

INTERNATIONAL STANDARD

Guideline for evaluating bias temperature instability of silicon carbide metal-oxide-semiconductor devices for power electronic conversion



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IEC Secretariat
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

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CONTENTS

FOREWORD.....	3
INTRODUCTION.....	5
1 Scope.....	6
2 Normative references	6
3 Terms and definitions	6
4 Considerations for bias-temperature instability (BTI) stress methods and shift evaluation for SiC-based MOS devices.....	11
4.1 General.....	11
4.2 Mechanisms of V_T shift and hysteresis resulting from PBTI/NBTI stress	12
4.3 Threshold voltage and hysteresis measurements	12
4.3.1 Comments concerning threshold voltage (V_T) measurements	12
4.3.2 V_T measurement and conditioning.....	15
4.3.3 Threshold hysteresis (V_T^{HYST}) and fast transient effects	16
4.4 Typical PBTI/NBTI stress considerations	17
4.5 Lifetime prediction models and failure determination.....	18
4.6 Overview of BTI methods	20
5 General Measure Stress Measure (MSM) method.....	21
6 Fast Drain Current (FDC) method.....	23
7 Gate sweep MSM method.....	24
8 Conditioning Method.....	26
9 Hysteresis method (or double sense method).....	27
10 Triple sense method	28
Annex A (informative) Supplemental sampling guidelines.....	30
Annex B (informative) Examples demonstrating V_T shift during BTI measurements	31
B.1 General.....	31
B.2 Single V_T sense measurements.....	31
B.3 Double V_T sense measurements (hysteresis method).....	33
B.4 Triple V_T sense measurements (V_T sense + hysteresis).....	35
Annex C (informative) Examples demonstrating V_T shift during gate switching	37
Annex D (informative) Lifetime models.....	39
Annex E (informative) General introduction to threshold voltage (V_T) stability and SiC-based MOS devices	41
Bibliography.....	43
Figure 1 – Proposed sweep methods for NBTI and PBTI for MOSFETs.....	14
Figure 2 – Proposed sweep methods for NBTI and PBTI for gated diode configuration	14
Figure 3 – Circuit diagram for the V_T measurement using the gated-diode configuration.....	15
Figure 4 – Sweep proposal and I_D vs V_{GS} response for the fixed V_{GS} method	15
Figure 5 – Hysteresis measurement sequence, measuring V_T using the gated diode V_T sense method	16
Figure 6 – Hysteresis measurement sequence using gate sweeps	17

Figure 7 – The absolute value of NBTI V_T shift	19
Figure 8 – The PBTI V_T shift as a function of time, fit to a power law for the longer time shift data	19
Figure 9 – MSM PBTI stress and measure waveforms	22
Figure 10 – MSM NBTI stress and measure waveforms	23
Figure 11 – Fast-drain current waveforms for PBTI stress	23
Figure 12 – Fast-drain current waveforms for NBTI stress	24
Figure 13 – Gate-sweep MSM method waveforms for PBTI	25
Figure 14 – Gate-sweep MSM method waveforms for NBTI	25
Figure 15 – Conditioning method waveforms for PBTI	26
Figure 16 – Conditioning method waveforms for NBTI	27
Figure 17 – Conditioning method waveforms for NBTI	27
Figure 18 – BTI hysteresis method using the full hysteresis measurement as the V_T sense step after each V_{GS} stress period	28
Figure 19 – BTI triple sense method using a first V_T sense followed by a hysteresis measurement (three V_T measurements per sense step)	29
Figure B.1 – Example showing the measured V_T over time during PBTI using a single V_T sense	32
Figure B.2 – Example showing the measured V_T over time during NBTI using a single V_T sense	32
Figure B.3 – Example showing the effect of a conditioning pulse on the measured V_T over time during NBTI using a single V_T sense	33
Figure B.4 – Example showing the two V_T versus time curves obtained during the PBTI hysteresis method	34
Figure B.5 – Example showing the two V_T versus time curves obtained during the NBTI hysteresis method	34
Figure B.6 – Example showing the three V_T versus time curves obtained during the PBTI triple sense method	35
Figure B.7 – Example showing the three V_T versus time curves obtained during the NBTI triple sense method	36
Figure C.1 – V_T evolution over time	38
Table 1 – BTI methods described in this document	21

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

Draft	Report on voting
47/2986/FDIS	47/2994/RVD

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

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INTRODUCTION

The objective of this document is to provide useful definitions and procedures for characterizing the threshold voltage instability of SiC-based power electronic conversion semiconductor (PECS) devices having a gate dielectric region biased to turn devices on and off. This typically refers to MOS (Metal-Oxide-Semiconductor) devices such as field-effect transistors (MOSFETs, Metal-Oxide-Semiconductor Field Effect Transistors) and insulated-gate bipolar transistors (IGBTs). For simplicity reasons, in the following paragraphs the terms MOSFET or MOS device are used only, while the content is valid for IGBT's as well. Monitoring of threshold-voltage instability in MOS devices is commonly referred to by the term "bias-temperature instability" (BTI), while the applied stress to check for instability is usually referred to as "bias-temperature-stress" (BTS). The terms BTI, BTS, and threshold-voltage instability will be used throughout this document.

1 Scope

The scope of this document covers SiC-based PECS devices having a gate dielectric region biased to turn devices on and off. This typically refers to MOS devices such as MOSFETs and IGBTs. In this document, only NMOS (N-type MOS) devices are discussed as these are dominant for power device applications; however, the procedures apply to PMOS (P-type MOS) devices as well.

This document does not define device failure criteria, acceptable use conditions or acceptable lifetime targets. That is up to the device manufacturers and users. However, it provides stress procedures such that the threshold voltage stability over time as affected by gate bias and temperature can be demonstrated and evaluated.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60747-8:2010, *Semiconductor devices - Discrete devices - Part 8: Field-effect transistors*

IEC 63505, *Guidelines for measuring the threshold voltage (V_T) of SiC MOSFETs*

3 Terms and definitions

3.1

metal-oxide-semiconductor field-effect transistor MOSFET

insulated-gate field-effect transistor in which the insulating layer between the gate electrode and the channel is oxide (or dielectric) material and the gate is metal or another highly conductive material

[SOURCE: IEC 60050-521:2002, 521-04-55, modified – The words “(or dielectric)” have been added between “oxide” and “material”; the words “and the gate is metal or another highly conductive material” have been added after the word “material”.]

3.2

silicon carbide

SiC

wide bandgap semiconducting material that serves as the active device semiconductor material, for example the channel and drift region

Note 1 to entry: Typically the 4H hexagonal polytype is preferred, denoted 4H-SiC, in the (0001) wafer orientation (other polytypes sometimes used are 6H-SiC, or 3C-SiC)

3.3

power electronic conversion semiconductor devices

PECS devices

power devices used for power conversion to different voltage or current levels, or as inverters between alternating and direct current power (or vice versa)

3.4

gate oxide

oxide (or dielectric) region under the gate electrode in the MOS portion of the MOS device