Application Note

Increasing Precision in LiDAR and Laser Scanner Applications with Discrete Non-Isolated GaN-Optimized Gate Drivers

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ABSTRACT

Non-isolated gate drivers are commonly used in industrial and automotive applications. Discrete non-isolated GaN gate drivers are common in applications where precision and high-frequency switching are required, such as light detection and ranging (LiDAR). This application note provides an overview of the non-isolated GaN-optimized gate drivers that Texas Instruments offers that can target the LiDAR and laser scanner end equipments.

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Trademarks

1 Introduction

LiDAR and laser scanners are key parts of automotive advanced driver-assistance systems (ADAS) and factory automation field transmitters. LiDAR and laser scanners use pulsed laser signals to help detect the distance of objects by collecting reflected pulses and arrival time. In automotive applications, it is most commonly seen in automatic braking systems in vehicles using time of flight (ToF).

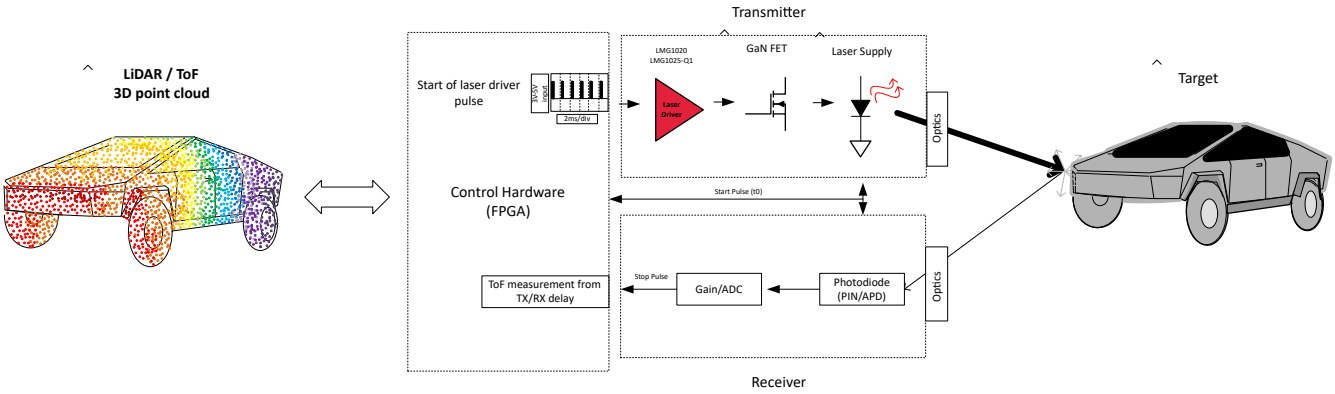

Figure 1-1. Example Automotive LiDAR Application Diagram

LiDAR and laser scanners have many advantages, including fast response times, high accuracy, and operation in many environments. To effectively support such applications, there are certain qualities of LiDAR and laser scanners that are vital to precise operation:

- **High-Frequency Capable:** GaNFETs are driven at high frequencies in LiDAR and laser scanner applications. During high-frequency switching, low-inductance packages can help support high current, low ringing operation. TI has multiple discrete GaN drivers are built in small packages for optimized operation.
- **Precision:** High-frequency operation must be supported by tiny pulse widths with minimal latency. The more pulses sent and received, the more accurate the resolution of the LiDAR or laser scanner mapping looks. Smaller delays between input signals and outputs allows for shorter delays between pulses. TI has discrete GaN drivers that can output pulse widths as low as one nanosecond with propagation delays under three nanoseconds.
- **Reliability:** The last thing any user wants is for system failure. A way to mitigate this is to use reliable components with built-in protection features. TI has discrete GaN drivers that have over-temperature protection (OTP) and undervoltage lockout (UVLO) which help mitigate the chances of damage to the driver in cases of fault conditions or overload.

2 Gate Drivers in Automotive LiDAR and Industrial Laser Scanner Applications

LiDAR and laser scanner systems have a switch that gate drivers help drive. A transistor is the component that performs the switching itself, handling the majority of the power transfer; this is typically a GaNFET in these end equipments. Finally, the gate driver is the in-between of the controller and the switch to efficiently control this transistor. The drive strength of the gate driver determines how fast the switch turns on or off, allowing for the optimization of system efficiency.

GaNFETs require more precise gate voltages compared to other types of FETs. Thus, it is important to have GaN-optimized discrete gate drivers to drive such GaNFETs. TI has both low-side GaN optimized gate drivers (such as the LMG1025-Q1 and LMG1020) and half-bridge GaN-optimized gate drivers (such as the LM5113-Q1 and LMG1205).

Ringing is something GaNFETs can experience and should be considered during design. To help alleviate this, it is recommended to have the ability to adjust the drive strength of a gate drive to help manage noise. Using discrete, GaN optimized gate drivers with split outputs helps designers independently adjust the resistor values to manage slew rate. TI has GaN optimized gate drivers such as the LMG1025-Q1, LMG1020, LM5113-Q1 and LMG1205 with split output. Selecting the best gate driver for the system allows for high performance operation.

3 LiDAR and Laser Scanner System Overview

LiDAR works by pulsing lasers and receiving the lasers a set amount of time later. Using the received signals, the LiDAR or laser scanner system can shape distances and objects to map out the environment.

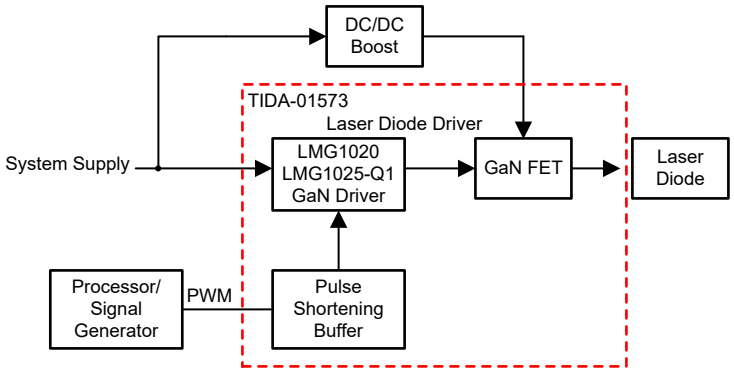

Figure 3-1. LiDAR System Block Diagram

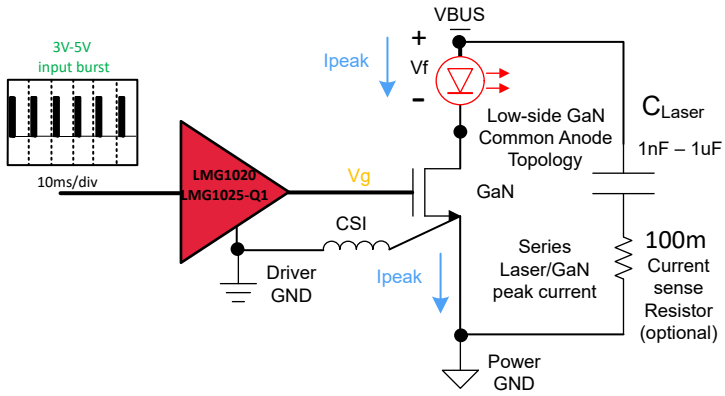

Figure 3-2. LMG1020 and LMG1025-Q1 Application Diagram

A LiDAR or laser scanner system consists of mainly three or four components: a discrete GaN gate driver, a GaN FET, a laser diode, and sometimes a buffer. The discrete GaN driver is optimized in a way to output pulses extremely quickly, requiring low propagation delays, high drive current, and tiny rise and fall times. Additionally, discrete GaN drivers can utilize small packages, such as the WCSP or eBGA packages, which can help minimize the gate loop inductance.

The discrete GaN drivers pair well with GaNFETs since GaNFETs have higher capability to switch faster compared to other FETs. GaNFETs also tend to be more efficient due to higher current handling. This high-frequency, high-efficiency switching allows for optimized pulses of the laser diode, resulting in accurate results in a compact solution. For more info on GaN FETs, see Key Parameters and Driving Requirements of GaNFETs.

For a useful reference design of an example LiDAR system, see Nanosecond Laser Driver Reference Design for LiDAR. For optimizing a LiDAR system, see Optimizing Gate Driver Layout for LiDAR Applications.

4 Hero Products

Table 4-1. Hero Products of LiDAR and Laser Scanner Subsystems

Subsystem	Configuration	Switch Type	Generic Part Number	Description
LiDAR/Laser Driver	Low-side 1-channel	GaNFET	LMG1025-Q1	Automotive 5V, 7A/5A Low-Side GaN and MOSFET Driver with 1.25ns Pulse Widths
		GaNFET	LMG1020	5V, 7A/5A Low-Side GaN and MOSFET Driver with 1ns Pulse Widths

5 References

- Texas Instruments: *GaN Applications*, application brief.
- Texas Instruments: *GaN Driver Schematic and Layout Recommendations*, application note.
- Texas Instruments: *Key Parameters and Driving Requirements of GaN FETs*, application brief.
- Texas Instruments: *GaN Gate Driver Layout Help*, application note.
- Texas Instruments: *Optimizing Gate Driver Layout for LiDAR Applications*, application note.
- Texas Instruments, *Nanosecond Laser Driver Reference Design for LiDAR*, reference design.
- Texas Instruments, LMG1025-Q1, product page.
- Texas Instruments, LMG1020, product page.

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