EVM User's Guide: DP83TD510E-PODL-EVM

DP83TD510E-PODL-EVM Evaluation Module

Description

The PoDL evaluation module (EVM) shows an implementation of a single-pair Ethernet (SPE) communication including power over data lines (PoDL). The EVM consists of a power sourcing equipment (PSE) media converter, and a powered device media converter. This allows simple evaluation using standard Ethernet networking hardware.

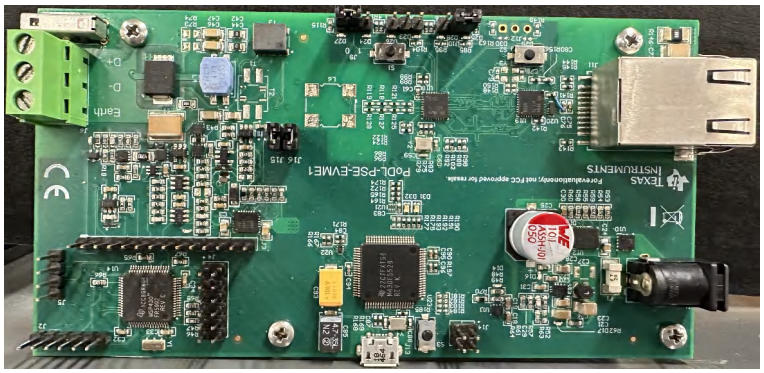
The PoDL EVM supports 10Mbps speed and implements 10 BASE-T1L according to IEEE802.3cg including PoDL with SCCP. The EVM implements a media converter from 10 BASE-TX to 10BASE-T1L to allow bit-error rate testing, interoperability and compliance testing. The EVM also includes a USB2MDIO interface to allow register access of the PHYs for configuration.

Features

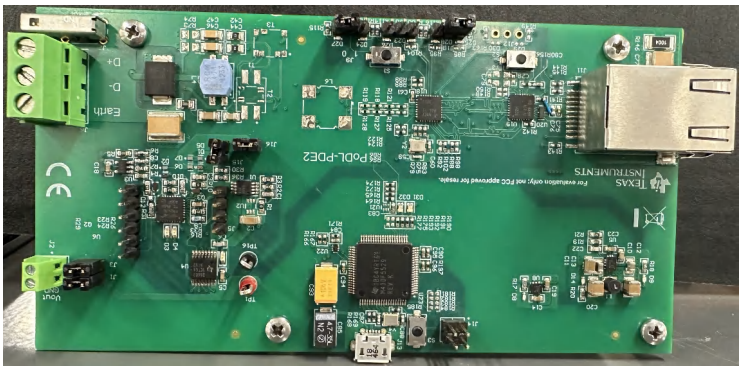
- 10BASE-T1L single-pair Ethernet
- PoDL power sourcing equipment (PSE), Type E, Class 12, compliant to IEEE802.3cg including serial communication classification protocol (SCCP)
- PoDL power delivery (PD), Type E, Class 12, compliant to IEEE802.3cg including serial communication classification protocol (SCCP)
- On-board USB 2 MDIO interface for PHY register access

Applications

- Factory automation and control
- Communication module
- Communication switch
- Communication module
- Single board computer



DP83TD510E_PODL_PSE Board



DP83TD510E_PODL_PD Board

1 Evaluation Module Overview

1.1 Introduction

The PoDL EVM consists of two boards, one implementing the PoDL PSE and one implementing the PoDL PD. The PoDL PSE board is powered by an external 24 V power supply and the PD is powered through the SPE connection from the PD and outputs the PoDL voltage. The DP83TD510E is IEEE802.3cg Compliant with PoDL PSE according to IEEE802.3cg, class 12 with SCCP and PoDL PD according to IEEE802.3cg, class 12 with SCCP.

1.2 Kit Contents

This evaluation module (EVM) consists of two PCBs, a PoDL enabled media converter with a power sourcing equipment (PSE), as well as the matching powered device (PD). So the complete setup can be used for evaluating a PoDL system.

1.3 Specification

- Media Converter: 10BASE-T1L to 10BASE-TX
- 10BASE-TX Interface For Standard Ethernet RJ-45 Connection Using DP83822
- RMII Back-to-Back Configuration
- On-board USB2MDIO to Configure PHY
- USB-2-MDIO Support

1.4 Device Information

The DP83TD510E is an ultra-low power Ethernet physical layer transceiver compliant with the IEEE 802.3cg 10Base-T1L specification. The PHY has very low noise coupled receiver architecture enabling long cable reach and very low power dissipation. The DP83TD510E has external MDI termination to support intrinsic safety requirements. The device interfaces with MAC layer through MII, Reduced MII (RMII) , RGMII, and RMII low power 5-MHz mode. The DP83TD510E also supports RMII back-to-back mode for applications that require cable reach extension beyond 2000 meters. The DP83TD510E supports a 25 MHz reference clock output to clock other modules on the system. The DP83TD510E offers integrated cable diagnostic tools; built-in self test, and loop back capabilities for ease of design or debug.

2 Hardware

2.1 Quick Setup

Connect SPE ports of both boards together by either using a SPE cable and the SPE connector J7, or by using a appropriate cable and the screw terminal J6. Verify the jumper settings are as shown below. The PSE needs to be connected to a 24 V power supply. For class 12 operation, the PSE needs to provide at least 700 mA. Figure 2-2 shows how the jumper have to be set for correct operation and explains the connections. Similar on the PD side, Figure 2-1 shows the connections and settings.

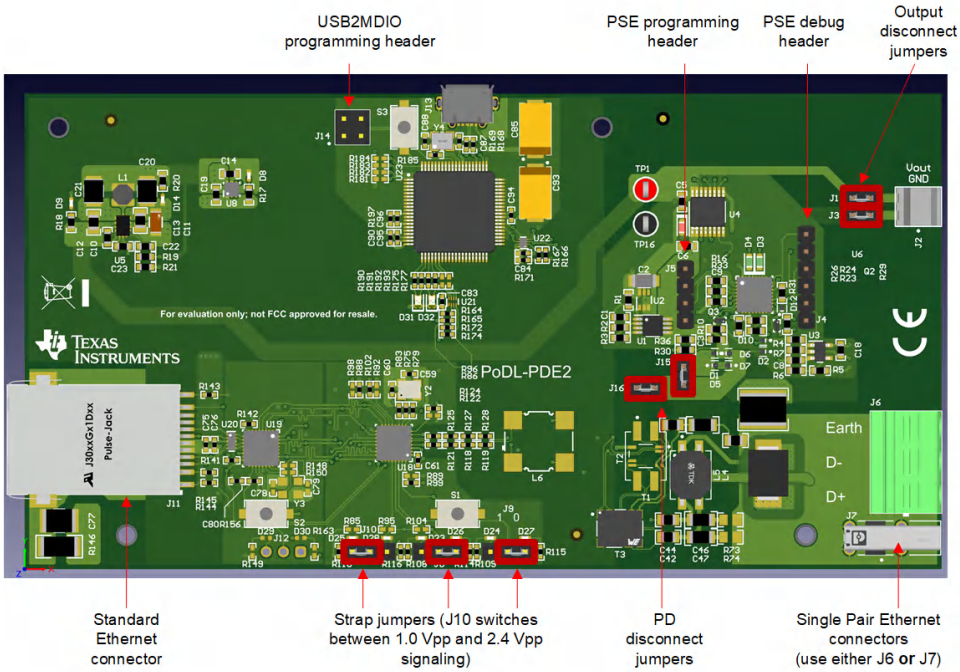


Figure 2-1. PD Jumpers

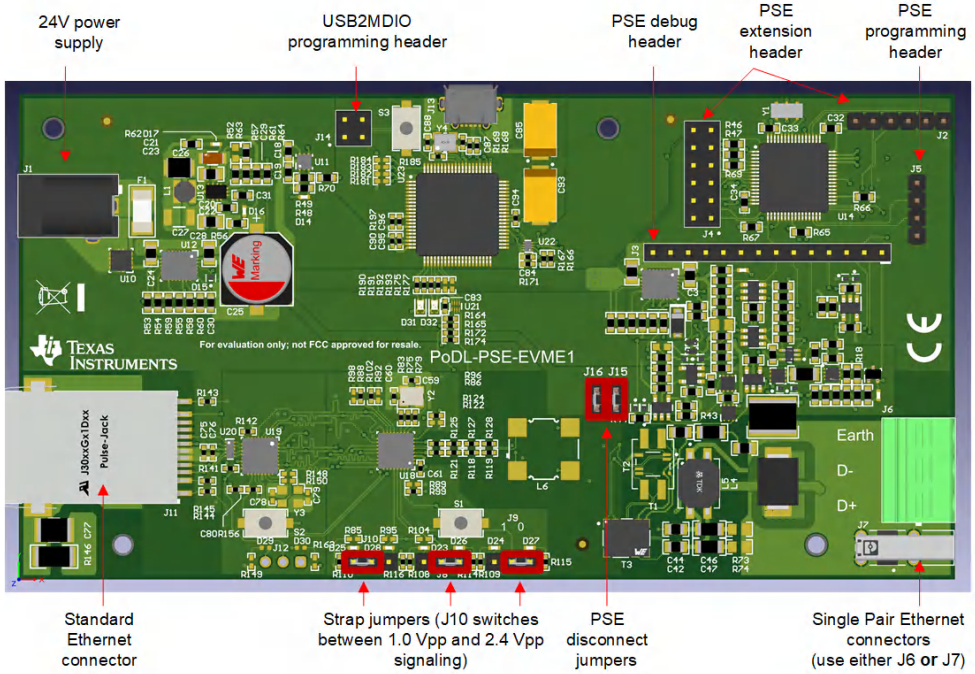


Figure 2-2. PSE Jumpers

Figure 2-3 shows how both boards have to be connected. For the SPE cable, make sure to connect D+ and D-, the polarity is not critical. If a shielded cable is used, then also connect the shield.

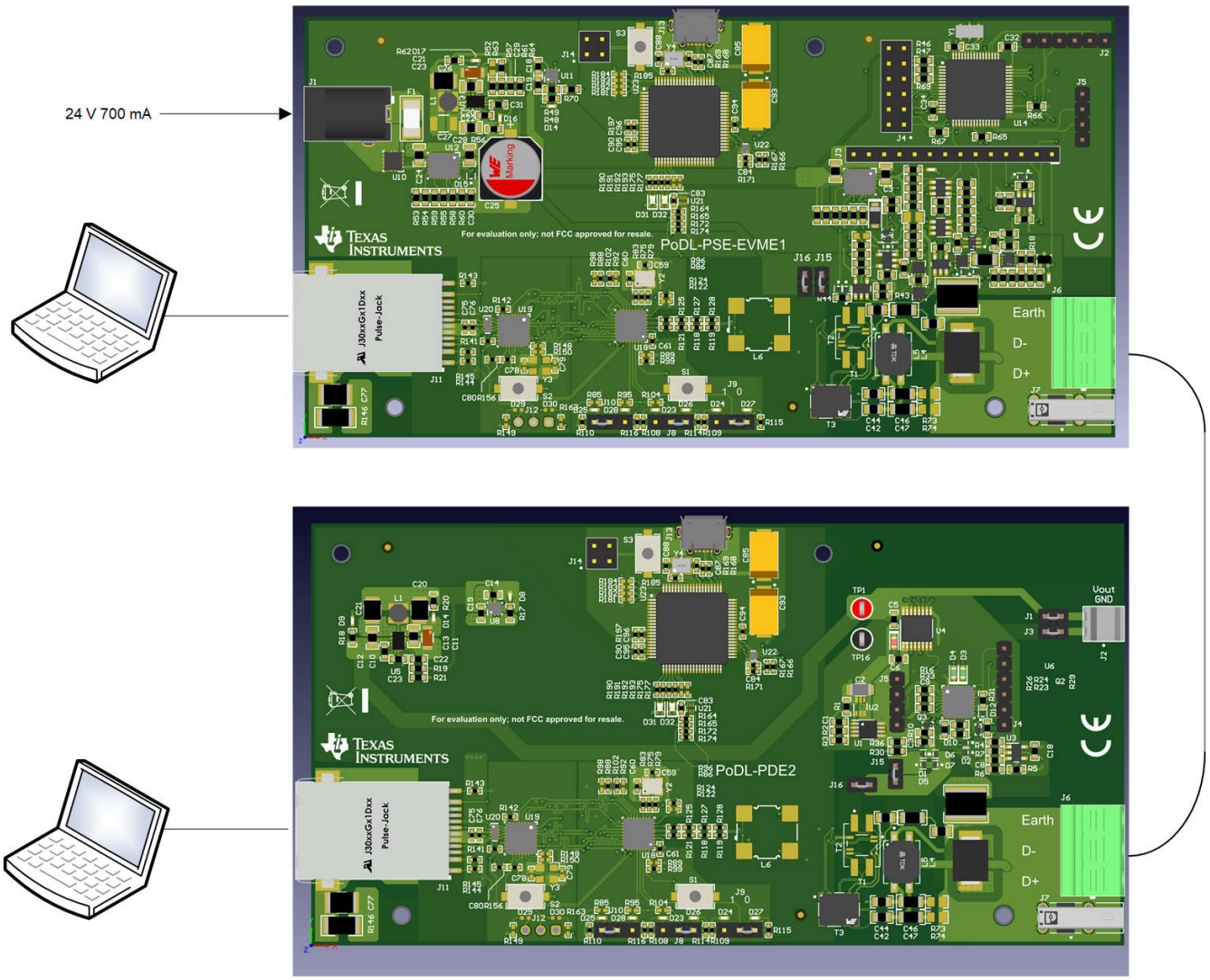


Figure 2-3. Board Connections

2.2 Header Information

This EVM consists of two boards: one is the power sourcing equipment (PSE) and one is the powered device (PD).

Power Sourcing Equipment (PSE)

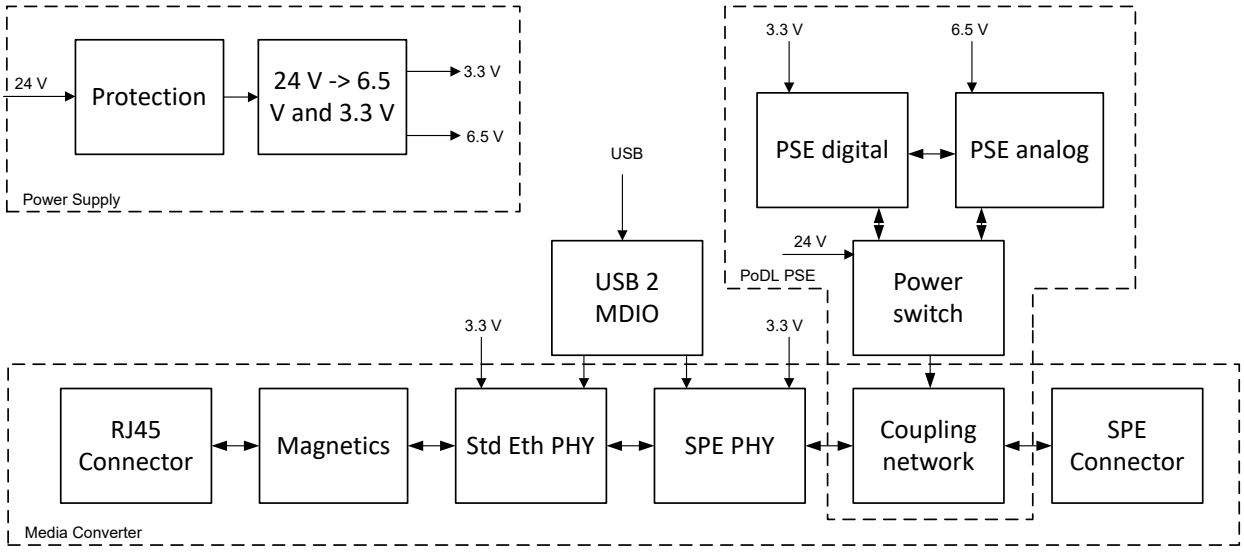


Figure 2-4. PSE Block Diagram

Figure 2-4 shows the block diagram of the PSE board. The board is divided in four sub blocks, the power supply, the PSE circuit, the media converter, and the USB2MDIO interface. For implementation details, refer to the schematic and related documentation.

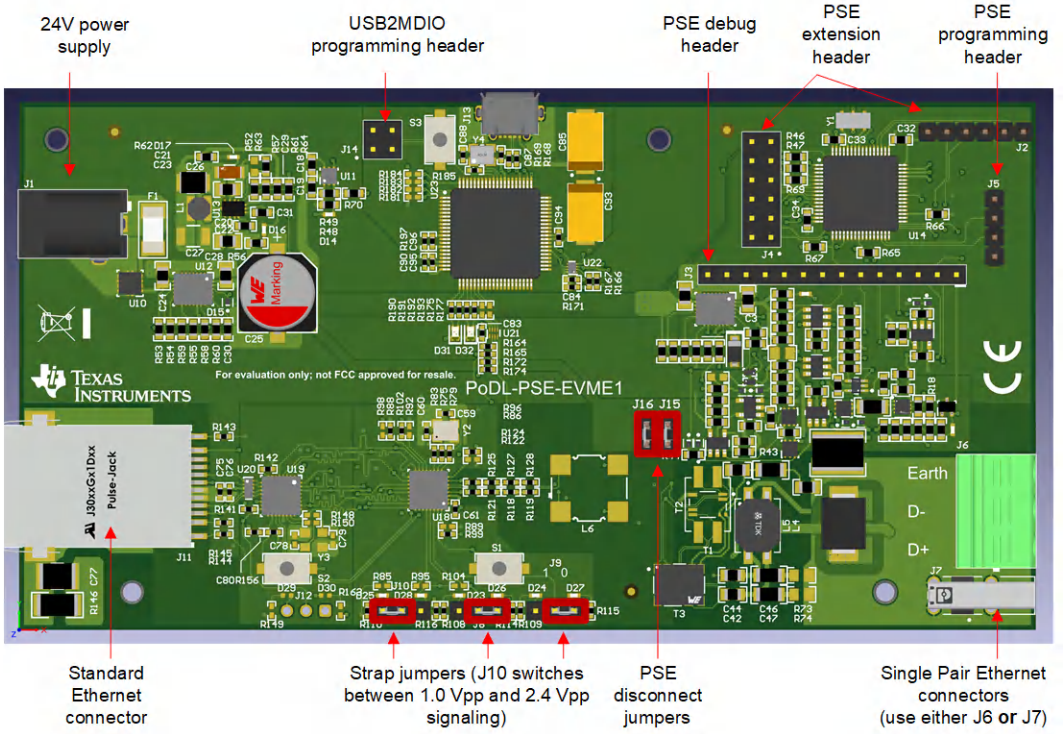


Figure 2-5. PSE Jumpers

All jumpers and headers are shown in Figure 2-5. The default settings are shown in the figure. Jumper J10 can be used to switch the SPE PHY between 1.0 Vpp signaling and 2.4 Vpp signaling. The default settings configure the PHY for 2.4 Vpp.

Two jumpers, J15 and J16, are allowed to disconnect the PSE stage from the coupling network. This allows to either use the PSE block in combination with a coupling network or to use an own PSE implementation with the onboard SPE PHY and coupling network. Also, these jumpers are a good point to probe the behavior of the PSE block without interfering with the data signal.

The USB2MDIO and PSE digital block have a microcontroller and are pre-programmed. Refer to the images below for the correct pinout of the programming headers if an update or change of the firmware is needed.

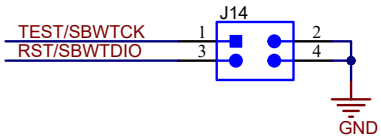


Figure 2-6. Programming header USB2MDIO

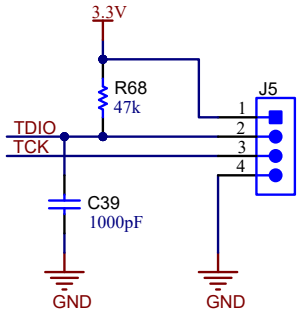


Figure 2-7. Programming Header PSE

The signals between the PSE digital part and analog parts are brought out on a connector for easy probing. This helps in case of problems to investigate what is happening. Figure 2-8 shows the pinout of this connector.

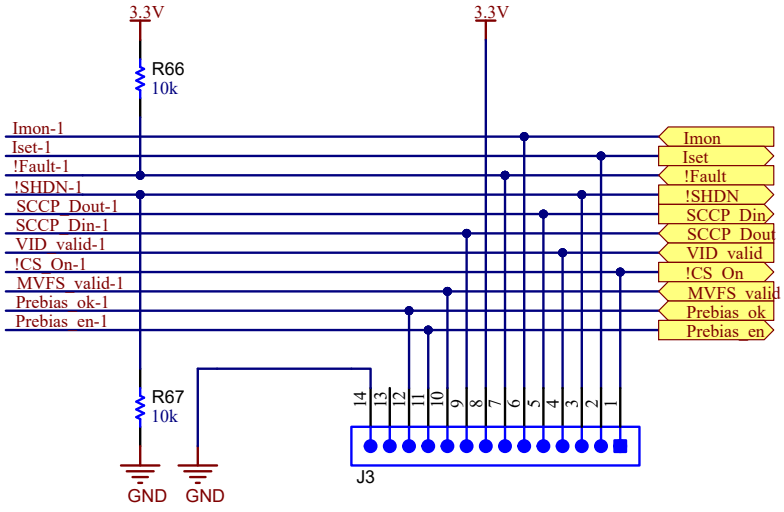


Figure 2-8. Debug header PSE

The table below details the signals present on the PSE debug header.

Signal	Description	Normal operation, PD connected and powered
Imon	Output from eFuse, outputs a voltage proportional to connected load	0 - 3 V
Iset	Input to eFuse to set current limit with a voltage	0 - 1 V
!Fault	Fault output from eFuse	3.3 V
!SHDN	Disabled output of eFuse	3.3 V
SCCP_DOUT	Output from MCU to send SCCP data	0 V, communication before power up
SCCP_DIN	Input to MCU for reading SCCP data	3.3 V, communication before power up
VID_valid	Signals a valid detection voltage	0 V, short pulse before power up
!CS_on	Enables current source for detection and classification	0 V, short pulse before power up
MVFS_valid	Signals current flow to MCU	3.3 V
Prebias_ok	Signals valid prebias current	0 V, short pulse before power up
Prebias_en	Enables prebias/sleep voltage source	0 V, short pulse before power up

If the user wants to modify the firmware of the PSE controller, then there are additional pins of the microcontroller brought out for extensions, such as an additional PSE port. Figure 2-9 shows the pinout.

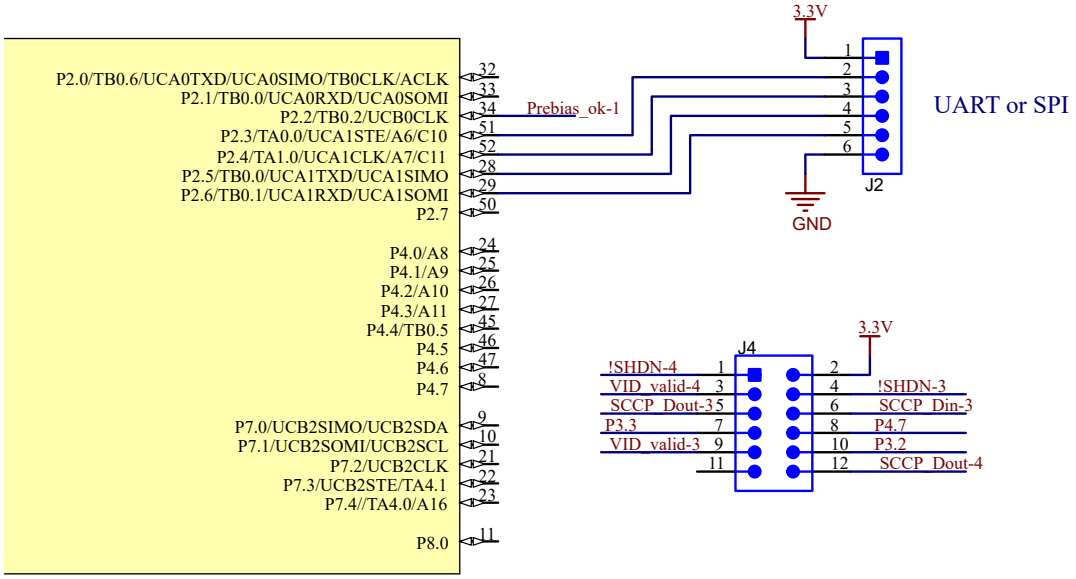


Figure 2-9. Extension Header PSE

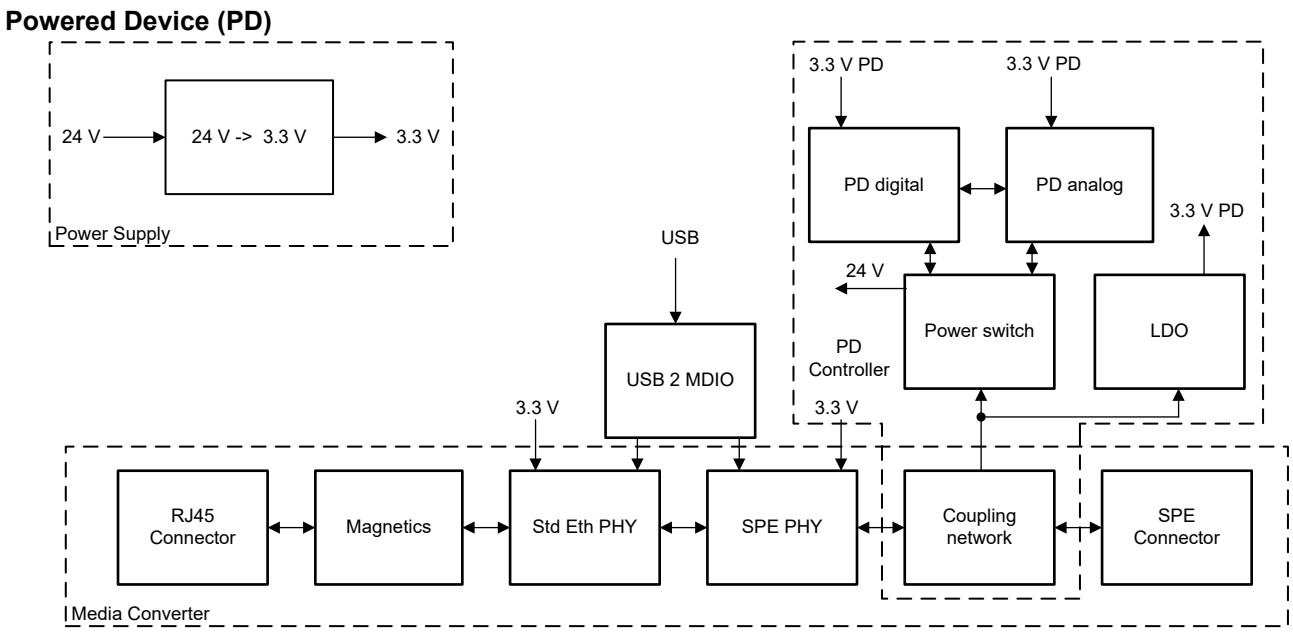


Figure 2-10. PD Block Diagram

Figure 2-10 shows how the power device is built up. The block diagram consists of similar blocks as the PSE, but includes a modified power supply and replaces the PSE by a PD block.

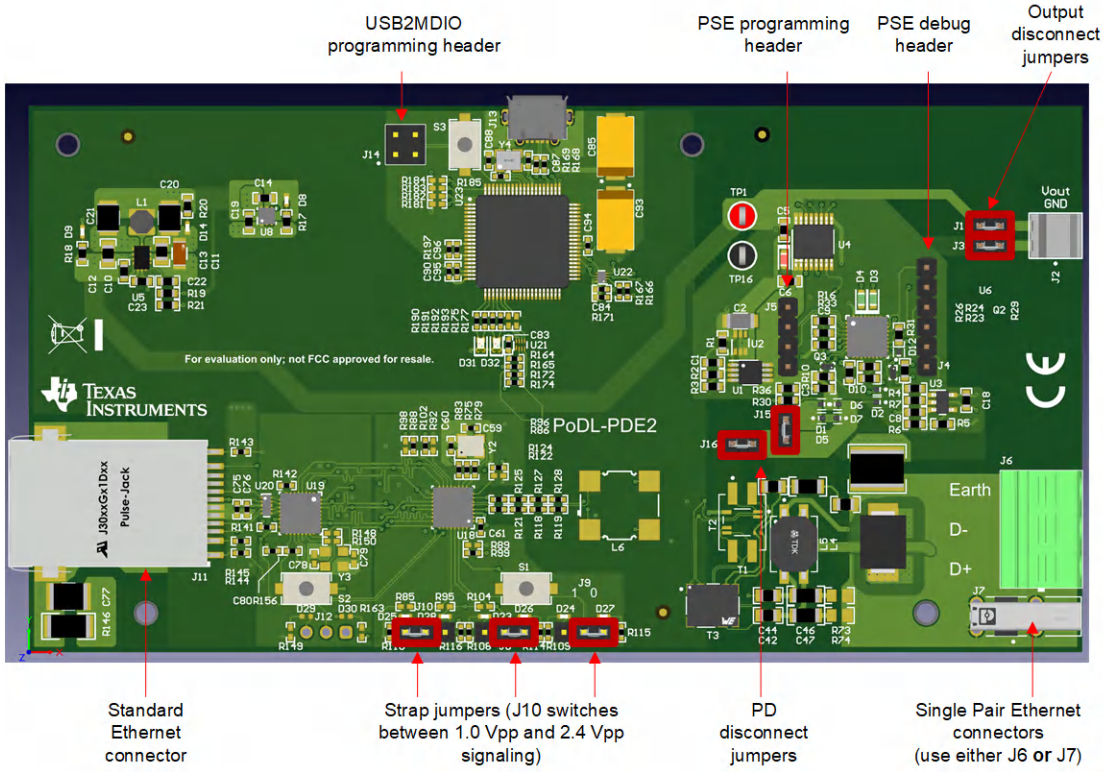


Figure 2-11. PD Jumpers

For the jumper settings, refer to Figure 2-11. Similarly as the PSE side, follow the settings shown. J10 can be used to select 1.0 Vpp instead of 2.4 Vpp. The jumpers J15 and J16 can be used to separate the PD from the coupling network. The jumpers J1 and J3 allow to disconnect the Vout connector and allows adding an isolated power supply instead of the jumpers.

Additionally, the microcontrollers involved, so there are programming headers as well. The USB 2 MDIO programming header is exactly the same as for the board mentioned before. The pinout for the PD controller header is shown in Figure 2-12.

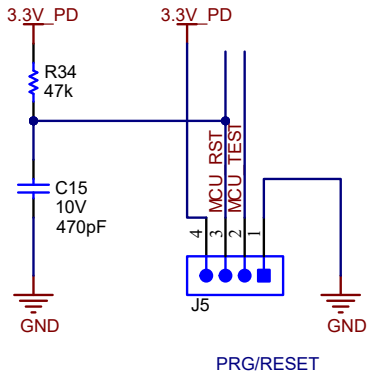


Figure 2-12. Programming Header PD

The PD board allows access to the SCCP signals for debugging purpose. The pinout of the connector is shown in Figure 2-13.

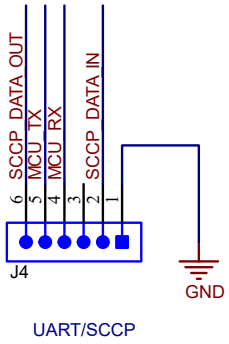


Figure 2-13. Debug Header PD

2.3 Push Buttons

Both boards contain two push buttons. Button S2 resets the DP83822 PHY and button S1 resets the DP83TD510E. The PSE keeps the DP83TD510E in reset as long as no power connection is established.

During normal operation, resetting the PHYs manually is not necessary. A power on reset takes care of the issue. However, resetting the PHYs manually can be useful when writing to different registers.

2.4 Debug Information

This section details some common issues that arise while using the boards.

The USB port does not need to be connected and cannot be used to power the boards. External 24 V are always needed on the PSE side.

Do not connect both USB ports (PSE and PD) to the same computer, USB hub or something sharing the same ground. These two USB connectors need to be isolated to each other for the PD to work properly.

No register access is possible on the PSE as long as no power connection is established, as the DP83TD510E is kept in reset in idle state. This also impacts the DP83822, as the clock is derived from DP83TD510E.

The layout provides the possibility to test different data transformers and coupling networks as well. Therefore, the layout is not optimized for EMC, and can be disturbed by EFT or ESD events causing intermittent link loss. Also, do not use this layout as reference, the option for different transformers violates the proper differential routing in some cases. However, this does not impact the performance in a lab environment.

3 Hardware Design Files

3.1 Schematics

3.2 PCB Layouts

3.3 Bill of Materials (BOM)

The bill of materials of the power sourcing equipment is shown in Table 3-1.

Table 3-1. Bill of Materials (Power Sourcing Equipment PSE)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
!PCB1	1		Printed Circuit Board		PoDL-PSE-EVM	Any
C1, C2, C24, C28	4	0.1uF	CAP, CERM, 0.1 µF, 100 V,+/- 10%, X7R, 0805	805	8.85012E+11	Wurth Elektronik
C3	1	0.068uF	CAP, CERM, 0.068 uF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0603	603	CGA3E2X7R1H683K080AA	TDK
C4, C5, C7, C9, C10, C14, C16, C17, C20, C30, C32, C33, C34, C35, C36, C37, C40, C41	18	0.1uF	CAP, CERM, 0.1 uF, 25 V, +/- 10%, X7R, 0603	603	8.85012E+11	Wurth Elektronik
C6, C12, C13	3	100 pF	CAP, CERM, 100 pF, 50 V, +/- 5%, C0G/NP0, 0603	603	8.85012E+11	Wurth Elektronik
C8	1	0.01uF	CAP, CERM, 0.01 uF, 16 V, +/- 10%, X7R, 0603	603	8.85012E+11	Wurth Elektronik
C15	1	330 pF	CAP, CERM, 330 pF, 50 V, +/- 5%, C0G/NP0, 0603	603	C0603C331J5GACTU	Kemet
C18, C19, C31	3	1uF	CAP, CERM, 1 uF, 16 V, +/- 10%, X7R, 0603	603	8.85012E+11	Wurth Elektronik
C21	1		4.7µF ±10% 50 V Ceramic Capacitor X7R 1206 (3216 Metric)	1206	8.85012E+11	Wurth Electronics
C22, C23	2	0.22uF	CAP, CERM, 0.22 uF, 50 V, +/- 10%, X7R, 0805	805	UMK212B7224KG-T	Taiyo Yuden
C25	1		WCAP-AS5H Aluminum Electrolytic Capacitor, V-Chip, SMT, D10xH10.5mm, 100 uF, 50 V		8.65231E+11	Wurth Elektronik
C26	1	22uF	CAP, CERM, 22 uF, 16 V, +/- 10%, X7R, 1210	1210	C3225X7R1C226K250AC	TDK
C29	1	20 pF	CAP, CERM, 20 pF, 50 V, +/- 5%, C0G/NP0, 0603	603	GRM1885C1H200JA01D	MuRata
C38	1	0.47uF	CAP, CERM, 0.47 uF, 16 V, +/- 10%, X7R, 0603	603	C0603C474K4RACTU	Kemet

Table 3-1. Bill of Materials (Power Sourcing Equipment PSE) (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
C39	1	1000 pF	CAP, CERM, 1000 pF, 50 V,+/- 10%, X7R, 0603	603	8.85012E+11	Wurth Elektronik
C42, C44	2	0	RES, 0, 5%, 0.125 W, AEC-Q200 Grade 0, 0805	805	ERJ-6GEY0R00V	Panasonic
C43	1	0.01uF	CAP, CERM, 0.01 uF, 2000 V, +/- 10%, X7R, 1825	1825	1825GC103KAT1A	AVX
C45, C46, C47	3	0.01uF	CAP, CERM, 0.01 µF, 1000 V,+/- 10%, X7R, 1206	1206	C1206X103KDRAC7800	Kemet
C48, C49	2	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 20%, X7R, 0805	805	08055C104MAT2A	AVX
C50, C54, C68, C72	4	10uF	CAP, CERM, 10 uF, 10 V, +/- 20%, X7T, 0603	603	GRM188D71A106MA73D	MuRata
C51, C55, C76, C80	4	1uF	CAP, CERM, 1 uF, 6.3 V, +/- 20%, X7R, 0402	402	GRM155R70J105MA12D	MuRata
C52, C56	2	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 20%, X7R, AEC-Q200 Grade 1, 0402	402	CGA2B3X7R1H104M050BB	TDK
C53, C57, C58, C61, C69, C73	6	0.01uF	CAP, CERM, 0.01 uF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0402	402	CGA2B3X7R1H103K050BB	TDK
C59, C60	2	22 pF	CAP, CERM, 22 pF, 50 V, +/- 5%, C0G/NP0, AEC-Q200 Grade 1, 0402	402	GCM1555C1H220JA16D	MuRata
C64, C77	2	4700 pF	CAP, CERM, 4700 pF, 2000 V, +/- 10%, X7R, 1812	1812	1812GC472KAT1A	AVX
C67, C71	2	100 pF	CAP, CERM, 100 pF, 50 V, +/- 5%, C0G/NP0, AEC-Q200 Grade 1, 0402	402	CGA2B2C0G1H101J050BA	TDK
C70, C74, C97	3	1000 pF	CAP, CERM, 1000 pF, 50 V, +/- 5%, C0G/NP0, 0402	402	GRM1555C1H102JA01D	MuRata
C75	1	0.1uF	CAP, CERM, 0.1 uF, 16 V, +/- 10%, X7R, 0402	402	8.85012E+11	Wurth Elektronik
C81, C82	2	10 pF	CAP, CERM, 10 pF, 16 V,+/- 10%, C0G, 0402	402	C0402C100K4GACTU	Kemet
C83, C84	2	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0402	402	GCM155R71H104KE02D	MuRata

Table 3-1. Bill of Materials (Power Sourcing Equipment PSE) (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
C85	1	4.7uF	CAP, TA, 4.7 uF, 35 V, +/- 10%, 1.3 ohm, SMD	7343-31	293D475X9035D2TE3	Vishay-Sprague
C86, C94, C95, C96	4	0.1uF	CAP, CERM, 0.1 µF, 10 V,+/- 10%, X7R, 0402	402	C0402C104K8RACTU	Kemet
C87, C88	2	36 pF	CAP, CERM, 36 pF, 50 V,+/- 5%, C0G/NP0, 0402	402	CL05C360JB5NNNC	Samsung Electro-Mechanics
C89, C92	2	0.22uF	CAP, CERM, 0.22 uF, 16 V, +80/-20%, Y5V, 0603	603	C0603C224Z4VACTU	Kemet
C90	1	0.47uF	CAP, CERM, 0.47 uF, 6.3 V, +/- 10%, X5R, 0402	402	04026D474KAT2A	AVX
C91	1	4.7uF	CAP, CERM, 4.7 uF, 35 V, +/- 10%, X5R, 0603	603	C1608X5R1V475K080AC	TDK
C93	1	10uF	CAP, TA, 10 uF, 35 V, +/- 10%, 0.125 ohm, SMD	7343-31	TPSD106K035R0125	AVX
D1	1	3 V	Diode, Zener, 3 V, 500 mW, SOD-123	SOD-123	MMSZ4683T1G	ON Semiconductor
D2	1	100 V	Diode, Schottky, 100 V, 1 A, SMA	SMA	SS110-TP	Micro Commercial Components
D3, D4, D7, D8, D10, D11, D12, D13, D15	9		DIODE SCHOTTKY 60 V 1 A DSN1006-2	SOD993	PMEG6010AESBYL	Nexperia
D5	1	5.6V	Diode, Zener, 5.6 V, 500 mW, SOD-123	SOD-123	MMSZ4690-E3-08	Vishay-Semiconductor
D6, D9, D14, D16, D17, D23, D24, D25, D26, D27, D28	11	Green	LED, Green, SMD	1x0.5mm	150040GS73240	Wurth Elektronik
D18, D19, D21, D22	4	100 V	Diode, Ultrafast, 100 V, 2 A, SMA	SMA	MURA110T3G	ON Semiconductor
D20	1	36 V	Diode, TVS, Bi, 36 V, 58.1 Vc, SMC	SMC	SMCJ36CA	Littelfuse
D31, D32	2	Rg	LED, Rg, SMD	1.6x0.8mm	HSMF-C165	Avago
F1	1		Fuse, 2 A, 125VAC/VDC, SMD	SloBlo452	0454002.MR	Littelfuse
FID1, FID2, FID3, FID4, FID5, FID6	6		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A
H1, H2, H3, H4	4		MACHINE SCREW PAN PHILLIPS M3		RM3X6MM 2701	APM HEXSEAL
H5, H6, H7, H8	4			SPACER_M3X20MM	970200365	Wurth Electronics
J1	1		DC POWER JACK, R/A, TH	DC POWER JACK, R/A, TH	PJ-102AH	CUI Inc.

Table 3-1. Bill of Materials (Power Sourcing Equipment PSE) (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
J2	1		Header, 2.54 mm, 6x1, Gold, TH	Header, 2.54mm, 6x1, TH	61300611121	Wurth Elektronik
J3	1		Header, 100mil, 14x1, Gold, TH	14x1 Header	61301411121	Würth Elektronik
J4	1		Header, 100mil, 6x2, Gold, TH	6x2 Header	61301221121	Würth Elektronik
J5	1		Header, 2.54 mm, 4x1, Gold, TH	Header, 2.54mm, 4x1, TH	61300411121	Wurth Elektronik
J6	1		3 Position Wire to Board Terminal Block Horizontal with Board 0.197" (5.00mm) Through Hole	HDR3	6.91217E+11	Wurth
J7	1		Jack Modular Connector 2P2C Single Pair Ethernet (SPE) 90° Angle (Right) Shielded CatB	PTH_ETHERNET_CONNECTOR	1163797	Phoenix Contact
J8, J9, J10	3		Header, 100mil, 3x1, Gold, TH	3x1 Header	TSW-103-07-G-S	Samtec
J11	1		Connector, RJ45 with integrated magnetics, 1x1, Gold, R/A, SMT	Connector, RJ-45 with integrated magnetics, 1x1, R/A, SMT	J3011G21DNL	Pulse Engineering
J13	1		Connector, Receptacle, Micro-USB Type AB, R/A, Bottom Mount SMT	5.6x2.5x8.2mm	475890001	Molex
J14	1		Header, 100mil, 2x2, Gold, TH	2x2 Header	TSW-102-07-G-D	Samtec
J15, J16	2		Header, 2.54 mm, 2x1, Gold, TH	Header, 2.54mm, 2x1, TH	61300211121	Wurth Elektronik
L1	1	15uH	Inductor, Shielded Drum Core, Ferrite, 15 uH, 0.72 A, 0.356 ohm, SMD	Inductor, 2.8x2.8x2.8mm	744025150	Wurth Elektronik
L3	1		Inductor Coupled 2x250uH 20% 0.25Ω 1200 mA	SMT4_15MM5_15MM5	PID150H-251M	TDK
L4	1		Common Mode Choke for 10 Base T1L	SMT4_7MM1_6MM0	RCM70CGI-471N	TDK
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
Q1	1	80 V	Transistor, PNP, 80 V, 1 A, SOT-223	SOT-223	BCP53,115	NXP Semiconductor
Q2, Q4	2	60 V	MOSFET, N-CH, 60 V, 0.115 A, SOT-323	SOT-323	2N7002W-7-F	Diodes Inc.
Q3, Q5	2	60 V	MOSFET, N-CH, 60 V, 2.2 A, YJK0003A (PICOSTAR-3)	YJK0003A	CSD18541F5	Texas Instruments
Q6	1	-20V	MOSFET, P-CH, -20 V, -20 A, DQK0006C (WSON-6)	DQK0006C	CSD25310Q2	Texas Instruments

Table 3-1. Bill of Materials (Power Sourcing Equipment PSE) (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
Q7, Q8	2	100 V	MOSFET, N-CH, 100 V, 4.5 A, DQK0006C (WSON-6)	DQK0006C	CSD19538Q2	Texas Instruments
Q9	1	45 V	Transistor, NPN, 45 V, 0.1 A, SOT-23	SOT-23	BC847CLT1G	ON Semiconductor
R1, R10, R20, R21, R22, R65, R69	7	1.00k	RES, 1.00 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW06031K00FKEA	Vishay-Dale
R2, R53	2	825k	RES, 825 k, 1%, 0.1 W, 0603	603	RC0603FR-07825KL	Yageo
R3	1	16.9k	RES, 16.9 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW060316K9FKEA	Vishay-Dale
R4, R54	2	60.4k	RES, 60.4 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW060360K4FKEA	Vishay-Dale
R5, R55	2	402k	RES, 402 k, 1%, 0.1 W, 0603	603	RC0603FR-07402KL	Yageo
R6, R40	2	62.0k	RES, 62.0 k, 1%, 0.1 W, 0603	603	RC0603FR-0762KL	Yageo
R7, R59	2	30.1k	RES, 30.1 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW060330K1FKEA	Vishay-Dale
R8	1	8.45k	RES, 8.45 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW06038K45FKEA	Vishay-Dale
R9, R16, R19, R26, R35, R36	6	10.0k	RES, 10.0 k, 1%, 0.1 W, 0603	603	RC0603FR-0710KL	Yageo
R11	1	68.1	RES, 68.1, 1%, 0.1 W, 0603	603	RC0603FR-0768R1L	Yageo
R12, R25	2	8.20k	RES, 8.20 k, 1%, 0.1 W, 0603	603	RC0603FR-078K2L	Yageo
R13	1	2.20k	RES, 2.20 k, 1%, 0.1 W, 0603	603	RC0603FR-072K2L	Yageo
R14, R24, R31, R34, R46, R49, R51, R57, R61, R63	10	100k	RES, 100 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW0603100KFKEA	Vishay-Dale
R15	1	47	RES, 47.0, 1%, 0.25 W, 1206	1206	RC1206FR-0747RL	Yageo America
R17, R48	2	3.3k	RES, 3.3 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW06033K30JNEA	Vishay-Dale
R18, R41	2	3.30k	RES, 3.30 k, 1%, 0.1 W, 0603	603	RC0603FR-073K3L	Yageo
R23	1	15.0k	RES, 15.0 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW060315K0FKEA	Vishay-Dale
R27, R56	2	68k	RES, 68 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW060368K0JNEA	Vishay-Dale

Table 3-1. Bill of Materials (Power Sourcing Equipment PSE) (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
R28	1	91.0k	RES, 91.0 k, 1%, 0.1 W, 0603	603	RC0603FR-0791KL	Yageo
R29	1	107k	RES, 107 k, 1%, 0.1 W, 0603	603	RC0603FR-07107KL	Yageo
R32, R33	2	470k	RES, 470 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW0603470KJNEA	Vishay-Dale
R37, R44, R47, R66, R67	5	10k	RES, 10 k, 5%, 0.1 W, 0603	603	RC0603JR-0710KL	Yageo
R38	1	220k	RES, 220 k, 1%, 0.1 W, 0603	603	RC0603FR-07220KL	Yageo
R39	1	120k	RES, 120 k, 1%, 0.1 W, 0603	603	RC0603FR-07120KL	Yageo
R42	1	4.02	RES, 4.02, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW06034R02FKEA	Vishay-Dale
R43	1	200	RES, 200, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW0603200RFKEA	Vishay-Dale
R45	1	100	RES, 100, 1%, 0.25 W, AEC-Q200 Grade 0, 0603	603	CRCW0603100RFKEAHP	Vishay-Dale
R58	1	23.2k	RES, 23.2 k, 1%, 0.1 W, 0603	603	RC0603FR-0723K2L	Yageo
R60	1	7.15k	RES, 7.15 k, 1%, 0.1 W, 0603	603	RC0603FR-077K15L	Yageo
R62	1	11.5k	RES, 11.5 k, 1%, 0.1 W, 0603	603	RC0603FR-0711K5L	Yageo
R64	1	18.2k	RES, 18.2 k, 1%, 0.1 W, 0603	603	RC0603FR-0718K2L	Yageo
R68	1	47k	RES, 47 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW060347K0JNEA	Vishay-Dale
R70	1	0	RES, 0, 0%, 0.25 W, AEC-Q200 Grade 0, 0603	603	PMR03EZPJ000	Rohm
R71	1	1.0Meg	RES, 1.0 M, 5%, 0.75 W, AEC-Q200 Grade 0, 2010	2010	CRCW20101M00JNEF	Vishay-Dale
R72	1	100	RES, 100, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	805	CRCW0805100RFKEA	Vishay-Dale
R75, R79, R82	3	0	RES, 0, 5%, 0.063 W, 0402	402	RC0402JR-070RL	Yageo America
R76, R81, R83, R142, R156, R172, R174, R180	8	2.20k	RES, 2.20 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW04022K20FKED	Vishay-Dale
R77, R78, R135, R136	4	0	RES, 0, 5%, 0.1 W, 0603	603	RC0603JR-070RL	Yageo

Table 3-1. Bill of Materials (Power Sourcing Equipment PSE) (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
R80, R146	2	1.00Meg	RES, 1.00 M, 1%, 1 W, 2010	2010	HVCB2010FKC1M00	Stackpole Electronics Inc
R87, R88, R93, R96, R99, R100, R101, R102, R105, R106, R107, R111, R112, R113, R145, R152, R155, R158	18	2.49k	RES, 2.49 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW04022K49FKED	Vishay-Dale
R108, R109, R110, R114, R115, R116	6	3.3k	RES, 3.3 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW04023K30JNED	Vishay-Dale
R117, R126	2	39.2	RES, 39.2, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW040239R2FKED	Vishay-Dale
R118, R119, R120, R121, R123, R125, R127, R128	8	0	RES, 0, 0%, 0.2 W, AEC-Q200 Grade 0, 0402	402	CRCW04020000Z0EDHP	Vishay-Dale
R122, R124	2	2.00k	RES, 2.00 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW04022K00FKED	Vishay-Dale
R137, R138, R139, R140	4	49.9	RES, 49.9, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW040249R9FKED	Vishay-Dale
R141	1	4.87k	RES, 4.87 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW04024K87FKED	Vishay-Dale
R143, R144, R190, R191, R192, R193	6	470	RES, 470, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW0402470RJNED	Vishay-Dale
R151	1	10.0k	RES, 10.0 k, 1%, 0.063 W, 0402	402	RC0402FR-0710KL	Yageo America
R164, R166	2	374k	RES, 374 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW0402374KFKED	Vishay-Dale
R165, R167	2	1.00Meg	RES, 1.00 M, 1%, 0.1 W, 0402	402	ERJ-2RKF1004X	Panasonic
R168, R169	2	27	RES, 27, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW040227R0JNED	Vishay-Dale
R170, R171	2	200k	RES, 200 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW0402200KJNED	Vishay-Dale
R185, R197, R198	3	0	RES, 0, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW04020000Z0ED	Vishay-Dale

Table 3-1. Bill of Materials (Power Sourcing Equipment PSE) (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
R194	1	1.40k	RES, 1.40 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW04021K40FKED	Vishay-Dale
R195	1	1.00Meg	RES, 1.00 M, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW04021M00FKED	Vishay-Dale
R196	1	47k	RES, 47 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW040247K0JNED	Vishay-Dale
S1, S2, S3	3		Switch, Normally open, 2.3N force, 200k operations, SMD	KSR	KSR221GLFS	C&K Components
SH-J1, SH-J2, SH-J3, SH-J5, SH-J6	5		Shunt, 2.54mm, Gold, Black	Shunt, 2.54mm, Black	60900213421	Wurth Elektronik
T3	1		Super Tiny Signal Transformer	SMT7_6MM55_5MM35	74930200	Wurth Electronics
U1	1		60-V, 2-A Industrial eFuse With Integrated Reverse Input Polarity Protection, RHF0024A (VQFN-24)	RHF0024A	TPS26601RHFR	Texas Instruments
U2, U8	2		Nanopower, small size comparator with push-pull output, DBV0005A (SOT-23-5)	DBV0005A	TLV7031DBVR	Texas Instruments
U3	1		40-V, dual 4.5MHz, rail-to-rail input/ output, low-offset-voltage, low-noise op amp 8-WSON -40 to 125	WSON8	OPA2991IDSGR	Texas Instruments
U4	1		Single 5-MHz, 15-V/µs high slew-rate, RRIO op amp 5-SC70 -40 to 125	SC-70-5	TLV9051IDCKR	Texas Instruments
U5, U6	2		Micropower, 18 V Window Comparator with 400 mV Reference, DDC0006A (SOT-23-THIN-6)	DDC0006A	TLV6700DDCR	Texas Instruments
U7, U9	2		Single Nanopower Push-Pull Comparator, DBV0005A (SOT-23-5)	DBV0005A	TLV3701IDBVR	Texas Instruments
U10	1		33 V Bidirectional Flat-Clamp Surge Protection Device, DRB0008A (VSON-8)	DRB0008A	TVS3301DRBR	Texas Instruments
U11	1		300-mA, 18-V, Low IQ, Low Dropout Voltage Regulator with Power Good, DRV0006A (WSON-6)	DRV0006A	TPS7A2533DRVR	Texas Instruments
U12	1		4.5V - 55 V, 2 A Industrial eFuse with Integrated Reverse Input Polarity Protection, RHF0024A (VQFN-24)	RHF0024A	TPS26600RHF	Texas Instruments

Table 3-1. Bill of Materials (Power Sourcing Equipment PSE) (continued)

Designator	Quantity	Value	Description	Package Reference	Part Number	Manufacturer
U13	1		65-V 0.6-A Synchronous Step-Down Converter, RNX0012B (VQFN-HR-12)	RNX0012B	LMR36006BRNXR	Texas Instruments
U14	1		Mixed-Signal Microcontrollers, PM0064A (LQFP-64)	PM0064A	MSP430FR5962IPMR	Texas Instruments
U15	1		8-Bit Micro Power QUAD Digital-to-Analog Converter with Rail-to-Rail Output, 10-pin MSOP	DGS0010A	DAC084S085CIMM	Texas Instruments
U16	1		1.25 V, 100 ppm / degC, 50 uA Series (Bandgap) Voltage Reference, -40 to 125 degC, 3-pin SOT-23 (DBZ), Green (RoHS & no Sb/Br)	DBZ0003A	REF2912AIDBZR	Texas Instruments
U17	1		3.6V Data-Line Surge and 30kV ESD Protection Diode Array, DBV0005A (SOT-23-5)	DBV0005A	ESDS302DBVR	Texas Instruments
U18	1		802.3cg 10-M Single-Pair Ethernet PHY for 1000 Meter, RHB0032M (VQFN-32)	RHB0032M	DP83TD510ERHBR	Texas Instruments
U19	1		Robust, Low Power 10/100 Ethernet Physical Layer Transceiver Extended Temperature, RHB0032B (VQFN-32)	RHB0032B	DP83822HRHBR	Texas Instruments
U20	1		Automotive 4-Channel ESD Protection Solution for SuperSpeed (up to 5 Gbps) Interface, DQA0010A (USON-10)	DQA0010A	TPD4E05U06QDQARQ1	Texas Instruments
U22	1		Dual Bidirectional Multi-Voltage Level Translator, DQE0008A (X2SON-8)	DQE0008A	LSF0102DQER	Texas Instruments
U23	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
Y1	1		Resonator, 4 MHz, 1000 ppm, 39 pF, SMD	4.5x1.2x2 mm	CSTCR4M00G15L99-R0	MuRata
Y2	1		Crystal, 25 MHz, 12 pF, AEC-Q200 Grade 1, SMD	3.2x2.5mm	ABM8AIG-25.000MHZ-12-2Z-T3	Abracon Corporation
Y4	1		Crystal, 24 MHz, 20 pF, SMD	3.2x2.5mm	ECS-240-20-33-DU-TR	ECS Inc.

The bill of materials of the powered device is shown in Table 3-2.

Table 3-2. Bill of Materials (Powered Device PD)

Designator	Quantity	Value	Description	PackageReference	PartNumber	Manufacturer
!PCB1	1		Printed Circuit Board		PoDL-PD	Any
C1	1	100 pF	CAP, CERM, 100 pF, 50 V, +/- 5%, C0G/NP0, 0603	603	8.85012E+11	Wurth Elektronik
C2	1	10uF	CAP, CERM, 10 µF, 25 V,+/- 10%, X7R, 1206	1206	C3216X7R1E106K160AB	TDK
C3, C6	2	0.01uF	CAP, CERM, 0.01 uF, 50 V, +/- 5%, C0G/NP0, AEC-Q200 Grade 1, 0603	603	CGA3E2C0G1H103J080AA	TDK
C4	1	0.047uF	CAP, CERM, 0.047 uF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0603	603	CGA3E2X7R1H473K080AA	TDK
C5	1	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, 0603	603	C0603C104K5RACTU	Kemet
C7	1	0.47uF	CAP, CERM, 0.47 uF, 10 V, +/- 10%, X7R, 0603	603	C0603C474K8RACTU	Kemet
C8	1	1000 pF	CAP, CERM, 1000 pF, 50 V, +/- 5%, C0G/NP0, 0603	603	C0603C102J5GACTU	Kemet
C9, C16, C18	3	0.1uF	CAP, CERM, 0.1 uF, 10 V,+/- 10%, X7R, 0603	603	8.85012E+11	Wurth Elektronik
C10	1	0.1uF	CAP, CERM, 0.1 uF, 25 V, +/- 10%, X7R, 0603	603	8.85012E+11	Wurth Elektronik
C11	1		4.7µF ±10% 50 V Ceramic Capacitor X7R 1206 (3216 Metric)	1206	8.85012E+11	Wurth Electronics
C12, C13	2	0.22uF	CAP, CERM, 0.22 uF, 50 V, +/- 10%, X7R, 0805	805	UMK212B7224KG-T	Taiyo Yuden
C14, C19, C23	3	1uF	CAP, CERM, 1 uF, 16 V, +/- 10%, X7R, 0603	603	8.85012E+11	Wurth Elektronik
C15, C17	2	470 pF	CAP, CERM, 470 pF, 10 V,+/- 5%, C0G/NP0, 0603	603	8.85012E+11	Wurth Elektronik
C20, C21	2	22uF	CAP, CERM, 22 uF, 16 V, +/- 10%, X7R, 1210	1210	C3225X7R1C226K250AC	TDK
C22	1	20 pF	CAP, CERM, 20 pF, 50 V, +/- 5%, C0G/NP0, 0603	603	GRM1885C1H200JA01D	MuRata

Table 3-2. Bill of Materials (Powered Device PD) (continued)

Designator	Quantity	Value	Description	PackageReference	PartNumber	Manufacturer
C24, C77	2	4700 pF	CAP, CERM, 4700 pF, 2000 V, +/- 10%, X7R, 1812	1812	1812GC472KAT1A	AVX
C42, C44	2	0	RES, 0, 5%, 0.125 W, AEC-Q200 Grade 0, 0805	805	ERJ-6GEY0R00V	Panasonic
C43	1	0.01uF	CAP, CERM, 0.01 uF, 2000 V, +/- 10%, X7R, 1825	1825	1825GC103KAT1A	AVX
C45, C46, C47	3	0.01uF	CAP, CERM, 0.01 µF, 1000 V,+/- 10%, X7R, 1206	1206	C1206X103KDRAC7800	Kemet
C48, C49	2	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 20%, X7R, 0805	805	08055C104MAT2A	AVX
C50, C54, C68, C72	4	10uF	CAP, CERM, 10 uF, 10 V, +/- 20%, X7T, 0603	603	GRM188D71A106MA73D	MuRata
C51, C55, C76, C80	4	1uF	CAP, CERM, 1 uF, 6.3 V, +/- 20%, X7R, 0402	402	GRM155R70J105MA12D	MuRata
C52, C56	2	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 20%, X7R, AEC-Q200 Grade 1, 0402	402	CGA2B3X7R1H104M050BB	TDK
C53, C57, C58, C61, C69, C73	6	0.01uF	CAP, CERM, 0.01 uF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0402	402	CGA2B3X7R1H103K050BB	TDK
C59, C60	2	22 pF	CAP, CERM, 22 pF, 50 V, +/- 5%, C0G/NP0, AEC-Q200 Grade 1, 0402	402	GCM1555C1H220JA16D	MuRata
C67, C71	2	100 pF	CAP, CERM, 100 pF, 50 V, +/- 5%, C0G/NP0, AEC-Q200 Grade 1, 0402	402	CGA2B2C0G1H101J050BA	TDK
C70, C74, C97	3	1000 pF	CAP, CERM, 1000 pF, 50 V, +/- 5%, C0G/NP0, 0402	402	GRM1555C1H102JA01D	MuRata
C75	1	0.1uF	CAP, CERM, 0.1 uF, 16 V, +/- 10%, X7R, 0402	402	8.85012E+11	Wurth Elektronik
C81, C82	2	10 pF	CAP, CERM, 10 pF, 16 V,+/- 10%, C0G, 0402	402	C0402C100K4GACTU	Kemet
C83, C84	2	0.1uF	CAP, CERM, 0.1 uF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0402	402	GCM155R71H104KE02D	MuRata
C85	1	4.7uF	CAP, TA, 4.7 uF, 35 V, +/- 10%, 1.3 ohm, SMD	7343-31	293D475X9035D2TE3	Vishay-Sprague

Table 3-2. Bill of Materials (Powered Device PD) (continued)

Designator	Quantity	Value	Description	PackageReference	PartNumber	Manufacturer
C86, C94, C95, C96	4	0.1uF	CAP, CERM, 0.1 µF, 10 V,+/- 10%, X7R, 0402	402	C0402C104K8RACTU	Kemet
C87, C88	2	36 pF	CAP, CERM, 36 pF, 50 V,+/- 5%, C0G/NP0, 0402	402	CL05C360JB5NNNC	Samsung Electro-Mechanics
C89, C92	2	0.22uF	CAP, CERM, 0.22 uF, 16 V, +80/-20%, Y5V, 0603	603	C0603C224Z4VACTU	Kemet
C90	1	0.47uF	CAP, CERM, 0.47 uF, 6.3 V, +/- 10%, X5R, 0402	402	04026D474KAT2A	AVX
C91	1	4.7uF	CAP, CERM, 4.7 uF, 35 V, +/- 10%, X5R, 0603	603	C1608X5R1V475K080AC	TDK
C93	1	10uF	CAP, TA, 10 uF, 35 V, +/- 10%, 0.125 ohm, SMD	7343-31	TPSD106K035R0125	AVX
D1, D2, D5, D6, D7, D10, D12	7		DIODE SCHOTTKY 60 V 1 A DSN1006-2	SOD993	PMEG6010AESBYL	Nexperia
D3, D4	2	Green	LED, Green, SMD	LED_0603	150060VS75000	Wurth Elektronik
D8, D9, D14, D23, D24, D25, D26, D27, D28	9	Green	LED, Green, SMD	1x0.5mm	150040GS73240	Wurth Elektronik
D11	1	Red	LED, Red, SMD	LED_0603	150060RS75000	Wurth Elektronik
D13	1	36 V	Diode, TVS, Bi, 36 V, 76 Vc, AEC-Q101, SMB	SMB	SM6T42CAY	STMicroelectronics
D18, D19, D21, D22	4	100 V	Diode, Ultrafast, 100 V, 2 A, SMA	SMA	MURA110T3G	ON Semiconductor
D20	1	36 V	Diode, TVS, Bi, 36 V, 58.1 Vc, SMC	SMC	SMCJ36CA	Littelfuse
D31, D32	2	Rg	LED, Rg, SMD	1.6x0.8mm	HSMF-C165	Avago
FID1, FID2, FID3, FID4, FID5, FID6	6		Fiducial mark. There is nothing to buy or mount.	N/A	N/A	N/A
H1, H2, H3, H4	4		MACHINE SCREW PAN PHILLIPS M3		RM3X6MM 2701	APM HEXSEAL
H5, H6, H7, H8	4			SPACER_M3X20MM	970200365	Wurth Electronics
J1, J3, J15, J16	4		Header, 2.54 mm, 2x1, Gold, TH	Header, 2.54mm, 2x1, TH	61300211121	Wurth Elektronik
J2	1		Terminal Block, 2x1, 2.54mm, TH	Terminal Block, 2x1, 2.54mm, TH	282834-2	TE Connectivity
J4	1		Header, 2.54 mm, 6x1, Gold, TH	Header, 2.54mm, 6x1, TH	61300611121	Wurth Elektronik

Table 3-2. Bill of Materials (Powered Device PD) (continued)

Designator	Quantity	Value	Description	PackageReference	PartNumber	Manufacturer
J5	1		Header, 2.54 mm, 4x1, Gold, TH	Header, 2.54mm, 4x1, TH	61300411121	Wurth Elektronik
J6	1		3 Position Wire to Board Terminal Block Horizontal with Board 0.197" (5.00mm) Through Hole	HDR3	6.91217E+11	Wurth
J7	1		Jack Modular Connector 2P2C Single Pair Ethernet (SPE) 90° Angle (Right) Shielded CatB	PTH_ETHERNET_CONNECTOR	1163797	Phoenix Contact
J8, J9, J10	3		Header, 100mil, 3x1, Gold, TH	3x1 Header	TSW-103-07-G-S	Samtec
J11	1		Connector, RJ45 with integrated magnetics, 1x1, Gold, R/A, SMT	Connector, RJ-45 with integrated magnetics, 1x1, R/A, SMT	J3011G21DNL	Pulse Engineering
J13	1		Connector, Receptacle, Micro-USB Type AB, R/A, Bottom Mount SMT	5.6x2.5x8.2mm	475890001	Molex
J14	1		Header, 100mil, 2x2, Gold, TH	2x2 Header	TSW-102-07-G-D	Samtec
L1	1	15uH	Inductor, Shielded Drum Core, Ferrite, 15 uH, 0.72 A, 0.356 ohm, SMD	Inductor, 2.8x2.8x2.8mm	744025150	Wurth Elektronik
L3	1		Inductor Coupled 2x250uH 20% 0.25Ω 1200 mA	SMT4_15MM5_15MM5	PID150H-251M	TDK
L4	1		Common Mode Choke for 10 Base T1L	SMT4_7MM1_6MM0	RCM70CGI-471N	TDK
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
Q2, Q3	2	60 V	MOSFET, N-CH, 60 V, 2.2 A, YJK0003A (PICOSTAR-3)	YJK0003A	CSD18541F5	Texas Instruments
R1, R10, R13	3	0	RES, 0, 5%, 0.1 W, 0603	603	ERJ-3GEY0R00V	Panasonic
R2, R5, R27	3	100k	RES, 100 k, 1%, 0.1 W, 0603	603	CRCW0603100KFKEA	Vishay-Dale
R3	1	63.4k	RES, 63.4 k, 0.1%, 0.1 W, 0603	603	RT0603BRD0763K4L	Yageo America
R4	1	22.0k	RES, 22.0 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	603	ERJ-3EKF2202V	Panasonic
R6	1	120k	RES, 120 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW0603120KJNEA	Vishay-Dale
R7, R38	2	68.0k	RES, 68.0 k, 1%, 0.1 W, 0603	603	RC0603FR-0768KL	Yageo
R8	1	33.2k	RES, 33.2 k, 1%, 0.1 W, 0603	603	CRCW060333K2FKEA	Vishay-Dale

Table 3-2. Bill of Materials (Powered Device PD) (continued)

Designator	Quantity	Value	Description	PackageReference	PartNumber	Manufacturer
R9	1	3.6k	RES, 3.6 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW06033K60JNEA	Vishay-Dale
R11	1	475k	RES, 475 k, 1%, 0.1 W, 0603	603	CRCW0603475KFKEA	Vishay-Dale
R12	1	49.9k	RES, 49.9 k, 1%, 0.1 W, 0603	603	CRCW060349K9FKEA	Vishay-Dale
R14, R22	2	390	RES, 390, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW0603390RFKEA	Vishay-Dale
R15	1	16.9k	RES, 16.9 k, 1%, 0.1 W, 0603	603	CRCW060316K9FKEA	Vishay-Dale
R16	1	10.0k	RES, 10.0 k, 1%, 0.1 W, 0603	603	RC0603FR-0710KL	Yageo
R17	1	3.3k	RES, 3.3 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW06033K30JNEA	Vishay-Dale
R18	1	68k	RES, 68 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW060368K0JNEA	Vishay-Dale
R19	1	100k	RES, 100 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW0603100KFKEA	Vishay-Dale
R20	1	6.8k	RES, 6.8 k, 5%, 0.1 W, 0603	603	RC0603JR-076K8L	Yageo
R21	1	24.9k	RES, 24.9 k, 1%, 0.1 W, 0603	603	RC0603FR-0724K9L	Yageo
R23	1	24	RES, 24.0, 1%, 0.1 W, 0603	603	RC0603FR-0724RL	Yageo
R24	1	1.00Meg	RES, 1.00 M, 1%, 0.1 W, 0603	603	CRCW06031M00FKEA	Vishay-Dale
R25	1	4.53k	RES, 4.53 k, 1%, 0.1 W, 0603	603	RC0603FR-074K53L	Yageo
R26	1	422k	RES, 422 k, 1%, 0.1 W, 0603	603	RC0603FR-07422KL	Yageo
R28, R35	2	10k	RES, 10 k, 5%, 0.1 W, 0603	603	CRCW060310K0JNEA	Vishay-Dale
R29	1	470k	RES, 470 k, 1%, 0.1 W, 0603	603	RC0603FR-07470KL	Yageo
R30	1	100k	RES, 100 k, 1%, 0.1 W, 0603	603	RC0603FR-07100KL	Yageo
R31	1	560	RES, 560, 5%, 0.1 W, 0603	603	RC0603JR-07560RL	Yageo
R32	1	47.0k	RES, 47.0 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW060347K0FKEA	Vishay-Dale
R33	1	1.0k	RES, 1.0 k, 5%, 0.1 W, 0603	603	CRCW06031K00JNEA	Vishay-Dale
R34	1	47k	RES, 47 k, 5%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW060347K0JNEA	Vishay-Dale
R36	1	3.90k	RES, 3.90 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0603	603	CRCW06033K90FKEA	Vishay-Dale

Table 3-2. Bill of Materials (Powered Device PD) (continued)

Designator	Quantity	Value	Description	PackageReference	PartNumber	Manufacturer
R37, R146	2	1.00Meg	RES, 1.00 M, 1%, 1 W, 2010	2010	HVCB2010FKC1M00	Stackpole Electronics Inc
R71	1	1.0Meg	RES, 1.0 M, 5%, 0.75 W, AEC-Q200 Grade 0, 2010	2010	CRCW20101M00JNEF	Vishay-Dale
R72	1	100	RES, 100, 1%, 0.125 W, AEC-Q200 Grade 0, 0805	805	CRCW0805100RFKEA	Vishay-Dale
R75, R79, R82	3	0	RES, 0, 5%, 0.063 W, 0402	402	RC0402JR-070RL	Yageo America
R76, R83, R142, R156, R172, R174, R180	7	2.20k	RES, 2.20 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW04022K20FKED	Vishay-Dale
R77, R78, R135, R136	4	0	RES, 0, 5%, 0.1 W, 0603	603	RC0603JR-070RL	Yageo
R87, R88, R93, R96, R99, R100, R101, R102, R105, R106, R107, R111, R112, R113, R145, R152, R155, R158	18	2.49k	RES, 2.49 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW04022K49FKED	Vishay-Dale
R108, R109, R110, R114, R115, R116	6	3.3k	RES, 3.3 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW04023K30JNED	Vishay-Dale
R117, R126	2	39.2	RES, 39.2, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW040239R2FKED	Vishay-Dale
R118, R119, R120, R121, R123, R125, R127, R128	8	0	RES, 0, 0%, 0.2 W, AEC-Q200 Grade 0, 0402	402	CRCW04020000Z0EDHP	Vishay-Dale
R122, R124	2	2.00k	RES, 2.00 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW04022K00FKED	Vishay-Dale
R137, R138, R139, R140	4	49.9	RES, 49.9, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW040249R9FKED	Vishay-Dale
R141	1	4.87k	RES, 4.87 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW04024K87FKED	Vishay-Dale
R143, R144, R190, R191, R192, R193	6	470	RES, 470, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW0402470RJNED	Vishay-Dale
R151	1	10.0k	RES, 10.0 k, 1%, 0.063 W, 0402	402	RC0402FR-0710KL	Yageo America

Table 3-2. Bill of Materials (Powered Device PD) (continued)

Designator	Quantity	Value	Description	PackageReference	PartNumber	Manufacturer
R164, R166	2	374k	RES, 374 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW0402374KFKED	Vishay-Dale
R165, R167	2	1.00Meg	RES, 1.00 M, 1%, 0.1 W, 0402	402	ERJ-2RKF1004X	Panasonic
R168, R169	2	27	RES, 27, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW040227R0JNED	Vishay-Dale
R170, R171	2	200k	RES, 200 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW0402200KJNED	Vishay-Dale
R185, R197, R198	3	0	RES, 0, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW04020000Z0ED	Vishay-Dale
R194	1	1.40k	RES, 1.40 k, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW04021K40FKED	Vishay-Dale
R195	1	1.00Meg	RES, 1.00 M, 1%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW04021M00FKED	Vishay-Dale
R196	1	47k	RES, 47 k, 5%, 0.063 W, AEC-Q200 Grade 0, 0402	402	CRCW040247K0JNED	Vishay-Dale
S1, S2, S3	3		Switch, Normally open, 2.3N force, 200k operations, SMD	KSR	KSR221GLFS	C&K Components
SH-J1, SH-J2, SH-J3, SH-J5, SH-J6, SH-J7, SH-J8	7		Shunt, 2.54mm, Gold, Black	Shunt, 2.54mm, Black	60900213421	Wurth Elektronik
T3	1		Super Tiny Signal Transformer	SMT7_6MM55_5MM35	74930200	Wurth Electronics
TP1	1		Test Point, Multipurpose, Red, TH	Red Multipurpose Testpoint	5010	Keystone
TP16	1		Test Point, Multipurpose, Black, TH	Black Multipurpose Testpoint	5011	Keystone
U1	1		50 mA, 3 V to 50 V, Micropower, Low-Dropout Linear Regulator, DGN0008B (VSSOP-8)	DGN0008B	TPS79801QDGNRQ1	Texas Instruments
U3	1		Nanopower, small size comparator with push-pull output, DBV0005A (SOT-23-5)	DBV0005A	TLV7031DBVR	Texas Instruments
U4	1		60 V 2 A Industrial eFuse With Integrated Reverse-Input Polarity Protection, PWP0016H (TSSOP-16)	PWP0016H	TPS26602PWPR	Texas Instruments
U5	1		65-V 0.6-A Synchronous Step-Down Converter, RNX0012B (VQFN-HR-12)	RNX0012B	LMR36006BRNXR	Texas Instruments

Table 3-2. Bill of Materials (Powered Device PD) (continued)

Designator	Quantity	Value	Description	PackageReference	PartNumber	Manufacturer
U6	1		Mixed-Signal Microcontroller, RHB0032E (VQFN-32)	RHB0032E	MSP430FR2476TRHBR	Texas Instruments
U7	1		2.5V Low Iq Adjustable Precision Shunt Regulator, DBZ0003A (SOT-23-3)	DBZ0003A	ATL431BIDBZR	Texas Instruments
U8	1		300-mA, 18-V, Low IQ, Low Dropout Voltage Regulator with Power Good, DRV0006A (WSON-6)	DRV0006A	TPS7A2533DRVR	Texas Instruments
U17	1		3.6V Data-Line Surge and 30kV ESD Protection Diode Array, DBV0005A (SOT-23-5)	DBV0005A	ESDS302DBVR	Texas Instruments
U18	1		802.3cg 10-M Single-Pair Ethernet PHY for 1000 Meter, RHB0032M (VQFN-32)	RHB0032M	DP83TD510ERHBR	Texas Instruments
U19	1		Robust, Low Power 10/100 Ethernet Physical Layer Transceiver Extended Temperature, RHB0032B (VQFN-32)	RHB0032B	DP83822HRHBR	Texas Instruments
U20	1		Automotive 4-Channel ESD Protection Solution for SuperSpeed (up to 5 Gbps) Interface, DQA0010A (USON-10)	DQA0010A	TPD4E05U06QDQARQ1	Texas Instruments
U22	1		Dual Bidirectional Multi-Voltage Level Translator, DQE0008A (X2SON-8)	DQE0008A	LSF0102DQER	Texas Instruments
U23	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
Y2	1		Crystal, 25 MHz, 12 pF, AEC-Q200 Grade 1, SMD	3.2x2.5mm	ABM8AIG-25.000MHZ-12-2Z-T3	Abracon Corporation
Y4	1		Crystal, 24 MHz, 20 pF, SMD	3.2x2.5mm	ECS-240-20-33-DU-TR	ECS Inc.

4 Additional Information

4.1 Trademarks

All trademarks are the property of their respective owners.

STANDARD TERMS FOR EVALUATION MODULES

1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an “EVM” or “EVMs”) to the User (“User”) in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.

   1.1 EVMs are intended solely for product or software developers for use in a research and development setting to facilitate feasibility evaluation, experimentation, or scientific analysis of TI semiconductors products. EVMs have no direct function and are not finished products. EVMs shall not be directly or indirectly assembled as a part or subassembly in any finished product. For clarification, any software or software tools provided with the EVM (“Software”) shall not be subject to the terms and conditions set forth herein but rather shall be subject to the applicable terms that accompany such Software

   1.2 EVMs are not intended for consumer or household use. EVMs may not be sold, sublicensed, leased, rented, loaned, assigned, or otherwise distributed for commercial purposes by Users, in whole or in part, or used in any finished product or production system.

2 *Limited Warranty and Related Remedies/Disclaimers*:

   2.1 These terms do not apply to Software. The warranty, if any, for Software is covered in the applicable Software License Agreement.

   2.2 TI warrants that the TI EVM will conform to TI's published specifications for ninety (90) days after the date TI delivers such EVM to User. Notwithstanding the foregoing, TI shall not be liable for a nonconforming EVM if (a) the nonconformity was caused by neglect, misuse or mistreatment by an entity other than TI, including improper installation or testing, or for any EVMs that have been altered or modified in any way by an entity other than TI, (b) the nonconformity resulted from User's design, specifications or instructions for such EVMs or improper system design, or (c) User has not paid on time. Testing and other quality control techniques are used to the extent TI deems necessary. TI does not test all parameters of each EVM. User's claims against TI under this Section 2 are void if User fails to notify TI of any apparent defects in the EVMs within ten (10) business days after delivery, or of any hidden defects with ten (10) business days after the defect has been detected.

   2.3 TI's sole liability shall be at its option to repair or replace EVMs that fail to conform to the warranty set forth above, or credit User's account for such EVM. TI's liability under this warranty shall be limited to EVMs that are returned during the warranty period to the address designated by TI and that are determined by TI not to conform to such warranty. If TI elects to repair or replace such EVM, TI shall have a reasonable time to repair such EVM or provide replacements. Repaired EVMs shall be warranted for the remainder of the original warranty period. Replaced EVMs shall be warranted for a new full ninety (90) day warranty period.

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 DEGREDATION 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/lsds/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。

https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-delivered-in-japan.html

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.

【無線電波を送信する製品の開発キットをお使いになる際の注意事項】 開発キットの中には技術基準適合証明を受けていないものがあります。 技術適合証明を受けていないもののご使用に際しては、電波法遵守のため、以下のいずれかの措置を取っていただく必要がありますのでご注意ください。

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。

なお、本製品は、上記の「ご使用にあたっての注意」を譲渡先、移転先に通知しない限り、譲渡、移転できないものとします。

上記を遵守頂けない場合は、電波法の罰則が適用される可能性があることをご留意ください。 日本テキサス・インスツルメンツ株式会社

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西新宿三井ビル

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

電力線搬送波通信についての開発キットをお使いになる際の注意事項については、次のところをご覧ください。https://www.ti.com/ja-jp/legal/notice-for-evaluation-kits-for-power-line-communication.html

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.

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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.

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