

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Audio, video, and related equipment – Determination of power consumption –
Part 3: Television sets**

**Appareils audio, vidéo et matériel connexe – Détermination de la consommation
de puissance –
Partie 3: Téléviseurs**



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DETERMINATION OF POWER CONSUMPTION –****Part 3: Television sets****FOREWORD**

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IEC 62087-3 has been prepared by technical area 19: Environmental and energy aspects for multimedia systems and equipment, of IEC technical committee 100: Audio, video and multimedia systems and equipment. It is an International Standard.

This second edition cancels and replaces the first edition published in 2015. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) it introduces measuring procedures for the determination of power consumption in the On mode while viewing static metadata HDR video content;
- b) all tests for On mode power determination are performed with MDD disabled;
- c) only progressive video signals are used for testing;
- d) a dimmable LED reflector lamp is used as a light source for illuminating the ABC sensor to achieve specific illuminance levels;

e) a dynamic box and outline video signal is used for determining the ratio of peak luminance.

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

Draft	Report on voting
100/3772/CDV	100/3849/RVC

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

A list of all parts in the IEC 62087 series, published under the general title *Audio, video, and related equipment – Determination of power consumption*, can be found on the IEC website.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

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- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

INTRODUCTION

This document specifies the determination of the power consumption of television sets for consumer use.

This document includes measuring procedures for the determination of power consumption in the On (operation) mode, which was identified as "On (average) mode" in previous editions of IEC 62087. Additionally, it specifies measuring procedures for the determination of power consumption in the Off mode and Partial On mode. This document also defines the determination of the peak luminance ratio for use associated with television set power consumption evaluation as well as the power factor. It also defines measuring procedures for the determination of power consumption in the On mode while viewing representative static metadata HDR video content.

A verification procedure to assess product compliance is described in Annex A of IEC 62087-1:2015.

The IEC 62087 series consists of the following planned or published parts:

- Part 1: General
- Part 2: Signals and media
- Part 3: Television sets
- Part 4: Video recording equipment
- Part 5: Set-top boxes
- Part 6: Audio equipment
- Part 7: Computer monitors

AUDIO, VIDEO, AND RELATED EQUIPMENT – DETERMINATION OF POWER CONSUMPTION –

Part 3: Television sets

1 Scope

This part of IEC 62087 specifies the determination of the power consumption and related characteristics of television sets. Television sets include, but are not limited to, those with LCD, OLED, or projection technologies.

The operating modes and functions, as they specifically apply to television sets, are defined in detail in this part of IEC 62087.

This document is limited to television sets that can be connected to an external power source. Television sets that include a non-removable, main battery are not covered by this document. Television sets can include any number of auxiliary batteries.

The measuring conditions in this document represent the normal use of the equipment and can differ from specific conditions, for example as specified in safety standards.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 62087-1:2015, *Audio, video, and related equipment – Determination of power consumption – Part 1: General*

IEC 62087-2:2023, *Audio, video, and related equipment – Determination of power consumption – Part 2: Signals and media*

IEC 62301, *Household electrical appliances – Measurement of standby power*

3 Terms, definitions, and abbreviated terms

For the purposes of this document, the terms and definitions given in IEC 62087-1:2015, IEC 62087-2:2023 and in the following apply.

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

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

3.1 Terms and definitions

3.1.1

television set

TV

equipment for the reception and display of television broadcast and similar services for terrestrial, cable, satellite and broadband network transmission of analogue and/or digital signals

Note 1 to entry: A television set can include additional functions that are not required for its primary function.

3.1.2

forced menu

on-screen menu that requires the user to choose a configuration option when a television set is first setup or after a factory reset

Note 1 to entry: For example, a forced menu can offer the user the option to select either "Normal"/"Home" or "Retail"/"Store" configuration.

Note 2 to entry: See Figure 1.

3.1.3

normal configuration

setting intended to be chosen for home use from the forced menu

Note 1 to entry: Subclause 4.2.2 describes the selection of normal configuration from the forced menu. This configuration selection is generally named "normal", "home", "standard", or equivalent.

Note 2 to entry: See Figure 1 and 3.1.16.

3.1.4

default configuration

manufacturer's preset configuration for television sets without a forced menu

Note 1 to entry: See Figure 1.

3.1.5

retail configuration

forced menu selection intended for use in a retail environment

Note 1 to entry: Subclause 4.2.3 describes the selection of retail configuration from the forced menu. This configuration selection is generally recommended by the manufacturer for presentation in a public space when the television set is offered for sale and might be named "retail", "store", "shop", or equivalent.

Note 2 to entry: See Figure 1.

3.1.6

preset picture setting

common set of manufacturer-defined parameters which differ in their settings

Note 1 to entry: Examples of parameters of preset picture settings are brightness, contrast, colour space, chroma control.

3.1.7

selectable preset picture setting

TV picture setting that is selectable by a user from a set of manufacturer-defined picture settings

Note 1 to entry: See Figure 1.

3.1.8

default picture setting

picture setting for television sets in the normal or default configuration that is highlighted, or if none is highlighted, the picture setting first available for user selection

Note 1 to entry: See Figure 1. The HDR default picture setting (if different than the default picture setting) is the one that the TV enters when HDR video is played from the starting point of the SDR default picture setting.

3.1.9

brightest selectable preset picture setting

user selectable, preset picture setting that produces the highest luminance picture in the normal or default configuration

Note 1 to entry: See Figure 1.

3.1.10

overall brightest preset picture setting

retail picture setting or the brightest selectable preset picture setting, whichever produces the highest luminance picture

Note 1 to entry: See Figure 1.

3.1.11

retail picture setting

selectable preset picture setting intended for use in a retail environment

Note 1 to entry: See Figure 1.

3.1.12

motion-based dynamic dimming

MDD

television feature that adjusts luminance in response to amount of motion in the displayed image

3.1.13

special function

function that is related to, but not required for, the primary function of the device

Note 1 to entry: Examples of special functions include, but are not limited to, special sound processing and power-saving functions (e.g. automatic brightness control).

Note 2 to entry: Refer to the definition of television set (TV) (3.1.1) for primary function.

3.1.14

conditional access

encryption, decryption, and authorization techniques employed to protect content from unauthorized viewing

3.1.15

conditional access module

plug-in module that enables conditional access

3.1.16

plug-in module

device that plugs into television sets to provide additional functionality

3.1.17

point of deployment module

conditional access module for digital signal reception

3.1.18

CAT5e

category 5e cable

twisted pair cable used for computer networks

Note 1 to entry: See IEC 61156-5 and IEC 61156-6.

3.1.19**neutral density filter****ND filter**

optical device that is designed to reduce the light intensity equally over the range of visible wavelengths

3.1.20**quick-start**

function that reduces the television set's resume time from Partial On mode to On mode

Note 1 to entry: Resume time is measured in accordance with 6.6.1.

3.1.21**colour rendering index****CRI**

measure of the degree to which the psychophysical colour of an object illuminated by the test illuminant conforms to that of the same object illuminated by the reference illuminant, suitable allowance having been made for the state of chromatic adaptation

Note 1 to entry: See also CIE 13, Method of Measuring and Specifying Colour Rendering of Light Sources.

[SOURCE: IEC 845-22-109, modified – Note 2 to entry and Note 3 to entry removed]

3.2 Abbreviated terms

ABC	automatic brightness control
AV	audio-visual
BD	Blu-ray Disc™ ¹
DVD	digital versatile disc
DHCP	dynamic host configuration protocol
DVI	Digital Visual Interface
EMC	electromagnetic compatibility
FM	frequency modulation
HDD	hard disk drive
HDMI® ²	High Definition Multimedia Interface
HDR	high dynamic range
HLG	hybrid log-gamma
IP	internet protocol
LAN	local area network
LED	light-emitting diode
LCD	liquid-crystal display
LMD	light measuring device
LNB	low-noise block
MDD	motion-based dynamic dimming
NAT	network address translation

¹ Blu-ray Disc™ is a trade mark of the Blu-ray Disc Association. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of the product named. Equivalent products may be used if they can be shown to lead to the same results.

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ND	neutral density
OLED	organic light-emitting diode
PC	personal computer
PQ	perceptual quantizer
RF	radio frequency
SCR	silicon-controlled rectifier
SDR	standard dynamic range
STB	set-top box
SSID	service set identifier
TV	television set
USB ³	Universal Serial Bus
UUT	unit under test
VGA	Video Graphics Array
WAN	wide area network
WCG	wide colour gamut
WLAN	wireless local area network
WOL	wake-on-LAN
WoWLAN	wake on wireless LAN
WPA	Wi-Fi protected access
WPA2	Wi-Fi protected access 2

4 Specification of operating modes and functions

4.1 Table of operating modes and functions

Table 1 describes the various operating modes and functions for television sets.

For all modes, main batteries, if any, shall be removed for the duration of the measurement procedure (see IEC 62087-1:2015, 5.1.1.1.)

³ USB Implementers Forum, Inc. takes the position that the terms "USB" and "Universal Serial Bus" are generic terms. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of the product named. Equivalent products may be used if they can be shown to lead to the same results.

Table 1 – Operating modes and functions

Power	Mode	Sub-mode	Function(s)	Functional description for TV
0 W	Disconnected	Disconnected	– Disconnected from power source	The television set is disconnected or galvanically isolated from all external power sources.
≥ 0 W	Off	Off	– Off	The television set is connected to an external power source and does not produce picture or sound and does not provide any other function that depends on an external power source. The television set cannot be switched into any other mode with the remote control unit, or an external or internal signal. Some power may be consumed if an EMC filter or other components exist on the source side of the power switch.
> 0 W	Partial On	Standby-passive	– Wake on • remote control • internal signal	The television set is connected to an external power source and does not provide picture or sound. The television set can be switched into another mode with the remote control unit or an internal signal, but not with an external signal.
		Standby-active, low	– Wake on • remote control • internal signal • external signal	The television set is connected to an external power source and does not provide picture or sound. The television set can be switched into another mode with the remote control unit or an internal signal and can additionally be switched into another mode with an external signal. NOTE 1 When in Standby-active, low mode, a television set may be able to be switched into the On mode, the Off mode, the Standby-passive, or the Standby-active, high mode. NOTE 2 A network-enabled TV is considered to be in Standby-active low when its presence on a local area network can be detected and there is minimal data communication beyond network maintenance.
		Standby-active, high	– Wake on • remote control • internal signal • external signal – Data communications	The television set is connected to an external power source and does not provide picture or sound. The television set can be switched into another mode with the remote control unit, an internal signal, or an external signal. Additionally, the television set is exchanging/ receiving data with/from an external source. Determination of power consumption in this sub-mode is not specified by this document.
	On	Operation	– Operation	The television set is connected to an external power source and provides picture and, if possible, sound.

4.2 Configurations and picture settings

4.2.1 Conceptual framework

Figure 1 shows a conceptual framework that includes the various configurations and picture settings for television sets.

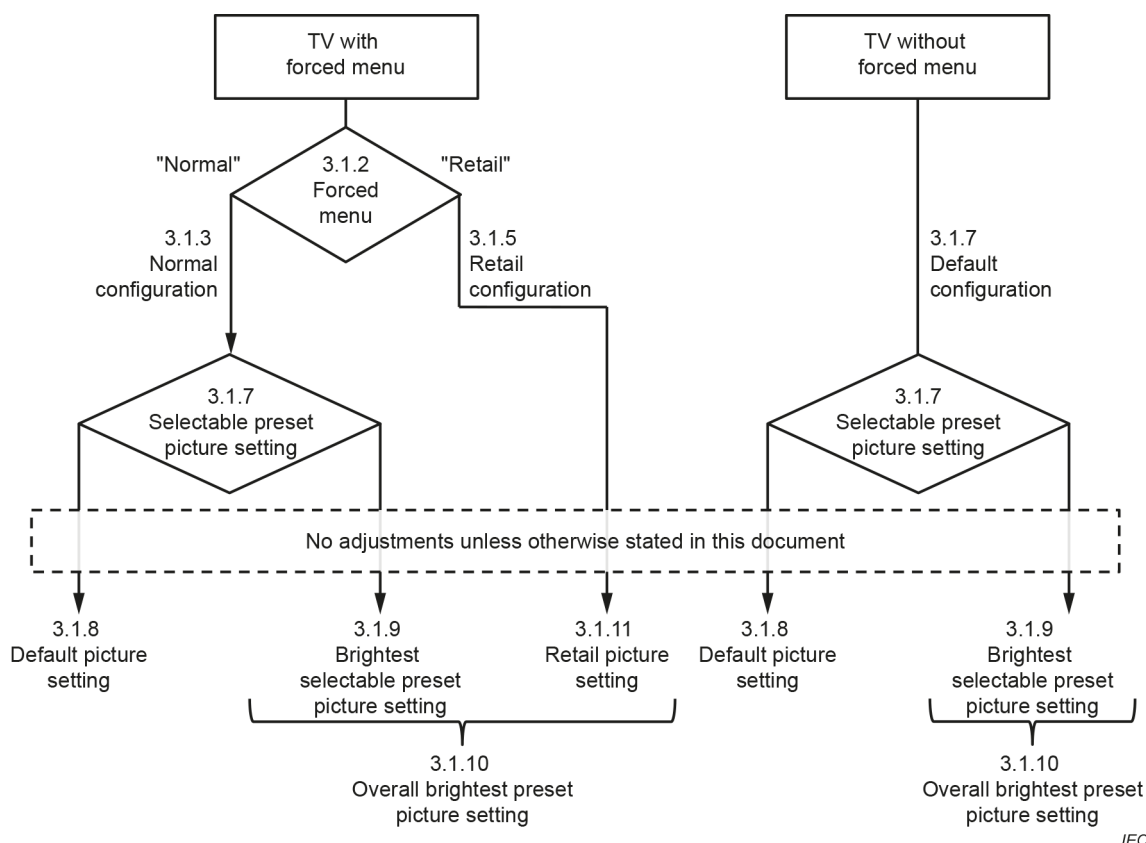


Figure 1 – Configurations and picture settings, conceptual framework

4.2.2 Selection of normal configuration

When directed in this document, the normal configuration shall be selected from the forced menu by choosing the configuration that is recommended for normal home use and, if not clearly defined, the default picture setting from the forced menu shall be selected: either the manufacturer's indicated option from the forced menu or, if no preference is indicated, the first option listed.

If the UUT has no forced menu, it shall remain in the default configuration.

NOTE A factory reset can be required in order to enter the normal configuration after the retail configuration has been previously selected.

4.2.3 Selection of retail configuration

When directed in this document, retail configuration shall be selected from the forced menu by choosing the configuration that, without any other adjustments, results in the highest display luminance.

If the UUT has no forced menu, it shall remain in the default configuration.

NOTE A factory reset can be required in order to enter the retail configuration after the normal configuration has been previously selected.

5 Measurement conditions

5.1 General

The measurement conditions clause specifies requirements that are independent of the equipment to be evaluated. When setting up a test laboratory, these requirements shall be taken into account.

The requirements of this clause apply to the procedures specified in Clause 6.

5.2 Power source

Defined in IEC 62087-1:2015, 5.1.1.

5.3 Environmental conditions

Defined in IEC 62087-1:2015, 5.1.2.

5.4 Ambient light conditions

For determining On mode power consumption for television sets with ABC enabled, ≤ 1 lx shall be confirmed at the surface of the ABC sensor assembly with the light sources (5.6.4, 5.6.5) off and the UUT in the Off or Disconnected mode.

For determining the peak luminance ratio (6.5.1.1) with a non-contact LMD, ≤ 5 lx shall be confirmed at the nominal centre of the display area of the UUT in Off or Disconnected mode. This requirement applies whether or not a light source (5.6.5) is applied to disable the ABC feature.

A dark room and/or shroud can be necessary in order to achieve the required ambient light conditions.

5.5 Measuring equipment

5.5.1 Power measuring instrument

Defined in IEC 62087-1:2015, 5.1.5. and IEC 62087-1:2015, 5.1.6.

5.5.2 Luminance measuring device

Defined in IEC 62087-1:2015, 5.1.7.

5.5.3 Illuminance measuring instrument

Defined in IEC 62087-1:2015, 5.1.8.

5.6 Signal generation

5.6.1 Equipment

Defined in IEC 62087-2:2023, 6.1 and IEC 62087-2:2023, 6.2.

5.6.2 Interfaces

Defined in IEC 62087-2:2023, 6.3.

5.6.3 Accuracy

Accuracy of video signal levels is defined in IEC 62087-2:2023, 6.4.

5.6.4 Light source for specific illuminance levels

The light source used for illuminating the ABC sensor to specific illuminance levels shall use a dimmable LED reflector lamp and shall have a diameter of $90 \text{ mm} \pm 5 \text{ mm}$. The rated beam angle of the lamp shall be $40^\circ \pm 5^\circ$. The rated correlated colour temperature (CCT) of the light source shall be $2\,700 \text{ K} \pm 300 \text{ K}$ at its rated voltage. The rated CRI shall be 80 ± 3 . The front surface of the lamp shall be clear (i.e., not coloured or coated with a spectrum modifying material) and may have a smooth or granular front surface; when shined against a uniform white surface, the diffusion pattern should appear smooth to the naked eye. The lamp assembly shall not modify the spectrum of the LED source, including the IR and UV bands.

To reach the illumination levels specified in 6.2.8, the lamp shall be wired with a compatible dimming switch capable of dimming it to the lowest level required in 6.2.8. The lamp shall be capable of providing the highest illumination level when wired with the dimming switch. For luminance levels below 10 lx, a 2-stop ND filter (3.1.19) may be used if the lowest setting of the lamp and dimmer combination does not reach the required level below 10 lx. No ND filter shall be used for luminance levels at or above 10 lx. The ND filter shall be large enough to cover the entire surface of the diffusion area of the lamp. The ND filter shall have an average transmission of $25 \% \pm 2,5 \%$ within the visible range, which is 400 nm to 700 nm, without selectively absorbing light at specific wavelengths.

Caution: the lamp shall be compatible with leading-edge or forward-phase dimmers (i.e. the lamp luminance does not vary with voltage).

Specific illuminance levels shall be obtained by adjusting the dimming switch.

The model of the lamp and dimmer (and versions thereof if available) used for illuminating the ABC sensor to specific illuminance levels shall be reported.

The lamp should be stabilized before testing by setting it to deliver the maximum tested lux to the ABC sensor in accordance with 6.4.2 and maintaining that light level for 10 minutes. Stabilisation may be carried out during the setting up of the light source (see 6.3.7).

5.6.5 Light source for disabling the ABC feature

The same light source as that used in 5.6.4 may be used to override the ABC feature by reducing the distance between the light source and the TV's ABC sensor.

The manufacturer, model and version of the LED bulb used to override the ABC feature shall be reported.

5.6.6 Test table surface material

The table used to hold the UUT shall be covered with black, minimally reflective cloth and shall have the area immediately in front of and underneath the UUT's ABC sensor, as shown in Figure 4, covered with material having a gloss measurement of 15 GU as measured by a 60° gloss meter. The material shall not alter visible light in the 400 nm to 700 nm range that arrives on, or is reflected by, the material. The thickness of the ABC sensor table surface material shall be 4 mm or less and shall be at least 203 mm wide by 177 mm deep; it shall be printed with a matte finish, with a colour adhering to the M1 lighting standard having CMYK values of (43, 53, 84, 84) ± 2 . The card shall not polarize light reflected off its surface.

NOTE See Annex D for further information.

6 Procedures

6.1 Order of activities

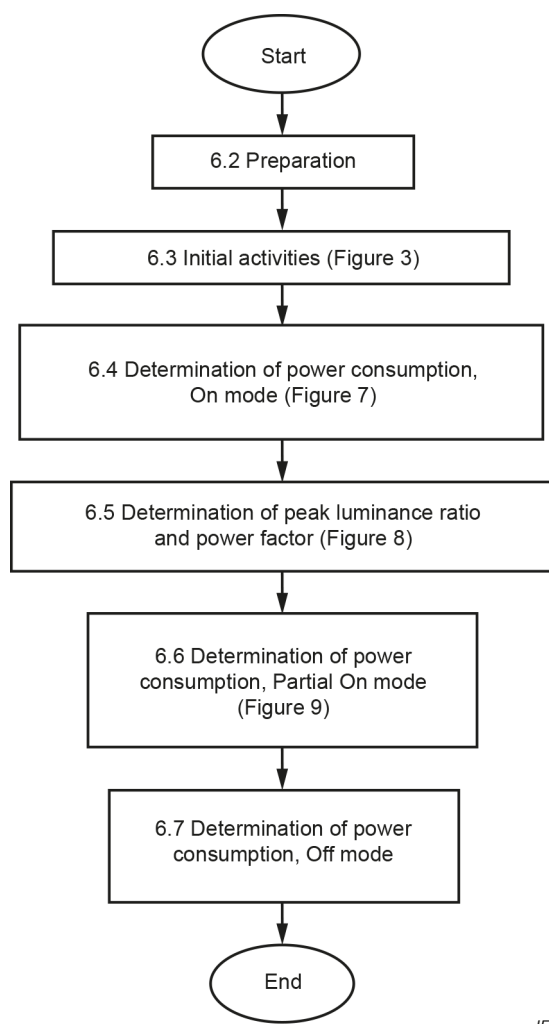
The following order of activities is recommended (also represented in Figure 2):

- preparation (6.2),
- initial activities (6.3),
- determination of power consumption, On mode (6.4),
- determination of peak luminance ratio and power factor (6.4.5.5),
- determination of power consumption, Partial On mode (6.6),
- determination of power consumption, Off mode (6.7).

The above order is chosen to ensure proper stabilization prior to the taking of each measurement. The technician performing the activities may vary the order as needed. However, the stabilization process prior to the taking of each measurement shall effectively be the same as if the recommended order had been followed.

A flowchart with the comprehensive measurement process is provided in Annex E, Figure E.1.

Countdown timers and 50 % grey field endings have been added to most of the video signal test clips referenced by this document to allow test personnel to easily maintain a UUT's stabilization while moving from one measurement method to the next. It is easy to inspect a given test's power consumption log to note when the test both started and ended. Test personnel are encouraged to familiarize themselves with each video signal test clip prior to using them for actual testing.



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Figure 2 – Recommended order of activities

6.2 Preparation

6.2.1 Measuring plan

Before the UUT has been installed, a measuring plan should be developed based on the specifications of the UUT and the region in which the results are to be reported. The measuring plan is based on the decision points in 6.2.2 through 6.2.9. These decision points include:

- power source voltage and frequency (6.2.2),
- input terminals (6.2.3),
- video signal, On mode power consumption procedure (6.2.4),
- video signal, peak luminance ratio procedure (6.2.5),
- video format (6.2.6),
- automatic brightness control capabilities (6.2.7),
- automatic brightness control levels (6.2.8),
- motion-based dynamic dimming (6.2.9),
- network connection selection (6.2.10).

When these decisions have been taken, the following activities can be expected to be deterministic.

A comprehensive list of items which shall be reported (test report) is provided in Annex B. Annex C shows an example test report template.

6.2.2 Power source voltage and frequency

Whether the UUT is to be powered by an included external power supply (IEC 62087-1:2015, 5.1.1.2), mains power (IEC 62087-1:2015, 5.1.1.3), and/or power from other than the mains (IEC 62087-1:2015, 5.1.1.4) shall be determined and shall be described in the report.

The voltage and frequency of the power source shall be reported.

6.2.3 Test signal input terminals

The following selection hierarchy for the test signal input terminal shall be used:

- USB (single USB stick directly inserted to the USB port of the UUT, the USB port recommended in the instruction manual for video file playback with the highest data rate specified shall be used),
- HDMI® (using a media player to play test media stored on a single USB stick),
- component analogue (using a media player to play test media stored on a single USB stick),
- S-Video (using a media player to play test media stored on a single USB stick),
- composite analogue (using a media player to play test media stored on a single USB stick),
- other AV or RF input.

DVI, VGA, and other inputs that are primarily used for connections with computers (as compared to AV equipment) shall not be used.

One type of input terminal shall be selected for use during the procedure. If the power consumption of the UUT is to be determined with multiple video input terminal types for comparison purposes, the entire procedure should be performed multiple times, each time with a single set of input terminals selected, to ensure proper stability under each condition.

The selected input terminals and used signal provision equipment shall be reported.

6.2.4 Video signal, On mode power consumption procedure

A video signal shall be selected for use during the On mode power consumption determination procedure. The dynamic broadcast-content video signals (SDR and HDR as applicable) noted below shall be used unless regional regulatory requirements mandate the use of the static video signals and/or Internet-content video signals referenced below.

- SDR dynamic broadcast-content video signal (IEC 62087-2:2023, 4.1.3.2),
- HDR dynamic broadcast-content video signal (IEC 62087-2:2023, 4.1.3.3),
- static video signals (IEC 62087-2:2023, 4.1.2),
- Internet-content video signal (IEC 62087-2:2023, 4.1.4).

The video signal selected for determining On mode power consumption shall be reported.

NOTE Information regarding the selection of the video signal for the On mode power consumption measurement is available in IEC 62087-2:2023, Annex B.

6.2.5 Video signal, peak luminance ratio determination

A video signal shall be selected for use during the peak luminance ratio procedure. One of the dynamic box and outline video signals noted below shall be used unless regional regulatory requirements mandate the three-bar video signal be used, also referenced below:

- dynamic box and outline video signals (IEC 62087-2:2023, 4.2.2.2),
- three-bar video signal (IEC 62087-2:2023, 4.2.2.1).

The selection of the appropriate dynamic box and outline video signal is given in 6.5.2.5. The selected video signal for determining the peak luminance ratio shall be reported.

NOTE Information regarding the selection of the video signal for the determination of the peak luminance ratio is available in IEC 62087-2:2023, Annex C.

6.2.6 Video format

6.2.6.1 SDR

The SDR video resolution and frame rate of the signals applied to the UUT during the procedure shall be selected. The selected resolution and frame rate shall be compatible with the input terminal selected in 6.2.3.

The priority order of video resolutions shall be:

- high definition 1 920 × 1 080 progressive;
- standard definition 720 x 576 or 720 x 480 progressive.

The maximum resolution of the SDR video signal applied to the UUT shall be 1 920 pixels by 1 080 pixels. If a standard definition video signal is used, it shall be at the standard broadcasting video resolution of the country or region in which the power consumption measurement is to be reported.

The video frame rate used during the measurements shall be at the standard broadcasting vertical frequency of the country or region in which the power consumption measurement is to be reported.

The selected resolution and frame rate of the SDR input signals shall be reported.

NOTE 1 Video with a 59,94 Hz frame rate is often casually referred to as "60 Hz".

NOTE 2 Technologies for the distribution of content with a resolution of more than 1 920 pixels × 1 080 pixels are prevalent. However, the SDR media available in IEC 62087-2:2023 is available in standard and high definition only. By limiting the video source resolution to 1 920 × 1 080 pixels, this document ensures that the associated signals will be up-converted by the UUT, avoiding the possibility of varying results from various external up-converters (see 6.3.10.6).

6.2.6.2 HDR

The HDR EOTF, video resolution and frame rate of the signals applied to the UUT during the procedure shall be selected from the IEC test signals provided. The selected resolution and frame rate shall be compatible with the input terminal selected in 6.2.3.

The priority order of video resolutions shall be:

- 3 480 × 2 160 progressive
- 1 920 × 1 080 progressive

The maximum resolution of the HDR video signal applied to the UUT shall be 3 480 pixels by 2 160 pixels.

The HDR EOTF (either HDR10 or HLG) from the IEC supplied test signals used during the measurements shall match the standard HDR EOTF used in the country or region in which the power consumption measurement is to be reported.

The video frame rate used during the measurements shall be at the standard broadcasting vertical frequency of the country or region in which the power consumption measurement is to be reported.

The selected resolution, HDR EOTF and frame rate of the HDR input signals shall be reported.

6.2.7 Automatic brightness control capabilities

There are three types of television sets with respect to ABC:

- television sets that do not have an ABC feature;
- television sets that have an ABC feature that is not enabled by default;
- television sets that have an ABC feature that is enabled by default.

The presence of an ABC feature and whether or not the ABC feature is enabled by default (in both SDR and HDR default pre-set picture settings) shall be reported.

6.2.8 Automatic brightness control levels

The On mode power consumption of television sets with the automatic brightness control disabled by default in the SDR or HDR default picture setting shall be determined with the ABC feature disabled.

For television sets with the ABC feature enabled by default in the default SDR or HDR picture setting, the On mode power consumption shall be determined with the ABC feature enabled and/or manually disabled. If the ABC feature is enabled, the On mode power consumption shall be determined over a minimum of one and a maximum of four different illuminance levels with respect to the ABC feature.

The state(s) of the ABC feature and the illuminance levels selected to be applied to the ABC sensor shall be reported along with exact illuminance meter readings prior to conducting each test.

NOTE Information for selecting the illuminance levels at the ABC sensor and the states of the ABC feature is available in Clause A.2.

6.2.9 Motion-based Dynamic Dimming

All tests for SDR or HDR On mode power determination in accordance with 6.4 shall be performed with MDD disabled. If MDD cannot be disabled, the unit shall be tested in the brightest selectable SDR or HDR preset picture settings as determined in 6.5.1.5 and 6.5.2.4.

Preset picture settings used for testing shall exclude the following:

- picture settings labelled "PC" or "Computer" or otherwise intended for the use case where the television set is to be used as a monitor connected to a computer;
- picture settings labelled "Game" or "Gaming" or otherwise intended for low-latency use when the television set is connected to a gaming console;
- picture settings labelled "Accessibility" or "Low Vision" or otherwise intended to produce high-contrast pictures explicitly for use by viewers with limited vision capabilities.

The state of the MDD feature during testing shall be reported.

6.2.10 Network connection selection

Network connections should be listed in the user manual. If no connections are specified in the user manual, verify that the TV does not have network capabilities by checking for the absence of physical connections and the absence of network settings in the menu. If the TV has the

capability to be connected to a network but was not shipped with a required piece of hardware (e.g. wireless adapter) excluding any external cables, that connection type shall not be tested.

If the TV is network enabled, connect it to a LAN in On mode and prior to being placed into Standby mode. The LAN shall allow devices to ping other devices on the network but will not allow access to a WAN. If the TV has multiple network connections (e.g. Wi-Fi and Ethernet), the TV shall be configured and connected to a single network source in accordance with the hierarchy of connections listed in Table 2.

Table 2 – Network Connection Hierarchy

Priority	Network connection type
1	Wi-Fi (Institution of Electrical and Electronics Engineers—IEEE 802.11-2007)
2	Ethernet (IEEE 802.3). If the TV supports Energy Efficient Ethernet (IEEE 802.3az-2010), then it shall be connected to a device that also supports IEEE 802.3az.
3	Bluetooth®

For wireless Wi-Fi connectivity, a Wi-Fi wireless access point that is compatible with the maximum performance specifications (e.g. the maximum speed or data rate supported by the Wi-Fi port of the UUT) shall be used.

For wireless Bluetooth® connectivity, an edge device that is compatible with the UUT's Bluetooth® implementation shall be used. For wired connectivity, a CAT5e or better cable and an Ethernet switch or router that supports the maximum performance specifications (e.g. the maximum speed or data rate supported by the Ethernet port of the UUT) shall be used. If the UUT supports Energy Efficient Ethernet, the Ethernet router shall also be compatible with the same version of Energy Efficient Ethernet.

The networking equipment shall not be connected to a wide area network (WAN).

Wireless networking equipment and the UUT shall be located in the same room within 1 m to 5 m of each other with no interfering objects in between.

The presence of Wi-Fi, Ethernet, and Energy Efficient Ethernet in the UUT shall be reported.

NOTE Devices that are supplied as part of the UUT that are capable of reactivating the UUT, for example an IR, RF, Wi-Fi or Bluetooth® remote control are not considered to be networking equipment. Devices or applications not supplied with the UUT, for example Wi-Fi connected sub-woofers, downloadable applications, that are capable of reactivating the UUT via IR, RF, Bluetooth® or Wi-Fi, for example an optional accessory or mobile phone, are considered to be networking equipment.

6.3 Initial activities

6.3.1 Order of initial activities

Figure 3 shows the order in which the initial activities shall be performed.

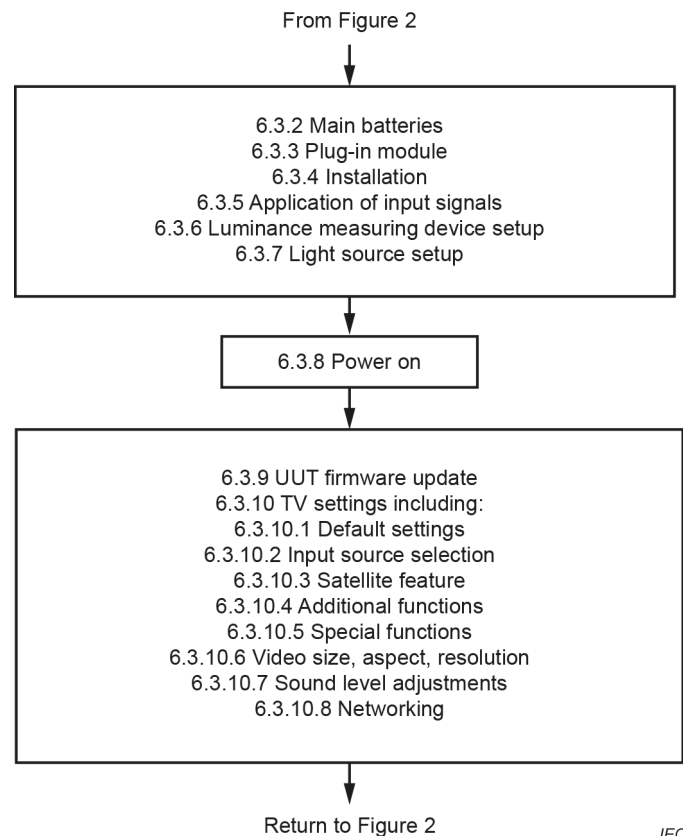


Figure 3 – Order of initial activities

6.3.2 Main batteries

Main batteries, if any, shall be removed for the duration of the measurement procedure.

6.3.3 Plug-in module

No user-removable plug-in module, such as a conditional access module, a point of deployment module, a USB or HDMI® stick or an external media storage unit, shall be connected to the UUT during the measurement procedure, unless it is installed in the UUT as shipped to the end customer. If the UUT is shipped to the end customer with a user-removable plug-in module which is described in the user manual as necessary for the product's primary out-of-box functionalities, that user-removable module shall be connected during the measurement procedure.

A USB stick that contains media files (video, image, audio) for testing as specified in this document may be connected to the UUT as a test media source during a given measurement procedure.

6.3.4 Installation

The UUT shall be installed in accordance with the manufacturer's instructions.

In order to simplify alignment of the light source, all four corners of the face of the UUT should be equidistant from a vertical reference plane (e.g. a wall) and the bottom two corners of the face of the UUT should be equidistant from a horizontal reference plane (e.g. the floor). See 6.3.7 and Figure 4 for the exact test environment setup.

The environmental conditions (5.3) and ambient light conditions (5.4) shall be confirmed. If a non-contact LMD is to be used and the ABC feature of the UUT cannot be manually disabled via the on-screen menus of the UUT, ambient light conditions at the nominal centre of the

display area shall be confirmed with the UUT in its Off or Disconnected mode and the light source of 5.6.5 is applied to the UUT.

6.3.5 Application of input signals

The video input signal selected in 6.2.4 and the audio signal described in IEC 62087-2:2022, 4.1.5 shall be applied to the respective input terminal(s) selected in 6.2.3. The video signal shall be in the format selected in 6.2.6. In the case of measurement with the static video signals, the full field colour bar video signal shall initially be used.

6.3.6 Luminance measuring device setup

The LMD (5.5.2) shall be aligned perpendicular to the centre of the display area.

- If a non-contact LMD is being used for testing, the LMD shall be at a distance capable of achieving the accuracy required in 5.5.2.
- If a contact LMD is being used, especially with smaller display sizes, it shall be ensured that the display area measured has a diameter at least as large as the LMD sensor area and that the sensor of the contact LMD can be positioned without overlap to neighbouring areas, otherwise a non-contact LMD shall be used.

6.3.7 Light source setup

The lamp shall be positioned to meet the following requirements:

- $X = K \times Y \pm 5 \text{ cm}$
where
 X equals the horizontal distance between the UUT front panel and the lamp front centre point
 Y equals the vertical distance between the ABC sensor window of the UUT and the lamp front centre point
 K is the tangent of the angle between X and Y
- $1 \text{ m} \leq X \leq 3 \text{ m}$
- $0,576 < K < 1,732$ (results in 30° to 60° reported lamp angle) where K is specified by manufacturer.

The centre of the beam shall be directed at the location on the bezel closest to the ABC sensor $\pm 10 \text{ cm}$ orthogonal to the centre of the beam at the sensor. This tolerance can be ensured by moving the lamp until the maximum lux level is observed on a illuminance meter and by running a string from the ABC sensor up to the lamp to visually check alignment. The X and Y positions of the centre of the beam and the illuminance meter's position relative to nearest corner of the TV (or associated device containing ABC sensor like sound bar) shall be recorded.

The illuminance meter shall be pointed orthogonally away from the surface of the TV screen/bezel and aligned with the ABC sensor (left/right, up/down when viewing TV). The measured lux levels shall be recorded.

A contact or non-contact luminance meter shall be pointed orthogonally at the centre of the screen.

The leading edge of the TV stand shall be placed $5 \text{ cm} \pm 1 \text{ cm}$ from front edge of table. The reflective card shall be positioned lengthwise in portrait orientation, centred left-to-right below the ABC sensor, below the TV stand, and aligned with the leading edge of the table.

No surface besides the table (e.g. a wall or the floor) shall be within 0,5 m of the ABC sensor.

The light source setup is illustrated in Figure 4.

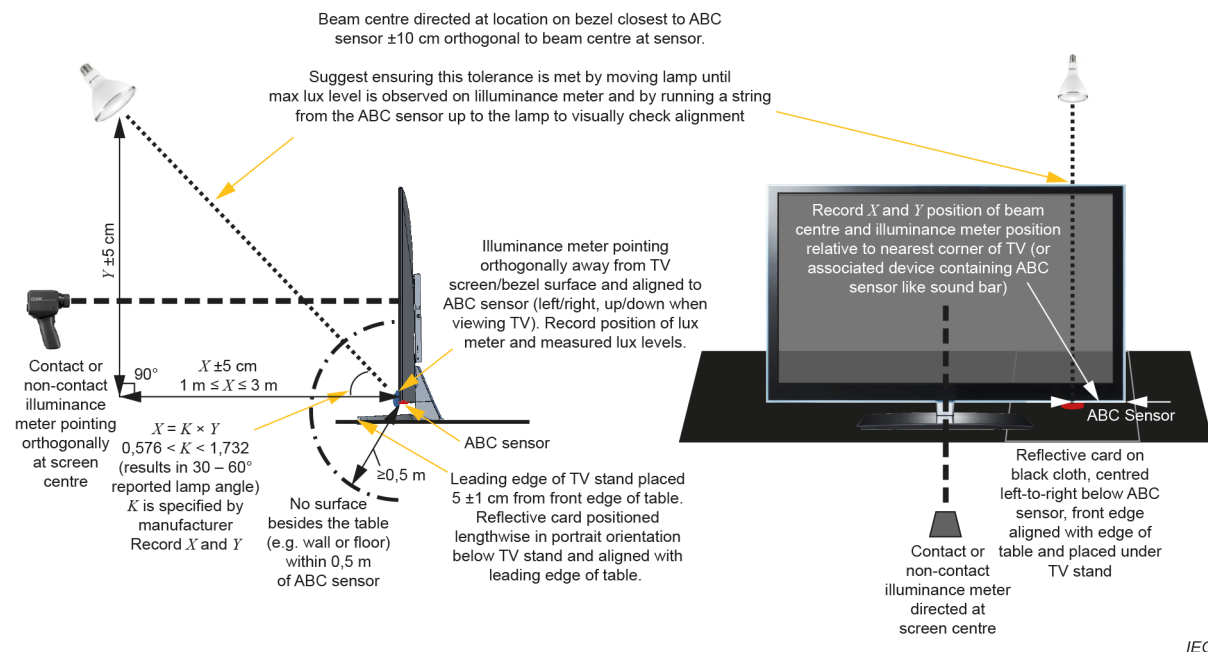


Figure 4 – Light source configuration

Aside from the possible use of a 2-stop ND filter when applying low illuminance levels to the ABC sensor assembly of the UUT, there shall be no obstructions (e.g. diffusing media, IR filters, UV filters) between the illuminating light source and the UUT's automatic brightness control (ABC) sensor assembly during power measurements.

The ND filter, when used, shall be positioned immediately in front of the illumination light source assembly with care to not exceed the filter's operating temperature range. The illumination levels shall be verified with the illuminance measuring instrument positioned immediately in front of the ABC sensor assembly, parallel with the unit's front frame regardless of the orientation of the ABC sensor (i.e. forward facing or downward facing), as shown in Figure 4.

No test room surface (i.e. floor, ceiling, and wall) shall be within a 0,5 m hemisphere in front of the centre of the UUT's ABC sensor. If the UUT ships with or has a built-in table stand, the UUT shall be setup on a table as shown in Figure 4. The table in front of the UUT's ABC sensor should be covered with test table surface material, as specified in 5.6.6.

To improve test repeatability, it is suggested that the illuminance meter be hung over the top of TV with string and a counterweight placed behind the TV, or that it be rested on an object on the surface of the table for improved placement accuracy.

When measuring relative peak luminance with a non-contact LMD and simultaneously illuminating the ABC sensor, a black tube or shroud may be used to shield the screen from the light source described in 5.6.5 as long as the shadow of the tube or shroud does not interrupt in any way the path between the light source and the reflective card.

For TVs/displays that are not capable of being positioned on a tabletop, for example TVs without a stand, they should be tested as close as possible to their intended configuration:

- a) For wall-mounted TVs that include the ABC sensor (Figure 5) within the display enclosure, the TV should be mounted on a matt white wall at least 1 m above floor level with no other objects on the wall within 50 cm of all screen edges.

NOTE A pure white wall colour called 'brilliant white' or matt white that gives a matt (non-glossy) surface is readily available.

Dimensions in centimetres

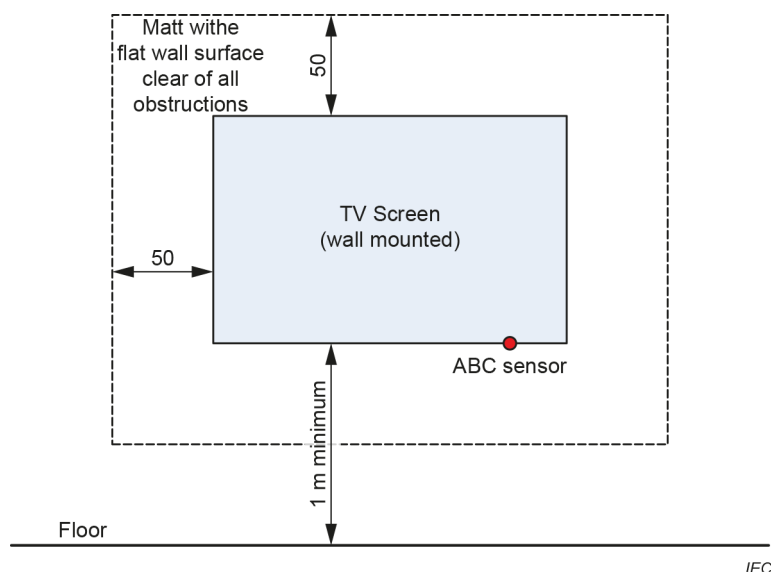


Figure 5 – Wall-mounted TV with built-in ABC sensor

- b) In addition, for wall-mounted TVs where the ABC sensor is located externally to the display (Figure 6) (e.g. in an external electronics box enclosure or sound bar), the ABC sensor enclosure should be positioned in the same vertical plane as the screen (e.g. fixed to the same wall) at no further than 50 cm away. The ABC sensor enclosure should be fixed with or placed on (right-angled) brackets and not on a shelf.

Dimensions in centimetres

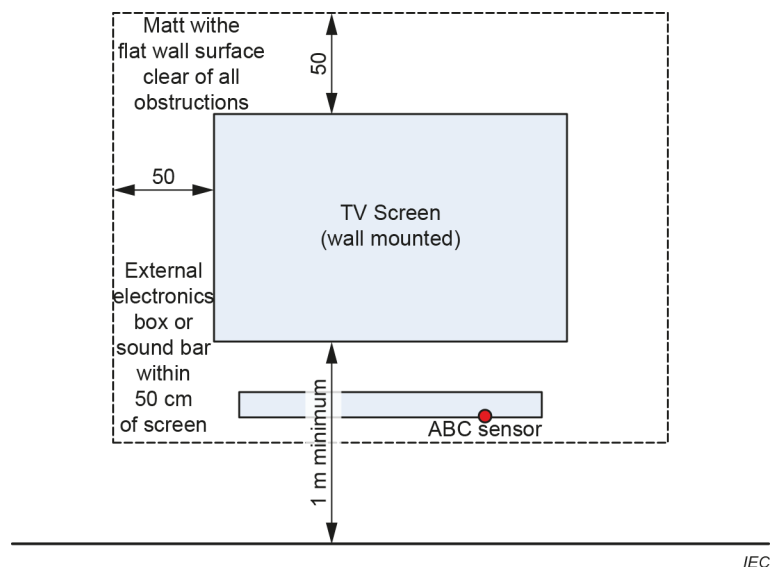


Figure 6 – Wall Mounted TV with External ABC Sensor

- c) For all other TV designs that do fit within the above guidance, for example a rollable display integrated into a furniture-stand supplied by the TV manufacturer, the TV should be tested with all such furniture on a floor covered with black felt material to a distance of at least 1 m away from all such furniture.

The UUT mounting configuration used in Figure 4, Figure 5 or Figure 6 during testing shall be reported, including details of the exact light source configuration used.

This document cannot consider every variation of consumer (or laboratory) test environment (e.g. exact ambient lighting colour temperature; lighting angle of incidence with respect to the UUT's ABC sensor; wall, floor, ceiling paint colour, texture, reflectivity; specific UUT mounting configuration). Therefore, this document provides the two methods most representative of consumer use, i.e. on an entertainment stand/table or wall-mounted/manufacturer-supplied furniture stand.

6.3.8 Power on

The UUT shall be connected to an external power source and shall be set in the On mode. The requirements specified in IEC 62087-1:2015, 5.1.1.5 (On mode) apply.

6.3.9 UUT firmware update

If a firmware update for the UUT is available, it shall be updated in accordance with the manufacturer's instructions, for example via a USB stick or the UUT's network connection by temporarily connecting it to the Internet. Upon completing any firmware update, disconnect the USB stick containing the firmware update files or Internet connection from the UUT.

The firmware version of the UUT as tested shall be reported.

Software applications that are optional for user installation shall not be installed.

6.3.10 TV settings

6.3.10.1 Default setting

The UUT shall remain or be set as originally shipped by the manufacturer unless the television set provides a forced or normal configuration, which shall then be selected. The UUT shall remain in the default picture setting as selected above throughout the procedure except when this document directs otherwise.

Within the context of the normal configuration, if the user is prompted by the forced menu to enable or disable the quick-start feature, the power consumption in Standby-passive (6.6.4) shall be determined with quick-start disabled. The power consumption in Standby-passive may be determined again with quick-start enabled via the on-screen menus. If the quick-start feature is not offered in the forced menu, the quick-start feature shall remain in the default setting throughout the procedure.

Also, within the context of the normal configuration, if the user is prompted by the forced menu to enable or disable the ABC feature, the power consumption in On mode (6.4) shall be determined with ABC disabled. The power consumption in On mode may be determined again with ABC enabled via the forced menu selection. If the ABC feature is not prompted in the forced menu, it shall remain in the default setting throughout the procedure, except where otherwise directed.

The selection(s) made within the forced menu, if it exists, shall be reported.

6.3.10.2 Input source selection

The input terminals chosen in 6.2.3 shall be selected as the active source of picture and sound generated by the UUT.

6.3.10.3 Satellite feature

If the UUT includes a satellite dish LNB power supply, it shall be turned off, if possible, during the measurement process to eliminate the power drawn by the LNB in the measurements. If this is not possible, then this shall be reported.

6.3.10.4 Additional functions

Capabilities not required for the primary function of the UUT, such as a VCR unit, a DVD unit, an HDD unit, an FM-radio unit, a memory card-reader unit, or an ambient lighting unit shall be turned off during the measurement process in the cases that those functions can be turned on and off by the end user.

6.3.10.5 Special functions

Special functions not otherwise mentioned in this clause shall be in the position adjusted by the manufacturer for shipment to the end user.

6.3.10.6 Video size, aspect ratio, and resolution

The UUT shall be set in such a manner that the active area of the video input signal fills the entire display area.

If the UUT has a display with a resolution higher than 1 920 pixels by 1 080 pixels and the UUT cannot be adjusted in such a manner that the video input signal fills the entire display area, an external player with an up-conversion function should be used in order to fill the entire display area.

If any setting of the UUT is changed from the default in order to fill the entire display area, the changed settings shall be reported. The player used and its related settings shall be reported.

6.3.10.7 Sound level adjustments

The volume control shall be adjusted to a level at which the sound output is just audible. If audibility cannot be confirmed, visual indication of the volume level on the on-screen-display shall be set within 8 % and 12 % of its maximum.

NOTE The intent of the above requirement is to ensure that the sound circuitry in the UUT is active while keeping sound pressure levels from the UUT low.

6.3.10.8 Networking

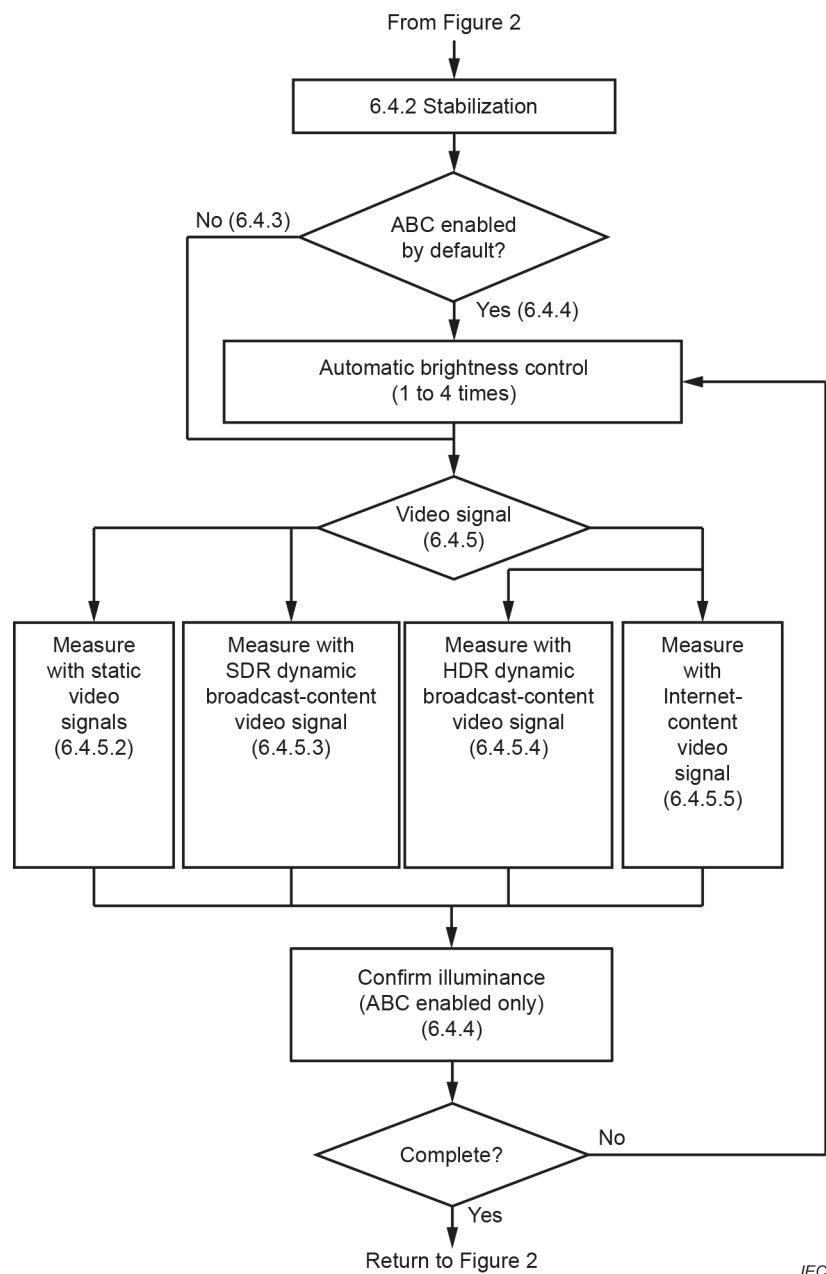
All Ethernet terminals, Wi-Fi and Bluetooth® adapters shall remain disconnected from the UUT except when otherwise directed. Networking functions in the UUT shall be disabled except when otherwise directed.

6.4 Determination of power consumption, On mode

6.4.1 Order of activities

To determine power consumption in the On mode, the order of activities shown in Figure 7 shall be followed.

Within the context of the normal configuration, if the user is prompted by the forced menu to enable or disable the ABC feature (6.3.10.1), the procedure in 6.4 shall be performed once as if the ABC feature were disabled by default (6.4.3) and may be performed again as if the ABC feature were enabled by default (6.4.4). For the optional second application of the procedure of 6.4, stabilization (6.4.2) does not need to be repeated.



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Figure 7 – Order of activities for determining power consumption, On mode

6.4.2 Stabilization

If ABC is disabled in the default picture setting, ABC shall be disabled for the stabilization period. If ABC is enabled in the default picture setting, ABC shall remain enabled and 300 lx or greater shall be applied directly to the ABC sensor using the light source of 5.6.5 for the duration of the stabilization period.

After the steps 6.3.8 to 6.3.10.8 have been completed, the measurements shall be made after the UUT has been in the On mode for a minimum stabilization period of one hour and shall be completed before a maximum of three hours in the On mode. The video signal selected in 6.2.4 shall be displayed during the entire duration of the stabilization period and On mode power measurement (6.2.5). For television sets that are known to stabilize within one hour, these durations may be reduced if the resulting measurement can be shown to be within 2 % of the results that would otherwise be achieved using the durations described herein.

A USB stick that contains media files (video, image, audio) for testing as specified in this document may be connected to the UUT as a test media source during a given measurement procedure. The UUT's 'Replay' feature commonly provided for consumers to repeatedly play a media file from a USB input may be used to loop an appropriate test signal as specified in this document during any required stabilization period. To avoid pattern burn on a UUT, it is recommended that an appropriate broadcast test signal be used during the stabilization period.

6.4.3 Television sets without automatic brightness control enabled by default

For television sets that do not have an automatic brightness control feature, or that have automatic brightness control that is disabled by default, the power measurement (6.4.5) shall be made once with the ABC feature disabled for the entire duration of the measurement.

6.4.4 Television sets with automatic brightness control enabled by default

For television sets with automatic brightness control enabled by default, the power measurement (6.4.5) shall be performed as selected in 6.2.8. If the ABC conditions include the case that the ABC feature is to be manually disabled, that case shall come first in the order. Disabling ABC shall be done from the on-screen menu system. If not possible, ABC shall be disabled by applying 300 lx or greater at the ABC sensor assembly. The conditions with ABC enabled shall be applied in descending order with the highest level of illuminance applied first and the lowest level of illuminance applied last.

The light source setup shall comply with 6.3.7. Illuminance levels shall be determined with the illuminance measuring instrument (5.5.3) positioned immediately in front of the ABC sensor assembly of the UUT (it is acceptable if the instrument covers the ABC sensor for this step) and ensure the illuminance meter is flush with the surface of the UUT pointing perpendicularly outwards such that the meter does not swing or change position once positioned. For illuminance levels of less than 10 lx, the illuminance may be set to four times the intended illuminance and a 2-stop ND filter (5.6.4) used immediately in front of the ABC sensor assembly of the UUT during the power measurement. The illuminance measuring instrument shall be moved away from the ABC sensor during the power measurement so that the light from the reference light source can reach the ABC sensor uninterrupted.

The lamp should be stabilized before testing by setting it to deliver the maximum tested lux to the ABC sensor and maintaining that light level for 10 minutes.

For each illuminance level, the illuminance shall be set within the required tolerance prior to the power measurement and shall be confirmed to be within tolerance after the power measurement.

NOTE See Annex A for more information regarding selection of ABC lighting conditions and weighting factors.

6.4.5 Power measurement

6.4.5.1 General

Depending on the video signal type selected in 6.2.4, one of the following procedures (6.4.5.2, 6.4.5.3, 6.4.5.4 or 6.4.5.5) shall be performed. If the dynamic broadcast content video signal is chosen, testing shall include both SDR (6.4.5.3) and HDR (6.4.5.4) for devices capable of both formats.

The ABC conditions and corresponding On mode power consumption shall be reported.

6.4.5.2 Measurements using static video signals

In the case that the static signals were selected in 6.2.4, On mode power consumption shall be determined using the four static test signals described in IEC 62087-2:2023, 4.1.2.

For the static video signal case, the On mode power consumption of the UUT shall be determined as follows:

$$P_{o_static} = ((P_b + P_w) / 2 + P_c + P_t) / 3$$

where

- P_{o_static} is the On mode power consumption using static signals (W);
- P_b is the power measured using the black video signal (W);
- P_w is the power measured using the white video signal (W);
- P_c is the power measured using the full-field colour bar video signal (W);
- P_t is the power measured using the three-bar video signal (W).

Depending on the state and illuminance level at the ABC sensor, the P_{o_static} values shall be recorded as follows:

$P_{o_static_ABC_Off}$: ABC feature disabled;

$P_{o_static_ABC_x}$: ABC feature enabled, where x indicates the illuminance level in lux.

6.4.5.3 Measurements using the SDR dynamic broadcast-content video signal

If SDR dynamic broadcast-content video signal was selected in 6.2.4, On mode power consumption shall be determined using the SDR dynamic broadcast-content video signal described in IEC 62087-2:2023, 4.1.3. The signal shall be generated from one of the video content sources available from the IEC online repository in a format compatible with the input terminal type under test.

The average power consumption measured over the full, 10 min duration of the SDR dynamic broadcast-content video signal shall be integrated over ten consecutive minutes to determine

$P_{o_broadcast_SDR}$: On mode power consumption using SDR dynamic broadcast-content video signal (W).

Depending on the state and illuminance level at the ABC sensor, the $P_{o_broadcast_SDR}$ values shall be measured and integrated as above and then recorded as follows:

$P_{o_broadcast_SDR_ABC_Off}$: ABC feature disabled;

$P_{o_broadcast_SDR_ABC_x}$: ABC feature enabled, where x indicates the illuminance level in lux.

6.4.5.4 Measurements using the HDR dynamic broadcast-content video signal

In the case that the HDR dynamic broadcast-content video signal was selected in 6.2.4, On mode power consumption shall be determined using the HDR dynamic broadcast-content video signal described in IEC 62087-2:2023, 4.1.3.3. The signal shall be generated from one of the video content sources available from the IEC online repository in a format compatible with the input terminal type under test.

The average power consumed over the full, 5-min duration of the HDR dynamic broadcast-content video signal shall be measured over five consecutive minutes to determine

$P_{o_broadcast_HDR}$: On mode power consumption using HDR dynamic broadcast-content video signal (W).

Depending on the state and illuminance level at the ABC sensor, the $P_{o_broadcast_HDR}$ values shall be recorded as follows:

$P_{o_broadcast_HDR_ABC_Off}$: ABC feature disabled;

$P_{o_broadcast_HDR_ABC_x}$: ABC feature enabled, where x indicates the illuminance level in lux.