



DEMO BOARD TEST REPORT

250W, PFC + LLC Power Supply (CC & CV) Reference Design with KP2806(A) + KP2591(A)

FEATURES

- Wide Operating Input Range(90Vac~265Vac)
- 250W Rated Power and supports CC & CV operation
- High Efficiency up to 94.30%
- Near Unity Power Factor
- Meets Class C Standard of IEC61000-3-2
- Meets EN55032 Class B Standard with 6dB margin for CE Test
- Output Over-Voltage Protection (OVP)
- Short-Circuit Protection (Auto-Recovery Mode)
- Adjustable Dead Time control and Robust Anti-Capacitive Mode Protection
- X2 Capacitor Discharge Function
- No Auxiliary circuits

APPLICATIONS

- Adapter/All-in-One PC Power Supply
- e-Bike battery charger
- General AC/DC Power Supply

INTRODUCTION

This demo board is used to support power supply for adapter, All-in-One PC, or similar equipment that accepts 24V voltage. Also, this demo board is suitable for battery charging due to the function of constant voltage(CV) and constant current(CC) by external control circuits.

The KP2806(A) controls the PFC front stage to realize unity power factor and low THD, which supports 500kHz switching frequency and Valley Turn-on function. The KP2591(A) is a resonant switching power controller based on half-bridge LLC resonant converter, which integrates half-bridge driver with 50% duty cycle, and the maximum operating frequency is up to 350kHz. Thanks to the HV Start-up function of KP2591(A), no auxiliary circuit is needed for cost down. This demo board can handle up to 250W continuous output power for AC input range 90Vac~265Vac (burn-in 2 hours @open air of Ta=30°C with no airflow).

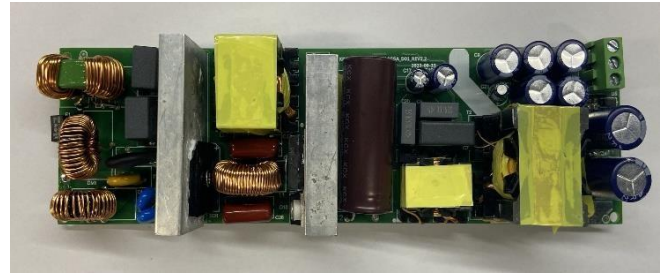
And the demo board is integrated with complete protection functions, such as output OVP, output short-circuit protection, AC brown-out protection, Anti-Capacitive Mode Protection and so on.

DEMO BOARD SEPCIFICATION

Description	Symbol	Min	Type		Max	Unit	Note
Input Voltage	Vin	90	115	230	265	Vrms	
Output	Vout				24	V	
Rate Output Current	Iout		10.5		11	A	
Rate Output Power	Pout		250			W	
Ripple & Noise	Vripple				196	mVp-p	Board end @115Vac/60Hz Full Load
Maximum Full Load Efficiency	η	94.30				%	Board end @265Vac/50Hz
Standby Power Consumption	Ptotal				365.5	mW	@265Vac/50Hz
Startup Time	Tst	1.244	1.324	0.9	0.76	s	@ Full Load
Operating Ambient	Ta	0			40	°C	
Operating Humidity		5			95	%R.H.	

Note: The table above shows the minimum acceptable performance of the design. Actual performance is listed in the results section.

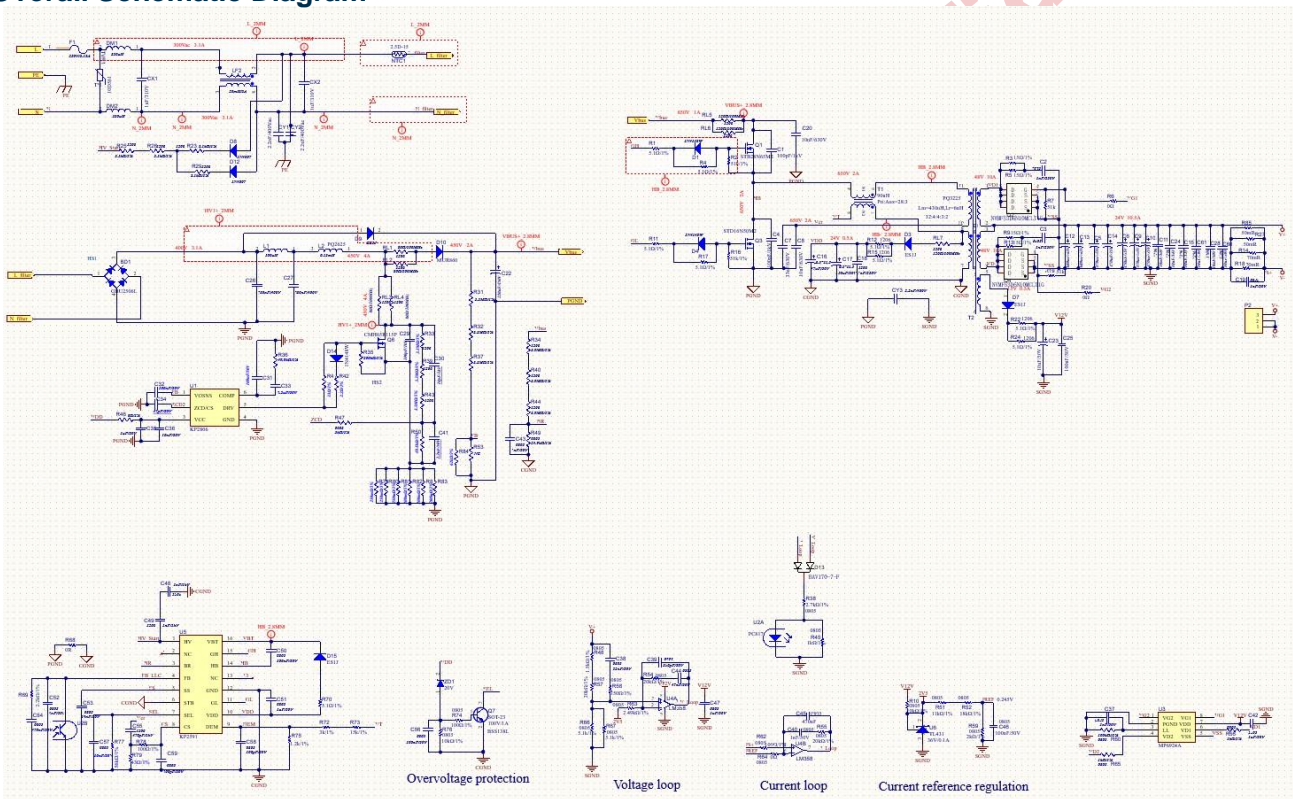
Demo Board of DBTR_2806A + 2591A-D01-REV1.0



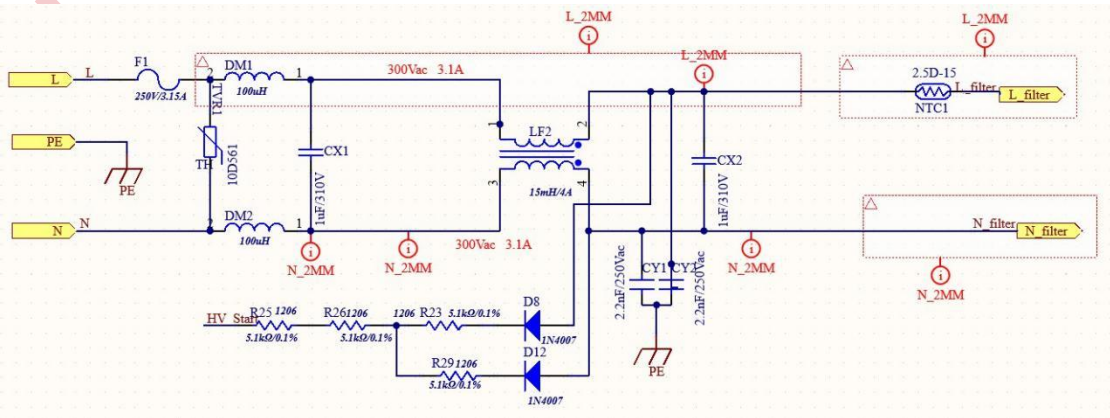
Board Size (mm): L x W x H = 197 x 57 x 34

Schematic

Overall Schematic Diagram

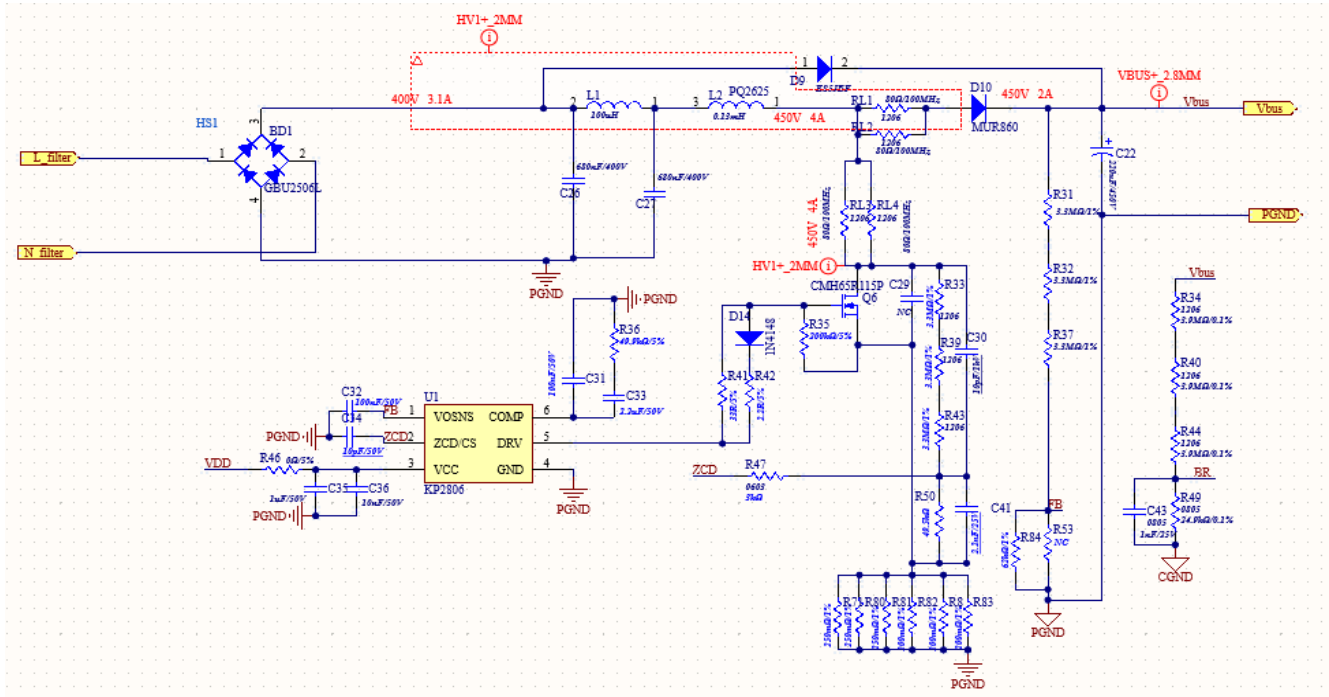


AC Input Filter

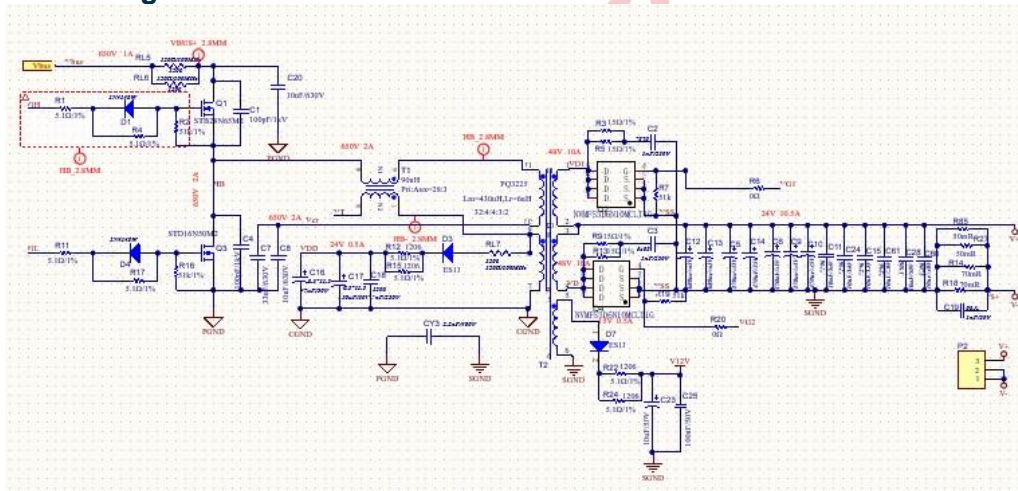


250W, PFC + LLC Power Supply (CC & CV)
Reference Design with KP2806(A) + KP2591(A)

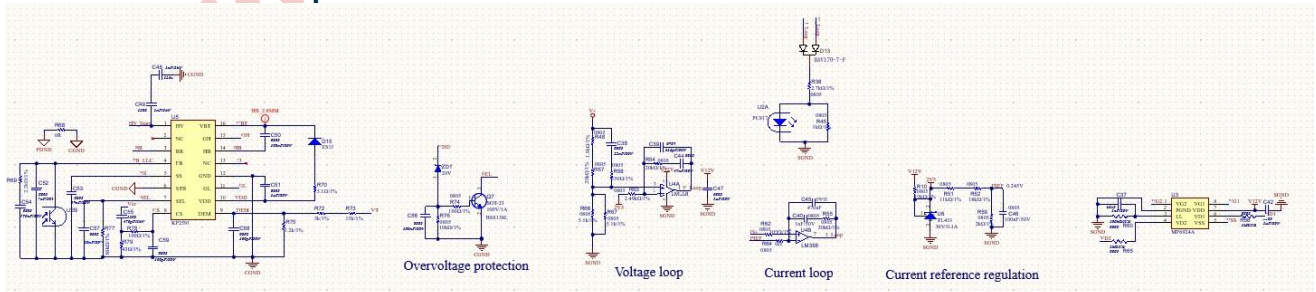
PFC Stage



LLC & SR Power Stage

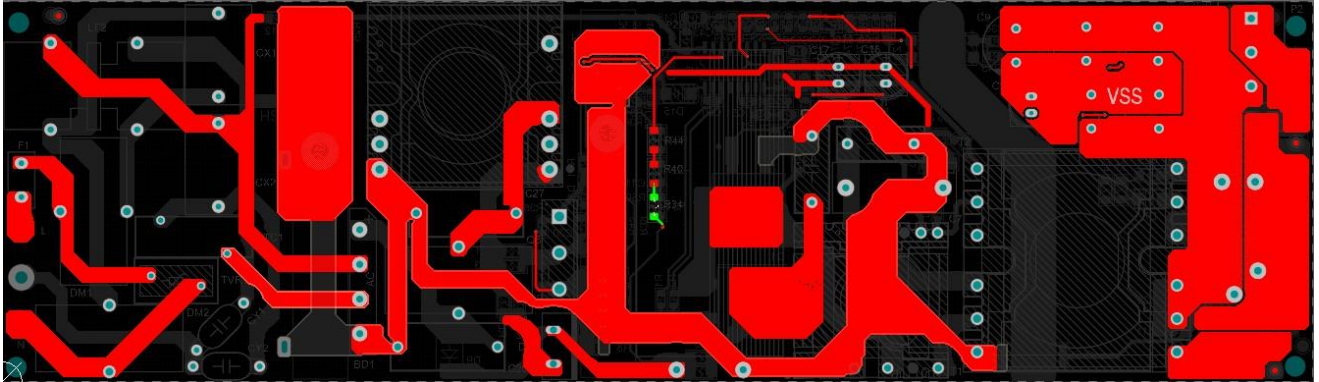


LLC & SR Control Loop

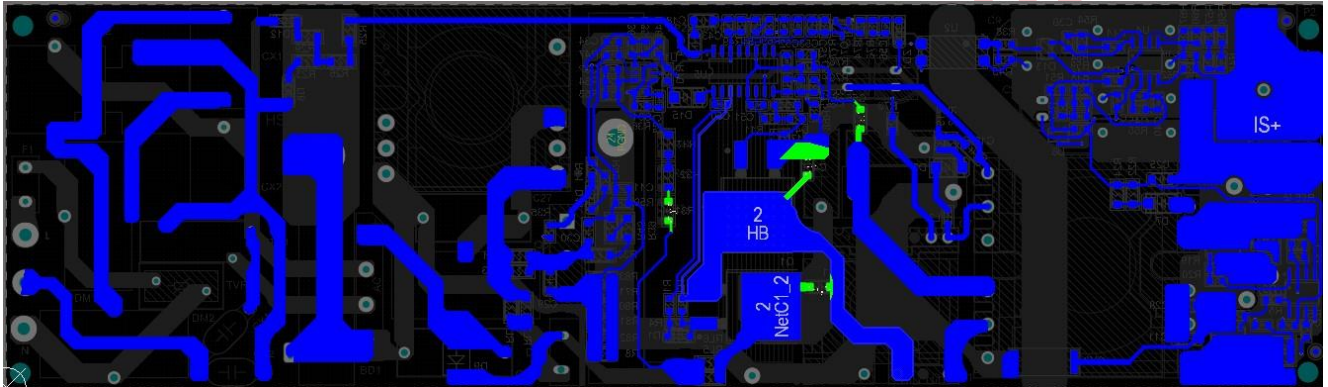


Printed Circuit Board Layout

Top Layer



Bottom Layer



Kiwi Instruments

Bill of Material

No.	Designator	Value	Description	Package	Manufacturer	Part Number
1	BD1	600V/25A	25A 600V BRIDGE RECTIFIER(VF=0.95V@IF=12.5A)	GBU	World	GBU2506L
2	C1, C4, C29	100pF/1kV	Ceramic Cap, 1kV X7R	1206	WE	885342008009
3	C2, C3, C18	1nF/250V	Ceramic Cap 250V ±5% NPO	0805	FH	0805B102K251NT
4	C48, C49,	1nF/1kV	Ceramic Cap 1000V ±10% X7R	1206	WE	885342208018
5	C19, C37, C40, C43, C52	1nF/50V	Ceramic Cap 50V ±5% NPO	0805	WE	885012007063
6	C5, C6, C9, C10, C14	470µF/35V	Electrolytic Cap 35V 10*16 P=5	TH	AISHI	ERS1VM471G16OT
7	C7	33nF/1000V	Film Capacitor 1000Vdc 18*7.5*13.5 P=15	TH	KYET	KP333J1000VP15
8	C8, C20	10nF/630V	Film Capacitor 630Vdc 13*7*13 P=10	TH	Faratronic	C822J103J40C000
9	C11, C15, C24, C28, C60, C61	10µF/50V	Ceramic Cap 50V ±10% X7R	1206	SAMSUNG	CL31A106KBHNNNE
10	C12, C13	680µF/63V	Electrolytic Cap 63V 12*25 P=5	TH	AISHI	ERR1JM681W25OT
11	C16	47µF/50V	Electrolytic Cap 50V 6.3*11 P=2.5	TH	AISHI	ERS1HM470E11OT
12	C17	100µF/50V	Electrolytic Cap 50V 8*12 P=3.5	TH	AISHI	ERS1HM101F12OT
13	C18	1nF/250V	Ceramic Cap 250V ±10% X7R	1206	YAGEO	CC1206KRX7RYBB102
14	C22	220µF/450V	Electrolytic Cap 450V 22*46 P=10	TH	AISHI	ERH2WM221O46OT
15	C23	10µF/50V	Electrolytic Cap 50V 6.3*11 P=2.5	TH	AISHI	ERS1HM470E11OT
16	C25, C31, C32, C46, C50, C56	100nF/50V	Ceramic Cap 50V ±10% X7R	0805	WE	85012207098
17	C26, C27	680nF/400V	CBB 400Vdc 17*7*12 P=15	TH	STE	B22G684JN1B0120150080EOZ
18	C34	47pF/50V	Ceramic Cap 50V ±5% NPO	0805	WE	885012007051
19	C30	10pF/1kV	Ceramic Cap 50V ±5% NPO	0805	WE	885012007051
20	C33	2.2µF/50V	Ceramic Cap 50V ±10% X7R	0805	YAGEO	CC0805KKX7R9BB225
21	C35, C42, C47, C51	1µF/50V	Ceramic Cap 50V ±10% X7R	0805	WE	885012207103
22	C36, C53, C57	10nF/50V	Ceramic Cap 50V ±10% X7R	0805	WE	885012207092
23	C38	22nF/50V	Ceramic Cap 50V ±10% X7R	0805	WE	885012207094
24	C39	330pF/50V	Ceramic Cap 50V ±5% NPO	0805	WE	885012007060
25	C41	2.2nF/50V	Ceramic Cap 50V ±5% NPO	0805	WE	885012007065
26	C44	47nF/50V	Ceramic Cap 50V ±10% X7R	0805	WE	885012207096
27	C45, C54	470nF/50V	Ceramic Cap 50V ±10% X7R	0805	WE	885012207102
28	C55	470pF/1kV	Ceramic Cap 1000V ±5% NPO	1206	WE	885342208017

**250W, PFC + LLC Power Supply (CC & CV)
Reference Design with KP2806(A) + KP2591(A)**

29	C58, C59	100pF/50V	Ceramic Cap 50V ±5% NPO	0805	WE	885012007057
30	CX1, CX2	1μF/310V	X2 Capacitor 310Vac 13*8*16 P=10	TH	KNSCHA	MPX105K318 2X20046
31	CY1, CY2	2.2nF/400V	Y1 Capacitor 400Vac ±10% T5 P10	TH	STE	Q09F1D222M N0B0S0N0
32	CY3	2.2nF/400V	Y1 Capacitor 400Vac SMD 7.8*5.4*2.38	SMD	TRX	TMY1222M
33	D1, D4, D14	100V/0.15A	DIO FRD 100V 150mA 1.25V@150mA	SOD123	CJ	1N4148W
34	D3, D15, D7	600V/1A	DIO FRD 600V 1A 1.7V@1A	SMA	Onsemi	ES1J
35	D8, D12	1000V/1A	DIO FRD 1000V 1A 1.1V@1A	SOD- 123FL	Lision Tech	1N4007
36	D9	600V/3A	DIO FRD 3A 600V 35nS 1.68V	SMB	MDD	ES3J
37	D10	600V/8A	DOIDE 600V 8A 1.45V@8A	TH	YANGJIE	MUR860
38	D13	85V/215mA	DIO 85V/215mA 1.25V@150mA	SOT-23	DIODES	BAV170-7-F
39	DM1 DM2	330μH/5A	Differential mode filter, 24*10 P=10 Winding 0.65mm, 90mΩ DCR	TH	SANCI	065-125
40	L1	330μH/8A	Differential mode filter, 20*10 P=10 Winding 0.8mm, 65mΩ DCR	TH	SANCI	080-125
41	F1	400V/3.15A	Fuse 400V/3.15A 8.4*4 P=5	TH	Subminiature Fuses	2010T3.15A25 0V
42	L2	0.13mH	PFC Chokes, PQ26/25, Pri:Aux = 45, Pri:0.1mm*60 Wire	TH		PQ26/25
43	RL7	120Ω/100MHz	Bead Core 120Ω ± 25% 100MHz 3A	1206	WE	742792023
44	LF2	20mH/5A	Common Mode Filter, 27*13 P=7*8 Winding 0.6mm, 45mΩ DCR	TH	Sanci	T22*14*8
45	NTC1	2.5Ω	2.5D-15D D=17.5mm T=6mm P=7.5mm	TH	XC	R15D2R5MP7 4CENB
46	P2	300V/20A	Header, 3-Pin 5.08mm 300V 20A Green	TH	KEFA	DG500-5.08- 03P-14- 00A(H)
47	Q1, Q3	650V/20A	MOSFET 650V 20A 0.18Ω@10V	D2PAK	ST	STB28N65M2
48	Q2, Q4	100V/132A	MOSFET 100V 132A 3mΩ@10V, 48A	DFN-5	ONSEMI	NVMFS3D6N1 0MCLT1G
49	Q6	650V/33A	MOSFET 650V 33A 115mΩ@10V	TO-247	Cmos	CMH65R115P
50	Q7	50V/200mA	N MOSFET 50V 200mA 350mW 3.5Ω@200mA	SOT-23	ONSEMI	BSS138L
51	R1, R4, R11, R17, R70	5.1Ω/1%	Chip Resistor ±1% 1/8W	0805	FH	RS- 05L5R10FT
52	R2, R7, R16, R19	51kΩ/1%	Chip Resistor ±1% 1/8W	0805	FH	RS- 05K5102FT
53	R3, R5, R9, R13	15Ω/1%	Chip Resistor ±1% 1/8W	0805	FH	RS- 05K15R0FT
54	R6, R20, R46, R64, R68	0Ω	Chip Resistor ±1% 1/8W	0805	FH	RS-05000FT
55	R8, R82, R83	200mΩ/1%	Chip Resistor ±1% 1/4W	1206	UNI-ROYAL	1206W4F200L T5E
56	R10, R76	10kΩ/1%	Chip Resistor ±1% 1/8W	0805	FH	RS- 05K1002FT
57	R12, R15, R22, R24	5.1Ω/1%	Chip Resistor ±1% 1/4W	1206	FH	RS- 06L5R10FT
58	R27, R85,	50mR	Chip Resistor ±1% 3W	2512	Milliohm	HoJLR2512- 3W-50mR
59	R14, R18	70mR	Chip Resistor ±1% 3W	2512	Milliohm	HoJLR2512- 3W-70mR

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60	R23, R25, R26, R29	5.1kΩ/1%	Chip Resistor ±1% 1/4W	1206	FH	RS-06L5R10FT
61	R31, R32, R33, R37, R39, R43	3.3MΩ/1%	Chip Resistor ±1% 1/4W	1206	FOJAN	FRC1206F3304TS
62	R34, R40, R44	3.9MΩ/1%	Chip Resistor ±1% 1/4W	1206	FOJAN	FRC1206F3904TS
63	R35	200kΩ/1%	Chip Resistor ±1% 1/8W	0805	FH	RS-05K2003FT
64	R36	49.9kΩ/1%	Chip Resistor ±1% 1/10W	0603	FH	RS-03K4992FT
65	R38	2.7kΩ/1%	Chip Resistor ±1% 1/10W	0603	FH	RS-03K2701FT
66	R41	33Ω/1%	Chip Resistor ±1% 1/8W	0805	FH	RS-05K33R0FT
67	R42	2.2Ω/1%	Chip Resistor ±1% 1/8W	0805	FH	RS-05L2R20FT
68	R45, R56, R65	1kΩ/1%	Chip Resistor ±1% 1/8W	0805	FH	RS-05K1001FT
69	R47	3kΩ/1%	Chip Resistor ±1% 1/8W	0805	FH	RS-05K3001FT
70	R48	1.5kΩ/1%	Chip Resistor ±1% 1/8W	0805	FH	RS-05K1501FT
71	R49	24.9kΩ/1%	Chip Resistor ±1% 1/10W	0603	FH	RS-03K2492FT
72	R50	49.9kΩ/1%	Chip Resistor ±1% 1/8W	0603	FH	RS-03K4992FT
73	R51	11kΩ/1%	Chip Resistor ±1% 1/8W	0805	FH	RS-05K1102FT
74	R52	18kΩ/1%	Chip Resistor ±1% 1/8W	0805	FH	RS-05K1802FT
75	R54, R55, R57	20kΩ/1%	Chip Resistor ±1% 1/8W	0805	FH	RS-05K2002FT
76	R58	150Ω/1%	Chip Resistor ±1% 1/8W	0805	FH	RS-05K1500FT
77	R59	2kΩ/1%	Chip Resistor ±1% 1/8W	0805	FH	RS-05K2001FT
78	R60	100kΩ/1%	Chip Resistor ±1% 1/8W	0805	FH	RS-05K1003FT
79	R62, R74, R78	100Ω/1%	Chip Resistor ±1% 1/8W	0805	FH	RS-05K1000FT
80	R63	2.49kΩ/1%	Chip Resistor ±1% 1/10W	0603	FH	RS-03K2491FT
81	R66, R67	5.1kΩ/1%	Chip Resistor ±1% 1/8W	0805	FH	RS-05K5101FT
82	R69	2.2kΩ/1%	Chip Resistor ±1% 1/10W	0805	FH	RS-03K2201FT
83	R71, R80, R81	250mΩ/1%	Chip Resistor ±1% 1/4W	1206	UNI-ROYAL	1206W4F250LT5E
84	R72	3kΩ/1%	Chip Resistor ±1% 1/8W	0805	FH	RS-05K3001FT
85	R73	15kΩ/1%	Chip Resistor ±1% 1/8W	0805	FH	RS-05K1502FT
86	R75	1.2kΩ/1%	Chip Resistor ±1% 1/8W	0805	FH	RS-05K1201FT
87	R77	56kΩ/1%	Chip Resistor ±1% 1/8W	0805	FH	RS-05K5602FT
88	R79	43Ω/1%	Chip Resistor ±1% 1/8W	0805	FH	RS-05K43R0FT
89	R84	62kΩ/1%	Chip Resistor ±1% 1/8W	0805	FH	RS-05K6202FT
90	RL1, RL2, RL3, RL4, RL5, RL6	80Ω/100MHz	80Ω@100MHz ±25% 3A	1206	FH	CBW321609U800T



Demo Board Test Report

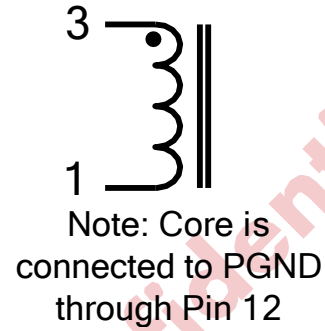
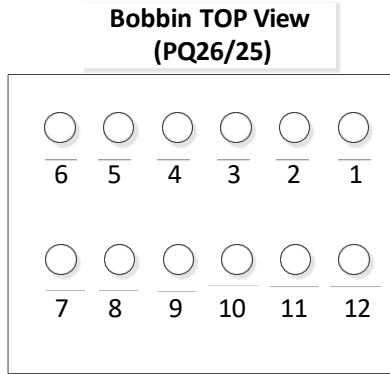
250W, PFC + LLC Power Supply (CC & CV) Reference Design with KP2806(A) + KP2591(A)

91	T1	90μH	90μH Pri:Aux=28:3 PQ20/20 6+8Pin Vertical 0.1mm*30 Aux:0.2mm	TH		PQ20/20
92	T2	430μH	430μH Pri: Sec1: Sec2: Aux1: Aux2 = 34: 4: 4: 2: 3 PQ32/25- 6+6Pin Pri:0.1x30mm Sec:0.1mm*180 Aux:0.2mm	TH		PQ32/25
93	TVR1	10D471	VARISTOR 300VAC 70J 2500A	TH	WE	820513011
94	U1	KP2806ALGA	High performance quasi resonant boost type constant voltage power factor correction controller	SOP-6	KIWI	KP2806ALGA
95	U2		DC 50mA 100mV@1mA, IF=20mA	SMD-4	EVERLIGHT	EL817S1(A) (TU)-F
96	U3	MP6924A	A dual circuit fast shutdown intelligent rectifier with synchronous rectification	SOP-8	MPS	MP6924A
97	U4	LM358	1.2MHz VIO:5mV	SOP-8	MSKSEMI	LM358
98	U5	KP2591ASGA	High Voltage, Half-bridge LLC Resonant Controller	SOP-16	KIWI	KP2591ASGA
99	U6	TL431	Precision adjustable shunt, VREF=2.5V 1% 37V	SOT-23	JSMSEMI	TL431
100	ZD1	20V	Diode Zener 20V ±5% 500mW 100nA@15V	SOD- 123	ONSEMI	SZMMSZ5250 BT1G
101	HS1, HS2		Heatsink, 56*8*28mm	TH		

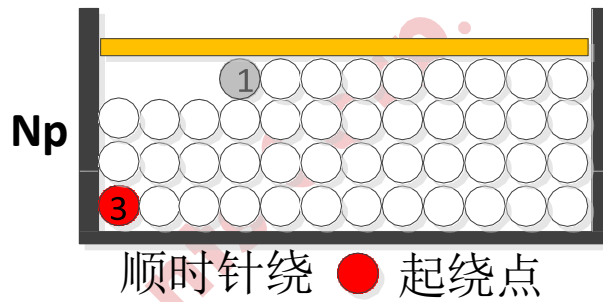
Transformer Manufacture Guide

1 PFC Inductor

1.1 Electrical Diagram



1.2 Winding Diagram



1.3 Winding Order

Number	Winding	Layer	Start	End	Wire Size (mm)	Turns	Note
1	Npri	Primary	Pin3	Pin1	0.1*60P	45Ts	Dense

1.4 Electrical Specification

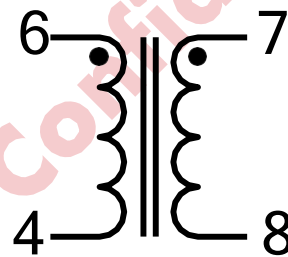
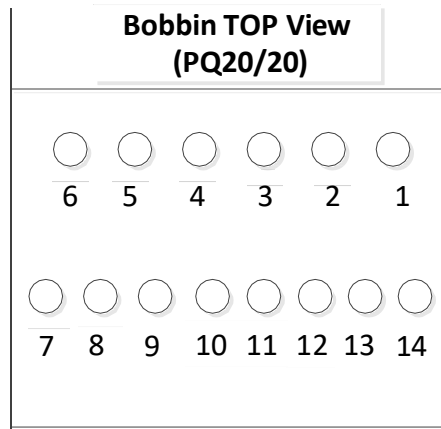
Number	Items	Test Condition	Test Pin	Specification
1	Primary Inductance	Ta=25°C 100kHz/100mVAC	Pin (3-1)	130μH (±10%)
2	Turn Ratio	Ta=25°C	Npri (3-1)	45Ts
3	DC Resistance	Ta=25°C	Pin (3-1)	0.065R Max

1.5 BOM

Number	Materials	Specifications
1	Core	PQ26/25, TPG33 or equivalent, AE=118mm ²
2	Bobbin	PQ26/25, 6+6 pin, Vertical
3	Wire	0.1mmΦ*60P, 2UEW, Litz
4	Duct tape	W=14mm, T=0.1mm

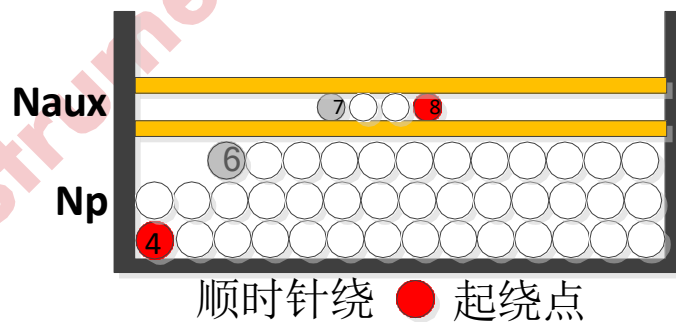
2 LLC Resonant Inductor

2.1 Electrical Diagram



Note: Core is connected to PGND through Pin 3

2.2 Winding Diagram



2.3 Winding Order

Number	Winding	Layer	Start	End	Wire Size (mm)	Turns	Note
1	Npri	Primary	Pin4	Pin6	0.1*30P	40Ts	Dense
2	Naux	Auxiliary	Pin8	Pin7	0.2	4Ts	Dense

2.4 Electrical Specification

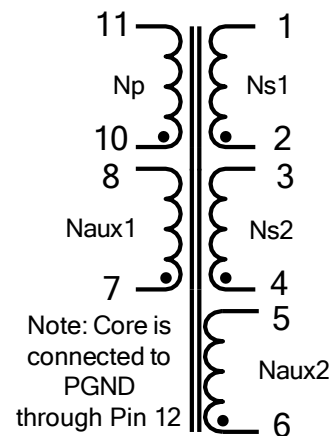
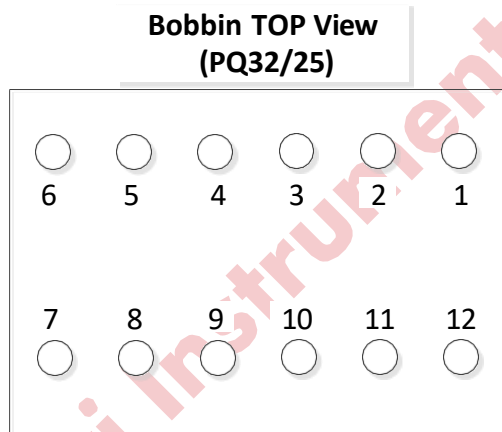
Number	Items	Test Condition	Test Pin	Specification
1	Primary Inductance	Ta=25°C 100kHz, 100mVAC	Pin (4-6)	90μH (±10%)
2	Turn Ratio	Ta=25°C	Pin (4-6): (8-7)	40Ts:4Ts
3	DC Resistance	Ta=25°C	Pin (4-6)	0.1R Max
4	DC Resistance	Ta=25°C	Pin (8-7)	0.12R Max

2.5 BOM

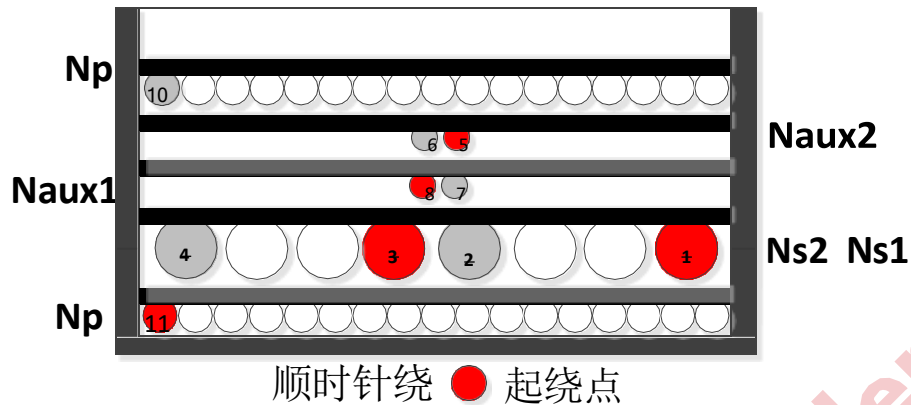
Number	Materials	Specifications
1	Core	PQ20/20, TPG33 or equivalent, AE=62mm ²
2	Bobbin	PQ20/20, 6+8 pin, Vertical
3	Wire	0.1mmΦ*30P, 2UEW, Litz
4	Wire	Φ0.2mm, 2UEW
6	Duct tape	W=12mm, T=0.1mm

3 LLC Main Transformer

3.1 Electrical Diagram



3.2 Winding Diagram



3.3 Winding Order

Number	Winding	Layer	Start	End	Wire Size (mm)	Turns	Note
1	Npri	Primary	Pin11	PinH	0.1*30P	16Ts	Dense
2	Ns1	Secondary	Pin1	Pin2	0.1*180P	4Ts	Dense
3	Naux1	Auxiliary	Pin8	Pin7	0.2	3Ts	Dense
4	Naux2	Auxiliary	Pin5	Pin6	0.2	2Ts	Dense
5	Ns2	Secondary	Pin3	Pin4	0.1*180P	4Ts	Dense
6	Npri	Primary	PinH	Pin10	0.1*30P	16Ts	Dense

3.4 Electrical Specification

Number	Items	Test Pin	Specification	Test Condition
1	Primary Inductance	Ta=25°C 100kHz, 100mVAC	Pin (11-10)	430μH (±10%)
2	Leakage Inductance	Ta=25°C 100kHz, 100mVAC (tie 1,2,3,4,5,6,7,8)	Pin 11 - 10	5.9μH (±10%)
3	Turn Ratio	Ta=25°C	Pin (11-10): (1-2): (3-4): (5-6) : (8-7)	32Ts: 4Ts: 4Ts: 2Ts: 3Ts
4	DC Resistance	Ta=25°C	Pin (11-10)	0.18R Max
5	DC Resistance	Ta=25°C	Pin (8-7)	0.15R Max
6	DC Resistance	Ta=25°C	Pin (5-6)	0.006R Max
7	DC Resistance	Ta=25°C	Pin (3-4)	0.006R Max
8	DC Resistance	Ta=25°C	Pin (1-2)	0.1R Max



Demo Board Test Report
250W, PFC + LLC Power Supply (CC & CV)
Reference Design with KP2806(A) + KP2591(A)

3.5 BOM

Number	Materials	Specifications
1	Core	PQ32/25, TPG33 or equivalent, AE=161mm ²
2	Bobbin	PQ32/25, 6+6 pin, Vertical
3	Wire	0.1mmΦ*30P, 2UEW, Litz
4	Wire	Φ0.2mm, 2UEW
5	Wire	0.1mmΦ*180, QA-1/155
6	Duct tape	W=14mm, T=0.1mm

Test Result

1 Input Characteristics

1.1 Maximum Rated Input AC Current

Standard: 10A max. @ 90Vrms/60Hz input & full load.

Result: Pass

Vin	lin_rms (A)	lin_max limit (A)	Result
90Vrms/60Hz	3.06	10	PASS

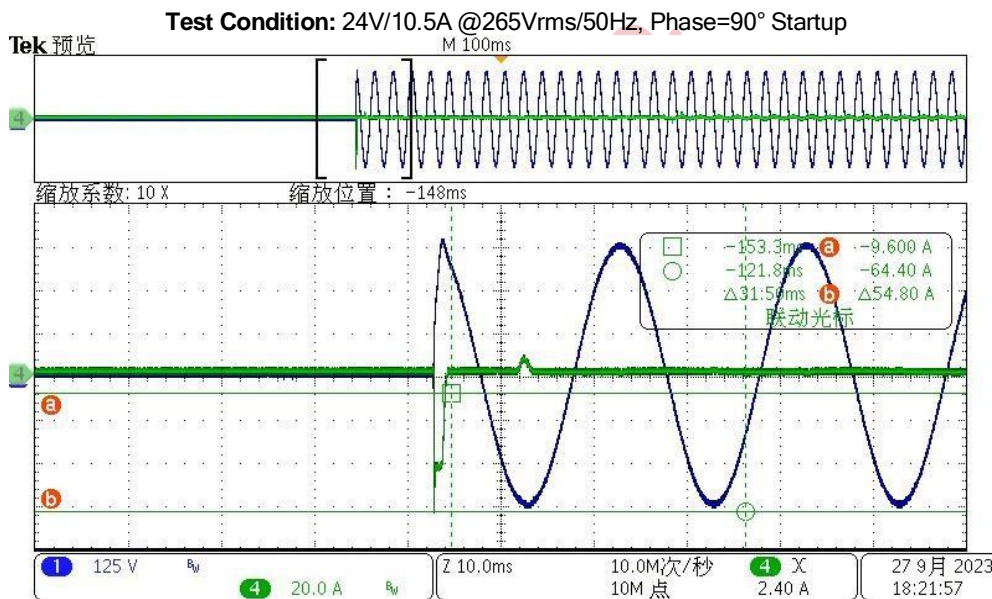
1.2 Inrush Current (Cold Start)

Standard:

Result:

Vin	Inrush (A)	lin_max limit (A)	Result
265Vrms/50Hz	64.40		PASS

Waveforms:



(CH1-Vin, CH4-linac)

Comments: Startup Normally

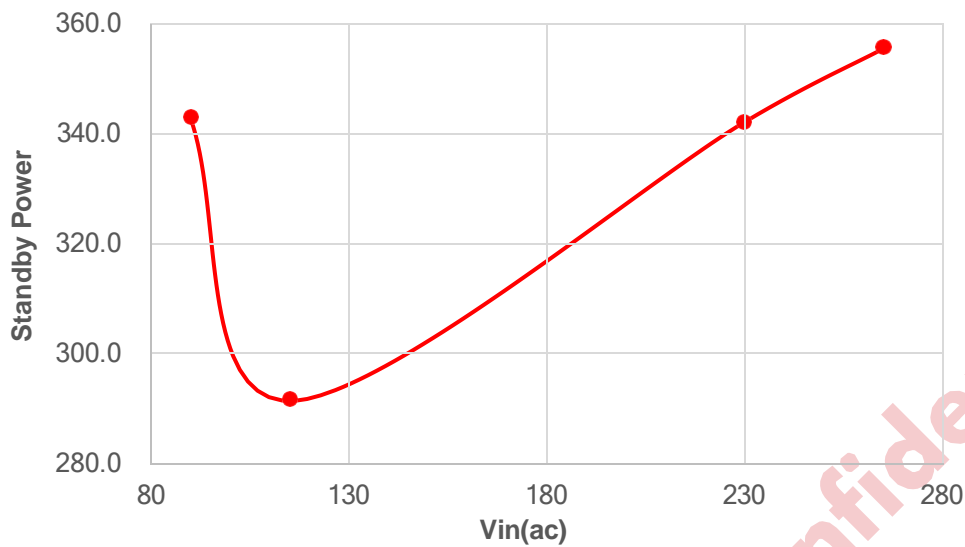
1.3 No Load Input Power Dissipation

Standard: While input 90~265Vrms and the output is no load, the input power loss must be less than 1W.

Result: Pass

Vin	90Vrms/60Hz	115Vrms/60Hz	230Vrms/50Hz	265Vrms/50Hz	Result
Pin (mW)	342.88	291.41	342.11	355.43	PASS

Standby Power Consumption



1.4 Efficiency

Standard: The average efficiency tested at the board end should larger than 89%.

Result: Pass

Test Data:

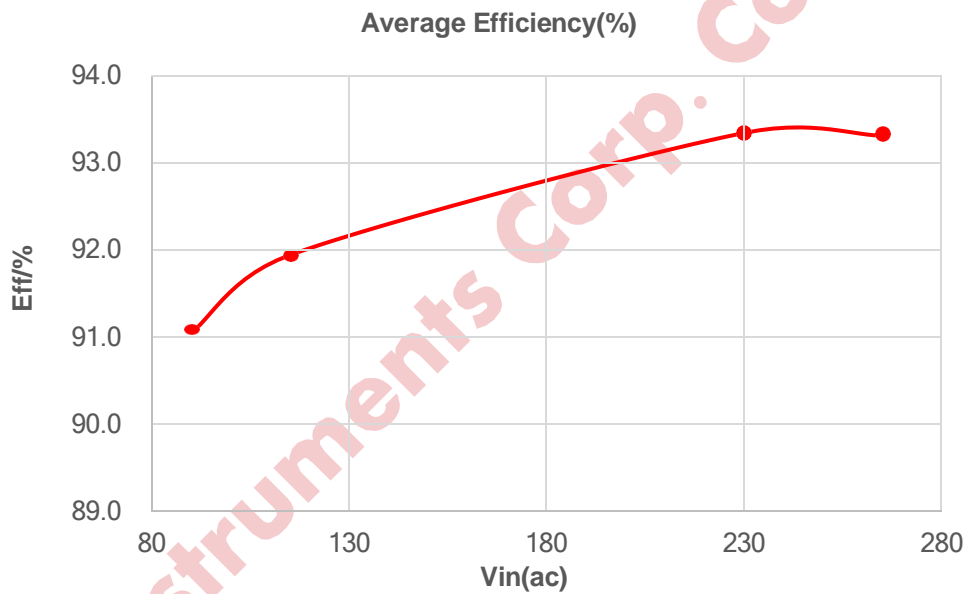
Output	Average Eff (%)				Result
	90Vrms/60Hz	115Vrms/60Hz	230Vrms/50Hz	265Vrms/50Hz	
24V/10.5A	89.78	90.56	92.00	92.02	PASS

Vin (Vrms)	Fline (Hz)	Pin (W)	Vout (V)	Iout (A)	Pout (W)	Eff (%)	Eff_AVG (%)
90	60	272.59	23.476	10.500	246.498	90.43	89.78
		202.57	23.517	7.875	185.196	91.42	
		134.56	23.556	5.250	123.669	91.91	
		68.49	23.595	2.625	61.937	90.43	
		29.27	23.617	1.050	24.798	84.71	
115		267.78	23.477	10.500	246.509	92.06	90.56
		199.71	23.519	7.875	185.212	92.74	
		133.31	23.558	5.250	123.680	92.78	
		68.67	23.596	2.625	61.940	90.19	
		29.16	23.619	1.050	24.800	85.06	

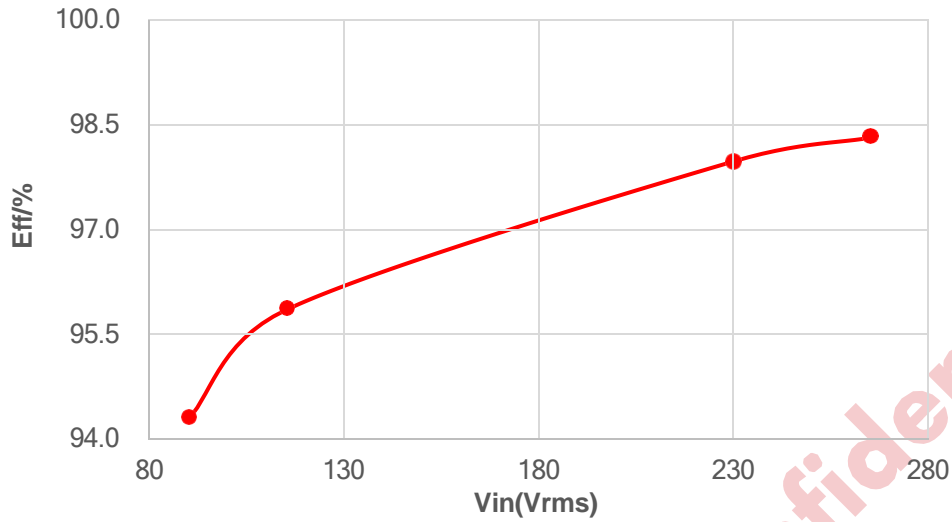


250W, PFC + LLC Power Supply (CC & CV)
Reference Design with KP2806(A) + KP2591(A)

230	50	261.80	23.475	10.500	246.488	94.15	92.00
		196.57	23.516	7.875	185.189	94.21	
		132.00	23.555	5.250	123.664	93.68	
		67.81	23.594	2.625	61.934	91.33	
		28.62	23.617	1.050	24.798	86.64	
265		261.46	23.482	10.500	246.561	94.30	92.02
		196.42	23.522	7.875	185.236	94.31	
		132.71	23.561	5.250	123.695	93.21	
		67.75	23.599	2.625	61.947	91.43	
		28.56	23.622	1.050	24.803	86.84	



Full Load Efficiency



1.5 PF

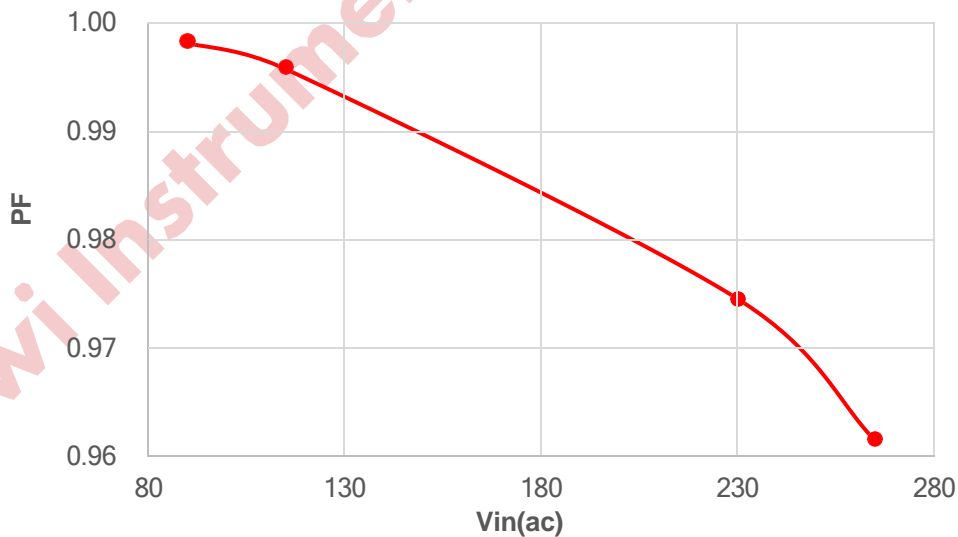
Standard: The Full Load PF should be larger than 0.94.

Result: Pass

Test Data:

Output	Full Load PF				Result
	90Vrms/60Hz	115Vrms/60Hz	230Vrms/50Hz	265Vrms/50Hz	
24V/10.5A	0.998	0.996	0.975	0.961	PASS

Full Load PF



1.6 THD

Standard: The Full Load THD should be smaller than 15% @ 115Vrms/60Hz & 230Vrms/50Hz.

Result: Pass

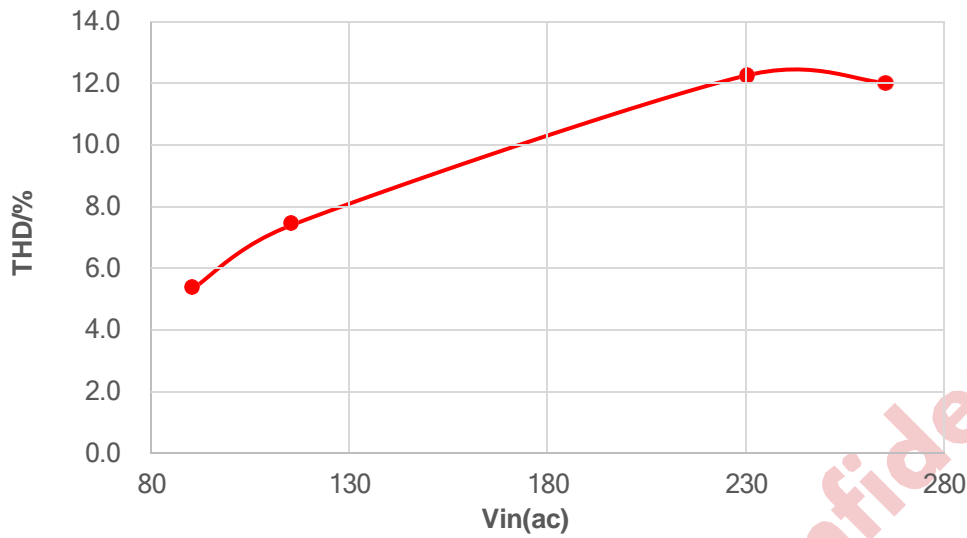
Test Data:

Output	Full Load THD				Result
	90Vrms/60Hz	115Vrms/60Hz	230Vrms/50Hz	265Vrms/50Hz	
24V/10.5A	5.321	7.398	12.265	12.021	PASS

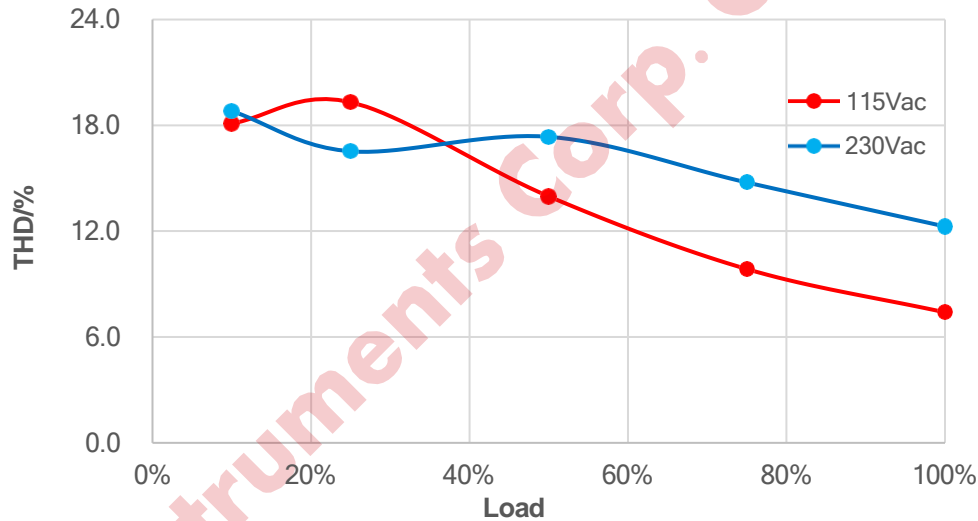
THD:

Vin (Vrms)	Fline (Hz)	Vout (V)	Iout (A)	Pout (W)	THD
90	60	23.476	10.500	246.498	5.321
		23.517	7.875	185.196	7.115
		23.556	5.250	123.669	10.690
		23.595	2.625	61.937	18.682
		23.617	1.050	24.798	13.917
115		23.477	10.500	246.509	7.398
		23.519	7.875	185.212	9.850
		23.558	5.250	123.680	13.972
		23.596	2.625	61.940	19.314
		23.619	1.050	24.800	18.101
230	50	23.475	10.500	246.488	12.265
		23.516	7.875	185.189	14.762
		23.555	5.250	123.664	17.351
		23.594	2.625	61.934	16.527
		23.617	1.050	24.798	18.812
265		23.482	10.500	246.561	12.021
		23.522	7.875	185.236	14.932
		23.561	5.250	123.695	15.606
		23.599	2.625	61.947	20.667
		23.622	1.050	24.803	21.426

Full Load THD



THD



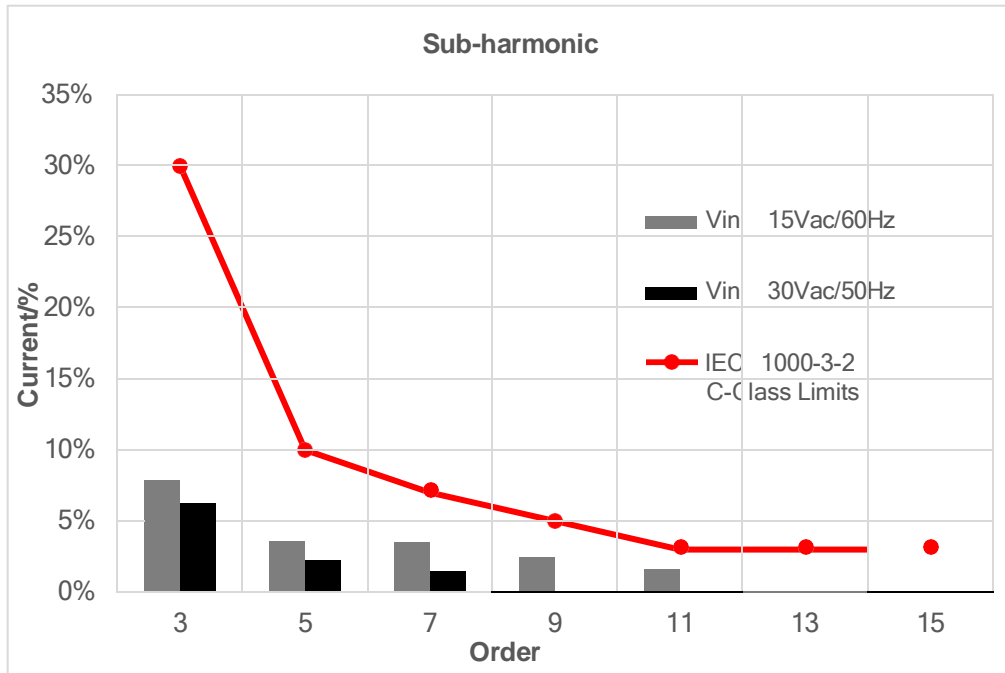
1.7 Sub-Harmonic

Standard: The Sub-Harmonic should be satisfied within the Limits for Class C equipment from IEC 61000-3-2.

Result: Pass

Test Data:

Current (A)	Order	3	5	7	9	11	13	15
Limits for Class C equipment from IEC 61000-3-2		30%	10%	7%	5%	3%	3%	3%
Vin= 115Vrms/60Hz	Vout=24V/10.5A (Full Load)	7.88%	3.58%	3.50%	2.47%	1.61%	1.07%	0.56%
Vin= 230Vrms/50Hz		6.29%	2.26%	1.44%	1.23%	1.12%	0.97%	0.78%



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2 Output Characteristics

2.1 Output Line Regulation and Load Regulation

Standard: Under the input voltage 90Vac~265Vac, line regulation <3%, load regulation <3%. The output voltage is tested at the output cap end.

Result: Pass

Test Data:

Input Voltage	Output Voltage (V)					Load Regulation
	10% Load	25% Load	50% Load	75% Load	Full Load	
90Vac/60Hz	23.467	23.507	23.547	23.585	23.607	0.60%
115Vac/60Hz	23.467	23.508	23.548	23.586	23.609	0.61%
230Vac/50Hz	23.475	23.516	23.555	23.594	23.617	0.60%
265Vac/50Hz	23.482	23.522	23.561	23.599	23.622	0.60%
Line Regulation	0.06%	0.06%	0.06%	0.06%	0.06%	

2.2 Ripple & Noise

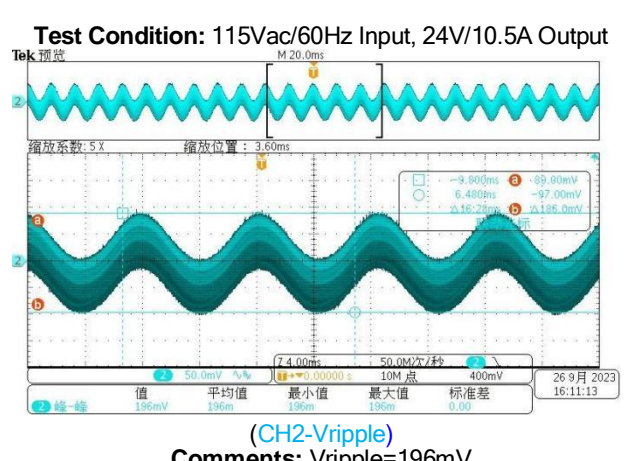
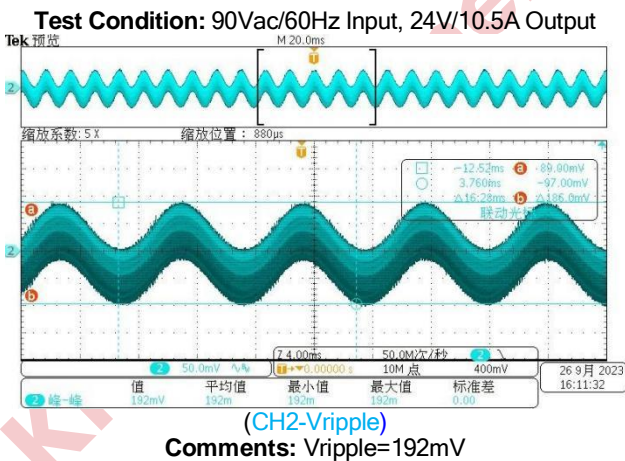
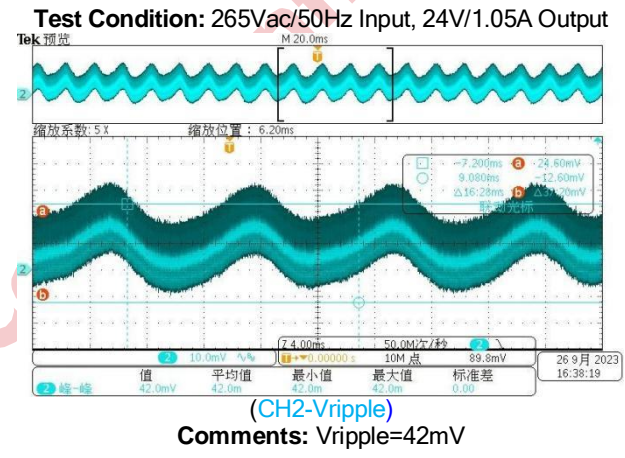
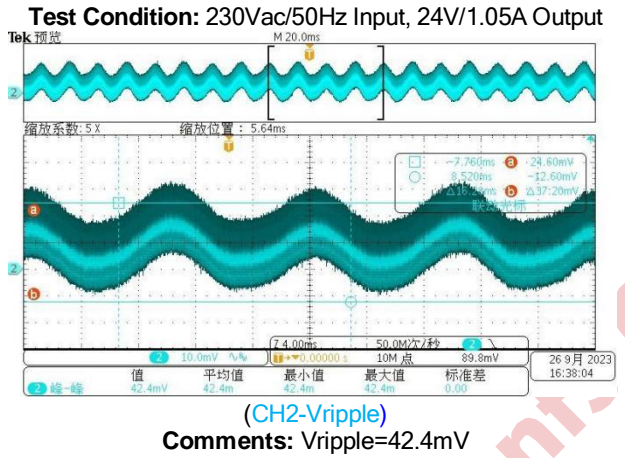
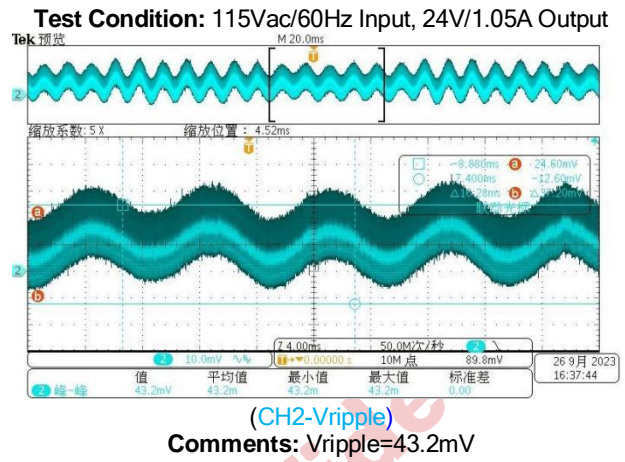
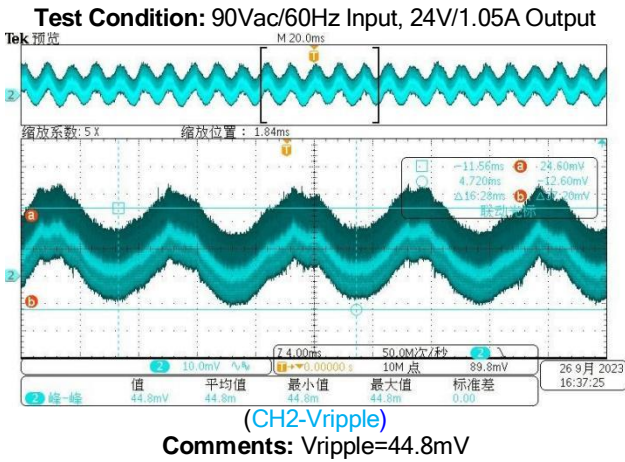
Standard: Under the input voltage 90Vac~265Vac, $V_{ripple_max} < 200mV$.

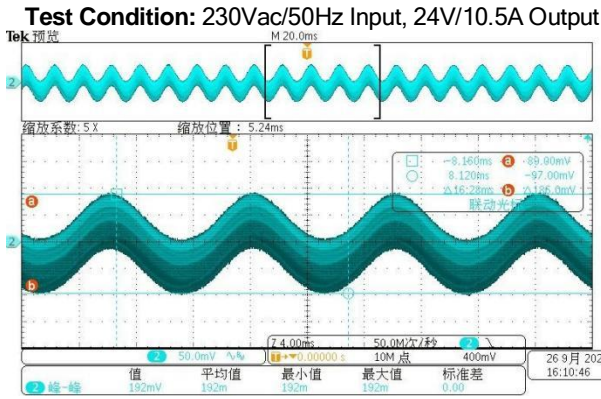
Result: Most of the ripple voltage comes from the ripple of the bus capacitors, which depends on the value of the bus capacitors.

Note: Ripple & noise are measured with minimum measurement loop. Bandwidth is limited to 20MHz.

Input Voltage	No Load Ripple (mV)	Full Load Ripple (mV)
	48V/0A	48V/10.5A
90Vac/60Hz	44.8	192
115Vac/60Hz	43.2	196
230Vac/50Hz	42.4	192
265Vac/50Hz	42	192

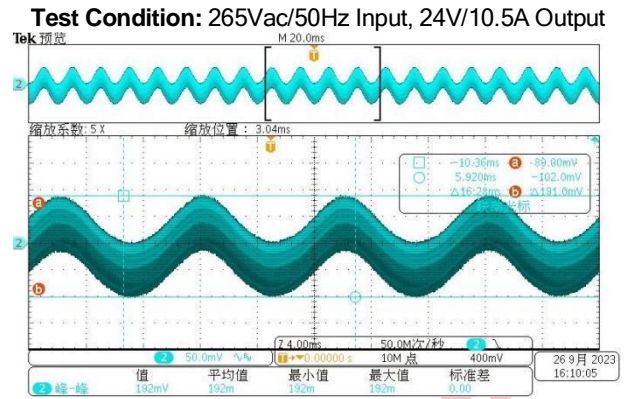
Waveforms:





(CH2-Vripple)

Comments: Vripple=192mV



(CH2-Vripple)

Comments: Vripple=192mV

2.3 Load Transient Test

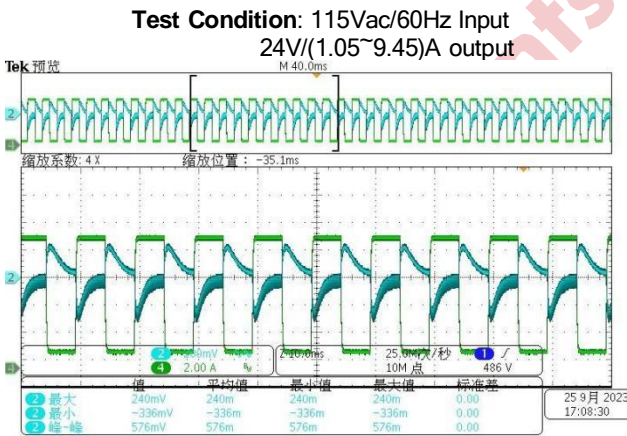
Standard: Under the typical input voltage 115Vac 60Hz/230Vac 50Hz, the output voltage transient response should be within $\pm 10\%$ normal voltage.

Result: Pass

Note: 10% load shift to 90% load with 0.25A/ μ s changing ramp and 100Hz changing frequency.

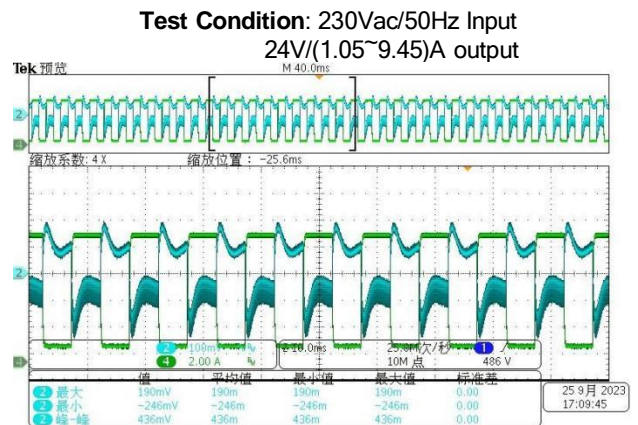
Input Voltage	115Vac/60Hz	230Vac/50Hz
24V/ 1.05-9.45A	0.576V	0.436V

Waveforms:



(CH2-Vout (ac), CH4-Iout)

Comments: $\Delta V_{out} = 0.576V$



(CH2-Vout (ac), CH4-Iout)

Comments: $\Delta V_{out} = 0.436V$

2.4 Capacitive Load Startup Test

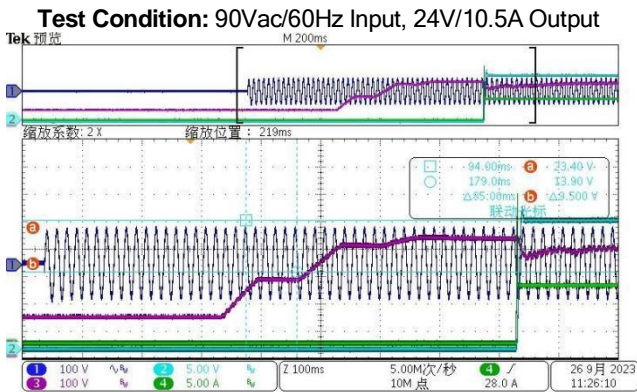
Standard: While capacitance load is 3000 μ F, the power supply can turn on normally and the output is in the rated range.

Result: Pass

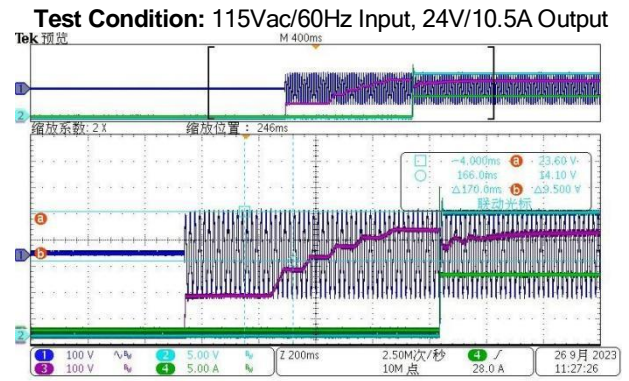
Note: Tested at the output cap end.

Waveforms:

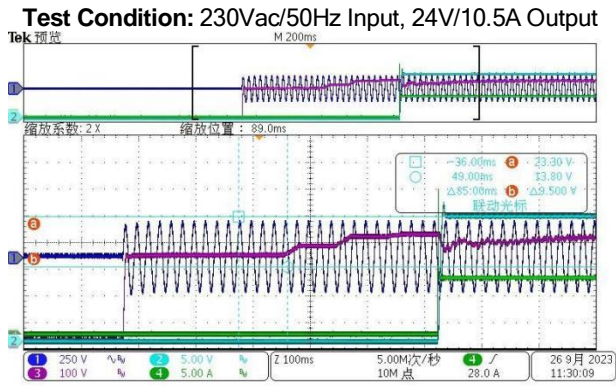
250W, PFC + LLC Power Supply (CC & CV)
Reference Design with KP2806(A) + KP2591(A)



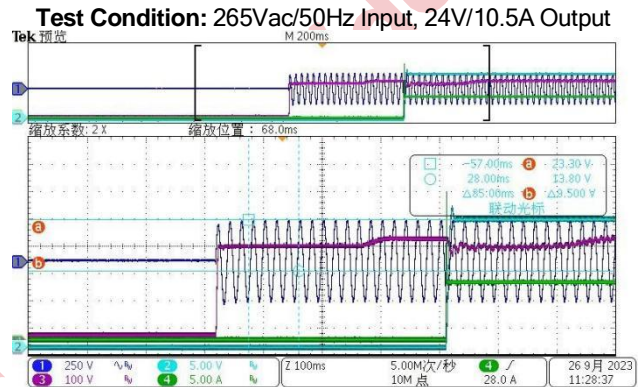
(CH1-Vin (ac), CH2-Vout, CH3-Vbus, CH4-Ir)
Comments: Full load normal start



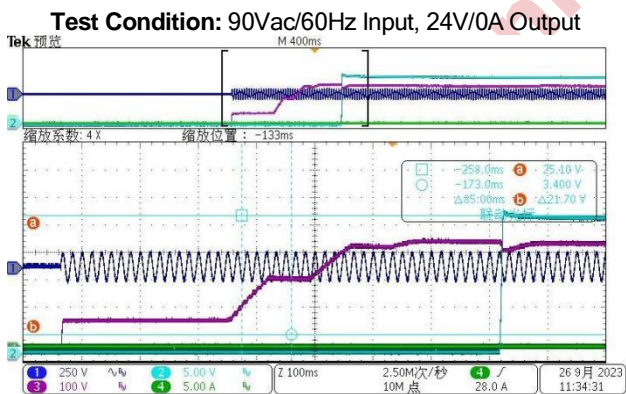
(CH1-Vin (ac), CH2-Vout, CH3-Vbus, CH4-Ir)
Comments: Full load normal start



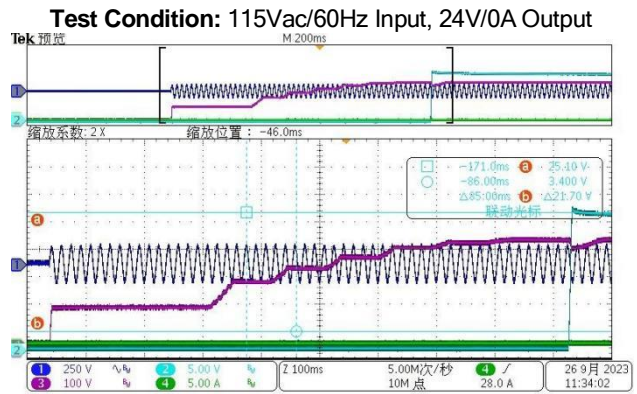
(CH1-Vin (ac), CH2-Vout, CH3-Vbus, CH4-Ir)
Comments: Full load normal start



(CH1-Vin (ac), CH2-Vout, CH3-Vbus, CH4-Ir)
Comments: Full load normal start

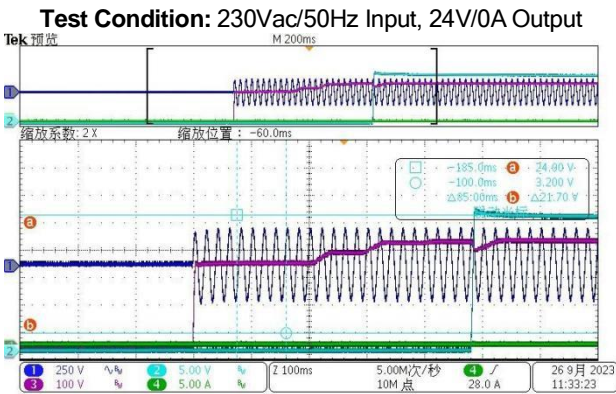


(CH1-Vin (ac), CH2-Vout, CH3-Vbus, CH4-Ir)
Comments: Normal start without load

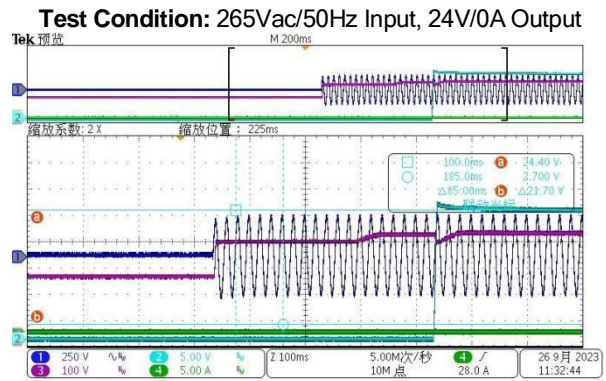


(CH1-Vin (ac), CH2-Vout, CH3-Vbus, CH4-Ir)
Comments: Normal start without load

250W, PFC + LLC Power Supply (CC & CV)
Reference Design with KP2806(A) + KP2591(A)



(CH1-Vin (ac), CH2-Vout, CH3-Vbus, CH4-Ir)
Comments: Normal start without load



(CH1-Vin (ac), CH2-Vout, CH3-Vbus, CH4-Ir)
Comments: Normal start without load

2.5 Startup Time and Raise Time

Standard: The startup time should be less than 3s @90Vac~265Vac.

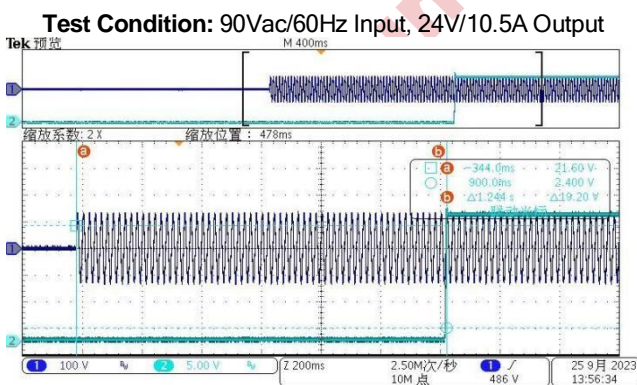
Result: Pass

Note: The output voltage is tested at the output cap end.

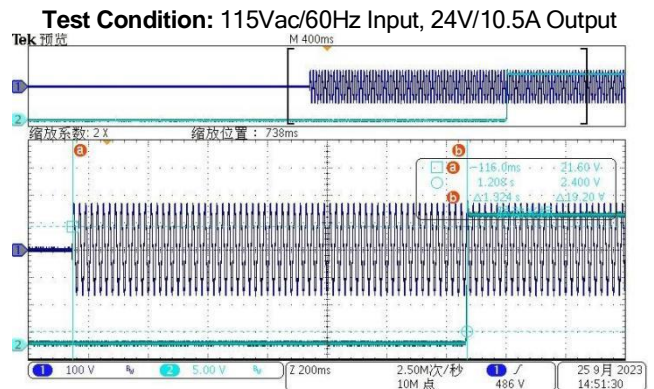
Test Data:

Input Voltage	90Vac/60Hz	115Vac/60Hz	230Vac/50Hz	265Vac/50Hz
Output	24V/10.5A			
Startup Time (ms) Full Load	1.244s	1.324s	899ms	764ms
Raise Time (ms) Full Load	3.18ms	3.16ms	3.26ms	3.3ms
Vo-peak(V)	25.9V	25.9V	25.9V	26V

Waveforms:



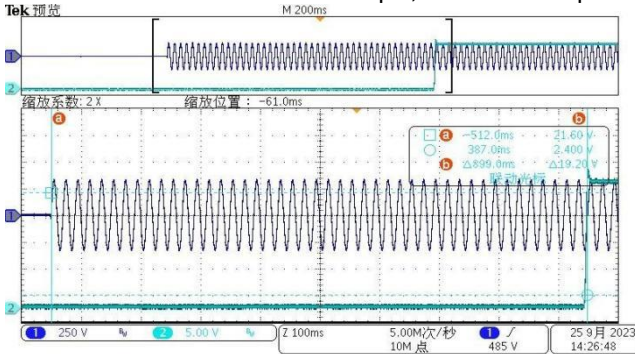
(CH1-Vin (ac), CH2-Vout)
Comments: Startup time=1.244s



(CH1-Vin (ac), CH2-Vout)
Comments: Startup time=1.324s

250W, PFC + LLC Power Supply (CC & CV)
Reference Design with KP2806(A) + KP2591(A)

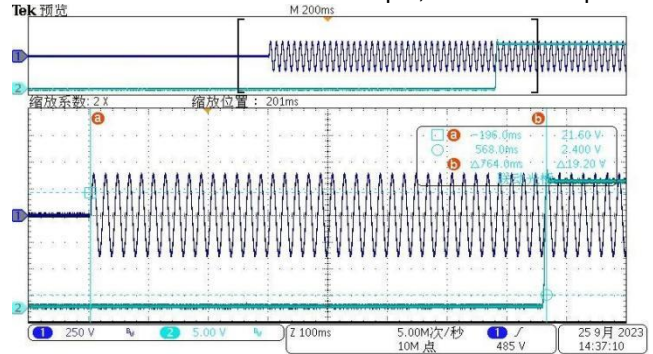
Test Condition: 230Vac/50Hz Input, 24V/10.5A Output



(CH1-Vin (ac), CH2-Vout)

Comments: Startup time=899ms

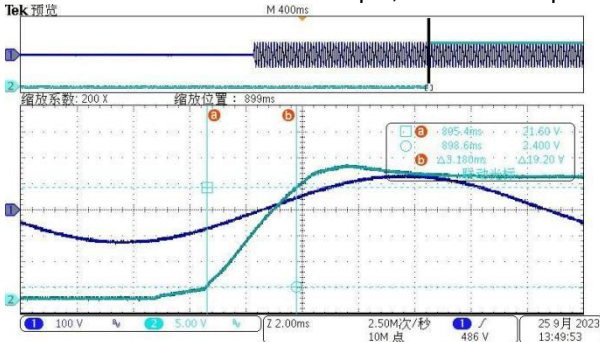
Test Condition: 265Vac/50Hz Input, 24V/10.5A Output



(CH1-Vin (ac), CH2-Vout)

Comments: Startup time=764ms

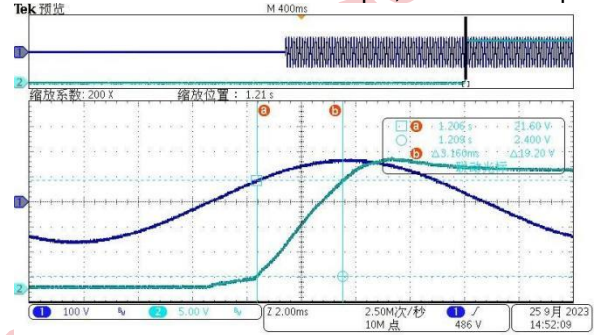
Test Condition: 90Vac/60Hz Input, 24V/10.5A Output



(CH1-Vin (ac), CH2-Vout)

Comments: Rise time=3.18ms

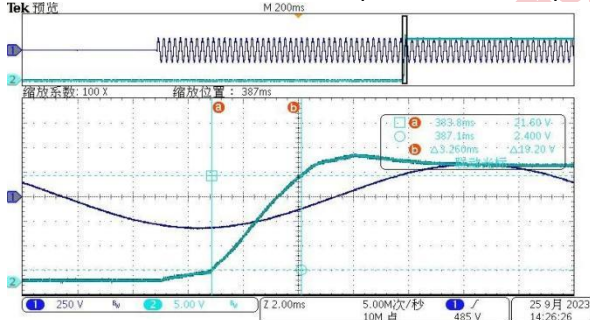
Test Condition: 115Vac/60Hz Input, 24V/10.5A Output



(CH1-Vin (ac), CH2-Vout)

Comments: Rise time=3.16ms

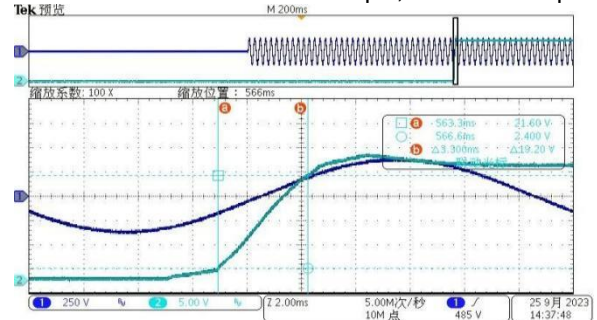
Test Condition: 230Vac/50Hz Input, 24V/10.5A Output



(CH1-Vin (ac), CH2-Vout)

Comments: Rise time=3.26ms

Test Condition: 265Vac/50Hz Input, 24V/10.5A Output



(CH1-Vin (ac), CH2-Vout)

Comments: Rise time=3.3ms

2.6 Holdup Time and Fall Time

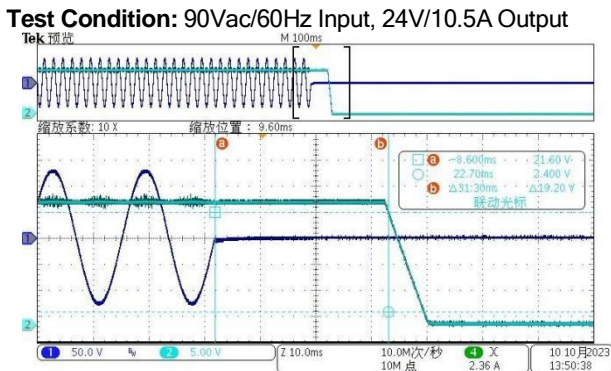
Standard: The holdup time should be larger than 20ms@90Vac-265Vac.

Result: Pass

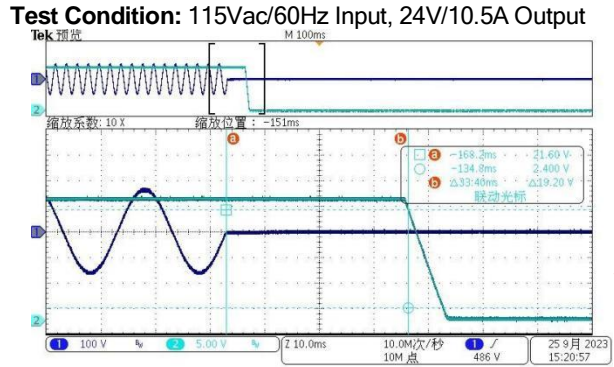
Note: The output voltage is tested at the output cap end.

Input Voltage	90Vac/60Hz	115Vac/60Hz	230Vac/50Hz	265Vac/50Hz
Output	24V/10.5A			
Holdup Time (ms)	31.3	33.4	33.3	31.3
Fall Time (ms)	6.4	6.38	6.36	6.36

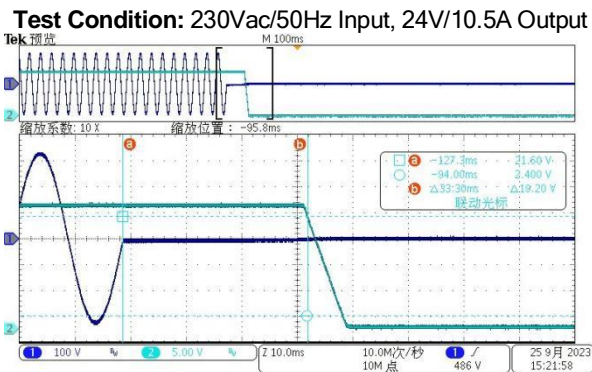
Waveforms:



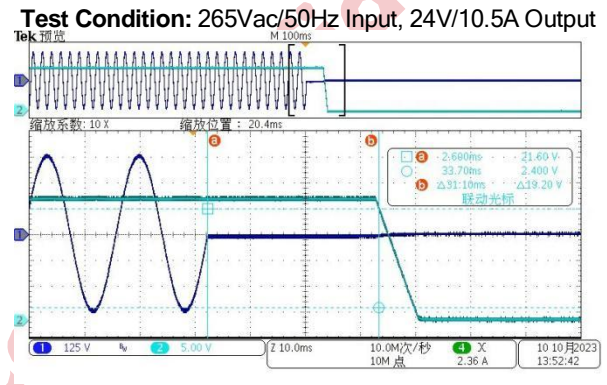
(CH1-Vin (ac), CH2-Vout)
Comments: Holdup time=31.3ms



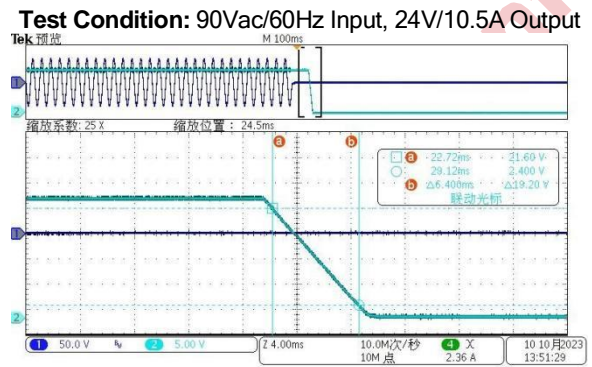
(CH1-Vin (ac), CH2-Vout)
Comments: Holdup time=33.40ms



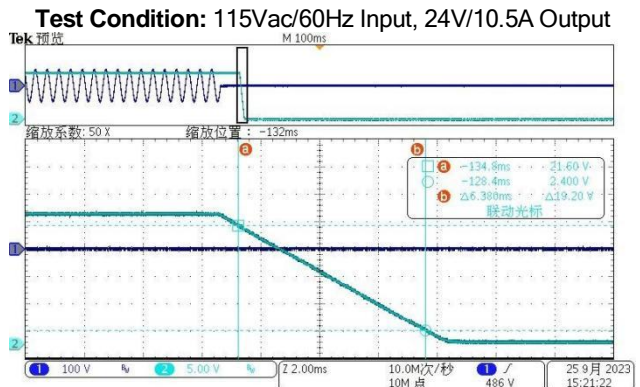
(CH1-Vin (ac), CH2-Vout)
Comments: Holdup time=33.40ms



(CH1-Vin (ac), CH2-Vout)
Comments: Holdup time=31.30ms

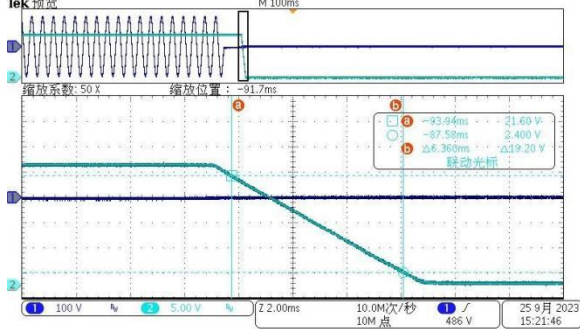


(CH1-Vin (ac), CH2-Vout)
Comments: Fall time=6.40ms



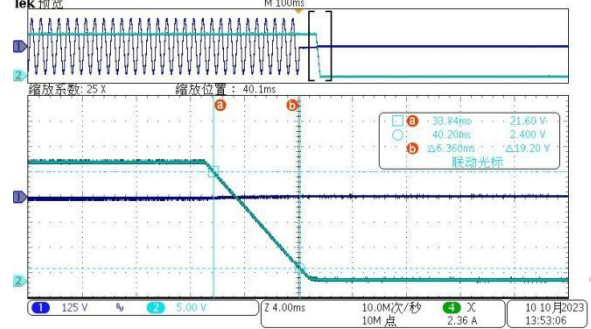
(CH1-Vin (ac), CH2-Vout)
Comments: Fall time=6.38ms

Test Condition: 230Vac/50Hz Input, 24V/10.5A Output



(CH1-Vin (ac), CH2-Vout)
Comments: Fall time=6.36ms

Test Condition: 265Vac/50Hz Input, 24V/10.5A Output



(CH1-Vin (ac), CH2-Vout)
Comments: Fall time=28.60ms

2.7 Output Overshoot Test

Standard: $V_{o-peak} < \text{Rated output voltage} * 110\%$.

Result: Pass

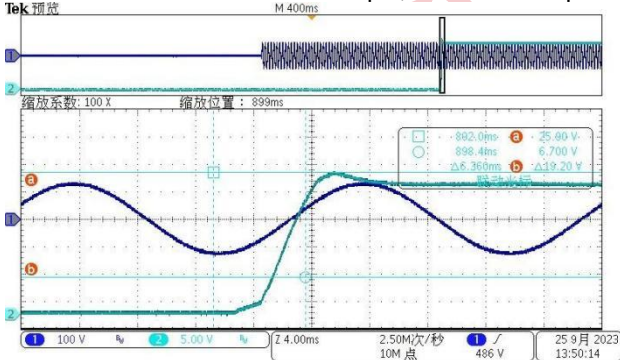
Note: The output voltage is tested at the output cap end.

Test Data:

Input Voltage	90Vac/60Hz	115Vac/60Hz	230Vac/50Hz	265Vac/50Hz
Output	24V/10.5A	24V/10.5A	24V/10.5A	24V/10.5A
Overshoot (V) Full Load	25.9	25.9	25.9	26
Overshoot (V) No Load	26	26	26	26

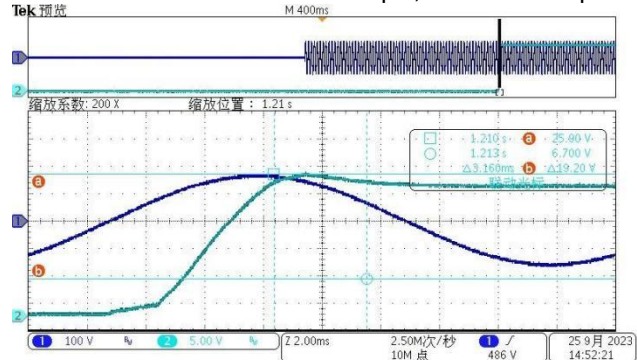
Waveforms:

Test Condition: 90Vac/60Hz Input, 24V/10.5A Output



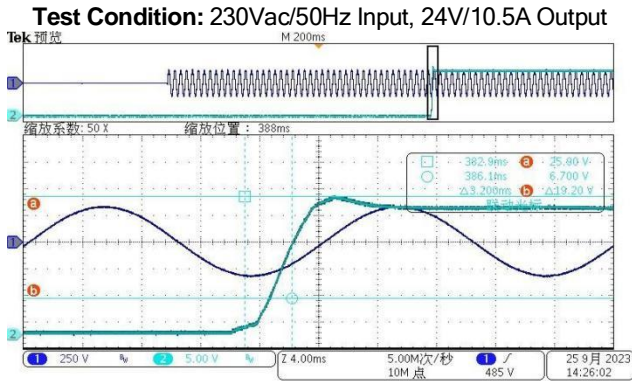
(CH1-Vin (ac), CH2-Vout)
Comments: Vo-peak=25.9V

Test Condition: 115Vac/60Hz Input, 24V/10.5A Output

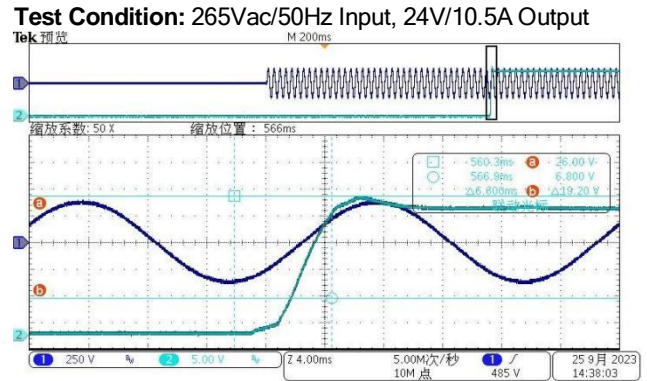


(CH1-Vin (ac), CH2-Vout)
Comments: Vo-peak=25.9V

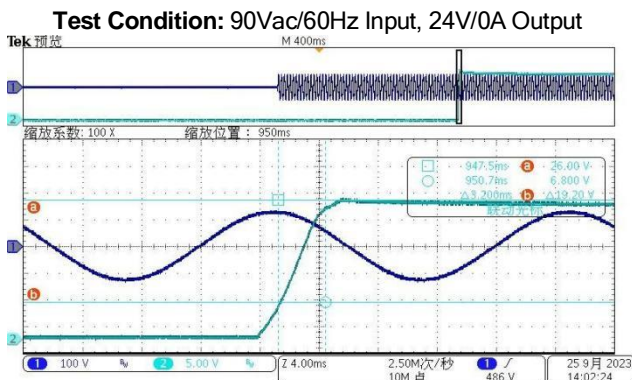
250W, PFC + LLC Power Supply (CC & CV)
Reference Design with KP2806(A) + KP2591(A)



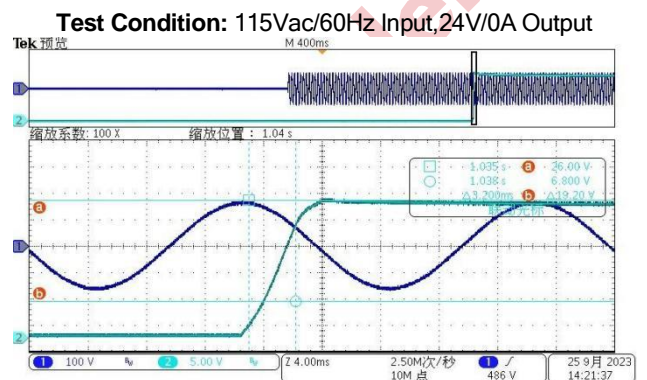
(CH1-Vin (ac), CH2-Vout)
Comments: Vo-peak=25.9V



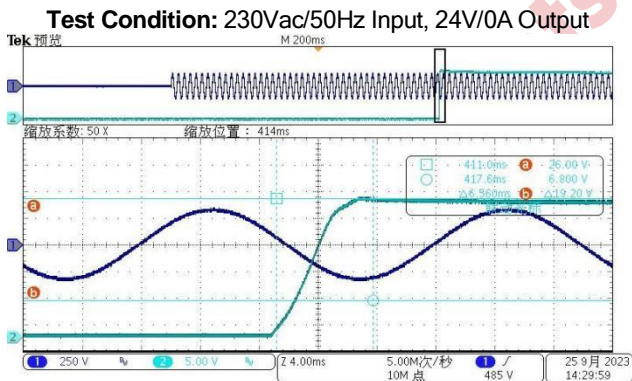
(CH1-Vin (ac), CH2-Vout)
Comments: Vo-peak=26V



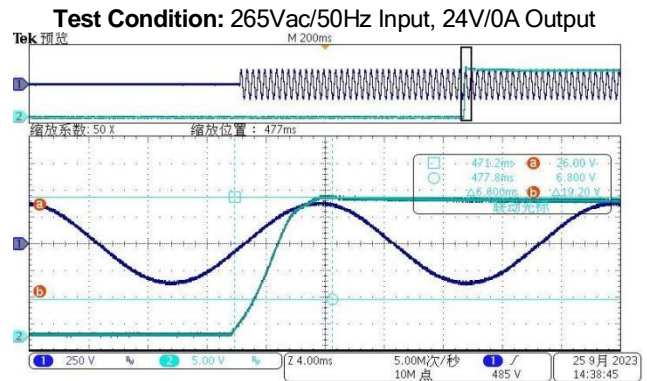
(CH1-Vin (ac), CH2-Vout)
Comments: Vo-peak=26V



(CH1-Vin (ac), CH2-Vout)
Comments: Vo-peak=26V



(CH1-Vin (ac), CH2-Vout)
Comments: Vo-peak=26V



(CH1-Vin (ac), CH2-Vout)
Comments: Vo-peak=26V

2.8 Output I-V Curve

Standard: The Output should satisfy the battery charging requirement.

Result: Pass

Test Data:

115V/60Hz

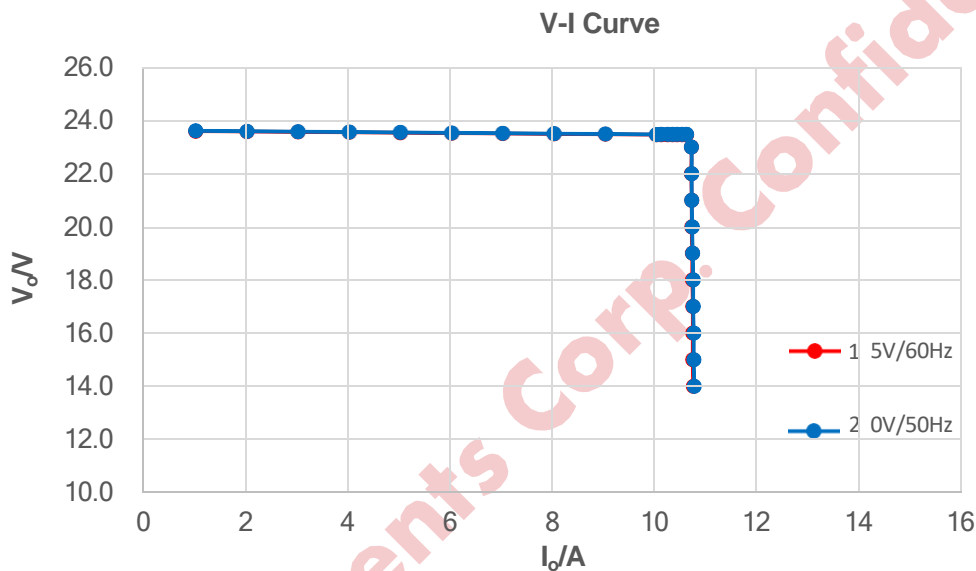
Io	1	2	3	4	5	6	7	8	9	10	10.1	10.2	10.3
Vo	23.60	23.58	23.57	23.55	23.54	23.52	23.51	23.49	23.48	23.46	23.46	23.46	23.46

I_o	10.4	10.5	10.6	10.68	10.68	10.69	10.69	10.7	10.7	10.71	10.71	10.71	10.72
V_o	23.46	23.46	23.46	23	22	21	20	19	18	17	16	15	14

230V/50Hz

I_o	1	2	3	4	5	6	7	8	9	10	10.1	10.2	10.3
V_o	23.61	23.60	23.58	23.57	23.55	23.54	23.52	23.506	23.49	23.48	23.48	23.48	23.48

I_o	10.4	10.5	10.6	10.68	10.68	10.69	10.69	10.7	10.7	10.71	10.71	10.71	10.72
V_o	23.48	23.48	23.48	23	22	21	20	19	18	17	16	15	14



3 Protection Test

3.1 Output Over Voltage Protection

Standard: The output over voltage should be within the voltage rating of output capacitor.

Result: Pass

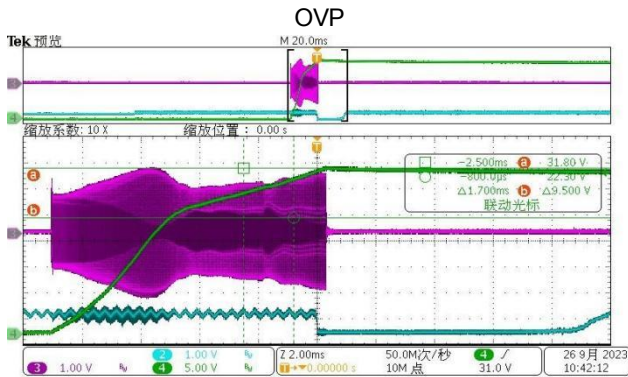
Note: Tested at the output cap end with secondary side of opto-coupler for FB shorted.

Test Data:

Input Voltage	90Vac /60Hz	115Vac /60Hz	230Vac /50Hz	265Vac /50Hz	Output Capacitor Voltage Rating
OVP (V) No Load	31.8	31.9	31.7	31.5	36V
OVP (V) Full Load	28.6	28.3	28.7	28.6	

Waveforms:

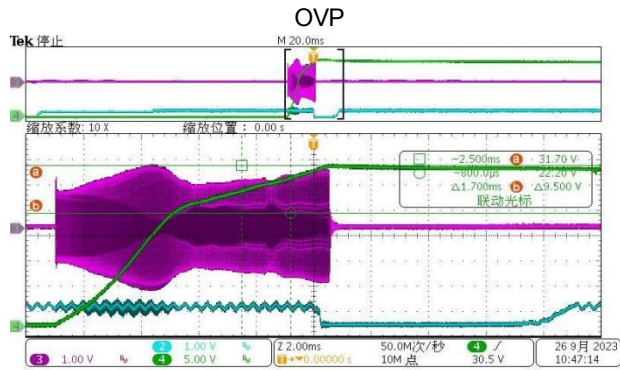
Test Condition: 90Vac/60Hz Input, 24V/0A Output,



(CH2-VSEL, CH3-VDEM, CH4-VO)

Comments: Vo-OVP=31.8V

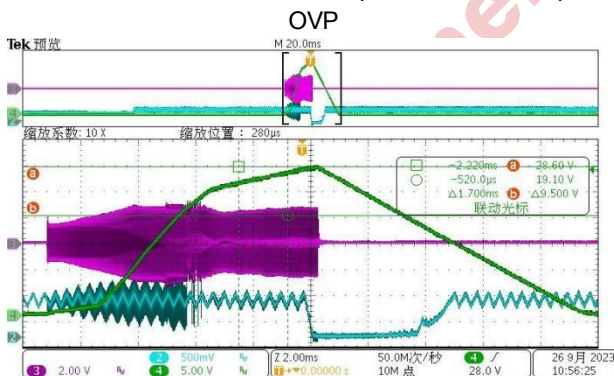
Test Condition: 230Vac/50Hz Input, 24V/0A Output,



(CH2-VSEL, CH3-VDEM, CH4-VO)

Comments: Vo-OVP=31.7V

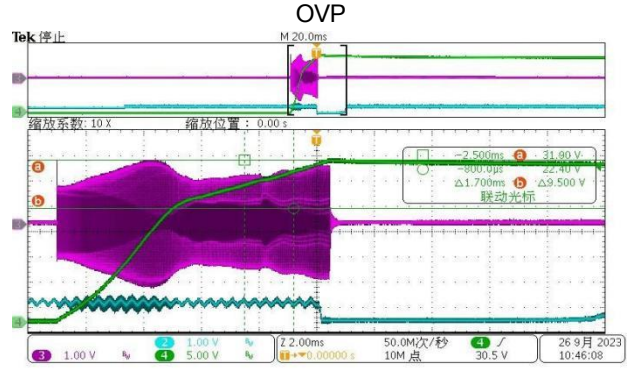
Test Condition: 90Vac/60Hz Input, 24V/10.5A Output,



(CH2-VSEL, CH3-VDEM, CH4-VO)

Comments: Vo-OVP=28.6V

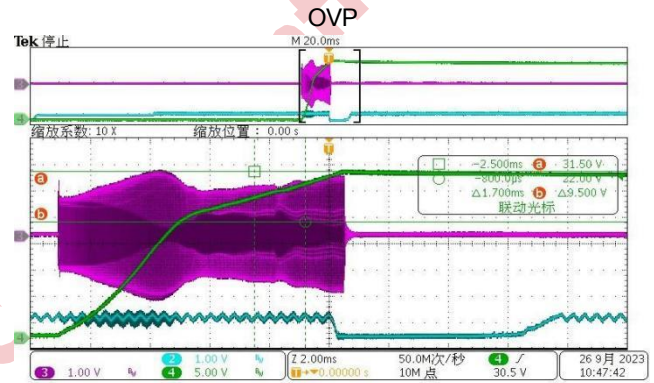
Test Condition: 115Vac/60Hz Input, 24V/0A Output,



(CH2-VSEL, CH3-VDEM, CH4-VO)

Comments: Vo-OVP=31.9V

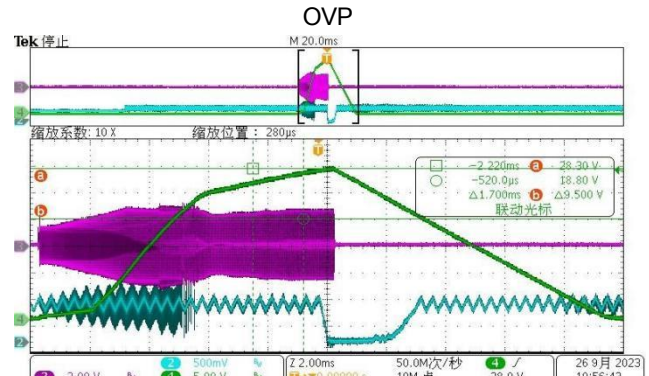
Test Condition: 265Vac/50Hz Input, 24V/0A Output,



(CH2-VSEL, CH3-VDEM, CH4-VO)

Comments: Vo-OVP=31.5V

Test Condition: 115Vac/60Hz Input, 24V/10.5A Output,

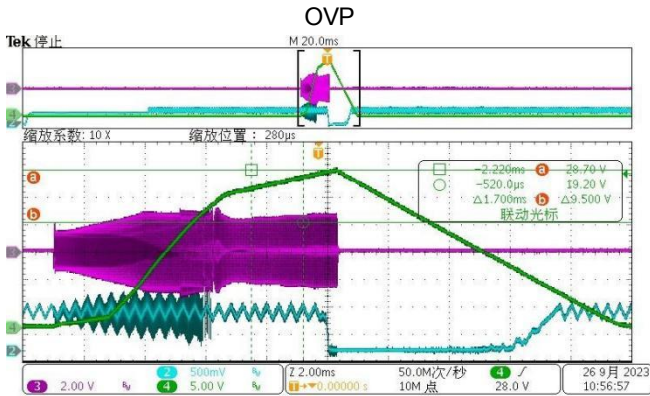


(CH2-VSEL, CH3-VDEM, CH4-VO)

Comments: Vo-OVP=28.3V

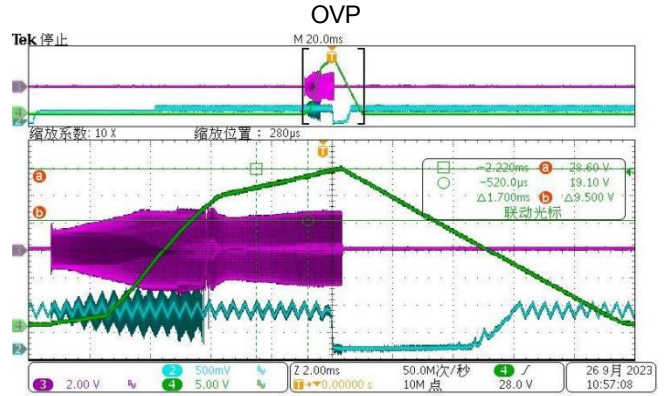
250W, PFC + LLC Power Supply (CC & CV)
Reference Design with KP2806(A) + KP2591(A)

Test Condition: 230Vac/50Hz Input, 24V/10.5A Output,



(CH2-VSEL, CH3-VDEM, CH4-VO)
Comments: Vo-OVP=28.7V

Test Condition: 265Vac/50Hz Input, 24V/10.5A Output,



(CH2-VSEL, CH3-VDEM, CH4-VO)
Comments: Vo-OVP=28.6V

3.2 Output Short-circuit Protection

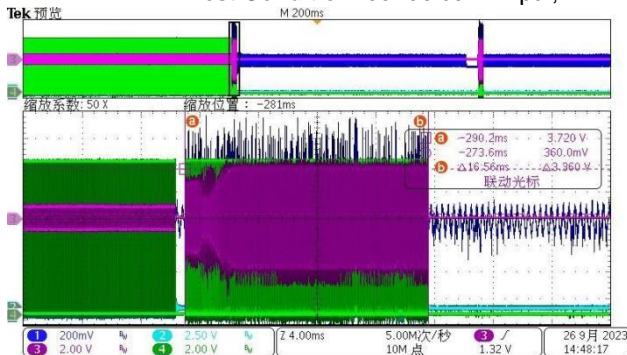
Standard: The power supply must shut down in the event of short-circuit condition and automatically return to normal operating condition once the fault condition has been removed.

Result: Pass

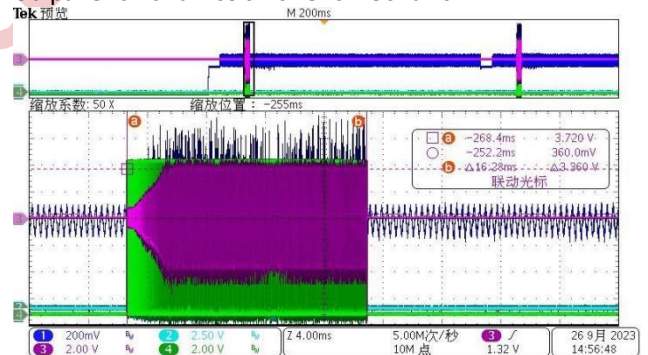
Note: The short circuit protection is tested at the output cap end.

Waveforms:

Test Condition: 90Vac/60Hz Input, 24V/10.5A Output Short and Restart at Short Condition

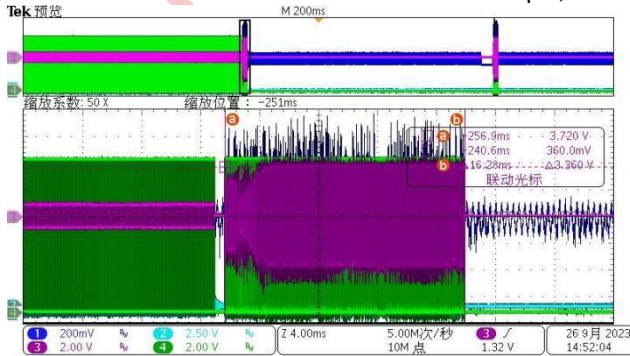


(CH1-VSEL, CH2-VGH, CH3-VCS, CH4-GL)
Comments: Protection Enter (OCP)

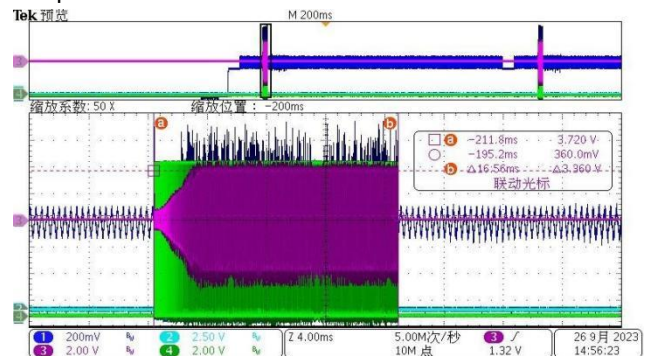


(CH1-VSEL, CH2-VGH, CH3-VCS, CH4-GL)
Comments: Restart at short condition

Test Condition: 115Vac/60Hz Input, 24V/10.5A Output Short and Restart at Short Condition

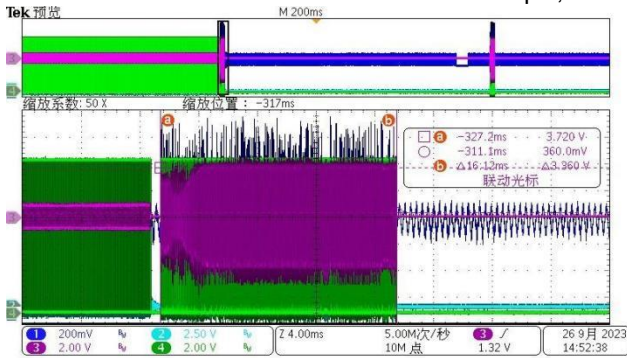


(CH1-VSEL, CH2-VGH, CH3-VCS, CH4-GL)
Comments: Protection Enter (OCP)

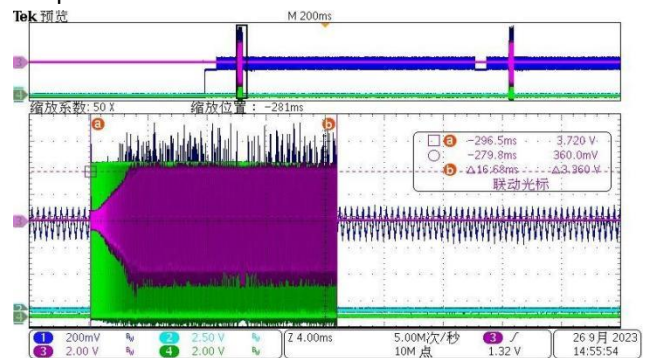


(CH1-VSEL, CH2-VGH, CH3-VCS, CH4-GL)
Comments: Restart at short condition

Test Condition: 230Vac/50Hz Input, 24V/10.5A Output Short and Restart at Short Condition

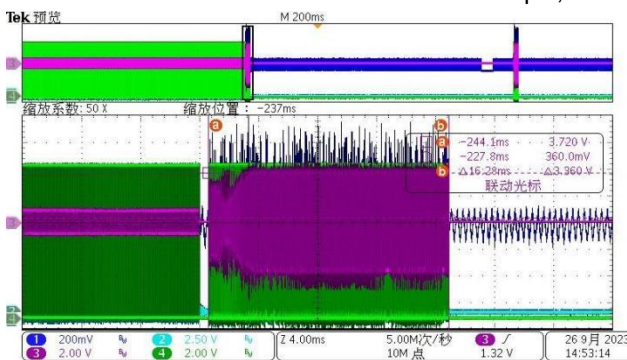


(CH1-VSEL, CH2-VGH, CH3-VCS, CH4-GL)
Comments: Protection Enter (OCP)

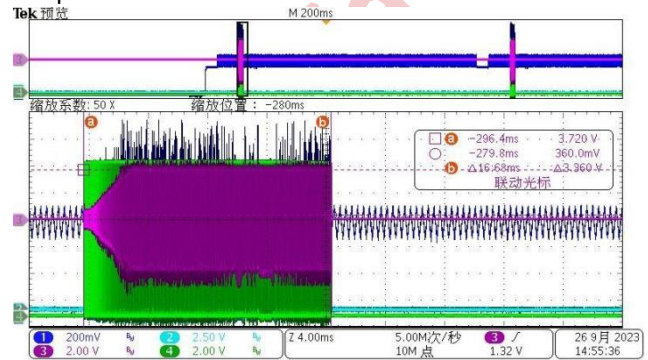


(CH1-VSEL, CH2-VGH, CH3-VCS, CH4-GL)
Comments: Restart at short condition

Test Condition: 265Vac/50Hz Input, 24V/10.5A Output Short and Restart at Short Condition



(CH1-VSEL, CH2-VGH, CH3-VCS, CH4-GL)
Comments: Protection Enter (OCP)



(CH1-VSEL, CH2-VGH, CH3-VCS, CH4-GL)
Comments: Protection Enter

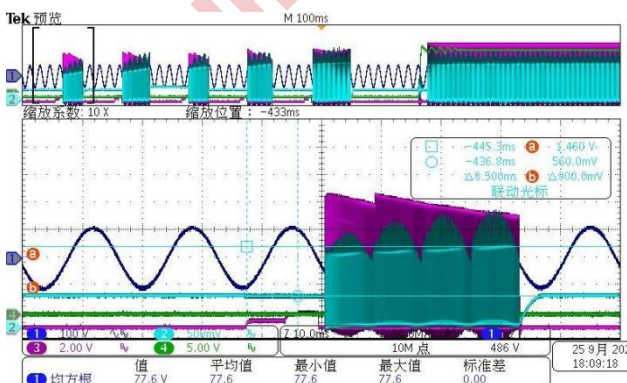
3.3 Input Brown-out Protection

Standard: The power supply should shut down when the input voltage is lower than the Brown-out protection value and return to normal operating condition when the input in the range of normal operating voltage

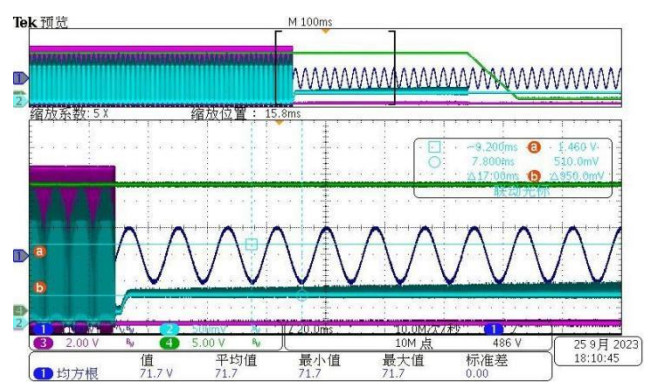
Result: Pass

Waveforms:

Test Condition: 24V/1A Output, Slowly adjust the input



(CH1-Vin (ac), CH2-ZCD, CH3-VGATE, CH4-VO)
Comments: 78Vac Protection recovery



(CH1-Vin (ac), CH2-ZCD, CH3-VGATE, CH4-VO)
Comments: 72Vac Protection enter

4 Reliability Requirements

4.1 Device Maximum Rating Test

Standard: MOSFET and Diode<95% Rating

Result: Pass

Test Data:

PFC:

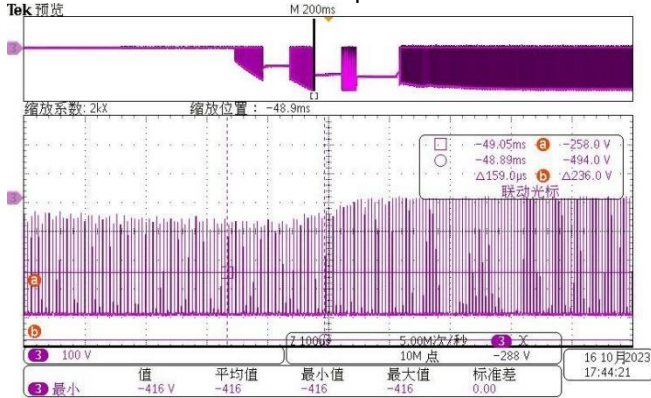
Component	Rating	90Vac 60Hz Input 24V/10.5A Output				115Vac 60Hz Input 24V/10.5A Output				Result
		Startup	Steady	Short	Short Start	Startup	Steady	Short	Short Start	
Doide (PFC)	600V	416V	416V	432V	416V	416V	416V	432V	416V	PASS
MOSFET (PFC)	650V	480V	514V	536V	464V	476V	506V	524V	476V	PASS
Inductor Current (PFC)		11.6A	9.68A	9.44A	5.2A	10.9A	7.68A	7.84A	5A	PASS
Component	Rating	230Vac 50Hz Input 24V/10.5A Output				265Vac 50Hz Input 24V/10.5A Output				
Doide (PFC)	600V	416V	416V	428V	416V	412V	416V	432V	412V	PASS
MOSFET (PFC)	650V	440V	452V	476V	428V	440V	452V	454V	428V	PASS
Inductor Current (PFC)		5.32A	3.34A	3.32A	5.36A	5.32A	3.34A	3.32A	5.36A	PASS

LLC:

Component	Rating	115Vac 60Hz Input 24V/10.5A Output				265Vac 50Hz Input 24V/10.5A Output				Result
		Startup	Steady	Short	Short Start	Startup	Steady	Short	Short Start	
MOSFET H (LLC)	650V	446V	422V	466V	442V	438V	422V	466V	438V	PASS
MOSFET L (LLC)	650V	444V	420V	452V	436V	436V	412V	452V	432V	PASS
Resonant Current		7.8A	2.32A	8.5A	8.2A	7.8A	2.32A	8.4A	8.2A	PASS
Resonant Capacitor Voltage	630V	428V	308V	540V	510V	552V	312V	532V	508V	PASS
SR-MOSFET1 (Q2)	100V	74V	70.4V	70.2V	37V	75.2V	69.6V	69.2V	37.6V	PASS
SR-MOSFET2 (Q4)	100V	84.8V	72.8V	72.4V	35.6V	83.2V	72.8V	71.2V	37.2V	PASS

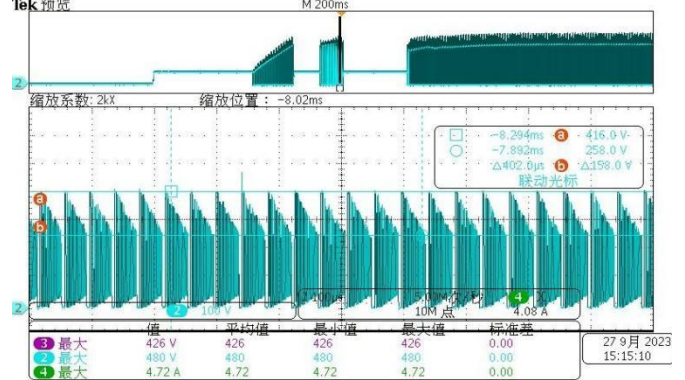
Waveforms (PFC):

Test Condition: 90Vac/60Hz Input, 24V/10.5A Output, Startup



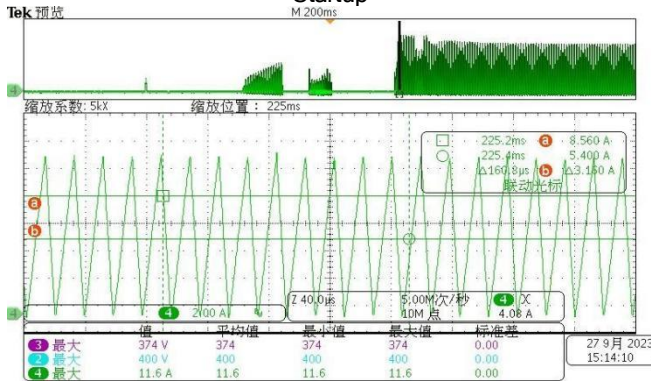
(CH3-Vdiode)
Comments: Vdiode=430V

Test Condition: 90Vac/60Hz Input, 24V/10.5A Output, Startup



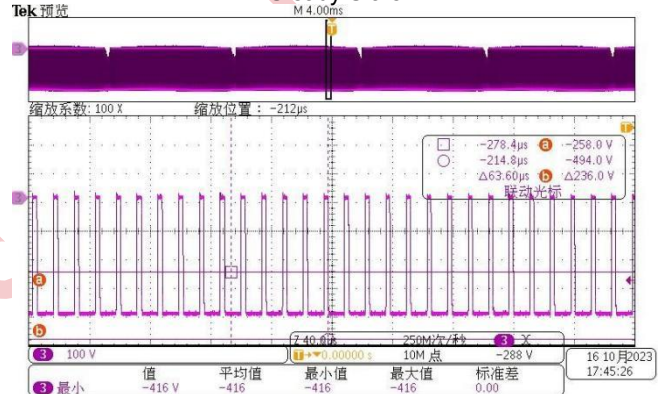
(CH2-VDS)
Comments: VDS=480V

Test Condition: 90Vac/60Hz Input, 24V/10.5A Output, Startup



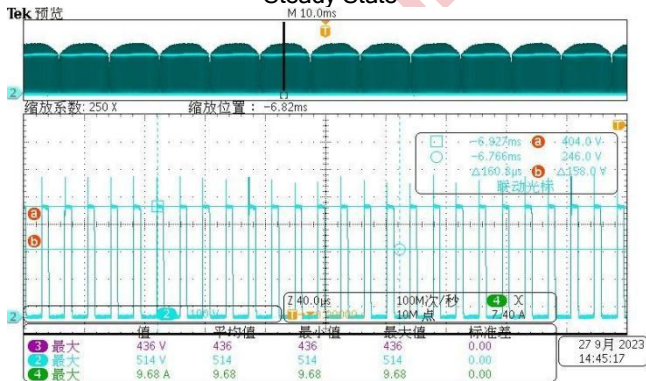
(CH4-IL)
Comments: IL=11.6A

Test Condition: 90Vac/60Hz Input, 24V/10.5A Output, Steady State



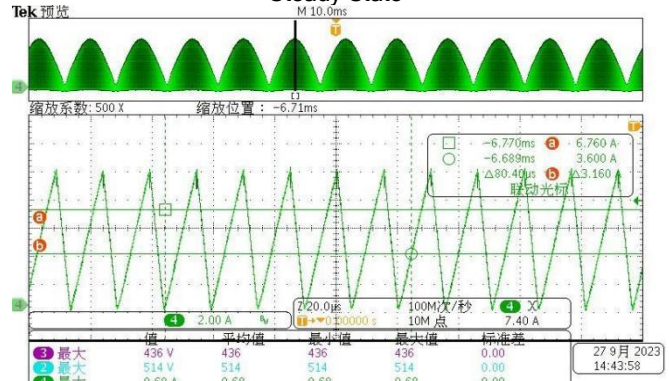
(CH3-VDiode)
Comments: VDiode=440V

Test Condition: 90Vac/60Hz Input, 24V/10.5A Output, Steady State



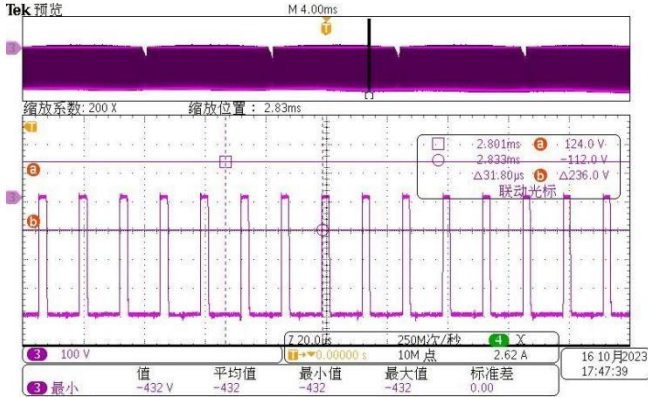
(CH2-VMosfet)
Comments: Vmosfet=514V

Test Condition: 90Vac/60Hz Input, 24V/10.5A Output, Steady State



(CH4-IL)
Comments: IL=9.68A

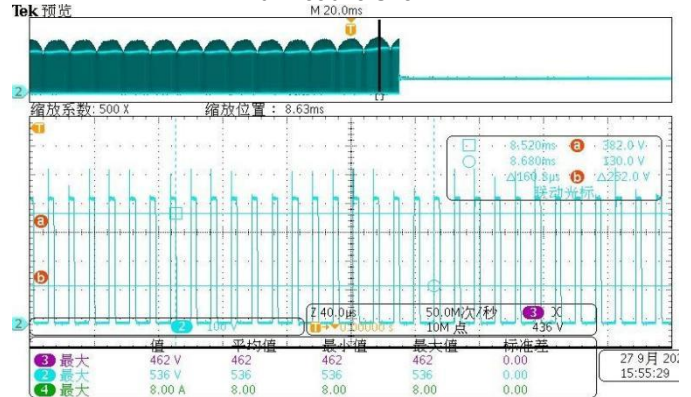
Test Condition: 90Vac/60Hz Input, 24V/10.5A Output, Full Load to Short



(CH3-VDiode)

Comments: VDiode=462V

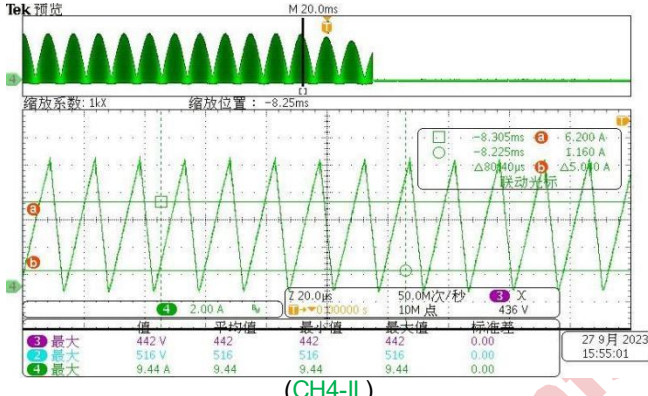
Test Condition: 90Vac/60Hz Input, 24V/10.5A Output, Full Load to Short



(CH2-VMosfet)

Comments: VMosfet=536V

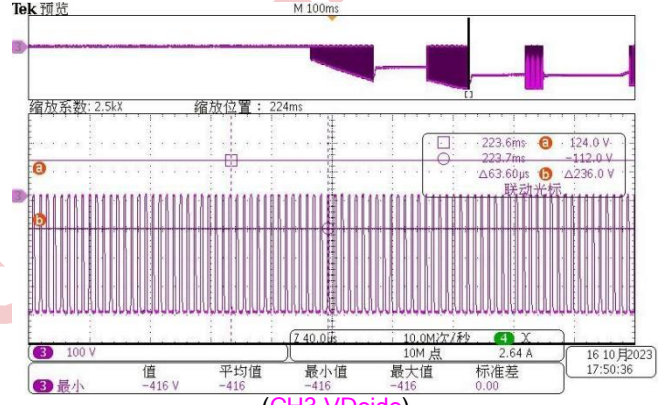
Test Condition: 90Vac/60Hz Input, 24V/10.5A Output, Full Load to Short



(CH4-IL)

Comments: IL=9.44A

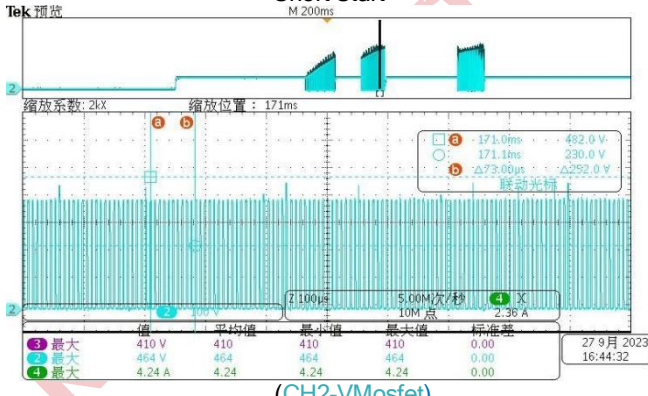
Test Condition: 90Vac/60Hz Input, 24V/10.5A Output, Short Start



(CH3-VDiode)

Comments: VDiode=418V

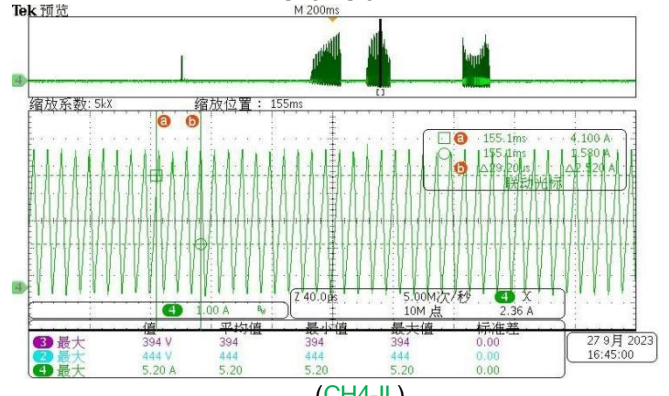
Test Condition: 90Vac/60Hz Input, 24V/10.5A Output, Short Start



(CH2-VMosfet)

Comments: VMosfet=464

Test Condition: 90Vac/60Hz Input, 24V/10.5A Output, Short Start



(CH4-IL)

Comments: IL=5.2A

Test Condition: 265Vac/50Hz Input, 24V/10.5A Output, Startup



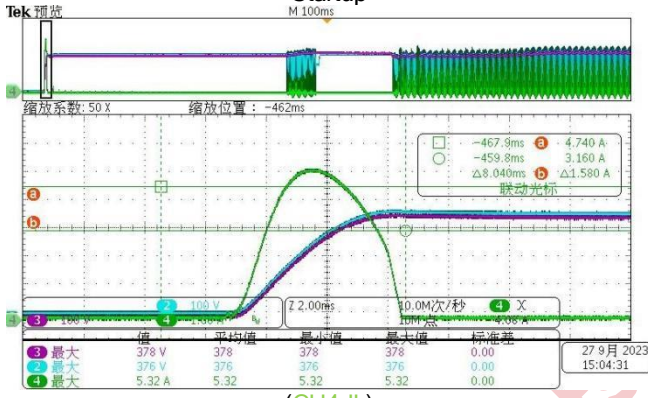
(CH3-Vdiode)
Comments: Vdiode=418V

Test Condition: 265Vac/50Hz Input, 24V/10.5A Output, Startup



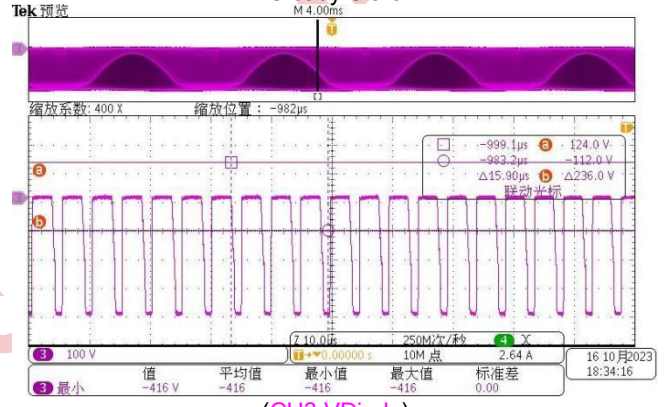
(CH2-VDS)
Comments: VDS=440V

Test Condition: 265Vac/50Hz Input, 24V/10.5A Output, Startup



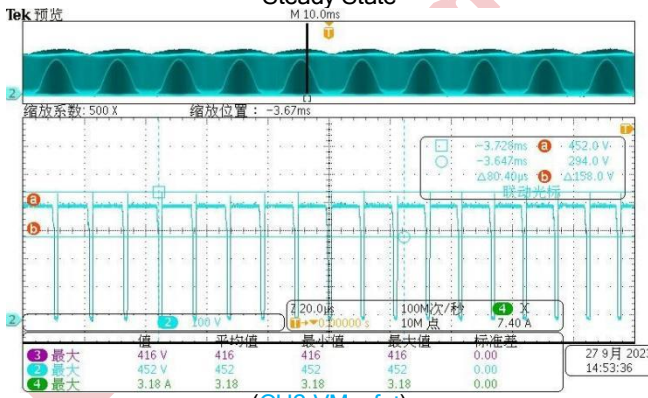
(CH4-IL)
Comments: IL=5.32A

Test Condition: 265Vac/50Hz Input, 24V/10.5A Output, Steady State



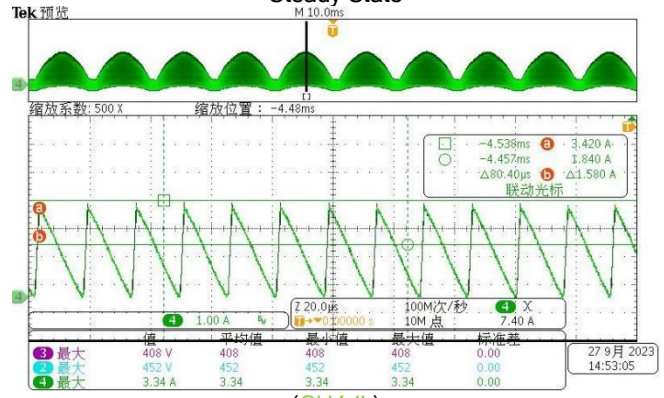
(CH3-VDiode)
Comments: VDiode=420V

Test Condition: 265Vac/50Hz Input, 24V/10.5A Output, Steady State



(CH2-Vmosfet)
Comments: Vmosfet=452V

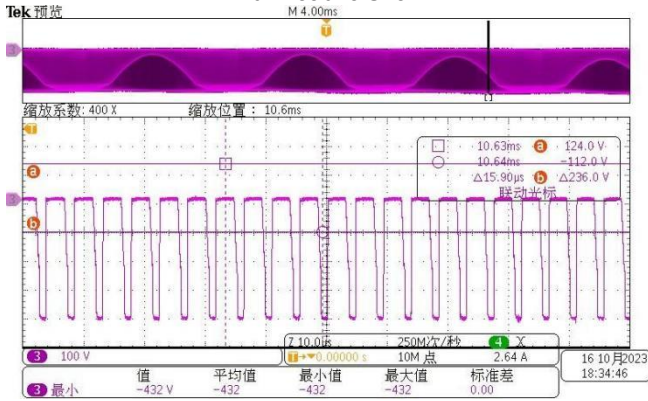
Test Condition: 265Vac/50Hz Input, 24V/10.5A Output, Steady State



(CH4-IL)
Comments: IL=3.34A

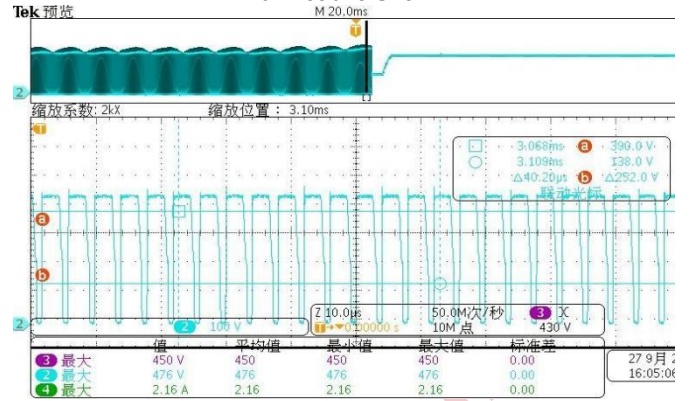
250W, PFC + LLC Power Supply (CC & CV)
Reference Design with KP2806(A) + KP2591(A)

Test Condition: 265Vac/50Hz Input, 24V/10.5A Output,
Full Load to Short



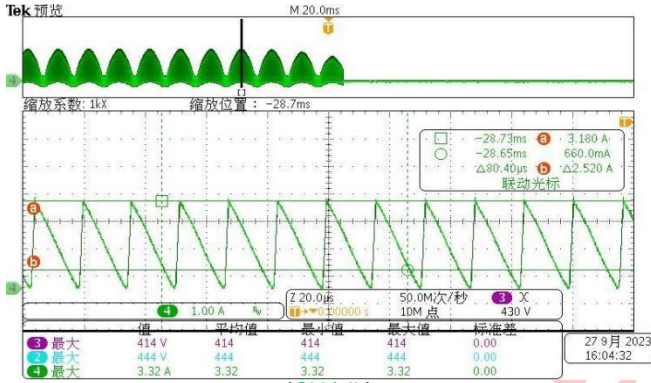
(CH3-VDiode)
Comments: VDiode=454V

Test Condition: 265Vac/50Hz Input, 24V/10.5A Output,
Full Load to Short



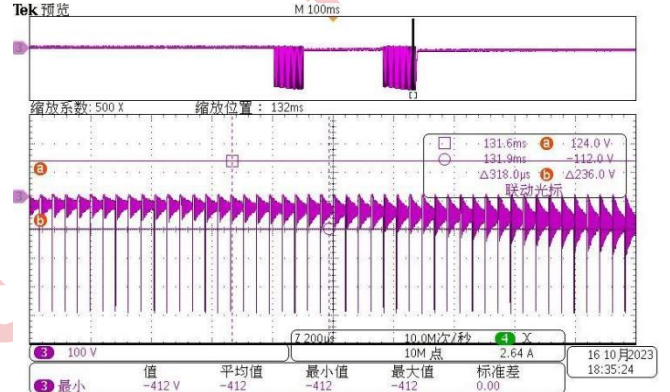
(CH2-VMosfet)
Comments: VMosfet=476V

Test Condition: 265Vac/50Hz Input, 24V/10.5A Output, Full
Load to Short



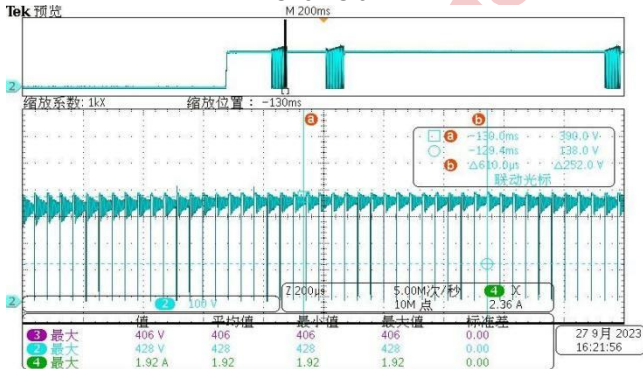
(CH4-IL)
Comments: IL=3.32A

Test Condition: 265Vac/50Hz Input, 24V/10.5A Output,
Short Start



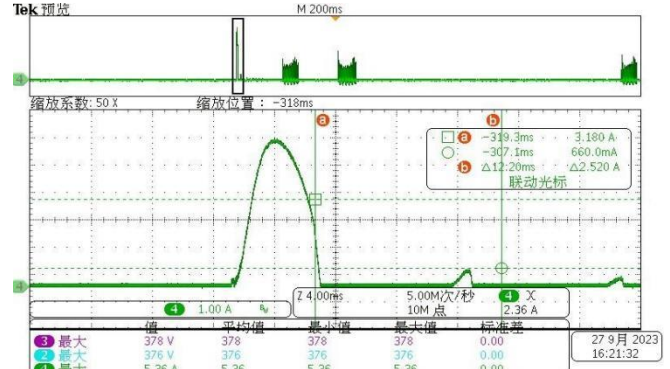
(CH3-VDiode)
Comments: VDiode=406V

Test Condition: 265Vac/50Hz Input, 24V/10.5A Output,
Short Start



(CH2-VMosfet)
Comments: VMosfet=428V

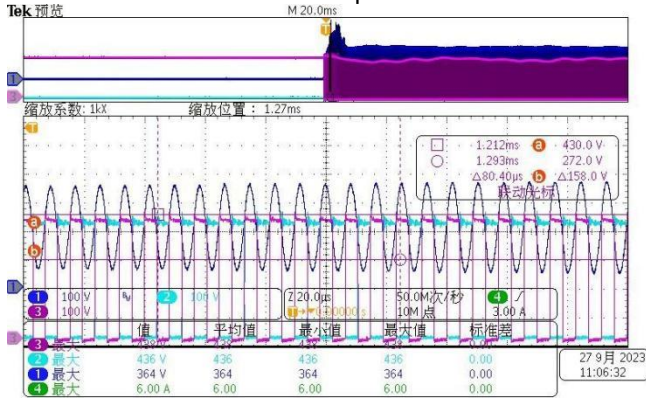
Test Condition: 265Vac/50Hz Input, 24V/10.5A Output,
Short Start



(CH4-IL)
Comments: IL=5.36A

Waveforms(LLC):

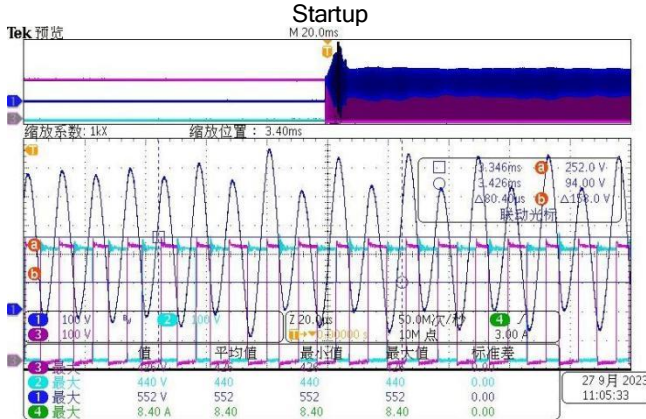
Test Condition: 265Vac/50Hz Input, 24V/10.5A Output, Startup



(CH3-VDrain_H)

Comments: VDrain_H_peak=438V

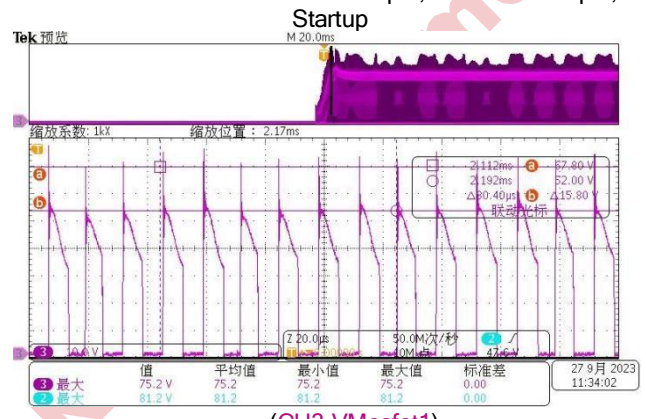
Test Condition: 265Vac/50Hz Input, 24V/10.5A Output, Startup



(CH1-VCr)

Comments: VCr=552V

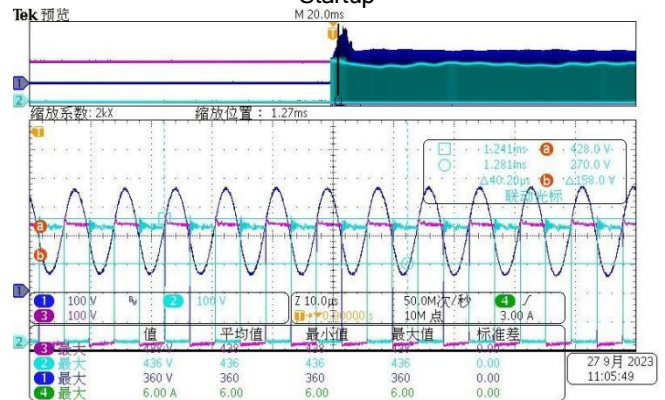
Test Condition: 265Vac/50Hz Input, 24V/10.5A Output, Startup



(CH3-VMosfet1)

Comments: VMosfet1=75.2V

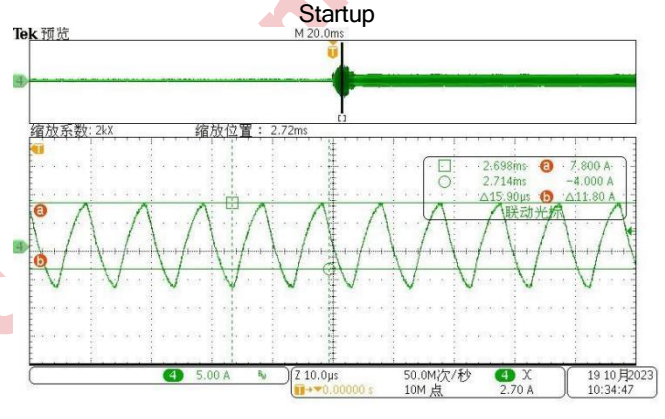
Test Condition: 265Vac/50Hz Input, 24V/10.5A Output, Startup



(CH2-VDrain_L)

Comments: VDrain_L_peak=436V

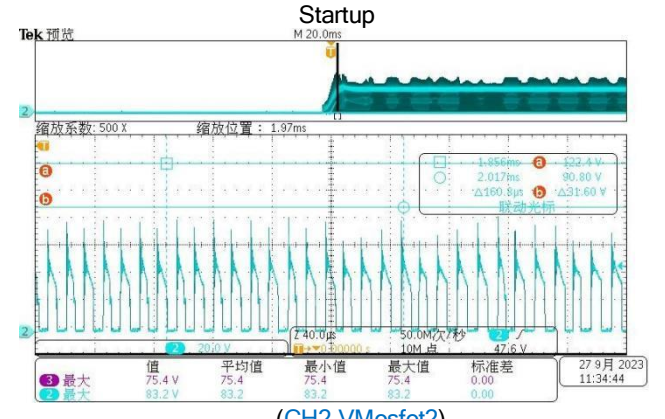
Test Condition: 265Vac/50Hz Input, 24V/10.5A Output, Startup



(CH4-Ir)

Comments: Ir_peak=7.8A

Test Condition: 265Vac/50Hz Input, 24V/10.5A Output, Startup

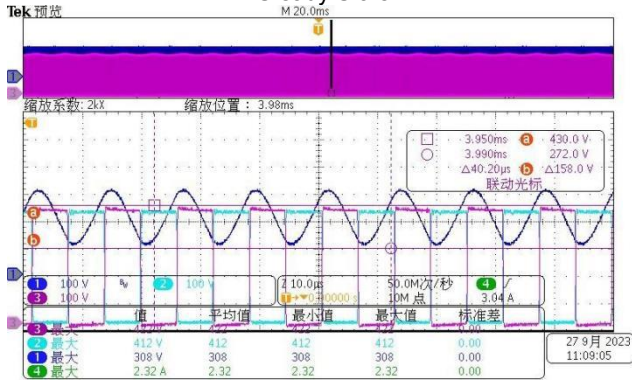


(CH2-VMosfet2)

Comments: VMosfet2=83.2V

250W, PFC + LLC Power Supply (CC & CV)
Reference Design with KP2806(A) + KP2591(A)

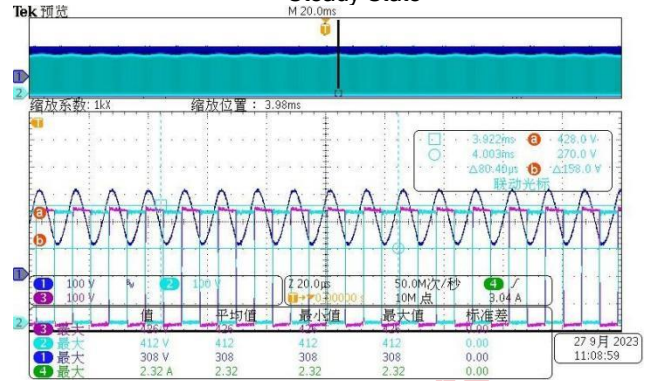
Test Condition: 265Vac/50Hz Input, 24V/10.5A Output, Steady State



(CH3-VDrain_H)

Comments: VDrain_H_peak=422V

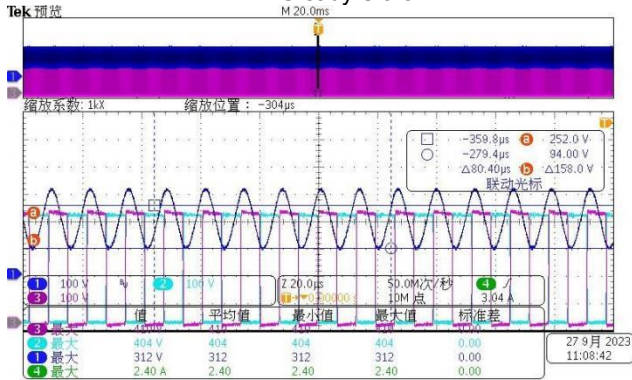
Test Condition: 265Vac/50Hz Input, 24V/10.5A Output, Steady State



(CH2-VDrain_L)

Comments: VDrain_L_peak=404V

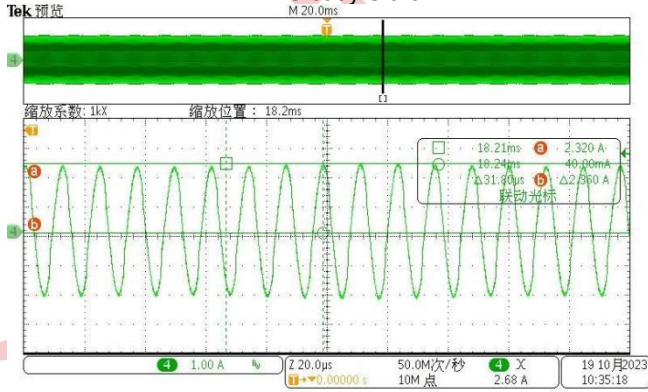
Test Condition: 265Vac/50Hz Input, 24V/10.5A Output, Steady State



(CH1-VCr)

Comments: VCr=303V

Test Condition: 265Vac/50Hz Input, 24V/10.5A Output, Steady State



(CH4-Ir)

Comments: Ir_peak=2.32A

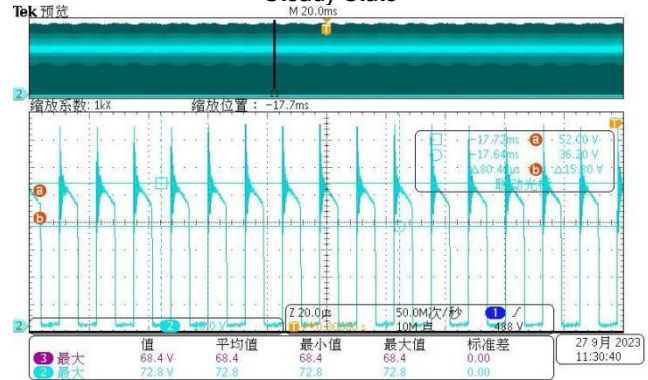
Test Condition: 265Vac/50Hz Input, 24V/10.5A Output, Steady State



(CH3-VMosfet1)

Comments: VMosfet=69.6V

Test Condition: 265Vac/50Hz Input, 24V/10.5A Output, Steady State

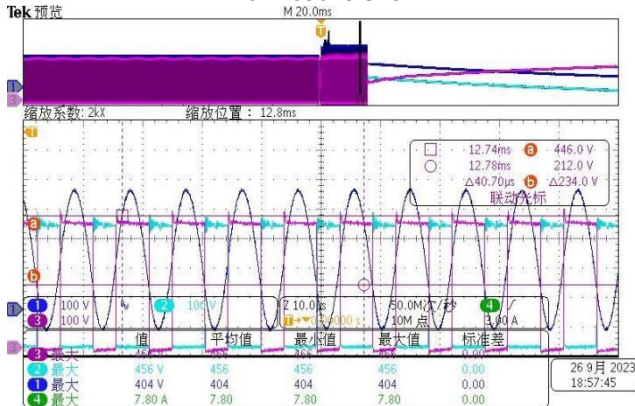


(CH2-VMosfet2)

Comments: VMosfet2=72.8V

250W, PFC + LLC Power Supply (CC & CV)
Reference Design with KP2806(A) + KP2591(A)

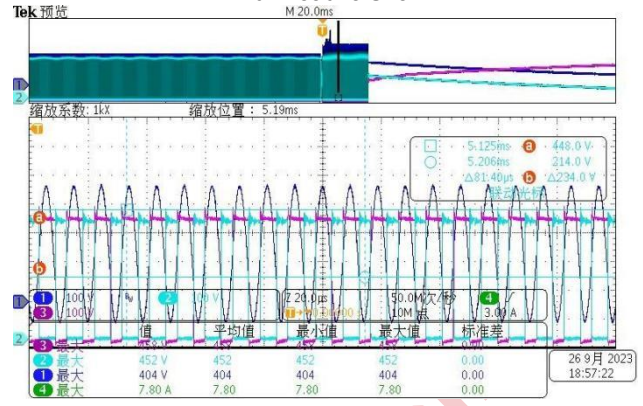
Test Condition: 265Vac/50Hz Input, 24V/10.5A Output,
Full Load to Short



(CH3-VDrain_H)

Comments: VDrain_H_peak =466V

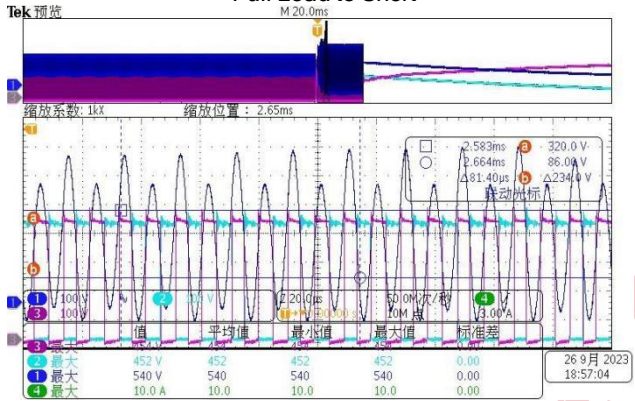
Test Condition: 265Vac/50Hz Input, 24V/10.5A Output,
Full Load to Short



(CH3-VDrain_L)

Comments: VDrain_L_peak =452V

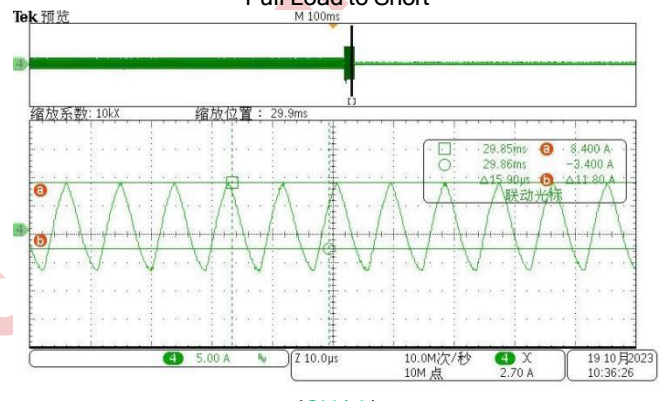
Test Condition: 265Vac/50Hz Input, 24V/10.5A Output,
Full Load to Short



(CH1-VCr)

Comments: VCr=540V

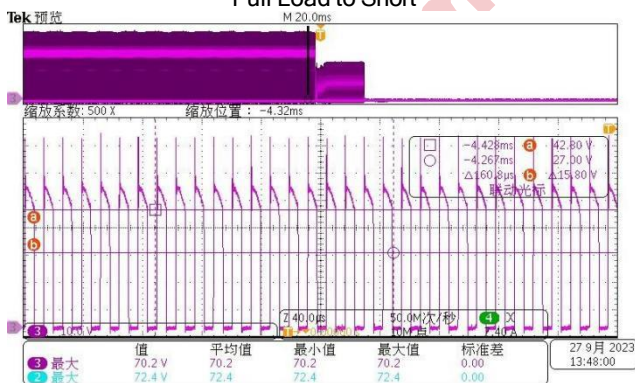
Test Condition: 265Vac/50Hz Input, 24V/10.5A Output,
Full Load to Short



(CH4-Ir)

Comments: Ir=8.4A

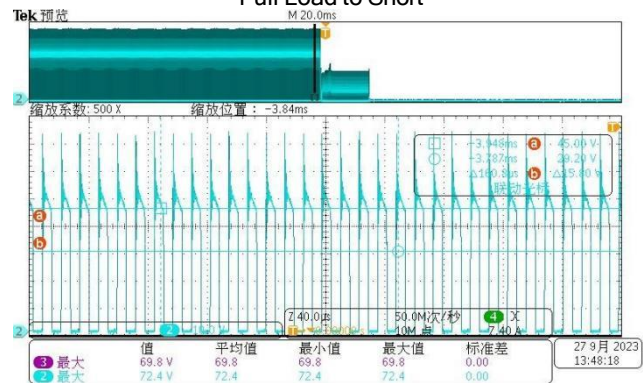
Test Condition: 265Vac/50Hz Input, 24V/10.5A Output,
Full Load to Short



(CH3-VMosfet1)

Comments: VMosfet1=70.2V

Test Condition: 265Vac/50Hz Input, 24V/10.5A Output,
Full Load to Short

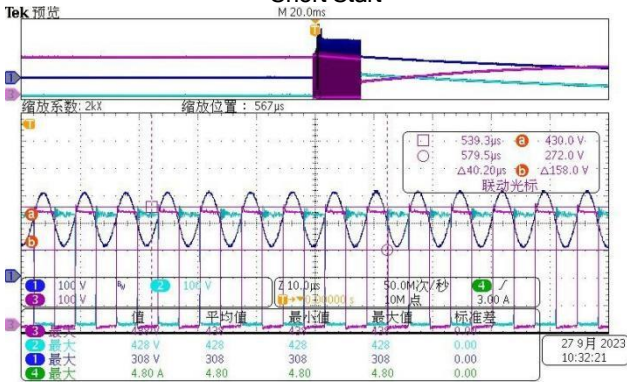


(CH2-VMosfet2)

Comments: VMosfet2=72.4V

250W, PFC + LLC Power Supply (CC & CV)
Reference Design with KP2806(A) + KP2591(A)

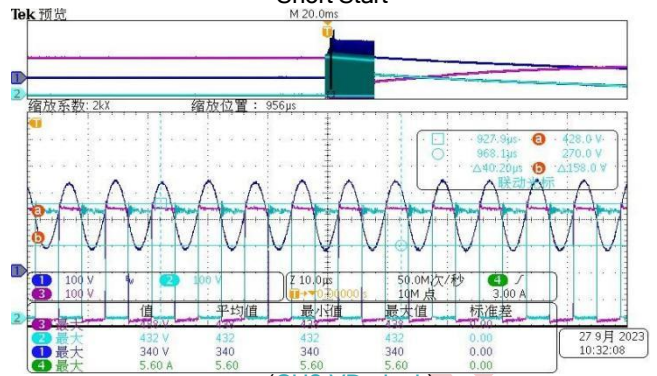
Test Condition: 265Vac/50Hz Input, 24V/10.5A Output, Short Start



(CH3-VDrain_H)

Comments: VDrain_H_peak=438V

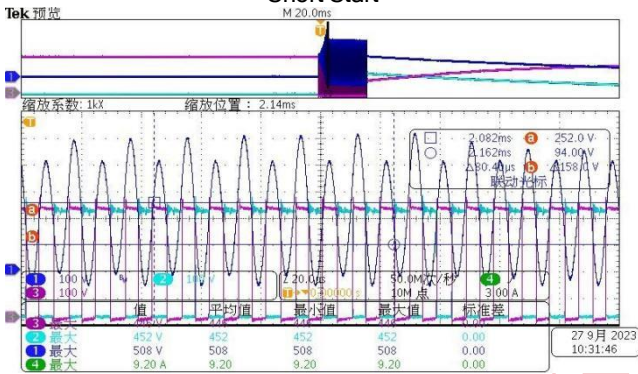
Test Condition: 265Vac/50Hz Input, 24V/10.5A Output, Short Start



(CH2-VDrain_L)

Comments: VDrain_L_peak=432V

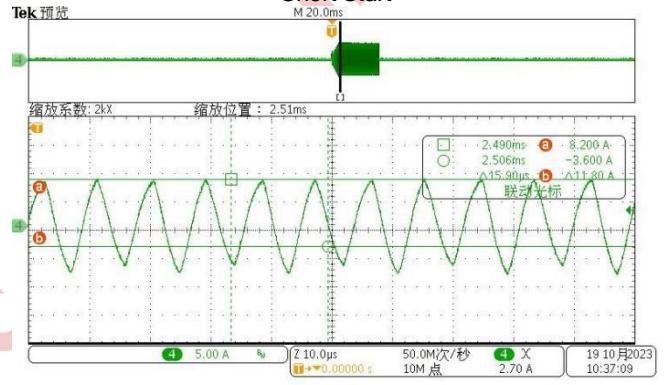
Test Condition: 265Vac/50Hz Input, 24V/10.5A Output, Short Start



(CH1-VCr)

Comments: VCr=508V

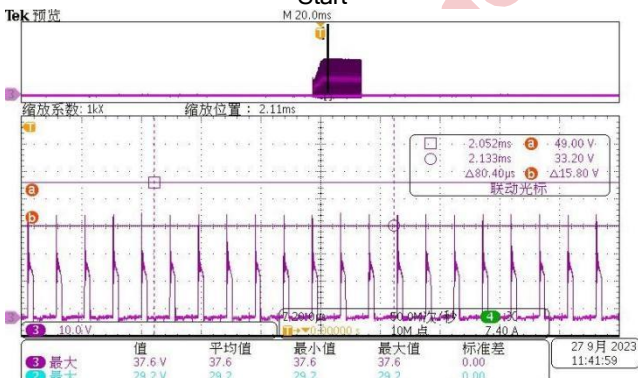
Test Condition: 265Vac/50Hz Input, 24V/10.5A Output, Short Start



(CH4-Ir)

Comments: Ir_peak=8.2A

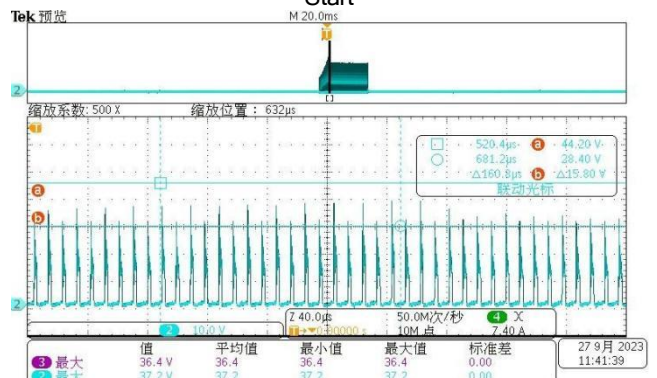
Test Condition: 265Vac/50Hz Input, 24V/10.5A Output, Short Start



(CH3-VMosfet1)

Comments: VDoide=37.6V

Test Condition: 265Vac/50Hz Input, 24V/10.5A Output, Short Start



(CH2-VMosfet2)

Comments: VMosfet=37.2V

4.2 Bmax Test

Standard: Steady-state rated load: $B_{max} \leq 0.32T$; Transient and its peak load: $B_{max} \leq 0.38T$.

Result: Pass

Note: The number of turns on the PFC inductor is 45 and the sectional area is 118mm^2 , The inductance of this PFC is $130\mu\text{H}$. The number of turns on the transform primary side is 32, and the sectional area is 161mm^2 , L_p is $430\mu\text{H}$, leakage inductance L_p' is $5.9\mu\text{H}$. The number of turns on the resonant inductor is 40 and the sectional area is 62mm^2 , L_r is $90\mu\text{H}$. If the primary current of transformer cannot be measured, resonant current and leakage inductance L_p' are used instead.

Test Data:

Comment	PFC Inductor				Bmax-limit (T)	Result
	90Vac/60Hz	115Vac/60Hz	230Vac/50Hz	265Vac/50Hz		
Output	24V/10.5A					
Startup	0.284	0.267	0.126	0.13	0.38	PASS
Steady	0.237	0.188	0.095	0.082	0.32	PASS
Short	0.231	0.192	0.137	0.081	0.38	PASS
Short Start	0.127	0.122	0.119	0.131	0.38	PASS

Comment	LLC Resonant Inductor		LLC Main Transformer		Bmax-limit (T)	Result
	115Vac/60Hz	265Vac/50Hz	115Vac/60Hz	265Vac/50Hz		
Output	24V/10.5A					
Startup	0.283	0.305	0.009	0.009	0.38	PASS
Steady	0.05	0.059	0.12	0.141	0.32	PASS
Short	0.308	0.305	0.011	0.011	0.38	PASS
Short Start	0.298	0.298	0.01	0.01	0.38	PASS

Note: As for the waveforms, please refer to Device Maximum Rating.

4.3 Thermal Test

Test Condition: 90Vac/60Hz input; 24V/10.5A output; Burn-in 2 Hours @ Open Air with no airflow, T_a is the ambient temperature.

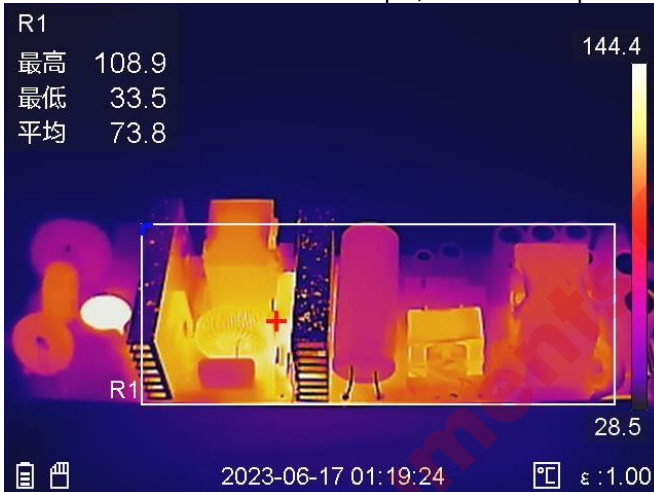
Standard: MOSFET, IC and Diode, $Trise < 90^\circ\text{C}$. Transformer, Inductor: $T_a = 25^\circ\text{C}$, $Trise < 120^\circ\text{C}$.

Result: The transformer needs additional heat dissipation measures.

Test Data:

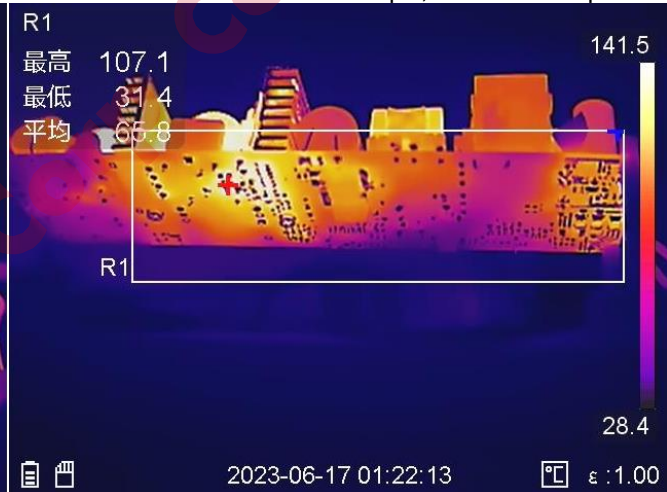
Ta: 30°C	90V/60Hz 24V10.5A				
	T(°C)	Trise(°C)		T(°C)	Trise(°C)
KP2591A	61.8	31.8	KP2806A	80.3	50.3
LLC MOSFET H	85.7	55.7	NTC	140.3	110.3
LLC MOSFET L	80.2	50.2	PFC MOSFET	112	82
SR MOSFET1	81.8	51.8	PFC Inductor	91.7	61.7
SR MOSFET2	81.9	51.9	PFC Doide	105.5	75.5
Rectifier	105.2	75.2	PFC Sampling resistor	103.3	73.3
SR IC	83.6	53.6	Transformer	85.2	55.2
LLC Bead	110.1	80.1	Resonant Inductor	97.6	67.6

Test Condition: 90Vac/60Hz Input, 24V/10.5A Output



Comments: TOP Side MAX=108.9°C (Transformer)

Test Condition: 90Vac/60Hz Input, 24V/10.5A Output



Comments: Bottom Side MAX=107.1°C

5 EMC Test Result

5.1 Conducted Emissions

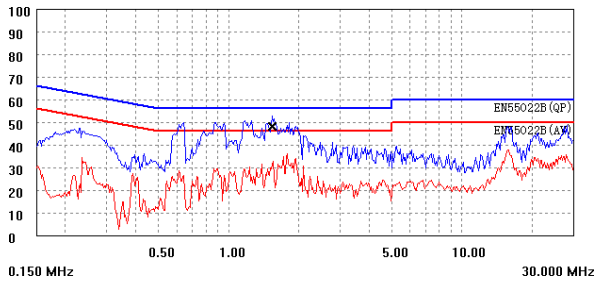
Standard:

standard	EN55022B
content	CE
requirement	6dB margin

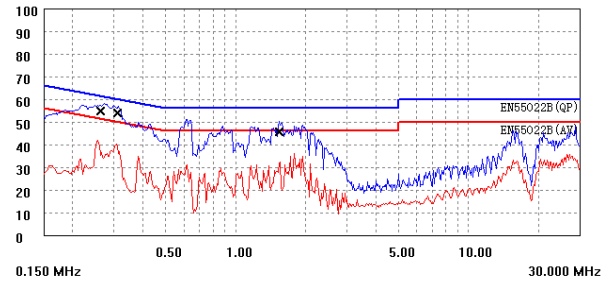
Result: Pass

Note: The resistor load is connected at the 1m Line end.

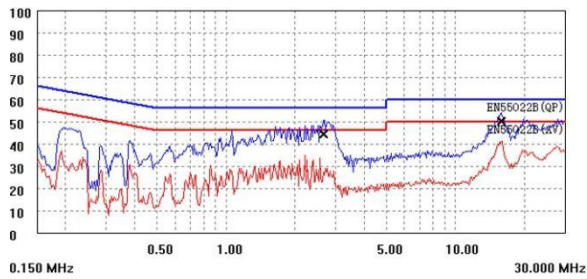
Test Condition: 220Vac/50Hz-L Input, 24V/10A Output



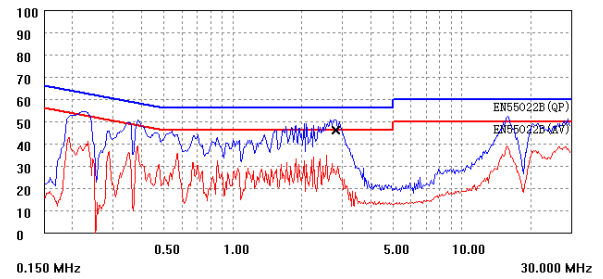
Test Condition: 220Vac/50Hz-N Input, 24V/10A Output



Test Condition: 110Vac/50Hz-L Input, 24V/10A Output



Test Condition: 110Vac/50Hz-N Input, 24V/10A Output



Kiwi Instruments Corp



Revision history

DATE	REV	DESCRIPTION
2023/10/19	1.0	First Release

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