IEC PAS 63702

Edition 1.0 2026-06

PUBLICLY AVAILABLE SPECIFICATION

Classification of additive manufacturing and 3D-printing processes for electronics

IEC PAS 63702:2026-06(en)

ICS 31.190 ISBN 978-2-8327-1330-3

THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2026 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 Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
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
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 It also gives information on projects, replaced and withdrawn publications.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
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
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC Products & Services Portal - 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
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.

INTERNATIONAL ELECTROTECHNICAL COMMISSION

____

Classification of additive manufacturing and 3D-printing processes for electronics

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 63702 has been prepared by IEC technical committee 91: Electronics assembly technology. It is a Publicly Available Specification.

It is based on a document issued by Fachverband Elektronikdesign und -fertigung e. V. (FED) entitled *Classification of additive manufacturing and 3D-printing processes for electronics, White Paper Edition 2024*, and was submitted as a PAS document.

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

Draft	Report on voting
91/2105/DPAS	91/2114/RVDPAS

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 Publicly Available Specification is English.

The structure and editorial rules used in this publication reflect the practice of the organization which submitted it.

This document was 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/publications.

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 in the data related to the specific document. At this date, the document will be

– reconfirmed,
– withdrawn, or
– revised.

NOTE In accordance with ISO/IEC Directives, Part 1, IEC PASs are automatically withdrawn after 4 years.

FED

We connect

FED-Working group 3D-Elektronik

Classification of additive manufacturing and 3D-printing processes for electronics

Additive Manufactured Electronics – AME

White Paper Edition 2024

1 Foreword

The growing demands for miniaturization and increased performance of electronic devices today go far beyond system integration, which is described as "More than Moore" and driving forces regarding Additive Manufacturing in the electrical and electronics industry.

AM is becoming increasingly important, especially for 3D electronics concepts. New 3D printing processes enable heterogeneous and functional integration through multi-hybrid and tool-free production. Both, physical and/or electrical functions, can be printed, additionally electronic components can be assembled within a single operation.

With the new 3D printing processes multidimensional substrates (components) and circuit carriers with integrated functions such as sensors, actuators, electro-optical or bionic properties can be realized, without the need for a carrier substrate or already manufactured Printed Circuit Board.

At the same time rapid progress due to material development is carried out. Nanomaterials in combination with new developed materials printed in one process enable advanced or new possibilities. As an additional positive effect material, energy and transportation costs can be saved in further production processes.

Given the large number of processes and applications it makes sense to classify the methods from the perspective of manufacturing. The FED 3D Electronics Working Group developed this classification in a two-year project and defined five classes of electronics integration using AM.

The classes differ in the used substrate material and the printing process. The different classes build on each other and the requirements for complexity and handling as well as printing technology and precision increase with each class.

The classification for Additive Manufacturing in electronics is intended to help manufacturers and users to find an easy way of the new and extensive possibilities of 3D electronics concepts. This creates a level playing field for discussion between the partners and lowers the entry threshold for the new technologies for users.

Hanno Platz
Head of „FED-Working Group 3D-Elektronik (AK 3D)“

Authors:
Hanno Platz, GED Gesellschaft Für Elektronik und Design (Leitung AK 3D)
Michael Matthes, Würth Elektronik
Markus Biener, Zollner Elektronik
Daniel Ernst, Technische Universität Dresden
Manuel Martin, KSG Leiterplatten
Michael Schleicher, Semikron Danfoss
Wolfgang Kühn, FED e.V.

Version: Jul 2024

Classification of Additive Manufacturing (AM) methods and processes and 3D printing processes for electronic

Content

FOREWORD 1
1 Foreword 4
1 Additive Manufacturing methods in electronic production, challenges and opportunities. 6
1.1 Digital Printing in electronics production 8
1.2 Procedures according to ISO ASTM 52900 9
2 Classification of products using Additive Manufacturing (AM) methods 10
2.1 Class 1 – basic class, 2D-substrate (carrier) and printing 11
2.1.1 Material Application 11
2.2 Class 2 – Multidimensional carrier (substrate) + printing 12
2.2.1 Class 2 Examples 13
2.3 Class 3 – Printed multidimensional substrate 14
2.3.1 Application and drying (curing/hardening) of the material 14
2.3.2 Examples of material application and drying (curing/hardening) 15
2.3.3 Internal and external shape (contour) 16
2.3.4 Advantages and Benefits 16
2.4 Class 4 - 3D printed substrate + printed components 17
2.5 Class 5 - Shape-changing solutions (4D) 18
2.5.1 Materials 19
2.5.2 Printing methods for 4D technology 19
2.5.3 Application examples 20
3 Overview of manufacturing technologies 21
4 Digital printing and environmental goals (European Green Deal) 22
5 Growth of Additive Manufacturing (AM) 23
6 Design tools for 3D electronics 25
7 Requirements for the data formats 27
8 Production and scalability 28
9 Thanks 29

Classification of Additive Manufacturing (AM) methods and processes and 3D printing processes for electronic

1 Additive Manufacturing methods in electronic production, challenges and opportunities.

Additive Manufacturing, 3D printing, Industry 4.0, digital twins and virtual manufacturing are hot topics throughout the manufacturing industry. The possibility of using Additive Manufacturing (AM) to create complex components or partial functions is inspiring people all over the world. AM is widely used in mechanical engineering, automotive engineering, aerospace and medical technology.

There are also initial areas of “classic” electronics and applications, suitable using AM for mass production and promising processes supporting electronics manufacturing. Substrates for electronics are usually "multi-material systems", consisting of conductive and non-conductive materials. Today, various printing methods and printers are on the market available. For the new design paradigms, however, the eCAD design tools and data formats still need to be developed considerably further.

Possible advantages of AM

- Main advantage:
  Only needed material will be printed!
- The design freedom of Additively Manufactured components seems endless!
- Printing directly "quantity one" without moulds or frames.
- When printing on site there is no need for logistics and transportation for the manufactured parts.
- If necessary, the re-design can start from "quantity one"!

Possible disadvantages of AM

- Depending on the complexity each part can take a long time to produce as it is printed layer by layer.
- Depending on the manufacturing process not all tolerances can be adhered to.
- If necessary, support structures must be taken into account in the design.
- Parts with a high surface quality may require extensive post-processing or post-processing may be necessary.

Various printing processes are known that are already in commercial use. Some of the processes listed are still in the early stages of development. The different processes each have specific areas of application that are not covered in detail in this document.

Possible printing processes in electronics production

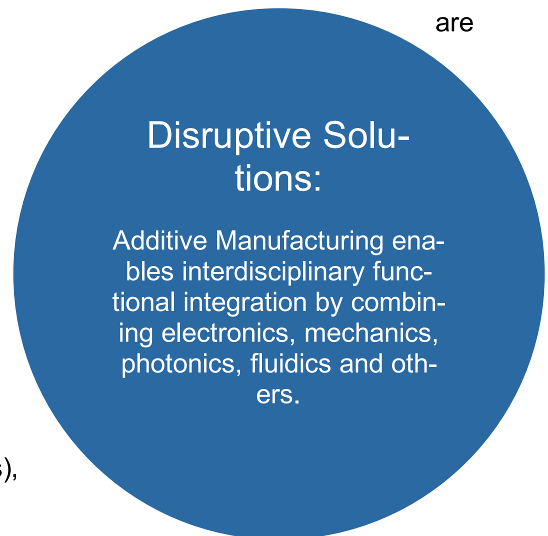
- Drop on Demand (e.g.: *Inkjet*)
- Aerosol Jet
- Dispensing (used for *3D-printing*)
- Impulse Printing
- Soft Lithography
- Electrohydrodynamic Printing (*E-Jet*)

Classification of Additive Manufacturing (AM) methods and processes and 3D printing processes for electronic

The “3D Electronics Working Group” of the Fachverband Elektronikdesign und -fertigung e.V. (FED) has looked in deep at the AM processes and made an initial classification into five groups. This structure helps for a future development of an "AM Roadmap: Electronics Manufacturing" for applications, processes and manufacturing methods, a consistent toolchain and data formats for Industry 4.0.

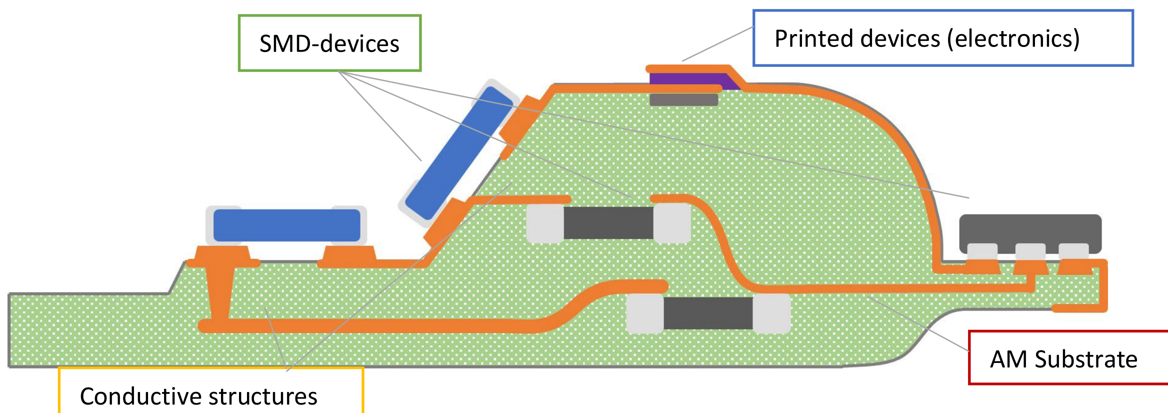
Comprehensive 3D Electronics offer the following features for which manufacturing processes are already available today:

- Many examples of multidimensional solutions, e.g.: known from 3D MID Technology, can only be described as 2.5D.
- Some technologies, such as sheet moulding, are planar and only then brought into a mould.
- Printing or embedding electronic components is only possible with an additive process such as 3D printing is used.
- Components must be mountable in any 3D position (azimuth) within the substrate or on the surface.
- Conductive structures (traces) must be able to be routed through the whole and available substrate at any angle.
- Twisted or shielded conductive structures (traces), e.g.: coaxial structures.



3D-Electronics

Free-formed components can be combined with functional layers and with SMD components or dies at any angle or azimuth within substrate or on the surface. Conductive structures are possible on the surface or within the substrates at any angle and shape.



Principle drawing of a three-dimensional circuit carrier (AM Substrate)