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Chapter 1. Summary

1.1 General Description

The 18W 1C+1A Evaluation Board exemplifies a dual-port charger adaptor design - 18W_USB-C PD 3.0 port, 18W_QC3.0 USB-A port, It also supports port-A trickle charge mode. It is composed of four main parts. AP39303 offers the Quasi-Resonant (QR) Flyback PWM switching. APR347 is a secondary side Synchronous Rectification (SR) Controller. AP43971, an PD3.0/QC4+ decoder, handshakes with the sink device through the CC1/CC2 of Port-C or the D+/D- of Port-A and feedbacks voltage and current regulation information to primary side controller-AP39303 for providing regulation function. AZV831, low-bias current and low voltage operational amplifier, determines if Port-A is in trickle charge mode (<100mA).

1.2 Key Features

1.2.1 System Key Features

- SSR Topology Implementation with an Opto-coupler for Accurate Step Voltage Controlling
- USB Type-A Port supports the 18W QC2.0/3.0 mode function
- USB Type-C Port supports the 18W PD3 function and PPS 3.3V-11V@20mV/step
- Meets DOE VI and CoC Tier 2 Efficiency Requirements
- <75mW No-Load Standby Power
- Low overall system BOM cost

1.2.2 AP39303 Key Features

- Quasi-Resonant (QR) operation/ Peak current mode control/ High-Voltage startup/ Soft Start
- Built-in 120V high voltage VCC LDO to guarantee wide range output voltage application (3.3V~20V, PPS)
- Built-in 700V high performance Power MOSFET
- Low VCC operating current reduces stand-by power (<30mW)
- Adaptive burst mode operation with output voltage
- Adaptive output power limit with output voltage
- Non-Audible-Noise Quasi-Resonant control
- Frequency fold back for high average efficiency
- Secondary winding short protection with FOCP
- Frequency dithering for reducing EMI
- VCC maintain mode
- Useful Pin fault protection:
 - SENSE Pin floating and FB/Opto-Coupler Open/Short
- Comprehensive system protection feature:
 - Programmable External OTP / OLP / BNO / SOVP / SUVP

1.2.3 APR347 Key Features

- Synchronous Rectification Works with DCM/ QR Flyback
- Eliminate Resonant Ringing Interference
- Fewest External Components used

1.2.4 AP43971 Key Features

- Compatible with QC4/QC4+ Protocol
- Support USB PD 3.0 Version 1.2 including PPS (Programmable Power Supply) Mode
- OTP (One-Time-Programmable) for main firmware
- MTP (Multi-Time-Programmable) for system configuration

1.3 Applications

- 18W Dual Port (Port-A/QC3.0 and Port-C/PD3) Wall Charger Adaptor

1.4 Main Power Specifications (CV & CC Mode)

Parameter		Value
Input Voltage		90V _{AC} to 264V _{AC}
Input standby power		< 75mW
Only Port-C	Fix	18W PD3.0 PDO_5V/3A, 9V2A, 12V1.5A
	PPS	20mV step voltage, 3.3V-5.9V/3A, 3.3V-11V/2A
Only Port-A	QC2.0	18W QC2.0 (5V3A, 9V2A, 12V1.5A), & QC3.0
	QC3.0	Continuous mode 200mV, 3.6V-12V
Port-A + Port-C		Port-A: DCP 5V/1.5A Port-C: 5V/2A
Efficiency		Comply with CoC version 5 tier-2
Total Output Power		18W / 22W at PPS
Protections		OCP, OVP, UVP, OLP, OTP
Dimension		35mm x 48mm x 20mm

1.5 Evaluation Board Picture



EVB Top View



EVB Bottom View

Chapter 2. Power Supply Specification

2.1 Specification and Test Results

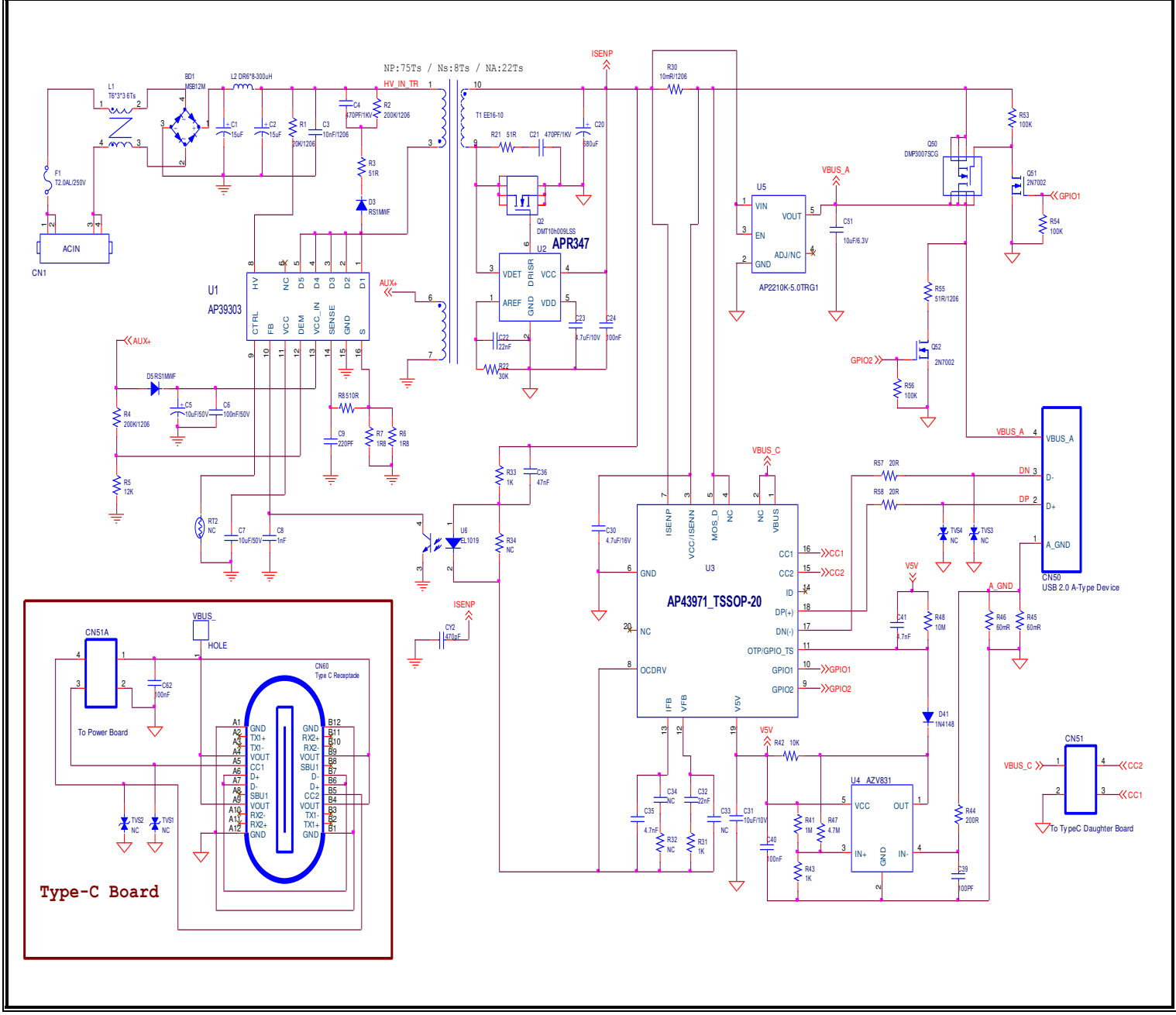
Parameter	Value	Test Summary
Input Voltage / Frequency	90V _{AC} to 264V _{AC} / 47Hz to 63Hz	Test Condition
Input Current	<0.5A _{RMS} at 100V _{AC}	
Standby Power	<75mW; load disconnected	PASS , 56.3mW@115V _{AC} /60Hz 45.5mW@230V _{AC} /60Hz
5V/3A Average Efficiency	DoE VI Efficiency >81.39%	PASS , 88.19%@115V _{AC} /60Hz 87.56%@230V _{AC} /50Hz
	CoC Version 5, Tier2 Efficiency >81.84%	
5V/0.3A Efficiency (10% Load)	CoC Version 5, Tier2 Efficiency >72.48%	PASS , 84.26%@115V _{AC} /60Hz 81.39%@230V _{AC} /50Hz
9V/2A Average Efficiency	DoE VI Efficiency >85.00%	PASS , 89.03%@115V _{AC} /60Hz 88.27%@230V _{AC} /50Hz
	CoC Version 5, Tier2 Efficiency >85.45%	
9V/0.2A Efficiency (10% Load)	CoC Version 5, Tier2 Efficiency >75.45%	PASS , 81.88%@115V _{AC} /60Hz 80.71%@230V _{AC} /50Hz
12V/1.5A Average Efficiency	DoE VI Efficiency >85.00%	PASS , 88.66%@115V _{AC} /60Hz 88.06%@230V _{AC} /50Hz
	CoC Version 5, Tier2 Efficiency >85.45%	
12V/0.15A Efficiency (10% Load)	CoC Version 5, Tier2 Efficiency >75.45%	PASS , 79.30%@115V _{AC} /60Hz 78.35%@230V _{AC} /50Hz
Output Voltage Regulation Tolerance	+/- 5%	PASS ,
5V PPS	3.3V – 5.9V +/- 5%, 0~3A +/-150mA	PASS ,
9V PPS	3.3V – 11V +/- 5%, 0~2A +/-150mA	PASS ,
Conducted EMI	>6dB Margin; according to EN55032 Class B	
Radiated EMI	>6dB Margin; according to EN55032 Class B	

2.2 Compliance

Parameter	Value	Summary
Output Connector	USB2.0 Type-A	
	USB Type-C	
Stress	<90%	
Dimensions W/D/H	35 x 48 x 20 (mm)	

Chapter 3. Schematic

3.1 Schematic



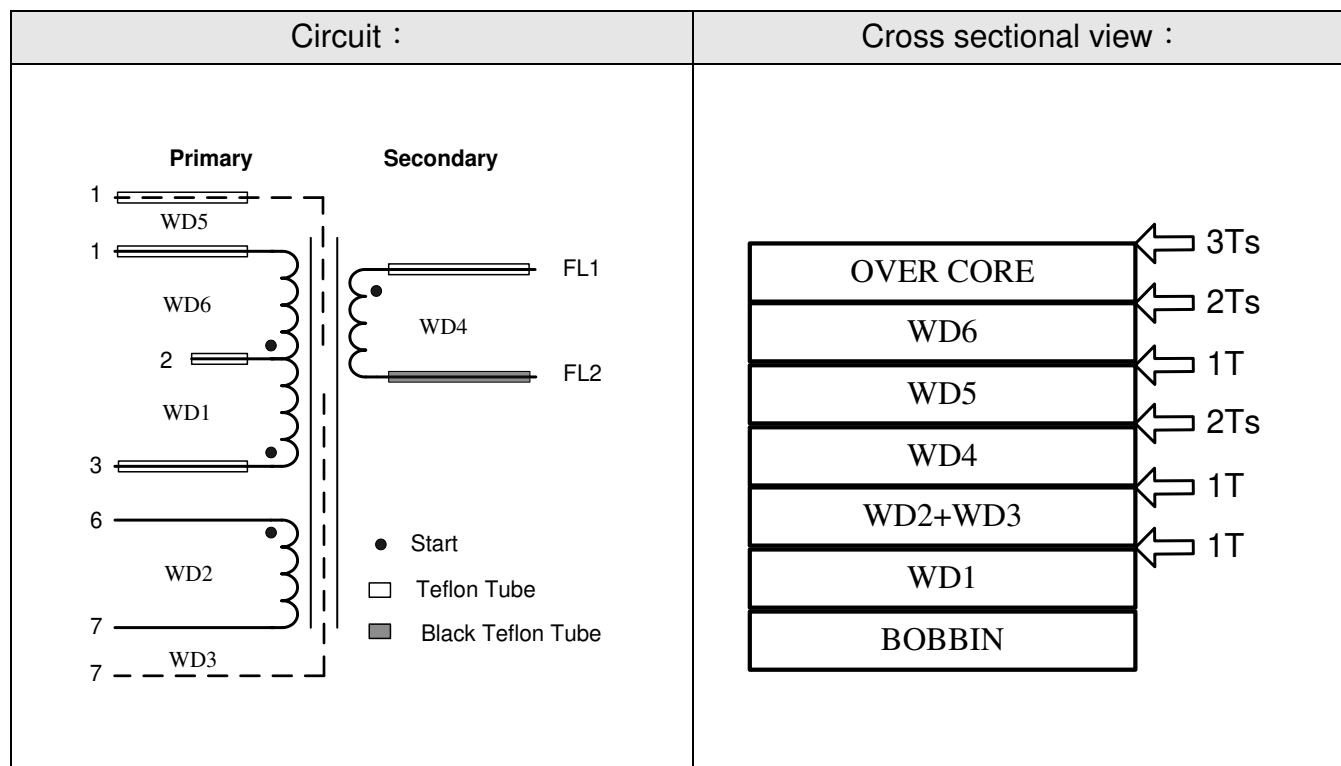
3.2 Bill of Material

Item	Quantity	Designator	Description	Manufacturer Part Number	Manufacturer
1	1	U1	AP39303, QR PWM Switcher	AP39303S16-13	Diodes
2	1	U2	APR347, SR Controller	APR347	Diodes
3	1	U3	AP43971_20L, Decoder	AP43971_20L	Diodes
4	1	U4	AZV831, Comparator	AZV831KTR-G1	Diodes
5	1	U5	AP2210K-5.0TRG1	AP2210K-5.0TRG1	Diodes
6	1	Q50	DMP3007SCG, 30V P-MosFET	DMP3007SCGQ-13	Diodes
7	1	BD1	MSB12M, Bridge Rectifier Diode	MSB12M-13	Diodes
8	1	Q2	DMT10H009LSS, 100V N-MosFET	DMT10H009LSS-13	Diodes
9	2	Q52,Q51	2N7002/SOT23	2N7002-13-F	Diodes
10	2	D3,D5	RS1MWF/SOD123	RS1MWF-7	Diodes
11	1	D41	1N4148/SOD323	1N4148WS-13-F	Diodes
12	1	U6	LTV1009TP-G (CTR-200/400)	LTV-1009TP1-G	Lite-On
13	1	C8	1nF/50V/X7R/0603		
14	1	C9	220PF/50V/NPO/0603		
15	2	C22,C32	22nF/50V/X7R/0603		
16	1	C23	4.7uF/50V/X7R/0603		
17	3	C6,C24,C40	100nF/50V/X7R/0603		
18	1	C30	4.7uF/16V/X7R/0603		
19	2	C35,C41	4.7nF/50V/X7R/0603		
20	1	C36	47nF/50V/X7R/0603		
21	1	C39	100PF/50V/X7R/0603		
22	1	C51	2.2uF/50V/X5R/0603		
23	1	C31	10uF/10V		
24	1	C7	10uF/50V/1206		
25	1	C3	10nF/1KV/1206		
26	2	C4,C21	470PF/1KV/1206		
27	2	C1,C2	15uF/400V/10*16		
28	1	C5	10uF/50V/5*11		
29	1	C20	680uF/16V/8*12/Polymer CAP		
30	1	CY2	470pF/Y1-CAP		
31	1	R1	20K/5%/1206		
32	1	R2	200K/5%/1206		
33	1	R3	51R/5%/0805		
34	1	R4	200K/1%/1206		
35	1	R5	12K/1%/0603		
36	2	R7,R6	1R5/1%/1206		
37	1	R8	510R/1%/0603		
38	1	R21	51R/5%/1206		
39	1	R22	30K/1%/0603		
40	1	R30	10mR/1%/1206 (Low TCR)	SMB12A1FR010T	SART
41	3	R31,R33,R43	1K/1%/0603		
42	1	R41	1M/1%/0603		
43	1	R47	4.7M/1%/0603		
44	1	R42	10K/1%/0603		
45	1	R44	200R/1%/0603		
46	2	R45,R46	60mR/1%/1206		
47	1	R48	10M/1%/0603		
48	3	R53,R54,R56	100K/5%/0603		
49	1	R55	51R/5%/1206		
50	2	R58,R57	20R/5%/0603		

18W Two ports 1C+1A PD3.0 and QC3.0 Adapter EVB1 User Guide

Item	Quantity	Designator	Description	Manufacturer Part Number	Manufacturer
51	1	F1	T2.0AL/250V		
52	1	T1	EE16-10 - 750uH_NP:NS:NA=75:8:22		
53	1	L1	T6*3*3 6Ts		
54	1	L2	DR6*8-300uH		
55	1	CN50	USB 2.0 A-Type Device		
56	2	TVS3,TVS4	NC		
57	5	RT2,R32,C33,R34,C34	NC		
Type-C Connector Daughter Board					
Item	Quantity	Designator	Description	Manufacturer Part Number	Manufacturer
1	1	CN60	Type C Connector	UT13513-1180A-7H	Foxconn
2	1	C62	100nF/50V/0603		
3	2	TVS2,TVS1	NC		
Note: ➤ Current sense resistor (R30) should use the Low TCR type resistor.					

3.3 Transformer SPEC



Definition	Pin define (Start >> End)	Wire (Diameter)	Turn (Ts)	Layers	Layers of Tape
WD1	3 >> 2	2UEW-B 0.27mm x 1P	52	2	1Ts
WD2	6 >> 7	2UEW-B 0.15mm x 1P	22	1	1Ts
WD3	7 >> Null	2UEW-B 0.15mm x 1P	22		
WD4	FL1 >> FL2	Triple wire-B 0.70mm x 1P	8	1	2Ts
WD5	1 >> Null	2UEW-B 0.20mm x 1P	15	1	1Ts
WD6	2 >> 1	2UEW-B 0.27mm x 1P	23	1	2Ts
OVER CORE					3Ts

Item	Test Condition	Rating
Primary Inductance	Pin 3-1, all other windings open, measured at 20kHz / 1V	750uH+/- 5%

3.4 Schematics Description

3.4.1 Fuse, EMI Filter and Rectifier

The Fuse F1 protects against over-current conditions which occur when some main components failed. The L2 is a common mode choke for the common mode noise suppression. The BD1 is a rectifier which converts alternating current and voltage into direct current and voltage. The C2, L1, C3 are composed of the Pi filter for filtering the differential switching noise back to AC source.

3.4.2 AP39303 Quasi-Resonant PWM Switcher

AP39303 is a highly integrated power switcher with a built-in Quasi-Resonant (QR) PWM controller and a 700V high performance Power MOSFET. With its high-voltage start-up circuitry, AP39303 provides an excellent green power solution. It also integrates a 120V VCC LDO circuitry and allows a wide voltage range of VCC_IN. This makes it a great choice in wide output voltage range application such as PD and QC.

3.4.3 APR347 Synchronous Rectification (SR) Controller

As a high performance solution, APR347 is a secondary side SR controller to effectively reduce the secondary side rectifier power dissipation which works in DCM operation.

3.4.4 AP43971 PD3.0 and QC2.0/3.0 Decoder

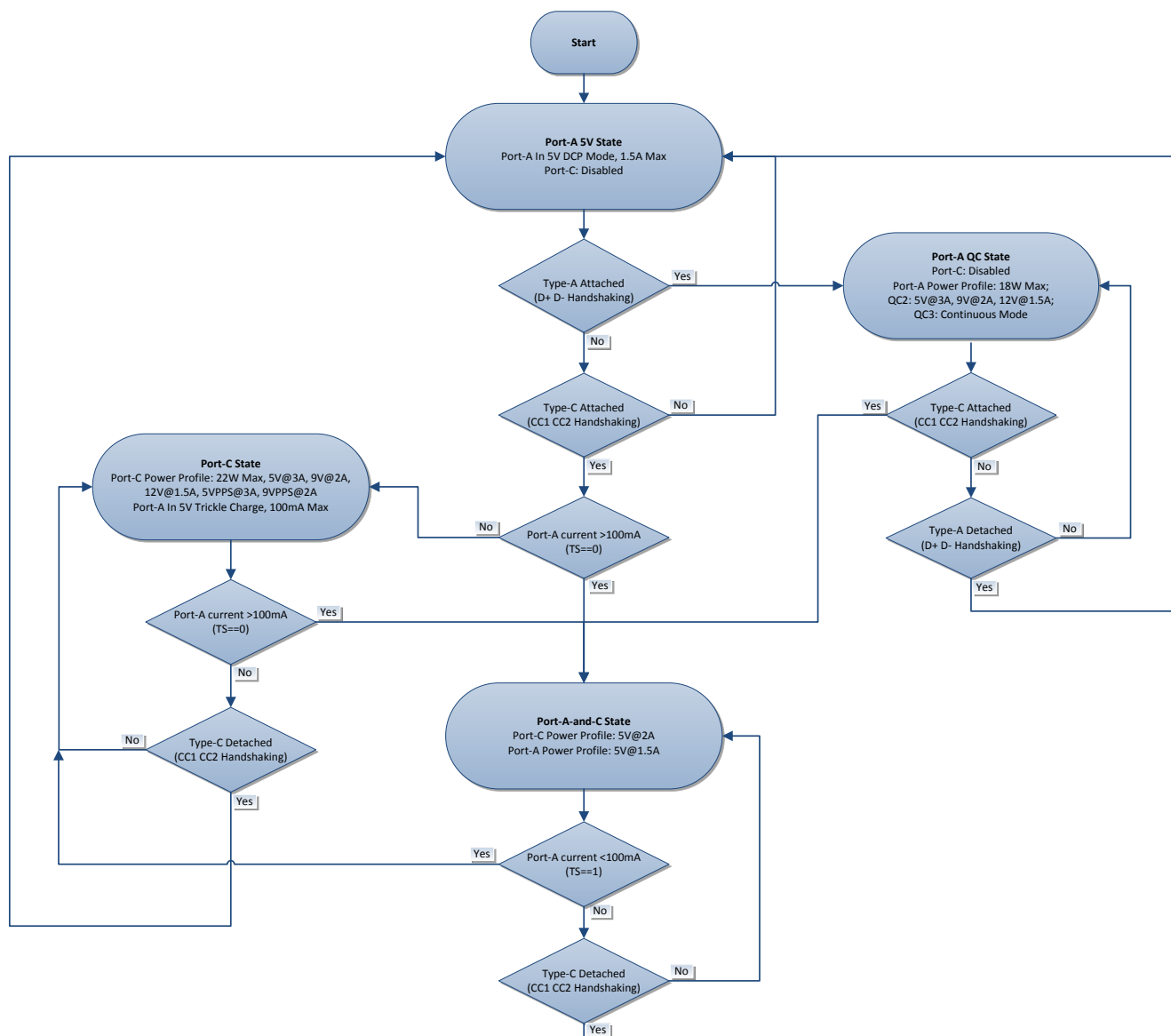
The following pins provide critical protocol decoding and regulation functions in AP43971:

- 1) **CC1 & CC2 (Pin 11, 10):** CC1 & CC2 (Configuration Channel 1 & 2) are defined by USB PD spec to provide the channel communication link between power source and sink devices. The CC1 & CC2 connected to Port-C and to perform PD3.0 power profile function.
- 2) **D+ & D- (Pin 13, 12):** 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. The D+ & D- connected to Port-A and to perform QC2.0/QC3.0 power profile function.
- 3) **Constant Voltage (CV):** The CV is implemented by sensing VCC (pin 3) via built-in resistor divider and compared with internal reference voltage. The output voltages can be adjusted by firmware programming.
- 4) **Constant Current (CC):** The CC is implemented by sensing the current sense resistor (R30, 10mΩ, 1%, Low TCR) and compared with internal programmable reference voltage. The output current can be adjusted by firmware programming.
- 5) **Loop Compensation:** C32, R31 & C33 form the voltage loop compensation circuit, and C35, R32 & C34 form the current loop compensation circuit.
- 6) **OCDRV (Pin 5):** It is the key interface link from secondary decoder (AP43971) to primary regulation circuit (AP39303). It is connected to Opto-coupler U6 Pin 2 (Cathode) for feedback information based on all sensed CC1 & CC2, D+ & D- voltage status for getting desired V_{BUS} voltage & current.
- 7) **GPIO1:** The pin is used to turn on the MOSFET_Q50 to bypass the LDO (U5), when Port-A output current is greater than 100mA.
- 8) **GPIO2:** The pin is used to turn on the MOSFET_Q52 to enable Port-A discharge function.
- 9) **GPIO-TS:** The pin connected to current sensing circuit output (U4_pin#1) to detection the Port-A output current. When Port-A output current greater than 100mA, the GPIO-TS is LOW, the Q50 turns on to bypass LDO_U5. The adapter exits 100mA trickle-charge mode and Port-A is capable of providing current greater than 100mA.

3.5 Dual Port Power/Current Sharing Control Flowchart

After AC power plugged in, the adapter starts up and enters into default “Port-A 5V State”. In this state, the adapter can provide 5V output to Port-A with less than 1.5A capability, while Port-C is disabled. The adapter remains in this mode until either Port-A handshake through D+/D- for QC or Port-C handshake through CC1/CC2 for PD occurs. If Port-A for QC mode request passes, the adapter enters into “Port-A QC State” and provides up to 18W for QC2.0 or QC3.0 operation through Port-A. If Port-C for PD mode request passes, the adapter further checks if Port-A consumes more than 100mA of current. If so, the adapter enters into “Port-A-and-C state” and provides only 5V to both Port-A with 1.5A and Port-C with 2.0A. Otherwise, the adapter enters into “Port-C State” and provides up to 18W for PD3.0 operation through Port-C and 5V@100mA for trickle charge through Port-A. The adapter will follow the mode operation described in the flowchart for operation mode change.

Detection of Port-A load is executed by sensing current drawn from Type A receptacle (A_GND pin). Once Port-A output current is greater than 100mA, AZV831 comparator pulls GPIO_TS pin LOW to notify the embedded MCU of AP43971_20L for proper operation mode change.



Chapter 4. Evaluation Board Connections

4.1 Quick Start Guide Before Connection

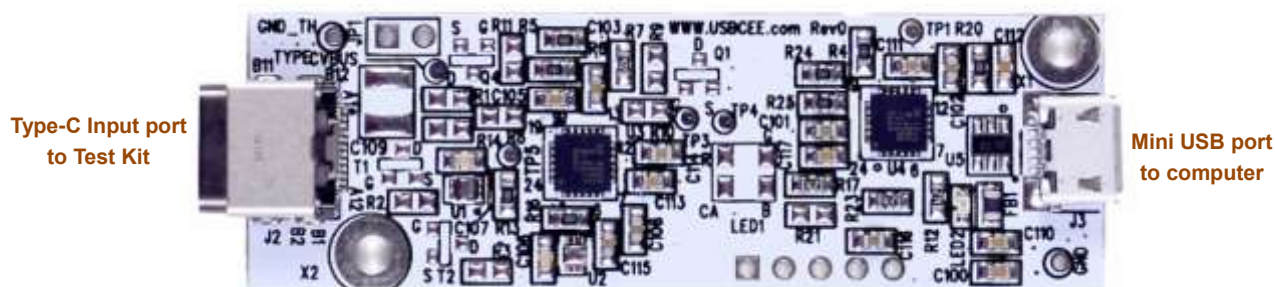
- 1) Before starting the EVB test, the end user needs to prepare the following tool, software and manuals.

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

- USBCEE PD3.0 Test Kit: USBCEE Power Adapter Tester. <https://www.usbcee.com/product-details/4>

USBCEE PAT Tester	GUI Display
	

- 2) Prepare a certified 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) Use a type-C cable for the connection between EVB to Tester.
- 6) Apply E-load at the terminal “JP1” on tester which indicated in figure below.
- 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.



The Test Kit Input & Output and E-load Connections

4.2 Connection with E-Load

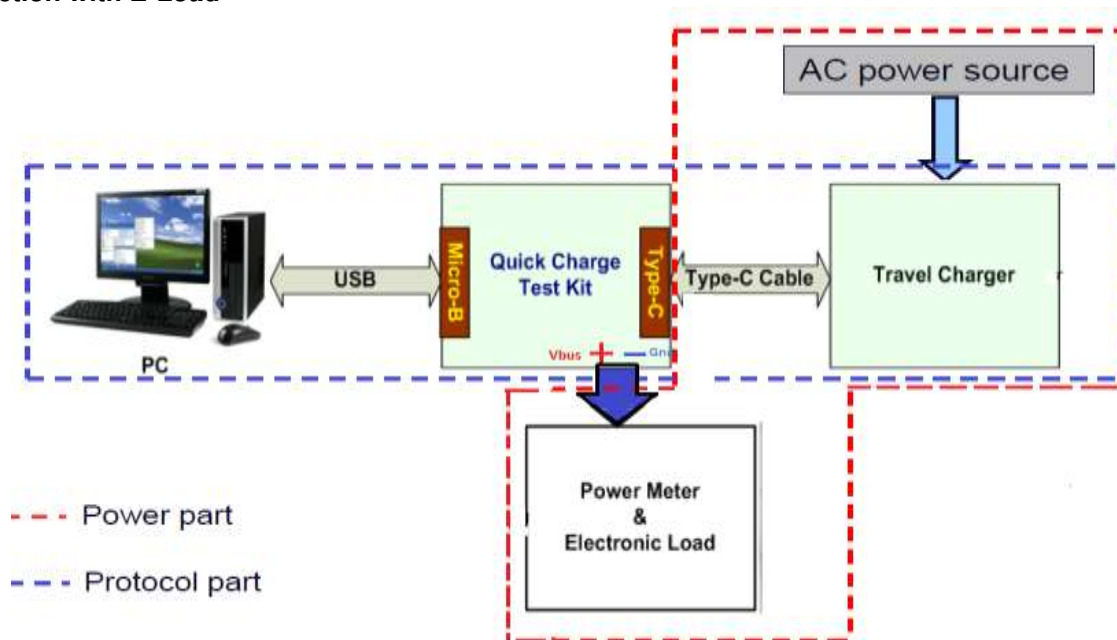
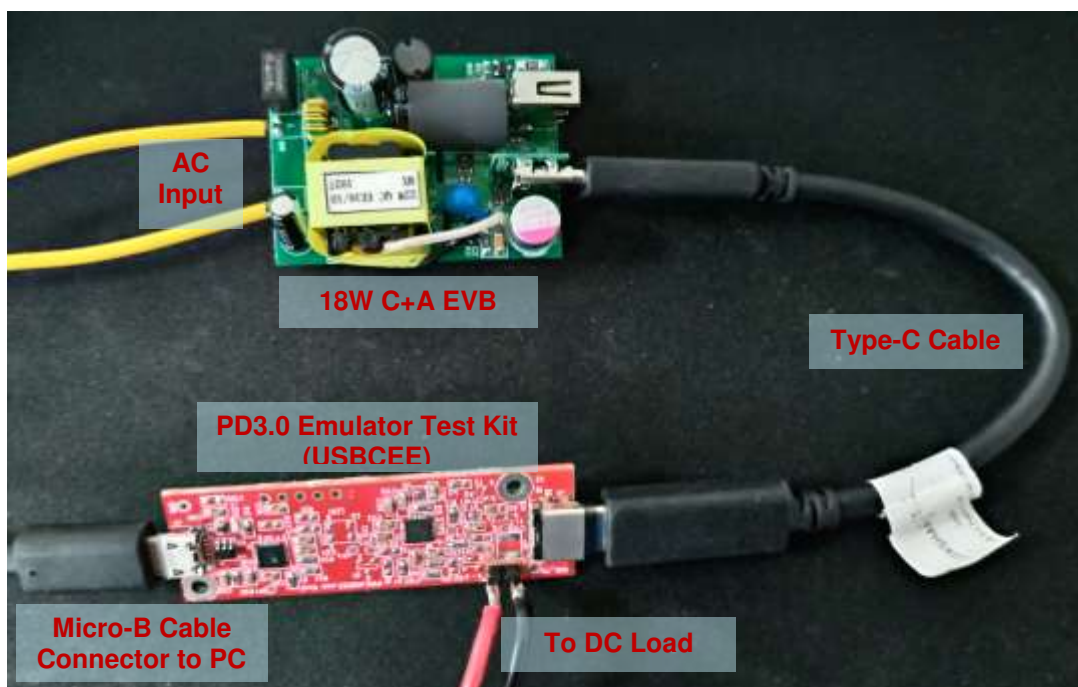


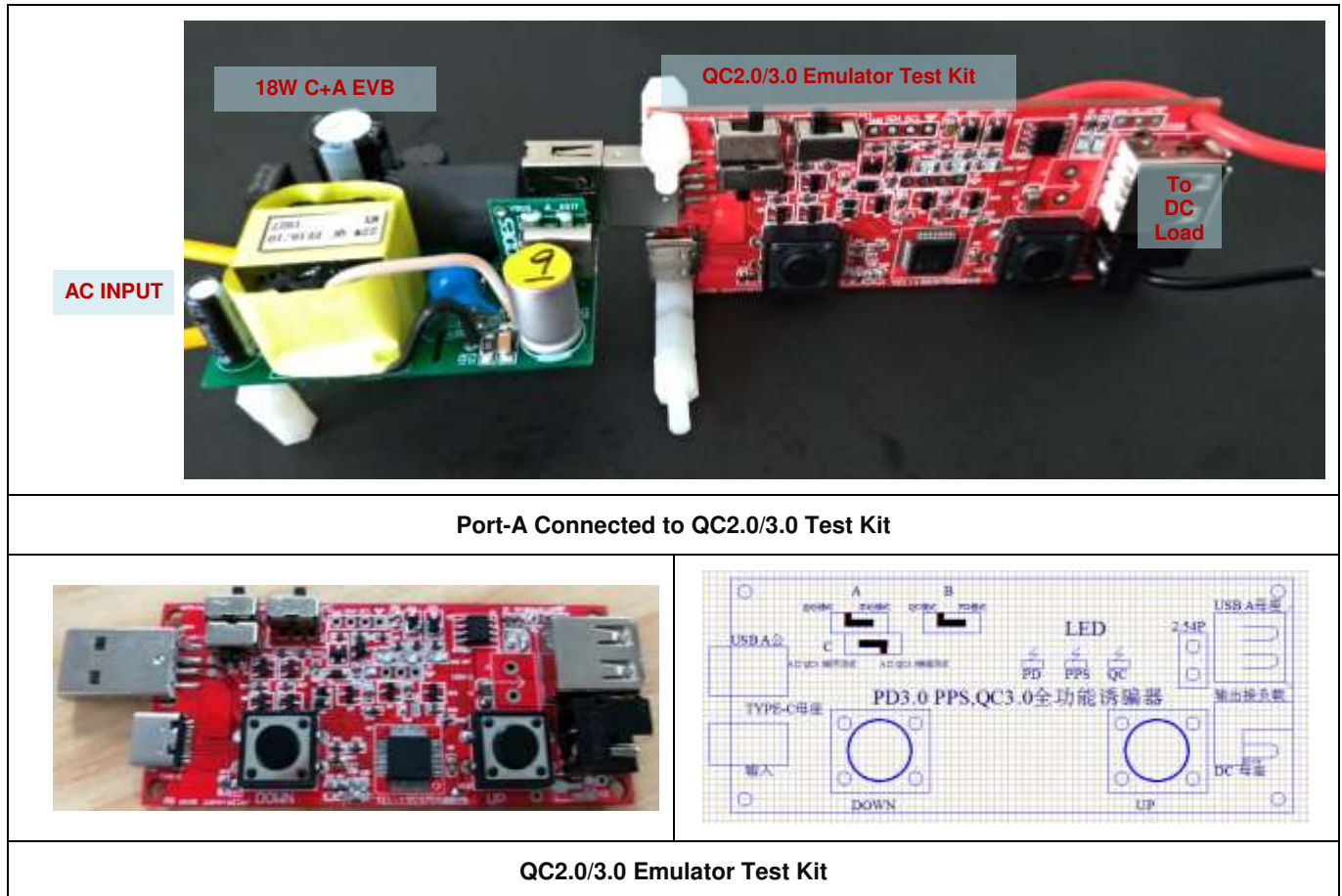
Diagram of Connections in the Sample Board



Wire Connection of Port-C of 18W EVB to Test Kit and PC Computer

4.3 QC2.0/3.0 Emulator connection

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.

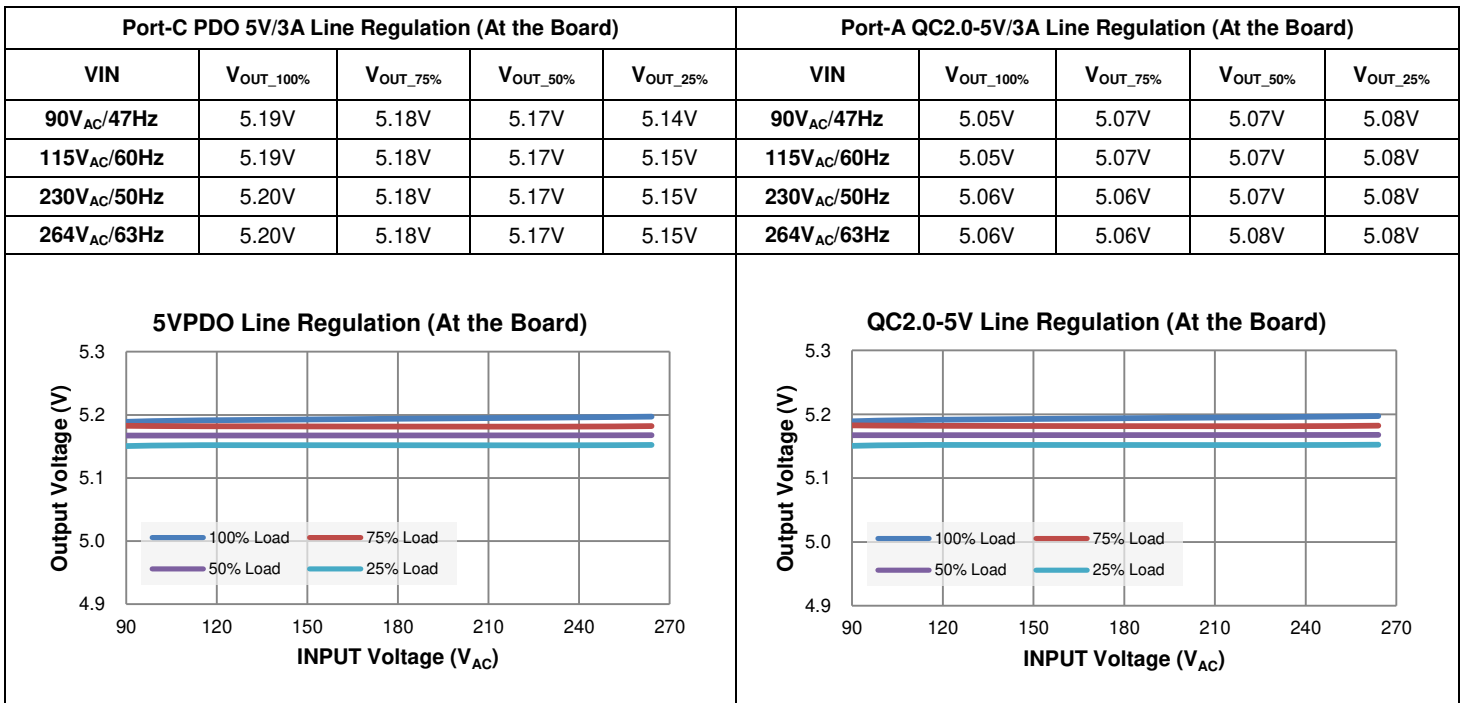


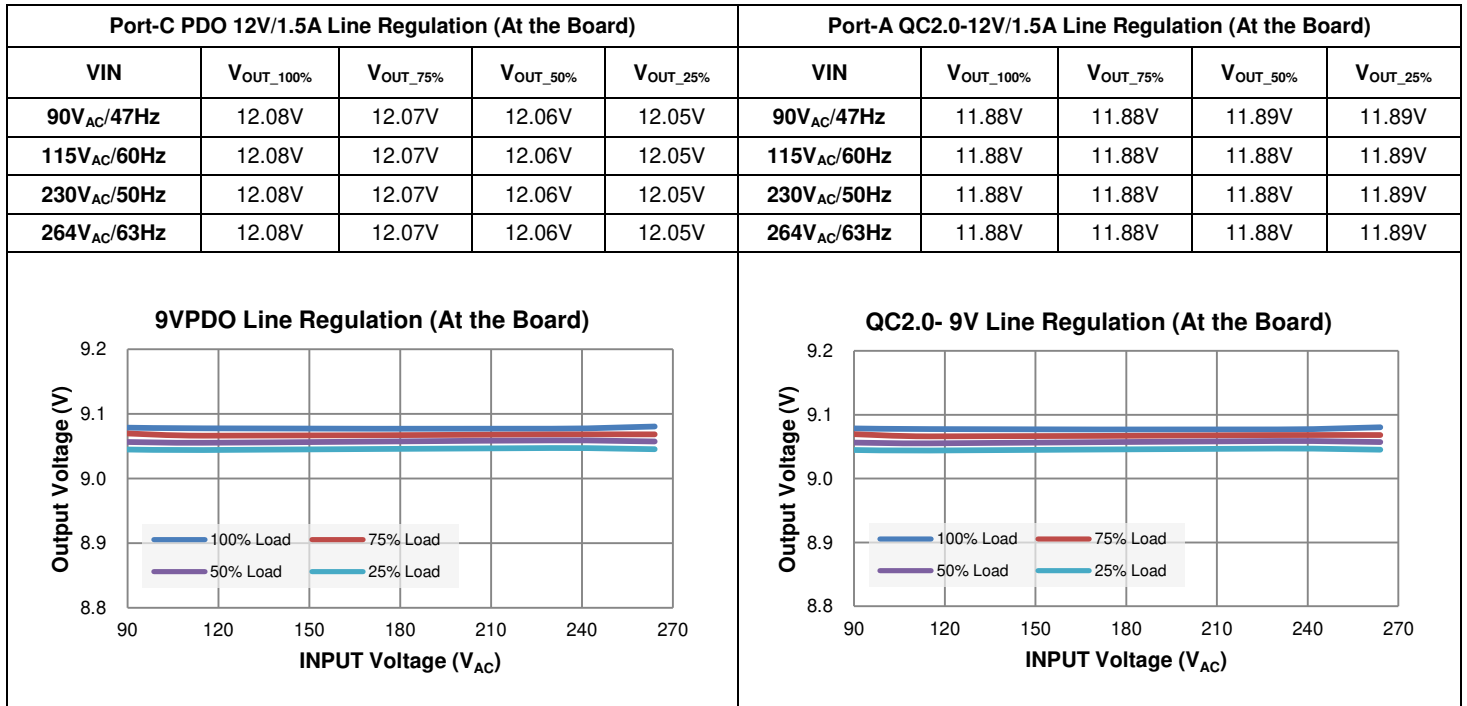
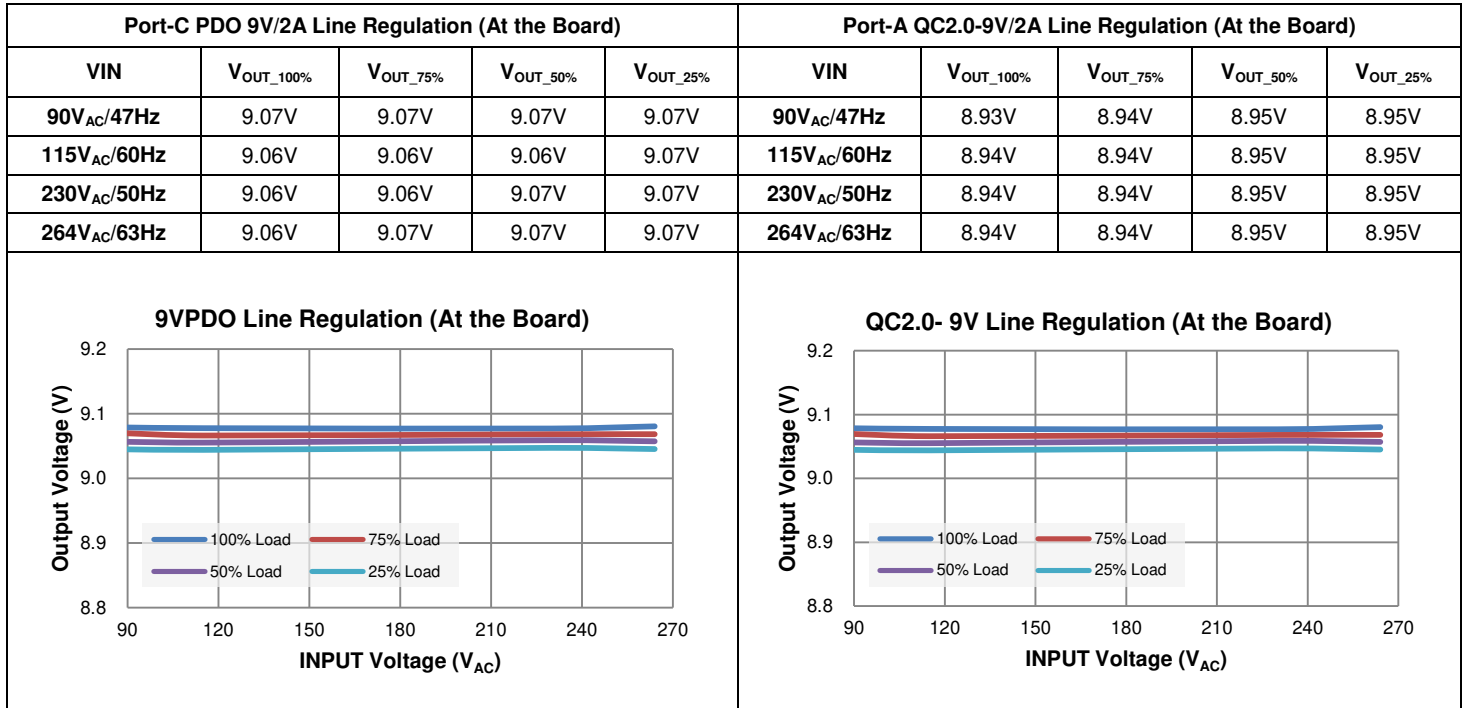
Chapter 5. Input & Output Characteristics

5.1 Input Standby Power

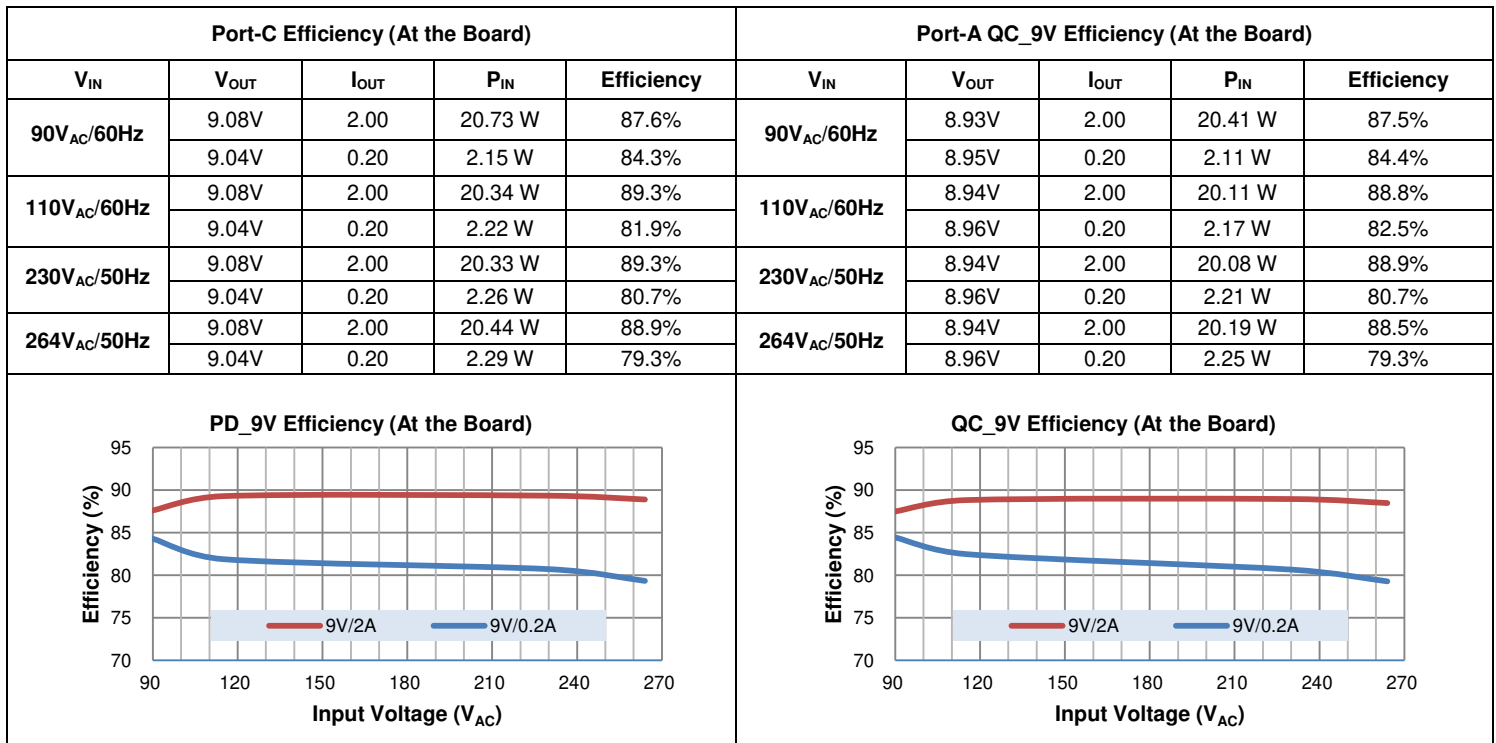
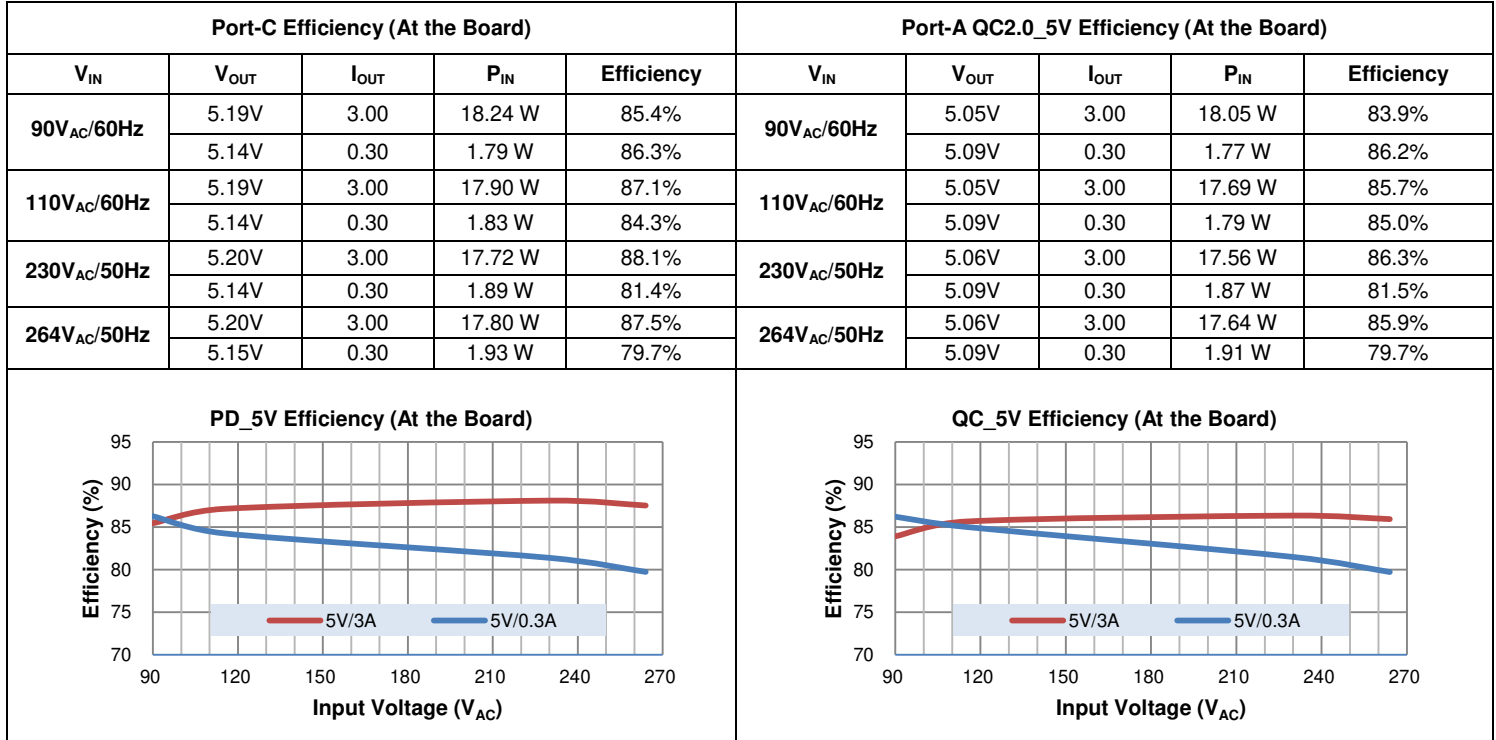
V_{IN}	V_{OUT}	P_{IN}
90V _{AC} /47Hz	5.14V	41.8mW
115V _{AC} /60Hz	5.14V	56.3mW
230V _{AC} /50Hz	5.14V	45.5mW
264V _{AC} /63Hz	5.14V	48.4mW

5.2 Output Voltage Regulation Performance Curve



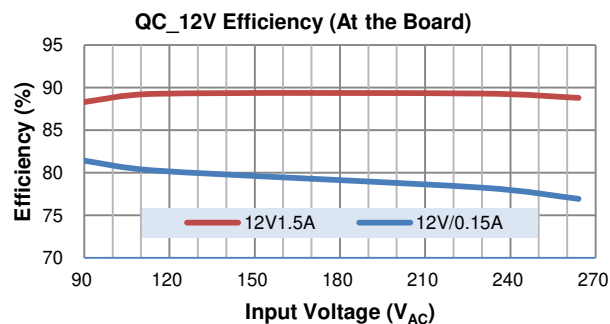
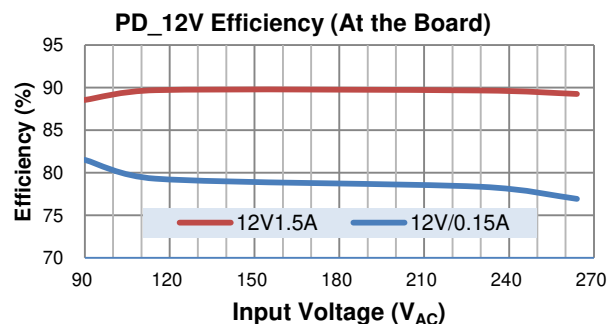


5.3 Efficiency vs. AC Line Input Voltage

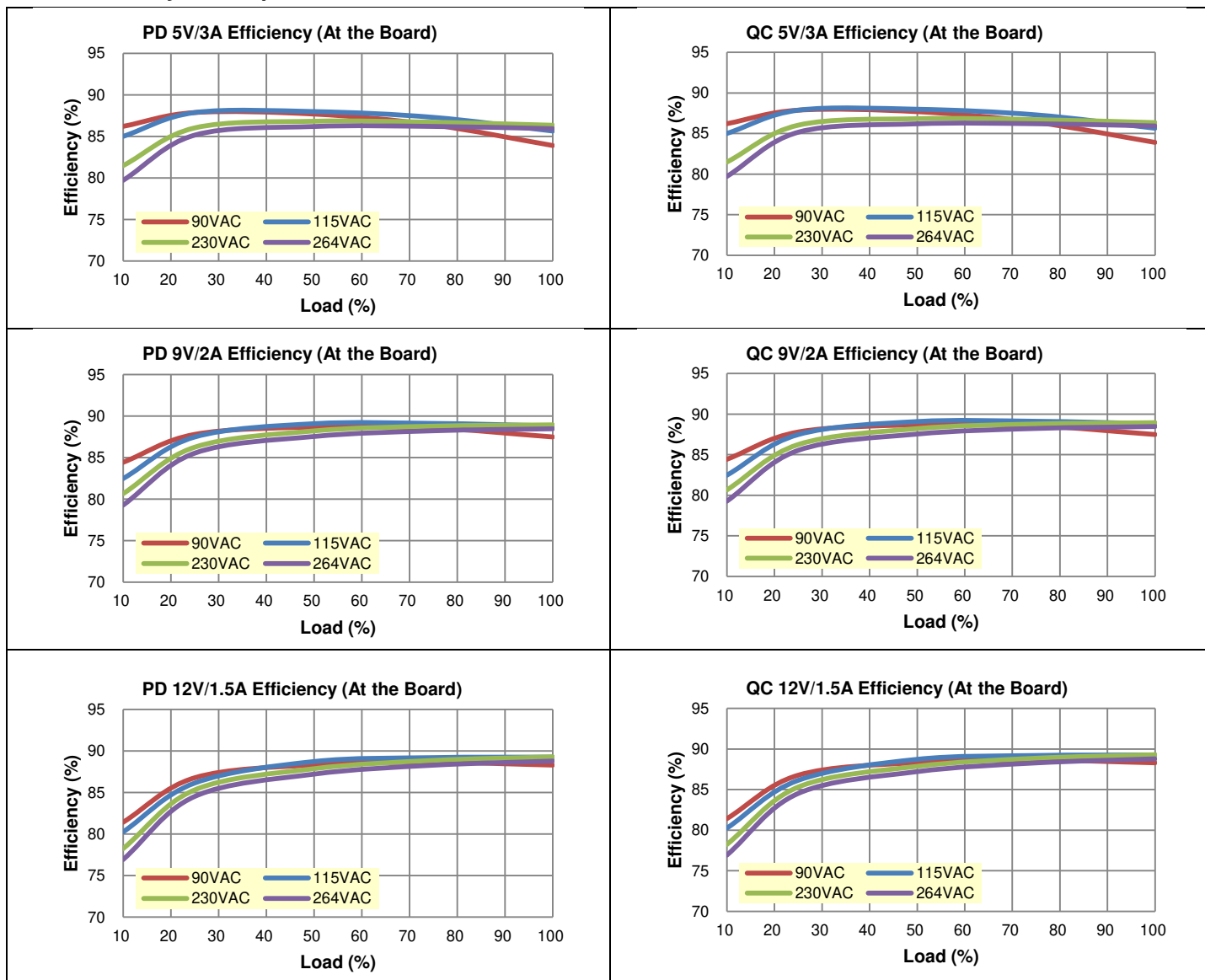


Port-C Efficiency (At the Board)	Port-A QC_12V Efficiency (At the Board)
----------------------------------	---

V _{IN}	V _{OUT}	I _{OUT}	P _{IN}	Efficiency	V _{IN}	V _{OUT}	I _{OUT}	P _{IN}	Efficiency
90V _{AC} /60Hz	12.08V	1.50	20.48 W	88.5%	90V _{AC} /60Hz	11.88V	1.50	20.17 W	88.3%
	12.05V	0.15	2.22 W	81.5%		11.89V	0.15	2.18 W	81.4%
110V _{AC} /60Hz	12.08V	1.50	20.20 W	89.7%	110V _{AC} /60Hz	11.88V	1.50	19.95 W	89.3%
	12.05V	0.15	2.28 W	79.3%		11.89V	0.15	2.21 W	80.3%
230V _{AC} /50Hz	12.08V	1.50	20.21 W	89.6%	230V _{AC} /50Hz	11.88V	1.50	19.95 W	89.3%
	12.05V	0.15	2.31 W	78.4%		11.89V	0.15	2.27 W	78.3%
264V _{AC} /50Hz	12.08V	1.50	20.30 W	89.2%	264V _{AC} /50Hz	11.88V	1.50	20.06 W	88.8%
	12.05V	0.15	2.34 W	76.9%		11.89V	0.15	2.31 W	76.9%



5.4 Efficiency vs. Output Load



5.5 Average Efficiency at Different Loading

5.5.1 Port-C Average Efficiency

Port-C PD3.0_PDO_5V / 3A Average Efficiency

V _{IN}	I _{OUT}		V _{OUT}	P _{IN}	P _{OUT}	Efficiency	Average Efficiency	CoC Tier 2 required
115V _{AC} /60Hz	100.0%	3.00A	5.19V	17.90W	15.60W	87.1%	88.19%	81.84%
	75.0%	2.25A	5.18V	13.17W	11.66W	88.5%		
	50.0%	1.50A	5.17V	8.74W	7.76W	88.8%		
	25.0%	0.75A	5.15V	4.38W	3.87W	88.3%		
	10.0%	0.30A	5.14V	1.83W	1.54W	84.3%		
230V _{AC} /50Hz	100.0%	3.00A	5.20V	17.72W	15.61W	88.1%	87.56%	81.84%
	75.0%	2.25A	5.18V	13.24W	11.65W	88.0%		
	50.0%	1.50A	5.17V	8.83W	7.75W	87.7%		
	25.0%	0.75A	5.15V	4.47W	3.86W	86.4%		
	10.0%	0.30A	5.14V	1.89W	1.54W	81.4%		

Port-C PD3.0_PDO_9V / 2A Average Efficiency

V _{IN}	I _{OUT}		V _{OUT}	P _{IN}	P _{OUT}	Efficiency	Average Efficiency	CoC Tier 2 required
115V _{AC} /60Hz	100.0%	2.00A	9.08V	20.34W	18.16W	89.3%	89.03%	81.84%
	75.0%	1.50A	9.07V	15.23W	13.61W	89.4%		
	50.0%	1.00A	9.06V	10.16W	9.07W	89.2%		
	25.0%	0.50A	9.04V	5.13W	4.53W	88.2%		
	10.0%	0.20A	9.04V	2.22W	1.82W	81.9%		
230V _{AC} /50Hz	100.0%	2.00A	9.08V	20.33W	18.16W	89.3%	88.27%	81.84%
	75.0%	1.50A	9.07V	15.29W	13.61W	89.1%		
	50.0%	1.00A	9.06V	10.27W	9.07W	88.3%		
	25.0%	0.50A	9.05V	5.25W	4.54W	86.3%		
	10.0%	0.20A	9.04V	2.26W	1.82W	80.7%		

Port-C PD3.0_PDO_12V / 1.5A Average Efficiency

V _{IN}	I _{OUT}		V _{OUT}	P _{IN}	P _{OUT}	Efficiency	Average Efficiency	CoC Tier 2 required
115V _{AC} /60Hz	100.0%	1.50A	12.08V	20.20W	18.12W	89.7%	88.66%	81.84%
	75.0%	1.13A	12.07V	15.17W	13.58W	89.5%		
	50.0%	0.75A	12.06V	10.17W	9.05W	89.0%		
	25.0%	0.38A	12.05V	5.23W	4.53W	86.5%		
	10.0%	0.15A	12.05V	2.28W	1.81W	79.3%		
230V _{AC} /50Hz	100.0%	1.50A	12.08V	20.21W	18.12W	89.6%	88.06%	81.84%
	75.0%	1.13A	12.07V	15.24W	13.58W	89.1%		
	50.0%	0.75A	12.06V	10.27W	9.04W	88.0%		
	25.0%	0.38A	12.05V	5.30W	4.53W	85.4%		
	10.0%	0.15A	12.05V	2.31W	1.81W	78.4%		

5.5.2 Port-A Average Efficiency

Port-A_QC2.0_5V / 3A Average Efficiency

V _{IN}	I _{OUT}		V _{OUT}	P _{IN}	P _{OUT}	Efficiency	Average Efficiency	CoC Tier 2 required
115V _{AC} /60Hz	100.0%	3.00A	5.05V	17.69W	15.15W	85.7%	87.2%	85.45%
	75.0%	2.25A	5.07V	13.05W	11.39W	87.3%		
	50.0%	1.50A	5.07V	8.65W	7.61W	88.0%		
	25.0%	0.75A	5.08V	4.33W	3.81W	87.9%		
	10.0%	0.30A	5.09V	1.79W	1.52W	85.0%		72.48%
230V _{AC} /50Hz	100.0%	3.00A	5.06V	17.56W	15.16W	86.3%	86.48%	85.45%
	75.0%	2.25A	5.06V	13.14W	11.39W	86.7%		
	50.0%	1.50A	5.07V	8.76W	7.61W	86.8%		
	25.0%	0.75A	5.08V	4.43W	3.81W	86.0%		
	10.0%	0.30A	5.09V	1.87W	1.52W	81.5%		72.48%

Port-A_QC2.0_9V / 2A Average Efficiency

V _{IN}	I _{OUT}		V _{OUT}	P _{IN}	P _{OUT}	Efficiency	Average Efficiency	CoC Tier 2 required
115V _{AC} /60Hz	100.0%	2.00A	8.94V	20.11W	17.86W	88.8%	88.62%	85.45%
	75.0%	1.50A	8.94V	15.05W	13.41W	89.1%		
	50.0%	1.00A	8.95V	10.04W	8.94W	89.1%		
	25.0%	0.50A	8.95V	5.11W	4.47W	87.5%		
	10.0%	0.20A	8.96V	2.17W	1.79W	82.5%		72.48%
230V _{AC} /50Hz	100.0%	2.00A	8.94V	20.08W	17.86W	88.9%	88.05%	85.45%
	75.0%	1.50A	8.94V	15.10W	13.41W	88.8%		
	50.0%	1.00A	8.95V	10.14W	8.94W	88.2%		
	25.0%	0.50A	8.95V	5.18W	4.47W	86.3%		
	10.0%	0.20A	8.96V	2.21W	1.79W	80.7%		72.48%

Port-A_QC2.0_12V / 1.5A Average Efficiency

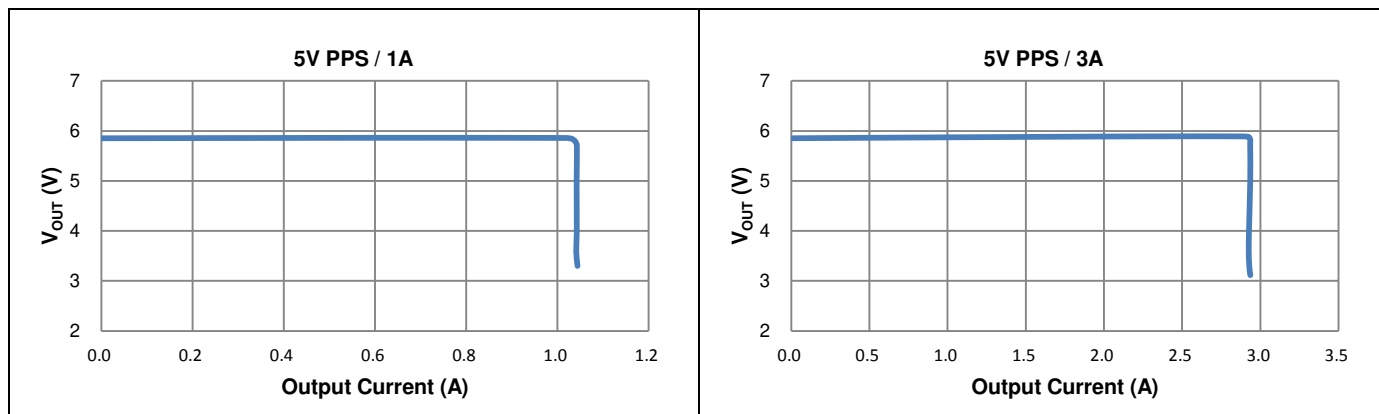
V _{IN}	I _{OUT}		V _{OUT}	P _{IN}	P _{OUT}	Efficiency	Average Efficiency	CoC Tier 2 required
115V _{AC} /60Hz	100.0%	1.50A	11.88V	19.95W	17.81W	89.3%	88.33%	85.45%
	75.0%	1.12A	11.88V	14.98W	13.36W	89.2%		
	50.0%	0.75A	11.88V	10.04W	8.91W	88.7%		
	25.0%	0.37A	11.89V	5.17W	4.46W	86.1%		
	10.0%	0.15A	11.89V	2.21W	1.78W	80.3%		72.48%
230V _{AC} /50Hz	100.0%	1.50A	11.88V	19.95W	17.81W	89.3%	87.83%	85.45%
	75.0%	1.12A	11.88V	15.03W	13.36W	88.9%		
	50.0%	0.75A	11.88V	10.14W	8.91W	87.9%		
	25.0%	0.37A	11.89V	5.22W	4.45W	85.3%		
	10.0%	0.15A	11.89V	2.27W	1.78W	78.3%		72.48%

5.6 PD3.0 & PPS Compatible Mode Testing

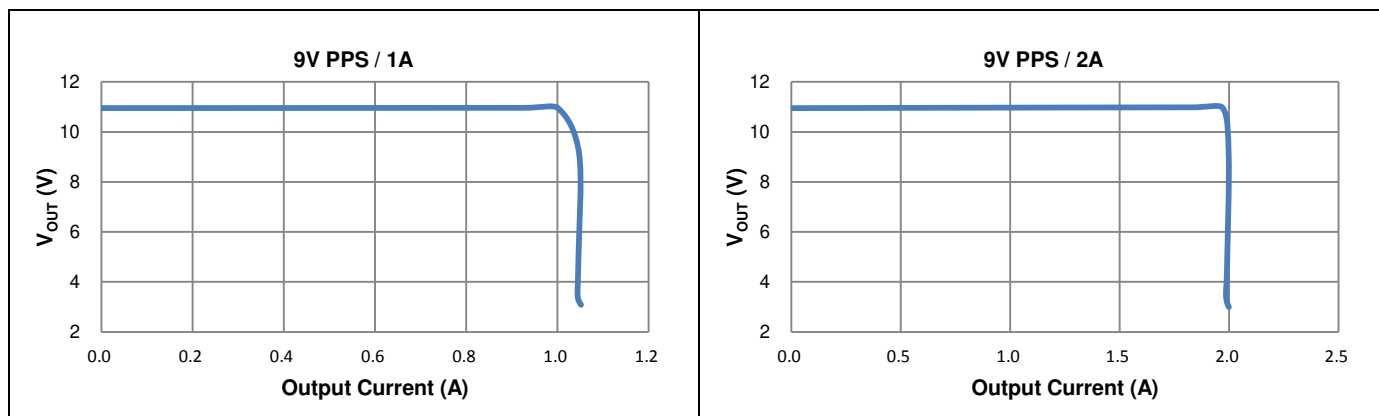
5.6.1 CC Mode current limitation function testing

The test is by USBCEE Tester and with E-Load set at CR mode.

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

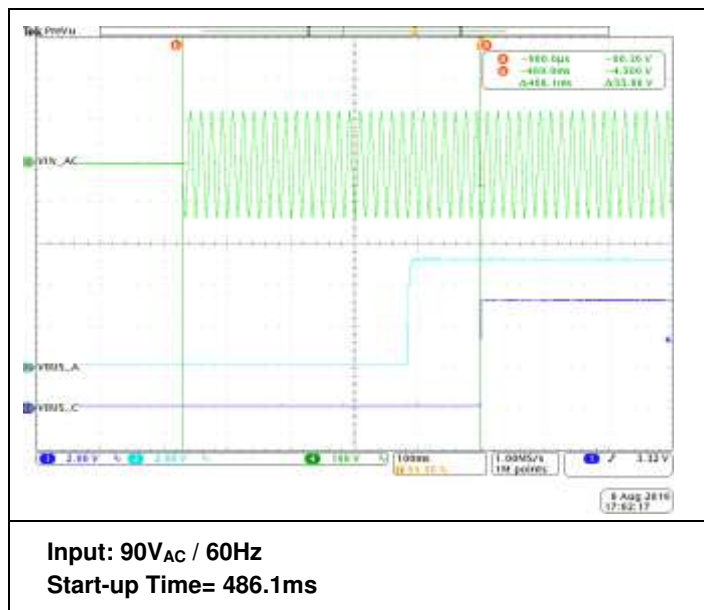


To Port-C PPS Mode set 9V-1A & 9V-2A and then increase the current (by reducing R) to see the CC-CV curve

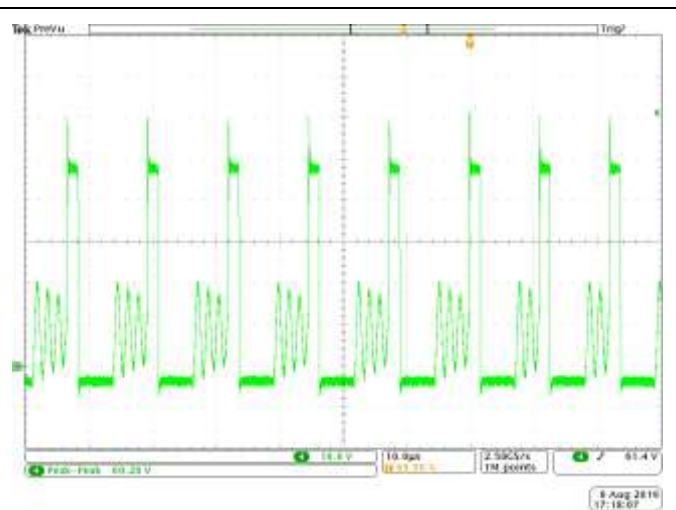
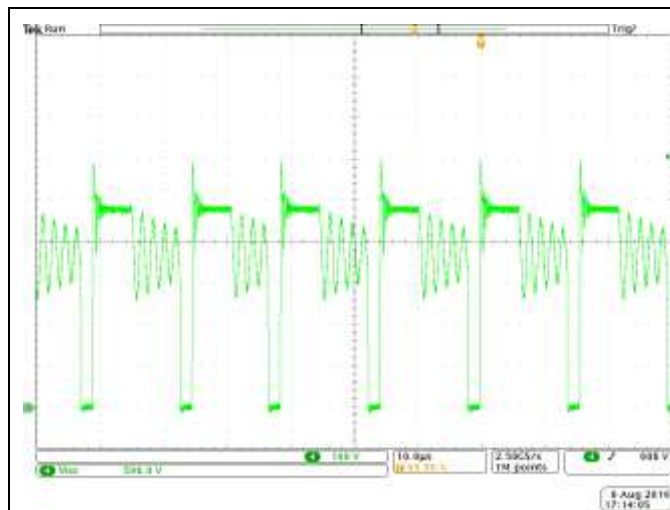


5.7 Key Performance Waveforms

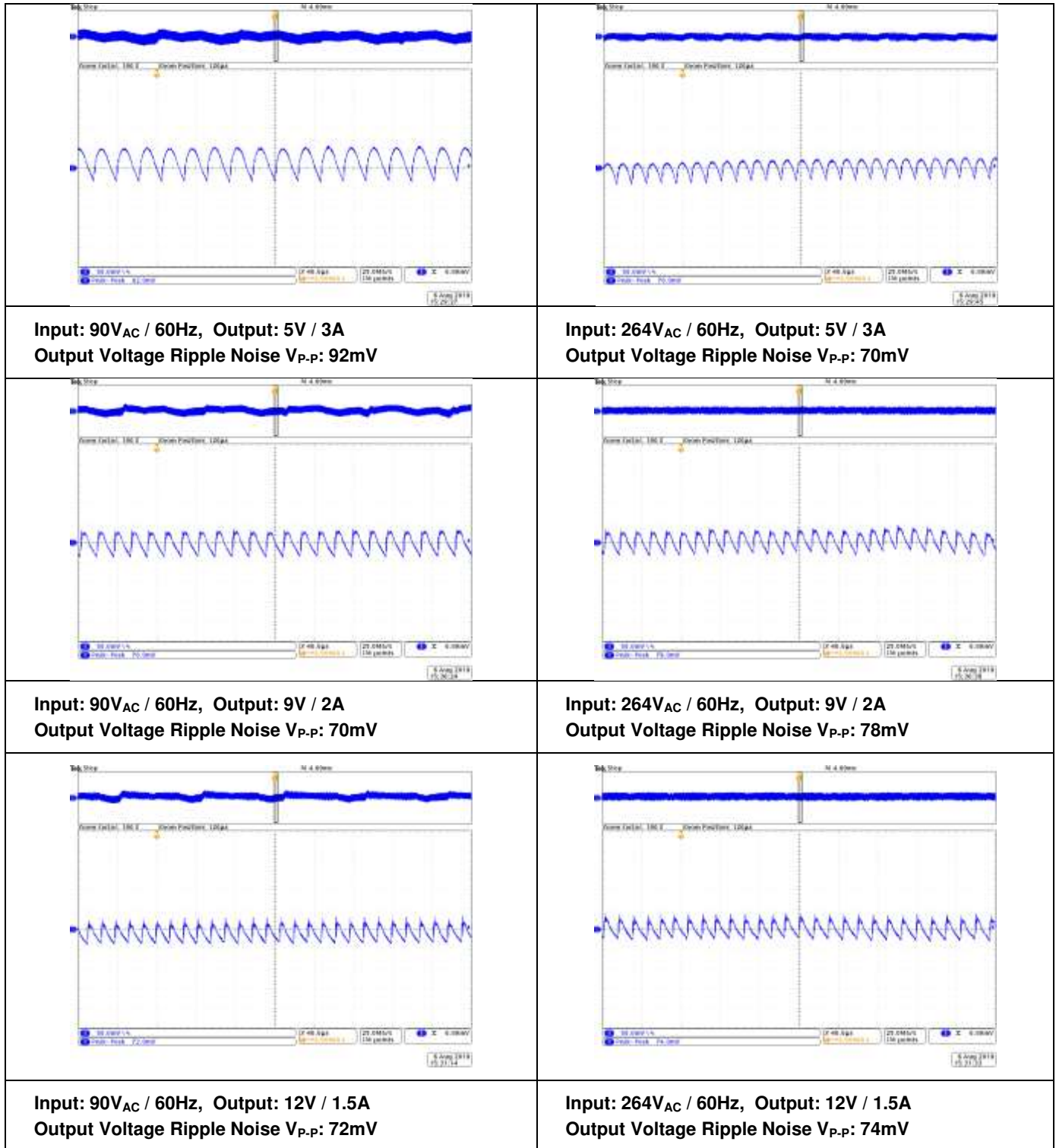
5.7.1 EVB System Start-up Time



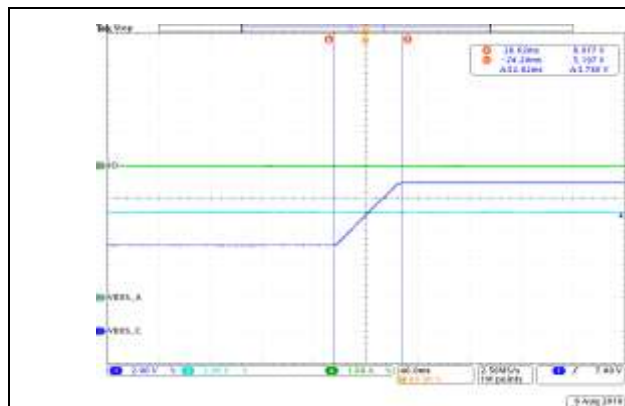
5.7.2 VDS_U1 & Q2 MOSFET V_{DS} Stress



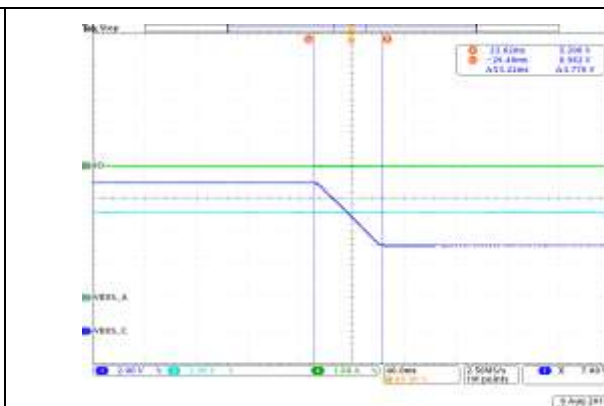
5.7.3 Output Ripple & Noise



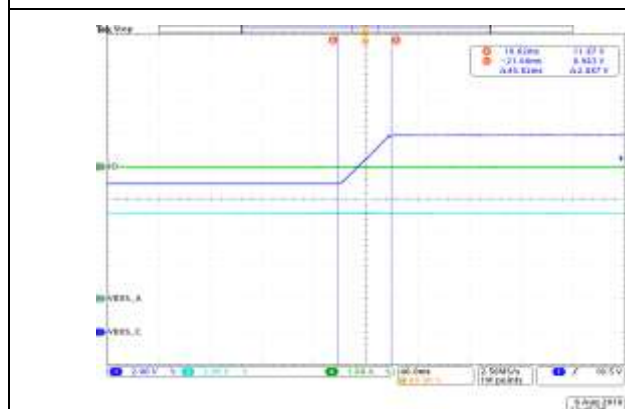
5.7.4 Output Voltage Transition Time



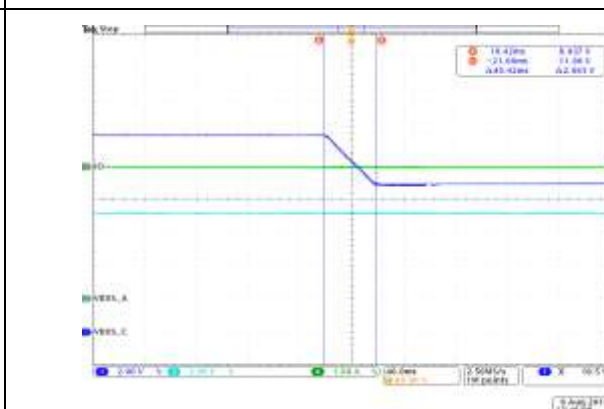
Input: 115V_{AC} / 60Hz, Output: 5V to 9V
Transition Time: 52.82ms



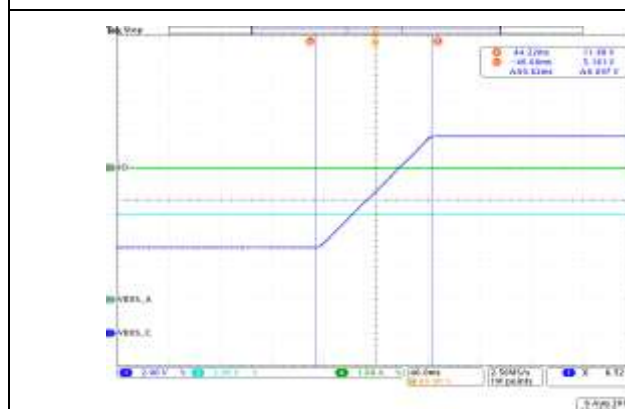
Input: 115V_{AC} / 60Hz, Output: 9V to 5V
Transition Time: 53.22ms



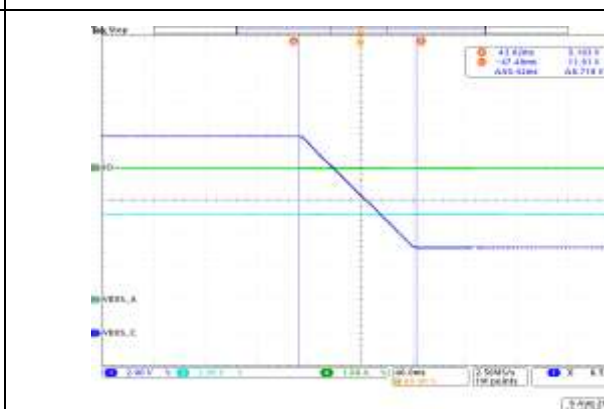
Input: 115V_{AC} / 60Hz, Output: 9V to 12V
Transition Time: 40.82ms



Input: 115V_{AC} / 60Hz, Output: 12V to 9V
Transition Time: 40.42ms

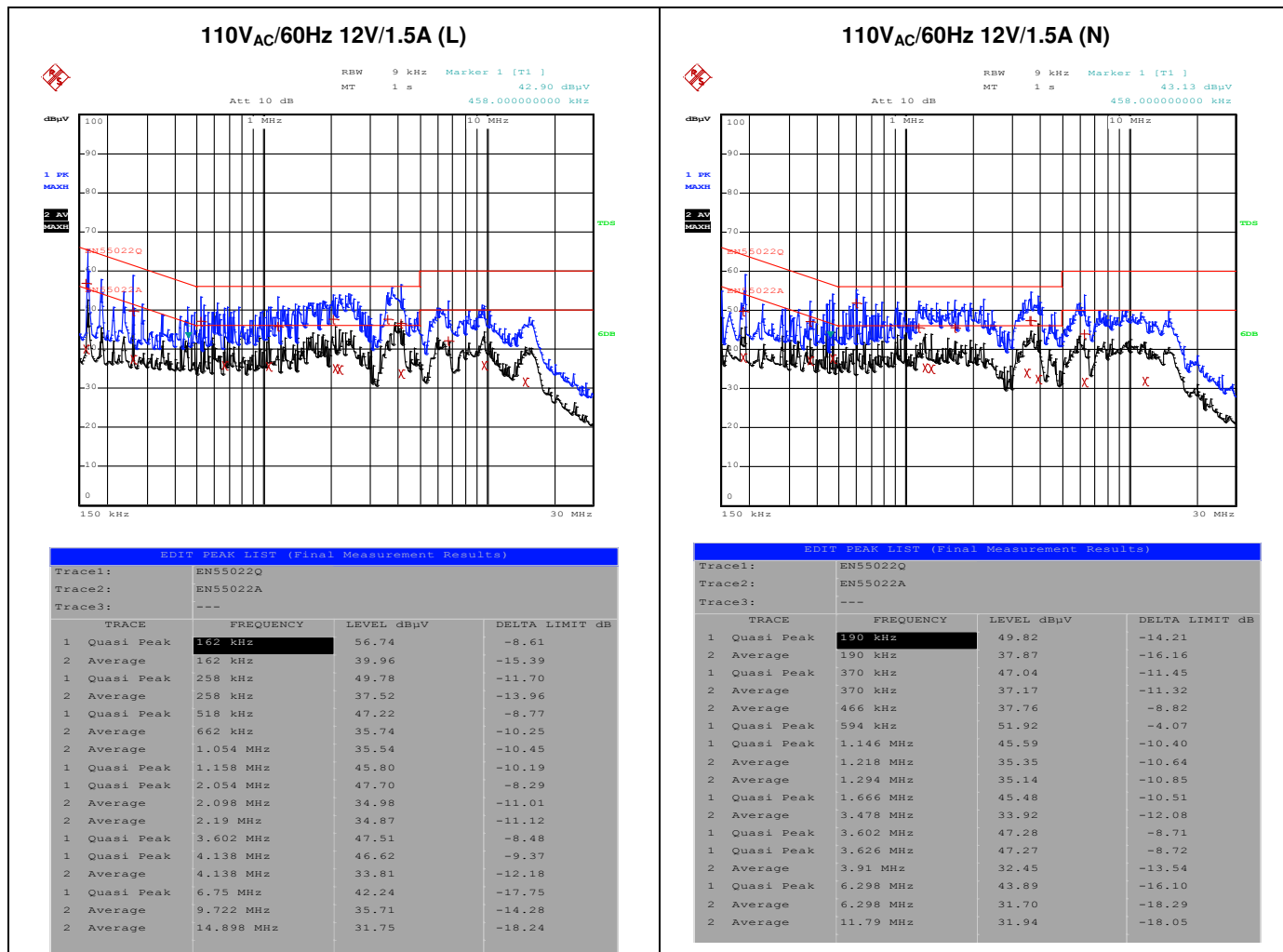


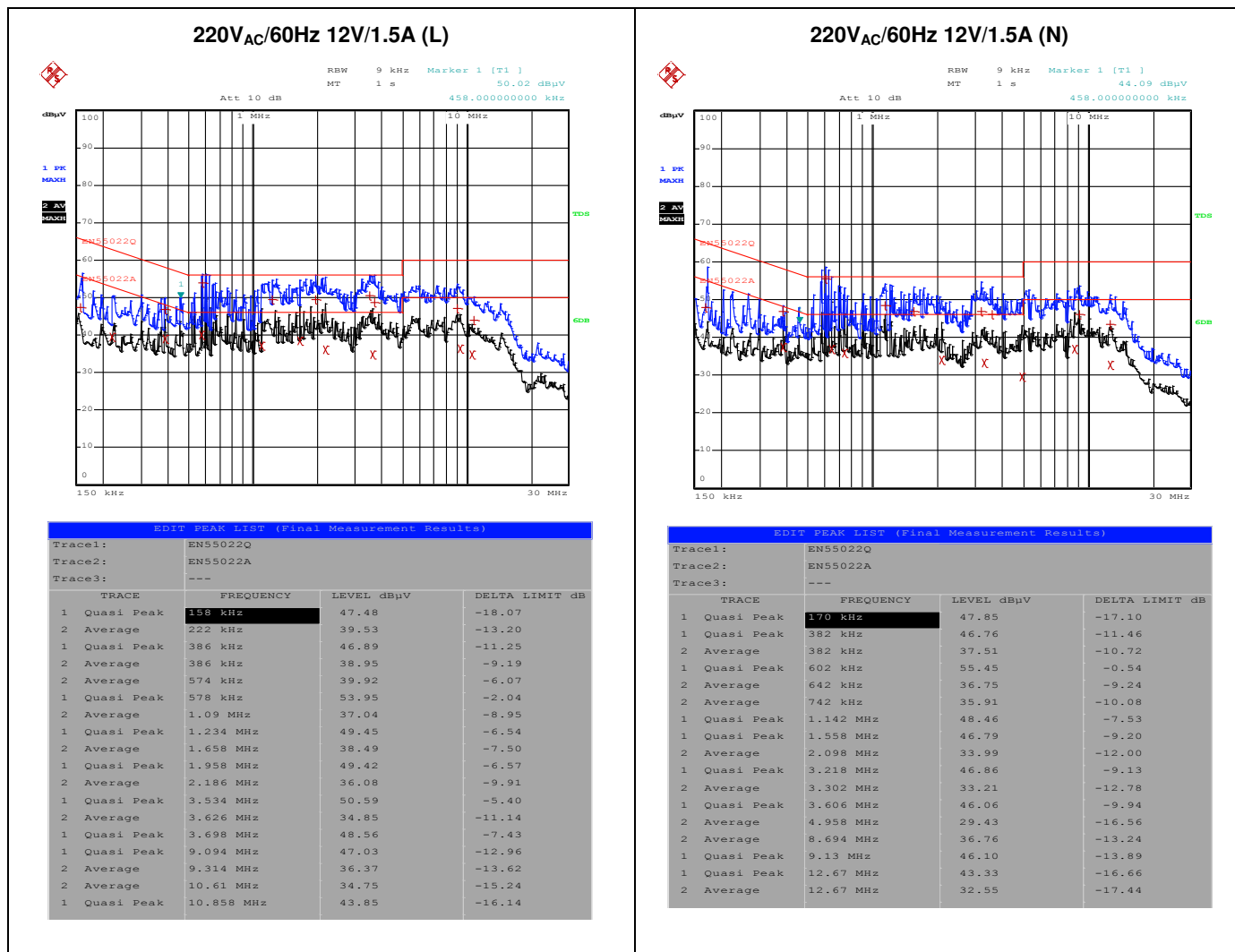
Input: 115V_{AC} / 60Hz, Output: 5V to 12V
Transition Time: 90.82ms



Input: 115V_{AC} / 60Hz, Output: 12V to 5V
Transition Time: 90.42ms

5.7.5 EMI (Conduction) Testing

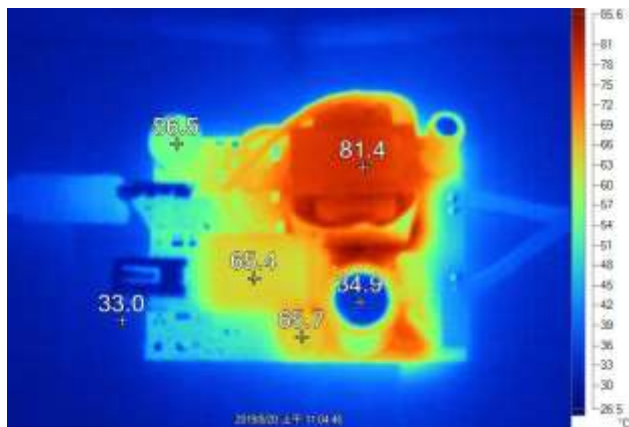




5.7.7 Thermal Testing

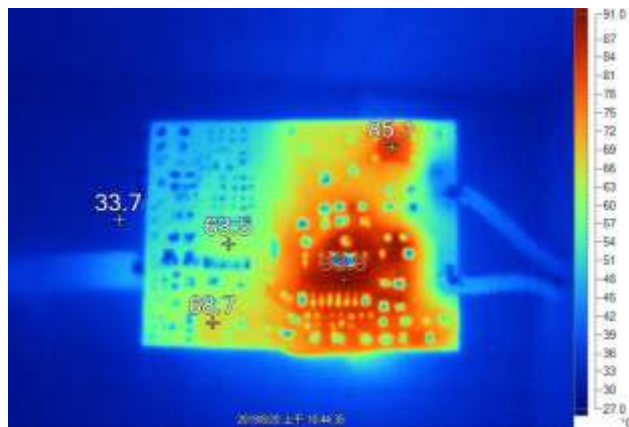
Test Condition: $V_O=12V$, $I_O=1.5A$, Set up the EVB into the closed box (120mm*7.5mm*6mm) at room temperature +25 °C

90V_{AC} 18W TOP Side



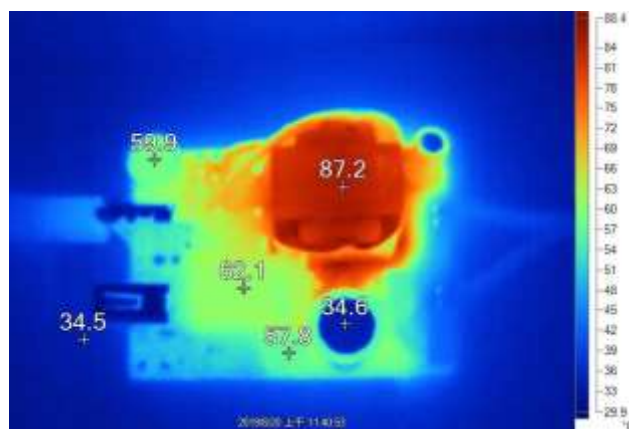
Ambient Temperature ----- 33.0 °C
 T1 (Transformer) ----- 81.4 °C
 L2 (DR6*8) ----- 65.7 °C
 C2 (15uF/400V) ----- 65.4 °C
 C20 (680uF/16V) ----- 56.5 °C

90V_{AC} 18W Bottom Side



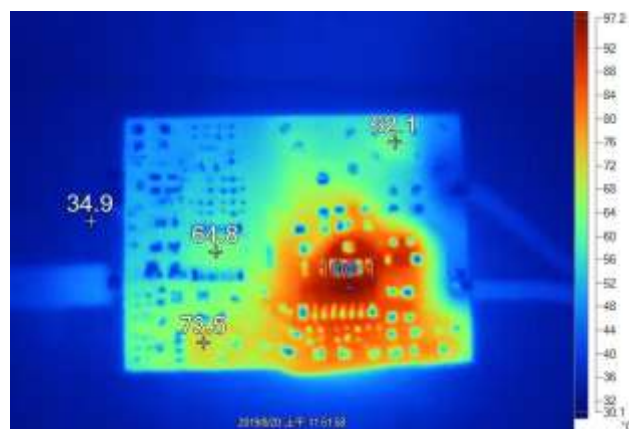
Ambient Temperature ----- 33.7 °C
 U1 (AP39303) ----- 93.9 °C
 BD1 (MSB12M) ----- 85.1 °C
 Q2 (DMT10H009LSS) ----- 68.7 °C
 U3 (AP43971) ----- 63.5 °C

264V_{AC} 18W TOP Side



Ambient Temperature ----- 34.5 °C
 T1 (Transformer) ----- 87.2 °C
 L2 (DR6*8) ----- 57.8 °C
 C2 (15uF/400V) ----- 62.1 °C
 C20 (680uF/16V) ----- 59.9 °C

264V_{AC} 18W Bottom Side



Ambient Temperature ----- 34.9 °C
 U1 (AP39303) ----- 100.1 °C
 BD1 (MSB12M) ----- 62.1 °C
 Q2 (DMT10H009LSS) ----- 73.5 °C
 U3 (AP43971) ----- 64.8 °C

Chapter 6. Revision Control

6.1 Revision table

Revision	Items Changed & added	The changing reason
1.0	Release	

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