

# INTERNATIONAL STANDARD

---

**Semiconductor devices – Semiconductor devices for energy harvesting and generation –  
Part 6: Test and evaluation methods for vertical contact mode triboelectric energy harvesting devices**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

---

ICS 31.080.99

ISBN 978-2-8322-7165-0

<p><b>Warning! Make sure that you obtained this publication from an authorized distributor.</b></p>
---

## CONTENTS

FOREWORD.....	4
1 Scope .....	6
2 Normative references .....	6
3 Terms and definitions .....	6
3.1 General terms .....	6
3.2 Triboelectric transducer .....	7
3.3 Characteristic parameters .....	8
4 Essential ratings and characteristics .....	10
4.1 Identification and type .....	10
4.2 Limiting values and operating conditions .....	10
4.3 Additional information .....	10
5 Test method .....	10
5.1 General.....	10
5.2 Electrical characteristics .....	12
5.2.1 Test procedure .....	12
5.2.2 Open-circuit voltage.....	13
5.2.3 Short-circuit current .....	13
5.2.4 Output voltage .....	14
5.2.5 Output current .....	14
5.2.6 Output power .....	15
5.2.7 Optimal load impedance .....	15
5.2.8 Maximum output power .....	15
5.2.9 Stored charge .....	15
5.2.10 Capacitance .....	16
5.3 Mechanical characteristics .....	17
5.3.1 Test procedure .....	17
5.3.2 Contact area.....	17
5.3.3 Input force .....	18
5.3.4 Input frequency.....	19
5.3.5 Relative humidity range .....	19
5.3.6 Temperature range .....	20
Annex A (informative) Vertical contact modes .....	21
A.1 Double electrode mode .....	21
A.2 Single electrode mode .....	21
Annex B (informative) Test setup for vertical contact mode triboelectric energy harvester .....	22
B.1 Example of test setup and characterization .....	22
B.2 Experimental data .....	22
Bibliography.....	24
Figure 1 – Vertical contact mode triboelectric energy harvester .....	7
Figure 2 – Fundamental theories of four working modes of vertical contact mode triboelectric energy harvester.....	8
Figure 3 – Equivalent circuit of triboelectric energy harvester .....	9
Figure 4 – Measurement procedure of vertical contact mode triboelectric energy harvester .....	11

Figure 5 – Test setup for the electrical characteristics of vertical contact mode triboelectric energy harvester.....	12
Figure 6 – Instantaneous open-circuit output voltage characteristics.....	13
Figure 7 – Instantaneous short-circuit output current characteristics .....	14
Figure 8 – Output voltage and current of triboelectric energy harvester under different loads.....	14
Figure 9 – Output power of triboelectric energy harvester at various external loads .....	15
Figure 10 – Stored charging time relationship at different load capacitances of triboelectric energy harvester.....	16
Figure 11 – Capacitance between the two electrodes of a triboelectric energy harvester .....	16
Figure 12 – Block diagram of a test setup for evaluating the reliability of vertical contact mode triboelectric energy harvester.....	17
Figure 13 – Instantaneous open-circuit voltage characteristics for four different contact areas of contact mode triboelectric energy harvester .....	18
Figure 14 – Output voltage and current under different input forces on vertical contact mode triboelectric energy harvester .....	18
Figure 15 – Output voltage and current under different working frequencies on vertical contact mode triboelectric energy harvester.....	19
Figure 16 – Triboelectric output voltage as a function of relative humidity.....	20
Figure 17 – Open-circuit voltage of triboelectric energy harvester at different temperatures .....	20
Figure A.1 – Operation mode of vertical contact mode triboelectric energy harvester.....	21
Figure B.1 – Measurement setup for vertical contact mode triboelectric energy harvester .....	22
Figure B.2 – Electrical characterization results of the pressure-voltage relationship.....	23
Table 1 – Specification parameters for vertical contact mode triboelectric energy harvester .....	10

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

---

**SEMICONDUCTOR DEVICES –  
SEMICONDUCTOR DEVICES FOR  
ENERGY HARVESTING AND GENERATION –**
**Part 6: Test and evaluation methods for vertical  
contact mode triboelectric energy harvesting devices**
**FOREWORD**

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 62830-6 has been prepared by IEC technical committee 47: Semiconductor devices.

The text of this standard is based on the following documents:

FDIS	Report on voting
47/2573/FDIS	47/2585/RVD

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

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 62830 series, published under the general title *Semiconductor devices – Semiconductor devices for energy harvesting and generation*, can be found on the IEC website.

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

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

A bilingual version of this publication may be issued at a later date.

# **SEMICONDUCTOR DEVICES – SEMICONDUCTOR DEVICES FOR ENERGY HARVESTING AND GENERATION –**

## **Part 6: Test and evaluation methods for vertical contact mode triboelectric energy harvesting devices**

### **1 Scope**

This part of IEC 62830 defines terms, definitions, symbols, and specifies configurations and test methods to be used to evaluate and determine the performance characteristics of vertical contact mode triboelectric energy harvesting devices for practical use. This document is applicable to energy harvesting devices as power sources for wearable devices and wireless sensors used in healthcare monitoring, consumer electronics, general industries, military and aerospace applications without any limitations on device technology and size.

### **2 Normative references**

There are no normative references in this document.