

ICS 31.080.01

CCS L 40



**NATIONAL STANDARD OF THE
PEOPLE'S REPUBLIC OF CHINA**

GB/T 48168-2026

**Semiconductor devices - Reliability test method by inductive
load switching stress for gallium nitride (GaN) transistors
(English Translation)**

Issued on: August 28, 2026

Implemented on: March 1, 2027

Issued by: State Administration for Market Regulation

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Foreword

This document complies with the provisions of GB/T 1.1-2020 "Standardization Work Guidelines Part 1: Structure and Drafting Rules of Standardization Documents".

Drafting.

This document adopts IEC 63284:2022 "Reliability testing of gallium nitride transistors based on inductive load switching for semiconductor devices".

method".

The following minimal editorial changes have been made to this document.

---The standard title has been changed to "Reliability Testing of Gallium Nitride (GaN) Transistors Based on Inductive Load Switching Stress in Semiconductor Devices".

method";

---The URLs for the ISO and IEC terminology databases in Chapter 3 have been removed;

---Added the diode symbol and symbol description to Figure 1;

Please note that some content in this document may involve patents. The issuing organization of this document assumes no responsibility for identifying patents.

This document was proposed by the Ministry of Industry and Information Technology of the People's Republic of China.

This document is under the jurisdiction of the National Semiconductor Device Standardization Technical Committee (SAC/TC78).

Introduction

Gallium nitride (GaN), as a wide-bandgap semiconductor, is used in power devices and possesses some characteristics superior to traditional silicon (Si), such as high breakdown voltage.

Electric field and high saturation velocity. Another advantage of GaN-related materials is that, through the heterojunction formed by GaN and aluminum gallium nitride (AlGaN), due to polarization...

The effect induces the generation of a two-dimensional electron gas with high mobility and high concentration. Furthermore, based on differences in device performance and cost requirements, [the appropriate device is selected].

Different materials such as silicon, sapphire, silicon carbide (SiC), or GaN are used as epitaxial growth substrates. Currently, GaN power transistors are widely used.

Development and commercial application.

The more compact layout of power transistors allows devices to operate at higher electric fields. Meanwhile, some thermal properties of silicon field-effect transistors (FETs) are also being improved.

Carrier and robustness tests are not applicable to GaN power transistors. For example, due to the blocking effect of the buffer layer, lateral...

Hot carrier injection (HCI) tests for MOSFETs are not applicable to lateral GaNFETs; furthermore, lateral GaNFETs do not exhibit avalanche behavior.

The breakdown capability cannot be assessed using non-clamped inductive switches (UIS) for avalanche withstand capability. Therefore, some silicon power devices are typically used.

Unnecessary special reliability testing methods are used for reliability assessment of GaN power transistors, such as dynamic on-resistance testing methods. (Special) Yes, switching test methods and reliability assessment procedures are of great significance for the practical application of GaN power transistors. Therefore, it is necessary to establish standards.

A standardized method for evaluating the reliability of GaN power transistor switches.

This document serves as a guide for conducting stress tests on inductive load switches, used to verify the reliable operating conditions of GaN power transistors.

Since inductive load switching stress is considered an important stress application scenario for power devices, this document will promote the application of GaN power transistors in power applications.

The widespread application of power devices. In addition, there are other application-related stress conditions (such as high-frequency soft switching), which are not discussed in this article.

The scope of the items covered.

Semiconductor devices based on inductive load switches Stressed gallium nitride (GaN) transistors Reliability testing methods

1 Scope

This document describes how to evaluate the reliability of gallium nitride (GaN) power transistors through inductive load switching stress (especially hard switching stress).

Stress procedures and corresponding test methods.

2 Normative references

This document has no normative references.

The following terms and definitions apply to this document.

Gallium nitride (GaN) Compound semiconductor materials composed of gallium and nitrogen.

Ternary compound semiconductor materials composed of aluminum, gallium, and nitrogen.

On-state resistance

R_{on}

The resistance of a device under rated current conditions.

dynamic on-state resistance the ratio of drain-source voltage (v_{DS}) to drain current (i_D) during the switching process.

Reliability testing under continuous switching stress at high junction temperatures.

Note: Dynamic high-temperature operational life (DHTOL) testing has a wide range of applications, including both anticipated failure and accelerated switching life (SALT) testing for aging modeling.

The tests also include high-temperature operational life (HTOL) tests, which are not

expected to fail.

Switching Locus