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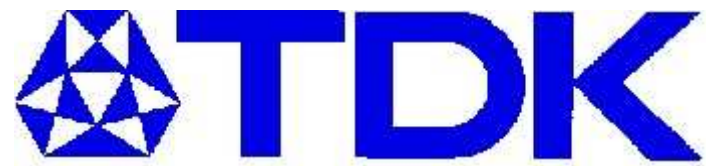
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# **PFH05W Evaluation Test Board**

**Application notes**

**Version 1.0**

## Table of Contents

**BEFORE USING THE POWER SUPPLY UNIT ..... Error! Bookmark not defined.**

1.0 Getting Started ..... 5

    1.1 Test Equipment ..... 6

    1.2 Test Setup ..... 7

    1.3 Test Points ..... 9

    1.4 PMBus and Remote On/Off Functions ..... 10

    1.5 Setting the PMBus Address ..... 11

    1.6 Turning PFH Module On/Off ..... 12

2.0 Electrical Schematic Drawing ..... 13

3.0 Bill of Material ..... 14

4.0 Board Files ..... 15

5.0 EMI Conducted Test Results ..... 22

## BEFORE USING THE POWER SUPPLY UNIT

Be sure to read and understand this instruction manual thoroughly before using this product. Pay attention to all cautions and warnings before using this product. Incorrect usage could lead to an electrical shock, damage to the unit or a fire hazard.

### DANGER

Never use this product in locations where flammable gas or ignitable substances are present. There are risks of igniting these substances and exploding by arcing.

### WARNING

- Do not touch this product or its internal components while circuit is live, or shortly after shut down. There may be high voltage or high temperature present and you may receive an electric shock or burn.
- While this product is operating, keep your hands and face away from it as you may be injured by an unexpected situation.
- Do not make unauthorized changes to this product, otherwise you may receive an electric shock and void your warranty.
- Do not drop or insert anything into the product. It might lead to a failure, fire or electric shock.
- Do not use this product if abnormal conditions such as emission of smoke and/or abnormal smell or audible noise, etc... are present. It might lead to fire and/or electric shock. In such cases, please contact TDK Lambda. Do not attempt repair by yourself, as it is dangerous for the user.
- Do not operate these products in the presence of condensation. It might lead to fire or electric shock.

### CAUTION

- This power supply is designed and manufactured for use within an end product such that it is accessible only to trained SERVICE ENGINEERS.
- Confirm that the connections to input/output terminals, and signal terminals are correct as specified in this instruction manual before turning on the power.
- Input voltage, Output current, Output power, ambient temperature, case temperature, and ambient humidity should be kept within the specifications, otherwise the product may be damaged.
- Do not operate and store this product in an environment where condensation might occur. In such case, waterproof treatment is necessary.
- The equipment has been evaluated for use in a Pollution Degree 2 environment.
- Do not use this product in environment with a strong electromagnetic field, corrosive gas or conductive substances.
- For applications, which require very high reliability, such as nuclear related equipment, medical equipment, traffic control equipment, etc., it is necessary to provide a fail-safe mechanism in the end equipment.
- Do not inject abnormal voltages into the output terminal or signal terminal of this product. The injection of reverse voltage or over voltage exceeding nominal output voltage into the output terminal or signal terminal might cause damage to internal components.
- Never operate the product under the over-current or short circuit conditions. Failure or other damage may occur.
- The output voltage of this power supply unit is considered to be a hazardous energy level (The voltage is 2V or more and the electric power is 240W or more). It must not be made accessible to users. Protection must be provided for Service Engineers against indirect contact with the output terminals and/or to prevent tools being dropped across them. While working on this product, the AC input power must be switched off, and the input, output, +VBus, and -VBus terminal voltages should be at a safe level.
- The application circuits and their parameters are for reference only. Be sure to verify effectiveness of these circuits and their parameters before finalizing the circuit design.
- Use a Fast-Blow external fuse to each module to ensure safe operation and compliance with the safety standards to which it is approved. The recommended input fuse rating within the instructions is as follows: 10A, 250V fast acting fuse. The breaking capacity and voltage rating of this fuse may be subject to the end use application.

 **CAUTION**

- This information in this document is subject to change without prior notice. Please refer to the latest version of the data sheet, etc., for the most up-to date specifications of the product.
- No part of this document may be copied or reproduced in any form without prior written consent TDK-Lambda.

**Reference Documents:**

- 1.) PFH Instruction Manual
- 2.) PFH PMBus Specification Customer Release

## 1.0 Getting Started



PFH05W##-100-EVK-S1 & PFH05W##-1D0-EVK-S1 Evaluation Boards



PFH05W-001-EVK-S0 Evaluation Board

## 1.1 Test Equipment

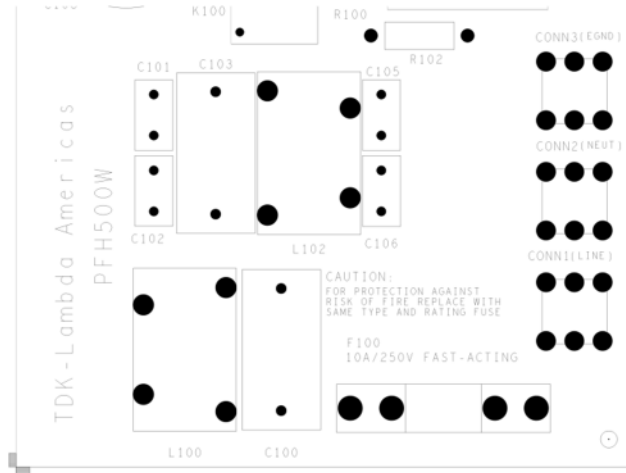
- 1.) **AC Voltage Source:** capable of single-phase output AC voltage 85 V<sub>AC</sub> to 265 V<sub>AC</sub>, 47 Hz to 63 Hz<sup>1</sup>, adjustable, with minimum power rating 500 W, the AC voltage source to be used should meet IEC60950 reinforced insulation requirement.

**NOTE: 1.** Input frequency above 63Hz, refer to PFH Datasheet

- 2.) **DC Multimeter:** capable of 0V to 500V input range.
- 3.) **Output Load:** DC load capable of 60 V<sub>DC</sub> or greater, DC Load current up to 42A or greater (12V/42A, 28V/18A, or 48V/10.5A), and 500 W or greater, with display such as load current and load power.
- 4.) **Fan:** 200 LFM to 400 LFM forced air cooling is recommended, but not a must.

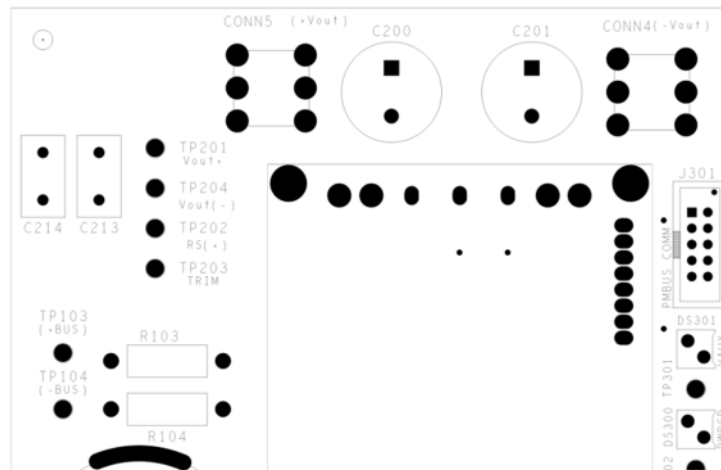
## 1.2 Test Setup

- 1.) Electrical Input Connections:
- |               |  |
|---------------|--|
| <b>CONN1:</b> | <b>LINE</b> , Input Line Connection    |
| <b>CONN2:</b> | <b>NEUT</b> , Input Neutral Connection |
| <b>CONN3:</b> | <b>EGND</b> , Earth Ground Connection  |



**NOTE:** Refer to the PFH Datasheet for specific module’s AC Input Current requirement when sizing wire gauge and cable length.

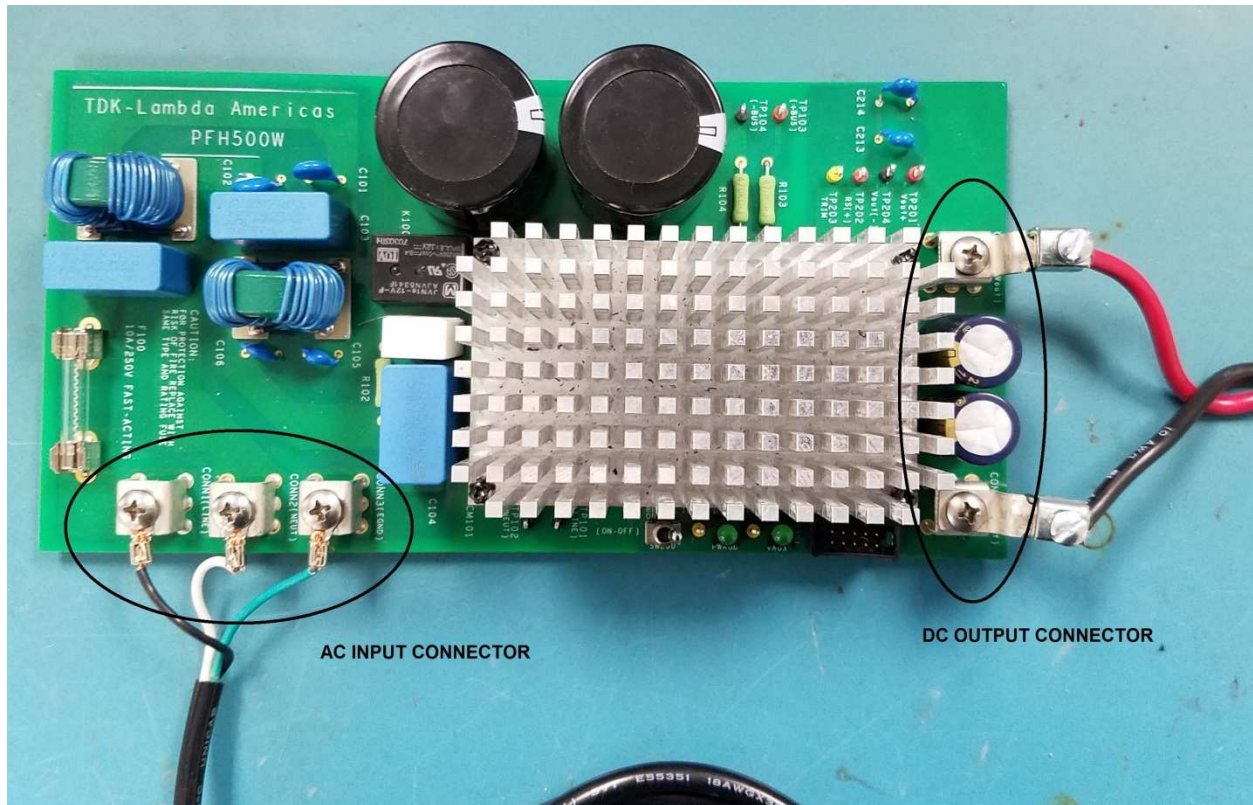
- 2.) Electrical Output Connection:
- |              |   |
|--------------|---|
| <b>CONN5</b> | <b>+Vout</b> , Output Load Connections (Red Cable)          |
| <b>CONN4</b> | <b>-Vout</b> , Output Load Return Connections (Black Cable) |



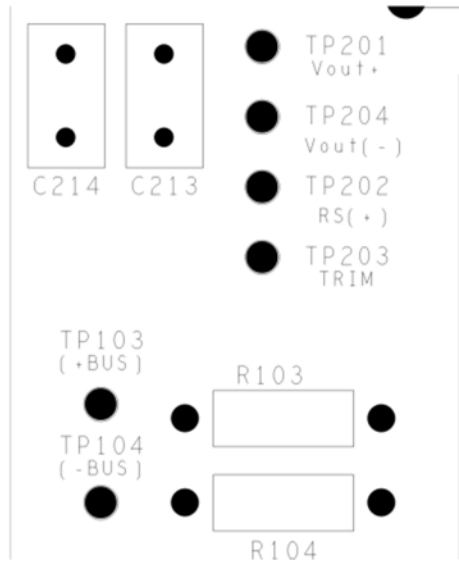


**⚠ WARNING**

*Make sure ALL input and output cables are de-energized before making electrical connections to the Evaluation Test Board*



### 1.3 Test Points



- |                            |   |
|----------------------------|---|
| 1.) Secondary Test Points: | <p>TP201      <b>Vout+</b>, Monitor Output Voltage</p> <p>TP204      <b>Vout(-)</b>, Monitor Output Voltage return</p> <p>TP202      <b>RS(+)</b>, Output Remote Sense (+) connection</p> <p>TP203      <b>TRIM</b>, Trim Test connection</p> |
|----------------------------|---|

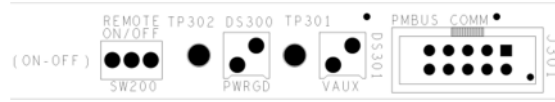
**⚠ WARNING HAZARDOUS VOLTAGE**

- |                          |  |
|--------------------------|--|
| 2.) Primary Test Points: | <p>TP103      <b>+BUS</b>, Monitor 400Vdc</p> <p>TP104      <b>-BUS</b>, Monitor 400Vdc return</p> |
|--------------------------|--|



- |       |  |
|-------|--|
| TP101 | <b>LINE</b> , Monitor AC Line Input    |
| TP102 | <b>NEUT</b> , Monitor AC Neutral Input |

## 1.4 PMBus and Remote On/Off Functions



### 1.) PMBus Connections (J301)

Pin #:	Description:
1	Not Used
2	Not Used
3	Not Used
4	Not Used
5	USB 3.3Vdc
6	SGND
7	Not Used
8	PMBus Alert
9	PMBus Clock
10	PMBus Data

**NOTE:** NOTE: J301 is compatible with TI USB Interface Adapter EVM (Evaluation Module), TI part #: **USB-TO-GPIO**. This adapter is available from,

- [TI](#)
- [Digi-Key](#)
- [Newark Element](#)
- [Mouser Electronics](#)
- [Arrow](#)

Texas Instruments offers a Free SMBus tool in their FUSION DIGITAL POWER STUDIO that allows the user to send and read PMBus commands to and from the module.

<http://www.ti.com/tool/FUSION-DIGITAL-POWER-STUDIO>

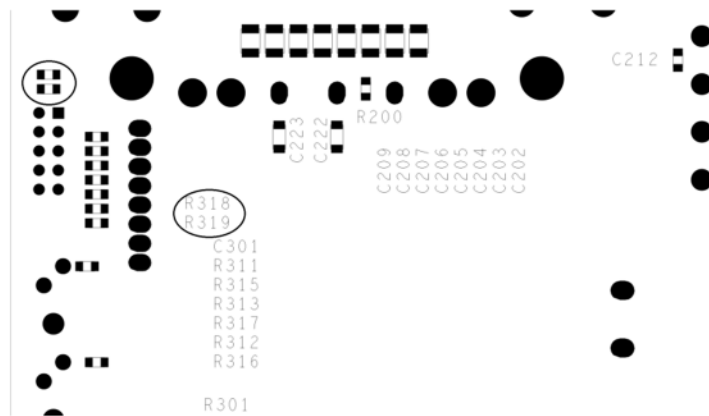
### FUSION DIGITAL POWER STUDIO System Requirements

- Window-Based application, support Window XP and Window 7
- Design, Configure & monitor TI digital power controllers and sequencers/health monitors using TI USB Adapter
- Support multiple devices in the same bus in Online (connected to live devices), Offline (file-base virtual devices), and Hybrid mode (mix of online & offline)
- Support exporting device’s configuration to different files formats for 3<sup>rd</sup> party programming
- Support Command Line Tools for scripting & automation

**⚠ WARNING When AC voltage is applied to the Evaluation Test Board the 450V bulk capacitors ARE energized at ALL time**

- |                               |   |
|-------------------------------|---|
| 2.) Remote On/Off (SW200)     | <b>SW200</b> , Will either turn the module On or put it into Standby                          |
| 3.) Auxiliary Voltage (DS301) | <b>DS301</b> , The LED will Turn-On when the 450Vdc bulk capacitors are energized above 70Vdc |
| 4.) Power Good (DS300)        | <b>DS300</b> , The LED will Turn-On once the module’s output has been Turned-On               |
| 5.) Test Points               | TP301 Monitor Auxiliary Voltage<br>TP302 Monitor Power Good Signal                            |

### 1.5 Setting the PMBus Address



- The PMBus address setting on the Evaluation Test Board comes with the Factory default setting, Address: 0x58 (Hex) (R318 & R319 are not populated)
- To change PMBus address to a different address R318 (AD1) and R319 (AD2) must be populated with appropriate resistor values located in “PFH PMBus Specification Customer Release” document.

**Example:** Suppose a PMBus address of 0x51 was desired instead of 0x58.

- |                   |   |
|-------------------|---|
| R318 (PMBus AD1): | Not Populated → Populate with 14K (0805 Resistor)   |
| R319 (PMBus AD2): | Not Populated → Populate with 69.8K (0805 Resistor) |

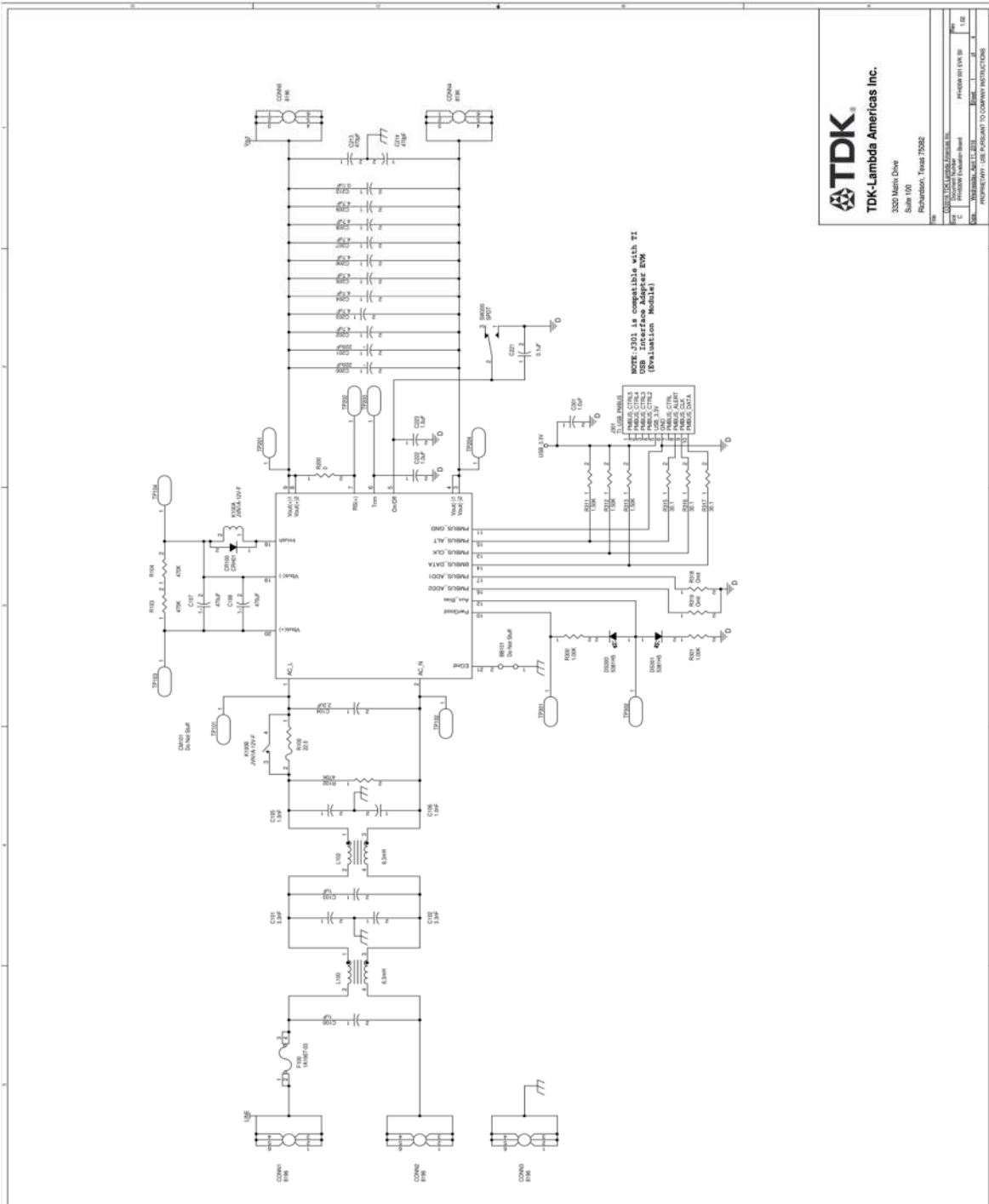
## 1.6 Turning PFH Module On/Off

- 1.) Before applying AC voltage to the module make sure,
  - a. The surface under the test fixture is a non-conductive surface
  - b. Securely connect Input and Output cables to the test board
  - c. Securely connect all monitoring devices to test board

**⚠ WARNING When AC voltage is applied to the Evaluation Test Board the 450V bulk capacitors ARE energized at ALL time**

- 2.) Apply AC input voltage to test fixture
  - a. AC input voltage range 100Vac – 265Vac
  - b. AC input voltage range < 100Vac, de-rated 6.7W/V
  - c. Once AC input voltage is applied, Auxiliary Voltage LED (DS301) will Turn-On
- 3.) Turning On PFH module can be accomplished 1 of 2 ways,
  - i. Remote On/Off
  - ii. PMBus
  - a. The method chosen to turn On PFH has to be the **SAME** method to turn Off PFH
    - i. Example: If Remote On/Off turns On PFH, then PMBus cannot turn it Off. Only Remote On/Off can turn Off PFH.
  - b. Method 1: Toggle Remote On/Off,
    - I. Toggle Remote On/Off switch (SW200) On – Will turn PFH On
    - II. Toggle Remote On/Off switch (SW200) Off – Will turn PFH Off.
  - c. Method 2: PMBus,
    - I. Write Byte 0x80 to CMD 0x01 – Turns PFH On
    - II. Write Byte 0x00 to CMD 0x01 – Turn PFH Off
  - d. Once PFH is turned On, Power Good LED (DS300) will turn On
  - e. When PFH is turned Off, Power Good LED (DS300) will turn Off

## 2.0 Electrical Schematic Drawing



### 3.0 Bill of Material

**PFH05W-001-EVK-S0 Bill of Material**

Part Reference	Mfr Part Number1	Value	Description	Voltage	Mfr1
BMPR1 BMPR2 BMPR3 BMPR4 BMPR5 BMPR6	SJ-5027 (BLACK)	Rubber Bumper	Bumper, Rubber, 0.63" Dia x 0.31"		3M
C100 C103	B32923C3105M2040	1uF	Film Capacitor,305V, X2 Cap	250V	TDK
C101 C102	CS45-E2GA332M-NKA	3.3nF	Film Capacitor,305V, Y2 Cap	250V	TDK
C104	B32923C3225M1040	2.2uF	Film Capacitor,305V, X2 Cap	250V	TDK
C105 C106	CS45-E2GA102M-NKA	1.0nF	Film Capacitor,305V, Y2 Cap	250V	TDK
C107 C108	B43508B5477M007	470uF	Electrolytic Capacitor, 450V, 35X40	450V	TDK
C200 C201	EEUFC2A221	220uF	Electrolytic Capacitor, 100V, 16X25	100V	Panasonic
C202 C203 C204 C205 C206 C207 C208 C209	C3225X7S2A475K200AB	4.7uF	Ceramic Capacitor, 100V, 1210, 4.7uF	100V	TDK
C212 C221	C2012X7R2A104K125AA	0.1uF	Ceramic Capacitor, 100V, 0805	50V	TDK
C213 C214	CS45-B2GA471K-NKA	470pF	Film Capacitor,305V, Y2 Cap	250V	TDK
C222 C223	C3216X7R2A105MT	1.0uF	Ceramic Capacitor,100V, 1206, 1.0uF	100V	TDK
C301	C2012X7R1E105KT	1.0uF	Ceramic Capacitor, 25V, 0805	25V	TDK
CONN1 CONN2 CONN3 CONN4 CONN5	8196	8196	PC Screw Terminal		Keystone Electronics
CR100	CRH01	CRH01	PN Diode, Single Package, SMT		TOSHIBA
DS300 DS301	5381H5	5381H5	LED, Green, Thru Hole		Chicago Miniature Lamp
F100	312010	312010	Fuse, 10A Fuse, Fast-Blow		Littlefuse
	1A1907-03		Fuse, Fuse Clips, PWB		BUSSMANN
J301	N2510-6003-RB	TI_USB_PMB US	.100" x .100" Four-Wall Header		3m
K100	JVN1A-12V-F	JVN1A-12V-F	RELAY SPST		Panasonic
L100 L102	ARA00499	6.3mH	Com Ind, 6325uH, Thru Hole		TDK-Lambda
PWB100	ZB00511	ZB00511	PWB, (n) oz. Cu, .062"		
R100	A5MC-220J	22.0	Res,22.0,5.0W	250V	UCHIHASHI
R102 R103 R104	SPR2C474J	470K	Res,470K,2.0W	250V	KOA SPEER
R200	RK73Z2ATTE	0	Res,0.2,0A,70C,0805	N/A	KOA SPEER
R300 R301	RK73H2ATTE1001F	1.00K	Res,1.00K,0.125W,100ppm,70C,0805	150V	KOA SPEER
R311 R312 R313	RK73H2ATTE1501F	1.50K	Res,1.50K,0.125W,100ppm,70C,0805	150V	KOA SPEER
R315 R316 R317	RK73H2ATTE30R1F	30.1	Res,30.1,0.125W,100ppm,70C,0805	150V	KOA SPEER
R318 R319	N/A	Omit	Res,Omit,0805	N/A	N/A
SW200	T101SHCQE	SPDT	SPDT two position switch vertical (On None On)		C&K
TP101 TP102 TP104 TP204	5011	5011	Test Point, Black, Thru Hole		Keystone Electronics
TP103 TP201 TP202	5010	5010	Test Point, Red, Thru Hole		Keystone Electronics
TP203 TP301 TP302	5014	5014	Test Point, Yellow, Thru Hole		Keystone Electronics

### 4.0 Board Files

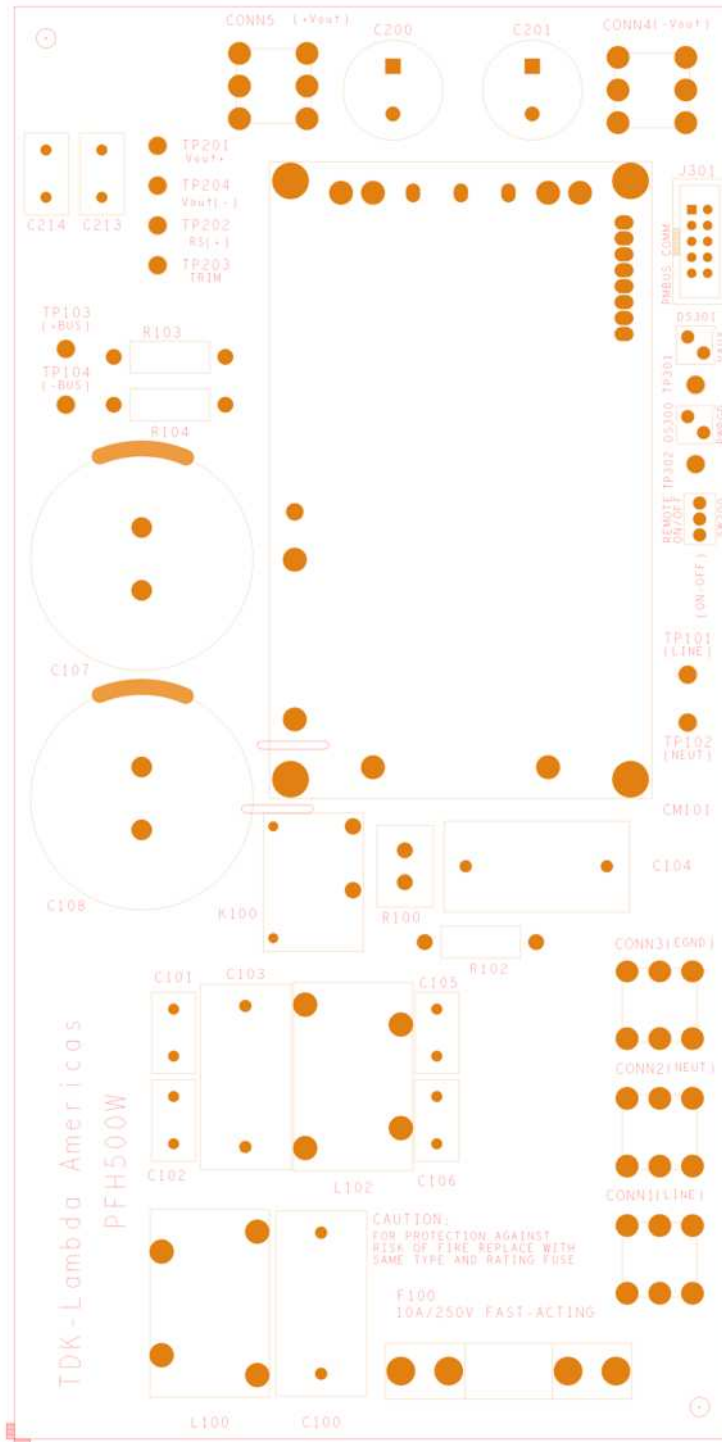


FIGURE 1 Top side Component Placement



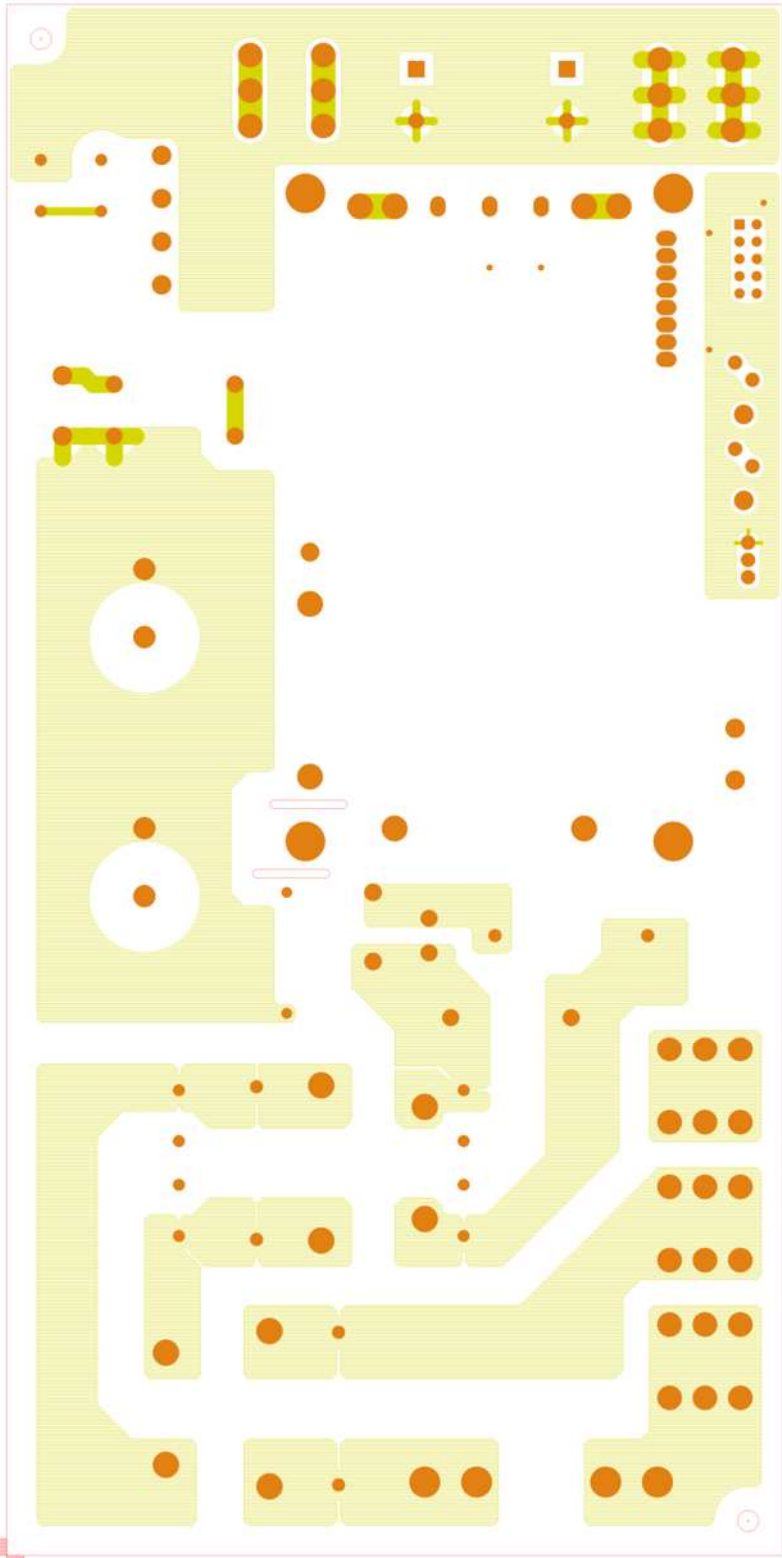


FIGURE 2 Top Layer (Etch 1)

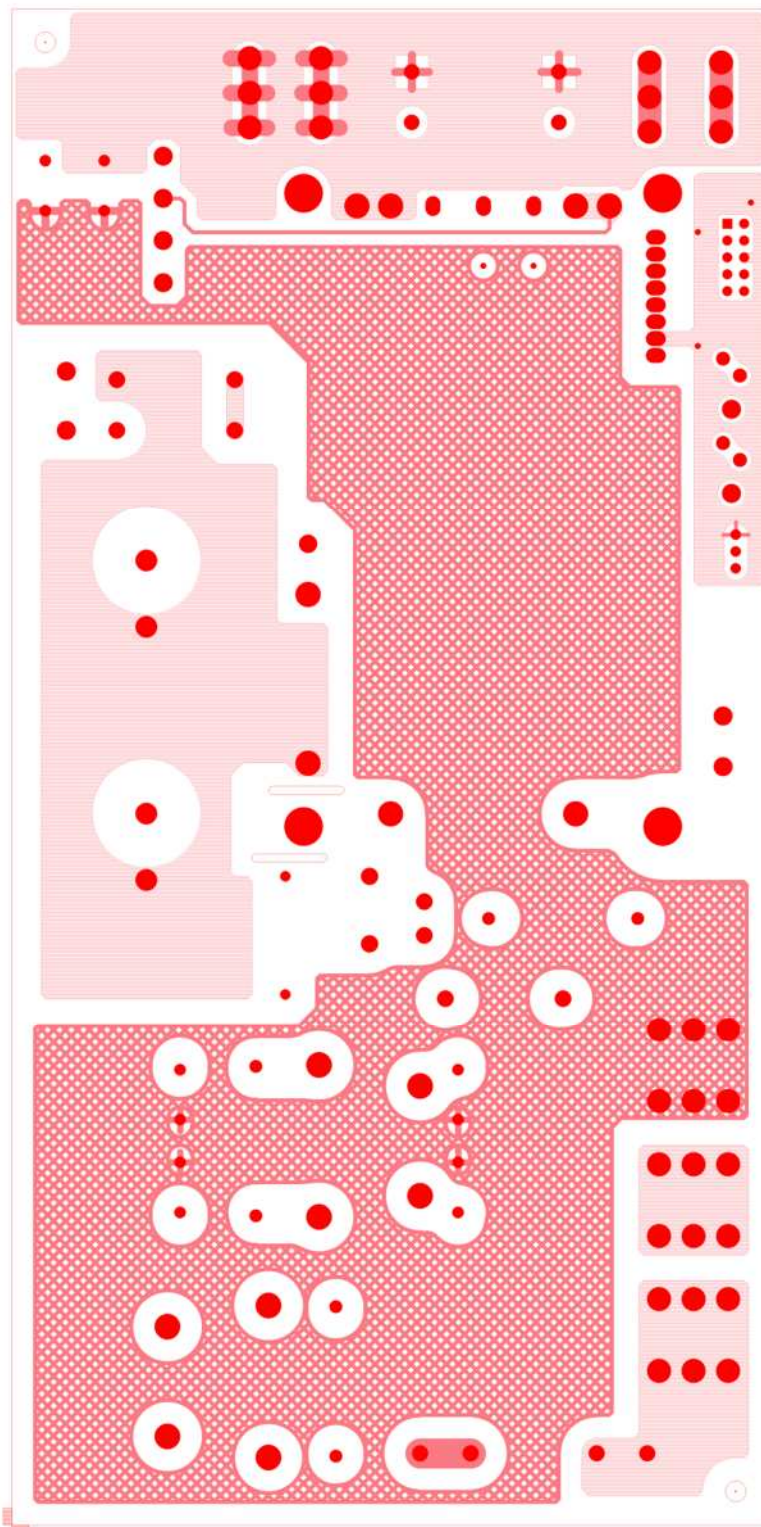


FIGURE 3 Internal Layer (Etch 2)

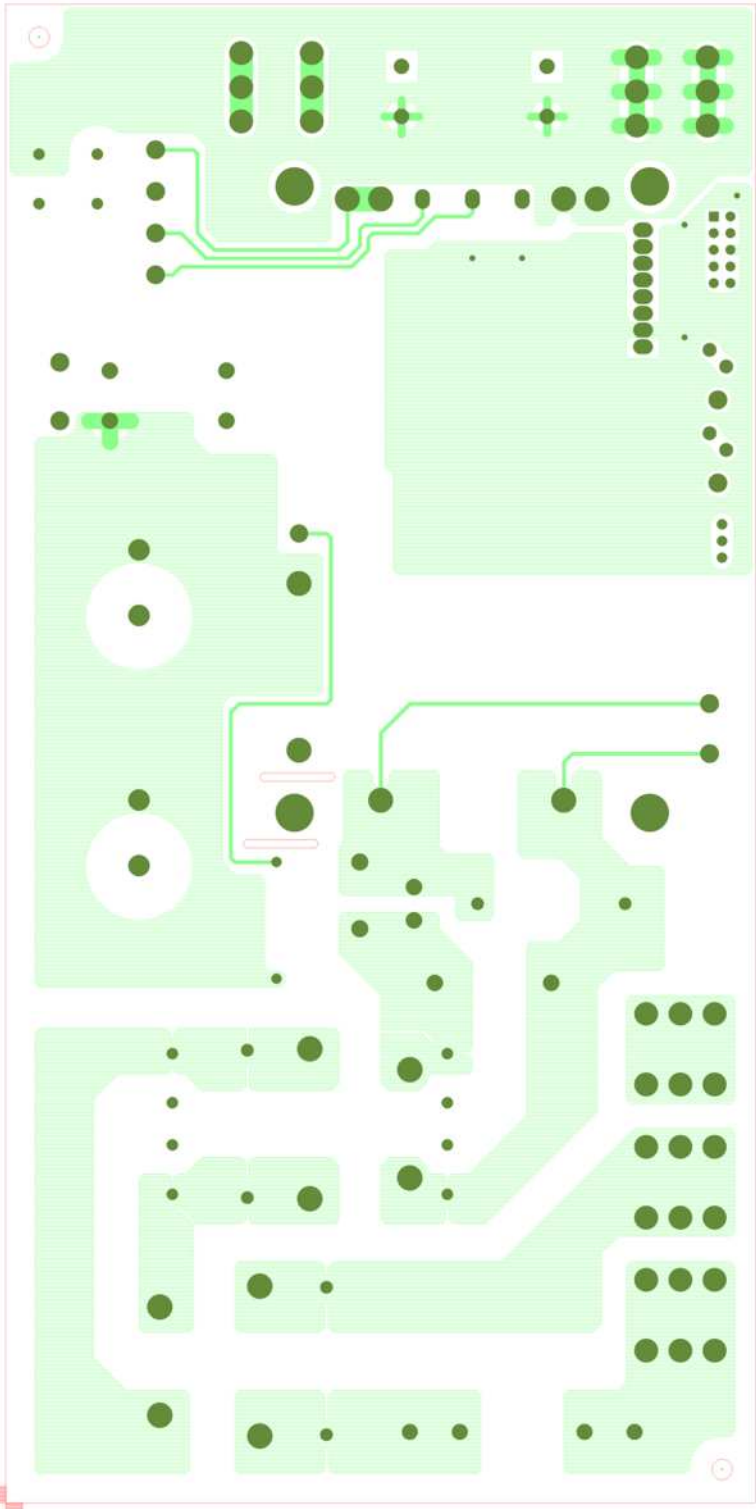


FIGURE 4 Internal Layer (Etch 3)

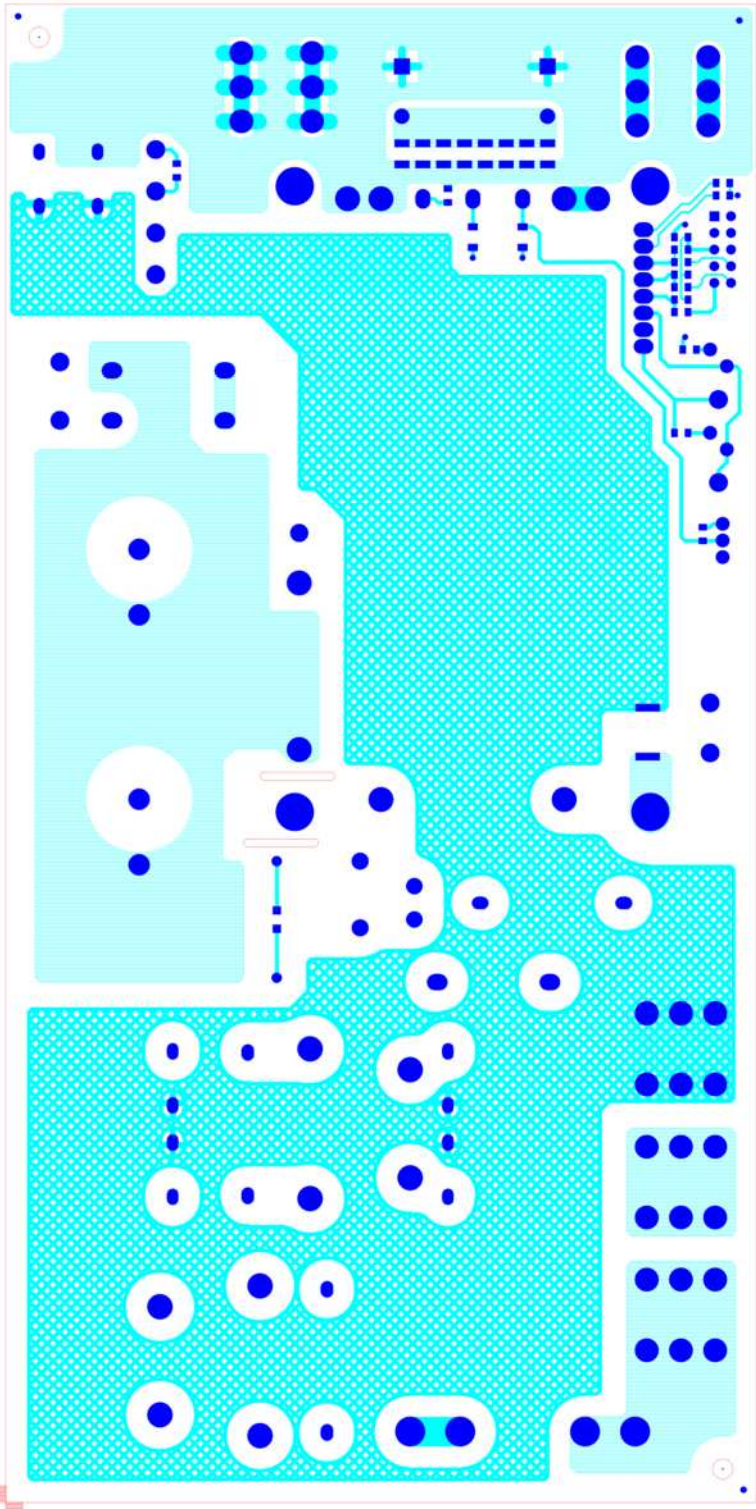


FIGURE 5 Bottom Layer (Etch 4)

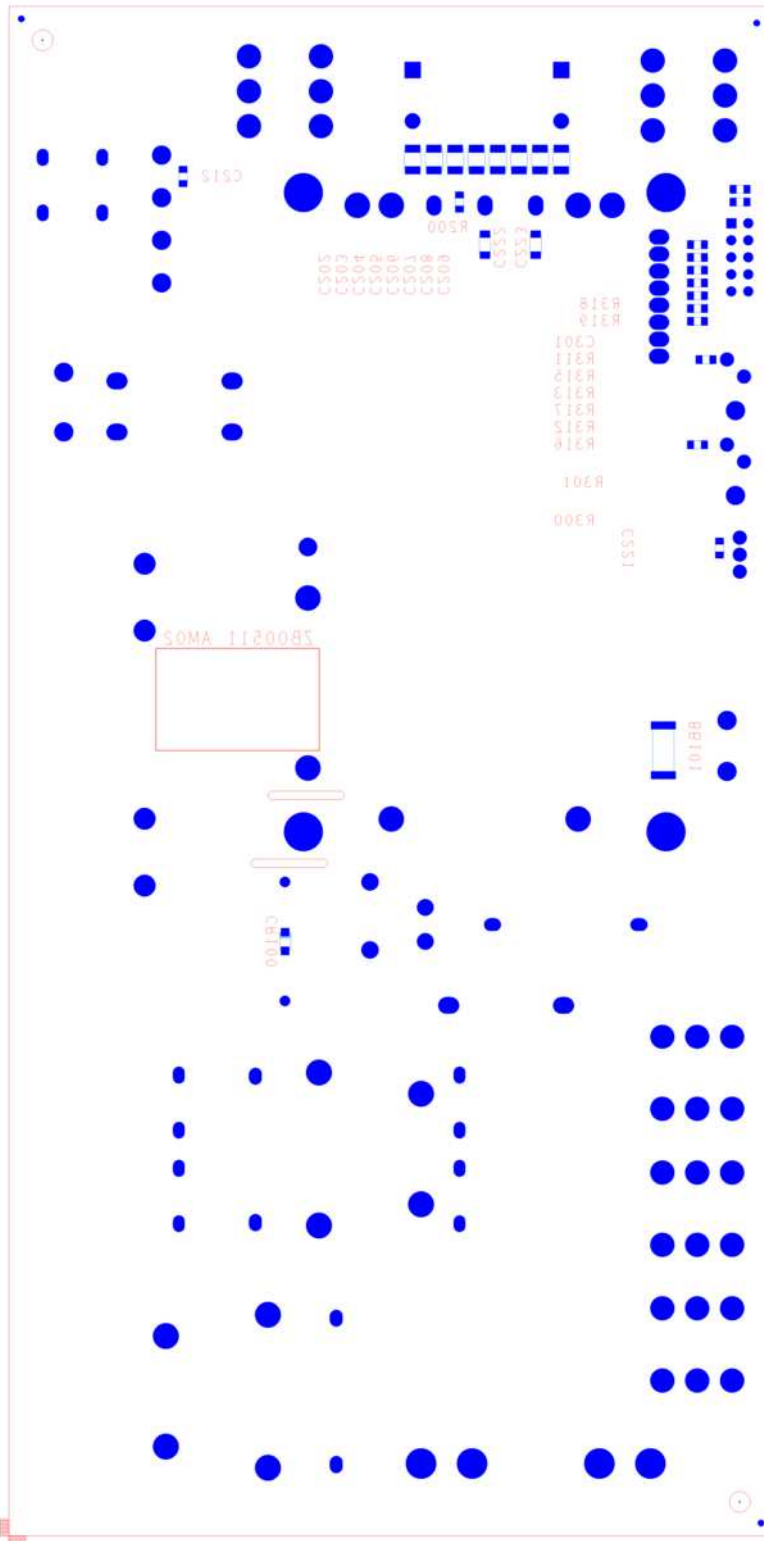


FIGURE 6 Bottom side Component Placement

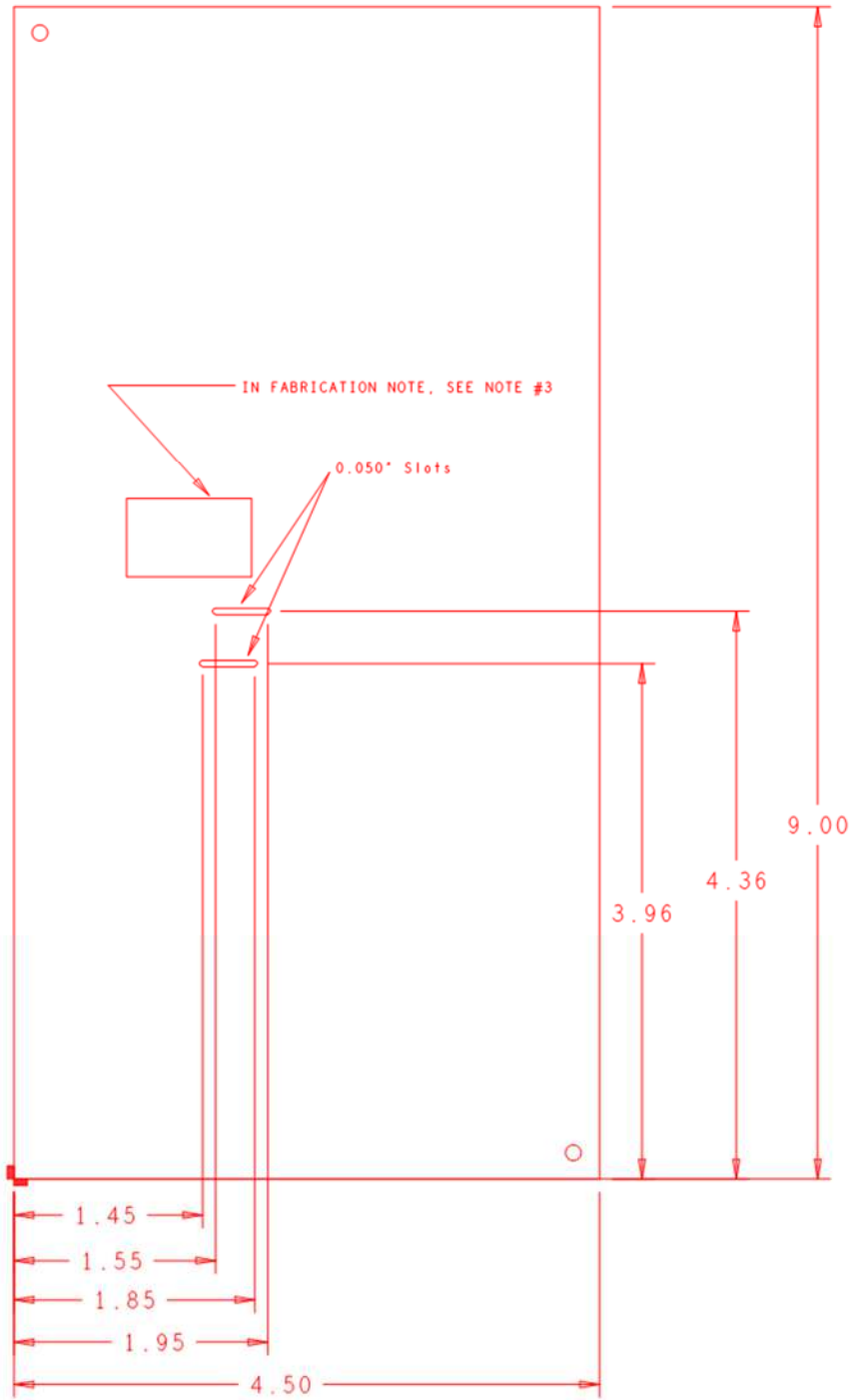


FIGURE 7 Circuit Outline

## 5.0 EMI Conducted Test Results

### Conducted Emissions CISPR22 Class B Test Results

**EUT Model:** PFH500F-28-100-R

**Test Dates:** 04/12/2018

**Test Location:** National Technical Systems  
1701 E. Plano Parkway #150  
Plano, TX 75074

**Engineer:** Michael D. Lawrence - TDK  
Ervin Williams - NTS

#### Test Equipment

Asset #:	Device:	Manufacture:	Model:	Cal Date:	Cal Due Date:
NTS – WC021859	Spectrum Analyzer PSA Series	Agilent	E4440A	6/29/17	6/29/18
NTS – WC021314	LISN	ROHDE & SCHWARZ	ESH3-Z5	5/8/17	5/8/18
NTS – WC021350	Transient Limiter	HAMEG Instruments	HZ560	7/4/17	7/4/18

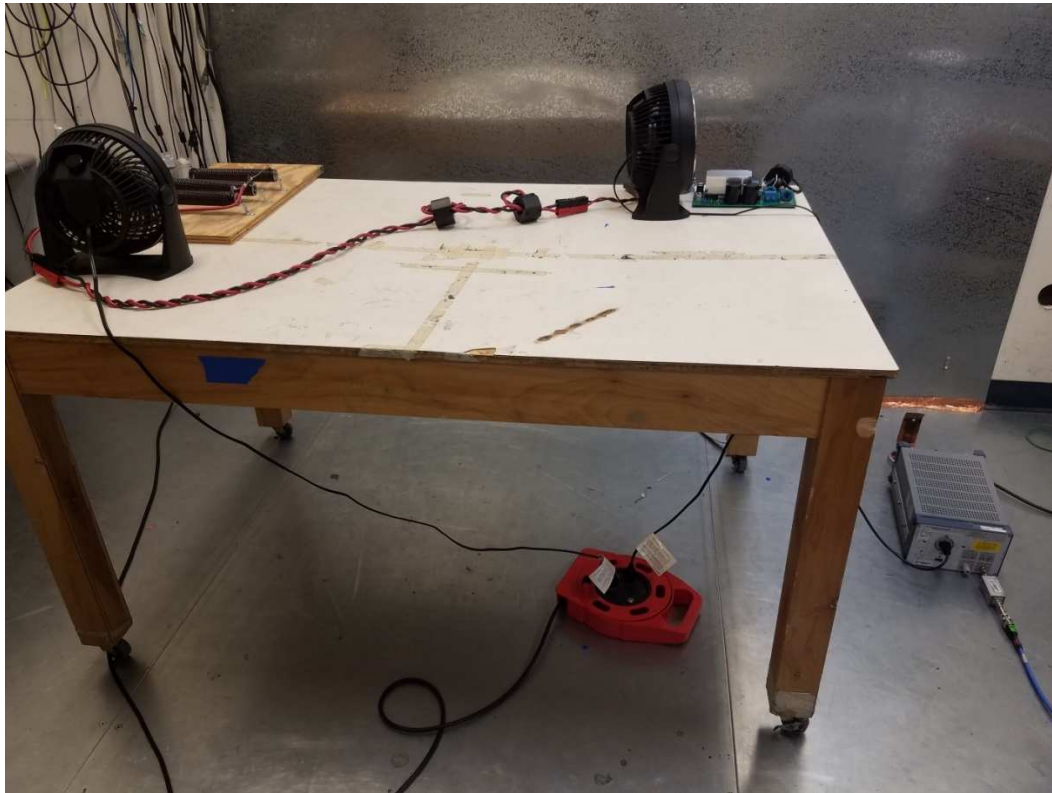
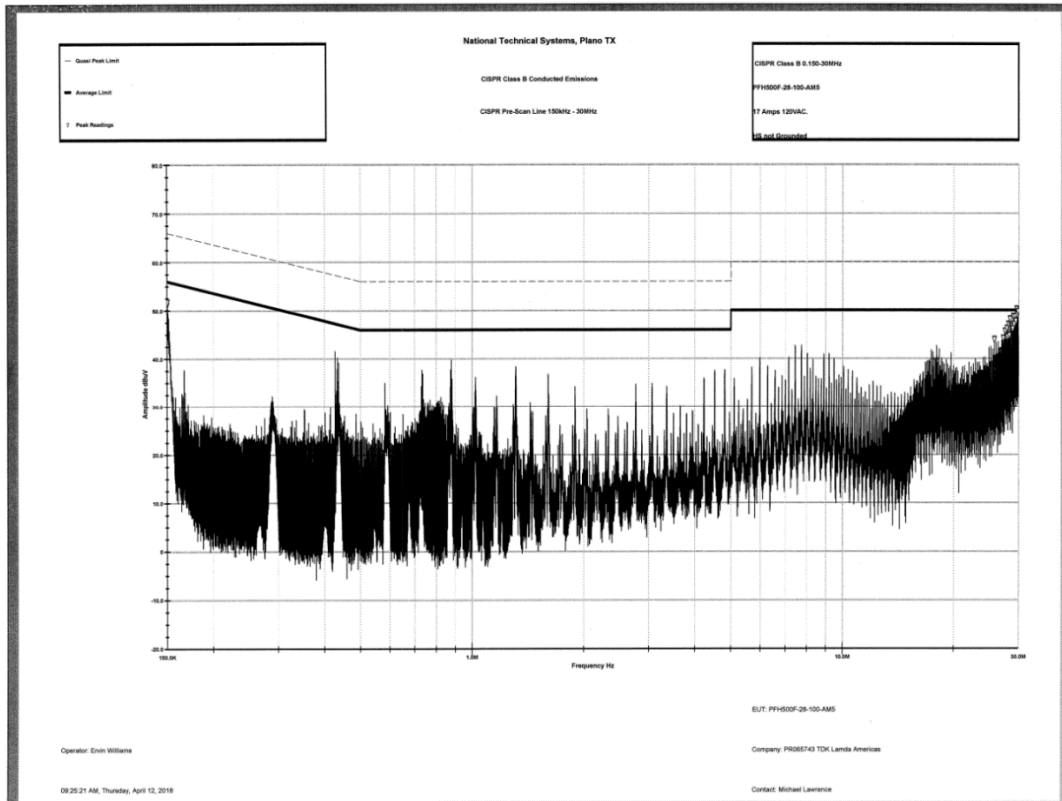


Figure 1

NTS (Richardson, TX) Conducted Emissions CISPR22 Class B Setup

**Basic Standard:** CISPR22, Class B  
**Test Voltage:** 120Vac / 60Hz – LINE  
**Heat Sink:** Not Connect to EGND



National Technical Systems, Plano TX  
 CISPR Class B Conducted Emissions  
 CISPR Final Line 150kHz-30MHz

09:25:21 AM, Thursday, April 12, 2018

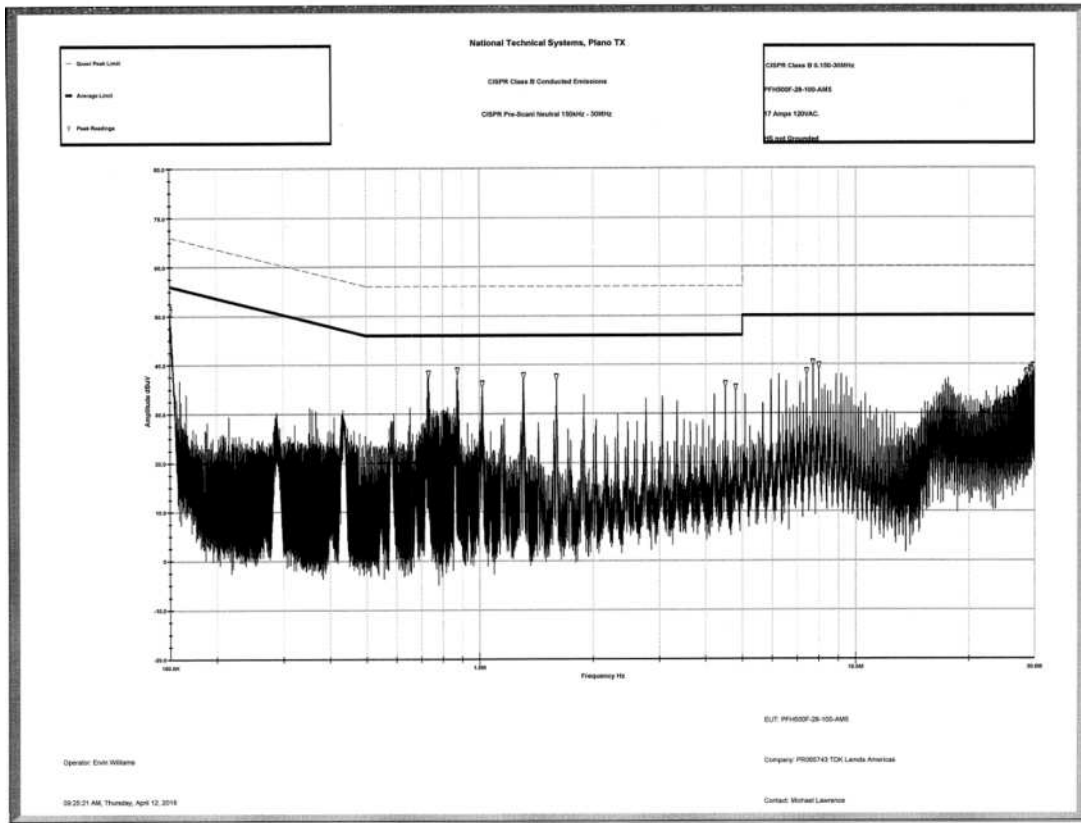
PR065743 TDK Lamda Americas  
 Michael Lawrence

Frequency	1	2	3	4	5	6
MHz	QP Limit	AVE Limit	AVE Reading	AVE Margi	QP Readings	QP Margin
	dBuV	dBuV	dBuV	dB	dBuV	dB
28.455 MHz	60.000	50.000	36.959	-13.041	44.977	-15.023
29.036 MHz	60.000	50.000	34.331	-15.669	41.697	-18.303
29.317 MHz	60.000	50.000	36.429	-13.571	46.786	-13.214
29.619 MHz	60.000	50.000	33.334	-16.666	41.819	-18.181
29.751 MHz	60.000	50.000	28.756	-21.244	36.344	-23.656
29.914 MHz	60.000	50.000	32.235	-17.765	40.028	-19.972
CISPR Class B 0.150-30MHz						
PFH500F-28-100-AM5						
17 Amps 120VAC.						
HS not Grounded						

**CONCLUSION:** **PASSED**



**Basic Standard:** CISPR22, Class B  
**Test Voltage:** 120Vac / 60Hz - NEUTRAL  
**Heat Sink:** Not Connect to EGN



National Technical Systems, Plano TX  
 CISPR Class B Conducted Emissions  
 CISPR Final Neutral 150kHz-30MHz

Operator: Ervin Williams

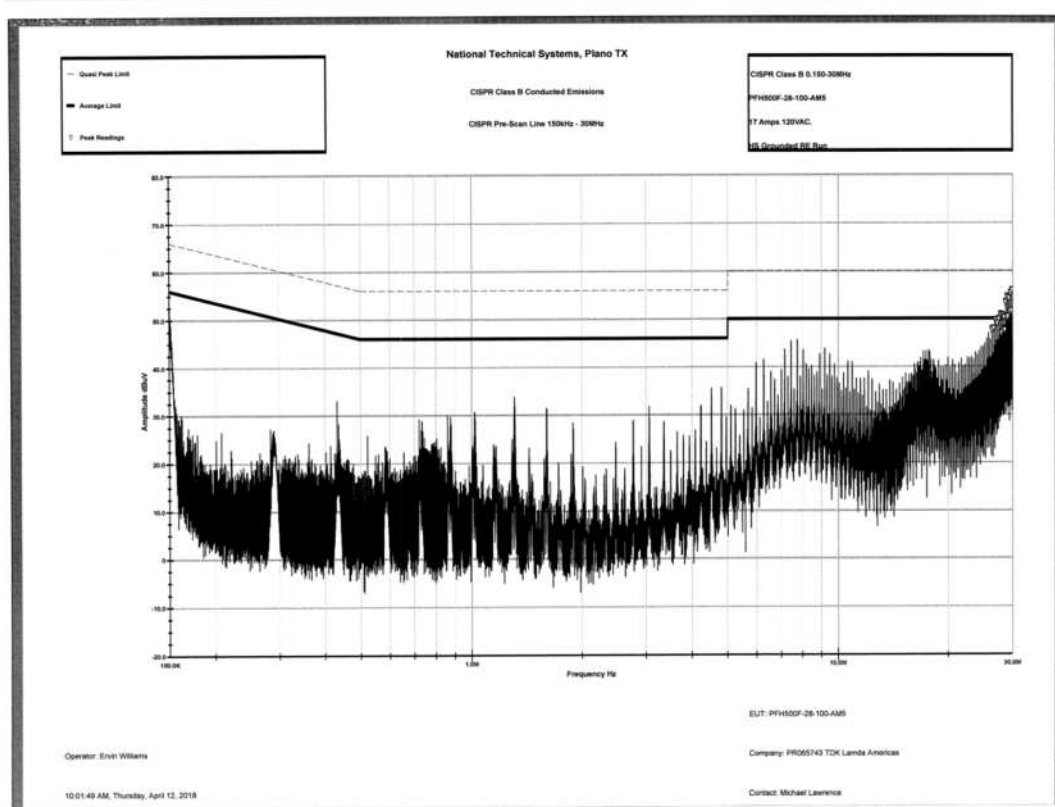
09:25:21 AM, Thursday, April 12, 2018

EUT: PFH500F-28-100-AM5  
 Company: PR065743 TDK Lambda Americas  
 Contact: Michael Lawrence

Frequency MHz	1 QP Limit dBuV	2 AVE Limit dBuV	3 AVE Reading dBuV	4 AVE Margin dB	5 QP Reading dBuV	6 QP Margin dB
0.150 MHz	66.000	56.000	41.717	-14.283	46.326	-19.674
0.151 MHz	65.984	55.984	39.335	-16.648	43.864	-22.119
0.733 MHz	56.000	46.000	7.256	-38.744	24.758	-31.242
0.875 MHz	56.000	46.000	12.106	-33.894	31.546	-24.454
1.309 MHz	56.000	46.000	25.175	-20.825	33.194	-22.806
1.600 MHz	56.000	46.000	21.673	-24.327	29.630	-26.370
CISPR Class B 0.150-30MHz						
PFH500F-28-100-AM5						
17 Amps 120VAC.						
HS not Grounded						

**CONCLUSION:** **PASSED**

**Basic Standard:** CISPR22, Class B  
**Test Voltage:** 120Vac / 60Hz – LINE  
**Heat Sink:** Connected to EGND



National Technical Systems, Plano TX  
 CISPR Class B Conducted Emissions  
 CISPR Final Line 150kHz-30MHz

10:01:49 AM, Thursday, April 12, 2018

PR065743 TDK Lamda Americas  
 Michael Lawrence

Frequency	1 QP Limit dBuV	2 AVE Limit dBuV	3 AVE Reading dBuV	4 AVE Margin dB	5 QP Readings dBuV	6 QP Margin dB
28.716 MHz	60.000	50.000	46.957	-3.043	52.427	-7.573
29.001 MHz	60.000	50.000	46.444	-3.556	53.279	-6.721
29.312 MHz	60.000	50.000	38.692	-11.308	44.912	-15.088
29.593 MHz	60.000	50.000	37.706	-12.294	48.773	-11.227
29.745 MHz	60.000	50.000	30.733	-19.267	39.520	-20.480
29.882 MHz	60.000	50.000	38.952	-11.048	50.748	-9.252
CISPR Class B 0.150-30MHz						
PFH500F-28-100-AM5						
17 Amps 120VAC						
HS Grounded RE Run						

**CONCLUSION:** *PASSED*