

INTERNATIONAL STANDARD

**Audio, video, and related equipment – Methods of measurement for power
consumption
Part 7: Computer monitors**

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INTERNATIONAL STANDARD

Audio, video, and related equipment – Methods of measurement for power consumption
Part 7: Computer monitors

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**AUDIO, VIDEO, AND RELATED EQUIPMENT –
METHODS OF MEASUREMENT FOR POWER CONSUMPTION**

Part 7: Computer monitors

FOREWORD

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

CDV	Report on voting
100/2916/CDV	100/2988/RVC

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

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

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

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document will be

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- withdrawn,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

A bilingual version of this publication may be issued at a later date.

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INTRODUCTION

This part of IEC 62087 specifies methods of measurement for the power consumption of computer monitors for use with computers. The test method includes power measurement using static patterns and both the broadcast and web-based dynamic test loops.

The test method also includes testing with the automatic brightness control (ABC) function where it is incorporated into a computer monitor.

The test method has also been made consistent with the test method for televisions in IEC 62087-3.

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AUDIO, VIDEO, AND RELATED EQUIPMENT – METHODS OF MEASUREMENT FOR POWER CONSUMPTION

Part 7: Computer monitors

1 Scope

This part of IEC 62087 specifies the determination of the power consumption of computer monitors including, but is not limited to, those with CRT, LCD, PDP or OLED technologies. Computer monitors that include touch screen functionality are included in the scope of this document. This document is limited to computer monitors that are powered from a main power source other than a battery. Computer monitors that are powered from a battery source are not covered by this document. However mains-powered computer monitors may include any number of auxiliary batteries.

Computer monitors connected by digital inputs such as DisplayPort, HDMI, DVI, or by analogue VGA input, are considered in this document. This document does not apply to network- and wirelessly connected computer monitors.

A computer monitor is a display device that does not include a TV tuner and is intended to be used to display the video signals from a computer. These video signals are produced from software programs that are operating within the computer and can consist of static and moving images. As such, test procedures using static patterns, dynamic video and web-based video are specified.

The test methods specified in this document can be applied to computer monitors of any size, however, this document is not applicable to specialized monitors associated with medical equipment, publishing and other professional, commercial or industrial uses.

The various modes of operation that are relevant for measuring power consumption are also defined.

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

IEC 62087-2, *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

3.1 Terms and definitions

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

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

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

3.1.1

ND filter

neutral density filter

optical device that reduces the light intensity in the visible wavelength region

3.1.2

computer monitor

product for the display of data, visual and video signals from a computer

3.1.3

default picture setting

picture setting as set by the manufacturer for computer monitors

3.1.4

special functions

functions that are related to, but not required for, the basic operation of the device

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

3.2 Abbreviated terms

AV	audio-visual
ABC	automatic brightness control
CRT	cathode ray tube
DVI	Digital Visual Interface
LCD	liquid crystal display
LMD	luminance measuring device
ND	neutral density
OLED	organic light-emitting diode
PDP	plasma display panel
SCR	silicon controlled rectifier
UUT	unit under test
VGA	Video Graphics Array

4 Specification of operating modes and functions

4.1 General

Table 1 contains the operating modes and functions for computer monitors.

4.2 Auto power down function

An auto power down feature may be implemented on a computer monitor to power down into a standby mode after a predetermined time and possibly predetermined conditions. Such a feature should be referred to as "auto power down".

Table 1 – Operating modes and functions

Power	Mode	Sub-mode	Function(s)	Description
0 W	Disconnected	Disconnected	Disconnect from power source	The equipment is disconnected from all external power sources.
≥ 0 W	Off	Off	Off	The equipment is connected to an external power source and provides no functions that depend on a power source. The equipment cannot be switched into any other mode with the remote control unit, or an external or internal signal. Note that 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 equipment is connected to an external power source and does not provide its primary functions. The equipment 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 equipment is connected to an external power source and does not provide its primary functions. The equipment can be switched into another mode with the remote control unit, an internal signal, or an external signal.
		Standby-active, high	– Wake on • remote control • internal signal • external signal – Data communications	The equipment is connected to an external power source and does not provide its primary functions. The equipment can be switched into another mode with the remote control unit, an internal signal, or an external signal. Additionally, the equipment is exchanging/receiving data with/from an external source.
	On	Operation	Operation	The computer monitor is connected to an external power source and provides pictures and, if possible, sound.

5 Measurement conditions

5.1 General

Clause 5 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 in Clause 5 apply to the procedures specified in Clause 6.

5.2 Power supply

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 computer monitors with ABC enabled, ≤ 1 lux shall be confirmed at the surface of the ABC sensor assembly with the light sources (5.7, 5.8) off and the UUT in the off or disconnected mode.

For determining the peak luminance ratio with a non-contact LMD, ≤ 5 lux shall be confirmed at the nominal centre of the display area of the UUT in the off or disconnected mode. This requirement applies whether or not a light source (5.8) is applied to disable the ABC feature.

A dark room and/or shroud may 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.

5.5.2 Luminance measuring device

Defined in IEC 62087-1:2015, 5.1.6.

5.5.3 Illuminance measuring instrument

Defined in IEC 62087-1:2015, 5.1.7.

5.6 Signal generation

5.6.1 Equipment

Defined in IEC 62087-2:2015, 6.1.

5.6.2 Interfaces

Defined in IEC 62087-2:2015, 6.2.

5.6.3 Accuracy

Defined in IEC 62087-2:2015, 6.3.

5.7 Light source for specific illuminance levels

The light source used for illuminating the ABC sensor to specific illuminance levels shall use a dimmable halogen lamp in a sealed reflector and shall have a diameter of 120 mm or less. The rated correlated colour temperature shall be $2\,800\text{ K} \pm 300\text{ K}$ at its rated voltage. 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. The lamp assembly shall not modify the spectrum of the halogen source, including the IR and UV bands.

For luminance levels below 10 lux, a 2-stop ND filter (3.1.1) shall be used. No ND filter shall be used for luminance levels at or above 10 lux. The ND filter shall be of the absorptive type and shall be large enough cover the entire light acceptance area of the ABC sensor assembly with a margin of at least 5 mm on all sides. 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.

Specific illuminance levels shall be obtained by controlling the voltage and/or duty cycle to the above light source.

The model of the lamp used for illuminating the ABC sensor to specific illuminance levels shall be recorded.

Some lighting controllers, such as those with SCR-based circuits, can introduce current spikes into the power source. Such controllers should be avoided or otherwise isolated from the power source for the UUT.

5.8 Light source for disabling the ABC feature

The light source used for disabling the ABC feature shall use a dimmable halogen lamp in a sealed reflector and shall have a diameter of 120 mm or less. The rated correlated colour temperature shall be $2\,800\text{ K} \pm 300\text{ K}$ at its rated voltage. 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. The lamp assembly shall not modify the spectrum of the halogen source, including the IR and UV bands. The light source shall be capable of providing 300 lux or greater when applied directly to the ABC sensor assembly.

The model of the lamp used for disabling the ABC feature shall be recorded.

5.9 Picture controls

5.9.1 Manufacturer's settings

Where manufacturer's settings are specified in the measurement procedure, the controls shall be in the position adjusted by the manufacturer for shipment to the end user. These controls shall remain in this state for the duration of the test.

5.9.2 Static test pattern settings

Without changing any the manufacturer's settings, the computer monitor shall display a test pattern that contains a 100 % white window covering 80 % of the screen. The luminance of the window shall be measured and recorded. The brightness shall then be adjusted until the window of the screen is set at the luminance specified in Table 2 for the appropriate resolution.

Table 2 – Luminance levels for specified MP resolutions

Product	cd/m ²
Less than or equal to $1,1 \times 10^6$ pixel resolution	175
Greater than $1,1 \times 10^6$ pixel resolution	200

If the display's maximum luminance is less than the prescribed luminance in the table above, the maximum luminance shall be used. Similarly, if the display's minimum luminance is greater than the prescribed luminance, the minimum luminance shall be used. The luminance used for power measurement shall be reported in the test report.

6 Procedure

6.1 Order of activities

The following order of activities is recommended (also represented in Figure 1):

- preparation (Subclause 6.2);
- initial activities (Subclause 6.3);
- determination of power consumption, on mode (Subclause 6.4);
- determination of power factor (Subclause 6.5);
- determination of power consumption, partial on mode (Subclause 6.6);
- determination of power consumption, off mode (Subclause 6.7).

The above order is chosen to ensure proper stabilization prior to the taking of each measurement. The order may be varied 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.

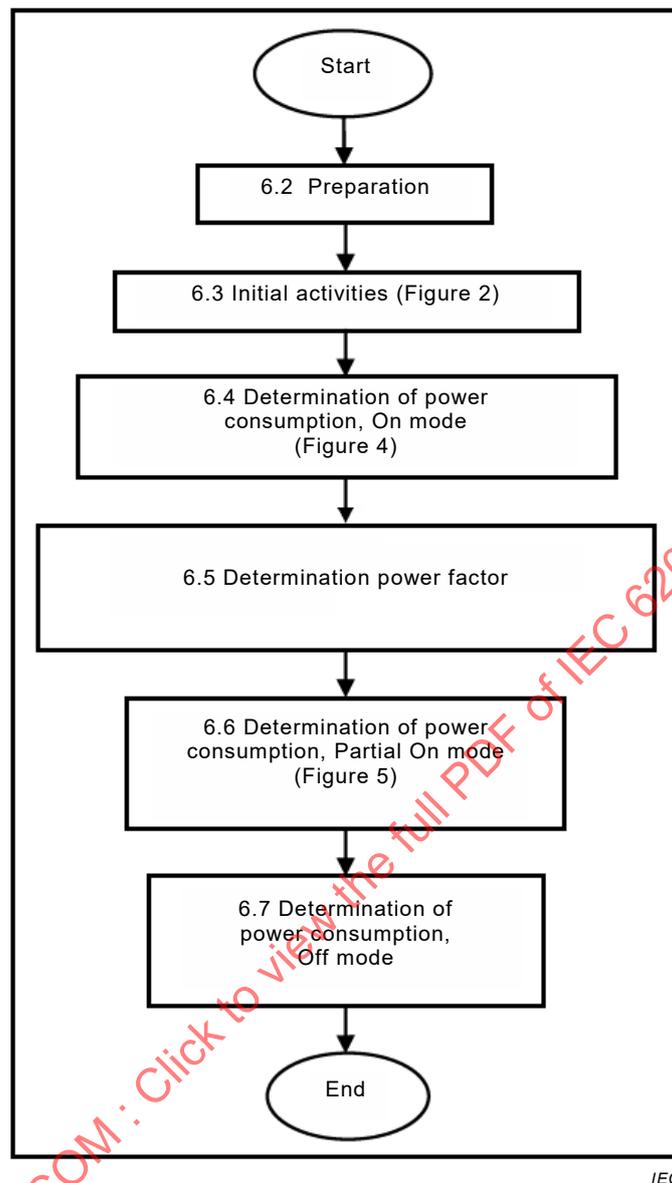


Figure 1 – Recommended order of activities

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 recorded. The measuring plan is based on the decision points in 6.2.2 to 6.2.9. These decision points include:

- power supply voltage and frequency (6.2.2);
- input terminals (6.2.3);
- video signal, On mode power consumption procedure (6.2.4);
- video format (6.2.6);
- automatic brightness control capabilities (6.2.7).

After these decisions have been made, the following activities can be expected to be deterministic.

6.2.2 Power supply 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 recorded.

6.2.3 Input terminals

A single set of input terminals 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.

If available, a digital input port shall be used such as DisplayPort, HDMI or DVI. If not available, a VGA input may be used.

If the UUT has audio capability but is not using a video interface that includes audio, an audio signal shall be connected to selectable audio input terminals if available.

If the UUT has special functions that require data transfer via a USB port, then that port shall also be connected to a USB port of a computer equipped with the appropriate drivers for the special functions.

The selected input terminals shall be recorded.

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 selection shall be made from one of the three following signals:

- static video signals as per 5.9.2,
- dynamic broadcast-content video signal (IEC 62087-2:2015, 4.1.2),
- internet-content video signal (IEC 62087-2:2015, 4.1.3).

The video signal selected for determining on-mode power consumption shall be recorded.

NOTE Information regarding the selection of the video signal for the On mode power consumption measurement is available in IEC 62087-2:2015, Clause A.1.

6.2.5 Video format

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

NOTE The media available in IEC 62087-2:2015 is available in standard and high definition only. By limiting the video source resolution to 1 920 × 1 080, 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 of IEC 62087-3:2015).

6.2.6 Automatic brightness control capabilities

There are three types of computer monitors with respect to ABC.

Computer monitors do not have an ABC feature.

Computer monitors have an ABC feature that is not enabled by default.

Computer monitors 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 shall be recorded.

6.2.7 Automatic brightness control levels

The on-mode power consumption of computer monitors with the automatic brightness control disabled by default in the default picture setting shall be determined with the ABC feature disabled.

For computer monitors with the ABC feature enabled by default in the default picture setting, the on-mode power consumptions 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 conditions with respect to the ABC feature.

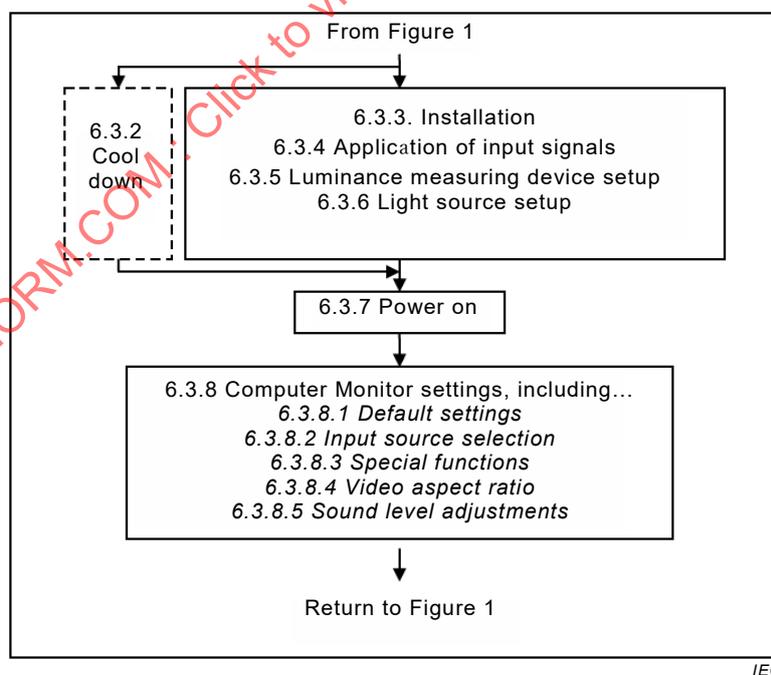
The state(s) of the ABC feature and the illuminance levels selected to be applied to the ABC sensor shall be recorded.

NOTE The number of luminance levels to be used is normally specified in the requirements of various energy efficiency programmes.

6.3 Initial activities

6.3.1 Order of initial activities

Figure 2 shows the order in which the initial activities shall be performed.



IEC

Figure 2 – Order of initial activities

6.3.2 Cool down

The UUT shall be in the off or disconnected mode for a minimum of one hour before the UUT is powered on. To optimise the initial activities, Subclauses 6.3.3 to 6.3.8 may be performed during the cool down period as indicated in Figure 2.

6.3.3 Installation

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

In order to simplify the 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. a floor).

The environmental conditions (Subclause 5.3) and ambient light conditions (Subclause 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 in the off or disconnected mode with the light source of 5.8 applied to the UUT.

6.3.4 Application of input signals

The video input signal selected in 6.2.3 and the audio signal described in IEC 62087-2:2015, 4.1.4 shall be applied to the respective input terminal(s) selected in 6.2.2. The video signal shall be in the format selected in 6.2.5. In the case of measurement with the static video signals, the full field colour bar video signal shall be used.

6.3.5 Luminance measuring device setup

The LMD 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 by 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.

6.3.6 Light source setup

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 lamp and the UUT's automatic brightness control (ABC) sensor assembly during power measurements.

The centre of the light source shall be aligned at a horizontal and vertical angle of $0^\circ \pm 5^\circ$ with respect to the surface of the ABC sensor assembly. The distance between the front of the light source and the surface of the ABC sensor assembly shall be $1,5 \text{ m} \pm 0,1 \text{ m}$.

The ND filter, when used, shall be positioned immediately in front of the ABC sensor assembly. The illumination levels shall be verified with the illuminance measuring instrument positioned immediately in front of the ABC sensor assembly or immediately in front of the ND filter.

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; however, if the UUT ships with or has a built-in table stand, the UUT may be set upon a table provided that table does not extend beyond the front edge of the UUT/stand assembly (see Figure 3). The table should be covered with black felt material.

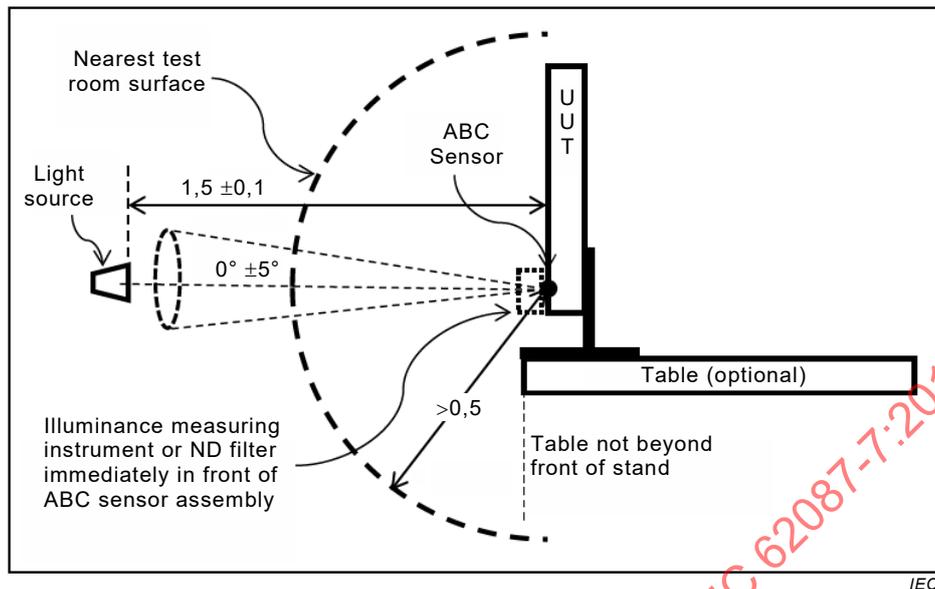


Figure 3 – Light source configuration

The illuminance level shall be varied by changing the voltage, and/or duty cycle of the light source.

If the UUT includes multiple ABC sensors, each sensor shall be illuminated to the same level, within the rated tolerance limits, and multiple light sources may be used.

6.3.7 Power

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.

6.3.8 Computer monitor settings

6.3.8.1 Default settings

For dynamic video measurements, the UUT shall remain or be set in accordance with 5.9.1. For static pattern measurements, the UUT should be adjusted in accordance with 5.9.2.

6.3.8.2 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.

6.3.8.3 Special functions

Special functions not otherwise mentioned in Clause 6 shall be in the position adjusted by the manufacturer for shipment to the end user.

6.3.8.4 Video size, aspect ratio, and resolution

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

For dynamic video measurements, where the UUT has a display with a resolution higher than 1 920 pixels by 1 080 pixels and the UUT cannot be adjusted such 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 recorded. The player used and its related settings shall be recorded.

6.3.8.5 Sound level adjustments

Where present, 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 to be between 8 % and 12 % of its maximum value.

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.

6.4 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 4 shall be followed.

6.4.2 Stabilization

In the case that ABC is disabled by default in the default picture setting, ABC shall be disabled for the stabilization period. In the case that ABC is enabled by default in the default picture setting, ABC shall remain enabled and 300 lux or greater shall be applied directly to the ABC sensor using the light source of 5.8 for the duration of the stabilization period.

After the steps in 6.3 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 the on-mode power measurement. For computer monitors 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.

6.4.3 Computer monitors without automatic brightness control enabled by default

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

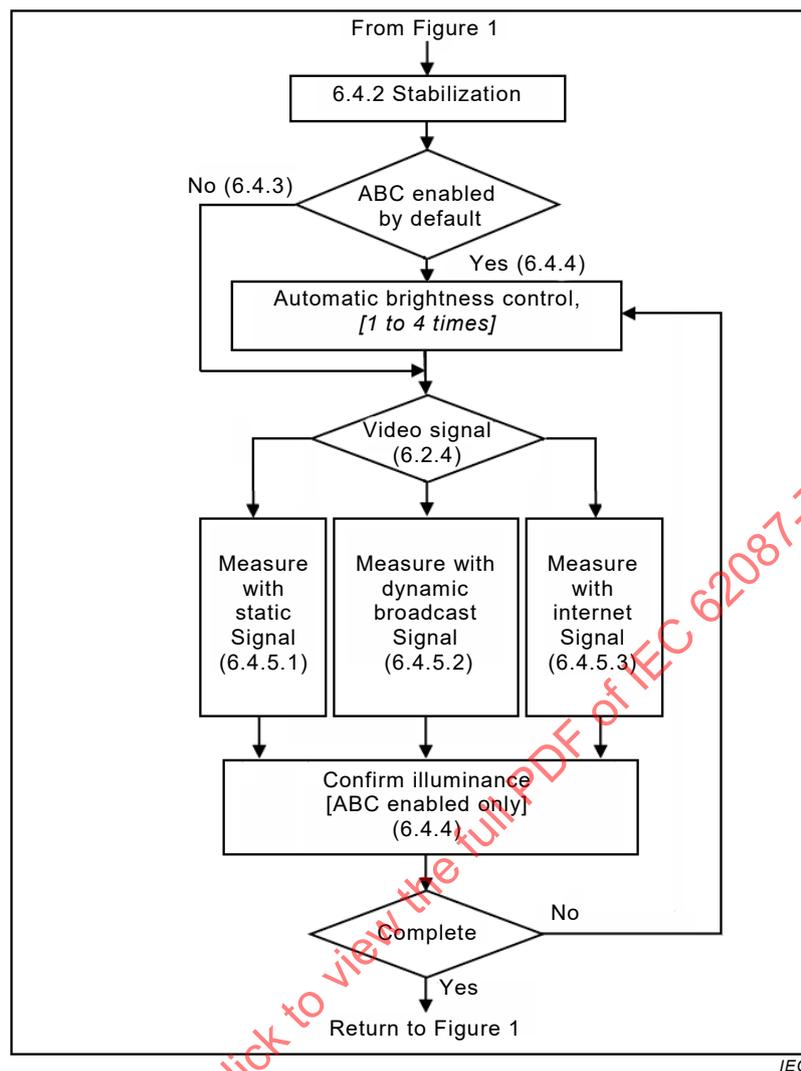


Figure 4 – Order of activities for determining power consumption, on mode

6.4.4 Computer monitors with automatic brightness control enabled by default

For computer monitors with automatic brightness control enabled by default, the power measurement shall be performed as selected in 6.2.7. 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 lux 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 6.3.6. Illuminance levels shall be determined with the illuminance-measuring instrument positioned immediately in front of the ABC sensor assembly of the UUT and manually aimed directly at the light source. For illuminance levels of less than 10 lux, the illuminance shall be set to four times the intended illuminance and a 2-stop ND filter shall be placed 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.

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 62087-3:2015, 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, or 6.4.5.4) shall be performed.

The ABC conditions and corresponding on-mode power consumption shall be recorded.

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 test pattern specified in 5.9.2.

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 dynamic broadcast-content video signal

In the case that the dynamic broadcast-content video signal was selected in 6.2.4, the on-mode power consumption shall be determined using the dynamic broadcast-content video signal described in IEC 62087-2:2015, 4.1.3. The signal shall be generated from one of the video content sources available from the IEC in a format compatible with the input under test.

The average power consumed over the full, 10-min duration of the dynamic broadcast content video signal shall be measured over ten consecutive minutes to determine on-mode power consumption, which is described below

$P_{o_broadcast}$: on-mode power consumption using dynamic broadcast-content video signal (W).

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

$P_{o_broadcast_ABC_Off}$: ABC feature disabled;

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

6.4.5.4 Measurements using the Internet-content video signal

In the case that the Internet-content video signal was selected in 6.2.4, the on-mode power consumption shall be determined using the Internet-content video signal described in IEC 62087-2:2015, 4.1.4.

The full duration of the Internet-content video signal is used for measuring TV power consumption when the UUT is used for viewing Internet content. The measurement shall be the average power consumed over ten consecutive minutes.

The Internet-content video signal shall be generated from video content available from the IEC in a format compatible with the input under test. There are 100 images. The images shall be displayed at a rate of six seconds per image for a total duration of 10 min.