Table of Contents

Chapter 1. Summary

1.1 General Description

The 57W adaptor EV1 board exemplifies a dual-port charger adaptor design - 45W USB-C PD 2.0 port and 12W USB-A port. It is composed of four main parts, AP3108L offers the CCM & DCM PWM switching, APR346 is a secondary side Synchronous Rectification (SR) Controller, CY2211 is USB 2.0 decoder based on monitoring CC1 & CC2 signals voltage levels, CY2211 interprets desired voltage and current setting, and then feedback information to primary side AP3108L controller for providing well regulated voltage and current as well as related power protections. AP1510, a DC-DC 3A buck controller, converts the Vbus voltage down to 5V.

1.2 Key Features

1.2.1 System Key Features

- SSR Topology Implementation with an Opto-coupler for Accurate Step Voltage Controlling
- USB PD 2.0 Compliance Type C Port, meets DOE6 and CoC Tier 1 Efficiency Requirements
- <75mW No-Load Standby Power
- Low overall system BOM cost

1.2.2 AP3108L Key Features

- Current Mode PWM Controller
- Frequency Shift function changes frequency per line loading
- Frequency fold back for high average efficiency
- Integration of High-Voltage Start-Up Circuit to enable low standby power
- Integration of 100V LDO, X-Cap discharge for minimal system BOM components
- Constant load output current during output short circuit
- Rich Protection Functions: , Precise Secondary Side OVP, UVP, OLP, BNO, FOCP, SSCP, External Programmable OTP

1.2.3 APR346 Key Features

- Synchronous Rectification Working at DCM, CCM and QR Flyback
- Eliminate Resonant Ringing Interference
- Fewest External Components used

1.2.4 CY2211-16L Key Feature

- Support type-C USB PD DFP USB 2.0
- Support 5V to 20V output voltage with 0.1V/step
- Built in Shunt Regulator for CV and CC loops feedback
- Support more than 6 groups PDO outputs
- Programmable OVP/UVP/OCP/OTP
- With cable voltage drop compensation
- Internal Discharge MOS
- Internal Vbus Load Switch Driver
- 0V- 32V Operation Voltage without External Regulator
- **TSSOP-16L**
- http://canyon-semi.com.tw/products.php

1.2.5 AP1510 Key Feature

- Duty ratio from 0 to 100% PWM, P-Mosfet built in
- Switching frequency 300KHz typical, SOP-8L package
- With current limit, Enable & Thermal shutdown functions

1.3 Applications

- 45W USB-C PD 2.0 + USB-A 5V-2.4A Adaptor

1.4 Main Power Specifications (CV & CC Mode)

Parameter	Value
Input Voltage	90Vac to 264Vac
Input standby power	< 100mW
Main Output Vo / Io	USB-A port: 5V/2.4A USB-C port: 5V/3A, 9V/3A,15V/3A
Type C only Efficiency	>89%
Combine Efficiency	>87%
Total Output Power	57W
Protections	OVP, UVP, OLP, BNO, FOCP, SSCP, OTP
XYZ Dimension	L89 x 37 x 25mm
ROHS Compliance	Yes

1.5 Evaluation Board Picture

Figure 1: Top View

Figure 2: Bottom View

Chapter 2. Power Supply Specification

2.1 Specification and Test Results

Parameter	Test conditions	Min	Nom	Max	Eff/ DoE VI	Eff/ Tier1	Test Summary
V_{acin} Input Voltage		90 V_{rms}	115/230	264 V_{rms}			
F_{line} Frequency		47 Hz	50/60	64 Hz			
I_{in} Input Current				1.5 A_{rms}			Pass
No load Pin	At 230Vac_in/50Hz @ 5V, Pin < 75mW			75mW			Pass , the test result is 70mW
5V/ 3A @115Vac/230Vac Average efficiency	Board end		5V/3A		81.39%	81.84%	Pass, average efficiency is 90.25%
5V/ 0.3A @115Vac/230Vac 10% efficiency	Board end		5V/0.3A			72.48%	Pass, efficiency is 78.5%
9V/ 3A @115Vac/230Vac Average efficiency	Board end		9V/3A		86.60%	87.30%	Pass, average efficiency is 90.86%
9V/ 3A @115Vac/230Vac 10% efficiency	Board end		9V/0.3A			76.62%	Pass, efficiency is 80.6%
15V/3A @115Vac/230Vac 100% efficiency	Board end		15V/3A		87.7%	88.8%	Pass, average efficiency is 90.47%
15V/0.3A@115Vac/230Vac 10% efficiency	Board end		15V/0.3A				
USB-A 5V-2.2A	Board end		5V-2.4V				

2.2 Compliance

Parameter	Test conditions	Low to High	High to Low	standard	Test Summary
Standby Power (mW)@ No load conditions	5V Output / @230Vac	-	70mW	100mW	Pass
Output Voltage Transition time	5V/3A to 9V/3A	13.1ms	16.3ms	25mS <	Pass
Output Voltage Transition time	9V/3A to 15V/3A	11.3ms	15ms	25mS <	Pass
Output Voltage Transition time	5V/3A to 15V/3A	18.7ms	20.3ms	25mS <	Pass
Output Voltage Transition time	15V/3A to 5V/3A				
Output Connector	USB Type C	-	-	-	
Temperature	90Vac , 15V / 3A	-	-	-	Pass
Dimensions (W /D/ H)	L89mm x 37mm x 25mm	-	-	-	
Safety	IEC/EN/UL 60950 Standard	-	-	-	
EMI/EMC	FCC/EN55022 Class B	-	-	-	Pass

Chapter 3. Schematic

3.1 EV1 Board Schematic

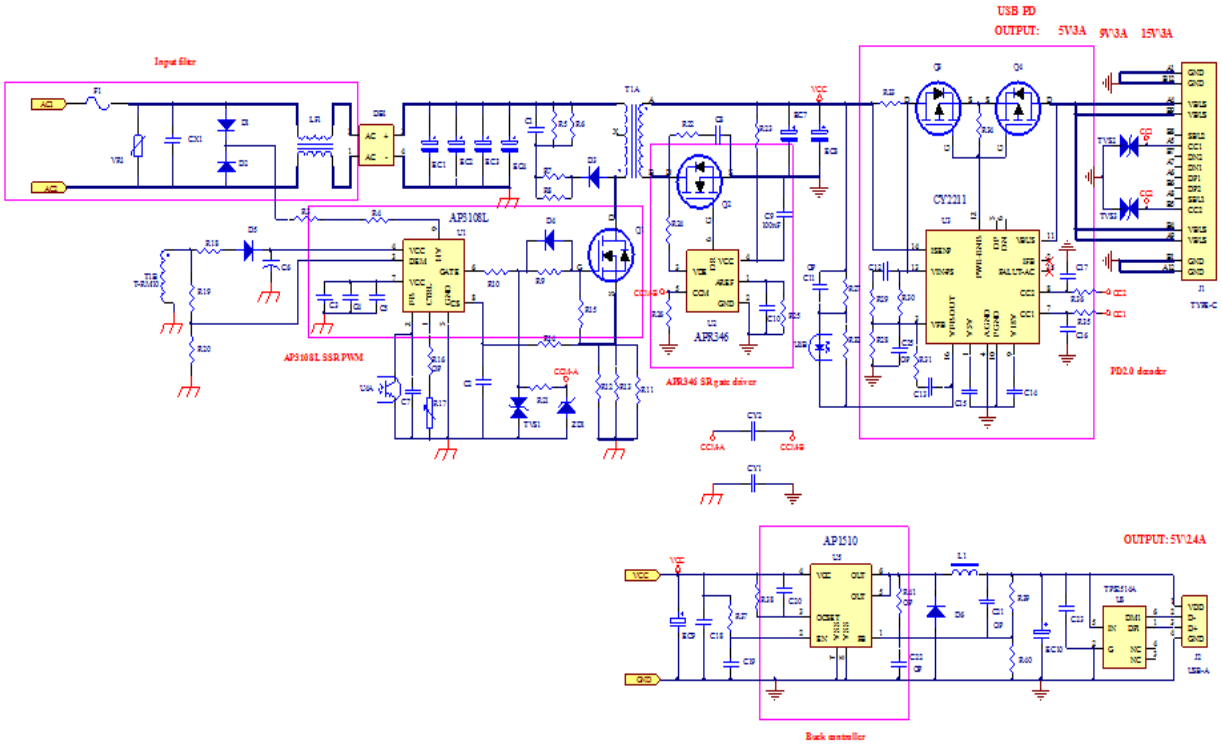


Figure 3: 57W Dual output Evaluation Board Schematic

For multiple outputs

		27W (5Vx3A+5Vx2.4A) Eff=80.8%
DoE VI Eff ≥ 0.0750xLn(Po)+0.561	1 --- 49W	39W(9Vx3A+5Vx2.4A) Eff =83.57%
DoE VI Eff ≥ Pout > 49W >= 86.0%	57W (45W+12W) >49W	Eff >= 86%

3.2 Bill of Material (BOM)

BOM1

Designator	Description	Part Number	Manufactory	Footprint	Quantity
D1, D2, D5	1.0A/1000V FAST RECOVER RECTIFIER	RS1MWF	DIODES	SOD123	3
D3	3.0A/1000V FAST RECOVERY RECTIFIER	S3MB	DIODES	SMB	1
D4	FAST SWITCHING DIODE	1N4148WS	DIODES	SOD-323	1
D6	15A SBR® SUPER BARRIER RECTIFIER	SBR15U30SP5	DIODES	PowerDI5	1
ZD1	18V/500mW, Zener DIODE	MMSZ5248B	DIODES	SOD-123	1
DB1	4.0A/1000V BRIDGE RECTIFIER	TT410	DIODES	TT	1
Q1	650V N-Channel MOSFET, RDS(ON)=600mΩ	DMJ65H600SCTI	DIODES	ITO220AB	1
Q2	100V N-CHANNEL ENHANCEMENT MODE MOSFET, RDS(ON)=8.3mΩ @VGS = 10V	DMT10H010LPS-13	DIODES	PowerDI5060-8	1
Q3, Q4	20V P-CHANNEL ENHANCEMENT MODE MOSFET	DMP26M7UFG	DIODES	PowerDI3333-8	2
TVS1, TVS2, TVS3	VBR (min)=25.4V & 17.1V,LIN-BUS BIDIRECTIONAL DUAL TVS DIODE	DESD1LIN2WSQ	DIODES	SOD-323	3
U1	CCM PWM CONTROLLER-	AP3108L	DIODES	SSOP-9	1
U2	SECONDARY SIDE SYNCHRONOUS RECTIFICATION CONTROLLER	APR346	DIODES	SOT23-6	1
U5	PWM CONTROL 3A STEP-DOWN CONVERTER	AP1510	DIODES	SOP-8	1
U3	CY2211-16		CANYON	SSOP-16	1
U4	TCLT1006		VISHAY	PC-SMD	1
U6	TPS2514A		TI	SOT23-6	1
VR1	10D561			VR-7D561	1
T1	T-RM10			RM10	1
C1	1nF/1KV			C1206	1
C2	220pF/50V			C0603	1
C3, C4	4.7uF/50V			C1206	2
C5,C9,C13,C14, C18, C20,C23	100nF/50V			C0603	7
C6	15uF/50V, E-CAP			EC6.5	1

BOM2

Designator	Description	Part Number	Manufactory	Footprint	Quantity
C7	1.0 nF/50V			C0603	1
C8	470F/200V			C0805	1
C10	22nF/50V			C0603	1
C21	56pF/50V			C0603	1
C11, C22, C25,	Optional				3
C12	3.3 nF/50V			C0603	1
C15	4.7uF/ 10V			C0805	1
C16, C17	560pF/50V			C0603	2
CE1A	Optional				
C19	220nF/25V			C0603	1
CX1	330nF/275VAC, X-CAP			X1-12*13.5	1
CY1	1nF/400VAC, Y-CAP			CY-10.0	1
CY2	10PF/400VAC, Y-CAP			CY-10.0	1
EC1, EC2, EC3, EC4	27UF/400V,E-CAP			EC10.0	4
EC7,EC9	680UF/25V, E-Cap			EC7	2
EC8	680UF/25V, Solid Cap			EC5.0	1
EC10	680uF/6.3V, Solid Cap			EC5.0	1
F1	T3.15A/250V, Fuse			FUSE1	1
J1	TYPE-C, Connector			C-TYPE-C	1
J2	USB-A, Connector			USB-A	1
L1	33uH / 4.2A	7447709330	WURTH ELEKTRONIK	L3	1
LF1	Common Chock, Lp>20mH				1
R3, R4	10K/1206			R1206	2
R5, R6	430K/1206			R1206	2

BOM3

Designator	Description	Part Number	Manufactory	Footprint	Quantity
R7, R8	33R/1206			R1206	2
R35, R36, R23, R24	22R/0603			R0603	3
R9,R10	5R/0603			R0603	1
R11, R12, R13	0.91 R/1206			R1206	3
R14, R29	1K/0603			R0603	2
R15	15K/0603			R0603	1
R41	Optional				
R16	Optional				
R17	NTC Resistor, Optional				1
R18	0R			R0805	1
R19	220K/0603			R0603	1
R20	22K/0603			R0603	1
R21	2K/1206			R1206	1
R22	22R/1206			R1206	1
R25	82K/0603			R0603	1
R30	91K/0603			R0603	1
R38	3.9K/0603			R0603	2
R26	3.6K/0805			R0805	2
R27	2K/0805			R0805	1
R28	10K/0603			R0603	1
R31	8.2K/0603			R0603	1
R32	10K/0603			R0603	1
R33	Ultra Low Ohm (Metal Strip) Chip Resistor, 10mR/1206, 1W		helisto	R1206	1
R34	36K/0603			0603	1
R37	100K/0603			R0603	1
R39	18.7K/0603			R0603	1
R40	3.6K /0603			R0603	1

3.3 Transformer design

RM10（Ae=98mm2）					Rev1	
NO	NAME	TERMINAL NO.		WINDING		
		START	FINISH	WIRE	TURNS	Layers
1	**Np1**	12（Add Tube）	X	Φ0.37mm*2	24.5	2
2	**Na**	1（Add Tube）	3（Add Tube）	Φ0.14mm*3	13	1
3	**Ns1**	Bottom	Top	Φ0.55TIW *2	6	1
4	**Ns2**	Bottom	Top	Φ0.55TIW *2	6	1
5	**Shield**	3	NC	Φ0.14mm*1	30	1
6	**Np2**	X	10（Add tube）	Φ0.37mm*2	23.5	2

Primary Inductance	Pin 12-10,all other windings open, measured at 20kHz, 0.4VRMS	660uH±5%
Primary Leakage Inductance	Pin 12-10, all other windings shorted, measured at 20kHz, 0.4VRMS	20 uH (Max.)
Note	***1，Core connect with Pin3.*** **2，Core material：PC44**	

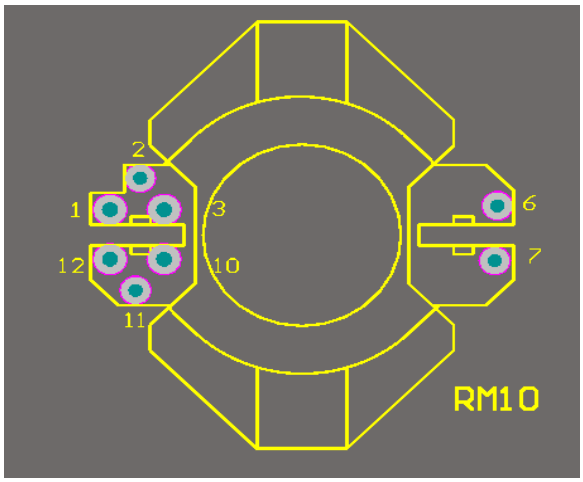


Figure 4: Pin sign（Top View）

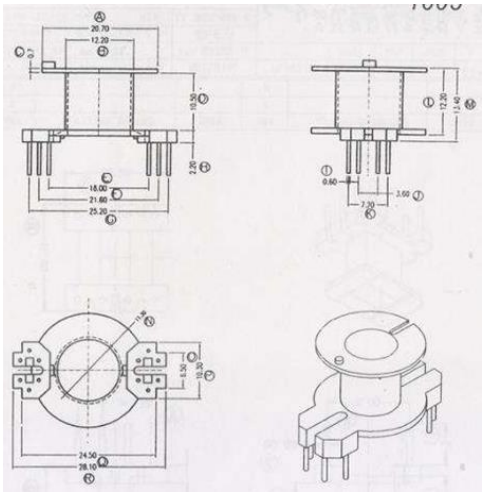


Figure 5: RM10 Bobbin & Pin assignments

3.4 Schematics Description

3.4.1 AC Input Circuit & Differential Filter

There are three components in the section. The Fuse F1 protects against over-current conditions which occur when some main components failed. The LF1 & CX1 are common mode chock filter for the common mode noise suppression filleting because of the each coil with large impedance. The DB1 is rectifier, and basically converts alternating current & voltage into direct current & voltage.

3.4.2 AP3108L PWM Controller

The AP3108L PWM controller U1 and Opto-Coupler U4 and Q1 are the power converting core components, connected to filtered AC input & after bridge circuit, R3 & R4 resistor path provides start-up voltage and current during starting up phase through HV (Pin 9). Subsequent VCC power will be provided by voltage feedback from the auxiliary winding through R18-D5. This design is to accommodate required wide arrange voltage range to support various protocols from 5V to 15V.

Based on feedback of secondary side current of information (Pin VFB_Out of CY2211 Decoder) through Opto-coupler U4 to primary side (FB pin of AP3108L), AP3108L PWM controller will switch ON and Off Q1 to regulate desired voltage and current on the secondary side.

3.4.3 APR346 Synchronous Rectification (SR) MOSFET Driver

The IC APR346 is SR Mosfet driver would operate at DCM/CCM mode in this design that based on input voltage & current loading. As the power loss with the APR346-controlled MOSFET Q2 that is less than Schottky Diodes, the total efficiency can be improved.

3.4.4 CY2211-16L PD2.0+ Decoder & Protection on /off P MOSFET and Interface to Power Devices

Few sets of important pins provide critical protocol decoding and regulation functions in CY2211 are:

1) **CC1 & CC2 (Pin 7, 8)**: CC1 & CC2 (Configuration Channel 1 & 2) are defined by USB PD spec to provide the channel communication link between power source and sink devices.
2) **Constant Voltage (CV)**: The CV is implemented by sensing VCC (pin 13) via resistor divider and comparing with internal reference voltage to generate a CV compensation signal on the VFB pin (pin 3). There is a loop compensation circuit C13 & R31 between Pin3 & Pin16, the fast voltage response can be obtained by adjusting their value. The output voltages can be adjusted by firmware programming.
3) **Over Current Protection (OCP)**: The OCP is implemented by using R33 between Pin13 & Pin14.
4) **VFB (Pin3)**: It is the key interface link from secondary decoder (CY2211) to primary regulation circuit (AP3108L). It is connected to Opto-coupler U4A cath for feedback information based all sensed CC1 & CC2 voltage status for getting desired Vbus voltage & current.
5) **GATE Driver (Pin12) to PMOSFET Gate**: The pin is used to turn on/off the back to back P-MOSFET (Q3 &Q4) to enable/disable voltage output to the Vbus and the back to back P-MOSFET also can prevent reverse current to the secondary side transformer from the user side of battery source.

Chapter 4. The Evaluation Board (EVB) Connections

4.1 EVB PCB Layout

The thickness for both sides of PCB board trace cooper is 2 Oz.

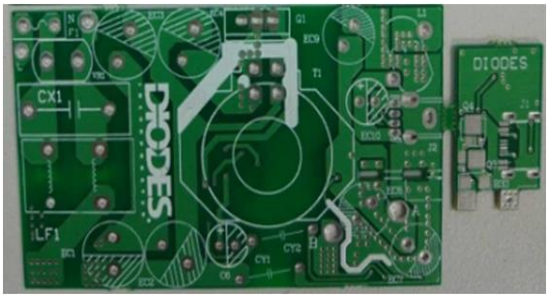


Figure 6: PCB Board Layout Top View

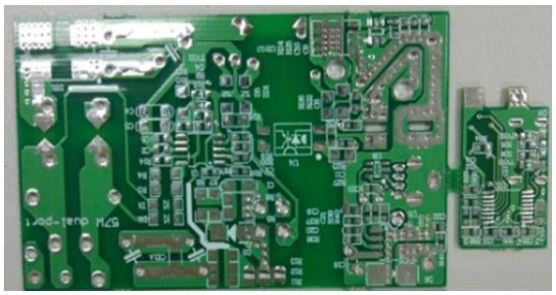


Figure 7: PCB Board Layout Bottom View

4.2 Quick Start Guide Before Connection

1) Before starting the 45W PD2.0 EVB test, the end user needs to prepare the following tool, software and manuals. For details, please contact Canyon Semiconductor local agent for further information.

- Test Kit: UFP_161228b (Canyon 45W PD2.0 Test Kit)
- Test kit operation Manual??

Test Kit—CANYON UFP_161228b

Standard-A to Micro-B Cable

Type-C Cable

Figure 8: Canyon Items: Test Kit / Test Cables

2) Prepare a certified three-foot Type-C cable and a Standard-A to Micro-B Cable.

3) Connect the input AC L & N wires to AC power supply output “L and N “wires.

4) Ensure that the AC source is switched OFF or disconnected before the connection steps.

5) A type-C cable for the connection between EVB’s and UFP_161228b ’s Type-C receptacles

6) Use 2 banana jack cables, one port of the cables are connected to E-load + & - terminals while the other port of the cables are connected to UFP_161228b’s USB port & its GND.

7) A Standard-A to Micro-B cable to be connected to the UFP_161228b test kit Micro-B receptacle & PC Standard-A receptacle respectively.

4.3 System Setup

4.3.1 Connection with E-Load

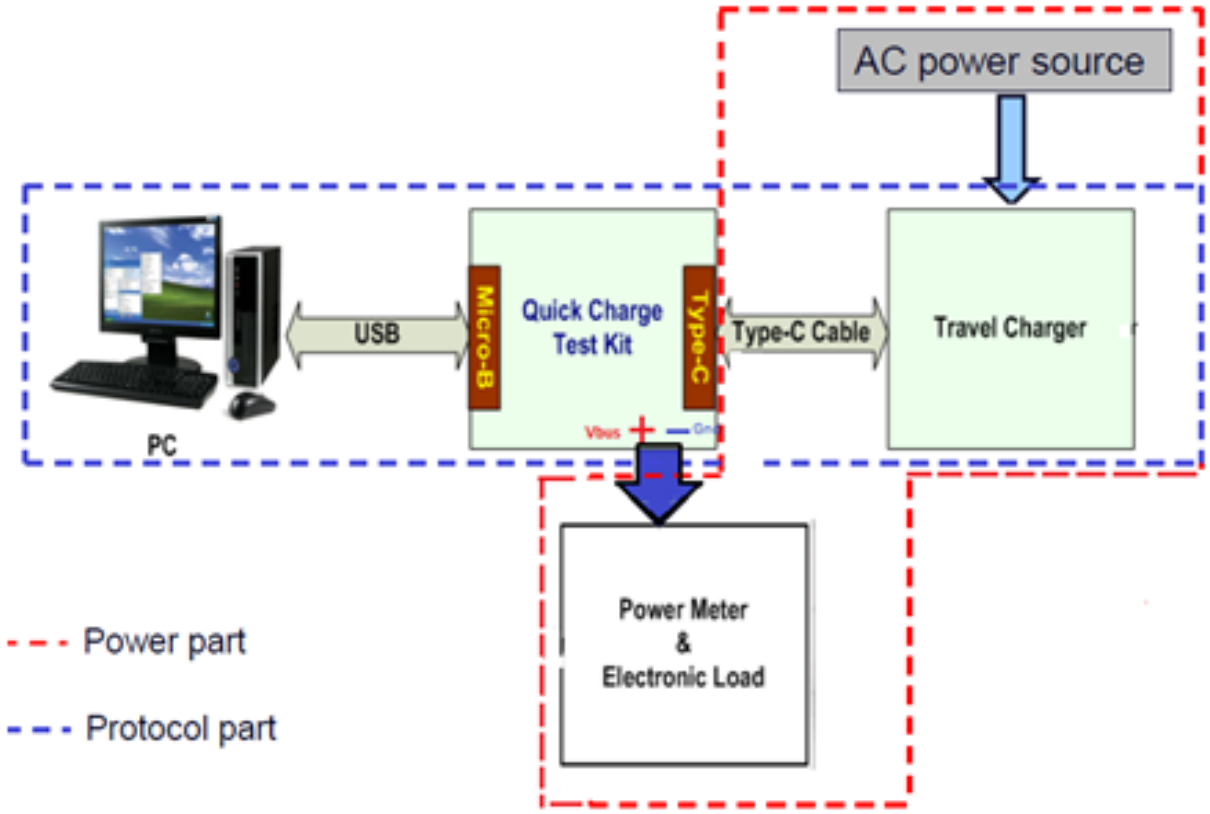
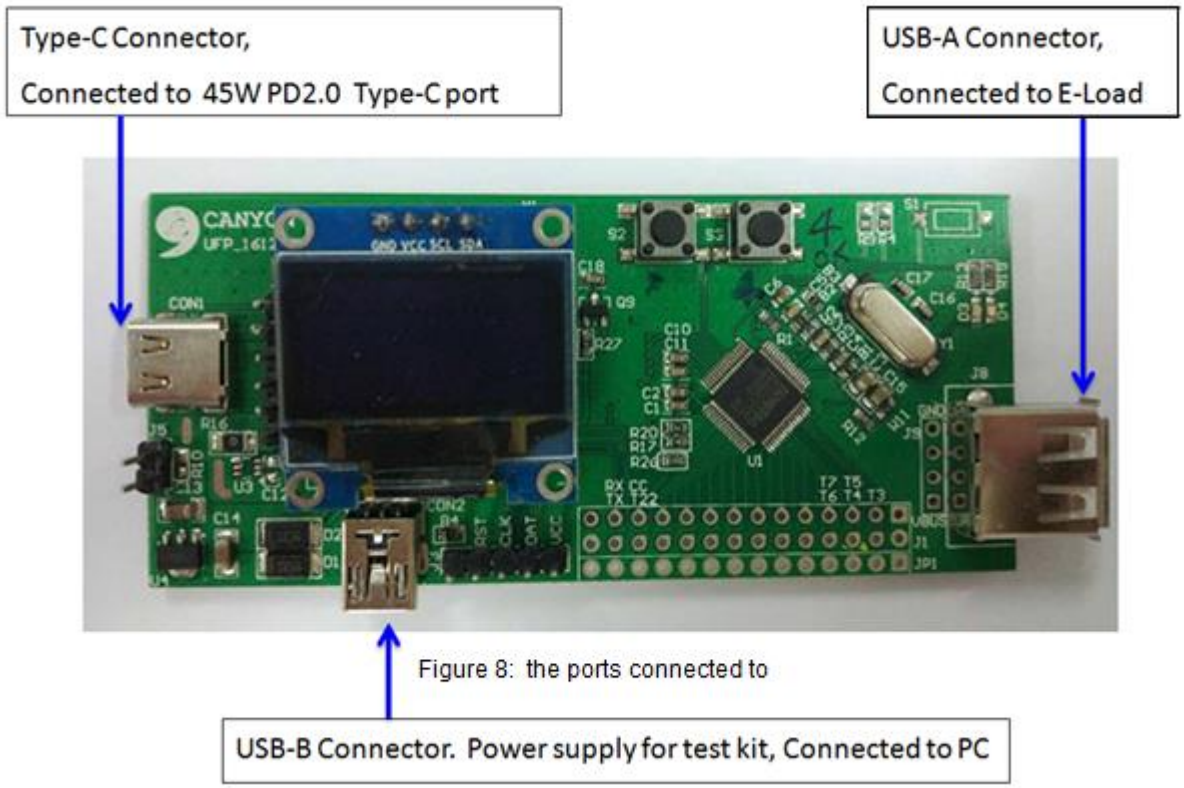


Figure 9: Diagram of Connections in the Sample Board

4.3.2 Canyon's UFP_161228b USB PD2.0 Test Kit



For detail, please contact Canyon Semiconductor (http://canyon-semi.com.tw/) or local agent for Test Kit **UFP_161228b** User Guide.

4.3.3 Input & Output Wires Connection

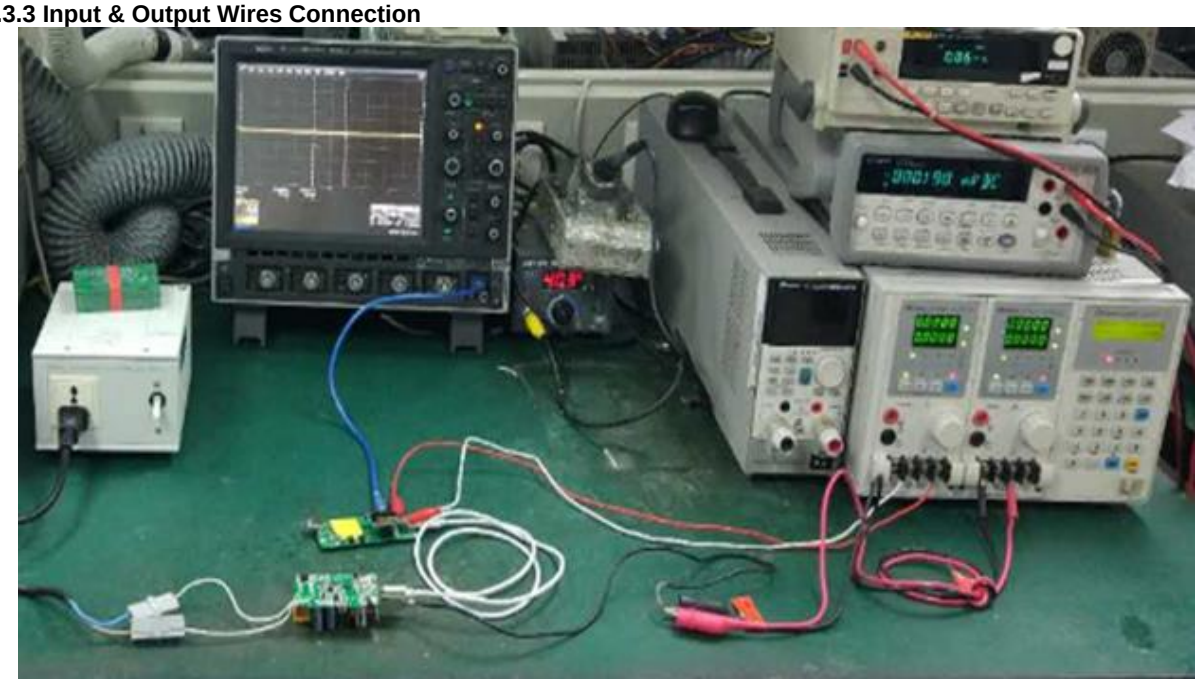


Figure 11: Wire Connection of 45W PD2.0 EVB to Test Kit and PC Computer

Chapter 5. Testing the Evaluation Board

5.1 Input & Output Characteristics

5.1.1 Input Standby Power

	Input Voltage (Vac)	Standby Power (mW)
57W dual port Wall Charger (USB-A Port =5V/0A & USB-Type C Port=5V/0A)	115	66
	230	70
45W PD2.0 Charger USB-A board is disconnected (USB-Type C Port = 5V/0A)	115	28
	230	36

5.1.2 Input Power Efficiency at Different AC Line Input Voltage

Vin(VAC)	Freq(HZ)	Vin(V)	Iin(A)	PF	Pin(W)	Vout(V)	Iout(A)	Pout(W)	Pd(W)	Eff（%）
90	47	89.92	0.719	0.511	33.13	5.592	3	16.776	-4.762	85.63
						4.83	2.4	11.592		
115	60	115.14	0.654	0.436	32.81	5.592	3	16.776	-4.442	86.46
						4.83	2.4	11.592		
230	50	230.37	0.38	0.373	32.67	5.594	3	16.782	-4.2984	86.84
						4.829	2.4	11.5896		
264	63	264.35	0.328	0.377	32.78	5.594	3	16.782	-4.4108	86.54
						4.828	2.4	11.5872		
90	47	90.01	0.942	0.54	45.79	9.385	3	28.155	-5.8726	87.17
						4.901	2.4	11.7624		
115	60	115.12	0.867	0.454	45.33	9.385	3	28.155	-5.4126	88.06
						4.901	2.4	11.7624		
230	50	230.35	0.516	0.377	44.89	9.385	3	28.155	-4.9726	88.92
						4.901	2.4	11.7624		
264	63	264.34	0.442	0.385	45.05	9.385	3	28.155	-5.1326	88.61
						4.901	2.4	11.7624		
90	47	89.96	1.289	0.58	67.34	15.43	3	46.29	-9.1652	86.39
						4.952	2.4	11.8848		
115	60	115.07	1.132	0.508	66.29	15.441	3	46.323	-8.0822	87.81
						4.952	2.4	11.8848		
230	50	230.32	0.73	0.386	64.98	15.44	3	46.32	-6.7752	89.57
						4.952	2.4	11.8848		
264	63	263.31	0.63	0.394	65.61	15.441	3	46.323	-7.4022	88.72
						4.952	2.4	11.8848		

5.1.3 Average Efficiency at Different Loading

Vin	Vo	25% Load	50% Load	75% Load	100% Load	Average Efficiency	Energy Star Level VI	10% Load Efficiency
115V/60Hz	PDO=5V/3A & 5V-2.4A	89.57%	88.92%	87.96%	86.81%	87.69%	>80.82%	87.81%
	PDO=9V/3A & 5V-2.4A	89.19%	89.38%	88.00%	88.30%	88.85%	>83.58%	86.01%
	PDO=15V/3A & 5V-2.4A	88.26%	88.52%	88.34%	87.89%	88.10%	>86.00%	83.67%
230V/50Hz	PDO=5V/3A & 5V-2.4A	88.21%	87.79%	88.00%	87.37%	87.84%	>80.82%	84.00%
	PDO=9V/3A & 5V-2.4A	88.56%	89.69%	89.48%	89.28%	89.25%	>83.58%	83.49%
	PDO=15V & 5V-2.4A	88.37%	87.79%	89.22%	89.56%	88.73%%	>86.00%	82.24%

5.1.4 45W PD2.0 Type-C Port Average Efficiency at Different Loading (USB-A Port Off)

Vin	Output	25% Load	50% Load	75% Load	100% Load	Average Efficiency	Energy Star Level VI	10% Load Efficiency
115V/60Hz	PDO=5V & 5V-0A	89.99%	90.75%	90.25%	90.02%	90.25%	>80.82%	85.79%
	PDO=9V & 5V-0A	90.50%	91.10%	91.04%	90.80%	90.86%	>83.58%	86.13%
	PDO=15V & 5V-0A	90.02%	90.64%	90.53%	90.68%	90.47%	>86.00%	85.13%
230V/50Hz	PDO=5V & 5V-0A	87.44%	89.75%	90.05%	90.07%	89.33%	>80.82%	83.56%
	PDO=9V & 5V-0A	89.11%	90.99%	91.44%	91.38%	90.73%	>83.58%	82.48%
	PDO=15V & 5V-0A	89.52%	91.43%	91.67%	91.45%	91.00%	>86.00%	83.03%

5.1.5 USB-A Port Average Efficiency at Different Loading (Type-C Port Off)

Vin	Output	25% Load	50% Load	75% Load	100% Load	Average Efficiency	Energy Star Level VI	10% Load Efficiency
115V/60Hz	PDO=5V-0A & 5V-2.4A	86.84%	87.34%	86.47%	84.92%	86.39%	>80.82%	79.09%
230V/50Hz	PDO=5V-0A & 5V-2.4A	83.17%	85.81%	85.88%	84.79%	84.91%	>80.82%	78.35%

5.2 Key Performance Waveforms

5.2.1 45W PD2.0 System Start-up Time & Hold-up Time

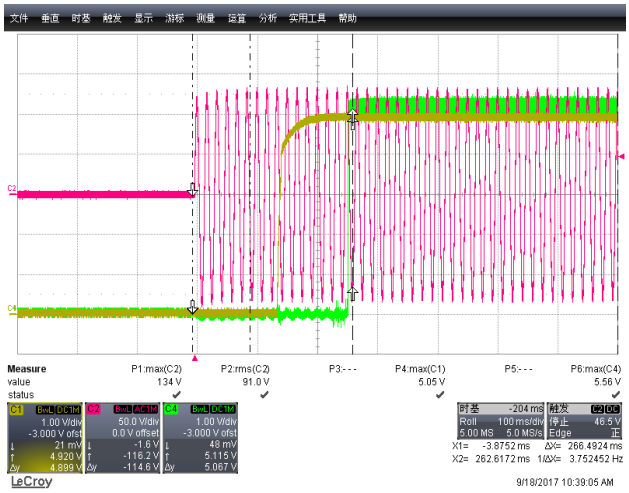


Figure 12: 45W PD3.0 turn on time 0.27s 15V/3A at 90Vac

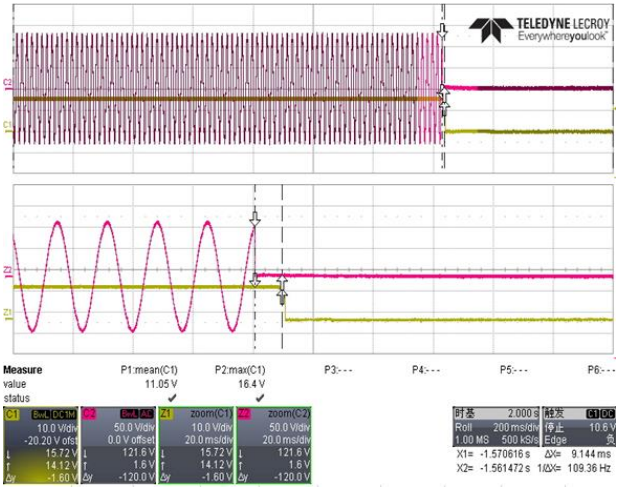


Figure 13: 45W PD2.0 hold up time 9.14ms at 15V- 3A, at 90Vac

5.2.2 Q1 /Q2 Main Switching Voltage MOSFET Stress on at 15V/ 3A Loading @264Vac

Primary side MOSFET - Q1

Figure 14: Q1 Vds=590V Vdsmax=650V, Trv = 90.8%

Secondary side SR MOSFET- Q2

Figure 15:Q2 Vds =82.7V Vdsmax=100V Trv = 82.7%

5.2.3 System Output Ripple & Noise with @ 1.2m Cable End

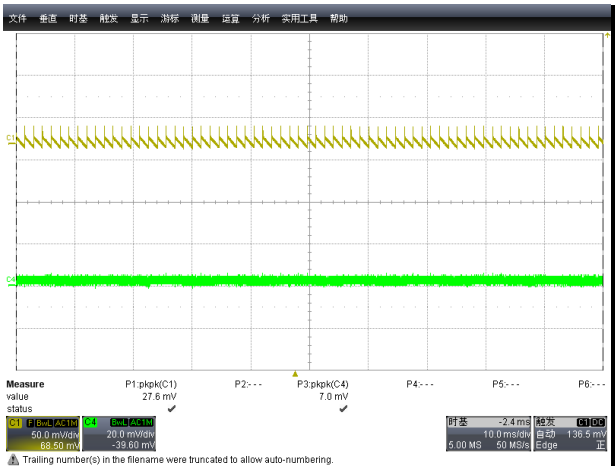


Figure 16: The Ripple at 90Vac/60Hz ΔV=30mV 5V/0A

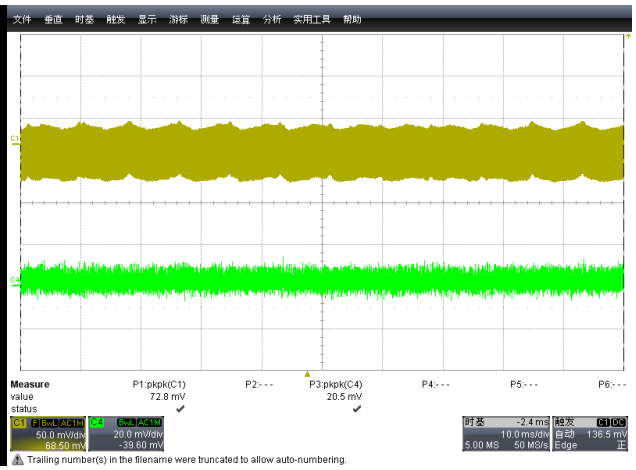


Figure 17: The Ripple at 264Vac/50Hz ΔV=72.8mv 5V/0A

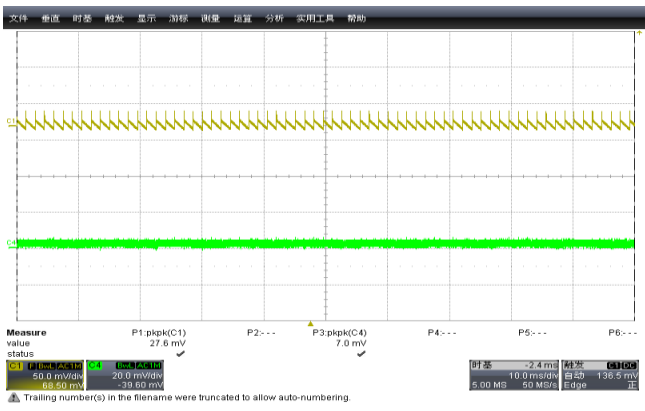


Figure 18: 90Vac/60Hz 5V/3A ΔV=68.5mV

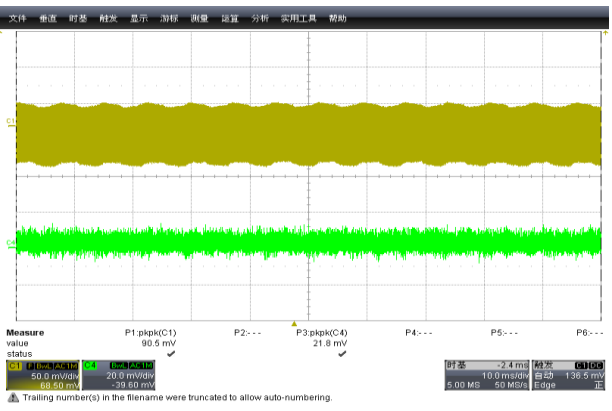


Figure 19: 264Vac/50Hz 5V/3A ΔV=90mv

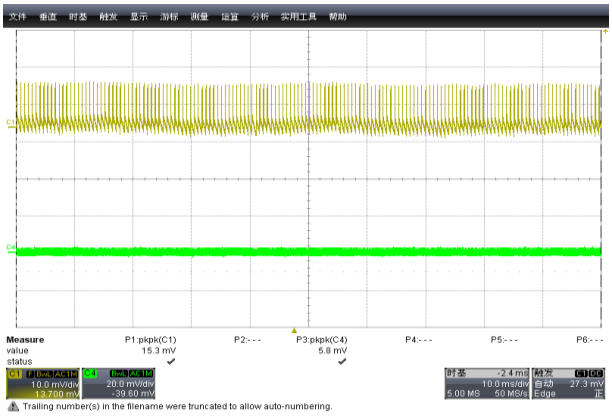


Figure 20: 90Vac/60Hz 9V/0A ΔV=15.3mV

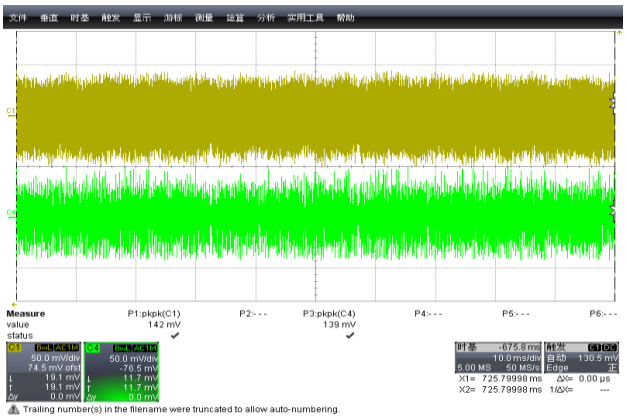


Figure 21: 264Vac/50Hz 9V/0A ΔV=142mv

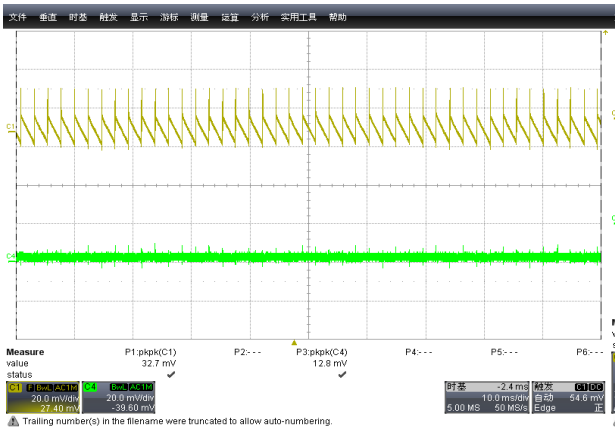


Figure 22: 90Vac/60Hz 9V/3A ΔV=32.7mV

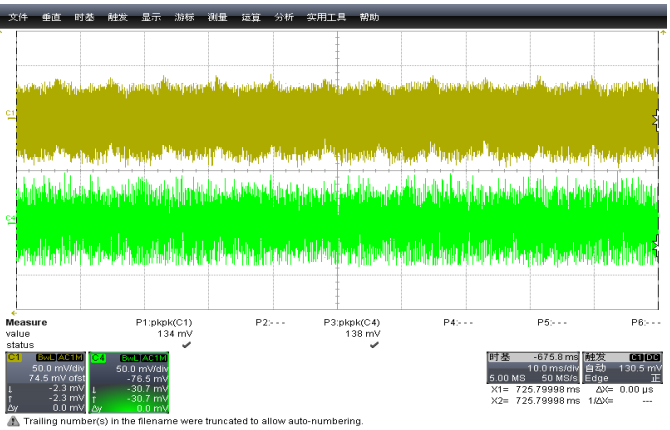


Figure 23: 264Vac / 60Hz 9V/3A ΔV=134mV

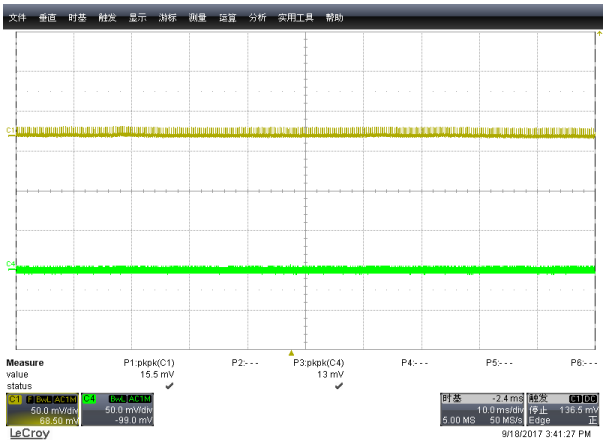


Figure 24: 90Vac/60Hz 15V/0A ΔV=15.5mV

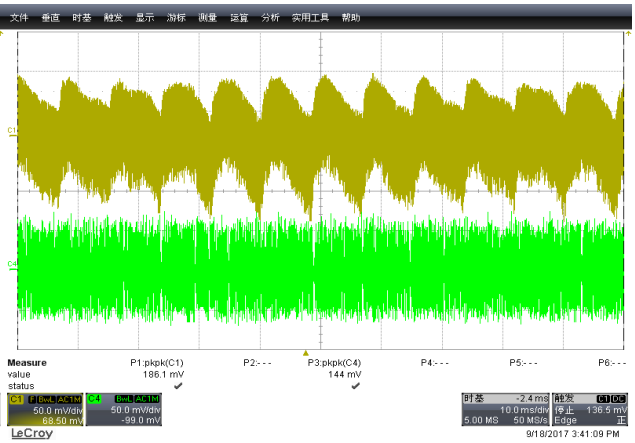


Figure 25: 264Vac / 60Hz 15V/0A ΔV=186mV

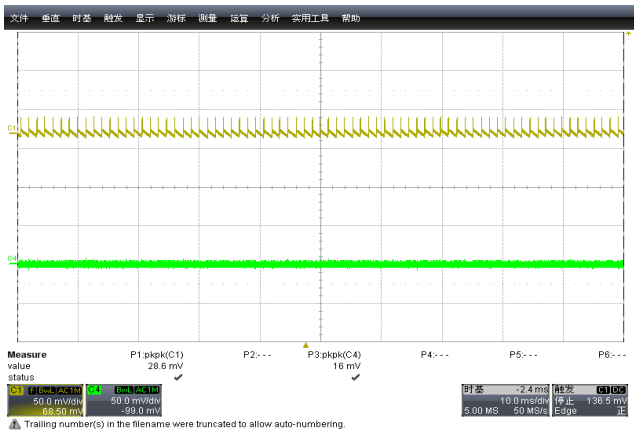


Figure 26: 90Vac/60Hz 15V/3A ΔV=28.6mV

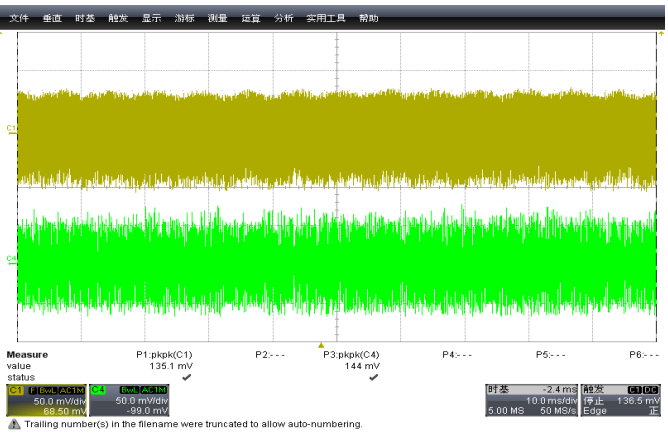


Figure 27: 264Vac / 60Hz 15V/3A ΔV=135mV

5.2.4 Dynamic load ----0A-2.4A & PD 2.0 0 ~ 3A 10mS 250mA/uS (PCB End)

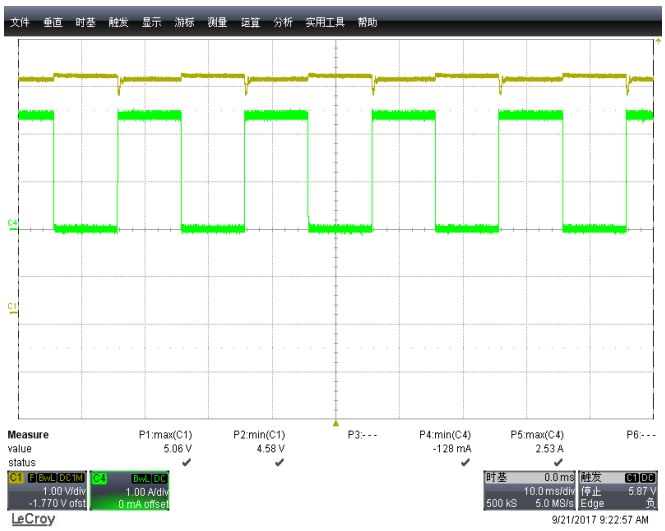


Figure 28: 90Vac / 60Hz 5V/2.4A ΔV=48mV

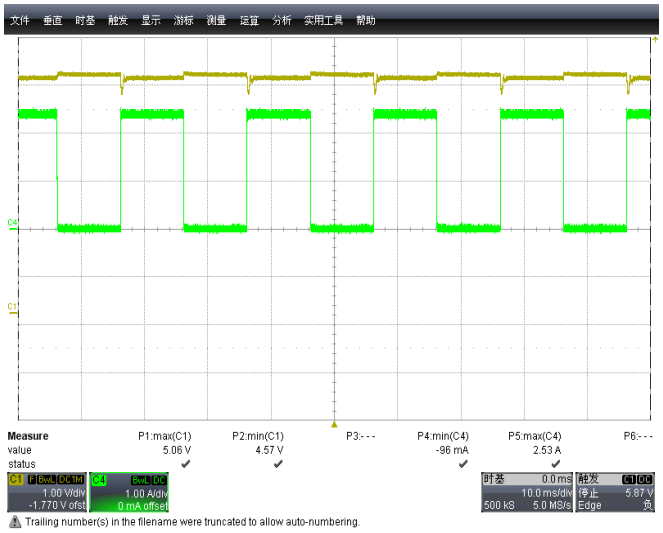


Figure 29: 264Vac / 60Hz 5V0 ~ /2.4A ΔV=49mV

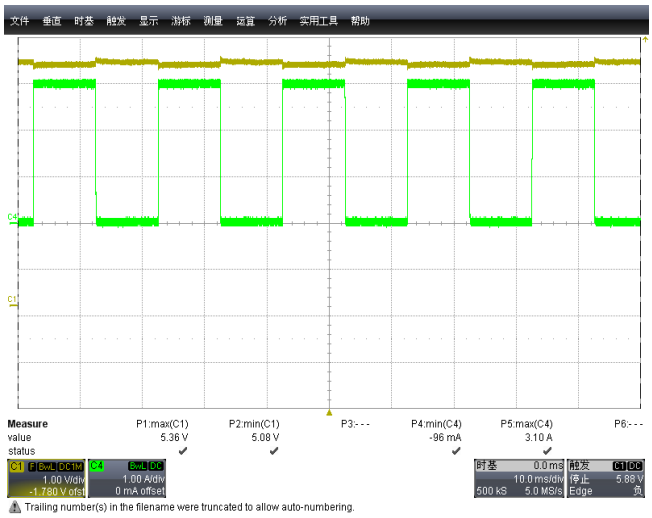


Figure 30: 90Vac / 60Hz 5V/0~3A ΔV=30mV

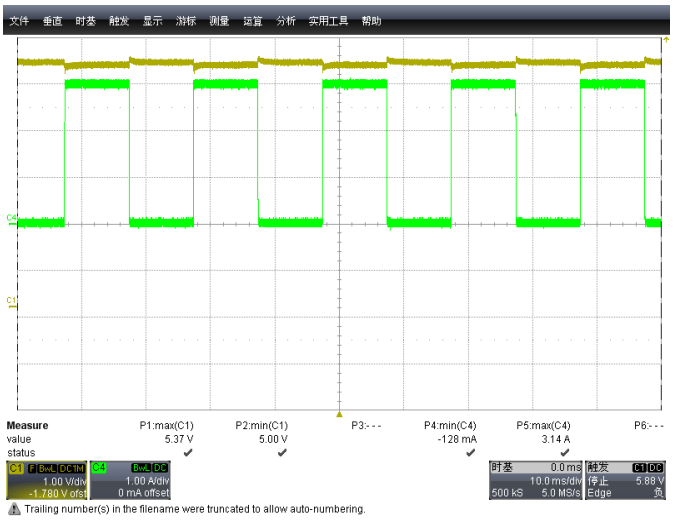


Figure 31: 264Vac / 60Hz 5V/0~3A ΔV=37mV

	Vo_ Undershoot(V)	Vo_ Overshoot(V)		Vo_Undershoot(V)	Vo_Overshoot(V)
Vin =90Vac 5V-2.4A port	4.58	5.06	Vin = 90Vac PDO PD2.0 =5V port	5.06	5.36
Vin=264Vac 5V-2.4A port	4.57	5.06	Vin = 264Vac PDO PD2.0 =5V port	5.00	5.37

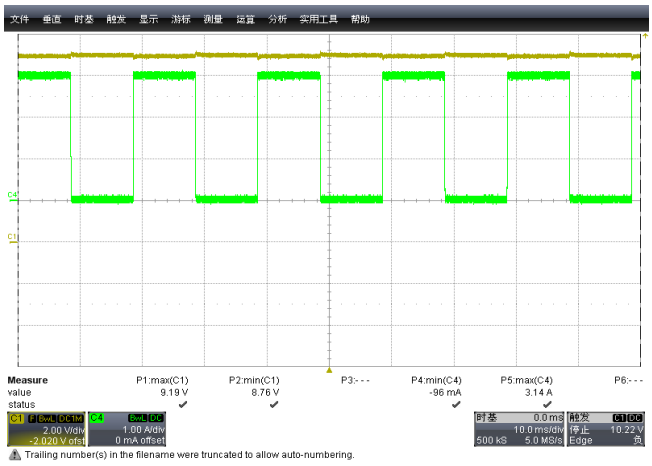


Figure 32: 90Vac / 60Hz 9V/ 0~3A ΔV=43mV

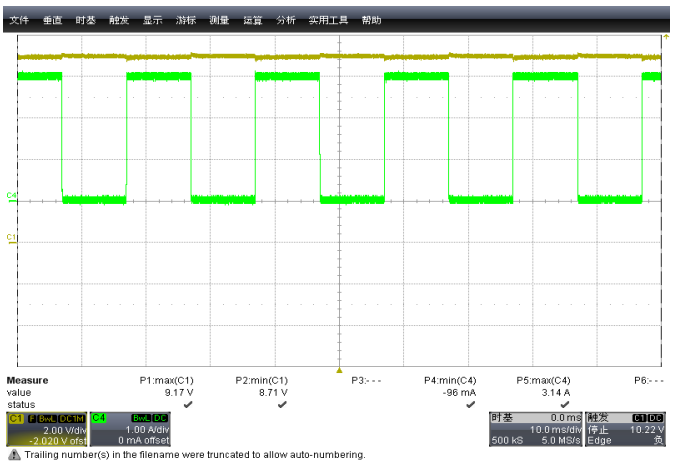


Figure 33: 264Vac / 60Hz 9V/ 0~3A ΔV=46mV

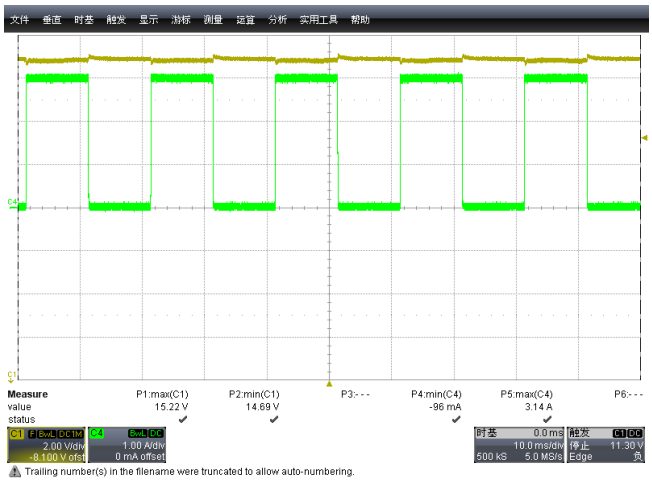


Figure 34: 90Vac / 60Hz 15V/ 0~3A ΔV=53mV

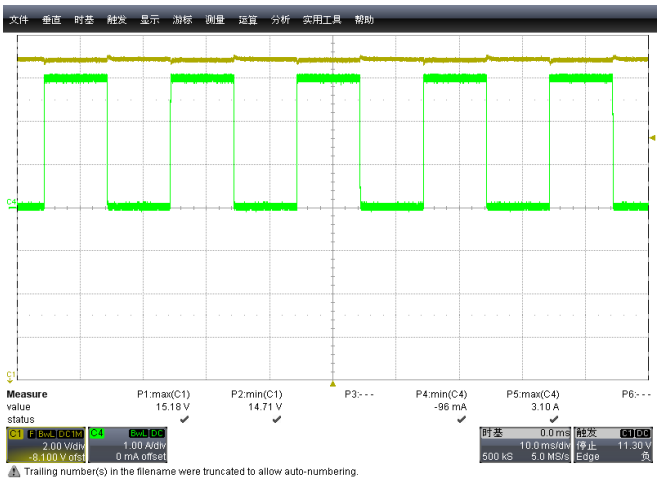


Figure 35: 264Vac / 60Hz 15V/ 0~3A ΔV=47mV

	Vo_ Undershoot(V)	Vo_ Overshoot(V)		Vo_Undershoot(V)	Vo_Overshoot(V)
Vin =90Vac PDO 9V- port	8.76	9.19	Vin = 90Vac PDO =15V port	14.69	15.22
Vin=264Vac PDO=9V port	8.71	9.17	Vin = 264Vac PDO =15V port	14.71	15.18

5.2.5 Output Voltage Transition Time from Low to High

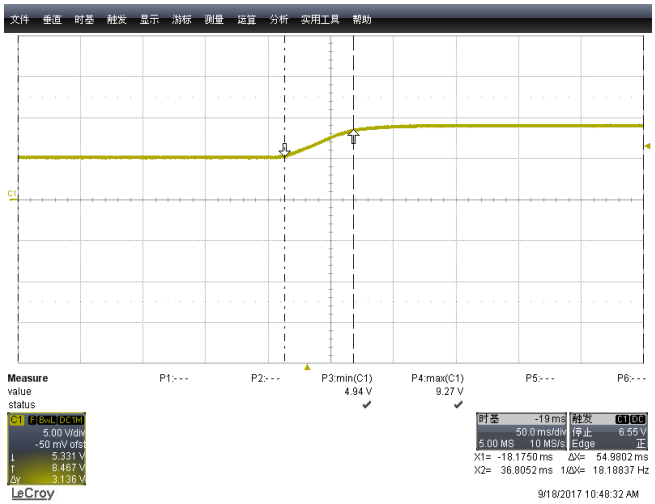


Figure 38: 5V→9V Rise Time: = 54.9ms

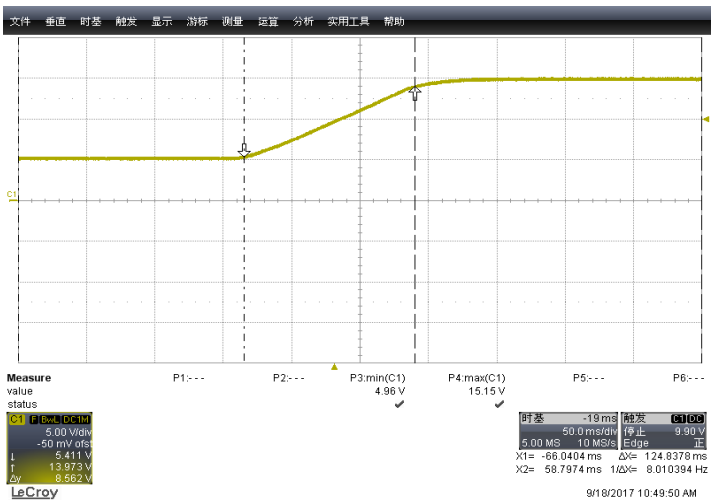


Figure 39: 5V→15V Rise Time: = 125ms

5.2.6 Output Voltage Transition Time from High to Low

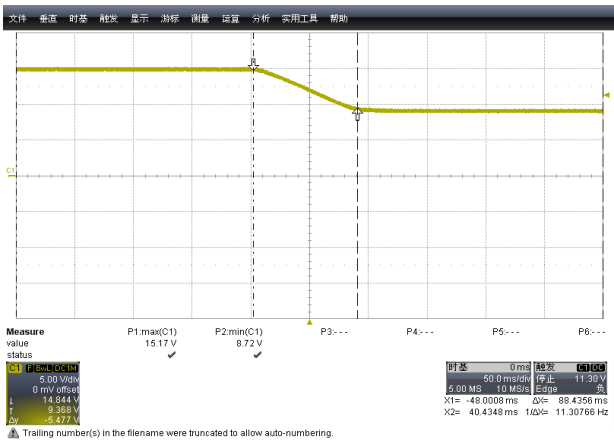


Figure 40: 15V→9V Fall Time: = 88ms

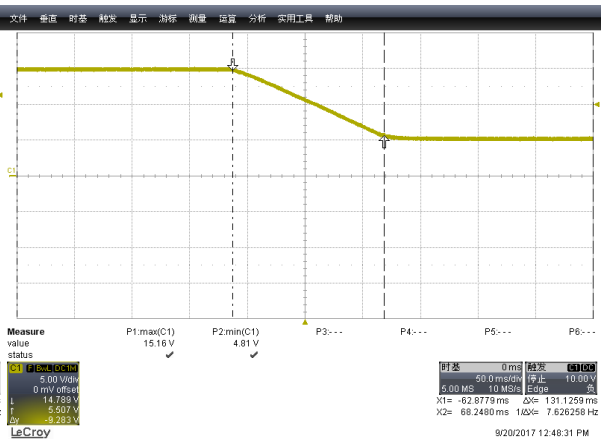


Figure 41: 15V→5.0V Fall Time: = 131ms

5.2.7 Thermal Testing

Test Condition: Vin=90V @ Full load Open Frame

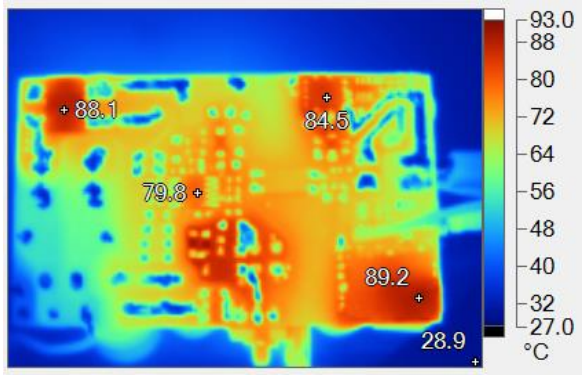


Figure 42: Bottom Suface Mount side

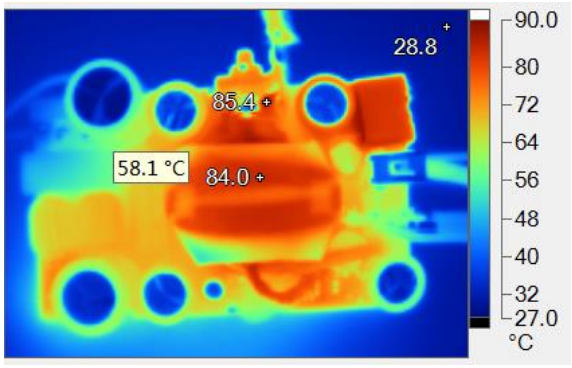


Figure 43: Top Components side

Note:

1. **Q1 must use a heatsink**
2. **AP1510 use a thermal rubber.**

Test Items	Temperature	Unit
Ambient Temp	28.8	℃
AP3108L	79.8	℃
Q1	85.4	℃
AP1510	89.2	℃
T1	84.0	℃

Q2	84.5	℃
DB1	88.1	℃

Test Condition: Vin=264Vac @ Full Load Open Frame.

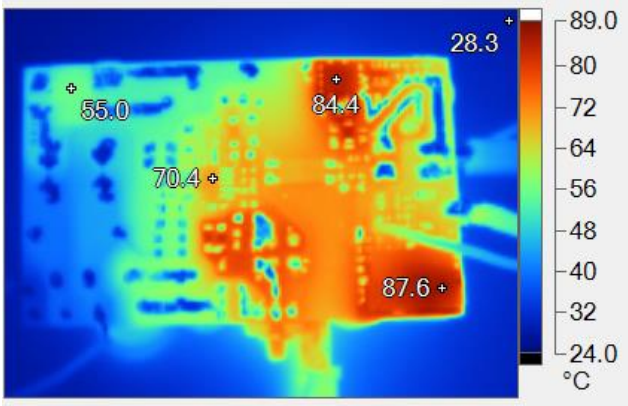


Figure 44: Bottom surface mount side

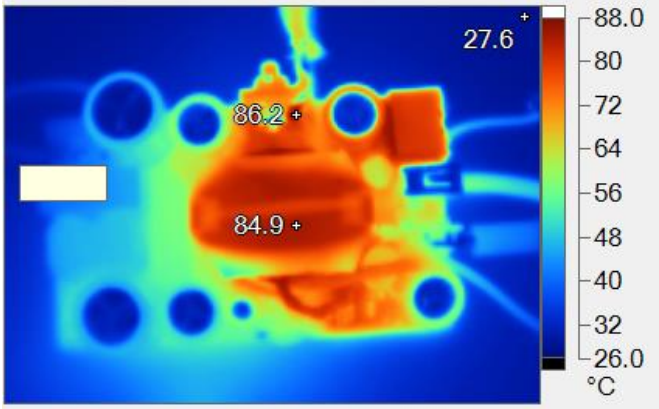


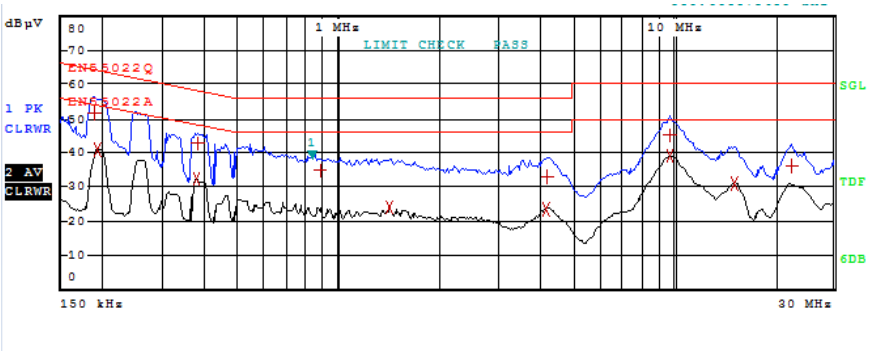
Figure 45: Top components side

Test Items	Temperature	Unit
Ambient Temp	27.6	℃
AP3108L	70.4	℃
Q1	86.2	℃
AP1510	87.6	℃
T1	84.9	℃
Q2	84.4	℃
BD1	55.0	℃

Note:

1. Q1 need to use a Heatsink for reducing heat.
2. AP1510 use a thermal rubber

5.3. EMI (CE) Testing



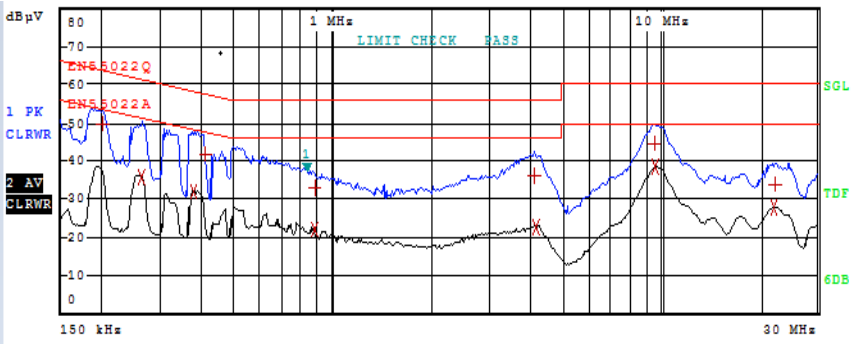
EDIT PEAK LIST (Final Measurement Results)

Trace1: EN55022Q
Trace2: EN55022A
Trace3: ---

TRACE		FREQUENCY	LEVEL dBµV	DELTA LIMIT dB
1	Quasi Peak	186.707378963 kHz	51.81	-12.36
2	Average	192.364799253 kHz	40.97	-12.96
2	Average	378.424303998 kHz	32.36	-15.94
1	Quasi Peak	382.208547038 kHz	42.75	-15.47
1	Quasi Peak	881.64914842 kHz	34.74	-21.25
2	Average	1.42141774845 MHz	24.08	-21.92
2	Average	4.12200703523 MHz	23.75	-22.24
1	Quasi Peak	4.16322710559 MHz	32.89	-23.10
1	Quasi Peak	9.69944475959 MHz	45.05	-14.94
2	Average	9.69944475959 MHz	39.29	-10.71
2	Average	15.0275202 MHz	31.19	-18.80
1	Quasi Peak	22.3739298315 MHz	36.41	-23.58

Frequency	Margin
9.69MHZ	10.71db

Figure 46: 115Vac/60Hz 15V/3A (L) at Full load



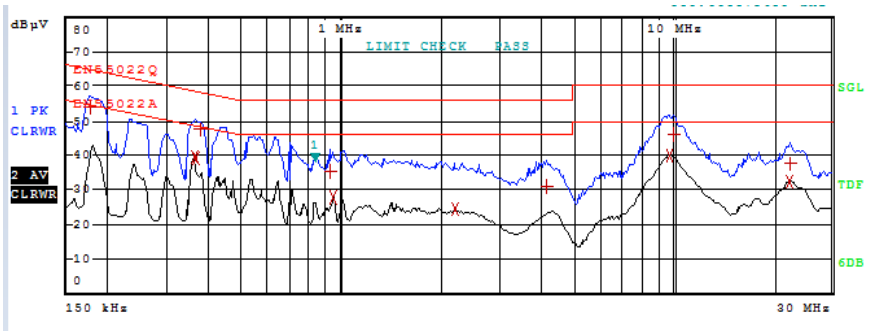
EDIT PEAK LIST (Final Measurement Results)

Trace1: EN55022Q
Trace2: EN55022A
Trace3: ---

TRACE		FREQUENCY	LEVEL dBµV	DELTA LIMIT dB
1	Quasi Peak	186.707378963 kHz	51.81	-12.36
2	Average	192.364799253 kHz	40.97	-12.96
2	Average	378.424303998 kHz	32.36	-15.94
1	Quasi Peak	382.208547038 kHz	42.75	-15.47
1	Quasi Peak	881.64914842 kHz	34.74	-21.25
2	Average	1.42141774845 MHz	24.08	-21.92
2	Average	4.12200703523 MHz	23.75	-22.24
1	Quasi Peak	4.16322710559 MHz	32.89	-23.10
1	Quasi Peak	9.69944475959 MHz	45.05	-14.94
2	Average	9.69944475959 MHz	39.29	-10.71
2	Average	15.0275202 MHz	31.19	-18.80
1	Quasi Peak	22.3739298315 MHz	36.41	-23.58

Frequency	Margin
9.69MHZ	10.71db

Figure 47: 115Vac/60Hz 15V/3A (N)



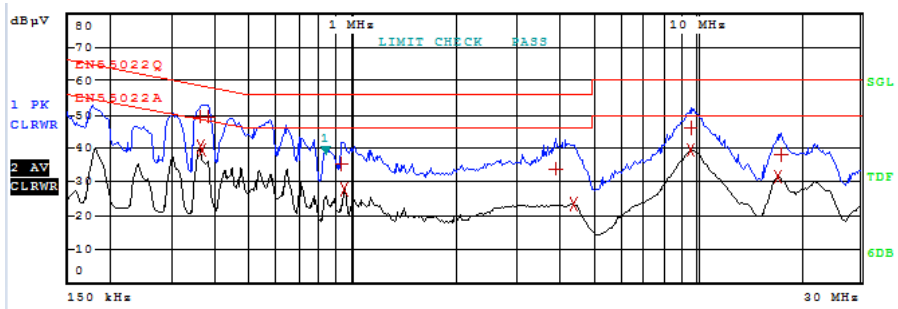
EDIT PEAK LIST (Final Measurement Results)

Trace1: EN55022Q
Trace2: EN55022A
Trace3: ---

TRACE		FREQUENCY	LEVEL dBµV	DELTA LIMIT dB
1	Quasi Peak	175.886796739 kHz	53.94	-10.73
2	Average	360.057740611 kHz	39.41	-9.30
2	Average	363.658318017 kHz	38.87	-9.76
1	Quasi Peak	378.424303998 kHz	47.70	-10.61
1	Quasi Peak	926.622115652 kHz	35.31	-20.69
2	Average	945.247220176 kHz	27.69	-18.30
2	Average	2.18042326152 MHz	24.50	-21.49
1	Quasi Peak	4.12200703523 MHz	31.13	-24.86
2	Average	9.69944475959 MHz	40.07	-9.92
1	Quasi Peak	9.99334763525 MHz	46.07	-13.92
2	Average	22.1524057738 MHz	32.47	-17.52
1	Quasi Peak	22.3739298315 MHz	37.75	-22.24

Frequency	Margin
363.65KHZ	9.63db

Figure 48: 230Vac/50Hz 15V/3A (L)



EDIT PEAK LIST (Final Measurement Results)

Trace1: EN55022Q
Trace2: EN55022A
Trace3: ---

TRACE		FREQUENCY	LEVEL dBµV	DELTA LIMIT dB
1	Quasi Peak	360.057740611 kHz	49.42	-9.30
2	Average	360.057740611 kHz	40.45	-8.27
2	Average	363.658318017 kHz	39.74	-8.90
1	Quasi Peak	382.208547038 kHz	49.48	-8.74
1	Quasi Peak	926.622115652 kHz	35.20	-20.79
2	Average	945.247220176 kHz	27.67	-18.32
1	Quasi Peak	3.88311708723 MHz	33.76	-22.23
2	Average	4.37559352882 MHz	23.61	-22.39
2	Average	9.50832737927 MHz	39.49	-10.50
1	Quasi Peak	9.60341065306 MHz	46.11	-13.88
2	Average	17.1027197612 MHz	31.61	-18.38
1	Quasi Peak	17.4464844284 MHz	38.18	-21.81

Frequency	Margin
360.05	8.27db

Figure 49: 230Vac/50Hz 15V/3A (N)

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