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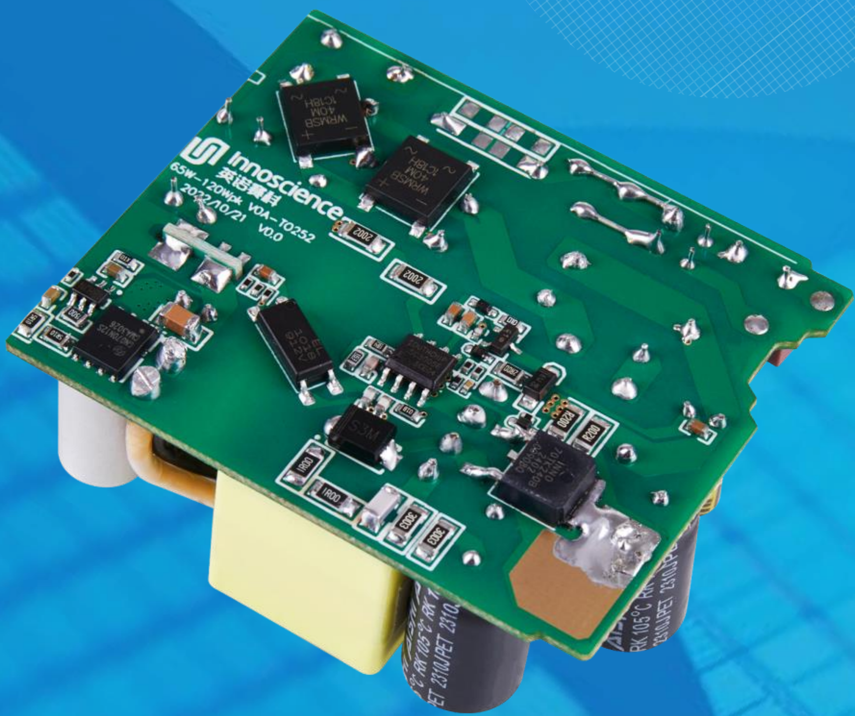
POWER THE FUTURE

INNDAD120B2

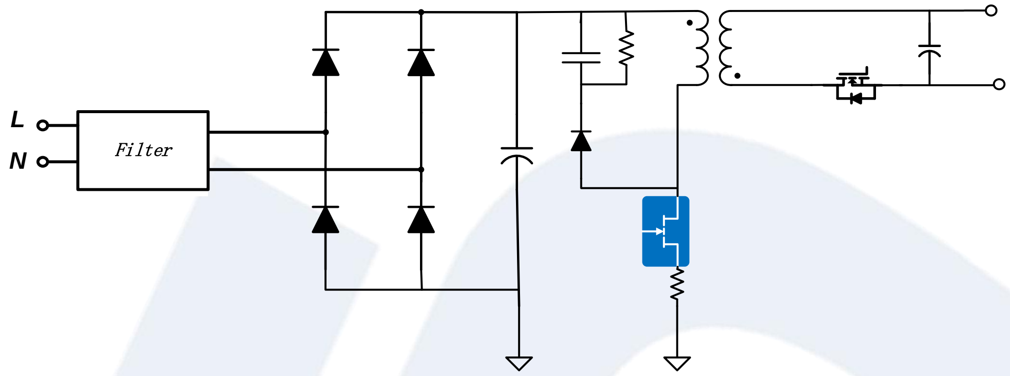
Demo Manual

65W（Peak 120W） QR Charger



65W（Peak 120W） QR Charger

The Introduction



INNDAD120B2 is mainly used in the field of chargers. The input voltage is 90Vac-264Vac, the output is 20V/6A, and the maximum output power of 120W can be maintained for 3 minutes when the input voltage is 230V. The peak efficiency is 94.14%, the full load efficiency is 94.1% @ 230Vac, and the power density is 29.4W/in^3. The primary side adopts QR control IC, and the secondary side adopts synchronous rectification.

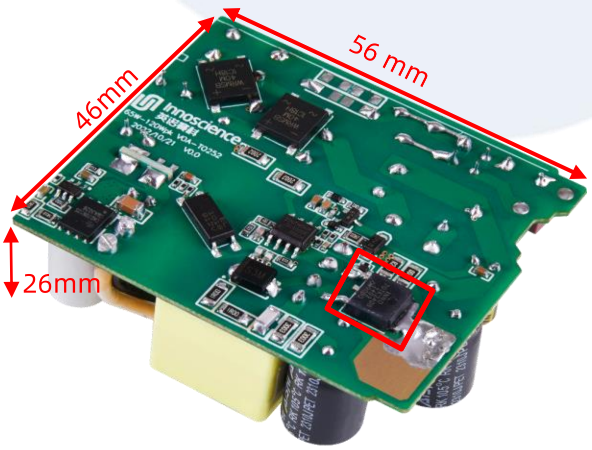
Highlighted Products

- INN700TK240B

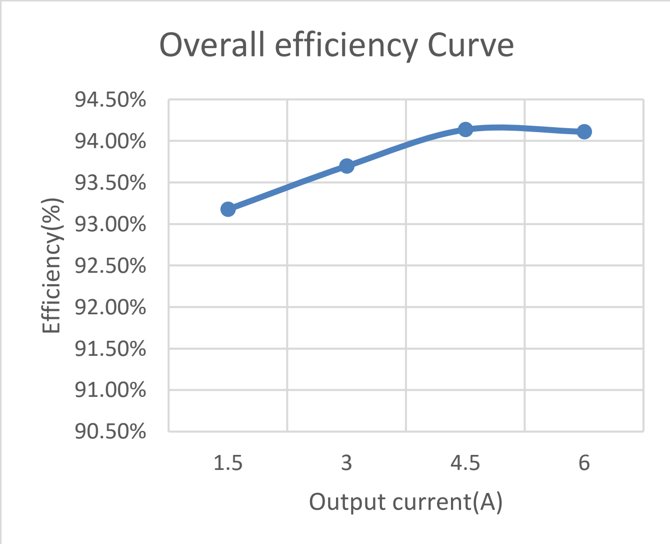
Target Applications

- Charger

Photo



Test



List of Content

1. Overview

1.1. Description

INNDAD120B2 is mainly used in the field of chargers. The input voltage is 90Vac-264Vac, the output is 20V/6A, and the maximum output power of 120W can be maintained for 3 minutes when the input voltage is 230V. The peak efficiency is 94.14%, the full load efficiency is 94.1% @ 230Vac, and the power density is 29.4W/in^3. The primary side adopts QR control IC, and the secondary side adopts synchronous rectification.

1.2. Features and Advantages

- Main features and Advantages
  - High efficiency：94.14%(@230Vac),
  - PCBA size：56*46*26mm
- Protection Function
  - Over current protection
  - Brown in/out with auto-recovery
  - Output over voltage protection
  - Output short protection
  - Over power protection (OPP)

1.3. Applications

- charger

2. Parameters

Table 1 Electrical Characteristic (Ta=25℃)

Symbol	Parameters	Test Conditions	Min	Nom	Max	Units
System Spec						
V_{in}	Input voltage		90	230	264	Vac
F_{ac}	Input frequency			50		Hz
$F_{sw,QR}$		V_{in}=230Vac, Full load		63		kHz
V_{out}	Output Voltage	0A≦I_o≦6A		20		V
P_{out}	Output power	@ 230Vac 3min			120	W
Demo Performance						
$P_{standby}$	Standby power	230Vac			0.5	W
V_{ripple}	Output voltage ripple	Full load			1000	mV
Eff_{pk}	Peak efficiency	V_{in}=230Vac			94.14	%
Eff	Full load efficiency	V_{in}=230Vac		94.1		%

3. Demo Solutions

3.1. Block Diagram

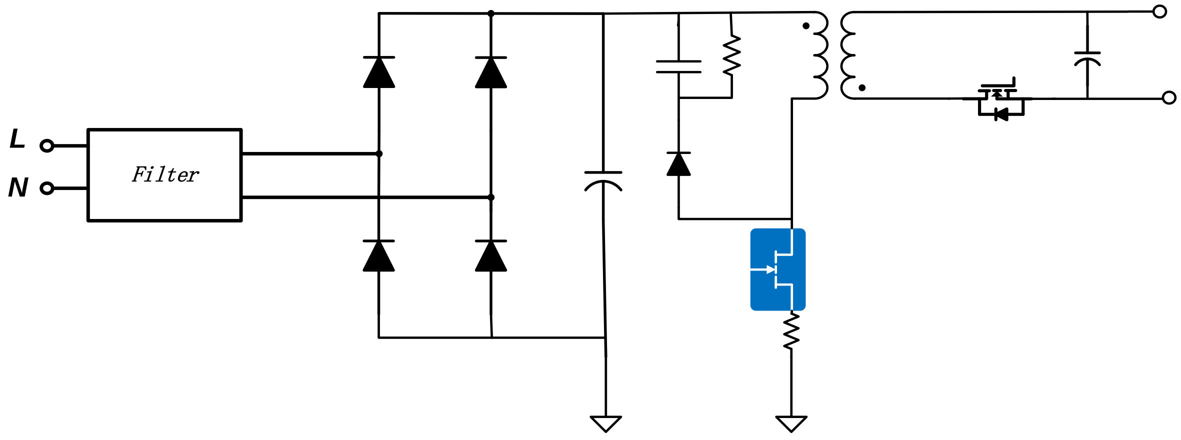


Figure 1 INNDAD120B2 System Block Diagram

3.2. INN700TK240B

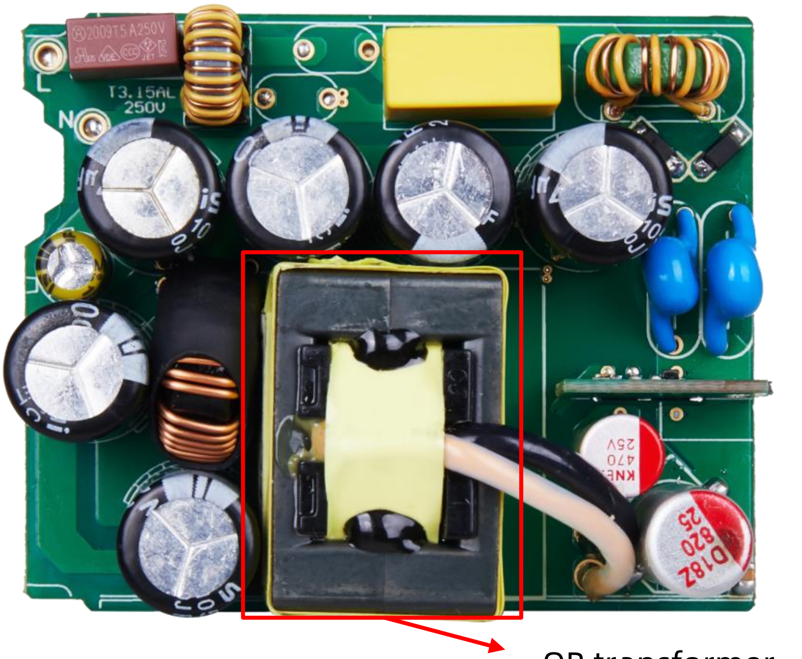
INN700TK240B is a 700V silicon-based gallium nitride enhanced power transistor packaged in a TO-252 package. Compared to Si-MOSFET devices with the same conduction resistance, INN700TK240B has advantages such as lower Q_g and C_{oss}, zero reverse recovery charges, etc., which can reduce the switching and driving losses of the system.

Table 2 INN700TK240B Key performance parameters(T_j=25℃)

Parameter	Value	Unit
$V_{ds,max}$	700	V
$R_{ds(on),max}$@V_{gs}=6V	240	mΩ
$Q_{g,typ}$@V_{ds}=400V	2	nC
$I_{d,pulse}$	18	A
Q_{oss}@V_{ds}=400V	21	nC
Q_{rr}@V_{ds}=400V	0	nC

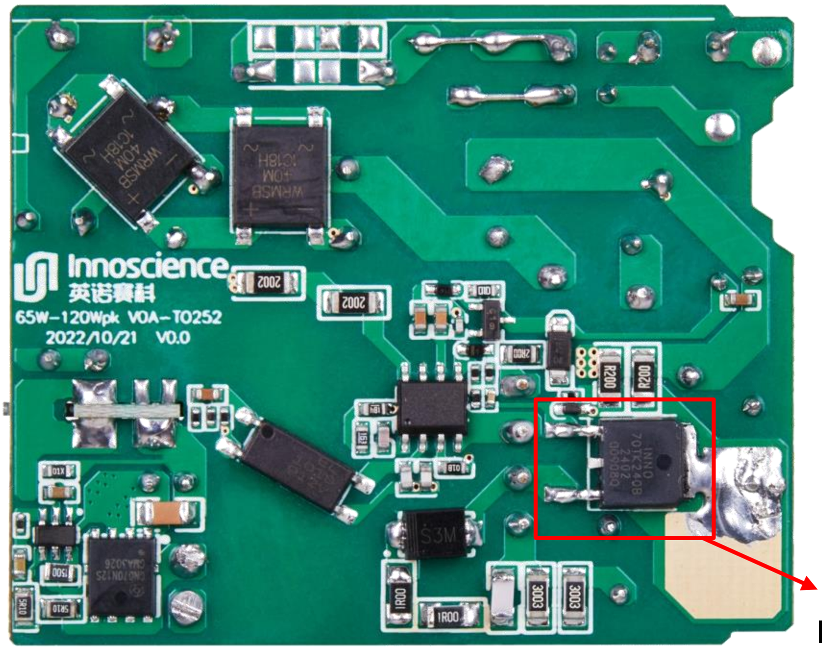
4. Hardware Implementation

4.1. Photos



QR transformer

Figure 2 Top view of INNDAD120B2



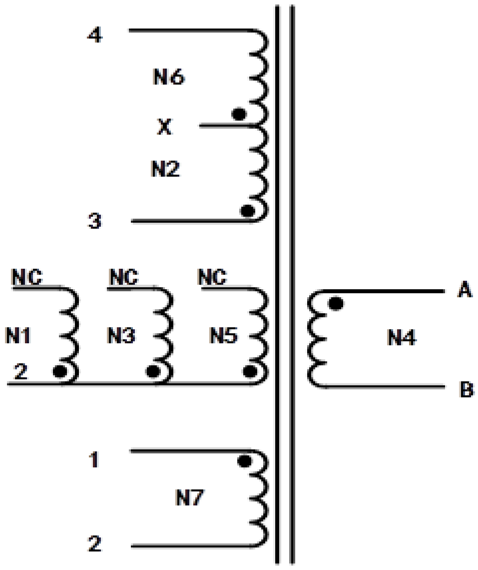
INN700TK240B

Figure 3 Bottom view of INNDAD120B2

4.2. Design Considerations

4.2.1. QR Transformer

Electrical diagram



Construction diagram

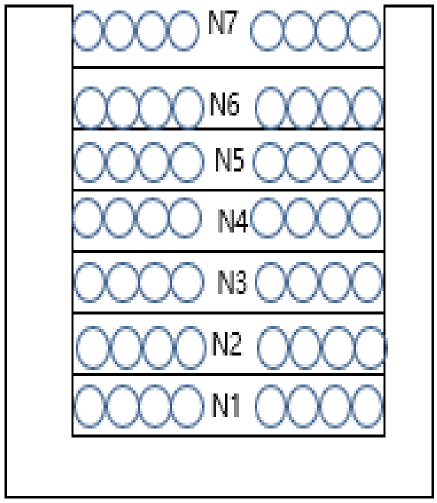


Table 3 Magnetic Core

No.	Name	Core Size/Material	Vendor
1	Core	ATQ25/16	
2	Bobbin	Bobbin: ATQ2516	
3	Material	PC95	A-CORE/TDG/

Table 4 Parameter

No.	Winding	Turns	position	wire diameter	Test Case
1	N1	16	2—NC	0.12*3 2UEW-H	/
2	N2	12	3—X	0.1*20 2UEW-H	/
3	N3	12	2—NC	0.12*3 2UEW-H	/
4	N4	4	A—B	0.1*150 TEX-E	/
5	N5	10	2—NC	0.12*3 2UEW-H	/
6	N6	12	X—4	0.1*20 2UEW-H	/
7	N7	4	1—2	0.12*2 2UEW-H	
Others	/	1	4- copper foil	6*0.05	
NP	/	/			L3-4 =200uH± 5%1V/100KHz
Short 1-2 A-B					L3-4_max=5uH 1V/100KHz

4.2.2. Layout

- **Single switch**

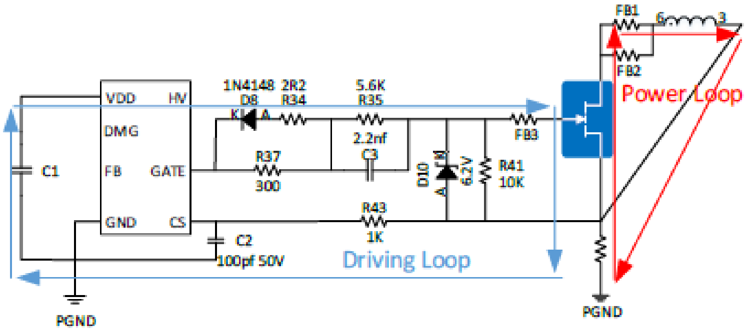


Figure 4 Single Switch Layout Recommendation (a)

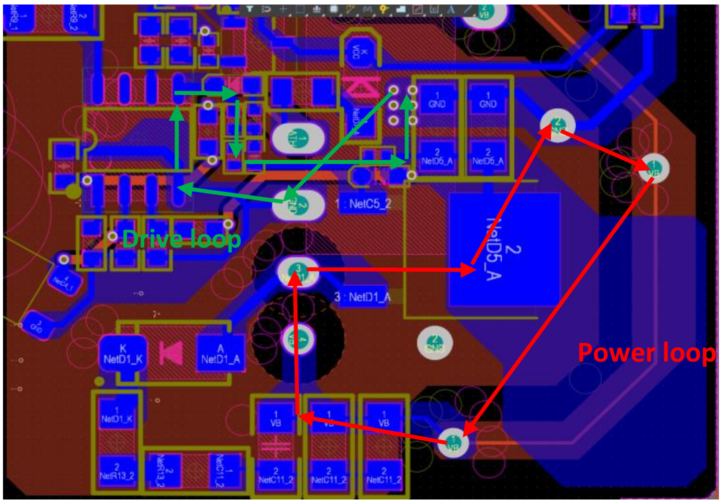


Figure 4 Single Switch Layout Recommendation (b)

As shown in Figure 4, set CBYPASS close to the IC and place the driver loop close to InnoGaN; CBUS, Transformer, InnoGaN circuits loop should be minimized.

5. Testing & Results

5.1. Test Setup

Input Power Meter: Tektronix PA1000

Output load: ITECH IT8712C

Oscilloscope: Tektronix MSO44 200MHz

Input AC Power Source: eec 6700

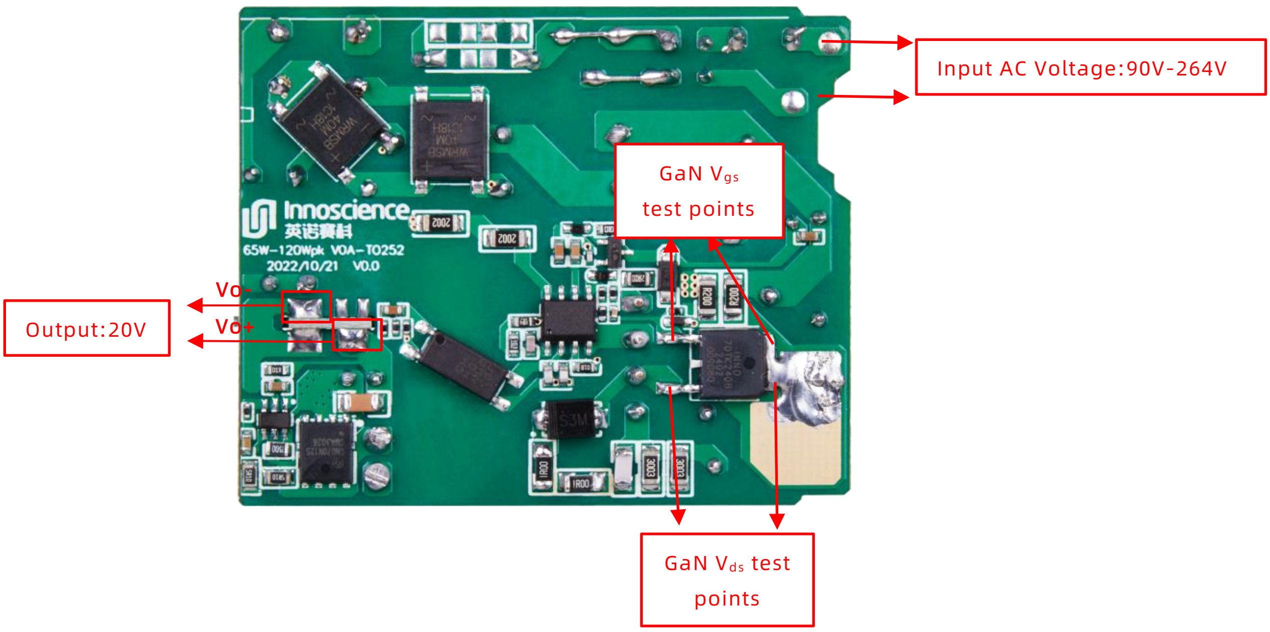


Figure 5 Test points

5.2. Test results

5.2.1. Efficiency

Table 5 Overall efficiency

V_{in} (V)	100%load η(%)	75%load η(%)	50%load η(%)	25%load η(%)	Average η(%)
90Vac	91	92.44	93.07	93.09	92.4
110Vac	92.42	93.44	93.56	93.38	93.2
230Vac	94.11	94.14	93.7	93.18	93.78
264Vac	93.59	93.63	93.27	92.45	93.24

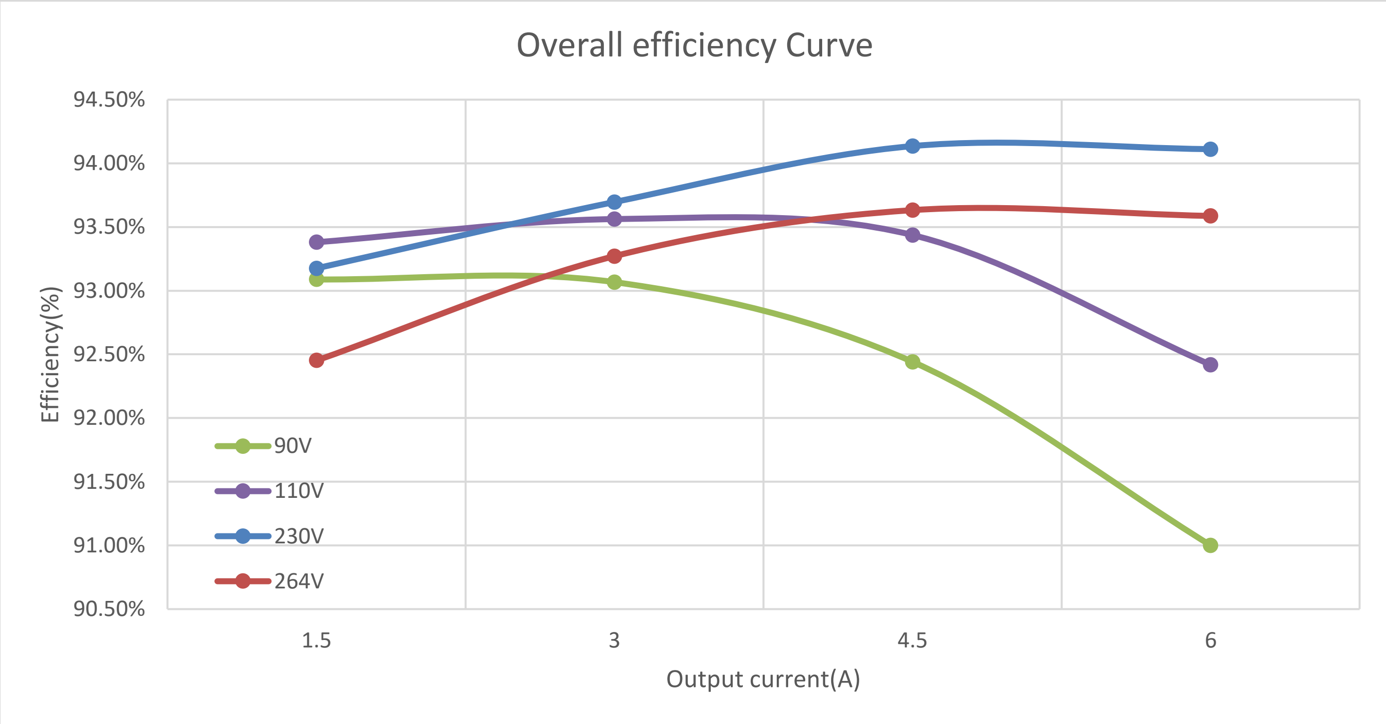
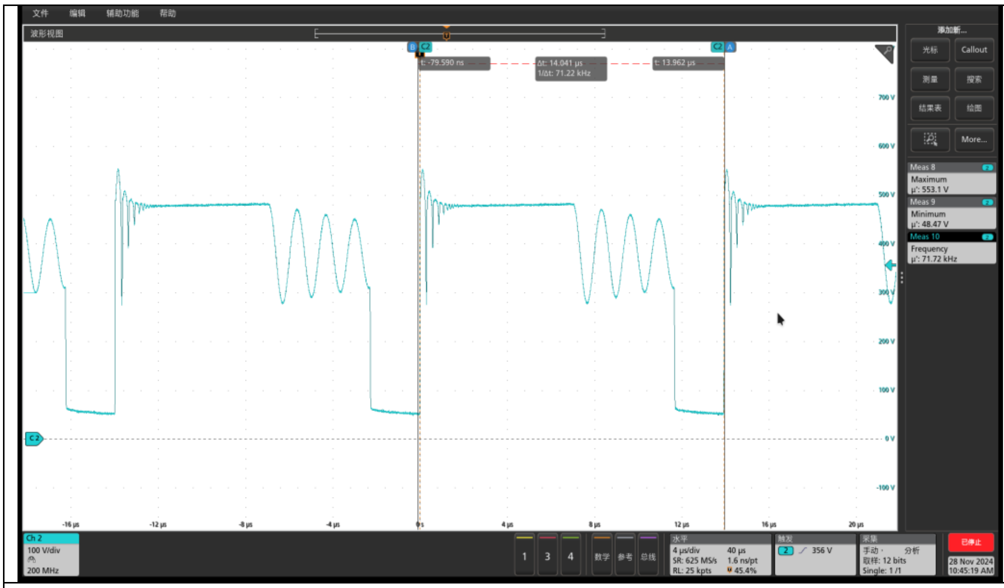
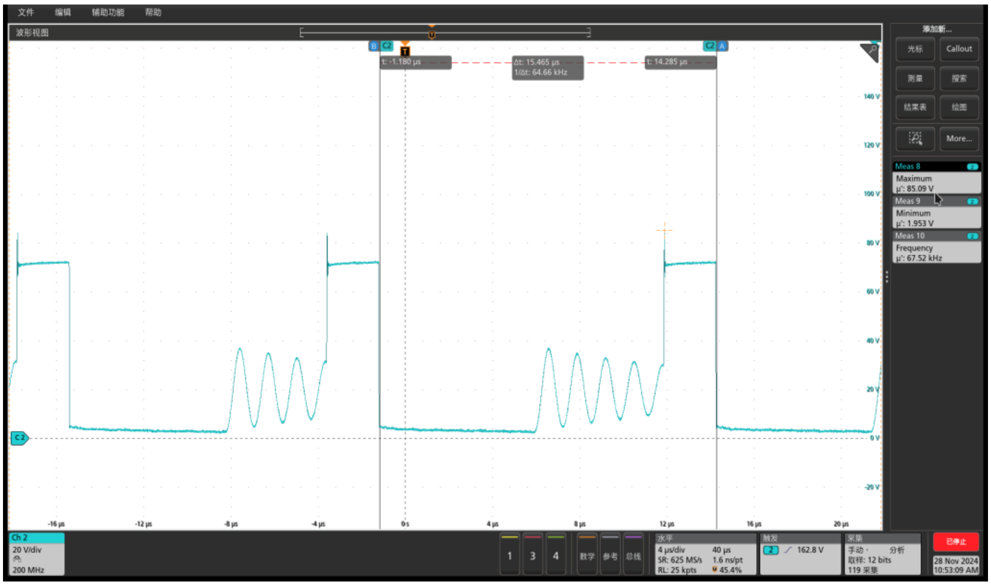
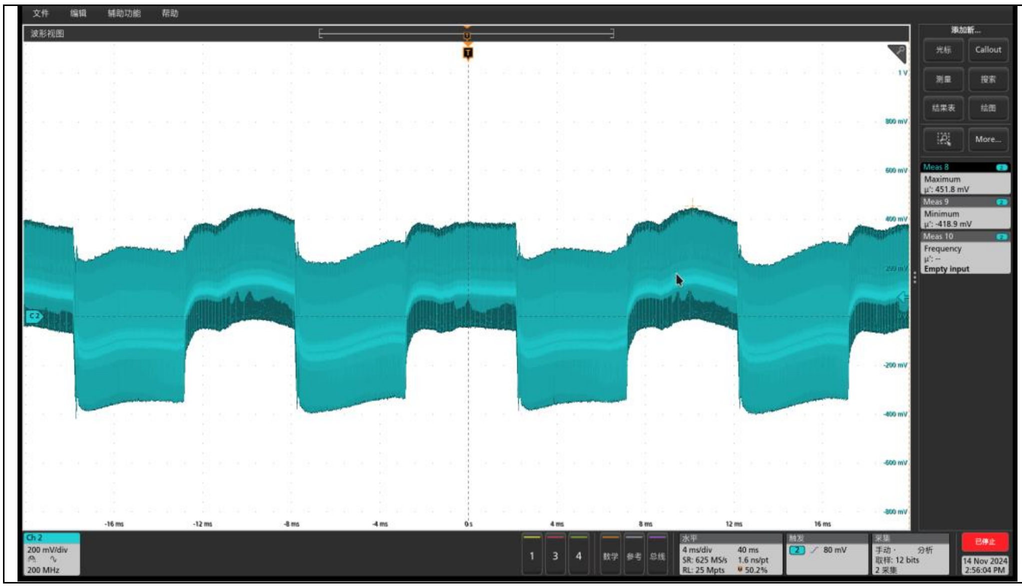


Figure 6 Overall efficiency curve

5.2.2. Switching Waveforms

	**Test conditions** V_{in}=264Vac/50Hz V_{out}=20V Full load **Result** V_{ds_max}=553.1V
	**Test conditions** V_{in}=264Vac/50Hz V_{out}=20V Light load to Full load **Result** $V_{ds\_max\_SR}$=85.09V

5.2.3. Dynamic Performance



Test conditions

V_{in}=90Vac/50Hz

V_{out}=20V

30%(2A) ~100%(6A) load

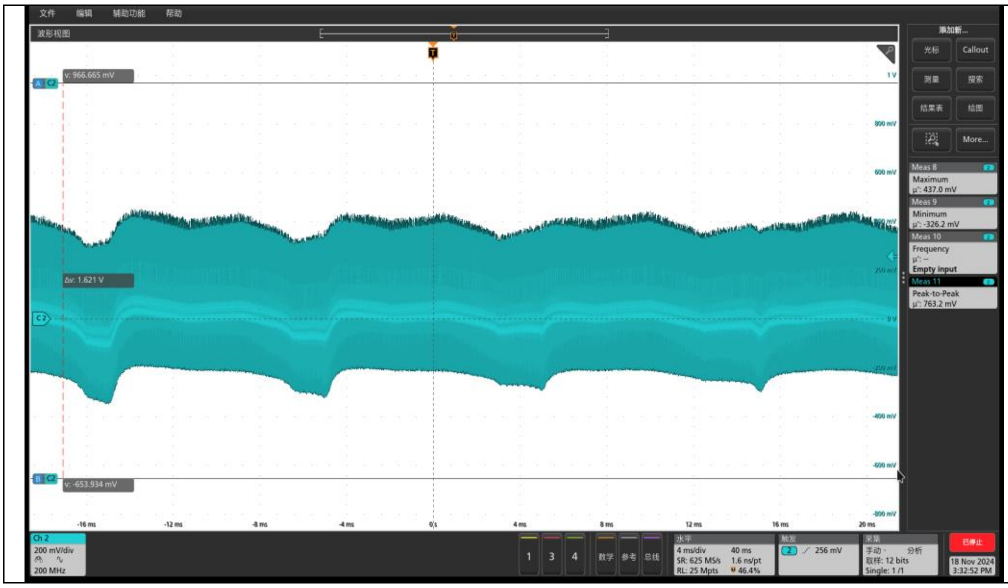
0.25A/us

T_1=T_2=5ms

Result

V_{pp}<5%（1V）

5.2.4. Output Ripple waveform



Test conditions

V_{in}=90Vac/50Hz

V_{out}=20V

Full load CV

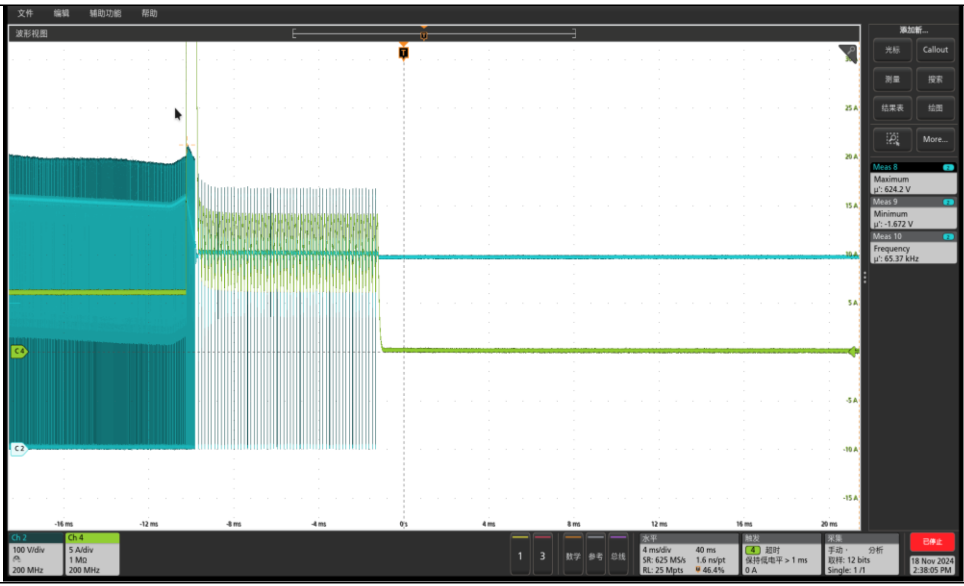
V_{out} +10μF+0.1μF cap

Result

V_{o_ripple}<5%

V_{o_ripple}=763.2 mV < 1V

5.2.5. Short



Test conditions

V_{in}=275Vac/50Hz

V_{out}=20V

Full load-short

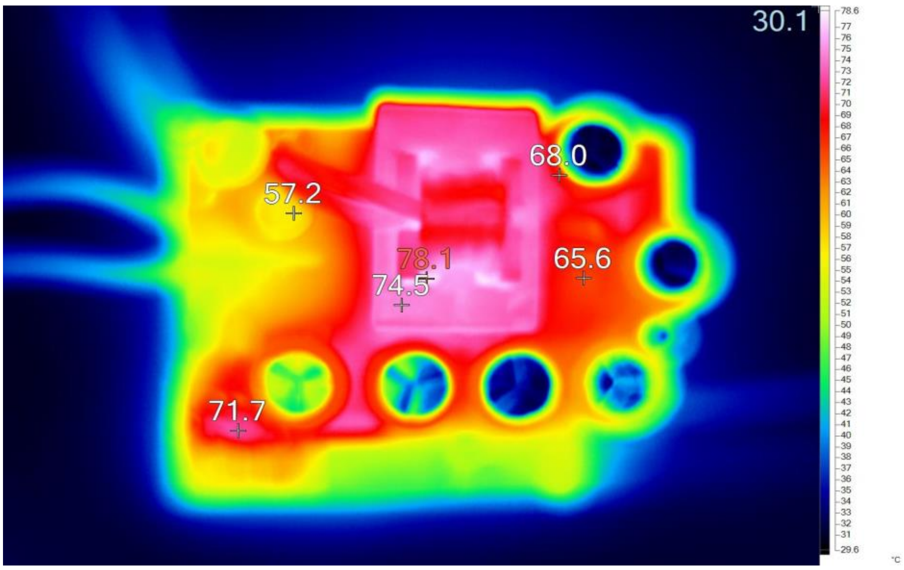
CH2: $V_{ds\_max\_QR}$

CH4:I_{out}

Result

$V_{ds\_max\_QR}$=624.2V

5.2.6. Thermal



TOP

Test conditions

V_{in}=90Vac/50Hz

V_{out}=20V

50% load 3A

Ambient temp 30.1℃

Run for 0.5h

Result

Transformer： Winding:78.1℃

Core： 74.5℃

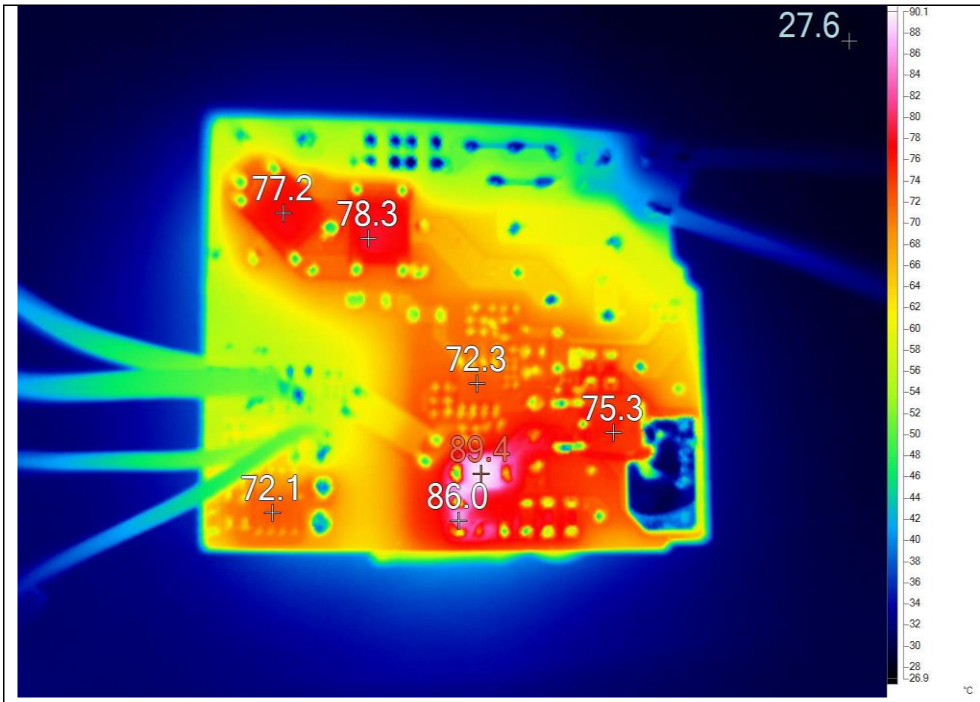
V_{bus} capacitor:68℃

V_{out} capacitor:57.2℃

Common mode choke:71.7℃

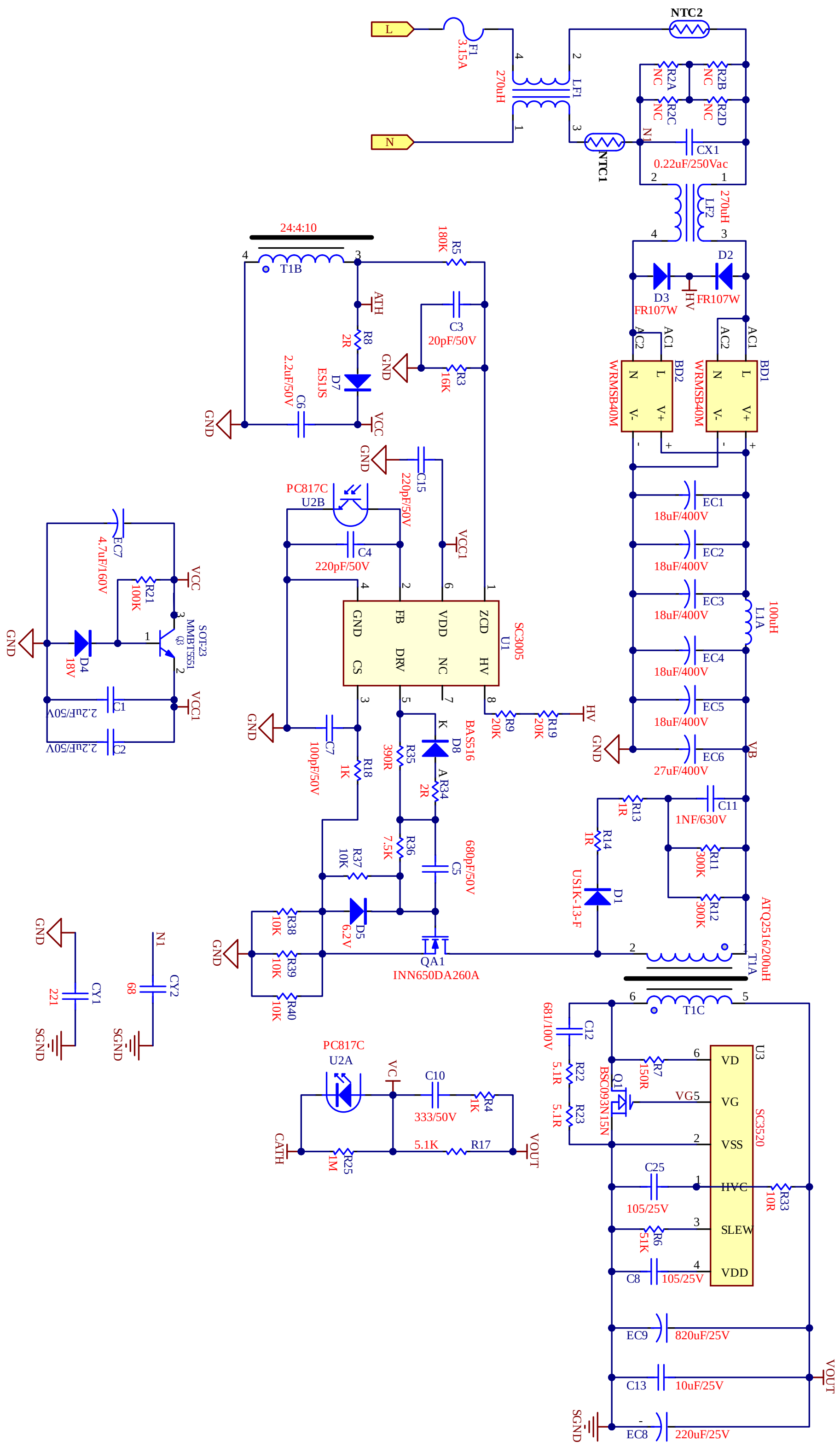
Differential modein

ductance :65.6℃

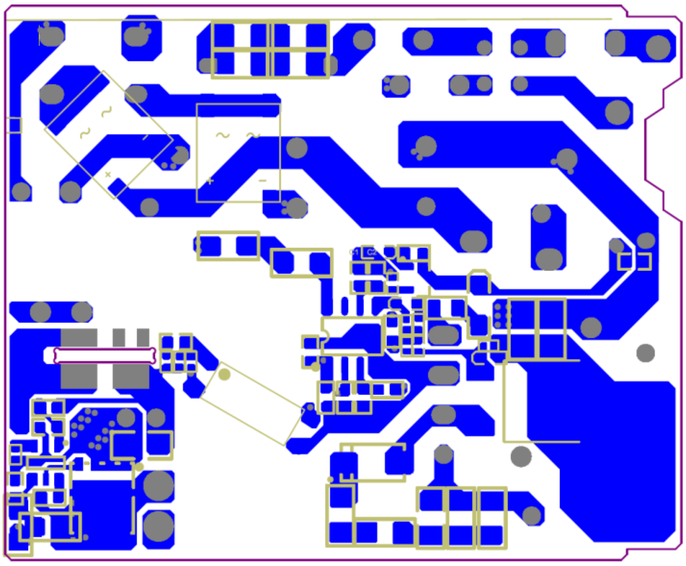
 Bottom	**Test conditions** V_{in}=90Vac/50Hz V_{out}=20V 50% load 3A Ambient temp 27.6℃ Run for 0.5h **Result** GaN: 75.3℃ Snubber Diode: 89.4℃ SR MOS:72.1℃ Bridge rectifiers:78.3℃

Appendix

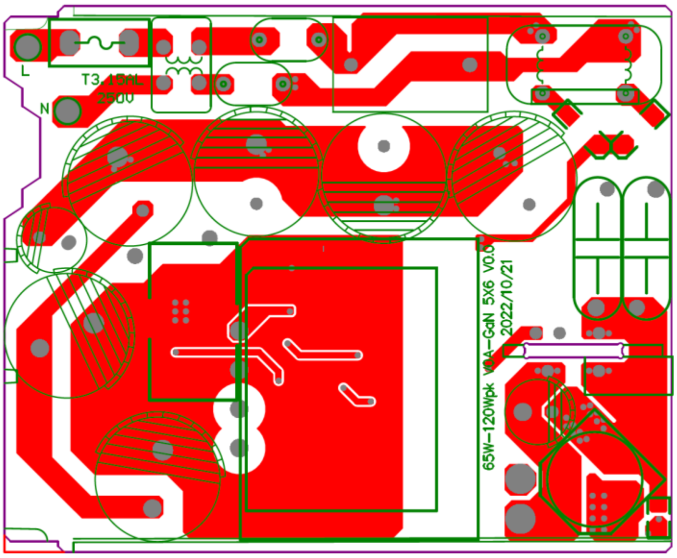
Appendix A. Schematics



Appendix B. PCB Layouts



(a) Top Layer Layout



(b) Bottom Layer Layout

Appendix C. BOM

Part Number	Manufacture	Description	Dsignator	Footprint	Quantity
WRMSB40M	/	Rectifier Bridge 1KV/4A	BD1, BD2	RMSB40	1
2.2uF/50V	YAGEO	Capacitor X7R 10%	C1, C2, C6	C0603R	1
20pF/50V	YAGEO	Capacitor X7R 10%	C3	C0603R	1
220pF/50V	YAGEO	Capacitor X7R 10%	C4	C0603R	2
680pF/50V	YAGEO	Capacitor X7R 10%	C5	C0402	1
100pF/50V	YAGEO	Capacitor X7R 10%	C7	C0603R	1
1uF/25V	YAGEO	Capacitor X7R 10%	C8, C25	C0603R	1
33nF/50V	YAGEO	Capacitor X7R, 10%	C10	C0603R	3
1nF/630V	YAGEO	Capacitor X7R, 10%	C11	C1206R	2
680pF/100V	YAGEO	Capacitor X7R, 10%	C12	C0805R	1
10uF/25V	YAGEO	Capacitor X7R, 10%	C13	C1206R	2
220pF/50V	YAGEO	Capacitor X7R, 10%	C15	C0402	2
0.15uF/250Vac	KNSCHA	X2 154K MPX/MKP 275VAC305VAC	CX1	X-12.7*8*14	1
220pF	ZNRC	Capacitor P=10mm,220PF,Y1	CY1	CY-12X4-P10	1
68pF	ZNRC	Capacitor P=10mm,68PF,Y1	CY2	CY-12X4-P10	2
US1K-13-F	/	fast recovery Diode 800V 1A	D1	SMA	2
FR107W	/	fast recovery Diode 1000V 1A	D2, D3	SOD-123	1
18V	/	18V Zener diode	D4	SOD-523	1
6.2V	/	6.2V Zener diode	D5	SOD-523	3
ES1JS	/	fast recovery Diode 600V 0.5A	D7	SOD-123	1
BAS516	/	Switching diode 100V 0.25A	D8	SOD-523	3

27uF/400V	AISHI	Aluminum electrolytic capacitor 27uF 400V	EC1, EC2, EC3, EC4, EC5, EC6	EC10-P5.0MM	1
10uF/160V	YMIN	Aluminum electrolytic capacitor 10uF 100V	EC7	EC5-P2.5MM	1
220uF/25V	/	Aluminum electrolytic capacitor 220uF 25V	EC8	CT 8*7-V	1
820uF/25V	/	Aluminum electrolytic capacitor 820uF 25V	EC9	EC5-P2.5MM	1
3.15A	/	FUSE P=5mm	F1	FUSE4X8	1
100uH	/	Differential mode choke	L1	LMR135	1
270uH	/	common mode choke	LF1	LF-L6*3*3	1
270uH	/	common mode choke	LF2	LF-SQ1012	1
JP		NTC	NTC1, NTC2	NTC-7-PIN5-K	2
HGN070N12S	HUNTECK	SR NMOSFET	Q1	PDFN-8-5060	1
MMBT5551	/	NPN General Purpose Amplifier Vceo=160V Ic=600mA	Q3	SOT23-3L	1
INNO700TK240B	INNOGaN	GaN 700V 240mR	QA1	PDFN5x6-MOS	1
NC	/	/	R2A, R2B, R2C, R2D	R1206	4
16K	YAGEO	Resistor 1%	R3	R0603	1
1K	YAGEO	Resistor 1%	R4	R0402	1
180K	YAGEO	Resistor 1%	R5	R0603	1

51K	YAGEO	Resistor 1%	R6	R0402	1
150R	YAGEO	Resistor 1%	R7	R0603	1
2R	YAGEO	Resistor 1%	R8	R0805	1
20K	YAGEO	Resistor 1%	R9, R19	R1206	1
300K	YAGEO	Resistor 1%	R11, R12	R1206	1
1R	YAGEO	Resistor 1%	R13, R14	R1206	2
5.1K	YAGEO	Resistor 1%	R17	R0402	1
1K	YAGEO	Resistor 1%	R18	R0603	2
100K	YAGEO	Resistor 1%	R21	R0603	2
5.1R	YAGEO	Resistor 1%	R22, R23	R1206	4
1M	YAGEO	Resistor 1%	R25	R0402	1
10R	YAGEO	Resistor 1%	R33	R0603	5
2R	YAGEO	Resistor 1%	R34	R0402	4
390R	YAGEO	Resistor 1%	R35	R0402	1
7.5K	YAGEO	Resistor 1%	R36	R0402	3
10K	YAGEO	Resistor 1%	R37	R0402	2
0.2R	YAGEO	Resistor 1%	R39, R40	R1206	1
ATQ2516/200uH	/	Transformer	T1	ATQ-2502 H	1
SC3005	SouthChip	QR IC	U1	SOP8_L	2
EL1018	Everlight	Optocoupler	U2	817-SMD-02	2
MP6908	MPS	SR IC	U3	SOT23-6L	2

Revision History

Date	Versions	Description	Check
2025. 1.20	1.0	First edition	AE Team