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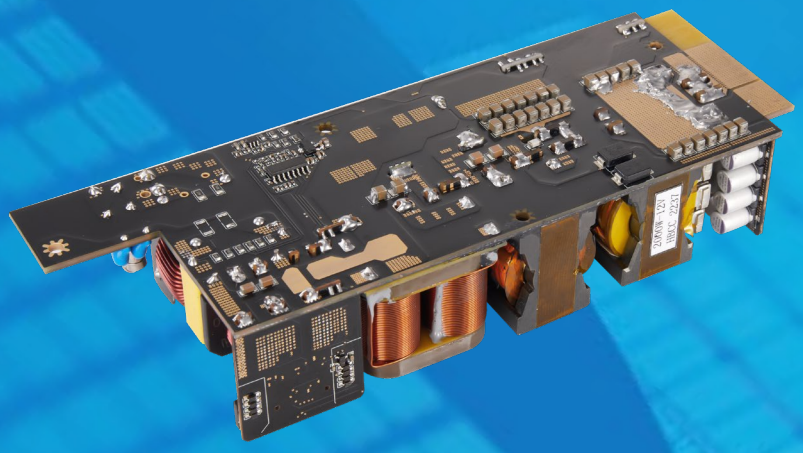
POWER THE FUTURE

INNDAD2K0A1

Demo Manual

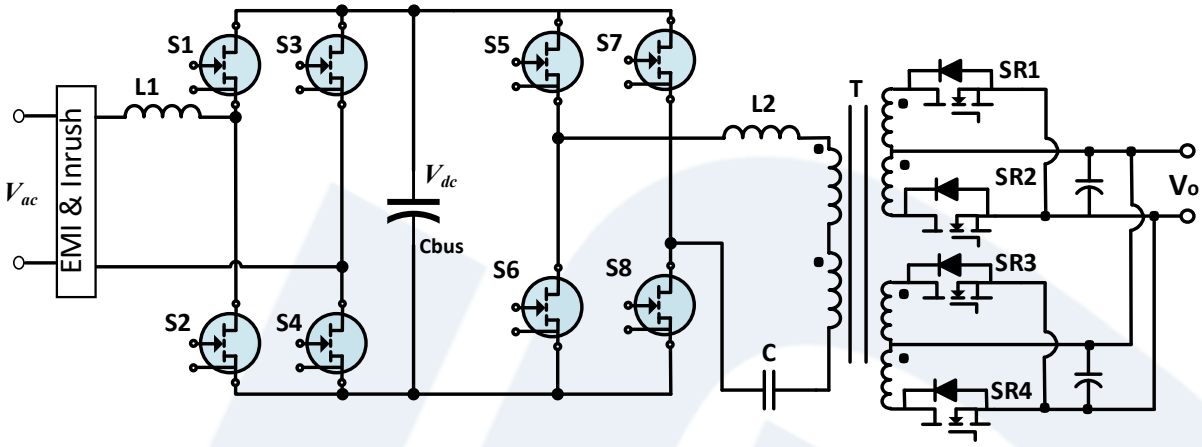
2KW 12V PSU



2KW 12V PSU

High Density Totem Pole PFC+LLC

Input voltage 180Vac-264Vac, output 12V/160A, maximum output power 2000W, peak efficiency up to 96.6%@50% load.



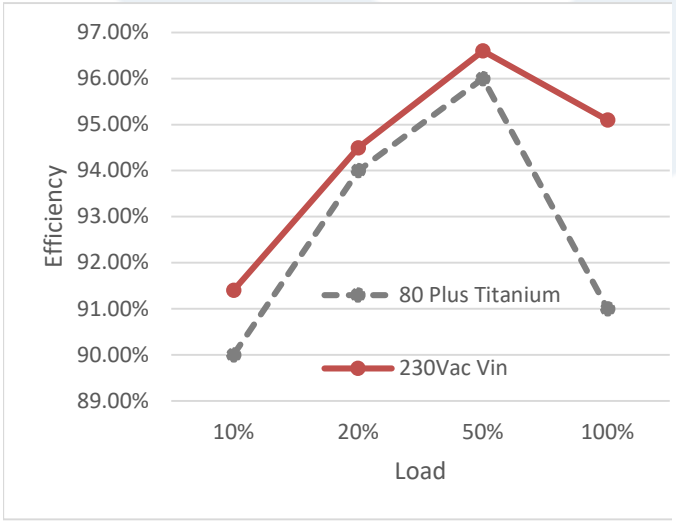
Highlighted Products

- S1/S2: INN650TA080AH
- S3/S4: INN650TA030AH
- S5~S8: INN650D080BS

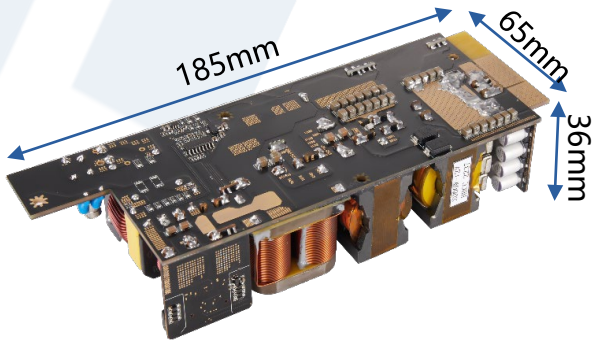
Target Applications

- Datacenter
- Telecom
- LED Lighting

Test Results



Photo



List of Content

1. Overview

1.1. Description

The INNDAD2K0A1 comprises a front-end AC-DC bridgeless totem pole PFC followed by a back-end DC-DC isolated full bridge LLC converter. The measured peak efficiency of the complete PSU at 230 Vac is 96.6%, exclude fan. The PCBA size are 185mm x 65mm x 36mm, which yields a power density in the range of 76 W/inch^3.

1.2. Features

■ Main features and Advantages

> High efficiency: 96.6% @ 230Vac Vin, meet 80 plus titanium standard

> High power density: 76W/inch^3

> 1U standard size: 185mm x 65mm x 36mm(PCBA)

■ Protection Function

> Input over voltage protection

> Input over current protection

> Output short-circuit protection

1.3. Applications

■ Datacenter

■ Telecom

■ LED Lighting

2. Parameters

Table 1 Electrical characteristics (Ta=25℃)

Symbol	Parameter	Conditions	Min	Nom	Max	Units
System Specifications						
VIN	Input voltage		180	230	264	Vac
fac	Input frequency		47	50	53	Hz
fsw,PFC	PFC Switching frequency			65		KHz
fsw,LLC	LLC Switching frequency			120		KHz
Vout	Output voltage			12		V
POUT	Output power				2000	W
Demo Performance						
Eff,pk	Peak efficiency	Measured @Vin=230Vac, Output=12V/80A		96.6		%
Eff	Full load efficiency	Measured @Vin=230Vac, Output=12V/160A		95.1		%

3. Demo Solutions

3.1. Topology

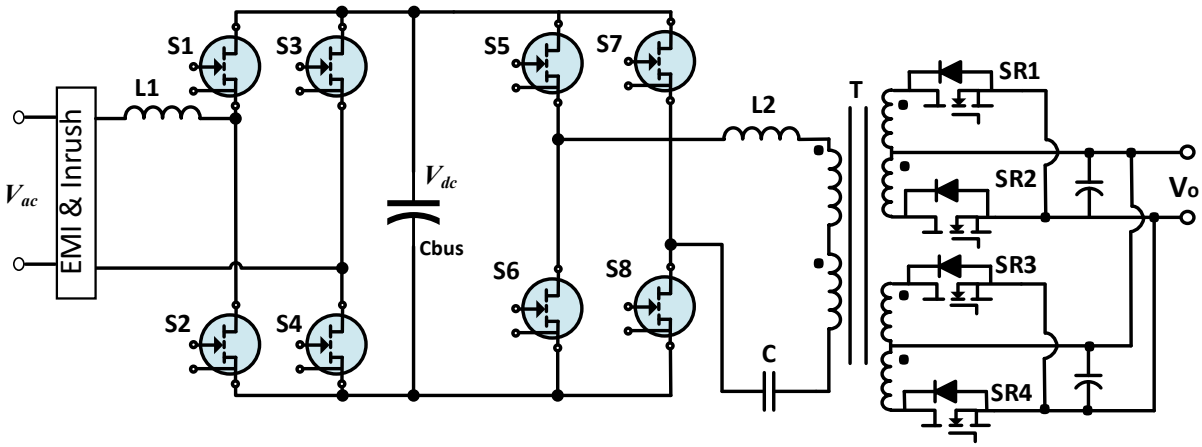


Figure 1 2KW 12V PSU topology

The 2KW 12V PSU comprises a front-end AC-DC bridgeless totem pole PFC followed by a back-end DC-DC isolated full bridge LLC converter.

3.2. Value of InnoGaN

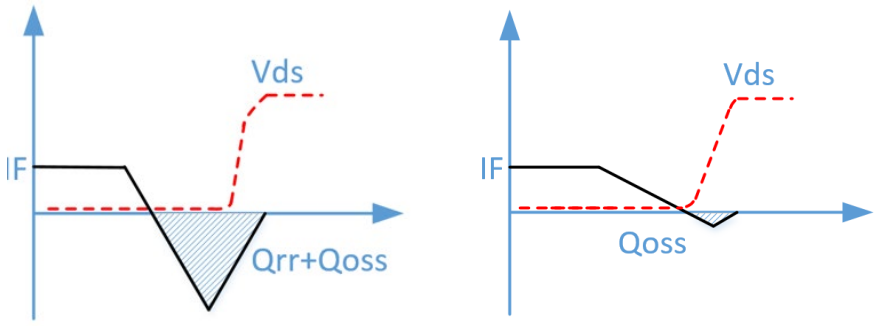
InnoGaN offer improved performance over silicon MOSFET due to several key characteristics:

■ Gate Charge Qg

Comparing InnoGaN to silicon MOSFET with the same Ron, GaN has about seven times lower Qg than silicon MOSFET. Lower Qg means faster turn on and turn off speed, resulting in lower switching loss and driver loss.

■ Reverse Recovery Charge Qrr

Si MOSFET have intrinsic body diode structures with a large reverse recovery charge. The poor reverse recovery performance in hard-switching half-bridge configuration makes it difficult for Si MOSFET to work in CCM totem pole PFC. InnoGaN have no Qrr because there are no minority carriers in the channel to recover, which makes it an ideal fit for CCM totem pole PFC.



(a) Si MOSFET (b) InnoGaN

Figure 2 turn off transition

■ Time Related Coss Coss(tr)

Coss(tr) is used to represent the equivalent fixed capacitance value under the same charging time condition when Vds rises from 0 to 400V. As shown in Figure 3, as Vds is increased from 0 to about 35 V, Coss of Si MOSFET changes rapidly at a steep slope. Comparing InnoGaN to silicon MOSFET with the same Ron, Coss curve of InnoGaN is more linear. Coss(tr) of InnoGaN is seven times lower than that of Si MOS, This is a significant benefit in LLC stage, shortening the required dead-time and enabling higher-frequency operation without additional loss.

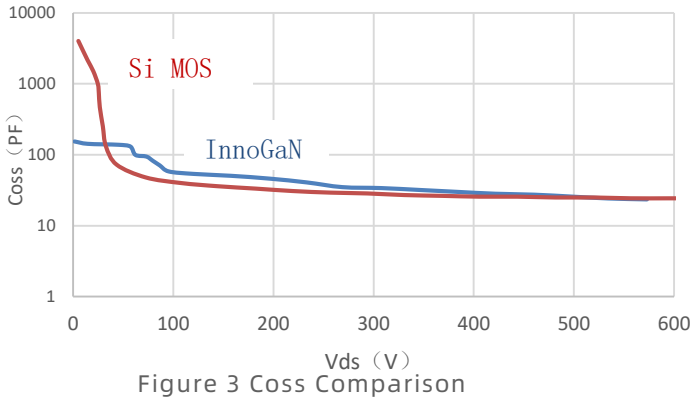


Figure 3 Coss Comparison

■ Ron temperature coefficient

The temperature coefficient of Ron for InnoGaN is lower than for Si MOSFET. Over the range from 25°C to 150°C, the typical temperature coefficient of Ron for InnoGaN is 2.1, compared to 2.4 for Si MOSFET. This is a benefit in power system, reducing conduction loss and achieving higher efficiency.

3.3. Highlighted Products

3.3.1. InnoGaN Device INN650TA080AH/INN650TA030AH

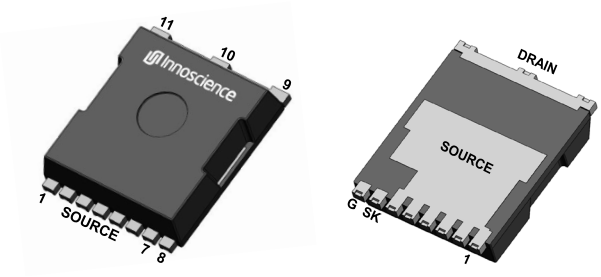


Figure 4 InnoGaN device INN650TA080AH/INN650TA030AH

InnoGaN Device INN650TA080AH/INN650TA030AH is in TOLL(TO-leadless) package and adopts Kelvin source design, drain-source voltage 650V, and the maximum conduction resistance of 80mΩ/30mΩ. These two products meet the requirements of more compact, lower loss, higher power design applications, help high-performance power supplies improve energy efficiency and power density, and simplify PCB design.

3.3.2. InnoGaN Device INN650D080BS

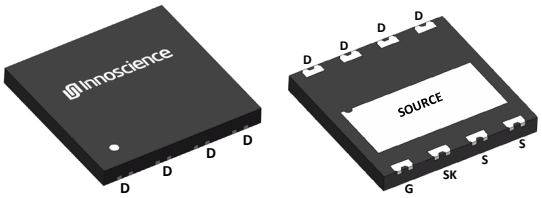


Figure 5 InnoGaN device INN650D080BS

InnoGaN Device INN650D080BS is in DFN8*8 package and adopts Kelvin source design, drain-source voltage 650V, and the maximum conduction resistance of 80mΩ.

4. Hardware Implementation

4.1. Hardware Introduction

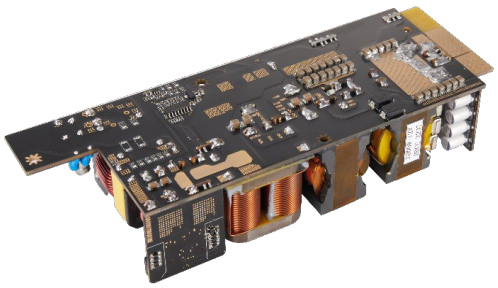


Figure 6 2KW 12V PSU

The 2KW 12V PSU demo board is shown as Figure 6. The reference design consists of following sub-assemblies:

1) **Main Board:** This board consists of an EMI filter, a start-up circuit and PFC&LLC control circuit.
2) **PFC Fast Bridge:** This board mainly consists of 2 INN650TA080AH switches, isolated half bridge driver NSI6602 and isolated power supply.
3) **PFC Slow Bridge:** This board mainly consists of 2 INN650TA030AH switches, isolated half bridge driver NSI6602 and isolated power supply.
4) **LLC1:** This board mainly consists of 4 INN650D080BS primary full bridge switches, isolated half bridge driver NSI6602, transformer and secondary SR switches.
5) **LLC2:** This board mainly consists of transformer2 and secondary SR switches.
6) **Auxiliary Power Supply:** This board is used to provide power supply for control circuit and driver power supply.

4.2. Design Considerations

4.2.1. InnoGaN Driver Circuit Design

In hard switching half bridge configuration, isolated driver power supply and negative Vgs off is recommended to ensure reliable operation. In 2KW 12V PSU PFC stage, +6V/-2V drive voltage is applied. Isolated driver power supply and negative voltage circuit design is shown as Figure 7. Isolated half bridge driver NSI6602 from NOVOSENSE is applied to driver fast bridge of totem pole PFC. Driver circuit is shown as Figure 8.

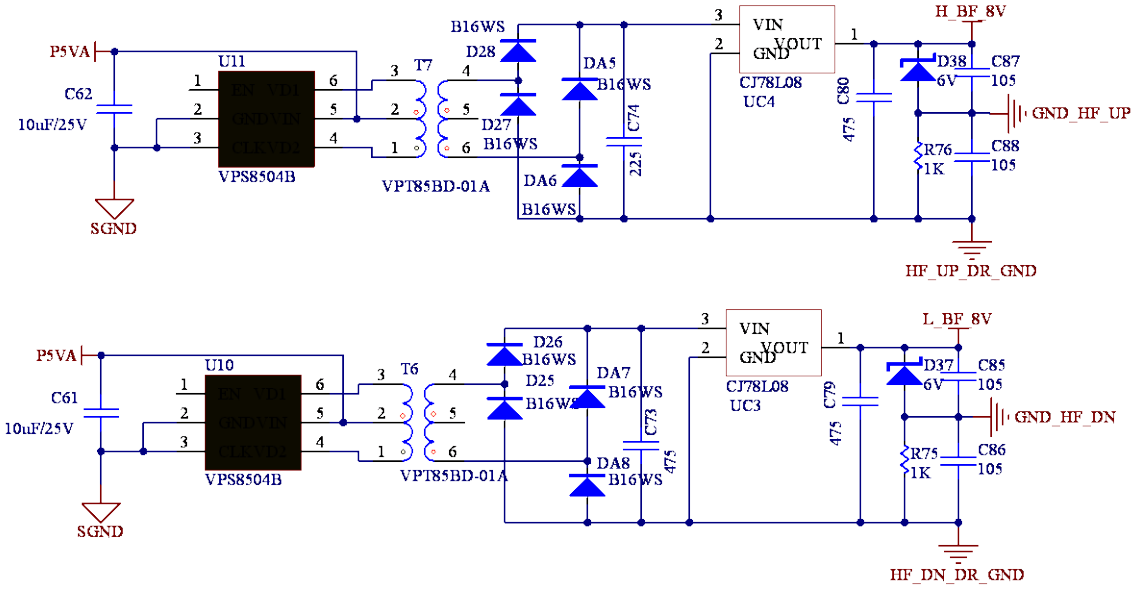


Figure 7 Isolated driver power supply and negative Vgs off circuit

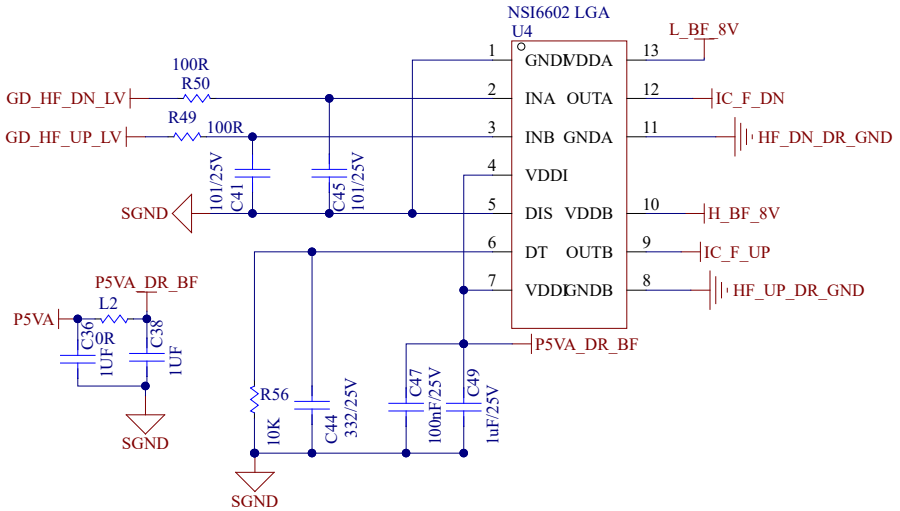
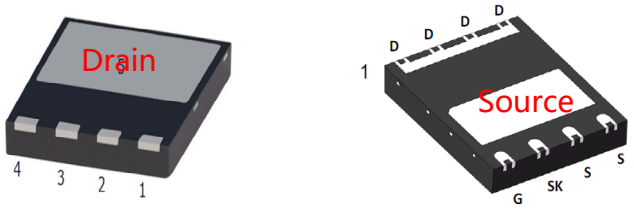


Figure 8 Half bridge drive circuit

4.2.2. InnoGaN Thermal Design

For DFN8*8 or TOLL package, InnoGaN is quite different from Si MOS. The main difference is thermal pad as shown in Figure 9. Thermal pad of Si MOS is Drain, while that of InnoGaN is Source. Attention is needed for this difference when layout. For InnoGaN in TOLL or DFN8*8 package, bottom side cooling is recommended and put as many vias as possible under thermal pad. Thermal dissipation path is shown as Figure 10.



(a) Si MOS (b) InnoGaN

Figure 9 Different thermal pad definition of Si MOS and InnoGaN

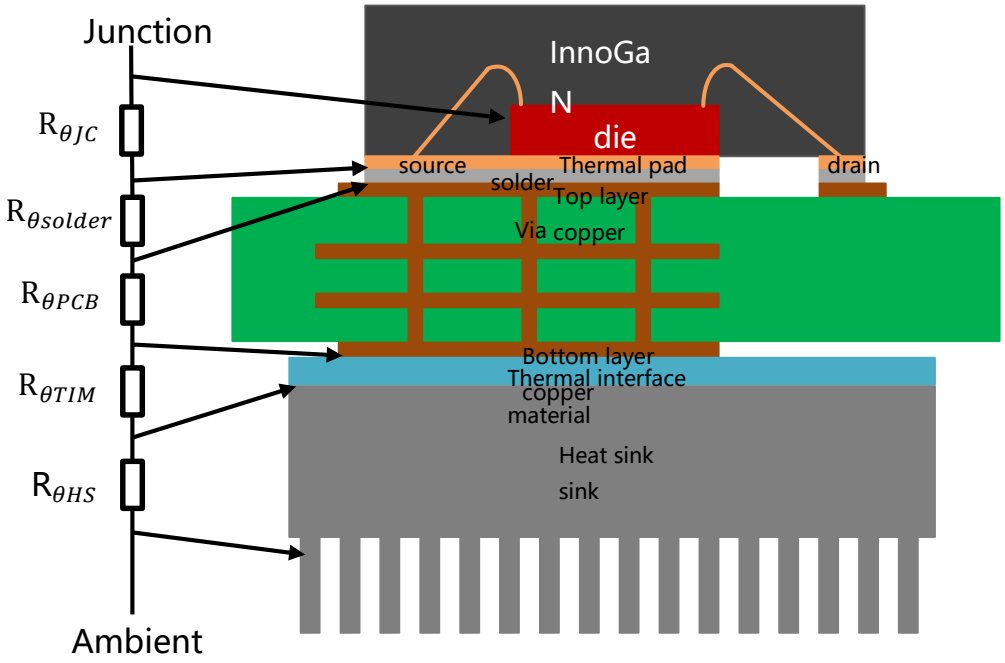


Figure 10 Thermal dissipation path

5. Testing & Results

5.1. Test Setup

INNDAD2K0A1 is designed mainly for evaluation of InnoGaN performance on PSU and provide reference solution for power stage. Demo board adopts analog control solution. To achieve better efficiency performance in light load(≤20%), it is recommended to connect the pad of RN5 and RN6 as shown in Figure 11. When working in other conditions, remember to remove the connection between RN5 and RN6.

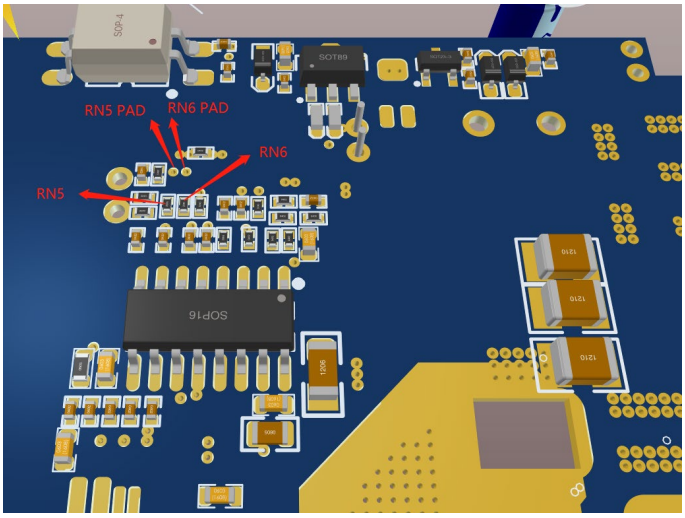


Figure 11 Positions of RN5 and RN6

5.2. Test Results

5.2.1. Efficiency curve

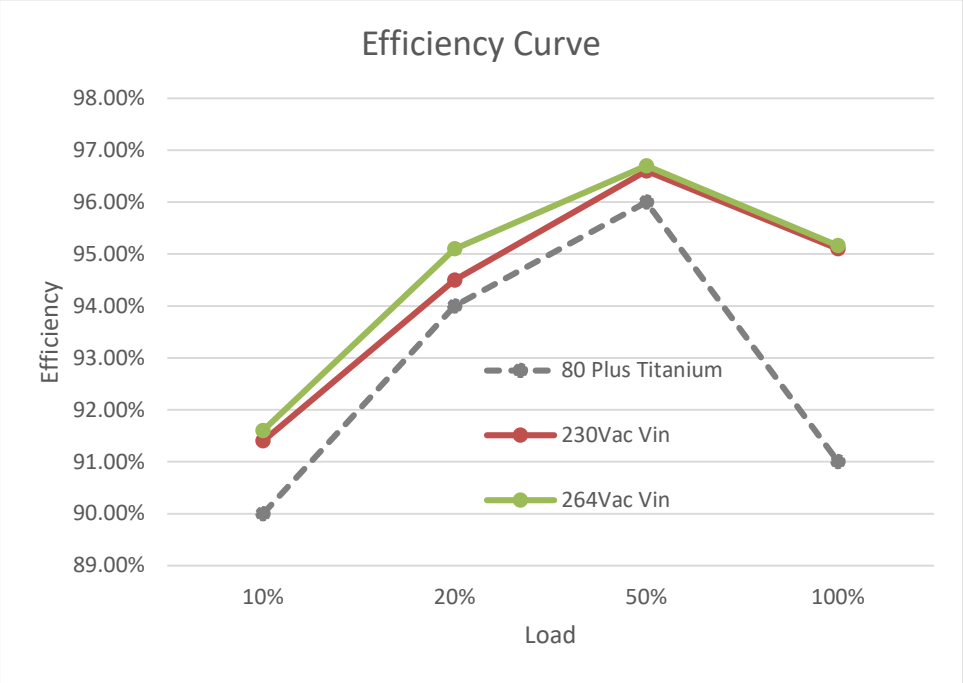


Figure 12 Efficiency Curve

5.2.2. Switching Waveforms

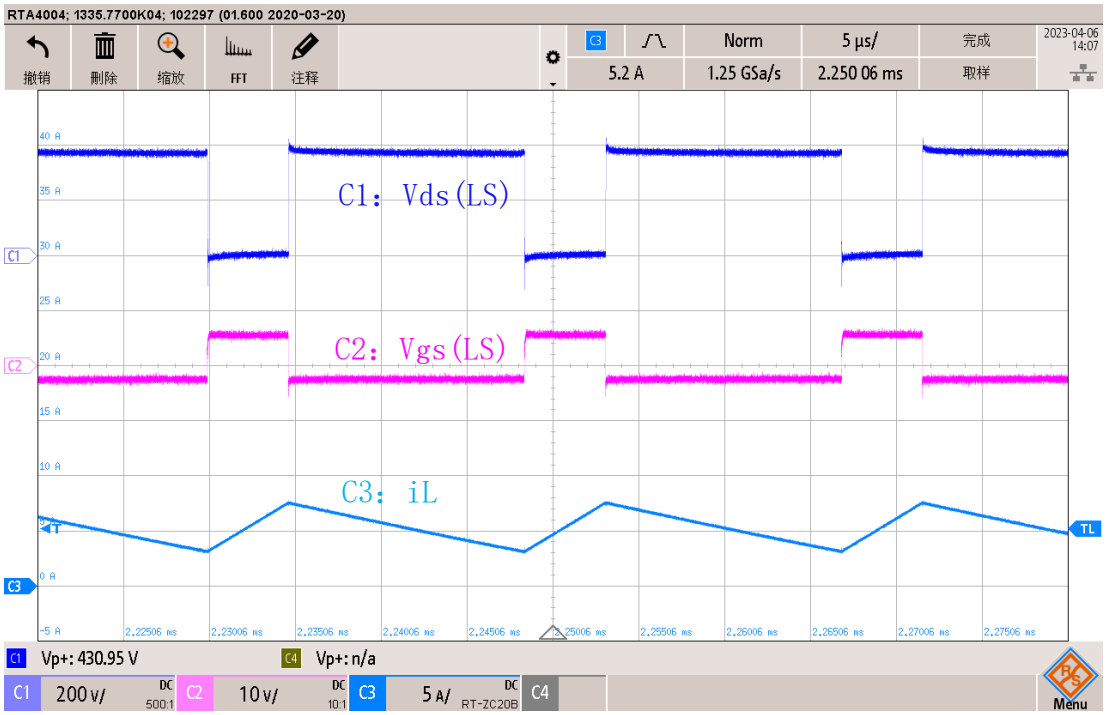


Figure 13 Waveforms of PFC

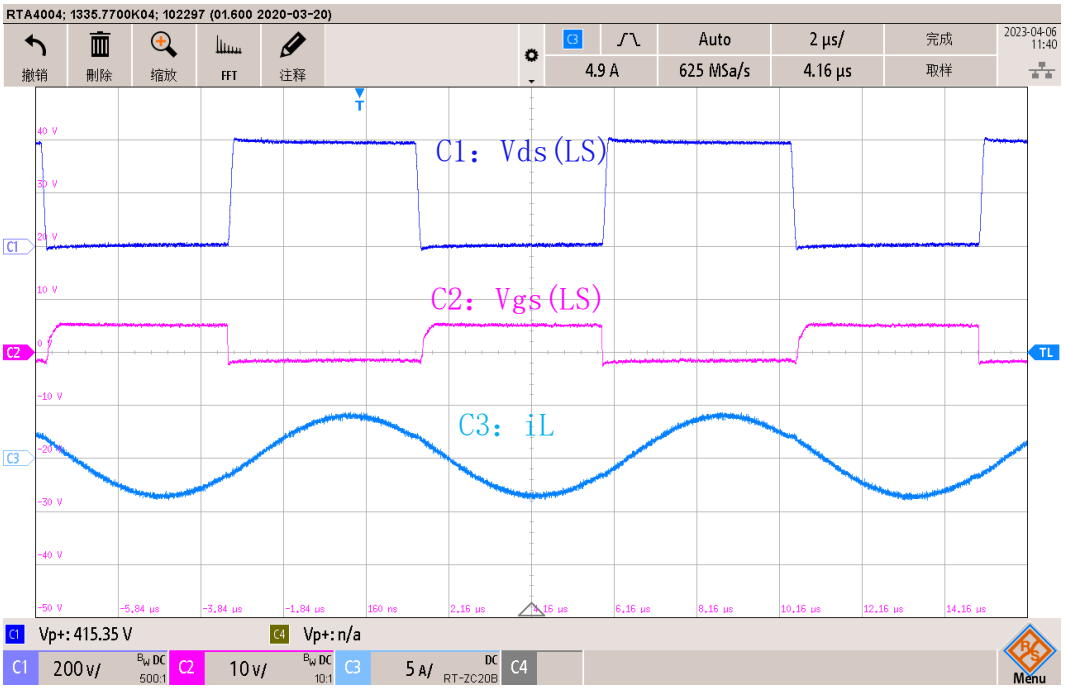


Figure 14 Waveforms of LLC

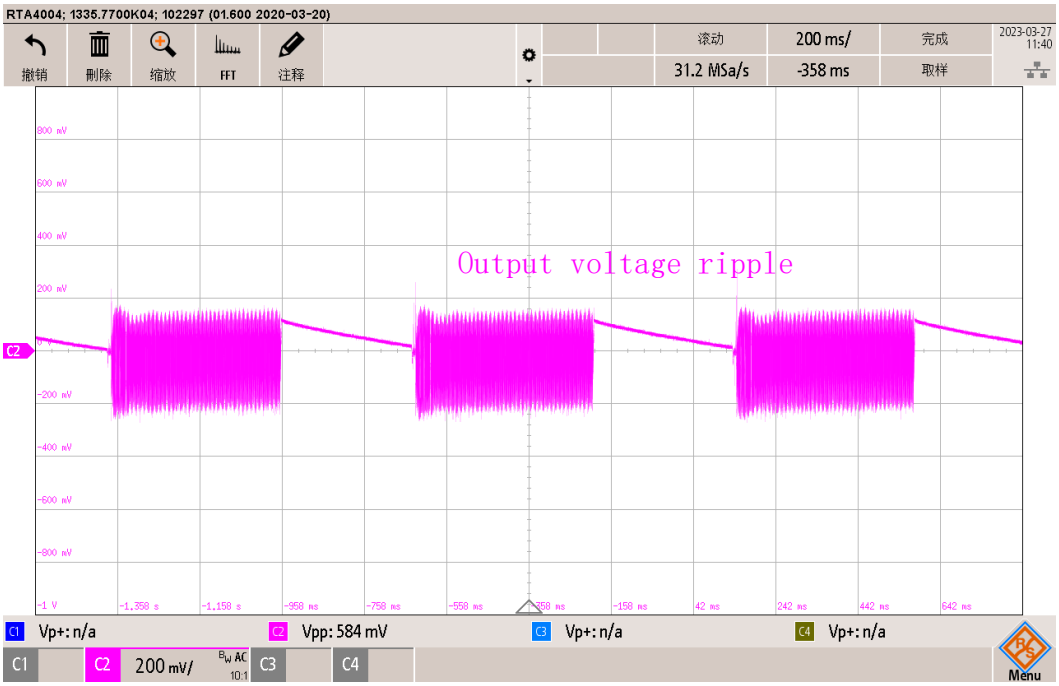


Figure 15 Dynamic load: 0A-136A-0A

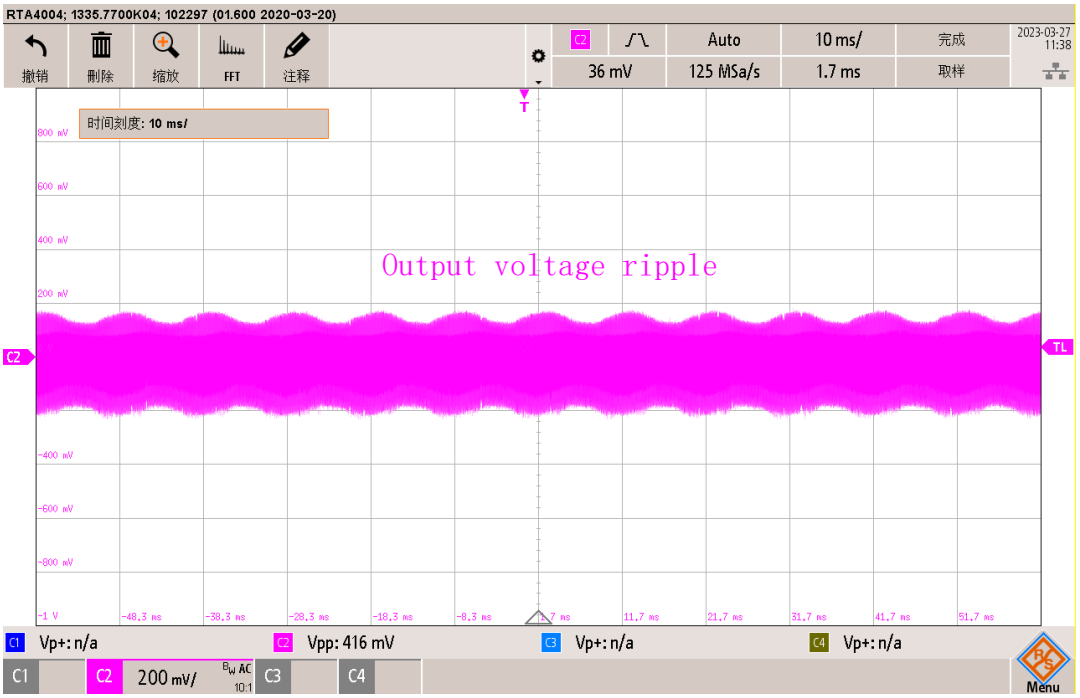
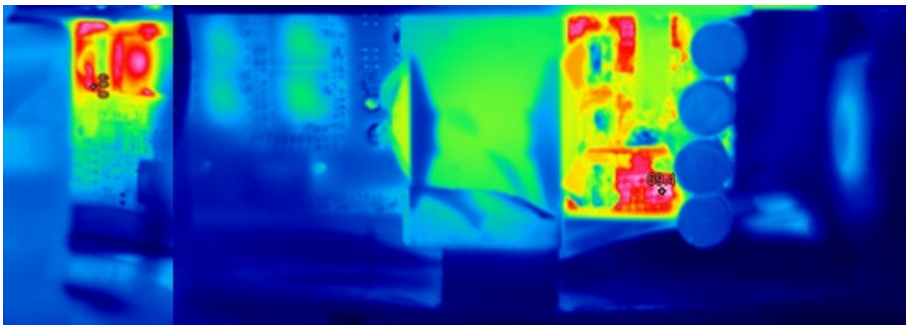


Figure 16 230Vac in, full load

5.2.3. Thermal Test



Test conditions

Vin=230Vac

Vout=12V

Iout=160A

Ambient temp 20°C

Airflow

Run for 1h

Result

PFC HS: 59.2°C

PFC LS: 60.0°C

PFC Inductor: 45.2°C

LLC HS: 40.1°C

LLC LS : 39.8°C

SR 2 : 69.4°C

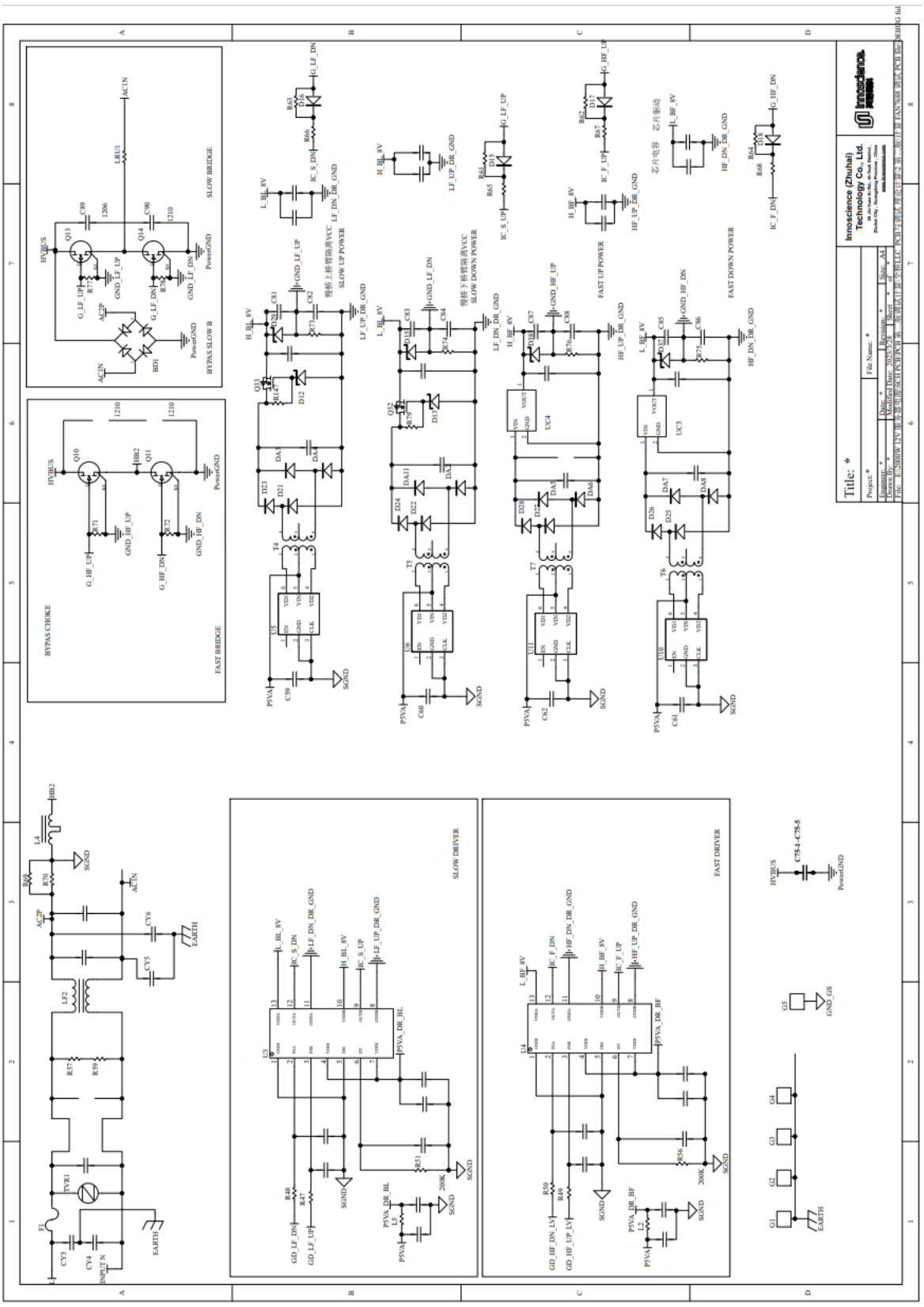
SR 1 : 68.0°C

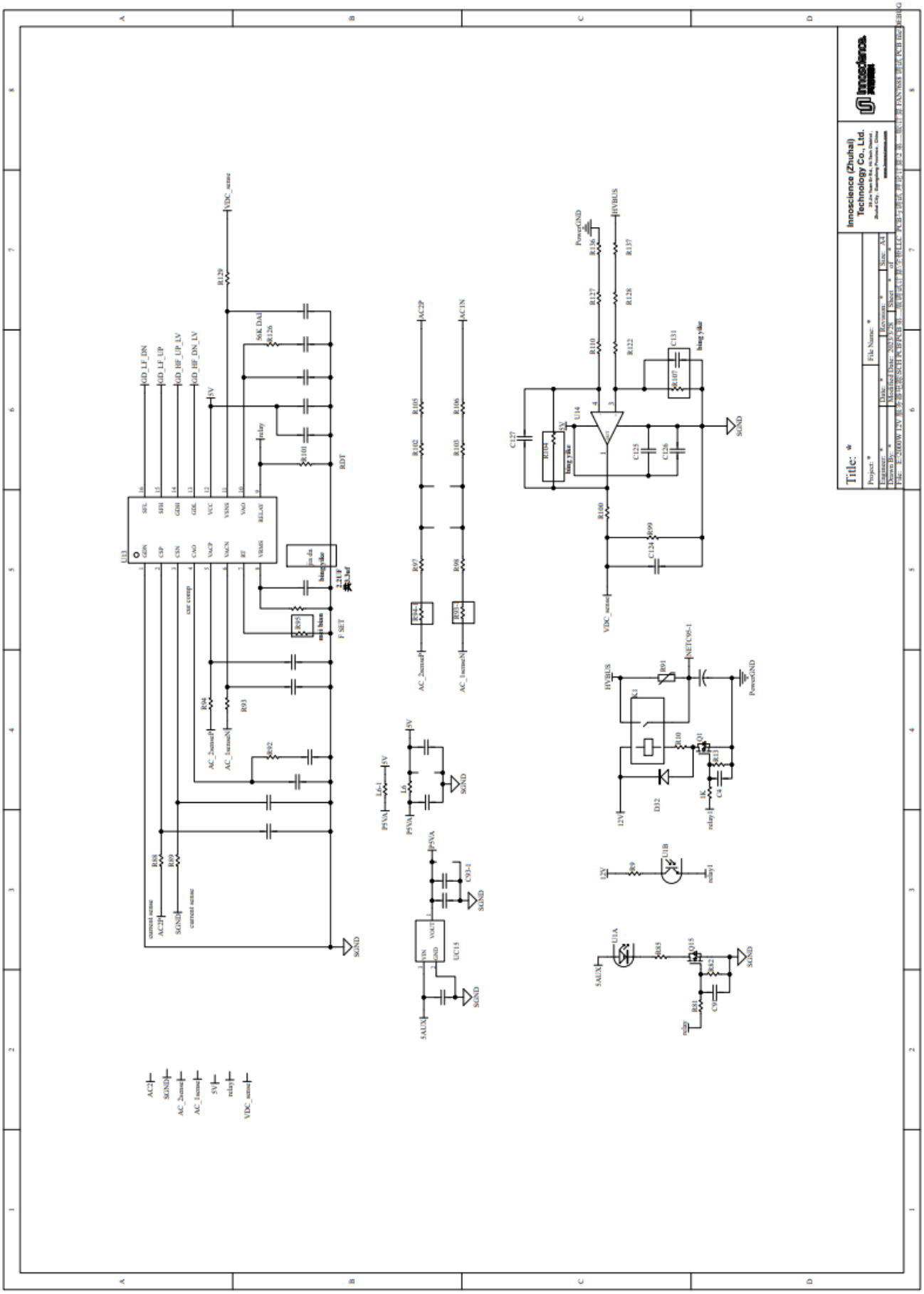
LLC T: 55.6°C

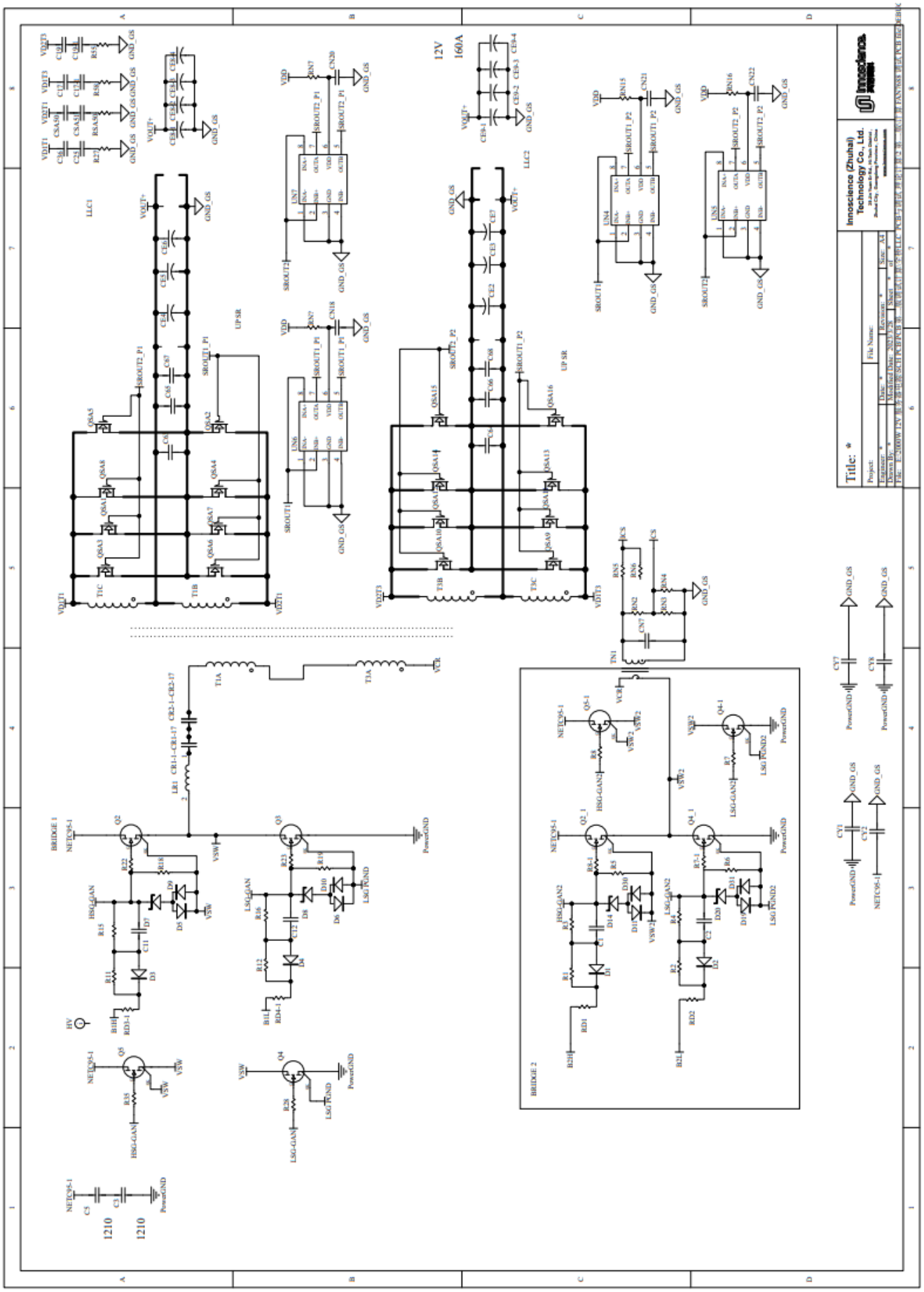
LLC LR: 42.5°C

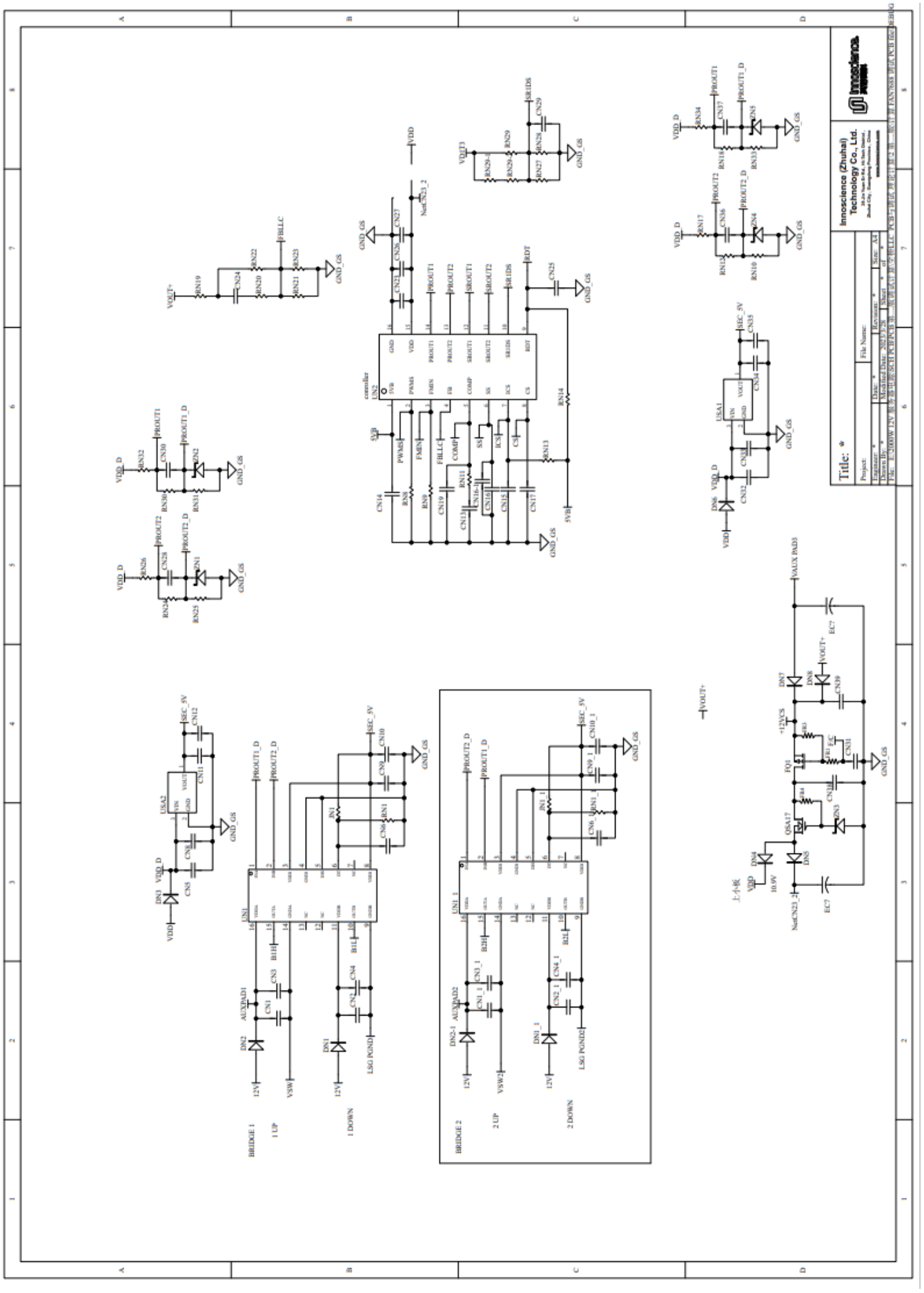
Appendix

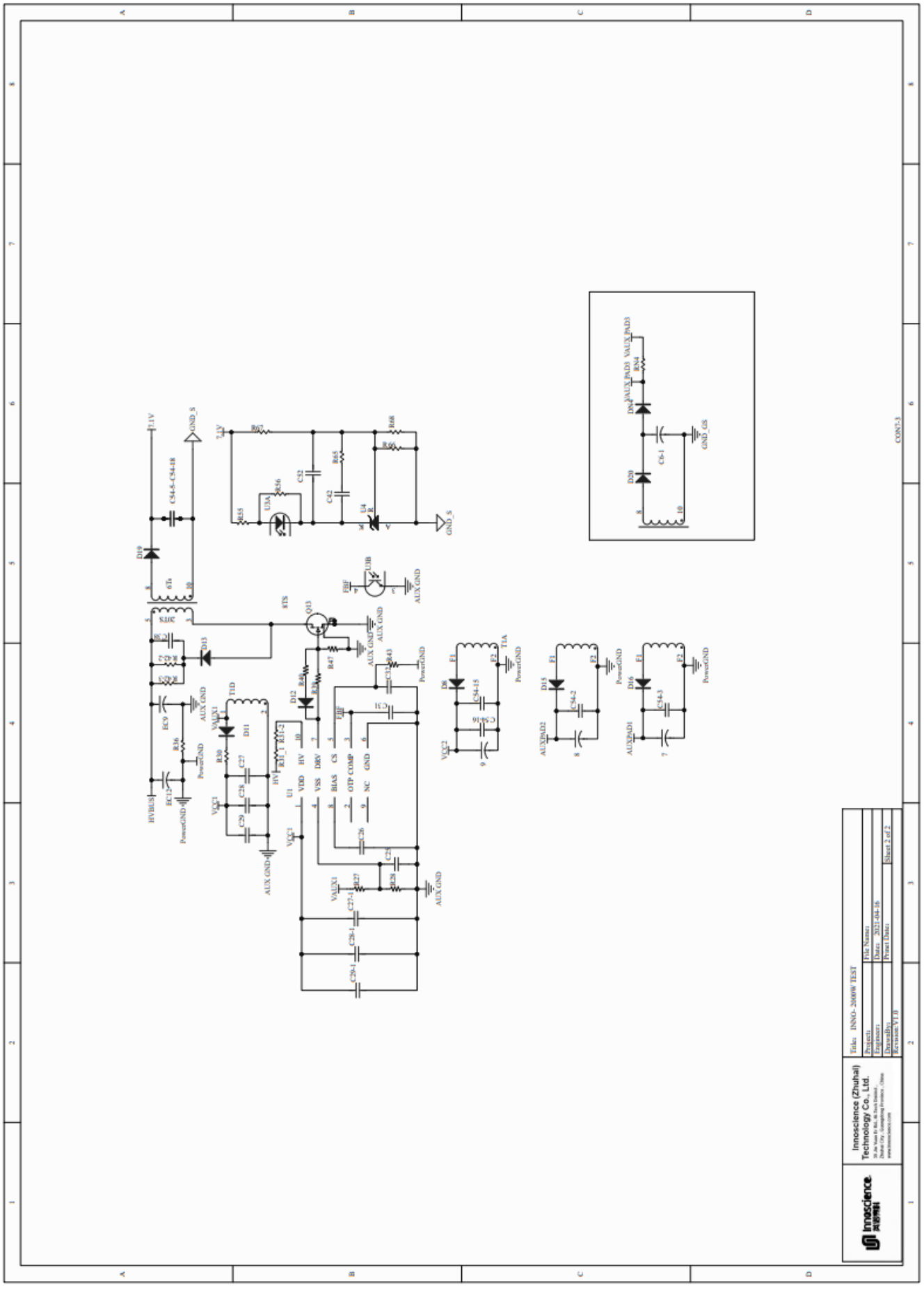
Appendix A. Schematics











Appendix B. BOM

Comment	Description	Designator	Quantity
BRIDGE	25A/600V, World	BD1	1
DIP CAP	270uF/16V,5*11	C6-1	1
DIP CAP	680uF/450V,UUCAP,30*60	C95	1
SOLID CAP	C8*20,1200UF/16V	CE2-1~C2-4, CE4-1~C4-4	2
E-CAP	3300UF/16V,C13*30	CE3	1
X CAP	1.5uf X cap,26*12mm，MEX	CX1, CX1-1	2
X CAP	X cap ，1.5uF,26*12mm	CX3	1
Y CAP	Y cap Y1	CY3, CY4	2
Y CAP	222,Y cap Y1, 222 Y1	CY5, CY6, CY7, CY8	4
E-CAP	100UF/25V,5*11	EC9-5, EC9-6, EC9-7	6
FUSE	FUSE,25A/250V	F1	1
PFC CHOKE	Hong Tai Da Inductor， Poco Core，300UH	L4	1
EMC CHOKE	3mH common mode choke	LF2	1
LLC CHOKE	Hong Tai Da ，43UH, Resonant Inductor，PQ3218	LR1	1
EMC CHOKE	DM Inductor， TBD,INRUSH	LRU1	1
LLC TRANSFORMER	PQ3220，Hong Tai Da ，Planar Transformer	T1, T3	2
AUX TRANSFORMER	Transformer-12pin	T2	1
Relays	OJE-SS-112HMF,relay，10A	K1	1
CURRENT TRANSFORMER	EE13,1:60,current transformer	TN1	1
INN650D080BS	INN650D080BS,Innoscience	Q2, Q2_1, Q3, Q4_1	4
INN650TA080AH	INN650TA080AH,TOLL,Innoscience	Q10, Q11	2
INN650DA260A	GaN，INN650DA260A，DFN 5X6，Innoscience	Q13	1
INN650TA030AH	INN650TA030AH,TOLL,Innoscience	Q13, Q14	2
SMD CAP	6.8nF/25V,X7R,0603,10% MLCC	C1, C2, C11, C12	4
SMD CAP	1nF/25V,X7R, 0402,10% MLCC	C4, C91, C93-1	3
SMD CAP	105/630V,2220, X7R,10% MLCC	C5, C75-1~C75-5, EC9, EC12	8
SMD CAP	5pF ±5% 25V，0402，COG	C25	1
SMD CAP	100nF ±10% 25V，0603, 100nF ±	C26, CN1, CN1_1, CN2, CN2_1,	11

	10% 25V，0402	CN5, CN9, CN9_1, CN23, CN31, CN32	
SMD CAP	106/25V,1206, X7R,10% MLCC	C27, C27-1, C28, C28-1, C29, C29-1	6
SMD CAP	100pF ±10% 25V，0402，COG	C31	1
SMD CAP	10pF ±5% 25V，0402，COG	C32, CN29	2
SMD CAP	1UF/10V，X5R, 0402,10% MLCC	C36, C37, C38, C39	4
SMD CAP	1nF/1KV//1210, 106/25V,1206, X7R,10% MLCC	C38, C54-5	2
SMD CAP	100pF/25V,X7R, 0402,10% MLCC	C40, C43	2
SMD CAP	100pF/25V,X7R, 0402,10% MLCC	C41, C45	2
SMD CAP	220nF ±10% 25V，0603	C42	1
SMD CAP	3.3nF ±10% 25V,0402	C42, C44	2
SMD CAP	100nF ±10% 25V，0402, 100nF ± 10% 25V,0402	C46, C47, C52, C53	4
SMD CAP	1uF ±10% 25V,0402	C48, C49	2
SMD CAP	100nF ±10% 25V,0402	C50, C51	2
SMD CAP	220pF ±10% 25V，0603	C52	1
SMD CAP	106/25V,1206, X7R,10% MLCC	C54-1	1
SMD CAP	4.7uF ±10% 25V，0805, 4.7UF,25V,X7R,0603,10% MLCC, 4.7uF ±10% 10V，0402, 4.7uF ± 10% 25V，0603	C54-2, C54-3, C54-15, C72, C77, CN10, CN10_1, CN11, CN34	9
SMD CAP	106/25V,1206, X7R,10% MLCC, 10uF/25V,X7R,0603,10% MLCC, 10uF ±10% 25V，0603, 10uF ±10% 25V，0805	C54-16, C57, C58, CN12, CN26, CN35, CN39	7
SMD CAP	10uF/25V,X7R,0603,10% MLCC	C55, C56	2
SMD CAP	10uF/25V,X7R,0805,10% MLCC	C59, C60, C61, C62	4
SMD CAP	C1210,Panasonic POSCAP, 47UF/16V	C63-1~C63-6, C64-1~C64-6	2
SMD CAP	4.7UF,25V,X7R,0603,10% MLCC	C71, C73	2
SMD CAP	4.7UF,25V,X7R,0603,10% MLCC	C74	1
SMD CAP	4.7uF ±10% 10V，0402	C78, C79, C80	3
SMD CAP	1uF/25V,X7R,0402,10% MLCC	C81, C82, C83, C84, C85, C86, C87, C88	8
SMD CAP	220nF,450V,1206,10% MLCC X7R	C89, C90	2
SMD CAP	1uF/25V,X7R, 0805,10% MLCC	C92	1

SMD CAP	1uF/25V,X7R, 0603,10% MLCC	C93, C97, C99-1	3
SMD CAP	1nF/25V,X7R, 0402,10% MLCC, 1nF/10V,X7R, 0402,10% MLCC	C94, C96, C124, C127, C131, C133	6
SMD CAP	22pF/25V,X7R, 0402,10% MLCC	C98	1
SMD CAP	8.2nF/25V,X7R, 0402,10% MLCC	C100	1
SMD CAP	2.2uF//1uF/10V,X7R, 0603,10% MLCC	C123	1
SMD CAP	100nF/25V,X7R, 0603,10% MLCC	C125	1
SMD CAP	4.7uF/25V,X7R, 0603,10% MLCC	C126	1
SMD CAP	4.7uF/10V,X7R, 0603,10% MLCC	C128	1
SMD CAP	100nF/10V,X7R, 0402,10% MLCC	C129	1
SMD CAP	22nF/10V,X7R, 0402,10% MLCC	C130	1
SMD CAP	220nF/10V,X7R, 0402,10% MLCC	C132	1
SMD CAP	1uF ±10% 25V，0603	CN3, CN3_1, CN4, CN4_1, CN14	5
SMD CAP	3.3nF ±10% 25V，0402	CN6, CN6_1	2
SMD CAP	1nF/50V,X7R, 0402,10% MLCC	CN7	1
SMD CAP	2.2uF ±10% 25V，0603	CN8, CN33	2
SMD CAP	2.2nF ±10% 25V，0402，COG	CN13	1
SMD CAP	1nF ±10% 25V，0402，COG	CN15	1
SMD CAP	470nF ±10% 25V，0402	CN16, CN16-1	2
SMD CAP	100pF ±10% 25V，0402，COG	CN17	1
SMD CAP	2.2uF/25V,X7R, 0603,10% MLCC	CN18, CN20, CN21, CN22	4
SMD CAP	680pF ±10% 25V，0402，COG	CN19	1
SMD CAP	NC	CN24, CN27, CN38	3
SMD CAP	270pF ±10% 25V，0402，COG	CN25	1
SMD CAP	27pF ±5% 25V，0402，COG	CN28, CN36	2
SMD CAP	33pF ±5% 25V，0402，COG	CN30, CN37	2
SMD CAP	Resonant Cap，1206,4.7nF/630V,NPO	CR1, CR1-1~CR1-17, CR2, CR2-1~CR2-17	4
Y CAP	102 Y1	CY1, CY2	2
Transistor	SR FET，1.2mR,60V，PG-TDSON-8	QSA1, QSA2, QSA3, QSA4, QSA5, QSA6, QSA7, QSA8, QSA9, QSA10, QSA11, QSA12, QSA13, QSA14, QSA15, QSA16	16
SHORT	SHORT	QSA17	1

SMD RES	200R,0402,,1%	R1, R2, R11, R12	4
SMD RES	7.5K,0402,,1%	R3, R4, R15, R16	4
SMD RES	9.1K,0402,,1%	R5, R6, R18, R19, R71, R72, R77, R78	8
SMD RES	0R,0402,,1%	R9	1
SMD RES	10R,0603,,1%	R10	1
SMD RES	100K,0402,,1%	R13	1
SMD RES	91K,0402,,1%	R27	1
SMD RES	6.8K,0402,,1%	R28	1
SMD RES	1R,0805,,1%	R30	1
SMD RES	2.4K,0603,,1%	R31-2, R31_1	2
SMD RES	0.12R,1206,,1%	R36	1
SMD RES	470R,0603,,1%	R39	1
SMD RES	10R,0603,,1% , 10R,0402,,1%	R40, RN19	2
SMD RES	200K,1206,,1%	R42-2, R42-3	2
SMD RES	2K,0603,,1%	R43	1
SMD RES	100R,0402,,1%	R47, R48, R49, R50	4
SMD RES	10K,0603,,1% , 10K,0402,,1%	R47, RN1, RN1_1	3
SMD RES	200K,0402,,1%	R51	1
SMD RES	1K,0402,,1%	R55	1
SMD RES	4.7K,0402,,1%	R56	1
SMD RES	200K, 10K,0402,,1%	R56, R79, R93, R94, R147	5
SMD RES	5.1M,1206, MLCC 1%	R57, R59	2
SMD RES	30R,0603,,1% , 30R,0402,,1%	R61, R62, R63, R64, RN3	5
SMD RES	6.8K,0402,,1%	R65	1
SMD RES	0R,0603,,1% , 0R,0402,,1%	R65, R66, R67, R68, RN7, RN15, RN16, RN30	8
SMD RES	27K,0402,,1%	R66	1
SMD RES	39K,0402,,1%	R67	1
SMD RES	100K,0402,,1% , 100K,0603,,1%	R68, R105, R106	3
SMD RES	0.024R ,2512 , 1%	R69	1
SMD RES	0.024//0.02R ,2512 , 1%	R70	1

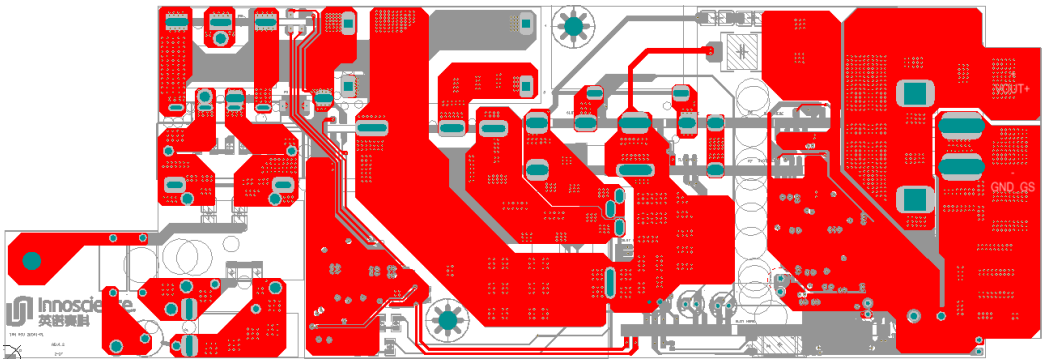
SMD RES	1K,0402,,1%	R73, R74, R75, R76, R81, R88, R89	7
SMD RES	100K,0402,,1%	R82	1
SMD RES	510K,0402,,1%	R85	1
SMD RES	50Ω ,PTC,P=10mm	R91	1
SMD RES	110K,0402,,1%	R92	1
SMD RES	330K,0805,,1%	R93-1, R94-1	2
SMD RES	33K,0402,,1%	R95	1
SMD RES	56K,0402,,1%	R96	1
SMD RES	330K,0805,,1%	R97, R98, R102, R103	4
SMD RES	4.7K,0402,,1%	R99	1
SMD RES	39K,0402,,1%	R101	1
SMD RES	5.6K//68K,0402,,1%	R104, R107	2
SMD RES	330K,0805,,1%	R110, R122	2
SMD RES	57K,0402,,1%	R126	1
SMD RES	330K,0805,,1%	R127, R128, R136, R137	4
SMD RES	5.1K,0402,,1%	R129	1
SMD RES	1K,0402,,1%	R202	1
SMD RES	1R,0402,,1%	RD1, RD2, RD3-1, RD4-1	4
SMD RES	82R,0402,,1%	RN2	1
SMD RES	5.1R,0402,,1%	RN4	1
SMD RES	43K,0402,,1%	RN5	1
SMD RES	47K,0402,,1%	RN6	1
SMD RES	13K,0402,,1%	RN8	1
SMD RES	9.1K,0402,,1%	RN9	1
SMD RES	4.7K,0402,,1%	RN10, RN25, RN31, RN33	4
SMD RES	51K,0402,,1%	RN11	1
SMD RES	5.1K,0402,,1%	RN12, RN18, RN24, RN30	4
SMD RES	200K,0402,,1%	RN13	1
SMD RES	270K//110K,0402,,1%	RN14	1
SMD RES	30K,0402,,1%	RN21	1
SMD RES	8.2K,0402,,1%	RN22	1
SMD RES	2.2K,0402,,1%	RN23	1
SMD RES	1.3K,0402,,1%	RN28	1
SMD RES	7.5K,0402,,1%	RN29	1
AUX CONTROLLER	FLAYBUCK Controller IC Joulwatt Fmax=260khz,JW1515HSSOP	U1	1
OPTOCOUPLER	EL3H7(B)(TA)-G,SSOP-4	U1, U3	3

DRIVER	NSI6602 LGA，Novosense	U3, U4	2
REGULATORS	ADJUSTABLE PRECISION SHUNT REGULATORS,SOT-23,AZ431	U4	1
IC	PMIC，VPS8504B,SOT-23-6,VPSC	U5, U6, U10, U11	4
PFC IC	CCM Totem-Pole PFC Controllers,IVCC1102	U13	1
Op amp	Higrand,OPA376M5,SOT23-5	U14	1
LDO	LDO,CJ78L08,SOT-89	UC3, UC4	2
LDO	LDO,SOT-89,CJ78L05	UC15	1
DRIVER	Novosense，NSI6602,SOW16	UN1, UN1_1	2
LLC IC	LLC Controller，SOP-16	UN2	1
DRIVER	Driver，SOP-8	UN4, UN5, UN6, UN7	4
LDO	LDO,CJ78L05,SOT-89	USA1, USA2	2
DIODE	Zener，5.1V,SOD-523	ZN1, ZN2, ZN4, ZN5	4
SMD CORE	VPT85BD-01A,SMT，VPSC	T4, T5, T6, T7	4
DIODE	SMT Schottky Diode,RB521,SOD-523	D1, D2, D3, D4, D5, D6, D9, D10, D11, D15, D16, D17, D18, D19, D30, D31, D32	17
DIODE	Zener，5.6V,SOD-323	D7, D8, D14, D20	4
DIODE	Ultrafast recovery diode，ES1J,SOD-123	D8, D11, D15, D16	4
DIODE	4148,SOD-523	D12	1
DIODE	Zener，9.1V,SOD-523	D12, D13	2
DIODE	Ultrafast recovery diode，ES1J,SOD-123	D13	1
DIODE	Ultrafast recovery diode，SMC,ES8J	D19	1
DIODE	Ultrafast recovery diode，ES1J,SOD-123	D20	1
DIODE	SMT Schottky Diode,B16WS,SOD-323	D21, D22, D23, D24, D25, D26, D27, D28, DA2, DA3, DA4, DA5, DA6, DA7, DA8, DA11	16

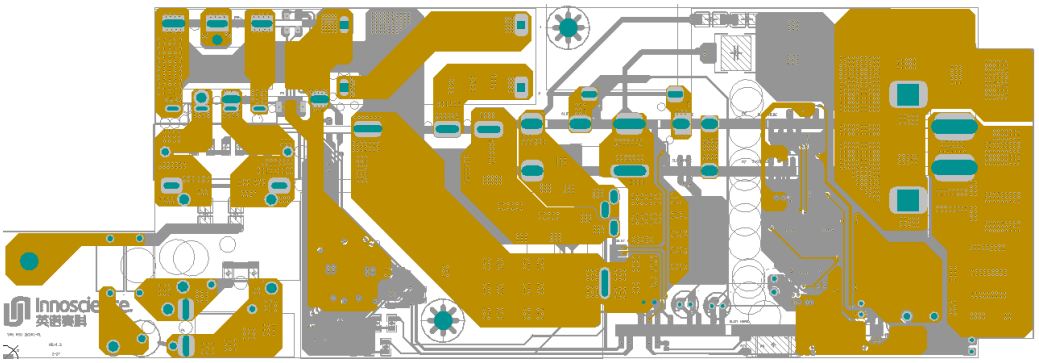
DIODE	Zener , 6V,SOD-323	D29, D35, D37, D38	4
DIODE	SMT Schottky Diode,BAT54C,SOD-523	DN1, DN1_1	2
DIODE	4148,SOD-523, 4148,SOD-323	DN3, DN4, DN6, DN7, DN8	5
DIODE	SMT Schottky Diode,RB521,SOD-523	DN4	1
DIODE	SMT Schottky Diode,BAT54C,SOD-523	DN5	1
Transistor	N channel 60V 190mA, NX7002AK, 215, SOT-23, Nexperia	Q1, Q15, Q32, Q33	4
Transistor	P-Channel MOSFET,SOT-23,YJL3401A	FQ1	1
SMD RES		FR1, FR3	2
SMD RES	0R,0402,1% , 0R,0402,1%	L2, L5, L6, L6-1, R7, R7-1, R8, R8-1, R22, R23, R28, R35, R100	13

Appendix C. PCB Layouts

Main Board



Top layer



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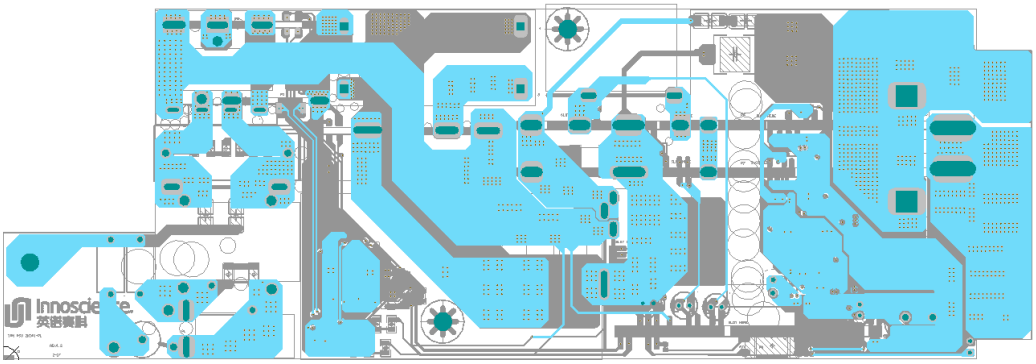

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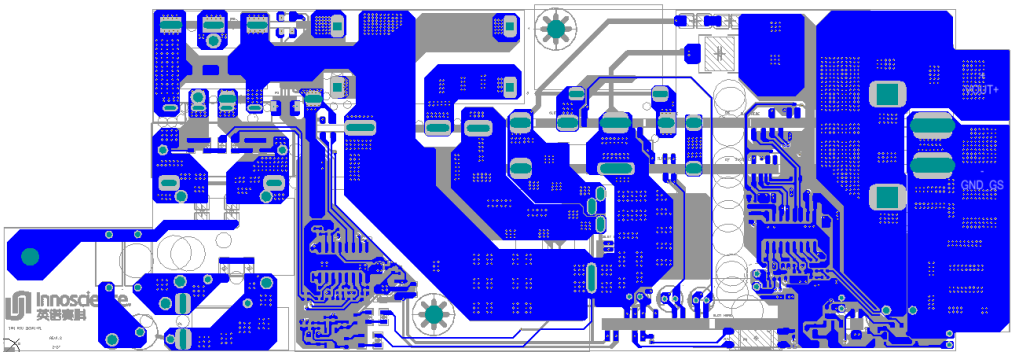
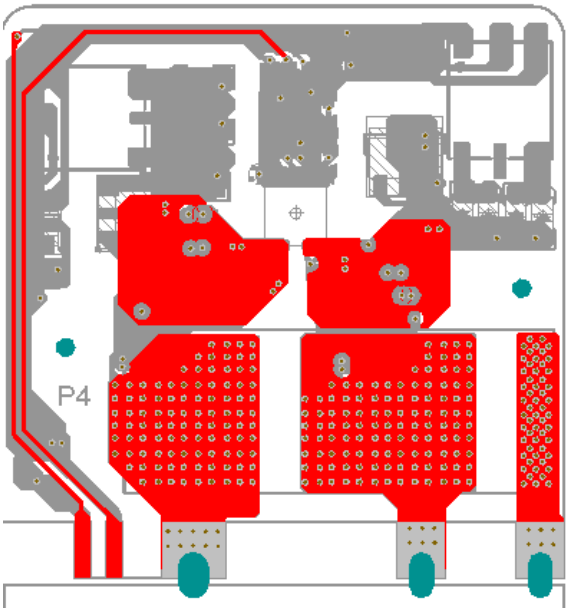


Bottom layer

PFC Fast Bridge



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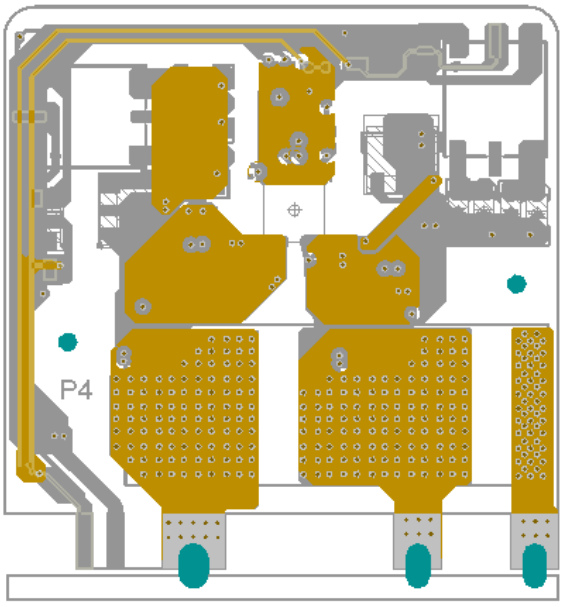

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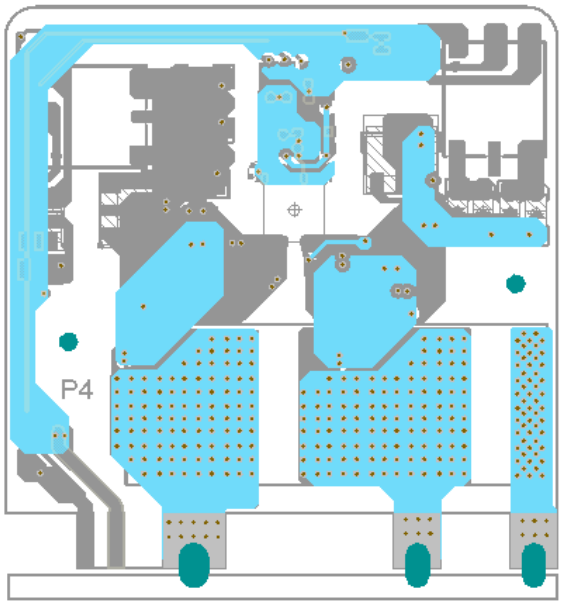

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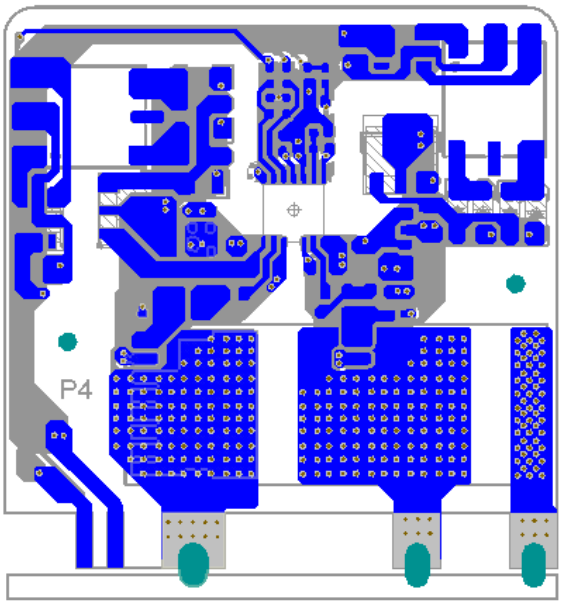
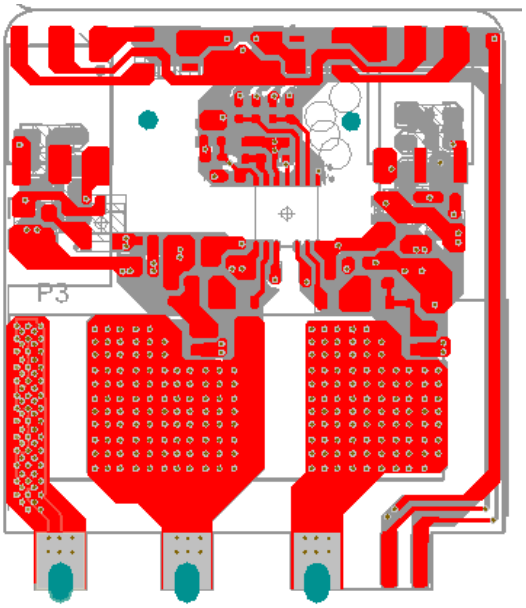


Bottom layer

PFC Slow Bridge



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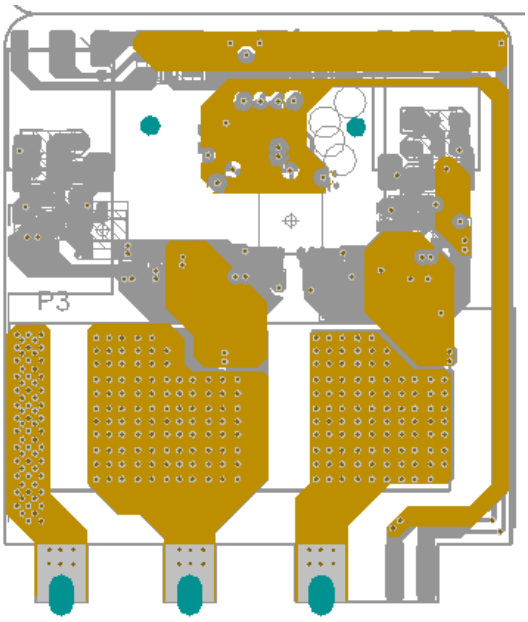

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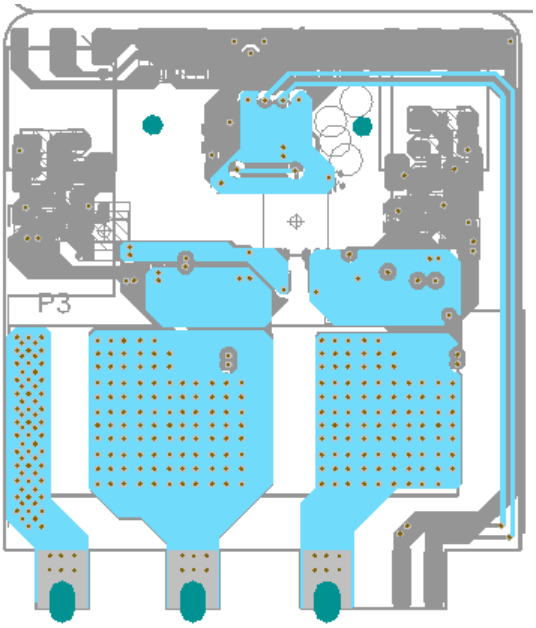

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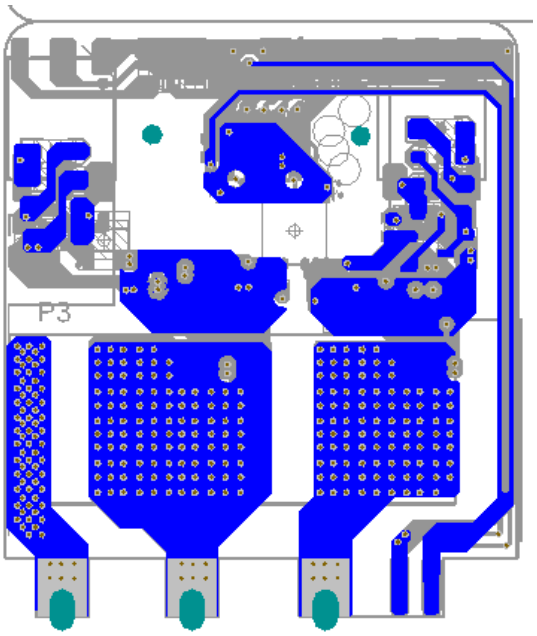
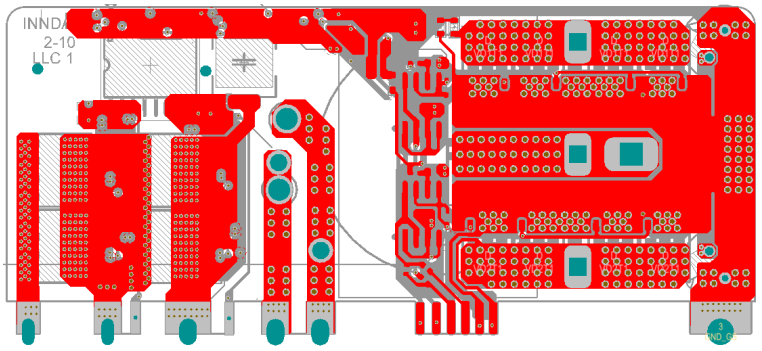


Bottom layer

LLC1



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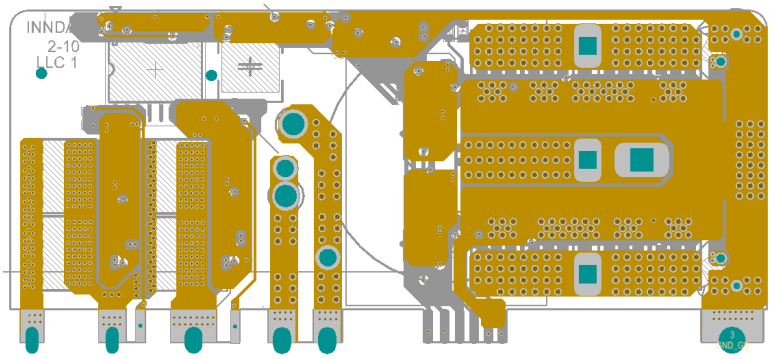

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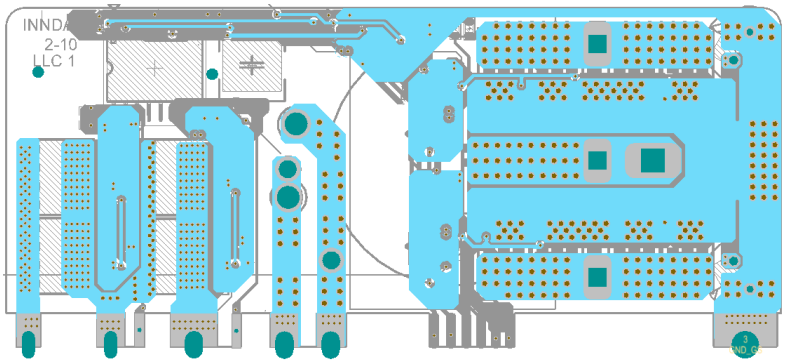

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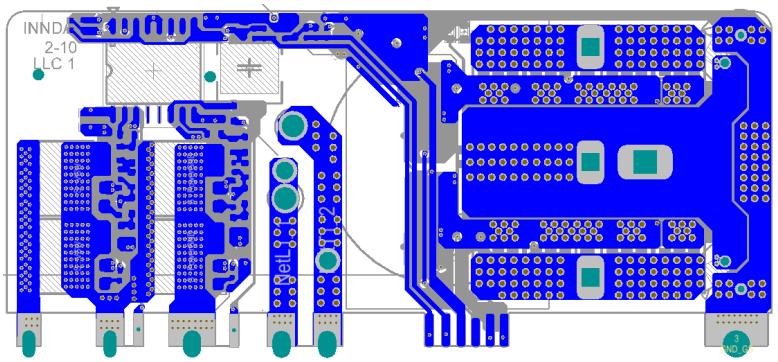
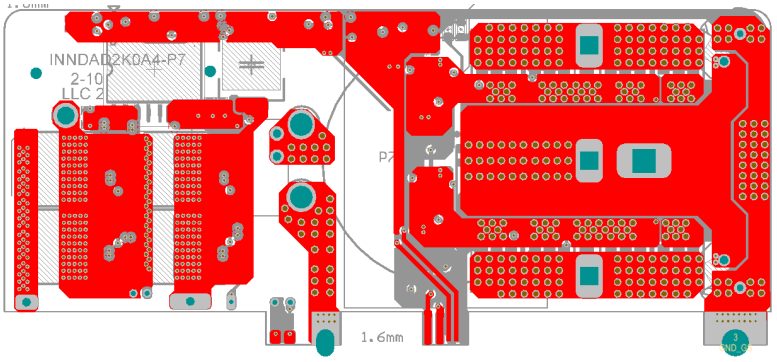


Bottom Layer

LLC2



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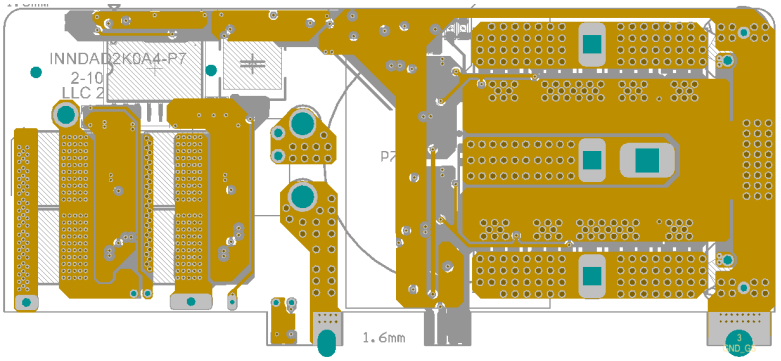

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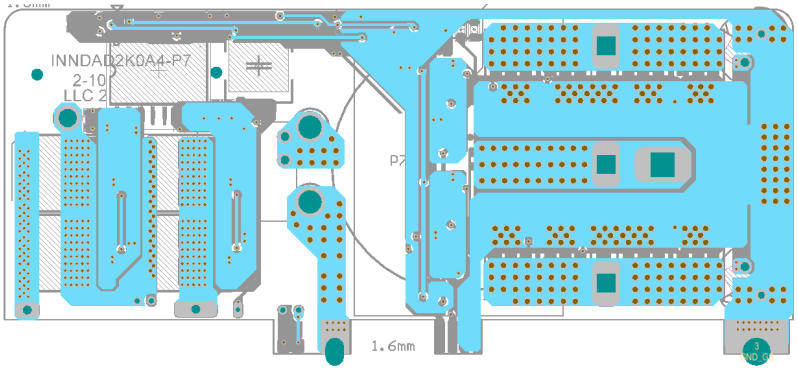

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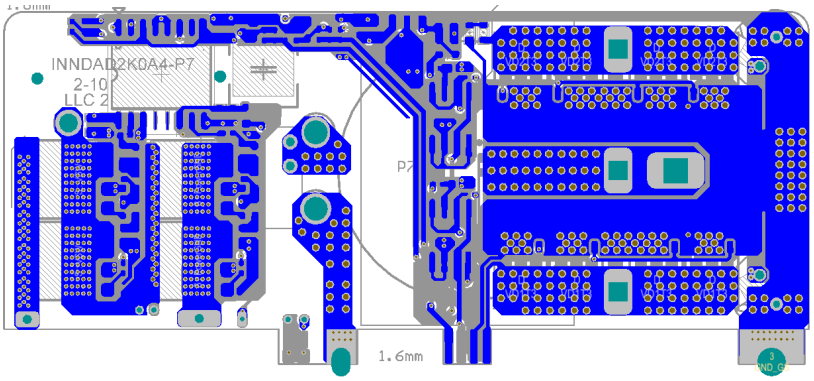

Bottom Layer

Revision History

Date	Author	Versions	Description	Check
04/10/2023	Shijian Liu Fada Du	1.0	First edition	AE Team

Note:

There is a dangerous voltage on the demo board, and exposure to high voltage may lead to safety problems such as injury or death.

Proper operating and safety procedures must be adhered to and used only for laboratory evaluation demonstrations and not directly to end-user equipment.

Reminder:

This product contains parts that are susceptible to electrostatic discharge (ESD). When using this product, be sure to follow antistatic procedures.

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