Demo 技术手册

CorEnergy®

能 华 半 导 体

目录

1. Solution 介绍/Introduction

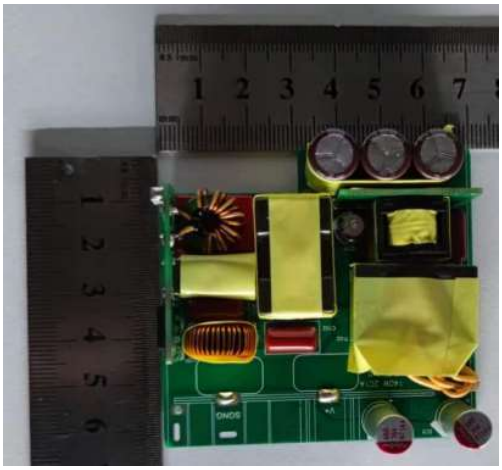
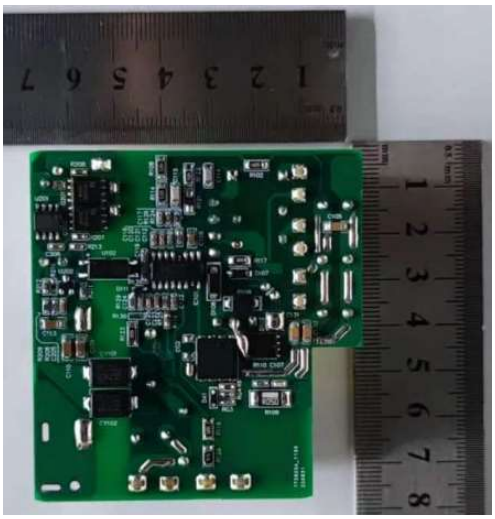
1.1 系统描述/System Description

140W2C1A demo 板是基于能华半导体公司的 Cascode GaN 器件开发的一款输出功率 140W 的快充 demo 板,支持 USB PD3.1 协议,充电器具备 2C1A 三个接口,两个 C 口支持盲插,输出功率为 140W,双口同时输出时可作为两个 65W 充电器使用；电源 AC-DC 部分控制方案采用高性能的 APFC+LLC+同步整流电路,主控芯片采用 NXP 公司的 TEA2016+TEA2095,系统 AC-DC 峰值效率可以达到 96%,待机损耗 100mW/240VAC. PFC 级主开关 HEMT 器件采用 CE65H160DNHI-S, 封装为 DFN8*8,LLC 级主开关 HEMT 器件采用 CE65H270DNHI-S + CE65H270DNFI-D, 封装为 DFN8*8;能华 Cascode GaN 器件采用能华微创新型 HEMT 级联技术，兼容硅管驱动，解决了传统低阈值电压增强型器件关断可靠性问题，创新型的桥式封装应用在 LLC 级有利于 EMC 问题处理系统具有很高的可靠性。

1.2 系统规格/System Specification

描述	符号	规格参数			单位	注释
		Min	Typ.	Max		
输入电压	V_{in}	90	110/220	264	*Vac*	
输入频率	f_{line}	47	50/60	63	*Hz*	
输出电压	V_{out}	5		20	*V*	~
输出功率	P_{out}		140		*W*	28V5A
输出纹波	V_{ripple}		300mV		*mV*	28V5A
工作频率	f_s	80	120	140	*KHz*	
系统效率	*eff*		95.8%			AC/DC 效率 230VAC
待机损耗	$P_{standby}$		260		*mW*	Measured@230V
PCBA 尺寸		L69	W65	H24	*mm*	

1.3 系统照片/System Photo

	
L69*W65*H24mm	

2.Demo 系统 Overview

2.1 原理框图 /Principle Block

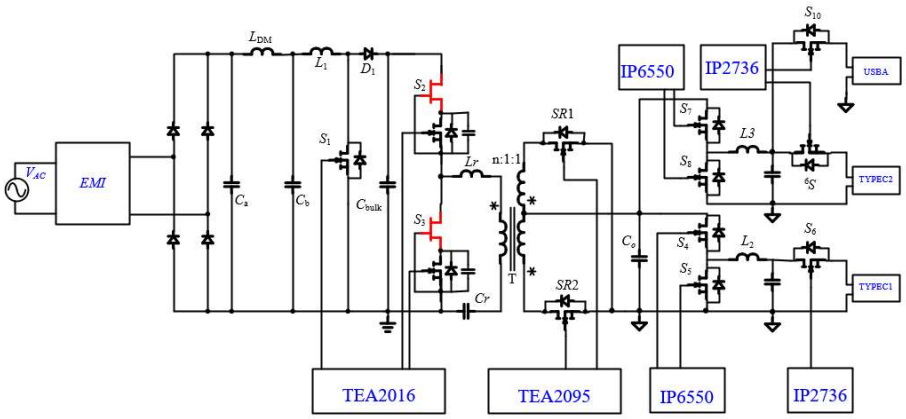


图 2.1 140W2C demo 板系统原理框图

图 2.1 显示的是 140W2C1A demo 板的系统原理框图，系统主要由 EMI 滤波器、输入整流桥、APFC 级、LLC 级和同步整流以及协议部分组成。

2.2 系统组成/Key Components

1．EMI 滤波器

本系统的 EMI 滤波器由一级桥前π型共模滤波器和桥后π型差模滤波器组成，将系统产生的共模噪音和差模噪音衰减到满足测试标准的水平。

2. 输入整流桥

输入整流桥将输入工频电转化为直流电。

3. APFC 级

本级的主电路拓扑采用 BOOST 升压电路，由输入电解容、升压电感、主功率 HEMT 管以及快恢复续流二极管组成，功能是将输入低压直流电通过 BOOST 升压电路转化为高压直流电，期间调整电压电流相位,从而失效系统功率因数校正功能。

主功率 HEMT 器件是来自能华半导体的 Cascode GaN 器件 CE65H160DNGI-S,，耐压 650V，瞬态耐压 750V，导阻为 160mΩ。封装 DFN8X8，这颗 CoreGaN 器件极低的 RDON 能大大提升系统效率、功率密度，减小系统尺寸及重量，并降低系统成本;相比市场上其他 GaN 产品，其兼容硅管驱动，保证了在各种应用场景的驱动可靠性，无需负压关断，PCB Layout 也变得更容易;作为一款散热焊盘为 S 极的器件，对系统 EMC 优化方面有很大好处。

4. LLC 级

本级的主电路拓扑采用 LLC 电路，由输入电解容、LLC 半桥变换器以及输出同步电路 FET 组成，功能是将输入高压直流电转化为低压直流电,LLC 控制电路确保了主功率 HEMT 器件在高压工作下能实现 ZVS 开通，同步整流控制电路确保了主功率 MOSFET 器件实现 ZCS 开通,从而实现系高效的系统功率变换。

主功率 HEMT 器件是来自能华半导体的 CE65H270DNGI + CE65H270DNFI，耐压 650V，瞬态耐压 750V，导阻为 270mΩ。封装 DFN8X8，这两颗 CoreGaN 器件配合使用，组成 H-BRIDGE 系统,能大大提升系统效率、功率密度，减小系统尺寸及重量，对系统 EMC 优化方面有很大好处,可以明显降低系统成本。相比市场上其他 GaN 产品，其驱动电路兼容硅

管，保证了在各种应用场景的驱动可靠性，无需负压关断，PCB Layout 也变得更容易。

6. 输出协议

本系统输出采用一颗英集芯半导体公司的~~~协议 IC,内含 PD 快充协议使得 C 口输出兼容 28V/5A,20V/5A,15V/3A,12V/3A,9V/3A,5V/3A 等输出。

3.系统测试/Test

3.1 系统效率/Efficiency Test

AC-DC 端效率测试

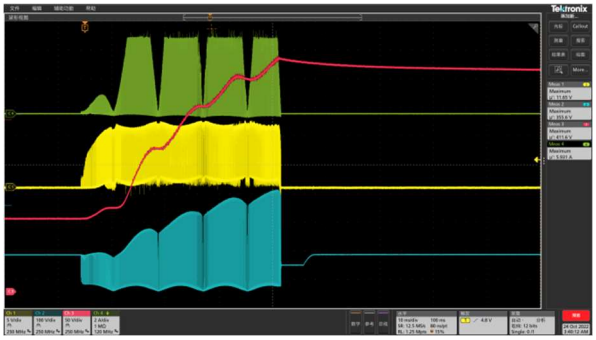
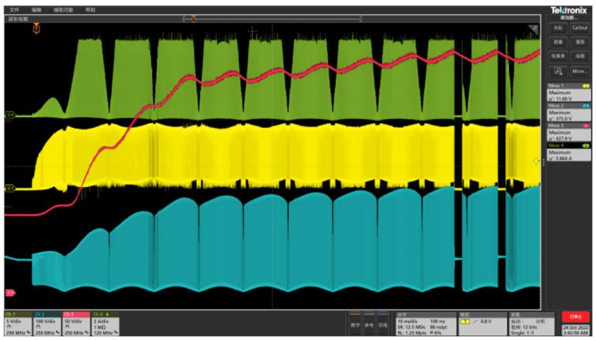
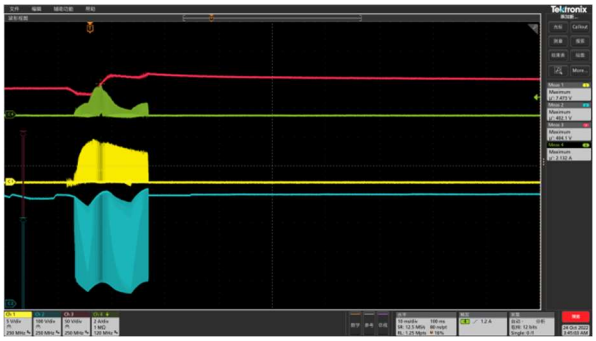
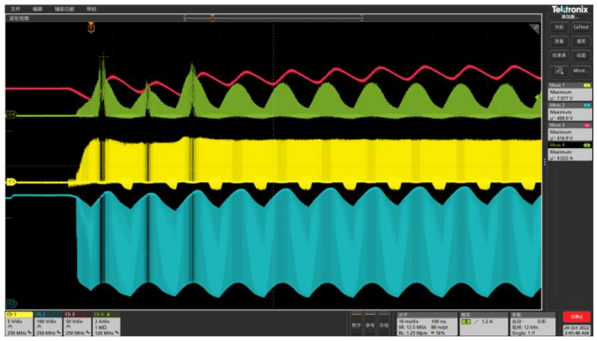
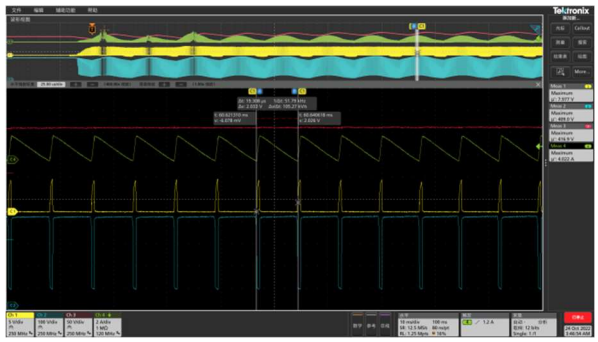
输入电压 (V)	负载	输入功率 (W)	PF 值	输出电压 (V)	输出电流 (A)	效率
90Vac/60Hz	28V/5A	152.89	0.996	29.16	4.9	93.44
115Vac/60Hz	28V/5A	151.29	0.992	29.16	4.9	94.43
230Vac/50Hz	28V/5A	149.16	0.916	29.16	4.9	95.79
264Vac/50Hz	28V/5A	148.82	0.897	29.16	4.9	96.00

Type C 效率测试

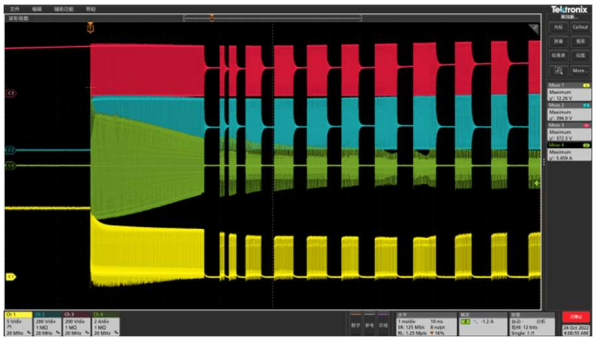
样机N./负载	输入电压	PF	输入电流	输入功率	输出电压	输出电流	输出功率	效率
28V/5A	90VAC	0.9905	1.7243	153.83	28.1910	5.00	140.96	91.63%
	115VAC	0.9893	1.3346	152.10	28.1870	5.00	140.94	92.66%
	230VAC	0.9150	0.7112	150.00	28.1860	5.00	140.93	93.95%
	264VAC	0.8929	0.6340	149.70	28.1830	5.00	140.92	94.13%
20V/5A	90VAC	0.9913	1.2894	115.05	20.8440	5.00	104.22	90.59%
	115VAC	0.9803	1.0118	114.13	20.8440	5.00	104.22	91.32%
	230VAC	0.8902	0.5496	112.75	20.8420	5.00	104.21	92.43%
	264VAC	0.8578	0.4971	112.70	20.8380	5.00	104.19	92.45%
15V/3A	90VAC	0.9744	0.6046	53.13	15.5345	3.00	46.60	87.72%
	115VAC	0.9606	0.4780	52.86	15.5338	3.00	46.60	88.16%
	230VAC	0.7866	0.2890	52.58	15.5341	3.00	46.60	88.63%
	264VAC	0.7052	0.2797	52.36	15.5336	3.00	46.60	89.00%
12V/3A	90VAC	0.9767	0.4950	43.55	12.5213	3.00	37.56	86.25%
	115VAC	0.9588	0.3935	43.39	12.5199	3.00	37.56	86.56%
	230VAC	0.7400	0.2526	43.20	12.5193	3.00	37.56	86.94%
	264VAC	0.6545	0.2475	43.15	12.5183	3.00	37.55	87.03%
9V/2A	90VAC	0.9461	0.2747	23.40	9.3150	2.00	18.63	79.62%
	115VAC	0.8974	0.2264	23.36	9.3749	2.00	18.75	80.26%
	230VAC	0.5416	0.1866	23.15	9.3745	2.00	18.75	80.99%
	264VAC	0.4653	0.1909	23.44	9.3742	2.00	18.75	79.98%
5V/3A	90VAC	0.9317	0.2532	21.24	5.6062	3.00	16.82	79.18%
	115VAC	0.8803	0.2087	21.22	5.6059	3.00	16.82	79.25%
	230VAC	0.5093	0.1806	21.09	5.6060	3.00	16.82	79.74%
	264VAC	0.4349	0.1856	21.41	5.6060	3.00	16.82	78.55%

输入电压	230V/50Hz	
空载损耗（mW）	260	

3.2 动态应力测试/Dynamic Stress Test

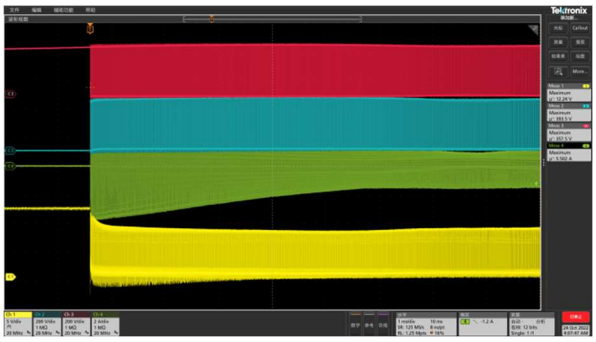
PFC 部分_GAN 管应力	
 90VAC Input_0% Load_Startup CH1:VGS CH2:VDS CH3:VO-PFC CH4:IL-PFC	 90VAC Input_100% Load_Startup CH1:VGS CH2:VDS CH3:VO-PFC CH4:IL-PFC
 264VAC Input_0% Load_Startup CH1:VGS CH2:VDS CH3:VO-PFC CH4:IL-PFC	 264VAC Input_100% Load_Startup CH1:VGS CH2:VDS CH3:VO-PFC CH4:IL-PFC
 90VAC Input_0% Load_Startup CH1:VGS CH2:VDS CH3:VO-PFC CH4:IL-PFC	 264VAC Input_100% Load_Startup CH1:VGS CH2:VDS CH3:VO-PFC CH4:IL-PFC

LLC 部分__GAN 管应力



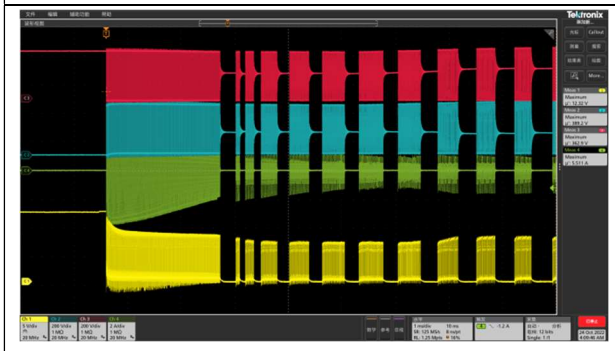
90VAC Input_0% Load_Startup

CH1:下管 VGS CH2:下管 VDS CH3:上管 VDS CH4:ICr



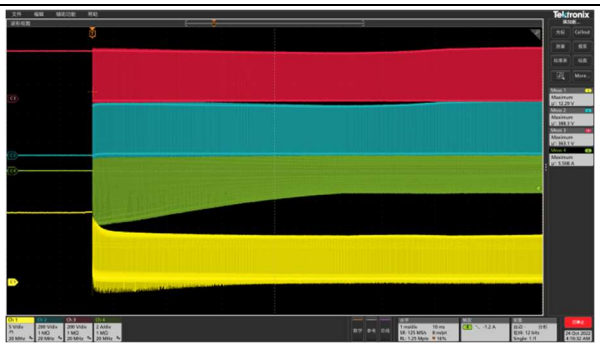
90VAC Input_100% Load_Startup

CH1:下管 VGS CH2:下管 VDS CH3:上管 VDS CH4:ICr



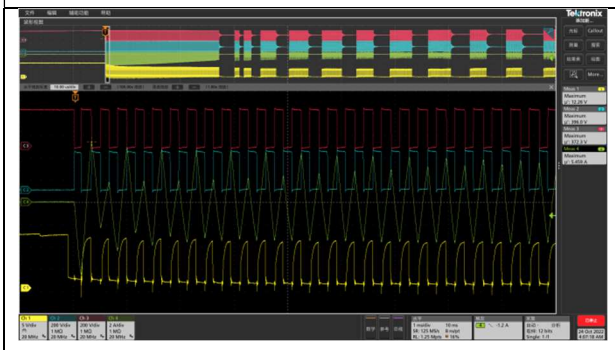
264VAC Input_0% Load_Startup

CH1:下管 VGS CH2:下管 VDS CH3:上管 VDS CH4:ICr



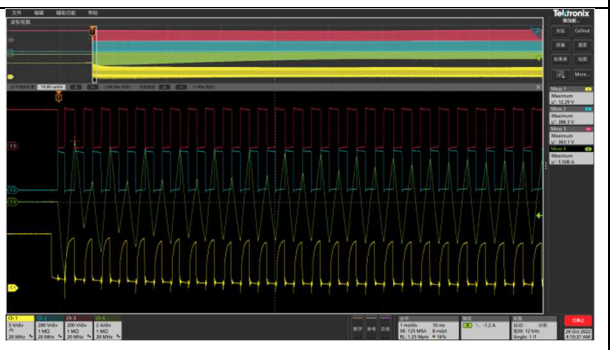
264VAC Input_100% Load_Startup

CH1:下管 VGS CH2:下管 VDS CH3:上管 VDS CH4:ICr



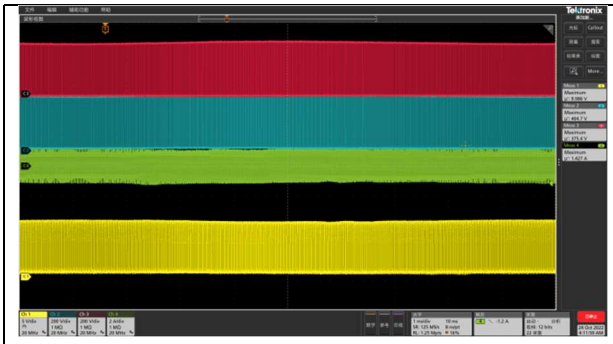
90VAC Input_0% Load_Startup

CH1:下管 VGS CH2:下管 VDS CH3:上管 VDS CH4:ICr



264VAC Input_100% Load_Startup

CH1:下管 VGS CH2:下管 VDS CH3:上管 VDS CH4:ICr



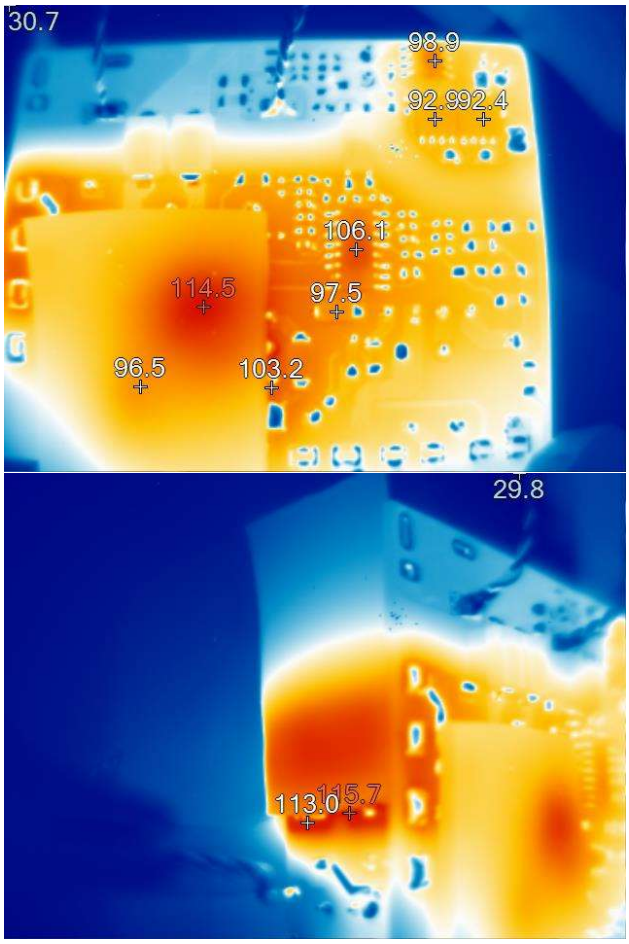
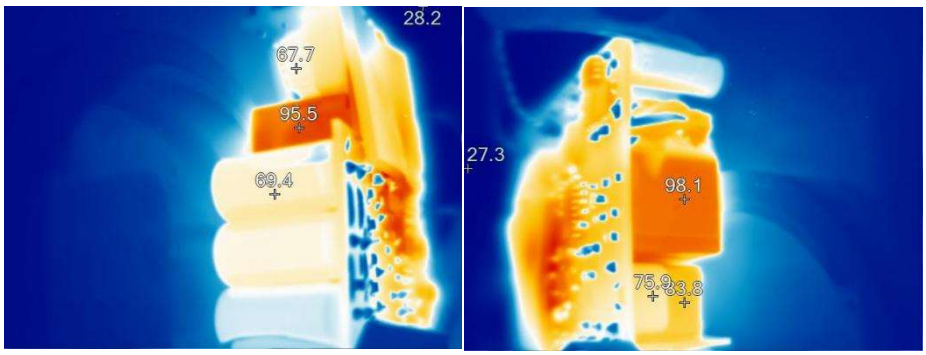
90VAC Input_100% Load_Workon

CH1:下管 VGS CH2:下管 VDS CH3:上管 VDS CH4:ICr

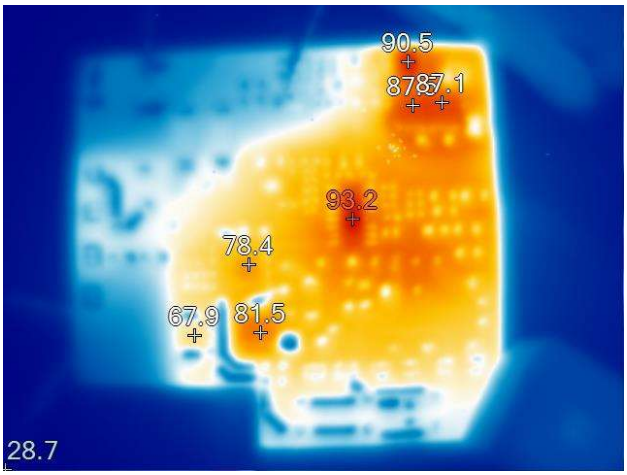
264VAC Input_100% Load_Workon

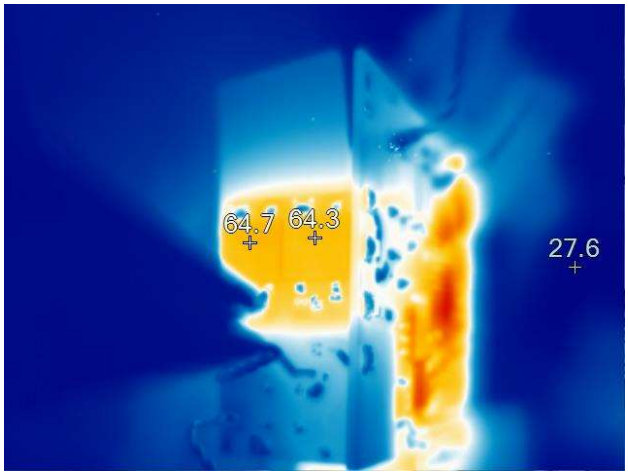
CH1:下管 VGS CH2:下管 VDS CH3:上管 VDS CH4:ICr

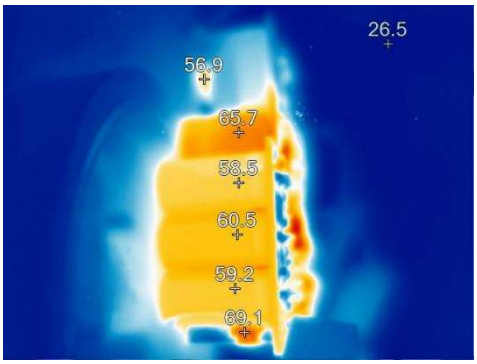
3.6 热测试 Thermal Test（90VAC/264VAC 满载）

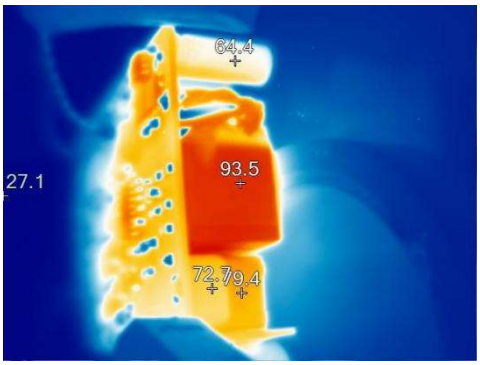
Input 90Vac,Output 29V/5A 热测试	
	PFC GAN :114.5℃ (加导热硅胶垫) PFC SIC :103.2℃ TEA2016：106.1℃ SR MOS1：92.4℃ SR MOS2：92.9℃ TEA2095：98.9℃ Bridge1 :113℃ (加导热硅胶垫) Bridge2 :115.7℃ (加导热硅胶垫) 电解电容：69.4℃ PFC 电感：95.5 共模电感：67.7 LLC 变压器：98.1 谐振电容：75.9 谐振电感：83.8
	环境温度：28.2

Input 264Vac,Output 29V/5A 热测试



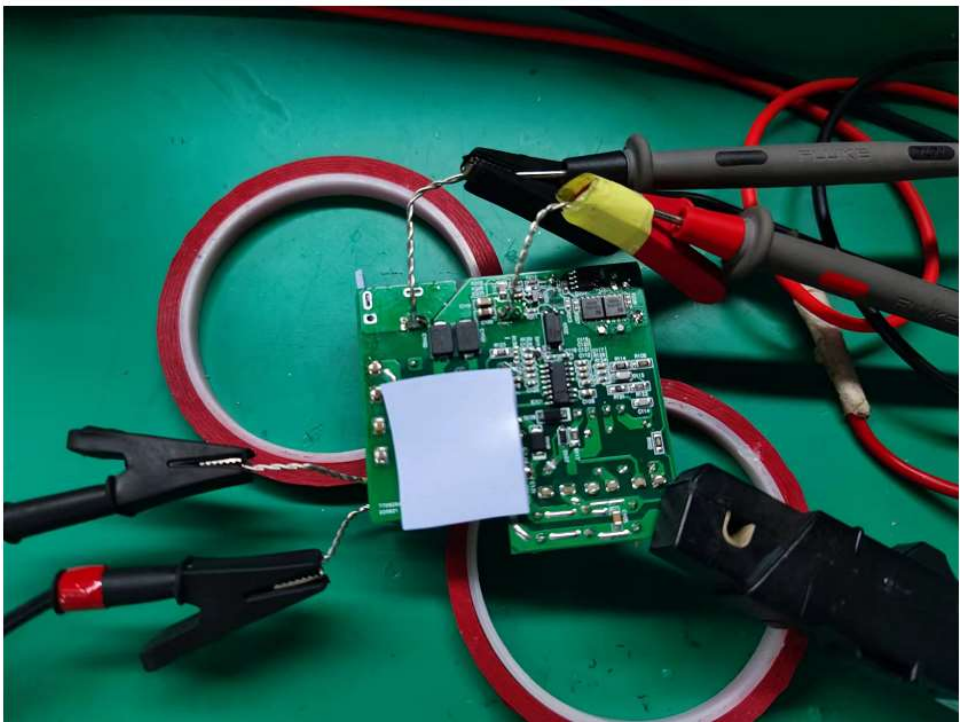




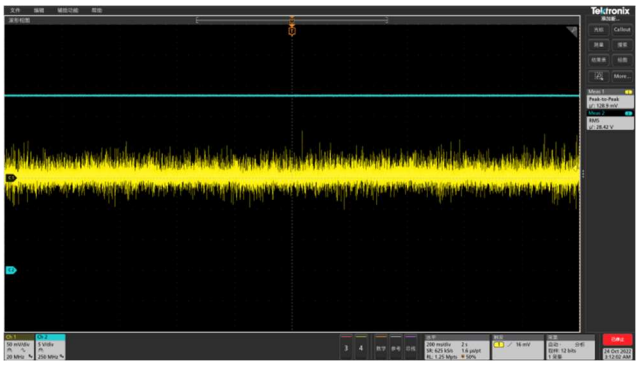
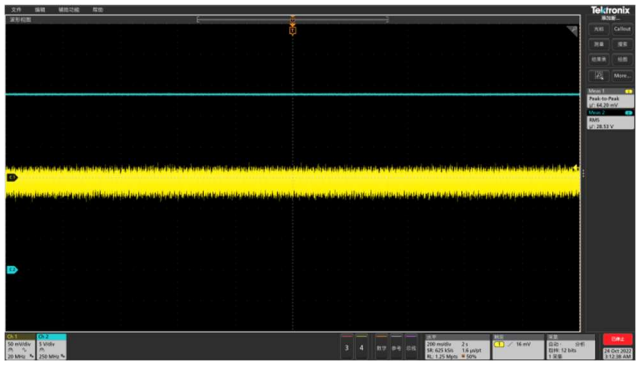
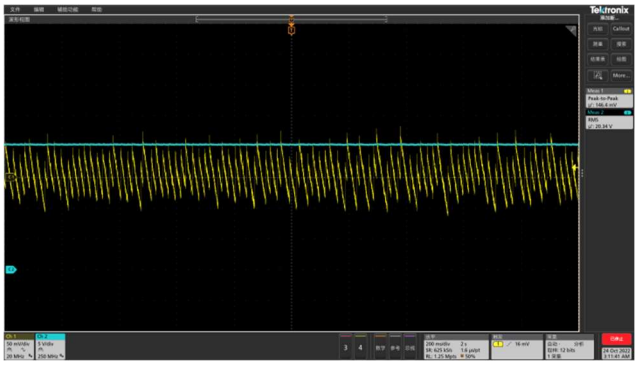
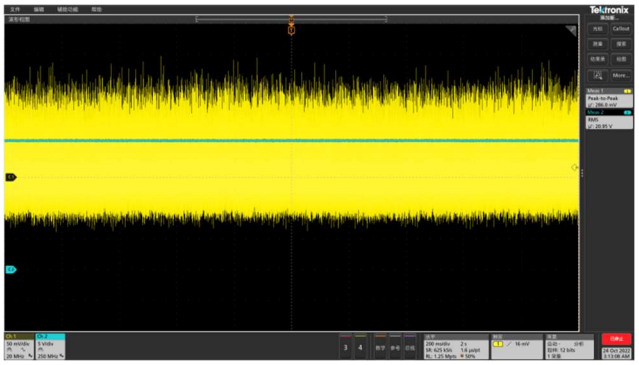
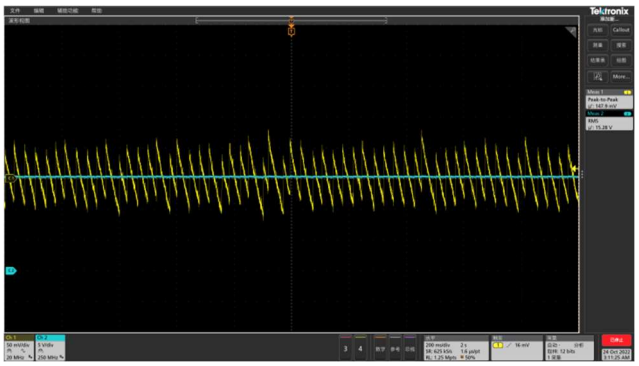
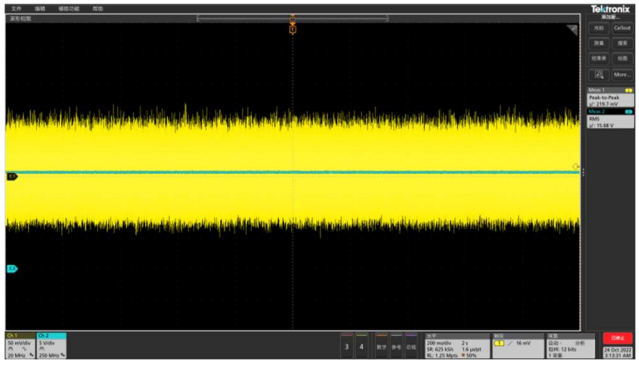


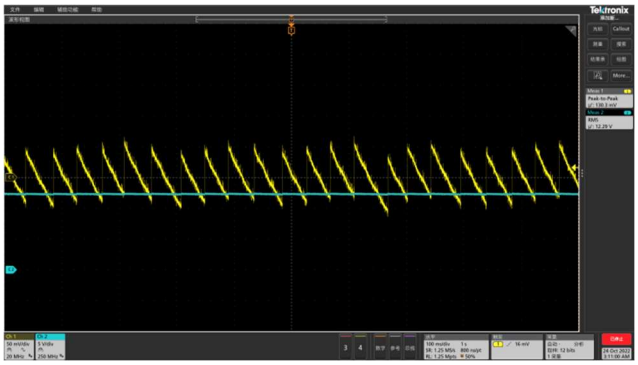
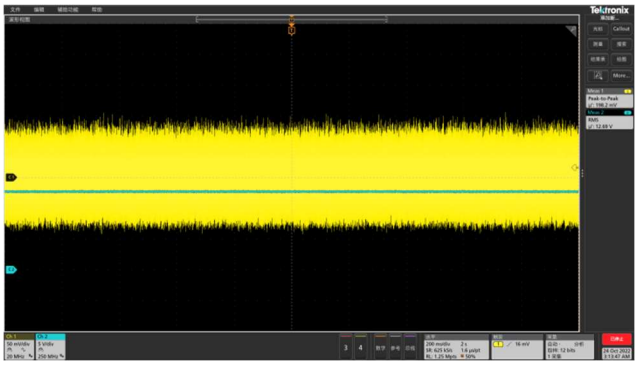
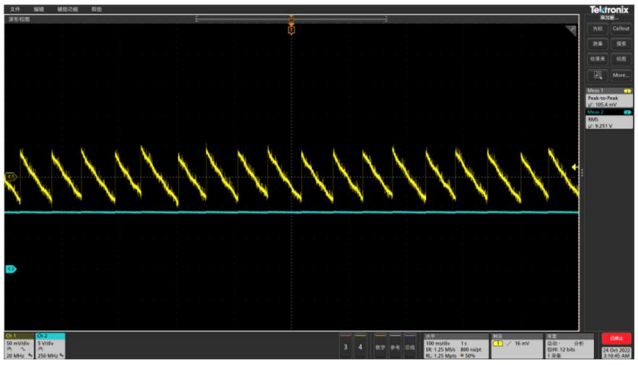
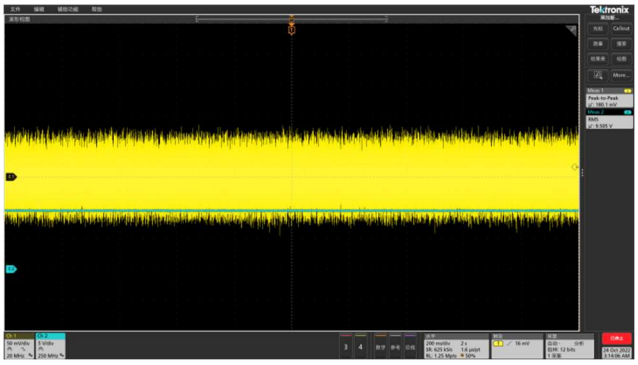
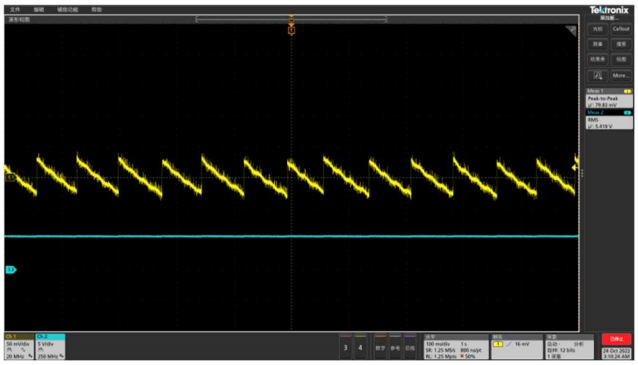
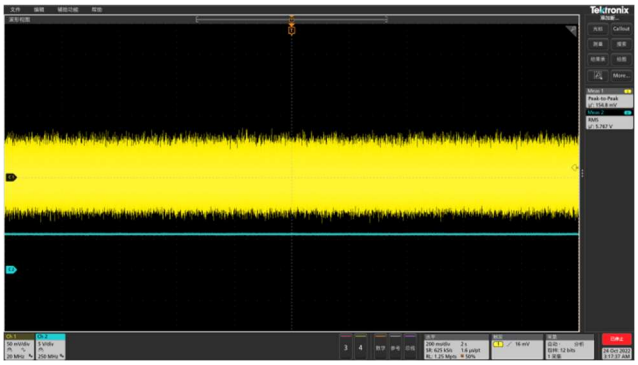
PFC GAN :78.4℃
PFC SIC :81.5℃
TEA2016：93.2℃
SR MOS1：87.1℃
SR MOS2：87.5℃
TEA2095：90.5℃
Bridge1 :64.3℃
Bridge2 :64.7℃
电解电容：60.5℃
PFC 电感：65.7
共模电感：56.9
LLC 变压器：93.5
谐振电容：72.7
谐振电感：79.4
环境温度：26.5

热测试 Setup(裸机)

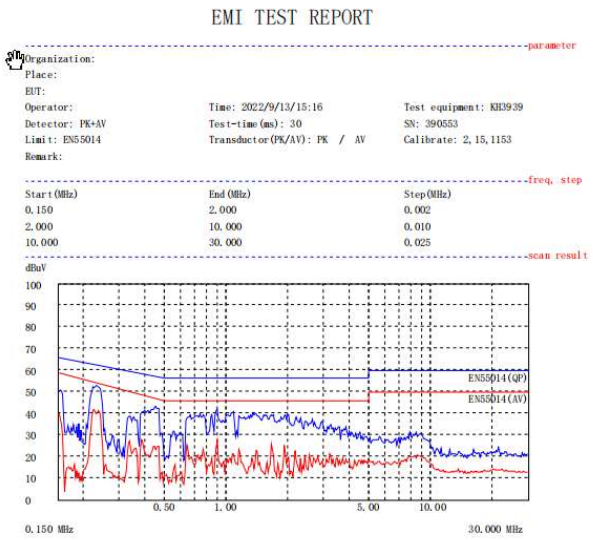
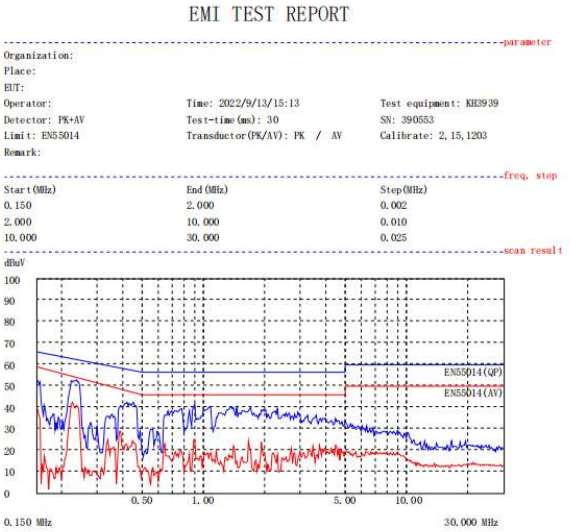
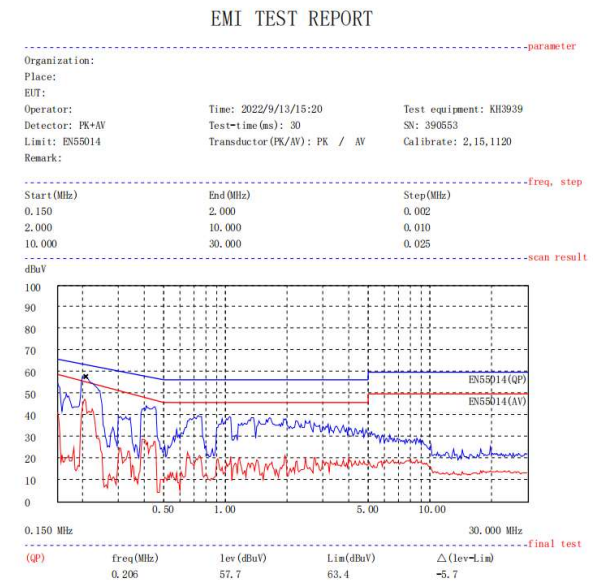
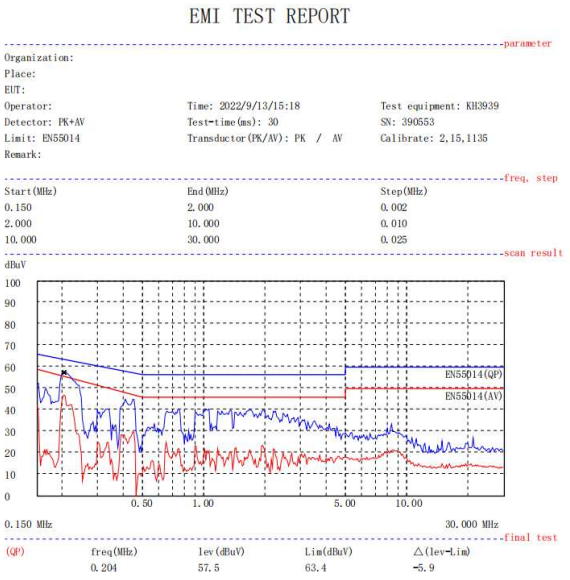


3.4 纹波测试/Ripple Test

Output:28V5A/0% Load	Output:28V5A/100% Load
	
Vpk-pk:129mV	Vpk-pk:64mV
Output:20V5A/0% Load	Output:20V5A/100% Load
	
Vpk-pk:147mV	Vpk-pk:286mV
Output:15V3A/0% Load	Output:15V3A/100% Load
	
Vpk-pk:147mV	Vpk-pk:219mV
Output:12V3A/0% Load	Output:12V3A/100% Load

	
Vpk-pk:130mV	Vpk-pk:198mV
Output:9V2A/0% Load	Output:9V2A/100% Load
	
Vpk-pk:106mV	Vpk-pk:180mV
Output:5V3A/0% Load	Output:5V3A/100% Load
	
Vpk-pk:79mV	Vpk-pk:154mV

3.5 EMI 测试/EMI Test（AC/DC　28V/5A）

CE:230VAC L	CE:230VAC N
	
CE:115VAC L	**CE:115VAC N**
	
RE 模拟:230V	**RE 模拟:115V**

EMI TEST REPORT

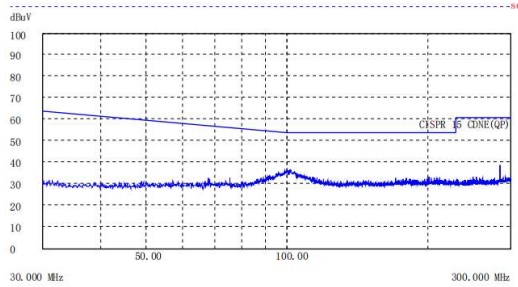
parameter

Organization:
Place:
EUT:
Operator:
Time: 2022/9/13/15:28
Test equipment: KH3939
Detector: PK
Test-time(ms): 30
SN: 390553
Limit: CISPR 15 CDNE
Transductor(PK/AV): CDNE / CDNE
Calibrate: 2,15,1067
Remark:

freq, step

Start(MHz)	End(MHz)	Step(MHz)
30.000	300.000	0.100

scan result



EMI TEST REPORT

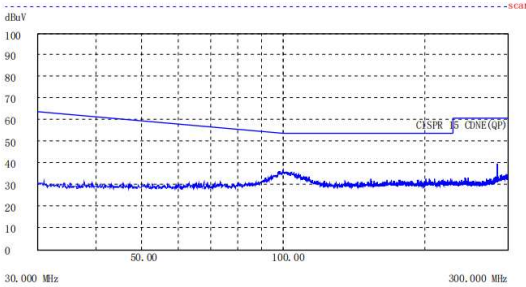
parameter

Organization:
Place:
EUT:
Operator:
Time: 2022/9/13/15:25
Test equipment: KH3939
Detector: PK
Test-time(ms): 30
SN: 390553
Limit: CISPR 15 CDNE
Transductor(PK/AV): CDNE / CDNE
Calibrate: 2,15,1090
Remark:

freq, step

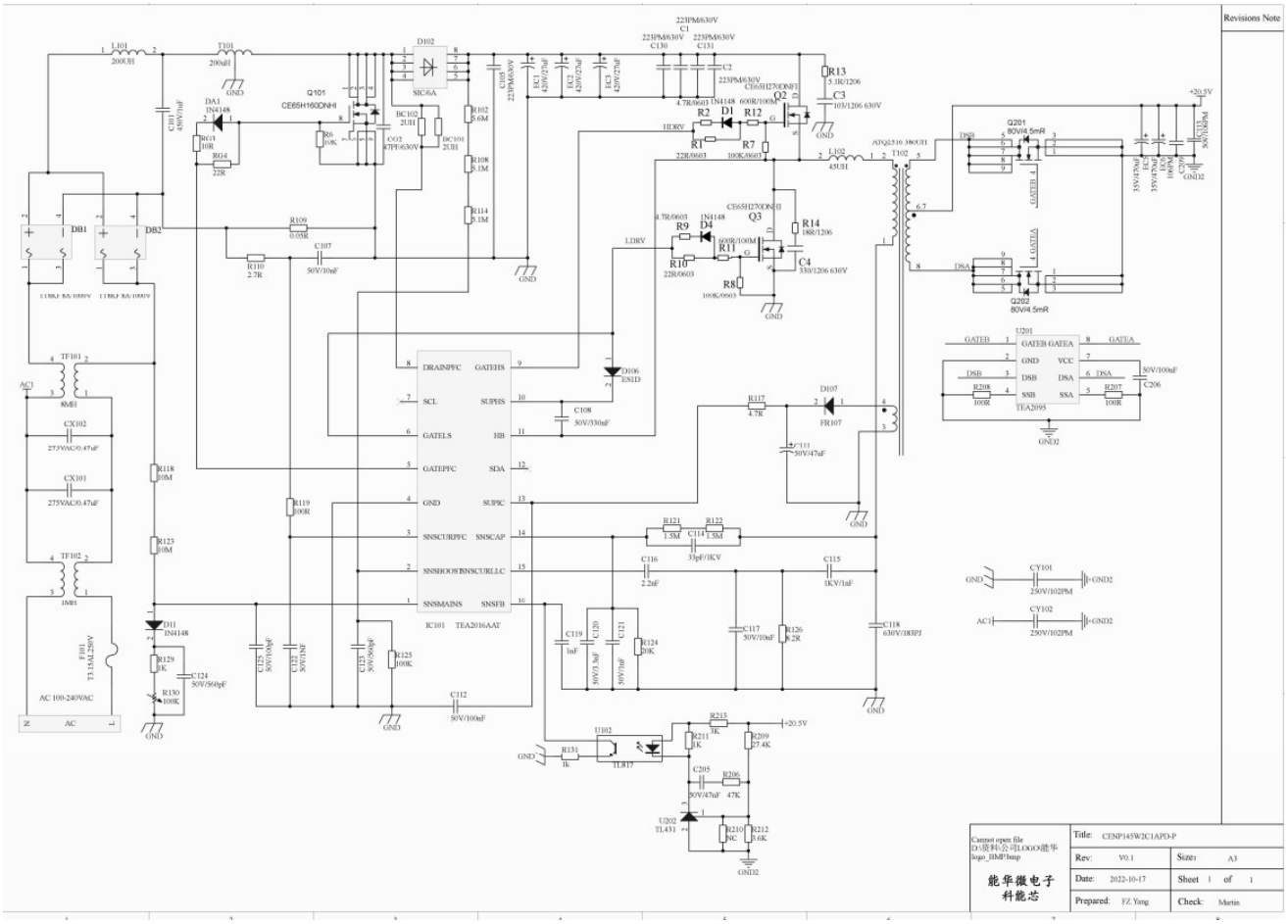
Start(MHz)	End(MHz)	Step(MHz)
30.000	300.000	0.100

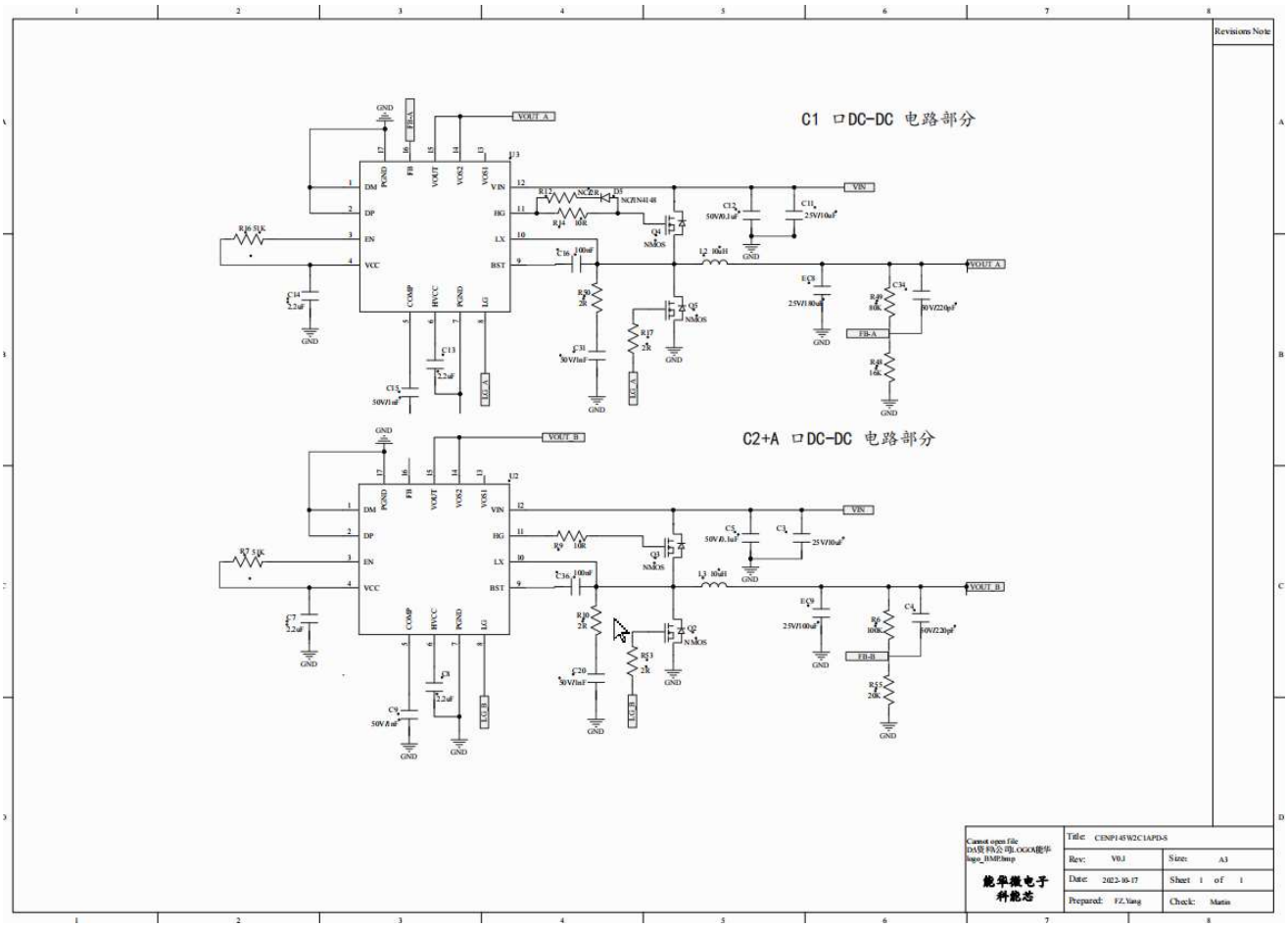
scan result

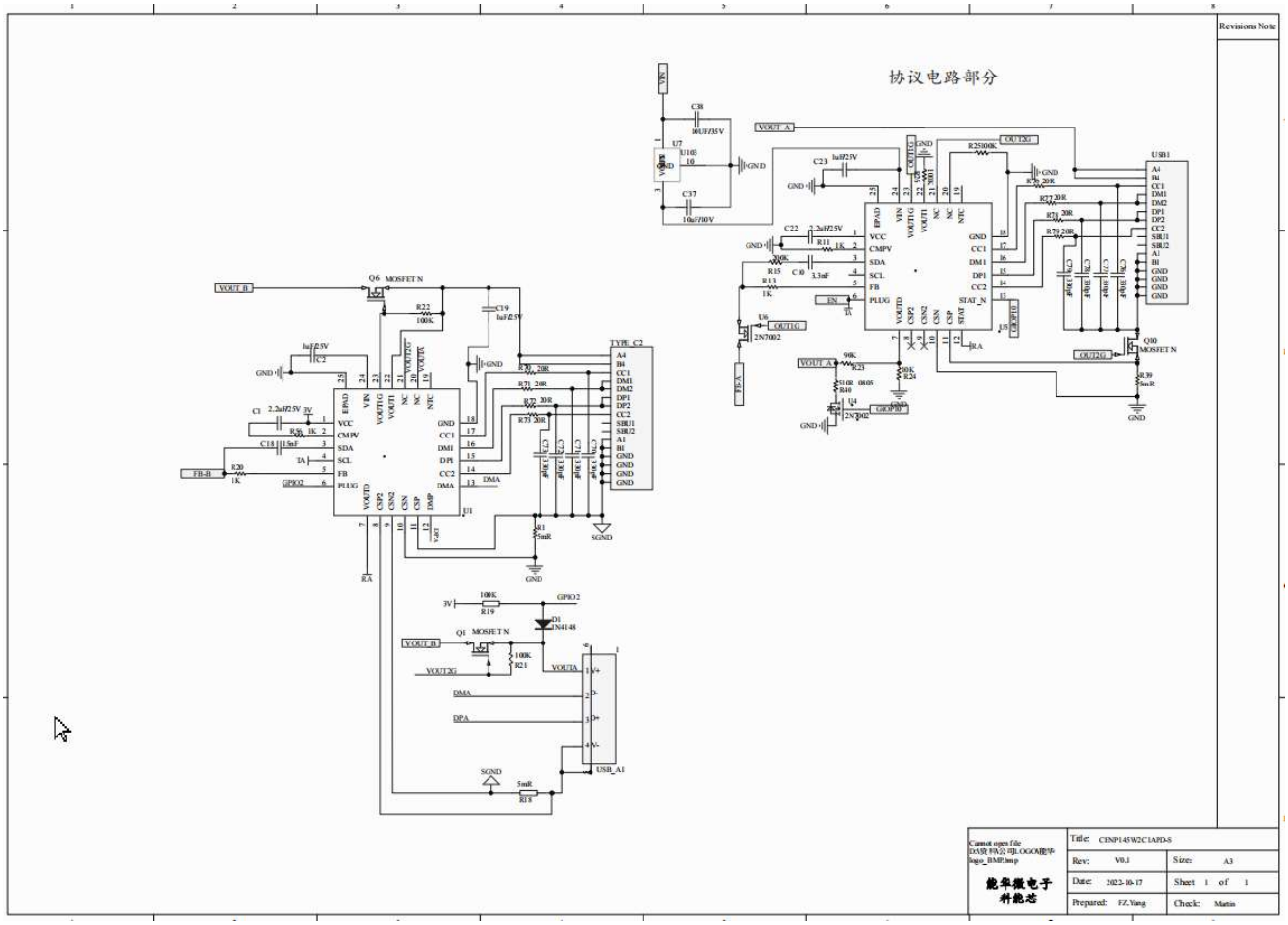


4.主要文件

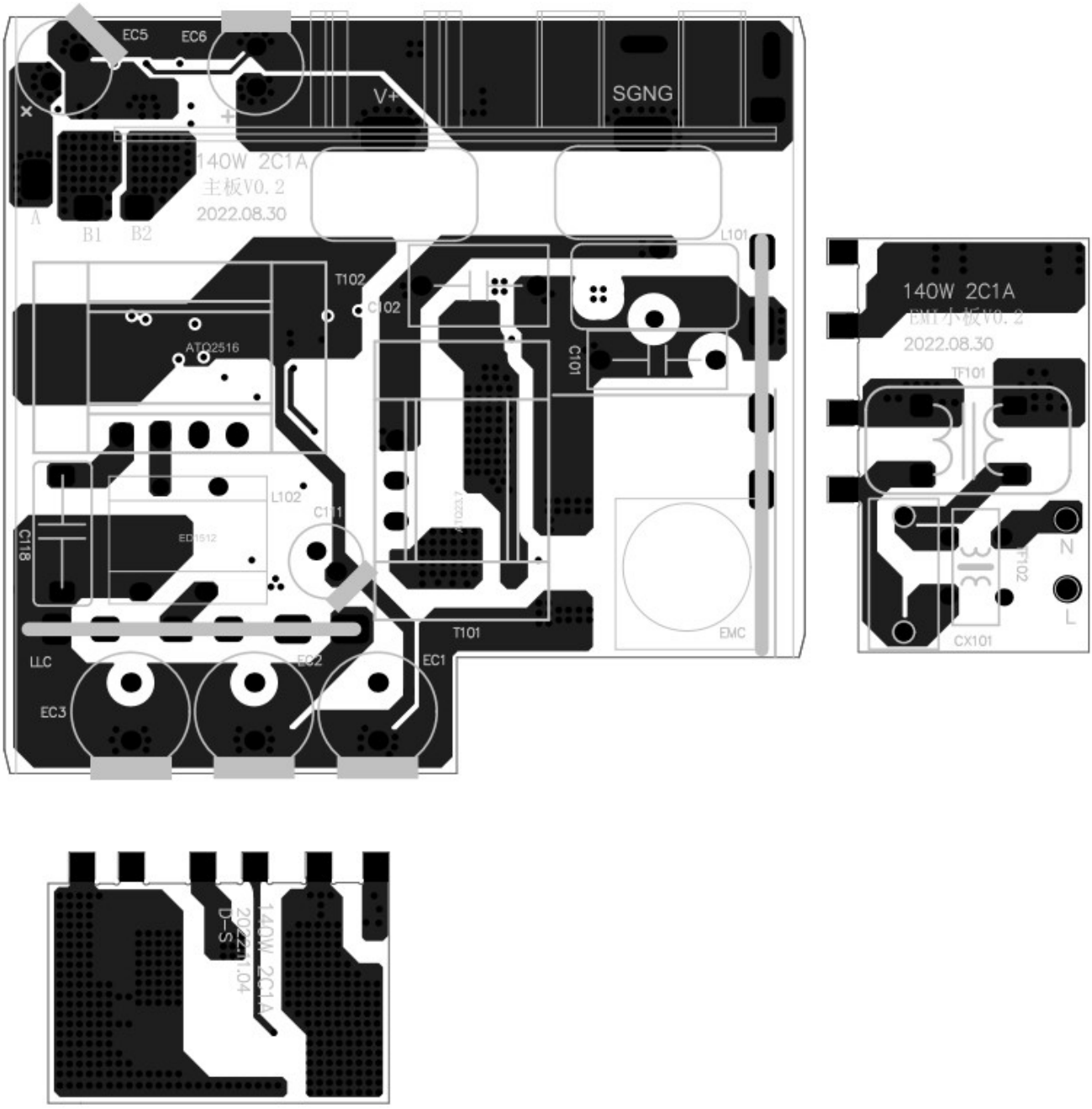
4.1 原理图/Schematics



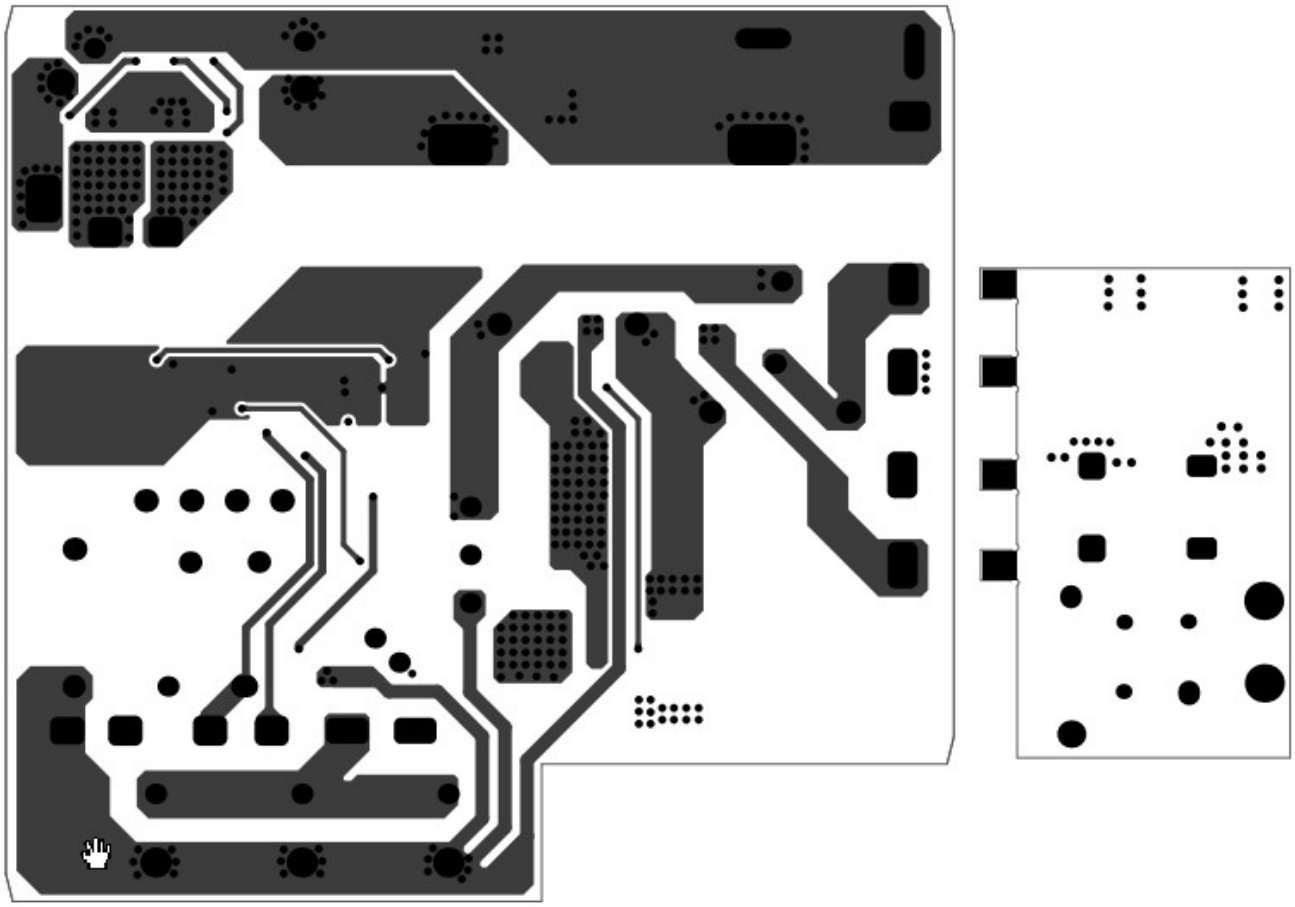

C1 口DC-DC 电路部分
C2+A 口DC-DC 电路部分
Revisions Note
VOUT_A
VOUT_B
VIN
GND
FB-A
FB-B
能华微电子
科能芯

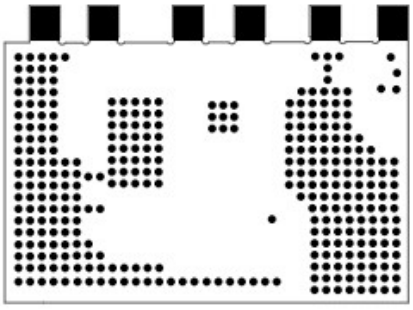

协议电路部分
Revisions Note
Title: CENP145W2C1APD-S
Rev: V0.1
Size: A3
Date: 2023-10-17
Sheet 1 of 1
Prepared: FZ.Yang
Check: Martin
能华微电子
科能芯

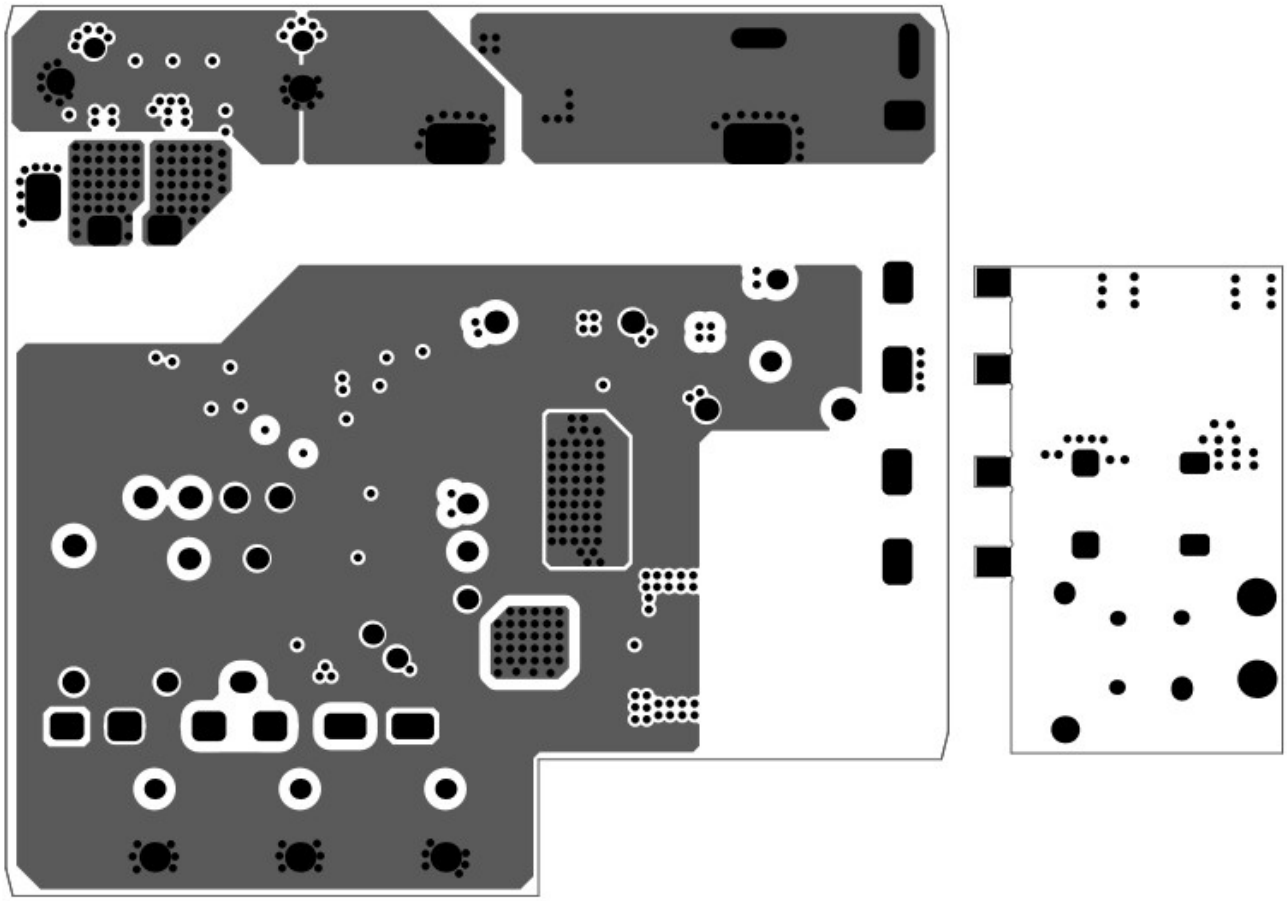
4.2 PCB 板/PCB

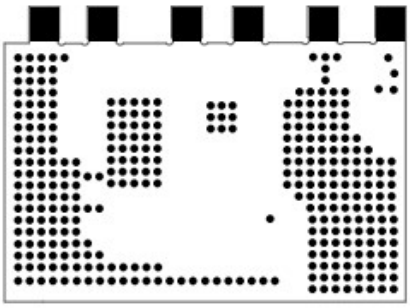

EC5
EC6
V+
SGNG
140W 2C1A
主板V0.2
2022.08.30
B1
B2
T102
C102
ATO2516
C101
L101
L102
C111
C118
T101
LLC
EC2
EC1
EC3
EMC
140W 2C1A
2022.08.30
TF101
CX101
N
L

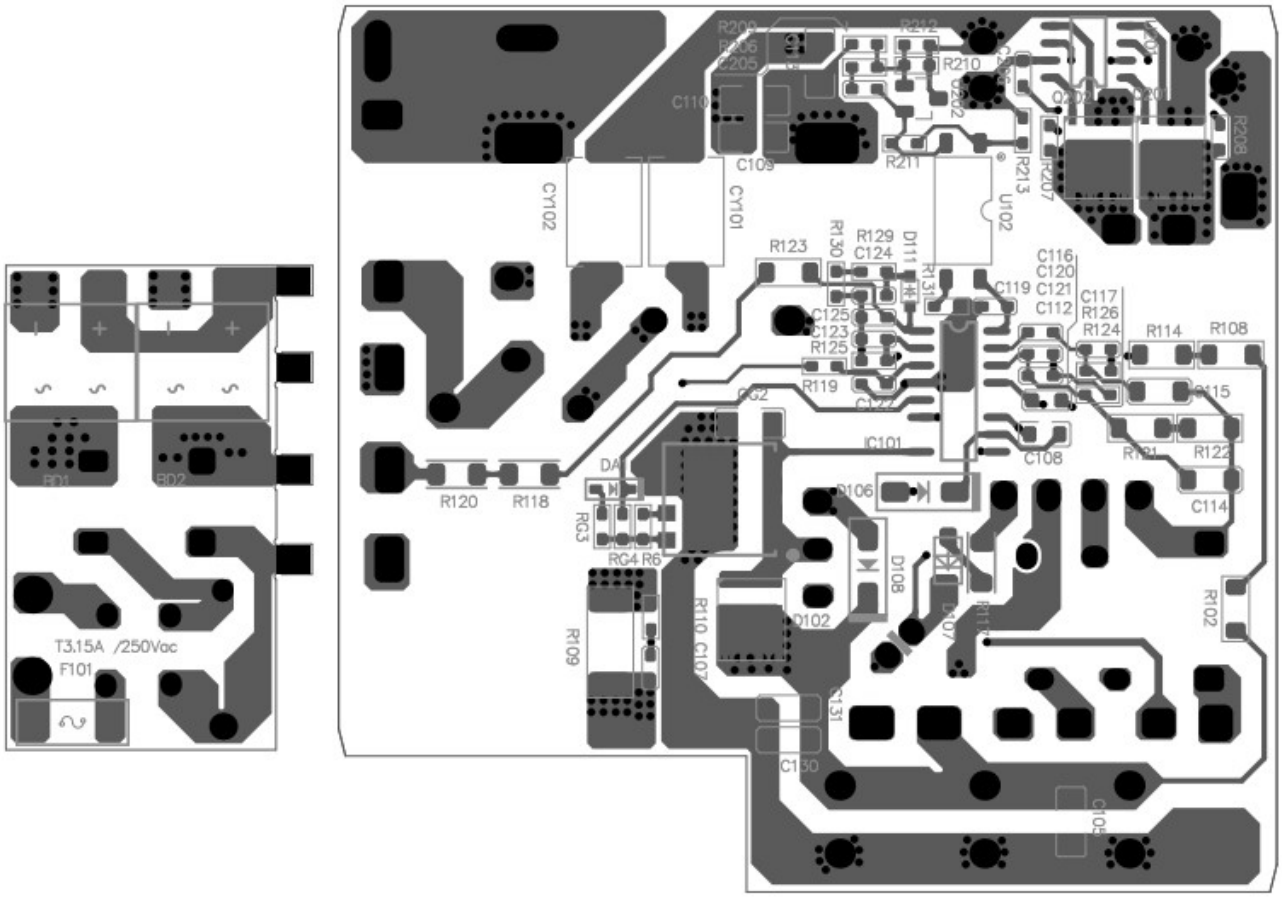
140W 2C1A
2022.01.04
D-S

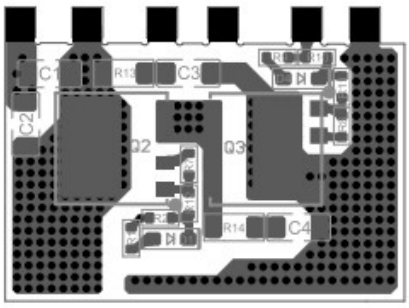









T3.15A /250Vac
F101
BD1
BD2
CY102
CY101
C109
C110
R211
R213
U102
R123
R129
C124
C116
C120
C121
C112
C117
R126
R124
R114
R108
C119
C125
C123
R125
R119
C115
IC101
C108
R120
R118
R106
C114
D108
D102
R102
R109
C107
C131
C130
C105


C1
C3
C2
Q2
Q3
C4

4.3 系统 BOM

序号	品名	规格	位号	用量
CY-140W2C1A-P1 电源板 物料BOM				
贴片物料				
1	PCB	CY-140W2C1A-P1, 69*65.2*1.2mm, 双面板, FR-4, 2OZ		1
2	贴片电容	贴片电容, 100pF, 50V, 0603, YAGEO, NPO, ±5%	C125	1
3	贴片电容	贴片电容, 1nF, 50V, 0603, YAGEO, NPO, ±5%	C121, C122,C119	3
4	贴片电容	贴片电容, 10nF, 50V, 0603, YAGEO, X7R, ±10%	C107,C117	2
5	贴片电容	贴片电容, 100nF, 50V, 0603, YAGEO, X7R, ±10%	C112	1
6	贴片电容	贴片电容, 2.2nF, 50V, 0603, YAGEO, X7R, ±10%	C116	1
7	贴片电容	贴片电容, 3.3nF, 50V, 0603, YAGEO, X7R, ±10%	C120	1
8	贴片电容	贴片电容, 47nF, 50V, 0603, YAGEO, X7R, ±10%	C205	1
9	贴片电容	贴片电容, 470nF, 50V, 0805, YAGEO, X7R, ±10%	C108	1
10	贴片电容	贴片电容, 560pF, 50V, 0603, YAGEO, NPO, ±5%	C123, C124	2
11	贴片电容	贴片电容, 1UF, 50V, 0603, YAGEO, X7R, ±10%	C206	1
12	贴片电容	贴片电容, 10uF, 50V, 1206, YAGEO, X7R, ±10%	C109,C110,C113	3
13	贴片电容	贴片电容, 10nF, 1000V, 1206, YAGEO, X7R, ±10%	C105,C130,C131	3
14	贴片电容	贴片电容, 33pF, 1000V, 1206, YAGEO, NPO, ±5%	C114	1
15	贴片电容	贴片电容, 1nF, 1000V, 1206, YAGEO, NPO, ±5%	C115	1
16	贴片电容	贴片Y电容, 1nF, 400V, , Y2, ±10%	CY101, CY102	2
17	贴片电阻	贴片电阻,10Ω,0603,Uniohm,,±5%	RG3	1
18	贴片电阻	贴片电阻,47Ω,0603,Uniohm,,±5%	RG4	1
19	贴片电阻	贴片电阻,10KΩ,0603,Uniohm,,±5%	R6	1
20	贴片电阻	贴片电阻,100Ω,0603,Uniohm,,±5%	R207,R208	2
21	贴片电阻	贴片电阻,100Ω,0603,Uniohm,,±1%	R119	1
22	贴片电阻	贴片电阻,1KΩ,0603,Uniohm,,±1%	R129, R131, R211	3
23	贴片电阻	贴片电阻,100KΩ,0603,Uniohm,,±1%	R125, R130	2
24	贴片电阻	贴片电阻,20KΩ,0603,Uniohm,,±1%	R124	1
25	贴片电阻	贴片电阻,2.7Ω,0603,Uniohm,,±1%	R110	1
26	贴片电阻	贴片电阻,110KΩ,0603,Uniohm,,±1%	R209	1
27	贴片电阻	贴片电阻,3KΩ,0603,Uniohm,,±1%	R213	1
28	贴片电阻	贴片电阻,10KΩ,0603,Uniohm,,±1%	R212	1
29	贴片电阻	贴片电阻,11Ω,0603,Uniohm,,±1%	R126	1
30	贴片电阻	贴片电阻,47KΩ,0603,Uniohm,,±1%	R206	1
31	贴片电阻	贴片电阻,5.6MΩ,1206,Uniohm,,±1%	R102	1
32	贴片电阻	贴片电阻,5.1MΩ,1206,Uniohm,,±1%	R108, R114	2
33	贴片电阻	贴片电阻,4.7Ω,1206,Uniohm,,±1%	R117	1
34	贴片电阻	贴片电阻,6.8MΩ,1206,Uniohm,,±1%	R118,R120,R123	3
35	贴片电阻	贴片电阻,1.5MΩ,1206,Uniohm,,±1%	R121, R122	2
36	贴片电阻	贴片电阻,0.05Ω,2512,Uniohm,,±1%	R109	1
37	贴片二极管	1N4148/SOD-323	DA1,D111	2
38	贴片二极管	ES2J/SMA	D106	1
39	贴片二极管	FR107/SOD-123	D107	1
40	贴片二极管	S3MF/SMBF	D108	1
41	贴片GAN管	贴片GAN管;CE65D160AOTI;DFN8*8;;能华微;N沟道;12A;650V	Q3	1
42	SIC 二极管	碳化硅快恢复二极管,,5A,600V,DFN5X6	D102	1
43	贴片MOSFET	贴片MOSFET;LH160N085S;DFN5X6;4.2mΩ;160A;85V	Q201，Q202	2
44	贴片IC	TEA2095T/SOP-8	U201	1
45	贴片IC	TEA2016/SOP-16	IC101	1
46	贴片IC	EL1018/SOP-4	U102	1
47	贴片IC	TL431/SOT-23	U202	1

插件物料				
1	AC	输入端子L/N	L,N	1
2	CBB电容	CBB电容,474/450V,脚距10mm	C101	1
3	CBB电容	CBB电容,105/450V,脚距10mm	C102	1
4	CBB电容	MKP电容,223/630V,脚距10mm	C118	1
5	电解电容	电解电容,47uF/50V,6.3*12mm	C111	1
6	电解电容	电解电容,27uF/450V,8*20mm	EC1, EC2, EC3	3
7	电解电容	固态电解电容,680uF/35V,8*20mm	EC5, EC6	2
8	磁性器件	LLC 变压器,ATQ2516 (3+3) /380uH 21Ts/0.1*20	T102	1
9	磁性器件	PFC电感,ATQ23.7 (3+3) /180uH 30TS /0.1*40	T101	1
10	磁性器件	差模电感,T12/100uH, 铁硅铝环	L101	1
11	磁性器件	谐振电感,ED1512/45uH 20Ts/0.1*30	L102	1

CY-140W2C1A-P2 整流小板 物料BOM				
贴片物料				
	PCB	CY-140W2C1A-P2,35.5*21.5*1.2mm,双面板,FR-4,2OZ		1
1	贴片保险管	保险管,3.15A/250VAC	F101	1
2	整流桥堆	TT8KF 8A/1000V	DB1, DB2	2
插件物料				
1	共模电感	12MH	TF101	1
2	共模电感	100UH	TF102	1
3	X2电容	275VAC/0.47uF	CX101	1

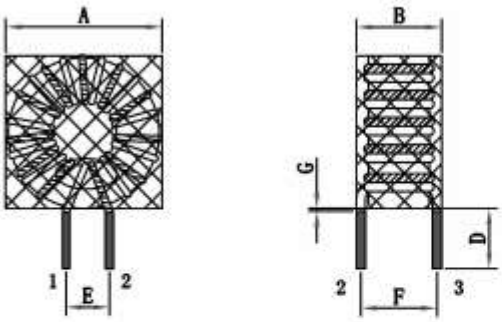
CY-140W2C1A-P4 LLC小板 物料BOM				
贴片物料				
1	PCB	CY-140W2C1A-P4,25*21.5*1.2mm,双面板,FR-4,2OZ		1
2	贴片GAN管	贴片GAN管;CE65H270DNFI;DFN8*8;大D焊盘;能华微;N沟道;7.9A;6	Q2	1
3	贴片GAN管	贴片GAN管;CE65H270DNHI;DFN8*8;大S焊盘;能华微;N沟道;7.9A;6	Q3	1
4	贴片二极管	整流二极管,1N4148,1A,75V,SOD-323	D1,D4	2
5	贴片电阻	贴片电阻,10Ω,0603,Uniohm,,±5%	R1,R9	2
6	贴片电阻	贴片电阻,47Ω,0603,Uniohm,,±5%	R2,R10	2
7	贴片电阻	贴片电阻,100KΩ,0603,Uniohm,,±5%	R7,R8	2
8	贴片电阻	贴片电阻,5Ω,1206,Uniohm,,±5%	R13	1
9	贴片电阻	贴片电阻,15Ω,1206,Uniohm,,±5%	R14	1
10	贴片电容	贴片电容,10nF,1000V,1206,YAGEO,X7R,±10%	C1,C2,C3	3
11	贴片电容	贴片电容,33pF,630V,1206,YAGEO,X7R,±10%	C4	1

4.4 关键器件图纸/Drawing

CUSTOMER		NH P/N	LC10-70uH

MECHANICAL DIMENSION: (UNIT:mm)

RoHS Compliant



NOTE:
1. 双线并绕, 且N1用漆包线, N2用三层绝缘线;
2. 起收线须点胶固定(3300A/B);
3. 成品圈包TAPE1.5TS(17.5mm(W))

WINDING STEP:

WDG	Terminal	Wire Gauge	Turns	Remarks
N1	1-4	2UEW-B 0.5	10Ts	
N2	2-3	TEX-E 0.5	10Ts	

ELECTRICAL CHARACTER:

NO.	Item	Measured Point	Technical Data	Test Condition & Instrument
1	Inductance	L(1-4)	70uH MIN	CH 1061 (1KHz, 0.25V)
		L(2-3)	70uH MIN	
2	DCR		待定	GKT2511 25℃
3	HI-POT	COIL TO COIL	600VAC	60Hz, 5mA, 3S CS2672C
		COIL TO CORE		

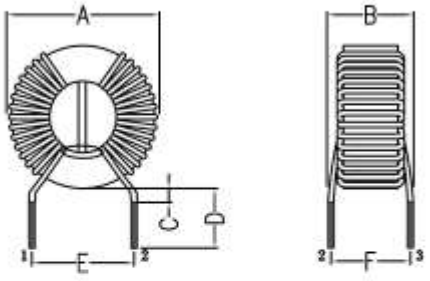
Material List:

NO	Items	Materials	Suppliers/Manufacturer
1	Ferrite Core	T10*5*6C 镍芯	
2	Copper Wire		
3	Epoxy		
4	Triple Wire		

	DRAWN BY	CHECKED BY	APPROVED BY	CUSTOMER P/N	
				MODEL /Rev.	
				DATE	
				SHEET_OF_	1 / 1

CUSTOMER		NH P/N	LC14-

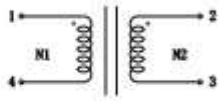
OUTLINE DIMENSION(UNIT:mm):



DIMENSION:(mm)
A: MAX
B: MAX
C: 1.5 MAX
D: 3.1~3.6
E: 8.0±1.0
F: 8.0±1.0

RoHS Compliant

SCHEMATIC:



1. 产品需含浸；
2. 点胶(3300A/B)固定隔板及进出线(两点)；
3. 排线尽量靠中间.

WINDING SEQUENCE:

WDG	TERMINAL	WIRE	TURNS	REMARKS
N1	1--4	2UEW-NY-B 0.5 N	12Ts REF	N1=N2
N2	2--3	2UEW-NY-B 0.N	12Ts REF	

TECHNICAL PARAMETER:

NO.	ITEMS	MAESURED POINT	TECHNICAL DATA	TEST CONDITION & INSTRUMENT
1	INDUCTANCE	L(1--4)	20mH MIN	CH-1061 (f=1KHz, V=0.25V)
		L(2--3)	20mH MIN	
		L(1--4)-L(2--3)	MAX	
2	DCR	R(1--4)&R(2--3)	mΩ MAX	GKT2511 25℃
3	HI-POT	COIL TO COIL	600VAC	50Hz, 5mA, 3S CS2672

MATERIAL:

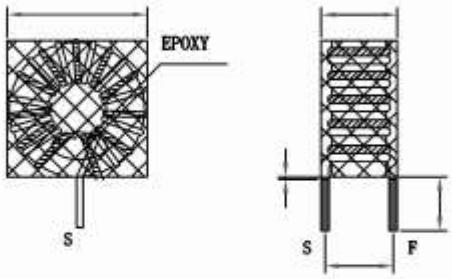
NO.	ITEMS	MATERIALS	MANUFACTURER
1	CORE	T12*6*7C 非晶环	
2	WIRE		
3	BASE		
4	Varnish		
5	Epoxy		

	DRAWN BY	CHECKED BY	APPROVED BY	CUSTOMER P/N	
				MODEL/REV.	
				DATE	
				SHEET_OF_	1 / 1

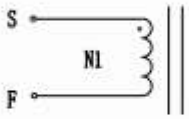
CUSTOMER		NH P/N	LC-12470

OUTLINE DIMENSION(UNIT:mm):

RoHS Compliant



SCHEMATIC:



NOTE:
1. 绕满80%窗口
2. 起收线须点胶固定
3. 成品圈包热缩套管

WINDING SEQUENCE:

WDG	TERMINAL	WIRE	TURNS	REMARKS
N1	S-F	2UEW-B 0.5 N	25 REF	

TECHNICAL PARAMETER:

NO.	ITEMS	MAESURED POINT	TECHNICAL DATA	TEST CONDITION & INSTRUMENT
1	INDUCTANCE	L(0A)(S-F)	100μH±10%	CH-1062 (f=1KHz, V=0.25V)
2	Irat Inductance	L(DC1.0A)(S-F)		GKT2511 25℃
3	DCR	R(S-F)		GKT2511 25℃

MATERIAL:

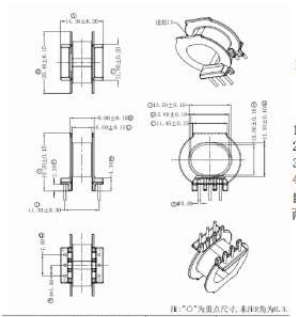
NO.	ITEMS	MATERIALS	MANUFACTURER
1	CORE	MKS112125	
2	WIRE		
3	CLIP		
4	EPOXY		
5	INK		

	DRAWN BY	CHECKED BY	APPROVED BY	CUSTOMER P/N	
				MODEL/REV.	
				DATE	
				SHEET_OF_	1 / 1

CUSTOMER		NH P/N	

OUTLINE DIMENSION(UNIT:mm):

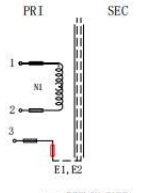
RoHS Compliant



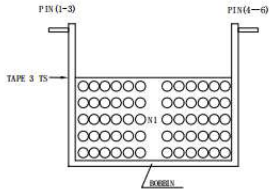
REMARK:

1. CUT OFF PIN4,5,6
2. PIN1 朝左绕线
3. 磁芯接口处需点胶固定.
4. 磁芯外包2Ts胶带后，沿磁芯方向用自粘铜箔绕一层，再沿线包方向绕一层铜箔，两层十字相交，侧面加锡引线，挂脚于PIN3

SCHEMATIC:



WINDING CONSTRUCTION:



	DRAWN BY	CHECKED BY	APPROVED BY	CUSTOMER P/N	
				MODEL/REV.	
				DATE	
				SHEET_OF_	1 / 2

CUSTOMER			

RoHS Compliant

WINDING STEP:

№	S-F	线 规	匝数TS	胶带TS	层数疏密	套 管	备 注
N1	1-2	2UEW-B 0.1X35mm	30REF	2	5/M	30L	
E1/E2	3-	FOIL:0.025*5.0mm	1.1	3	center	30L	

ELECTRICAL CHARACTER:

NO.	ITEM	MEASURED POINT	TECHNICAL DATA	TEST CONDITION & INSTRUMER
1	INDUCTANCE	L(1-2)	180uH±10%	CH 1061 (1KHz, 0.25V)
2	LEAKAGE INDUCTANCE			CH 1061 (10KHz, 0.25V)
3	HI-POT	PRI TO SEC	3000VAC	50Hz,1mA,60S CS2672C
		PRI TO CORE	1500VAC	
		SEC TO CORE	1500VAC	

MATERIAL LIST:

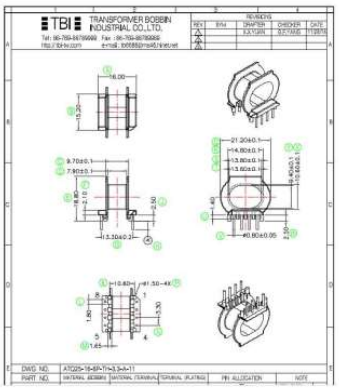
NO.	ITEM	MATERIAL	MANUFACTURER
1	BOBBIN	ATQ23.7(3+3)	
2	CORE	ATQ23.7 PC95或同等材质	
3	WIRE		
4	MYLAR TAPE		
5	MARGIN TAPE		
6	TUBE		
7	VARNISH		

	DRAWN BY	CHECKED BY	APPROVED BY	CUSTOMER P/N	
				MODEL/REV.	
				DATE	
				SHEET_OF_	2 / 2

CUSTOMER		NH P/N	

OUTLINE DIMENSION(UNIT:mm):

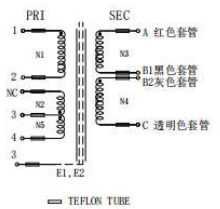
RoHS Compliant



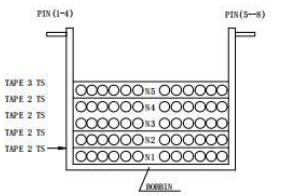
REMARK:

1. CUT OFF PIN5,6,7,8
2. PIN1 朝右绕线,N1绕组不可交叉
3. 磁芯接口处需点胶固定.
4. 磁芯外包2Ts胶带后，沿磁芯方向用自粘铜箔绕一层，再沿线包方向绕一层铜箔，两层十字相交，侧面加锡引线，挂脚于PIN3
4. PIN5-8侧需做全包胶带绝缘处理

SCHEMATIC:



WINDING CONSTRUCTION:



	DRAWN BY	CHECKED BY	APPROVED BY	CUSTOMER P/N	
				MODEL/REV.	
				DATE	
				SHEET_OF_	1 / 2

CUSTOMER			

RoHS Compliant

WINDING STEP:

№	S-F	线 规	匝数TS	胶带TS	层数疏密	套 管	备 注
N1	1-2	2UEW-B 0.1mmX20P	21	2	2/M	30L	
N2	3-NC	2UEW-B 0.2mmX2P	12	2	1/均绕	30L	
N3	A-B1	TEX-1 0.1mmX80P	3	2	1/M	30L	N3 N4绕组需双线并绕
N4	B2-C	TEX-1 0.1mmX80P	3	2	1/M	30L	N3 N4绕组需双线并绕
N5	3-4	2UEW-B 0.2mmX2P	3	2	1/均绕	30L	

ELECTRICAL CHARACTER:

NO.	ITEM	MEASURED POINT	TECHNICAL DATA	TEST CONDITION & INSTRUMER
1	INDUCTANCE	L(1-2)	380uH±10%	CH 1061 (100KHz, 0.25V)
2	LEAKAGE INDUCTANCE	Lk(1-2)(次级短路)	5uH MAX	CH 1061 (100KHz, 0.25V)
3	HI-POT	PRI TO SEC	3000VAC	50Hz,1mA,60S CS2672C
		PRI TO CORE	1500VAC	
		SEC TO CORE	1500VAC	

MATERIAL LIST:

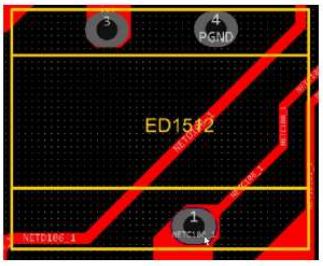
NO.	ITEM	MATERIAL	MANUFACTURER
1	BOBBIN	ATQ2516(4+4)	
2	CORE	ATQ2516 PC95或同等材质	
3	WIRE		
4	MYLAR TAPE		
5	MARGIN TAPE		
6	TUBE		
7	VARNISH		

	DRAWN BY	CHECKED BY	APPROVED BY	CUSTOMER P/N	
				MODEL/REV.	REV01
				DATE	12/08/2022
				SHEET_OF_	2 / 2

CUSTOMER		NH P/N	

OUTLINE DIMENSION(UNIT:mm):

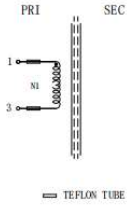
RoHS Compliant



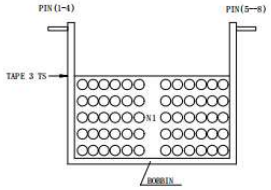
REMARK:
2.PIN1 朝左绕线
3.磁芯接口处需点胶固定.

顶视图，按此截图中脚位绕线

SCHEMATIC:



WINDING CONSTRUCTION:



	DRAWN BY	CHECKED BY	APPROVED BY	CUSTOMER P/N	
				MODEL/REV.	
				DATE	
				SHEET_OF_	1 / 2

CUSTOMER			

RoHS Compliant

WINDING STEP:

№	S-F	线 规	匝数TS	胶带TS	层数疏密	套 管	备 注
N1	1-2	2UEW-B 0.1X30mm	26REF	2	5/M	30L	

ELECTRICAL CHARACTER:

NO.	ITEM	MEASURED POINT	TECHNICAL DATA	TEST CONDITION & INSTRUMER
1	INDUCTANCE	L(1-2)	45uH±10%	CH 1061 (100KHz, 0.25V)
2	**LEAKAGE INDUCTANCE**			CH 1061 (100KHz, 0.25V)
3	HI-POT	PRI TO SEC	3000VAC	50Hz,1mA,60S CS2672C
		PRI TO CORE	1500VAC	
		SEC TO CORE	1500VAC	

MATERIAL LIST:

NO.	ITEM	MATERIAL	MANUFACTURER
1	BOBBIN	ED1512(5+2?)	
2	CORE	ED1512 PC95或同等材质	
3	WIRE		
4	MYLAR TAPE		
5	MARGIN TAPE		
6	TUBE		
7	VARNISH		

	DRAWN BY	CHECKED BY	APPROVED BY	CUSTOMER P/N	
				MODEL/REV.	
				DATE	
				SHEET_OF_	2 / 2

5.高可靠性 E CoreGaN 产品

5.1 开关器件驱动可靠性

5.1.1 米勒电容对 GaN 驱动可靠性影响

在开关器件关断沿，器件的漏源电压 Vds 上升，器件 D 端电流 Id 流入米勒电容 Cgd，Cgd 两端电压上升。流过米勒电容的电流 Icgd 通过驱动电阻和驱动 IC Sink 到地，该电流大小：

$$Icgd = Cgd * \frac{dVds}{dt}$$

器件关断沿的 dVds/dt 由器件的关断速度和负载电流决定，在高开关速度、高频和负载电流较大的工况下，Icgd 较大。

电流 Icgd 通过器件的关断电阻 Rg(off) 、驱动环路寄生 Lg、驱动 IC 的 Pin 脚流到地，在 Rg(off)较大、Lg 较大、驱动 IC Sink 电流能力较小的情况下，Icgd 中的部分电流会流入 Cgs 电容，导致器件栅源电压 Vgs 出现尖峰。

$$\Delta Vgs = \frac{1}{Cgs}\int (Icgd - Isink)\, dt$$

该尖峰电压有可能触发器件误开通甚至桥臂直通，导致器件驱动可靠性问题；另外也会增加器件的开关损耗以及造成驱动环路的振铃从而恶化系统 EMI。

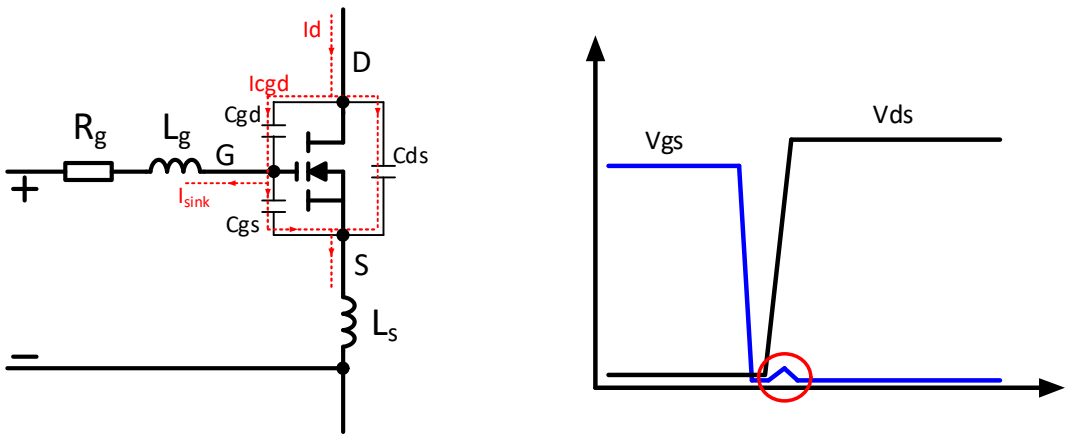


图 5.1 米勒电容对驱动可靠性的影响

5.1.2 源极寄生感对 GaN 驱动可靠性影响

在实际电路中，开关管的源端不可避免存在一些寄生感 Ls，主要包括开关器件的封装和 Pin 脚寄生感、电路 PCB 走线的寄生感、Sense 电阻的 ESL 等。在开关器件关断沿，器件的电流 Is 快速降到 0，Ls 上的 di/dt 会产生负的电压 V_{Ls}，该电压大小为：

$$V_{Ls} = Ls * \frac{dIs}{dt}$$

寄生感电压 V_{Ls} 通过驱动环路耦合到器件的栅极，导致器件栅源电压 Vgs 出现尖峰。

$$\Delta Vgs = -V_{Ls} = -Ls * \frac{dIs}{dt}$$

该尖峰电压也可能触发器件误开通甚至桥臂直通，导致器件驱动可靠性问题；另外也会增加器件的开关损耗以及造成驱动环路的振铃从而恶化系统 EMI。

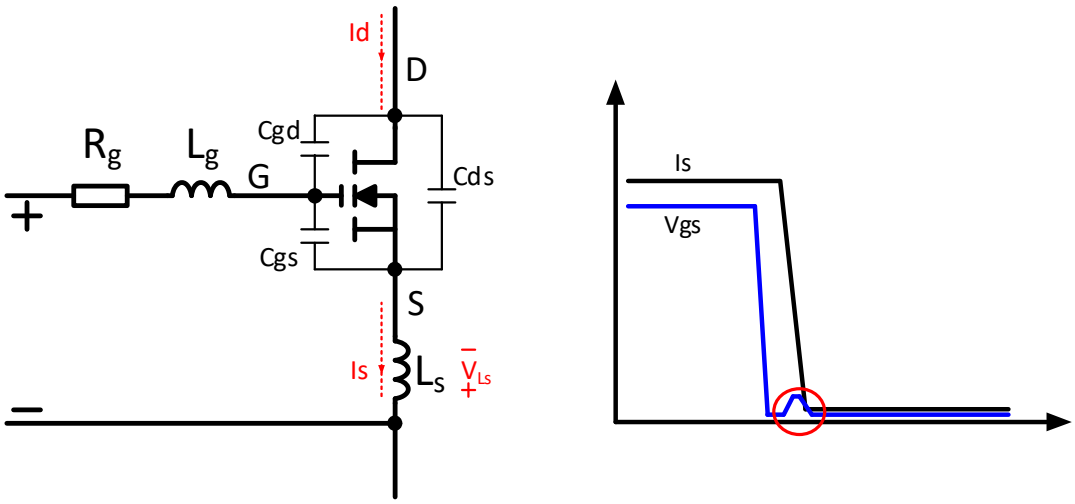


图 5.2 寄生电感对驱动可靠性的影响

5.2 高可靠性的增强型 CoreGaN 器件

5.2.1 Kelvin Source 引脚设计

能华半导体的增强型器件采用 Kelvin Source 引脚设计，这样可以避免功率回路 di/dt 通过功率器件的源极寄生感 Ls 耦合到驱动回路，从而提高系统高频开关时关断可靠性。

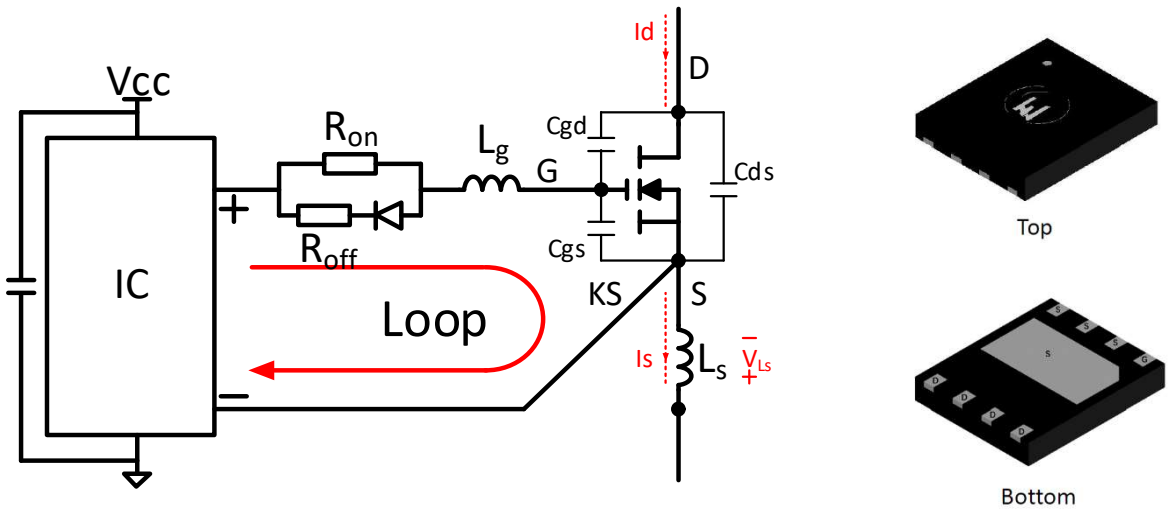


图 5.3　CoreGaN KS 引脚设计提高系统关断可靠性

5.3　高可靠性的 Cascode GAN 器件

CorEnergy

CE65H160DNGI

CoreGaN 650V GaN HEMT

Description

The CE65H160DNGI Series 650V, 160mΩ gallium nitride (GaN) FETs are normally-off devices.

Corenergy GaN FETs offer better efficiency through lower gate charge, faster switching speeds, and lower dynamic onresistance, delivering significant advantages over traditional silicon (Si) devices.

Corenergy is a leading-edge wide band gap supplier with world-class innovation .

Automotive

- Adapter
- Renewable energy
- Telecom and data-com
- Servo motors
- Industrial
- Automotive

General Features

Easy to drive—compatible with standard gate drivers

Low conduction and switching losses

RoHS compliant and Halogen-free

Benefits

Increased efficiency through fast switching

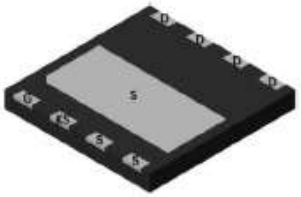
Increased power density

Reduced system size and weight

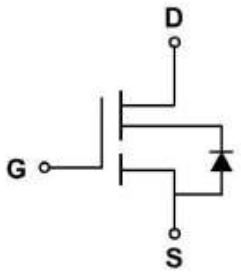
Ordering Information

Part Number	Package	Package Configuration
CE65H160DNGI	DFN 8*8	Source

Top



Bottom



Circuit Symbol

Features

BV_{DSS}	R_{DSON}	I_{DS}	Q_G
650V	160mΩ	16A	7.2nC

CorEnergy

CE65H270DNGI

CoreGaN 650V GaN HEMT

Description

The CE65H270DNGI Series 650V, 270mΩ gallium nitride (GaN) FETs are normally-off devices.

Corenergy GaN FETs offer better efficiency through lower gate charge, faster switching speeds, and lower dynamic onresistance, delivering significant advantages over traditional silicon (Si) devices.

Corenergy is a leading-edge wide band gap supplier with world-class innovation .

Automotive

- Adapter
- Renewable energy
- Telecom and data-com
- Servo motors
- Industrial
- Automotive

General Features

Easy to drive—compatible with standard gate drivers

Low conduction and switching losses

RoHS compliant and Halogen-free

Benefits

Increased efficiency through fast switching

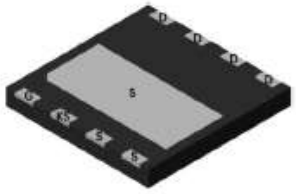
Increased power density

Reduced system size and weight

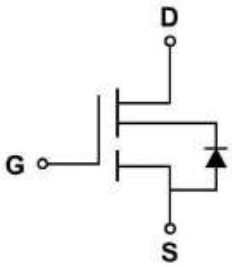
Ordering Information

Part Number	Package	Package Configuration
CE65H270DNGI	DFN 8*8	Source

Top



Bottom



Circuit Symbol

Features

BV_{DSS}	R_{DSON}	I_{DS}	Q_G
650V	270mΩ	7.9A	7.2nC