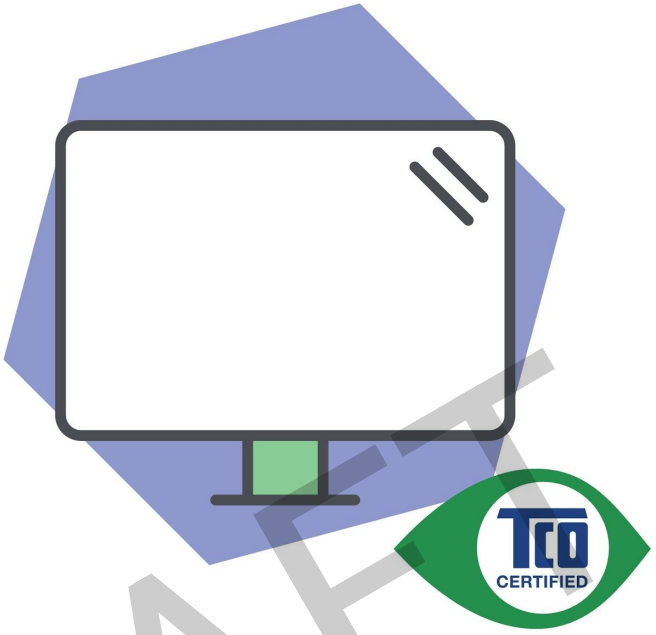


TCO Certified

Generation 9, for displays

-

Draft 1

TCO Certified — driving sustainable development in IT products

Established in 1992, TCO Certified is a global sustainability certification for IT products. Certificates are valid worldwide and can be used as proof in all countries, without the need for local adaptation. TCO Certified is currently available for eleven product categories: displays, notebooks, tablets, smartphones, desktops, all-in-one PCs, projectors, headsets, servers, network equipment and data storage. The organization behind TCO Certified is TCO Development.

Comprehensive criteria with a life cycle perspective

Certified products must meet comprehensive environmental and social criteria throughout the life cycle. The criteria are science-based and developed in an open process with TCO Development's international network of stakeholders which includes users, buyers, industry, NGOs, researchers and subject matter experts. To address the most pressing sustainability challenges and stay current with the latest technology developments, a new generation of TCO Certified is released every three years.

A third-party certification, independently verified

TCO Certified is a third-party certification, independent of the IT industry and buyers. It meets the requirements in ISO 14024 Ecolabel Type 1 and has been approved by the Global Ecolabelling Network as part of the GENICES peer review process. Independent verification organizations, accredited to ISO 17025, verify that products conform with all criteria in TCO Certified. Verification is done both before and after certification, throughout the full validity period of the certificates.

How to certify

Certifying your products is straightforward. You'll find a guide that explains the process and what you need to do at tcocertified.com. It generally takes three to five weeks to receive the certificate, once all documents and the product sample are delivered to the verification organization.

Need help?

Need help getting started? Or, would you like us to explain the certification process in more detail? Our certification team is always here to help. Email us on certification@tcodevelopment.com. Our approved verifiers around the world are also at your hand, and are able to explain the criteria and certification process in your local language. Contact details are available on tcocertified.com.

About this document

This is TCO Certified, generation 9, for displays, released in December 2021. A display is defined as a visual display unit with fixed positions of the pixels. The criteria cover the display, its stand and the external power supply as it is delivered to the end user, but not any peripherals. Televisions and large format public displays may also be certified in accordance with this criteria document.

All product categories are generation 9

TCO Certified is available for eleven product categories and they all have the same generation number: generation 9. A majority of the criteria are the same for all product categories.

The criteria include:

Mandate: A description of the requirements that needs to be fulfilled, and how conformity is verified. Forms and signatures for application are available in chapter 11 of this document.
Definitions: Explanations of important terms relevant to the criterion.
References: References to sources, presented in chapter 10.
Clarifications: Further details and explanations of the mandate.

Conformity

Conformity with the mandates is verified by verification organizations (verifiers) independent of both the certification body (TCO Development), the applicant and the brand owner. Each mandate includes a description of the proof that must be submitted to the verifier, and to TCO Development together with the application form. This may be a test report or a verification report:

1. A test report presents the results from tests conducted by a test facility accredited to ISO 17025, and is issued by that same facility.
2. A verification report is issued by a verifier approved by TCO Development and includes a summary and a result (pass or fail) based on either:
    - a test report issued by the same test facility,
    - a test report issued by a different test facility, or
    - certificates or other proof from the company or brand owner applying for the certificate.

Editions of TCO Certified

When we publish a new generation of TCO Certified, our ambition is always to maintain criteria levels until the next generation of TCO Certified is launched, which typically happens after three years. Several editions of the criteria document may be released, but will be considered only as updates within the eighth generation, with improved precision of the mandates, test methods and clarifications. To ensure that all currently certified products complies with the new edition of the criteria document, the criteria levels are never raised within a generation.

Table of contents

1 Product and sustainability information

TCO Certified — sustainability certification in accordance with ISO 14024

TCO Certified is a third-party certification that meets the requirements of ISO 14024 Ecolabel Type 1. The certification has been assessed and approved by the Global Ecolabelling Network, as part of the GENICES peer review process. The ISO 14024 standard establishes the principles and procedures for third-party ecolabels, ensuring that consumers and professional purchasers are given accurate and comparable information. Criteria must cover the product life cycle and be based on scientific principles. Compliance with criteria must be verified by an independent party.

Data gathering in TCO Certified

To measure the impact of TCO Certified and the sustainability benefits of certified products, TCO Development continually collects data based on the use of the certification. The collected data is used in several ways:

- For TCO Development, the data is crucial for the continuous development of TCO Certified. It is used to ensure that criteria are set at reasonable levels and that the most relevant sustainability challenges are being addressed, throughout the product's life cycle.
- Manufacturers and brand owners use the data to verify their performance in various sustainability areas, and compare with their peers.
- Other stakeholders, such as purchasing organizations, use the data as key performance indicators to determine the sustainability benefits for their organization by asking for TCO Certified, and to track this over time.

1.1 Information to end users - REVISED

Background
End users must clearly be able to identify which products are certified and what sustainability features the product fulfills.

Applicability
All product categories.

References
The license agreement between TCO Development and the applicant/brand owner.

1.1.1 Mandate

1. The information document for end users must be written in English or in the local language of the country where the product is to be sold. It must accompany the product in at least one of the following ways:
    - As a separate printed or digital document.
    - Included in a printed or digital user manual.
    - As a separate digital document that is hosted on the brand owner's website. A direct link to the document must be included in the printed or digital user manual mentioned above.

2. The product and its retail packaging must be labeled with the TCO Certified logo. See clarifications for details.

3. "TCO Certified" must be mentioned on the brand owner's website(s) where the specific certified product is marketed and or sold.

Submit the following to an approved verifier:
- A completed and signed product form (chapter 11.3).

Submit the following together with the application to TCO Development:
A copy of the verification report(s) from a verifier approved by TCO Development.

1.1.2 Clarification

Products that are designed to be installed in a rack (supporting framework to hold hardware modules, typically servers, data storage products and networking equipment) are excluded from "Part 2 - labeling of the product and packaging".

Part 1: information document for end users
No editorial changes to the information document for end users are accepted without consent from TCO Development. The information document for end users is available at tcocertified.com.
If the applicant is separate from the brand owner, the applicant must ensure that the brand owner agrees to fulfill their part of this requirement.

The mandate is fulfilled in one of the following ways:

1. As a separate printed or digital document
   The information document for end users in print or on digital media is placed together with the product in the packaging.
2. In a printed or digital user manual
   The information document for end users is included in a printed or digital user manual that accompanies the product when it is distributed to the end user. The content of the document, with the headline "TCO Certified", must be a separate chapter of the user manual and be included in the table of contents.
3. As a separate digital document that is hosted on the brand owner's website.
   The information document for end users is placed on the brand owner's website. A direct link to the information document is placed in the printed or digital user manual that accompanies the product when it is distributed to the end user. TCO Certified must be a separate headline in the user manual. The headline must be visible in the table of contents.

Part 2 - labeling of the product and packaging

The TCO Certified logo must be displayed in one of the following ways:

Alternative A

On a permanent or temporary label. Temporary labels must be affixed to the product with an adhesive or cling-type application. The packaging material that is supposed to be removed in order to get the full functionality of a product (such as a screen protector) is defined as packaging material and not the product in this mandate and thus may not be the place for the product logo.

a. The logo must be visible on the top or front of the product. (The front of the product is defined as the surface seen when viewing the product from the front and may include the stand. The top is defined as the surface that is seen from the top and the back is the surface that is seen from the back.)
b. The minimum size of the logo is 16mm in width and 10mm in height.
c. If the logo is to be placed alongside other logos or graphic elements, a minimum of 2,5mm padding must be used on all sides of the TCO Certified logo.

   Exception
   If the top and front of the product don't have a contiguous and coplanar area (area used for display or touch input are excluded) which is at least 16mm in width or 10mm in height, then the logo may be placed on the back side of the product.

or

Alternative B

Via electronic labeling displayed on the screen in one of the below ways:

a. During the startup of the product:

The logo must cover at least 1% of the screen. The logo must be legible and be in color, black, or white; must appear at system start-up, and must be displayed for a minimum of 0,5 seconds.

b. Via a shortcut on the desktop screen of the product. The shortcut must be in the form of the TCO Certified logo in color and clicking it should link to "the information document for end users" available at tcocertified.com.
c. TCO Certified logo as a part of the product picture The TCO Certified logo is shown on the first product picture where the product is marketed on the brand owners web site. In the product specification on this page, TCO Certified is also listed with a link to the "information to end-user document" which is the document required under mandate 1.1 point 1.

TCO Development will consider alternative proposals for electronic labeling on a case-by-case basis.

The retail packaging of the product must be labeled with the TCO Certified logo:

a. The minimum size of the logo must be 16mm in width and 10mm in height.
b. If the logo is to be placed alongside other logos or graphic elements, a minimum of 2,5mm padding must be used on all sides of the TCO Certified logo.

The certificate owner and brand owner must also conform with all the other logo rules on color, design, marketing, etc., that are specified in the TCO Certified license agreement appendix 2. The following two paragraphs (§2.2 and §2.5 in appendix 2 of the license agreement) are replaced by the rules listed above if a conflict occurs:

Paragraphs that may be replaced:

§2.5 The TCO Certified logo must at all times be reproduced in a quality that allows the text of the TCO Certified logo to be read under normal circumstances. Recommended minimum size for the trademarks TCO Certified and TCO Certified Edge can be found in "Using the TCO Certified brand" guide available at tcocertified.com. If there are limitations and a smaller or different type of logo is used this must first be agreed on in writing with TCO Development.

1.2 Product specification - REVISED

Background

It is important to ensure that each product to be certified corresponds exactly to the product specification. Therefore, a physical sample of each product to be certified must be sent to an approved verifier, that examines it carefully to ensure that product marking and physical aspects conform with the reported information from the applicant or brand owner.

Definition

The marking label is a label with the product's electrical rating (voltage, frequency, current), the manufacturer's name, trademark or identification mark, and the manufacturer's model or type reference according to IEC 60 950:1 clause 1.7.1.

Applicability

All product categories.

References

1.1.

1.2.1 Mandate

- A product specification and marking label must be provided for the product.
- The total weight of the heaviest product configuration and power supply (without packaging) in kg must be reported by the brand owner.

Submit the following to an approved verifier:

1. A copy of the marking label, for the product and all external power supplies.
2. A completed and signed product form (chapter 11.3).

Submit the following together with the application to TCO Development:

1. A copy of the verification report(s) from a verifier approved by TCO Development.
2. The total weight of the heaviest product configuration and power supply (without packaging) in kg must be reported in TCO Certified portal.

1.2.2 Clarification

The template must be completed with the requested information about the product. A type key that includes an asterisk (*) for unidentified characters, if any, in the model name and for other identification names must be submitted to the verifier. Only two * may be used in the model type key and each * must include two or more options.

Published sustainability performance indicator(s):

Product weight is an indication of the amount of potential e-waste at end-of-life. By decreasing the product weight, e-waste can be reduced. The product weight (in kg) of the heaviest configuration of the product including any power supply but excluding packaging must be reported by the brand owner and rounded to the nearest 5 gram.

1.3 Sustainability performance - REVISED

Background

Sustainability is a long term goal and therefore a responsible way to work with sustainability is through a long term strategy. Improvements must often be phased in gradually and requires planning and preparation. The sustainable performance indicators will measure the development of products and brand owners, enabling new criteria levels in future generations of TCO Certified to be challenging but yet reasonable, and ensure that the most relevant parts of the product life cycle is covered.

The sustainability performance indicators also measure the sustainability benefits that the certified products create, and track this over time. A purchasing organization can use the published sustainability performance indicators in sustainability reporting and, for example, implement climate compensation or other sustainability related measures connected to the sustainability impact of the product.

Applicability

Displays

1.3.1 Mandate

- Complete all fields for the sustainability performance indicators in chapter 11.3.

Submit the following to an approved verifier:

- A completed and signed product form (chapter 11.3)

Submit the following together with the application to TCO Development:

- A copy of a verification report from a verifier approved by TCO Development.
- All results of the sustainability performance indicators must be reported in TCO Certified Portal.

1.3.2 Clarification

Sustainability performance indicators

The sustainability performance indicators are divided in two categories.

1. "The published sustainability performance indicators" which are considered extra important in order for purchasers to determine the sustainability benefits of certified products.
   These may be published and used by TCO Certified. The published sustainability performance indicators may also be used to compare how one or more certified products relate to each other.
2. The "impact sustainability performance indicators" which are collected for the purpose of developing future criteria and measuring the impact of TCO Certified. Some of these

will be published in an anonymous format in impacts reports published by TCO Development.

New applications

A verification report for the sustainability performance indicators must be issued by an approved verifier and the results must be reported to TCO Certified Portal.

Reassessments

Changes made to the product or its manufacturing may affect the sustainability performance indicators.The applicant can choose to do a re-assessment or not. To do a re-assessment, the necessary documentation (and in some cases the product) must be sent to a verifier that issues a verification report for the sustainability performance indicators and report the new data to TCO Certified Portal.

Quoting sustainability performance indicators in the marketing of a product

The following guidelines apply to all communications about sustainability performance indicators. Quoting or referring to the sustainability performance indicators in conjunction with the brand name TCO Certified is not allowed unless a written agreement to do so is made with TCO Development.

“Worst case” reporting

If the verifier has conducted a “worst case” testing and accepts a number of similar configurations of the product in the issued verification report based on these tests, the sustainability performance indicators may also be the same for all accepted configurations and thus represented by the worst case configuration.

1.3.3 Sustainability Performance Indicators list

The following is a summary of all the sustainability performance indicators collected.

SPI's described under product specification

Published sustainability performance indicators:

- 1.2 The total weight of the product and power supply (without packaging)

SPI's described under socially responsible manufacturing criteria

Published sustainability performance indicators:

- 2.1 The % of final assembly factories SA8000 certified
- 2.2 (SAQ 1.1) Level of brand owner communication of CoC in the supply chain
- 2.2 (SAQ 2.1) The level of the supply chain identified
- 2.2 (SAQ 2.2)The level transparency for final assembly factories and smelters
- 2.2 (SAQ 3.1) The level of brand owner due diligence on suppliers not owned
- 2.2 (SAQ 3.2) The level of brand owner audits and follow up on suppliers not owned
- 2.2 (SAQ 4..1) Level of brand owner Initiatives to avoid child labour
- 2.2 (SAQ 4.2) Level of brand owner remediation process for child labour
- 2.2 (SAQ 5.1) Level of brand owner requirement on excessive temporary contracts
- 2.2 (SAQ 5.2) Level of brand owner engagement in living wage programs
- 2.2 (SAQ 6.1) Level of brand owner process to avoid excessive overtime
- 2.2 (SAQ 7.1) The level of factories with trade union or worker representatives
- 2.2 (SAQ 7.2) Level of brand owner involvement with union or worker representatives
- 2.2 (SAQ 7.3) Level of brand owner work to counter union discrimination
- 2.2 (SAQ 8.1) Level of brand owner work to improve management and worker dialogue

Non-published sustainability performance indicators:

- 2.2 (SAQ 8.2) Level of brand owner grievance reporting system
- 2.2 (SAQ 8.3) Level of brand owner feedback on grievances
- 2.2 (SAQ 8.4) Level of brand owner improvements on grievance reporting system
- 2.2 (SAQ 9.1) Level of brand owner engagement with NGOs
- 2.3 (SAQ 10.1) Level of anti-bribery management system assessment
- 2.4 (SAQ 11.1) Level of transparency for smelters and refiners

SPI's described under environmental responsible manufacturing criteria

Published sustainability performance indicators:

- 3.2 The energy efficiency indicators for each final assembly factory
- 3.4 Percentage of post consumer recycled plastics content by weight
- 3.4 Percentage of identified post consumer recycled materials by weight
- 3.4 Percentage of identified renewable materials by weight
- 3.5 The PCF result of the product in kg CO2 if reported
- 3.5 The classification of the PCF method and age of source data

SPI's described under user health and safety criteria

Published sustainability performance indicators:

- 4.2 The sound power level (LWAd) in operating and Idling mode

SPI's described under product performance criteria

Published sustainability performance indicators:

- 5.1 Energy efficiency
- 5.2 The pixel density
- 5.3 The default CCT difference Δu'v' compared to D65
- 5.4 The minimum color triangle area
- 5.5 The color uniformity
- 5.6 The color uniformity - angular dependence
- 5.7 The largest Δu'v' measurement of color grayscale linearity
- 5.8 The maximum and minimum (if applicable) luminance level
- 5.9 The luminance variation
- 5.11 The luminance contrast
- 5.12 The luminance contrast - angular dependence
- 5.13 The black level
- 5.14 Grayscale gamma curve

SPI's described under product lifetime extension criteria

Published sustainability performance indicators:

- 6.2 Classification of fasteners and connectors (Class A-C)
- 6.2 Classification of Necessary tools for repair/upgrade, (Class A-B)
- 6.2 Classification of Availability of spare parts by target group (Class A-E)
- 6.2 Classification of Availability of spare parts by duration of availability (Class A-D)
- 6.2 Classification of Availability of comprehensive information (Class A-C)

SPI's described under reduction of hazardous substances criteria

Published sustainability performance indicators:

- 7.3 The % of substances with a GreenScreen® benchmark 3 or higher.

SPI's described under material recovery criteria

Published sustainability performance indicators:

- 8.3 The current ratio of collected versus manufactured products for each product type
- 8.3 The current ratio of reused versus collected products for each product type
- 8.3 The current ratio of recycled versus collected products for each product type

Non-published sustainability performance indicators:

- 8.3 The annual production volume of certified products per product category

2 Socially responsible manufacturing

Human rights and social responsibility in the IT supply chain

Market competition and the constant push for new technologies have increased pressure on the IT industry to deliver new product models faster and at a lower cost. With these pressures comes the continued social risk throughout the supply chain. Problems remain with human rights and working conditions, including forced labor, working hours, wages, discrimination and unsafe work environments. From more responsible mineral supply chains, to safer factory conditions and protection of worker rights, a sustainable approach to IT products requires attention to these social responsibility issues as well as environmental factors.

IT buyers are increasingly focused on supply chain responsibility and human rights, and rely on TCO Certified as verification of product conformity.

TCO Certified — driving worker safety, human rights and closing non-conformities

Chapter 2 in TCO Certified, generation 9, aims to drive more socially responsible manufacturing in the final assembly factories and throughout the supply chains. Brand owner companies and their suppliers are required to conform with criteria that cover responsible minerals sourcing, anti-corruption management and responsible manufacturing practices of the certified product, designed to increase transparency, protect worker rights and reduce exposure to hazards during the manufacturing phase.

The criteria are categorized into five main areas:

- Supply chain responsibility
- Supply chain transparency
- Anti-bribery management system
- Responsibly sourced minerals
- Process chemical management

Verification of conformity of supply chain responsibility uses a risk-based factory assessment model. Continued follow up verification is conducted for all areas in TCO Certified and is vital for monitoring that any non-conformities are corrected and closed. New criteria in this generation require that brand owners have a global policy for responsible mineral sourcing for the certified product, an anti-bribery management system covering all business of the certified product, and are taking steps to eliminate worker exposure to hazardous chemicals in the final assembly factories and the supply chains of the certified product.

2.1 Supply chain responsibility - REVISED

Background

Social responsibility is a continuing challenge throughout the IT supply chain. From raw materials extraction to final assembly, working hours, health and safety and forced labor are examples of industry-wide issues. However, for those who want to drive greater social responsibility, a major issue is the complexity of the IT product supply chain. It includes many suppliers that are spread all over the world.

The most basic aspect of social responsibility in the supply chains is to define who holds the responsibility. After this is done, the level of conformity and the implementation in the supply chains need to be defined. Finally, to make sure that problems are solved and improvements are made, independent verification and follow-up is crucial. Continued monitoring is essential, even after closure. TCO Certified offers a structured platform to guide industry progress:

- The responsibility for correcting non-conformities is placed on the brand owner which is at the top of the product value chain.
- Define minimum standards of the brand owner code of conduct covering the manufacturing of the certified product.
- We provide a control system to ensure that the brand owner takes the responsibility in the final assembly factories and supply chains of the certified product, and works in a structured way in accordance with the code of conduct.
- By including a system of consequences for continued non-conformities, we create an incentive for the brand owner to work proactively.

Definitions

Brand owner: The company or organization owning or controlling the brand name of the product.
Final assembly factory: A final assembly factory is where the final assembly of the certified product is taking place and is defined as the whole operation covered by a business license. A business licence covers an independent work unit, which means it has its own separated production areas, operation and management system, including but not limited to recruitment, working hours system, wage and benefit system, factory rules, etc. and all employees that under contract are dedicated to that factory.
Corrective action plan (CAP): A list of actions and an associated timetable detailing the remedial process to address a specific problem.
Sub-suppliers, 2nd tier suppliers: Factory supplying the final assembly factory of the certified product with the critical parts and packaging listed in the supply chain identification template.

Applicability

All product categories.

References

2.1, 2.2, 2.3.

2.1.1 Mandate

By signing this mandate, the brand owner agrees to (1.) the Commitment and agrees to conduct (2) the Structured work. Additionally, TCO Development requires that the brand owner shows (3) Proof of the commitment and the structured work by allowing inspections in the final assembly factories and the supply chains of the certified product, by sharing audit reports and CAPs, and by providing other documented proof described below.

1. Commitment

- The brand owner must have a public code of conduct for the manufacture of certified products, that is considered consistent with the following:
    - ILO's eight core conventions: 29, 87*, 98*, 100, 105, 111, 138 and 182.
    - The UN Convention on the Rights of the Child, Article 32.
    - All applicable local and national health and safety and labor laws effective in the country of manufacture, and a maximum 60-hour workweek including overtime*.

*See clarifications, 1 and 2

2. Structured work

- When applying for a new certificate, the brand owner must report all final assembly factories manufacturing the product model(s) that the application covers to TCO Certified Portal.
- The brand owner must supervise the implementation of the code of conduct at all final assembly factories that the brand owner is using to manufacture the certified product.
- The brand owner must ensure that corrective action plans are developed and implemented within reasonable time, for all non-conformities to the code of conduct that the brand owner is made aware of, at all final assembly factories where certified products are made, and in their supply chains.
- Final assembly factories that are registered to TCO Certified Portal must have a process to identify their sub-suppliers of parts and packaging for all certified products.
- The brand owner's code of conduct must be effectively communicated to the sub-suppliers.
- The final assembly factory must have a self-reported risk assessment of their sub-suppliers.

3. Proof

- TCO Development may conduct/commission factory inspections (spot checks) at any final assembly factory manufacturing a certified product and may require full audit reports during the certification period in order to assess social commitment and advancement.
- The supply chain identification template must be submitted to TCO Certified Portal for each registered final assembly factory.
- TCO Development may annually select sub-suppliers it identifies as higher risk for social and/or environmental impact to submit the following, within 12 months of registration:
    - An independent audit report in accordance with RBA or SA8000 procedures.
    - A completed Process Chemical Data Collection (PCDC) Tool.

    - Proof of an independently verified OHS management system - ISO45001 certificate or equivalent (OHSAS18001, RBA or SA8000 audit).
- TCO Development may also require seeing audit reports and corrective action plans from factories further down the supply chains of the certified product, to ensure that corrective actions have been successfully implemented.
- TCO Development additionally requires the documentation below to be verified by an independent verifier, approved by TCO Development.

Submit the following to an approved verifier:

Once a year at the Senior Management Representative interview:

- The most recent version of the brand owner's public code of conduct, covering the final assembly factories and the supply chains of the certified product. The code of conduct must be considered consistent with this mandate.
- Supporting Information on the routines of how management and workers in the final assembly factories and the supply chains of the certified product are informed about the brand owner's code of conduct.
- A completed and signed brand owner form covering the certified product. (Chapter 11.1.)

For each application:

- Names and addresses of all final assembly factories manufacturing the product model that the application covers. If any final assembly factory manufacturing certified products is not registered to the TCO Certified Accepted Factory List, then the brand owner must submit the factory identification template to register final assembly factories to the list.

For each final assembly factory manufacturing the certified product:

- The most recent independent audit and a corrective action plan for each non-conformity. The audit interval is determined by the risk category of the factory. The risk category is determined by the verifier according to the mandate.
- The supply chain identification template must be completed and submitted to TCO Certified Portal.

Submit the following, together with the application to TCO Development:

- A copy of a verification report from a verifier approved by TCO Development.
- A copy of an English version of the public code of conduct must be uploaded to TCO Certified Portal. It must cover all final assembly factories where certified products are made, and the supply chains of the certified product. All final assembly factories manufacturing the certified product must be registered to TCO Certified Accepted Factory List on TCO Certified Portal.
- All sub-suppliers of parts and packaging to the registered final assembly factory of the certified product must be registered to TCO Certified Portal.
- An independent audit, and a corrective action plan for each non-conformity, must be reported to TCO Certified Portal, at an interval determined by the risk category of the factory, for all final assembly factories manufacturing the certified product.

2.1.2 Clarification

General clarifications

The mandate is a social performance mandate and criteria are based on the eight ILO (International Labour Organization) core conventions and local legislation. The mandate requires that the brand owner comply with the minimum standards for code of conduct, inspection and corrective action engagement, regarding the situation at their own and/or their supplier factories manufacturing certified products.

* Collective bargaining and freedom of association: All workers must have the right to form, join and organize trade unions of their choice and to have them bargain collectively on their behalf with employers. In situations where this is restricted under law, employers must allow workers to freely and democratically elect their own representative(s) for the purpose of defending the rights and interests of workers.

* Local labor law: The limit and enforcement of local law regarding working hours differs tremendously across the world. To harmonize with other initiatives and to find a reasonable level for the industry, the criteria in TCO Certified sets a maximum 60 hour workweek, including overtime, as a global requirement regardless of the local law.

This criterion sets a global limit for weekly working hours that includes overtime based on ILO convention 1 (56 hours per work week including overtime). An additional four hours per workweek is given to harmonize with SAI and RBA. Therefore, workweeks including overtime are not to exceed a total of 60 hours and that workers receive at least 1 day off every 7 consecutive days.

To monitor continued conformity during an agreed period of time, when considered necessary the factory will be required to submit workweek data to TCO Development using a workweek data template. For factories up to 15000 employees the tolerance for excessive working hours per week in TCO Certified is up to 2% of the total workforce working between 60 and 72 hours per week for minor, 2-15% for major and over 15% for priority. Any working hours above 72 hours per week is considered a priority.

The verification process

Proof documentation must be submitted to an independent verifier approved by TCO Development. It is the verifier's responsibility to request any additional documents necessary for the review. The verifier will evaluate the information received from the brand owner according to the principles described below (1-5).

1. The code of conduct

The brand owner must have their code of conduct covering the final assembly factories and the supply chains of the certified product reviewed annually by an approved verifier. If the code of conduct has not changed since the previous annual review, then the brand owner does not have to submit it again. In this instance, the Senior Management Representative for supply chain responsibility must report this to an approved verifier.

- The code of conduct must be considered consistent with:
    - ILO's eight core conventions: 29, 87*, 98*, 100, 105, 111, 138 and 182.
    - The UN Convention on the Rights of the Child, article 32.
    - All applicable local and national health and safety and labor laws effective in the country of manufacture, and a maximum 60-hour workweek including overtime*.

  * See local labor law clarifications under "General clarifications" above.
- The contents of the code of conduct must have been adopted by the brand owner's board and addressed by management.
- The code of conduct must relate to the manufacturing of the certified product.

2. Information about the code of conduct

The brand owner must annually submit a description of how management and workers at all final assembly factories manufacturing certified products, and at sub-suppliers, are informed about the code of conduct. It will be reviewed by an approved verifier. Proof of training classes or other means of worker training and how the factory measures the effectiveness of the worker training must be submitted for review. If there are no changes to the communication routine since the previous annual review, then the brand owner does not have to submit it again. In this instance the Senior Management Representative must report this to an approved verifier.

Examples may be that the brand owner:

- has translated the code of conduct into local languages. This shows that the company has made efforts to inform management and employees about the code's content in their own language.
- has conducted training on the code for employees and/or management at final assembly factories or factories further down in the supply chains of the certified product.
- has made suppliers of the certified product complete a questionnaire (self-assessment) on their understanding of, and conformity with, the code of conduct.

3. The brand owner form

The brand owner signs the brand owner form to confirm that one or all products that are included in the application to TCO Development complies with this criterion.

4. Factory registration on TCO Certified Portal

For each certified product, all final assembly factories the brand owner is using to manufacture the certified product must be identified. Also, all sub-suppliers the final assembly factory is using for parts and packaging of the certified product must be identified. The approved verifier will ensure that all final assembly factories are listed on TCO Certified Accepted Factory List and that each factory has submitted the supply chain identification template on TCO Certified Portal.

- Final assembly factories must be registered to TCO Certified Accepted Factory List using the factory identification template for final assembly factories.
- Every registered final assembly factory on TCO Certified Accepted Factory List must submit the supply chain identification template.
- Each time a final assembly factory is removed, added or updated in any way, it is the brand owner's responsibility to ensure that this information is updated on TCO Certified Portal by submitting the correct documentation to an approved verifier.

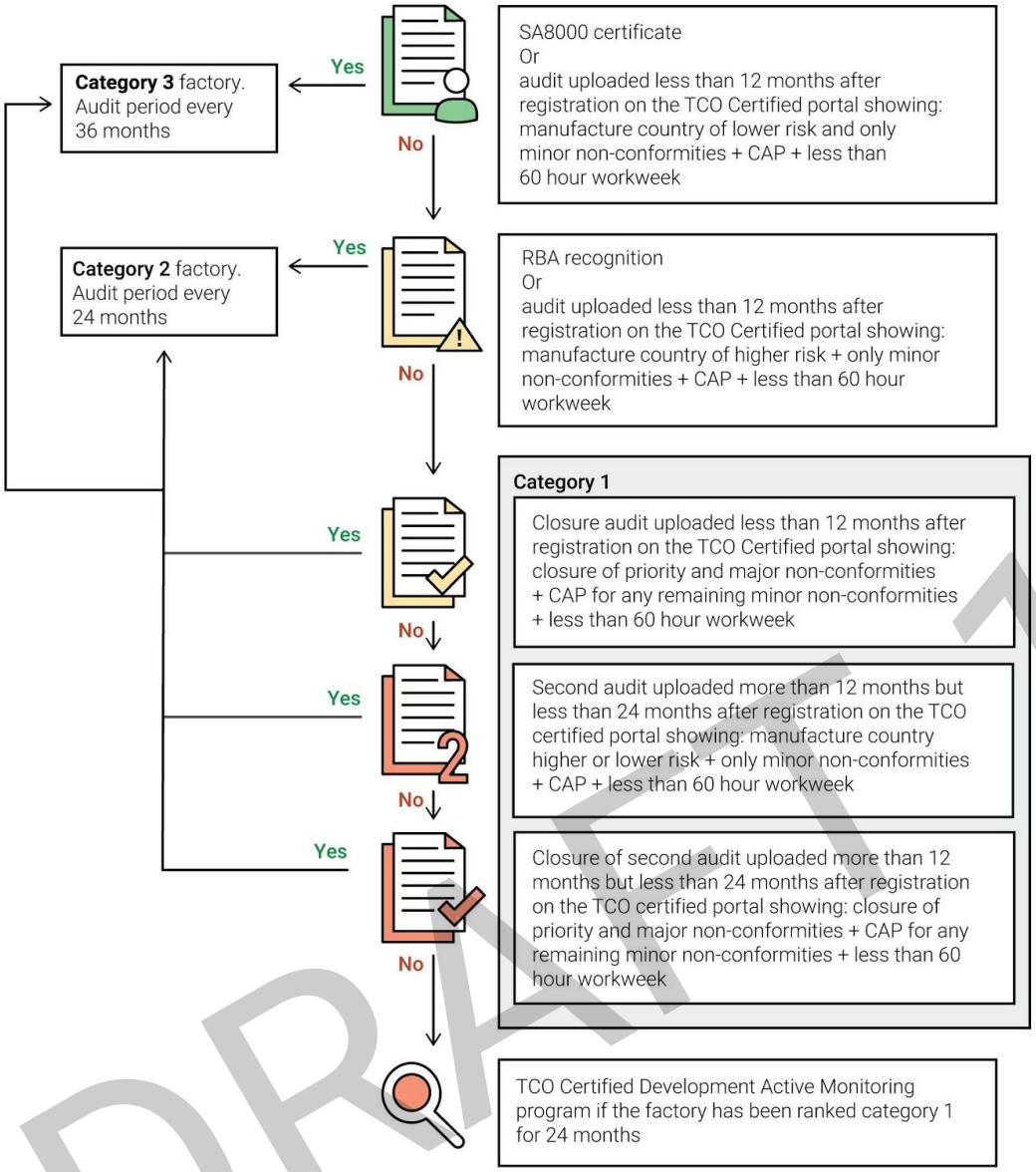
5. Independent social audit reports

The brand owner must ensure that TCO Certified Portal is continuously updated with the most recent independent initial audit report, and corrective action plans for all non-conformities that were found during this audit, from all final assembly factories manufacturing the certified product.

Brand owners or applicants/manufacturers must submit audit reports and corrective action plans to an approved verifier for upload to TCO Certified Portal. Consistency of these reports are ensured through annual spot-checks by TCO Development.

The audit interval is determined by the risk category of the factory.

1. Independent audits must be conducted by organizations accredited to ISO 17021 and carried out by SA8000 or RBA lead auditors. An independent party is considered to be a person or body that is recognized as being independent of the parties involved, regarding the issue in question.
2. Types of accepted audits are:
    a. SA8000,
    b. RBA VAP,
    c. Other audit types, if they are verified to be of equal quality to one of the accepted audits (a or b). This includes auditor qualification, audit process (e.g. triangulation of non-conformities), reporting and CAP. Verification will be conducted by an approved verifier before an alternative audit is accepted as proof.



Risk category diagram 2.1.2

Defining the factory risk category and audit intervals

If a newly added final assembly factory is not yet risk categorized, then TCO Certified Portal must be updated with either the latest independent audit report (less than 36 months old), a valid SA8000 certificate, or proof of an RBA recognition from the factory. The proof of an RBA recognition must be submitted with an initial audit report showing that working hours are under 60 hours per workweek. Initial audit reports must cover at least this criterion and be an accepted type of audit according to the definition in “Verification process” above. The factory will then be assessed in accordance with the process shown in the ***Risk category diagram 2.1.2*** for its level of risk for continued non-conformity. A factory assigned risk category 1, 2 or 3 will reflect the interval, in years, during which a factory must conduct the next initial audit.

Until the brand owner has submitted a factory audit report, the factory will automatically be categorized as risk category 1. (See below: “Audit report and factory risk categorization”.) Brand owners that are new to TCO Certified, or apply for certification to a new product category will need to undergo an additional risk assessment in order for TCO Development to

be sure factory audit requirements will be fulfilled within the given time. If the brand owner is considered a high risk for not fulfilling the initial audit requirements, then the brand owner is required to submit an audit report and a corrective action plan before the factory can be registered to TCO Certified Portal.

Factories will receive a better risk category categorization if they:

- are situated in lower risk countries,
- are involved in a social conformity certification and surveillance system that requires a minimum level of conformity before approval, or
- have proven a high level of progress in non-conformity closure meaning that all non-minor non-conformities are closed.
- providing proof of well-functioning dialogue between the factory management and a democratically elected trade union or worker representatives. See clarification section: Qualification method and assessment of worker-management dialogue.

Lower risk countries

Some countries are considered as lower risk of social non-conformities by the SA8000 Country Risk Assessments Process, which is based on World Governance Indicators (WGI). These countries include but are not limited to: EU countries, USA and Japan. A full list is available here: saasaccreditation.org.

TCO Certified Accepted Factory List

All brand owners, applicants and verifiers who have access to TCO Certified Portal will have access to see TCO Certified Accepted Factory List with the risk category (excluding factories which are directly owned by a brand owner, which can only be accessed by the owner). This is an advantage for those factories that work proactively with sustainability issues, closing non-conformities and monitoring continued conformity. These factories will be considered a better choice to do business with than risk category 1 factories.

Audit report and factory risk categorization

Initial audits are required regularly. The audit interval is based on the factory risk category.

- An **initial audit** is covering the full scope of the factory and this criterion.
- A **closure audit** covers at least the open non-conformities from the latest initial audit.
- An initial audit is more comprehensive and is accepted as a closure audit.
- Audits older than 12 months are not accepted. However, they can be used for the initial risk categorization of new registered factories to TCO Certified Portal.

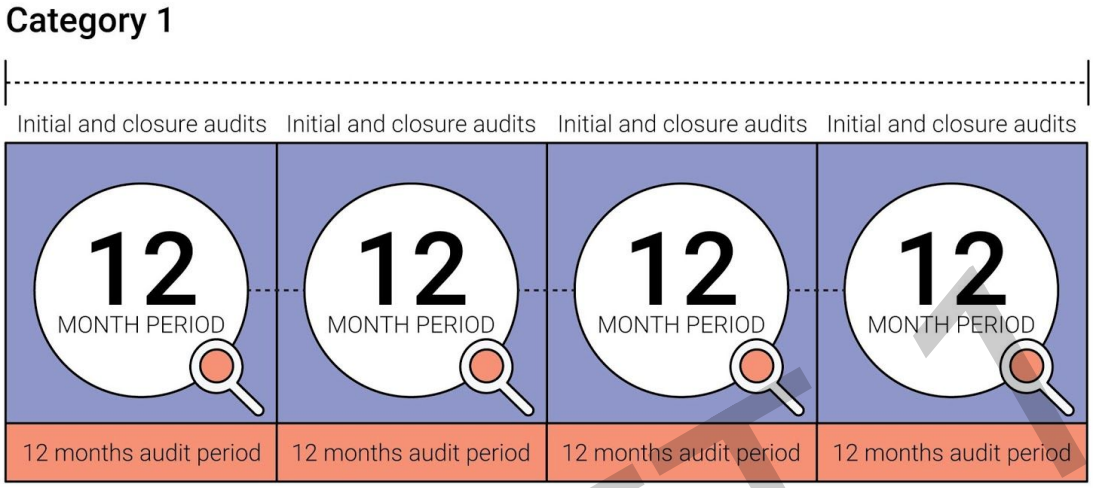
Initial risk categorization

- For all new factories on TCO Certified Portal, existing independent audits that are less than 36 months old must be uploaded to TCO Certified Portal for risk categorization. If no such audit exists, then the factory will be classified as risk category 1 by default.

Risk category 1

Initial audit

- For risk category 1, the factory must be audited every 12 months and a new initial audit must be uploaded to TCO Certified Portal during these 12 months. The start and end date of a new period is always on the date when the factory was first registered to TCO Certified Portal.



Corrective action plan

- When an audit has been uploaded it often includes some non-conformities. For each non-conformity to the mandate in TCO Certified, a corrective action plan must be uploaded to TCO Certified Portal. It must include closure deadlines, set by the audit program, for the completion of each corrective action.

Closure audit

- If there are major or priority non-conformities, a closure audit must be submitted within 12 months of the date the factory was registered to TCO Certified Portal. For minor non-conformities, the corrective action plan must be completed but it is not necessary to submit the closure audit.

Re-categorization

- When all non-conformities other than minor are closed, the factory will be categorized as risk category 2. If the factory is also placed in a lower risk country, or if it is certified according to SA8000, it will be categorized as 3 instead of 2.
- Otherwise the factory will continue to be categorized as risk category 1.

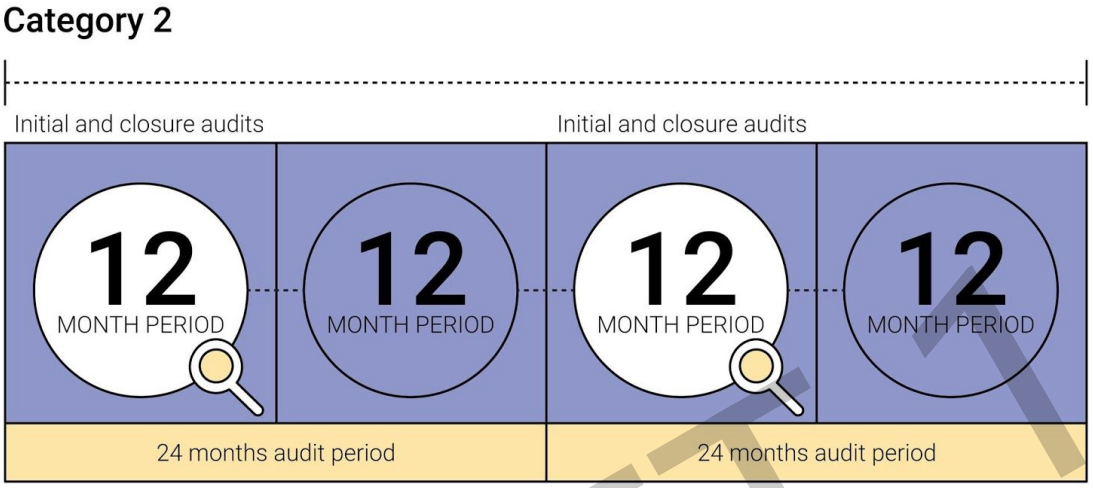
Final assistance

- If the factory has been categorized as a risk category 1 for 24 months, then the factory management will receive final assistance toward conformity through the TCO Certified Active Monitoring Program on tcocertified.com. If the brand owner or factory decides to not commit to the active monitoring program, the factory will be removed from TCO Certified Accepted Factory List, and the factory will no longer be allowed to manufacture products certified to TCO Certified.

Risk category 2

Initial audit

- For risk category 2, the factory must be audited every 24 months and a new initial audit must be uploaded to TCO Certified Portal during the first 12 months of every audit period. The start and end date of a new period is always on the date when the factory was first registered to TCO Certified Portal.



Corrective action plan

- When an audit has been uploaded it often includes some non-conformities. For each non-conformity to the mandate in TCO Certified, a corrective action plan must be uploaded to TCO Certified Portal. It must include closure deadlines, set by the audit program, for the completion of each corrective action.

Closure audit

- If there are major or priority non-conformities, a closure audit must also be uploaded to TCO Certified Portal during the first 12 months of every audit period. If the factory only has minor non-conformities, the corrective action plan must be completed but it is not necessary to upload the closure audit to TCO Certified Portal. The closure of minor non-conformities will be verified in the next initial audit.

  ATTENTION

  It is recommended to conduct the initial audit early in the first 12 month audit period, to have time to also provide the closure audit during the first 12 months. If the closure audit is provided later than 12 months after the start of the audit period, the factory may be re-categorized. This may happen even if the audit closure deadline in the corrective action plan allows for more time to close the non-conformities.

Re-categorization

- As long as all non-conformities other than minor are closed within the time specified in the corrective action plan, the factory will continue to be categorized as risk category 2. If it is certified according to SA8000, it will be categorized as risk category 3 instead of 2.

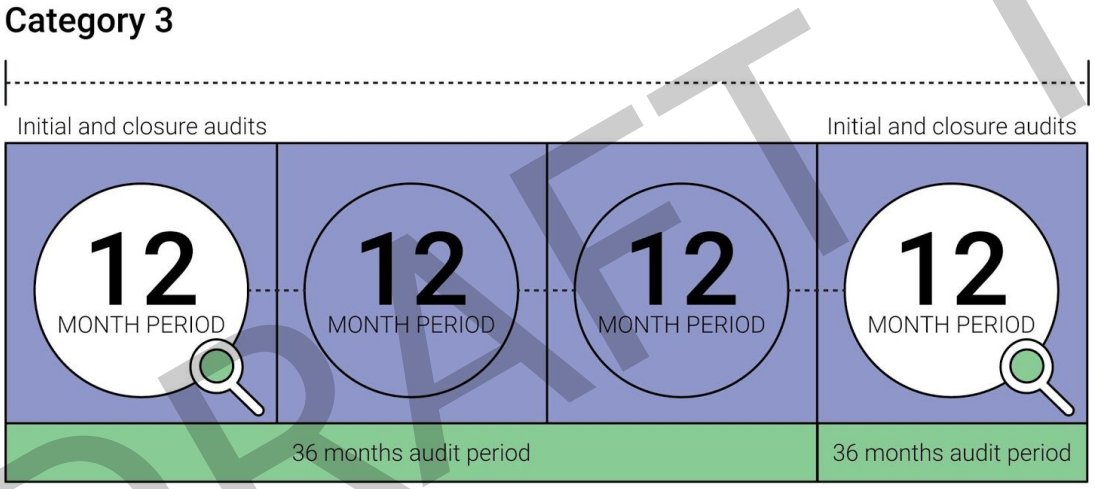
- Otherwise, the factory will be categorized as risk category 1.

Conformity option: As proof of conformity to risk category 2 without the need to upload a closure audit report to TCO Certified Portal, factories that can prove they have received the status of Platinum, Gold or Silver under the RBA recognition program and provide additional proof that working hours are under 60 hours per workweek will be categorized risk category 2, or 3 if the factory is placed in a lower risk country. Silver level is only accepted if there are no major non-conformities to this criterion.

Risk category 3

Initial audit

- For risk category 3, the factory must be audited every 36 months and a new initial audit must be uploaded to TCO Certified Portal during the first 12 months of every audit period. The start and end date of a new period is always on the date when the factory was first registered to TCO Certified Portal.



Corrective action plan

- When an audit has been uploaded it often includes some non-conformities. For each non-conformity to the mandate in TCO Certified, a corrective action plan must be uploaded to TCO Certified Portal. It must include closure deadlines, set by the audit program, for the completion of each corrective action.
    - If the factory is SA8000 certified then the non-conformities are solved in accordance with the SA8000 certification procedure.

Closure audit

- If there are major or priority non-conformities, a closure audit must also be uploaded to TCO Certified Portal during the first 12 months of every audit period. If the factory only has minor non-conformities, the corrective action plan must be completed but it is not necessary to upload the closure audit to TCO Certified Portal. The closure of minor non-conformities will be verified in the next initial audit.

- A valid SA8000 certificate is considered proof that major and priority non-conformities are being monitored during regular intervals by SAAS accredited verifiers, and that issues are being solved.

Re-categorization

- Factories certified according to SA8000 are categorized as risk category 3. If it is discovered that non-conformities other than minor still occur, the factory will be categorized as risk category 1.
- Factories that are not SA8000 certified but are situated in lower risk countries and have provided a satisfactory closure of all non-minor non-conformities within the first 12 months of the audit period can achieve risk category 3 status.
- Factories of risk category 2 can apply for re-categorization to risk category 3 by providing proof of well-functioning dialogue between the factory management and a democratically elected trade union or worker representatives. See the qualification method below.

Qualification method and assessment of worker-management dialogue

For factories at-risk category 1 it is very likely that the worker-management dialogue is not mature enough due to the number of persistent non-conformities. However, once a factory has managed to solve their major and priority non-conformities and achieved risk category 2, they may apply for risk category 3 re-categorization based on worker-management dialogue. To qualify for re-categorization to risk category 3 all the below verification points for a Trade union or non-union worker representation must be considered compliant without remarks.

Verification of the level of worker/management dialogue at the factory.

In order for a factory to be able to get re-categorization from risk category 2 to 3 based on the worker-management dialogue, the factory management, and worker representatives must together prove the following. The proof must be assessed during the factory audit every 3 years by an independent auditor approved by TCO Development. To become approved the auditor evaluating worker management dialogue must fulfill all the requirements of auditors in TCO Certified and must also have documented experience and deep understanding of trade union work.

In the case of a Trade union (TU)

Criteria for assessing a Trade union (TU) presence at factories in high-risk countries for consideration for TCO Certified risk category 3 status.
Requirements on the trade union

1. The TU is not in any way interfered with or financed by the factory management and is independent from the local and national government.
2. The TU is financed by membership fees or donations from non-profit organisations and is non-profit
3. The TU has bargaining rights and acts on the behalf of employees in collective bargaining negotiations with employers.
4. The TU should set and fulfill some or all of the goals it sets itself to win concessions for workers, such as: improve working conditions, working hours, wages and benefits

Requirements on the management

5. Factory management contributions are limited to providing meeting space/materials
6. Payroll records etc show TU employees are not discriminated if they also work at the factory
7. No management interference with the TU representative meeting new consenting employees to explain their rights to freely join the TU and membership is open to all employees.
8. The TU has the ability to call a strike, without restriction from government or company management.

Requirements on the worker - management dialogue

9. TU meets with management regularly for the purpose of furthering and defending the rights and interests of workers for mutual gains. TU meeting minutes and financial records are kept and made available.
10. TU representatives have access to
    a. Risk assessments
    b. Internal audits and monitoring of the organization
    c. Relevant and appropriate aspects of management review
    d. Opening and closing meetings of labor audits
    e. Reporting back to workers on any corrective and preventive actions taken
    f. Reporting back to Senior Management on the performance and benefits of actions taken to meet the criteria in the audit

In case of a non-union worker representation

If the above union criteria are not possible to fulfill due to country laws restricting freedom of association and collective bargaining, workers shall be allowed to freely elect their own non-union representatives. (Note: worker representation should not be seen as a substitution for a union representative in organizations where workers freely choose to organize.)
An organised committee of democratically elected worker representatives from non-management personnel is defined as a democratic trade union like system and must meet the following criteria:

1. An organised committee consists of democratically elected representatives from non-management personnel and is independent from the local and national government.
2. The number of representatives shall be in proportion to the number of workers at the factory and must be in the range 1 for every 50-100 workers.
3. The worker committee has the right to represent the workers in collective negotiations with management.
4. The committee has set and fulfills some or all of the goals it sets itself to win concessions for workers, such as: improve working conditions, working hours, wages and benefits.

Requirements on the management

5. Management has not intervened or interfered in any way in the nomination, election, operation, administration of the committee.

6. Payroll records etc show worker representatives are not discriminated against if they also work at the factory. Workers representatives must be allowed to carry out their duties in the organized worker committee during normal working hours without any wage deductions.
7. The worker committee is free to fulfill their goals without being subjected to discrimination, harassment, intimidation, or retaliation for being representative(s) of workers or engaged in organizing workers, and that all workers have access to the representatives in the workplace and access to their services.
8. Worker representatives have the possibility to meet all new consenting employees to explain their labor rights.
9. Committee members shall be allowed to attend relevant committee-training during normal working hours without getting wage deductions to help fulfill their duties
10. Factory management must provide meeting space/materials

Requirements on the worker - management dialogue

11. Committee meets with management regularly for the purpose of furthering and defending the rights and interests of workers for mutual gains. Meeting minutes and financial records are kept and made available.
12. The non-union committee have access to
    a. Risk assessments
    b. Internal audits and monitoring of the organization
    c. Relevant and appropriate aspects of management review
    d. Opening and closing meetings of labor audits, includes RBA and SA8000 audits
    e. Reporting back to workers on any corrective and preventive actions taken
    f. Reporting back to Senior Management on the performance and benefits of actions taken to meet the SA8000 Standard.

Additional clarifications that are valid for all risk categories

- If the audit program and lead auditor accepts an offsite closure audit it will also be accepted in TCO Certified.
- If proven conditions change, such as when non-conformities are found during a spot check, the risk categorization will be re-assessed.
- Closure of priority findings within the CAP deadline will be monitored in particular by TCO Development through the spot check program.

Spot checks of supply chain responsibility

Spot checks are financed by TCO Development as long as no non-conformities are found. If non-conformities are found and further investigations are necessary, the cost for this must be covered by the license holder.

Audit reports and corrective action plans

Central to the spot check conformity program is the review of the factory audit report and corrective action plan conducted by a verifier approved by TCO Development. TCO Development will randomly select audit reports and corrective action plans on TCO Certified Portal to be spot checked. This is to ensure that the data uploaded to TCO Certified Portal is correct.

During the spot check conformity program, the corrective action plan will also be evaluated for effectiveness by the approved verifier. A judgement on the remedial effectiveness and a summary will be given in the verification report issued by the approved verifier. This summary is permitted to be shared with the clients of the factory.

On-site inspection initiated by TCO Development

TCO Development reserves the right to require full audit reports and conduct or commission on-site inspections at final assembly factories manufacturing the certified product, to verify that the brand owner is fulfilling the obligations in this criterion. The planning of social audits will be done in cooperation with the Senior Management Representatives appointed by the brand owner.

Social audits initiated by TCO Development will be realized on a judgement sample basis, in each case decided upon and financed by TCO Development. Results from the audits will be shared with the audited factory (both management and worker representatives) and all the brand owners listed as using the audited factory. This is in order to create a combined effort toward implementing the corrective action plan. For TCO Development, the spot checks and all other uploaded reports contain valuable information on social performance, making it possible to translate non-conformities into metrics and then measure improvements through code of conduct and audit methodology.

The verifier approved for supply chain responsibility

Only an independent verifier approved by TCO Development has the authority to approve the following:

For each brand owner:

- Code of conduct covering the final assembly factories and the supply chains of certified products.
- Communication of the code of conduct to the final assembly factories and the supply chains of certified products.
- Supporting documentation.
- Conduct interview with senior management representative.

Other assessments

- Review evidence that could prove that another audit protocol can be considered “equal quality to other approved audit protocols”. This includes but is not limited to; auditor qualification, audit process, reporting and corrective action plan.

The list of approved verifiers is found at tcocertified.com.

2.2 Supply chain transparency

Background

Supply chain transparency includes two vital parts: a) the extent to which information about a company and its sourcing locations is made public to end-users and stakeholders and b) the company's process of taking action through supply chain visibility, to manage it effectively. Companies struggle to achieve supply chain transparency since they lack a solid process and structure to manage risks and monitor behavior in their extended supplier network. Without visibility into their supply chains, brand owners create a blind spot where damage to reputation can emerge.

Transparency toward an independent party provides a company not only with the possibility to measure its own performance in key areas against their peers, but also a way to share and gain knowledge about solutions. Supply chain transparency requires a solid management system, where improvements are achieved by acting on responses to shared information.

Applicability

All product categories.

2.2.1 Mandate

The brand owner must appoint a Senior Management Representative (SMR) for supply chain responsibility for the certified product, who reports directly to senior management.
Irrespective of other duties, this person must have the authority to ensure that the certified product meets the supply chain criteria in TCO Certified.
The SMR must annually complete the TCO Certified self-assessment questionnaire (SAQ) and complete a follow-up interview with an approved verifier.

Submit the following to an approved verifier:

- A completed and signed self-assessment questionnaire (SAQ)
- A completed and signed brand owner form covering the certified product (chapter 11.1)

Submit the following together with the application to TCO Development:

- A copy of a verification report from a verifier approved by TCO Development.
- The report from the SMR interview including the verified self-assessment questionnaire (SAQ).

2.2.2 Clarifications

General clarifications

The aim of the mandate is to create transparency between TCO Development and senior management at the brand owner company of the certified product.

Senior Management Representative (SMR) details

The required details of the SMR must appear in TCO Certified Portal and the SMR must be available for dialogue in English with TCO Development and verifiers throughout the validity of all the brand owner's certificates.
If the appointed SMR is changed, then details of the new SMR must be updated in TCO Certified Portal. TCO Development must be informed immediately.
The SMR must ensure that TCO Certified Portal is up to date covering:

- Name, title, telephone number and email address of the SMR.
- A date, with a period of less than 12 months, of the completed and / or planned SMR interview with the name of the approved verifier.

SMR interview

The interview with the SMR must be done with one of the verifiers approved by TCO Development. It is booked and paid for by the SMR. The purpose is to ensure that the appointed person has the necessary authority and is working in a structured way to implement the brand owner's code of conduct. Primarily, the interview will cover the self-assessment questionnaire (SAQ) answers about supply chain management.
All questions in the SAQ must be answered and submitted to the verifier prior to the interview. During the part of the interview that covers the SAQ, the SMR will be required to explain in more detail the brand owner's work toward a socially responsible supply chain of the certified product and provide supporting documentation where needed. It is recommended that SMRs involve colleagues in the meeting who can provide necessary expertise in the areas covered by the SAQ.
The interview will likely be an online meeting. If for some reason it is not possible to have an online meeting or if the interview does not obtain an acceptable quality due to language difficulties, then the verifier may require a face to face interview.
The report from this interview is then uploaded to TCO Certified Portal. TCO Development have the right to participate at the interview with the SMR. In this case TCO Development will cover their own expenses.

About the self-assessment questionnaire (SAQ) and result benchmarking

The SAQ is a set of questions aimed at gaining transparency into the brand owner's risk management in the supply chain of the certified product. This includes areas such as child labor, worker representation, unions, ethics and minerals.
The SMR is responsible for answering all questions and providing supporting documentation where needed. The SMR must follow the SAQ guidelines when answering. Each answer must be given according to the following three levels of commitment that can be proven. Answers are color benchmarked for easy reference: invested (green), involved (yellow) or interested (red).
There is no minimum graded level required to be fulfilled, since the SAQ is only intended to gather information on the actual level of social commitment and assist in the development of future generations of TCO Certified criteria. Feedback to the brand owner is given in the form of a report and table that shows the brand owner's final grading (after the interview) in comparison to other certifying brand owners (all brand names will remain anonymous). This will help the brand owner identify areas for improvement and measure their progress within the industry.
Result data will also be used to risk assess factories of the certified product for the spot-check program. In this program, TCO Development orders annual factory audits according to the code of conduct by independent auditors at a number of final assembly factories where certified products are manufactured.

The questionnaire and guidelines for the assessment are public and available for download at tcocertified.com.

Clarification of sustainability performance indicator(s)

One or more "sustainability performance indicators" (chapter1.3) are collected for this criterion. There is no mandatory level for these indicators but they must be verified and reported according to the description below.

- Public factory list
  The percentage of final assembly factories manufacturing the certified product which are publically listed on the brand owners website must be reported in TCO Certified portal, together with the application (0% may be reported if the number is unknown).

  In order to count a final assembly factory as publicly listed it must be made public on the brand owner website under a heading "Supply Chain" or similar. The factory information must show at least the supplier name, factory full address and type of products produced at the factory. Additional information on whether the supplier has produced a GRI-based sustainability report is optional.

2.3 Anti-bribery management system - REVISED

Background

Bribery is a widespread phenomenon. It raises serious moral, economic and political concerns, undermines good governance, hinders development and distorts competition. It erodes justice, undermines human rights and is an obstacle to the relief of poverty. It also increases the cost of doing business, introduces uncertainties into commercial transactions, increases the cost of goods and services, diminishes the quality of products and services, which may lead to loss of life and property, destroys trust in institutions and interferes with the fair and efficient operation of markets.

Organizations have a responsibility to prevent all forms of corruption within their businesses and their supply chains. To do so, organizations must align their business policy, monitoring and enforcement mechanisms with internationally recognized best practices against all forms of bribery.

With TCO Certified, brand owners that apply for product certification are interviewed by an independent reviewer, who assesses the brand owner's anti-bribery management system, to ensure that it meets the requirements of ISO 37001.

Definitions

Corruption: Gaining an advantage through illegitimate means. Bribery, abuse of power, extortion, fraud, deception, collusion, cartels, embezzlement and money laundering are all forms of corruption.
Bribery: Giving or receiving an unearned reward to influence someone's behavior.
Anti-bribery management system: Instilling an anti-bribery culture and appropriate controls to detect and reduce the incidence of bribery for financial or nonfinancial benefits.

Applicability

All product categories.

References

2.4.

2.3.1 Mandate

The brand owner must have internal processes and routines in place to prevent and respond to all forms of bribery, covering all business activities connected to the certified product. This includes making sure that the supply chain proves alignment with the anti-bribery management system standard ISO 37001.

Submit the following to an approved verifier:

- A completed and signed brand owner form covering the certified product (chapter 11.1).
- An ISO 37001 certificate, or a booked date for the self-assessment questionnaire (SAQ) and follow-up interview with an approved verifier.

Submit the following together with the application to TCO Development:

- A copy of a verification report from a verifier approved by TCO Development.

2.3.2 Clarification

The brand owner's anti-bribery management system covering all business activities connected to the certified product including the supply chain must be considered to be aligned with ISO 37001. If an ISO 37001 certificate is not available as proof, the brand owner has the option to complete the self-assessment questionnaire (SAQ) and take part in a follow-up verification interview with an approved verifier. A date for the interview must be set before the verifier can issue a verification report to TCO Development.

A follow-up review of the brand owner anti-bribery management system will be in the form of a self-assessment questionnaire (SAQ) and included in the first interview with the assigned Senior Management Representative (SMR) for supply chain responsibility.

Each answer of the SAQ will be graded using a color. Green is pass, yellow is room for improvement and red is non-compliance. A completed SAQ and required supporting documentation must be submitted to the verifier prior to the interview. These will be verified in the online interview between the verifier and the brand owner SMR and any experts responsible for anti-bribery the SMR wishes to include.

Verification guidelines

- If all answers are scored green (except 12.1) in the first annual interview, then there's no need to include the anti-bribery interview in the following annual cycle.
- If any point is yellow (except 12.1), only these need to be covered in the following annual interview, to check if the brand owner has improved to green level.
- If any point is red, a corrective action plan must be submitted and the point will be included in the following annual interview and must then be either yellow or green.
- Only question 12.1 can be graded red indefinitely, since the interview is considered an independent verification of the anti-bribery management system.

2.4 Responsibly sourced minerals - REVISED

Background

Minerals such as tin, tantalum, tungsten, gold and cobalt are connected to armed conflicts and human rights abuses in the regions of the world where they are extracted. Unsafe mining methods also lead to severe health problems for workers, and environmental degradation in local communities. Since the mineral supply chain can include hundreds of suppliers, from mines and smelters to final production, it is a challenge to make informed choices about mineral sourcing, from extraction to finished product.

TCO Certified drives more responsible mineral sourcing in all countries where the mining industry and trade are present. Suppliers must adopt a responsible approach to mineral sourcing, irrespective of where in the world they operate. TCO Certified goes beyond the current definition of conflict minerals and requires that brand owners include cobalt as part of their due diligence process. To drive widespread, positive impacts at a faster rate, due diligence and risk reporting is standardized, with focus on long-term, continuous improvement.

Definitions

Conflict-affected and high-risk areas: Areas in a state of armed conflict, fragile post-conflict areas, as well as areas witnessing weak or non-existing governance and security, such as failed states. In these areas, there are often widespread and systematic violations of international law, including human rights abuses.
Responsible Minerals Assurance Process (RMAP): Independent third-party assessment of smelter/refiner management systems and sourcing practices to validate conformance with RMAP standards.
Responsible minerals initiative (RMI): Member initiative for the implementation of minerals supply chain due diligence.
Smelting: The process of applying heat to ore in order to extract a base metal.
Refining: A process that increases the grade or purity of a metal.
Conflict minerals: Tantalum, tin, tungsten and gold.
Other risk minerals: Cobalt, mica, lithium, copper, nickel and rare earth metals.

Applicability

All product categories.

References

2.5, 2.6, 2.7, 2.8.

2.4.1 Mandate

The brand owner must:

- Have a strict supply chain policy for responsible minerals sourcing, for the certified product that can be considered to cover at least 3TG and cobalt. The policy must be both public and communicated to the supply chain.
- Have a process to identify smelters and refiners of at least 3TG and cobalt for the certified product.

- Make sure that the final assembly factory submits the name and address of identified smelters and refiners for 3TG and cobalt in the supply chain of the certified product by using the supply chain identification template.
  The information entered in the template must show:
  - Factory information:
    - The final assembly factory registered by the brand owner on the TCO Certified Accepted Factory List.
  - Mineral due diligence:
    - Answer all questions in the Mineral due diligence tab.
  - Mineral smelters and refiners:
    - The names and addresses of the smelter and refiner identified by each factory as the source of 3TG and cobalt of the certified product.
    - Whether the smelter and refiner is conformant or active with the Responsible Minerals Assurance Process (RMAP).
  - As additional verification of compliance, TCO Development can require that the names and addresses of manufacturers directly sourcing the minerals from the smelter and refiner are submitted to the verifier.

Submit the following to an approved verifier:

- The most recent version of the public responsibly sourced minerals policy and a description of how it is communicated to the supply chain of the certified product.
- A description of the brand owner's structured work on identifying risk areas in the supply chain of the certified product with supporting documentation.
- The supply chain identification template must be completed and submitted to TCO Certified Portal.
- A completed and signed brand owner form covering the certified product (chapter 11.1).

Submit the following together with the application to TCO Development:

- A copy of a verification report from a verifier approved by TCO Development.
- A copy of the responsibly sourced minerals policy, in English. (Must be uploaded to TCO Certified Portal.)

2.4.2 Clarifications

Responsibly sourced minerals policy

The responsibly sourced minerals policy is an essential statement by the brand owner. It reflects the brand owner's commitment toward responsible sourcing of minerals and the expectations that their raw material suppliers adhere to the policy.

Verification guidelines

The verifier must be able to verify that the responsibly sourced minerals policy can be considered to cover at least 3TG and cobalt for the certified product, is public, and also that it is clear how the policy communicated to suppliers.

- "Public" means that the policy is visible on the brand owner website, or is included in the brand owner's annual sustainability or responsible minerals report.

- "Communicated" could be as part of a contract and/or in a written agreement with suppliers.

To verify the level of strictness, the policy must require at least the following:

- That suppliers conform with the policy.
- That suppliers neither directly nor indirectly finance armed groups in conflict-affected regions.
- That suppliers neither tolerate nor contribute to human rights abuses that include forced labor, child labor and environmental degradation.
- A commitment to supporting responsible sourcing from those regions in which specific mining operations may present risk.

Structured work on identifying risk areas

The brand owner must carry out structured work to identify if at least 3TG and cobalt are present anywhere in the supply chain of the certified product, with the goal to identify the smelters and refiners.

Identifying risk areas is a process that helps map the chain of custody of risk minerals down to the smelters and refiners within the supply chain. This is commonly done by a minerals reporting template such as a conflict minerals reporting template and a cobalt reporting template being systematically sent through the supply chain. This transfer of information facilitates the identification of high-risk smelters and refiners.

Verification guidelines

The verifier has been provided a description of how the brand owner identifies risk areas in its supply chain of the certified product. The verifier can also require a copy of the completed template as further evidence of compliance. See below examples:

- Using an established conflict minerals reporting template as part of the brand owner's due diligence process. As a random follow up at the request of TCO Development, completed examples of the template are to be submitted to the verifier.
- A public list of smelters and refiners on the brand owner website is considered verification that the brand owner has identified the list through using a minerals reporting template.

Supporting smelter and refiner responsible sourcing programs

Involvement in multi-company coordinated action that supports the development of responsible sourcing initiatives within the conflict-affected and high-risk areas is essential. These initiatives help suppliers meet due diligence requirements, maintain trade and benefit local mining communities, whose livelihoods depend on a legitimate mining trade.

Verification guidelines

The verifier is provided with a completed supply chain identification template with the completed mineral suppliers tab showing the identified smelters and refiners of the certified products. The template requires that the manufacturer also indicate which 3TG and cobalt identified smelters and refiners are comformant or active with RMAP. The template is uploaded to the TCO Certified Portal. The number of registered smelters and refiners used by the final assembly factory of the certified product (as a percentage) will be shown on the TCO

Certified Portal to enhance the preferred choice of factory mechanism in the TCO Certified Accepted Factory List.

More information:

- The OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas ("the Guidance"), available at oecd.org. Brand owners require suppliers to disclose their sourcing origins of conflict minerals by using a questionnaire template such as the responsible minerals initiative (RMI), conflict minerals reporting template (CMRT) or similar in order to prevent the potential use of risk minerals.

- Member of the responsible minerals initiative (RMI). Members contribute to a number of tools and resources including the conflict minerals reporting template; supporting in-region sourcing schemes and the Responsible Minerals Assurance Process (RMAP).

- Responsible Minerals Assurance Process (RMAP) helps companies make informed choices about responsibly sourced minerals in their supply chains. Independent third-party assessments of smelter/refiner management systems and sourcing practices are used to validate conformance with RMAP standards. The assessment employs a risk-based approach to validate smelters' company-level management processes for responsible mineral procurement.

  The RMAP standards are developed to meet the requirements of the OECD Due Diligence Guidance, the Regulation (EU) 2017/821 of the European Parliament and the U.S. Dodd-Frank Wall Street Reform and Consumer Protection Act.

2.5 Process chemical management - REVISED

Background

Scientific research shows that workers that come into contact with chemical substances used in the manufacture of IT products are more likely to suffer from cancer, reproductive damage, birth defects and other serious illnesses.
The use of chemicals such as benzene and n-hexane (industrial cleaning solvents), that have well-documented toxic human health effects, have been restricted in some parts of the world, but are often used by the manufacturing industry in developing countries where legislation is weaker and workers are less protected. These chemicals need to be phased out of production, and not be replaced with equally hazardous substances.
To replace chemicals with safer alternatives, process chemicals and their suitable safer alternatives must be identified and independently assessed by an approved toxicologist. The Personal Protective Equipment (PPE), training and exposure monitoring provided to the workers who risk chemical exposure also needs to be reviewed and improved.

Definitions

Final assembly factory: A final assembly factory is where the final assembly of the certified product is taking place and is defined as the whole operation covered by a business license. A business licence covers an independent work unit, which means it has its own separated production areas, operation and management system, including but not limited to recruitment, working hours system, wage and benefit system, factory rules, etc. and all employees that under contract are dedicated to that factory.
Process chemicals: Chemicals (individual chemicals or mixtures) used during the manufacture of a product and/or maintenance of related production equipment, that are not intentionally fully incorporated into the product.
Cleaning solvents: Chemicals and chemical mixtures used to remove contaminants, unwanted materials and/or manufacture process residues (e.g. lubricants, adhesives, solder flux residues, plastic residue, mold releases, etc.). Examples of process chemicals used for cleaning include: solvents, aqueous detergent solutions, stencil/ink removers, adhesive removers, solvent vapor degreaser solutions, ultrasonic parts cleaner solutions, photo-resist strippers, solder defluxing solutions, etc.
Process chemical inventory: A record kept by the factory showing at least the process chemicals used at the factory.
SMT: Surface-mount technology is a method in which the electrical components are mounted directly onto the surface of a printed circuit board (PCB). An electrical component mounted in this manner is referred to as a surface-mount device (SMD).
GreenScreen Profilers: Toxicology firms licensed by CPA to provide GreenScreen assessment services for a fee to clients.
TCO Certified Accepted Substance List: Public list of independently assessed safer available alternatives considering toxicity and functionality. Go to tcocertified.com.
CPA: Clean Production Action. Developers of GreenScreen® for Safer Chemicals.

Applicability

All product categories.

References
2.1, 2.2, 2.9, 2.10, 2.11, 2.12, 2.13.

2.5.1 Mandate

Each final assembly factory manufacturing the certified product:

- must have a structured health and safety management system in place, that is independently certified to ISO 45001.
- must only use cleaning solvents necessary for product and PCB process cleaning that contain individual chemicals or mixtures that appear on the TCO Certified accepted substance list for process chemicals.
- All substances of a mixture must be accounted for. Non-accepted substances must not exceed concentration levels of 0.1% by weight of the chemical product.

Submit the following to an approved verifier:

- A copy of the ISO 45001 certificate for each final assembly factory manufacturing the certified product.
- A completed Process Chemical Data Collection (PCDC) Tool for each final assembly factory manufacturing the certified product. The chemical data must cover cleaning solvents used for product cleaning and PCB process cleaning at the production lines where certified products are manufactured. The scope of chemical data to be submitted is stated in the Process Chemical Data Collection (PCDC) Tool, that can be downloaded at tcocertified.com.
- A completed and signed factory form (chapter 11.2).

Submit the following together with the application to TCO Development:

- A copy of a verification report from a verifier approved by TCO Development.
- A copy or access to a copy kept on a database of the complete assessment report conducted and issued by an approved licensed profiler independent of the approved screened chemistry program.
- The process chemical data template must be reported in TCO Certified Portal.

2.5.2 Clarification

The process chemicals that appear on TCO Certified Accepted Substance List are commonly used by final assembly factories to clean display panels, product enclosures and printed circuit boards (PCBs) and SMT machinery. They have been identified by TCO Development during the previous generation of TCO Certified. PCB cleaners are relevant since many final assembly factories include surface-mount technology (SMT) production lines that cover solder machines, stencils, flux, ovens, PCBs, glues and tools.

These processes must only use cleaners that are listed on TCO Certified Accepted Substance List. To be included on the list, chemicals must be independently assessed, and receive a GreenScreen® benchmark score of 2, 3 or 4. Alternatively chemical mixtures that are GreenScreen certified (silver or gold) by a licensed GreenScreen Profiler are accepted. Chemicals on the list without an approved benchmark or certification will receive a sunset

date for when they will be removed from the list. Before the sunset date, the chemical may be used on production lines where products certified according to TCO Certified are made. This gives the supplier/s time to have an independent assessment of the chemical, or to replace it with an approved benchmarked or certified alternative from the list.

From the date when the factory is registered on the TCO Certified Accepted Factory List, a factory has up to 12 months to make sure that the cleaning chemicals used on production lines where certified products are made are listed as safer alternatives on TCO Certified Accepted Substance List.

TCO Development and Clean Production Action (CPA) must have access to a copy of the GreenScreen assessment report before the benchmarked substance can be added to TCO Certified Accepted Substance List, available at tcocertified.com.

Proof of health and safety management system conformity

The applicant must upload a valid ISO 45001 certificate to TCO Certified Portal. The certificate must be issued by a certification body that is accredited to issue the certification. Factories that do not yet have a certified health and safety management system according to ISO 45001, may apply to TCO Development for an extended time period of 12 months to complete certification by submitting an extension application. This application can be obtained from TCO Development. TCO Development has the right to deny the applicant an extended period of time if there is reason to believe the factory will not be able to achieve the ISO 45001 certification within the extended time period (for example, if other critical non-compliance issues are pending, or if the timeplan is insufficient). A factory that has been certified to OHSAS 18001 has good prerequisites for an extended time approval.

Process Chemical Data Collection (PCDC) Tool and guidelines

The applicant must complete and upload the PCDC Tool to TCO Certified Portal. TCO Development has entered the scope of the data to be entered, therefore it is preferred that applicants download it from tcocertified.com/certification-documents.
For the default PCDC Tool, guidelines and films on how to complete the tool, go to: http://www.centerforsustainabilitysolutions.org/pcdctool.

Completing the Process Chemical Data Collection (PCDC) Tool

- The senior representative at the factory, whose responsibilities cover chemical management, must assist the applicant in the completion of the PCDC Tool.
- The areas that must be completed by the applicant are stated in the Requested Scope tab of the PCDC Tool that can be downloaded from tcocertified.com.
- In cases of proprietary, confidential business information of a CAS# number, the chemical supplier can directly submit this information to TCO Development. This must first be agreed upon by the applicant and TCO Development. If this information is not submitted, then the chemical ingredient must be treated as a restricted substance and the cleaning product must be replaced with an accepted alternative.
- The information must cover all cleaning solvents and their chemical ingredients used in the assembly of TCO Certified production lines.
- Upon request, the process chemical inventory at the factory must also be submitted for independent verification purposes.

- The PCDC Tool must be updated at the request of TCO Development.
- TCO Development has the right to compile confidential information with CAS numbers. TCO Development reserves the right to publish such compiled, anonymous information, but no information will be presented in such a way that the company or the products in question can be identified.

To verify compliance with this criterion, the completed PCDC Tool will be reviewed by TCO Development. The factory will be audited by independent assessment bodies.

Exposure controls and personal protective equipment (PPE)

TCO Certified Accepted Substance List reduces the risk of worker exposure to highly hazardous chemicals. However, safer alternatives do not remove the responsibility of the factory management to provide personal protection equipment as described in section 8 of the chemical safety data sheet (SDS), that covers exposure controls and personal protection. Verification of PPE (availability, training and use) is included in the factory audit requirement of mandate 2.1.

3 Environmentally responsible manufacturing

Environmental risks in the manufacturing phase

Of the wide range of environmental risks throughout the IT product life cycle, many of these occur in the manufacturing phase. For example, life cycle assessments confirm that a typical IT product consumes more energy during its manufacture than during its entire usable life. Other problems include the extensive use of natural resources required to manufacture IT products, along with resulting, soil, water and air pollution, and greenhouse gas emissions.

TCO Certified — focused on environmental management and energy efficiency in manufacturing

In chapter 3 of TCO Certified, generation 9, the criteria focus on two main areas designed to create a more environmentally responsible manufacturing environment in the final assembly factories of the certified product:

- Environmental Management System, EMS. With an environmental management system (EMS) in place in the final assembly factories of the certified product, the brand owner can work systematically to continuously improve the environmental performance of the product.
- Energy efficiency indicators - measurement of energy efficiency in the final assembly factories of the certified product.
- Energy management system
- Post-consumer recycled content and renewable materials
- Product carbon footprint

3.1 Environmental management system

Background
A certified environmental management system helps an organization work in a systematic way with environmental performance, and make continuous environmental improvements. To be efficient, an environmental management system must include independent, external reviews.

Definitions
Final assembly factory: A Final assembly factory is where the final assembly of the certified product is taking place and is defined as the whole operation covered by a business license, and thereby the employment agreements of the factory workers.

Applicability
All product categories.
The company or companies that manufacture the product.

References
3.1 and 3.2.

3.1.1 Mandate

Each final assembly factory manufacturing the certified product must be certified in accordance with ISO 14001.

Submit the following to an approved verifier:

- A copy of a valid ISO 14001 certificate for every final assembly factory manufacturing certified products.

Submit the following together with the application to TCO Development:

- A copy of a verification report from a verifier approved by TCO Development.

3.1.2 Clarification

The applicant must ensure that a valid ISO 14001 certificate is available on TCO Certified Portal at all times, for every final assembly factory manufacturing certified products.

The certificate(s) or an appendix to the certificate(s) must make it clear what the certification covers.

The applicant may ask for an extended time period of 12 months maximum on behalf of a factory that is not yet certified, by presenting a time plan for achieving the ISO 14001 certification and signing an agreement. TCO Development has the right to deny the applicant an extended period of time if there is a substantial risk that the factory will not be able to achieve ISO 14001 certification within the extended time period.

The certificate must be issued by a certification body that is accredited by an accreditation body covered by the International Accreditation Forum, iaf.nu, Multilateral Arrangement on Environmental Management Systems.

3.2 Energy efficiency indicators - REVISED

Background

While IT products become increasingly energy efficient in the use phase, there are still improvements to be made in the manufacturing phase. Life cycle assessments show that many IT products consume more energy during manufacturing than during the use phase.

Applicability

All product categories.

3.2.1 Mandate

Each final assembly factory which manufactures the certified product must report the previous calendar year energy efficiency indicators by the end of April each year. (This applies until the year after a certificate has expired.)

Submit the following to an approved verifier:

- A completed and signed factory form(s) (chapter 11.2)

Submit the following together with the application to TCO Development:

- A copy of the verification report(s) from a verifier approved by TCO Development.
- The energy efficiency indicators must be reported in TCO Certified Portal.

3.3 Energy management system - NEW

Background

A certified energy management system helps an organization work in a systematic way with energy performance, and make continuous improvement at both company and product levels. To be efficient, an energy management system must include independent, external reviews.

Definitions

Final assembly factory: Factory where the final assembly of the certified product takes place.

Applicability

All product categories

3.3.1 Mandate

Each final assembly factory manufacturing the certified product must be certified in accordance with ISO 50001

Submit the following to an approved verifier:

- A copy of a valid ISO 50001 certificate for every final assembly factory manufacturing certified products.

Submit the following together with the application to TCO Development:

- A copy of a verification report from a verifier approved by TCO Development

3.3.2 Clarification

The applicant must ensure that a valid ISO 50001 certificate is available on TCO Certified Portal at all times, for every final assembly factory manufacturing certified products. The certificate(s) or an appendix to the certificate(s) must make it clear what the certification covers. The applicant may ask for an extended time period of a maximum 18 months on behalf of a factory that is not yet certified or registered, by completing and signing an agreement. TCO Development has the right to deny the applicant an extended period of time if there is a substantial risk that the factory will not be able to achieve ISO 50001 certification within the extended time period. The certificate must be issued by a certification body that is accredited by an accreditation body covered by the International Accreditation Forum, iaf.nu, Multilateral Arrangement on Energy Management Systems

3.4 Post-consumer recycled content and renewable materials - NEW

Background

Use of recycled materials lowers the environmental impact. The manufacturing of recycled plastics can reduce the energy consumption up to 80 percent, compared to virgin plastics. Less raw materials are required to produce recycled plastics, which can lead to a reduced carbon footprint. Every metric ton of recycled plastic produced can result in up to 1-3 metric tons of carbon dioxide savings, compared to virgin plastics.

The long term goal is that all materials in certified products are circulated and renewable where technically possible.

Definition

PCR – Post-consumer recycled: Post-consumer recycled plastics are materials derived from used consumer products, often packaging, bottles, durable goods including IT-products. (aluminum cans, PET bottles)
PCM - "Pre-consumer Material": Material or by-products generated after the manufacture of a product is completed but before the product reaches the end-use consumer.
Recycled Content: means the total percentage of recovered material in a product, including pre-consumer and post-consumer materials.
Renewable materials: Materials that use only resources taking <50 years to be renewed. Renewable materials are those which can be manufactured or generated quickly enough to keep pace with how fast they are used up. Non-renewable materials, including materials for energy sources, are those which take a long time to renew and are generally used faster than they can be regenerated.

Applicability

All product categories.

3.4.1 Mandate

The brand owner must report the following information for the heaviest configuration of the certified product (including any external power supply):

- Percentage of post consumer recycled plastics by weight versus the total weight of all plastics.
- Percentage of identified post consumer recycled materials by weight versus the product weight
- Percentage of identified renewable materials by weight versus the sum of the product weight minus the post consumer content weight.

Submit the following to an approved verifier:

- A completed and signed product form (chapter 11.3).

Submit the following together with the application to TCO Development:

- A copy of the verification report(s) from a verifier approved by TCO Development.

3.4.2 Clarification

Only post consumer recycled content and renewable material where the weight is confirmed by documented proof as described below may be reported. If no proof exists then 0% must be reported. TCO Development has the right to require a full bill of material.

Exceptions plastics

Panels, electronic components, cables, connectors, PCBs, insulating mylar sheets and labels are exempted. These exclusions are due to a general lack of available alternative materials for use in these components in IT products. This also means that the weight of these items is not included when calculating the total weight of the plastic in the product in this requirement.

The following information must be reported in chapter 11.3

For each plastic part with a weight above 0.5g the following must be reported:

- The weight in grams

For each part with a weight above 0.5g and more than 0% post consumer recycled content or renewable material the following must be reported:

- The post consumer recycled plastics weight in grams
- The post consumer recycled content weight in grams
- The renewable material weight in grams

Clarification of sustainability performance indicator(s)

One or more “sustainability performance indicators” (chapter 1.3) are collected for this criterion. There is no mandatory level for these indicators but they must be verified and reported according to the description below.

3.5 Product carbon footprint - NEW

Background

Product Carbon Footprint (PCF) is one of the most established ways for determining the climate impact of a product. PCFs cover the whole life cycle of a product, from the raw material extraction to the recycling or disposal phase. Using product carbon footprints, enables an overall picture in order to work on reductions and measures in the right places.

The accuracy of PCFs can vary enormously based on the methodology and the age of the source data used. As it is very time consuming and costly to make accurate PCFs the majority of PCFs are based on very general and old source data. This results in large uncertainties making product comparisons useless.

Applicability

All product categories.

3.5.1 Mandate

The PCF methodology and age of source data must be classified and reported

Submit the following to an approved verifier:

- Necessary documentation for the PCF evaluation
- A completed and signed product form (11.3).

Submit the following together with the application to TCO Development:

- A copy of the PCF report and a verification report(s) from a verifier approved by TCO Development.
- The classification of the PCF method and age of source data must be reported in TCO Certified Portal.

3.5.2 Clarification

The PCF for the product is estimated based on product type data using either ISO 14067, ISO 14040, ISO 14044, IEC TR 6292, PAS 2050, the WRI GHG Protocol Product Life Cycle Accounting and Reporting Standard, PAIA-tool or equivalent PCF standard.

For Class A-D the product carbon footprint result must include the following:

1. Inputs used in the assessment (at a minimum, lifetime of product, amount of electricity consumed in the use phase by the product per year, and significant product model elements/parameters).
2. Total life cycle carbon footprint and carbon footprint of the product's life cycle stages (at a minimum manufacturing, use, transport and end-of-life).
3. Explanation of uncertainty, addressed either through a statistical assessment or through a disclaimer statement.

The PCF method

The accuracy of product carbon footprint results are determined by the type of method used and the data sourcers.

Class A

- The PCF for the product is based on a LCA report of the product model.
- The LCA consists of primary data sources only.

Class B

- The PCF for the product is based on a LCA report of the product model.

Class C

- The PCF for the product is based on the product model.

Class D

- The PCF for the product is based on the product model family.
    - **Example**
      Similar chassi appearance
      Same display size
      Similar functionality (e.g. headset with microphone,)

Class E

- No data available

Data age

The development of ICT products transpire in a rapid pace. Therefore the age of data is of high importance in order to make accurate PCF estimates.

Class A

- The data used to calculate the PCF is maximum 3 years old.

Class B

- The data used to calculate the PCF is maximum 6 years old.

Class C

- The data used to calculate the PCF is maximum 10 years old

Class D

- The data used to calculate the PCF is older than 10 years old.

or

- No data available

4 User health and safety

User health and safety — essential for IT product sustainability

An IT product must be safe to use and should provide the user with the function and comfort needed to support productivity.
Examples of identified safety risks that are relevant to IT products include:

- product overheating, leading to increased fire risk.
- battery volatility, burning or explosion.
- poor electrical safety design, that may give the user an electric shock or cause a fire.

In addition, an ergonomically designed IT product is better positioned to meet the user's needs longer and be a more sustainable product choice.

TCO Certified — verifying product safety, protecting the user

Chapter 4 in TCO Certified includes criteria for product and electrical safety as well as ergonomic design, and user health.

4.1 Electrical safety - REVISED

Background

IT products must be safe to use. Electrical safety refers to the electrical design of the product. Electrical insulation and other arrangements must be in place to prevent the user from touching live components. Faulty or inadequate electrical insulation can also result in an electrical flashover that may cause a fire or an explosion.

Applicability

All products with built-in power supplies as well as any external power supply intended to be used together with the product.

References

4.1.

4.1.1 Mandate

The product and external power supply/supplies must be certified according to EN/IEC 62368-1.

Submit the following to an approved verifier:

- A copy of a valid CB certificate or a national certificate from a CB member (NCB) for the product.

Submit the following together with the application to TCO Development:

- A copy of the verification report(s) from a verifier approved by TCO Development.

4.2 Alternating electric fields

Background

Electrical alternating fields are created between objects that have different levels of electrical potential that change over time. When the potential changes in a periodic manner, an electrical alternating field is set up, with a field strength and a frequency. An IT product can contain many sources of electrical alternating fields. The field characteristics depend on the actual electrical potential difference and the distance from the product.

Some users are concerned that electric alternating fields may be a health risk. The aim of this criteria is to reduce the electrical alternating fields to such a low level so as not to burden the work and home environment with unnecessary factors. The mandatory criteria should not be regarded as hygienic limit values.

Applicability

All displays and all-in-one PCs that are delivered with a stand.

4.2.1 Mandate

Band I: 5 Hz to 2 kHz, ≤ 10 V/m

Displays ≤ 26” are measured at 0.30 m and 0.50 m in front of the product.
Displays > 26” are measured at 0.50 m in front of the product.

Band II: 2 kHz to 400 kHz, ≤ 1.0 V/m

Displays ≤ 26” are measured at 0.30 m in front of- and 0.50 m around the product.
Displays > 26” are measured at 0.50 m from the surface around the product.

Submit the following together with the application to TCO Development:

A copy of the test report(s), and a copy of the verification report(s) from a verifier approved by TCO Development.

4.2.2 Clarification

Test facility requirements

Background electric field strengths in the test facility, including disturbances transmitted by power lines and internally generated noise in the measuring system, must together not exceed 2.0 V/m in band I and 0.20 V/m in band II. The mains voltage to the product must be within 3 % of its nominal value.

Preparation of the product for testing

All necessary preparations described in 9.1 and 9.3 must be done. An external optical filter may not be used in order to comply with the mandatory requirement.

Equipment

Alternating electric field meter.

Test method

Compliance may be verified in three ways.

1. Technical judgement

Several thousands of products have been tested for this mandate since 1992. It is now clear that for LCD displays the measured values are predictable and only in very rare cases exceed the mandated levels as long as the product is correctly grounded.

This testing is time consuming and currently offer limited value as it is almost certain that the product will pass as long as it's grounded. Therefore, the approved verifier may verify compliance based on technical judgement that the product is correctly grounded. The technical judgement template is signed by both the approved verifier and the applicant. If the product has an external power supply then the approved verifier must also verify that the ground is going through from the power plug to the secondary side of the powers supply.

2. Quick check

If the approved verifier finds that the technical judgement is not enough, a quick check may be made to verify if complete testing is necessary or not. The test object is placed on the turntable as described in the instructions for complete testing below. The measurement point should be 30 cm from the center center point in front of the product. An uncertainty of 5 cm is accepted in each direction x, y and z for this quick check which makes it acceptable to use visual positioning with a ruler. If the measured result is below 4.0 V/m in Band I and 0.4 V/m in Band II, the product can be considered to comply with the requirements in this mandate without further testing.

3. Complete testing

If the results from the quick check exceed the limits defined in the mandate, or if the approved verifier believes that the product may be non-compliant due to the product design or other reasons, then complete testing of the product must be carried out.

The true r.m.s.-value of the amplitude of the electric field strength, at the surface of the measuring probe, is measured in front of the product in band I and in four azimuths in band II. The frequency ranges are selected by means of filters in the measuring equipment.

Screens smaller or equal to 26”

The product must be positioned so that the tangential plane, to the centre-centre point of the screen surface, is at a right angle of the horizontal plane. The distance between the centre-centre points of the screen surface and the back of the product, including any part of a stand holder, along the normal to this tangential plane is called L, see figure ***alternating electric fields 1***.

The origin of the cylindrical coordinate system must be situated at a distance L/2 behind the screen surface on the normal to the tangential plane through the centre-centre point. The z-axis must be at a right angle to the horizontal plane. The angular reference direction is along the above mentioned normal in the direction pointing outwards from the screen. An angle (ϑ) is positive in the counterclockwise direction. The measurement instrument is moving in a counter-clockwise direction around the test sample (as illustrated in the figure ***alternating electric fields 1***).

Measurements must be made at all points that have a minimum clearance of 0.25 m to the outer surface of the product and with coordinates according to:
z = 0
r = (L/2 + 0.5) m (at the front also (L/2 + 0.3) m)
ϑ = 0 for band I
ϑ = 0, 90, 180 and 270 for band II
If clearance is less than 0.25 m, the instrument must be moved out radial until 0.25 m clearance is achieved.

Distances are given in metres and angles in degrees. The coordinates are given for the centre of the measuring probe. The surface of the probe must be perpendicular, within ± 5, to the radial axis.

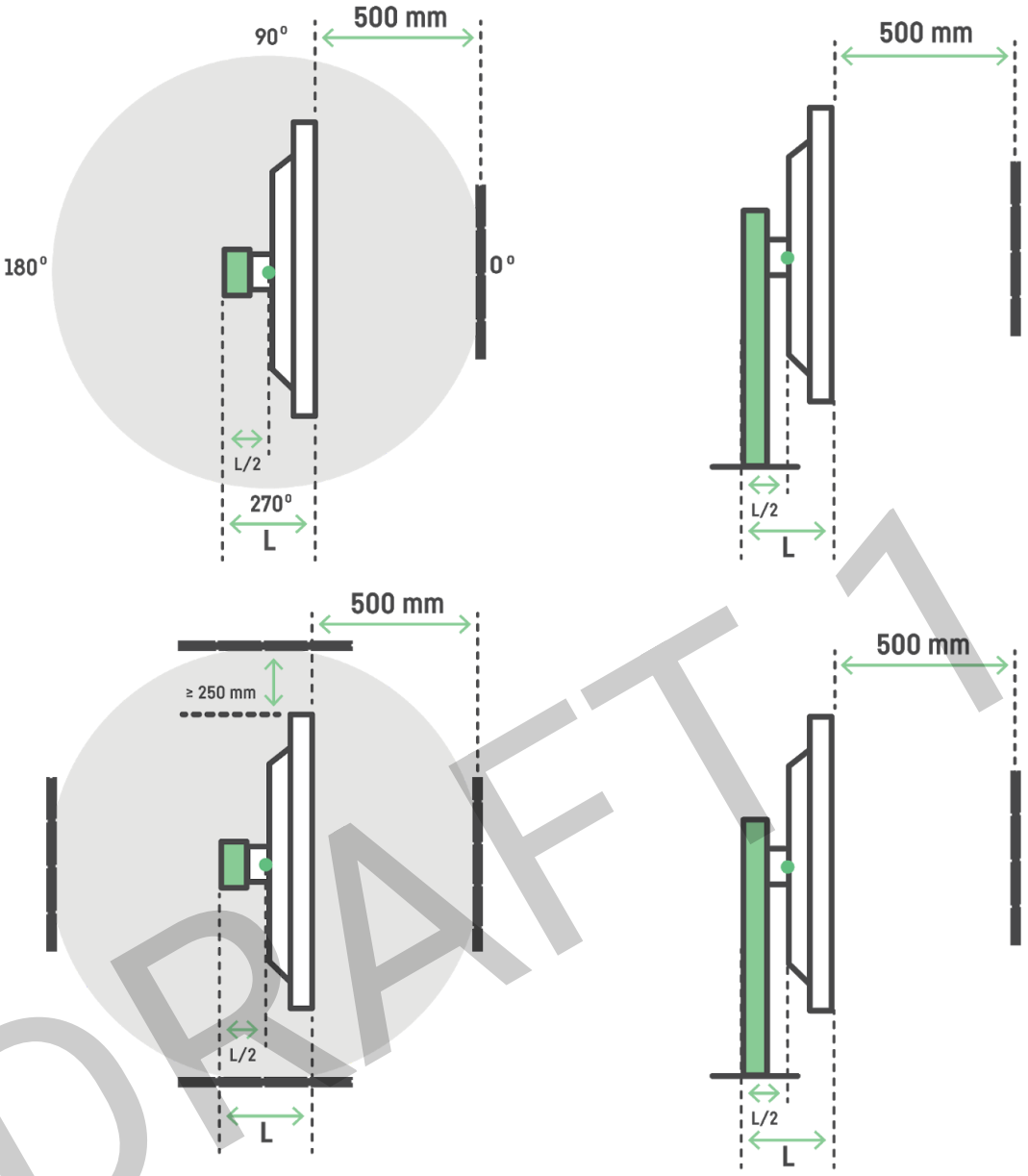


Figure *alternating electric fields 1*. Measurement geometry for band I (top) and band II (bottom).

Screens larger than 26”

For screens larger than 26”, measurements must be taken in four directions around the product at 0º, 90º, 180º, 270º. All measurements must be taken at 0.5 m from the surface of the product.

For products that have a width or height ≥1 m, additional measuring positions for front, rear and sides are required.
The width and height of the screen does not include the frame but only the viewable screen area. The number of positions depend on the size of the screen and is given in horizontal and vertical direction by the width and height in metres of the screen divided by 0.5 rounded to the

closest integer. The positions must be equally divided over the screen surface. See figure *alternating electric fields 2.*

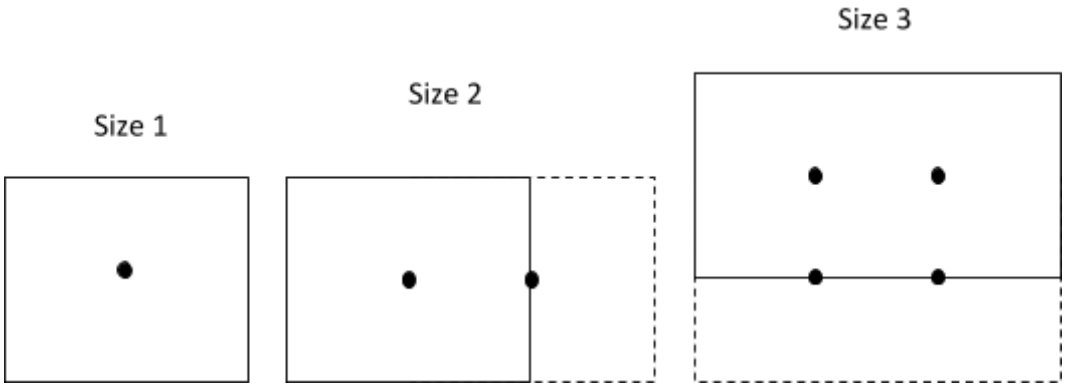


Figure *alternating electric fields 2*. Measurement point on different screen sizes. The dotted lines indicate a screen increase from size 1 by 0.5 m in width and then 0.5 m in height.

The product and the measuring probe must be positioned at least 1 m from all significant metallic structures and objects apart from the test object.

Additional units and connecting cables necessary for the operation of the product, that are not part of the test, must be placed so far away from the measuring setup that the fields they emit do not influence the measurement. Shielding may be added to these units and cables, as long as the 1 m clearance is maintained.

The measuring probe must be connected to ground. Any cables running between the measuring probe and the measuring instrument must be positioned in such a way that they do not influence the measured value.

The power cable of the test object must be connected to the phase and the neutral conductors of the mains power supply. If the mains power supply plug permits an interchange of the live and neutral conductors, measurements must be taken with the connection that gives the highest reading in band I.

Test evaluation

Results must be presented as r.m.s. values of the alternating electric field expressed in volt per meter (V/m). For band I, results must be presented as the measured values at 0.3 m and 0.5 m for normal and stand-by operations if they differ. For band II, the measured values in front of the product and the maximum value at rotation must be presented for normal and stand-by operations if they differ.

If the measured values are less than 10.0 V/m in band I or less than 1.0 V/m in band II the result must be reported as “< 10.0 V/m” or “<1.0 V/m”, respectively.

If measuring more than one position on the front, rear or sides of the screen the worst-case must be given in the report.

Overall uncertainty

The test must be performed in such a way that the total extended uncertainty in the test result will be less than ± (10 % of the reading + 1.5 V/m) for band I and ± (10 % of the reading + 0.1 V/m) for band II.

4.3 Alternating magnetic fields

Background

Alternating magnetic fields are created when an alternating electrical current flows through a conductor. IT products are surrounded by alternating magnetic fields that are generated by different parts of the product, e.g. power supply unit, voltage inverters and other electrical circuits. The field strength depends on the actual electric current and on the distance from the product.

Some users are concerned that alternating magnetic fields may be a health risk. The aim of this criteria is to reduce the magnetic alternating fields to such a low level as not to burden the work and home environment with unnecessary factors. The mandatory criteria must not be regarded as hygienic limit values.

Applicability

Displays and all-in-one PCs that are delivered with a stand.

4.3.1 Mandate

Band I: 5 Hz to 2 kHz, ≤ 200 nT

Displays ≤ 26” are measured at 0.30 m in front of, and at 0.50 m around the product.
Displays > 26” are measured at 0.50 m from the surface of the product around the product.

Band II: 2 kHz to 400 kHz, ≤ 25 nT

Displays ≤ 26” are measured at 0.50 m around the product.
Displays > 26” are measured at 0.50 m from the surface of the product around the product.

Submit the following together with the application to TCO Development:

A copy of the test report(s), and a copy of the verification report(s) from a verifier approved by TCO Development.

4.3.2 Clarification

Test facility requirements

Background magnetic fields in the test facility, including disturbances transmitted along the power line and internally generated noise in the measuring system, must together not exceed 40 nT in band I and 5 nT in band II.

Preparation of the product for testing

All necessary preparations described in 9.1 and 9.3 must be done.

Equipment

Alternating magnetic field meter in band I and band II.

Test method

Compliance may be verified in three ways.

1. Technical judgement

Several thousands of products have been tested for this mandate since 1992. it is now clear that for LCD displays the measured values are predictable and very rarely exceed background levels in the test chamber.

This testing is time consuming and currently offer limited value as it is almost certain the product will pass. Therefore, the approved verifier may verify compliance based on technical judgement that the product has a well known design that the lab has already tested several times. The technical judgement template is signed by both the approved verifier and the applicant.

2. Quick check

If the approved verifier finds that the technical judgement is not enough, a quick check may be made to verify if complete testing is necessary or not.
The test object is placed on the turntable as described in the instructions for complete testing below. The measurement point should be 30 cm from the center center point in front of the product. An uncertainty of 5 cm is accepted in each direction x, y and z for this quick check which makes it acceptable to use visual positioning with a ruler. One measurement is taken in this position. If the measured result are below 80 nT in Band I and 10 nT in Band II, the product can be considered to comply with the requirements in this mandate without further testing.

3. Complete testing

If the results from the quick check exceed the limits defined in the mandate, or if the approved verifier believes that the product may be non-compliant due to the product design or other reasons, then complete testing of the product must be carried out.

Screens smaller or equal to 26”

The true r.m.s. value of the amplitude of the magnetic flux density vector is measured at twelve points on a cylindrical surface around the test object in the two frequency ranges, band I and band II. The frequency ranges are selected by specified filters in the alternating magnetic field meter.

The measuring geometry is illustrated in figure ***alternating magnetic fields 1***. The measurement points are mathematically defined in the following way.

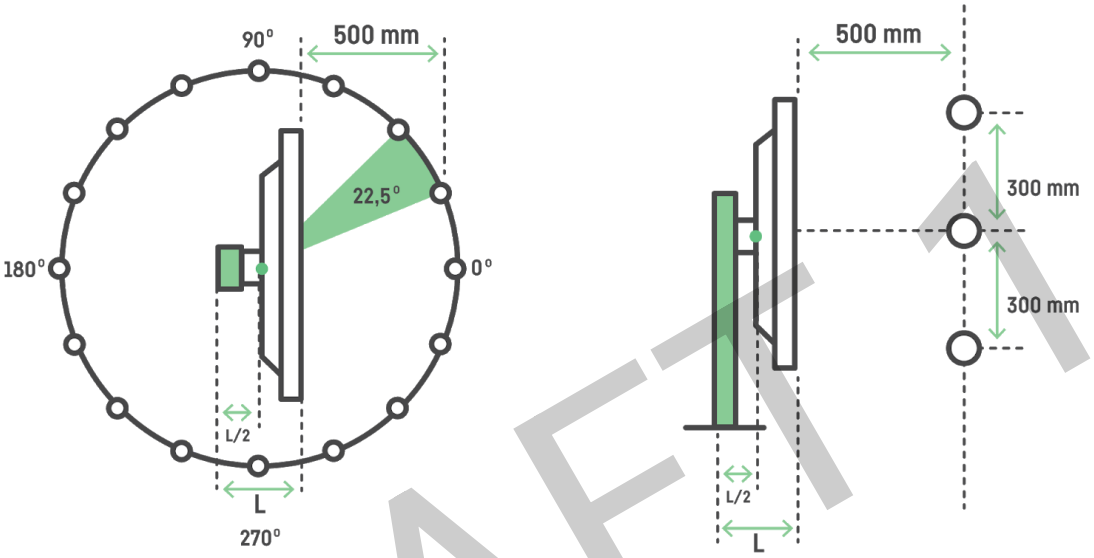


Figure alternating magnetic fields 1. Measurement geometry for the test object.

The product must be positioned so that the tangential plane, to the centre-centre point of the screen surface, is at a right angle of the horizontal plane. The distance between the centre-centre points of the screen surface and the back of the product, including any part of a stand holder, along the normal to this tangential plane is called L.

The origin of the cylindrical coordinate system must be situated at a distance L/2 behind the screen surface on the normal to the tangential plane through the centre-centre point. The z-axis must be at a right angle to the horizontal plane. The angular reference direction is along the above-mentioned normal in the direction pointing outwards from the screen. An angle (ϑ) is positive in the counterclockwise direction. The measurement instrument is moving in a counter-clockwise direction around the test sample (as illustrated in the figure ***alternating magnetic fields 1***). Measurements must be made at all points that have a minimum clearance of 0.25 m to the outer surface of the product and with coordinates according to:

z = - 0.3 m, z = 0 and z = + 0.3 m
r = (L / 2 + 0.5) m (at the front also (L / 2 + 0.3) m in band I)
ϑ= p 22.5° where p represents all integers in the range $1 \leq p \leq 15$.
In case of less than 0.25 m clearance the instrument must be moved out radial until 0.25 m clearance is achieved.

Screens larger than 26”

For screens larger than 26” measurements must be taken in four directions around the product at 0º, 90º, 180º, 270º. All measurements must be taken at 0.5 m from the surface of the product.

For products that have a width or height ≥1 m additional measuring positions for front, back and sides are required.

- The width and height of the screen does not include the frame but only the viewable screen area.
- The number of positions depend on the size of the screen and is given in horizontal and vertical direction by the width and height in cm of the screen divided by 0.5 rounded to the closest integer.
- The positions must be equally divided over the screen surface. See figure ***alternating electric fields 2***.
- Distances are given in metres and angles in degrees.
- The measuring coils must be stationary during the measurements.
- For display luminance settings – see chapter 9, General test conditions for emissions.
- The power cable of the test object must be connected to the phase and the neutral conductors of the mains power supply.
- The product does not need to be measured with the phase and neutral interchanged, as the magnetic fields are not influenced by such a change.

Test evaluation

Results must be presented as r.m.s. values of the magnetic flux density expressed in nanotesla (nT) for the two frequency bands. The values in front of the product and the maximum value and its position must be given both for normal and for standby operation if they differ. If measured values are less than 200 nT in band I or less than 10.0 nT in band II the result must be reported as “< 200 nT” or “< 10.0 nT” respectively.

Overall uncertainty

The test must be performed in such a way that the total extended uncertainty in the test result will be less than (10 % of the reading + 30 nT) for band I and (10 % of the reading + 1.5 nT) for band II.

Note

The uncertainties given are worst case limits. In many cases it will be possible to obtain better accuracy, especially in band II.

4.4 Acoustic noise

Background
Acoustic noise from fans, disk drives, etc. can be disturbing to users. Therefore, IT products should be as silent as possible during use. To make it possible for the user to choose a product with a comfortable noise level and frequency characteristics, this information should be reported.

To provide comparable information about acoustic noise levels, the reported A-weighted sound power level (LWAd) in operating and idling mode must be measured in accordance with ISO 7779:2010 and reported in accordance with ISO 9296 p.4.4.1 in bels (B). As these standards do not include any clear definition of operating and idling mode, the following definitions apply for these modes and for the reported sound values:

Definitions
Sound power level (L_W): Total emitted sound power from a sound source, given in bels (B) and with the reference 1 pW
A-weighting: The measured linear sound level (sound pressure or sound power) weighted against the sensitivity of the human ear for different frequencies (A-curve).
Reported A-weighted sound power level (L_{WAd}): in bels (B). Defined in accordance with ISO 9296 3.2.5.
Idling mode: A condition in which the system must be operated, at a load equal to or higher than “idling mode” for personal visual display units and terminals defined in defined in ECMA-74 (C.10.1).

Applicability
Displays with integrated moving parts.

References
4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.8

4.4.1 Mandate

1. The reported A-weighted sound power level (LWAd) must not exceed:

   Operating mode: 4.4B
   Idling mode: 3.9B

   If the product does not emit prominent discrete tones according to procedures specified in ECMA 74 Annex D, a higher reported A-weighted sound power level (LWAd) is accepted but must not exceed:

   Operating mode: 4.7B
   Idling mode: 4.2B

2. The A-weighted sound power level for a product must be reported in the product data sheet and/or in any other product descriptions.

Submit the following to an approved verifier:

- A copy of the test report(s) from a laboratory accredited according to ISO 17025.
- A completed and signed product form (chapter 11.3).

Submit the following together with the application to TCO Development:

1. A copy of the test report(s), and a copy of the verification report(s) from a verifier approved by TCO Development.

4.4.2 Clarification

The acoustic noise test must only be carried out if the product has any internal moving mechanical parts.This noise measurement is to be carried out at any test facility accredited according to ISO 17025, but the test report must be verified by a verification organization approved by TCO Development The verifier must sign a verification document for noise, covering all configurations.

The noise measurements must follow ISO 7779:2010 and must be reported according to ISO 9296:1988. (However, the principle for how the measurement uncertainty is handled must be the same as for all the other criteria in the certification. This means that no uncertainty must be added to the result presented in the report.)

In addition to reporting the measured A-weighted sound power level (L_{WA}) in Bels (B), the single measurement values of the 9 measurement positions and the mean value of these A-weighted sound pressure level (L_{pA}) in decibels (dB) must be included in the test report.

Overall uncertainty

The test must be performed in such a way that the total extended uncertainty in the test result will be less than ± 2.5dB.

Note

The uncertainties given are worst case limits. In many cases it will be possible to obtain better accuracy.

Workload ergonomics

Workload ergonomics refers to the adaptation of the tasks, tools, workspace and physical environment where the product will be used. These criteria are put in place in order to meet the user's needs for a good work environment.

Electronic devices are, just like furniture, lighting and other equipment, an important part of the modern workspace. TCO Development wants to contribute to the development of products that feature user characteristics based on the principles of good workload ergonomics. Ergonomic design enhances the possibility for users to be able to have high quality products that allow for physical variation.

It is important that products offer users the ability to vary their work posture. An aesthetically appealing design should not restrict ergonomic function.

Displays larger than 26" are not normally used in a typical workspace. They are also not considered to be easily movable on a normal display stand but are often placed on wall mounts. They are therefore excluded from the Workload ergonomics criteria. Some displays are sold without any kind of stand device. This can be in order to mount the display on walls or on a custom VESA compatible stand by the end user. Such displays are also excluded from Workload ergonomics criteria.

4.5 Vertical tilt

Background

It is beneficial to be able to tilt the display in the vertical plane. This creates the possibility to tilt the display back and achieve a 90 degree viewing angle. This offers the user the option of altering work posture for maximum comfort and also to obtain the best visual ergonomics of the product.

Applicability

Displays and all-in-.one PCs ≤ 26” that are delivered with a stand.

References

4.9-4.18.

4.5.1 Mandate

Displays ≤ 26” must allow a backward tilt of at least 20 degrees in the vertical plane.

Submit the following to an approved verifier:

1. A completed and signed product form (chapter 11.3).

Submit the following together with the application to TCO Development:

A copy of the verification report(s) from a verifier approved by TCO Development.

4.5.2 Clarification

It must be possible to tilt the display at least 20° backwards from an upright position (vertical plane) in at least one of the height positions.

The measurement of 20 degrees backwards tilt starts from the vertical plane (0 degrees). Some displays may have a starting position (minimal tilt) that is already tilted backwards, for example 5 degrees. If this is the case then it must be possible to tilt the display another 15 degrees to achieve the full 20 degree requirement. However, the starting position (minimal tilt) must not be more than 10 degrees backwards.

1° test tolerance is allowed. This is a tolerance for test set up and not for the test sample.

4.6 Vertical height

Background

For long-term display use, a straight or slightly downward viewing angle is important for maintaining good posture and visual comfort. The top of the active display area must not be positioned above the normal line of sight (0º - 15º below horizontal), so that users do not need to tilt the neck backwards to look at the display. This is even more important for users with bifocal or multifocal glasses who will be forced to tilt the head backwards if the display is positioned too high. A height adjustment function is recommended to allow the user to change position and achieve optimal visual ergonomics conditions.

Applicability

Displays and all-in-one PCs ≤ 26” that are delivered with a stand.

References

4.9-4.20.

4.6.1 Mandate

Displays ≤ 26” must meet at least one of the following mandates:

1. With the display aligned vertically in its lowest point of height adjustment, the distance measured from the underside of the display's foot (desktop surface) to the upper edge of the active screen area must be ≤ 42 cm.
2. The product must have a mounting interface applicable to the VESA mounting interface standard.

Submit the following to an approved verifier:

1. A completed and signed product form (chapter 11.3).

Submit the following together with the application to TCO Development:

A copy of the verification report(s) from a verifier approved by TCO Development.

4.6.2 Clarification

The height requirement level in mandate 1 is based on documented anthropometric data for the eye height variance for adults in the 2.5-97.5 percentile. The shortest distance between eye and work surface level is taken from the 2.5 percentile of adults. The distance is from the operator's elbow (work surface height) to eye level. With a maximum height measurement set for displays that cannot be height adjusted, these operators will avoid the need to extend the neck backwards when scanning the screen.

The height of the population in the US and Europe has been documented in the "humanscale"

- The 2.5 percentile of the population in these regions is 145 cm. According to the "humanscale" this gives an eye height of 42 cm from the table top surface.
- The height measurement must be taken with the display in normal (non-tilted) position standing directly on a flat surface and at the lowest point of height adjustment. The measurement must be taken from the table surface to the upper edge of the active screen area – see figure *vertical height 1.*

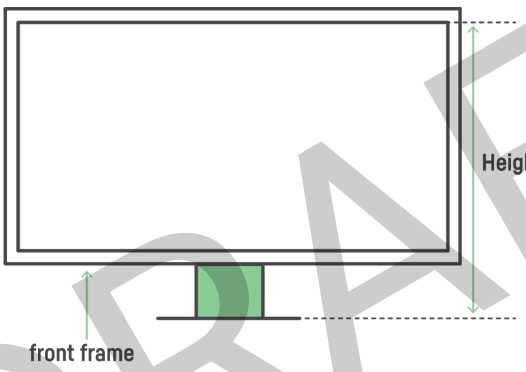


Figure vertical height 1.

5 Product performance

Product performance is vital for extended life and user productivity

Product performance is essential for user satisfaction and productivity. A well-performing product can also likely be used effectively for a longer period of time before being replaced. Products that maintain a high level of performance can also be valuable for re-use, further extending its usable life. Cost savings and reduced environmental impact are also viable outcomes.

To move toward greater sustainability, product performance factors must also be in balance with environmental effects. For example, high product performance should not be at the expense of energy efficiency, which is vital for reducing the climate impact of IT products.

A high performing product should also be comfortable to use. It may improve user productivity and reduce the risk of health and safety problems, such as eyestrain, headache and repetitive strain injuries.

TCO Certified — product performance for extended life and lower environmental impact

In chapter 5 of TCO Certified, generation 9, criteria for product performance are specific to each product category and focus on energy efficiency, display image quality, computer keyboard design as well as volume control and sound quality, where relevant.

5.1 Energy efficiency - REVISED

Background

The IT industry and people's IT usage are large sources of greenhouse gas emissions, which remain the leading factor in climate change. As the volume of IT equipment in use grows, greenhouse gas emissions are also increasing. Reducing the problem requires a number of measures, of which energy-efficient products are one part.

This criterion focuses on energy efficiency in the use phase and helps purchasing organizations independently verify that the IT product they source meets the energy efficiency requirements of ENERGY STAR.

Applicability

Displays.

References

5.1.

5.1.1 Mandate

The energy consumption and power supply requirements in version 8 of the ENERGY STAR® program for displays must be fulfilled.

Submit the following to an approved verifier:

- A copy of the test report(s) from a laboratory accredited according to ISO 17025.

Submit the following together with the application to TCO Development:

A copy of the test report(s), and a copy of the verification report(s) from a verifier approved by TCO Development.
The measured energy values must be reported in TCO Certified Portal

5.1.2 Clarification

The product must be tested according to version 8 (or a more recent version) of the ENERGY STAR program for computers. Testing is to be carried out at any test facility accredited according to ISO 17025, but the test report must be verified by a verification organization approved by TCO Development

The tests only need to cover the energy consumption requirements and the ~~external~~ power supply requirements of that program. The product does not need to be ENERGY STAR certified to be approved for TCO Certified.

Exceptions and special requirements

All exceptions and special requirements, test methods etc. that are accepted by ENERGY STAR are also accepted by TCO Development.

Products that are covered under other ENERGY STAR product specification must be tested under that specification.

Clarification of sustainability performance indicator(s)

In addition to the requirements in the mandate, "sustainability performance indicators" (chapter 1.3) must be reported. There is no mandatory level for these indicators but they must be verified and reported according to this description:

- Energy efficiency
  Measured energy consumption according to ENERGY STAR®, as well as Typical energy consumption (TEC), and the allowed maximum consumption (TEC_LIMIT) must be submitted to TCO Certified Portal, together with the application.
- The energy efficiency index of the product must be calculated in accordance with the Regulation on ecodesign for electronic displays (EU) 2019/2021 using the specified dynamic broadcast-content video signal in Annex 1, table 1.

Calculation for TEC_LIMIT with the use of EnergyStar variables

$$TEC\_LIMIT = (E_{TEC\_MAX} + E_{EP} + E_{AB} + E_{N} + E_{R} + E_{C} + E_{HDR} + E_{USB})\, x\, eff_{AC\_DC}$$

Visual ergonomics

Good visual ergonomics is a very important aspect of quality that can also have a direct effect on the health, comfort and productivity of the user. Good ergonomics, such as a high quality display image, can also influence our productivity and extend the usable life of a product. In this way, ergonomic design can also offer sustainability benefits.

In developing criteria for visual ergonomics, the possible health effects of various parameters have been taken into account. Other features that characterise high quality displays have also been in focus when developing these criteria.

TCO Development used three main methodologies to determine suitable levels and test methods for the visual ergonomics criteria:

1. Acceptable visual levels, as determined by scientific research.
2. Statistics from tests carried out in accordance with TCO Development, ISO, MPR regulations and from specialized VDU tests.
3. Manufacturers' knowledge and experience, which is invaluable. Manufacturers, consumer groups and other organisations with interests in the visual ergonomics field have contributed a great deal of valuable information and ideas throughout the development process.

5.2 Display resolution

Background

Image quality is negatively affected by a low fill factor, visible “jaggies” and poor rendering of details. All of these are related to the resolution of the display. For display resolution characteristics, it is important to take the viewing distance into account.

Definition

A pixel is the smallest addressable imaging element of the display panel capable of reproducing a full range of luminance and colors.

Applicability

Displays and all-in-one PCs.

References

5.3-5.5.

5.2.1 Mandate

The display panel should have a pixel density of at least 70 PPI.

Submit the following together with the application to TCO Development:

- A copy of the test report(s), and a copy of the verification report(s) from a verifier approved by TCO Development.
- The pixel density must be reported in TCO Certified Portal.

5.2.2 Clarification

The defined viewing distance in this criteria document is 80 cm, which can be regarded as a normal viewing distance to a typical display monitor on a desktop workspace, based on anthropometric data.

Preparations for testing

No specific preparation of the product is needed.

Equipment

Calibrated ruler for the diagonal measurement. Product manual or similar information about the display resolution.

Test method

The maximum resolution and size of the display panel can be found in the manual or in a similar information document from the manufacturer. Verify the diagonal distance in inches rounded to one decimal and calculate the PPI.

Test evaluation

The pixel density (PPI, pixels per inch) should be calculated as following:

$$PPI = \frac{\sqrt{horizontal\ pixels^2 + vertical\ pixels^2}}{the\ diagonal\ of\ the\ panel\ in\ inches}$$

Overall uncertainty

Measurement uncertainty in diagonal measurement is ≤±2mm. Product data information is sufficient.
See 9.1.10

5.3 Correlated color temperature

Background

Physical measurements of color stimuli can only give an indication of the color appearance in a practical situation. The color of the frame, the spectral composition of the lighting, the color of various areas in the visual field, and the complexity of brightness variations in the visual field all influence the color appearance of a display image.
It is important to be able to set a color temperature that represents average daylight. It will be intuitive to most users to have their document background and photo editing in this color temperature as this is a light source that users will be exposed to daily. Average atmospheric filtered daylight has a correlated color temperature of approximately 6500K and is reproduced by a number of standards ex. D65, sRGB, ITU rec 709 which are widely used in photo and video editing.

Definition

The correlated color temperature is a measure of the perceived screen color expressed in Kelvin (K).

Applicability

Displays and all-in-one PCs.

References

5.4, 5.5, 5.10, 5.19-5.22, 5.23, 5.26, 5.27, 5.30-5.33, 5.34-5.40.

5.3.1 Mandate

The product’s default preset correlated color temperature may have any name but must have a color difference $\Delta u'v' \leq 0.012$ when compared to CIE u' and v' chromaticity coordinates for D65.

Submit the following together with the application to TCO Development:

- A copy of the test report(s), and a copy of the verification report(s) from a verifier approved by TCO Development.
- The measured values must be reported in TCO Certified Portal.

5.3.2 Clarification

Preparations for testing

- All necessary preparations described in 9.1 and 9.2 must be done.
- A TCO Certified default test image, as shown in figure 9.1.7, must be used for this measurement.

Equipment

Spectro-radiometer capable of presenting CIE u' and v' chromaticity coordinates with at least three decimals.

Test method

The spectral properties at the centre of the measurement area must be measured with a spectroradiometer. The spectral data must then be processed, which is normally done directly in the instrument's microprocessor, to give chromaticity coordinates. In this case, the CIE coordinates u' and v' are needed for the test evaluation and are often presented directly by the spectro-radiometer used.

Test evaluation

CIE u'v' chromaticity coordinates for D65.

u'	v'
0,1979	0,4683

If the spectro-radiometer used only can produce CIE 1931 x and y chromaticity coordinates, these can be transformed to u' and v' chromaticity coordinates by using the formulae in the CIE Publication 15.2 mentioned above. The relevant CIE material – conversion formulae and tabulated data for u'_{CCT} and v'_{CCT} – can also be found on tcocertified.com.

The resulting color difference calculation must be presented to 3 decimal places.

Overall uncertainty

≤ ± 0.003 in u' and v'.
See 9.1.10

5.4 Color gamut

Background

Accurate color rendering is important when realistic color images or color presentations are presented on the display screen. Poor color rendering can lead to poor readability and misinterpretation.

Definition

The color characteristics of a display are based on the visual appearance of the primary color stimuli of the display, the R, G, B-stimuli. The color gamut of a device or process is that portion of the color space that can be represented or reproduced.

Applicability

Displays and all-in-one PCs.

References

5.5, 5.19-5.23, 5.26, 5.27, 5.30-5.34, 5.37-5.40.

5.4.1 Mandate

The following mandates must be met:

1. The minimum color triangle must be ≥ 29%.
2. The following tolerances to the sRGB coordinates:

	Red		Green		Blue	
Coordinate	u'	v'	u'	v'	u'	v'
Requirement	≥ 0.411	≥ 0.503	≤ 0.140	≥ 0.548	≥ 0.150	≤ 0.210

Submit the following together with the application to TCO Development:

1. A copy of the test report(s), and a copy of the verification report(s) from a verifier approved by TCO Development.
2. The measured values must be reported in TCO Certified Portal.

5.4.2 Clarification

The u' and v' chromaticity coordinates of the primary colors red (R), green (G) and blue (B) of the screen must aim at values given in international IEC, EBU and ITU standards. The u' and v' chromaticity coordinates of the primary colors R, G and B form a triangle in the CIE 1976 uniform chromaticity scale diagram. The larger the area of the triangle, the more saturated and the wider the range of colors the screen is capable of presenting if the same numbers of color bits are used. The relative color gamut calculation in this document is expressed as a percentage of the total CIE 1976 uniform chromaticity scale diagram. However, it is also important that the u´ and v´ for red, green and blue are accurate enough to present as true colors as possible.

Preparations for testing

- All necessary preparations described in 9.1 and 9.2 must be done.
- A TCO Certified default test image, as shown in figure 9.1.7, must be used for this measurement.
- The measurement area must have each of the following RGB settings: (255, 0, 0) for red, (0, 255, 0) for green, (0, 0, 255) for blue.

Equipment

Spectroradiometer with a capacity to present u' and v' coordinates with at least 3 decimals.

Test method

The instrument must be directed orthogonally towards the different test square centers at the measurement distance described in 9.2.5. Measure the chromaticity coordinates at the center of the measurement area for each color setting specified above, or alternatively, the larger measurement area image (80% of the active screen area) described in 9.1.7 may be used for these measurements. Change the color of the area for each measurement.

Reference color coordinates are based on sRGB: Red (u' 0.451,v'0.523), Green (u'0.125,v' 0.563), Blue (u'0.175,v'0.158) which corresponds to 33.3% of the total CIE 1976 uniform chromaticity scale diagram (100% sRGB and 87% Adobe RGB).

Test evaluation

Mandate 1

Calculate the color gamut using the equation below.
A (%) = 256.1 x |(u´R - u´B)(v´G - v´B) - (u´G - u´B)(v´R - v´B)|
The indexes R, G and B are short for Red, Green and Blue.
Example: The following reading gives a gamut of A = 31.65%
Red u'/v' = 0,436/0,526
Green u'/v' = 0,132/0,572
Blue u'/v' = 0,181/0,158

Mandate 2

The recorded chromaticity coordinates u´ and v´ for the Red, Green and Blue squares must be reported. The u' and v' must be presented to 3 decimal places.

Overall uncertainty

≤ ± 0.003 in u' and v' for red and green.
≤ ± 0.007 in u' and v' for blue.
See 9.1.10

5.5 Color uniformity

Background

The human visual system is very sensitive to changes in color hue in white and gray areas. White and gray color hues also serve as reference colors on the screen, that affect how all other colors are perceived. Patches of color variation on an active white or gray screen may reduce the contrast, be disturbing and affect readability, color rendering and color differentiation.

Definition

The color uniformity of a display is the capability to maintain the same color on any part of the screen.

Applicability

Displays and all-in-one PCs.

References

5.4, 5.5, 5.18, 5.23, 5.26, 5.27, 5.28, 5.29, 5.34, 5.40.

5.5.1 Mandate

The maximum color deviation between measured active areas on the screen that are intended to present the same color must be $\Delta u'v' \leq 0.012$.

Submit the following together with the application to TCO Development:

1. A copy of the test report(s), and a copy of the verification report(s) from a verifier approved by TCO Development.
2. The measured values must be reported in TCO Certified Portal.

5.5.2 Clarification

Preparations for testing

- All necessary preparations described in 9.1 and 9.2 must be done.
- The entire active area of the screen must be white and the display color setting must be RGB 255, 255, 255.

Equipment

Spectroradiometer with a capacity to present u' and v' coordinates with at least 3 decimals.

Test method

The color uniformity must be measured orthogonally to the display screen plane at nine points. The four corner positions (1, 3, 7 and 9) are measured 1º from the edges of the screen as shown in *luminance uniformity 1*. The 4 side positions (2, 4, 6 and 8) are measured on the middle of the side 1º from the edge. These measurement points have a 1/2º margin to the

edges if the measurement area of the instrument is 1º (see figure *luminance uniformity 1*). Finally, the center position (5) is measured.
In addition to the nine default positions, the color uniformity must also be evaluated visually by the technician in order to find areas where the color varies the most. If a significant difference within the 1º from the edge area is found, these measuring points must also be measured and used to evaluate the color uniformity. The conditions for color measurement in the corner positions and the distribution of other measurement points are illustrated in figure *luminance uniformity 1.*

Test evaluation

Δu'v' according to the CIE (1976) uniform chromaticity scale diagram must be calculated for each measured position using the formula:

$$\Delta u'v' = \sqrt{(u'_A - u'_B)^2 + (v'_A - v'_B)^2}$$

where A and B are the two points found to have the largest color difference between them.
The largest difference in u'v' value must be reported.
The result must be presented to 3 decimal places.
The evaluation procedure is exemplified below:

- Make a table of color chromaticity values for each measured position.

Measurement position no.	u [1]	v [1]
1	0.190	0.447
2	0.186	0.441
3	0.186	0.437
-	-	-
n-1	0.185	0.434
n	0.186	0.432
Largest difference	0.005 in this example	0.015 in this example

- The largest u' difference, Δu', is 0.005 (between 0.190 and 0.185) at measurement positions 1 and n-1.
- The largest v' difference, Δv', is 0.015 (between 0.447 and 0.432) at measurement positions 1 and n.
- Since Δv' (= 0.015) is much larger than Δu' (= 0.005), the Δv' value must be used for the calculation of Δu'v'.
- The corresponding two pairs of u' and v' to be used for the calculation are thus the values found at position 1 and position n and thus become the values used for points A and B such that $u'_1 = u'_A = 0.190$ and $v'_1 = v'_A = 0.447$ for point A in this example and $u'_n = u'_B = 0.186$ and $v'_n = v'_B = 0.432$ for point B in this example.

  Hence $\Delta u'v' = \sqrt{0.000016 + 0.000225} = 0.01552$, which must be reported as 0.016.

Overall uncertainty
≤ ± 0.003 in u' and v'.
See 9.1.10

5.6 Color uniformity – angular dependence

Background

The human visual system is very sensitive to changes in color hue in white and gray areas. White and gray color hues also serve as reference colors on the screen, that affect how all other colors are perceived. Angular-dependent color variations on an active white or gray screen may be disturbing and affect readability, color rendering and color differentiation.

Definition

The white color uniformity – angular dependence of a display is the capability of the display to maintain constant white color over the screen surface depending of the direction from which the screen is viewed.

Applicability

Displays and all-in-one PCs.

References

5.4, 5.18, 5.23, 5.26-5.29, 5.34.

5.6.1 Mandate

In landscape mode, the Δu'v' of white color between areas on the left side and the right side of the screen when it is positioned at +30° and at -30° horizontally to the screen normal (rotated around the vertical axis through the center of the screen). must be Δu'v' ≤ 0.024.

Submit the following together with the application to TCO Development:

- A copy of the test report(s), and a copy of the verification report(s) from a verifier approved by TCO Development.
- The measured value must be reported in TCO Certified Portal.

5.6.2 Clarification

Preparations for testing

- All necessary preparations described in 9.1 and 9.2 must be done.
- The screen background must be RGB 102,102,102.
- Chromaticity coordinates u' and v' must be measured at three different positions on the screen as shown in figure *color uniformity - angular dependence 1*. Each measurement position must consist of white RGB 255, 255, 255 areas with a size that is 4% of the active screen size.
- The spectro-radiometer must be positioned and directed orthogonally to the screen center-point as described in 9.2.5.

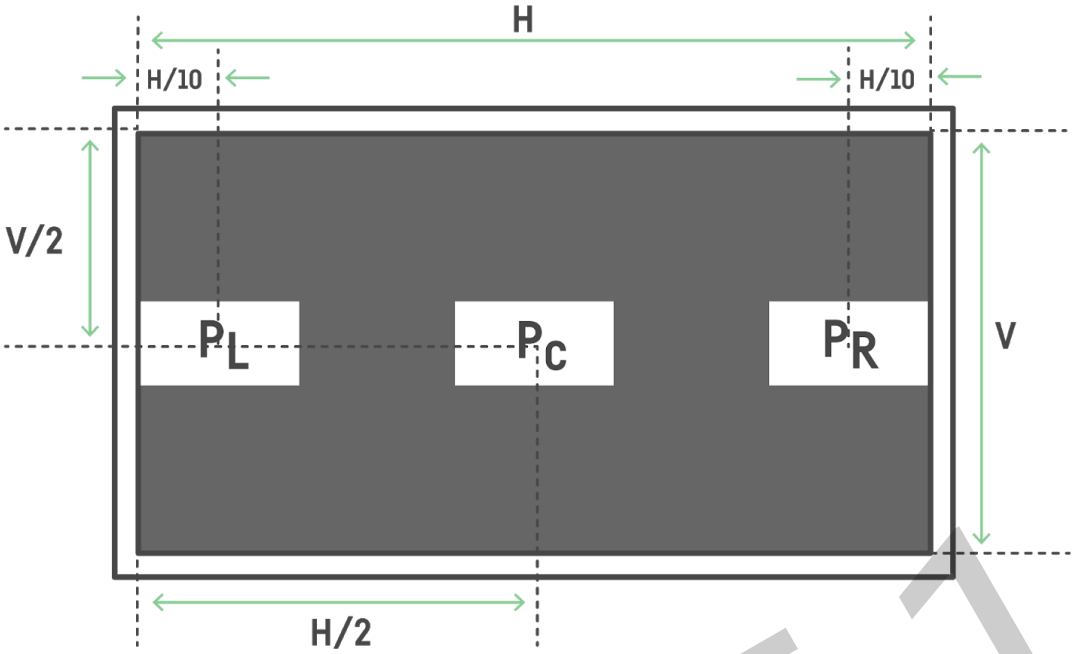


Figure *color uniformity - angular dependence 1*. Measurement positions for color uniformity-angular dependence.

Equipment

Spectroradiometer with a capacity to present u' and v' coordinates with at least 3 decimals.

Test method

- The spectro-radiometer must always be directed towards a measurement point and rotated around a fixed vertical axis, (or horizontal axis for the tilt measurement) through the focal point of the front lens from the distance described in 9.2.5.
- The spectro-radiometer must be turned towards positions P_L and P_R and focused. The color coordinates at positions P_L and P_R ($u'_{PL/0}$, $v'_{PL/0}$ and $u'_{PR/0}$, $v'_{PR/0}$ respectively) must be recorded.
- The screen must then be rotated +30 degrees around a vertical axis through the screen's center-point and the chromaticity coordinates at positions P_L, P_R, ($u'_{PL/+30}$, $v'_{PL/+30}$ and $u'_{PR/+30}$, $v'_{PR/+30}$ respectively) must be recorded.
- The screen must finally be rotated -30 degrees around a vertical axis through the screen's center-point and the chromaticity coordinates at positions P_L, P_R, ($u'_{PL/-30}$, $v'_{PL/-30}$ and $u'_{PR/-30}$, $v'_{PR/-30}$ respectively) must be recorded.
- Pivot screens must only be measured in the usual landscape mode.

Test evaluation

$\Delta u'v'$ according to the CIE (1976) uniform chromaticity scale diagram must be calculated for each measured position using the formula:

$$\Delta u'v' = \sqrt{(u'_A - u'_B)^2 + (v'_A - v'_B)^2}$$

where A and B are the two points found to have the largest color difference between them. The largest difference in u'v' value must be reported

The result must be presented to 3 decimal places.
The evaluation procedure is exemplified below:

- Make a table of chromaticity values for each measurement position and calculate Δu'v' for +30° for and -30°.

Measurement position no.	**Example value u'**	**Example value v'**
PL /+30	0.190	0.447
PR /+30	0.187	0.442
Difference at +30º	0.003	0.005
Δu' v' at +30º	0.0059	
Measurement position no.	**Example value u'**	**Example value v'**
PL /-30	0.182	0.436
PR /-30	0.189	0.432
Difference at -30º	0.007	0.004
Δu' v' at -30º	0.0081	
Largest difference Δu'v'	0.0081 in this example	

The largest calculated Δu'v' difference is 0.0081 when the screen is rotated -30°. The test value to be reported is this value, reported to 3 decimal places, thus 0.008.

Overall uncertainty

≤ ± 10% in luminance.
≤ ± 0.003 units for u' and v'.
≤ ± 0.3° in rotation angle.
See 9.1.10

5.7 Color grayscale linearity

Background

A well-tuned color grayscale is the basis for good color rendering of the screen. This is measured by comparing steps in a grayscale on the screen. To enable correct color interpretation, each grayscale step should have similar color hues. To avoid confusion for the user, only the luminance should vary.

Definition

Color grayscale linearity is the capability of the screen to maintain the same u',v' coordinates of a grayscale pattern at all grayscale levels. Only the luminance should change from one grayscale step to the next.

Applicability

Displays and all-in-one PCs.

References

5.4, 5.6, 5.18, 5.23, 5.26-5.29.

5.7.1 Mandate

$\Delta u'v' \leq 0.020$ between 28 evenly distributed grayscale levels combinations.

Table *color grayscale linearity 1*

	Maximum u´v´difference							
Grayscale	255	225	195	165	135	105	75	45
255	0							
225	**0.020**	0						
195	**0.020**	**0.020**	0					
165	**0.020**	**0.020**	**0.020**	0				
135	**0.020**	**0.020**	**0.020**	**0.020**	0			
105	**0.020**	**0.020**	**0.020**	**0.020**	**0.020**	0		
75	**0.020**	**0.020**	**0.020**	**0.020**	**0.020**	**0.020**	0	
45	**0.020**	**0.020**	**0.020**	**0.020**	**0.020**	**0.020**	**0.020**	0

Submit the following together with the application to TCO Development:

1. A copy of the test report(s), and a copy of the verification report(s) from a verifier approved by TCO Development.
2. The largest $\Delta u'v'$ measurement must be reported in TCO Certified Portal.

5.7.2 Clarification

Preparations for testing

- All necessary preparations described in 9.1 and 9.2 must be done.
- A TCO Certified default test image, as shown in figure 9.1.7, must be used for this measurement.
- The measurement area must have a size that is 4% of the active screen size and have the following RGB settings: R=G=B= 255, 225, 195, 165, 135, 105, 75, 45.

Equipment

Spectroradiometer with a capacity to present u' and v' coordinates with at least 3 decimals.

Test method

The instrument must be directed orthogonally towards the center of the measurement area, from the distance described in 9.2.5. Measure the chromaticity coordinates at the center of the measurement area for each grayscale step specified above. Change the grayscale of the area for each measurement.

Test evaluation

A spreadsheet is available on tcocertified.com, which will calculate the Δ u' v' differences between all the grayscale levels according to the equation:

$$\Delta u'v' = \sqrt{(u'_A - u'_B)^2 + (v'_A - v'_B)^2}$$

Fill in the chromaticity values of u' and v' for each measured grayscale step into the corresponding cells of the spreadsheet.

Overall uncertainty

≤ ± 10% in luminance.
≤ ± 0.003 units for u' and v'.
See 9.1.10

5.8 Luminance level

Background

Poor screen luminance can lead to low contrast, poor readability and color discrimination, which may cause misinterpretations and eye strain. Therefore, it is important that the luminance levels can be set both high and low enough, with respect to the ambient lighting.

Definition

Luminance being emitted from a particular area is a measure of the luminous intensity per unit area of light travelling in a given direction and falls within a given solid angle.
The unit of luminance is candela per square meter (cd/m^2)

Applicability

Displays and all-in one PCs.

References

5.3-5.5, 5.7-5.11.

5.8.1 Mandate

The following conditions must be fulfilled:

- The luminance at default setting must be ≥ 150 cd/m^2
- The maximum luminance must be ≥ 200 cd/m^2
- The minimum luminance must be ≤ 100 cd/m^2

Submit the following together with the application to TCO Development:

- A copy of the test report(s), and a copy of the verification report(s) from a verifier approved by TCO Development.
- The maximum and minimum luminance must be reported in TCO Certified Portal

5.8.2 Clarification

Preparations for testing

- All necessary preparations described in 9.1 and 9.2 must be done.
- The TCO Certified default test image with an 18 step grayscale as shown in figure *Luminance level 1* must be used for luminance level measurement.

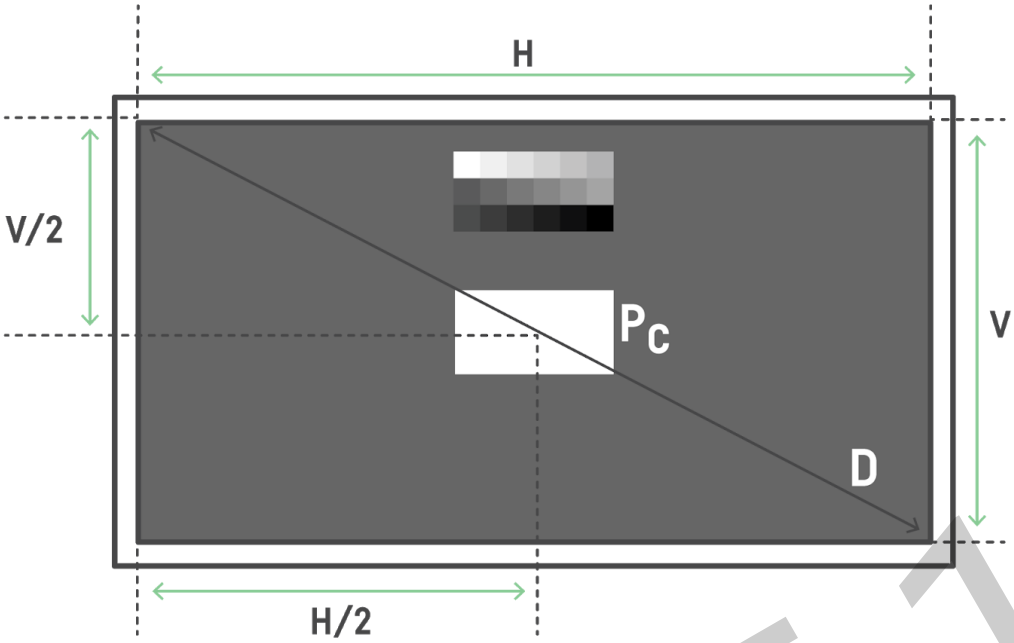


Figure ***Luminance level 1***. TCO Certified default test image with the 18-step grayscale inserted.

- The measurement position P_C must be at the center of the measurement area without line borders, have an RGB setting of 255, 255, 255, and be positioned at the center of the screen. The background must be RGB 102,102,102.
- Reset the display to its default setting. Check that the luminance is ≥ 150 cd/m^2.

The following evaluations must be carried out orthogonally to the screen surface.

- To achieve the maximum luminance, proceed as follows:
  Use the TCO Certified default test image with an 18 step grayscale pattern presented on the screen. From the default setting, adjust the controls on the display to achieve as high luminance as possible with an acceptable image quality. The image quality is considered acceptable if at least 15 of the 18 grayscale steps are visible. Check that the display has a luminance of ≥ 200 cd/m^2.
- Reset the display to its default setting. From the default setting, adjust the controls on the display to achieve as low luminance as possible with an acceptable image quality. The image quality is considered acceptable if at least 15 of the 18 grayscale steps are visible. Check that the display has a luminance of ≤ 100 cd/m^2.
- If it difficult to visually determine if 15 of the 18 grayscale steps are visible, then the display must conform with the ***grayscale gamma curve*** criteria in the max and min luminance setting.
- After this test is completed the display must be put back in its default mode by pressing a reset button or similar. After each reset, the display has to stabilize before other test measurements are made.

Equipment

Luminance meter or spectroradiometer.

Test method
The luminance at the center of the white measurement area must be measured with the luminance meter directed orthogonally to the measurement area as described in 9.2.5.

Test evaluation
The measured luminance is the required value. The luminance must be reported with no decimal places.

The measured luminance, contrast and brightness settings for all conditions must be noted in the test report. The preset CCT in default setting must also be noted.

Overall uncertainty
≤ ± 10 % in luminance.
See 9.1.10

5.9 Luminance uniformity

Background
Poor luminance uniformity can locally affect the contrast and consequently the readability of information on the display. The areas of deviating luminance can have different sizes and cause varying contour sharpness.

Definition
Luminance uniformity is the capacity of the display to maintain the same white luminance level over the whole active screen area. The luminance uniformity is defined as the ratio of maximum to minimum luminance within the fully active screen area.

Applicability
Displays and all-in-one PCs.

References
5.3-5.10, 5.12-5.15.

5.9.1 Mandate

Luminance variation across the active screen, L_{max} : L_{min} must be ≤ 1.50.

Submit the following together with the application to TCO Development:

- A copy of the test report(s), and a copy of the verification report(s) from a verifier approved by TCO Development.
- The Luminance variation must be reported in TCO Certified Portal

5.9.2 Clarification

Preparations for testing

- All necessary preparations described in 9.1 and 9.2 must be done.
- The entire active area of the screen must be white and the display color setting must be RGB 255, 255, 255.

Equipment
Luminance meter or spectroradiometer.

Test method
The luminance must be measured orthogonally to the display screen plane at nine points. The four corner positions (1, 3, 7 and 9) are measured 1º from the edges of the screen as shown in figure ***luminance uniformity 1***. The four side positions (2, 4, 6 and 8) are measured on the middle of the side, 1º from the edge. Finally, the center position (5) is measured. This means that all measurement points have 1/2º marginal to the edges if the measurement area of the instrument is 1º.

The luminance uniformity must also be evaluated visually by the technician in order to find any dark or bright areas outside of the nine default positions. If a significantly bright or dark area is found, these measuring points must also be measured and used to evaluate the luminance uniformity.

The conditions for luminance measurement in the corner positions and the distribution of other measurement points are illustrated in figure *luminance uniformity 1*.

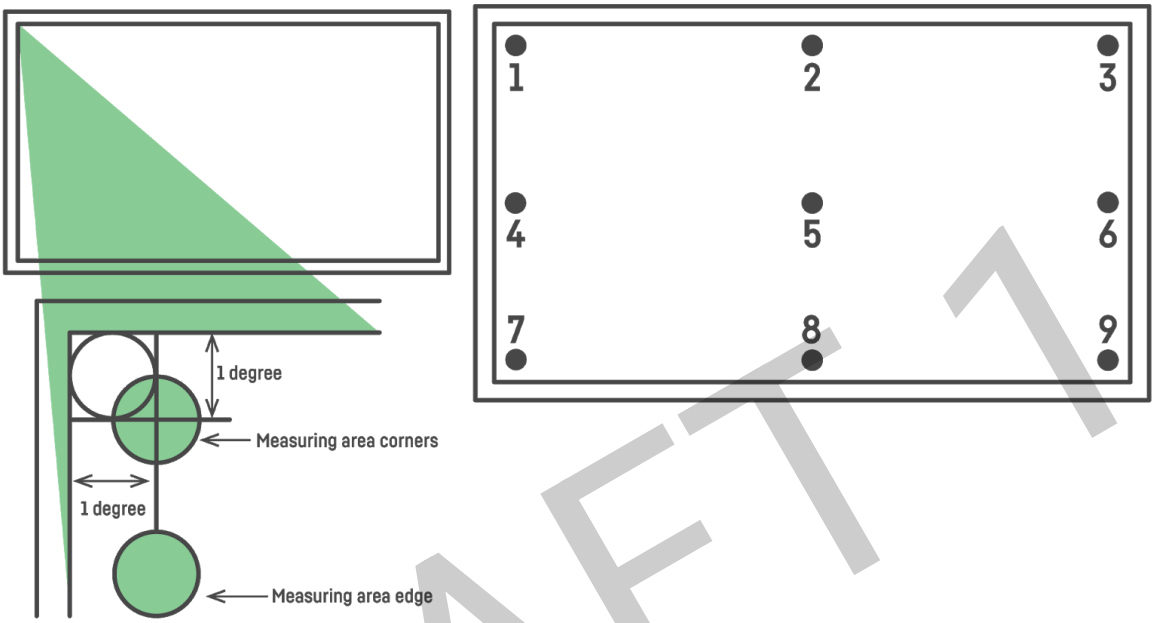


Figure *luminance uniformity 1* Measurement positions for the measurement of luminance and color uniformity.

Test evaluation

The luminance uniformity must be reported as the ratio between the highest and the lowest measured luminance values. The result must be presented to 2 decimal places.

Overall uncertainty

≤ ± 10 % in luminance.
≤ ± 0.1 unit in luminance uniformity.
See 9.1.10

5.10 Luminance uniformity — angular-dependence

Background

The luminance of a display may be angular-dependent which means that screen luminance decreases when the display is viewed slightly from the side, either horizontally or vertically. This can have a negative effect on contrast and can affect the readability of the display.

Definition

Luminance uniformity – angular dependence, is the capacity of the display to maintain a certain luminance level irrespective of the viewing direction. The angular-dependent luminance uniformity is defined as the ratio of maximum luminance to minimum luminance in the specified measurement areas.

Applicability

Displays and all-in-one PCs.

References

5.7, 5.10-5.15.

5.10.1 Mandate

1. In landscape mode, when the screen is rotated around the vertical axis through the center of the screen the mean value of the L_{max} to L_{min} ratios at ±30° must be ≤ 1.73.
2. In landscape mode, when the screen is rotated around the horizontal axis through the center of the screen, the largest value of the L_{max} to L_{min} ratios at ±15° must be ≤ 1.73.

Submit the following together with the application to TCO Development:

- A copy of the test report(s), and a copy of the verification report(s) from a verifier approved by TCO Development.

5.10.2 Clarification

Preparations for testing

- All necessary preparations described in 9.1 and 9.2 must be done.
- Luminance values must be measured at five different positions on the screen as shown in figure ***luminance uniformity - angular-dependence*** 1. Each measurement position must present white RGB 255, 255, 255 measurement areas (4% of the active screen size) without line borders.
- The background must be RGB 102,102,102.
- The luminance meter must be positioned and directed orthogonally to the screen center-point as described in 9.2.5

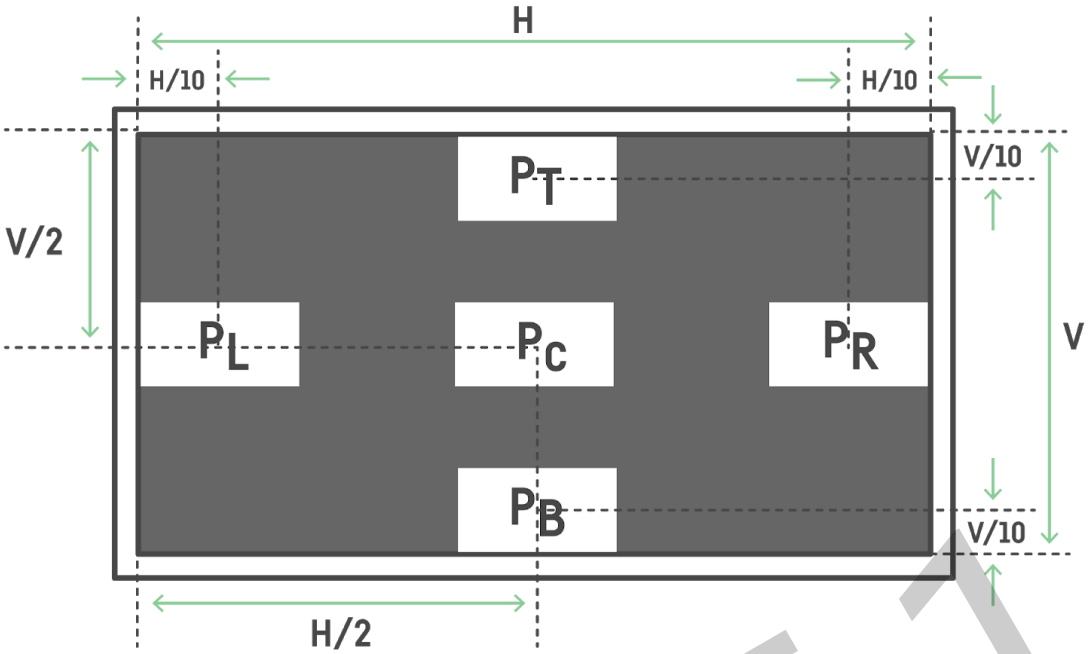


Figure: ***luminance uniformity - angular-dependence 1***. Measurement positions for luminance uniformity - angular dependence.

Equipment

Luminance meter.

Test method (steps)

1. The luminance meter must always be directed towards a measurement point and rotated around a fixed vertical axis, (or horizontal axis for the tilt measurement) through the focal point of its front lens with a distance as described in 9.2.5.
2. In landscape mode the display must be rotated +30 degrees around a vertical axis through the display-glass center-point and the luminance at positions P_L and P_R, ($L_{PL/+30/0}$ and $L_{PR/+30/0}$ respectively) must be recorded. See figure ***luminance uniformity - angular-dependence 2***.
3. In landscape mode the display must then be rotated -30 degrees around the vertical axis through the display-glass center-point and the luminance at positions P_L and P_R ($L_{PL/-30/0}$ and $L_{PR/-30/0}$ respectively) must be recorded. See figure ***luminance uniformity - angular-dependence 2***.
4. In landscape mode the display must then be tilted +15 degrees backwards around a horizontal axis through the display-glass center-point and the luminance at positions P_T and P_B ($L_{PT/0/+15}$ and $L_{PB/0/+15}$ respectively) must be recorded. See figure ***luminance uniformity - angular-dependence 3.***
5. In landscape mode the display must then be tilted -15 degrees forwards around a horizontal axis through the display-glass center-point and the luminance at positions P_T and P_B ($L_{PT/0/-15}$ and $L_{PB/0/-15}$ respectively) must be recorded. See figure ***luminance uniformity - angular-dependence 3.***

6. The measurements to be carried out are summarized in table *luminance uniformity - angular-dependence 4*. The steps numbers in the step column correspond with the test method paragraphs.

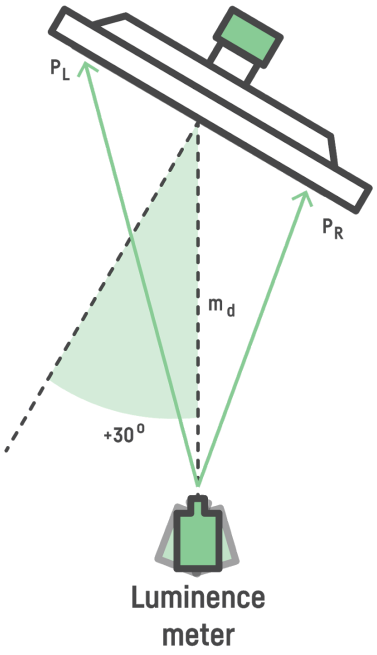


Figure *luminance uniformity - angular-dependence 2.* Top view of test set-up when the display is rotated ±30 degrees. The + rotation is defined clockwise.

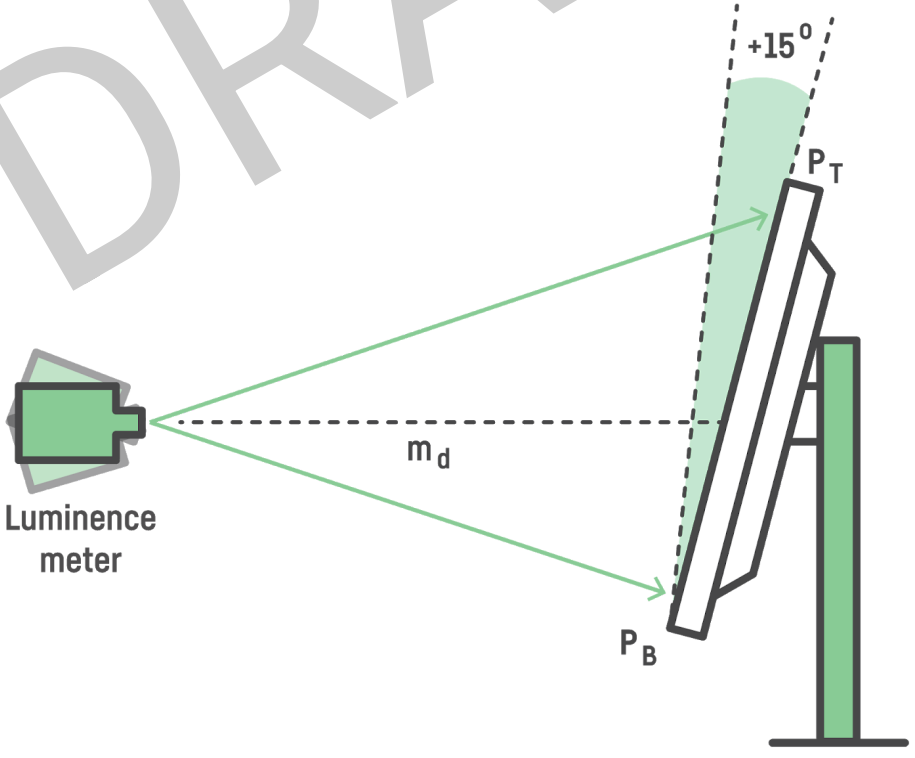


Figure ***luminance uniformity - angular-dependence 3.*** Side view of the test set-up when the display is tilted ±15°. The + rotation is defined as backwards.

Table ***luminance uniformity - angular-dependence 4***.

Test method step (reference above)	Landscape mode	Screen rotation	Screen tilt	Measuring points			
				P_L	P_R	P_T	P_B
Step 2	Horizontal direction (turned around vertical axis)	+30°	0°	X	X		
Step 3	Horizontal direction (turned around vertical axis)	-30°	0°	X	X		
Step 4	Backwards tilt = (turned around the horizontal axis)	0°	+15°			X	X
Step 5	Forwards tilt = (turned around the horizontal axis)	0°	-15°			X	X

Test evaluation

The luminance uniformity for angular dependence must be calculated as follows:

- In landscape mode, for the horizontal direction, (turned around the vertical axis) measurement presented in table ***luminance uniformity - angular-dependence 4*** (test step 2 and 3). A ratio between the two measured luminances must be calculated. This ratio, or its inverse if it has a higher value, must be reported as the requested L_{max} to L_{min} luminance uniformity in mandate 1. The requirement is on the mean value of the two ratios +30° and -30°. The result must be presented to 2 decimal places.
- In landscape mode, for the vertical direction (turned around the horizontal axis). Tilt backwards and tilt forwards +15° test step 4 and 5. A ratio between the two measured luminances must be calculated. This ratio, or its inverse if it has a higher value, must be reported as the requested L_{max} to L_{min} luminance uniformity in mandate 2. The requirement is on the larger of the two ratios +15° and -15°. The result must be presented to 2 decimal places.

Overall uncertainty

≤ ± 10 % in luminance.
≤ ± 0.3° in rotation angle.
≤ ± 0.1 unit in luminance uniformity.
See 9.1.10.

5.11 Luminance contrast – characters

Background
The degree of contrast is important for readability and for distinguishing one character from another.

Definition
Luminance contrast – characters is the capacity of the display to maintain a high luminance difference between a bright background and dark characters or parts of characters over the whole active area.
Luminance contrast – characters is expressed as the ratio of the L_{max} to L_{min} difference over the sum of L_{max} and L_{min}, in accordance with Michaelson's formula.

Applicability
Displays and all-in-one PCs.

References
5.3, 5.4, 5.10, 5.12-5.14, 5.16-5.18.

5.11.1 Mandate
The luminance contrast must be ≥ 0.70 measured orthogonally to the screen.

Submit the following together with the application to TCO Development:
- A copy of the test report(s), and a copy of the verification report(s) from a verifier approved by TCO Development.
- The luminance contrast must be reported in TCO Certified Portal

5.11.2 Clarification
Preparations for testing
- All necessary preparations described in 9.1 and 9.2 must be done.
- A micro-photometer for luminance measurement must be aligned orthogonally to the display surface.
- The test images must be presented in a pixel matched way. (One program that does this up to 8-bit color is Microsoft Paint.)

Equipment
A micro-luminance meter such as an array photodetector capable of measuring luminance on structures ≤ 0.02 mm. Measurement requirements are given in clause 9.2.2.

Test method
This measurement is a modified version of the measurements in IDMS 7.2 and IDMS 7.8.

By visual evaluation of the standard test measurement position, the technician must search for and locate visual stripes, or patches, that clearly influence the contrast of characters or even parts of characters. If patches with significantly lower contrast are found, they must be geometrically referenced from the upper left corner of the active image and the position must be reported in the test report. If no such position is found, the default test position is the center of the screen. If one position is found that does not fulfil the mandate, there is no need to make further measurements.

With an array or scanning light measuring device, obtain the luminance profile of the vertical black-pixel line and the corresponding white region. Obtain the net signal S as a function of distance with any background subtracted (this is the background inherent in the detector if a nonzero signal exists for no light input). A correction for veiling glare must be made. See the figure below for an illustration of the pixel configuration and data. 12 consecutive pixel rows must be used for integration in vertical direction to get a one-dimensional intensity signal.

Here, the 1-1-1-1 patterns must be used, i.e. the 6-groups with the highest resolution. Inside each group, the pattern with the worst measured performance must be chosen.

Perform a running window average (moving box-car filter) of the luminance profile where the averaging window width is as close as possible to the pixel pitch as rendered by the light measuring device. There should be at least ten or more detector pixels per display pixel. For example, if an array detector is used and with the magnification of the imaging lens there are 53.4 array pixels which cover the display pixel pitch, then the running average window width is 53 array pixels wide.

From the resulting modulation curve, determine (1) the net intensity level of the vertical black line $S_K = S_d – S_g$, where S_d is the minimum intensity level (dim) of the black line generated by the product, S_g is the ground level, and (2) the net intensity level of the white line $S_W = S_h – S_g$, where S_h is the maximum intensity level (high) of the white line generated by the product. Compute the resolution contrast ratio as, $C= (S_W-S_K)/(S_W+S_K)$.

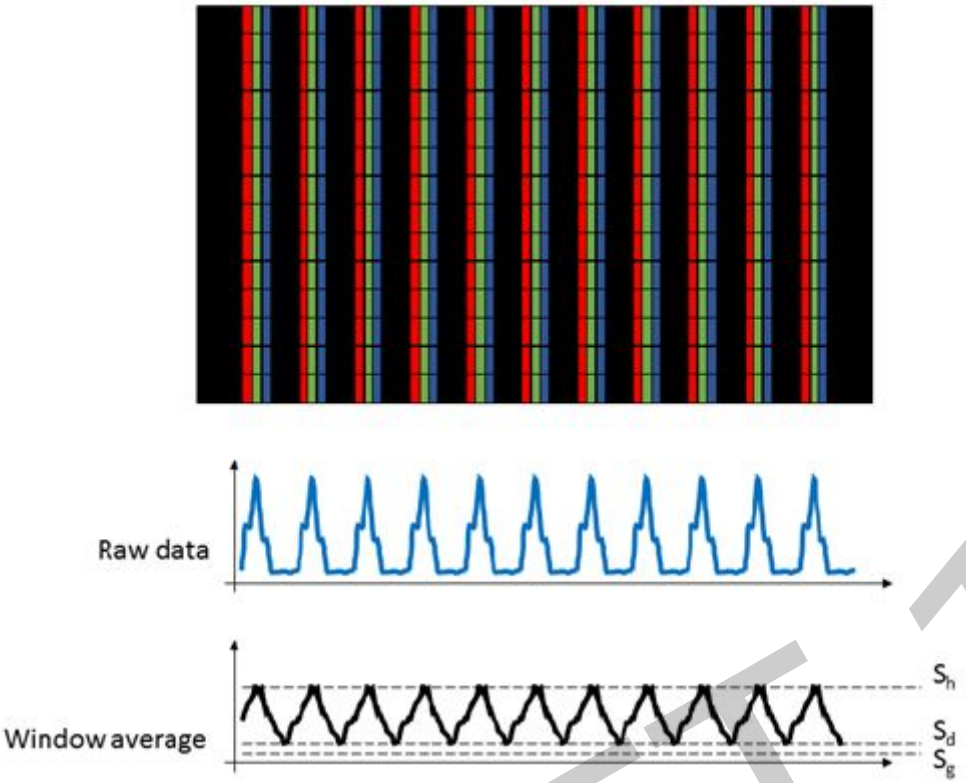


Figure *Luminance contrast - characters 1*: Measurement principle (from IDMS 7.2).
In summary:

$S_K = S_d - S_g$ (1)

$S_W = S_h - S_g$ (2)

$C = (S_W - S_K)/(S_W + S_K)$

Then perform the same operation but in vertical mode for the other set of grille patterns. Record the contrast values for both directions.

Test picture: "WGrille pattern" with the same resolution as the display.

Test evaluation

- C must be ≥0.70.
- The lowest luminance contrast found must be reported.
- The result must be presented to 2 decimal places.

Overall uncertainty

≤ ± 0.05 in contrast.
The misalignment between the screen surface normal and the optical axis of the luminance meter must be ≤ 0.3°.
See 9.1.10

5.12 Luminance contrast – angular dependence

Background

For displays, the luminance and consequently the contrast of the display may be angular-dependent. The luminance variations can influence both the bright white and the dark areas of the screen, causing a change in contrast. This can have a negative effect on the readability of the display.

Definition

Luminance contrast – angular dependence, is the capability of the display to maintain the same white/black contrast regardless of the direction from which the screen is viewed. Luminance contrast – angular dependence, is expressed as the ratio of the L_{max} to L_{min} difference over the sum of L_{max} and L_{min}, in accordance with Michaelson's formula. It is measured at two different angles.

Applicability

Displays and all-in-one PCs.

References

5.4, 5.12, 5.15-5.19.

5.12.1 Mandate

In landscape mode, the luminance contrast-angular dependence must be ≥ 0.80 at ± 30° horizontally from the viewing direction (rotated around the vertical axis through the center of the screen).

Submit the following together with the application to TCO Development:

- A copy of the test report(s), and a copy of the verification report(s) from a verifier approved by TCO Development.
- The luminance contrast-angular dependence must be reported in TCO Certified Portal.

5.12.2 Clarification

Preparations for testing

- All necessary preparations described in 9.1 and 9.2 must be done.
- A TCO Certified default test image, as shown in figure 9.1.7, must be used for this measurement.
- The measurement area must have each of the following RGB settings: (RGB 255, 255, 255) and (RGB 0, 0, 0).

Equipment

Luminance meter or spectroradiometer.

Test method

- The luminance meter must be positioned and directed orthogonally to the screen center-point as described in 9.2.5.
- The display must be rotated around a vertical axis through the screen front center, changing the azimuth angle to + 30°. The luminance of the white measurement area L_{W+30} and the luminance when the measurement area is black L_{k+30} at the center must be recorded.
- Finally the azimuth angle of the screen must be changed to -30°and the new measurements $L_{W/-30}$ and $L_{k/-30}$ taken.

Test evaluation

The luminance contrast values C_{+30} and C_{-30} must be calculated using the formula

$$C = \frac{L_W - L_K}{L_W + L_K}$$

Of C_{+30} and $C_{-30,}$ only the lowest value must be reported as the luminance contrast.

Overall uncertainty

≤ ± 10% in luminance.
See 9.1.10

5.13 Black level

Background
It is important that a display can produce a black level dark enough to show shadow details in pictures at high and low white luminance levels. The black level is also important for achieving a good contrast ratio.

Definition
Black level is the capacity of the display to maintain a good reproduction of black even when its white luminance is high.

Applicability
Displays and all-in-one PCs.

References
5.6.

5.13.1 Mandate

The luminance of black must be ≤ 2 cd/m² at a white luminance setting of ≥ 200 cd/m².

Submit the following together with the application to TCO Development:
- A copy of the test report(s), and a copy of the verification report(s) from a verifier approved by TCO Development.
- The measured luminance must be reported in TCO Certified Portal.

5.13.2 Clarification

Preparations for testing
- All necessary preparations described in 9.1 and 9.2 must be done.
- The TCO Certified default test image with an 18-step grayscale as shown in figure *luminance level 1* or alternative the larger measurement area image also described in 9.1.7 must be used for luminance level measurement.
- The measurement position P_C must be at the center of the measurement area without line borders, have an RGB setting of 0, 0, 0, and be positioned at the center of the screen. Alternatively, a measurement area with a size that is 80% of the active screen size may be used.
- The black level must be tested at maximum luminance, i.e., ≥ 200 cd/m^2.
- To achieve the maximum luminance, proceed as follows:
  Use the TCO Certified default test image with an 18-step grey scale pattern presented on the screen. From the default setting, adjust the controls on the display to achieve as high luminance as possible with an acceptable image quality. The image quality is considered acceptable if at least 15 of the 18 grey scale steps are visible. The maximum luminance level must be ≥ 200 cd/m^2.

- If it is difficult to visually determine if 15 of the 18 grey scale steps are visible, then the display must conform with the ***grayscale gamma curve*** criteria in the max luminance setting.
- Change the color of the white measurement area in the test image to black (RGB: 0,0,0) and measure the luminance of the black area, check that it is ≤ 2 cd/m^2.

Equipment
Luminance meter or spectroradiometer.

Test method
The luminance at the center of the black measurement area must be measured with the luminance meter directed orthogonally to the measurement area as described in 9.2.5.

Test evaluation
The measured luminance is the required value. The luminance must be reported to one decimal place.

Overall uncertainty
≤ ± 10 % in luminance.
See 9.1.10

5.14 Grayscale gamma curve

Background

A calibrated gamma curve makes it easier to distinguish between similar light levels. A well-tuned grayscale is the basis for accurate detail rendering of any imaging device. The grayscale rendering is measured by comparing a set number of steps in a grayscale in the test image. In order to give accurate rendering of the grayscale of the original image, each grayscale step, regardless of gray level, must have a luminance level close to what is specified by the common standard sRGB.

Definition

Grayscale gamma curve is the capability of the imaging device to maintain the original grayscale luminance or a grayscale pattern at all tested grayscale levels.

Applicability

Displays and all-in-one PCs.

References

5.6, 5.17, 5.20-5.25.

5.14.1 Mandate

The different grayscale luminance levels must be within the max and min levels specified in the table below, where 100% is the luminance level measured for white: RGB 255, 255, 255.

gray level	L_{sRGB}	L_{min}	L_{max}
	%	%	%
255	100	100,0	100,0
225	75	70	93
195	55	46	68
165	38	29	49
135	24	17	36
105	14	8	24
75	7	3	14
45	3	1	7

Submit the following together with the application to TCO Development:

- A copy of the test report(s), and a copy of the verification report(s) from a verifier approved by TCO Development.

5.14.2 Clarification

Preparations for testing

- All necessary preparations described in 9.1 and 9.2 must be done.
- A TCO Certified default test image, as shown in figure 9.1.7, must be used for this measurement.
- The measurement area must have each of the following RGB settings: R=G=B=255, 225, 195, 165, 135, 105, 75 and 45.

Equipment

Luminance meter or spectroradiometer.

Test method

Measure the luminance at the center of the measurement area for each grayscale setting specified above. Change the grayscale of the area for each measurement.

Comments on the limits tolerance from the sRGB curve

A linear tolerance has been applied symmetrically around the sRGB gamma curve. However, as many displays on the market today have a somewhat S-shaped gamma curve, a "S-correction" has been added to the linear tolerance on the gamma level 225 and 195.

This correction has been determined based on statistics from measured displays. TCO Development may decide to remove this "S-correction" in the next generation of this criteria document.

Overall uncertainty

≤ ± 10 % in luminance.
See 9.1.10

6 Product lifetime extension

IT products and the circular economy

The concept of a circular economy is one that moves away from the linear “take, make and dispose” approach to products, to an economy that is more regenerative, and decouples economic activity from the consumption of finite resources. For products, a move to a more circular approach means designing out waste from the product ecosystem, and keeping products and materials in their intended use longer.

Today, too many IT products are discarded prematurely because of components or performance aspects that could have been upgraded or repaired. There is also a growing market for second hand use of IT products, which also allows computers and other electronics to stay in use longer.

The best way to begin taking a more circular approach to the production and consumption of IT products, is extending their usable life. Product reuse is also more resource efficient than remanufacturing and recycling. For the IT industry, this means designing products that are durable, built to last, and upgradeable, making them more attractive for reuse or secondary markets.

TCO Certified — extending product life, upgradability, durability

We believe that a more circular approach to IT products is critical in the drive toward an environmentally and socially responsible life cycle. Therefore, in TCO Certified, generation 9, we have included criteria that enable and promote product lifetime extension.

6.1 Product warranty

Background
By extending product lifetime, natural resources are used more efficiently and the pollution to air and water is reduced. A precondition for an extended product lifetime is that the product is of high quality. A product warranty provides the brand owner with an economic incentive to design a durable product that lasts longer.

Definitions
Brand owner: The company or organization owning or controlling the brand name.
Brand name: The name or sign, including but not limited to a trademark or company name, used to identify, amongst users and customers, the manufacturer or seller of a product.
Product warranty: Is an agreement where the brand owner offers to repair or replace broken products at no charge.

Applicability
All product categories.

6.1.1 Mandate

The brand owner must provide a product warranty for at least one year, covering all markets where the product is sold.

Submit the following to an approved verifier:

- A completed and signed brand owner product form (chapter 11.4).

Submit the following together with the application to TCO Development:

- A copy of the verification report(s) from a verifier approved by TCO Development.

6.2 Replaceable components - REVISED

Background

Extending the lifetime of IT products is the most effective way to reduce their environmental impact. Components that often break or become outdated may limit the total lifespan of the product and must be replaceable. By making these critical replaceable components available and providing the user with clear instructions on how to exchange them, IT-products can live longer.

Definitions

CPU: Central processing unit.
GPU: Graphics processing unit.
RAM: Random access memory.
Storage: Any computing hardware that is used for storing, porting, and extracting data files and objects, including temporary and permanent storage of information (SSD, HDD, RAM).
Display assembly: Main display panel.
All batteries: Defined as all batteries with one or more cells that are installed in the product.
System board: Also referred to as the motherboard.
Keyboard: Built-in keyboard.
External/Internal PSU: The power supply unit used to convert AC to low voltage DC power for the internal components of the product.
Critical, replaceable components: Components that are crucial for the functionality and have a high risk of failing during normal use. Components that are defined as critical, replaceable components (per product category) are listed in the clarifications section of this criterion.

Applicability

All product categories.

References

6.1, 6.2.

6.2.1 Mandate

- The brand owner must provide a service manual describing how to replace at least all critical replaceable components. The service manual must be available online for anyone to read, free of charge.

- The brand owner must guarantee that, during the validity of the certificate, all critical replaceable components for the product type:, that are listed in the clarifications of this criterion;
    - are available for anyone to purchase
      or
    - may be replaced by a service network for repair and maintenance of the certified product on all markets where it is sold.

Submit the following to an approved verifier:

- A completed and signed brand owner form (chapter 11.4)
- A link to the service manual on the brand owner website or a pdf of the material that will be published there during the validity of the certificate

Submit the following together with the application to TCO Development:

- A copy of the verification report(s) from a verifier approved by TCO Development.

6.2.2 Clarification

Replaceable parts management

- The brand owner must provide a service manual including step-by-step instructions and component descriptions for the disassembly and assembly.
    - External PSU, charger, and AC Adapters are exempted from the disassembly instructions.
    - If instructions on how to replace all critical replaceable components (listed below) are included in the user manual, no additional service manual is needed to comply with the mandate 6.2.1.

- A critical, replaceable component must be possible to replace with an equivalent component. However, the replacement component does not have to be identical to the original component.
- Instructions on how to replace the critical components must be available online during the validity of the certificate.
- Step-by-step instructions on how to replace CPU and RAM does not need to be listed in the service manual (mandate 6.2.1) when CPU or RAM is soldered directly onto the system board/motherboard.
- For data center products, if one or more critical replaceable component(s) are part of a controller canister or system board, the controller canister or system board must be treated as the critical component.

Critical replaceable components:
The critical replaceable components listed below must only be made available if they are included in the certified product.

Displays Connectivity cables Power cables External PSU	**Tablets** Battery Display Panel/display assembly External/internal PSU
All-in-one PCs CPU External/internal PSU Storage (SSD, HDD, ODD) System memory (RAM) System board/motherboard	**Smartphones** Battery Display Panel/display assembly Charger
Notebooks Battery Display Panel/display assembly Storage (SSD, HDD) System memory (RAM) External/internal PSU Keyboard System board/motherboard	**Headsets** Battery External/internal PSU Earloop Neckband Ear tips Ear cushions Microphone shield Headband (for mono headsets)
Desktops CPU GPU (PCIe) External/internal PSU Storage (SSD, HDD, ODD) System memory (RAM) System board/motherboard	**Projectors** The light source (except lasers) Filters External PSU

Data center products

Servers: System boards(s) Storage (i.e. SSD, HDD) CPU RAM Network device PSU GPU Fan module(s) Connectivity cables Rack rails Cable management arms	**Storage products:** System board(s) Storage (i.e. SSD, HDD) Storage controller (i.e. RAID controllers) PSU Fan module(s) Batteries Connectivity cables Rack rails Cable management arms
Network equipment System board(s) Storage (i.e. SSD, HDD) PSU Fan module(s) Expansion module(s) I/O module(s) Connectivity cables Rack rails Cable management arms	

Clarification of sustainability performance indicator(s)

One or more “sustainability performance indicators” (chapter 1.3) are collected for this criterion. There is no mandatory level for these indicators but they must be verified and reported according to the description below.

Replaceability and repairability of the product

For each critical component in the list above, the following evaluation must be completed to calculate the repairability and reusability of the product. The evaluation is based on the standard EN 45554:2020 - General methods for the assessment of the ability to repair, reuse and upgrade energy-related products.

1. Fasteners and connectors (Class A-C)
2. Necessary tools for repair/upgrade, (Class A-B)
3. Availability of spare parts
    a. Availability by target group (Class A-E)
    b. Duration of availability (Class A-D)
4. Types and availability of information - Availability of comprehensiveness (Class A-C)

1. Fasteners and connectors (Class A-C)

The reusability of fasteners and connectors is interlinked with the repairability and reusability of products and components. Knowledge of type of fasteners can assist with the assessment of tools and skill necessary for repair reuse or upgrade.

Evaluation procedure

The assessment of the fasteners and connectors must be done from the start until the component is removed. This means that if any other part needs to be removed before it is possible to remove the critical component, then those steps must also be taken into consideration for the final score.

- **Class A: Reusable**
    - An original fastening system that can be completely reused, or any elements of the fastening system that cannot be reused are supplied with the new part for the repair, reuse or upgrade process.
- **Class B: Removable**
    - An original fastening system that is not reusable, but can be removed without causing damage or leaving residue which hinders reassembly (in case of repair or upgrade) or reuse of the removed part (in case of reuse) for the repair, reuse or upgrade process.
- **Class C: Neither removable nor reusable**
    - An original fastening system that is not removable and not reusable, as defined above, for the repair, reuse or upgrade process.

Example for a battery in a notebook:

Step 1 - Remove eight screws to open the chassis - Class A

Step 2 - Remove four screws and loosen the connector to the motherboard - Class A
Step 3 - The battery can now be removed without using tools - Class A
Total score for battery component: Class A

Step 1 - Remove eight screws to open the chassis - Class A
Step 2 - Remove four screws and loosen the connector to the motherboard - Class A
Step 3 - The battery is glued with non-reusable adhesive - Class B
Total score for battery component: Class B

If a component is soldered to another component, it automatically receives Class C.

2. Necessary tools for repair/upgrade

The availability of tools necessary for repair, service or upgrade, are interlinked with the product lifetime. Without easy access to tools needed for repair, upgrade or service the likelihood of these decrease. Therefore, it is important to make use of tools that are readily available instead of using proprietary tools.

- **Class A: Basic tools, no tools, provided tools**
  - Replacing critical components can be carried out without the use of any tools, or with a tool or set of tools that is supplied with the product or spare part, or with basic tools as listed in Table A.
  - All tools required must be listed in the service manual.

Tool type	**Reference**
Screwdriver for slotted heads, cross recess or for hexalobular recess heads	ISO, 2380, ISO, 8764, ISO 10664
Hexagon socket key	ISO 2936
Combination Wrench	ISO 7738
Combination pliers	ISO 5746
Half round nose pliers	ISO 5745
Diagonal cutters	ISO 5749
Multigrip pliers (multiple slip joint pliers)	ISO 8976
Locking pliers	
Combination pliers for wire stripping and terminal crimping	
Prying lever	
Tweezers	
Hammer, steel head	ISO 15601

Utility knife cutter with snap off blades	
Multimeter	
Voltage tester	
Soldering iron	
Magnifying glass	

Table A - Basic tools

- **Class B: Other commercially available tools.**
    - Replacing critical components can be carried out with non-proprietary tools that are not Class A.
    - All tools required must be listed in the service manual.

Verification: The brand owner must include a link to a shop where the tools can be bought in the service manual.

- **Class C: Can be carried out with proprietary tools.**
    - The tools required to replace critical components can be carried out with use of proprietary tools. These are tools that are not available for purchase by the general public or for which any applicable patents are not available to license under fair, reasonable, and non-discriminatory terms.

Verification: The brand owner must state in the service manual that the tools needed are proprietary.

- **Class D: Not enough information, or not feasible with any existing tools.**
    - The tools listed in the service manual are not Class A, and no extra information is made available on where usable tools can be purchased, or if they are proprietary.

or

    - The tools required to replace the critical components are not listed in the service manual.

3. Availability of spare parts

The availability of spare parts is a prerequisite for a successful repair. Spare parts availability refers to both the availability to various target groups and the availability over a specific period of time. These two perspectives are assessed in sequence.

3.a. Availability by target group

- **Class A: Publicly available**
- **Class B: Available to independent repair service providers**

- **Class C: Available to manufacturer-authorized repair service providers**
- **Class D: Available to the manufacturer only**
- **Class E: No spare parts available or no information on availability**

Verification: The brand owner must pledge the availability of spare parts in the service manual.

3.b. Duration of availability

- **Class A: Long-term availability (6 or more years)**
- **Class B: Mid-term availability (4 or more years)**
- **Class C: Short-term availability (2 or more years)**
- **Class D: No information on duration of availability**

Verification: The brand owner must pledge the minimum duration of availability for spare parts in the service manual.

4. Comprehensiveness of available information

The comprehensiveness of service information facilitates the possibility for repairs, maintenance and upgrades, which enables the extension of product lifetime.

- **Class A: Comprehensive information available**
  A repair, reuse or upgrade process, for which the following information is available for anyone to read, free of charge:
    - Step-by-step disassembly instructions with identification of tools needed.
    - Information on where to attain all tools needed for repair/upgrade.
    - An overview of repair or upgrade services offered by the manufacturer.
    - Troubleshooting charts.
    - Circuit board schematics.
    - Functional specification of parts (e.g. resistance value of resistors).
    - Recommended torque for fasteners.
    - Diagnostic and error resetting codes.

or

    - Appropriate formats for reporting comprehensive information can include IEEE1874 (IEEE Standard for Documentation Schema for Repair and Assembly of Electronic Devices).

- **Class B: Basic information available**
  A repair, reuse or upgrade process, for which the following information is available for anyone to read, free of charge:
    - Step-by-step disassembly instructions with identification of tools needed.
    - Information on where to attain all tools needed for repair/upgrade.
    - An overview of repair or upgrade services offered by the manufacturer.
    - Troubleshooting charts.

- **Class C: Limited information available**

A repair, reuse or upgrade process, for which the following information is available for anyone to read, free of charge:

- Step-by-step disassembly instructions with identification of tools needed.

Verification: Unless the brand owner provides documentation showing compliance with Class A or B, the product will be categorized as Class C.

7 Reduction of hazardous substances

Hazardous substances in IT products: A human health and environmental risk
Chemicals and heavy metals used in IT products present a wide variety of human health and environmental hazards. Throughout the life cycle, products may release dioxins, halogens and other toxins, which can persist in the natural environment and human body.

IT products contain a number of substances that can be categorized as hazardous. These include flame retardants, used to prevent products from catching fire, and plasticizers, that make plastics, especially cables, more flexible.

Risks include worker and environmental exposure in the manufacturing supply chain as well as during end of life handling. In addition, contaminated materials cannot responsibly be used in new products since they include substances that may be banned in the future. These materials risk being incinerated or discarded directly into the waste stream, adding to the problem.

While some hazardous substances have been phased out through legislation or voluntary initiatives, too little is known about the substances being used to replace them. Only a small percentage of chemicals in use today have been evaluated for their environmental and human health risk. Better knowledge and transparency around these chemicals is needed, along with a pathway for making substitutions.

TCO Certified — reducing risk, driving a shift to safer substitutes

Criteria in chapter 7 focus on:

- Further reducing the use of hazardous substances by restricting the use of them in certified products. These substances include heavy metals, halogens and high hazard non-halogens.
- Driving a shift toward transparency and safer substitutes through independent assessment and use of safer alternative substances to non-halogenated flame retardants and plasticizers. The assessed and approved safer alternatives are presented on the TCO Certified Accepted Substance List.

7.1 Heavy metals

Background

Electronic devices contain hazardous substances like heavy metals and brominated flame retardants. The effects of cadmium, mercury, lead and hexavalent chromium are well documented as substances hazardous both to human health and the environment. They may cause problems, both in the manufacturing phase where workers or the environment can be exposed, and at the material recovery, where uncontrolled recycling can cause the release of toxins such as dioxins and furans.
This criterion is harmonized with EU RoHS2 Directive (2015/863/EU), except that TCO Certified does not allow mercury in lamps. As TCO Certified is a global certification, this also affects products sold outside the EU.

Applicability

Displays, notebooks, tablets, smartphones, desktops, all-in-one PC's, headsets, servers, network equipment, data storage products.

References

7.1, 7.2.

7.1.1 Mandate

The product must not contain cadmium, mercury, lead and hexavalent chromium

The maximum concentration values tolerated by weight in homogeneous materials are 0.01% for cadmium, 0.1% for mercury, 0.1% for lead and 0.1% for hexavalent chromium according to EU Directive 2015/863/EU (RoHS) and the documents supporting the directive.

The limit value for batteries is 0.0005 % for mercury, 0.002 % for cadmium and 0.004 % lead per listed part, according to EU Directive 2013/56/EC.

Submit the following to an approved verifier:

- A completed and signed product form (chapter 11.3).

Submit the following together with the application to TCO Development:

- A copy of a verification report from a verifier approved by TCO Development.

7.2 Halogens - REVISED

Background

Halogenated substances are often persistent and can bio-accumulate in living organisms. They are problematic from both a human health and environmental perspective throughout the product life cycle and should be phased out. Workers may be exposed during manufacturing. Substances risk leaking out into the natural environment at end of life. PVC is by far the most common halogen-containing plastic.

Definitions

Printed wiring board (PWB) laminate is a printed board that provides point-to-point connections.
Halogens are a group of five chemically related non-metallic elements in the periodic table: fluorine, chlorine, bromine, iodine and astatine.
Polybrominated biphenyls (PBB) and polybrominated diphenyl ethers (PBDE) are restricted in the RoHS directive (2002/95/EC) due to the hazardous properties of these substances.
Hexabromocyclododecane (HBCDD) has been identified as a substance of very high concern in accordance with EU REACH criteria due to PBT (persistent, bio accumulative, toxic) properties.

Applicability

All product categories.

References

7.2, 7.3.

7.2.1 Mandate

1. The product must not contain flame retardants or plasticizers with halogenated substances or intentionally added halogens as part of the polymer.
    a. Exempted are electronic components, all kinds of cable insulation, and plastic parts weighing less than 0.5 grams.

2. The product must not contain PBB, PBDE and HBCDD. No parts of the product are exempted.

3. The main PCB must be XRF screened to ensure that it does not contain bromine or chlorine (see clarification below).

Maximum concentration values tolerated for a restricted substance (including decaBDE) is 0.1 % by weight of the material in homogeneous materials.
Fluoroorganic additives, used to modify the dripping behavior of plastics in fire conditions or to improve the processing behavior, are exempted provided that they do not exceed 0.5 % by weight of the material in homogeneous materials.

Submit the following to an approved verifier:

- A completed and signed product form (chapter 11.3).

Submit the following together with the application to TCO Development:

- A copy of the test report(s), and a copy of the verification report(s) from a verifier approved by TCO Development.

7.2.2 Clarification

1. The criterion applies to plastic parts in all assemblies and sub-assemblies. LCD panels are included in the requirement.

2. The criterion applies to the whole of the product, including components, parts and raw materials in all assemblies and sub-assemblies, such as batteries, paint, surface treatment, plastics, electronic components and printed wiring boards.

3. HBCDD has been identified as a substance of very high concern in accordance with EU's REACH criteria. The main application of HBCDD in electrical and electronic equipment (EEE) is a flame retardant in HIPS plastic being used for closures and structural parts of different types of EEE. TCO Development considers that the use of HBCDD in EEE is not deemed essential as technically suitable alternative substances and materials are available and already used extensively today.

X-Ray Fluorescence (XRF) screening of product hotspots

- The main PCB must be screened with XRF for bromine and chlorine.
- If the product has a power supply unit, then the main PCB of that power supply unit must also be screened with XRF for bromine and chlorine.
- If other substances are discovered by the XRF screening, these are disregarded as the uncertainty is considered too large for everything other than bromine and chlorine.
- If indications of bromine or chlorine >1000ppm are discovered, the applicant must proceed with additional testing in order to prove compliance with this criterion.
- If the concentration of detected substance is <1000ppm (0.1%), then no additional testing is needed.

7.3 Non-halogenated substances - REVISED

Background

Hazardous non-halogenated substances are problematic in the manufacturing and material recovery phases where workers and the environment can be exposed, leading to both human health and environmental risks. The purpose of this criterion is to increase the knowledge of which non-halogenated substances are used in certified products, how hazardous they are to human health and the environment, and to drive a shift toward less hazardous alternatives. This mandate uses the hazard assessment and decision logic framework GreenScreen® for Safer Chemicals, developed by the non-profit organization Clean Production Action (CPA). GreenScreen criteria are in line with international standards and regulations that assess the human health and environmental risks of chemicals. These include the Regulation on the classification, labelling and packaging of substances and mixtures (CLP), Globally Harmonized System of Classification and Labelling of Chemicals (GHS), OECD testing protocols, European REACH Regulation that includes RoHs, POPs, SVHCs and the U.S. EPA's Design for Environment (DfE) Alternatives Assessment.

Definitions

GreenScreen Profilers: Toxicology firms licensed by CPA to provide GreenScreen assessment services for a fee to clients.
TCO Certified Accepted Substance List: Public list of independently assessed safer available alternatives considering toxicity and functionality. Go to tcocertified.com.
CPA: Clean Production Action. Developers of GreenScreen® for Safer Chemicals.

Applicability

All product categories.

References

7.4, 7.5, 7.6.

7.3.1 Mandate

- Non-halogenated flame retardants used in parts that weigh more than 0.5 grams and are made mainly of plastics must have been assigned a GreenScreen benchmark score of 2, 3 or 4 by a licensed GreenScreen Profiler and appear on the public TCO Certified Accepted Substance List. (A benchmark U may only be accepted when the "worst case scenario" for data gaps is considered to be a benchmark 2 or above.)
- All substances of a mixture must be accounted for. Non-accepted substances must not exceed concentration levels of 0.1% by weight of the flame retardant.
- Exempted are electronic components and all kinds of cable insulation.

Submit the following to an approved verifier:

- A completed and signed product form (chapter 11.3).

Submit the following together with the application to TCO Development:

- A copy of a verification report from a verifier approved by TCO Development.
- A document copy or access to a database copy of the certified assessment report conducted and issued by a licensed GreenScreen Profiler.

7.3.2 Clarification

TCO Certified Accepted Substance List

Non-halogenated flame retardants can be used in certified products once they receive an accepted benchmark and appear on the public TCO Certified Accepted Substance List. The list is dynamic, which allows new substances that have undergone a valid assessment to be added. Accepted substances may be reassessed in light of new scientific findings. If an accepted substance is reassessed and given a benchmark score lower than 2, TCO Development reserves the right to remove the substance from TCO Certified Accepted Substance List. Before a substance is removed from the list a sunset date (at least one year) is set and shown on the list. This is to give chemical and product manufacturers time to submit additional information to improve the benchmark score or to transfer to an alternative on the list. Models certified before a sunset date that use a removed chemical are permitted to reach their end of life as TCO Certified. Models certified after the sunset date may only contain flame retardants or plasticisers that are listed on TCO Certified Accepted Substance List.
Any spot checks by TCO Development will require manufacturers to disclose substance details being used in randomly chosen products. To verify that the obligations according to this mandate are fulfilled CASNR disclosure and laboratory assessments of selected plastic parts will be conducted to assess the completeness, quality and validity of a benchmark score.

TCO Development and Clean Production Action (CPA) must have access to a copy of the GreenScreen assessment report before the benchmarked substance can be added to TCO Certified Accepted Substance List, available at tcocertified.com.

Conformity procedure (See also Flow chart 7.3.2)

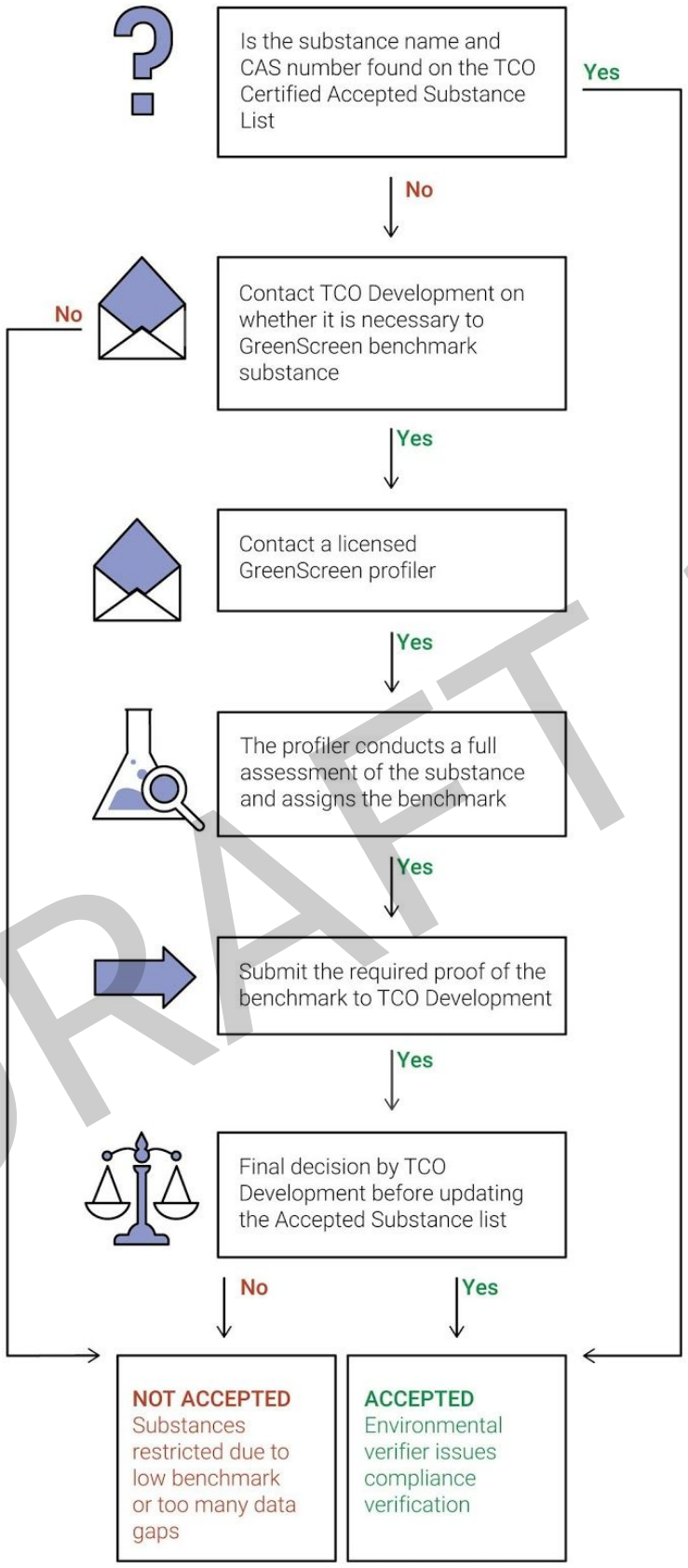
- The applicant must contact suppliers, such as the plastic and panel manufacturer, and ask them to confirm that the flame retardants and plasticizers they use only include substances listed on TCO Certified Accepted Substance List.

- If all flame retardants and plasticizers only include substances on TCO Certified Accepted Substance List, complete the product form 11.3 and submit it to an approved verifier. When the verifier considers all documentation to be compliant, they will issue an environmental verification to the applicant.

- If any flame retardant or plasticizer is used that contains a substance that is above the threshold level but doesn't appear on TCO Certified Accepted Substance List, then it must be added before approval can be given by a verifier. An extended time period to comply can be applied for here (see "Applying for an extended period…" below).

Adding a substance to the TCO Certified Accepted Substance List:

1. Contact TCO Development directly to see if we have any additional information on the substance. Reasons for the substance's absence can be that the substance has received benchmark 1, that no assessment has been conducted or that it has a benchmark score U (unspecified), due to a high number of data gaps.
2. If TCO Development requires the substance to be benchmarked, we recommend that you contact your suppliers and inform them that the substance will need an assessment by a licensed GreenScreen Profiler. The list of licensed profilers can be found on the Clean Production Action website at greenscreenchemicals.org.
3. A draft report per substance (not per product) is assembled by the licensed profiler from the available information (literature search, structural similarity comparison, expert judgment).
4. It is the licensed profiler that sets the benchmark score per relevant substance, which is valid for at least five years (assessments conducted after January 1, 2020).
5. Benchmark reports must be submitted to TCO Development for final approval before a substance is added to TCO Certified Accepted Substance List. A copy must also be made available to CPA.
6. Once a substance is added to the list and the environmental verifier identifies them, then they will issue the environmental verification to the applicant (see above point 1: "If all flame retardants and plasticizers only include substances on TCO Certified Accepted Substance List the procedure is as follows").



Flow chart 7.3.2 Conformity procedure, TCO Certified Accepted Substance List

Applying for an extended period of time to add a substance to TCO Certified Accepted Substance List

Applicants signing the mandate have the option to seek an extended period of time in order to complete assessments or substitute substances with unknown hazard levels. Upon request for an extension, the applicant is required to complete a risk assessment questionnaire and submit it to TCO Development. The risk assessment requires the applicant to clarify why an extension is necessary, provide information on the chemical and its substitute in question, and include a timeline for the assessment and/or substitution to be completed. If an extension application is not granted, the applicant is required to ensure that all used flame retardants or plasticizers only include substances that are on TCO Certified Accepted Substance List before an environmental verification can be issued for the product model by an environmental verifier. If the agreed extension due date is exceeded without conformity, then the environmental verifier must contact TCO Development and a course of action will be decided after discussing the issue with the applicant.

Clarification of sustainability performance indicator(s)

One or more “sustainability performance indicators” (chapter1.3) are collected for this criterion. There is no mandatory level for these indicators but they must be verified and reported according to the description below.

- Substances with benchmark 3 or higher.
  Percentage of non-halogenated flame retardants and plasticizer substances used according to 7.3 with a GreenScreen® benchmark 3 or higher. (If no non-halogenated flame retardants or plasticizer substances are used then N/A must be declared.)

7.4 Plasticizers

Background

Plasticizers are increasingly associated with negative environmental and human health impacts. RoHs is a restricted substances list that, beginning in 2019, restricts the use of four phthalates. TCO Development is committed to take a much broader approach by identifying and restricting not only these four, but all substances of high concern used in IT products. Our criteria are therefore designed to make sure that replacement substances are independently assessed as safer alternatives, and that transparency increases. The full list of safer alternatives is available on tcocertified.com.

This mandate uses the hazard assessment and decision logic framework called GreenScreen® for Safer Chemicals, developed by the non-profit organization Clean Production Action (CPA).

GreenScreen criteria are in line with international standards and regulations that assess chemicals on their human health and environmental hazards. These include the Regulation on the classification, labelling and packaging of substances and mixtures (CLP), Globally Harmonized System of Classification and Labelling of Chemicals (GHS), OECD testing protocols, European REACH Regulation that includes RoHs, POPs, SVHCs and the U.S. EPA's Design for Environment (DfE) Alternatives Assessment .

Definitions

Plasticizer: An additive to a polymer (plastic), to increase its flexibility, transparency, durability, or longevity.
Phthalates: The most common type of plasticizer in PVC cables.
Licensed profilers: Toxicology firms licensed by CPA to provide GreenScreen assessment services for a fee to clients.
TCO Certified Accepted Substance List: Public list of independently assessed safer available alternatives considering toxicity and functionality. Available at tcocertified.com.
CPA: Clean Production Action. Developers of GreenScreen® for Safer Chemicals,

Applicability

All product categories.

References

7.4, 7.5, 7.6.

7.4.1 Mandate

- Plasticizers used in product housing and cable / wire insulations must have been assigned a GreenScreen benchmark score of 2, 3 or 4 by a licensed GreenScreen profiler and appear on the public TCO Certified Accepted Substance List. A benchmark U is only accepted when the “worst case scenario” for data gaps is considered to be a benchmark 2 or above. Exempted are wires inside electronic components.
- The product must not contain Bis (2-ethylhexyl) phthalate (DEHP), Butyl benzyl phthalate (BBP), Dibutyl phthalate (DBP), and Diisobutyl phthalate (DIBP). No parts of the product are exempted.
- All substances of a plasticizer mixture must be accounted for. Non-accepted ingredients must not exceed concentration levels of 0.1% by weight of the plasticizer.

Submit the following to an approved verifier:

- A completed and signed product form (chapter 11.3).

Submit the following together with the application to TCO Development:

- A copy of a verification report from a verifier approved by TCO Development.
- A document copy or access to a database copy of the complete assessment report conducted and issued by an approved GreenScreen licensed profiler.

7.4.2 Clarification

TCO Development and Clean Production Action (CPA) must have access to a copy of the GreenScreen assessment report before the benchmarked substance can be added to the accepted substance list. Once this is done the substance will be added to the TCO Certified Accepted Substance List available at tcocertified.com.

For more TCO Certified accepted substance list clarifications, conformity procedure, rules for adding a substance and applying for an extended period of time for substances not on the list, refer to clarifications under the mandate non-halogenated substances 7.3 clarifications.

7.5 Hazardous substances in product packaging

Background

The use of hazardous substances in packaging materials is problematic and should be minimized. It poses a risk to human health and the environment, not least because packaging materials have a short lifespan and generate large volumes of waste. Several hazardous substances are regulated in many countries, and the use of them should be phased out.

Applicability

All product categories.

References

7.7.

7.5.1 Mandate

The packaging material must not contain lead (Pb), cadmium (Cd), mercury (Hg) or hexavalent chromium (Cr6). Plastic packaging material must not contain organically bound halogens.

Submit the following to an approved verifier:

- A completed and signed product form (chapter 11.3).

Submit the following together with the application to TCO Development:

- A copy of a verification report from a verifier approved by TCO Development.

7.5.2 Clarification

Limit values are according to Directive 94/62/EC on packaging and packaging waste.

8 Material recovery

E-waste prevention and recovery of safer materials is essential for a sustainable life cycle

According to the United Nations University, electronic waste is the fastest growing waste stream in the world, with nearly 50 million metric tons generated every year. Today, a large share of e-waste ends up in scrap heaps or is incinerated, causing pollution, human health hazards, and the loss of valuable resources such as copper, gold and rare earth metals.

The amount of e-waste can be reduced if IT products are recovered at their end of life. Product and material recovery should be made easier for three main reasons:

- to conserve natural resources,
- to decrease environmental impact and,
- to encourage material reuse.

Taking back used products and recovering their materials supports a more sustainable, circular approach to the product life cycle. To drive this positive development, products and their packaging must be designed in a way that enables remanu facturing and recycling. To be effective, this approach also requires that products are made using safer materials that are more attractive for re-use.

8.1 Material coding of plastics

Background

The best way of reducing IT products' environmental impact is to extend product life through reuse. Once this no longer is possible, the materials must be recycled. By coding the plastic parts, recycling is made easier and the materials can be used in new products.

Definitions

Plastic parts are parts made mainly of plastics, e.g. the product housing. Parts containing other materials in any significant amounts, e.g. cables with metal conductors, are not included in the definition.
Printed wiring board laminate is a printed board that provides point-to-point connections but not printed components in a predetermined configuration on a common base.

Applicability

Displays, desktops, all-in-one PCs, projectors, servers, network equipment, data storage products, Imaging equipment.

References

8.1-8.3.

8.1.1 Mandate

- Parts made with a majority of plastics weighing more than 25 grams (5 grams for smartphones) must be material coded in accordance with ISO 11469 and ISO 1043-1, -2, -3, -4.

Submit the following to an approved verifier:

- A completed and signed product form (chapter 11.3)

The following information must be submitted with the application to TCO Development:

- A copy of a verification report from a verifier approved by TCO Development.

8.1.2 Clarification

Printed wiring board laminates are exempted from the mandate.

If the amount of flame retardant exceeds 1 % by weight, the coding must be complemented in accordance with ISO 1043-4.
The requirements also apply to plastics in the LCD panel, however, labeling of the light guide may instead consist of the application of a label in close proximity, for example PLASTIC LIGHT GUIDE:>*plastic type(s)*< or >PLASTIC LIGHT GUIDE:*plastic type(s)*<.
Labeling of plate diffuser (not thin plastic film diffuser) must follow the same rules as for the light guide. The requirement does not cover other thin plastic films in the panel due to difficulties in labeling these.

8.2 Product packaging

Background
Packaging is a well-known environmental problem that is regulated in many countries worldwide. Packaging material has a short lifetime and generates large volumes of waste.

Applicability
All product categories.

8.2.1 Mandate

- Non-reusable packaging components of the certified product weighing more than 25 grams must be possible to separate into single material types without the use of tools in order for the material to be recycled.
- Exempted is reusable packaging.

Submit the following to an approved verifier:
A completed and signed product form (chapter 11.3)

The following information must be submitted with the application to TCO Development:
A copy of the verification report(s) from a verifier approved by TCO Development.

8.2.2 Clarification

A reusable package or container is designed for repeated reuse without impairment of its protective function. A take back system of the packaging must also be available for all end users in order for packaging to be defined as reusable.

8.3 E-waste compensation - NEW

Background

Enormous amounts of e-waste is generated every year. It is the world's fastest growing waste stream, and much of it is exported to developing countries, burdening local communities with this global problem. Unsafe handling of e-waste causes pollution, human health hazards and the loss of valuable, finite resources. The Basel Convention governs the export of many types of electronic waste, however it is not properly implemented in all countries. To help reduce the e-waste problem, manufacturers need to provide mechanisms to take back their products. This is consistent with the principle of individual producer responsibility, where each manufacturer is financially responsible for managing its own branded products at end-of-use. The purpose of this criterion is to influence the expansion of better electronic waste management practices to more countries.

Applicability

All product categories.

8.3.1 Mandate

By the end of April each year, the brand owner must report the following for the previous calendar year on a global scale for each certified product. (This applies until one year after the certificate expires):

- The number of certified products that were manufactured
- The number of products collected on the brand owner's expense which are of the same product category as the certified product
- The percentage of these collected products that are processed to be reused
- The percentage of these collected products that are recycled
- The name, addresses and standards fulfillment of the reuse and recycling facilities processing the collected products.

Submit the following to an approved verifier:

A completed and signed brand owner product form (chapter 11.4).

Submit the following together with the application to TCO Development:

- A copy of the verification report(s) from a verifier approved by TCO Development.
- All results in the mandate above must be reported annually in TCO Certified Portal

8.3.2 Clarification

Instead of reporting manufacturing volumes for each certified product, reporting may be done by combining all certified products within each product category.

9 Test conditions for displays

9.1 General test conditions

9.1.1 Definition of a test object

The product that are subject to tests within this product category are defined in the chapter “About this document”.

9.1.2 Required information about the product

The applicant must specify:

- Name(s), type designation(s) and manufacturer for all exchangeable parts of the product.
- If a particular graphic card or video generator must be used for testing (see 9.3).
- Display resolution and the vertical and horizontal frequencies for testing.

Test conditions

- The product must be delivered to the test facility in test-ready condition and include any required accessories. All necessary information about how to operate and adjust the product must be provided.
- The performance of the tested product must in all aspects be equal to the product that is delivered to the end-user.
- The applicant must inform the test facility if any image enhancement software or hardware is used for the display and which input ports that have image enhancement.
- The product must be warmed up for at least 30 minutes or until it is stabilised. If the display is not stable within one hour, the engineer may cancel the test and demand a replacement sample.
- The screen surface must be clean when tested.
- The product must be tested under nominal conditions of input voltage, current, etc. If sold on different markets, the manufacturer must choose one setup which represents the conditions of the country where the largest number of products are sold.
- If possible, testing must be done with the digital signal input. If the product has several digital inputs, the one with the lowest bandwidth that can still support the native resolution must be used. The same signal input must be used for testing of all parameters. The signal input used must be specified in the test report.
- If the product relies on a network connection to function, a network connection must be established. Otherwise the product must be tested without load on any peripheral interface such as USB, firewire or network hub, memory card slot, loudspeakers or similar unless otherwise stated by the test procedure.

9.1.3 Graphic card (video adapter)

- The applicant must specify if a particular graphic card must be used for testing. If so, the graphic card must be representative of the use of the display, for example included in the motherboard of associated equipment. Non-standard graphic cards must not be accepted for testing, unless they are for a special purpose relevant for the product and sold together with it. If the client does not specify a graphic card, a high quality standard graphic card from the test facility must be used. This must be reported in the test report and the client must be informed. The graphic card must be easily commercially available or supplied with the display and be of recent model, in order to give the tested combination a more general validity and to give any user of the display the possibility of purchasing the same graphic card as used in the testing. The most recent versions of graphic cards and drivers are recommended. The graphics board must offer a typical output voltage on RGB of 0.7 V ± 10%.
- A character generator or video generator must only be used to operate the display if it is not possible to use a standard graphic card. This is because a character generator is not representative of the usual way a display is run.
- The graphic card used for testing must not be used for more than one product sample during the test.
- The computer or similar devices used to run the product in the test must not use any unnecessary software or hardware that could influence the test.
- All settings in the operating systems must be the default ones as delivered to the end user or the default as it appears directly after the installation of the operating system.

9.1.4 Product alignment for testing

The display screen front must be aligned vertically with the possibility to rotate the screen ±30° around a vertical axis through the centre-point of the screen front. It must also be possible to tilt the screen forwards and backwards ±15° around a horizontal axis through the same centre-point.

9.1.5 Settings of the display

- Pivot screens must only be measured in the usual landscape mode.
- The display resolution must be set to the native resolution.
- The display must be put in its factory default mode. The CCT of the default mode must be used.
- All tests must be performed with the display in the factory default mode if not stated otherwise in the test methods.
- Integrated automatic sensors and any eco-mode functions enabled by default on the display must be disabled by the test engineer for all the tests, as long as the default CCT setting does not change.
- Testing may be done with a preset instead of the default mode if the user is informed in the user manual which preset is used for conformity with the criteria in TCO Certified. In this case this preset must be treated as the default mode in the criteria document and noted in the test report.
- The settings must be the same for all tests, if not specified otherwise in the test method.
- An external control unit that is not a standard part of the display is not allowed.

- The color depth of the source signal must be 24 bits (8 bits per color channel) or more.
- In Windows/Display Properties/Settings/Advanced, the Windows “Small fonts” option must be used.
- In Windows/Display Properties/Appearance the “Windows standard” color scheme option must be used.

9.1.6 Test image/test character

- All test images can be found on tcocertified.com.
- The default testing 12 point Arial font and 100% “zoom/magnification” must be used.
- The latest version of MS Windows operating system is the default user interface, if not otherwise stated. For Macintosh displays, Mac OS can be used during the testing.
- Another possibility is to use a testing program that must consist of software commonly used in office and home computer work. The word processor should be able to produce the text and graphics required for the test procedures.
- The default testing polarity is positive polarity (black characters on a white background).
- All parts of the tests must be carried out using the same font, character size, correlated color temperature, resolution, operating system and other settings of the display controls etc., unless otherwise stated in the test procedure.

9.1.7 Test image and test luminance setting

- The TCO Certified default test image (*figure 9.1.7.*) has a 40 % image loading. The test image must fill the whole usable screen that represents the “full screen mode”. This image must be used for testing unless otherwise specified in the test procedure.
- If the measured display is not affected by image loading, alternative images may be used (described in *procedure* below) instead of the default test image for measurement of ***Black level*** and ***Color gamut***, to minimize the contribution of stray-light for some measurement equipment. If this method is selected, pay extra attention to displays with dynamic backlight as they may be affected by different levels of image loading.

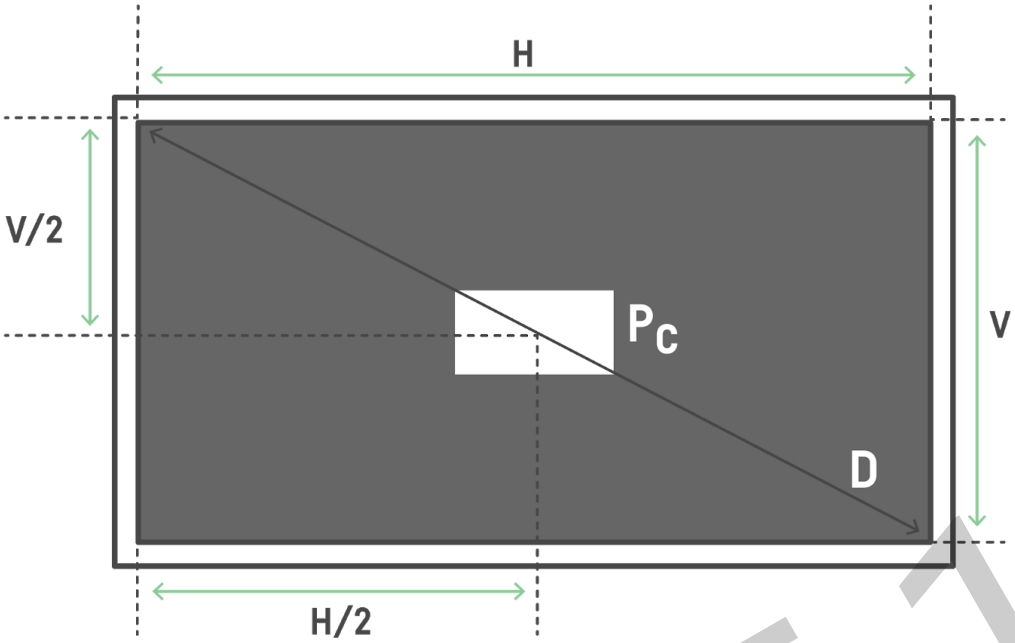


Figure 9.1.7, the TCO Certified default test image. H: horizontal size of the active area of the screen. V: vertical size of the active area of the screen.

Procedure

- The background color must be set to RGB 102,102,102 (i.e. equal to 40% image loading).
- An active white measurement area at the centre of the screen must have a size that is 4% of the active screen size and have an RGB setting of 255, 255, 255.
- A permitted alternative to the 4% active screen size measurement area when testing **black level** and **color gamut** is to increase the measurement area to a size that is equal to 80% of the active screen size. The background must continue to be RGB 102, 102, 102.

Test luminance setting

- Reset the product to its default mode settings (the settings that are used when the product is delivered to the end user). If the product has an automatic adjustment, this can be activated once. In the default mode the luminance of the display must be ≥ 150 cd/m^2. If the luminance is lower, then testing cannot proceed since the product does not conform with the criteria in TCO certified.

9.1.8 Instruments used for testing

All instruments used for testing must be calibrated and there must be a valid calibration report. Calibration must be done before the tests are carried out. Calibrations must be traceable to national standards.

9.1.9 Test report

The test results are valid only for the presentation form(s) and configuration(s) that are included in the test. However, configurations may be accepted by the test facility based on tests of a “worst case” configuration. In this case, it must be clearly specified in the test report which of the configurations that have been tested.

The test report must include the following information:

- Any changes to the test methods.
- The manufacturer, brand name, model type and serial number (if available).
- The supply voltage and frequency used during the test and whether it is a CLASS I or CLASS III type. If CLASS III the AC external power supply brand name and model number must also be stated.
- The degree of uncertainty for each given measurement result.
- Photographs of the product showing: front, rear and, if applicable, the external power supply with legible marking label.
- The setting of contrast, brightness and CCT preset at the reset default setting.
- The panel brand name, full panel number, if the screen is pivot stand type and if it has a LED backlight.
- The mode(s) (i.e. horizontal and vertical scan frequency and resolution) used during the test and the aspect ratio.

9.1.10 Overall uncertainty

The overall uncertainty of the test facility must be calculated for each measurement procedure in this document and presented in the test report. The uncertainty must be within the required levels for each criterion. All measurement uncertainties claimed for used instruments must be referred to traceable calibration reports.

About combining overall uncertainty values during test measurements:

- Criteria are fulfilled without adding or subtracting the overall measurement uncertainty.
- Report the value shown on the instrument without adding or subtracting the overall measurement uncertainty.
- The overall measurement uncertainty of the test facility must be printed in the test report together with the reported value.
- If a test facility has an overall measurement uncertainty higher than the one allowed by TCO Development for a certain criterion, then the test report for that criterion is not valid for certification and the test result will not be accepted by TCO Development.

9.2 Visual ergonomics

9.2.1 General test requirements

General test requirements are specified in section 9.1. During all tests, the display screen must be clean.

9.2.2 Photometric test facility general requirements

Photometric measurements must be performed under darkroom conditions. This means that measurement data must in no way be affected by direct light from sources or light reflected from interiors, equipment, clothes etc. The test facility must have a routine for controlling the stray-light level at the display panel screen (see also 9.2.6).

9.2.3 Power supply and test room climate requirements for testing

- AC mains voltage* 230 VAC RMS, tolerance ≤ 1 %
- AC mains frequency* 50 Hz, tolerance ≤ 2 %
- Test room temperature 23± 3 ºC
- Humidity 20-75 % RH (non-condensing)

* – or other voltage and frequency combination specified by the client.

9.2.4 Photometric and spectrometric measurements

Several instruments are to be used when carrying out measurements for visual ergonomics.

The following instrument types are to be used for testing:

- **Luminance meter**. A luminance meter must have a sufficiently good V_λ-sensitivity (Requirements for luminance meters are covered by CIE Publication 69 (1987). Luminance meters of CIE Class L(aboratory) with a combined performance characteristic ≤ 3 % must be used) and integrate luminance over a finite measuring field during a finite time. The meter must be equipped with adjustable optics and always be focused on the measured area. The luminance meter must incorporate a sufficiently long time constant of integration in order to ensure averaging of the pulsation of the light emitted by displays. The sensitivity must be independent of the polarization of the measured light (often referred to as f_8 error).

  The luminance meter measuring field must be one degree for all measurements, except for the micro-photometric luminance measurements, see below.

  An automated instrument using collimating optics may be used for testing although the measurement area will differ somewhat from the area covered by the luminance meter. When the luminance measurement in this case is done at a shorter distance than 1.5 × the screen diagonal (D) because of instrumental constraints, the facility must verify that the results are equal to those done at 1.5 × D.
- **Micro photometer**. Micro Photometric registration of the luminance distribution of test patterns must be performed with an array photodetector device capable of resolving structures of ≤ 0.02 mm. A scanning device must not be used because it is sensitive to jitter and other variations that may occur during a scanning.

- **Spectroradiometer.** An instrument for the measurement of radiant flux as a function of wavelength must be used. A spectroradiometer for the measurement of light and color is normally equipped with a microprocessor that makes it possible to obtain luminance and color coordinates directly from raw measurement data. A spectroradiometer can replace the luminance meter when suitable. The wavelength

resolution must be ≤ 4nm for accurate color measurements. The sensitivity must be independent of the polarization of the measured light (often referred to as f_8 error).

9.2.5 Measurement distance

All measurements must be carried out through a point, simulating the eye position of the operator, at a distance of 1.5 × “diagonal of the screen” from the centre-point of the display screen but no less than 500 mm which is considered an absolute minimum distance for comfortably viewing the display. The instrument must be focused on the presented test image for all measurements.

9.2.6 Stray light

Stray light may cause errors which can negatively affect measurement of luminance, contrast and chromaticity coordinates. It is therefore necessary to make an evaluation of stray light influence for the different measurement procedures described in this document. If it is verified that stray light affects the measurement result, it is necessary to take actions to eliminate the source of error. Two possible ways to solve the problem are to equip the luminance meter with a well-designed screening attachment, a frustum or to use a black screening sheet at the display surface.

9.3 Emissions

9.3.1 General test requirements

General test requirements are specified in section 9.1. During all tests, the display screen must be clean.

9.3.2 Power supply and test room climate requirements for testing

- AC mains voltage* 230 VAC RMS, tolerance ≤ 1 %
- AC mains frequency* 50 Hz, tolerance ≤ 2 %
- Test room temperature 23±3 ºC
- Humidity 20-75 % RH (non condensing)

The equipment must be connected to phase and neutral.
* – or other voltage and frequency combination specified by the client.

9.3.3 Product conditions and set up

The tests must be performed with the full screen size activated.

The display control settings must be the same as for visual ergonomics: The default setting at reset must be used for the emission testing of alternating electric and magnetic fields. The luminance at this setting must be ≥150 cd/m^2. See section 9.1.7 for details.

During the test, the display must show a full screen of capital “H” pattern in dark/black Arial letters on a bright background (positive polarity). See section 9.1.6 for details.

Any pivot display that can be used in both normal landscape position and portrait position (turned 90°) must have measurements taken in both positions. The “worst case” result must be reported.

Any display equipped with a height-adjustable stand must have measurements taken in both the lowest and highest positions. Both measurements must be done with the measurement instrument positioned to the centre-centre point of the screen surface. The “worst case” result must be reported.

The display must conform with the mandatory requirements without having to rely on an earth connection via the signal cable. However, if the display gets mains power solely through the signal cable, then it may also rely on it’s earth connection through the signal cable. In order to test a display without an earth connection via the power cable, a battery operated computer, with no connection to earth, can be used to operate the display.

If the display is connected to mains via a detachable mains cord, the measurement must be performed with a shielded mains cord (connected to earth for CLASS I device). Most shielded power cords have the text “shielded” printed on them. The quality of the shielding must be verified in the following way:

- Bend the cable in half and put the bended point of the cable at the centre of the turntable, with both of the connectors hanging down behind the turntable. Put the antenna 30 cm above and 30 cm in front of the centre of the turntable.
- Connect one side of the cable to mains and measure the alternating electric field of the cable. The values must be below (5.0 V/m in band I and 0.20 V/m in band II).

A display without an external power supply must be connected to mains via the above mentioned power cable. The power cable and signal cable must run from the points of connection on the display and then horizontally straight to a point 0.4 m behind the screen surface. The cables must then from this point run downwards at least 1 m. (*See figure 9.3.3.1.*) The power and signal cables may not be placed together unless the display is provided with an integrated cable holder. When an integrated cable holder is present it must be used in the test to secure the cables.

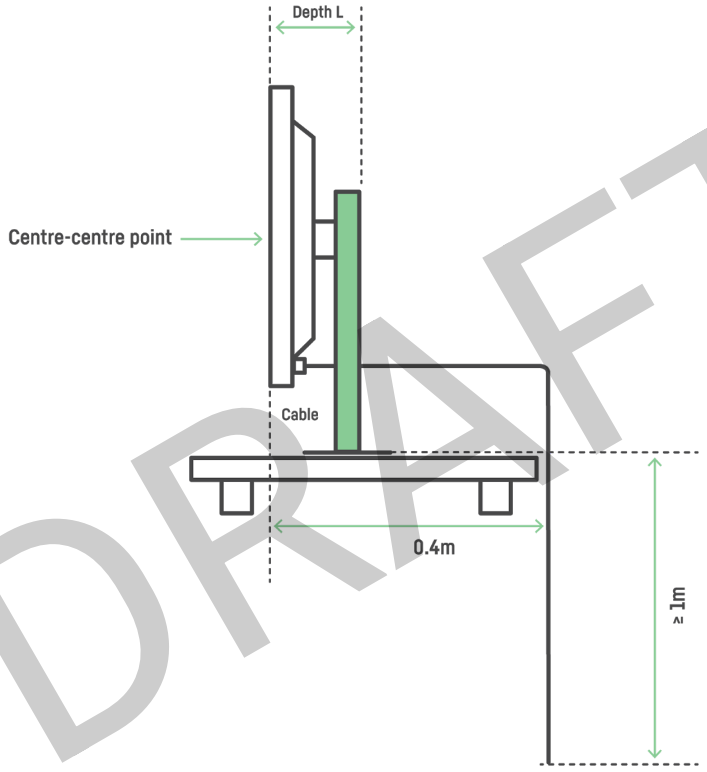


Figure 9.3.3.1. Display without external power supply unit.

The external power supply unit, if any, will contribute to the electromagnetic fields around the display. Power supply units, which are connected via a primary cable to the outlet, must be positioned centrally, directly behind the test sample, on the turntable, with the secondary side towards the display (see figure 9.3.3.2). The primary cable must extend horizontally on the turntable to a point 0.4 m behind the screen surface. The cable must then, from this point, run downwards at least 1 m. If the power supply can be positioned with different sides up, it must be tested in all positions and the “worst case” result must be used. However, if it is obvious which side is intended to be the top side or bottom side by the placement of LED indicator or integrated supports to stand on, testing the power supply in the one intended position is enough.

The secondary cable of the power supply must run the shortest distance from the point of its connection on the display to the secondary side of the power supply. The unused portion of the secondary cable, if any, must be bundled together with the power supply unit. The bundle loops must have a length equal to the longest dimension of the power supply. For supply units with dimensions less than 0.1 m, a 0.1 m bundle loop length must be used.

For power supply units which are designed to be attached to the display bezel or directly in the outlet without a primary cable, the secondary cable must in these cases run vertically down to the turntable from the point of its connection on the display and then horizontally straight to a point 0.4 m behind the screen surface. The cable must then, from this point, run downwards at least 1 m.

If the display bezel has an integrated external power supply holder, this must be used during the test and the cables placed according to the set-up conditions for a display without external power supply as described above, if the display does not have an integrated cable holder. When an integrated cable holder is present, it must be used in the test to secure the cables.

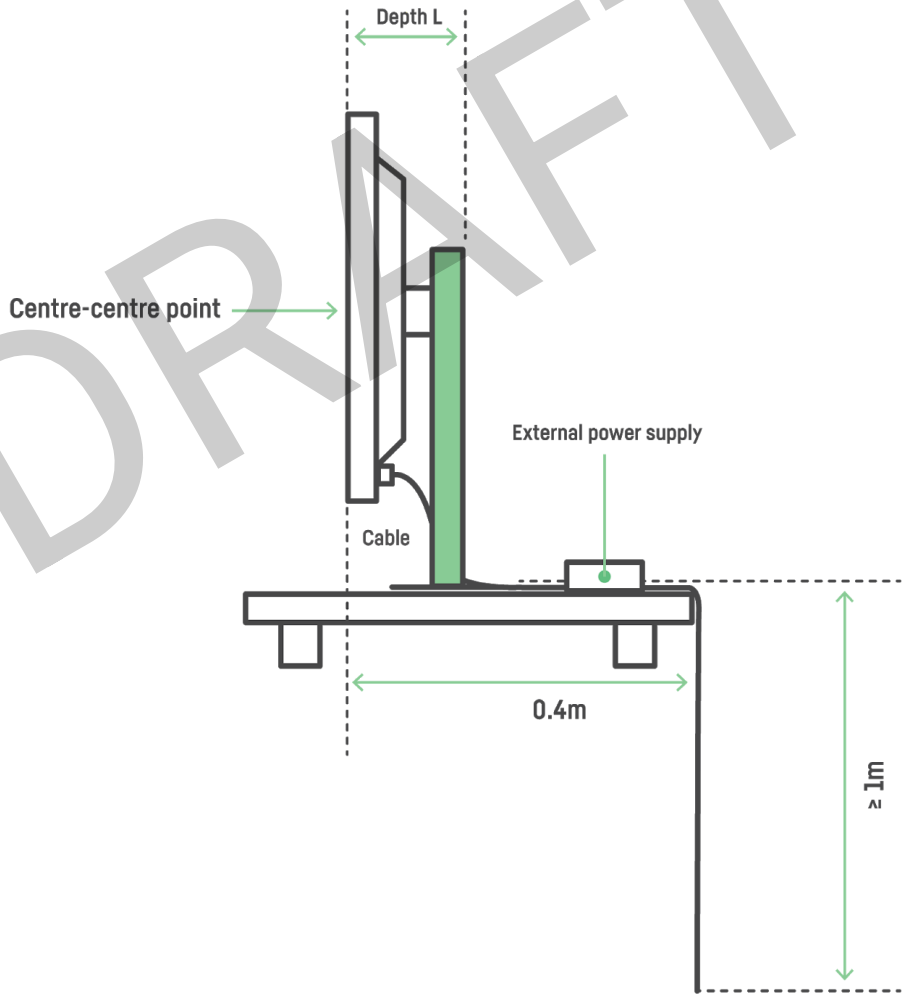


Figure 9.3.3.2. Display with external power supply units.

Note! For pivot displays and displays equipped with height-adjustable stands, the cable has to be adjusted to the different positions.

For measurements of ***alternating magnetic fields*** the power cable does not need to be shielded and it may be positioned in another way, as the cable only contributes to a negligible amount of the magnetic field. However, external power supplies must be correctly positioned behind the display, as they may give rise to magnetic fields.

If positioning according to the above rules is not possible, then the positioning of the external power supply and cables must be described in the test report.

9.3.4 Emission measurement instruments

The instruments used for emission testing must conform with the requirements and calibration procedures described below:

Alternating electric field meter

The alternating electrical field emission from the display under test must be determined by measuring the displacement current passing a given surface of the measuring probe. The probe consists of a disc of double sided printed circuit board laminate with a diameter of 300 mm. On the front of the board, the copper layer is removed in the annulus between radii 50 and 52 mm (see figure 9.3.4.1).

The copper foil surrounded by the annulus is the active measuring surface. It is connected to one input terminal of an operational amplifier, with capacitive feedback. The other input terminal of the operational amplifier, the copper ring outside the active surface, and the back of the board are connected to ground. The output voltage (U) from the probe (active surface with area (A)) is related to the incident electric field, E, averaged over the active surface according to $U = \varepsilon \cdot E \cdot A/C$ where C is the capacitance in the feedback loop of the operational amplifier and ε is the permittivity for a vacuum.

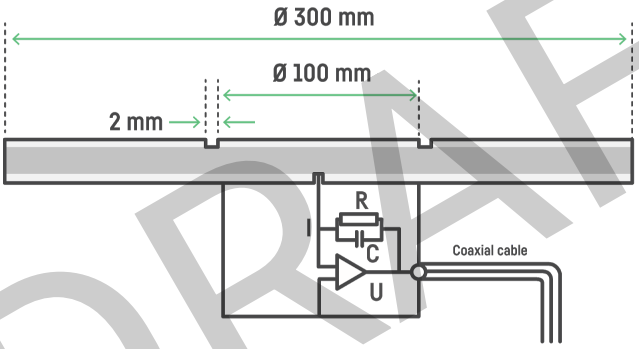


Figure 9.3.4.1. Sketch and circuit principle of the Alternating electric field meter for alternating electrical field measurements. The feedback circuit of the operational amplifier is a capacitance C in parallel with a high value resistor R to ensure that there is no DC voltage across the plates of the capacitor C.

The specifications for the frequency response of the measuring probe are given by the calibration procedure. The signals from the probe must be filtered by high-pass and low-pass filters. The specification of the filters is given in table 9.3.4.2.

Table 9.3.4.2. Filter specifications

Frequency Band I					
Frequency	**< 5 Hz**	**5 Hz**	**100 Hz**	**2 kHz**	**> 2 kHz**
Attenuation	**> 80 dB/decade**	**3 dB**	**0 dB**	**3 dB**	**> 40 dB/decade**

Frequency Band II					
Frequency	**< 2 kHz**	**2 kHz**	**30 kHz**	**400 kHz**	**> 400 kHz**
Attenuation	**> 80 dB/decade**	**3 dB**	**0 dB**	**3 dB**	**> 40 dB/decade**

After amplification and filtering, the output voltage of the measuring probe must be used to determine the r.m.s. value of the electric field strength in both frequency bands.

The measuring time must be sufficiently long to enable measurements with an accuracy of ±5% at 50/60 Hz.

The measuring system must be capable of measuring at least down to 2.0 V/m in band I and down to 0.20 V/m in band II.

The measuring probe must be calibrated using a parallel plate capacitor (air dielectric) consisting of the measuring probe and a metal plate of at least 300 mm diameter. The distance between the surface of the probe and the plate must be 30 mm.

The calibration must be performed with sinusoidal fields at the amplitudes and frequencies specified in table *9.3.4.3*.

Table 9.3.4.3. Calibration frequencies and amplitudes

	Frequencies	**Amplitude**
Band I	**50, 100, 500, 1000 Hz**	**10, 25 V/m**
Band II	**15, 30, 60,120 kHz**	**1.0, 2.5, 10 V/m**

Recorded values at these calibration points must be within ± 5 % of the nominal value. Due to the nature of the specified filters, the deviation must be calculated at 1 kHz from 9.5 and 22.5 V/m and at 120 kHz from 0.95, 2.4 and 9.5 V/m.

Alternating magnetic field meter in band I and band II

The magnetic field must be measured using coil systems that must consist of three mutually perpendicular concentric circular coils each with an area of 0.01 m^2. The coils may depart

from a circular shape where they intersect. The minimum inner diameter must be 110 mm and the maximum outer diameter 116 mm. The measuring coils must not be sensitive to electric fields.

The resonance frequency of each coil appropriately connected to cables and amplifiers must not be so low that it may influence the specified frequency response according to table 9.3.4.2.
Amplifiers and integrating networks that makes the output voltage proportional to the magnetic flux density and independent of frequency must follow each coil. The specifications in respect of the frequency response are given in the calibration procedure.

High-pass and low-pass filters must filter the signals from the coil systems. The specifications of the filters are given in table 9.3.4.2.

After amplification, integration and filtering, the signals from the three coils in each coil set must be used as input values for calculating the r.m.s. values of the amplitudes of the magnetic flux density vectors in both frequency bands. It is permissible to calculate the r.m.s. value for each of the coil signals and use the root of the squared sum of those r.m.s. values as the test result.

The measuring time must be sufficiently long to enable measurement with an accuracy of ±5% at 50/60 Hz.

The alternating magnetic field meter in band I and band II must be capable of measuring down to at least 40 nT in band I and down to 5.0 nT in band II.

The alternating magnetic field meter in band I and band II must be calibrated using a Helmholtz-type calibration coil as shown in the figure 9.3.4.4. Calibration set-up. Calibration must be performed with sinusoidal fields at the amplitudes and frequencies specified in table 9.3.4.2.

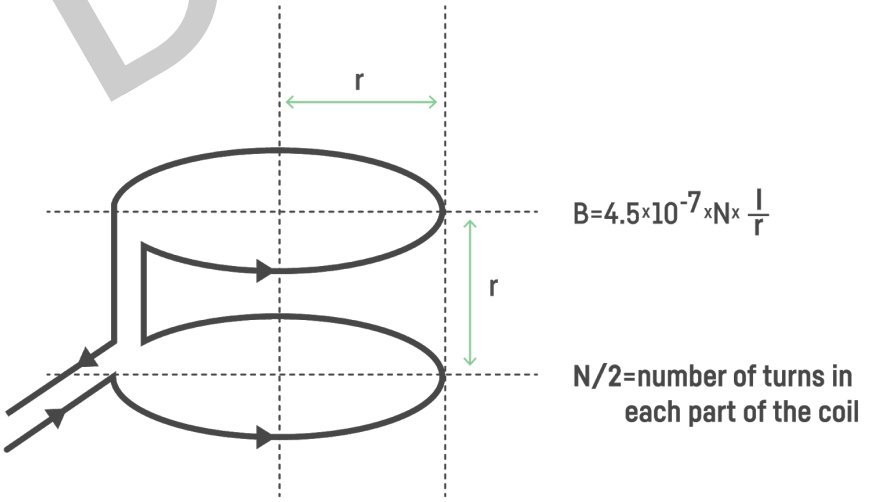


Figure 9.3.4.4. Calibration using a Helmholtz-type calibration coil.

Table 9.3.4.5. Calibration frequencies and amplitudes

	Frequencies	Amplitudes
Band I	**60, 100, 500, 1000 Hz**	**200, 2000 nT**
Band II	**15, 30, 60,120 kHz**	**25, 250 nT**

Recorded values for these calibrations must not deviate more than ± 5 % from the nominal value. Due to the nature of the specified filters, the deviation at 1 kHz must be calculated from 180 nT and 1800 nT and at 120 kHz from 24 nT and 240 nT.

The calibration must be performed for each of the three individual coils separately exposed and for one situation where approximately the same flux density passes through all three coils.