



**BSI Standards Publication**

## **Nanomanufacturing — Key control characteristics**

---

Part 6-27: Graphene-related products — Field-effect mobility for layers of two-dimensional materials: field-effect transistor method

## National foreword

This Published Document is the UK implementation of IEC TS 62607-6-27:2025.

The UK participation in its preparation was entrusted to Technical Committee NTI/1, Nanotechnologies.

A list of organizations represented on this committee can be obtained on request to its committee manager.

### Contractual and legal considerations

This publication has been prepared in good faith, however no representation, warranty, assurance or undertaking (express or implied) is or will be made, and no responsibility or liability is or will be accepted by BSI in relation to the adequacy, accuracy, completeness or reasonableness of this publication. All and any such responsibility and liability is expressly disclaimed to the full extent permitted by the law.

This publication is provided as is, and is to be used at the recipient's own risk.

The recipient is advised to consider seeking professional guidance with respect to its use of this publication.

This publication is not intended to constitute a contract. Users are responsible for its correct application.

This publication is not to be regarded as a British Standard.

© The British Standards Institution 2025  
Published by BSI Standards Limited 2025

ISBN 978 0 539 22348 4

ICS 07.120

### Compliance with a Published Document cannot confer immunity from legal obligations.

This Published Document was published under the authority of the Standards Policy and Strategy Committee on 31 December 2025.

### Amendments/corrigenda issued since publication

| Date | Text affected |
|------|---------------|
|------|---------------|

# TECHNICAL SPECIFICATION

---

**Nanomanufacturing - Key control characteristics -  
Part 6-27: Graphene-related products - Field-effect mobility for layers of two-  
dimensional materials: field-effect transistor method**



**THIS PUBLICATION IS COPYRIGHT PROTECTED**  
**Copyright © 2025 IEC, Geneva, Switzerland**

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

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

Tel.: +41 22 919 02 11  
[info@iec.ch](mailto:info@iec.ch)  
[www.iec.ch](http://www.iec.ch)

**About the IEC**

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

**About IEC publications**

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

**IEC publications search -**

[webstore.iec.ch/advsearchform](http://webstore.iec.ch/advsearchform)

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, ...). It also gives information on projects, replaced and withdrawn publications.

**IEC Just Published - [webstore.iec.ch/justpublished](http://webstore.iec.ch/justpublished)**

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

**IEC Customer Service Centre - [webstore.iec.ch/csc](http://webstore.iec.ch/csc)**

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: [sales@iec.ch](mailto:sales@iec.ch).

**IEC Products & Services Portal - [products.iec.ch](http://products.iec.ch)**

Discover our powerful search engine and read freely all the publications previews, graphical symbols and the glossary. With a subscription you will always have access to up to date content tailored to your needs.

**Electropedia - [www.electropedia.org](http://www.electropedia.org)**

The world's leading online dictionary on electrotechnology, containing more than 22 500 terminological entries in English and French, with equivalent terms in 25 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

**Warning! Make sure that you obtained this publication from an authorized distributor.**



**Documents**

Document Sharing Hub

## CONTENTS

|                                                                                                                                                                                                   |    |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| FOREWORD .....                                                                                                                                                                                    | 3  |
| INTRODUCTION .....                                                                                                                                                                                | 5  |
| 1 Scope .....                                                                                                                                                                                     | 6  |
| 2 Normative references .....                                                                                                                                                                      | 6  |
| 3 Terms and definitions .....                                                                                                                                                                     | 6  |
| 3.1 General terms .....                                                                                                                                                                           | 6  |
| 3.2 Key control characteristics measured according to this standard .....                                                                                                                         | 7  |
| 3.3 Terms related to the measurement method .....                                                                                                                                                 | 7  |
| 4 General .....                                                                                                                                                                                   | 8  |
| 4.1 Measurement principle .....                                                                                                                                                                   | 8  |
| 4.2 Description of the measurement equipment .....                                                                                                                                                | 9  |
| 4.3 Sample preparation method .....                                                                                                                                                               | 9  |
| 4.3.1 Sample preparation .....                                                                                                                                                                    | 9  |
| 4.3.2 Fabrication of FETs with a 2D channel material .....                                                                                                                                        | 9  |
| 4.4 Description of measurement equipment .....                                                                                                                                                    | 10 |
| 5 Measurement procedure .....                                                                                                                                                                     | 10 |
| 6 Data analysis .....                                                                                                                                                                             | 11 |
| Annex A (informative) Worked example – 2PP and 4PP mobility measurements in bottom-contacted WSe <sub>2</sub> FETs .....                                                                          | 13 |
| A.1 Background .....                                                                                                                                                                              | 13 |
| A.2 Results to be reported .....                                                                                                                                                                  | 14 |
| Annex B (informative) Worked example – 2PP and 4PP mobility measurements in an organic FET .....                                                                                                  | 15 |
| B.1 Background .....                                                                                                                                                                              | 15 |
| B.2 Results to be reported .....                                                                                                                                                                  | 15 |
| Annex C (informative) Worked example – Mobility measurements on WSe <sub>2</sub> FETs .....                                                                                                       | 17 |
| C.1 Background .....                                                                                                                                                                              | 17 |
| C.2 Results to be reported .....                                                                                                                                                                  | 18 |
| Bibliography .....                                                                                                                                                                                | 19 |
| Figure 1 – Schematic of field-effect transistor where $V_g$ and $V_{ds}$ are the gate voltage and drain voltage applied with respect to source .....                                              | 8  |
| Figure 2 – Determination of field-effect mobility using a current–voltage transfer curve of a FET .....                                                                                           | 9  |
| Figure 3 – Schematic (left) and optical microscope image (right) of the four-terminal configuration .....                                                                                         | 11 |
| Figure 4 – Transfer curve (a) and corresponding transconductance (b) used to obtain field-effect mobility which is extracted from the transconductance of a FET biased in the linear regime ..... | 11 |
| Figure 5 – Mobilities obtained as a function of gate voltage .....                                                                                                                                | 12 |
| Figure A.1 – Schematic of FET WSe <sub>2</sub> used for 2PP mobility measurement .....                                                                                                            | 13 |
| Figure A.2 – Cross-sectional schematic .....                                                                                                                                                      | 13 |
| Figure A.3 – Optical microscopic picture of a FET used for 4PP mobility measurement .....                                                                                                         | 14 |
| Figure B.1 – Device structure used for 2PP and 4PP measurements .....                                                                                                                             | 15 |

|                                                                                                                                            |    |
|--------------------------------------------------------------------------------------------------------------------------------------------|----|
| Figure B.2 – Comparison of the 2PP and 4PP mobility measurements in a rubrene single-crystal organic FET for different gate voltages ..... | 16 |
| Figure C.1 – Colour-corrected optical image .....                                                                                          | 17 |
| Figure C.2 – Schematic cross section of the device .....                                                                                   | 17 |
| Figure C.3 – Temperature-dependent transfer characteristics showing the linear region of device operation for $V_{GS} < -80$ V .....       | 18 |
| Figure C.4 – Extracted field-effect mobility at $V_{GS} = -95$ V at different temperatures .....                                           | 18 |
| Table A.1 – Comparison of 2PP and 4PP mobilities .....                                                                                     | 14 |

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**Nanomanufacturing - Key control characteristics -  
Part 6-27: Graphene-related products -  
Field-effect mobility for layers of two-dimensional materials:  
field-effect transistor method**

## 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) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at <https://patents.iec.ch>. IEC shall not be held responsible for identifying any or all such patent rights.

IEC TS 62607-6-27 has been prepared by IEC technical committee 113: Nanotechnology for electrotechnical products and systems. It is a Technical Specification.

The text of this Technical Specification is based on the following documents:

| Draft       | Report on voting |
|-------------|------------------|
| 113/899/DTS | 113/940/RVDTS    |

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 Technical Specification 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](http://www.iec.ch/members_experts/refdocs). The main document types developed by IEC are described in greater detail at [www.iec.ch/publications](http://www.iec.ch/publications).

A list of all parts in the IEC 62607 series, published under the general title *Nanomanufacturing - Key control characteristics*, can be found on the IEC website.

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

- reconfirmed,
- withdrawn, or
- revised.