Technology, Device and Application of BiGaN™ with Dual Drains and Single Gate

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About This Document

Scope and Purpose
This document is intended to describe INNOSCIENCE™ bi-directional GaN HEMT with dual Drains and single Gate (BiGaN™), fitted with INNOSCIENCE™ high-performance e-mode GaN-on-Silicon technology. It works equivalently as two back-to-back MOSFETs with common source connection and is extremely suitable for load switch applications. The major advantages of BiGaN™ for load switch applications are (1) a smaller footprint, which helps to reduce the size of PCB and improve power density to the next level, and (2) lower Ron, a reduced power dissipation and therefore higher power efficiency. The document will focus on introduction of the technology and application of BiGaN™.

Intended Audience
This document is intended for IC and system designers to understand how to use and drive the bi-directional GaN HEMT.

We Listen to Your Comments
Is there any information within this document that you feel is wrong, unclear, or missing? Your feedback will help us to continuously improve the quality of this document.

Revision History
Major changes since the last revision

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1 Introduction

1.1 INNOSCIENCE™ GaN HEMT (InnoGaN™) Technology Introduction

INNOSCIENCE™ BiGaN™ (Bi-directional GaN HEMT) device was developed based on INNOSCIENCE™ 8-inch GaN-on-Silicon (InnoGaN™) technology. A cross-section diagram related to an InnoGaN™ device is shown in Fig1.1. A buffer layer is grown on the silicon to provide a seed layer for the subsequent growth of a gallium nitride heterostructure. A GaN layer is grown on top of the buffer layer and then a thin layer of aluminum gallium nitride (AlGaN). This interface, combined with the intrinsic piezoelectric nature of GaN, creates a 2DEG which is filled with highly mobile and abundant electrons [1]. To turn the device into normally off mode, or enhancement mode (e-mode), a pGaN Gate structure is inserted and the device is in off-state in normal condition, just like an N-MOSFET. To turn on the GaN switch, a positive voltage is applied to the Gate in relative to source in the same manner as turning on an n-channel, enhancement mode power MOSFET. However, there are two major differences comparing GaN HEMT to power MOSFETs: (1) An InnoGaN™ device is a purely lateral device while most of the power MOSFETs above 30V are vertical devices, (2) There is no parasitic “body diode” for GaN device and no reverse recovery losses, i.e. Qr is zero. GaN HEMTs have world’s best Rsp (specific resistance) and Figure of Merit (FOM) in semiconductor industry thanks to GaN material benefits.

![Fig1.1 pGaN e-mode GaN Single HEMT Cross Section](image1)

1.2 INNOSCIENCE™ bi-directional GaN HEMT (BiGaN™) Device Introduction

Some applications require switches with bi-directional voltage blocking function at off state. In order to achieve this functionality, system engineers generally use two N type MOSFETs in back-to-back connection with common source, using Drain sides to block high voltage, as shown in Fig1.2.

![Fig1.2 Two N-MOSFETs back-to-back connection with common source to form a bi-directional switch](image2)