INNELD090B1
Evaluation Board Manual
LiDAR Application EVB
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.

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

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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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/\text{ns}, \ dv/dt=22.5 \ V/\text{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°C)

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</table>
3. Block Diagram

![Block Diagram of Lidar Evaluation Board](image)

**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](image1)

![Figure 3 Top Side Silkscreen for INNELD090B1](image2)
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

5.2. Test setup
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

![Parameter setting of signal generator](image)

**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 $V_{gs}$ (SMA1), the charging and discharging capacitor voltage $V_{charge}$ (SMA2), the pulse current $I_d$ (SMA3), and the switch voltage $V_{ds}$ (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 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:

   \[ V_{gs1} = V_{gs1\_sense} \times \frac{(R_{in} + R_{10})}{R_{in}} = V_{gs1\_sense} \times 21 \]

   Then the external attenuation factor of the oscilloscope with Vgs is, \((R_{in} + R_{10})/R_{in} = 21\)

2. Attenuation of GaN HEMT voltage Vds:
$V_{ds1} = V_{ds1, sense} \times \frac{(R_{in}||R_{11}||R_{12} + R_{9})}{(R_{in}||R_{11}||R_{12}) + V_{in}} = V_{ds1, sense} \times 41 + V_{in}$

Then the external attenuation factor of the oscilloscope with $V_{ds}$ is,

$\left(\frac{R_{in}||R_{11}||R_{12} + R_{10}}{R_{in}||R_{11}||R_{12}}\right) = 41$

3. Attenuation of pulse current $I_d$:

$I_d = V_{cs} \times \frac{(R_{in} + R_{2})}{R_{cs}} = V_{cs} \times 2.02/R_{cs}$

Then the external attenuation factor of the oscilloscope with $I_{ds}$ is, $(R_{in} + R_{2})/R_{in}) = 2.02$

4. Attenuation of charge and discharge capacitor voltage $V_{charge}$:

$V_{charge1} = V_{charge1, sense} \times \frac{(R_{in}||R_{6}||R_{7} + R_{1})}{(R_{in}||R_{6}||R_{7}) + V_{in}} = V_{charge1, sense} \times 41 + V_{in}$

Then the external attenuation factor of the oscilloscope with $V_{charge}$ is,

$\left(\frac{R_{in}||R_{6}||R_{7} + R_{10}}{R_{in}||R_{6}||R_{7}}\right) = 41$
6. Evaluation Results

6.1. Working Waveforms

Test conditions
Vin=26V  
Cres=1.35nF  
Rcharge=97.5Ω  
Fsignal=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
### Table 2 BOM

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