

**PD70201EVB25FW-3**  
**3.3V/25W Isolated Active Clamp Forward Converter PD**  
**Evaluation Board User Guide**  
Revision 1.02

## 1 About this guide

This user guide provides both description and operation procedures for Microsemi's PD70201EVB25FW-3 evaluating board. This board is used for evaluating the performance of PD70201A PD controller with integrated switching regulator, and PD70224 Dual MOSFET – Based Active Bridge Rectifier.

PD70201ILQ device supports both the standard IEEE802.3at PD application interface, and a PWM controller that is used to provide the PD operational voltage.

The evaluation board supports a 25 Watt, 3.3V output in its existing configuration, with no heat sink.

### 1.1 Audience

This user guide is intended for qualified personnel, meaning operators and technicians who have a background in basic concepts of electronics.

### 1.2 Organization

This guide is divided into several sections as follows:

• Chapter 1	<b>About this Guide:</b> Describes the objectives, audience, and organization
• Chapter 2	<b>Introduction:</b> Provides an overview about evaluation board's main functions, features, physical characteristics and ordering information.
• Chapter 3	<b>Physical Description:</b> Provides explanation related to the physical description (switches, jumpers, connectors).
• Chapter 4	<b>Electrical Characteristics:</b> Provides electrical characteristics of the evaluation board.
• Chapter 5	<b>Installation:</b> Provides description of the installation process.
• Chapter 6	<b>Test Data:</b> Provides board test data information
• Chapter 7	<b>Schematic:</b> Provides board schematic diagram
• Chapter 8	<b>List of Material:</b> Provides board's list of materials.
• Chapter 9	<b>Board Layout:</b> Provides board Gerber files description for all layers.

### 1.3 Reference Documents

PD70201 datasheet, catalogue number DS\_PD70201

PD70224 datasheet, catalogue number DS\_PD70224

## 2 Introduction

Microsemi's PD7201ILQ device is part of a family of devices which are targeted for realizing the 802.3at standard PD interface.

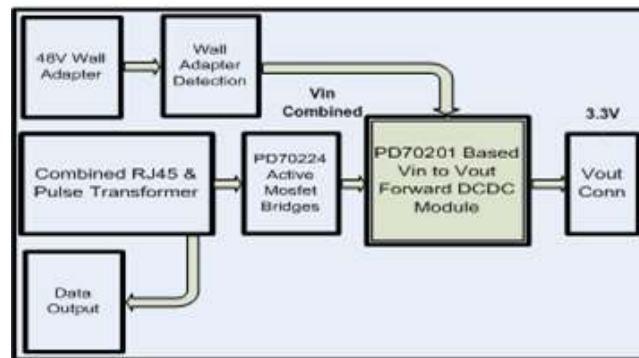
The PD interface family of devices includes the following:

Device type	Power capability	Integrates PWM controller
PD70100	IEEE802.3at Type 1 (IEEE802.3 af level)	No
PD70101	IEEE802.3at Type 1 (IEEE802.3 af level)	Yes
PD70200	IEEE802.3at Type 2	No
PD70201	IEEE802.3at Type 2	Yes
PD70210(A)	2 x IEEE802.3at Type 2 (4 pair) HDBaseT (95W)	No
PD70211	2 x IEEE802.3at Type 2 (4 pair) HDBaseT (95W)	Yes

Microsemi's PD7201EVB25FW-3 Evaluation Board (see Figure 2) provides designers with an environment needed for evaluating the performance and implementation of PD applications based on PD70201 controller.

The board is using a single PD controller, PD70201ILQ, to support the Detection, Class, and Power Supplying phases on the 4 Pairs of the Cat5 cable. The board supports sync detection of the 4 pairs. PD70201ILQ supports the current of the HDBaseT over 4 Pairs, which is more than twice the power of a standard IEEE802.3AT Type 2 interface.

All necessary steps and connection instructions required to install and operate this board are provided within this document.



**Figure 1: PD7201EVB25FW-3 Block Diagram**



**Figure 2: PD7201EVB25FW-3 Evaluation Board – General View**

### Evaluation Boards Ordering Information

Microsemi supplies the following Evaluation Board as shown below:

Ordering Number	Description
PD7201EVB25FW-3	2 x IEEE802.3at Type 2 (4 pair) PD based on PD7201 device having 4 pair supply, controlling an <b>isolated Forward converter</b> , having a <b>3.3V 7.5A</b> output.

## 2.1 Evaluation Board Features

- Designed to support Data and Spare current by a single PD70201A device
- Power is supplied through the 4-pairs of the Cat5 cable
- Wall Adapter input – Standard Barrel Jack available for connecting to an external 48-54V Wall Adapter.
- Data pass-through connector
- On board AT detected LED indicator
- On board Power Good LED indicator
- $T_A = -40^\circ$  to  $+70^\circ\text{C}$
- RoHS compliant

## 2.2 Physical Characteristics

Table 1 lists evaluation board's physical characteristics.

**Table 1: Physical Characteristics**

Parameter	Value
Mechanical dimensions in mm	165 x 57 x 20 mm (L x W x H)

### 3 Physical Description

#### 3.1 Package Contents

Upon opening the Evaluation Board package, verify the following part is included.

If it seems damaged, contact local representative or Microsemi's headquarters.

Package content for standard shipments is:

- PD70201EVB25FW-3 Evaluation Board.
- Wall Adapter Input Cable

#### 3.2 Connectors

The following sections provide both general and detailed information regarding unit's connectors.

##### 3.2.1 Connectors Table

Table 2 lists the Evaluation Board's connectors.

**Table 2: Connectors List**

#	Connector	Name	Description
1	J1	Magjack	RJ45 port for Data + Power In for PSE connection
2	J2	Wall Adapter Input	Standard Barrel Jack used for 48V Wall Adapter. Wall adapter connection will be automatically sensed and will override the PSE power connected to J1.
3	J3	Converter Output	Screw terminals for easy connecting a load to 3.3V output.
4	J4	RJ45 Connector	An RJ45 port for Data pass – through output

##### 3.2.2 Connectors Detailed Explanation

(The numbering is in reference to the numbers listed in Table 2.)

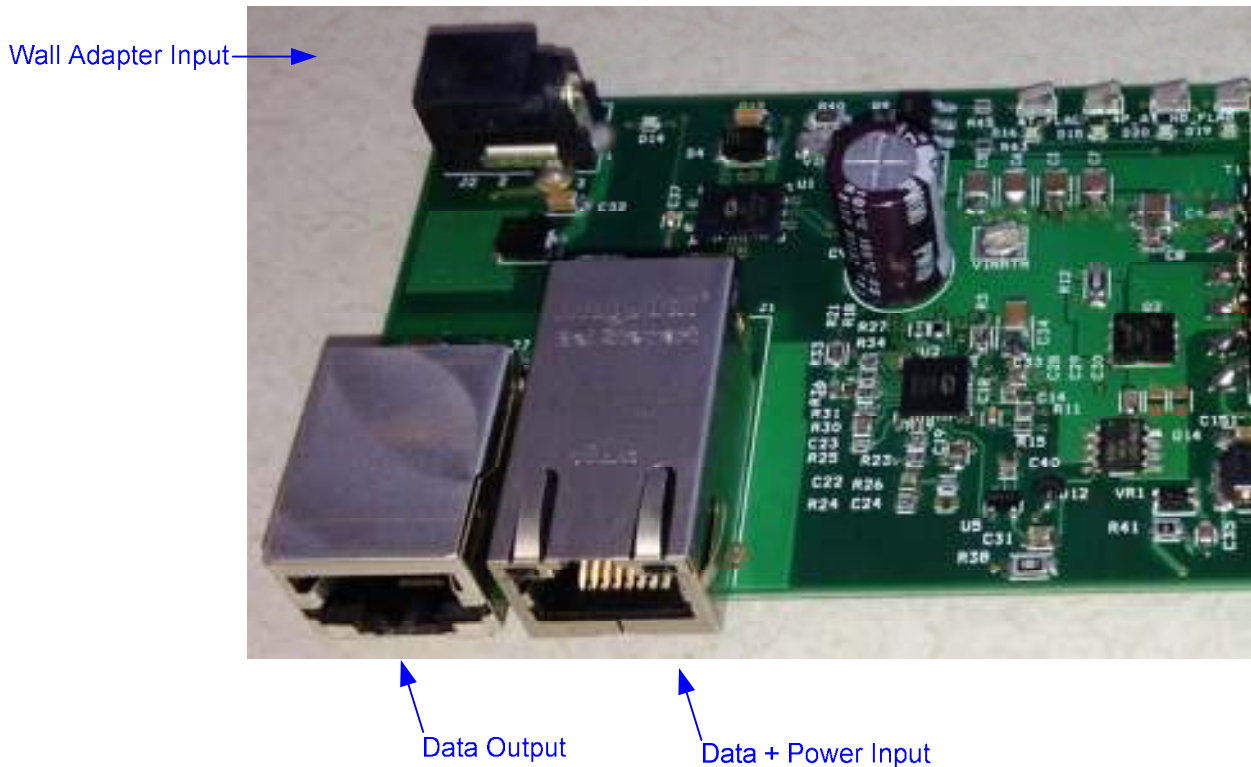
###### 1. RJ45 Connectors.

See Figure 3.

**Table 3: RJ45 Connectors**

J1 & J4 Pin No	Signal Name	Description
J1 - 1, 2	Data and Power In	Data and power input to powered device (PoE Master Negative data port)
J1 - 3, 6	Data and Power In	Data and power input to powered device (PoE Master Positive data port)
J1 - 4, 5	Data and Power In	Data and power input to powered device (PoE Master Positive data port)
J1 - 7, 8	Data and Power In	Data and power input to powered device (PoE Master Negative data port)

J1 & J4 Pin No	Signal Name	Description
J4 - 1, 2	Data Output	Isolated data pass-through to external monitoring device.
J4 - 3, 6	Data Output	Isolated data pass-through to external monitoring device.
J4 - 4, 5	Data Output	Isolated data pass-through to external monitoring device.
J4 - 7, 8	Data Output	Isolated data pass-through to external monitoring device.



**Figure 3: Front RJ45 and Auxiliary 48V Wall Adapter Connectors**

**2. Wall Adapter Connections**

See Figure 3.

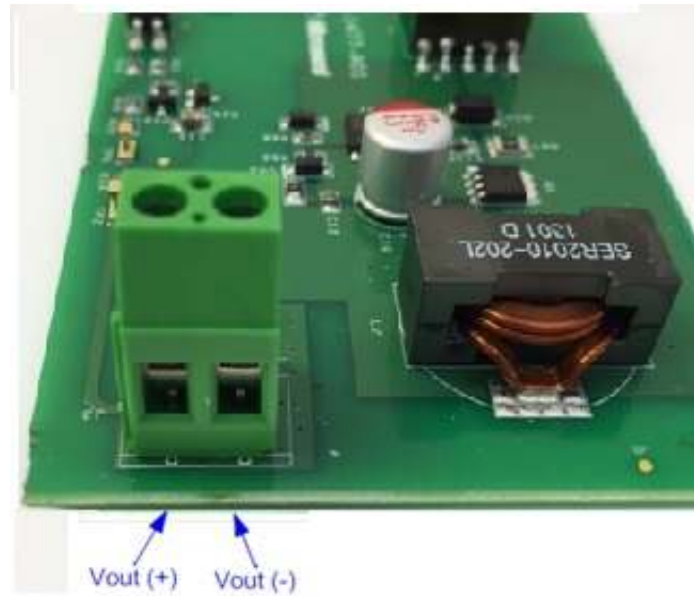
J2 Pin No	Signal Name	Description
Center Pin	VIN (+)	42V to 57V input from wall adapter.
Outer Barrel	VIN (-)	Wall Adapter Return

**3. V<sub>out</sub> Connections**

See Figure 4.

**Table 4: Output Load Connections**

Pin No.	Signal Name	Description
J3 - 2	Vout (-)	Return of DC-DC output voltage
J3 - 1	Vout (+)	Positive DC-DC output voltage



**Figure 4: V<sub>out</sub> Connections**



### 3.3 Indications

The following sections provide general information regarding unit's indications.

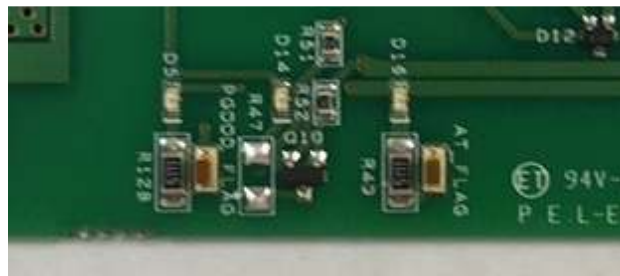
#### 3.3.1 LED Indication

See Figure 5.

D16 is the AT\_FLAG indication LED, a PD70201 device output signal indicating the device has detected a 2 finger class event from the PSE side in the class stage.

D5 is the Power Good indication, a PD70201 device output signal indicating presence of PoE power.

D14 is the input power indicator, indication power presence from either PoE or auxiliary source (wall adapter).



**Figure 5: LED Indications**

## 4 Electrical Characteristics

Evaluation board's electrical characteristics are described below:

**Table 5: Electrical Characteristics**

Parameter		Min	Max	
Main DC Supply – J1, VIN+, VINRTN		42*	57	V
Wall Adapter Supply – J2, VIN+, VINRTN		42	57	V
Output voltage		3.25	3.40	V
Maximum Output Current			7.5	A
Port Isolation to Chassis		-	1.5	kVrms

\*After start-up, the minimum voltage is 37V with load  $\leq$  13W per IEEE specification.

## 5 Installation

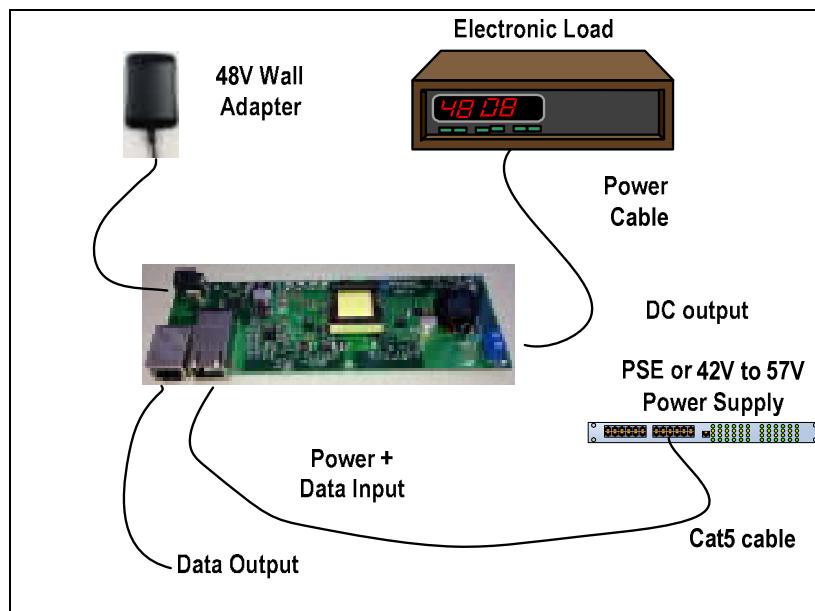
### 5.1 Preliminary Considerations and Safety Precautions

- If using an external supply in place of a PSE, verify the external power supply is turned “off” before all peripheral devices are connected. Insure the external supply is connected to the RJ45 input (J1) per Table 3.

### 5.2 Initial Configuration

**Note:** It is important to verify evaluation board is setup as shown in Figure 6 prior to starting any operation.

1. Connect load to evaluation board (J3 -1 (+) & J3 - 2 (-), or TP17 (+) & TP16 (-)).
  2. Connect a Cat5 cable from PSE to Evaluation Board (J1), or a 48V Wall Adapter to Evaluation Board (J2).
- Note: Wall Adapter will override power from PSE.



**Figure 6: Test Setup**

## 6 Test Data

This chapter describes typical EVB test data under various loads and POE input voltage levels. The efficiency is indicated up to 15A output load current.

Overall efficiency is measured at the input to the bridge. It does not include system-level components (input/output connectors, data transformer, and EMI filter).

$$Eff = \frac{V_{out} * I_{out}}{V_{in} * I_{in}}$$

DC-DC efficiency is measured after the PD chip.

### 6.1 Efficiency vs. Input Voltage to the bridge at full load (7.5A)

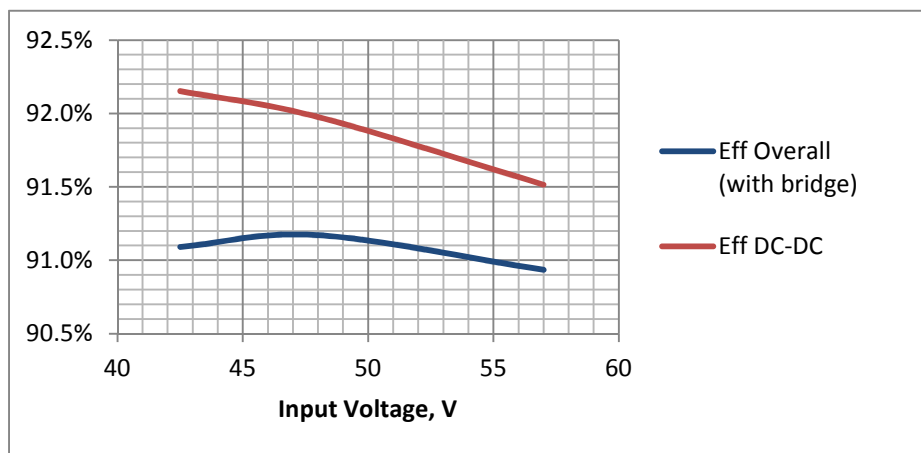


Figure 7: Efficiency vs. Input Voltage

### 6.2 Efficiency vs. Load Current at 48V Input to the bridge

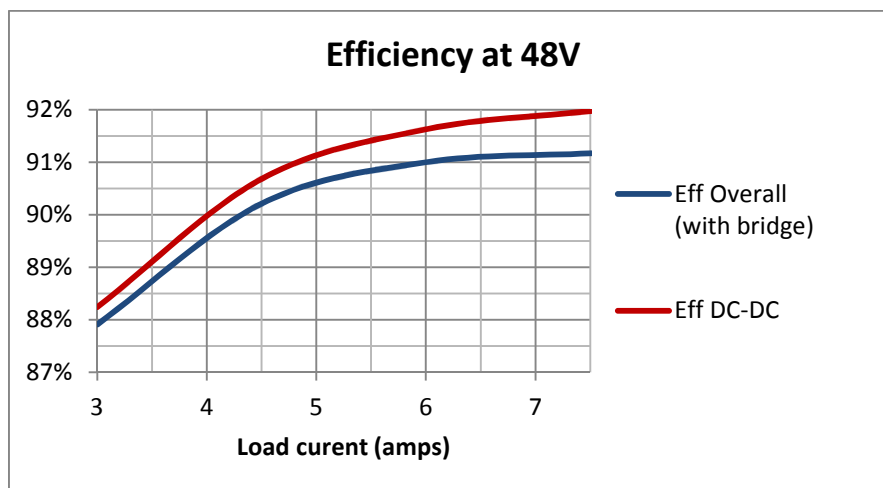
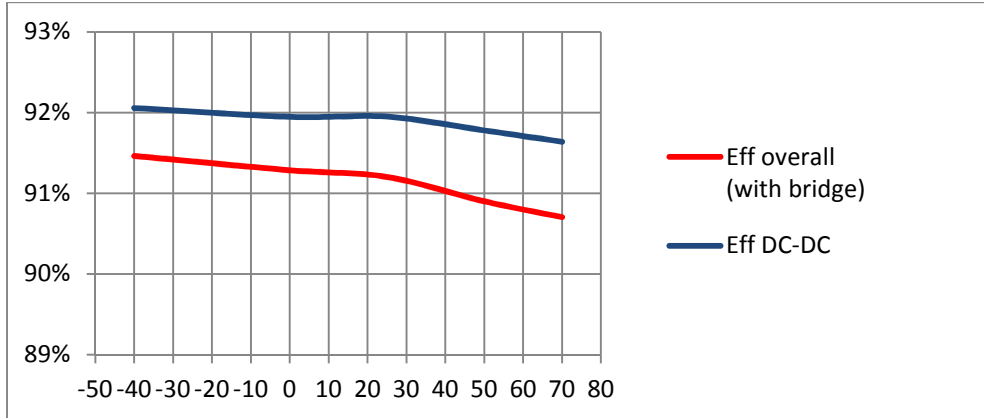


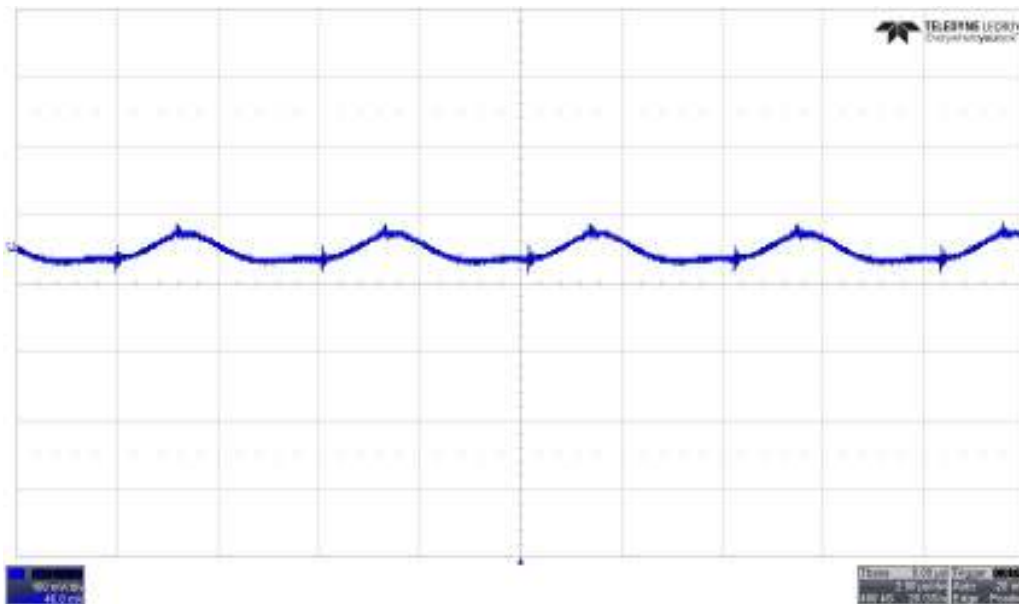
Figure 8: Efficiency at 48V Input

**6.3 Efficiency vs. ambient temperature at 48V input to the bridge at full load**



**Figure 9: Efficiency vs. temperature at 48V Input**

**6.4 Output Ripple measured with 20 MHz bandwidth**

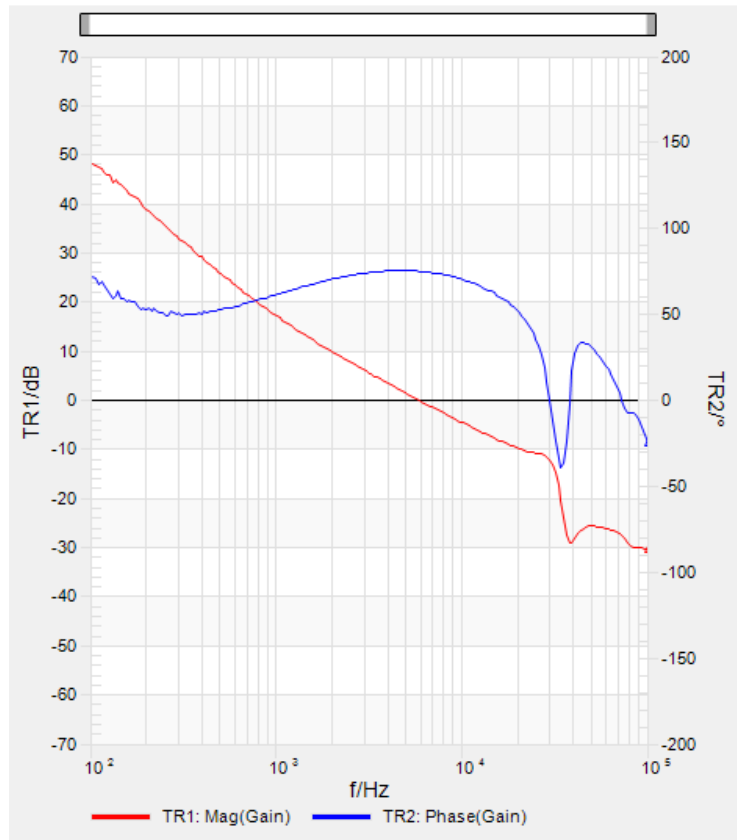


**Figure 10: Full Load Voltage Ripple and Noise at 48V Input (100mV/div)**



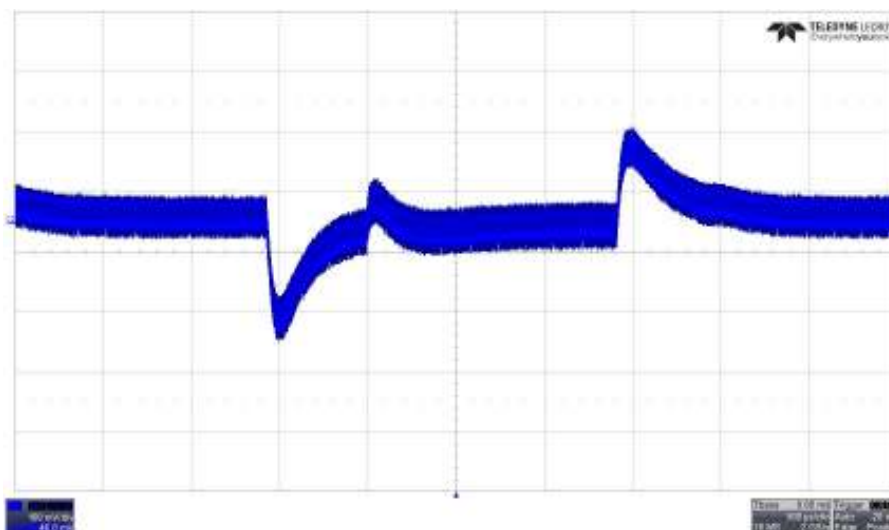
**Figure 11. Proper ripple measurement**

**6.5 Bode Plots at full load at 48V input**



**Figure 12. Bode plots (gain and phase)**  
 Phase margin: 70°, gain margin: -12dB.

**6.6 Step Load Response for transitions between 15% and 100% load at 48V input**



**Figure 13: Load Step Response (100mV/div)**

## 7 Schematic

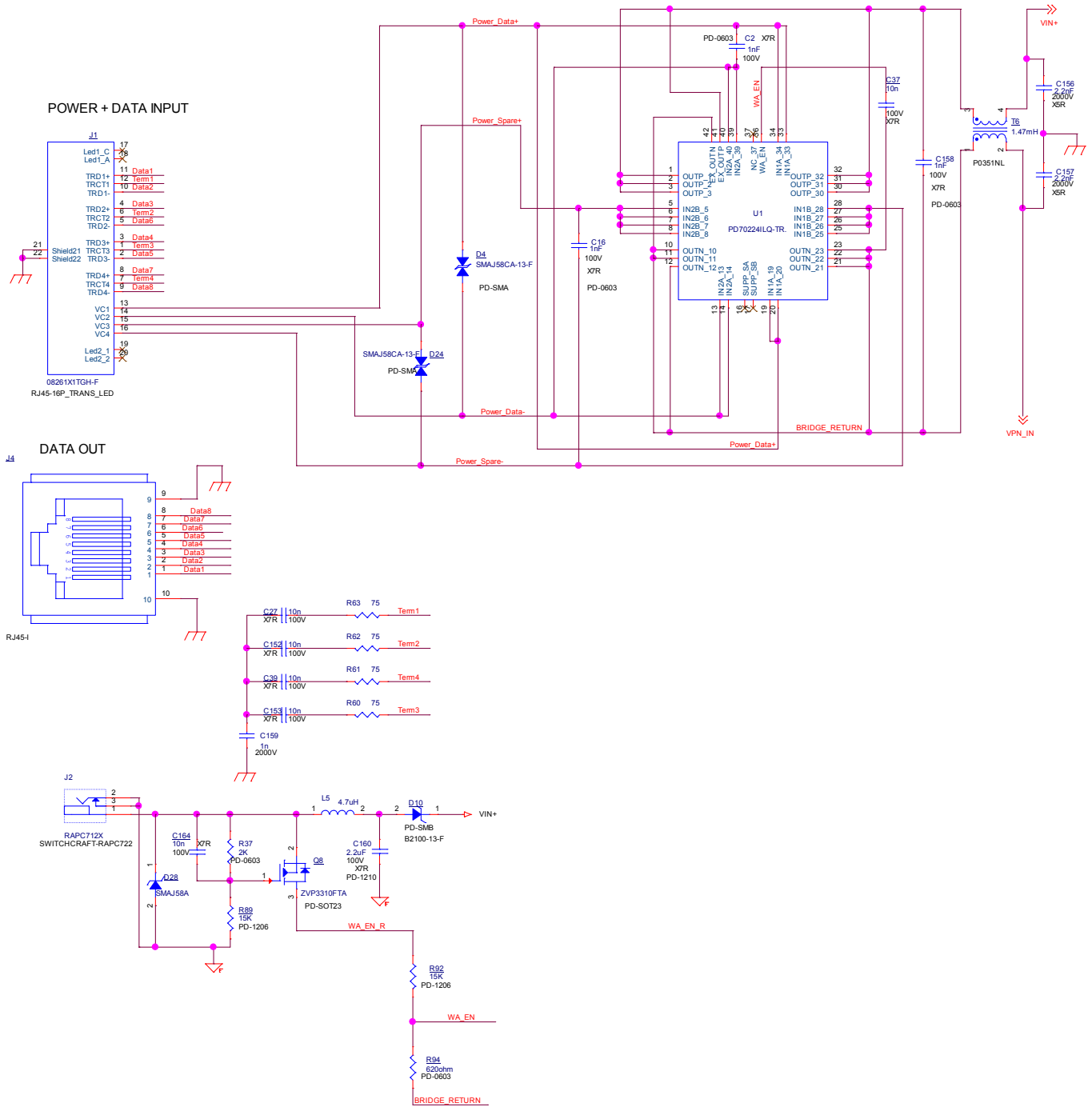


Figure 14: Evaluation Board Schematic (1 of 2)



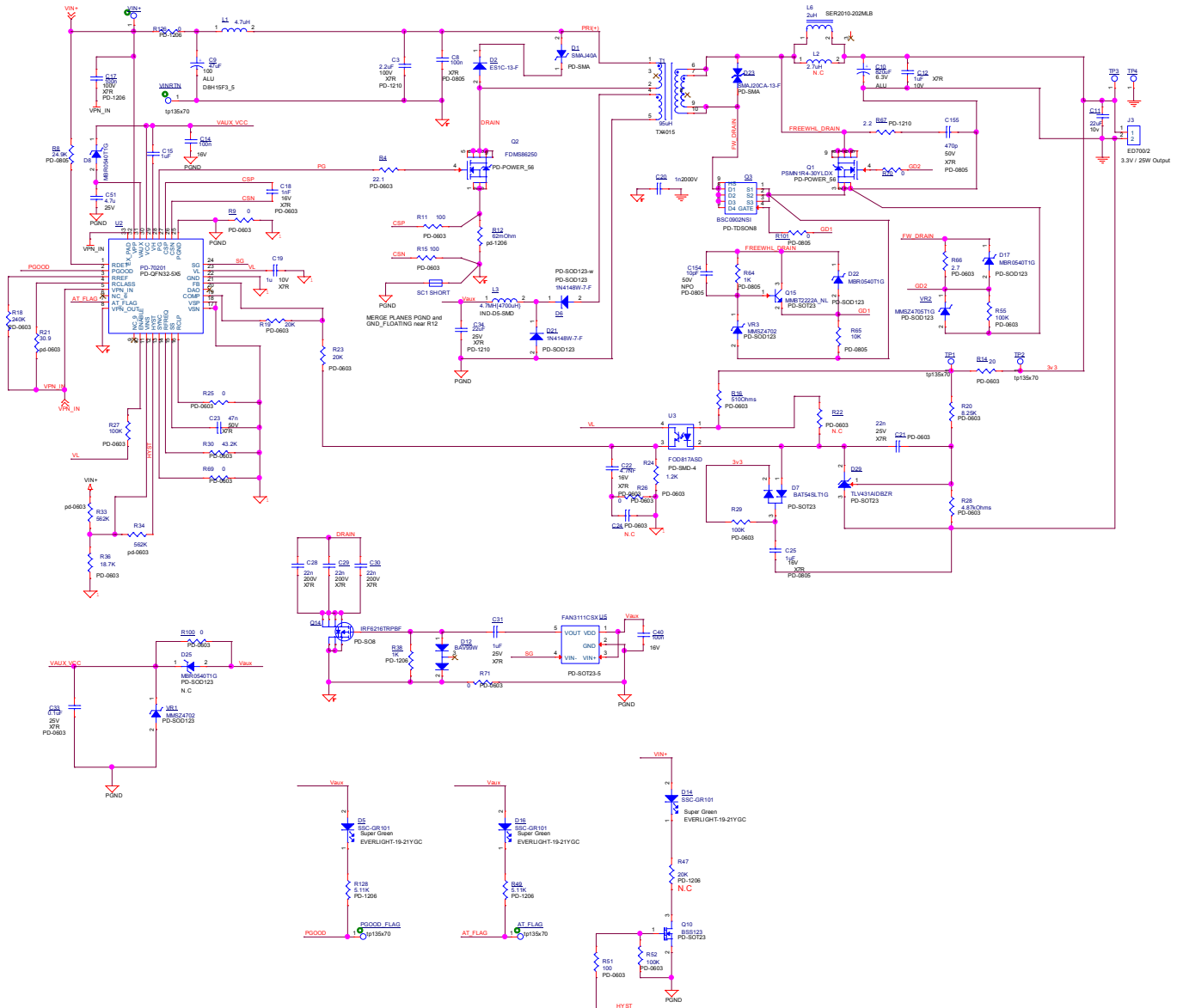


Figure 15: Evaluation Board Schematic (2 of 2)



**Microsemi**

**PD7211EVB25FW-3**

25W Isolated Forward Converter PD

Evaluation Board

## 8 List of Materials

QTY	REFERENCE	Value	Description	Mfr. Name	Mfr. Part Number
3	C2,C16, C158	1nF	Cap 1nF 100V 10% X7R 0603 SMT	Samsung	CL10B102KC8NNNC
2	C3,C160	2.2uF	CAP CER 2.2uF 100V 10% X7R 1210 SMT	Kemet	C1210C225K1RACTU
1	C8	100n	Capacitor, X7R, 100nF 100V 10% 0805	TDK	C2012X7R2A104K
1	C9	47uF	CAP ALUM 47uF 100V 20% 105C RADIAL 8X15	Samsung	NHA100VB47M
1	C10	820uF	CAP ALUM 820UF 6.3V 20% RADIAL TH	Nichicon	RL80J821MDN1KX
1	C11	22uF	CAP CRM 22uF 10V 1206 X7R SMT	TDK	C3216X5R1A226M
1	C12	1uF	Capacitor, X7R, 1uF, 10V, 10% 0603	Kemet	C0603C105K8RACTU
2	C14,C40	100n	Capacitor, X7R, 100nF, 16V, 20% 0805	Kemet	C0805C104M4RACTU
1	C15	1uF	Capacitor,X7R, 1uF, 25V, 10% 0603	Murata	GRM188R71E105KA12 D
1	C17	100n	CAP CRM 100nF 100V 10%X7R 1206 SMT	Kemet	C1206C104K1RACTU
1	C18	1nF	Capacitor, X7R, 1nF, 16V, 10% 0603	Samsung	CL10B102KANNNC
1	C19	1u	CAP CRM 1uF 10V 10%X7R 0805 SMT	TDK	C2012X7R1C105K
2	C20,C159	1n	CAP CRM 1nF/2000V 10%++X7R 1206 SMT	AVX	1206GC102KAT1A
1	C21	22n	Capacitor,0.1uF, X7R, 10V, 10% 0603	Walsin	0603B223K250CT
1	C22	4.7NF	CAP CRM 4.7nF 16V 10% X7R 0603 SMT	Samsung	CL10B472KB8NNNC
1	C23	47n	Capacitor, X7R, 47nF, 50V, 10% 0603	TDK	C1608X7R1H473K
1	C24	0.1 uF	Capacitor,0.1uF, X7R, 10V, 10% 0603	Kemet	C0603C104K8RACTU
1	C25	1uF	CAP CRM 1uF 16V 10%0805 X7R SMT	Murata	GRM21BR71C105KA01
6	C27,C37, C39,C152, C153, C164	10n	CAP CRM 10nF 100V 5% X7R 0805 SMT	Kemet	C0805C103J1RAC



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25W Isolated Forward Converter PD  
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QTY	REFERENCE	Value	Description	Mfr. Name	Mfr. Part Number
3	C28, C29, C30	22n	CAP CRM 22nF 200V 10% X7R 0805 SMT	Vishay	VJ0805Y223KXCAT
1	C31	1uF	CAP CRM 1uF 25V 10% X7R 0805 SMT	AVX	08053C105KAT2A
1	C33	0.1uF	CAP 100NF 25V X7R 10% 0603	Murata	GRM188R71E104KA01D
1	C34	22uF	CAP CRM 22uF 25V 20% 1210 X7R SMT	Murata	GRM32ER71E226ME15L
1	C51	4.7u	Capacitor, X7R, 4.7uF, 25V, 10% 1210	Taiyo Yuden	TMK325BJ475KN-T
1	C154	10pF	CAP CRM 10pF 50V 5%NPO 0805 SMT	Samsung	CL21C100JBANNNC
1	C155	470p	CAP CRM 470pF 50V 10% X7R 0805 SMT	Walsin	0805B471K500CT
2	C156, C157	2.2nF	CAP CRM 2.2nF 2000V X5R 1206 SMT	Walsin	1206B222K202CT
1	D1	SMAJ40A	DIODE TVS 40V 400W 5uA 6.2 Amps Uni-Dir SMT	Bourns	SMAJ40A
1	D2	ES1C-13-F	DIODE SUPER FAST 150V 1A SMA SMT	Diodes Inc.	ES1C-13-F
2	D4,D24	SMAJ58CA	TVS DIODE 58VWM 93.6VC SMA	Diodes Inc.	SMAJ58CA-13-F
3	D5,D14, D16	SSC-GR101	LED SuperGreen 16mcd h=0.8 0603 SMD	SEOUL	SSC-GR101
2	D6,D21	1N4148W-7-F	DIODE SW 100V 0.15A SOD123 SMT	Diodes Inc.	1N4148W-7-F
1	D7	BAT54SLT1G	Diode Schottky Dual 200mA 30V SOT23 BAT54S	ON Semi	BAT54SLT1G
4	D8,D17, D22,D25	MBR0540T1G	DIO SCHOTTKY 40V 500mASOD123 REC. SMT	ON Semi	MBR0540T1G
1	D10	B2100-13-F	DIODE SCHOTTKY 100V 2A SMB	Diodes Inc.	B2100-13-F
1	D12	BAV99W	Diode, Dual Switching BAV99W SOT323	NXP	BAV99W
1	D23	SMAJ20CA	DIODE TVS 20VWM 32.4VC SMT	Diodes Inc.	SMAJ20CA-13-F
1	D28	SMAJ58A	DIO TVS 58V 40A SRG400WPK SMA SMT	Vishay	SMAJ58A
1	D29	TLV431AIDBZR	IC PROG. SHUNT REGULATOR SOT23-3 1% SMT	TI	TLV431AIDBZR
1	J1	08261X1TGH-F	CONN MAGJACK 1PORT 1000 BASE-T	Bel Stewart	08261X1TGH-F
1	J2	RAPC712X	DC Power Jack 16V 5A TH Pin dia 2.5mm	Switchcraft	RAPC712X



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25W Isolated Forward Converter PD  
Evaluation Board

QTY	REFERENCE	Value	Description	Mfr. Name	Mfr. Part Number
1	J3	ED700/2	TERMINAL BLOCK 20A 5mm 2POS PCB	OnShore	ED700/2
1	J4	RJ45	CON RJ45 SINGLE 8 POS. SHIELDED	Bel Stewart	SS71800-007F
2	L1,L5	4.7uH	FIXED IND 4.7uH 5.5A 40mOHM SMD	Vishay	IHLP2525CZER4R7M01
1	L2	2.7uH	Inductor 2.7uH 12A 2.6mOhm SMT	Coilcraft	SER1360-272KL
1	L3	4.7MH[4700uH}	FIXED IND 4700uH 40mA 48OHM SMD	Bourns	SDR0503-472JL
1	L6	2uH	Fixed Inductors 2 uH 20% 45A	Coilcraft	SER2010-202MLB
1	Q1	PSMN1R4-30YLDX	MOSFET N-CH with Schottky 30V 1.4mOhm 30V	NXP	PSMN1R4-30YLDX
1	Q2	FDMS86250	MOSFET PT5 150V 25mOhm Nch Power-56	Fairchild	FDMS86250
1	Q3	BSC0902NSI	MOSFET N-Ch 30V 100A TDSO8-8	Infineon	BSC0902NSI
1	Q8	ZVP3310FTA	MOSFET P-CH 100V 75MA SOT23-3	Diodes Inc.	ZVP3310FTA
1	Q10	BSS123	FET NCH 100V 0.15A 6RLogic Level SOT23	Infineon	BSS123
1	Q14	IRF6216TRPBF	MOSFET P-CH 150V 2.2A 8- SOIC	I.R.	IRF6216TRPBF
1	Q15	MMBT2222A_NL	TRN NPN 40V 600mA SOT23 MMBT2222	Fairchild	MMBT2222A_NL
1	R4	22.1	RES TCK FLM 22.1R 62.5mW 1%0603 SMT	Samsung	RC1608F22R1CS
1	R8	24.9K	RES TK FLM 24.9K 100mW1% 0805	Bourns	CR0805-FX-2492-ELF
1	R9	0	RES TCK FLM 0R 62.5mW 5% 0603 SMT	Panasonic	ERJ3GEY0R00V
2	R11,R15	100	RES TCK FLM 100R 62.5mW 1%0603 SMT	Yageo	RC0603FR-07100RL
1	R12	62 mOhm	RES .062 OHM 1/2W 1% 1206 SMT	Panasonic	ERJ8BWFR062V
1	R14	20	Resistor, 20 OHM 5% 1/10W 0603	Rohm	MCR03EZPJ200
1	R16	510	RES 510R 1% 1/10W 0603 SMD	Yageo	RC0603FR-07510RL
1	R18	240K	Resistor, 240K, 1%, 1/10W 0603	Rohm	MCR03EZPFX2403
2	R19,R23	20K	RES 20K 62.5mW 1%0603 SMT FLM	Panasonic	ERJ3EKF2002V
1	R20	8.25K	RES 8.25K 62.5mW 1% 0603 SMT	Yageo	RC0603FR-078K25-L



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25W Isolated Forward Converter PD

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QTY	REFERENCE	Value	Description	Mfr. Name	Mfr. Part Number
1	R21	30.9	Resistor, 30.9R 1%, 1/10W 0603	Panasonic	ERJ3EKF30R9V
1	R24	1.2K	Resistor, SMT 1.2K, 5%, 1/10W 0603	Panasonic	ERJ3GEYJ122V
5	R25,R26, R69,R71, R100	0	RES TCK FLM OR 62.5mW 5% 0603 SMT	Rohm	MCR03EZPJ000
1	R27	100K	RES 100K 62.5mW 1% 0603 SMT FLM	Samsung	RC1608F1003CS
1	R28	4.87k	Resistor, 4.87K 1% 1/10W 0603	Yageo	RC0603FR-074K87L
3	R29,R52, R55	100K	Resistor, 100K, 5%, 1/16W	ASJ	CR16-104JL
1	R30	43.2K	RES 43.2K 100mW 0603 SMT 1%	ASJ	CR16-4322FL
2	R33,R34	562K	RES 562K, 1%, 1/16W, 0603	Vishay	CRCW0603562KFKEA
1	R36	18.7K	Resistor, 18.7K, 1%, 1/16W 0603	Rohm	MCR03EZPF1872
1	R37	2K	RES 2K 62.5mW 1% 0603 SMT FLM	Vishay	CRCW06032KFKEA
1	R38	1K	RES 1K 250mW 1%1206 SMT FLM	Samsung	RC3216F1001CS
1	R47	20K	RES TK FLM 20K 250mW 1%1206	Samsung	RC3216F2002CS
2	R49,R128	5.11K	RES TCK FLM 5.11K 250mW1% 1206 SMT	Samsung	RC3216F5111CS
1	R51	100	Resistor, 100 Ohm, 5%, 1/16W 0603	Samsung	RC1608J101CS
4	R60,R61, R62,R63	75	RES 75R 125mW 1% 0805 SMT	Yageo	RC0805FK-0775RL
1	R64	1K	RES TCK FLM 1K 125mW 1% 0805 SMT	Rohm	MCR10EZPF1001
1	R65	10K	RES 10K 125mW 1%0805 SMT Thick Film	Vishay	D12 10K FCS-E3
1	R66	2.7	Resistor, SMT 2.7 Ohm, 5%, 1/16W 0603	ASJ	CR16-2R7JL
1	R67	2.2	RES TCK FLM 2.2R 0.5W 5% 1210 SMT	KOA	RK73B2ETTD2R2J
2	R70,R101	0	RES TCK FLM OR 125mW 5% 0805 SMT	Bourns	CR0805-J/-000-ELF
2	R89,R92	15K	RES 15K 250mW 1%1206 SMT FLM	Rohm	MCR18EZPF1502
1	R94	620	RES 620 OHM 1/10W 1% 0603 SMT	KOA	RK73H1JTDD6200F



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25W Isolated Forward Converter PD

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QTY	REFERENCE	Value	Description	Mfr. Name	Mfr. Part Number
1	R126	0	RES OR 250mW 5%1206 SMT JUMPER<0.05R	Samsung	RC3216J000CS
1	SC1	SHORT			
1	T1	95uH	Transformer forward 3.3V 7.2A	Tesla Coilcraft	TX4015 TA-7861-AL
1	T6	1.47mH	Inductor common mode 1.47mH 2.8A SMD	Pulse	P0351NL
1	U1	PD70224	Ideal Diode Bridge 6x8 SMT PD70224	Microsemi	PD70224ILQ-TR
1	U2	PD70201	AT POE PD controller for IEEE 802.3 PD70201	Microsemi	PD70201ILQ-TR
1	U3	FOD817ASD	OPTOISOLATOR 5KV TRANSISTOR 4 SMD	Fairchild	FOD817ASD
1	U5	FAN3111CSX	IC GATE DVR 1CH 1A LOW SOT23-5	Fairchild	FAN3111CSX
2	VR1,VR3	MMSZ4702	DIODE ZENER 15V 500MW SOD123_MMSZ4702	Fairchild	MMSZ4702
1	VR2	MMSZ4705T1G	DIODE ZENER 18V 500MW SOD-123	ON Semi	MMSZ4705T1G
8	TP1,TP2, TP3,TP4, VINRTN, VIN+, PGOOD, AT_FLAG	HK-2-G-S05	TEST POINT TIN PLATED HEAD	MAC-8	HK-2-G-S05

Parts may be replaced by approved equivalent.

## 9 Board Layout

This section presents the layout of the evaluation board. The board is a 2 layer board. All layers are 2 Oz layers. Below figures present the 2 copper layers and the silk of the board for tracking devices placements.

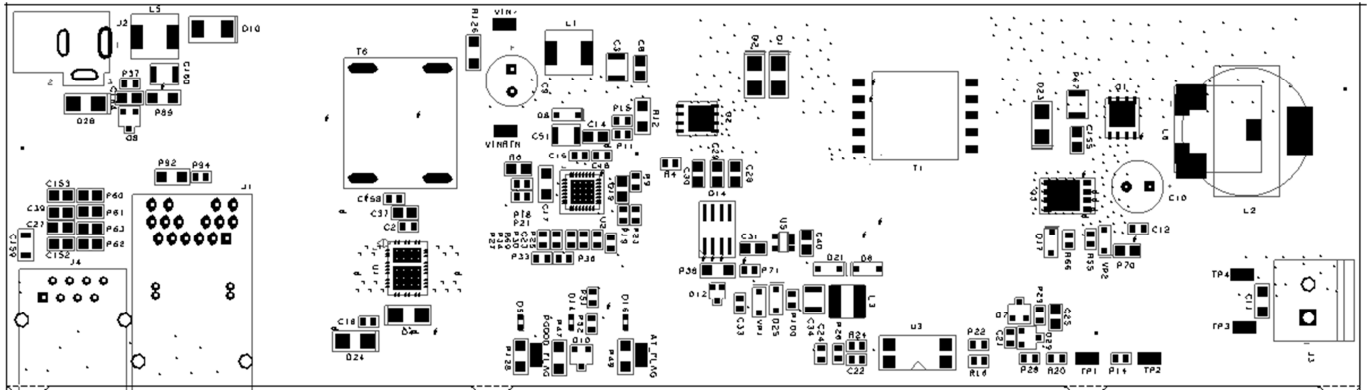


Figure 14: Top Silk and Solder Mask

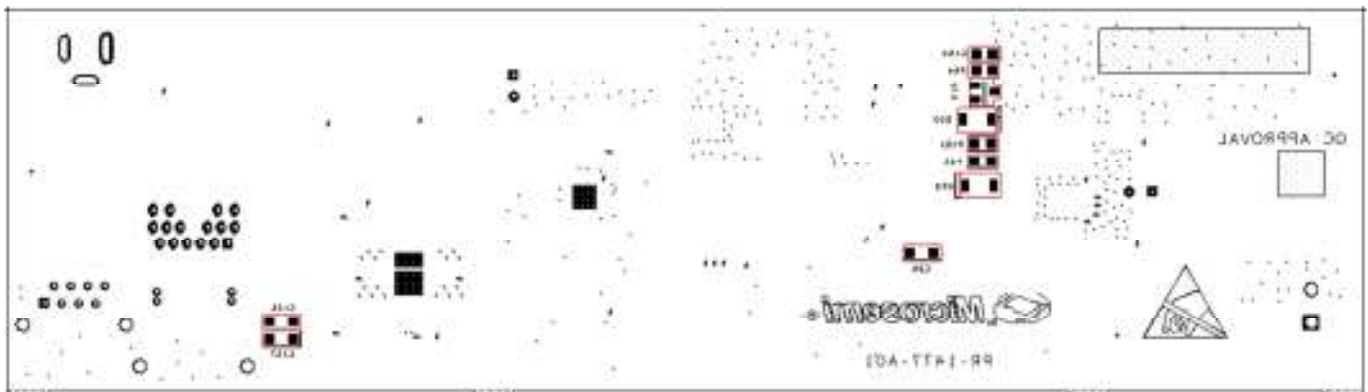


Figure 15: Bottom Silk and Solder Mask (Image Looking From Bottom)

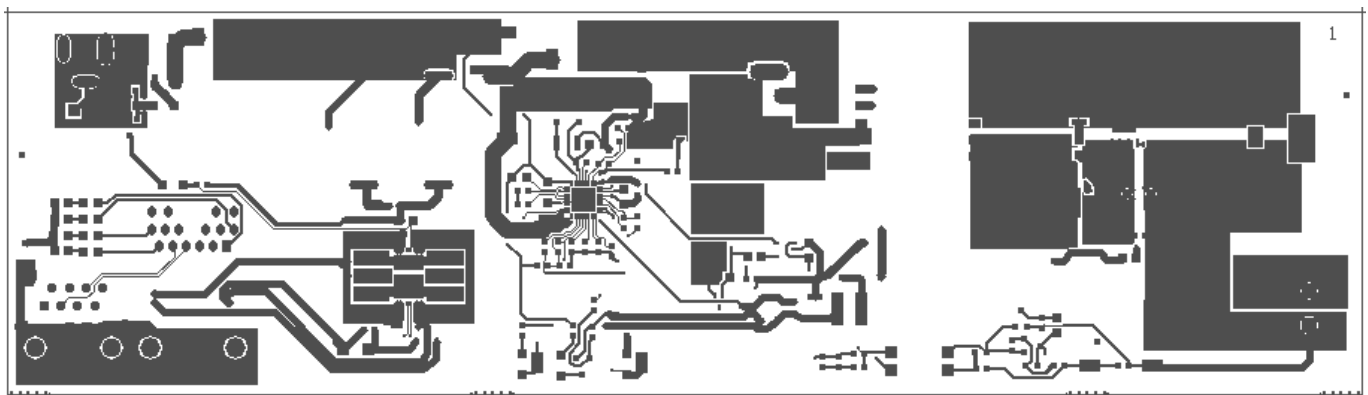
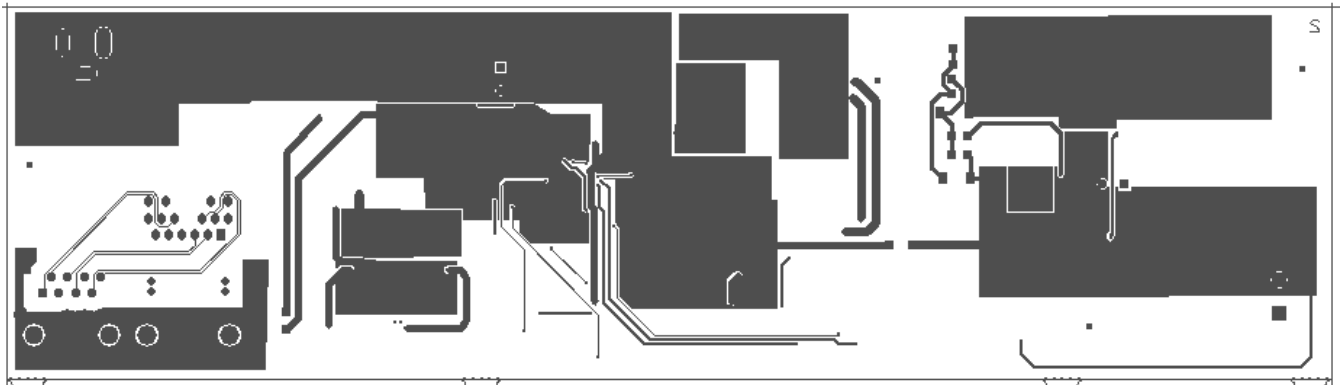


Figure 16: Top Layer



**Figure 17: Bottom Layer**





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**Revision History**

Revision Level / Date	Paragraph Affected/Page	Description
1.01 / 18-June-16		Initial release
1.02 / 24-August-16	Page #2, 1.2 Organization, Chapter 1	Chapter 1-Error

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