Table of Contents

Chapter 1. Summary

1.1 General Description

The 27W QC4/4+ Class A charger Evaluation Board EV5 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 F75183 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, F75183 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
- QC4+ Offers QC3.0/QC2.0 Backward Compliance
- 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 F75183 Key Features

- Type-C Source
- USB PD 3.0 v1.1 (PPS)
- BC1.2 DCP
- Qualcomm Quick Charge 4/4+
- Support OVP/OCP/OTP
- Internal Discharge MOS
- Internal Vbus Load Switch Driver
- 3V- 30V Operation Voltage without External Regulator
- Web Site: http://www.fintek.com.tw/index.php/usb-type-c-power-delivery-pd/item/178-f75183q

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	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	89%
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

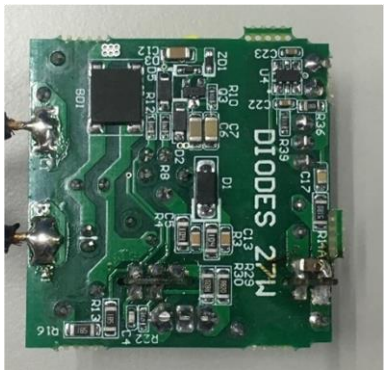


Figure 2: Bottom View

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_{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, the test result is 58mW
3V/ 3A @115Vac/230Vac Average efficiency	Board end	-	3V / 3A	-	77.87%	81.34%	Pass, average efficiency is 82.22% / 80.3%
5V/ 3A @115Vac/230Vac Average efficiency	Board end	-	5V/3A	-	81.39%	81.84%	Pass, average efficiency is 87.06% / 86.6%
5V/ 3A @115Vac/230Vac 10% efficiency	Board end	-	5V/0.3A	-	-	72.48%	Pass, efficiency is 84.9% / 83.04%
9V/ 3A @115Vac/230Vac Average efficiency	Board end	-	9V/3A	-	86.60%	87.30%	Pass, average efficiency is 88.84% / 88.5%
9V/ 3A @115Vac/230Vac 10% efficiency	Board end	-	9V/0.3A	-	-	76.62%	Pass, efficiency is 84.19% / 84.05%
12V/ 2.25A @115Vac/230Vac Average efficiency	Board end	-	12V/2.25A	-	86.20%	87.30%	Pass, average efficiency is 88.3% / 88.41%

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
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
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 EV5 Board Schematic

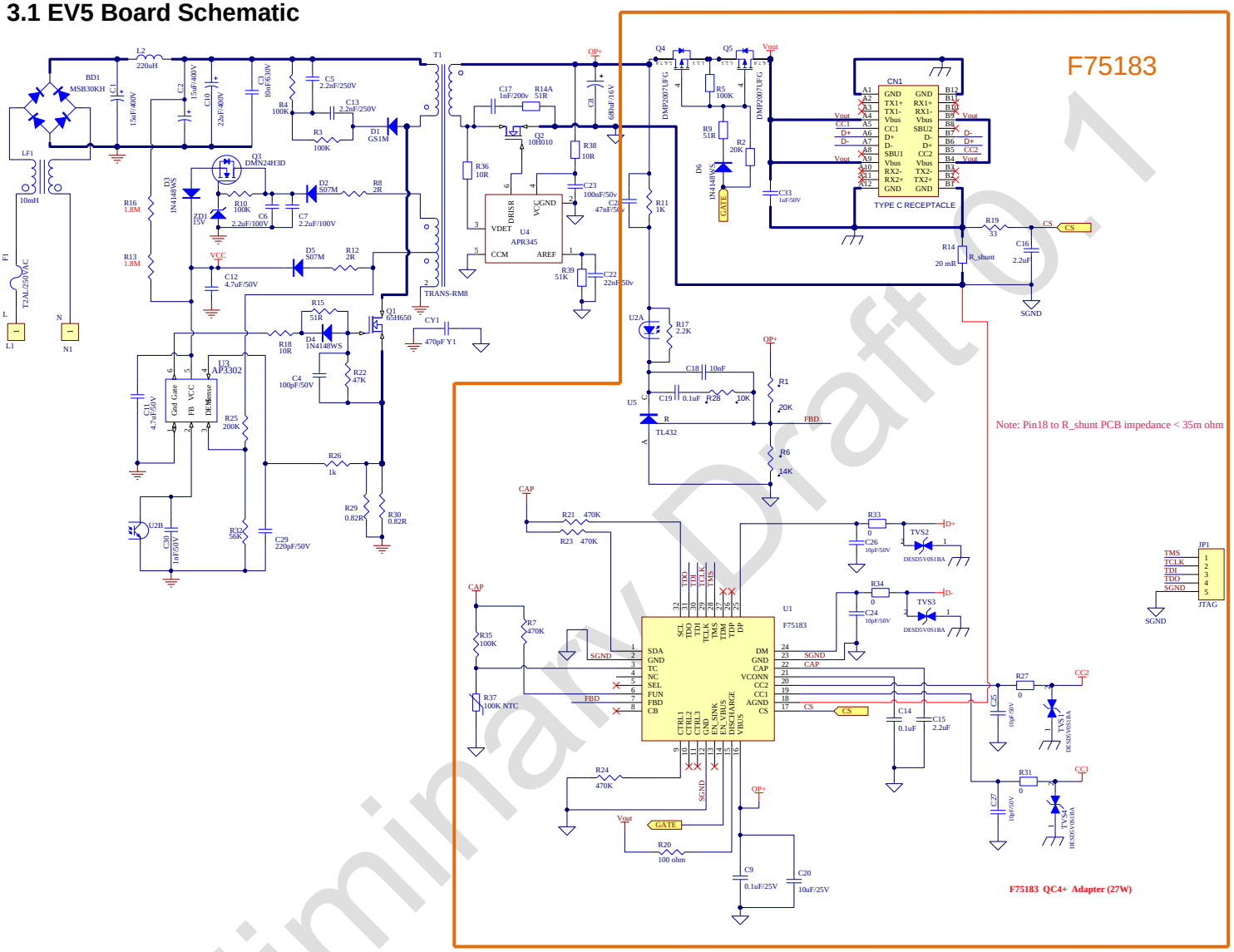


Figure 3: Evaluation Board Schematic

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		

3.2.2 Controller Daughter Board (EV5)

Bill of Material for Daughter Board					
Designator	**Comment**	**Designator**	**Comment**	**Designator**	**Comment**
C9	0.1uF/25V	D4, D6	1N4148WS	R18	10R
C11	4.7uF/50V	JP1	JTAG	R19	33
C14	0.1uF	Q4, Q5	DMP2007UFG	R20	100 ohm
C15, C16	2.2uF	R1, R2	20K	R25	200K
C18	10nF	R5, R35	100K	R27, R31, R33, R34	0
C19	0.1uF	R6	14K	R28	10K
C24, C25, C26, C27	10pF/50V	R7, R21, R23, R24	470K	R32	56K
C28	47nF/50v	R9	51R	R37	100K NTC
C29	220pF/50V	R11, R26	1K	TVS1, TVS2, TVS3, TVS4	DESD5V0S1BA
C30	1nF/50V	R14	20mR	U1	F75183
C33	1uF/50V	R15	51R	U2	PC-4PIN
CN1	TYPE C RECEPTACLE	R17	2.2K	U3	AP3302A
U5	TL432				

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 F75183 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 F75183 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 F75183:

1) **CC1 & CC2 (Pin 19, 20)**: 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 25, 24):** 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 VBUS voltage before Q4 P-Mosfet via the resistor divider ratio (R1 & R6) and comparing with the U5 TL432 internal reference voltage to generate a CV compensation signal through U1 photo coupler to primary side PWM IC AP3302A FB pin & tune the duty cycle time for maintaining desired Vbus voltage. This voltage ratio point also is connected to with F75183 decoder IC FBD pin (pin 7), through FBD pin the output voltages can be adjusted by firmware programming to satisfy the PD or QC devices of needing the different voltage requirements.

4) **Constant Current (CC)**: The CC mode is implemented by sensing across current sense resistor (R14=20mohm) voltage and feeds it into F75183 inner current sense amplifier, and then comparing with internal set programmable reference voltage to generate a current limited compensation signal and send it to primary side PWM AP3302A controller through FBD pin, U5 TL432 and U1 photo coupler.

5) **EN_VBUS (Pin 14) to PMOSFET Gate:** The pin is used to turn on/off Vbus load switch (Q4 & Q5) to enable/disable voltage output to the Vbus. Two back to back PMOSFETs (Q4 & Q5) are required to prevent reverse current from the attached battery source.

Chapter 4. The Evaluation Board (EVB) 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 and manuals. For details, please contact Fintek local agent for further information (http://www.fintek.com.tw/index.php/2014-08-04-00-48-50/contactus-en) .

- Test Tool: F75183 (Fintek's Qualcomm Quick Charge 4/4+ Test Tool)
- Manual: F75183_QC4.0/4.0+ Test Tool_User Guide_V1.0

F75183 Test Tool	Standard-A to Micro-B Cable	Type-C Cable
		

Figure 6: Fintek Items: Test Tool / Test Cables

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

3) The Standard-A to Micro-B cable should be connected to the Test Tool's Micro-B receptacle & Adapter Standard-A receptacle respectively.

4) Connect the test tool input to Micro-B power supply output.

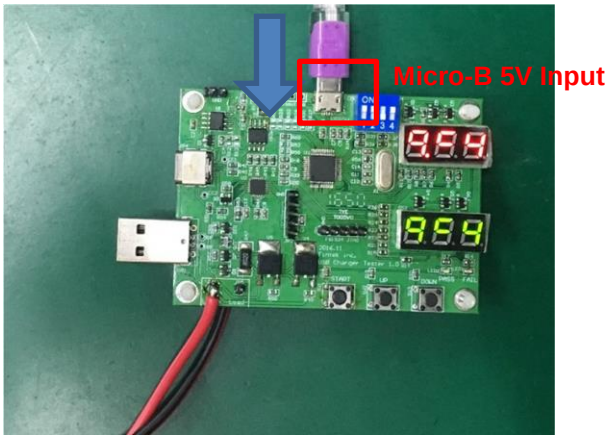


Figure 7: The Test Tool Input & Output Location

5) A type-C cable for the connection between Test Tool and 27W Adapter Type-C receptacles.

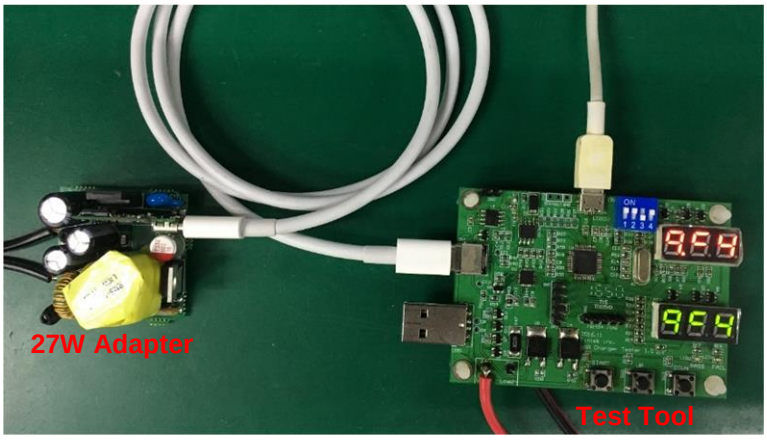


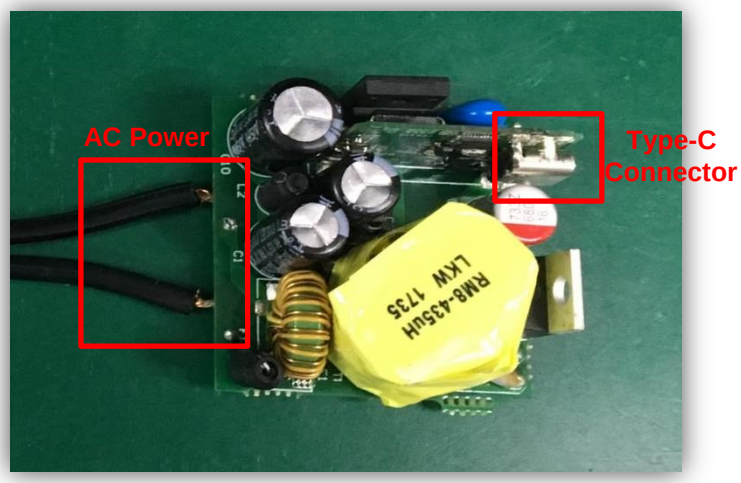
Figure 8: 27W Adapter & Test Tool

6) Connect the 27W Adapter input to AC power supply output.

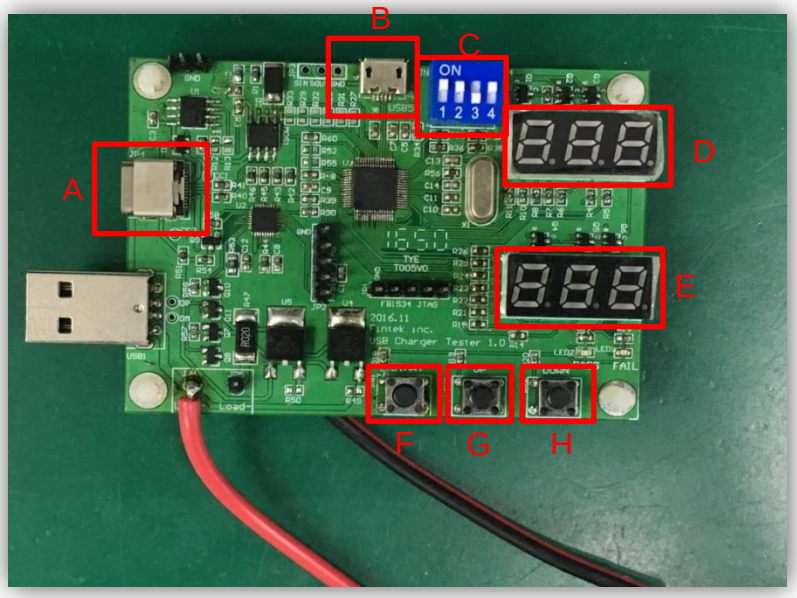
7) Ensure that the AC source is switched OFF or disconnected before the connection steps.

4.2 System Setup

4.2.1 Fintek's Qualcomm Quick Charge 4/4+ Charger



4.2.2 Fintek's Qualcomm Quick Charge 4/4+ Test Tool



A. Type-C connector
B. Micro-B (5V Power Input)
C. Protocol Switch
D. 80 Port For Voltage
E. 80 Port For Protocol
F. START
G. UP
H. DOWN

Figure 9: The Test Tool Input & Output and Connections

Chapter 5. Testing the Evaluation Board

5.1 Input & Output Characteristics

5.1.1 Input Standby Power

Vin(Vac)	Fin(Hz)	Vin(V)	Iin(A)	PF	Pin(W)	Vout(V)	Iout(A)	Pout(W)
90	60	90.1	0.003	0.13	0.033	*	*	*
115	60	115.12	0.003	0.21	0.035	*	*	*
230	50	230.14	0.03	0.08	0.057	*	*	*
264	50	264.15	0.003	0.08	0.067	*	*	*

5.1.2 Input Power Efficiency at Different AC Line Input Voltage

Efficiency (+12VDC)

Vin(Vac)	Fin(Hz)	Vin(V)	Iin(A)	PF	Pin(W)	Vout(V)	Iout(A)	Pout(W)	Pd(W)	Eff(%)
90	60	89.920	0.615	0.558	31.037	12.168	2.251	27.37	3.27	89.32%
115	60	115.000	0.514	0.517	30.681	12.138	2.251	27.32	3.36	89.05%
230	50	230.080	0.339	0.394	30.522	12.137	2.251	27.32	3.20	89.51%
264	50	264.110	0.318	0.364	30.646	12.160	2.251	27.37	3.27	89.32%

Efficiency (+9VDC)

Vin(Vac)	Fin(Hz)	Vin(V)	Iin(A)	PF	Pin(W)	Vout(V)	Iout(A)	Pout(W)	Pd(W)	Eff(%)
90	60	89.930	0.612	0.567	31.278	9.109	3.001	27.34	3.94	87.39%
115	60	114.990	0.513	0.520	30.743	9.041	3.001	27.13	3.61	88.25%
230	50	230.180	0.331	0.401	30.640	9.061	3.002	27.20	3.44	88.78%
264	50	264.210	0.314	0.370	30.815	9.099	3.001	27.31	3.51	88.61%

Efficiency (+5VDC)

Vin(Vac)	Fin(Hz)	Vin(V)	Iin(A)	PF	Pin(W)	Vout(V)	Iout(A)	Pout(W)	Pd(W)	Eff(%)
90	60	90.010	0.381	0.511	17.647	5.039	3.001	15.12	2.52	85.69%
115	60	115.010	0.324	0.465	17.501	5.024	3.001	15.08	2.42	86.15%
230	50	230.120	0.211	0.361	17.560	5.028	3.011	15.14	2.42	86.21%
264	50	264.230	0.194	0.345	17.691	5.040	3.001	15.13	2.57	85.50%

Efficiency (+3VDC)

Vin(Vac)	Fin(Hz)	Vin(V)	Iin(A)	PF	Pin(W)	Vout(V)	Iout(A)	Pout(W)	Pd(W)	Eff(%)
90	60	90.040	0.262	0.455	10.789	2.973	2.941	8.74	2.05	81.04%
115	60	115.080	0.223	0.429	10.826	2.973	2.951	8.77	2.05	81.04%
230	50	230.120	0.137	0.348	10.987	2.973	2.951	8.77	2.21	79.85%
264	50	264.240	0.124	0.336	10.987	2.973	2.930	8.71	2.28	79.28%

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)	Eff(%)	Average EFF(%)
115	60	115.000	0.514	0.517	30.681	12.138	2.251	27.323	3.358	89.05%	88.30%
115	60	115.030	0.414	0.485	23.047	12.143	1.687	20.485	2.562	88.88%	
115	60	115.060	0.303	0.446	15.456	12.159	1.125	13.679	1.777	88.50%	
115	60	115.090	0.176	0.396	7.881	12.167	0.562	6.838	1.043	86.76%	
230	50	230.080	0.339	0.394	30.522	12.137	2.251	27.320	3.202	89.51%	88.41%
230	50	230.100	0.268	0.370	22.943	12.133	1.687	20.468	2.475	89.21%	
230	50	230.110	0.187	0.356	15.425	12.131	1.125	13.647	1.778	88.48%	
230	50	230.130	0.102	0.333	7.899	12.151	0.562	6.829	1.070	86.45%	

Average 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	114.990	0.513	0.520	30.743	9.041	3.001	27.132	3.611	88.25%	88.84%
115	60	115.030	0.407	0.488	23.041	9.095	2.251	20.473	2.568	88.85%	
115	60	115.060	0.304	0.443	15.378	9.111	1.501	13.676	1.702	88.93%	
115	60	115.090	0.173	0.404	7.753	9.135	0.758	6.924	0.829	89.31%	
230	50	230.180	0.331	0.401	30.640	9.061	3.002	27.201	3.439	88.78%	88.50%
230	50	230.200	0.260	0.383	22.963	9.061	2.251	20.396	2.567	88.82%	
230	50	230.220	0.182	0.366	15.375	9.077	1.501	13.625	1.750	88.62%	
230	50	230.140	0.099	0.340	7.767	9.092	0.750	6.819	0.948	87.79%	

Average 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	115.010	0.324	0.465	17.501	5.024	3.001	15.077	2.424	86.15%	87.06%
115	60	115.040	0.256	0.452	13.119	5.041	2.258	11.383	1.736	86.76%	
115	60	115.070	0.182	0.419	8.774	5.065	1.515	7.673	1.101	87.46%	
115	60	115.090	0.096	0.379	4.401	5.089	0.760	3.868	0.533	87.88%	
230	50	230.120	0.211	0.361	17.560	5.028	3.011	15.139	2.421	86.21%	86.60%
230	50	230.110	0.162	0.351	13.188	5.053	2.251	11.374	1.814	86.25%	
230	50	230.130	0.113	0.338	8.825	5.079	1.511	7.674	1.151	86.96%	
230	50	230.140	0.062	0.311	4.453	5.102	0.759	3.872	0.581	86.96%	

Average Efficiency (+3VDC)

Vin(Vac)	Fin(Hz)	Vin(V)	Iin(A)	PF	Pin(W)	Vout(V)	Iout(A)	Pout(W)	Pd(W)	Eff(%)	Average EFF(%)
115	60	115.080	0.223	0.429	10.826	2.973	2.951	8.773	2.053	81.04%	82.22%
115	60	115.090	0.176	0.410	8.298	3.001	2.258	6.776	1.522	81.66%	
115	60	115.100	0.129	0.387	5.549	3.034	1.515	4.597	0.952	82.83%	
115	60	115.120	0.067	0.358	2.790	3.067	0.758	2.325	0.465	83.33%	
230	50	230.120	0.137	0.348	10.987	2.973	2.950	8.770	2.217	79.82%	80.30%
230	50	230.120	0.109	0.338	8.529	3.001	2.258	6.776	1.753	79.45%	
230	50	230.130	0.076	0.322	5.705	3.034	1.516	4.600	1.105	80.62%	
230	50	230.140	0.042	0.294	2.864	3.068	0.759	2.329	0.535	81.31%	

5.2 Output CV & CC Mode Testing

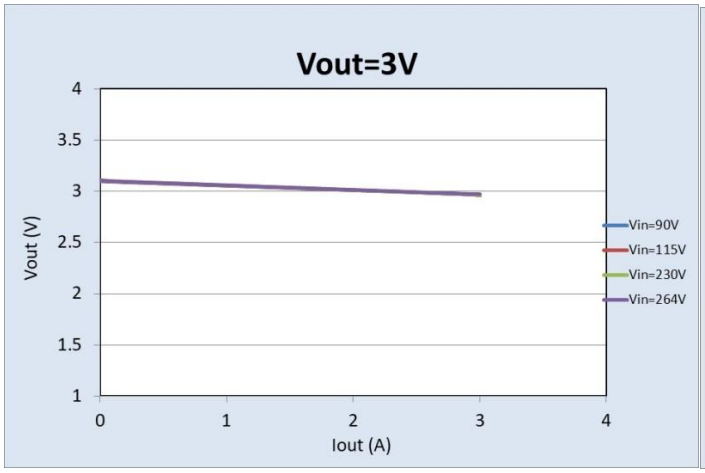


Figure 12: I-V Curve – 3.0V Output

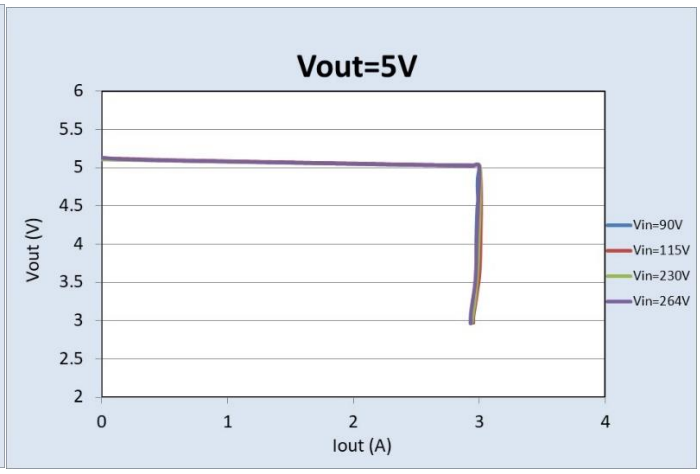


Figure 13: I-V Curve – 5V Output

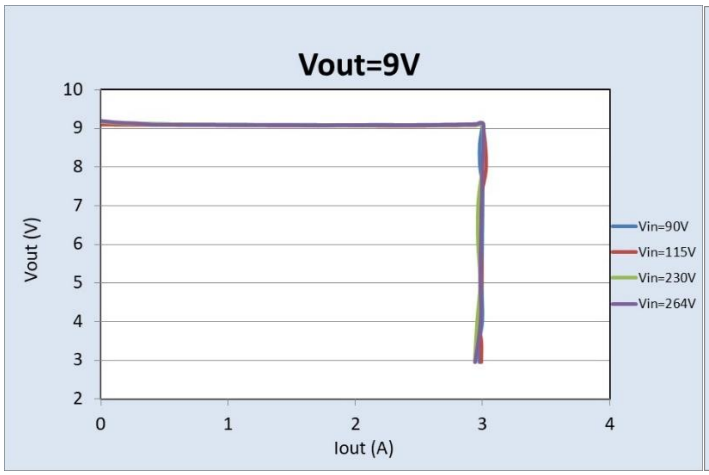


Figure 14: I-V Curve – 9V Output

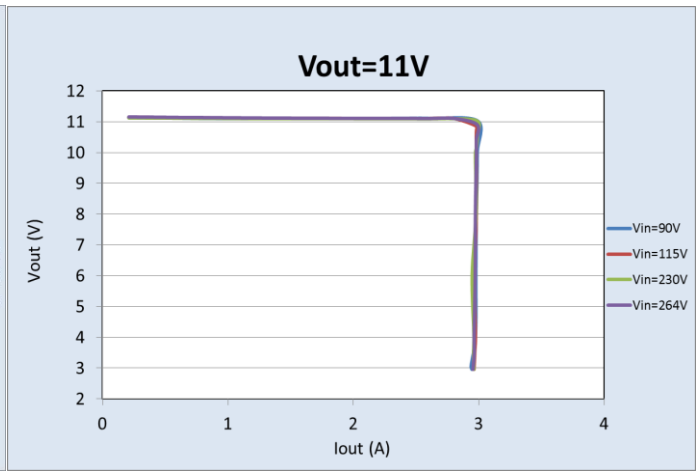


Figure 15: I-V Curve - 11V Output

5.3 QC Series Compatible Mode Testing

5.3.1 QC 2.0 Mode Testing

		
5.105V	9.102V	12.108V

5.3.2 QC 3.0 Continuous Mode 200mV/Step Testing

		
5.1V	9.099V	11.912V
		
5.299V	9.301V	12.114V

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

					
5,813mV	5,792mV	5,772mV	5,752mV	5,732mV	5,713mV

					
4,623mV	4,604Mv	4,585mV	4,566mV	4,544mV	4,524mV

					
3,190mV	3,172mV	3,155mV	3,138mV	3,119mV	3,102mV

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

					
3,002mA	2,951mA	2,900mA	2,849mA	2,801mA	2,751mA

					
1,800mA	1,753mA	1,702mA	1,651mA	1,600mA	1,553mA

5.4 Key Performance Waveforms

5.4.1 AC Input Requirements

AC Brownout on/off

		Input AC Reading
Turn_Off	Max Load	75Vac
	Min Load	72.3Vac
Turn_On	Max Load	82.9Vac
	Min Load	82.6Vac

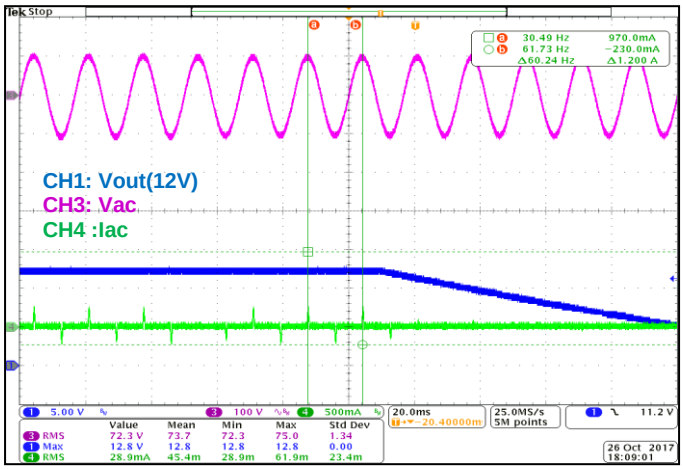


Figure 16

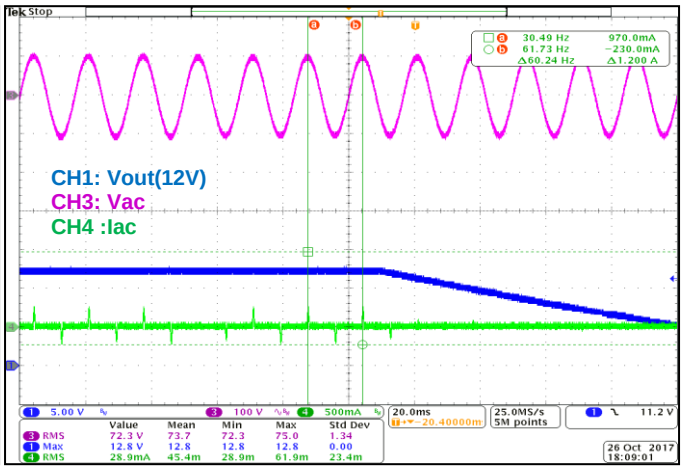


Figure 17

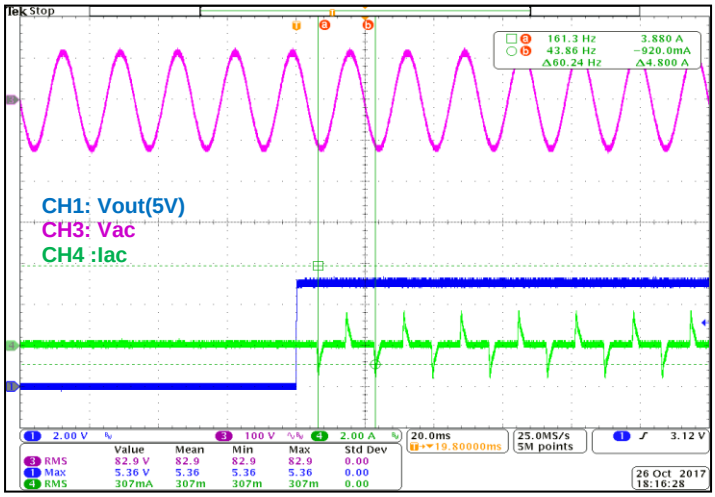


Figure 18

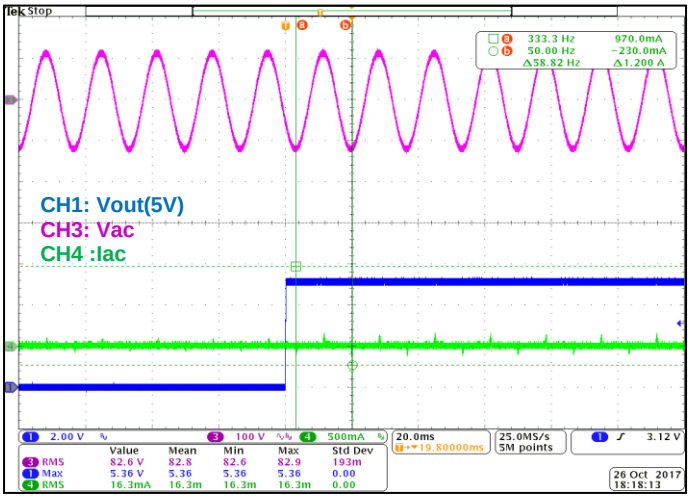


Figure 19

5.4.2 AC Line Slow Transients (Sag/Surge)

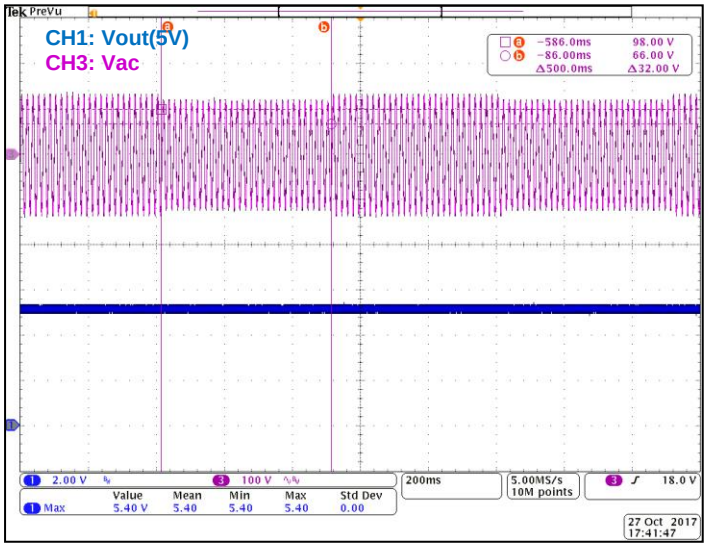


Figure 20: 500ms Sag at 10% of 90Vac with 5Vo at 1.5A

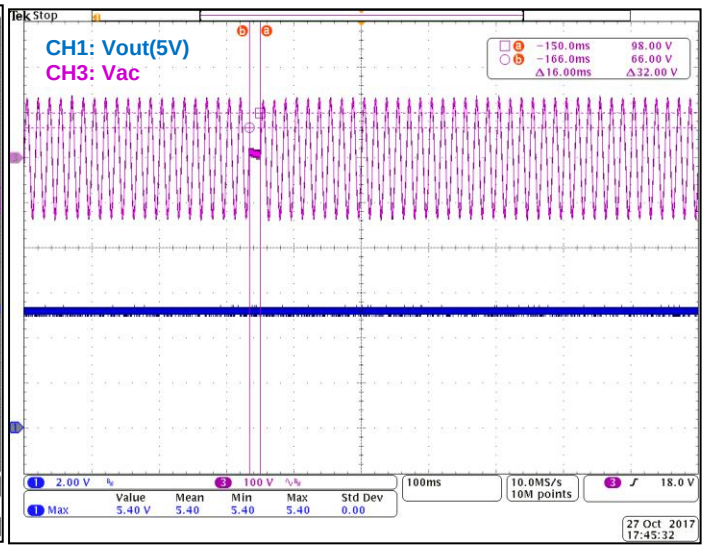


Figure 21: 16ms 100% Sag of 90Vac with 5Vo at 1.5A

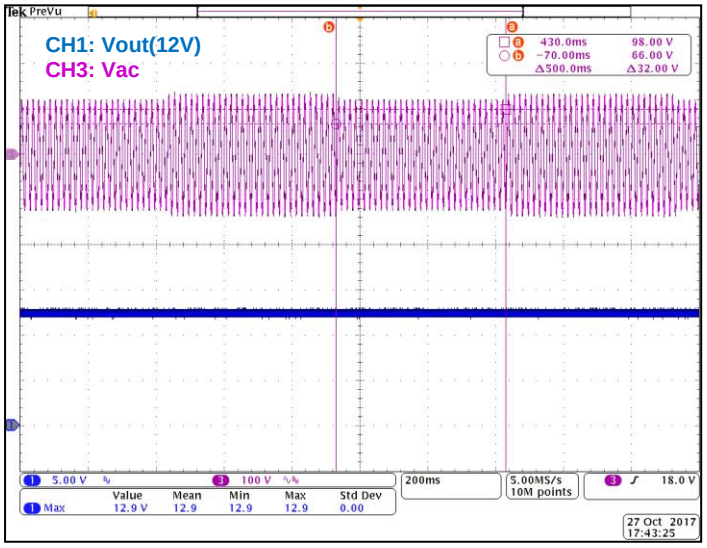


Figure 22: 500ms Sag 10% of 90Vac with 12Vo at 1.15A

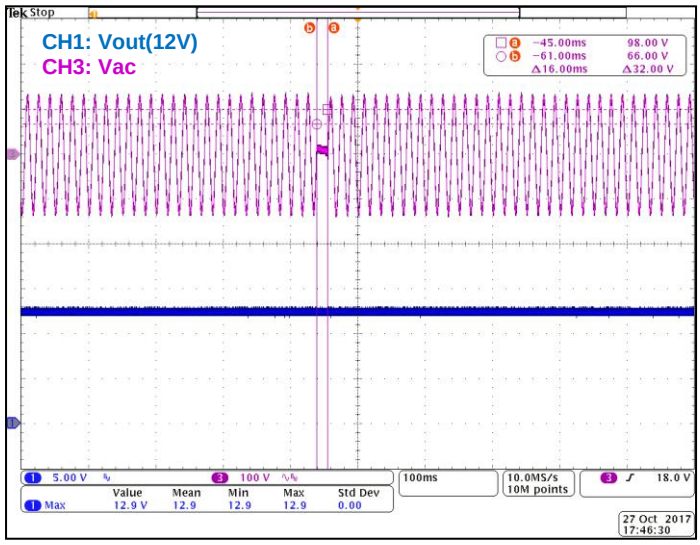


Figure 23: 16ms 100% Sag of 90Vac with12V at 1.15A

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

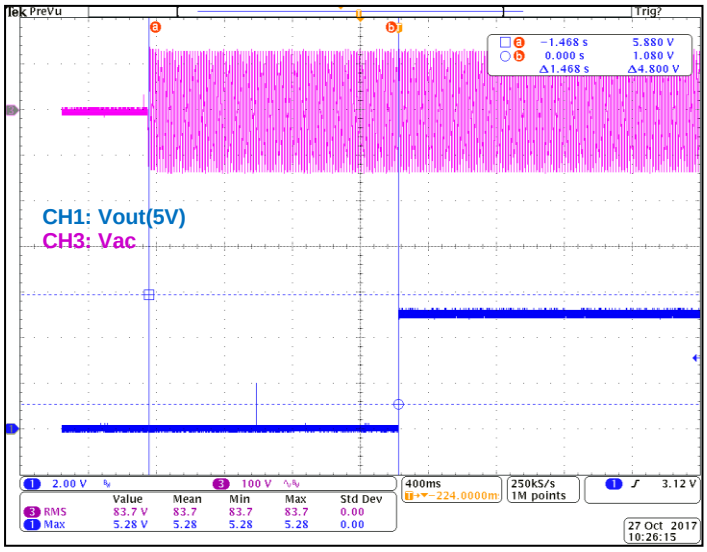


Figure 24: 27w QC4/4+ turn on time 1.46s FL at 90Vac

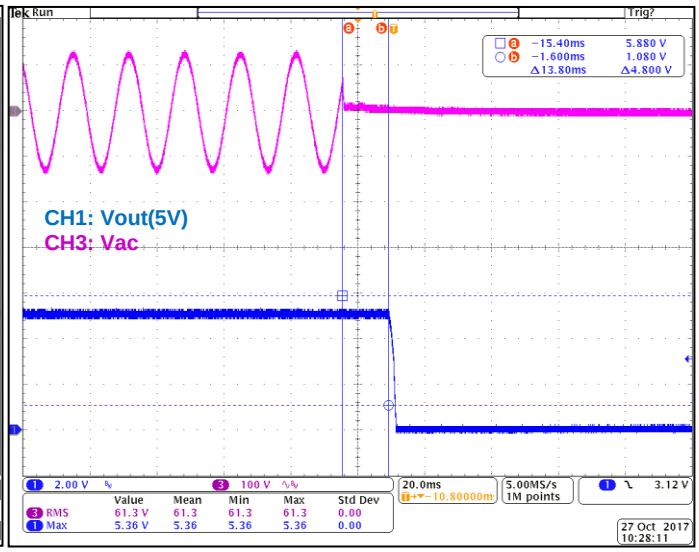


Figure 25: 27w QC4/4+ hold time 13.8ms at 12V- 2.25A, at 90Vac

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

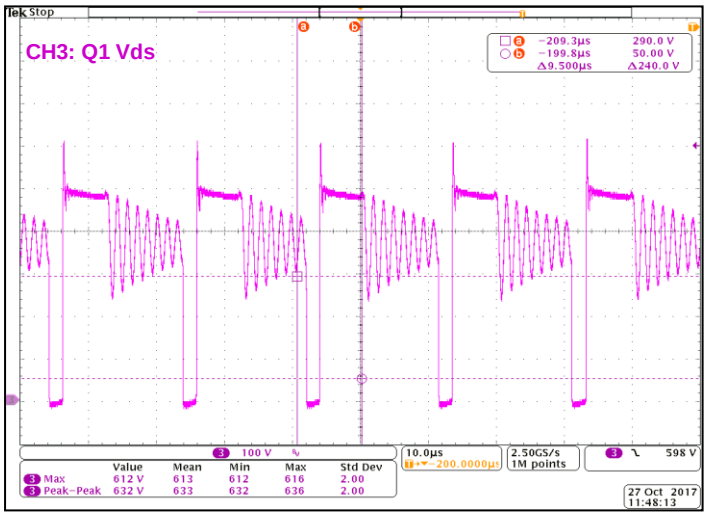


Figure 26: 264Vac/50Hz Primary Q1 Vds(max)= 632Vp-p

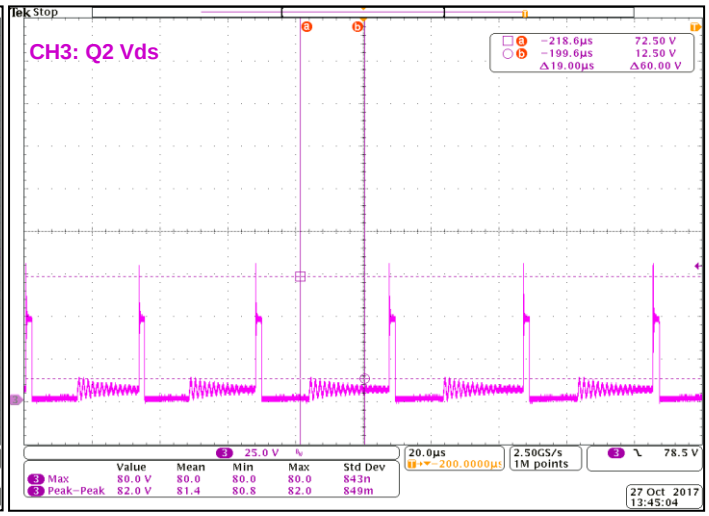


Figure 27: 264Vac/50Hz Secondary Q2 Vds(max) = 82Vp-p

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

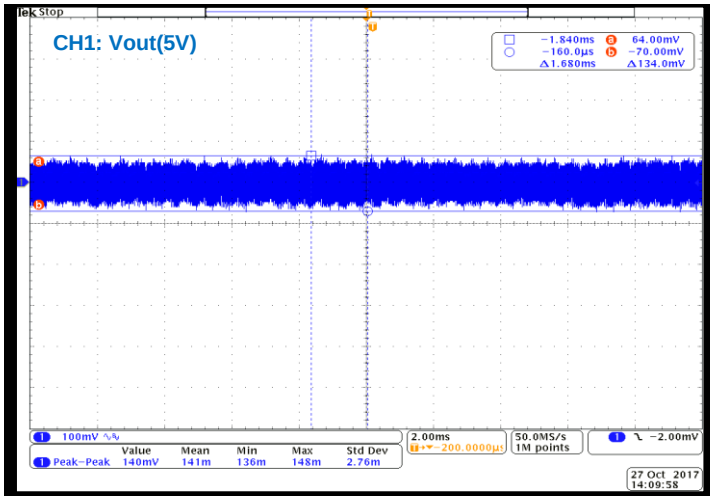


Figure 28: The Ripple at 90Vac/60Hz ΔV=140mV 5V/3A

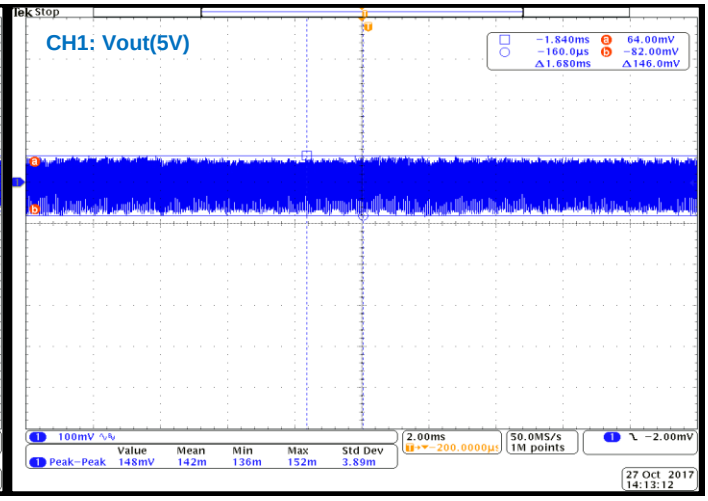


Figure 29: The Ripple at 264Vac/50Hz ΔV=148mv 5V/3A

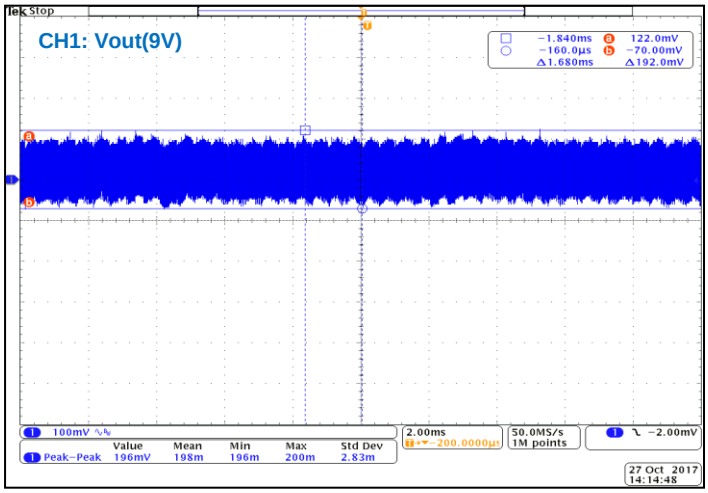


Figure 30: The Ripple at 90Vac/60Hz ΔV=196mV 9V/3A

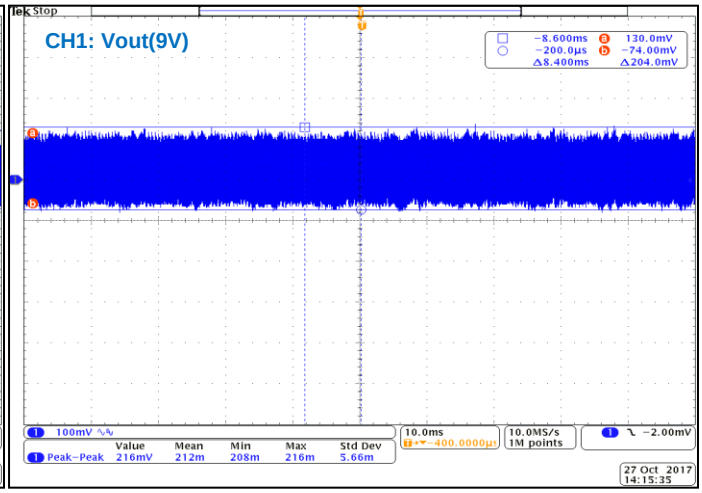
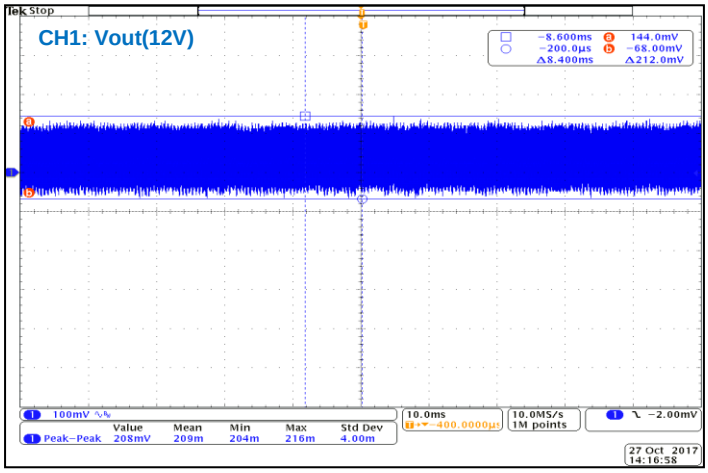


Figure 31: The Ripple at 90Vac/60Hz ΔV=216mV 9V/3A



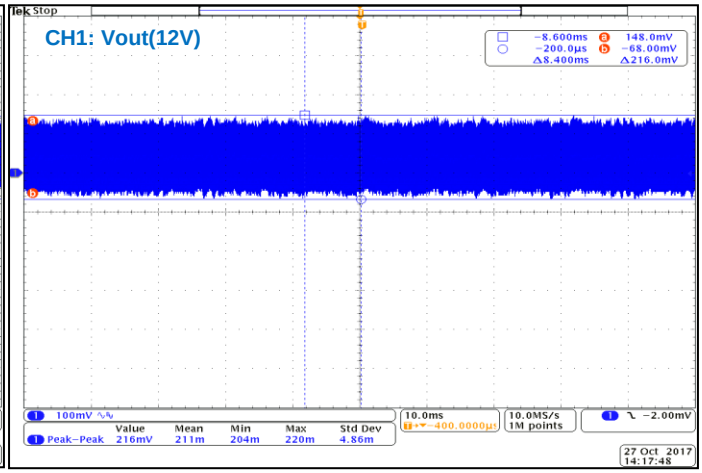


Figure 32: The Ripple at 90Vac/60Hz ΔV=208mV 12V/2.25A

Figure 33: The Ripple at 90Vac/60Hz ΔV=216mV 12V/2.25A

5.4.6 Output Voltage Transition Time

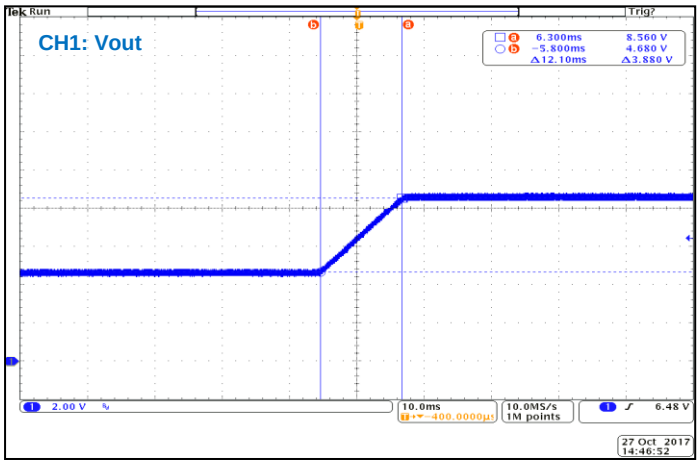


Figure 34: 5V→9V Rise Time: 12.1ms

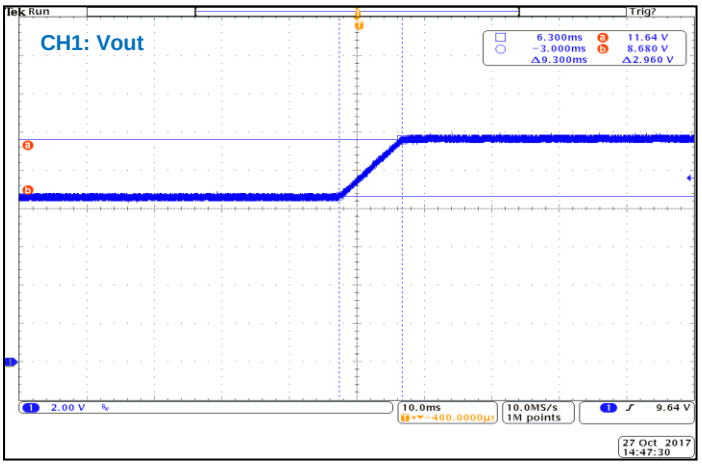


Figure 35: 9V→12V Rise Time: 9.3ms

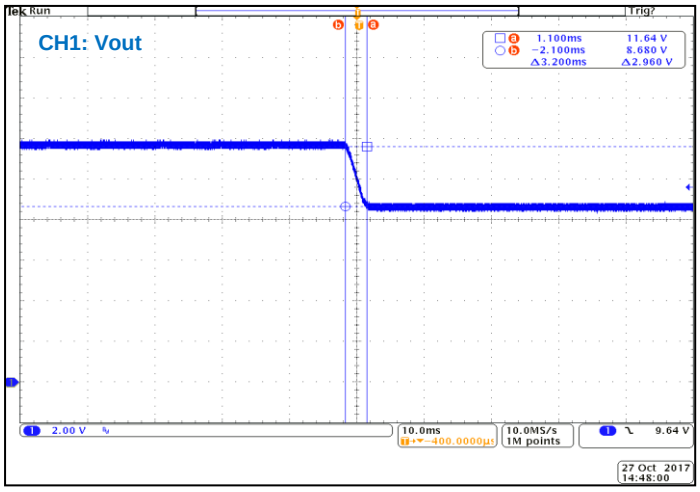


Figure 36: 12V→9V Fall Time: 3.2ms

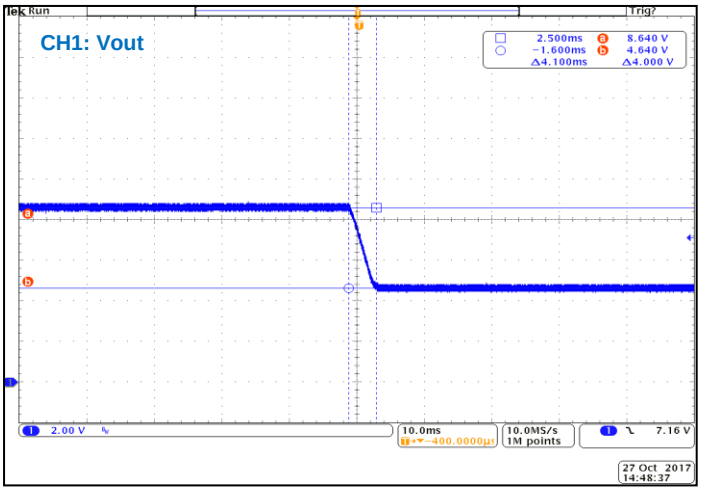
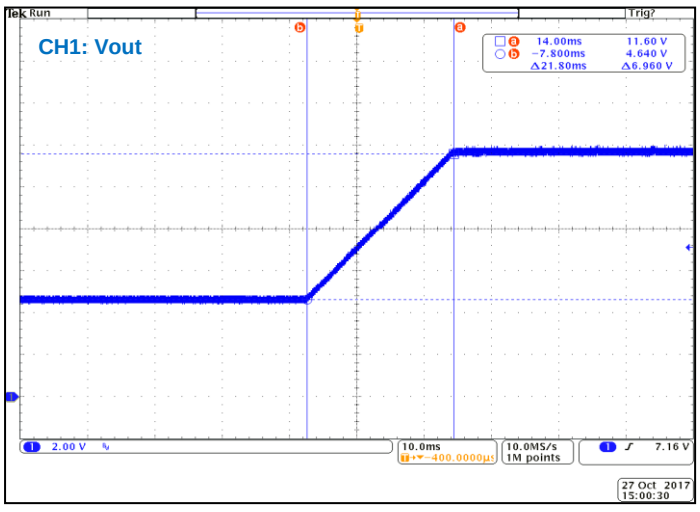


Figure 37: 9V→5V Fall Time: 4.1ms



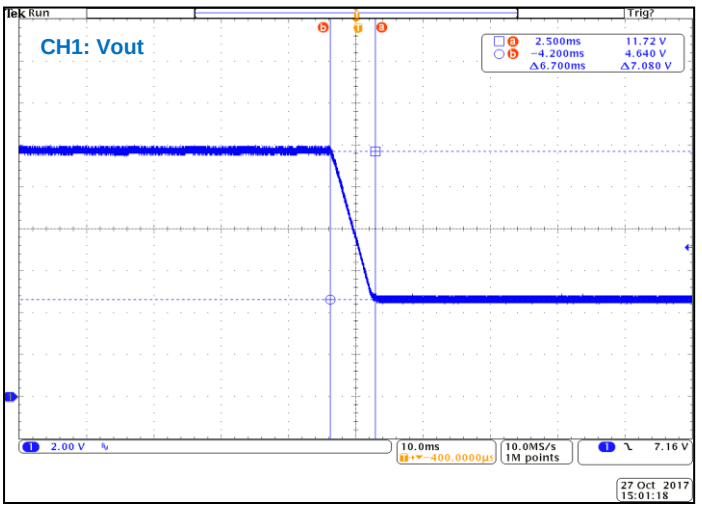


Figure 38: 5V→12V Fall Time: 21.8ms

Figure 39: 12V→5V Fall Time: 6.7ms

5.4.7 Thermal Testing

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

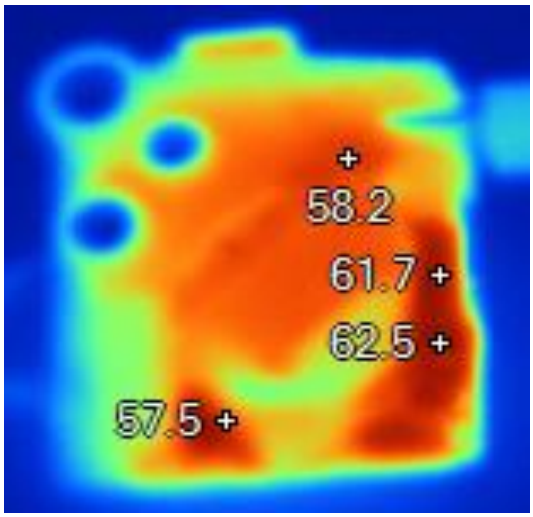


Figure 40: components side

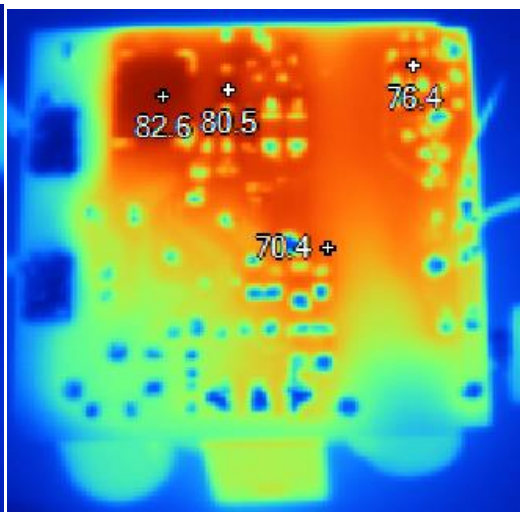


Figure 41: surface mount side

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

5.4.8 EMI (CE) Testing

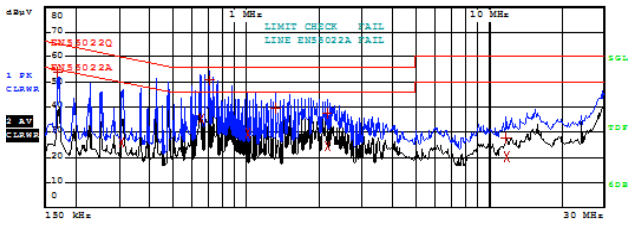


Figure 42: 115Vac/60Hz 12V/2A (L)

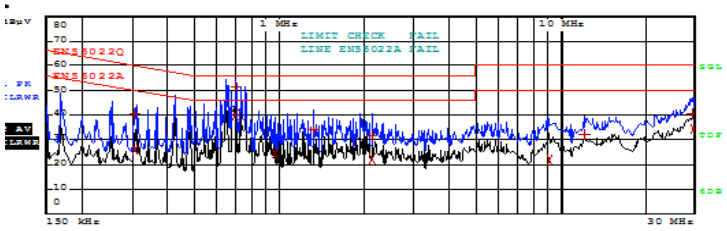


Figure 43: 115Vac/60Hz 12V/2A (N)

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

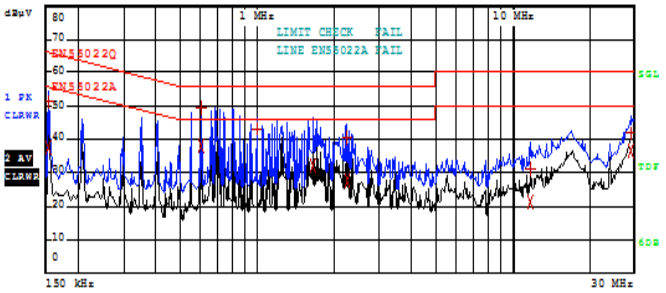


Figure 44: 230Vac/50Hz 12V/2A (L)

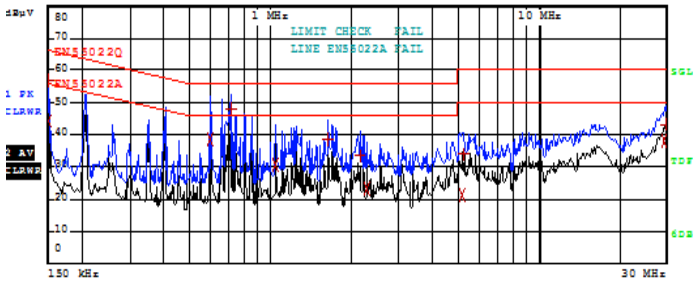


Figure 45: 230Vac/50Hz 12V/2A (N)

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

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