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Date: 21 January 2022

Origin: International

Latest date for receipt of comments: 23 February 2022

Project No. 2021/03174

Responsible committee: EPL/47 Semiconductors

Interested committees:

Title: Draft BS EN 63419 Guideline for Switching Reliability Evaluation procedures for Gallium Nitride Power Conversion Devices

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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

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Submission of Comments

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



47/2744/CDV

COMMITTEE DRAFT FOR VOTE (CDV)

PROJECT NUMBER: IEC 63419 ED1	
DATE OF CIRCULATION: 2021-12-31	CLOSING DATE FOR VOTING: 2022-03-25
SUPERSEDES DOCUMENTS:	

IEC TC 47 : SEMICONDUCTOR DEVICES	
SECRETARIAT: Korea, Republic of	SECRETARY: Mr Cheolung Cha
OF INTEREST TO THE FOLLOWING COMMITTEES: TC 91, TC 104	PROPOSED HORIZONTAL STANDARD: ☐ Other TC/SCs are requested to indicate their interest, if any, in this CDV to the secretary.
FUNCTIONS CONCERNED: ☐ EMC ☐ ENVIRONMENT ☐ QUALITY ASSURANCE ☐ SAFETY	
☐ SUBMITTED FOR CENELEC PARALLEL VOTING	☒ NOT SUBMITTED FOR CENELEC PARALLEL VOTING

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Recipients of this document are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

TITLE:

Guideline for Switching Reliability Evaluation procedures for Gallium Nitride Power Conversion Devices

PROPOSED STABILITY DATE: 2027

NOTE FROM TC/SC OFFICERS:

This CDV is based upon JEDEC document JEP180 (title: Guideline for Switching Reliability Evaluation procedures for Gallium Nitride Power Conversion Devices) and is circulated according to the IEC fast-track procedure (see F.2 of ISO/IEC Directives, Part 1, 2021).

This document is proposed by the US National Committee. TC 47 / WG 8 at the October 2021 meeting approved the document for fast-track procedure and was presented to TC 47 Plenary at the October 2021 Plenary. TC 47 Secretariat has reviewed and approved the circulation of the CDV according to the fast-track procedure.

This document is allocated to TC 47 / WG 8 and the project leader is Dr Stephanie Watts Butler.

This document is also of interest to TC 47/WG 5.

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**GUIDELINE FOR SWITCHING RELIABILITY EVALUATION PROCEDURES
FOR GALLIUM NITRIDE POWER CONVERSION DEVICES**

FOREWORD

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The text of this International Standard is based on the following documents:

Draft	Report on voting
XX/XX/FDIS	XX/XX/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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INTRODUCTION

This document is intended for use by GaN product suppliers and related power electronic industries. It provides guidelines for evaluating the switching reliability of GaN power switches and assuring their reliable use in power conversion applications. It is applicable to planar enhancement-mode, depletion-mode, GaN integrated power solutions and cascode GaN power switches.

Gallium Nitride (GaN) power switches are important devices for high-efficiency, small form-factor power conversion applications. Current GaN power switches are based upon the planar High Electron Mobility Transistor (HEMT), which is a Field-Effect Transistor (FET). The switch can be a discrete enhancement or depletion-mode GaN FET, a GaN FET in combination with a silicon transistor forming a cascode and/or co-packaged with silicon control electronics. It can also be a GaN power FET with integrated GaN electronics. During operation, all power devices experience switching stress for which the reliability needs to be evaluated and lifetimes assured.

For many silicon power conversion products, operational robustness is often validated by a combination of technology and product-level tests, e.g., Hot Carrier Injection (HCI) [1], Unclamped Inductive Switching (UIS) [2], high-temperature operating life (HTOL) [3]. Individual silicon tests do not necessarily validate operation under actual-use conditions of power conversion products, which simultaneously involve high power transfer through the device, high slew rates, and hot-carrier effects. Each addresses different aspects, and over the years they have been developed to work well together. These tests are either not applicable or have not been comprehensively specified for GaN switches. For example, the HCI test relies on a body contact that is not available in GaN FETs and the UIS test takes the device into avalanche, which is not recommended for GaN FETs. The GaN industry has therefore been conducting switching reliability testing to assure the reliability and robustness of GaN switches [4]-[8], both at the technology level and in application.

The industry and research community now need to work towards standardizing the methodology for assuring both the switching reliability of the technology platform and the robustness of GaN switches for use in a broad class of power management applications. Typically, standards lag technology introduction because there needs to be substantial public knowledge of failure modes and mechanisms before a standards document can be published. This takes time because confidential information needs to be de-classified and new knowledge discovered. It is, however, desirable for the industry to develop common approaches sooner, so that customers can readily evaluate the technology options available. The goal of this document is to present guidelines for a common approach, and to accelerate progress towards the future standard.

A common approach for power management needs to consider many aspects. Power conversion involves different modes of operation, e.g., hard and soft-switching, the usage of the power switch in many different topologies, and the interaction of the switch with other system components. The approach also needs to detect failure modes of interest to the power electronics industry, e.g., lower efficiency from an increase in on-resistance [7]. It also needs to consider the limitations and strengths of classes of boards and hardware in conducting the stress-testing needed. Finally, the approach needs to assure broad coverage, so as not to introduce unnecessary burden on the industry.

This document provides a common approach for assuring that GaN products are reliable in power conversion applications. It provides guidelines for broad coverage, addresses the detection of relevant failure modes, provides guideline stress-test procedures, and proposes common ways to collect and present data. The approach is broken down into guidelines for the three key aspects as shown in Figure 1.

- 1) A procedure for obtaining broad coverage by classifying the switching stress stimuli with their switching loci and explaining the use of a harsher stress condition to cover a milder use-case condition.

- 2) A procedure for obtaining the switching lifetime of the technology platform. This involves performing accelerated life testing with a suitable type of GaN die or core switch to generate a model.
- 3) A procedure for validating reliable operation under application-use conditions by running parts in an application environment using stress conditions that, if passing, would assure reliable operation for a broad range of use-conditions.

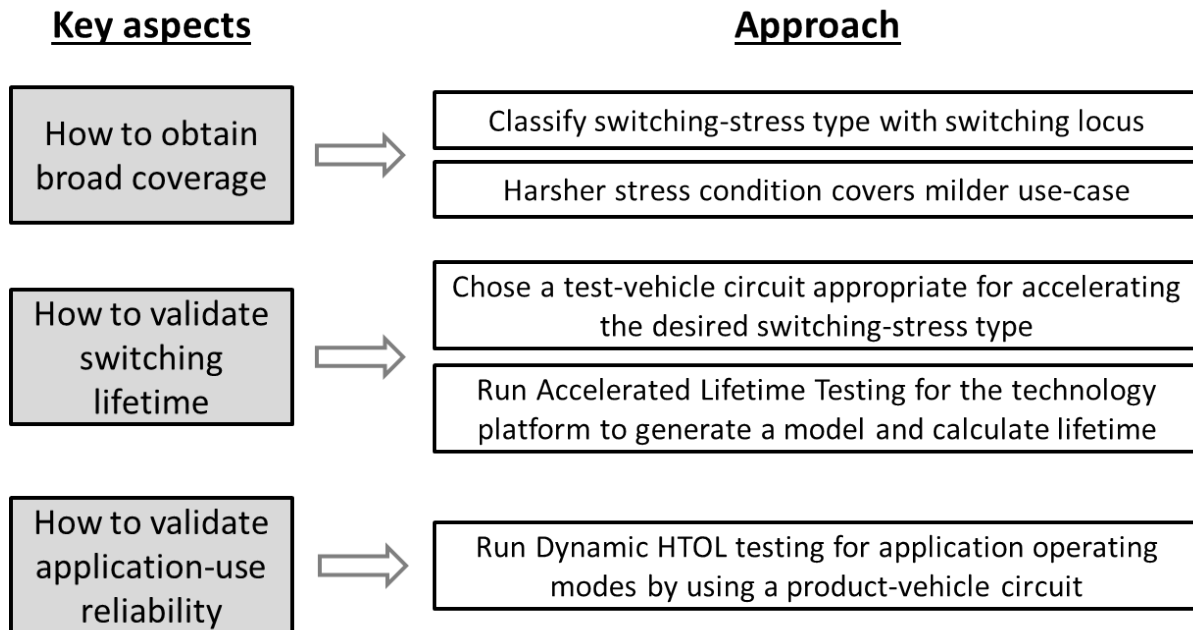


Figure 1 — Simplified explanation of the approach for assuring GaN product reliability. It consists of three key aspects as shown. The approach is not intended to be restrictive, as is described in the text

The approach is not intended to be restrictive. It takes into account the strengths and limitations of boards, hardware, and components, while also recognizing the need to not introduce unnecessary burden on the industry. It does not restrict additional testing, larger sample sizes, and stress conditions with higher acceleration. It also does not restrict the use of boards and device types. For instance, lifetime determination can be made using more complex boards or GaN switches by verifying that the complexity does not mask the acceleration of relevant failure mechanisms. Conversely simpler boards can be used to assure application-use reliability by providing collateral material showing robustness to operating modes not tested.

The core of this guideline is organized into four clauses, with clauses 5-7 reflective of the aspects of Figure 1.

- Clause 4 gives general guidance for selecting test devices, test circuits and developing test plans.
- Clause 5 provides an approach for broad coverage by using the switching locus curve.
- Clause 6 gives the procedure for obtaining wearout models and device lifetime.
- Finally, clause 7 provides guidance on validating reliable operation of GaN switches in power conversion applications.