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Chapter 1. Summary

1.1 General Description

The 27W QC4 Class A charger Evaluation Board EV3 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 CY2312 is USB PD and Qualcomm® Quick Charge™ 4 Controller for implementing quick charger decoder functions. Based on monitoring D+ & D- and CC1 & CC2 signals, CY2312 will interprets desired voltage and current setting, and then feedback 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
- Supports the USB PD3.0 Function and PPS (3V-11V@20mV)
- Meet DOE level 6 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 CY2312 Key Features

- Compliant with USB Type-C Rev 1.2
- Compliant with USBPD Rev.3.0 V1.1
- USB PD 3.0 v1.1 (PPS)
- Support QC4+
- Support non-USBPD Quick Charge
  - BC1.2 DCP
  - Apple Legacy built-in
- Built in CC/CV controller
- Built in Vconn switch, support E-marker cable detection
- Programmable OVP/UVP/OCP/OTP with auto-restart
- Internal Discharge MOS
- Programmable Cable Compensation
- Support fast VBUS fast turn off without external components
- Low standby current below 600uA
- High side current sense
- http://www.canyon-semi.com.tw/products.php

1.3 Applications

- QC4 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	3V/3A, 5V/3A, 9V/3A, 12V/2.25A
	PPS Mode 3V-11V, 20mV/step, 50mA/step
Per Step Voltage	Continuous Mode 200mV, 3.6V-12V
	PPS 20mV, 3V-11V
Efficiency	88% at 12V/2.25A
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

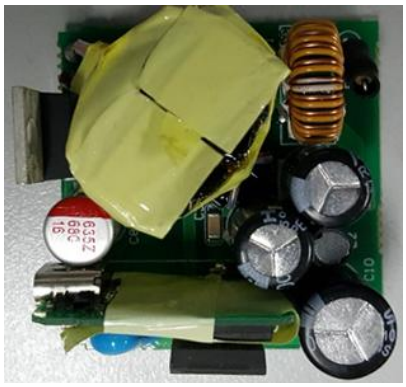


Figure 1: Top View

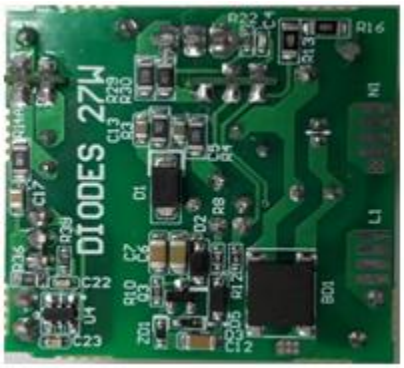


Figure 2: Bottom View

Chapter 2. Power Supply Specification

2.1 Specification and Test Results

Parameter	Test conditions	Min	Nom	Max	Eff /DOE Level VI	Eff /CoC V5 Tier2	Test Summary
V_{ACIN} Input Voltage	-	90 V_{RMS}	115/230	264 V_{RMS}	-	-	-
F_{LINE} Frequency	-	47Hz	50/60	64Hz	-	-	-
I_{IN} Input Current	-	-	-	1.5 A_{RMS}	-	-	Pass
No load Pin	At 230Vac/50Hz, @ 5V, Pin < 75mW	-	-	75mW	-	-	Pass, 230Vac: 57.17mW
3VDC / 3A @115Vac/230Vac Average efficiency	Board end	-	3V / 3A	-	77.96%	78.23%	Pass, 115Vac: 82.6% 230Vac: 81.1%
5VDC / 3A @115Vac/230Vac Average efficiency	Board end	-	5V/3A	-	81.39%	81.84%	Pass, 115Vac: 86.5% 230Vac: 87.5%
5VDC / 3A @115Vac/230Vac 10% efficiency	Board end	-	5V/0.3A	-	-	72.48%	Pass, 115Vac: 82.8% 230Vac: 82.9%
9VDC / 3A @115Vac/230Vac Average efficiency	Board end	-	9V/3A	-	86.62%	87.30%	Pass, 115Vac: 89.4% 230Vac: 89.1%
9VDC / 3A @115Vac/230Vac 10% efficiency	Board end	-	9V/0.3A	-	-	77.3%	Pass, 115Vac: 84.9% 230Vac: 82.3%
12VDC / 2.25A @115Vac/230Vac Average efficiency	Board end	-	12V/2.25 A	-	86.62%	87.30%	Pass, 115Vac: 89.1% 230Vac: 89.0%

2.2 Compliance

Parameter	Test conditions	Min	Nom	Max	Test Summary
Standby Power (mW)	5V Output	-	-	75mW	Pass
Output Voltage Tolerance	3V/0-3A		3V		Pass
Output Voltage Tolerance	5V/0-3A	4.75V	5V	5.25V	Pass (of 60mohm Cable end)
Output Voltage Tolerance	9V/0-3A	8.55V	9V	9.45V	Pass (of 60mohm Cable end)
Output Voltage Tolerance	12V/0-2.25A	11.4V	12V	12.6V	Pass
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	-	-	-	

Chapter 3. Schematic

3.1 EV3 Board Schematic

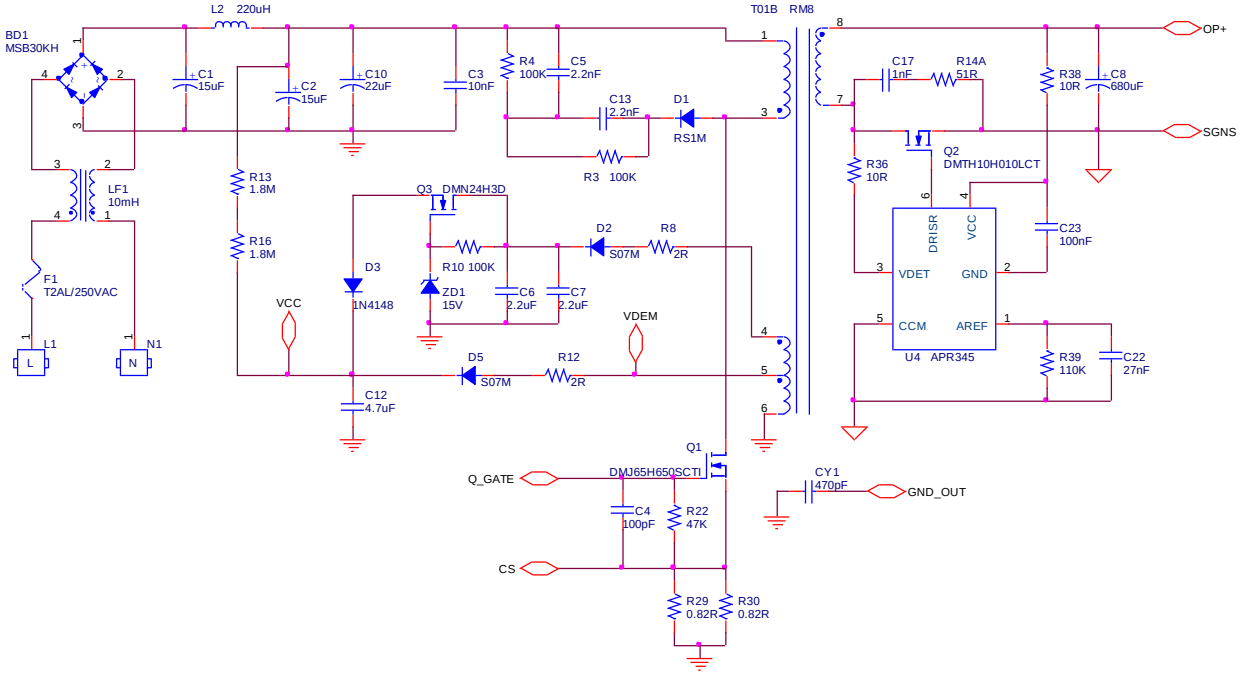


Figure 3a: Evaluation Board Schematic (Power Main Board)

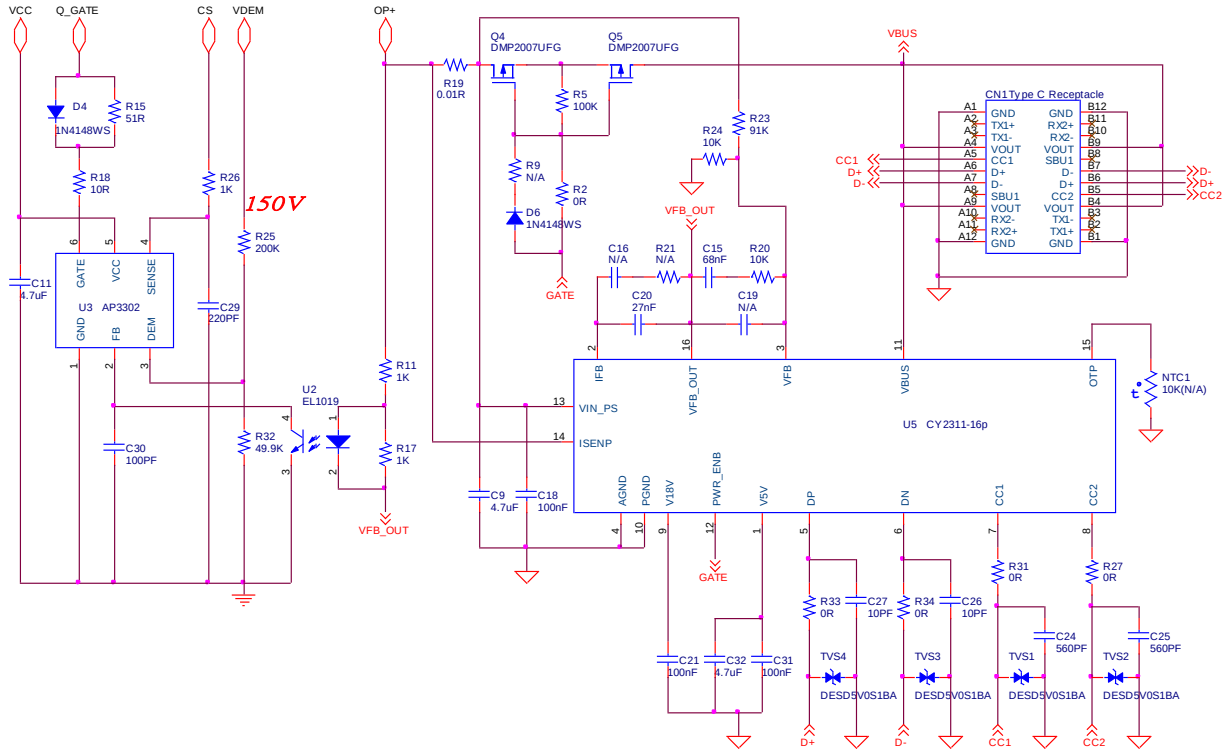


Figure 3b: Evaluation Board Schematic (Controller Daughter Board)

3.2 Bill of Material (BOM)

3.2.1 Power Main Board

Bill of Material for Power Main Board					
Designator	**Comment**	**Designator**	**Comment**	**Designator**	**Comment**
BD1	MSB30KH	CY1	470pF/Y1	R10	100kΩ/0603
C1, C2	15μF/400V	D1	RS1M	R13, R16	1.8MΩ/1206
C3	10nF/630V	D2, D5	S07M	R14A	51Ω/1206
C4	100pF/50V/0603	D3,	1N4148WS	R36	10Ω/0805
C5, C13	2.2nF/250V/0805	F1	T2AL/250VAC	R22	47kΩ/0603
C6, C7	2.2μF/100V/1206	L2	220μH	R29, R30	0.82Ω/1206
C8	680μF/16V	LF1	10mH	R38	10Ω/0603
C12	4.7μF/50V/1206	Q1	DMJ65H650SCTI, TO220	R39	110K//0603
C10	22μF/400V	Q2	DMTH10H010LCT	T1	TRANS-RM8
C17	1nF/200V/0805	Q3	DMN24H3D	U4	APR345
C23	100nF/50v/0603	R3, R4	100kΩ/1206	ZD1	15V Zener
C22	27nF/50V/0603	R8, R12	2Ω/0603		
Note:					

3.2.1 Controller Daughter Board (EV3)

Bill of Material for Daughter Board					
Designator	**Comment**	**Designator**	**Comment**	**Designator**	**Comment**
C9, C11, C32	4.7μF/50V/1206	R11, R17, R26	1kΩ/0603	D4, D6	1N4148WS
C18, C21, C31	100nF/50V/0603	R15	51Ω/0805	Q4, Q5	DMP2007UFG
C20	27nF/50V/0603	R18	10Ω/0805	TVS1, TVS2，TVS3, TVS4	DESD5V0S1BA
C24, C25	560pF/50V/0603	R19	10mΩ 1206(1W)	U2	EL1019 / LTV-1009
C26, C27	10pF/50V/0603	R20, R24	10kΩ/0603	U3	AP3302A
C29	220pF/50V/0603	R25	200kΩ/0805	U5	CY2312--QFN16
C30	100PF/50V/0603	R23	91kΩ/0603	CN1	TYPE C RECEPTACLE
C15	68nF/50V/0603	R32	49.9kΩ/0603		
R5	100kΩ/0603	NTC1	10kΩ NTC (N/A)/0603		
R2, R27, R31, R33, R34	0Ω/0603	R9, R21, C16, C19,	N/A /0603		
Note: 1. Current sense resistor (R19) use the Low TCR type (Reference Type: SMF12M1FR010T “http://www.sartfuse.com”).					

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 and Q1 are the power converting core components. Connected to filtered output after bridge circuit, R13 & R16 resistor path will provide start-up voltage and current during starting up through Vcc (Pin 5). Subsequent VCC power will be provided by voltage feedback from middle-tapped auxiliary winding through two options, R12-D5 and R8-D2-Q3-D3, depending on desired output voltage. This design is to accommodate with the required wide voltage range to support various protocols (including QC 4/USB PD Programmable Power Supply PPS), from 3V to 12V.

Based on feedback of secondary side (Pin CATH of CY2312 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

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 that with Schottky Diodes, the total efficiency can be improved.

3.3.4 CY2312 QC4/4+ Decoder & Protection on/off P MOSFET and Interface to Power Devices

The few sets of important pins provide critical protocol decoding and regulation functions in CY2312:

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) **D+ & D- (Pin 5, 6):** 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 VIN_PS (pin 13) via resistor divider and comparing with internal reference voltage to generate a CV compensation signal on the VFB_OUT pin (pin 16). The output voltages can be adjusted by firmware programming.
4) **Constant Current (CC)**: The CC is implemented by sensing by current sense resistor (R19, 10mΩ) and current sense amplifier, then comparing with internal programmable reference voltage to generate a compensation signal on VFB_OUT pin (pin 16)
5) **Loop Compensation:** C15, R20 & C19 form the voltage loop compensation circuit, and C16, R21 & C20 form the current loop compensation circuit.
6) **VFB_OUT (Pin 16)**: It is the key interface link from secondary decoder (CY2312) 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) **PWR_ENB Driver (Pin 12) 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.

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.

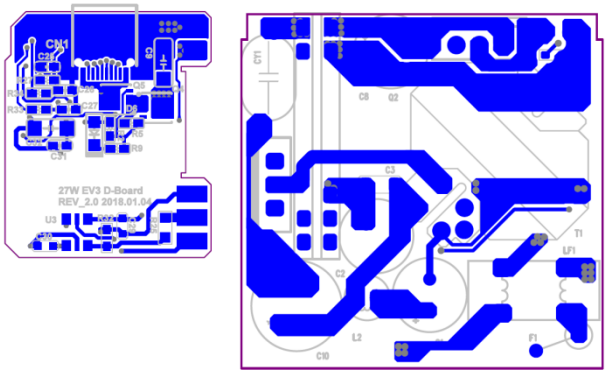


Figure 4: PCB Board Layout Top View

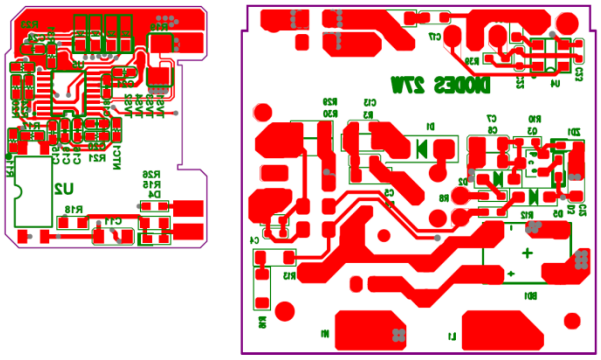


Figure 5: PCB Board Layout Bottom View

4.2 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 Canyon Semiconductor local agent for further information.

- Test Kit: USBCEE Power Adapter Tester.
- Software: USBCEE_Adavanced_Tester_Version 1.0.1 (file name: USBCEETester)
- Firmware: CY2312PD20180119
- To buy a USB-C POWER ADAPTER PROGRAMMER AND TESTER (white color) - https://www.usbcee.com/

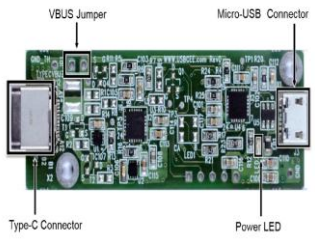
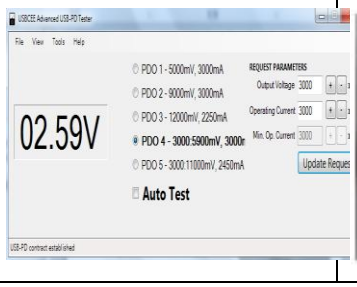
USBCEE PAT Tester	USBCEE_Adavanced _Tester_V1.0.1	Standard-A to Micro-B Cable	Type-C Cable
			

Figure 6: Canyon 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 7: The Sample Board Input & Output Location

5) Use a type-C cable for the connection between EV3's board to Type-C receptacles of Tester (“USBCEE PAT Tester”).

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 Micro-B receptacle of tester (“USBCEE PAT Tester”) & PC Standard-A receptacle respectively.

4.3 System Setup

4.3.1 Connection with E-Load

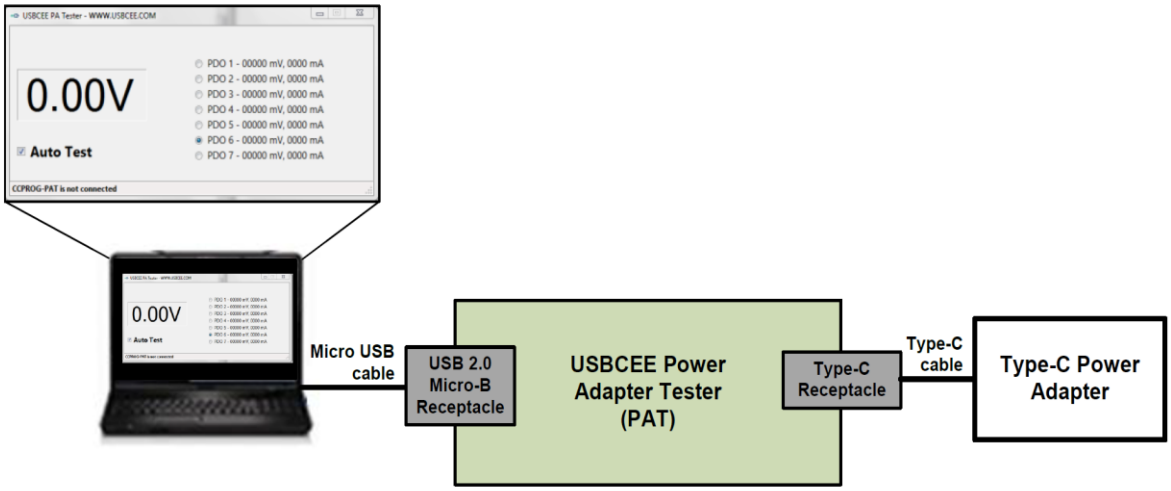


Figure 3. USBCEE PAT System setup

Figure 8: Diagram of Connections in the Sample Board

4.3.2 USBCEE Power Adapter Tester (PAT)

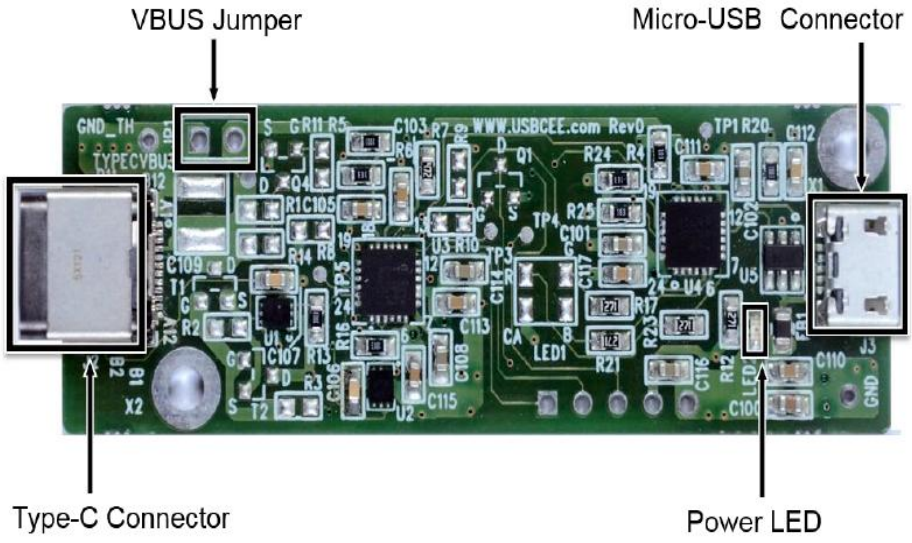


Figure 9: The Test Kit Input & Output and E-load Connections

4.3.3 Input & Output Wires Connection

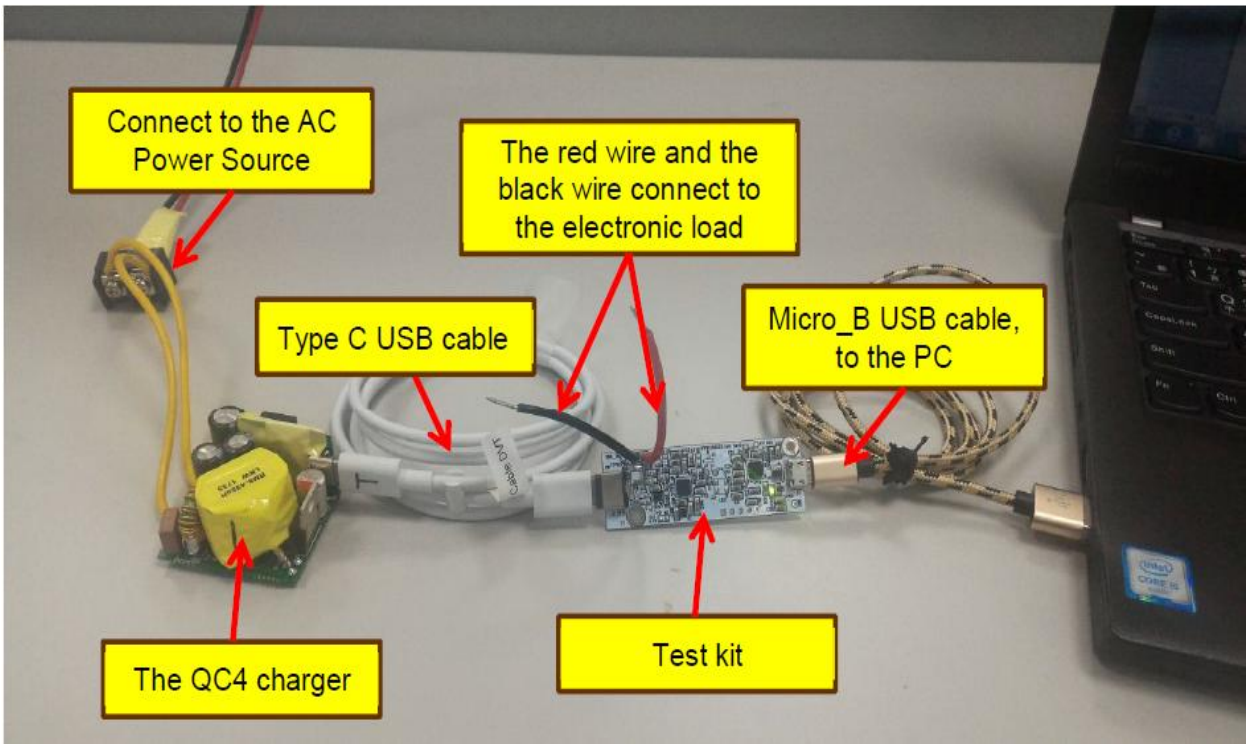


Figure 10: Wire Connection of 27W QC4/4+ EVB to Test Kit and PC Computer

Chapter 5. Testing the Evaluation Board

5.1 Input & Output Characteristics

5.1.1 Input Standby Power

Load Condition: No Load +5VDC

Vin(Vac)	Fin(Hz)	Vin(V)	Iin(mA)	PF	Pin(mW)	Vout(V)	Iout(A)	Pout(W)	Pd(W)	EFF
90	47	90.12	2.486	0.146	32.646	5.043	0	0	--	--
115	60	115.12	3.101	0.126	44.844	5.043	0	0	--	--
230	50	230.36	2.722	0.090	56.616	5.042	0	0	--	--
264	63	264.28	2.879	0.088	66.726	5.042	0	0	--	--

5.1.2 Input Power Efficiency at Different AC Line Input Voltage

Load Condition: 2.25A @ 12VDC

Vin(Vac)	Fin(Hz)	Vin(V)	Iin(A)	PF	Pin(W)	Vout(V)	Iout(A)	Pout(W)	Pd(W)	EFF
90	47	90.06	0.587	0.582	30.761	12.07	2.25	27.15	3.61	88.27%
115	60	115.07	0.523	0.506	30.444	12.07	2.25	27.17	3.28	89.23%
230	50	230.34	0.346	0.380	30.312	12.07	2.25	27.16	3.15	89.62%
264	63	264.32	0.317	0.363	30.411	12.08	2.25	27.17	3.24	89.35%

Load Condition: 3A @ 9VDC

Vin(Vac)	Fin(Hz)	Vin(V)	Iin(A)	PF	Pin(W)	Vout(V)	Iout(A)	Pout(W)	Pd(W)	EFF
90	47	90.05	0.600	0.578	31.262	9.10	3.00	27.29	3.98	87.28%
115	60	115.06	0.531	0.506	30.901	9.10	3.00	27.29	3.62	88.30%
230	50	230.34	0.351	0.381	30.788	9.09	3.00	27.28	3.51	88.61%
264	63	264.32	0.322	0.363	30.896	9.09	3.00	27.28	3.62	88.30%

Load Condition: 3A @ 5VDC

Vin(Vac)	Fin(Hz)	Vin(V)	Iin(A)	PF	Pin(W)	Vout(V)	Iout(A)	Pout(W)	Pd(W)	EFF
90	47	90.1	0.373	0.533	17.902	5.12	3.00	15.35	2.56	85.73%
115	60	115.1	0.343	0.452	17.800	5.12	3.00	15.35	2.45	86.22%
230	50	230.36	0.219	0.355	17.894	5.12	3.00	15.35	2.55	85.76%
264	63	264.34	0.192	0.355	17.984	5.12	3.00	15.35	2.64	85.33%

Load Condition: 3A @ 3.3VDC

Vin(Vac)	Fin(Hz)	Vin(V)	Iin(A)	PF	Pin(W)	Vout(V)	Iout(A)	Pout(W)	Pd(W)	EFF
90	47	90.11	0.270	0.495	12.050	3.30	3.00	9.90	2.15	82.13%
115	60	115.11	0.252	0.414	12.016	3.30	3.00	9.90	2.12	82.37%
230	50	230.37	0.152	0.346	12.167	3.30	3.00	9.90	2.27	81.33%
264	63	264.32	0.134	0.346	12.253	3.30	3.00	9.90	2.36	80.76%

5.1.3 Average Efficiency at Different Loading

Average Efficiency (12VDC)

Vin(Vac)	Fin(Hz)	Vin(V)	Iin(A)	PF	Pin(W)	Vout(V)	Iout(A)	Pout(W)	Pd(W)	Efficiency	Average Efficiency
115	60	115.08	0.520	0.507	30.356	12.02	2.25	27.04	3.31	89.1%	89.1%
		115.10	0.412	0.479	22.723	12.00	1.69	20.25	2.48	89.1%	
		115.11	0.301	0.433	14.968	11.98	1.13	13.47	1.49	90.0%	
		115.12	0.169	0.391	7.629	11.95	0.56	6.72	0.90	88.1%	
230	50	230.30	0.344	0.382	30.220	12.02	2.25	27.05	3.17	89.5%	89.0%
		230.32	0.273	0.361	22.695	12.00	1.69	20.25	2.45	89.2%	
		230.32	0.186	0.351	15.011	11.98	1.13	13.47	1.54	89.8%	
		230.33	0.101	0.330	7.685	11.96	0.56	6.73	0.96	87.5%	

Average Efficiency (9VDC)

Vin(Vac)	Fin(Hz)	Vin(V)	Iin(A)	PF	Pin(W)	Vout(V)	Iout(A)	Pout(W)	Pd(W)	Efficiency	Average Efficiency
115	60	115.09	0.552	0.512	32.539	9.72	3.00	29.16	3.38	89.6%	89.4%
		115.10	0.432	0.483	24.005	9.57	2.25	21.53	2.47	89.7%	
		115.12	0.318	0.432	15.782	9.42	1.50	14.13	1.65	89.6%	
		115.13	0.174	0.392	7.861	9.28	0.75	6.96	0.90	88.5%	
230	50	230.31	0.361	0.389	32.372	9.72	3.00	29.16	3.22	90.1%	89.1%
		230.32	0.286	0.364	23.989	9.57	2.25	21.54	2.45	89.8%	
		230.32	0.195	0.353	15.845	9.42	1.50	14.13	1.71	89.2%	
		230.34	0.104	0.331	7.952	9.28	0.75	6.96	0.99	87.5%	

Average Efficiency (5VDC)

Vin(Vac)	Fin(Hz)	Vin(V)	Iin(A)	PF	Pin(W)	Vout(V)	Iout(A)	Pout(W)	Pd(W)	Efficiency	Average Efficiency
115	60	115.11	0.361	0.46	19.225	5.55	3.00	16.65	2.57	86.6%	86.5%
		115.12	0.286	0.43	14.055	5.41	2.25	12.17	1.89	86.6%	
		115.13	0.199	0.40	9.141	5.27	1.50	7.90	1.24	86.4%	
		115.14	0.103	0.38	4.498	5.18	0.75	3.89	0.61	86.4%	
230	50	230.33	0.230	0.36	19.115	5.64	3.00	16.92	2.19	88.5%	87.5%
		230.33	0.173	0.35	14.050	5.51	2.25	12.39	1.66	88.2%	
		230.34	0.118	0.34	9.203	5.37	1.50	8.06	1.14	87.6%	
		230.34	0.063	0.32	4.579	5.24	0.75	3.93	0.65	85.9%	

Average Efficiency (3VDC)

Vin(Vac)	Fin(Hz)	Vin(V)	Iin(A)	PF	Pin(W)	Vout(V)	Iout(A)	Pout(W)	Pd(W)	Efficiency	Average Efficiency
115	60	115.10	0.237	0.42	11.538	3.13	3.00	9.39	2.15	81.4%	82.6%
		115.11	0.184	0.40	8.526	3.12	2.25	7.02	1.51	82.3%	
		115.12	0.126	0.39	5.605	3.10	1.50	4.66	0.95	83.1%	
		115.12	0.067	0.36	2.774	3.09	0.75	2.32	0.46	83.6%	
230	50	230.29	0.146	0.35	11.648	3.13	3.00	9.39	2.26	80.6%	81.1%
		230.33	0.112	0.34	8.648	3.12	2.25	7.02	1.63	81.1%	
		230.33	0.076	0.33	5.710	3.10	1.50	4.66	1.05	81.5%	
		230.33	0.042	0.30	2.856	3.09	0.75	2.32	0.54	81.1%	

5.2 Output CV & CC Mode Testing

5.2.1 PPS Mode I-V Curve

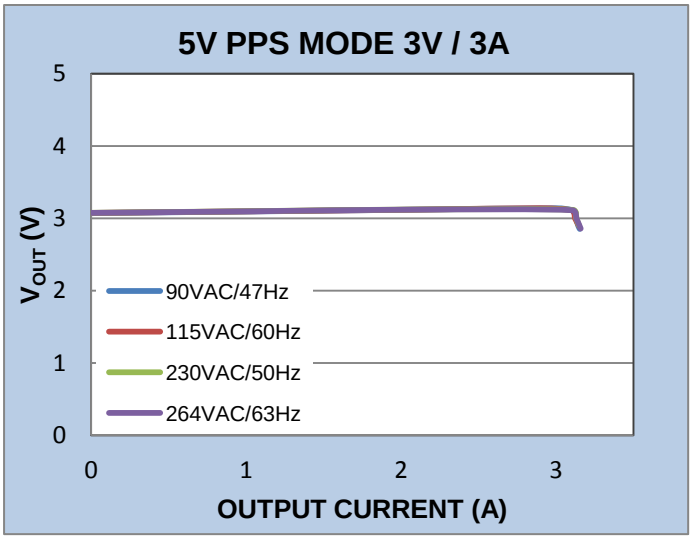


Figure 12: I-V Curve – 3V Output

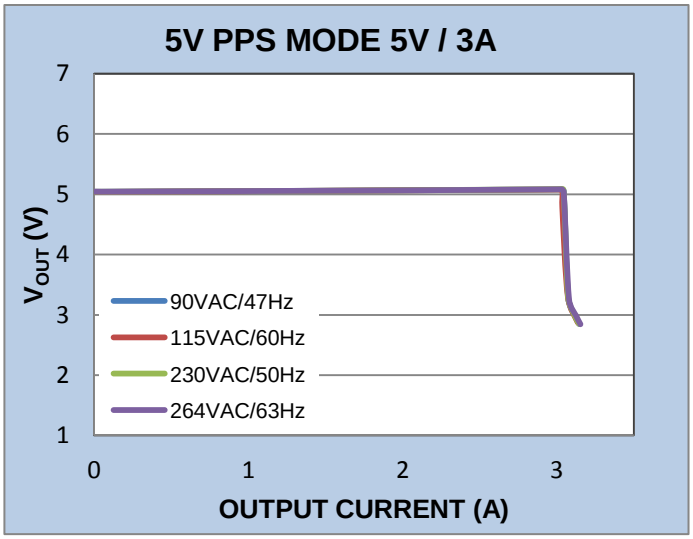


Figure 13: I-V Curve – 5V Output

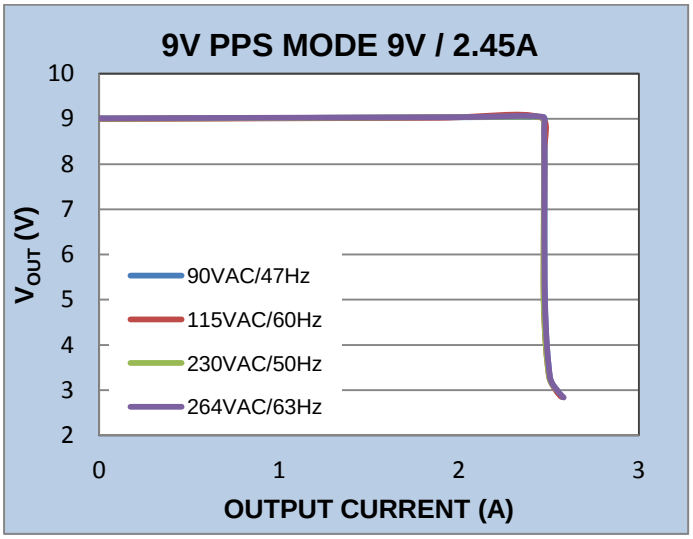


Figure 14: I-V Curve – 9V Output

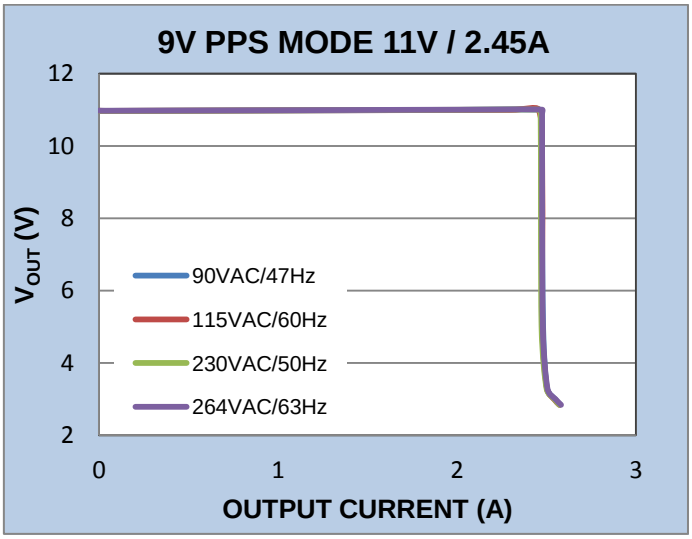


Figure 15: I-V Curve - 11V Output

5.2.2 Fixed Mode I-V Curve

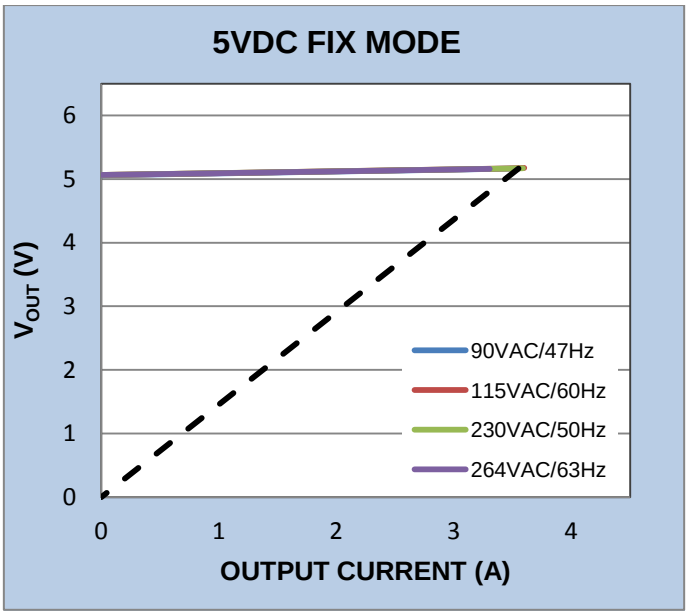


Figure 16: I-V Curve – 5VDC Fixed Mode

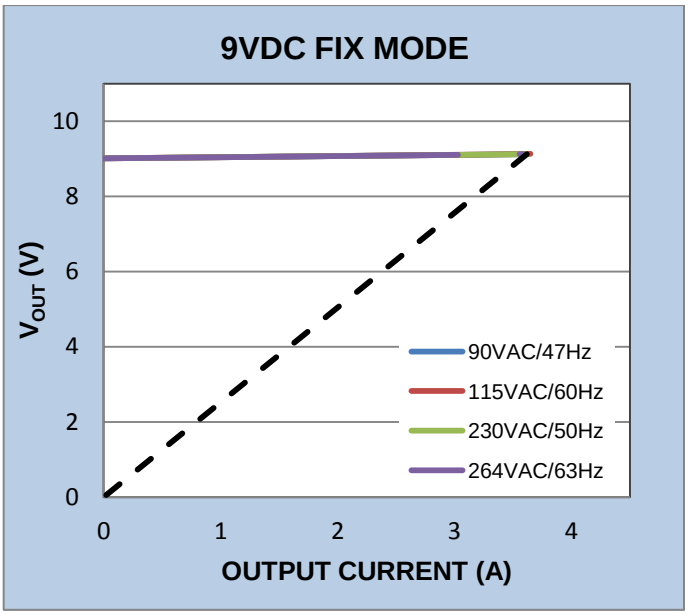


Figure 17: I-V Curve - 9VDC Fix Mode

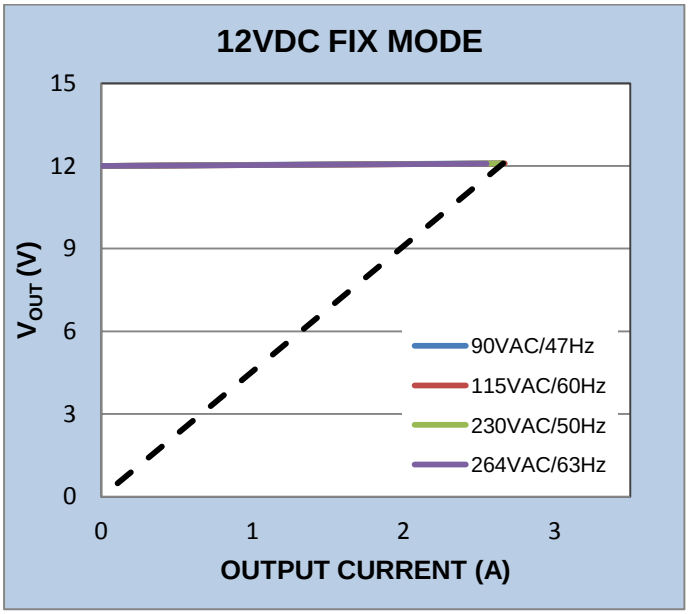


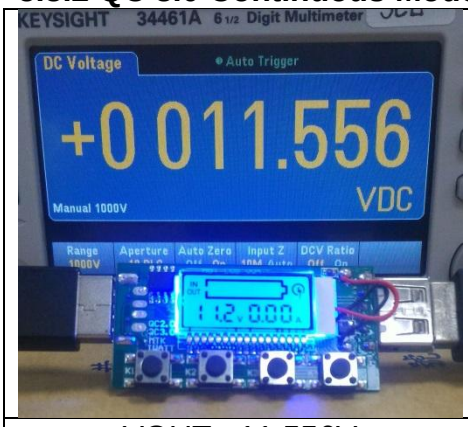
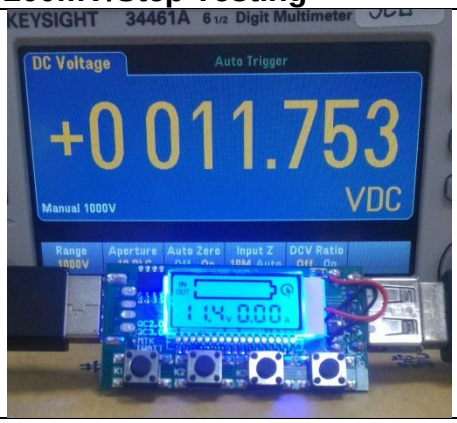
Figure 18: I-V Curve – 12VDC Fixed Mode

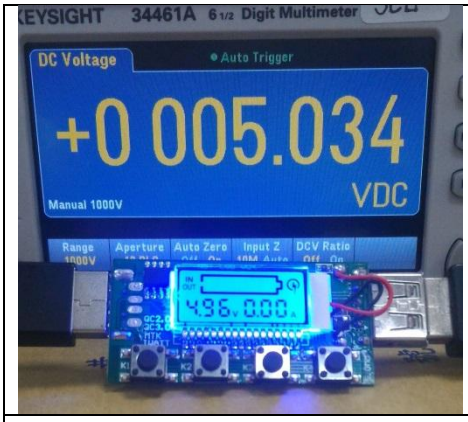
5.3 QC Series Compatible Mode Testing

5.3.1 QC 2.0 Mode Testing

		
VOUT : 5.035V	VOUT : 8.997V	VOUT : 11.955V

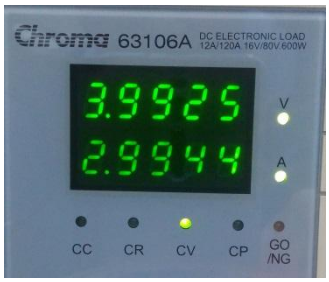
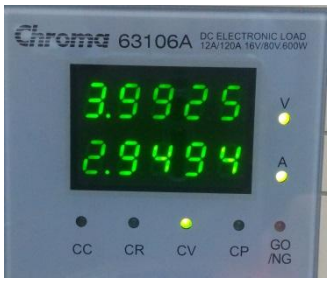
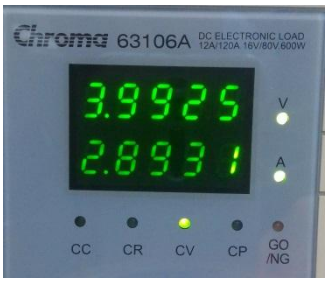
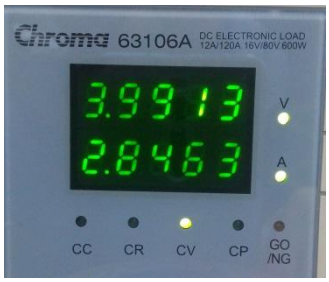
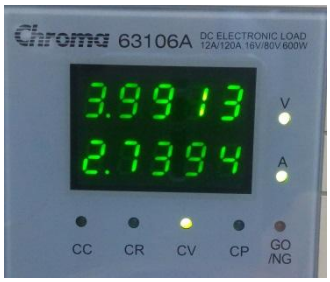
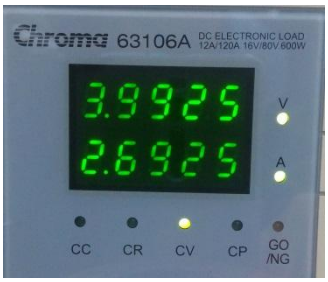
5.3.2 QC 3.0 Continuous Mode 200mV/Step Testing

		
VOUT : 11.556V	VOUT : 11.753V	VOUT : 11.952V
		
VOUT : 9.193V	VOUT : 9.391V	VOUT : 9.589V

		
VOUT : 5.034V	VOUT : 5.227V	VOUT : 5.428V
		
VOUT : 3.651V	VOUT : 3.821V	VOUT: 4.044V

5.3.3 QC4/4+ CV Accuracy 20mV/Step Testing (PPS Support)

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

			
Output Current : 1516.9mA	Output Current : 1.563.8mA	Output Current : 1618.1mA	Output Current : 1670.6mA
			
Output Current : 1723.8mA	Output Current : 1770.0mA	Output Current : 1824.4mA	Output Current : 1873.1mA
			
Output Current : 3045.0mA	Output Current : 2994.4mA	Output Current : 2949.4mA	Output Current : 2893.1mA
			
Output Current : 2846.3mA	Output Current : 2790.0mA	Output Current : 2739.4mA	Output Current : 2692.5mA

5.4 Key Performance Waveforms

5.4.1 AC Input Requirements

AC Brownout on/off

		Input AC Reading
Turn_Off	Max Load	73.54Vac
	Min Load	72.38Vac
Turn_On	Max Load	80.43Vac
	Min Load	81.48Vac

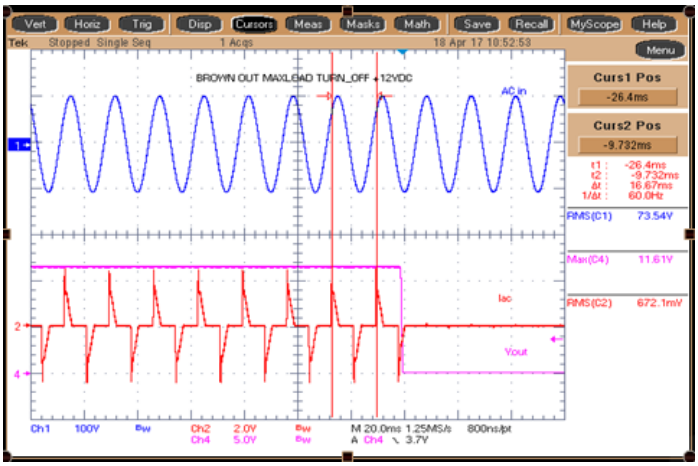


Figure 19

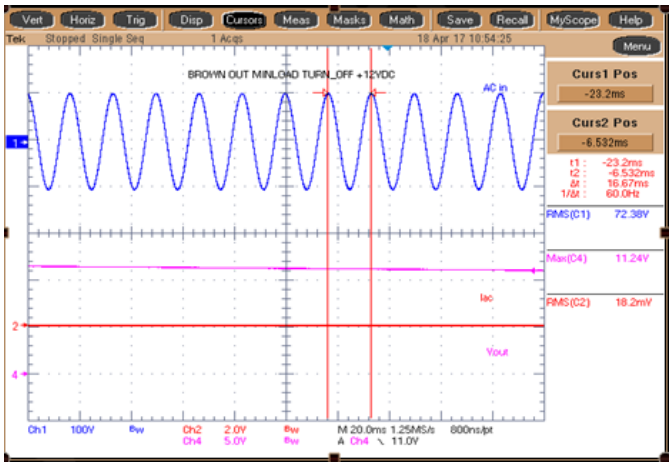


Figure 20

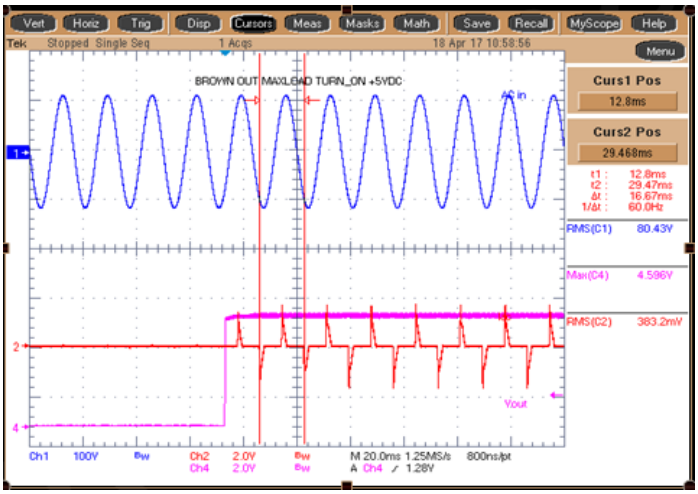


Figure 21

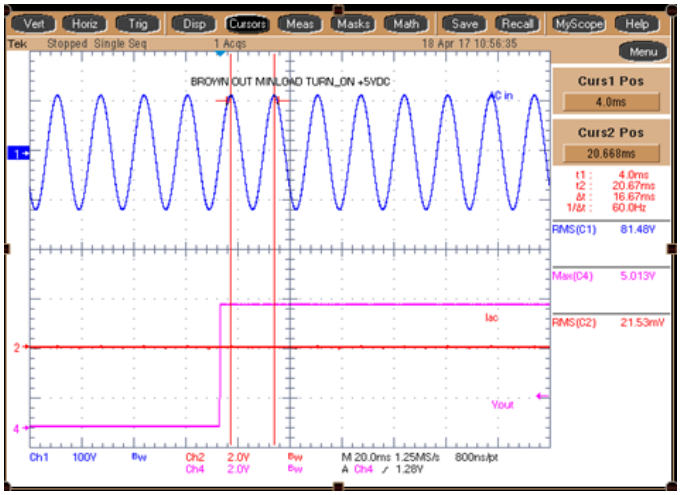


Figure 22

5.4.2 AC Line Slow Transients (Sag/Surge)

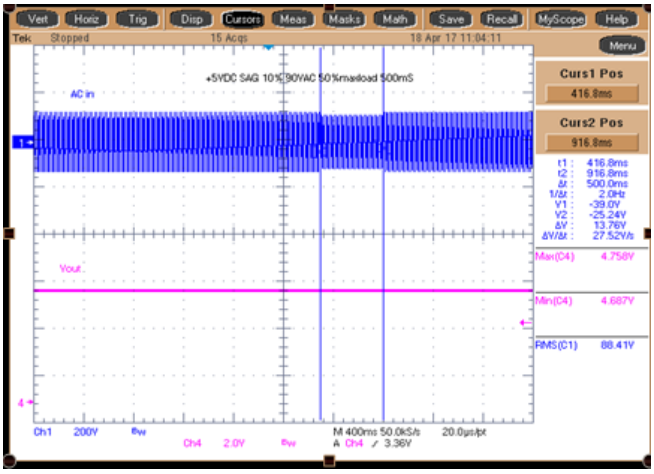


Figure 23: 500ms Sag at 10% of 90Vac with 5Vo at 1.5A

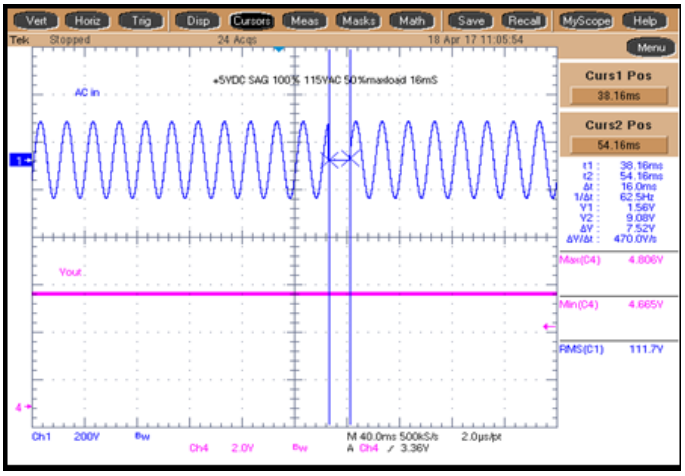


Figure 24: 16ms 100% Sag of 90Vac with 5Vo at 1.5A

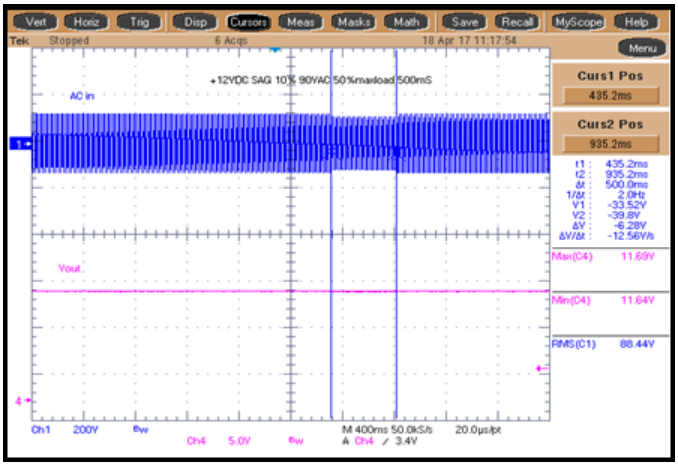


Figure 25: 500ms Sag 10% of 90Vac with 12Vo at 1.15A

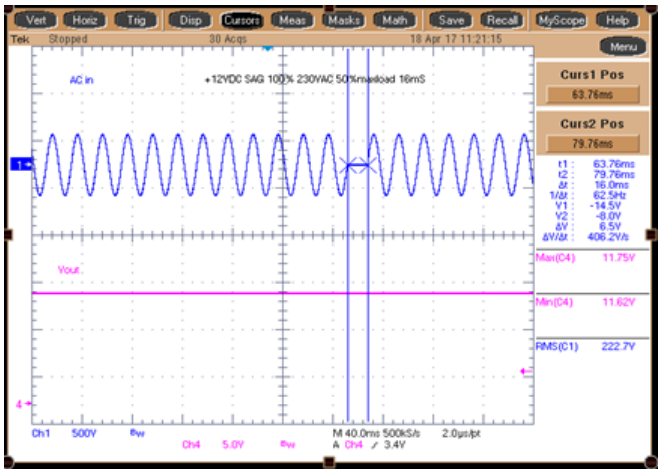


Figure 26: 16ms 100% Sag of 90Vac with12V at 1.15A

5.4.3 27W QC4/4+ System Start-up Time & Hold-up Time

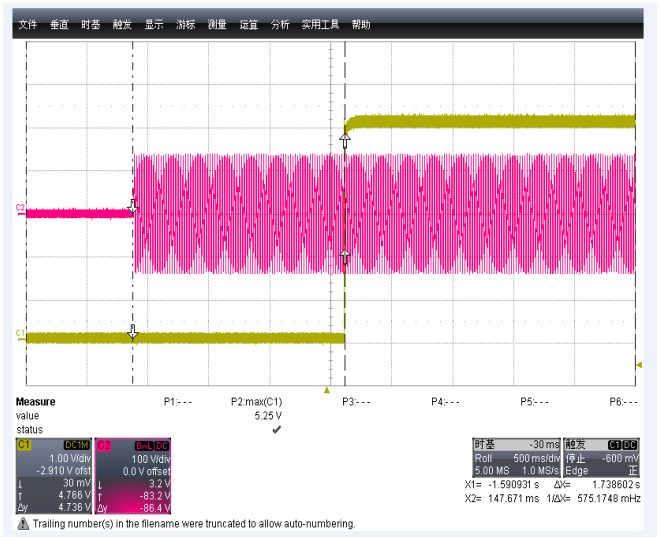


Figure 27: 27w QC4/4+ turn on time 1.74s FL at 90Vac

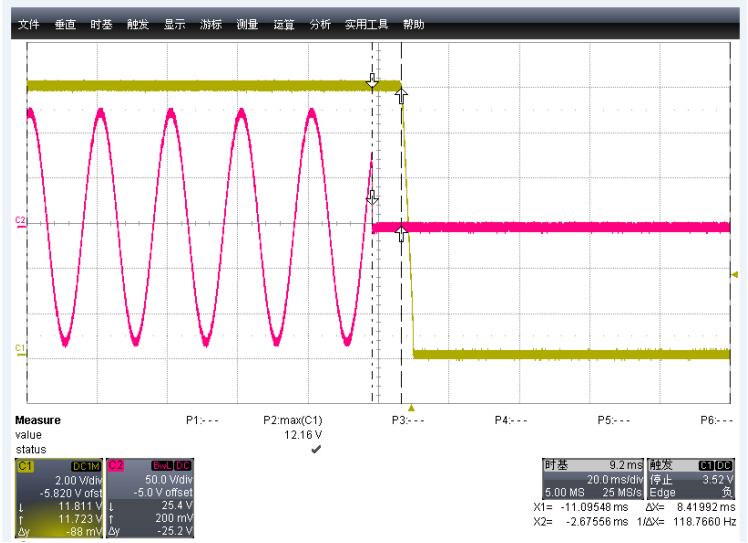


Figure 28: 27w QC4/4+ hold time 8.42s at 12V- 2.25A, at 90Vac

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

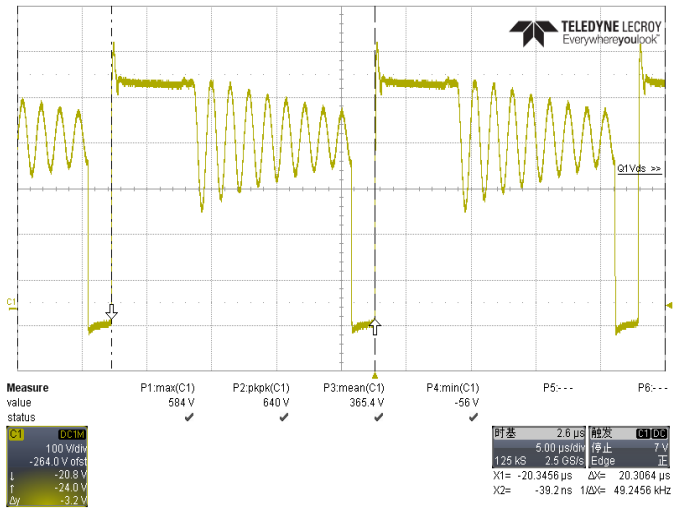


Figure 29: 264Vac/50Hz Primary Q1 Vds(max)= 584Vp-p

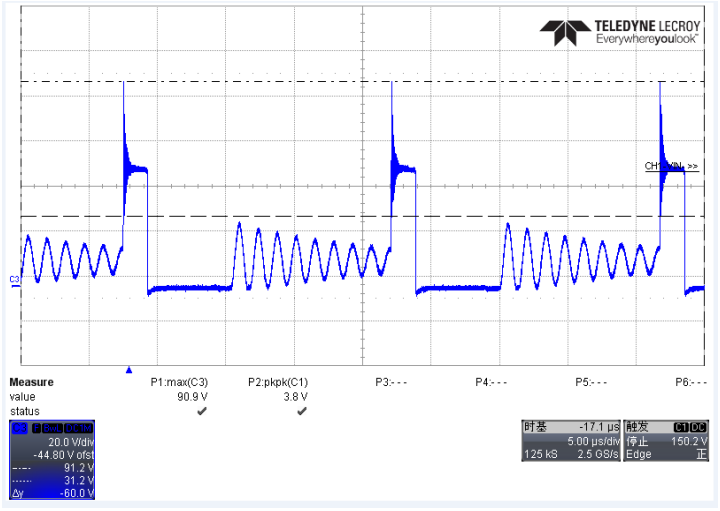


Figure 30: 264Vac/50Hz Secondary Q2 Vds(max) = 90.9Vp-p

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

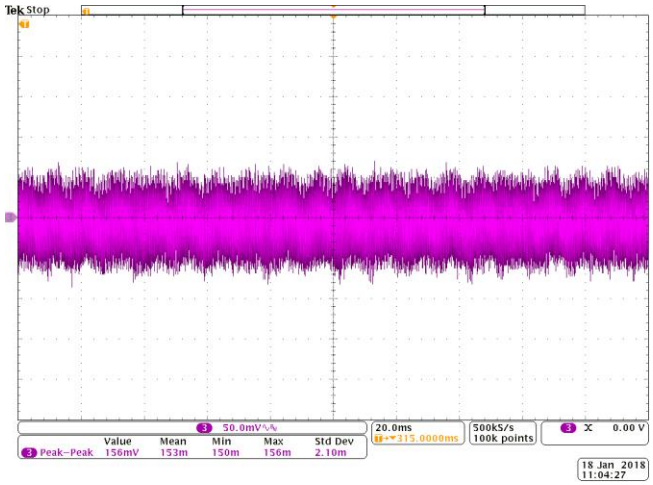


Figure 31: 90Vac/60Hz ΔV_{P-P}=156mV 5V/3A

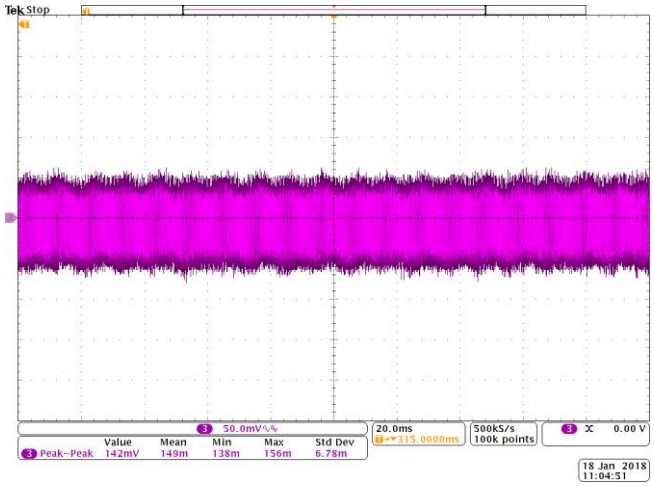


Figure 32: 264Vac/50Hz ΔV_{P-P}=142mv 5V/3A

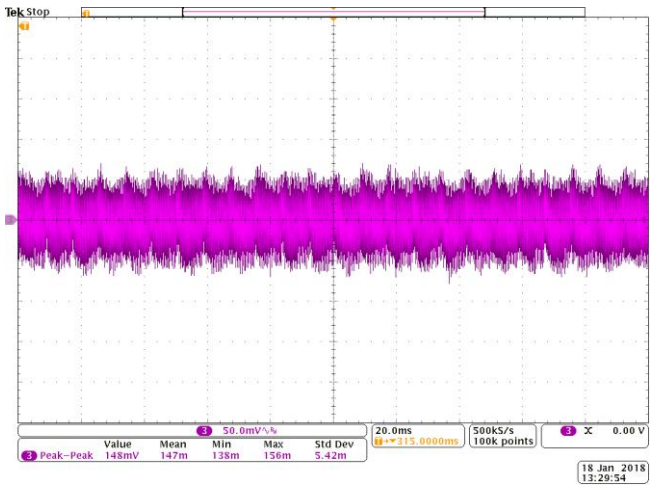


Figure 33: 90Vac/60Hz 9V/3A ΔV=148mV

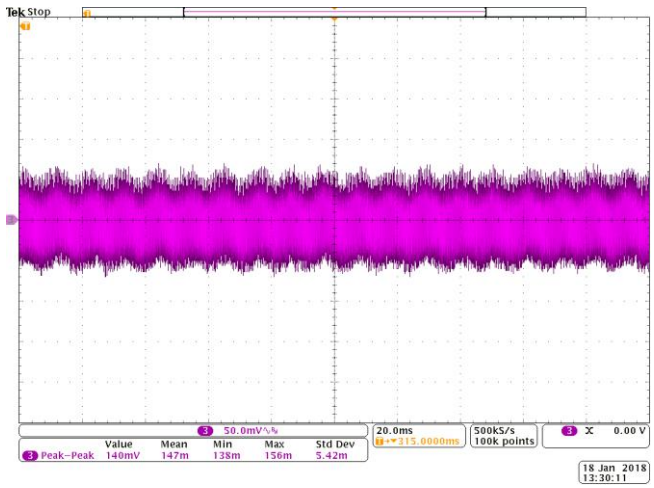


Figure 34: 264Vac/50Hz 9V/3A ΔV=140mv

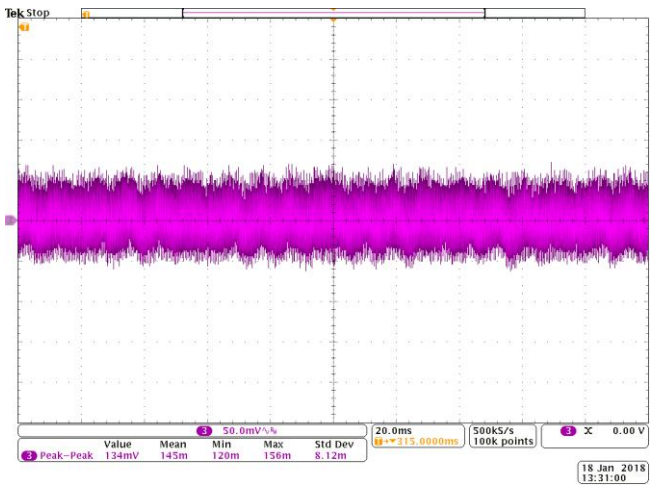


Figure 35: 90Vac/60Hz 12V/2.25A ΔV=134mV

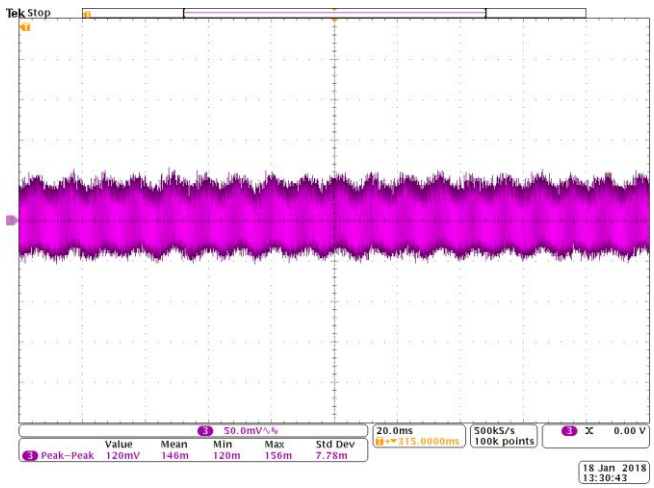


Figure 36: 264Vac/50Hz 12V/2.25A ΔV=120mv

5.4.6 Output Voltage Transition Time

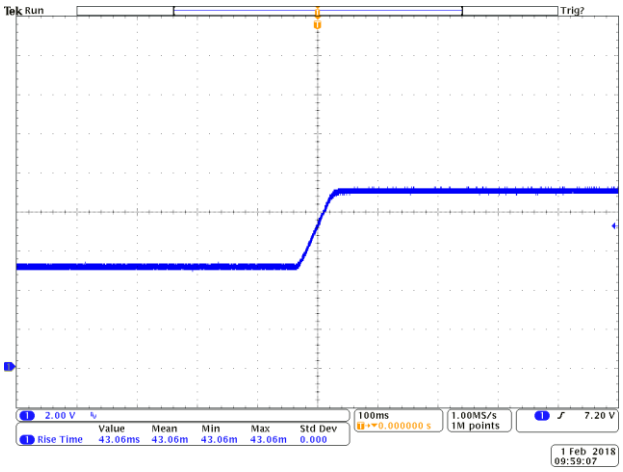


Figure 37: 5V→9V Rise Time: 43.06ms

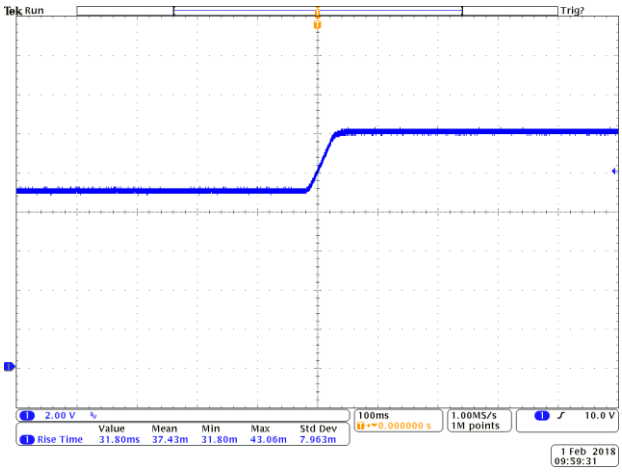


Figure 38: 9V→12V Rise Time: 31.8ms

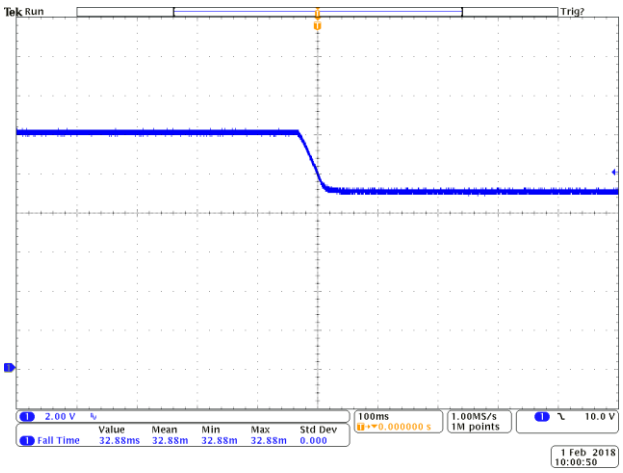


Figure 39: 12V→9V Fall Time: 32.88ms

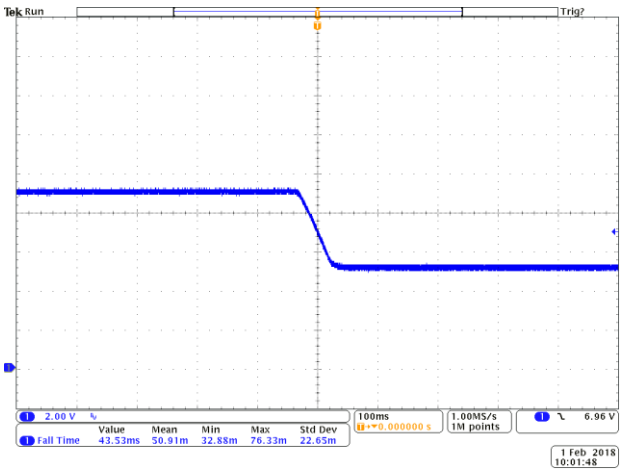


Figure 40: 9V→5V Fall Time: 43.53ms

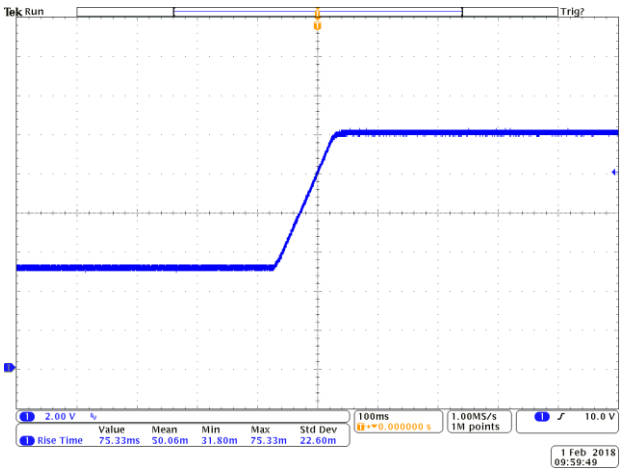


Figure 41: 5V→12V Fall Time: 75.33ms

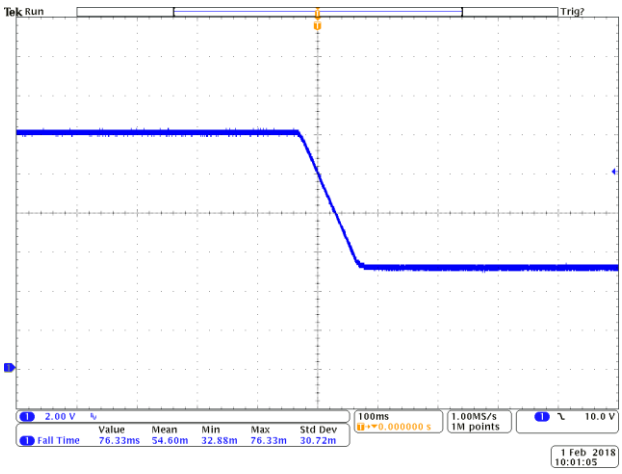


Figure 42: 12V→5V Fall Time: 76.33ms

5.4.7 Thermal Testing

Test Condition: Vin=90V Vo=9V Io=3A Open Frame

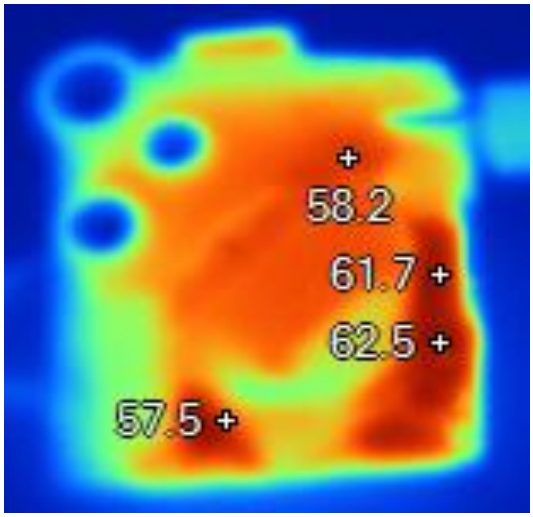


Figure 43: components side

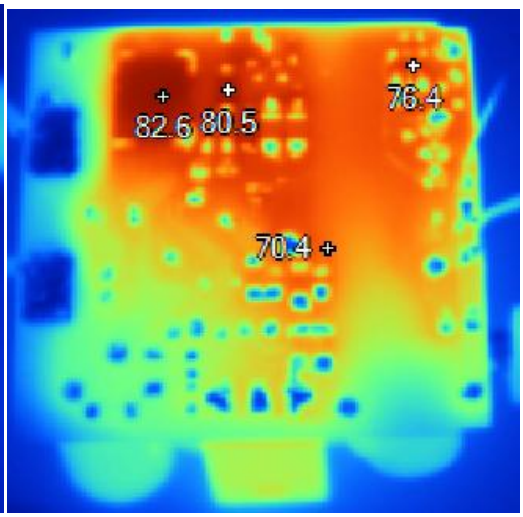


Figure 44: surface mount side

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

5.4.8 EMI (CE) Testing

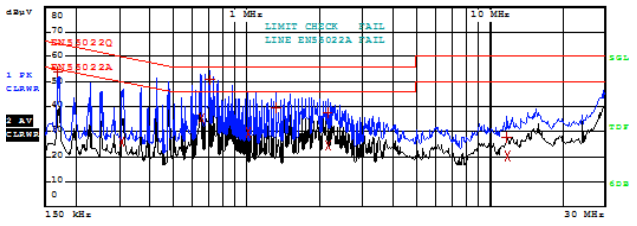


Figure 45: 115Vac/60Hz 12V/2A (L)

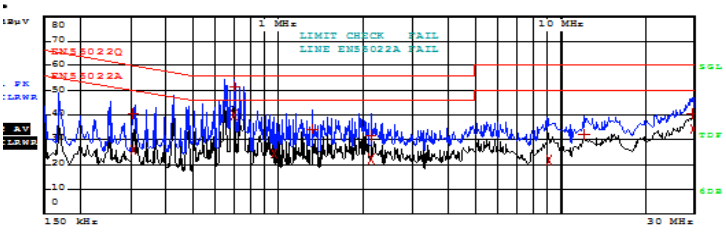


Figure 46: 115Vac/60Hz 12V/2A (N)

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

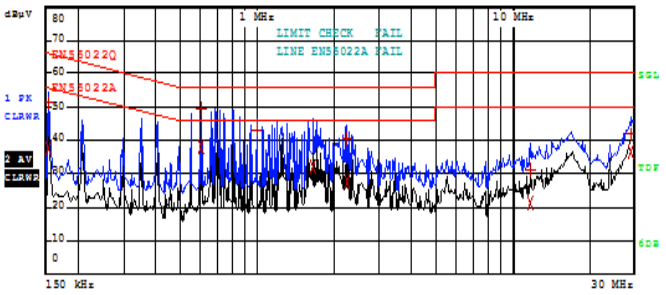


Figure 47: 230Vac/50Hz 12V/2A (L)

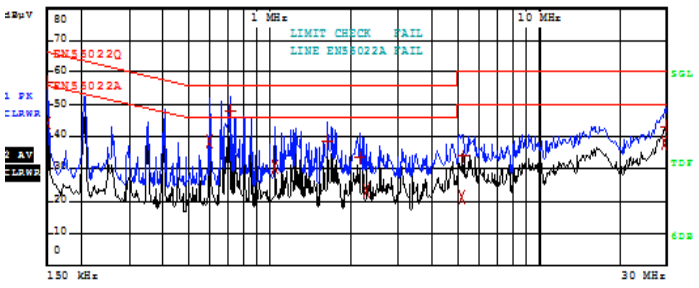


Figure 48: 230Vac/50Hz 12V/2A (N)

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

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