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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Electronic components – Long-term storage of electronic semiconductor devices – Part 3: Data

Composants électroniques – Stockage de longue durée des dispositifs électroniques à semiconducteurs – Partie 3: Données

IEC 62435-3:2020-02(en-fr)

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INTERNATIONAL
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ELECTRONIC COMPONENTS – LONG-TERM STORAGE OF ELECTRONIC SEMICONDUCTOR DEVICES –

Part 3: Data

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

FDIS	Report on voting
47/2608/FDIS	47/2615/RVD

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

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

A list of all parts in the IEC 62435 series, published under the general title *Electronic components – Long-term storage of electronic semiconductor devices,* 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 "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- withdrawn,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.

INTRODUCTION

This document applies to the long-term storage of electronic components.

This document deals with the long-term storage (LTS) of electronic devices drawing on the best long-term storage practices currently known. For the purposes of this document, LTS is defined as any device storage whose duration can be more than 12 months for product scheduled for long duration storage. While intended to address the storage of unpackaged semiconductors and packaged electronic devices, nothing in this document precludes the storage of other items under the storage levels defined herein.

Although it has always existed to some extent, obsolescence of electronic components and particularly of integrated circuits, has become increasingly intense over the last few years.

Indeed, with the existing technological boom, the commercial life of a component has become very short compared with the life of industrial equipment such as that encountered in the aeronautical field, the railway industry or the energy sector.

The many solutions enabling obsolescence to be resolved are now identified. However, selecting one of these solutions should be preceded by a case-by-case technical and economic feasibility study, depending on whether storage is envisaged for field service or production, for example:

- remedial storage as soon as components are no longer marketed;
- preventive storage anticipating declaration of obsolescence.

Taking into account the expected life of some installations, sometimes covering several decades, the qualification times, and the unavailability costs, which can also be very high, the solution to be adopted to resolve obsolescence should often be rapidly implemented. This is why the solution retained in most cases consists in systematically storing components which are in the process of becoming obsolescent.

The technical risks of this solution are, a priori, fairly low. However, it requires perfect mastery of the implemented process and especially of the storage environment, although this mastery becomes critical when it comes to long-term storage.

All handling, protection, storage and test operations are recommended to be performed according to the state of the art.

The application of the approach proposed in this document in no way guarantees that the stored components are in perfect operating condition at the end of this storage. It only comprises a means of minimizing potential and probable degradation factors.

Some electronic device users have the need to store electronic devices for long periods of time. Lifetime buys are commonly made to support production runs of assemblies that well exceed the production timeframe of its individual parts. This puts the user in a situation requiring careful and adequate storage of such parts to maintain the as-received solderability and minimize any degradation effects to the part over time. Major degradation concerns are moisture, electrostatic fields, ultra-violet light, large variations in temperature, air-borne contaminants, and outgassing.

Warranties and sparing also present a challenge for the user or repair agency as some systems have been designated to be used for long periods of time, in some cases for up to 40 years or more. Some of the devices needed for repair of these systems will not be available from the original supplier for the lifetime of the system or the spare assembly may be built with the original production run but then require long-term storage. This document was developed to provide a standard for storing electronic devices for long periods of time.

The storage of devices that are moisture sensitive but that do not need to be stored for long periods of time is dealt with in IEC TR 62258-3.

Long-term storage assumes that the device is going to be placed in uninterrupted storage for a number of years. It is essential that it be useable after storage. It is important that storage media, the local environment and the associated part data be considered together.

These guidelines do not imply any warranty of product or guarantee of operation beyond the storage time given by the manufacturer.

The IEC 62435 series is intended to ensure that adequate reliability is achieved for devices in user applications after long-term storage. Users are encouraged to request data from suppliers to applicable specifications to demonstrate a successful storage life as requested by the user. These standards are not intended to address built-in failure mechanisms that would take place regardless of storage conditions.

These standards are intended to give practical guide to methods of long-duration storage of electronic components where this is intentional or planned storage of product for a number of years. Storage regimes for work-in-progress production are managed according to company internal process requirements and are not detailed in IEC 62435 (all parts).

The overall standard is split into a number of parts. Parts 1 to 4 apply to any long-term storage and contain general requirements and guidance, whereas Parts 5 to 9 are specific to the type of product being stored.

Electronic components requiring different storage conditions are covered separately starting with Part 5.

The structure of the IEC 62435 series as currently planned consists of the following:

– Part 1: General
– Part 2: Deterioration mechanisms
– Part 3: Data
– Part 4: Storage
– Part 5: Die and wafer devices
– Part 6: Packaged or finished devices
– Part 7: MEMS
– Part 8: Passive electronic devices
– Part 9: Special cases

ELECTRONIC COMPONENTS – LONG-TERM STORAGE OF ELECTRONIC SEMICONDUCTOR DEVICES –

Part 3: Data

1 Scope

This part of IEC 62435 describes the aspects of data storage that are necessary for successful use of electronic components being stored after long periods while maintaining traceability or chain of custody. It defines what sort of data needs to be stored alongside the components or dies and the best way to do so in order to avoid losing data during the storage period. As defined in this document, long-term storage refers to a duration that can be more than twelve months for products scheduled for long duration storage. Philosophy, good working practice, and general means to facilitate the successful long-term-storage of electronic components are also addressed.

NOTE In IEC 62435 (all parts), the term "components" is used interchangeably with dice, wafers, passives and packaged devices.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
long-term storage
LTS
planned storage of components to extend the lifecycle for a duration with the intention of supporting future use

Note 1 to entry: Allowable storage durations will vary by form factor (e.g. packing materials, shape) and storage conditions. In general, long-term storage is longer than 12 months.

Note 2 to entry: This note applies to the French language only.

[SOURCE: IEC 62435-1:2017, 3.1.2]

4 Data storage

4.1 General

Data associated with the electronic components that are stored shall itself be stored securely without degradation in order to be available when required during the entire storage period or longer, if specified. Data not currently required may be archived for future use and reassessment.

The data archive is generally stored on any medium, which may include non-volatile memory, optical disk or storage in redundant array disk servers. It is important to ensure the environment for media storage is low risk for degradation, and accidental or random events that could destroy or corrupt the data. The value of the parts is highly dependent upon the data without which the company might cease to function. See Table A.1 for critical data storage considerations. The physical and cyber security of the archive store are not mentioned further here, but should be a main consideration when planning its location and access.

4.2 Data storage options

From the early 1960s onwards, media for storing data other than paper, have historically evolved towards magnetic, optical and other forms of solid-state media. It is common practice to ensure redundancy of storage within storage servers, across physical sites and geographies. Redundant array storage enables periodic back-up copies and checks to ensure longevity. Some printed data is effectively undecipherable without computer assistance (such as bar codes or matrix marks). It is conceivable to store enough information in the optical markings to satisfy business requirements for traceability. Similarly, printed data may be recovered from paper or from the part using optical character recognition and associated software. Other legacy storage media, such as microfiche, can also be in use.

4.3 Paper data storage concerns

Paper storage with the components being stored is subject to many hazards that can be mitigated with regular intervention. Data and information stored on paper can be corrupted by aging of ink, moisture or water exposure or simple loss of the physical paper record and/or it's facsimile. It is recommended that the stored paper be acid free to minimize the risk of brittle degradation. The permanence of the printed mark on the archival paper should also be considered for long-term storage of paper with components.

4.4 Electronic data storage concerns

Careful selection of the electronic medium is required, as there are many hazards in relying on this media that are not instantly apparent. It shall be remembered that data to be archived shall be retrievable, otherwise the purpose of archiving is negated. Data redundancy can be achieved by redundant array of independent disks (RAID) at a local or remote network host. Similarly redundant optical storage may also be used for network storage. Third party "data storage"/"data warehouse" companies exist, and these are often used as a suitable secondary location backup and repository for critical or sensitive data.

Data security should be considered in any storage scheme to avoid loss of data upon retrieval, storage itself or during decoding. Data security measures should be in place upon data recording on the systems used to generate and store the data. Data to be stored should be checked prior to storage. Finally, upon retrieval, data extraction equipment should employ data security measures in additional to ensuring that older data formats are not miscategorised as unsafe for security.

All electronic data requires the use of a computer of some sort or another device to retrieve the data and possibly convert it into a human-readable or machine-useable format. Storage relies on four main precepts to recover this data:

- the useable lifetime of the media itself;
- the presence of the specific media-reading hardware;
- the associated computer;
- the interpreting and display/application software.

4.5 Data storage media failure mode considerations

Storage media preservation or maintenance is as important as physical part storage to maintain the ability to re-establish provenance, design or test parameters or performance when the components are to be used. When considering magnetic media, such as tapes and disks, it is well known that the long-term storage of magnetic media has its own attendant issues, such as oxide-shedding and magnetic "punch-through" in as little as 5 years. Platter disks are generally less susceptible, but "punch-through" can still occur, and head-dust, caused by deterioration of the ferric-oxide bonding agent, can lead to irreparable damage to both the platter and read heads as soon as the platter is mounted. Network-attached storage and RAID schemes are used to mitigate the risks for the storage of drives.

Floppy disks are susceptible to mechanical and magnetic damage. Optical media, such as the compact disk (CD) and the digital versatile disk (DVD), can also present problems. CD-Rs that are written by the average computer have a distinct shelf life, and, dependent upon the storage ambience can lose data in 18 months or less; the quality of the initial CD-R or CD-RW media is paramount.

Shedding of the reflective aluminised coating and delamination can also occur, and the sensitivity to UV light and certain cleaning chemicals is well documented. There are other electronic storage mechanisms, such as holographic storage, ferro-optical disks.

Paper storage has concerns of bulk, weight and flammability, coupled with the vulnerability to damage from water, chemical degradation and fire. Paper de-acidification technology is in regular use in relation to the preservation of many of our important historical documents. Despite known issues, some forms of paper will continue to have a valuable place and be used for a long time.

Non-volatile flash memory solutions with redundancy are another medium for data storage that can have its own issues. Primarily, the program-erase cycles shall be controlled while ensuring re-use of media is not near the end of its endurance lifetime. Network attached storage and control software shall maintain data integrity. Local environmental temperature, field and radiation exposure can also result in error or data loss.

Online or data warehouses that use redundant array disks pose their own challenges. Care should be taken to mitigate random error while ensuring redundancy protocols are maintained.

4.6 Media reader and decoding

This is often the most critical item, as even if the data remains intact upon the storage media, the function of the media reader and the conversion to useable information cannot be ensured. Data formats change, sometimes rapidly, due in part to the need for increased storage density and retrieval speed. Data media readers and decoders should be selected with storage, back-up and the extended duration and storage duration in mind. Standalone media recording devices and media readers/decoders should be afforded the same storage consideration as components and they should be tested periodically to ensure they are in working order.

Integral with the reader is the native format of the data and operational commands, such that many drives will not function without the appropriate software functions. Specialised driver software is, therefore, required to operate the reader. Data media and reader/decoder should be selected for the expected long-term storage duration.

4.7 Computer

The computer or data storage systems should be compatible with the media reader hardware to perform the decoding and possible data conversion. Compatibility with decoding hardware should be considered when periodic software patches, driver updates, operating system updates or firmware updates are applied. The complete system and the associated data operations should be tested periodically to ensure they are in working order.

4.8 Software and data format

Software and data formats are often a hidden pitfall, as even if a new computer and hardware can be retrofitted to extract the data from the archive media, it cannot be ensured that the data will be understandable without some additional conversion software. Data character formats, such as EBDIC, TRASCII, CSV (comma-separated variable) or XML (extensible mark-up language) formats, require significant re-translation before becoming human-readable or machine-readable again. Another issue arises because of the different versions of reader software in addition to the normal readability of the data format.

The advantage of data formats like plain ASCII or direct binary is that the conversion is straightforward, albeit tedious. Not all plain ASCII data need be carriage-return / linefeed (<CR/LF>) bound; as it was employed when computer memory was expensive, link-list or tokenised ASCII data were also common data formats.

When performing data conversion, it is often easy to pick out conversion errors if the data was originally human-sensible. But if the data was originally in pure binary, intended as ‘computer only', then conversion errors are often difficult to detect and identify.

Other data formats can be proprietary and associated with commercially available software. Whilst these formats may be well used and documented, they are nonetheless subject to "upgrades", "revisions" or security patches beyond the immediate control of the users.

Many companies have attempted to standardise their documents and formats. For example, DXF format has been used for all mechanical drawings. As such, the user is reliant upon backwards compatibility from the software supplier, or legacy equipment and software is required for the eventuality of data retrieval. Standardized formats that account for some forward and backward compatibility such as the STEP formats (see ISO 10303 (all parts)) are widely integrated into electronic design and analysis tools at the time of the publication of this document.

Periodic "upgrading" and transfer to modern media and software of the archived data can be routinely required. Standardisation on document formats, such as Word from Microsoft®[1], can also lead to periodic revisiting, as upwards compatibility is often problematic.

5 Data elements

5.1 General data element considerations

The data element clauses provide suggested data to be stored for later uses. Measures should be taken to ensure that unit, bag and box identifiers are also stored and in good condition to re-establish the data record to the physical unit. Table A.1 can be used to identify and record the data necessary and agreed between a supplier and a user. It is required that a risk assessment and a business assessment be done to determine the critical data that shall be stored for traceability and component description for future use.

1 Microsoft® Word is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of this product.

5.2 Traceability data

Various data is recorded during, manufacturing, conditioning and de-conditioning, where applicable, for example:

- the component manufacturer's name and part number;
- the procurement source;
- the date-code;
- the conditioning/de-conditioning history;
- the validation tests performed;
- the origin of the request for part number storage;
- the equipment on which the component can be used.

The purpose of this data is to perfectly identify the components stored, to ensure the traceability of maintenance operations and to organize feedback.

5.3 Periodic checks of data

When there are periodic checks, the relative data are recorded (date, nature of the checks, components tested, results, etc.).

5.4 Component description data package

a) Manufacturer's code

   The manufacture's code represents the item code, or store code that enables the link between the list of circuit boards and the parts list.

b) Component description

   1) type;
   2) function;
   3) model (standardized each time it exists, or generic name);
   4) electrical characteristics (for example: voltage and/or power or other parametric values, and tolerances);
   5) temperature range;
   6) package type.

c) Manufacturers

   Name of the approved original manufacturers or producers

d) Manufacturers' part numbers

   Specific commercial part numbers corresponding to each original manufacturer or producer.

e) Definition and test specification

   Accurate specification number

f) Qualification level, quality assurance, etc.

   Information related to the component qualification.

g) Component position in the life cycle

   Corresponding category in the component life cycle, such as the following: "introduction", "growth", "maturity", "decline", "phase-out", "discontinuance", etc.

h) Supply

   1) Name of the organization (original manufacturer, producer or distributor) that supplied the electronic components for storage.
   2) Certificate of conformity.

Annex A
(informative)

Example checklist for project managers

Table A.1 – Example checklist for data management

Item	Mandatory or good practice	Question	Reference	Answer
Data		What data is required for successful use of the product, refer to data requirements?	5	
		What are the business, security and/or regulatory requirements for the data being stored?		
		What are the data file formats used to record the data to be stored? Are the file formats defined for future use by humans and machines?		
Media		What form of media will be used to store data?		
		Will the data be stored internally and/or at a data warehouse – online?		
		Has a fault tree analysis and/or risk assessment been performed on the media storage method and system? Is mitigation in place to meet storage requirements?		
		Is the storage media encoding designed to for long-term storage retrieval?		
		If media is stored, are physical protections and software in place to facilitate de-archival?		
		Is there a business continuity plan in place to ensure the data can be retrieved from a duplicate copy, network or remote access site?		
		Are validated measures in place to physically store and maintain the data storage medium?		
		If the storage is a mark, has the permanency for the mark been validated for storage and end of storage readability?		
Data		Is the data format in a long-lived and standardised format or file type?		
		Do data format comply to the business, security or regulatory requirement		
		Has a fault tree analysis/ risk assessment and associated mitigated plan been performed for the data and are mitigations in place?		
Storage		Where is media stored and can it be easily mapped to the physical storage?	4.1	

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