Test Report of TEA8918 TA application 160W demo board

PL Smart Power

Jan 31th 2019

Version: v1.0

SECURE CONNECTIONS FOR A SMARTER WORLD

Agenda

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3. PCB Layout
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10. Turn on delay time
11. Ripple & noise
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13. Dynamic load
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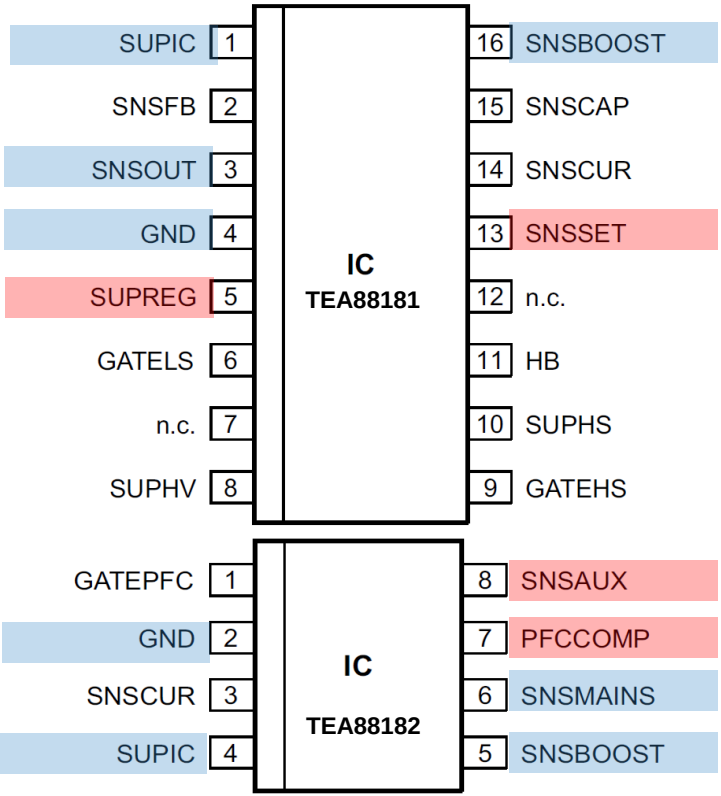
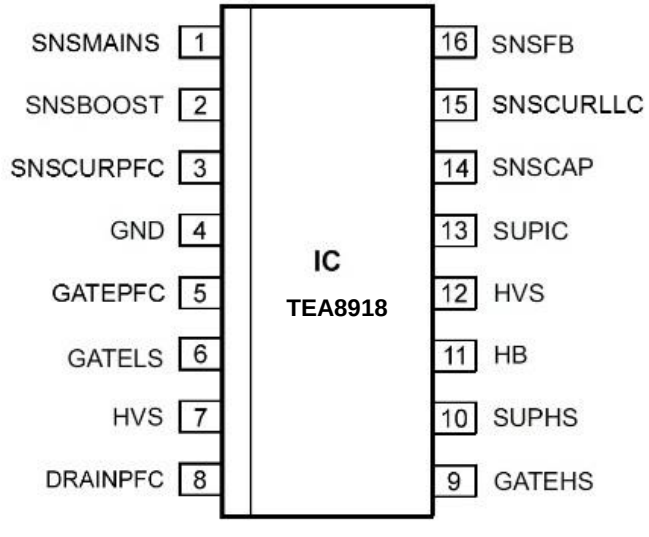
15. Voltage derating
16. LLC mode change status
17. Operation Frequency
18. OVP protection
19. OCP protection
20. OPP protection
21. AC dip
22. EMI
23. Acoustic noise

Pin Configuration

24 pins ➔ 16pins (Common : SUPIC, SNSBOOST, SNSMAINS, GND. Built IN : SNSAUX, PFCCOMP, SNSOUT, SUPREG



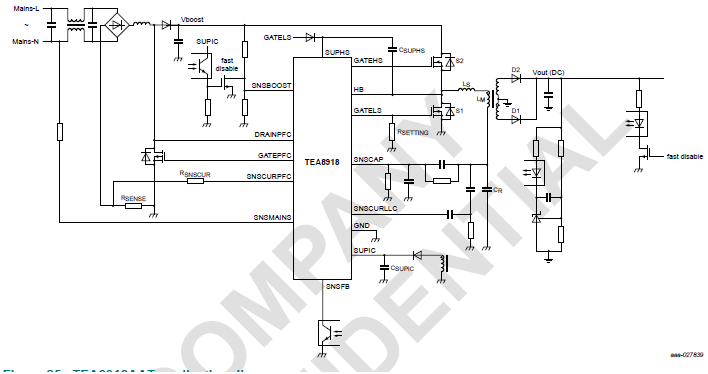


- **SUPREG ➔ GATELS**
- **SNSSET ➔ MTP programming**
- **SNSAUX ➔ DRAINPFC**
- **PFCCOMP ➔ Built IN**

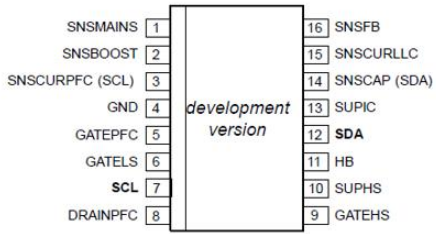
TEA8918- Digital Resonant Power Platform

Resonant Power made easy to design

- Single SO16 package PFC + LLC combo controller (SO16 package size with High Voltage Spacing)
- Parameter programming during evaluation with use of GUI
- Improved audible noise
- Parameter table selection resistor at pin GATELS
- HV resistor removed, replaced by internal current source
- Most innovative resonant power platform in the market today

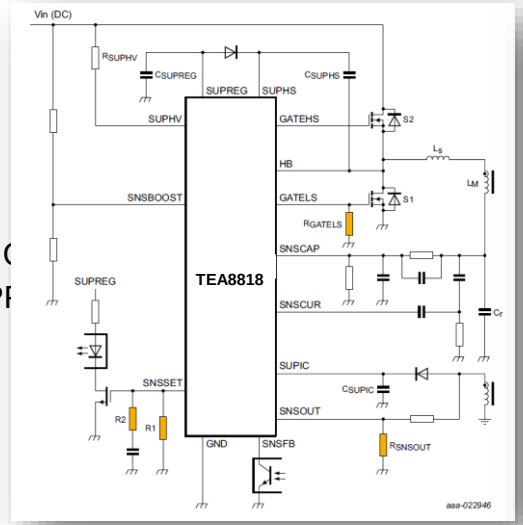


- Digital cycle-by-cycle control by state machine for stable operation
- Enabled by NXP's patented Vcap control (cycle-level accuracy)
- Ease of use – pre-configured with limited settings
- Accurate burst-mode level and reduced audible noise
- Very high efficiency at light load, and very low no-load
- Enables removing standby supply
- Fast dynamic load response

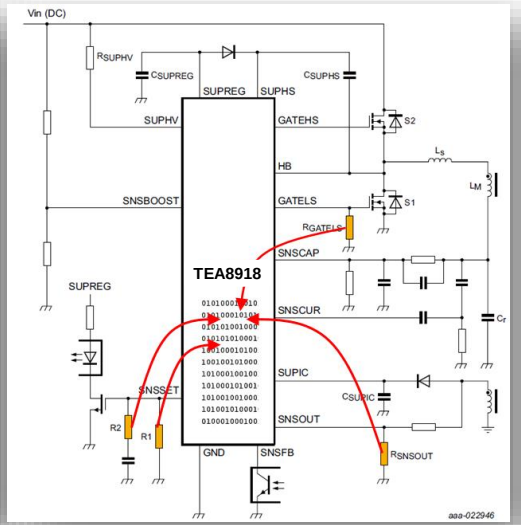


TEA8918T – LLC Resistor Settings Overview

- Soft start power level
- Protections
  - Peak Power limit (150% or 200%)
  - Start OPP timer (125%, 175% or no OPP)
  - Start OPP timer at start-up (120%, 170% or no O
  - OPP time to protection (50ms, 200ms or no OPP
  - Protection mode (restart or latched)
  - OVP PFC & OVP LLC (output OVP)
  - OCP LLC & OCP PFC
  - Brown-in / Brown-out



TEA8818
Resistor Settings



TEA8918
Internal MTP Settings

- Power settings:
  - Power level for High Power/Low Power transition (25%, 37.5%, 50% or 62.5%)
  - Burst repetition frequency (200Hz, 400Hz, 800Hz or 1600Hz)
  - Low Power to Burst Mode mode transition (9%, 10%, 11%, 12%, 13%, 14%, 15%, 17%, 17.5% or 20%)
  - Minimum Energy per Cycle (5%, 6%, 7%, 9%, 10%, 11%, 14%, 17%, 18% or 23%)

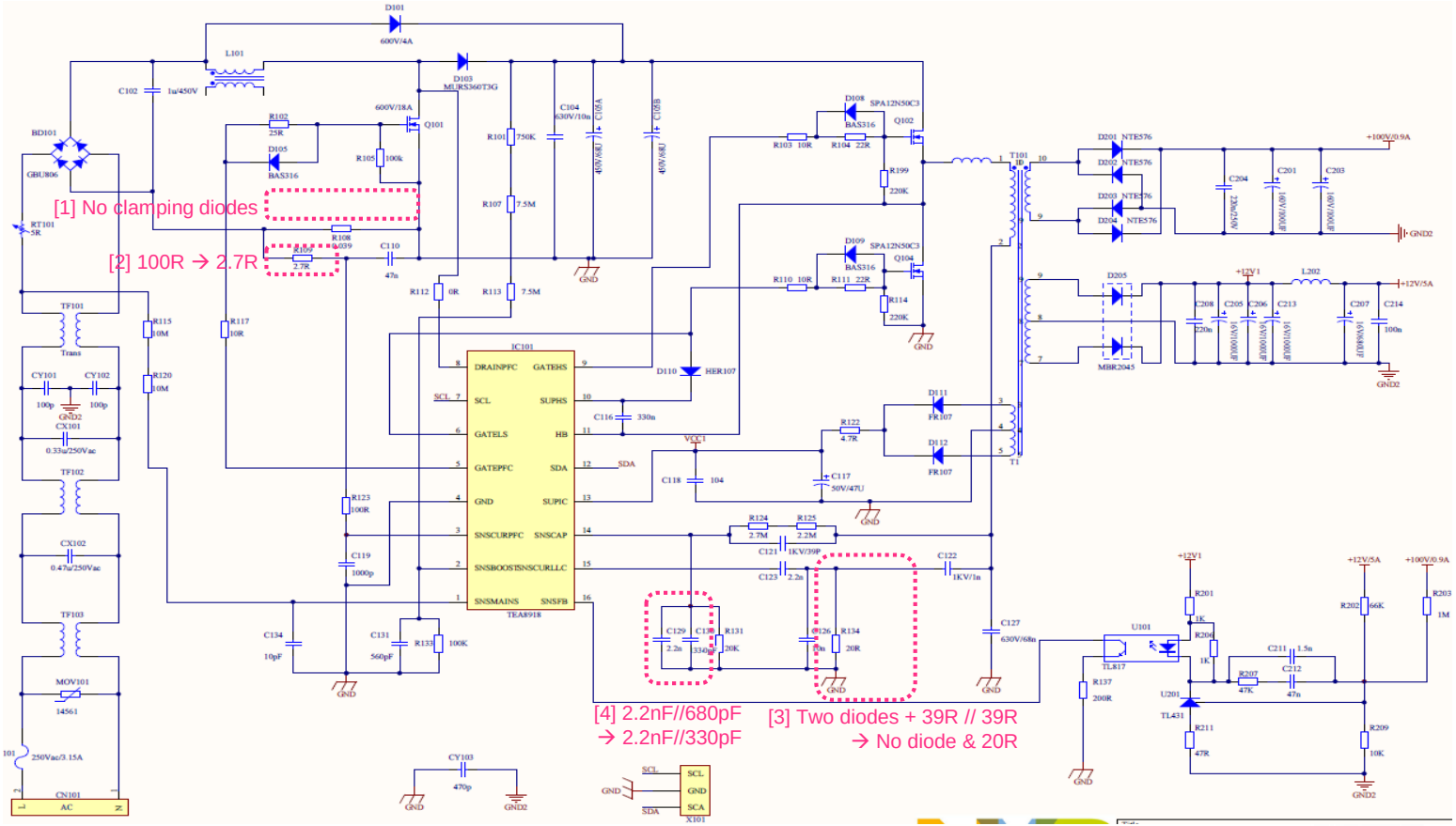
TEA8918AAT MTP settings

NXP Confidential

Parameter	1st version TEA8918	2nd version TEA8918	Update details
vburst_ripple	70mV	70mV	
max_llc_freq	350kHz	350kHz	
llc_tsoftstart	3.3x	3.3x	
max_llc_istartup	0.75V	0.75V	
capm_lvl	100mV	100mV	
hp_lp_lev	30%	30%	
lp_bm_lev	10%	10%	
bm_lp_hys	50%	50%	
bm_freq	800Hz	800Hz	
bm_incr	1	1	
sr_time__r1_	1s	1s	
lp_nr_peaks	2	2	
otp_ltch__r1_	safe restart	safe restart	
brownin_lvl	5.7uA	5.7uA	
brownin_hys	0.75uA	0.75uA	
t_brownout	50ms	50ms	
ovp_lvl	2.63V	2.63V	
ovpprot_lvl	470	470	
t_ovpprot	5ms	5ms	
ovp_ltch__r1_	safe restart	safe restart	
snsb_stop	1.1	1.1	
snsb_start	2.2V	2.2V	
pow_lim	125%	140%	Previous OPP were set as 100%. And according to external SNSCAP divider ratio, real OPP point was designed as 125%. → For new MTP, OPP is set as 125% and external divider does not have an offset (real OPP is also 125%). Accordingly, power limit is also increased to 140%.
opp1_lvl	-20%	-14%	
opp1_time__r1_	50ms	50ms	
opp_ltch__r1_	safe restart	safe restart	
llc_ovp	10V	15V	→ Why it is modified? OVP was checked?
llc_tovp	50us	50us	
llc_ovp_ltch__r1_	safe restart	safe restart	
llc_ocp_ltch__r1_	safe restart	safe restart	
llc_tocp__r1_	5	5	

Evaluation Board Schematic

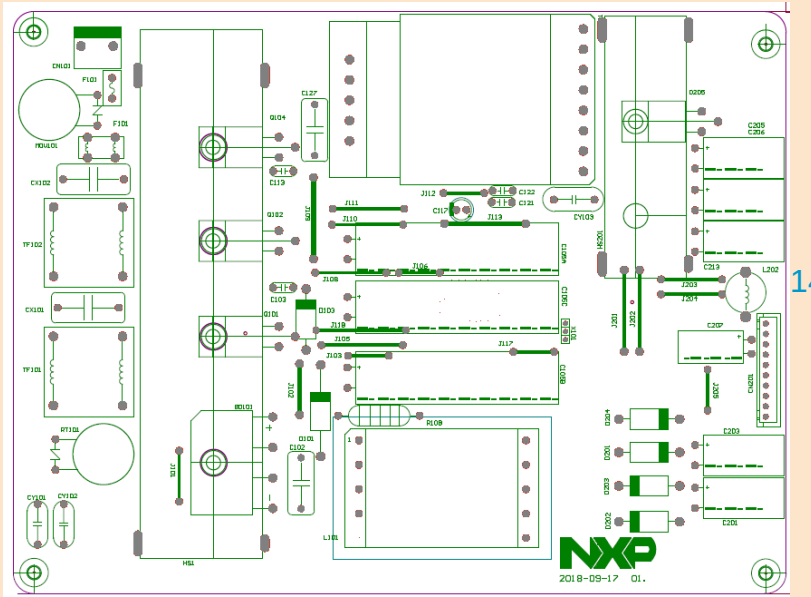
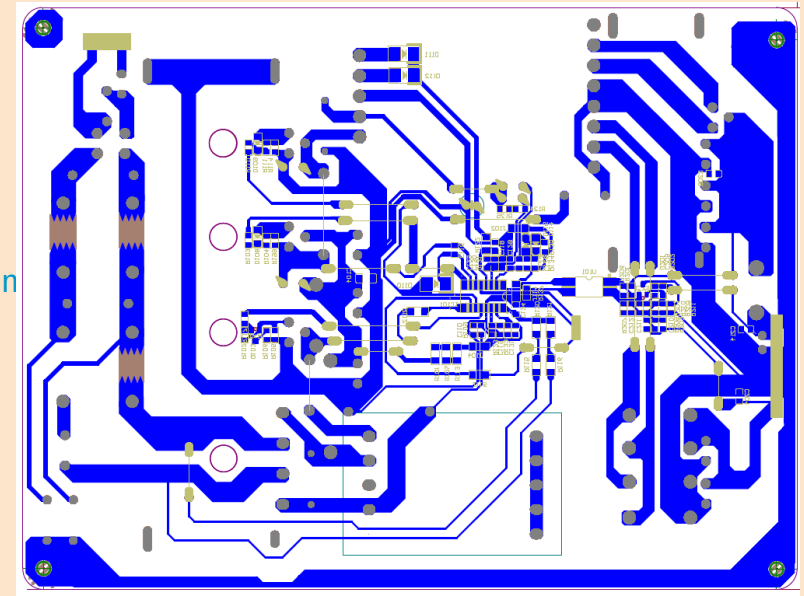
Updated BOM is described individually



Evaluation Board Schematic ; Update BOM detail

#	Updated BOM list	Before	After	Detail
1	SNSCURPFC negative voltage clamping diode	2 series connected diodes	NC	Even though negative voltage is applied to external sensing resistor, SNSCURPFC can sustain with specific condition • Negative voltage > -18V & • Series resistance between sensing resistor and SNSCURPFC > 100ohm Since these conditions can be met without 2-diode, they are removed
2	SNSCURPFC filter resistance	100R + 47nF	2.7R + 47nF	The filter frequency of 100R + 47nF is lower than switching frequency. So, SNSCURPFC pin voltage is distorted a lot. It avoids correct demag detection, and there are much valley cycles on DRAINPFC. After reducing filter frequency by reducing resistor from 100R to 2.7R, demag detection is normal and # of valley cycles is normal as well. Since there is 2nd RC filter with 100R, the total series resistance between sensing resistor and SNSCURPFC is still greater than 100R.
3	SNSCURLLC clamping diodes	(Two diodes + 39R) // 39R	20R	Two diodes are conducted when the high voltage is applied on SNSCURLLC (OCP condition). Then, the total resistance becomes 39R//39R. When low voltage is applied (CMR condition), only 39R can be seen. So, OCP and CMR can be adjusted separately. Since TEA8918 can adjust CMR via MTP, the two diodes and 39R are removed and the remaining resistor is reduced to be same as 39R//39R
4	SNSCAP external capacitor divider ratio	Lower side ; 2.2nF//680pF	Lower side ; 2.2nF//330pF	Since OPP is modified to 125%, the external divider does not need to give offset more. So, the ratio is modified to fit 125% OPP correctly.

PCB Layout

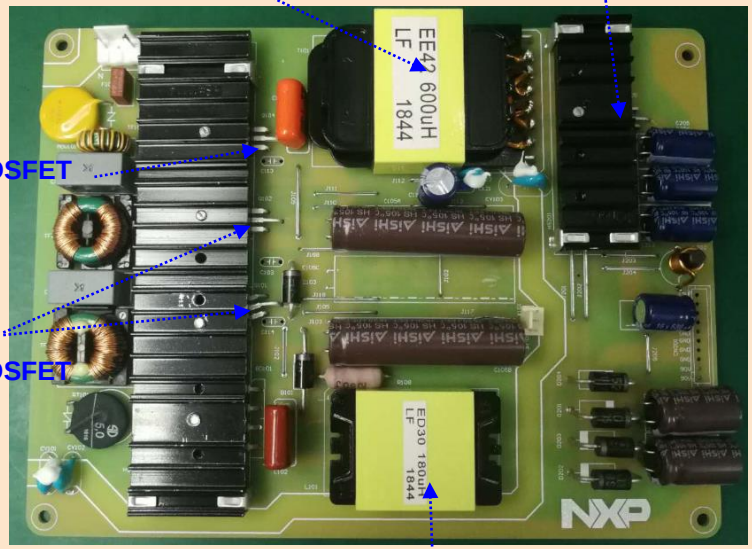
Top Side	Bottom side
190mm	190mm
	

143mm

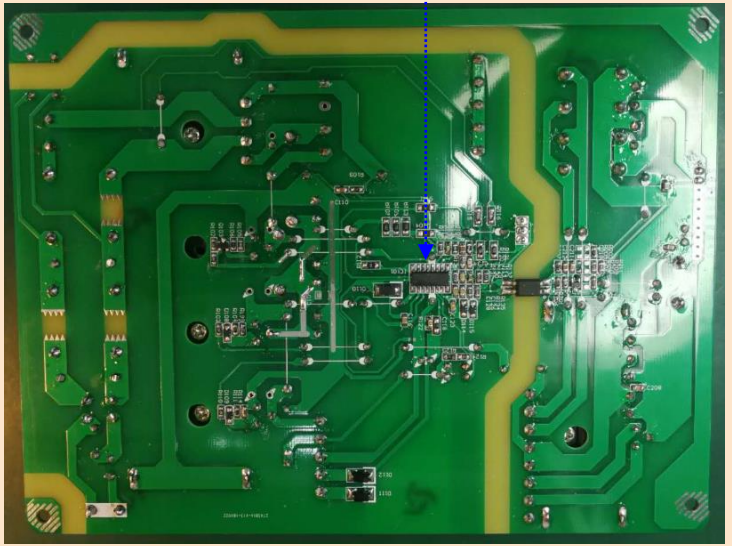
L:W:H=190mm*143mm*13.5mm

Evaluation Board Pictures

Top Side



Bottom side



L:W:H=190mm*143mm*13.5mm

BOM

	Comment	Description	Vendor part number	Designator	Footprint	LibRef	Vendor	Quantity
2	GBU806	DIO BRD BA 600V GBU-4P	GBU8J-47L	BD101	BD-223X4-P5.08 (UXKBA80R型)	Bridge1	GULF	1
3	1u/450V	CAP MM DP 450V 1uF K P15	MFTD105K0450DB1151	C102	MC-15.5X6.5-P12.5	Cap	Epcos	1
4	630V/10n	CAP MM DP 630V 0.01uF K P10	MEF-103K0630DB1101	C104	1206C(W)	Cap	Panasonic	1
5	450V/68U	CAP AL 450V 68uF M 12.5*50 P5	EKXJ451ELL680MK50S	C105A	EC-13*50	Cap Pol1	NCC	1
6	450V/68U	CAP AL 450V 68uF M 12.5*50 P5	EKXJ451ELL680MK50S	C105B	EC-13*50	Cap Pol1	NCC	1
7	450V/68U	CAP AL 450V 68uF M 12.5*50 P5	EKXJ451ELL680MK50S	C105C	EC-13*50	Cap Pol1	NCC	1
8	47n/50V	X7R		C110	0805C(W)	Cap	MURATA	1
9	330n/50V	X7R		C116	0805C(W)	Cap	MURATA	1
10	50V/150U	CAP AL LD 50V 150uF M 10*12.5 TP P5		C117	EC-10X11-P5.5-C	Cap Pol1	LUMINOUS	1
11	50V/47U	CAP AL LD 50V 47uF M 6.3*11 TP P5	ZGD1HM470E11A	C117	EC-8X16-P3.5-C	Cap Pol1	LUMINOUS	1
12	100n/50V	X7R		C118	0805C(W)	Cap	MURATA	1
13	1nF/50V	COG		C119	0805C(W)	Cap	MURATA	1
14	1KV/33P	CAP CD 1KV 33pF K R TP V5	CC45SL330JYAN	C121	CC-6.5X2.5-P5	Cap	MURATA	1
15	1KV/1n	CAP CD 1KV 1000pF K R TP V5	CK45-R3AD102K-VR	C122	CC-6.5X2.5-P5	Cap	MURATA	1
16	2200p/50V	X7R		C123	0805C(W)	Cap	MURATA	1
17	10n/50V	X7R		C126	0805C(W)	Cap	MURATA	1
18	630V/68n	CAP MP DP 1KVH 0.068uF J P15	4C6W333J-BO(PHP)	C127	MC-15.5X6.5-P12.5	Cap	Shinyei	1
19	680P/50V	X7R		C128	0805C(W)	Cap	MURATA	1
20	3.3n/50V	X7R		C129	0805C(W)	Cap	MURATA	1
21	680p/50V	X7R		C130	0805C(W)	Cap	MURATA	1
22	560pF/50V	X7R		C131	0805C(W)	Cap	MURATA	1
23	160V/82UF	CAP AL 160V 82uF M 12.5*20		C201	EC-10X20-P5-C	Cap Pol1	AISHI	1
24	160V/82UF	CAP AL 160V 82uF M 12.5*20		C203	EC-10X20-P5-C	Cap Pol1	AISHI	1
25	100n/25V	X7R		C214	0805C(W)	Cap	MURATA	1
26	220n/250V	X7R		C204	0805C(W)	Cap	MURATA	1
27	16V/1000UF	CAP AL LD 16V 1000uF M 10*20 TP P5	ZGD1CM102G208	C205	EC-10X20-P5-C	Cap Pol1	LUMINOUS	1
28	16V/1000UF	CAP AL LD 16V 1000uF M 10*20 TP P5	ZGD1CM102G208	C206	EC-10X20-P5-C	Cap Pol1	LUMINOUS	1
29	16V/680UF	CAP AL LD 16V 680uF M 10*16 TP P5	EKZE160ETD681MJ16S	C207	EC-8X16-P3.5	Cap Pol1	NCC	1
30	220n/25V	X7R		C208	0805C(W)	Cap	MURATA	1
31	1.5n/25V	X7R		C211	0805C(W)	Cap	MURATA	1
32	47n/25V	X7R		C212	0805C(W)	Cap	MURATA	1
33	16V/1000UF	CAP AL LD 16V 1000uF M 10*20 TP P5	ZGD1CM102G208	C213	EC-10X20-P5-C	Cap Pol1	LUMINOUS	1
34	0.47u/250Vac	CAP X2 MP PC 275VAC 0.47uF K P22.5	LE474	CX101	XC-18X7.5-P15	Cap	OKAYA	1
35	0.22u/250Vac	CAP X2 MP PC 300VAC 0.22uF K S15	LE224-MX-30-C3.2	CX102	XC-18X10-P15	Cap	OKAYA	1
36	100p	CAP Y1/Y1 CD 250VAC 100pF M B TP VI10	DE1B3KY101KN4AL01	CY101	YC-10.5X5-P7.5	Cap	MURATA	1
37	100p	CAP Y1/Y1 CD 250VAC 100pF M B TP VI10	DE1B3KY101KN4AL01	CY102	YC-10.5X5-P7.5	Cap	MURATA	1
38	470p	CAP Y1/Y1 250VAC 470pF K B TP TP P10	DE1B3KY471KN4AL01	CY103	YC-10.5X5-P7.5	Cap	MURATA	1
39	600V/4A	DIO FRD 4A 600V DO-201AD-2P 45nS	MUR460-47L	D101	DO-201AD-P15	Diode	GULF	1
40	600V/4A	DIO FRD 4A 600V DO-201AD-2P 45nS	MUR460-47L	D103	DO-201AD-P15	Diode	GULF	1
41	BAS316	DIO SW 250mA 100V SOD-323-2P SMD	BAS316	D108	SMD-4148	Diode	NXP	1
42	BAS316	DIO SW 250mA 100V SOD-323-2P SMD	BAS316	D109	SMD-4148	Diode	NXP	1
43	S1J-13-F	DIO SI 1A 600V SMA-2P	S1J-13-F	D110	SMD(DO-214AA)	Diode	DIODES	1
44	S1J-13-F	DIO SI 1A 600V SMA-2P	S1J-13-F	D111	SMD(DO-214AA)	Diode	DIODES	1
45	S1J-13-F	DIO SI 1A 600V SMA-2P	S1J-13-F	D112	SMD(DO-214AA)	Diode	DIODES	1

46	BAS316	DIO SW 250mA 100V SOD-323-2P SMD	BAS316	D114	SMD-4148	Diode	NXP	1
47	BAS316	DIO SW 250mA 100V SOD-323-2P SMD	BAS316	D115	SMD-4148	Diode	NXP	1
48	1N5406G-47L	DIO SI 3A 600V DO-201AD-2P	1N5406G-47L	D201	DO-201AD-P15	Diode	GULF	1
49	1N5406G-47L	DIO SI 3A 600V DO-201AD-2P	1N5406G-47L	D202	DO-201AD-P15	Diode	GULF	1
50	1N5406G-47L	DIO SI 3A 600V DO-201AD-2P	1N5406G-47L	D203	DO-201AD-P15	Diode	GULF	1
51	1N5406G-47L	DIO SI 3A 600V DO-201AD-2P	1N5406G-47L	D204	DO-201AD-P15	Diode	GULF	1
52	STPS2045CTC	DIO SBD 20A 45V TO-220AB-3P C.C.	STPS2045CTC	D205	To220-3P-T2.54 -1	DS	ST	1
53	250Vac/3.15A	FUSE T 5 3.15A 250VAC L	2010T3.15A	F101	L-11X5.5-P7X5	Fuse 2	Walter	1
54	Wire Jump	JUMP WIRE CU 0.6*12.5*4 NAT		J101	JUMP.6/12.5			1
55	0R	RES SMD 1/8W 0ohm J 0805		J102	0805(W)	Res2	WALSIN	1
56	Wire Jump	JUMP WIRE CU 0.6*12.5*4 NAT		J102	JUMP.6/12.5			1
57	0ohm	RES SMD 1/8W 0ohm J 0805		J103	0805(W)	Res2	WALSIN	1
58	Wire Jump	JUMP WIRE CU 0.6*10*4 NAT		J103	JUMP.6/10			1
59	Wire Jump	JUMP WIRE CU 0.6*10*4 NAT		J104	JUMP.6/10			1
60	Wire Jump	JUMP WIRE CU 0.6*20*4 NAT		J105	JUMP.6/20			1
61	Wire Jump	JUMP WIRE CU 0.6*10*4 NAT		J106	JUMP.6/10			1
62	0R	RES SMD 1/8W 0ohm J 0805		J107	0805(W)	Res2	WALSIN	1
63	Wire Jump	JUMP WIRE CU 0.6*17.5*4 NAT		J108	JUMP.6/17.5			1
64	Wire Jump	JUMP WIRE CU 0.6*20*4 NAT		J109	JUMP.6/20			1
65	Wire Jump	JUMP WIRE CU 0.6*17.5*4 NAT		J110	JUMP.6/17.5			1
66	Wire Jump	JUMP WIRE CU 0.6*17.5*4 NAT		J111	JUMP.6/17.5			1
67	Wire Jump	JUMP WIRE CU 0.6*10*4 NAT		J112	JUMP.6/10			1
68	Wire Jump	JUMP WIRE CU 0.6*20*4 NAT		J113	JUMP.6/20			1
69	0R	RES SMD 1/8W 0ohm J 0805		J114	0805(W)	Res2	WALSIN	1
70	0R	RES SMD 1/4W 0ohm J 1206		J115	1206(W)	Res2	WALSIN	1
71	0R	RES SMD 1/4W 0ohm J 1206		J116	1206(W)	Res2	WALSIN	1
72	Wire Jump	JUMP WIRE CU 0.6*6*4 NAT		J117	JUMP.6/6			1
73	Wire Jump	JUMP WIRE CU 0.6*20*4 NAT		J118	JUMP.6/20			1
74	Wire Jump	JUMP WIRE CU 0.6*20*4 NAT		J201	JUMP.6/20			1
75	Wire Jump	JUMP WIRE CU 0.6*20*4 NAT		J202	JUMP.6/20			1
76	Wire Jump	JUMP WIRE CU 0.6*15*4 NAT		J203	JUMP.6/15			1
77	Wire Jump	JUMP WIRE CU 0.6*15*4 NAT		J204	JUMP.6/15			1
78	Wire Jump	JUMP WIRE CU 0.6*10*4 NAT		J205	JUMP.6/10			1
79	14561	VARISTOR 350VAC 12SJ 4.5KA	TVR14561KSUQY	MOV101	MOV-16X8-P7.5	Res Varistor	THINKING	1
80	4403	TR -40V -600mA SOT-23-3P 100 SMD	PMBT4403,215	Q103	SOT23	PNP	NXP	1
81	750K	Resistor		R101	1206(W)	Res2	WALSIN	1
82	25R	Resistor		R102	0805(W)	Res2	WALSIN	1
83	10R	Resistor		R103	0805(W)	Res2	WALSIN	1
84	22R	Resistor		R104	0805(W)	Res2	WALSIN	1
85	100k	Resistor		R105	0805(W)	Res2	WALSIN	1
86	4.7R	Resistor		R106	0805(W)	Res2	WALSIN	1
87	7.5M	Resistor		R107	1206(W)	Res2	WALSIN	1
88	0.033	RES WW 3W 33mohm J FR W/O L	NKNPSW 0R3 JP	R108	R-3WS-P20	Res2	FUTABA	1
89	82R	Resistor		R109	0805(W)	Res2	WALSIN	1
90	10R	Resistor		R110	0805(W)	Res2	WALSIN	1

BOM

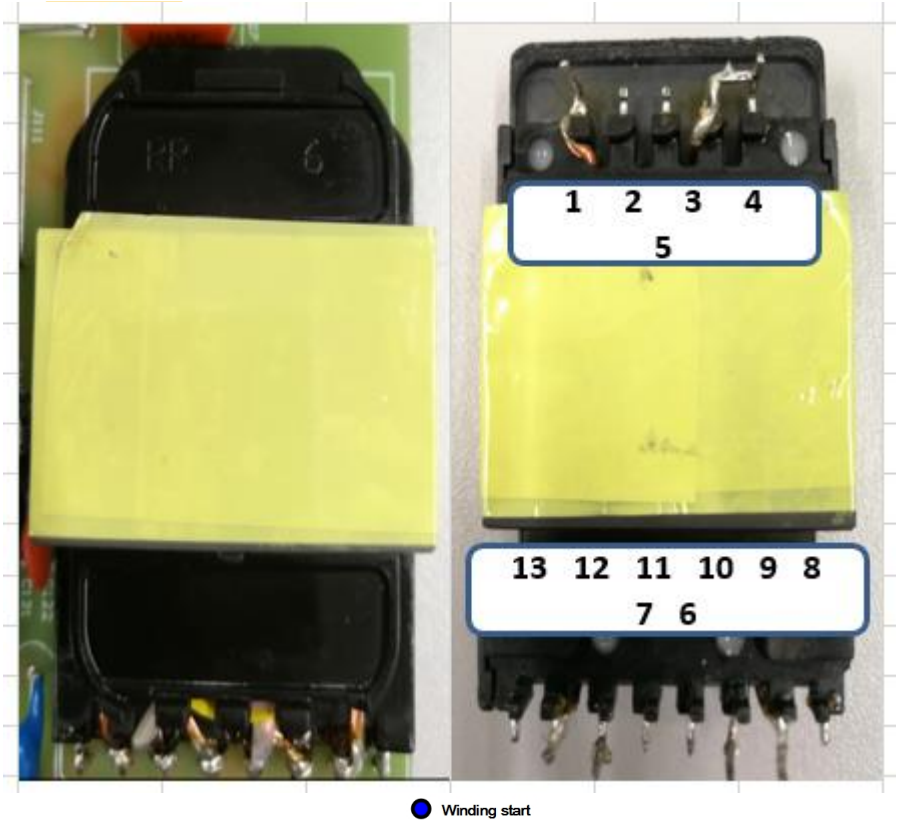
91	22R	Resistor		R111	0805(W)	Res2	WALSIN	1
92	0R	Resistor		R112	0805(W)	Res2	WALSIN	1
93	7.5M	Resistor		R113	1206(W)	Res2	WALSIN	1
94	180K	Resistor		R114	0805(W)	Res2	WALSIN	1
95	10M	Resistor		R115	1206(W)	Res2	WALSIN	1
96	10M	Resistor		R116	1206(W)	Res2	WALSIN	1
97	10R	Resistor		R117	0805(W)	Res2	WALSIN	1
98	10M	Resistor		R120	1206(W)	Res2	WALSIN	1
99	10M	Resistor		R121	1206(W)	Res2	WALSIN	1
100	4.7R	Resistor		R122	0805(W)	Res2	WALSIN	1
101	100R	Resistor		R123	0805(W)	Res2	WALSIN	1
102	2.7M	Resistor		R124	0805(W)	Res2	WALSIN	1
103	2.2M	Resistor		R125	0805(W)	Res2	WALSIN	1
104	20K	Resistor		R131	0805(W)	Res2	WALSIN	1
105	100K	Resistor		R133	0805(W)	Res2	WALSIN	1
106	10R	Resistor		R134	0805(W)	Res2	WALSIN	1
107	10R	Resistor		R135	0805(W)	Res2	WALSIN	1
108	0R	Resistor		R136	0805(W)	Res2	WALSIN	1
109	200R	Resistor		R137	0805(W)	Res2	WALSIN	1
110	180K	Resistor		R199	0805(W)	Res2	WALSIN	1
111	1K	Resistor		R201	0805(W)	Res2	WALSIN	1
112	66K	Resistor		R202	0805(W)	Res2	WALSIN	1
113	1M	Resistor		R203	0805(W)	Res2	WALSIN	1
114	1K	Resistor		R206	0805(W)	Res2	WALSIN	1
115	47K	Resistor		R207	0805(W)	Res2	WALSIN	1
116	10K	Resistor		R209	0805(W)	Res2	WALSIN	1
117	47R	Resistor		R211	0805(W)	Res2	WALSIN	1
118	5R	RES NTC 5ohm L 6A 3153K +/-7%	SCK15056LAY751	RT101	NTC-11.5X5-P5-X(1.9)-R	Res Adj1	THINKING	1
119				L101				
120				L202				
121				T101				
122				TP101				
123				TP102				
124				TP103				
125				HS1				
126				HS201				
127				CN101				
128				CN201				
129				X101				
130				IC101			NXP	1
131	PC817	PHOTO TR 60mA 80V DIP-4P 100%-200%	PC817XF	U101			Sharp	1
132	TL431	IC REGU ADJ 36V 2.495V 100mA 1% SOT-23-3	TL432AIDBZR	U201	SOT-23	Diode	TEXAS	1

SMD type: 87PCS
DIP type : 45PCS
Total: 132 PCS components

TEA8918 can save as below compare with TEA8818:

1. 13 SMD components.
2. 1 SO-8 IC.
3. PFC Auxiliary winding.

Transformer Specification



Winding	Terminal		Wire	Turns	Layers
	Start	End			
W1	4	5	0.3 x 0.1	30	Np
W2	2	3	0.4	3	Naux
W3	3	1	0.4	3	Naux
W4	11	9,10	0.1x 60	2	Ns(12V)
W5	9,10	12	0.1 x 60	2	Ns(12V)
W6	7	8	0.12 x 30	15	Ns(100V)

Note : all winding layer should be one layer & solenoid winding)

	Pin	Specification	Remark
L_M (magnetizing inductance)	4-5	**500µH ± 5%**	100kHz, 1V
L_{LKG} (leakage inductance)	4-5	**60 µH± 5%**	Short secondary windings

EE4213 Bobbin
Core:PC95

Transformer Specification

Winding	Terminal		Wire	Turns	Layers
	Start	End			
W1	1	2	0.1x 60	31	

	Pin	Specification	Remark
L_M (magnetizing inductance)	1-8	**180μH ± 5%**	100kHz, 1V

EEW3013 Bobbin Ae:$163mm^2$
Core:PC95

Test summary

Item	Test result	Specification	Comment
Efficiency	91.4% at 230Vac 75% loading	>Ave 87%	115Vac and 230Vac for four point
Standby Power	94mW at 230Vac	<150mW	230Vac at no load
	231mW at 230Vac	<260mW	230Vac at 10mA
	394mW at 230Vac	<500mW	230Vac at 20mA
Turn delay time	428mS at 264Vac	<1S	230Vac at no load
Ripple	268mV at 264Vac into burst mode	<300mV	230Vac at HP to LP mode
Rising time	2.4ms from 12V start up	<25ms	230Vac at HP, LP.BM mode
Hold up time	52ms at full load	<10ms	230Vac at full load
Dynamic	823mV for 12V and 5.78V for 100V	<10% Voltage regulation	230Vac at min load to Max load
Cross regulation	12.48V to 12.85V and 94.8 to 101.7	<10% Voltage regulation	230Vac at min load and Max load
EMI	-7.24dB at 150KHz @230Vac	<6dB	230Vac at full load
Acoustic noise	28.8B form PFC choke	<30dB	230Vac at HP, LP.BM mode

Standby power consumption

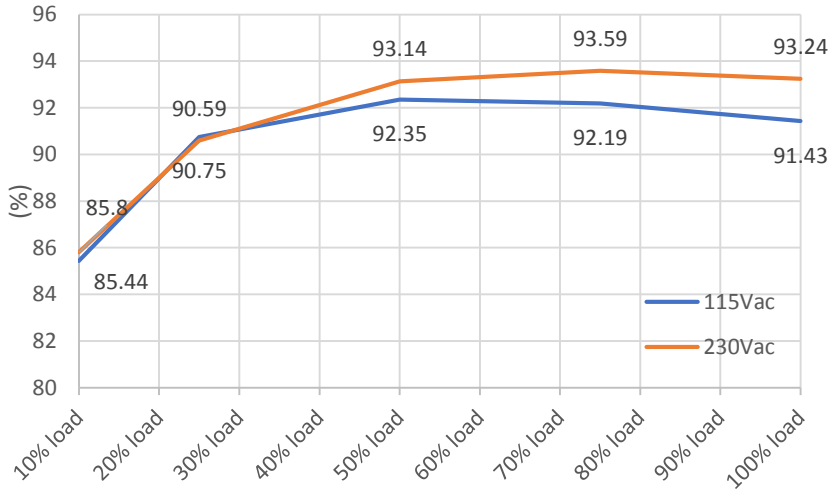
- Test condition
  - Measure input power
  - Meet the specification as below

Loading	115Vac	230Vac	Spec
No load	90mW	94mW	<150mW
12V/10mA	225mW	231mW	<260mW
12V/20mA	385mW	394mW	<0.5W

On board four point average efficiency

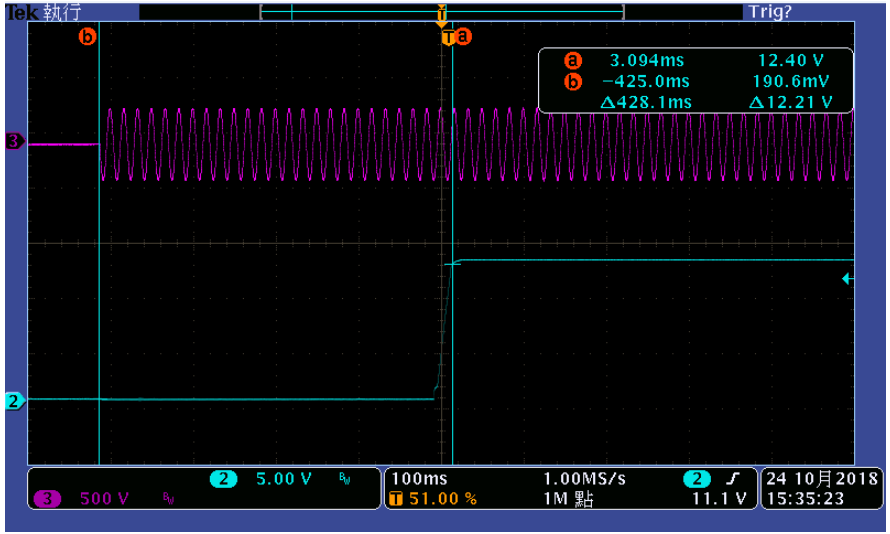
- Test condition
  - Measured on board
  - Test at 12V and 100V output voltage
  - Meet the specification

115Vac										
	100% load		75% load		50% load		25% load		10% load	
Vo(V)	13.01	100.9	13.04	100.9	13.06	100.8	13.08	100.7	13.1	100.6
Io(A)	5	1	3.75	0.75	2.5	0.5	1.25	0.25	0.5	0.1
Pin(W)	181.51		135.13		89.93		45.76		19.44	
Efficiency(%)	91.43		92.19		92.35		90.75		85.44	
Average(%)	91.68									
230Vac										
	100% load		75% load		50% load		25% load		10% load	
Vo(V)	13.03	101	13.05	100.9	13.06	100.8	13.08	100.7	13.1	100.6
Io(A)	5	1	3.75	0.75	2.5	0.5	1.25	0.25	0.5	0.1
Pin(W)	178.19		133.15		89.17		45.84		19.36	
Efficiency(%)	93.24		93.59		93.14		90.59		85.8	
Average(%)	92.64									



Turn on delay time

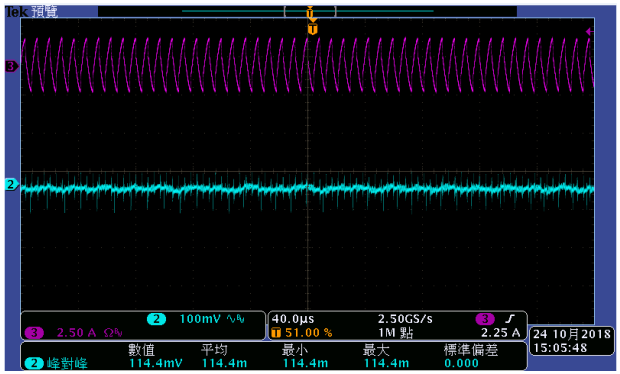
- Test condition
  - Measured at the on board end
  - With no load @12V
  - Meet the specification with in 1s.



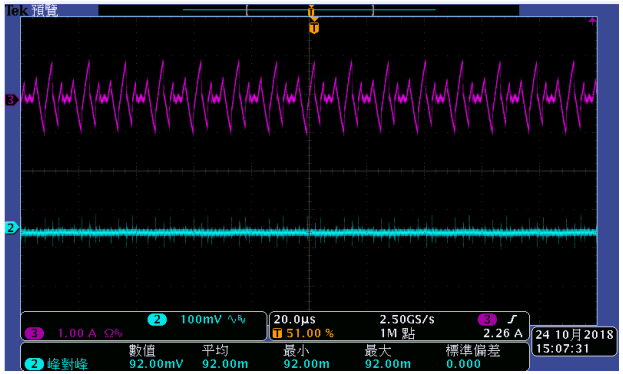
Delay time =428.1ms @12V 0A 264V
CH2:Vo (5V/div)
CH3:AC IN (500V/div)

Ripple&noise

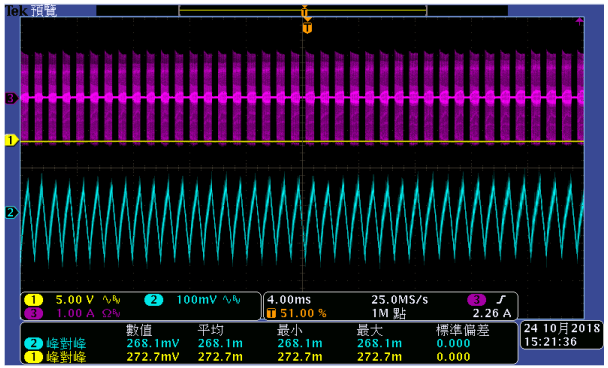
- Test condition
  - Measured on board with 4.7uF AL Cap and 10nF MLCC with 20MHz bandwidth
  - With HP，LP，BM mode
  - Meet the specification below 300mV.



Vp-p=114.3mV 12V 5A 100V @ 264Vac
CH2:Vo (100mV/div)
CH3:LLC current (2.5A/div)



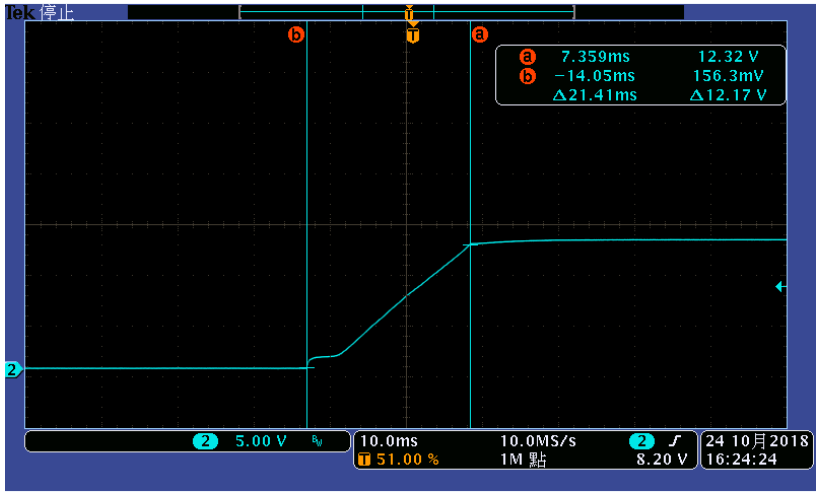
Vp-p=92mV 12V 2A 100V0.3A @ 264Vac
CH2:Vo (100mV/div)
CH3:LLC current (1A/div)



Vp-p=268mV 12V 2A 100V 0.1A @ 264Vac
CH2:Vo (100mV/div)
CH3:LLC current (1A/div)

Rising time

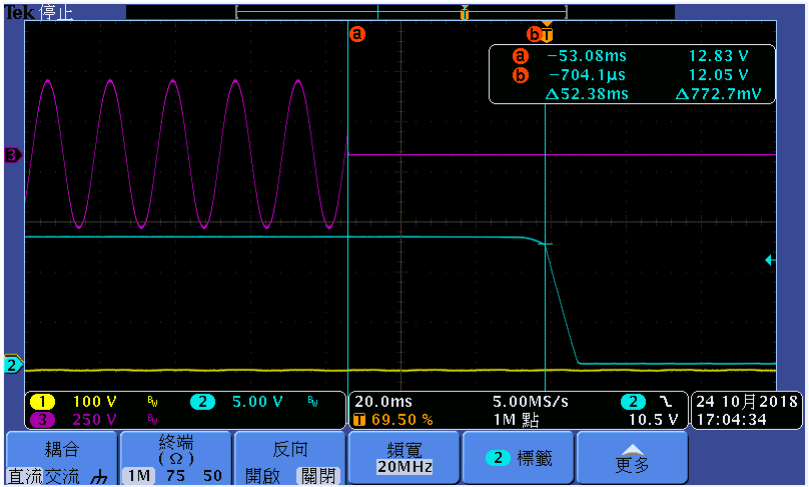
- Test condition
  - Check transient time and undershoot/overshoot while mode change between 12V at no load .
  - Meet rise time specification with in 25mS.



21.4ms for AC on 12V from 10% rise to 90%
CH1:Vo (5V/div)

Hold up time

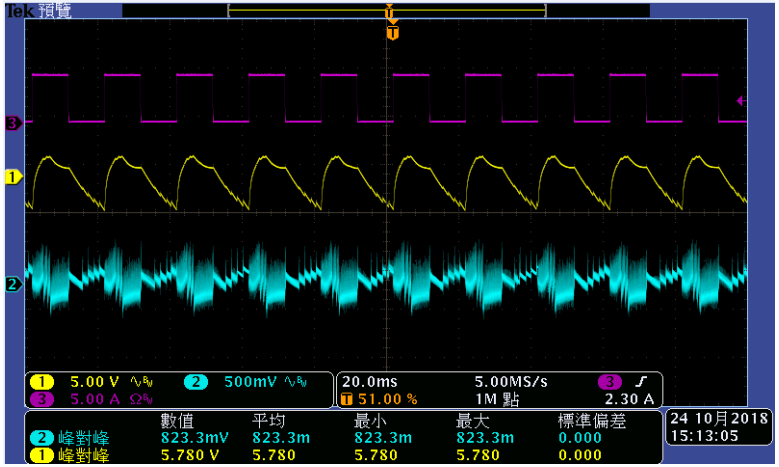
- Test condition
  - Check transient time and undershoot/overshoot while mode change between AC off at full load .
  - Meet discharge time specification above 20mS.



52.3ms for AC off to 12V drop to 90%
CH1:Vo (5V/div)

Dynamic load

- Test condition
  - Measured on board with 4.7uF AL Cap and 10nF MLCC
  - min load-full load; 10mS:10ms; 1A/uS @Vo
  - Meet the specification below 10% Vo



Vp-p=823.3mV for 12V 0.1-5A
Vp-p=5.78V for 100V 0.1-0.9A dynamic
CH1:100Vo ripple (5V/div)
CH2:12Vo ripple (500mV/div)
CH3:Vo dynamic(5Av/div)

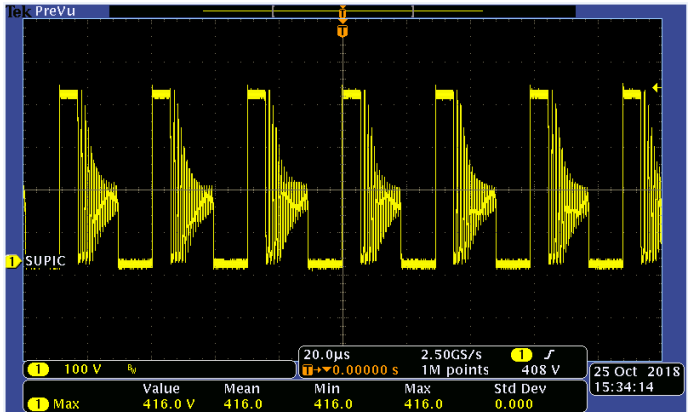
Cross regulation

- Test condition
  - Measured at the 1m cable end with 4.7uF AL Cap and 10nF MLCC
  - min load-full load;
  - Meet the specification below 10% Vo

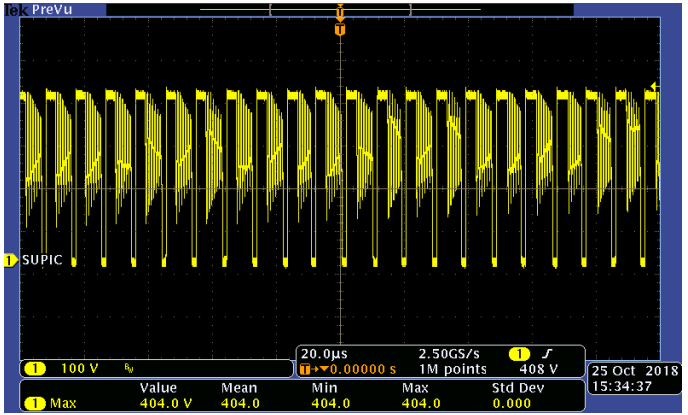
	Loading		Output Voltage	
condition 1	12V/5A	100V/0.9A	12.7V	101V
condition 2	12V/5A	100V/0A	10.1V	142V
condition 3	12V/0A	100V/0.9A	13.7V	90V
condition 4	12V/5A	100V/0.1A	12.48V	101.7V
condition 5	12V/0.1A	100V/0.9A	12.956V	94.8V

Vds Derating

- Test condition
  - Measured Vds at PFC MOSFET
  - With full load PDO @264Vac.
  - Meet the MOSFET voltage derating specification below 90% rating



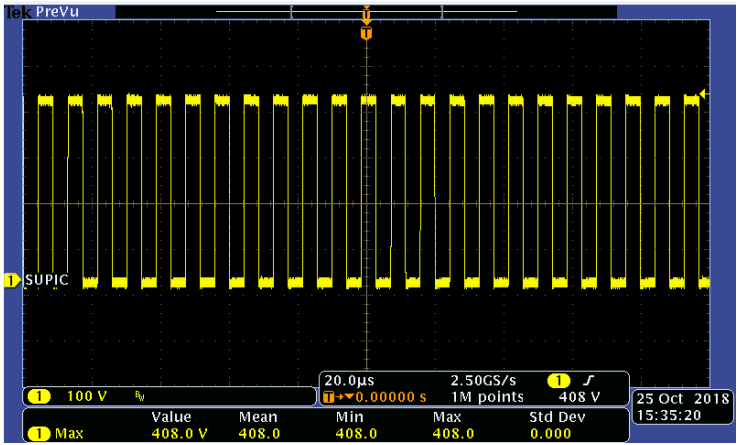
Q1 Vds=416V 12/5A 100V0.9A @90V
CH1:VPFC (100V/div)



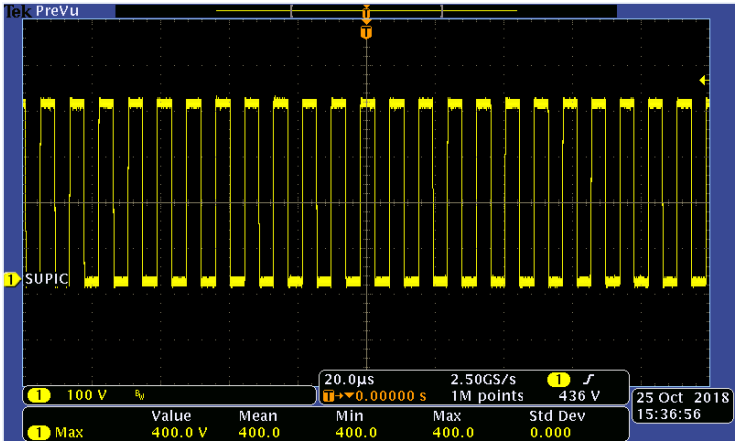
Q1 Vds=404V 12/5A 100V0.9A @264V
CH1:VPFC (100V/div)

Vds Derating

- Test condition
  - Measured Vds at LLC MOSFET
  - With full load PDO @264Vac.
  - Meet the MOSFET voltage derating specification below 90% rating



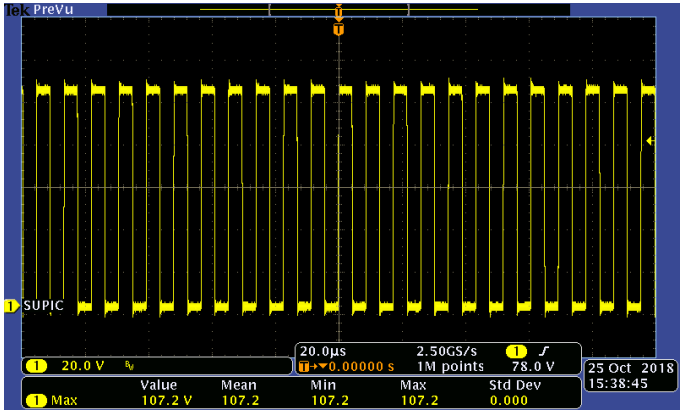
VLS =408V 12/5A 100V0.9A @264V
CH1:VLS (100V/div)



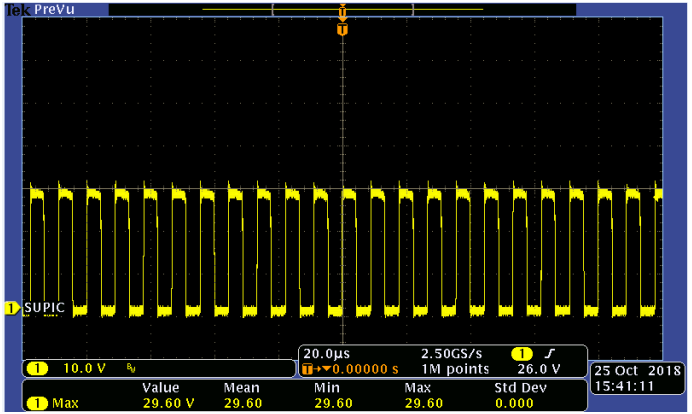
Q1 VHS=400V 12/5A 100V0.9A @264V
CH1:VHS (100V/div)

Vds Derating

- Test condition
  - Measured Vds at secondary side diode
  - With full load PDO @264Vac.
  - Meet the MOSFET voltage derating specification below 90% rating



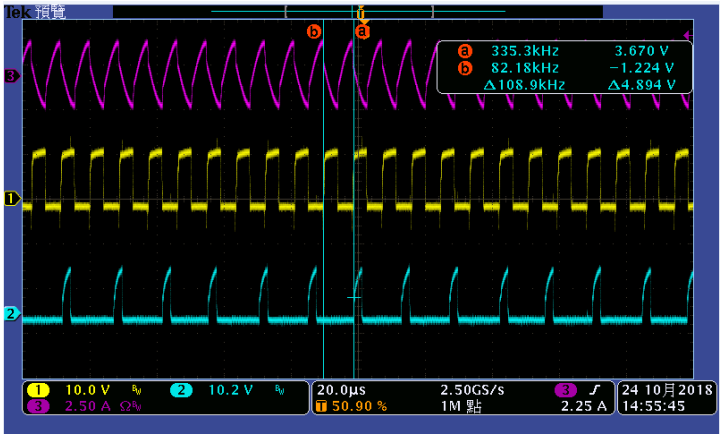
V_{100V} diode =107.2V 12/5A 100V0.9A @264V
CH1:V_{100V} diode (20V/div)



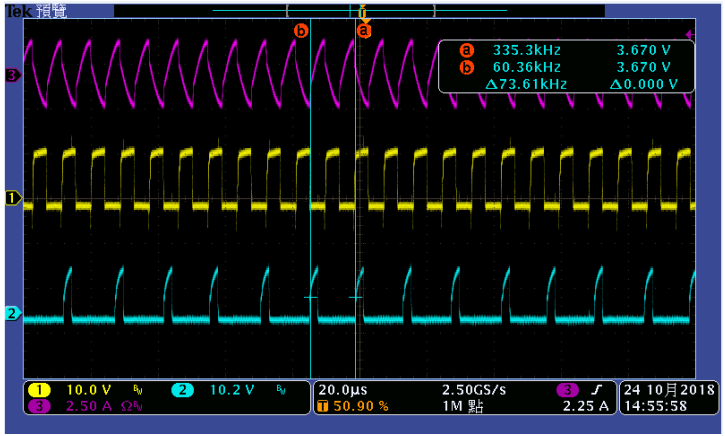
V_{12V} diode =29.6V 12/5A 100V0.9A @264V
CH1:V_{12V} diode (10V/div)

LLC mode change

- Test condition
  - Measured PFC , LLC gate and LLC current.
  - With HP mode @264Vac.



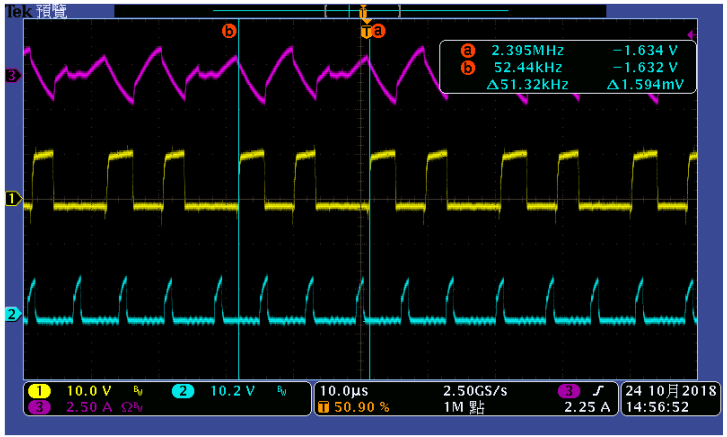
CH1:LLC gate (10V/div)
CH2:PFC gate(10.2V/div)
CH3:LLC current(2.5A/div)



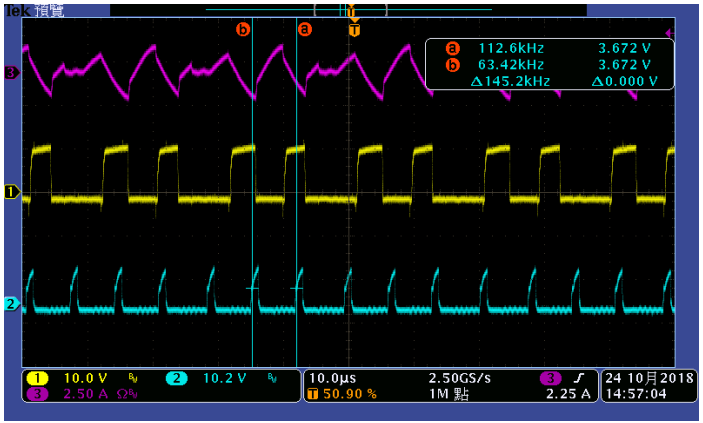
CH1:LLC gate (10V/div)
CH2:PFC gate(10.2V/div)
CH3:LLC current(2.5A/div)

LLC mode change

- Test condition
  - Measured PFC , LLC gate and LLC current.
  - With LP mode @264Vac.



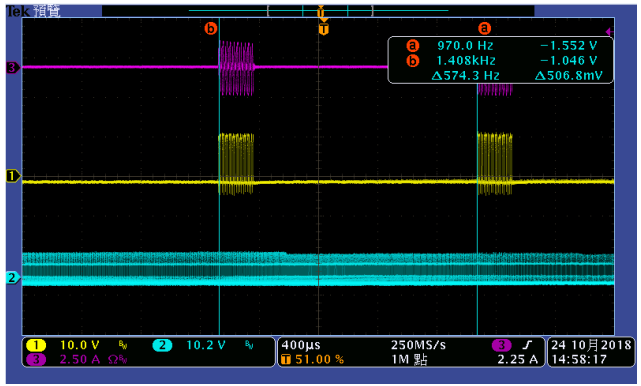
CH1:LLC gate (10V/div)
CH2:PFC gate(10.2V/div)
CH3:LLC current(2.5A/div)



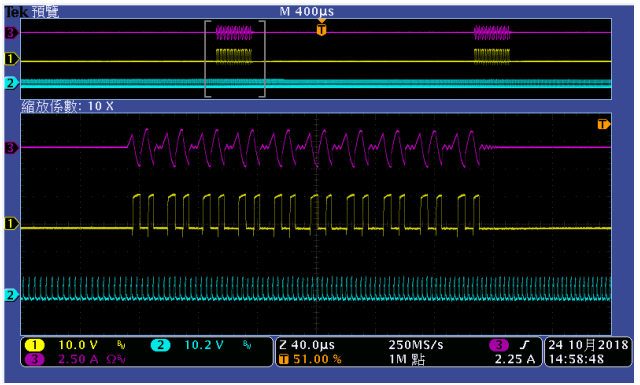
CH1:LLC gate (10V/div)
CH2:PFC gate(10.2V/div)
CH3:LLC current(2.5A/div)

LLC mode change

- Test condition
  - Measured PFC , LLC gate and LLC current.
  - With BM mode @264Vac.



CH1:LLC gate (10V/div)
CH2:PFC gate(10.2V/div)
CH3:LLC current(2.5A/div)



CH1:LLC gate (10V/div)
CH2:PFC gate(10.2V/div)
CH3:LLC current(2.5A/div)

LLC mode change power

- Test condition
  - Measured LLC output power.
  - With HP,LP ,BM mode @230Vac.

	HP to LP	LP to HP	LP to BM	BM to LP
Power(W)	58.25	62.69	17.05	17.14
Percentage per rated power	36.4%	39.2%	10.7%	10.7%

Frequency variation with different LLC mode

- Test condition
  - Measured LLC current frequency.
  - With HP,LP ,BM mode @230Vac.

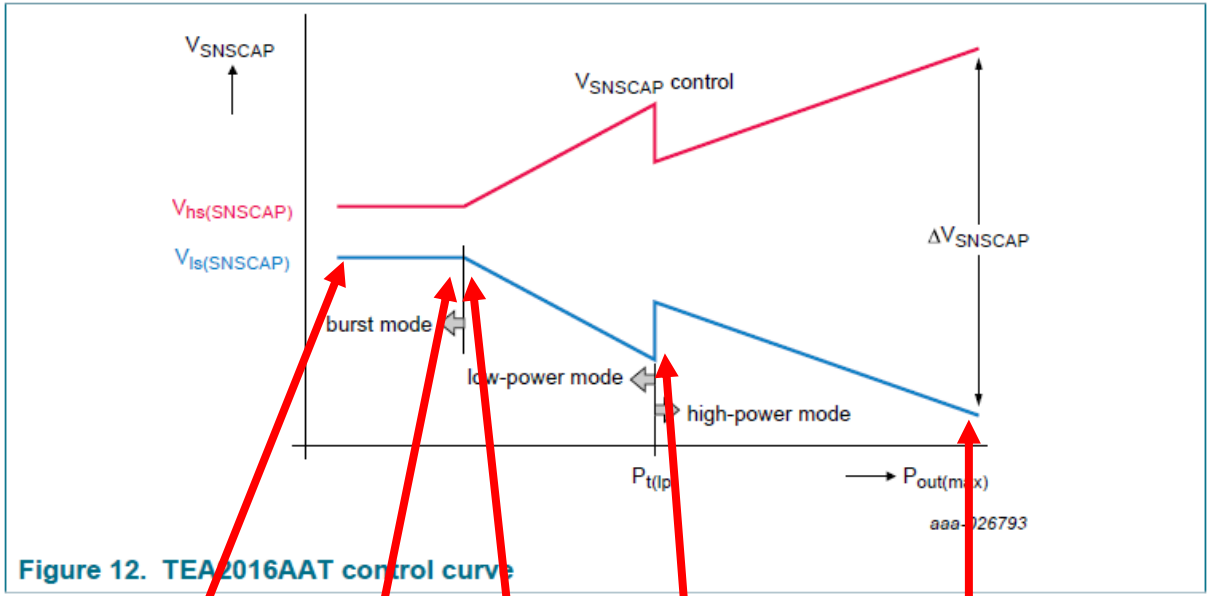
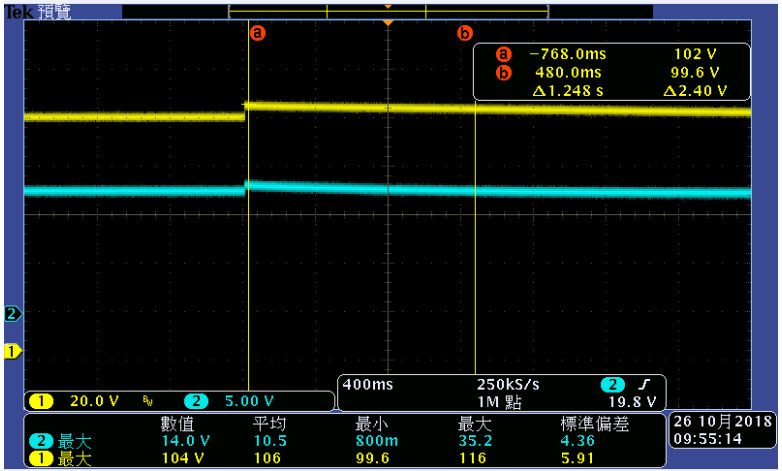


Figure 12. TEA2016AAT control curve

116KHz 98KHz 151KHz 129KHz 100KHz LLC switch frequency

OVP protection

- Test condition
  - Measured output and output AL cap voltage when OVP.
  - With no load @264Vac.
  - Meet the output Cap voltage specification rating .



V12V=14V 12V/no load @264V
V100V=104V 12V/no load @264V
CH1:V12V (10V/div)
CH2:V100V (5V/div)

OCP protection

- Test condition
  - Measured output current and output voltage when OCP.
  - With normal load @230Vac.
  - The OCP 12V rise to 18A trigger and auto-recovery and 100V rise to 5.04A trigger and auto-recovery.

CH2: 12Vo
CH4: Io

CH2: 100Vo
CH4: Io

OPP protection

- Test condition
  - Measured output current and output voltage when OPP.
  - With normal load @230Vac.
  - The OPP 12V rise to 7.28A trigger and auto-recovery and 100V rise to 1.735A trigger and auto-recovery.

CH2: 12Vo
CH4: Io

CH2: 100Vo
CH4: Io

AC Dip

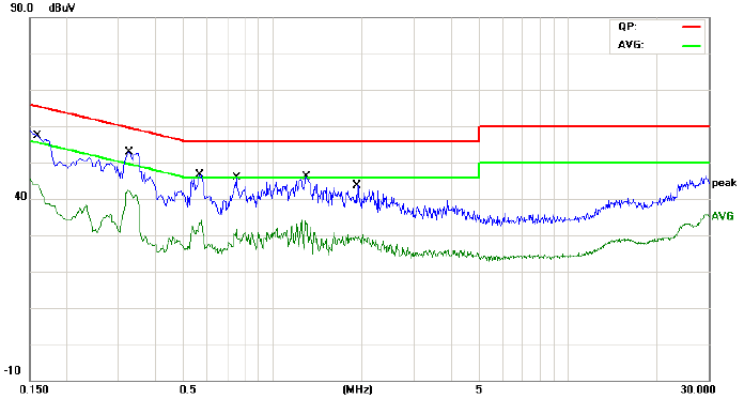
- Test condition
  - Measured at the output Voltage.
  - With AC on off 1S.
  - Check the 12Vo can restart and not trigger the protection.

CH2:12Vo
CH3:100VAC
CH4: Icap

CH2:12Vo
CH3: 230VAC
CH4: Icap

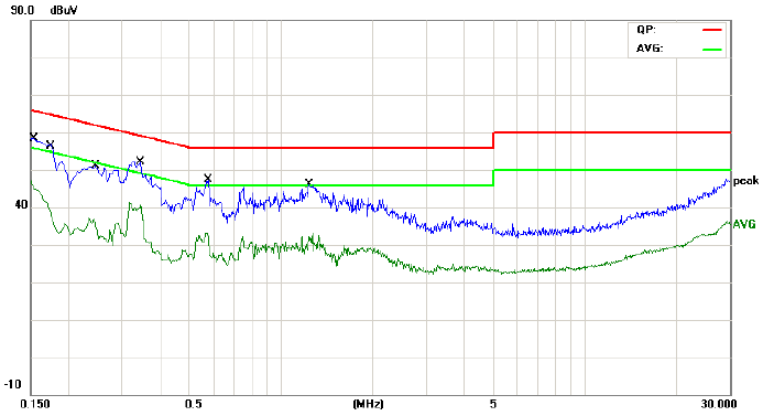
EMI

- Test condition
  Measured with dummy load



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1		0.1607	45.97	9.58	55.55	65.42	-9.87	QP	
2		0.1607	32.83	9.58	42.41	55.42	-13.01	AVG	
3		0.3260	41.27	9.59	50.86	59.55	-8.69	QP	
4	*	0.3260	31.64	9.59	41.23	49.55	-8.32	AVG	
5		0.5660	32.33	9.60	41.93	56.00	-14.07	QP	
6		0.5660	21.98	9.60	31.58	46.00	-14.42	AVG	
7		0.7539	29.01	9.61	38.62	56.00	-17.38	QP	
8		0.7539	20.17	9.61	29.78	46.00	-16.22	AVG	
9		1.3020	33.33	9.60	42.93	56.00	-13.07	QP	
10		1.3020	19.97	9.60	29.57	46.00	-16.43	AVG	
11		1.9300	26.57	9.61	36.18	56.00	-19.82	QP	
12		1.9300	19.32	9.61	28.93	46.00	-17.07	AVG	

110V-L @full load

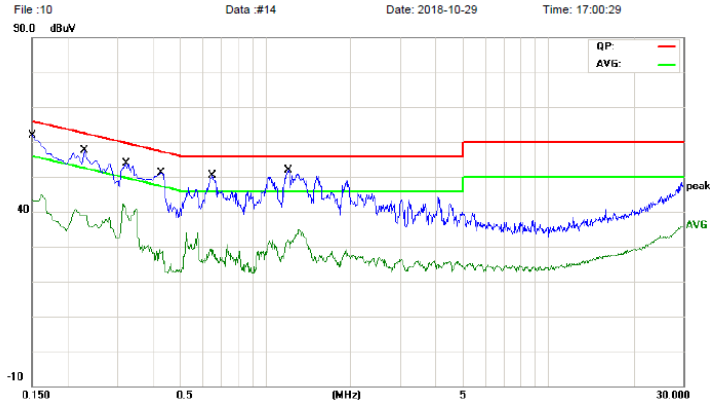


No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1	*	0.1539	46.51	9.58	56.09	65.78	-9.69	QP	
2		0.1539	35.13	9.58	44.71	55.78	-11.07	AVG	
3		0.1768	43.17	9.58	52.75	64.63	-11.88	QP	
4		0.1768	27.41	9.58	36.99	54.63	-17.64	AVG	
5		0.2460	37.57	9.58	47.15	61.89	-14.74	QP	
6		0.2460	25.83	9.58	35.41	51.89	-16.48	AVG	
7		0.3460	38.34	9.59	47.93	59.06	-11.13	QP	
8		0.3460	29.20	9.59	38.79	49.06	-10.27	AVG	
9		0.5780	32.68	9.60	42.28	56.00	-13.72	QP	
10		0.5780	21.10	9.60	30.70	46.00	-15.30	AVG	
11		1.2380	33.41	9.60	43.01	56.00	-12.99	QP	
12		1.2380	20.16	9.60	29.76	46.00	-16.24	AVG	

110V-N @ full load

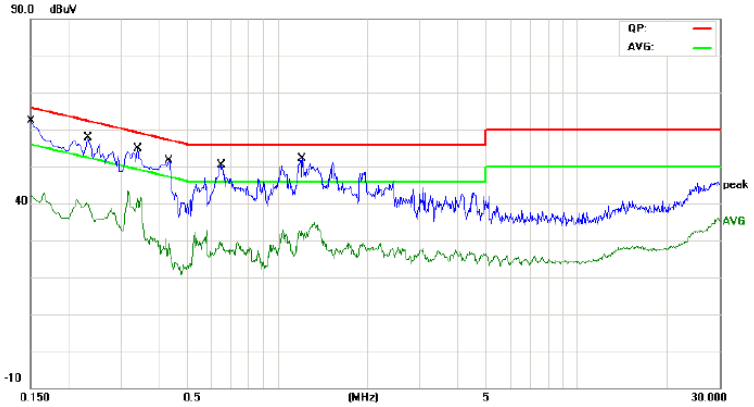
EMI

- Test condition
  Measured with dummy load



No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1	*	0.1524	49.04	9.58	58.62	65.86	-7.24	QP	
2		0.1524	31.96	9.58	41.54	55.86	-14.32	AVG	
3		0.2300	44.60	9.58	54.18	62.45	-8.27	QP	
4		0.2300	29.47	9.58	39.05	52.45	-13.40	AVG	
5		0.3220	40.27	9.59	49.86	59.65	-9.79	QP	
6		0.3220	30.25	9.59	39.84	49.65	-9.81	AVG	
7		0.4300	38.62	9.60	48.22	57.25	-9.03	QP	
8		0.4300	18.70	9.60	28.30	47.25	-18.95	AVG	
9		0.6540	35.47	9.61	45.08	56.00	-10.92	QP	
10		0.6540	18.52	9.61	28.13	46.00	-17.87	AVG	
11		1.2100	36.88	9.60	46.48	56.00	-9.52	QP	
12		1.2100	21.45	9.60	31.05	46.00	-14.95	AVG	

230V-L @full load

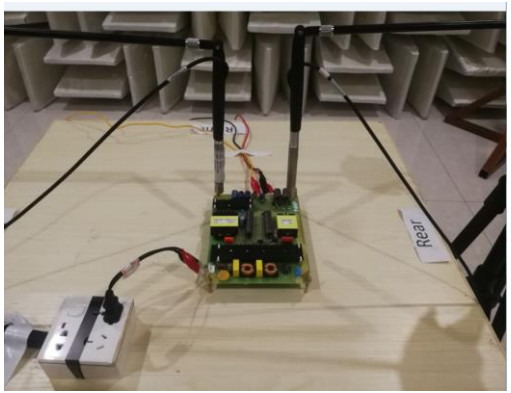


No.	Mk.	Freq.	Reading Level	Correct Factor	Measure-ment	Limit	Over		
		MHz	dBuV	dB	dBuV	dBuV	dB	Detector	Comment
1	*	0.1500	48.53	9.58	58.11	65.99	-7.88	QP	
2		0.1500	31.23	9.58	40.81	55.99	-15.18	AVG	
3		0.2340	44.10	9.58	53.68	62.30	-8.62	QP	
4		0.2340	28.71	9.58	38.29	52.30	-14.01	AVG	
5		0.3420	39.69	9.59	49.28	59.15	-9.87	QP	
6		0.3420	30.05	9.59	39.64	49.15	-9.51	AVG	
7		0.4340	38.62	9.60	48.22	57.18	-8.96	QP	
8		0.4340	18.79	9.60	28.39	47.18	-18.79	AVG	
9		0.6540	36.04	9.61	45.65	56.00	-10.35	QP	
10		0.6540	19.35	9.61	28.96	46.00	-17.04	AVG	
11		1.2140	35.87	9.60	45.47	56.00	-10.53	QP	
12		1.2140	21.83	9.60	31.43	46.00	-14.57	AVG	

230V-N @ full load

Acoustic noise

- Test condition
  - The acoustic criteria of component are under 30dBA
  - when Microphones are 5cm away from PSU component.



AC input	Output load condition	SPL value(dBA) 100~20KHz		Specification	Judge
		LLC transformer	PFC choke		
230V/50Hz	12V/ 5A 100V/ 0.9A(HP)	19.839	28.757	<30dB	PASS
	12V/ 2.5A 100V/ 0.45A(HP)	14.921	27.567	<30dB	PASS
	12V/ 1A 100V/ 0.1A(LP)	26.089	22.817	<30dB	PASS
	12V/ 0.8A 100V/ 0.05A(LP)	26.356	21.946	<30dB	PASS
	12V/ 0.25A 100V/ 0.05A(BM)	24.519	19.781	<30dB	PASS
	12V/ 0A 100V/ 0A(BM)	11.609	10.336	<30dB	PASS
110V/50Hz	12V/ 5A 100V/ 0.9A(HP)	18.473	28.909	<30dB	PASS
	12V/ 2.5A 100V/ 0.45A(HP)	13.551	28.102	<30dB	PASS
	12V/ 1A 100V/ 0.1A(LP)	25.741	21.88	<30dB	PASS
	12V/ 0.8A 100V/ 0.05A(LP)	25.594	21.051	<30dB	PASS
	12V/ 0.25A 100V/ 0.05A(BM)	23.749	19.679	<30dB	PASS
	12V/ 0A 100V/ 0A(BM)	10.279	8.751	<30dB	PASS

SECURE CONNECTIONS
FOR A SMARTER WORLD