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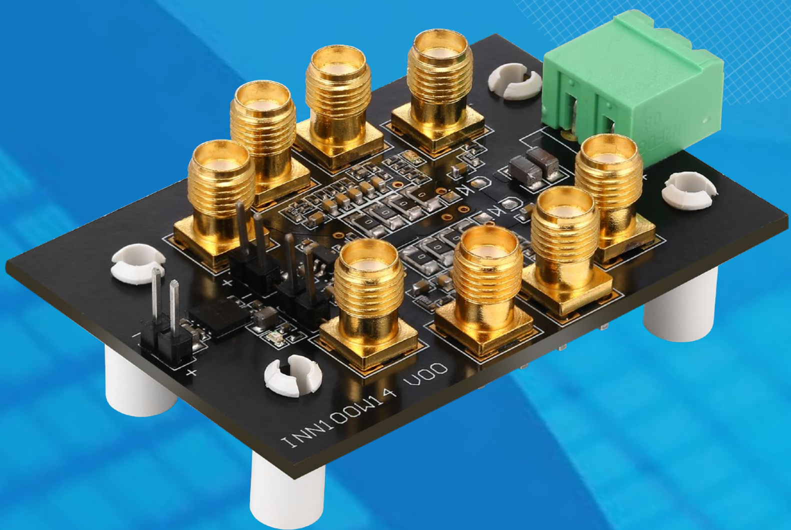
POWER THE FUTURE

INNELD090B1

Evaluation Board Manual

LiDAR Application EVB



CAUTION

Please carefully read the following content since it contains critical information about safety and the possible hazard it may cause by incorrect use.

ELECTRICAL SHOCK HAZARD

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.

HOT SURFACE

The surface of PCB can be hot and could cause burns. DO NOT TOUCH THE PCB WHILE OPERATING!!

REMINDER

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

List of Content

1. Overview

1.1. Introduction

INNELD090B1 is a Lidar evaluation board for generating narrow pulse width (< 3 ns) high current pulses (> 90 A) to drive laser diodes. The board uses INN100W14 Enhanced Mode (E-Mode) FET, and INNELD090B1 integrates two GaN devices. For more detailed information about the devices, please visit the Innoscience official website. The INNELD090B1 Lidar EVB evaluation board adjusts the peak value of the output pulse current by changing the main power supply voltage and adjusts the pulse width of the output pulse current by changing the pulse generated by the signal generator. The measurement interface uses an SMA probe, which can realize the measurement of sub-ns waveform, which perfectly demonstrates the ultra-fast switching capability of GaN HEMT (di/dt=150 A/ns, dv/dt=22.5 V/ns), INNELD090B1 The commutator switching transient is <1 ns.

1.2. Test Equipment Requirement

To evaluate the performance properly, you need to prepare the following test equipment:

1) High speed digital oscilloscope（>1GHz Bandwidth, 4CH）
2) High voltage DC power supply (maximum output voltage ≥ 100V)
3) Low voltage DC power supply (maximum output voltage ≥ 12V)
4) PWM generator (minimum pulse width≤20ns)
5) SMA to BNC probe; (impedance 50Ω)

2. Parameters

Table 1 Electrical Characteristic（Ta=25℃）

Symbol	Parameters	Min	Nom	Max	Units
Vaux	Auxiliary supply	2.5	6.5	12	V
Vbus	Bus input voltage	0	60	100	V
Io	Output load current			90	A
Zin	Input impedance		50		Ω
Vsignal	Input pulse range	0		5	V
Fsignal	Input pulse frequency	0		150	MHz
Tsignal	Input pulse width	20		1000	ns

3. Block Diagram

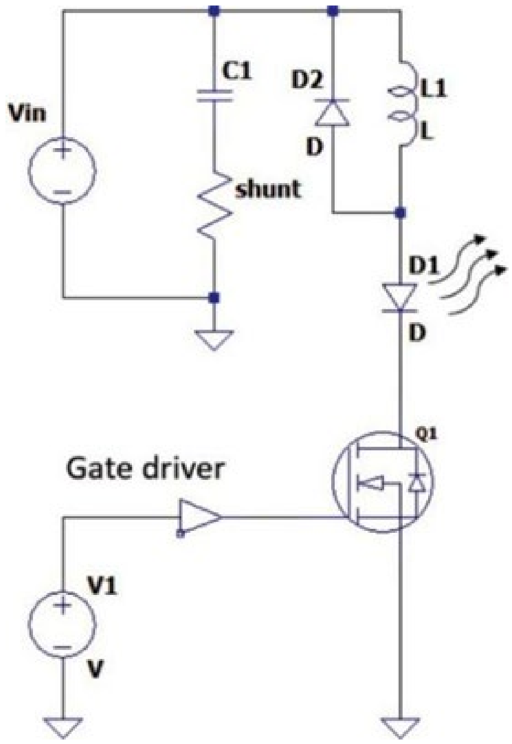


Figure 1 Block diagram of lidar evaluation board

1. Working Principle

The block diagram of the INNELD090B1 Lidar evaluation board is shown in Figure 1. The pulse generated by the signal generator V1 is transmitted to the gate driver, and when the input pulse goes high, the gate driver turns on Q1, allowing capacitor C1 to discharge through laser diode D1. When the input pulse goes low, Q1 turns off and the input power charges the C1 capacitor. Due to the extremely fast switching speed of the GaN HEMT and the existence of the parasitic inductance L1, the laser diode D1 and the switching tube Q1 will suffer high voltage stress. Diode D2 can be added to provide a freewheeling loop for parasitic inductance, clamp the induced voltage when GaN turns off, and prevent overvoltage failure of laser diode D1 and switch Q1.

4. PCBA Overview and Schematic

4.1. PCBA Overview

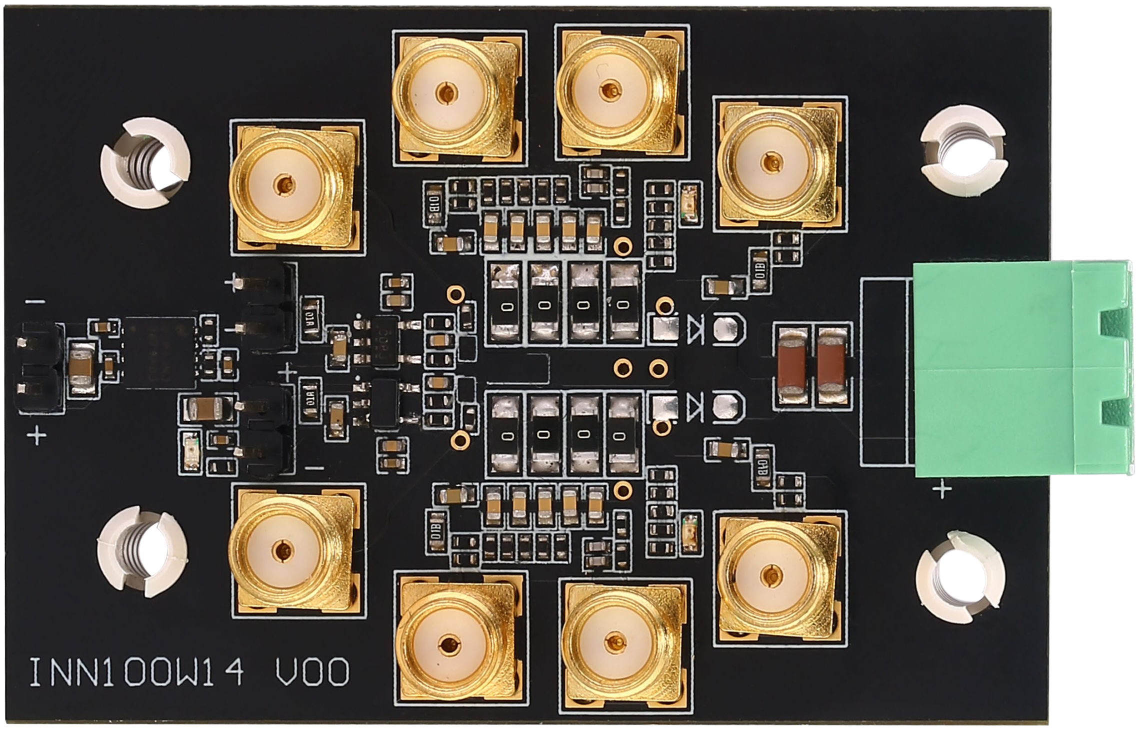


Figure 2 Top view for INNELD090B1

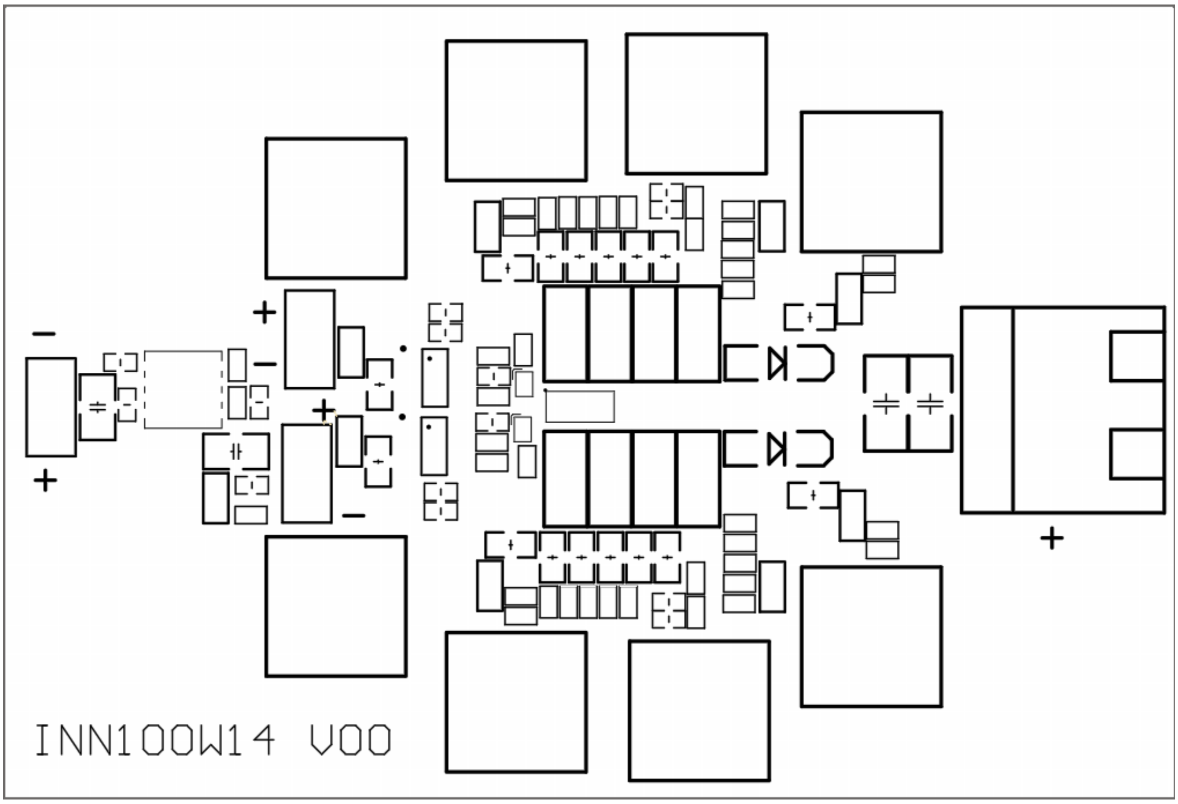


Figure 3 Top Side Silkscreen for INNELD090B1

4.2. Schematic

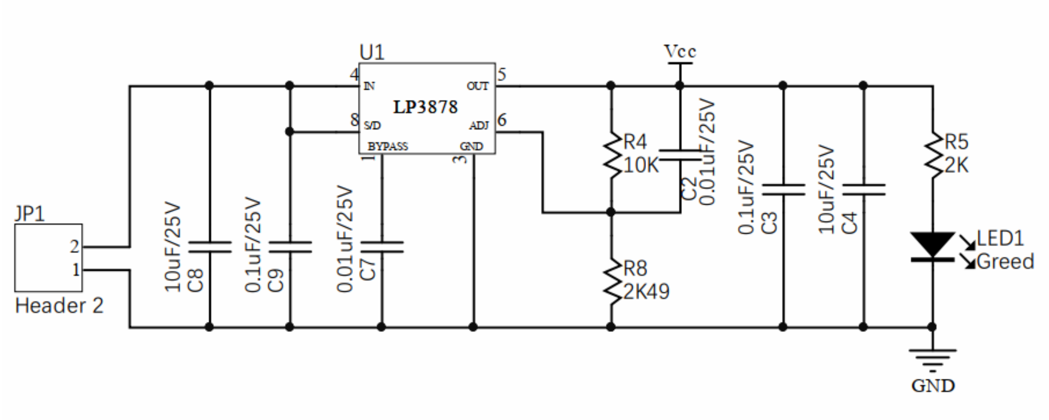


Figure 4 Auxiliary power supply for INNELD090B1

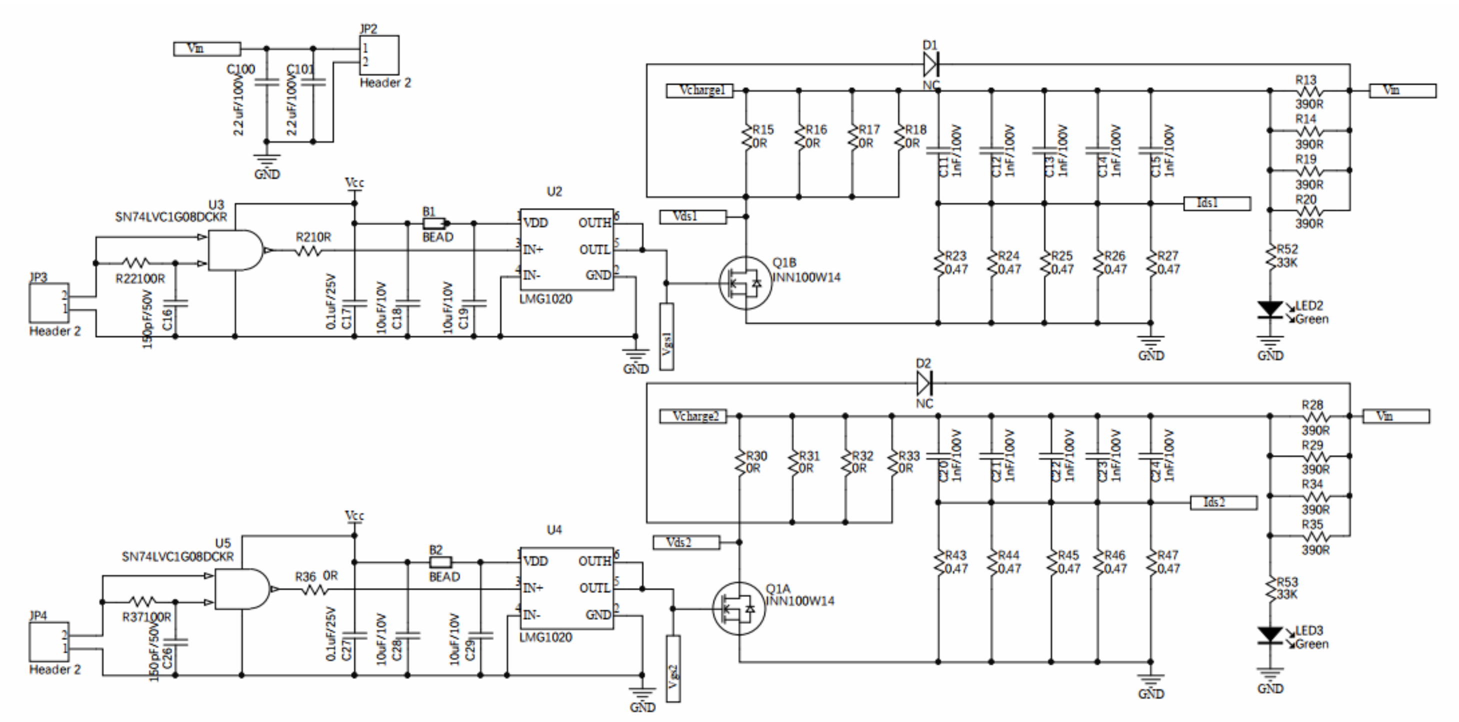


Figure 5 Main power loop for INNELD090B1

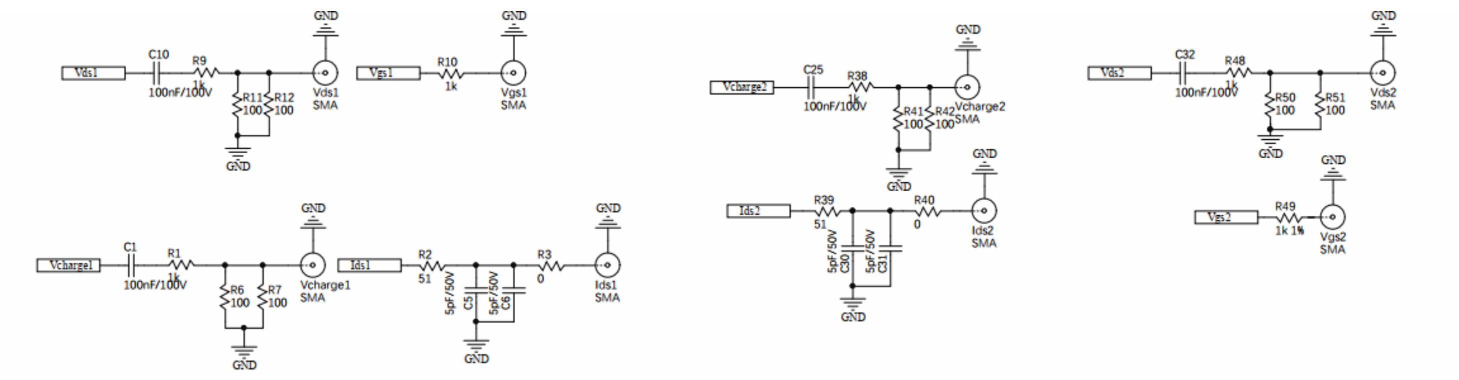


Figure 6 Test points for INNELD090B1

5. Testing Guide

5.1. Test point location

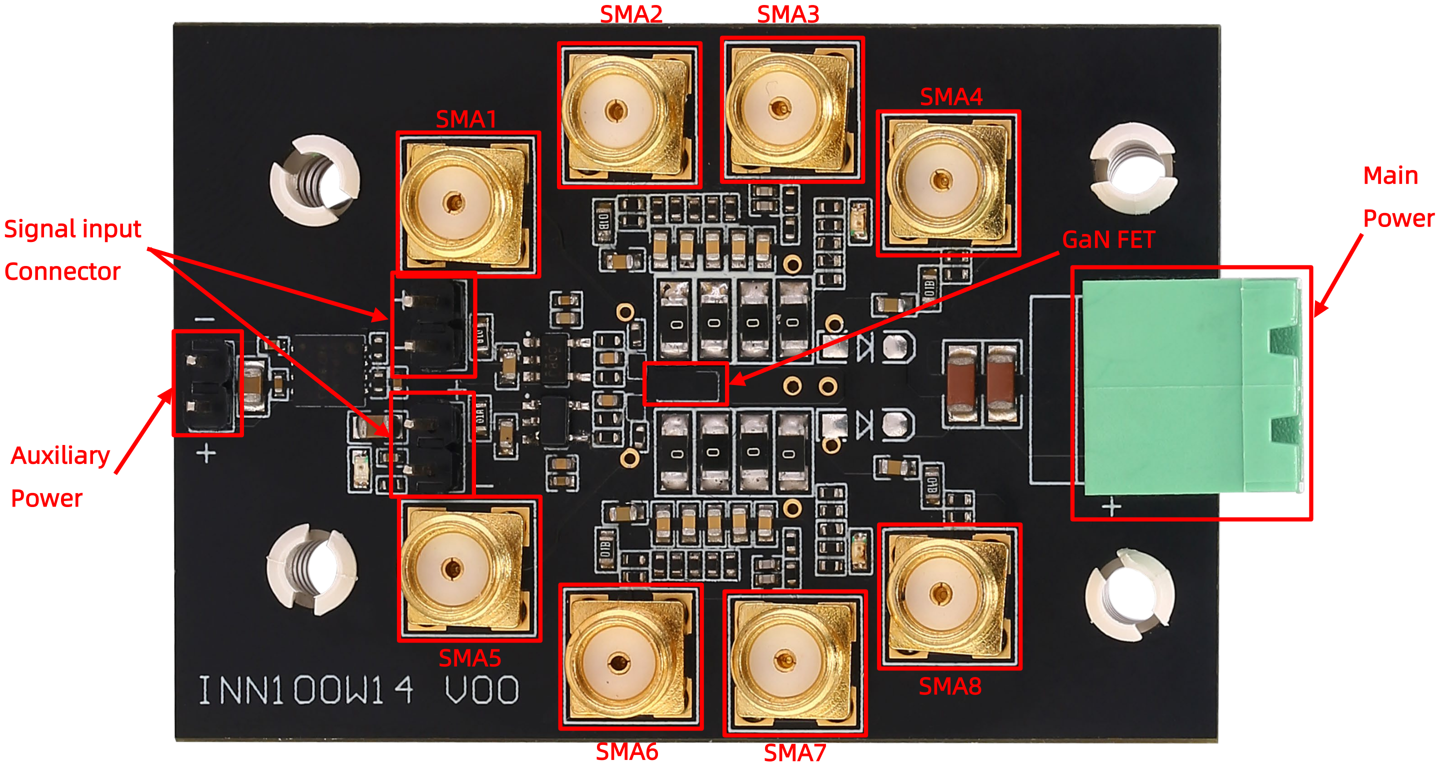


Figure 7 Test points

5.2. Test setup

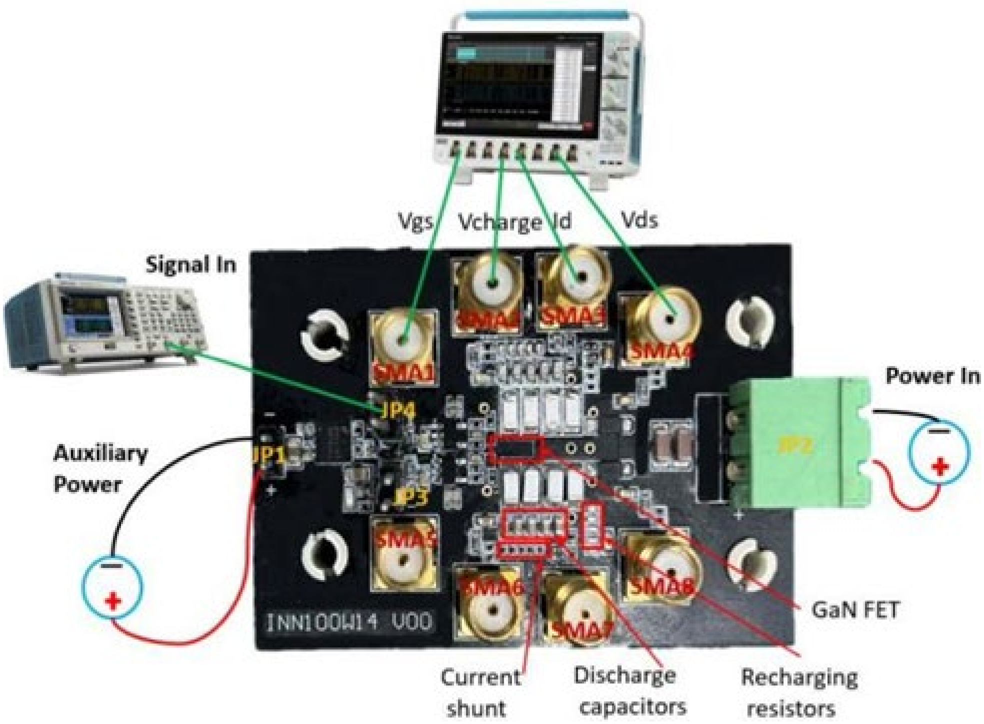


Figure 8 Test connection

As shown in Figure 8, **JP1** is the auxiliary supply input interface, **JP2** is the main power supply input interface that connected to a high-voltage power supply, **JP3&JP4** are the input pulse signal interfaces that connected to a signal generator; **SMA1&SMA5** are the driving voltage Vgs test points, **SMA2&SMA6** are the charging and discharging capacitor Vcharge test points, **SMA3&SMA7** are the output pulse current Id test points, **SMA4&SMA8** are GaN HEMT voltage Vds test points.

5.3. Power up and down sequence

5.3.1. Power-up sequence

1. Auxiliary supply power off, connect the auxiliary supply to JP1, keep the main source power off, connect the main power supply to JP2.
2. Keep the signal off, connect the signal generator to JP3 and JP4.
3. Keep the two power supplies and signal off and connect the oscilloscope probe to the SMA test points.
4. Then adjust the pulse width, frequency and amplitude of the output waveform of the signal generator (for the specific adjustment method of the signal generator, please refer to the following 'Specific steps of the signal generator setting').
5. Adjust the input waveforms of the oscilloscope and signal generator, and observe the waveforms of Vgs, Vcharge, Vds and Id of the two channels.

5.3.2. Power-down sequence

1. Turn off the signal generator
2. Turn off the main power supply
3. Turn off the auxiliary power supply

5.3.3. Specific steps of the signal generator setting

1. After the power is turned on, choose Pulse in BASIC MODE

2. The output impedance selects high impedance
3. Frequency selects the actual required frequency, such as 100kHz
4. The amplitude is 5V, and the bias is half of the amplitude, which is 2.5V
5. Choose a suitable value for pulse width, such as 20ns
6. The operating mode can be selected as pulse or continuous as required. If you choose pulse mode, you need to set the period time and source
7. Press ON to output the PWM signal, and press Manual to trigger when the pulse is selected in the running mode

Figure 9 Parameter setting of signal generator

5.4. Test setup consideration

Use the SMA probe to measure the voltage and current waveforms in the circuit, including the driving voltage Vgs (SMA1), the charging and discharging capacitor voltage Vcharge (SMA2), the pulse current Id (SMA3), and the switch voltage Vds (SMA4). 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:

- The auxiliary power supply is recommended to output 6.5V;
- The output voltage of the main power supply is set as required, and the recommended setting range is 30-80V;

- 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 100 kHz - 10MHz.
- Set CH1 to Vgs, use SMA to BNC probe, 50Ω impedance, and the external attenuation factor of the oscilloscope is set to 21;
- CH2 is set to Vcharge, use SMA to BNC probe, 50Ω impedance, and the attenuation factor of the oscilloscope is 41;
- Set CH3 to Ids, use SMA to BNC probe, 50Ω impedance, and the external attenuation factor of the oscilloscope is 2.02;
- Set CH4 to Vds, use SMA to BNC probe, 50Ω impedance, and the external attenuation factor of the oscilloscope is 41.

Note: The external attenuation factor of the oscilloscope is related to the parameters of the schematic diagram. For the detailed calculation method, see the section "Calculation of Attenuation Coefficient" below.

The attenuation coefficient is calculated as follows:

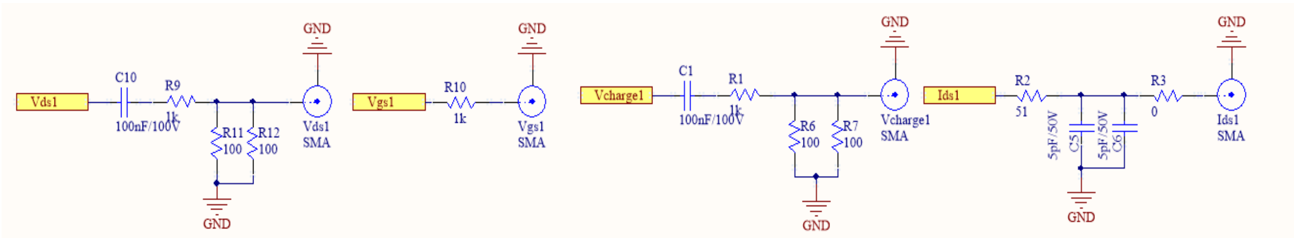


Figure 10 Parameter setting of signal generator

Figure 10 is a schematic diagram of the relevant part of the attenuation coefficient in the EVB schematic. In the figure 5, R9=1KΩ, R10=1KΩ, R1=1KΩ, R2=51Ω, R11=R12=100Ω, R6=R7=100Ω, Oscilloscope terminal resistance impedance, Rin=50Ω, Shunt resistance=0.094Ω. According to the principle in the figure, the relationship is as follows:

1、Attenuation of the drive signal Vgs:

$$V_{gs1} = V_{gs1\_sense} * (Rin + R10)/Rin = V_{gs1\_sense} * 21$$

Then the external attenuation factor of the oscilloscope with Vgs is, $(Rin + R10)/Rin = 21$

2、Attenuation of GaN HEMT voltage Vds:

$$V_{ds1} = V_{ds1\_sense} * (Rin||R11||R12 + R9)/(Rin||R11||R12) + Vin = V_{ds1\_sense} * 41 + Vin$$

Then the external attenuation factor of the oscilloscope with Vds is,

$$(Rin||R11||R12 + R10)/(Rin||R11||R12) = 41$$

3、Attenuation of pulse current Id:

$$Id = Vcs * ((Rin + R2)/Rin)/Rcs = Vcs * 2.02/Rcs$$

Then the external attenuation factor of the oscilloscope with Ids is, $(Rin + R2)/Rin) = 2.02$

4、Attenuation of charge and discharge capacitor voltage Vcharge:

$$V_{charge1} = V_{charge1\_sense} * (Rin||R6||R7 + R1)/Rin||R6||R7 + Vin = V_{charge1\_sense} * 41 + Vin$$

Then the external attenuation factor of the oscilloscope with Vcharge is,

$$(Rin||R6||R7 + R10)/(Rin||R6||R7) = 41$$

6. Evaluation Results

6.1. Working Waveforms

Test conditions

Vin=26V

Cres=1.35nF

Rcharge=97.5Ω

Fsingal=100kHz

Result

pulse width Tw = 1.56ns

Ipk = 85.2A

Appendix

Appendix A. PCB Layout

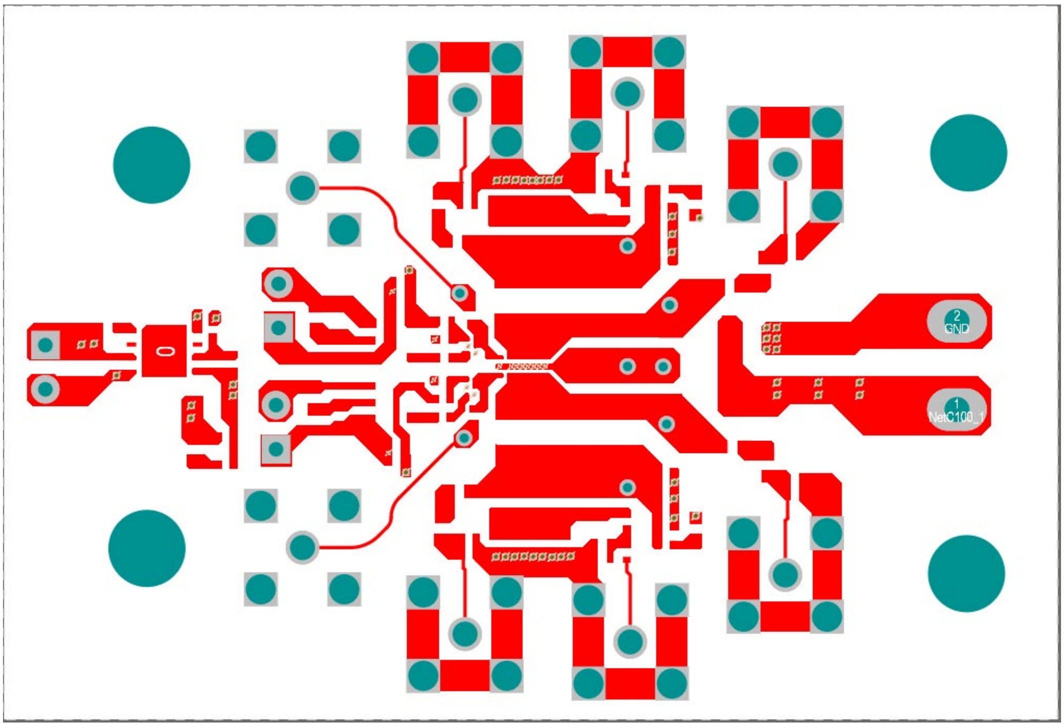


Figure 11 Top layer of INNELD090B1

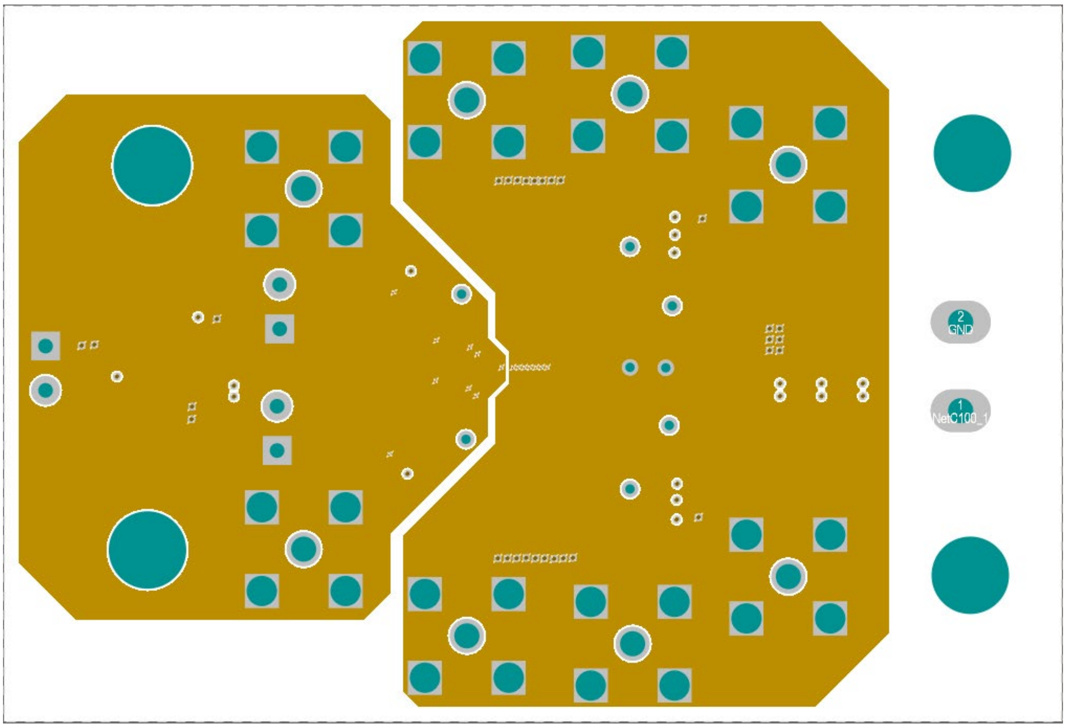


Figure 12 Signal layer 1 of INNELD090B1

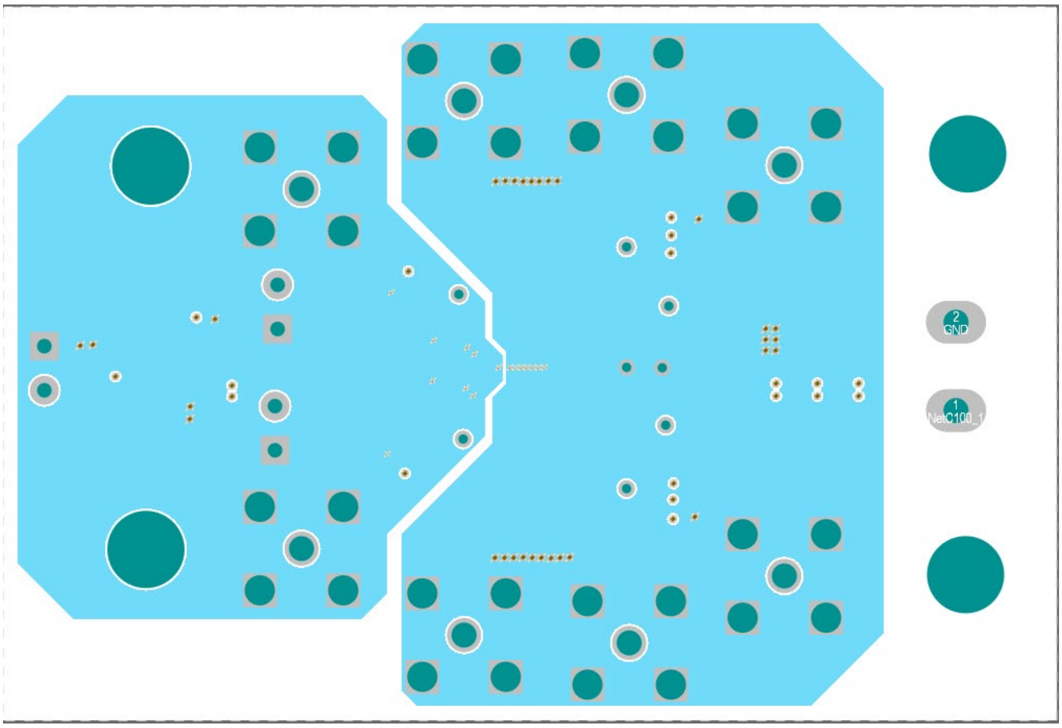


Figure 13 Signal layer 2 of INNELD090B1

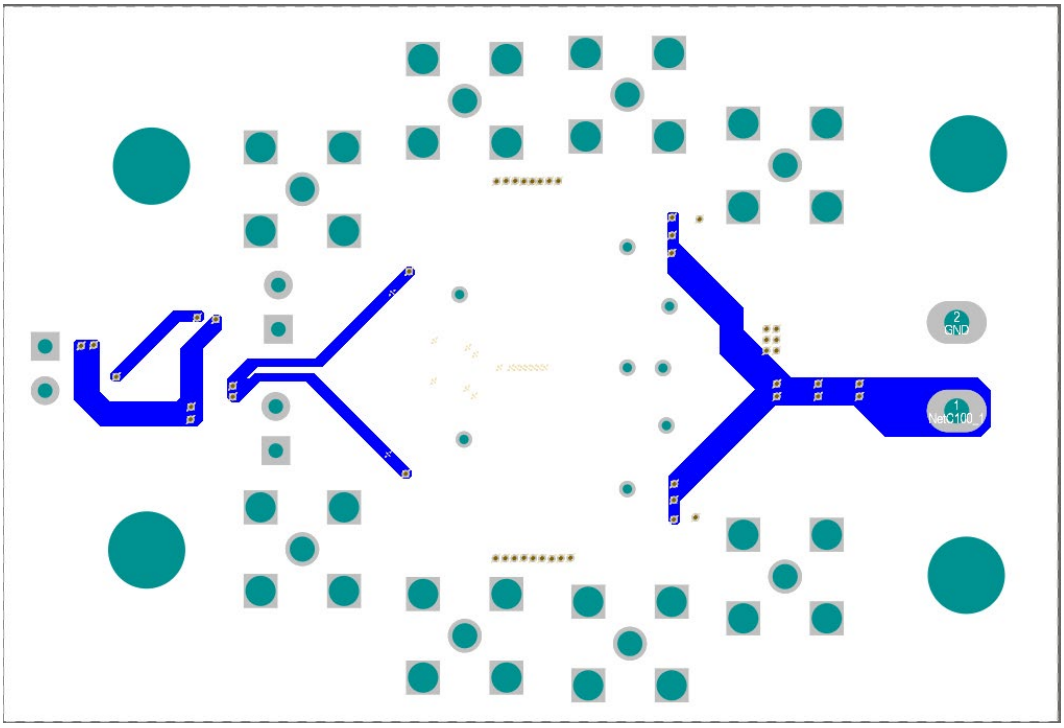


Figure 14 Bottom layer of INNELD090B1

Appendix B. BOM

Table 2 BOM

Comment	Designator	Footprint	Quantity
BEAD	B1, B2	0402r	2
100nF/100V	C1, C10, C25, C32	0603c	1
0.01uF/25V X7R	C2, C7	0402c	2
0.1uF/25V X7R	C3, C9, C17, C27	0402c	1
10uF/25V X7R	C4, C8	0805c	3
5pF/50V X7R	C5, C6, C30, C31	0402c	1
1nF/100V	C11, C12, C13, C14, C15, C20, C21, C22, C23, C24	0603c	2
150pF/50V	C16, C26	0603c	1
10uF/10V	C18, C19, C28, C29	0402c	1
2.2uF/100V	C100, C101	1206C	1
NC	D1, D2	SOD-123_AK	1
SMA Connector	Ids1, Ids2, Vcharge2, Vds1, Vds2, Vgs1, Vgs2	SMA_Tz_1	1
Header 2-Pin	JP1, JP3, JP4	HDR2.54-LI-2P	2
Header 2-Pin	JP2	KF128-5.08-2P	4
Greed LED	LED1	0603_LED	1
Green LED	LED2, LED3	0603_LED	1
INN100W14	Q1	INN0019 3X4	3
1k 1%	R1, R9, R38, R48	0603r	1
51R 1%	R2, R39	0402r	1
0R 1%	R3, R40	0402r	1
10K 1%	R4	0402r	1
2K 1%	R5	0402r	1
100R 1%	R6, R7, R11, R12, R41, R42, R50, R51	0402r	2
2K49 1%	R8	0402r	1
1k 1%	R10	0402r	2
390R 1%	R13, R14, R19, R20, R28, R29, R34, R35	0402r	3
0R 1%	R15, R16, R17, R18, R30, R31, R32, R33	1206R	1
0R 1%	R21, R36	0402r	2
100R 1%	R22, R37	0603r	3
0.47R 1%	R23, R24, R25, R26, R27, R43, R44, R45, R46, R47	0402r	1
1k 1%	R49	0402r	1
33K 1%	R52, R53	0402r	1
LP3878SDX-ADJ/NOPB	U1	WSON	1
LMG1020	U2, U4	DSBGA-0.625	2
SN74LVC1G08DBVR	U3, U5	SOT23-5L	2

Revision History

Date	Author	Versions	Description	Check
1/3/2023	Xinwei Li/ Bingwei Jing	1.0	First edition	AE Team

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