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## Chapter 1 Summary

### 1.1 General Description

The 22W Evaluation Board (EVb) is composed of the AP3190P controller.

The AP3190P is a high-performance offline PSR AC/DC power supply controller. It is specially designed for applications that require higher efficiency at light loads and is cost effective.

Using the multi-mode control scheme, the AP3190P can also achieve high conversion efficiency with full load conditions. At heavy load and low line, the AP3190P will operate in QR mode to achieve high performance. When the load is decreasing, it will enter into fixed switching frequency operating mode. To optimize product performance, the fixed frequency is different in high (60kHz) and low line (80kHz).

The AP3190P is designed to authorize a transient peak power excursion for peak load. It means the OCP reference can be increased to 1.75 times when the peak load event appears.

### 1.2 Key Features

#### 1.2.1 System Key Features

- Primary Side Control for Eliminating Opto-Coupler
- A Transient Peak Power Excursion for Peak Load
- Low standby power (<65mW)
- Multiple QR/AM Modes to Improve Audio Noise and Efficiency

#### 1.2.2 AP3190P Key Features

- Primary Side Control for Eliminating Opto-Coupler
- A Transient Peak Power Excursion for Peak Load
- 65mW No-Load Input Power
- Adjustable Overtemperature Protection
- Multiple QR/AM Mode to Improve Audio Noise and Efficiency
- QR for Higher Efficiency and Better EMI
- Totally Lead-Free & Fully RoHS Compliant

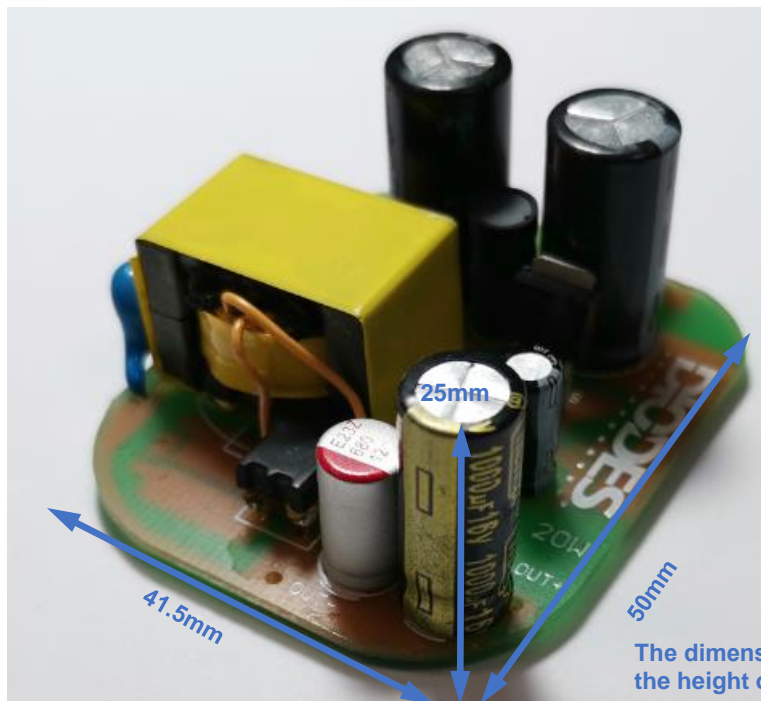
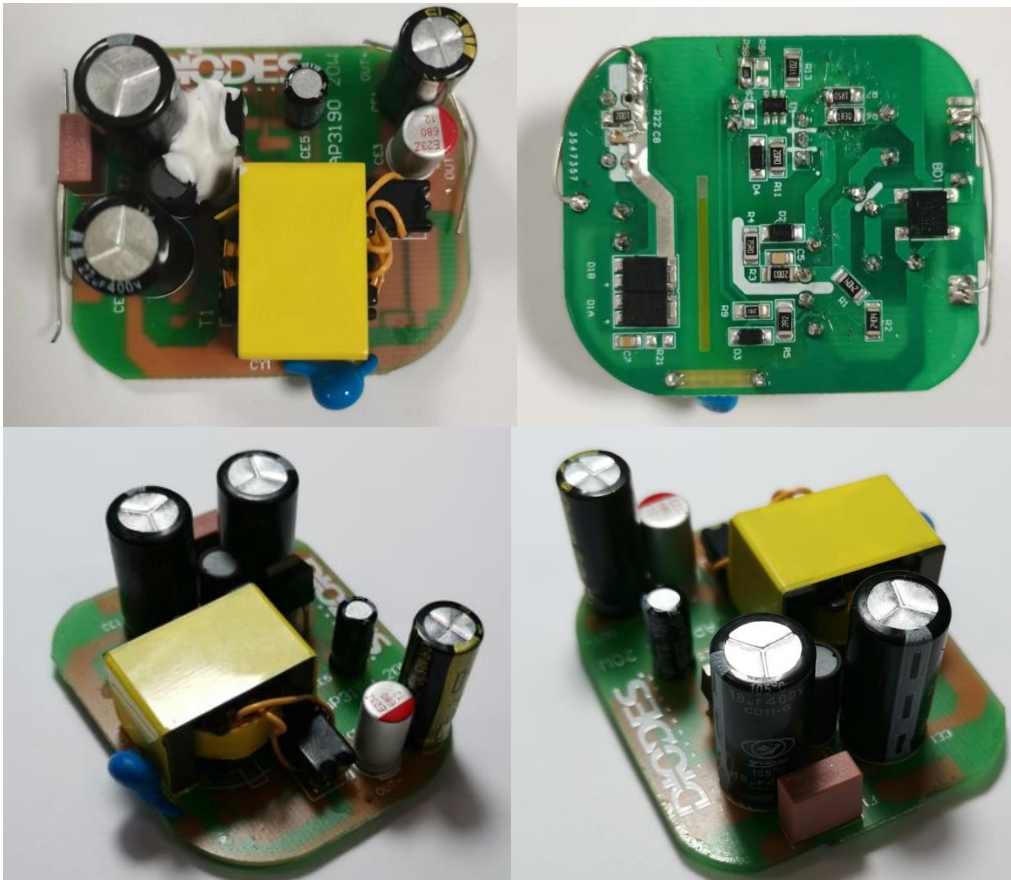
### 1.3 Applications

- IoT offline powers Set-Top Box Power Supply
- Smart speakers
- Set-top box power supplies
- Network Adaptors

### 1.4 Main Power Specifications

Parameter	Value
Input Voltage	90V <sub>AC</sub> to 264V <sub>AC</sub>
Input Standby Power	< 65mW
Main Output (V <sub>o</sub> / I <sub>o</sub> )	10V/2.2A
Efficiency	88.47%@230V <sub>in</sub> ; 87.98%@115V <sub>in</sub>
Total Output Power	22W
Protections	OCP, OVP, UVP, OLP, OTP, SCP
Dimensions	PCB: 41.5 * 50 * 25 mm <sup>3</sup> , 1.633" * 1.968" * 0.984" inch <sup>3</sup>
Power Density Index	0.424 W/CC; 6.936 W/CI
EMI	Min. margin 10dB@ >6dB

**1.5 Evaluation Board Pictures**



The dimension “25mm” includes the height of components

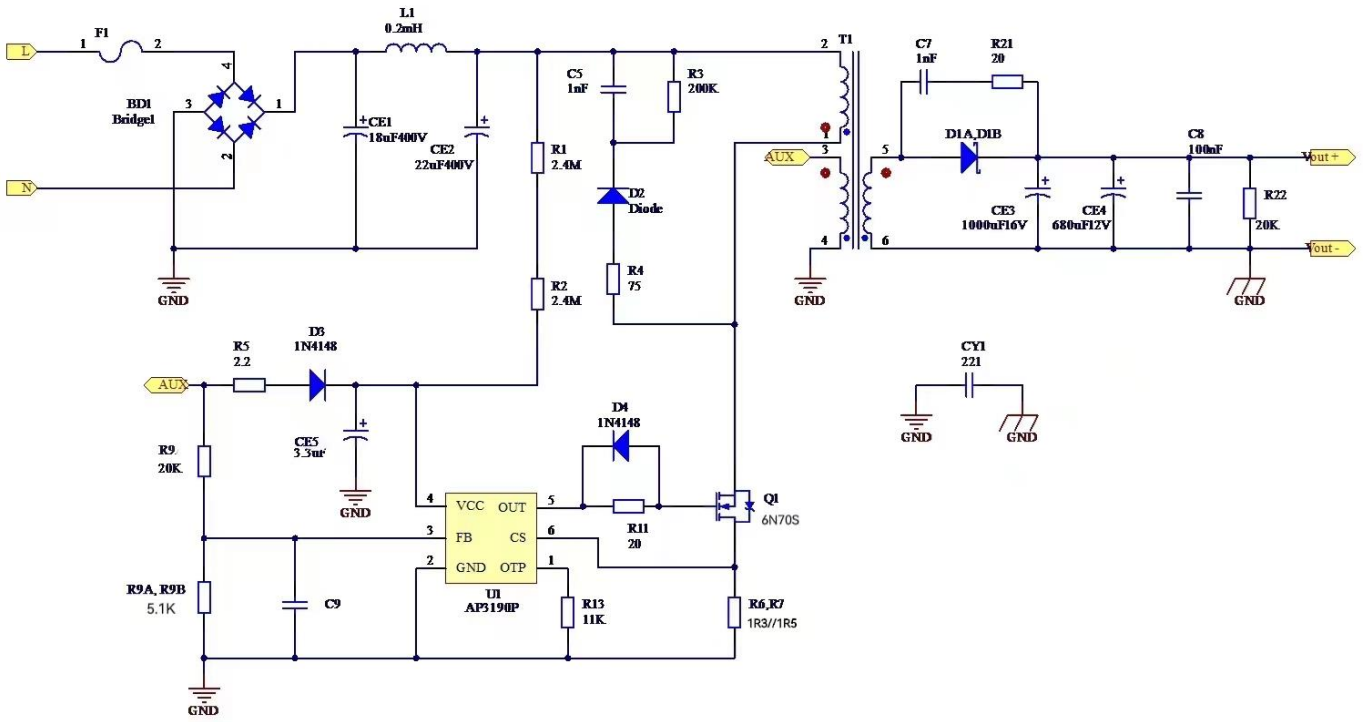
## Chapter 2 Power Supply Specification

### 2.1 Specification and Test Results

Parameter	Value	Test Summary
Input Voltage / Frequency	90VAC to 264VAC / 50Hz or 60Hz	Test Condition
Input Current	<2ARMS	
Standby Power	< 65mW, load disconnected	PASS, 35.7mW@230VAC/50Hz
10V/2.2A Average Efficiency	CoC Version 5, Tier-2 Efficiency >86.42%	PASS, 87.98%@115VAC/60Hz 88.47%@230VAC/50Hz
Output Voltage Regulation Tolerance	+/- 5%	PASS,
Output Voltage Start time	1.81s	90Vac, Full Load
Conducted EMI	>6dB Margin; according to EN55032 Class B	Min. margin 10.29dB@ with 2nd grounding

**Chapter 3 Schematics**

**3.1 Board Schematics**

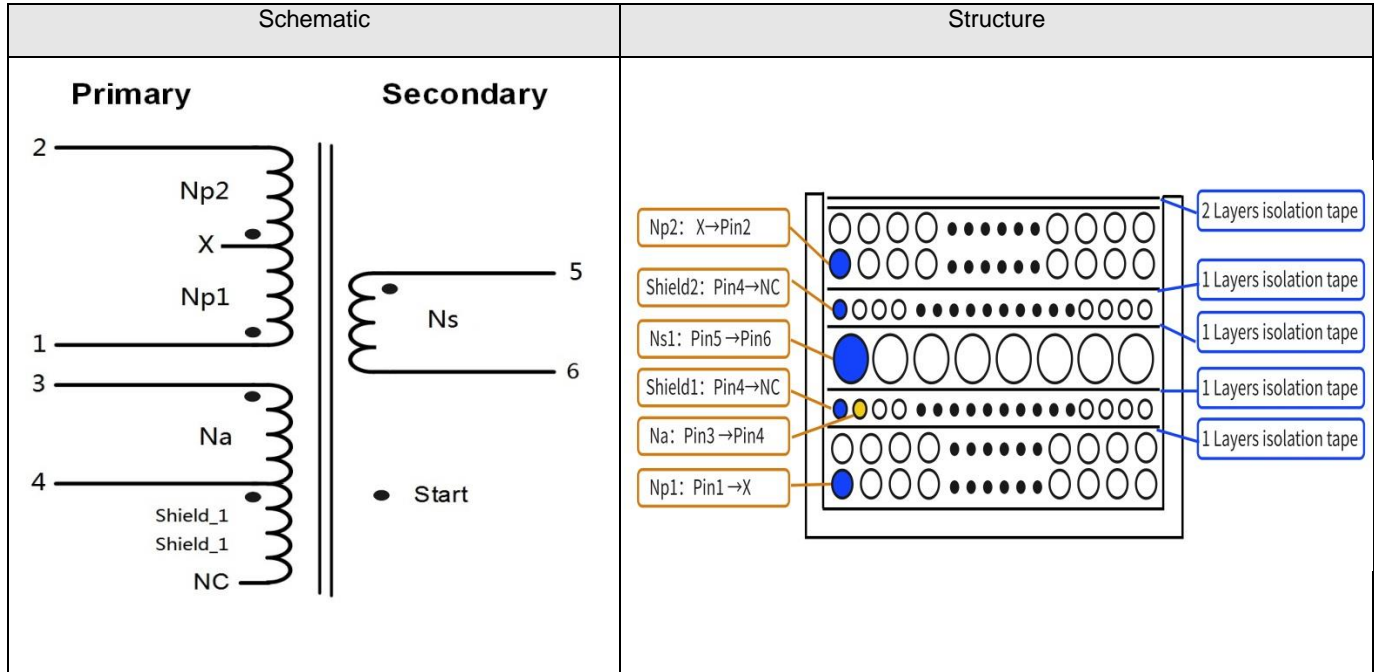


**Figure 1. 22W EVB Schematics**

## 3.2 Bill of Material (BOM)

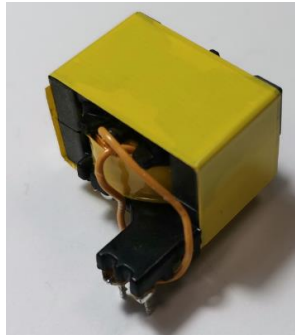
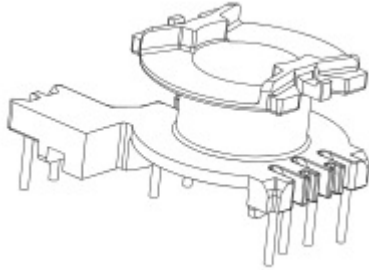
Item	Quantity	Reference	Description	Manufacturer
1	1	BD1	ABS10A Bridge1	Diodes Incorporated (Diodes)
2	1	CE5	3.3μF/50V	AISHI
3	1	C5	1nF/1KV 0805	muRata
4	1	C7	1nF/200V 0805	muRata
5	1	C8	100nF/25V 0805	muRata
6	1	C9	NC	
7	2	CE1	18μF/400V	AISHI
8	1	CE2	22μF/400V	AISHI
9	NA	CE3	1000μF/16V	AISHI
10	1	CE4	680μF/12V	AISHI
11	2	CY1	Y-Cap	JNC
12	1	D1A,D1B	15A/100V PowerDI5	Diodes
13	1	D2	S2MA SMC	Diodes
14	1	D3, D4	1N4148 SOD-123	Diodes
15	1	F1	Fuse	JDTfuse
16	1	L1	DM Inductor 200μH	SANCI
17	2	Q1	U6N70S TO-251	Semihow
18	1	R1, R2	2.4M 1206	fenghua
19	NA	R3	200K 1206	fenghua
20	1	R4	75R 1206	fenghua
21	1	R5	2R2 1206	fenghua
22	2	R6	1R3 1206	fenghua
23	1	R7	1R5 1206	fenghua
24	2	R9	20K 0805	fenghua
25	1	R9A	NC 0805	fenghua
26	1	R9B	5.1K 0805	fenghua
27	1	R11	20R 1206	fenghua
28	1	R13	11K 1206	fenghua
29	1	R21	20R 0805	fenghua
30		R22	22K 1206	fenghua
31		T1	PQ2014	
32		U1	AP3190P	Diodes

### 3.3 Transformer Design



Definition	Pin define (Start >> End)	Wire (φ)	No. of Turns	Layers	Layers of Tape
Np1	1 → X	φ 0.32*1	28.5T	2	1 L
Na	3 → 4(GND)	φ 0.14*2	8T	IN PARALLEL	1 L
Shield_1	4 → NC	φ 0.14*2	8T		1 L
Ns	5 → 6	φ 0.60*1 (Triple Insulated Wire)	6T	1	1 L
Shield_2	4 → NC	φ 0.14*2	14T	1	1 L
Np2	X → 2	φ 0.32*1	25.5T	2	2L

**BOBBIN PIN Define:**



Item	Test Condition	Rating
Primary Inductance	Pin 1-2, all other windings open, measured at 100kHz / 1V	700μH±5%
Note	Bobbin: PQ2014 Core: PQ2014	

### 3.4 Schematics Description

#### 3.4.1 AC Input Circuit & Differential Filter

The Fuse F1 protects against overcurrent conditions which occur when some main components fails. The L1 is a differential mode chock for the differential mode noise suppression. The BD1 is a bridge rectifier which converts alternating current and voltage into direct current and voltage.

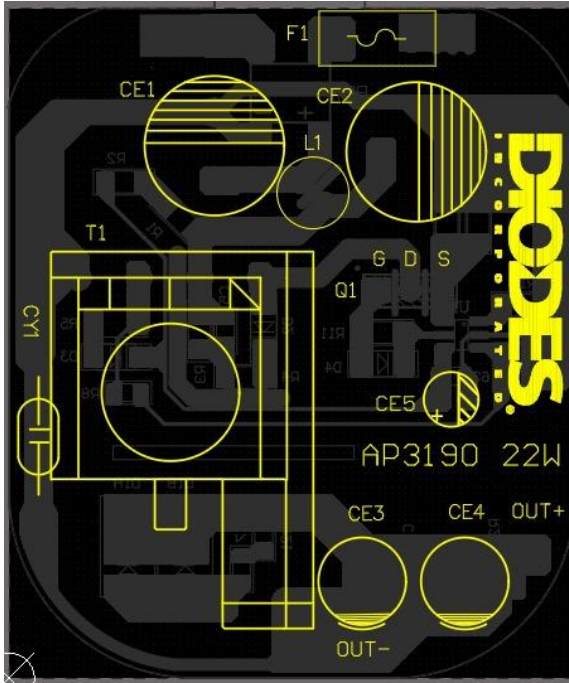
#### 3.4.2 AP3190P PWM Controller

The AP3190P is a high performance offline PSR AC/DC power supply controller. It is specially designed for the application that require the peak load.

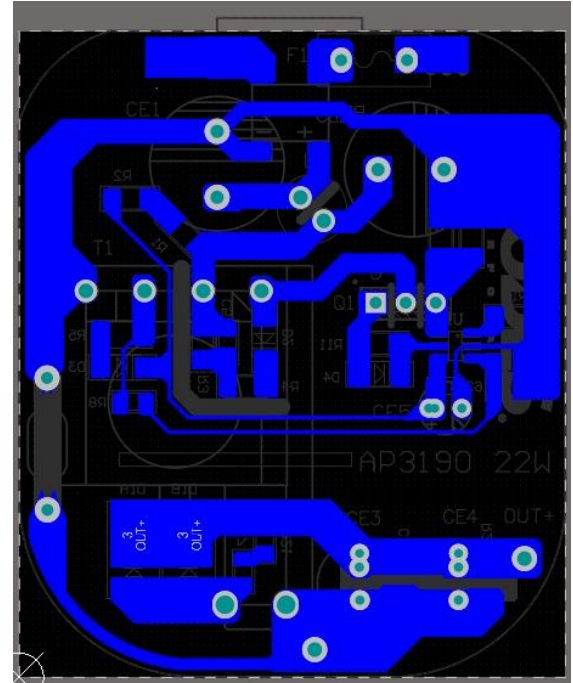


**Chapter 4 The Evaluation Board (EVb) Layout**

**4.1 EVb PCB Layout**



**Figure 2. PCB Layout Top View**



**Figure 3. PCB Layout Bottom View**

## Chapter 5 Testing the Evaluation Board

### 5.1 Input & Output Characteristics

#### 5.1.1 Input Standby Power

Vin(Vac)	Pin(mW)
90/60Hz	15.7
115/60Hz	17.9
230/50Hz	35.7
264/50Hz	44.3

#### 5.1.2 Output Full Load Efficiency & 10% load at Different AC Line Input Voltage

Vin	Pin	Vout	Iout	Efficiency	Efficiency_Ave.	Specification
115	6.22	9.94	0.55	87.93	87.98%	87%
115	12.52	10.00	1.10	87.92		
115	18.99	10.14	1.65	88.10		
115	25.57	10.22	2.20	87.95		
230	6.21	9.94	0.55	88.02	88.47%	87%
230	12.46	10.02	1.10	88.46		
230	18.88	10.15	1.65	88.70		
230	25.38	10.24	2.20	88.73		

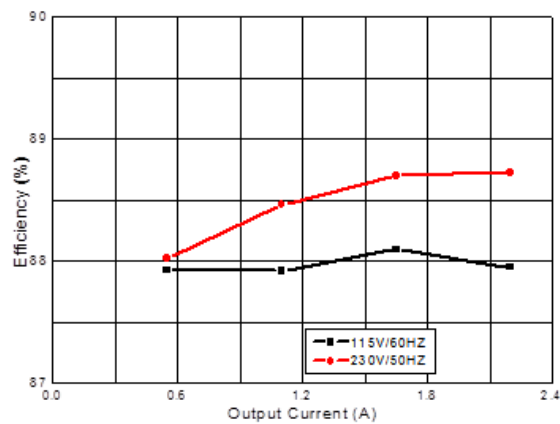


Figure 4. Efficiency vs. AC Line At Board End

Vin	Pin	Vout	Iout	Efficiency	Comments	Specification
115	2.51	9.92	0.22	87.50%	10% Load	85%
230	2.52	9.93	0.22	86.65%	10% Load	

**5.2 Key Performance Waveforms**

**5.2.1 22W System Start-up Time**

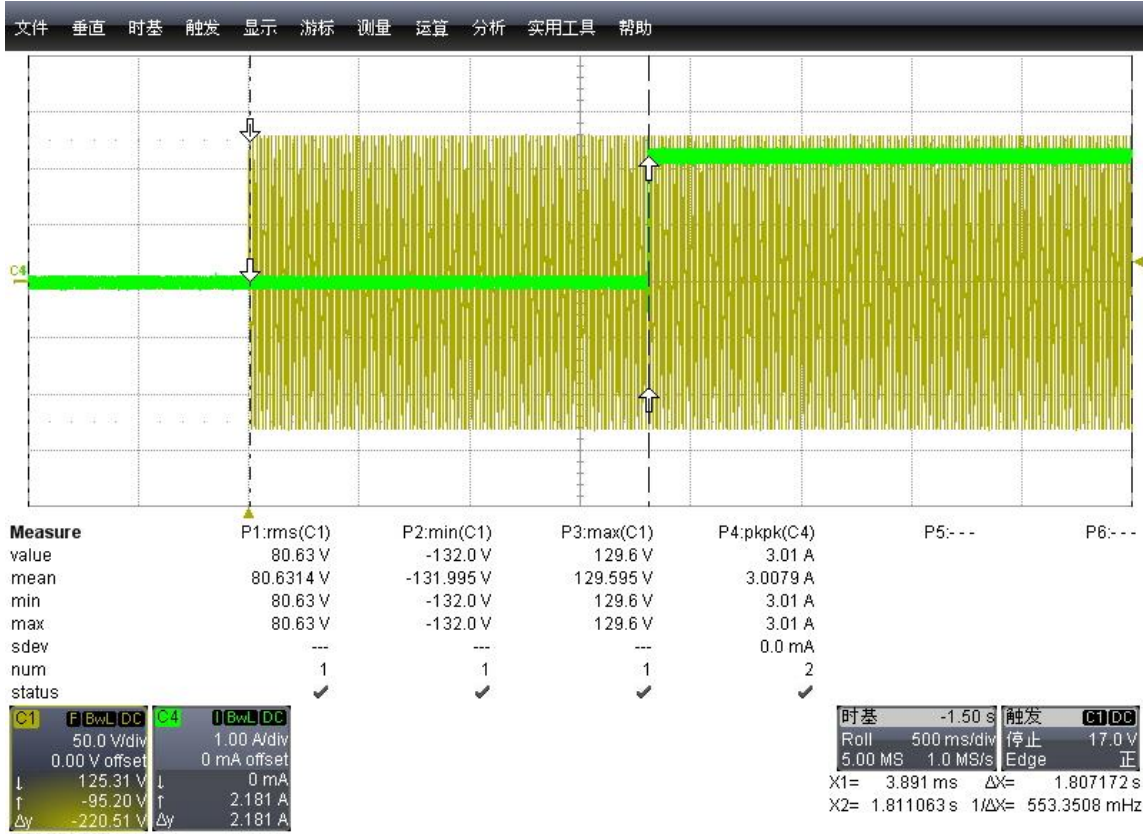


Figure 5. Turn on time is 1.81s at Full Load @ 90Vac

**5.2.2 Q1 / D1A/D1B MOSFET Voltage Stress at Full Load @264Vac**

Primary side MOSFET: Q1 and Secondary side D1A/D1B

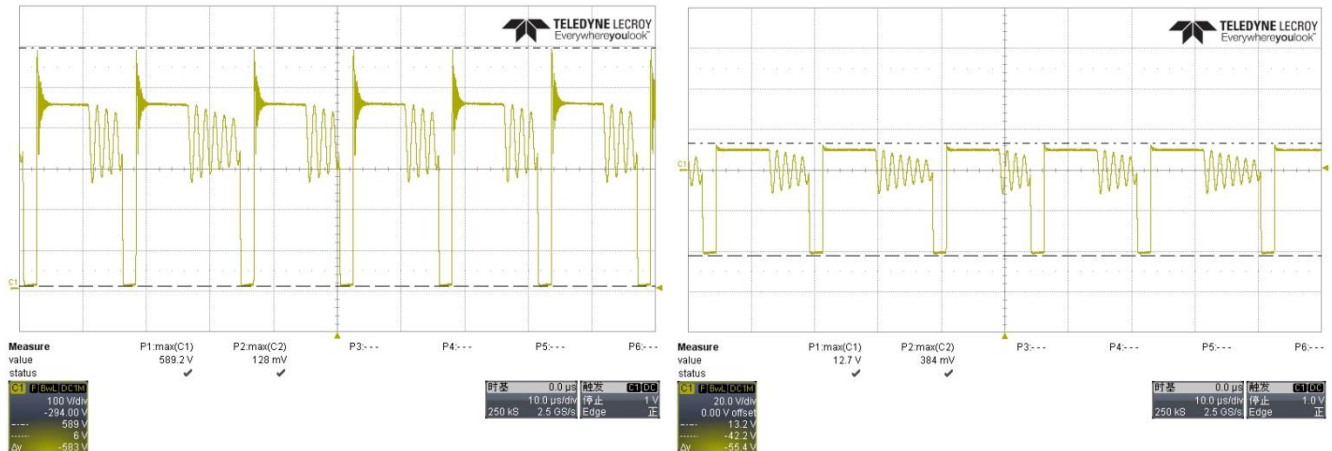


Figure 6. Q1 & D1A/D1B Vds Voltage stress

Component	Vout	Vds	Vds_Max_Spec	Ratio of voltage stress
Q1	10V	55.4V	100V	55.4%
D1A/D1B		583.0V	700V	83.3%

**5.2.3 System Output Ripple & Noise with the Cable**

Connect 47µF AL Cap and 104MLCC to the cable output unit in parallel

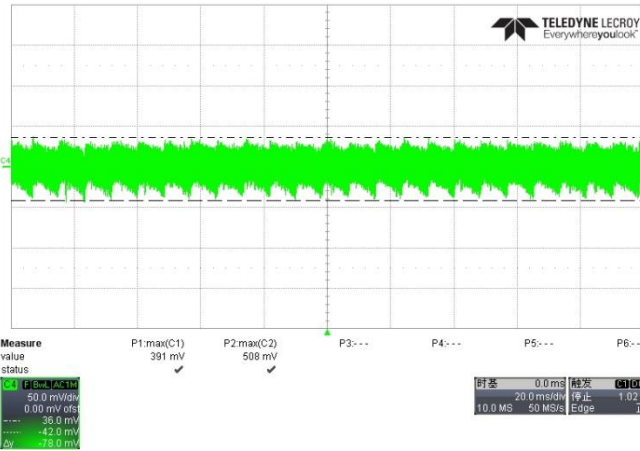


Figure 7. 90Vac/60Hz@10V/2.2A, ΔV=78mV

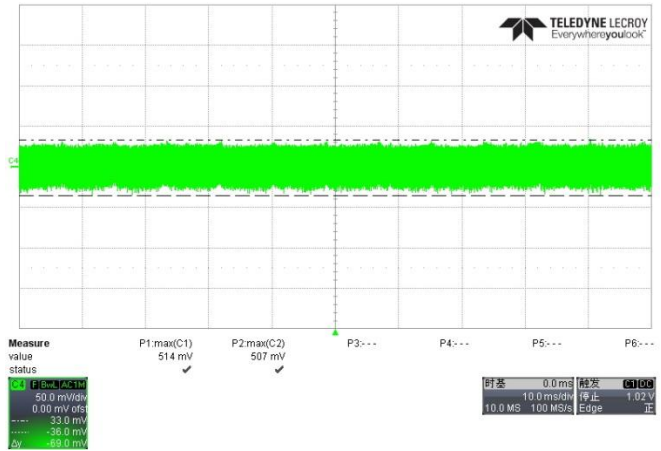


Figure 8. 264Vac/50Hz@10V/2.2A, ΔV=69mV

**5.2.4 Audible Noise**

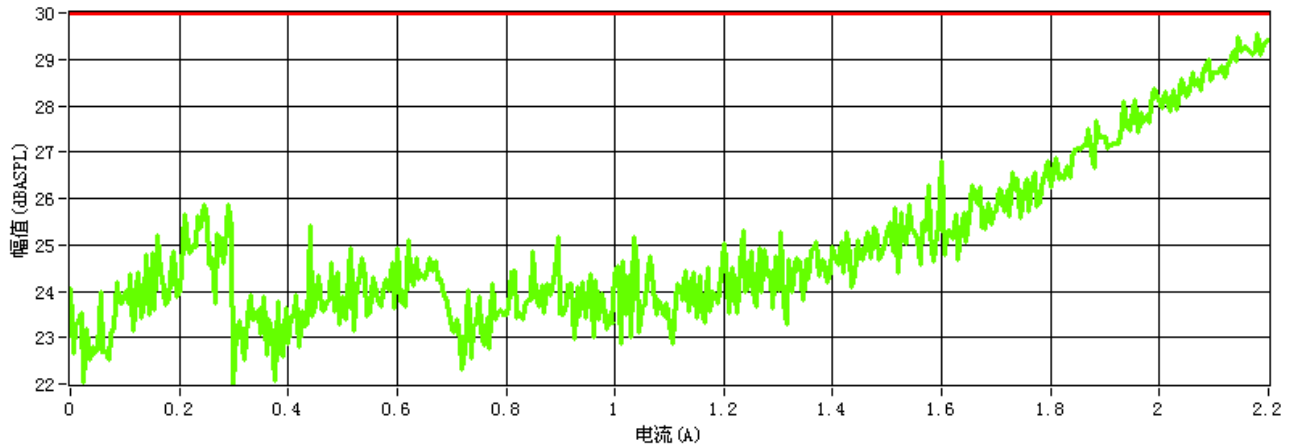
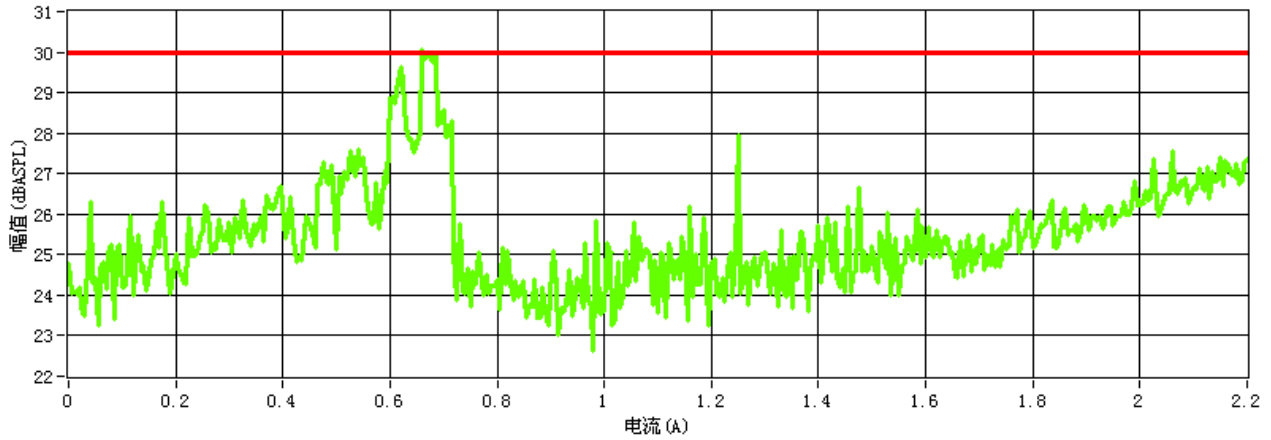
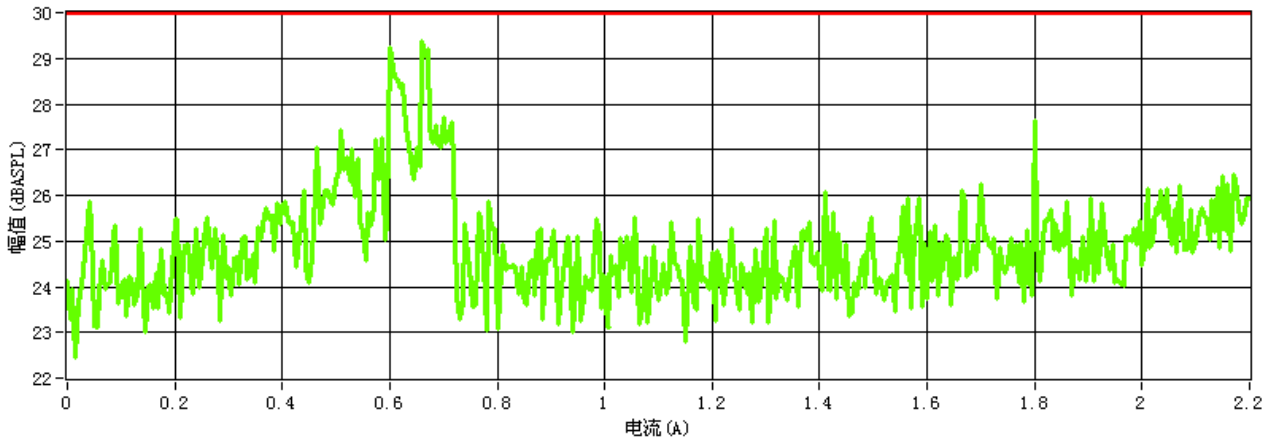


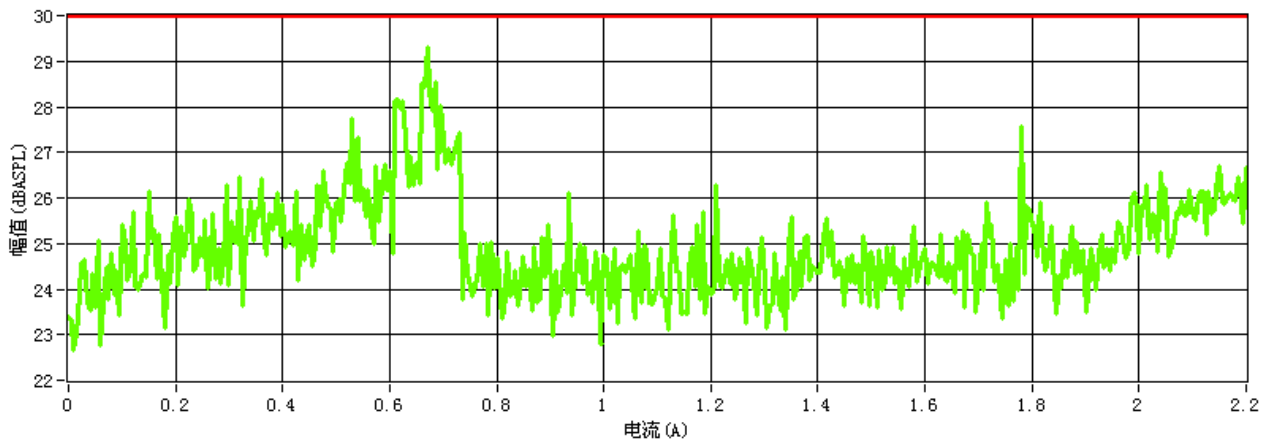
Figure 9. Audible Noise\_2cm@85Vin, Noise is 29.62dB



**Figure 10. Audible Noise\_2cm@115Vin 30.05dB**



**Figure 11. Audible Noise\_2cm@230Vin 29.48dB**



**Figure 12. Audible Noise\_2cm@264Vin 29.37dBdB**

5.2.5 Dynamic load ----10% Load~100% Load, T=20mS, Rate=250mA/μS

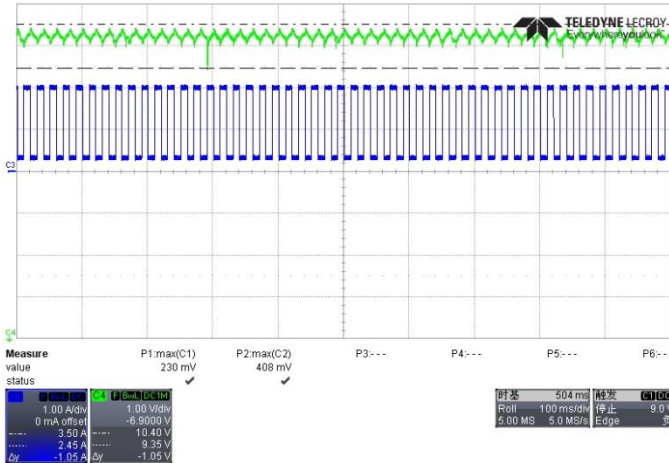


Figure 13. 90Vac/60Hz @ Vout=10V

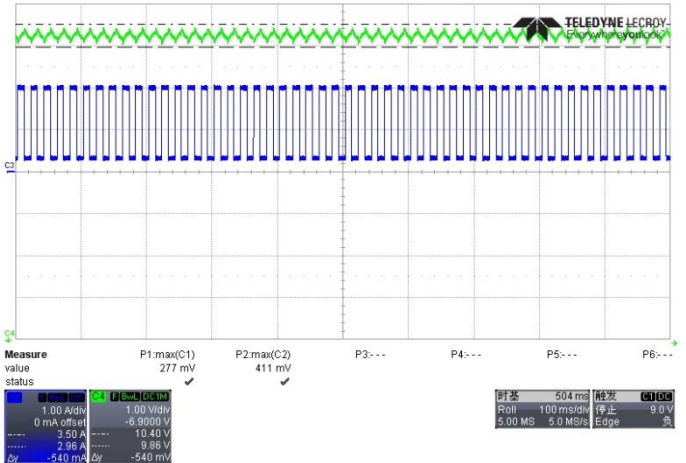


Figure 14. 264Vac/50Hz @ Vout=10V

5.2.6 Peak load test

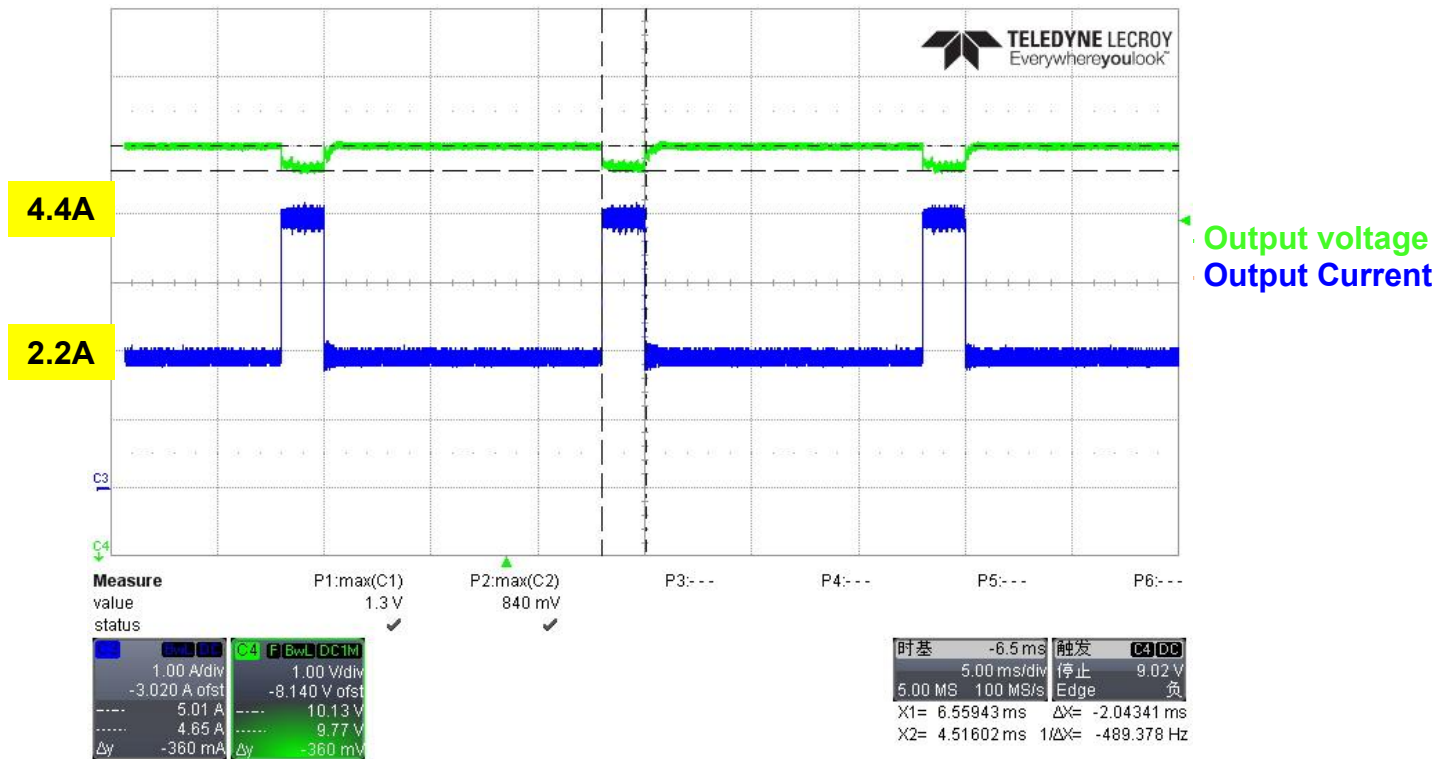


Figure 15. Peak load time>2mS Io=2.2A—4.4A. Vo=9.77V-10.13V



**5.2.7 Thermal Testing**

Output Condition: 10V/2.2A 230VAC

Test Condition: Vin=90Vac @10V-2.2A

Main Voltage	Temperature (°C)					
	Primary MOSFET	Core of Transformer	Primary Controller (AP3190)	Secondary Schottky Diode	Resistance of RCD	Ambient Temperature
90Vac/50Hz	77.5	67.5	60.8	104.6	95.6	25
230Vac/50Hz	66.8	73.2	53.7	106.6	88.4	25

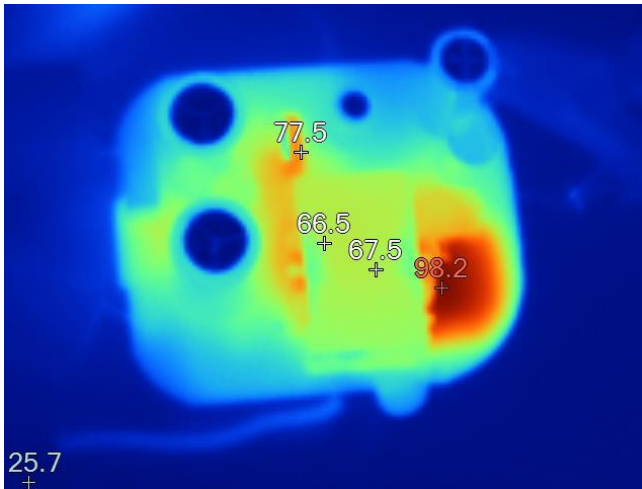


Figure 16. 90V Top Surface Mount side

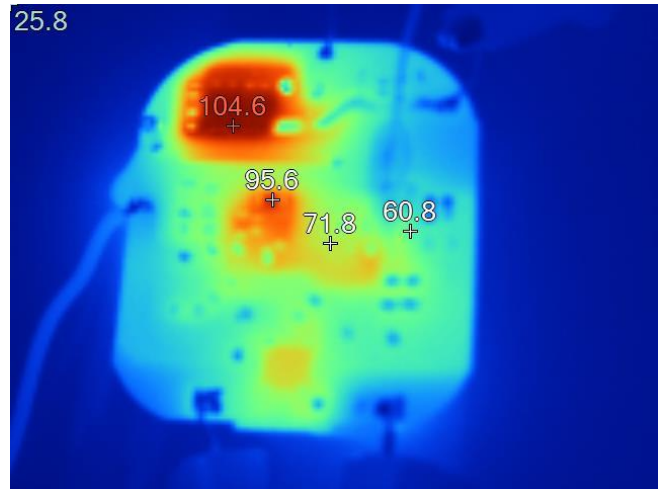


Figure 17. 90V Bottom Surface Mount side

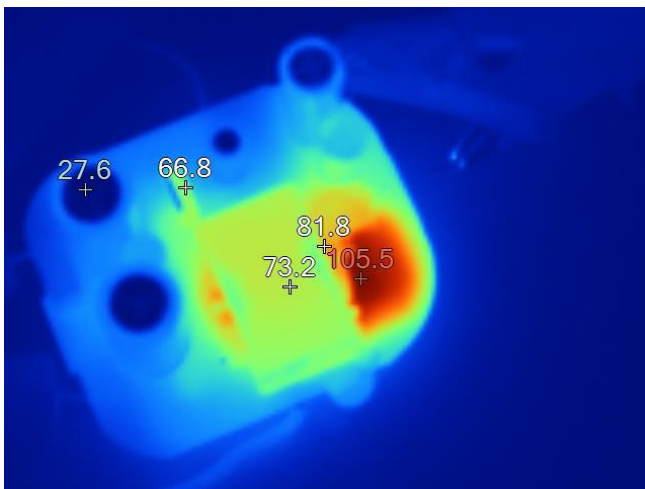


Figure 18. 230V Top Surface Mount side

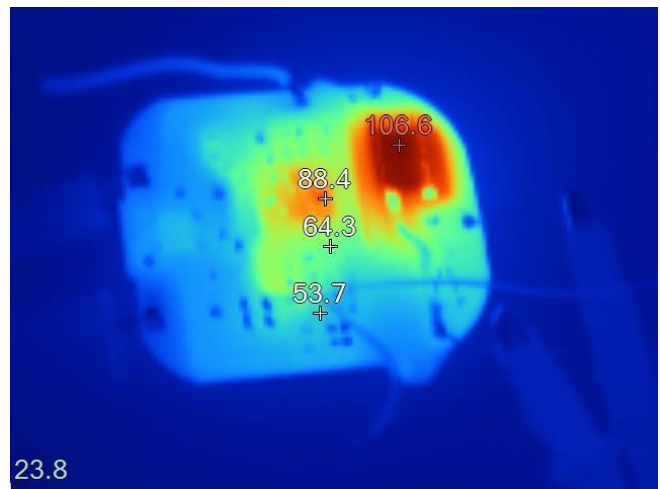
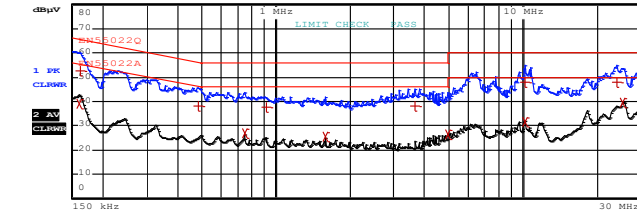


Figure 19. 230V Bottom Surface Mount side

- Notes:**
- 1) Component temperature can be further optimized with various system designs and thermal management approaches by manufacturers.
  - 2) The data has been revised according to the Ta=25C.

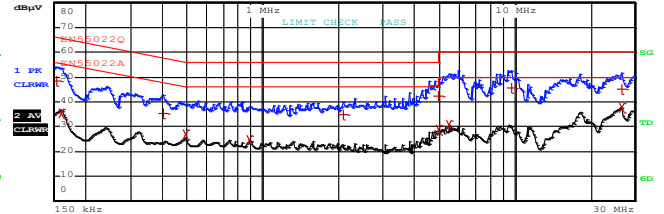
## 5.3 EMI (Conduction) Testing

Output Condition: 10V/2.2A



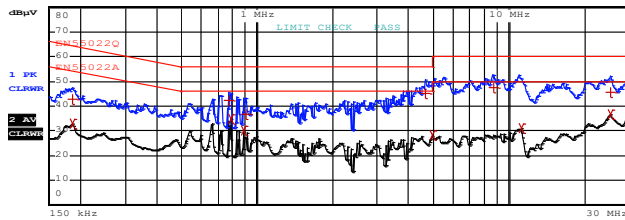
EDIT PEAK LIST (Final Measurement Results)				
TRACE	FREQUENCY	LEVEL dBµV	DELTA LIMIT dB	
2 Average	157.651507515 kHz	38.84	-16.74	
1 Quasi Peak	159.22802259 kHz	52.52	-12.97	
1 Quasi Peak	480.498450633 kHz	38.21	-18.11	
2 Average	744.444692652 kHz	26.96	-19.03	
1 Quasi Peak	908.363999266 kHz	37.69	-18.31	
2 Average	1.57012949439 MHz	25.32	-20.67	
1 Quasi Peak	3.65807194995 MHz	38.11	-17.88	
2 Average	4.93052830996 MHz	26.53	-19.46	
1 Quasi Peak	10.1942139227 MHz	47.84	-12.15	
2 Average	10.1942139227 MHz	31.70	-18.29	
1 Quasi Peak	23.9878811379 MHz	48.08	-11.91	
2 Average	25.4636191981 MHz	39.70	-10.29	

Figure 20. 115Vac/50Hz L line



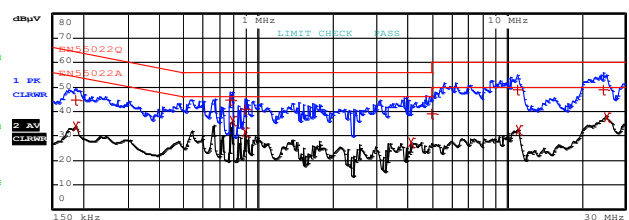
EDIT PEAK LIST (Final Measurement Results)				
TRACE	FREQUENCY	LEVEL dBµV	DELTA LIMIT	
1 Quasi Peak	153.015 kHz	48.23	-17.59	
2 Average	157.651507515 kHz	35.23	-20.34	
1 Quasi Peak	401.705024172 kHz	35.10	-22.71	
2 Average	490.156469491 kHz	26.99	-19.17	
2 Average	881.64914842 kHz	24.38	-21.61	
1 Quasi Peak	2.0745979178 MHz	34.67	-21.32	
1 Quasi Peak	4.93052830996 MHz	42.17	-13.82	
2 Average	4.93052830996 MHz	28.67	-17.32	
2 Average	5.44637066114 MHz	30.83	-19.16	
1 Quasi Peak	9.69944475959 MHz	45.39	-14.60	
1 Quasi Peak	26.4975442467 MHz	45.09	-14.90	
2 Average	26.4975442467 MHz	37.54	-12.45	

Figure 21. 115Vac/50Hz N line



EDIT PEAK LIST (Final Measurement Results)				
TRACE	FREQUENCY	LEVEL dBµV	DELTA LIMIT	
1 Quasi Peak	183.028505992 kHz	42.84	-21.50	
2 Average	183.028505992 kHz	32.92	-21.41	
1 Quasi Peak	767.002111284 kHz	42.30	-13.69	
2 Average	782.418853721 kHz	35.01	-10.98	
2 Average	881.64914842 kHz	30.35	-15.64	
1 Quasi Peak	899.370296303 kHz	36.91	-19.08	
1 Quasi Peak	4.64478070168 MHz	45.13	-10.86	
2 Average	4.93052830996 MHz	28.16	-17.83	
1 Quasi Peak	8.69384238477 MHz	47.61	-12.38	
2 Average	11.1492616339 MHz	30.96	-19.03	
1 Quasi Peak	25.4636191981 MHz	45.47	-14.52	
2 Average	25.4636191981 MHz	36.78	-13.22	

Figure 22. 230Vac/50Hz L line



EDIT PEAK LIST (Final Measurement Results)				
TRACE	FREQUENCY	LEVEL dBµV	DELTA LIMIT dB	
1 Quasi Peak	183.028505992 kHz	44.58	-19.76	
2 Average	183.028505992 kHz	33.72	-20.62	
1 Quasi Peak	767.002111284 kHz	44.70	-11.30	
2 Average	782.418853721 kHz	36.14	-9.85	
1 Quasi Peak	881.64914842 kHz	40.86	-15.13	
2 Average	881.64914842 kHz	31.55	-14.44	
2 Average	4.08119508439 MHz	27.55	-18.44	
1 Quasi Peak	4.97983359306 MHz	39.14	-16.85	
1 Quasi Peak	10.9295771335 MHz	48.79	-11.20	
2 Average	11.0388729048 MHz	32.38	-17.61	
1 Quasi Peak	24.2277599493 MHz	48.72	-11.28	
2 Average	24.9618853035 MHz	37.75	-12.24	

Figure 23. 230Vac/50Hz N line



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