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Chapter 1: Summary

1.1 General Description

The 27W QC4/4+ Class A charger Evaluation Board EV2 is composed of three main parts, AP3302A offers the QR PWM switching control & working under the DCM mode with peak current controlling, APR345 is a Synchronous Rectification Controller, and the CYPD3174 is USB PD and Qualcomm® Quick Charge™ 4/4+ Controller for implementing quick charger decoder functions. Based on monitoring D+ & D- and CC1 & CC2 signals, CYPD3174 will interprets desired voltage and current setting, and then feedback those information to primary side AP3302A controller for providing well regulated voltage and current as well as related power protections.

1.2 key Features

1.2.1 System Key Features

- SSR Topology Implementation with an Opto-coupler for Accurate Step Voltage Controlling
- QC4+ Offers QC3.0/QC2.0 Backward Compliance
- QC4 supports the USB PD3.0 Function and PPS (3V-11V@20mV)
- Meet DOE6 and CoC Tier 2 Efficiency Requirements
- <75mW No-Load Standby Power

1.2.2 AP3302A Key Features

- Quasi-Resonant Operation with Valley Lock under all Lines and Load Conditions
- Switching Frequency: 22kHz-120kHz
- Non-audible-noise QR Controlling
- Soft Start Process during the Start-up Turn-on Moment
- During the burst mode operation and Low start-up operating quiescent currents, 75mW standby power can be achieved
- Built-in Jittering Frequency Function which is the EMI emission can be improved
- Internal Auto Recovery OCP, OVP, OLP, OTP Power Protection, cycle by cycle current limit, also with DC polarity & transformer short and Brown out Protection

1.2.3 APR345 Key Features

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

1.2.4 CYPD3174-24LQXIT Key Features

- with a 32-bit ARM® Cortex™-M0 processor
- Supports one USB PD3.0 Type-C port, Support QC4
- Internal Vbus load switch driver
- Internal VBUS_C_MON_DISCHARGE pin
- 3V – 24.5V operation voltage without external regulator
- On-chip OVP, OCP, UVP, and SCP
- Supports OTP through integrated ADC circuit
- ESD protection ± 8-kV Contact Discharge
- http://www.cypress.com/ccg3pa

1.3 Applications

- QC4/4+ Wall Chargers

1.4 Main Power Specifications (CV & CC Mode)

Parameter	Value
Input Voltage	90Vac to 264Vac
Input standby power	< 75mW
Main Output Vo / Io	5V/3A, 9V/3A, 12V/2.25A
	PPS 3V-5.99V 3A
Per Step Voltage	Continue Mode 200mV, 3.6V-12V
	PPS 20mV step voltage, 3V-11V
Efficiency	88.0%
Total Output Power	27W
Protections	OCP, OVP, UVP, OLP, OTP
XYZ Dimension	40 x 40 x 25mm
ROHS Compliance	Yes

1.5 Evaluation Board Picture

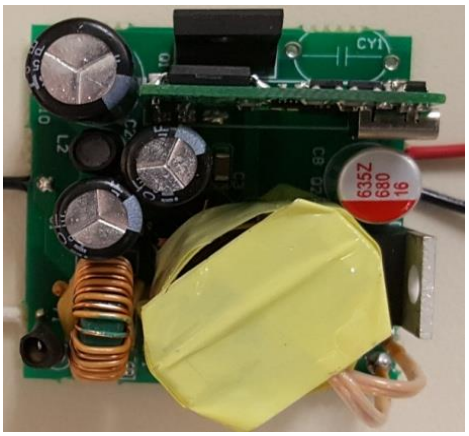


Figure 1: Top View

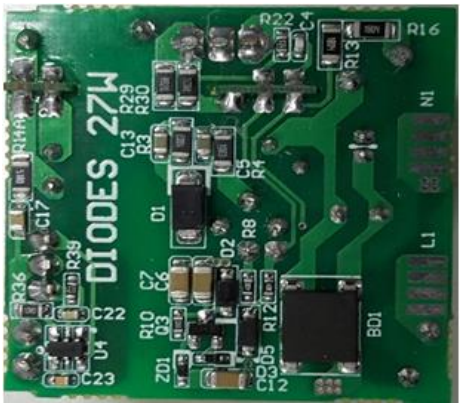


Figure 2: Bottom View

Chapter 2: Power Supply Specification

2.1 Specification and Test Results

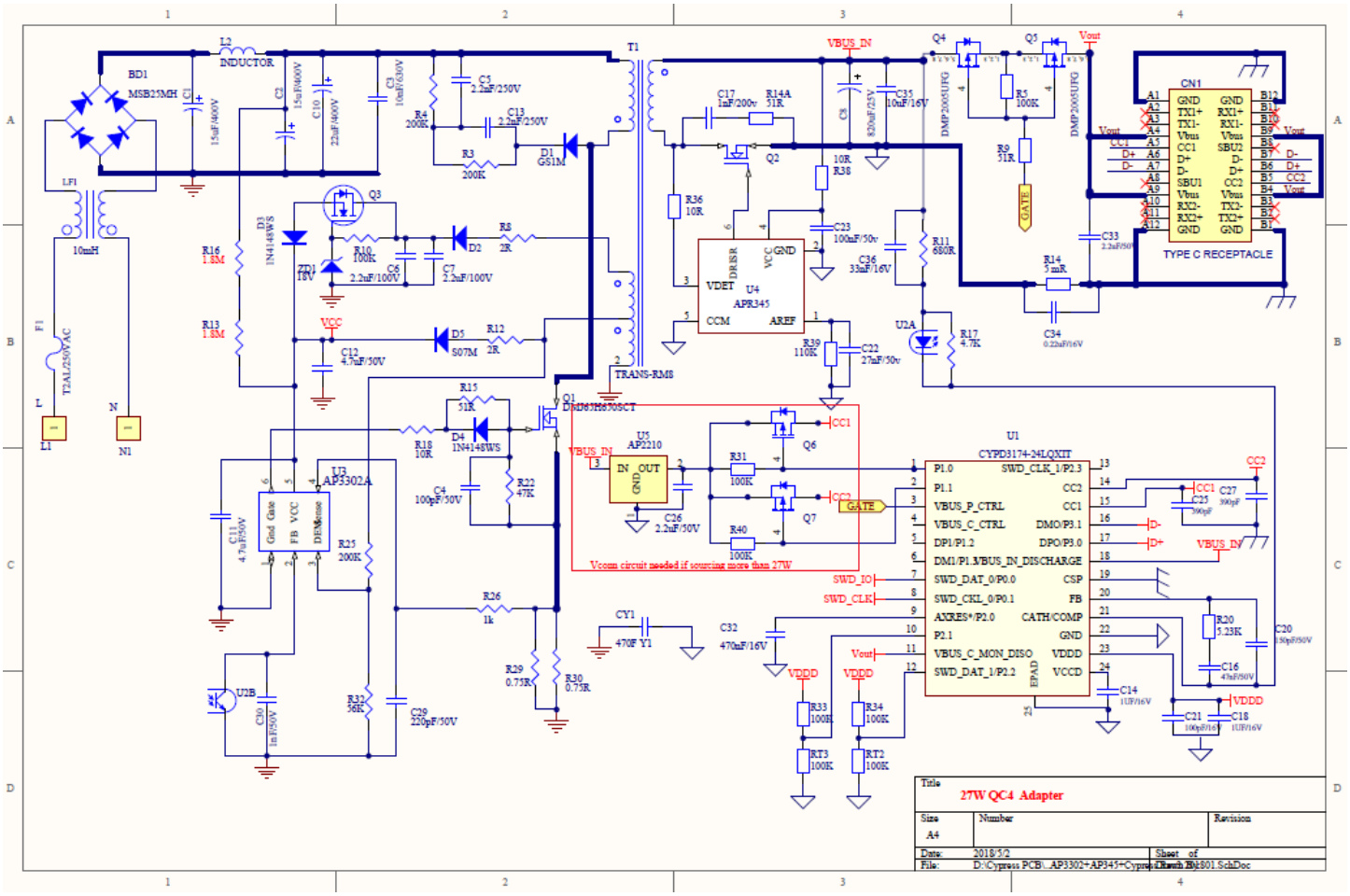
Parameter	Test conditions	Min	Nom	Max	Eff / DoE VI	Eff / Tier2	Test Summary
V_{ac} Input Voltage		90 V_{ac}	115/230	264 V_{ac}			
F_{line} Frequency		47 Hz	50/60	64 Hz			
I_{in} Input Current				0.8 A_{ac}			Pass
No load Pin	At 230Vac_in/50Hz , @ 5V, Pin < 75mW			75mW			Pass , the test result is 58mW
3V/ 3A @115Vac/230Vac Average efficiency	Board end		3V/3A		77.87%	81.34%	Pass, average efficiency is 83.6%
5V/ 3A @115Vac/230Vac Average efficiency	Board end		5V/3A		81.39%	81.84%	Pass, average efficiency is 87%
5V/ 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 89.32%
9V/ 3A @115Vac/230Vac 10% efficiency	Board end		9V/0.3A			76.62%	Pass, efficiency is 80.6%
12V/ 2.25A @115Vac/230Vac Average efficiency	Board end		12V/2.25A		86.20%	87.30%	Pass, average efficiency is 88.89%
12V/ 2.25A @115Vac/230Vac 10% efficiency	Board end		12V/0.225A			74.39%	Pass, efficiency is 81.7%

2.2 Compliance

Parameter	Test conditions	Min	Nom	Max	Eff / DoE VI	Eff / Tier2	Test Summary
Standby Power	5V Output			75mW			Pass
Output Voltage Tolerance	5V/0-3A	4.75V	5V	5.25V			Pass
Output Voltage Tolerance	9V/0-3A	8.55V	9V	9.45V			Pass
Output Voltage Tolerance	12V/0-2.25A	11.4V	12V	12.6V			Pass
PPS	3V ~ 6V		5A				With E-marked cable detecting To be update
PPS	3V ~ 11V		3A				Class A≤ 27W, @11V/2.45A
Output Connector	USB Type C						
Temperature	90Vac , 9V / 3A						Pass
Dimensions W/D/H	40mm x 40mm x 25mm						
Safety	IEC/EN/UL 60950 Standard						
EMI/EMC	FCC/EN55022 Class B						pass

Chapter 3: Schematic

3.1 EV2 Board Schematic



3.2 Main board Bill of Material

Designator	Comment	Designator	Comment	Designator	Comment
C1, C2 x 2	15uF/400V D8X18	BD1	MSB30KH	R3, R4 x 2	200K 1206
C3	10nF/630V 1206	D1	DFLR1600 SMA	**R8, 0805**	**2.2R** 0805 1/8W
C4	100pF/50V 0603	D2, D5 x 2	S1MWF SOD-123	R12	2.2R 0603
C5, C13 x 2	2.2nF/250V 0805	D3, D4 x 2	1N4148WS SOD-523	R10	100K 0805
C6, C7	2.2uF/100V 1206	F1	T2AL/250VAC	R13, R16 x 2	1.8M 1206
C8	**820uF/16V Polymer**	L2 inductor	220uH D5 x H11mm 0.9A	R14A	51R 1206
C9, C12 x 2	4.7uF/50V 1206	LF1 EMI Filter	10mH D13.5xT5.5mm 1A	R15	200ohm 0603
C10	22uF/400V D10X18	Q1	DMJ65H650SCTI ,TO220	R22	47K 0603
C17	1nF/200v 0805	Q2	DMTH10H010LCT	**R29, R30 x 2**	**0.75R 1206**
C22	22nF/50v 0603	Q3	DMN24H3D	R36, R38 x 2	10R 0805
C23	100nF/50v 0603	T1	TRANS-RM8	R39	110K 0603
CY1	470pF Y1 JN471K	U4	APR345 SOT-6		
		ZD1 SOD-523	18V Zener BZT52C18T		
					Small Board Total 43

PROJECT NAME : CCG3PA QC4.0 Adapter Diodes Board						PAC JOB NUMBER : Small daulter cut board S3		
CUSTOMER NAME : CYPRESS						Date : 4-06-2018	Rev : 3.1	
S.NO	REF DES	QTY	VALUE	JEDEC_TYPE	COMMENTS	MFR_PN	MFR	DESCRIPTION
1	CN1	1	USB_TYPE-C	USB type C	-	DX07S024JJ2R1300	JAE Electronics	CONN RCPT USB3.1 TYPEC SMD R/A
2	C11	1	4.7uF	1206C(W)	-	C1206C475K5RACTU	Kemet	CAP CER 4.7UF 50V X7R 1206
3	C14, C17, C18	2	1uF	0603C(W)	-	UMK107AB7105KA-T	Taiyo Yuden	CAP CER 1UF 50V X7R 0603
4	**C16**	1	**47nF**	0603C(W)	-	GRM188R71H473KA01D	Murata	CAP CER 0.047UF 50V X7R 0603
5	C20	1	150pF	0603C(W)	-	C0603C151K5RACTU	Kemet	CAP CER 150PF 50V X7R 0603
6	C21	1	100nF	0603C(W)	-	C0603C104K5RACTU	Kemet	CAP CER 0.1UF 50V X7R 0603
7	C26	1	2.2uF	0603C(W)	-	GRM188R61H225KE11D	Murata	CAP CER 2.2UF 50V X5R 0603
8	C24,C25,C27,C28	4	390pF	0603C(W)	-	C0603C391F5GACTU	Kemet	CAP CER 390PF 50V C0G/NP0 0603
9	C29	1	220pF	0603C(W)	-	GRM1885C1H221JA01D	Murata	CAP CER 220PF 50V C0G/NP0 0603
10	C30	1	1nF	0603C(W)	-	GRM1885C1H102JA01D	Murata	CAP CER 1000PF 50V C0G/NP0 0603
11	**C32**	1	**470nF**	0603(W)		C0603C474K5RACTU	Kemet	CAP CER 0.47UF 16V X7R 0603
12	**C33**	1	**2.2uF**	0805C(W)	-	UMK212B7225KG-T	Taiyo Yuden	CAP CER 2.2UF 16V X7R 0805
13	**C34**	1	**0.22uF/16V**	1206(W)		C1206C224K5RACTU	Kemet	CAP CER 0.22UF 16V X7R 1206
14	**C35**	1	**10uf/16V**	1206(W)		C1206C475K5RACTU	Kemet	CAP CER 10UF 16V X7R 1206
15	**C36**	1	**33nF/16V**	0603(W)		C0603C333K5RACTU	Kemet	CAP CER 33nFF 50V X7R 0603
15	D4	1	1N4148WS	SMD-(SOD-523)	-	1N4148WS-7-F	Diodes Inc	DIODE GEN PURP 75V 150MA SOD323
16	Q4,Q5	2	DMP2007UFG-7	INF-PG-TSDSON-8-1_V	-	DMP2007UFG-7	Diodes Inc	MOSFET P-CH 20V 18A PWRDI3333-8
17	Q6,Q7	2	DMP3068L-7	sot-23	-	DMP3068L-7	Diodes Inc	MOSFET N-CH 30V 4A SOT23-3
18	R31,R33,R34,R40,RT2,RT3	6	100K	0603(W)	-	RC0603JR-07100KL	Yageo	RES SMD 100K OHM 5% 1/10W 0603
19	R5	1	100K	0402(W)	-	RC0402FR-07100KL	Yageo	RES SMD 100K OHM 1% 1/16W 0402
20	R9	1	51R	0603(W)	-	RC0603FR-0751RL	Yageo	RES SMD 51 OHM 1% 1/10W 0603
21	R11	1	**680ohm**	0603(W)		RC0603FR-07680RL	YAGeo	RES SMD 680 OHM 1% 1/10W 0603
22	R14	1	5mR	1206(W)	-	CSR1206-0R005F1	Riedon	RES SMD 0.005 OHM 1% 1W 1206
23	R15	1	51R	0805(W)	-	RC0805JR-0751RL	Yageo	RES SMD 51 OHM 5% 1/8W 0805
24	R17	1	4.7K	0603(W)	-	RC0603FR-074K7L	Yageo	RES SMD 4.7K OHM 1% 1/10W 0603
25	R18	1	10R	0805(W)	-	RC0805FR-0710RL	Yageo	RES SMD 10 OHM 1% 1/8W 0805
26	R20	1	5.23K	0603(W)	-	RC0603FR-075K23L	Yageo	RES SMD 5.23K OHM 1% 1/10W 0603
27	R25	1	200K	0805(W)	-	RC0805JR-07200KL	Yageo	RES SMD 200K OHM 5% 1/8W 0805
28	R32	1	56K	0603(W)	-	RC0603FR-0756KL	Yageo	RES SMD 56K OHM 1% 1/10W 0603
29	R26	1	1K	0603(W)	-	RC0603FR-071KL	Yageo	RES SMD 1K OHM 1% 1/10W 0603
30	R21A,R21B	2	100R	0603(W)	-	RC0603FR-07100rL	Yageo	RES SMD 100 OHM 1% 1/10W 0603
31	U1	1	CYPD3174-24LQXIT	TQFN24_4X4	Customer Supplie	CYPD3174-24LQXIT	Cypress	USB Type C Port Controller
32	U2	1	VOL617A-3X001T	SO-4(P10) - photocoupler	-	VOL617A-3X001T	Vishay Semi	OPTOISOLATOR 5KV TRANS 4-LSOP
33	U3	1	AP3302A	SOT-23-6	-	AP3302AK6TR-G1	Diodes Inc	IC OFFLINE CONV FLYBACK SOT26
34	U5	1	AP2210	sot-23-1	-	AP2210N-3.3TRG1	Diodes Inco	IC REG LINEAR 3.3V 300MA SOT23-3

3.3 Schematics Description

3.3.1 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 is a common mode chock for the common mode noise suppression filleting because of the each coil with large impedance. The BD1 is rectifier, and basically converts alternating current & voltage into direct current & voltage. The C1, L2, C2, C3 & C10 are composted of the Pi filter for filtering the differential switching noise back to AC source.

3.3.2 AP3302A PWM Controller

The AP3302A PWM controller U1 and Opto-coupler U2 as well Q1 are the power converting core components. The R13 & R16 two resistors will provide start-up voltage and current to AP3302A Vcc Pin 5 during starting up moment. Subsequent VCC voltage will be provided by voltage feedback from middle-tapped auxiliary winding through two options, when the output Vbus voltage is around 3V the Vcc will be provided by high side wending & through R8-D2-Q3-D3-ZD1 circuit and when the output Vbus voltage is around 12V that the Vcc will be provided by thought the low side wending & through the R12-D5, or depending on desired output voltage as well ZD1 zener voltage chosen. This design is to accommodate with the required wide voltage range to support various protocols (including QC 4/4+ & USB PD Programmable Power Supply PPS), from 5V, 9V,12V & 3V to 11V.

Based on the feedback of secondary side (Pin CATH of CYPD3174 decoder) to primary side (FB pin of AP3302A) through Opto-coupler U2, AP3302A will switch ON and Off Q1 to regulate desired voltage and current on the secondary side.

3.3.3 APR345 Synchronous Rectification (SR) MOSFET Driver

The APR345 operates in DCM mode in this design and drives the Q2 MOSFET based on the secondary side transformer on/off 's duty cycle. As the power loss with the APR345-controlled MOSFET Q2 is less than Schottky Diodes, the total efficiency can be improved.

3.3.4 CYPD3174 QC4/4+ Decoder & Protection on /off P MOSFET and Interface to Power Devices

The following pins provide critical protocol decoding and regulation functions in CYPD3174:

1) **CC1 & CC2 (Pin 15, 14)**: 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) **D+ & D- (Pin 17, 16):** While defined under USB PD for data transfer only, D+ and D- are used in QC4+ to provide voltage information and backward compatibility with QC2.0 and QC3.0 devices.
3) **Constant Voltage (CV)**: The CV is implemented by sensing VCC (pin 18) via resistor divider and comparing with internal reference voltage to generate a CV compensation signal on the CATH pin (pin 21). The output voltages can be adjusted by firmware programming.
4) **Constant Current (CC)**: The CC is implemented by sensing the current sense resistor (R14, 5mΩ) and current sense amplifier, then comparing with internal programmable reference voltage setting to generate a compensation signal on CATH pin (pin 21)
5) **Loop Compensation:** C20, R20 & C16 form the voltage loop compensation circuit.
6) **CATH (Pin 21):** It is the key interface link from secondary decoder (CYPD3174) to primary regulation circuit (AP3302A). It is connected to Opto-coupler U2A cath for feedback information based all sensed CC1 & CC2, D+ & D- voltage status for getting desired Vbus voltage & current.
7) **GATE Driver (Pin 3) to PMOSFET Gate**: The pin is used to turn on / off Vbus load switch (Q4 & Q5) to enable/disable voltage output to the Vbus. An extra PMOSFET (Q5) is required to prevent reverse current from the attached battery source.
8) **Vconn Power to support E-marker Type C cable by using U5, Q6 and Q7:** There is a Vconn power circuit provided thought CC1 & CC2 for E-marker cable detecting, Q6 & Q7 on/off are controlled by CYPD3174 pin 1 & pin 2.

Chapter 4: Evaluation Board Connections

4.1 Quick Start Guide Before Connection

1) Before starting the QC4/4+ 27W EVB test, the end user needs to prepare the following tool, software and manuals.

   For details, please contact Cypress Semiconductor local sales for further information.

   - QC2.0 & 3.0 Test Kit: https://detail.1688.com/offer/534013607443.html
   - Software: GUI USBCEE Advanced USB PD Tester V1.2 from USBCEE (available with purchase of Cypress Test kit).
   - Firmware version in CYPD3174-24LQXQIT decoder IC: CYPD3174-24LQXQ(FW_1503 or above)
   - To buy a USB-C POWER ADAPTER PROGRAMMER AND TESTER (blue color) - https://www.usbcee.com/products/1

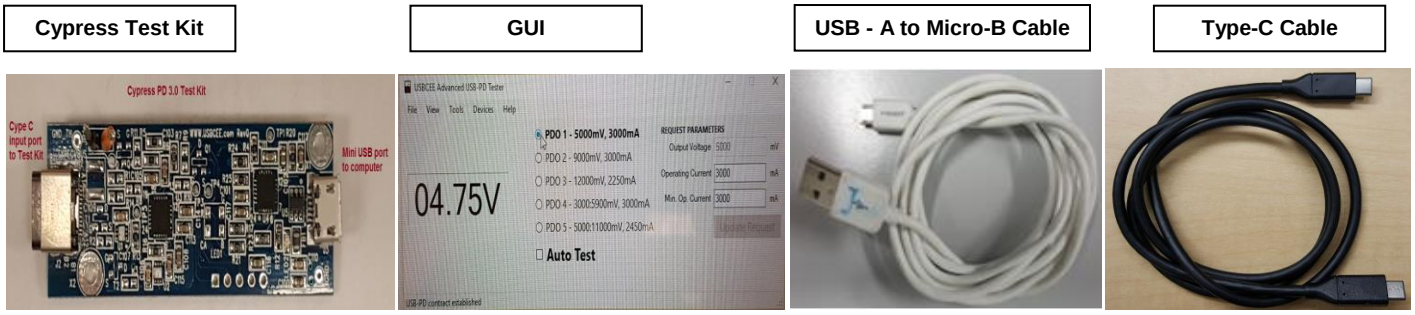


Figure 4: Cypress Items: Test Kit / PC Test GUI Software /Test Cables

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.

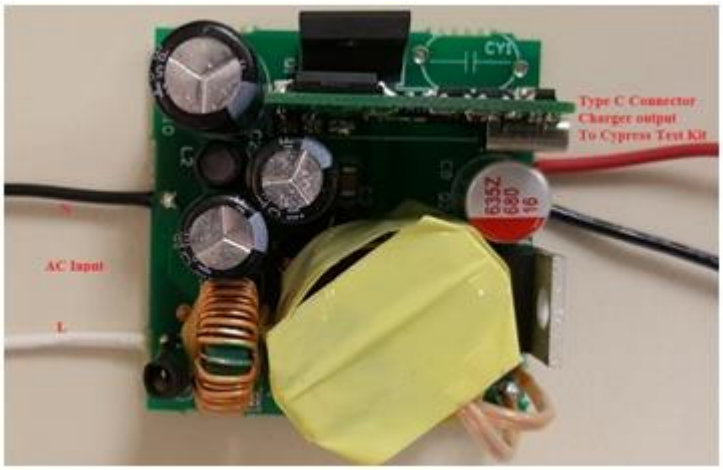


Figure 5: The Sample Board Input & Output Location

5) Use a type-C cable for the connection between EV2 board to Cypress'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 27W QC4 unit's VBUS & GND holes.

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

4.2 System Connection Setup

4.2.1 Connection with E-Load

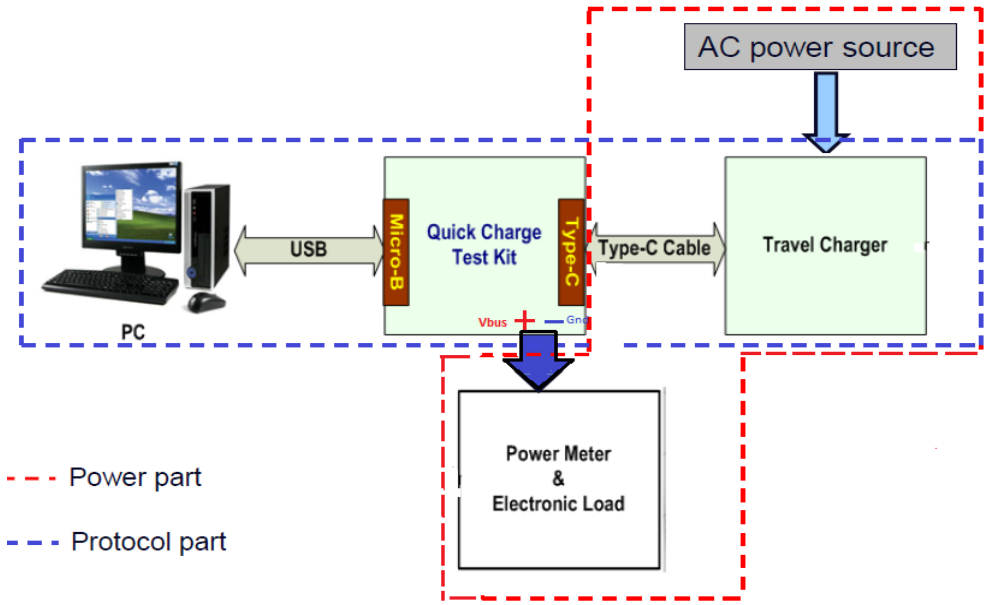


Figure 6: Diagram of Connections in the Sample Board

4.2.2 Cypress Test Kit

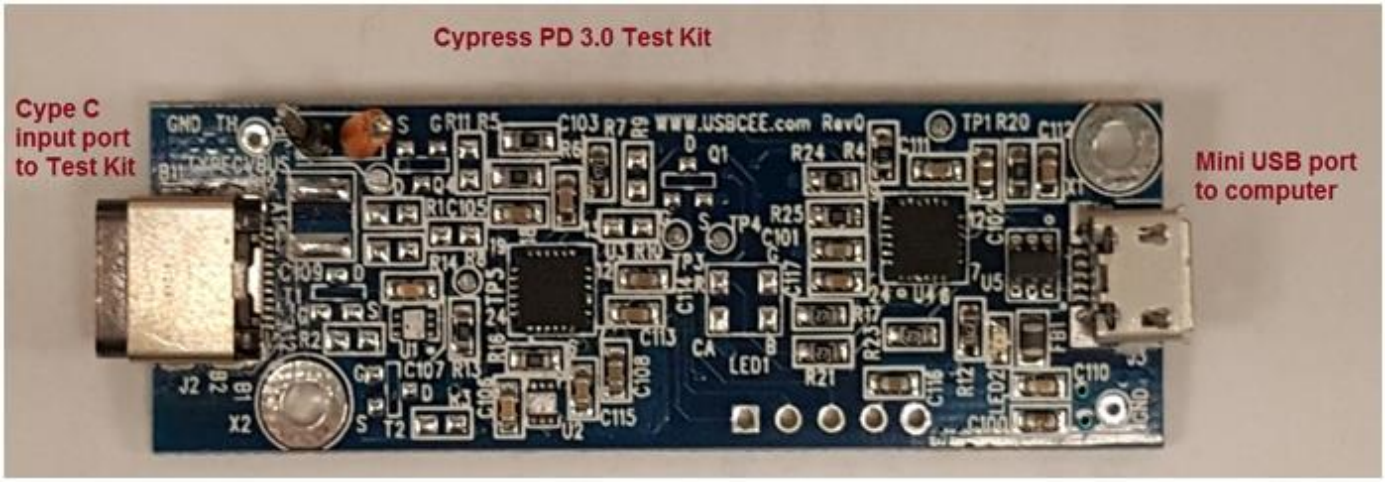


Figure 7: The Test Kit Input & Output and E-load Connections

4.2.3 The sample board Input & Output Wires Connection and QC2.0/3.0 Emulator connection

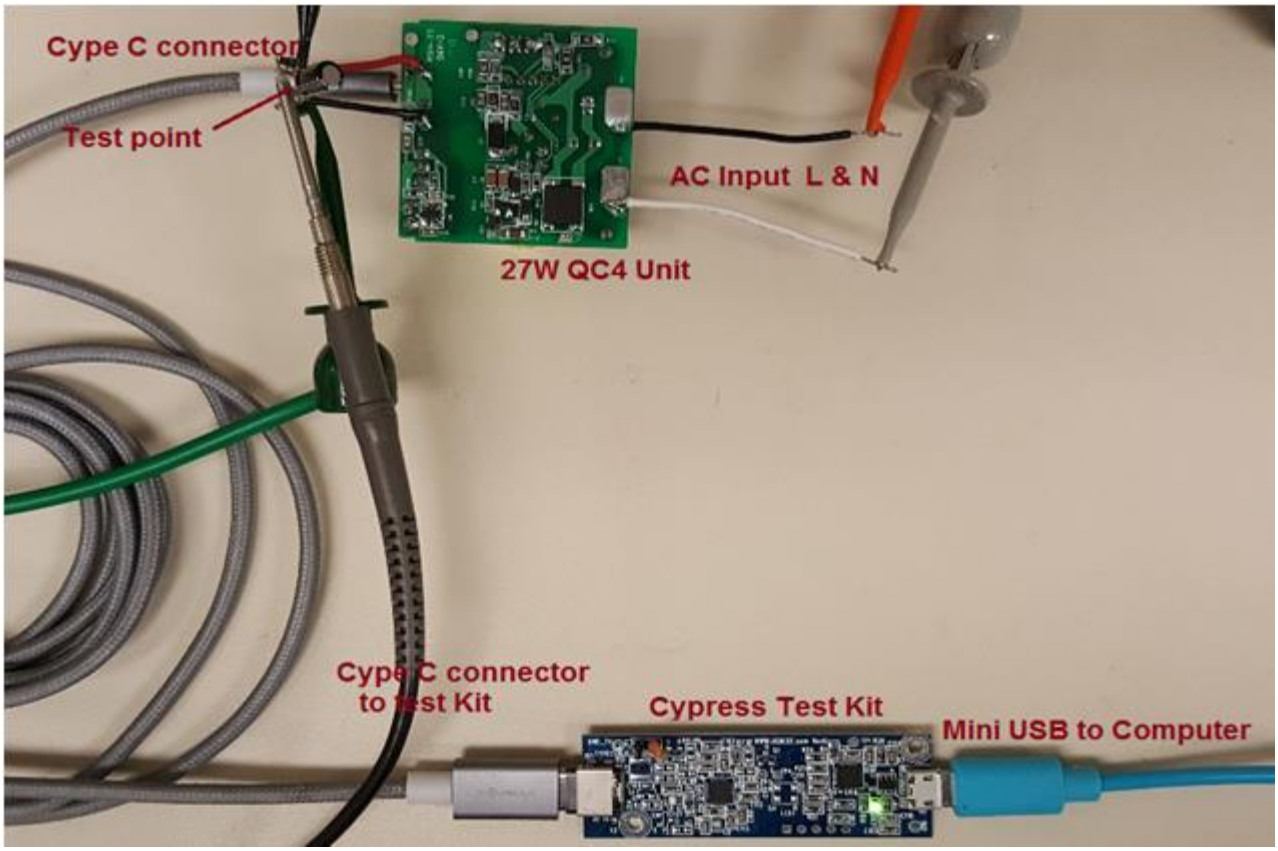


Figure 8: Wire Connection of 27W QC4/4+ EVB to Test Kit and PC Computer

Or using the QC2.0/QC3.0 emulator test Kit to testing the QC2.0 & QC3.0 functions, see the connection the between testing sample board to DC load by mean of a USB-C to USB A converting cable.

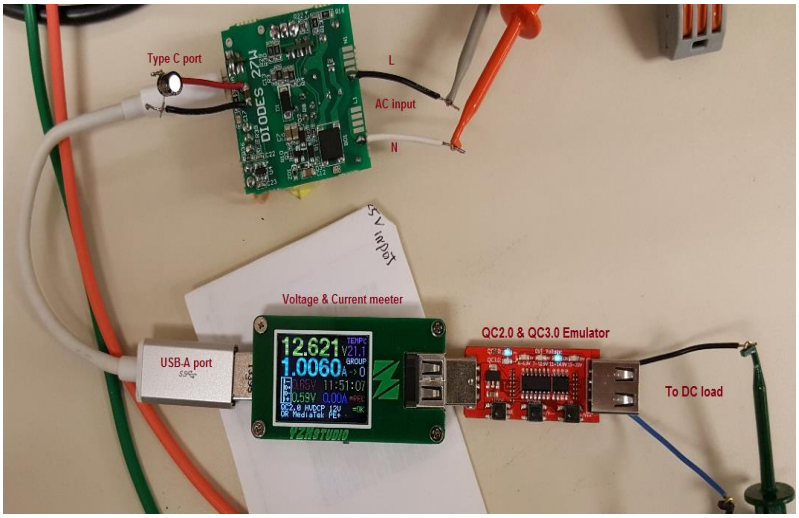


Figure 9: Wire Connection of 27W QC4/4+ EVB to QC2.0/3.0 Test Kit

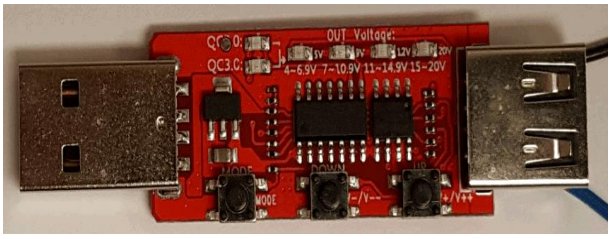


Figure 10: QC2.0/3.0 Emulator Test Kit

Chapter 5: Testing the Evaluation Board

5.1 Input & Output Characteristics

5.1.1 Input Standby Power

@No Load +5VDC

Vin(Vac)	Fin (Hz)	Vin(V)	Iin (mA)	PF	**Pin(mW)**	Vout(V)	Iout(A)	Pout(W)	Pd(W)
90	47	89.97	3.4069	0.0963	**29.52**	*	*	*	*
115	60	115.03	3.2842	0.0791	**29.88**	*	*	*	*
230	50	230.15	2.9293	0.0634	**42.6**	*	*	*	*
264	63	264.26	2.842	0.0632	**47.4**	*	*	*	*

5.1.2 Input Power Efficiency at Different AC Line Input Voltage

5.1.3 Average Efficiency at Different Loading

Aerage efficiency(+12VDC)

Vin (Vac)	Fin (Hz)	Vin(V)	Iin (A)	PF	Pin (W)	Vout(V)	Iout (A)	Pout (W)	Pd(W)	Eff(%)	Average EFF(%)
115	60	114.98	0.47774	0.5391	29.611	**11.7884**	2.2512	26.538	3.0729539	89.62%	89.06%
115	60	114.99	0.37842	0.5123	22.293	**11.802**	1.6878	19.9194	2.3735844	89.35%	
115	60	115.00	0.2710	0.4779	14.891	**11.8073**	1.1252	13.2856	1.605426	89.22%	
115	60	115.02	0.15207	0.4315	7.548	**11.8163**	0.5623	6.64431	0.9036945	88.03%	
230	50	230.08	0.31255	0.4096	29.46	**11.7882**	2.2512	26.5376	2.9224042	90.08%	88.89%
230	50	230.13	0.24711	0.3912	22.24	**11.801**	1.6878	19.9177	2.3222722	89.56%	
230	50	230.14	0.18125	0.3583	14.94	**11.8084**	1.1252	13.2868	1.6531883	88.93%	
230	50	230.15	0.09334	0.3559	7.64	**11.8186**	0.5623	6.6456	0.9944012	86.98%	

Aerage efficiency(+9VDC)

Vin (Vac)	Fin (Hz)	Vin(V)	Iin (A)	PF	Pin (W)	Vout(V)	Iout (A)	Pout (W)	Pd(W)	Eff(%)	Average EFF(%)
115	60	114.99	0.49156	0.5393	30.483	**9.0424**	3.0006	27.1326	3.3503746	89.01%	89.32%
115	60	114.98	0.39013	0.5078	22.811	**9.0628**	2.2512	20.4022	2.4088246	89.44%	
115	60	115.00	0.2920	0.4520	15.175	**9.0732**	1.5001	13.6107	1.5642927	89.69%	
115	60	115.01	0.17458	0.3807	7.645	**9.0855**	0.75	6.81413	0.830875	89.13%	
230	50	230.16	0.33052	0.3977	30.26	**9.0411**	3.0006	27.1287	3.1312753	89.65%	88.99%
230	50	230.12	0.2628	0.3766	22.77	**9.0621**	2.2512	20.4006	2.3694005	89.59%	
230	50	230.14	0.19534	0.3402	15.29	**9.0732**	1.5001	13.6107	1.6792927	89.02%	
230	50	230.07	0.10983	0.3077	7.77	**9.0842**	0.75	6.81315	0.95685	87.69%	

Aerage efficiency(+5VDC)

Vin (Vac)	Fin (Hz)	Vin(V)	Iin (A)	PF	Pin (W)	**Vout(V)**	Iout (A)	Pout (W)	Pd(W)	Eff(%)	Average EFF(%)
115	60	115.00	0.32056	0.4563	16.82	**4.9059**	3.0006	14.7206	2.0993565	87.52%	87.53%
115	60	115.00	0.23996	0.461	12.719	**4.9257**	2.2512	11.0887	1.6302642	87.18%	
115	60	115.01	0.1888	0.3886	8.438	**4.9398**	1.5001	7.41019	1.027806	87.82%	
115	60	115.01	0.10662	0.3458	4.24	**4.9532**	0.75	3.7149	0.5251	87.62%	
230	50	230.12	0.21543	0.3435	17.03	**4.9058**	3.0006	14.7203	2.3096565	86.44%	86.24%
230	50	230.14	0.17082	0.3247	12.763	**4.9253**	2.2512	11.0878	1.6751646	86.87%	
230	50	230.11	0.12056	0.3091	8.585	**4.9393**	1.5001	7.40944	1.1755561	86.31%	
230	50	230.04	0.06462	0.2929	4.353	**4.9526**	0.75	3.71445	0.63855	85.33%	

Aerage efficiency(+3.0VDC)

Vin (Vac)	Fin (Hz)	Vin(V)	Iin (A)	PF	Pin (W)	Vout(V)	Iout (A)	Pout (W)	Pd(W)	Eff(%)	Average EFF(%)
115	60	115.01	0.24034	0.42	10.75	**3.028**	3.0006	9.08582	1.6641832	84.52%	**84.28%**
115	60	115.01	0.19542	0.3872	8.067	**3.026**	2.2512	6.81213	1.2548688	84.44%	
115	60	115.02	0.1422	0.3559	5.386	**3.02**	1.5001	4.5303	0.855698	84.11%	
115	60	115.02	0.07583	0.3339	2.695	**3.02**	0.75	2.265	0.43	84.04%	
230	50	230.09	0.16144	0.3194	10.872	**3.03**	3.0006	9.09182	1.780182	83.63%	**82.77%**
230	50	230.14	0.1251	0.309	8.223	**3.027**	2.2512	6.81438	1.4086176	82.87%	
230	50	230.14	0.08654	0.3007	5.48	**3.02**	1.5001	4.5303	0.949698	82.67%	
230	50	230.05	0.04682	0.2823	2.756	**3.01**	0.75	2.2575	0.4985	81.91%	

5.2 QC4/4+ & PPS Compatible Mode Testing

5.2.1 QC 2.0 Mode Testing by using the QC2.0/3.0 Emulator board

QC2.0 test: to click the emulator board "+ V" button for selecting desired the charger output voltage @ **5V/ 9V/ 12V**

4.977V

9.023V

12.62V

5.2.2. QC 3.0 Continuous Mode 200mV/Step Testing

Enable click "+" or "-" to transit one rising pulses or falling pulses to do the 200mV increment/decrement per step.

5.1988V

5.3994V

5.5999V

5.7984V

5.2.3 QC4/4+ CV Accuracy 20mV/Step Testing (@ PPS Support 3V~5.99V & 3V~11V)

Go to PPS 3V ~5.99V 3A push + once for getting 20mV step voltage up & push - botton for -20mV step down

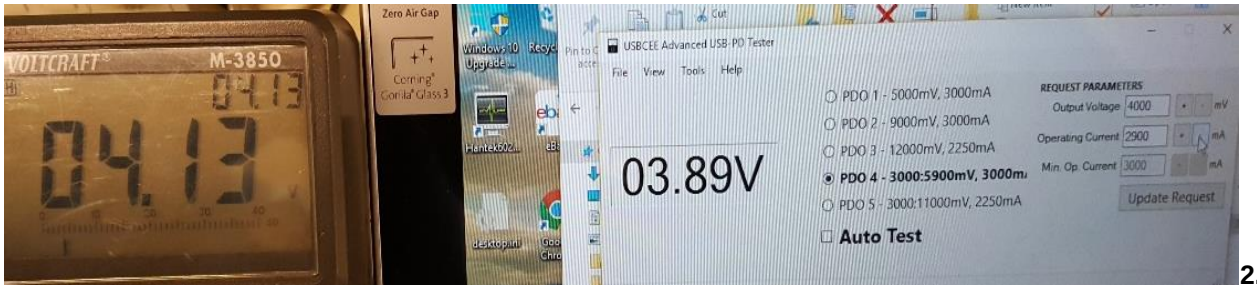
5.2.4 PPS 3V ~ 11V voltage arrange & current arrange 3A & @11V< 2.454A

6.130V to 6.150V with 20mV step

Set to 7.100V **Set to 11.120V**

5.2.5 QC4/4+ CC Accuracy 50mA/Step Testing (PPS Support)

To push current '+' botton,the +50mA step up and push current '-' botton, the -50mA step down.



2.90A

2.95A

5.2.6 CC Mode current limitation function testing by using E-Load set at CR mode

To PPS Mode set 5V-1A & 5V-3A and then increase the curreent (by reducing R) to see the CC-CV cuve

PPS at 5.0V CC mode current limit is set at 1A				
Pin	Vo	CR = Ω	converted	CC limited
5.63w	**4.93V**	5.0Ω	1A	**1A**
5.81w	**4.48V**	4.00Ω	1.25A	**1.10A**
4.49w	**3.38V**	3.00Ω	1.67A	**1.103A**
4.06w	**2.86V**	2.50Ω	2A	**1.112A**

PPS at 5.0V CC mode current is set at 3A				
Pin	Vo	CR = Ω	converted	CC limited
15.4W	**4.75V**	1.666Ω	3A	3A
17.4W	**4.71V**	1.428Ω	3.5A	3.04A
17.9W	**4.48V**	1.25Ω	4.0A	3.25A
15.1W	**3.66V**	1.10Ω	5.0A	3.248A

To PPS Mode set 9V-1A & 9V-3A and then increase the curreent (by reducing R) to see the CC-CV cuve

PPS at 9.0V CC mode current limit is set at 1A				
Pin	Vo	CR = Ω	converted	CC limited
10.31w	**9.00V**	9.0Ω	1A	1A
9.82w	**7.78V**	7.00Ω	1.285A	1.102A
7.78w	**6.09V**	5.50Ω	1.64A	1.102A
6.47w	**5.02V**	4.5Ω	2.00A	1.103A

PPS at 9.0V CC mode current is set at 3A				
Pin	Vo	CR = Ω	converted	CC limited
29.2W	**8.84V**	3.0Ω	3A	2.95A
32.7W	**8.59V**	2.57Ω	3.5A	3.25A
29.1W	**7.60V**	2.25Ω	4A	3.25A

To PPS Mode set 11V-1A & 11V-2.454A and then increase the curreent (by reducing R) to see the CC-CV cuve

PPS at 11V CC mode current is set at 1A				
Pin	Vo	CR = Ω	converted	CC limited
12.46w	**10.98V**	11.0Ω	1A	1A
11.20w	**9.88V**	9.00Ω	1.375A	1.1A
9.84w	**7.79V**	7.00Ω	1.571A	1.104A
7.81w	**6.11V**	5.5Ω	2.00A	1.105A

PPS at 11V CC mode current is set at 2.25A				
Pin	Vo	CR = Ω	converted	CC limited
30.1w	**10.95V**	4.48Ω	2.454A	2.41A
29.65w	**9.82V**	3.66Ω	3A	2.624A
25.75w	**8.49V**	3.143Ω	3.5A	2.623A
22.65w	**7.42V**	2.75Ω	4A	2.622A

5.3 Key Performance Waveforms

5.3.1 27W QC4/4+ System Start-up Time & Hold-up Time

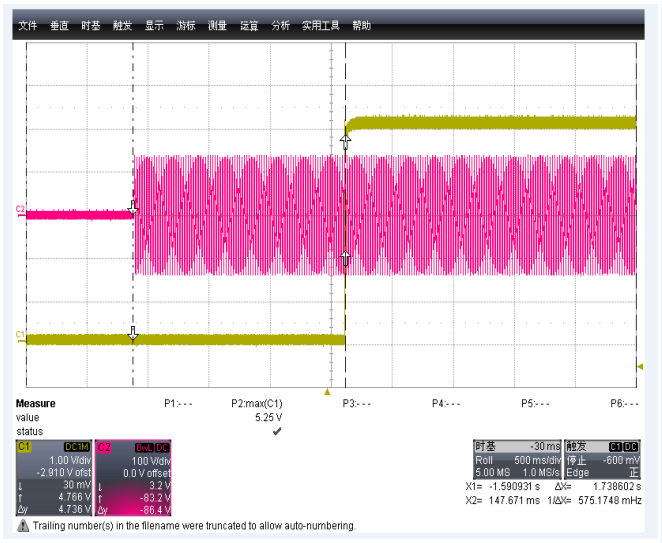


Figure 11: 27w QC4/4+ turn on time 1.74s FL at 90Vac

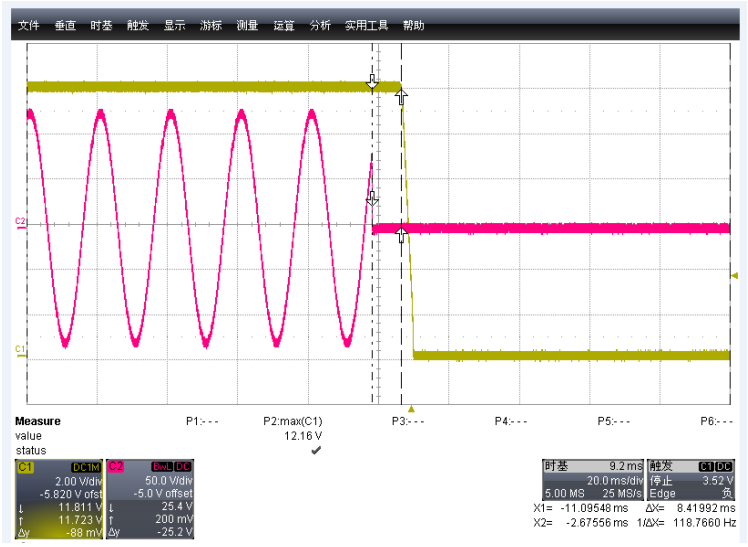


Figure 12: 27w QC4/4+ hold time 8.42ms at 12V- 2.25A, at 90Vac

5.3.2 Q1 /Q2 Main Switching Voltage MOSFET Stress on at 12V/ 2.25A Loading

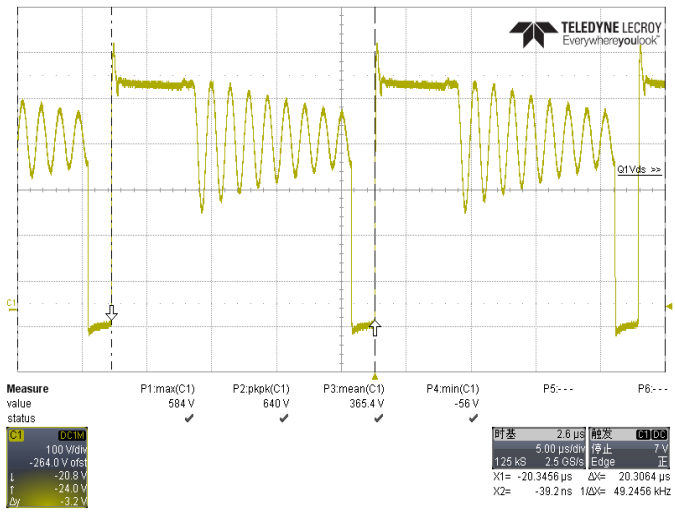


Figure 13: 264Vac/50Hz Primary Q1 Vds(max)= 584Vp-p

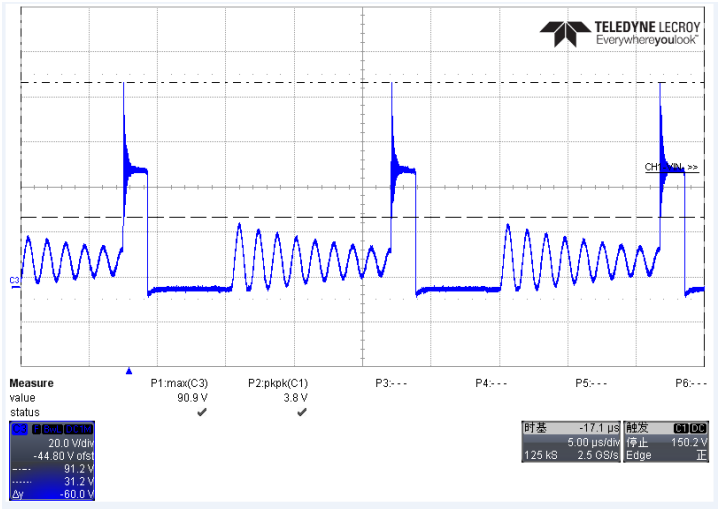


Figure 14: 264Vac/50Hz Secondary Q2 Vds(max) = 90.9Vp-p

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

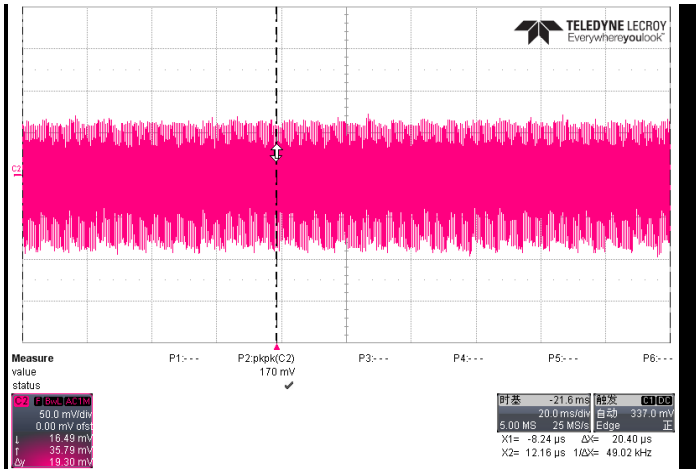


Figure 15: The Ripple at 90Vac/60Hz ΔV=170mV 5V/3A

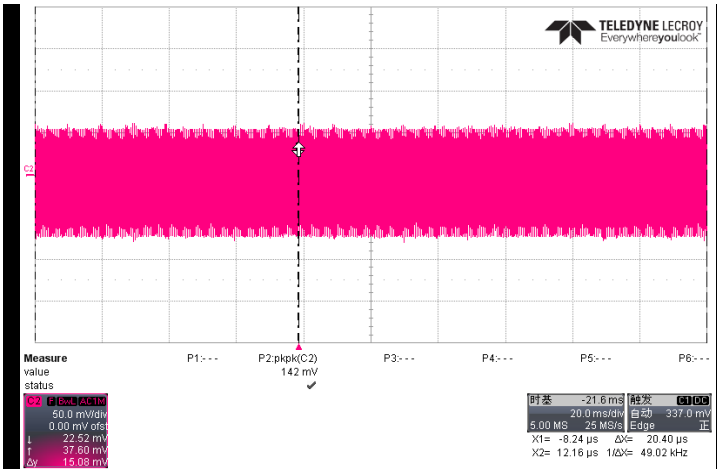


Figure 16: The Ripple at 264Vac/50Hz ΔV=142mv 5V/3A

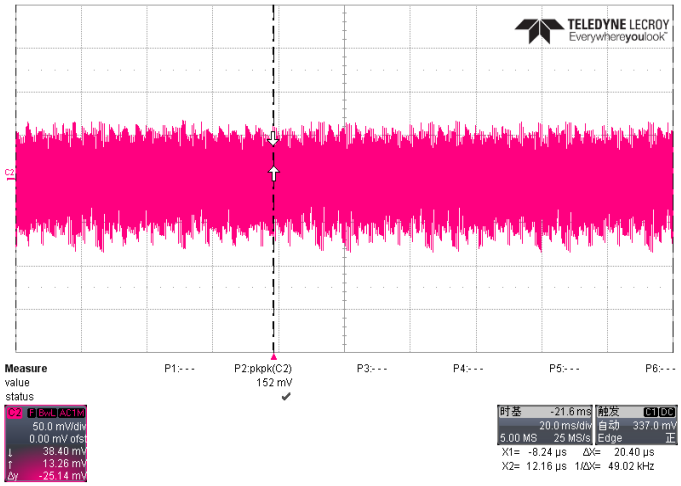


Figure 17: 90Vac/60Hz 9V/3A ΔV=152mV

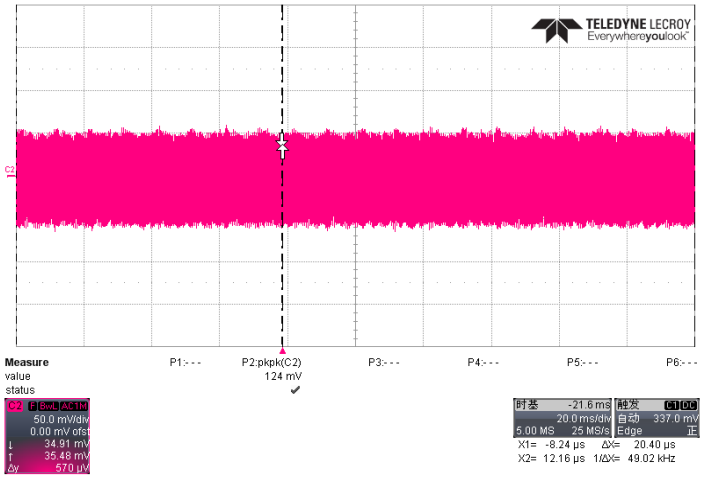


Figure 18: 264Vac/50Hz 9V/3A ΔV=124mv

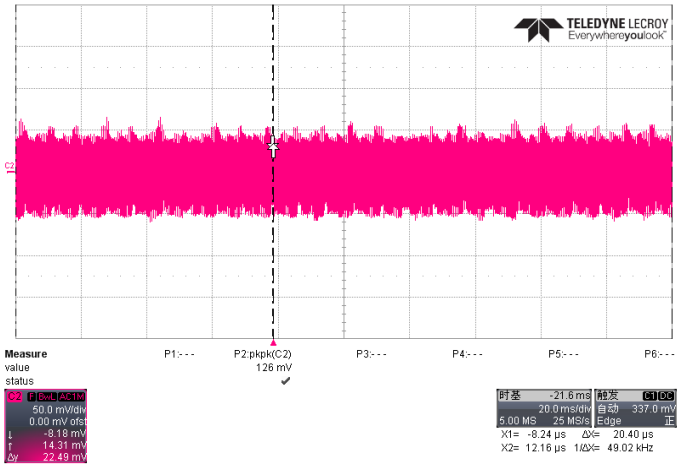


Figure 19: 90Vac/60Hz 12V/2.25A ΔV=126mV

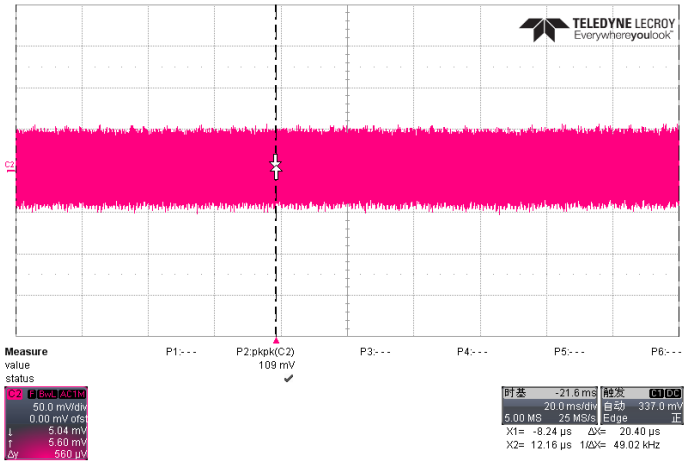


Figure 20: 264Vac/50Hz 12V/2.25A ΔV=109mv

5.3.4 Output Voltage Transition Time

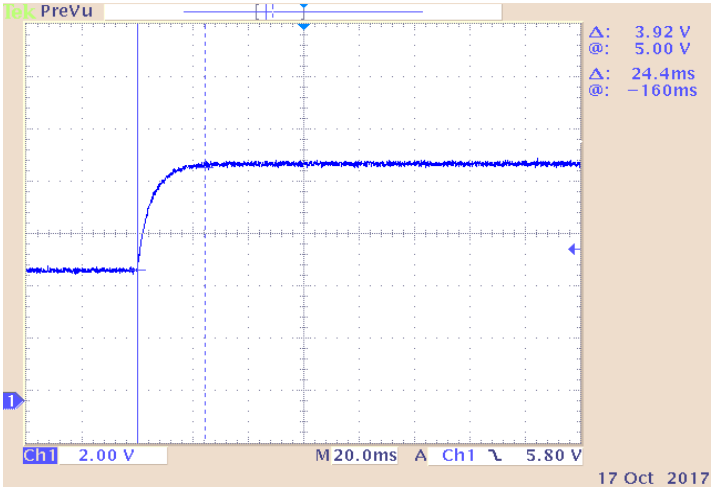


Figure 21: 5V→9V Transition Time: @ 0A load

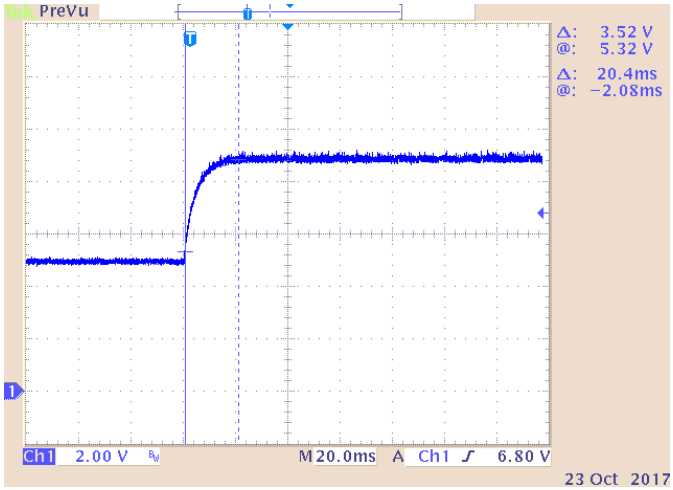


Figure 22: 5V→9V Transition time @ .2.25A load

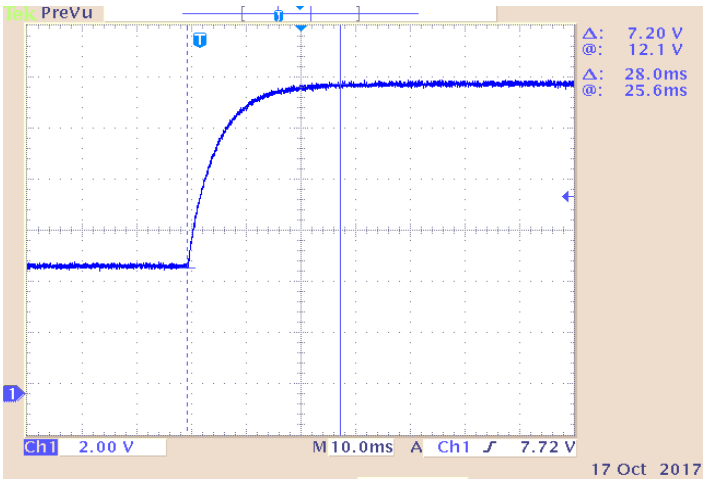


Figure 23: 5V→12V Transition Time @ 0 Loading

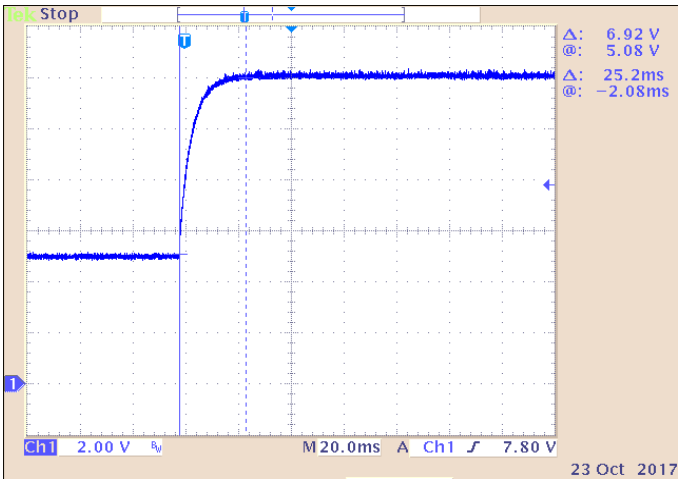


Figure 24: 5V→12V Transition Time @ 2.25A

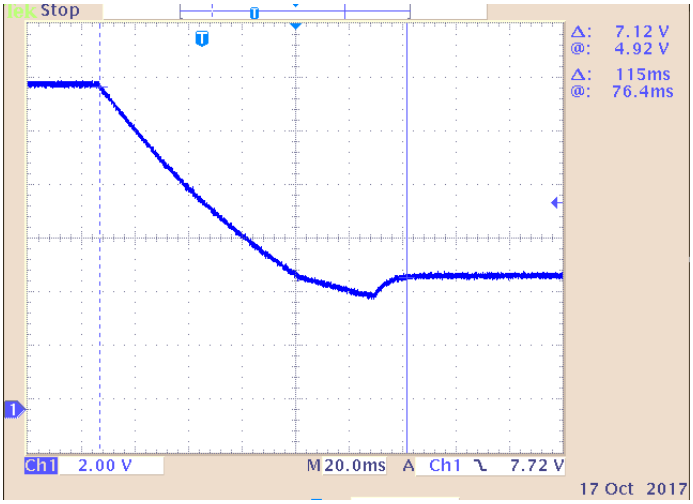


Figure 25: 12V→5V Transition Time @ 0A Loading

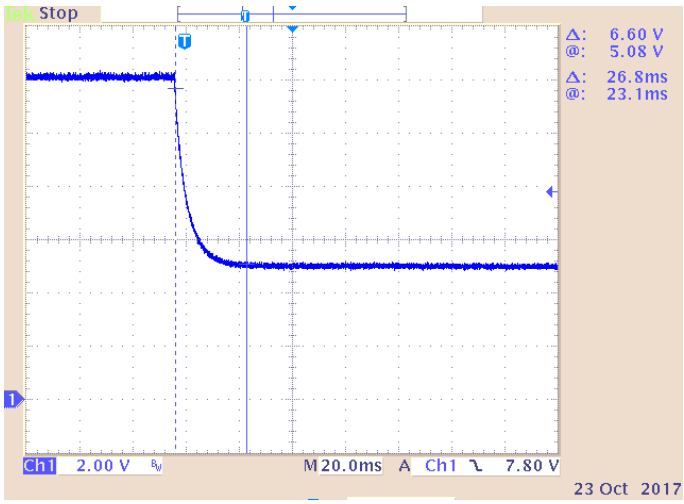


Figure 26: 12V→5V Transition Time @ 2.25A loading

5.3.5 Dynamic loading performance test from 0A ~ 3A

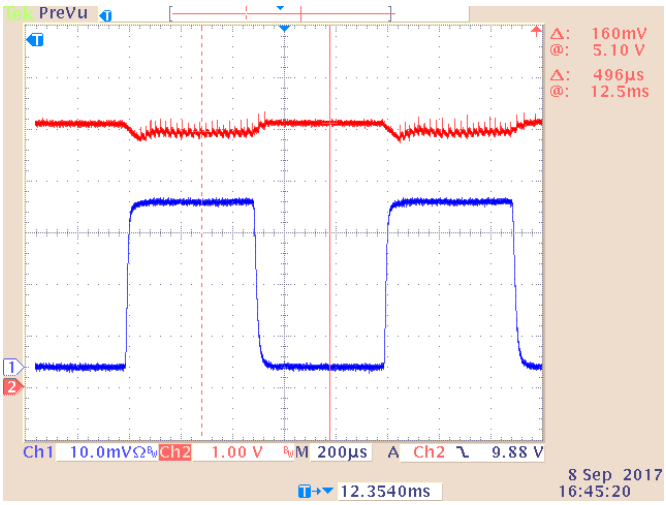


Figure 27: Dynamic Load 0A ~ 3A @ 1Khz @115Vac

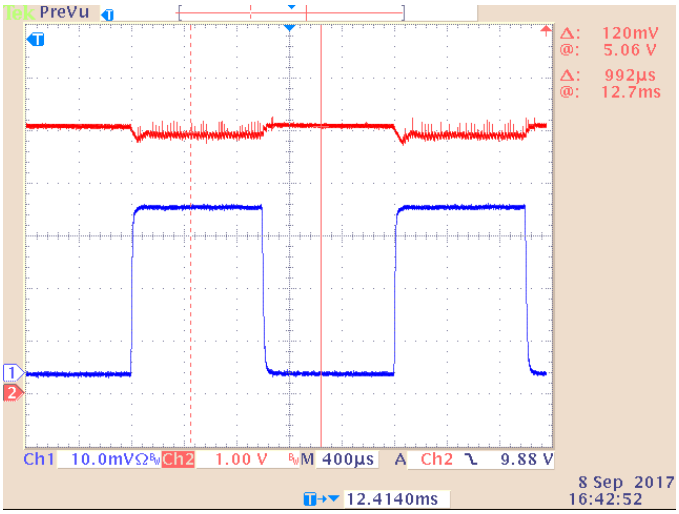


Figure 28: Dynamic Load 0A ~ 3A @ 0.5Khz @115Vac

5.3.6 Thermal Testing

Test Condition: Vin=90V Vo=9V Io=3A Open Frame at room Temperature +25 C

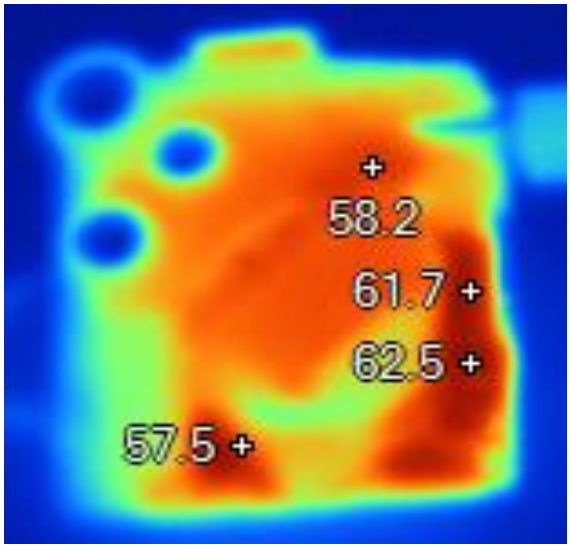


Figure 29: components side

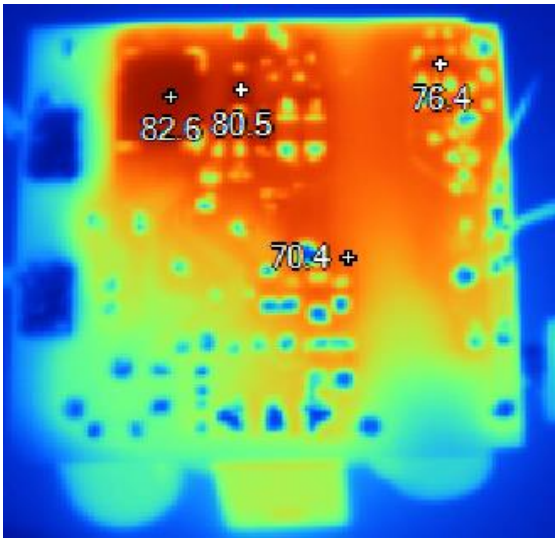


Figure 30: surface mount side

	Temperature
Ambient Temp.	24.7℃
Bridge	82.6℃
Q3	80.5℃

5.3.7 EMI (CE) Testing

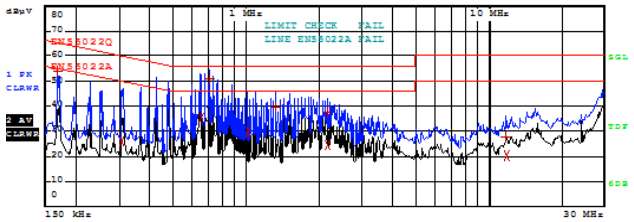


Figure 31: 115Vac/60Hz 12V/2A (L)

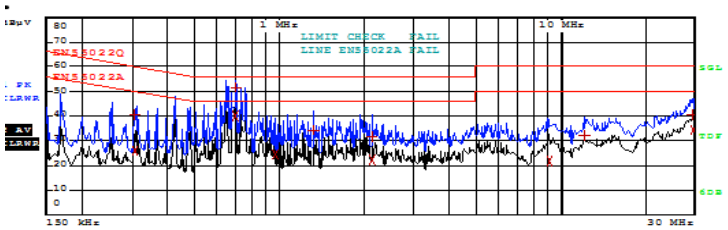


Figure 32: 115Vac/60Hz 12V/2A (N)

EDIT PEAK LIST (Final Measurement Results)

Trace1: EN55022Q
Trace2: EN55022A
Trace3: ---

TRACE		FREQUENCY	LEVEL dBµV	DELTA LIMIT dB
1	Quasi Peak	170 kHz	54.16	-10.79
2	Average	310 kHz	26.14	-23.82
2	Average	650 kHz	35.40	-10.59
1	Quasi Peak	706 kHz	50.73	-5.26
2	Average	1.018 MHz	29.78	-16.21
1	Quasi Peak	1.326 MHz	39.63	-16.36
1	Quasi Peak	2.154 MHz	37.57	-18.42
2	Average	2.154 MHz	24.64	-21.35
1	Quasi Peak	11.746 MHz	27.63	-32.36
2	Average	11.966 MHz	20.39	-29.61
2	Average	29.318 MHz	35.29	-14.71
1	Quasi Peak	29.45 MHz	41.08	-18.91

EDIT PEAK LIST (Final Measurement Results)

Trace1: EN55022Q
Trace2: EN55022A
Trace3: ---

TRACE		FREQUENCY	LEVEL dBµV	DELTA LIMIT dB
1	Quasi Peak	310 kHz	40.29	-19.67
2	Average	310 kHz	25.85	-24.11
1	Quasi Peak	702 kHz	51.71	-4.28
2	Average	702 kHz	40.04	-5.95
2	Average	962 kHz	24.34	-21.65
1	Quasi Peak	1.322 MHz	34.50	-21.49
1	Quasi Peak	2.13 MHz	31.52	-24.47
2	Average	2.13 MHz	22.00	-23.99
2	Average	9.162 MHz	21.93	-28.06
1	Quasi Peak	12.218 MHz	31.98	-28.01
1	Quasi Peak	29.466 MHz	40.57	-19.42
2	Average	29.63 MHz	34.48	-15.51

L		N	
QP	AV	QP	AV
-10.79dB	-5.26dB	-5.95dB	-4.28dB

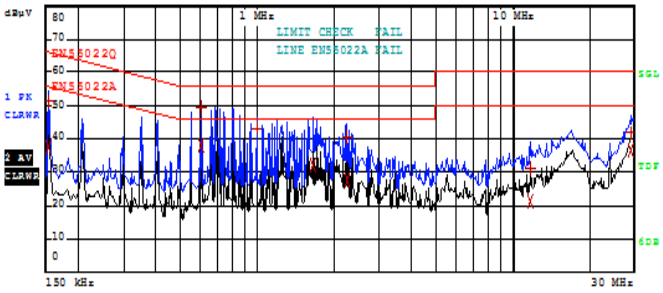


Figure 33: 230Vac/50Hz 12V/2A (L)

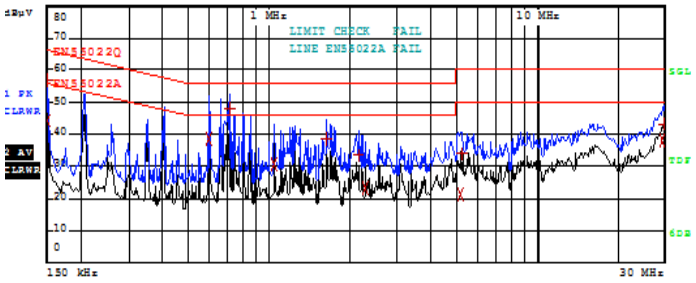


Figure 34: 230Vac/50Hz 12V/2A (N)

EDIT PEAK LIST (Final Measurement Results)

Trace1: EN55022Q
Trace2: EN55022A
Trace3: ---

TRACE		FREQUENCY	LEVEL dBµV	DELTA LIMIT dB
1	Quasi Peak	154 kHz	51.43	-14.34
2	Average	154 kHz	37.83	-17.94
1	Quasi Peak	602 kHz	49.41	-6.58
2	Average	602 kHz	37.97	-8.02
1	Quasi Peak	998 kHz	43.08	-12.91
2	Average	1.65 MHz	31.96	-14.03
1	Quasi Peak	2.254 MHz	40.37	-15.63
2	Average	2.254 MHz	27.74	-18.25
1	Quasi Peak	11.75 MHz	31.18	-28.81
2	Average	11.75 MHz	21.19	-28.80
2	Average	29.014 MHz	36.52	-13.47
1	Quasi Peak	29.15 MHz	41.84	-18.15

EDIT PEAK LIST (Final Measurement Results)

Trace1: EN55022Q
Trace2: EN55022A
Trace3: ---

TRACE		FREQUENCY	LEVEL dBµV	DELTA LIMIT dB
1	Quasi Peak	150 kHz	56.70	-9.29
2	Average	150 kHz	44.21	-11.78
2	Average	598 kHz	38.38	-7.61
1	Quasi Peak	714 kHz	48.08	-7.91
2	Average	1.05 MHz	30.61	-15.38
1	Quasi Peak	1.646 MHz	38.82	-17.17
1	Quasi Peak	2.166 MHz	33.64	-22.35
2	Average	2.298 MHz	22.94	-23.05
2	Average	5.23 MHz	21.36	-28.63
1	Quasi Peak	5.278 MHz	34.10	-25.89
2	Average	29.446 MHz	38.17	-11.82
1	Quasi Peak	29.61 MHz	43.47	-16.52

L		N	
QP	AV	QP	AV
-6.58B	-8.02dB	-7.91dB	-7.61dB

Chapter 6: Revision Control

6.1 Revision table

The Change list from Rev 1.0 to Rev1.1

No #	Items Changed & added	The changing reason
1	C8=**820u**F/16V from 680uF/16V	For improving Vbus Ripple @ Full 3A loading
2	R29,R30=0.75 ohm 1% 1206	For increasing OPP power level to supporting Pout = 33W
3	Add in C34=0.22uf/16V cap 1206 // R15	For flitting Gnd noise into CYPD3174
4	Add in a 33nf/16V 0603 // with R11	For reducing an oscillation @3.2v-3A
5	C32=470nF/16V 0603	Pin 9 need a holding CAP for CC-CV Mode
6	C16=47nf/16V 0603	For improving undershot voltage drop during at 3V-11V transition mode
7	C33=2.2uF/16V 0805	For increasing holding time when Vbus off
8	R8=2.2ohm 1/8W0805	For reducing voltage transient stress
9	Add in C35 10uF/16V 1206 cap	For improving the Vp-p ripple voltage

6.2 USB IF Power Brick Certification Test detail

1, USB IF Power Brick Certification name: PD3.0 +PPS

2, Diodes Product Marketing name: PD3.0 27W Quick Charge(with CYPD3174-decoder)

3, AC-DC 27W PD3.0 Quick Charge Rev 3.1

4, Test TID: 1080032

5, Certification Testing & Passing date: 4-27-2018

6, USB IF Certified list link: http://www.usb.org/kcompliance/ilist

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