# IEC TR 61191-7

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# TECHNICAL REPORT

colour inside

## Printed board assemblies –
## Part 7: Technical cleanliness of components and printed board assemblies



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## FOREWORD

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IEC/TR 61191-7, which is a technical report, has been prepared by IEC technical committee 91: Electronics assembly technology.

The text of this Technical Report is based on the following documents –

| Draft TR | Report on voting |
|---|---|
| 91/1583/DTR | 91/1595/RVDTR |

Full information on the voting for the approval of this Technical Report 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 61191 series, published under the general title *Printed board assemblies*, 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//www.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- withdrawn,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.

**IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.**

# INTRODUCTION

The Technical Report applies to electric, electronic and electromechanical components, circuit boards and electronic assemblies and describes the resulting level of technical cleanliness that can be expected for products that are manufactured with state-of-the-art standard production methods and processes.

The Technical Report is an informative document which serves to illustrate the technically feasible options and provide a basis for customer and supplier agreements. It is not intended to be regarded as a specification or standard. It does not cover the production of electric motors, batteries, cable harnesses and relays.

Its primary focus is on loose or easily detachable particles (labile particles). Film residues, chemical and biological contamination are also briefly covered. It does not deal with the cleanliness of functional fluids and/or gases.

This Technical Report provides information, how the requirements put down in VDA 19.1 and VDA 19.2 could become reasonably applied in electronic industry It provides information about particle generation considering processes and materials, illustrates their impact on performance and reliability and describes suitable countermeasures as well as procedures for risk assessments.

Related standards issued by the automotive industry and the electronic industry are gathered in the bibliography.



The Technical Report has been prepared based on material provided by the working group on component cleanliness of the ZVEI (Zentralverband Elektrotechnik- und Elektronikindustrie e.V., Germany).

# PRINTED BOARD ASSEMBLIES –

# Part 7: Technical cleanliness of components and printed board assemblies

## 1 Scope

This part of IEC 61191 serves as a Technical Report and provides information, how technical cleanliness can be assessed within the electronics assembly industry. Technical cleanliness concerns sources, analysis, reduction and control as well as associated risks of particulate matter, so-called foreign-object debris, on components and electronic assemblies in the electronics industry.

## 2 Normative references

There are no normative references in this document.

## 3 Terms and definitions



No terms and definitions are listed in this document.



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

## 4 Technical cleanliness

### 4.1 What is technical cleanliness?

The term 'technical cleanliness' was coined by the automotive industry to address particle-related system interruptions in the automotive industry. In contrast to 'optical cleanliness', which relates to the cosmetic or visual appearance, e.g. vehicle coating, technical cleanliness always refers to the performance of components, assemblies and systems.

Particulate contamination in the automotive industry is often not limited to a certain area but may migrate from a previously non-critical to a sensitive location and hence impair performance. For instance, a particle on the lens of a traffic sign detection camera may cause it to malfunction. Similarly, a conductive particle from the aluminum cover of an electronic control unit may cause a short circuit on the circuit board and undermine its performance. This is why the cleanliness requirements of the automotive industry often apply to complete systems, whereby the most particle-sensitive component (weakest link in the chain) determines the cleanliness level and admissible limiting values for the entire system and all components within it. With regard to components, technical cleanliness refers to the specification, observance and verification of limiting values, e.g. according to weight of residual contamination, particle count, type and size. At the same time, the automotive industry tolerates failures only in the ppm range. New stipulations are continuously being added to the existing specifications. These are often tailored to suit the specific requirements of a company or component and its performance. Their scope of application is limited, i.e. they are valid in-house and/or for suppliers.

Although the term 'technical cleanliness' was coined by the automotive industry, the procedures relating to cleanliness inspections in accordance with VDA 19 (liquid extraction, membrane filtration and subsequent analysis of the retained particles) have been increasingly adopted by other industries such as medical technology, the optical industry, hydraulic and mechanical engineering. Since there is no such thing as total cleanliness or purity, the focus should be on the most practically feasible and economically viable solution for the designated location and purpose.

### 4.2 History – standardisation of technical cleanliness

Contamination had been a growing problem for the automotive industry since the early 1990s as systems became increasingly complex and installation spaces ever smaller. The anti-lock braking systems in general or direct fuel injection systems for diesel engines were particularly prone.

In some cases, customers and suppliers concluded individual agreements about technical cleanliness to address the risk of potential damage.

As a result, the automotive industry called for the introduction of general standards regulating the technical cleanliness of components. In summer 2001, TecSa was founded, an industrial alliance for technical cleanliness. This panel published VDA 19 (*Inspection of Technical Cleanliness – Particulate Contamination of Functionally-Relevant Automotive Components*) in 2004, which was revised in 2015 and republished as VDA 19 Part 1. These guidelines make recommendations for inspecting the technical cleanliness of automotive products.



Its international counterpart is standard ISO 16232, which was published in 2007.



In 2010, VDA 19 Part 2 (*Technical Cleanliness in Assembly*) was published, detailing cleanliness-related design aspects for assembly areas.



### 4.3 Technical cleanliness in the electronics industry

The industry increasingly uses the generally valid VDA 19 guidelines in addition to company-specific standards.

This Technical Report outlines a system for designing and implementing component cleanliness analyses to enable quantifiable comparisons of component cleanliness levels. However, VDA 19 does not specify any limiting values for component cleanliness. These must be defined according to component function, producibility and verifiability.

This Technical Report supplements VDA 19 and ISO 16232 by addressing outstanding questions and providing practical solutions.

The producibility of a component as well as its performance must be considered in this context, as is the case when defining dimensional tolerances. Production processes, production environment and final packaging also influence component cleanliness. This often calls for agreements concerning compliance with limiting values between customer and supplier or product development and production. This is particularly relevant in instances where limiting values are exceeded without necessarily impairing performance. A careful review shall be carried out to ensure that efforts to comply with these values do not outweigh the potential risk, thereby avoiding excessive cleanliness requirements.

### 4.4 Potential particle-related malfunctions

Limiting values for component cleanliness ensure component performance and should be defined as early as possible during the component development stage. The following possible malfunctions should be considered:

- electrical short circuit;

- shorter creepage and clearance distance;
- electrical insulation of contacts;
- impairment of optical systems such as cameras;
- reduced wettability/solderability;
- mechanical obstruction;
- increased or reduced friction;
- increased or reduced power;
- leaks.

If the remaining particulate contamination – also called residual contamination – is sufficiently low in a technical system to cause no short or long-term performance impairment or system damage, the system is considered adequately clean in the context of technical cleanliness.

## 5 Technical cleanliness as a challenge for the supply chain

### 5.1 General

In the past, drawings usually contained rather general information on component cleanliness, which was not systematically verified. Example:

**Parts must be free from contamination e.g. swarf, release agents, grease, oil, dust, silicone…**



With the publication of VDA 19 and ISO 16232, standardised cross-company procedures were defined to record, analyse and document component cleanliness information.



General attributive provisions that had previously been customary and checked via visual inspection were replaced, e.g. by specifying particle size classes with maximum particle count, which can be verified by means of laboratory analysis.

The procedures to determine component cleanliness according to VDA 19 are standardised, reproducible and also more objective than previously applied methods. However, the following points should be observed when applying these procedures:

- particle generation may vary significantly, even from the same production glass;
- particle detection depends on the method and quality of analysis;
- inspections are costly and require a laboratory;
- measurement system analyses (MSA) are not possible for the entire inspection process of technical cleanliness;
- in-process inspections with associated regulatory measures can be implemented only after lengthy delays.

In practice, cleanliness analyses according to VDA 19 are used for production releases or requalification, during production and when there are reasonable grounds for suspicion.

Limiting non-metallic particle contamination (e.g. dust, lint, abrasion) poses a further challenge to the supplier. If these particles are classified as functionally critical and hence limited, account shall also be taken of the manufacturing environment, suitability for subsequent cleaning, packaging (to maintain cleanliness) and logistical considerations when determining the limit. Detailed information is provided in VDA 19 Part 2. The controlled production conditions (clean zone grades) necessitated by this require more effort and expenditure. For this reason, it is advisable to determine limiting values only where functionally relevant.