Innoscience 英诺赛科

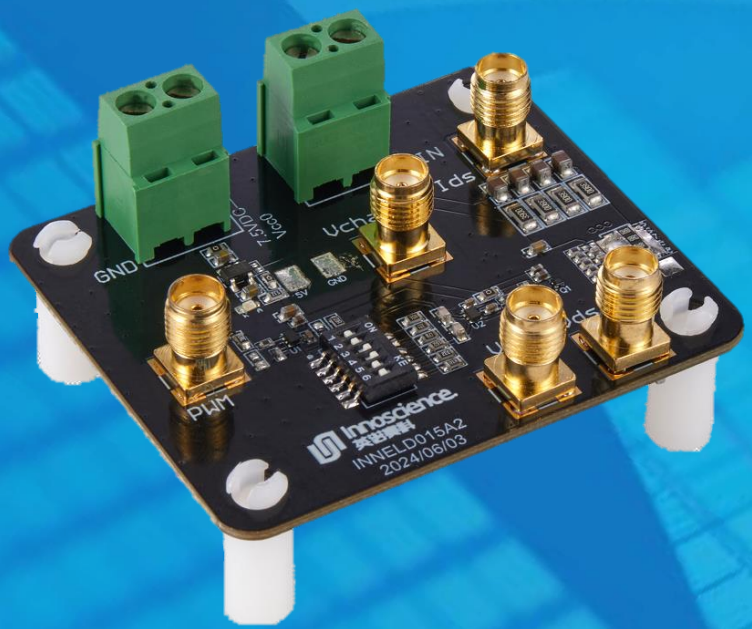
POWER THE FUTURE

INNELD015A2

Evaluation Board Manual

INN100W800A-Q

LiDAR Application EVB



目录

1. 概述

1.1. 引言

INNELD015A2是一款评估INN100W800A-Q的器件评估板，该器件是应用于驱动雷达电路中产生窄脉宽（＜10ns）高峰值电流（≤17A）的开关器件。

2. 关键参数

2.1. 评估板规格

表格 1 关键电气参数规格（T_A=25℃）

符号	参数说明	最小	典型	最大	单位
V_{CC}	辅助供电	7.5	10	12	V
V_{IN}	输入电压	-	-	100(1)	V
I_{PEAK}	最大峰值电流	-	-	17(2)	A
V_{PWM}	输入PWM电压	0	-	5	V
F_{PWM}	开关频率	-	-	1000(3)	kHz
W_{PWM}	输入PWM脉冲宽度	1	-	10(4)	ns

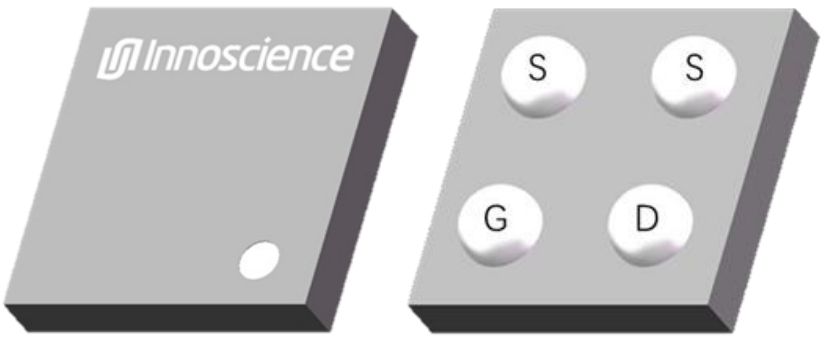
(1) 确保器件的 V_{DS} 峰值电压 ≤100V。

(2)、(3) 最大的上限值受限于器件的热。

(4)上限值要考虑器件的温度， 实际管子的 V_{GS} 脉宽推荐范围 1ns 到 10ns。

2.2. 关键器件参数

本评估板上被评估的器件型号为INN100W800A-Q，该器件是硅基氮化镓，封装是WLCSP， 尺寸：0.9 mm x 0.9mm。



Top view　　Bottom view

图 1 英诺赛科器件 INN100W800A-Q

表格 2 INN100W800A-Q的电气参数（T_A=25℃）

参数	参数值	单位
$V_{DS,max}$	100	V
$R_{DS(on)}$,@V_{GS}=5V	80	mΩ
$Q_{G,typ}$,@V_{DS}=50V	0.7	nC
$I_{DS,Pulse}$	17	A
Q_{oss},@V_{DS}=50V	4	nC

2.2.1. 关键器件优势

a. AEC-Q101 认证

b. GaN-on-Silicon E-mode HEMT 技术

c. 极低的栅极充电电容

d. 极小的封装

e. 零反向恢复电荷

2.2.2. 关键器件的应用

a. LiDAR 应用

b. 高功率密度DC-DC转换器

c. D类音频功放

d. 高强度前照灯

3. 功能框图

3.1. 系统框图

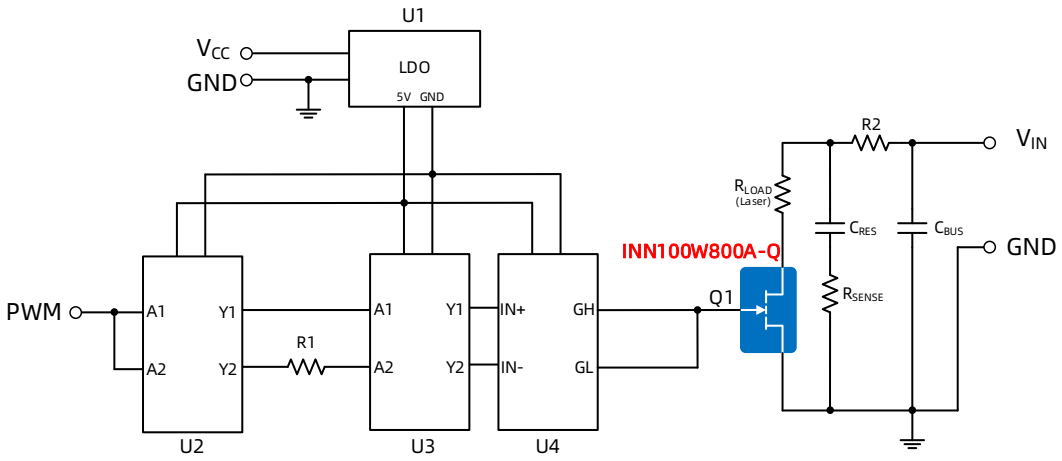


图 2 评估板拓扑图

3.2. 工作原理

评估INN100W800A-Q器件应用于LiDAR的原理图如图2。外部PWM进来后通过U2，R1和U3调节脉冲宽度。 调节后的信号通过U4驱动INN100W800A-Q。系统有两种工作模式：

1)谐振模式(R2=97.5Ω)：当V_{GS}=0时，Q1关断且 V_{DS}=V_{IN}。当V_{GS}=5V时，Q1 开通且电容$C_{_RES}$ 通过Q1放电，电容$C_{_RES}$ 电压下降到零。当 V_{DS}下降到零时Q1关断。

2)双边缘控制模式模式(R2=0Ω)：当V_{GS}=0时，Q1关断且 V_{DS}=V_{IN}。当V_{GS}=5V时，Q1开通，V_{IN} 通过Q1放电且电容$C_{_RES}$ 电压等于V_{IN}。当Q1关断时V_{IN}对地停止放电。

4. PCBA 实物图

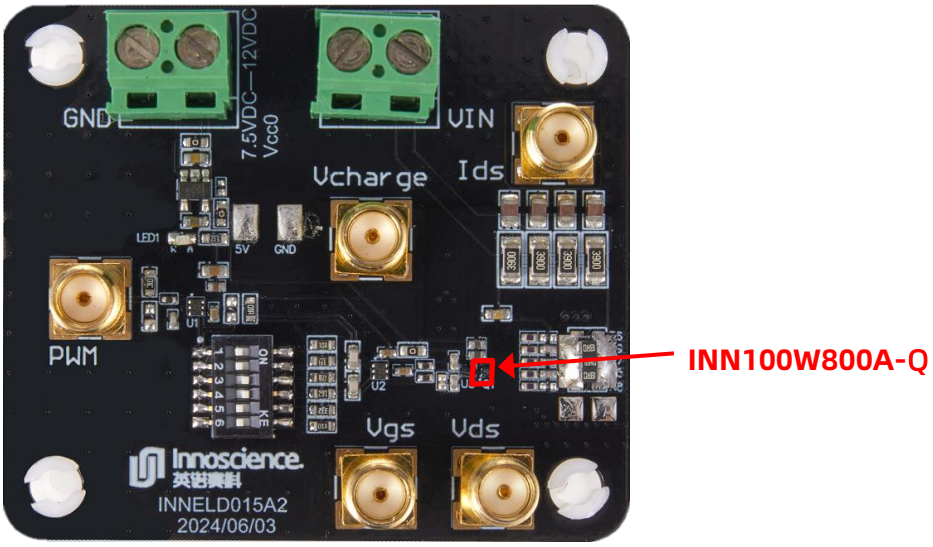


图 3 INNELD015A2 PCBA正面

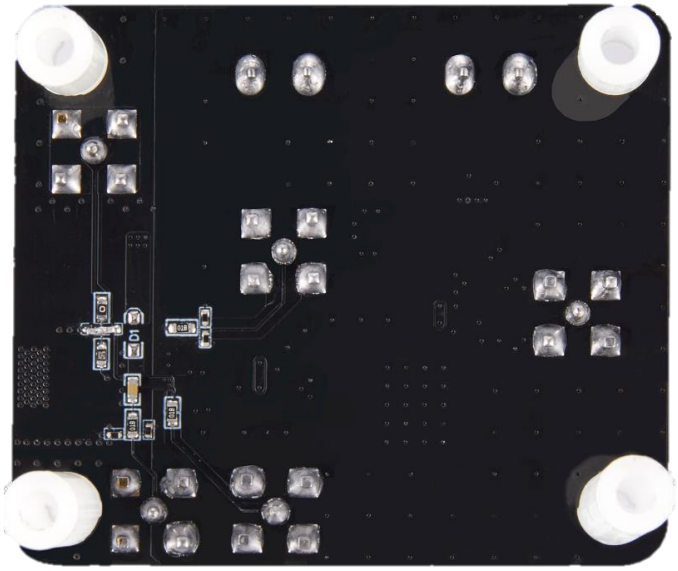


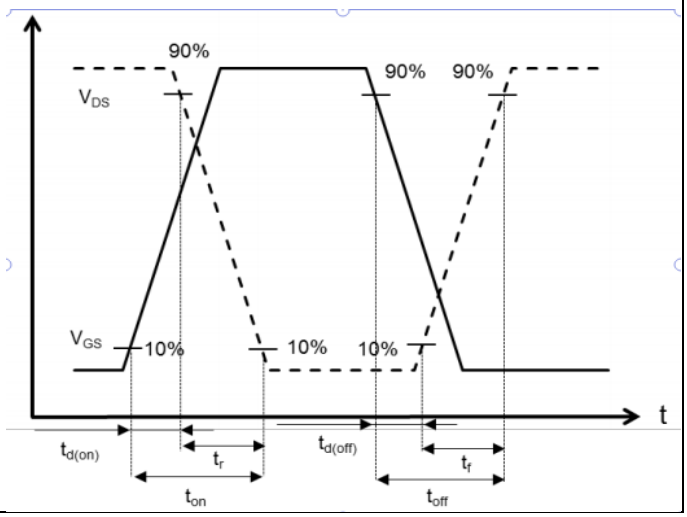
图 4 INNELD015A2 PCBA背面

5. 评估结果

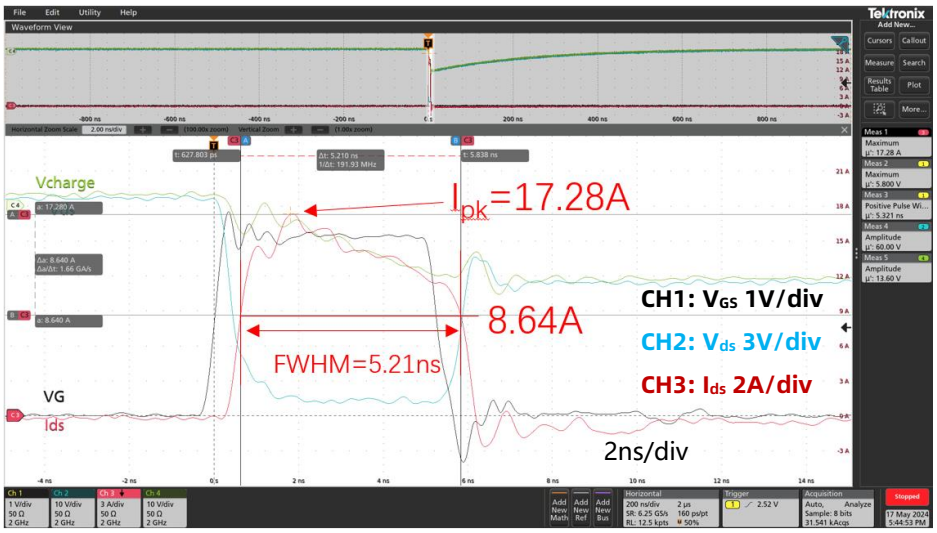
5.1. 测试数据

测试项	谐振模式	双边缘控制
T_r	1.114ns	0.735ns
T_f	-	412.1ps
$T_{d(on)}$	427.5ps	365.9ps
$T_{d(off)}$	-	366.7ps
T_{on}	1.537ns	1.101ns
T_{off}	-	0.7789ns
V_{pk}	59V	50V
V_{bus}	60V	59.2V

参数定义：



5.2. 开关波形



测试条件

工作模式：谐振模式

V_{IN}：59Vdc

$T_{on(VGS)}$：5.8ns

测试结果

V_{GS} max：5.8V

V_{DS} max：60V

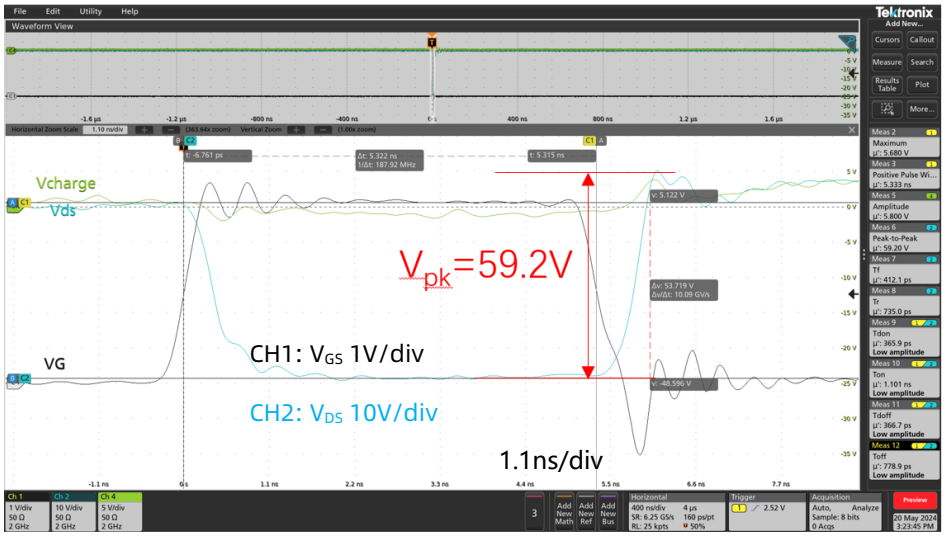
I_{DS} max：17.28A

FWHM：5.21ns

T_r：1.114ns

$T_{d(on)}$：427.5ps

T_{on}：1.537ns



测试条件

工作模式：双边缘控制模式

V_{IN}：50Vdc

$T_{on(Vgs)}$：5ns

测试结果

V_{GS} max：5.68V

V_{DS} max：59.2V

I_{DS} max：16.7A

T_r：735ps

T_f:412.1ps

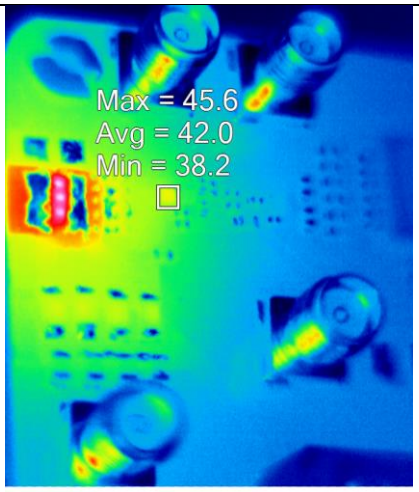
$T_{d(on)}$：365.9ps

$T_{d(off)}$:366.7ps

T_{off}：0.7789ns

T_{on}：1.101ns

5.3. 温度测试



测试条件

工作模式：谐振模式

V_{IN}：55Vdc

I_{PK}:17A

FWHM=5.1ns

Fre:330kHz

T_A：25℃

Airflow：without air flow

测试结果

INN100W800A-Q：45.6℃

附录 Appendix

附录 A. 测试指导　Testing guidance

1、　测试点位置和接线示意图

Test point location and wiring diagram

测试前需要的测试设备需求如下:

Equipment preparation before test

1）高带宽示波器(≥1GHz 带宽，4通道)

High speed digital oscilloscope(≥1GHz Bandwidth,4CH)

2）高压DC 直流源(最大输出电压≥100V)

High voltage DC power supply (maximum output voltage≥100V)

3）低压直流源 (最大输出电压≥12V)

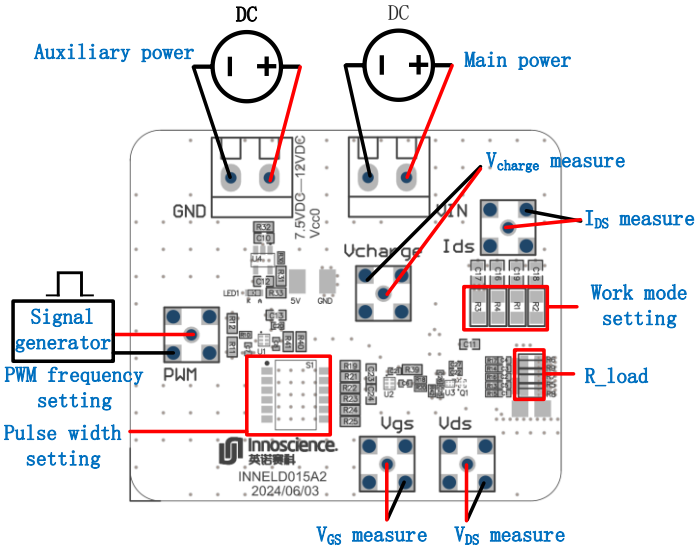
Low voltage DC power supply (maximum output voltage≥12V)

4）信号发生器(最小输出脉宽≤20ns)

PWM generator (minimum pulse width≤20ns)

5）SMA 转BNC同轴线(匹配阻抗 50Ω)

SMA to BNC probe(impedance 50Ω)



附录图 1 设备连接与测试点

Appendix Figure 1 Test point location and wiring diagram

2、　上电顺序

Power on sequence

a) 关机状态，按**附录图 1**连接好辅助电源，输入电源，信号发生器，示波器探头。

Power off, connect the DC voltage source, as shown in **Appendix Figure 1** (note polarity).

b) 打开辅助电源的输出达到要求的电压值(7.5V 到 12V)。

Auxiliary Power input Auxiliary power supply output voltage range 7.5V~12V.

c) 打开信号发生器， PWM的参数设置要符合要求，可参考**附录表 1**。 PWM的频率等于信号发生器。需要注意的是外部信号的脉宽一定要大于或等于最终的控制脉宽要求。

PWM input refer to **Appendix Table 1**. It should be noted that the pulse width of the external signal must be greater than or equal to the final control pulse width requirement.

d) V_{GS}脉宽的设置: 拨动六位拨码开关到相应的位置对应相应的脉冲宽度。六位拨码开关位置对应的脉冲宽度值请参考**附录表 2**。

V_{GS} pulse width Settings: Please refer to **Appendix Table 2** for the pulse width values corresponding to the position of the six-bit dial switch.

e) 打开输入DC源，慢慢调高电压，直到达到预定的最大峰值电流(≤17A)，注意最大的 V_{DS}(≤100V)。

Power on, turn up the input voltage from 0V to reach the predetermined maximum peak current (≤17A), noting the maximum V_{DS} (≤100V).

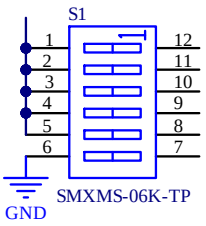
附录表 1 信号参数设置

Appendix Table 1 Signal generator setting

Setting	Specification	Min	Typ	Max	Unit
Frequency	Output pulse signal frequency	1	-	1000	kHz
High	Output pulse signal voltage high value	3.3	-	5	V
Low	Output pulse signal voltage low value	-	-	0	V
Load	Pulse signal output load	-	High Z	-	-
Width	Output pulse width	1	-	100	ns

附录表 2　脉冲宽度设置

Appendix Table 2　Pulsewidth Control setting

NO.	Width(ns)	NO.	Width(ns)	S1
1	2.3	2+3	3.1	
2	5.5	2+4	3.9	
3	12.8	2+5	4.5	
4	26.3	3+4	7.5	
5	55.5	3+5	9.5	
1+2	0	-	-	
6	当位号6连接时，脉冲宽度与外部的PWM宽度保持相同。When this bit number(6) is connected, the pulse width is consistent with the input PWM pulse width			

3、测试设置注意事项

Test setup consideration

使用SMA同轴线探头测试电压电流波形,测试点包括驱动V_{GS}, 充放电电容的电压V_{charge}, 脉冲电流I_D，开关管电压V_{DS}。所有的SMA测试点设计匹配阻抗电阻50Ω,所以示波器输入端口设置阻抗匹配50Ω。使用SMA同轴线缆测试确保波形能在纳秒级别的上升下降不失真。详细的设备参数设置如下:

Use the SMA probe to measure the voltage and current waveforms in the circuit, including the driving voltage V_{GS}, the charging and discharging capacitor voltage V_{charge}, the pulse current I_D, and the switch voltage V_{DS}. All SMA measurement points are designed to match impedance of 50Ω, so when viewing waveforms, the oscilloscope input impedance should also be set to 50Ω. The use of SMA ensures that the acquired waveforms are not distorted on sub-ns time scales. The detailed test setup parameters are as follows:

a) 辅助电源建议输出电压8V。

The auxiliary power supply is recommended to output 8V

b) 主功率电源的输出也有限制要求，建议电压范围①0到90V(谐振模式，R1||R2||R3||R4=97.5Ω)，电压范围②0到40V (双边缘控制模式，R1||R2||R3||R4=0Ω)。

The output voltage of the main power supply is set as required, and the

recommended setting range is 0V to 90V(Resonant Control,R1||R2||R3|| R4=97.5 Ω)and 0V to 40V (Dual Edge Control,R1||R2||R3||R4=0Ω).

c) 信号发生器设置输出高阻抗，高值5V，PWM 脉宽可以设置 20ns-500ns，开关频率输出设置范围 1 Hz-10MHz（脉冲宽度与频率最大值主要受限于器件的热。最终到达器件的驱动V_{GS}脉冲宽度建议1ns到 10ns，频率小于330kHz）。

The signal generator is set to high impedance output, the amplitude is set to 5V, and the PWM pulse width range is set to 20ns-500ns,switching frequency is set to 1Hz - 10MHz. (The maximum pulse width and frequency are mainly limited by the heat of the device. The final drive V_{GS} pulse width to reach the device is recommended to be 1ns to 10ns, and the frequency is less than 330kHz).

d) 设置示波器通道CH1 测试V_{GS},使用同轴线端子SMA转BNC到示波器端口，设置阻抗50Ω，设置通道的衰减倍数为21。

Set CH1 to V_{GS}, use SMA to BNC probe, 50Ω impedance, and the external attenuation factor of the oscilloscope is set to 21.

e) 设置示波器通道CH2 测试V_{charge},使用同轴线端子SMA转BNC到示波器端口，设置阻抗50Ω，设置通道的衰减倍数为41。

CH2 is set to V_{charge}, use SMA to BNC probe, 50Ω impedance, and the attenuation factor of the oscilloscope is 41.

f) 设置示波器通道CH3 测试I_{DS},使用同轴线端子SMA转BNC到示波器端口，设置阻抗50Ω，设置通道的衰减倍数为2.02（同时设置单位为“A”倍率94mV/A）。需要注意的是测试电流I_{DS}仅在谐振模式时有效。

Set CH3 to I_{DS}, use SMA to BNC probe, 50Ω impedance, and the external attenuation factor of the oscilloscope is 2.02(Units is “A” and Ratio:94mV/A); It should be noted that the test current I_{DS} is only accurate when working in Resonant Control(R=97.5Ω).

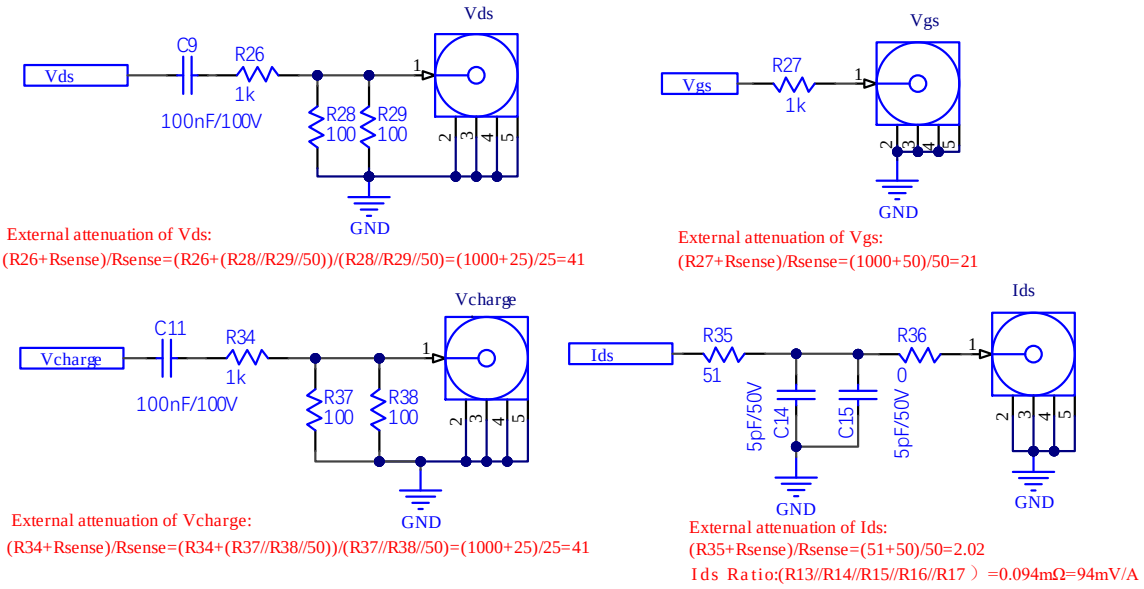
g) 设置示波器通道CH4 测试V_{DS},使用同轴线端子SMA转BNC到示波器端口，设置阻抗50Ω，设置通道的衰减倍数为41。

Set CH4 to V_{DS}, use SMA to BNC probe, 50Ω impedance, and the external attenuation factor of the oscilloscope is 41.

备注：外部的测试衰减倍数与测试电路的参数相关。 详细的计算过程见"测试点的信号

衰减倍数计算" 如下**附录图 2**。

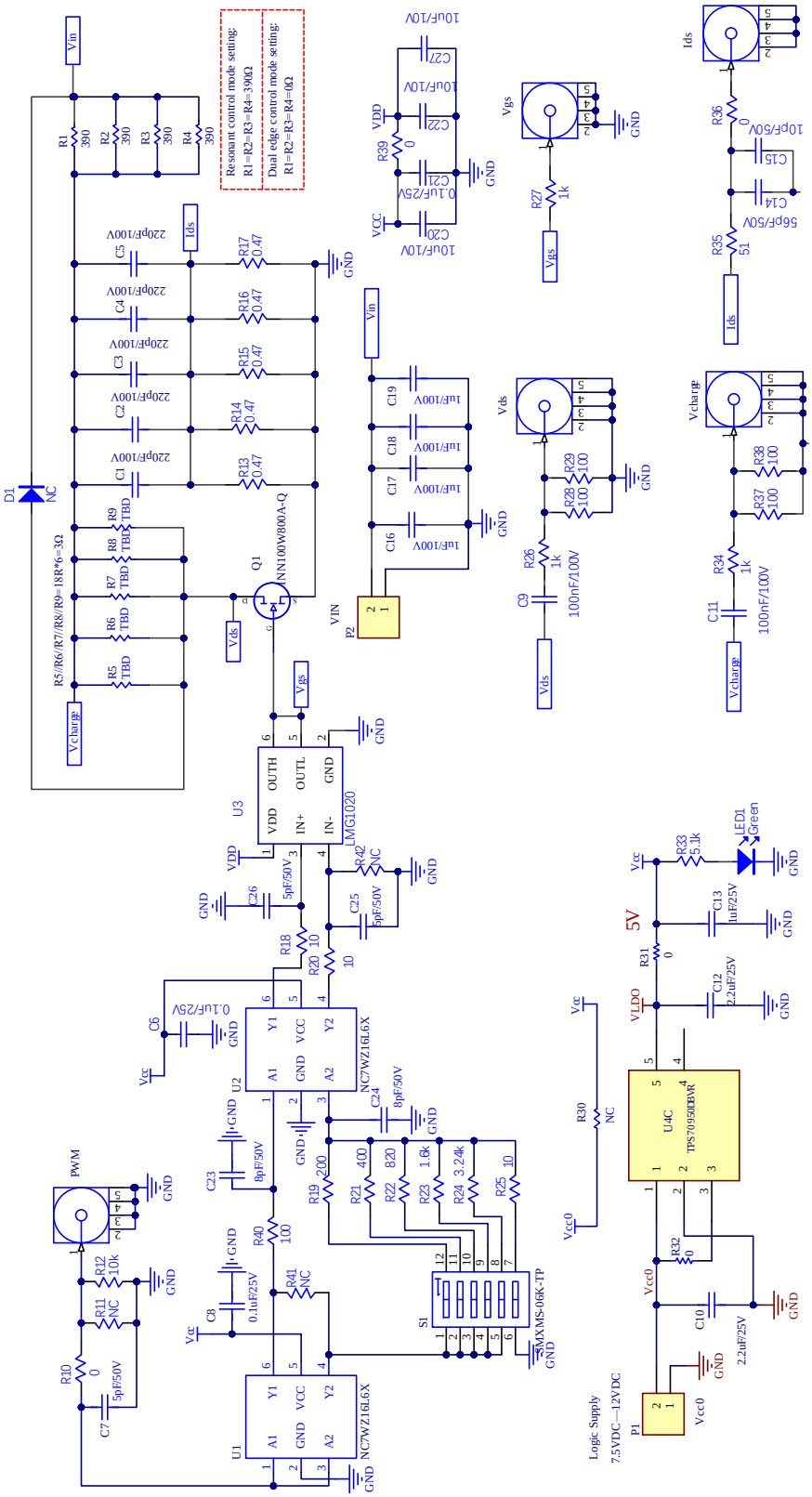
Note: The external test attenuation factor is related to the parameters of the test circuit. For detailed calculation procedures, please refer to "Calculation of Signal Attenuation Factor at Test Points" as shown in **Appendix Figure 2**.



附录图 2 测试点的信号衰减倍数计算

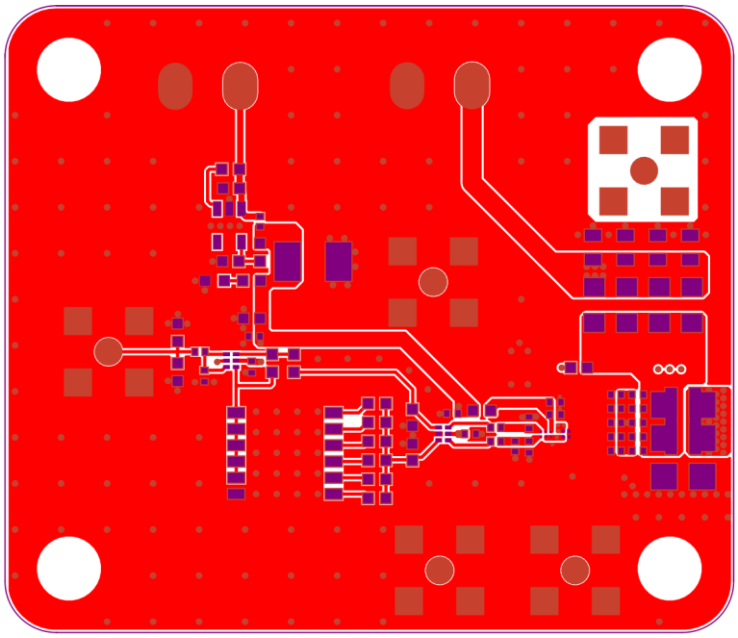
Appendix Figure 2 Calculation of Attenuation Coefficient

附录 B. 电路原理图

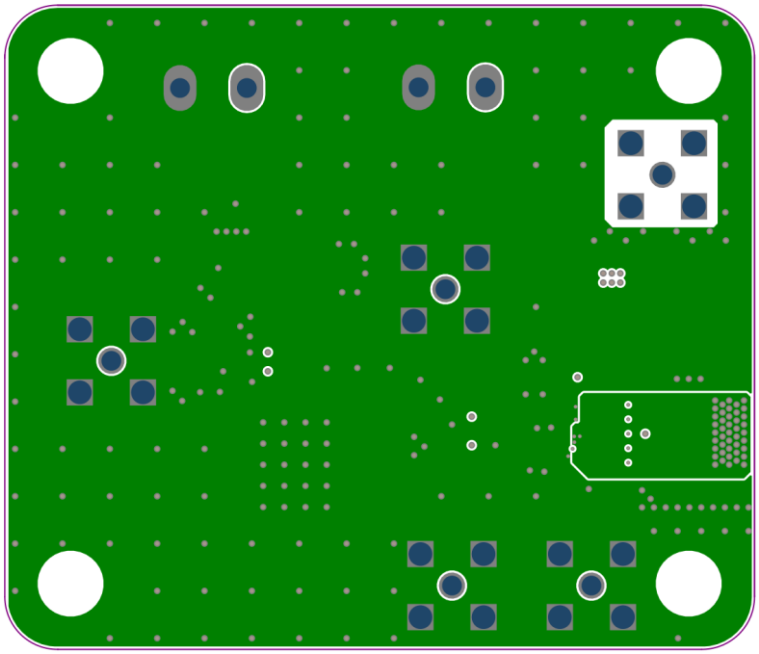


附录图 3 原理图

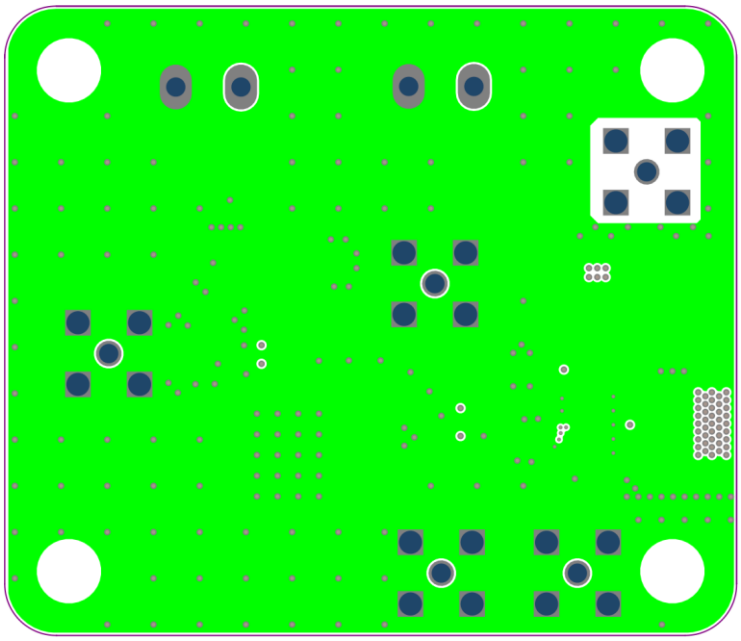
附录 C. PCB Layout



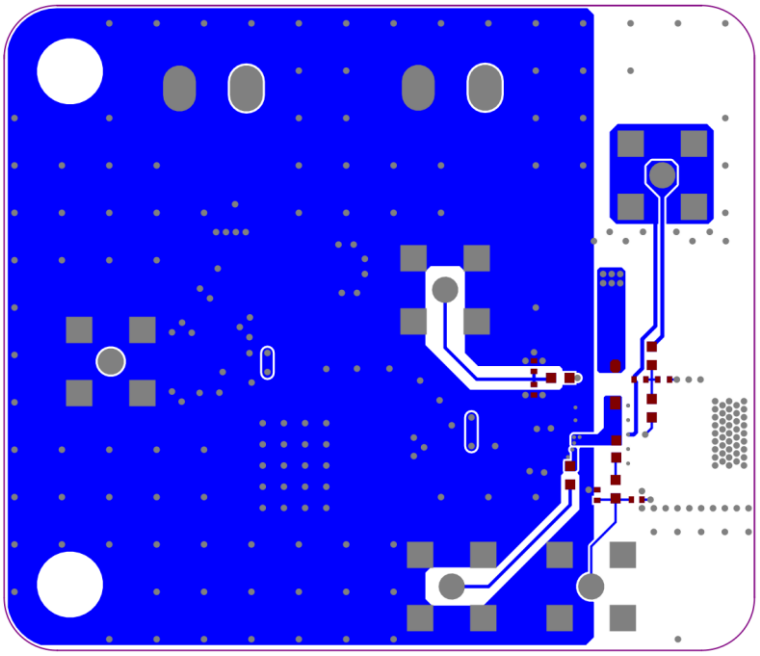
附录图 4 Top层



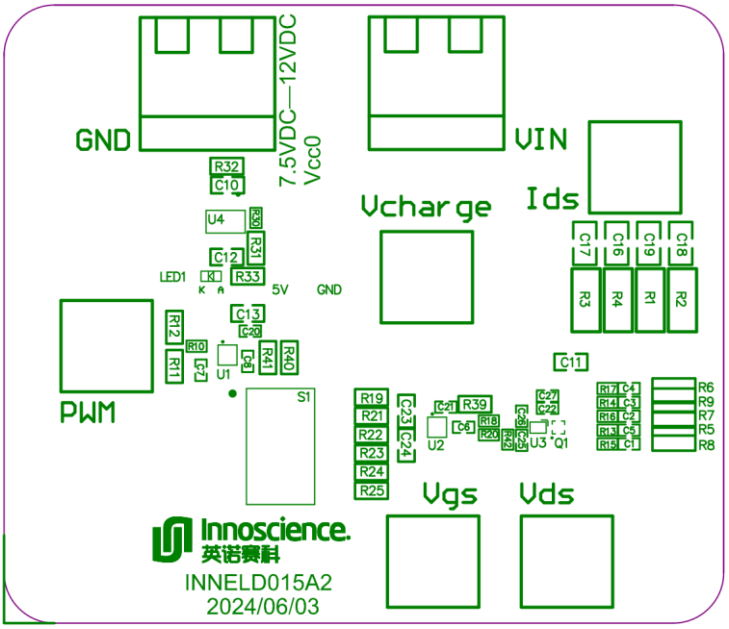
附录图 5 Middle1层



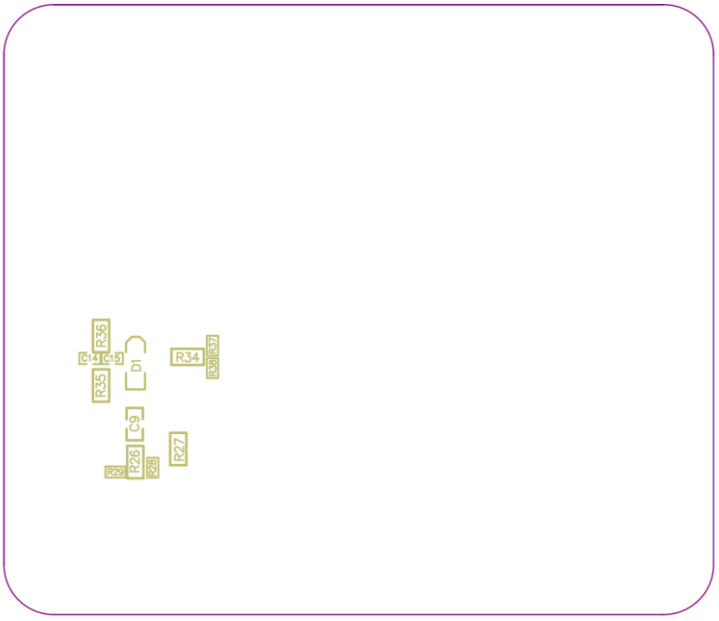
附录图 6 Middle2层



附录图 7 Bottom层



附录图 8 Top Overlayer层



附录图 9 Bottom Overlayer层

附录 D. BOM

Designator	Part Number	Manufacturer	Description	Quantity
C2, C3,C5	CGA2B1C0G2A102JT0Y0E	TDK	CAP, 1nF/100V, ±5%, C0G	3
C1, C4,	NC	NC	NC	0
C6, C8, C21	0402B103K250CT	Walsin	CAP, 10nF/25V, ±10%, X7R	3
C7, C25, C26	GRM1555C2A5R0BA01D	Murata	CAP, 5pF/50V, ±0.1pF, C0G	3
C9, C11	CL10B104KC8NNNC	SAMSUNG	CAP, 100nF/100V, ±10%, X7R	2
C10, C12	0603X225K250NT	FH	CAP，2.2uF/25V,±10% , X5R	2
C13	CL10B105KA8NNNC	SAMSUNG	CAP, 1uF/25V, ±10%, X7R	1
C14	GRM1555C1H560JA01D	Murata	CAP, 56pF/50V, ±5%, C0G	1
C15	0402N100J500CT	Walsin	CAP, 10pF/50V, ±5%, C0G	1
C16, C17, C18, C19	HMK212BC7105KGHTE	Taiyo Yuden	CAP, 1uF/100V, ±10%, X7R	4
C20, C22, C27	CL05A225MA5NUNC	SAMSUNG	CAP,2.2uF/25V, ±20%, X5R	3
C23, C24	0603CG6R8C500NT	FH	CAP, 6.8pF/50V, ±0.25pF, C0G	2
D1	NC	NC	NC	0
LED1	SZYY0603G	yongyu	LED1,Green,VF=2.6V,10mA	1
P1,P2	KF128-5.08-2P-AA	KEFA	1*2P	2
Q1	INN100W800A-Q	INNOSCIENCE	100V，80mΩ，17A，WLCSP	1
R1, R2, R3, R4	RS-06K3900FT	FH	RES，390Ω, ±1%，1/4W	4
R5, R6, R7, R8, R9,	0805W8F180JT5E	UNI-ROYAL	RES，18Ω, ±1%，1/8W (6 parallel total parallel value=3Ω)	6
R10	RTT0200000FTH	RALEC	RES，0Ω, ±1%，62.5mW	1
R11, R41	NC	NC	NC	0
R12	0603WAF1002T5E	UNI-ROYAL	RES，10kΩ, ±1%，1/10W	1
R13, R14, R15, R16, R17	0402WGF470LTCE	UNI-ROYAL	RES，0.47Ω, ±1%，62.5mW	5
R18, R20	0402WGF100JTCE	UNI-ROYAL	RES，10Ω, ±1%，62.5mW	2
R19	0603WA2000T5E	UNI-ROYAL	RES，200Ω, ±1%，1/10W	1
R21	0603WAF3900T5E	UNI-ROYAL	RES，390Ω, ±1%，1/10W	1
R22	0603WAF8200T5E	UNI-ROYAL	RES，820Ω, ±1%，1/10W	1
R23	RS-03K1601FT	FH	RES，1.6kΩ, ±1%，1/10W	1
R24	RC0603FR-073K3L	YAGEO	RES，3.3kΩ, ±1%，1/10W	1
R25	WR06X10R0FTL	Walsin	RES，10Ω, ±1%，1/10W	1
R26, R27, R34	RC0603FR-071KL	YAGEO	RES，1kΩ, ±1%，1/10W	3
R28, R29, R37, R38	RC0402FR-07100RL	YAGEO	RES，100Ω, ±1%，62.5mW	4
R30, R42	NC	NC	NC	0
R31, R32, R36, R39	RC0603FR-070RL	YAGEO	RES，0Ω, ±1%，1/10W	4
R33	RS-03K5101FT	FH	RES，5.1kΩ,±1% 1/10W	1
R35	0603WAF510JT5E	UNI-ROYAL	51Ω±1% 1/10W	1
R40	0603WAF1000T5E	UNI-ROYAL	100Ω±1% 1/10W	1
S1	SMXMS-06K-TP	SM Switch	SMXMS-06K-TP	1
PWM,Vds,Vgs,Vcharge,Ids	KH-SMA-KE-Z	kinghelm	RF Coaxial PCB Connector	5
U1, U2	NC7WZ16L6X	onsemi	NC7WZ16L6X MicroPak-6	2

U3	LMG1020YFFR	TI	LMG1020YFFR, SBGA-6	1
U4	TPS70950DBVR-TP	TECH PUBLIC	TPS70950DBVR, SOT-23-5	1

版本历史

Date	Versions	Description	Author
2025.04.07	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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