working days from the return of the components(s), excluding any postage or packaging costs.
10. *Governing Law:* These terms and conditions shall be governed by and interpreted in accordance with the laws of the State of Texas, without reference to conflict-of-laws principles. User agrees that non-exclusive jurisdiction for any dispute arising out of or relating to these terms and conditions lies within courts located in the State of Texas and consents to venue in Dallas County, Texas. Notwithstanding the foregoing, any judgment may be enforced in any United States or foreign court, and TI may seek injunctive relief in any United States or foreign court.

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