
**Photography — Digital still cameras —
Measuring shooting time lag, shutter
release time lag, shooting rate, and
start-up time lag**

*Photographie — Caméras numériques — Décalage dans le temps du
mesurage de la prise, décalage dans le temps de l'ouverture de
l'objectif, cadence de prise et temps de démarrage*

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee 42, *Photography*.

This third edition cancels and replaces the second edition (ISO 15781:2015), which has been technically revised.

The main changes compared to the previous edition are as follows:

- Current scope includes digital still cameras that continuously shoot images into the buffer and select an image depending on the moment the exposure button is pressed.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Taking pictures of a moving target was nearly impossible in the early days of digital photography. After pressing the exposure button it took a significant amount of time to capture the image and the chance to preserve the desired moment was gone.

Part of the time between pressing the exposure button and the exposed picture is needed to focus, another part is needed to adjust the exposure, etc. This unwelcome but unavoidable period of time is called shooting time lag. This is often mixed with the term shutter release time lag, which is also defined in this document. Optimized systems are nowadays able to decrease these time lags.

Capturing the different stages of a fast moving object is sometimes very important especially in areas like sports or people photography. This high shooting rate requires fast image processing within the digital still camera that can be measured according to the method described in this document.

When a photographer decides to capture an image of a changing scene, if his or her digital still camera takes a long time to be ready to shoot once it is turned on, the opportunity to capture the image is lost. This time named start-up time lag is therefore another important value, which can be determined using this document.

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Photography — Digital still cameras — Measuring shooting time lag, shutter release time lag, shooting rate, and start-up time lag

1 Scope

This document specifies how to measure and report the shooting time lag, shutter release time lag, shooting rate and start-up time lag for digital still cameras, including camera modules in phones and tablet computers. It includes a method that uses control signals inside the digital still camera and a method that determines the timing values without requiring access to the inside of the digital still camera.

This document does not address the measurement either of auto focus speed below recommended illumination level or auto focus accuracy.

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.

ISO 7589, *Photography — Illuminants for sensitometry — Specifications for daylight, incandescent tungsten and printer*

3 Terms and definitions

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

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

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

3.1

digital still camera

device which incorporates an image sensor and produces a digital signal representing a still picture (1)

Note 1 to entry: A digital still camera is typically a portable, hand-held device. The digital signal is usually recorded on a removable memory, such as a solid-state memory card or magnetic disk.

[SOURCE: ISO 12231, 3.40, modified — Note 2 to entry has been deleted.]

3.2

shooting time lag

t_{SL}

time elapsed from stand-by state to reaching capture point on a digital still camera or a module built into a mobile device and the beginning of the exposure

Note 1 to entry: This period of time includes all measurements and adjustments (e.g. auto focus and exposure control) a digital still camera needs to make prior to the beginning of the exposure.

Note 2 to entry: When the exposure button of a digital still camera is pressed it performs a number of time-consuming measurements and adjustments, e.g. determination of the exposure and focus adjustment. The time needed for these procedures is part of the shooting time lag.

Note 3 to entry: A capture point is often initiated from stand-by state by firmly depressing the shutter button to the maximum extent without introducing a discontinuity, see 3.8.

**3.3
shutter release time lag**

t_{RL}
time elapsed from pre-capture point (3.7) to the time of starting the exposure by reaching capture point after having stabilized the focus operation (often due to half pressing of the shutter button), in the case of digital still cameras that distinguish between pre-capture and *capture points* (3.8) (often the half pressing and the fully pressing of the shutter button)

Note 1 to entry: Instead of shutter release time lag, the terms shutter lag and release lag are used in some publications.

Note 2 to entry: A capture point is often initiated from pre-capture point by fully pressing down the shutter button.

**3.4
start-up time lag**

$t_{start-up}$
time elapsed between switching a digital still camera on and the moment the camera has reached a standby state (3.6) ready to shoot

Note 1 to entry: Start-up time lag excludes the initialization of a memory card.

Note 2 to entry: How this time is determined for the different devices is described in 5.2.1.

**3.5
shooting rate**

$f_{shooting}$
reciprocal of the time elapsed between the beginning of the exposure of an image until the beginning of the exposure of the next image, that is, between successive capture start states

**3.6
standby state**

state achieved following the power-up process, in which a digital still camera is powered on and ready to capture an image

Note 1 to entry: If the digital still camera uses an electronic viewfinder, a preview image is normally displayed during the standby state.

Note 2 to entry: Standby state excludes the initialization of a memory card.

**3.7
pre-capture point**

position of a user control of a digital still camera which activates pre-capture processes, such as auto-focus and exposure calculation

Note 1 to entry: The pre-capture point is typically reached by pressing an exposure button roughly halfway down on traditional digital still camera. On mobile devices with touchscreen this point might be reached by long pressing the trigger button.

**3.8
capture point**

position of a user control of a digital still camera which activates the image capture operation

Note 1 to entry: The capture point is typically reached by fully depressing the exposure button on traditional digital still cameras. On mobile devices with touchscreen this point can be reached either when pushing the trigger button, or releasing it.

3.9

push duration

total elapsed time during which the trigger button is pushed

Note 1 to entry: This duration is not usually associated with a particular function on traditional digital still camera other than capture burst. On mobile devices that use a touchscreen, it can trigger some particular functions such as the autofocus.

4 Test conditions

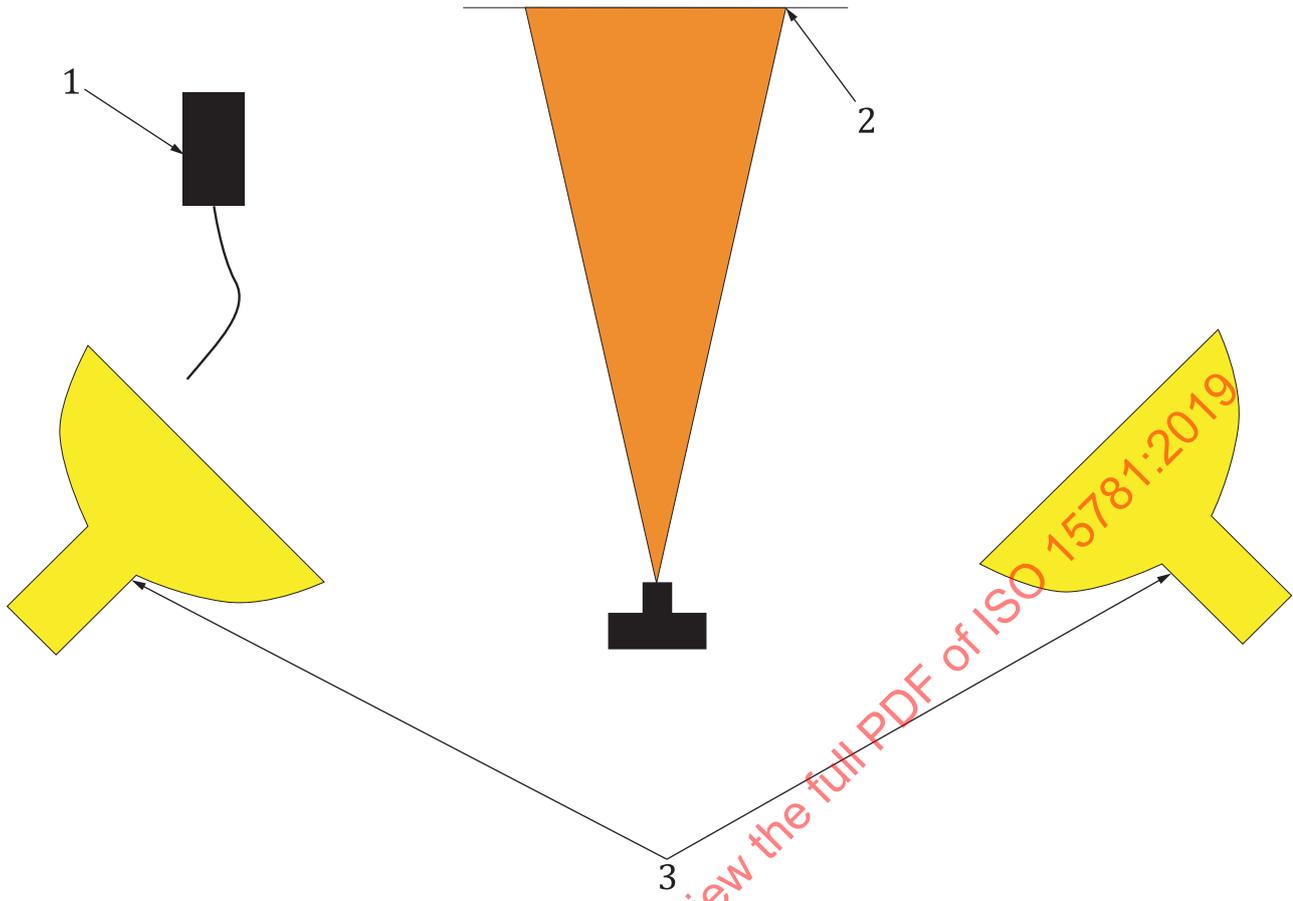
4.1 Illumination of the test scene

An illumination level between 500 lx to 5 000 lx is recommended. Special measurement purposes may require other levels.

The test scene shall be illuminated in a way that avoids specular reflection (see [Figure 1](#)). This can be achieved by using a geometry typical for reproduction photography, which means positioning the light sources in approximately a 45° angle to the surface of the chart. The illumination level of the area shall be reported together with the measurements.

Timing measurements shall be performed under daylight conditions or a tungsten lamp. Procedures for determining whether the illumination used is an acceptable match to the daylight illuminant, shall be conducted in accordance with ISO 7589.

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Key

- 1 calibrated spectral photometer
- 2 test chart
- 3 light source tungsten or filtered to D55

Figure 1 — Principle for illuminating the target

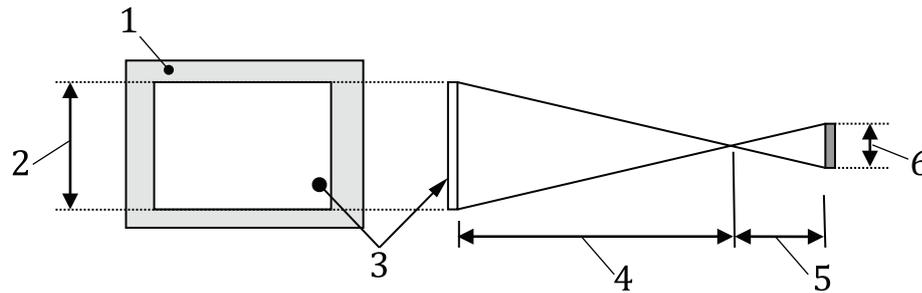
4.2 The chart and positioning of the digital still camera

The digital still camera shall be mounted on a solid stand (e.g. heavy tripod) perpendicular to and facing the surface of the chart (see [Figure 2](#)).

As for a test chart, the chart shall allow the digital still camera to focus easily and allow an easy determination whether the captured image is correctly focused. Examples include a black-and-white checker board or the three-line chart shown in informative [Annex B](#). If the above condition is met, a typical image assessment chart may be used. Also, the ISO 12233 resolution chart may be placed in the chart area to determine whether the captured images are in focus.

The height of the chart shall be 80 (±10) cm and the distance to the chart shall be adjusted in a way that the height of the image is in accord with the chart height.

The surround areas should be filled with a reflective area of 18 % neutral grey. Prior to the measurement, the digital still camera shall be checked to see if it correctly focuses on the chart. If not, the correct focus shall be obtained by changing the chart or the illumination condition. If different setup conditions are required when the focal length of the lens is extremely long or short, these setup conditions shall be reported together with the measurement results.

**Key**

- 1 surround area: 18% grey chart
- 2 chart height 800 mm
- 3 chart
- 4 33 x focal length
- 5 focal length
- 6 image height

Figure 2 — Chart and positioning

4.3 Battery status

A secondary battery should always be fully charged and a primary battery should always be a new one prior to performing the measurements in order to avoid inconsistent measurements caused by varying power supply. For cameras that support an AC power supply, the AC power supply should be used.

4.4 Memory card

For digital still cameras that support connection to a removable memory card, a card with a sufficient capacity and speed so that it does not interfere with the test shall be used. Slow cards can interfere with the measurements and increase the measured times. The card shall be initialized and formatted in the camera. After formatting the card, it shall remain in the digital still camera.

If the digital still camera only has internal memory, all images should be deleted and sufficient memory should be free that any lack of memory does not interfere with the test.

4.5 Flash

If the flash is used to perform the measurements, it shall be reported together with the results.

4.6 Image stabilization

In case the image stabilization is used to perform the measurement, it shall be reported together with the results.

4.7 Other camera settings

Since camera settings can impact the measurement results the factory settings of the camera shall be used and any deviation from those shall be reported with the measurement results.

5 Measurements

5.1 Definition of measurement

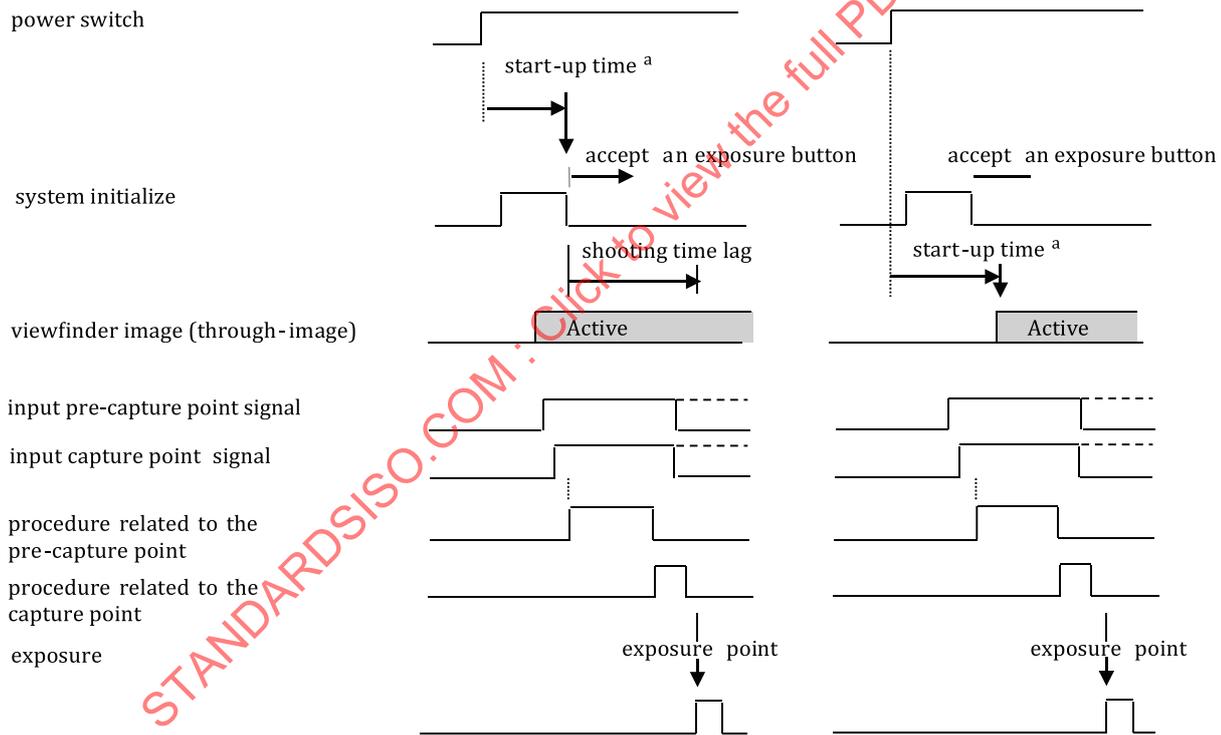
5.1.1 General

This document defines two measurement methods. The first method is the “external measurement” method, which can be performed without disassembling the digital camera. The second method is the “internal measurement” method, which requires the camera body to be partially disassembled, in order to perform measurements using electrical signals inside the camera body. The first method is the preferred method for measurements made by users of digital cameras. The second method is the preferred method for measurements made by digital camera manufacturers.

NOTE 1 Figures 3, 4, and 5 show the periods of time to be measured.

NOTE 2 “Procedure related to the pre-capture point” means the procedure by which the digital still camera measures the light intensity and distance, determines the exposure, and adjusts the focus when the pre-capture point switch of the digital still camera is pressed.

NOTE 3 “Procedure related to the capture point” means the procedure by which the digital still camera processes the image captures and preparation of the image storage when the capture point switch of the camera is pressed.



In the case where the time until pre-exposure point can be accepted is longer than the time until the viewfinder image (through-image) is displayed.

In the case where the time until the viewfinder image (through-image) is displayed is longer than the time until pre-exposure point can be accepted.

^a The time between switching the power on and the moment the viewfinder image (through-image) is displayed, or the time between switching the power on and the moment pre-capture point can be accepted, whichever is longer.

Figure 3 — Measurement period for start-up time lag

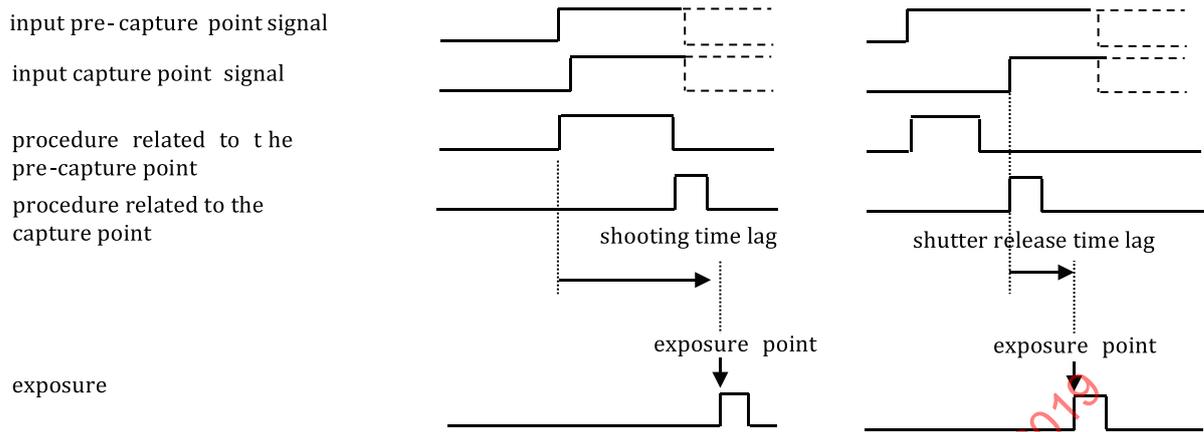


Figure 4 — Measurement period for shooting time lag and shutter release time lag

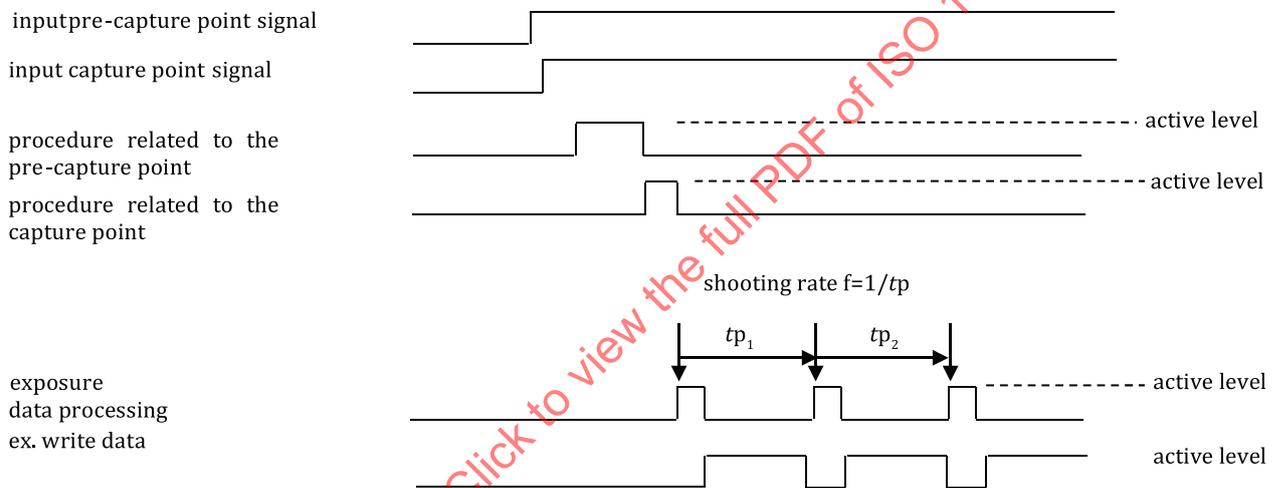


Figure 5 — Measurement period for shooting rate

5.1.2 Measurement with external controls

The measurement with external controls is performed without disassembling the camera with the advantage that the measurement can be performed on the product level. Specifically, for instance, the measurement can be performed shooting a timing device that can determine a time interval from captured images. An example of this method is shown in informative [Annex B](#).

When using the measurement with external controls the acceptable level of the time lag between pressing the exposure button and activating the timing device is application dependent and needs to be considered prior to performing a test and the estimated error caused by this time lag shall be reported together with the results (see [Annex B](#)). A test was performed using different approaches and the results are shown in [Annex A](#).

5.1.3 Measurement with internal controls

The measurement using internal controls and connectors enables a direct measurement of time intervals between input signals and device control signals but it involves disassembling the camera. This allows the operational timing to be obtained reliably and has the advantage that the measurement can be performed accurately and stably. With this method, there is no bias due to the accuracy of the actuation device (see [Annex B](#)).

However, only camera manufacturers usually use this method because it is very difficult for parties other than camera manufacturers to disassemble the camera and select and measure the device control signals. An example of this method is shown in [Annex C](#).

5.2 Measurement method

5.2.1 Start-up time

The digital still camera shall be switched on and set to record mode. Every setting that requires additional time when switching the camera on (e.g. playing an intro sound) shall be turned off, and the camera shall be focused on the timing device before it is switched off again. Start the measurement when the power switch is turned on again. The measurement value shall be an average of at least 10 measurements.

In cases of devices that include other applications besides the camera (mobile devices) the devices shall be switched off completely prior to the measurement and switched on again to make sure all applications running on the device have been terminated. The power switch for turning the camera on may be substituted by starting a camera app or pressing an activation key. In these cases, the fastest method of starting the camera shall be selected and be reported together with the results.

For these devices the starting point for turning the camera function on is the regular operational standby mode of the device. This means the device is in standby and locked. If it is necessary to unlock the mobile device and to enter one or multiple menus to start the camera module, this time shall be integrated in the reported start-up time lag.

The digital still camera shall not be disconnected from the power supply until the test is finished. The measurement results and conditions shall be reported according to the description in [Clause 6](#).

When using the measurement with external controls, the timing device shall be inserted electronically to control the power switch or the power supply of the camera, if possible. The accuracy of the timing device for measuring the start-up time shall be at least 0,1 s (the sampling shall be 0,01 s). If the timing device is started manually all measured values <0,5 s shall be reported as 0,5 s and the fact of the manual activation shall be reported together with the result. When the power switch is turned on, the timing device shall be started. A picture of the chart (object) shall be taken immediately after the shutter release becomes active after turning the camera on.

The start-up time lag is obtained through the [Formula \(1\)](#).

$$t_s = t_0 - t_{SL} \quad (1)$$

where

t_s is start-up time lag;

t_0 is time elapsed from operating the switch until the beginning of the exposure of the first image;

t_{SL} is shooting time lag.

When using the measurement with internal controls, suppliers as shown in [Annex C](#) shall directly observe appropriate signals, and the time defined in [5.1.1](#) shall be measured.

NOTE The shooting time lag t_{SL} needs to be measured before applying Formula (1) to determine the start-up time lag t_s .

5.2.2 Shooting time lag

5.2.2.1 General

Continuous autofocus of the camera shall be switched off if possible. In case that is possible follow procedure described in 5.2.2.2. If that is not possible follow procedure described in 5.2.2.3. For digital still cameras that continuously shoot images into a buffer, exposure time has an influence on the shooting time lag measurement since the exposure point depends on the exposure time. [Annex E](#) provides more details on this issue.

Exposure time shall be reported.

5.2.2.2 Measurement in case of normal autofocus

Prior to each measurement of the shooting time lag, the digital still camera shall be defocused by either:

- a) turning to face a distant object that shall be located at a distance of at least 100 times the focal length of the camera lens or 5 m, whichever is greater;
- b) manually focused to infinity;
- c) focused to infinity using a collimator.

The shooting time lag, t_{SL} , shall be measured by turning the digital still camera to face the chart and by fully pressing the exposure button.

In the case of the measurement with external controls, the shooting time lag is obtained by comparing the state of the timing device at the moment the exposure button is fully pressed and the state of the timing device in the correct focused image. If the image is clearly out of focus, it shall not be used to measure the shooting time lag because in this case the camera may trade the focus accuracy for higher speed (shutter priority) and the image of the timing device is blurred and unable to show the correct timing. For cameras that do not deliver sharp images when pressing the exposure button fully, the digital still camera shall be allowed to focus by first pressing the exposure button halfway down; immediately after the camera indicates that it is in focus, the exposure button shall be fully pressed. The state of the timing device shall be recorded when the exposure button is pressed halfway down and the fact that the digital still camera did not focus correctly without this manual adjustment shall be reported together with the results.

In the case of the measurement with internal controls, appropriate signals shall be directly observed as shown in [Annex C](#), and the time period defined in 5.1.1 shall be measured.

The reported shooting time lag shall be an average of at least 10 measurements shot in a row (with the camera defocused between each shot) right after the previous image has been stored to the storage media and without switching the camera off. Depending on the required measurement accuracy, additional measurements might be necessary as shown in [Annex E](#).

If the measured time is significantly shorter or longer for the first of the 10 images, the measurement shall be repeated. If the same results occur, values for the first and the following exposures shall be reported separately.

The measured shooting time lag will vary depending on the focal length the camera is set to.

The measurement results and conditions shall be reported according to the description in [Clause 6](#).

5.2.2.3 Measurement in case of continuous autofocus

It is necessary to take into account the time the continuous autofocus requires to focus on the chart before the capture point.

To ensure consistent and repeatable results the camera needs to focus on a close distance “defocus chart” prior to focusing on the test chart. This “defocus chart” shall be placed in the optical path at

a minimum distance of 150 mm from the camera or to the shortest distance the camera can focus on whichever is longer. The “defocus chart” shall consist of high contrast structures on which the camera can easily focus. A dead leaves target (See ISO TS 19567-2) with a contrast of 50 % and greater is one potential chart. The “defocus chart” shall be illuminated with a light source that delivers a spectral distribution comparable to the one for the illumination of the test chart and at an illumination level that is within $\pm 0,3$ exposure values of the one for the test chart. This avoids a readjustment of the auto white balance and auto exposure setting for the final image.

In the case the above procedure is not applicable (e.g. measuring in macro mode) the defocus chart and the test chart can be switched so that the defocus is done on a longer distance and the focus on the test chart on a short distance. This specific case needs to be reported with the results.

The defocus chart shall be extracted out of the optical path in 0,1 s or less. This can be done by mechanically moving the “defocus chart” or by using a mirror or turning the camera. However, it needs to be made clear that no vibrations occur that influence the results. In special occasions setups may be used where the extraction of the defocus target takes longer than the 0,1 s. These setups are optional and measurements made with those shall clearly be marked in the results.

The moment the defocus target is out of the optical path is the time 0. The timing device itself may be started at a defined time prior to the process to be able to measure negative shooting time lags. For cameras with focus priority the exposure shall be triggered at time 0. For cameras with shutter priority exposure, shooting time lag shall be measured as the shortest delay from time 0 that ensures to give not more than 20 % of the images that are obviously out of focus. This delay shall be introduced by increasing the time between time 0 and the pressing of the exposure button from 0 with accuracy of 0,01 s with no less than 30 shots.

[Annex F](#) is one out of many potential setups how the measurement may be performed in case of continuous autofocus.

That the device is using continuous autofocus shall be reported.

The reported shooting time lag shall be an average of at least 10 measurements shot in a row right after the previous image has been stored to the storage media and without switching the camera off. As specified above, the camera shall be defocused using the “defocus chart” in between each measurement.

Depending on the required measurement accuracy, additional measurements might be necessary as shown in [Annex E](#).

If the measured time is significantly shorter or longer for the first of the 10 images, the measurement shall be repeated. If the same results occur, values for the first and the following exposures shall be reported separately.

The measurement results and conditions shall be reported according to the description in [Clause 6](#).

5.2.3 Shutter release time lag

The shutter release time lag shall be measured using the same requirements for the shooting time lag except that the state of timing device shall be recorded after the digital still camera is facing the chart (object) and is in focus.

For digital still cameras that continuously shoot images into a buffer, exposure time has an influence on the shutter release time lag measurement since the exposure point depends on the exposure time. [Annex E](#) provides more details on this issue.

The measurement results and conditions shall be reported according to the description in [Clause 6](#).

5.2.4 Shooting rate

The default setting for measuring the shooting rate should be the camera set to the highest pixel count available in the camera and the highest image quality for compressed and fully processed images (e.g. lowest JPEG compression) available. However, any other setting may be used and the setting shall be

reported along with the measurement results. The camera shall be positioned as described in 4.2 and correctly focused on the target. To achieve the highest frequency possible, the digital still camera shall be set to burst mode (if it exists), and the exposure time shall be 1/100 of a second or less (if adjustable). If the camera does not allow setting mode and exposure time, the measurement shall be performed using the default setting.

A set of the images should be taken with the camera by keeping the exposure button pressed until the shooting rate slows significantly down or until 100 images are captured whichever number is smaller. The reciprocal of the time elapsed from the beginning of the exposure for one image and the beginning of the exposure of the next image is the value of the shooting rate. If the shooting rate changes significantly during the test, the number of exposures possible at the used mode shall be reported along with the value of the shooting rate.

NOTE Digital still cameras often shoot several images at a constant frequency at the beginning of capturing a series of images. In case the buffer memory fills up because the camera is not able to process and transfer the images to the storage medium fast enough, the frequency decreases after the memory is full. This is the point where the camera noticeably slows down.

The shooting rate shall be calculated on a specified number of frames, at least 10. If either of the following events takes place prior to 10 frames, the number of frames actually taken shall be recorded and reported:

- a) The camera ceases to function for more than 2 s — effectively rendering multiple exposure mode useless, or
- b) The frame rate slows significantly and the camera indicates that its internal buffer is full.

The frame rate shall be determined using the Formulae (2) and (3):

$$f = \frac{1}{T_n} \quad \text{with } T_n = \frac{1}{n-1} \sum_{i=2}^n (t_i - t_{i-1}) \quad (2)$$

$$s = \frac{1}{n-1} \sqrt{\sum_{i=2}^n ((t_i - t_{i-1}) - T_n)^2} \quad (3)$$

where

- f is image frequency;
- n is the number of the last image before the camera begins to slow down;
- t is the time from the start until the beginning of the exposure for a specific image;
- T_n is the arithmetic mean of the measured value for n intervals from the beginning of the exposure for one image until the beginning of the exposure for the next image;
- s standard deviation.

The shooting rate, the standard deviation of the mean, and measurement conditions shall be reported according to the description in Clause 6.

6 Reporting the results

The results of the timing values described in this document depend on several camera settings as well as surrounding conditions. These camera settings and surrounding conditions shall be managed enough during the measurement and they shall be reported with the results. In some cases, however, simpler presentation without complete description on the camera settings or the surrounding conditions may be used. An example is specification notes in a catalogue for the end users. In this case the missing information should be accessible and in the public domain.

The results of measurements should be reported with at least two significant digits. When the shooting time lag and start-up time lag is less than one second, the shutter release time lag is less than 10 ms or the shooting rate is less than one image per second, the results may be reported with one significant digit.

With respect to the reporting of the shutter release time lag:

If either of the maximum or minimum value according to the measurement method in 5.2.3 is shifted from the average value (20 ms or more), maximum and minimum values shall also be reported in addition to the average value.

A complete report of the results shall contain all the necessary information in order to reproduce the measurement.

Small letters indicate for the measurements for which the reporting of these settings are mandatory, if not all: (a) for shooting time lag, (b) for shutter release time lag, (c) for start-up time lag and (d) for shooting rate.

In particular, the following shall be recorded:

- measurement method used;
- exposure time for digital still cameras that continuously shoot images into a buffer (a,b);
- the push time for devices for which the push duration might trigger some particular functions (a, b);
- identification of the measured product, e.g. product type, serial number, firmware version, information on the used lens;
- identification of the used memory card, e.g. card specifications, memory size (c, d);
- any special environmental conditions in which the test was performed, e.g. illumination of the test scene, subject distance, special setup conditions (a, b, d);
- any specific conditions necessary to enable the test to be performed, e.g. power supply;
- any operating states of the camera necessary to enable the test to be performed, e.g. exposure time, number of recorded pixels, image quality, capture mode (e.g. portrait, sports), focal length, focus mode (e.g. high speed), flash usage, stabilization (a, b, d);
- In case of reporting the measurement result of continuous autofocus, indication that this is the result of continuous autofocus and the distance of “defocus chart” (a);
- In case of shutter priority, the ratio of images are obviously out of focus unless the ratio is 0 (a);
- In case of devices that include other applications the method of activating the camera (c).

Camera settings and surrounding conditions shall be maintained during measurements and reported with the results.

An example of a test report with information to report and associated values are given in [Annex D](#).

Annex A (informative)

Test results of methods to start the timing device

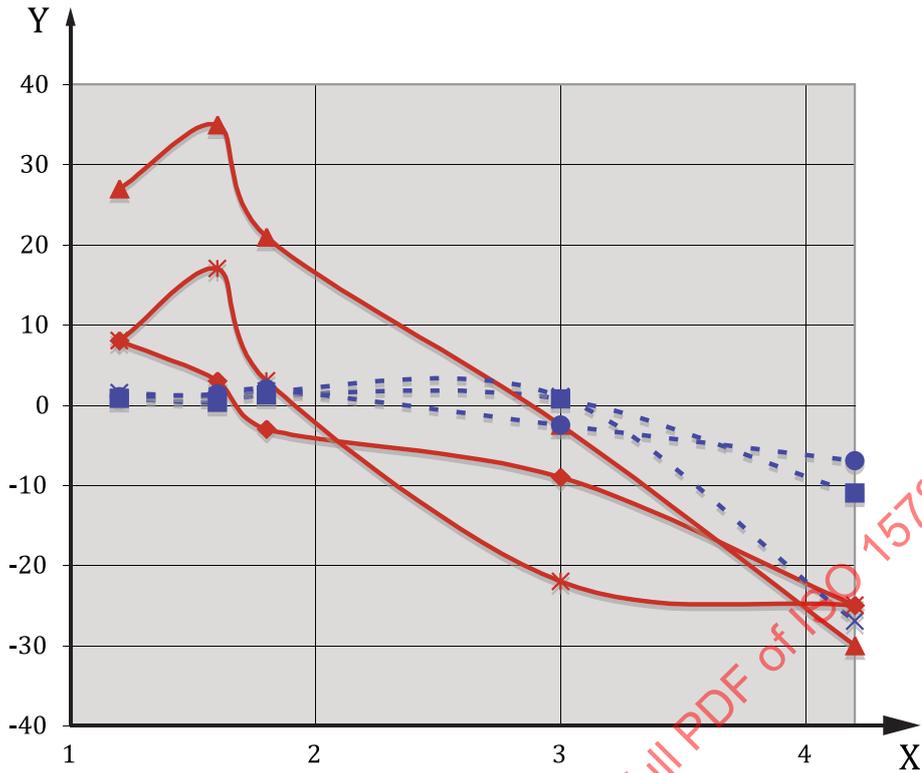
To find out about the time lag between the actuation of the timing device and the closure of the exposure switch (activated by the exposure button) of the digital still camera, an experiment has been performed using several real cameras (see [Figure A.1](#)).

A modified version of the timing device mentioned in [B.2](#) has been used. This version used one input for the micro switch to start the device and a second input that was connected to the exposure button of the sample camera as a stop signal. This way the time lag between the two signals could be measured.

A positive value in [Table A.1](#) means that the micro switch was actuated before the camera exposure switch. A negative value means that the force needed for the micro switch was higher than that needed for the camera, which leads to the case that the camera was actuated before the micro switch.

Table A.1 — Measured times lags between actuation of the micro switch and the camera exposure switch

Activating force needed for micro switch	Camera 1 index finger	Camera 1 electromagnetic finger	Camera 2 index finger	Camera 2 electromagnetic finger	Camera 3 index finger	Camera 3 electromagnetic finger
N	ms	ms	ms	ms	ms	ms
1,2	8	0,8	27	1,5	8	1
1,6	3	0,35	35	1,1	17	1,4
1,8	-3	1,25	21	1,7	3	2
3	-9	0,75	-2,5	1	-22	-2,5
4,2	-25	-11	-30	-27	-25	-7



- Key**
- X activation force [N]
 - Y time lag [mSec.]
 - ◆— camera 1 index finger
 - camera 1 electromagnetic finger
 - ▲— camera 2 index finger
 - ×- camera 2 electromagnetic finger
 - *— camera 3 index finger
 - camera 3 electromagnetic finger

NOTE Solid lines show the results from the index finger and the dashed lines the results from the electromagnetic finger.

Figure A.1 — Time lag

The experiment shows that for using the index finger it is important to select a micro switch that has about the same activating force as the camera exposure button if a time lag smaller than 10 ms is needed. Using an average switch, the time lag is typically within the area of 30 ms. Therefore, the assigned accuracy of the measurement using the index finger to actuate a micro switch is ± 30 ms.

For the “electromagnetic finger” the results show that as long as the force needed to actuate the micro switch is smaller than the force needed to actuate the camera exposure button, the time lag is within ± 2 ms. Only if the force needed to actuate the micro switch is much higher than the one needed to actuate the exposure button, the time lag is significantly higher. Therefore the assigned accuracy for the measurement using the electromagnetic finger is ± 2 ms.

Annex B (informative)

Timing device

B.1 Actuation of the timing device

This document notes four different ways to actuate the timing device that is needed to perform the described measurements. The first two ways have been evaluated (see informative [Annex A](#) for details) and, based on the results, been given a related deviation. The term deviation in this case describes the time lag between the actuation of the timing device and the closure of the exposure switch of the camera.

When an actuation method is used, it is a good practice to determine and report its statistical accuracy (mean and standard deviation). If a switch is used, it is also good practice to report the activating force.

Index finger: starting the timing device using a micro switch that is activated by the tester's index finger (see [Figure B.1](#)). Although a carefully selected switch in combination with an experienced tester may lead to higher accuracies the typical accuracy is $\pm 0,03$ s. The typical activating force for a camera exposure button is between 1,0°N and 3,0 N. If a micro switch is used to activate the timing device it should have about the same activating force. There are various switches with a defined activation force commercially available.



Figure B.1 — Digital still camera with a micro switch mounted on the exposure button using an adhesive tape

Electronic finger: the timing device is activated using an “electromagnetic finger” that either actuates a micro switch on top of the exposure button of the camera or the switch that activates the finger also starts the timing device. This construction can have a typical accuracy of 0,002 s.

An even more accurate alternative to the electronic finger shown in [Figure B.2](#) is the use of an actuator with a calibrated position.

In case a remote control (such as a Bluetooth^{®1)} device) that operates both the shutter release and the timing device is shown to be accurate and fast it can also be used.

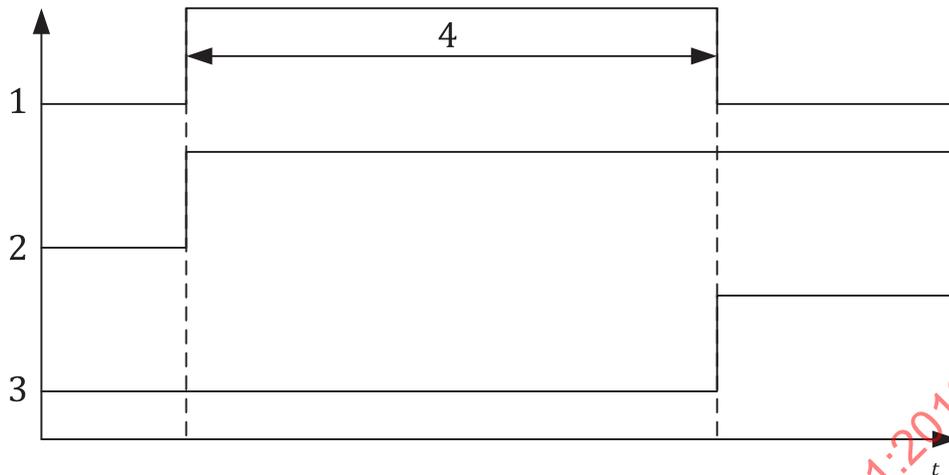
1) Bluetooth[®] is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.



NOTE An electronic finger provides a higher accuracy compared to manual pressing of the exposure button with a mounted micro switch.

Figure B.2 — Electronic finger

Electronic trigger for touch-screen shutter: the trigger button on the touchscreen of a digital still camera can be activated by a “capacitive trigger”. The capacitive trigger usually consists of a thin metal sheet connected to the device electrical ground (usually accessible via its USB port). The connection may be controlled by an electronic switch signal and an electric signals generator. This generator may also be used to activate the timing device. Both the push duration and the type of capture point (either when pushing or releasing the trigger button) can be adjusted. Measured time differences between the connection of the metal sheet to the device ground and the signal to activate the timing device can be shorter than 10 μ s.

**Key**

- 1 signal to the capacitive trigger
- 2 synchronization signal to the timer for push synchronization
- 3 synchronization signal to the timer for release synchronization
- 4 push time

Figure B.3 — Representation of push duration and push time and release time synchronisation



Figure B.4 — Electronic trigger touch-screen shutter

Direct electronic connection to the exposure switch: the highest level of accuracy reaches the direct electronic connection of the timing device with the exposure switch of the camera. The timing device is started at the same time the camera's exposure switch is closed. Typically this method requires partially disassembling the camera and modifying the exposure switch and is therefore not applicable to all kinds of tests although if applicable it should be the first choice.

The way the timing device was activated should be reported together with the results (see [Clause 6](#)).

B.2 The timing device

The device used to measure the time should have an accuracy of at least 1 ms and be capable of measuring times up to 10 s or more.

It is possible to use digital clocks if the display is fast enough to show at least a 1/100 of a second.

For measuring digital still cameras that continuously shoot images into a buffer, a timing device that can be started before the exposure switch of the camera is activated and that records its state when the exposure switch of the camera is activated can be used. A timing device that starts running when activated can lead to false results since with such cameras shutter lags can be negative.

If a shooting time lag or a shutter release time lag shorter than the accuracy of the actuation device is measured, a timing device that is started when the exposure switch of the camera is activated will give unambiguous results. With a timing device that starts running when the exposure switch of the camera is activated, cameras with a negative shutter lag will give null (\pm measurement accuracy) results.

NOTE 1 The problem with using a digital clock is that the display always stays at the same location, which means that numbers lay on top of each other. Therefore, the beginning of an exposure cannot be clearly identified if the exposure time is longer than the required accuracy.

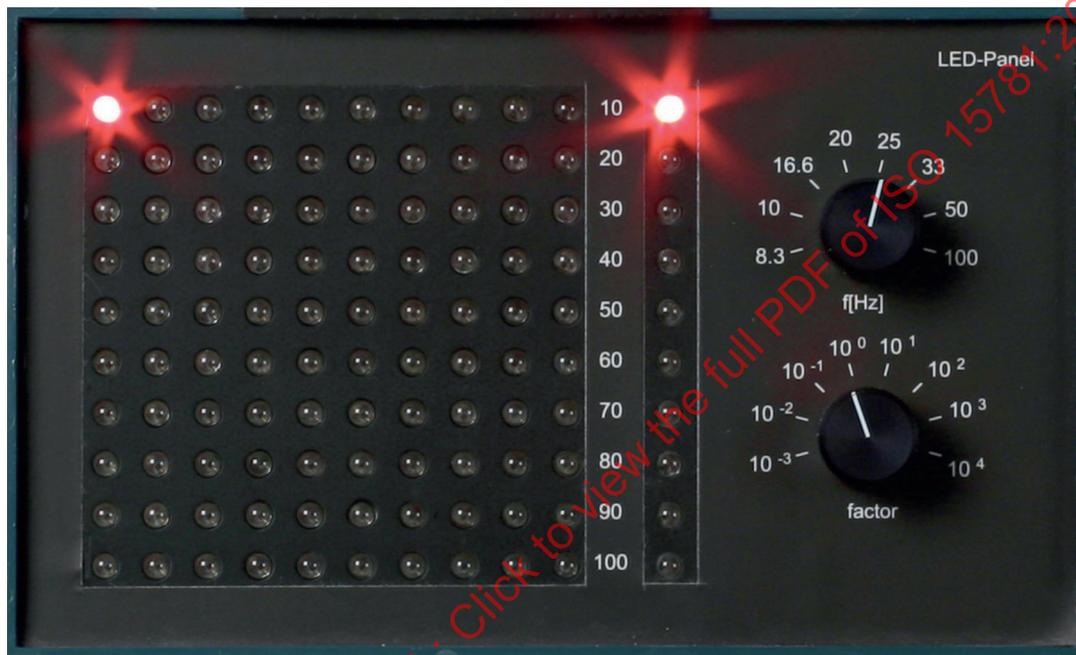


Figure B.5 — Sample device for a LED panel

The frequency of the LEDs is selectable and each LED is illuminated for a defined period of time. With longer exposure times, one or more LEDs will be illuminated in the image.

NOTE 2 The same thing may be possible using a software solution and displaying a “virtual LED panel”. In this case care has to be taken for the image frequency of the monitor. Many LCD monitors are not set to refresh rates high enough or suffer from a long response time. In that case the “digital LEDs” are not displayed fast enough to lead to reliable results. In addition the timing circuit on the computer board has to be checked for its accuracy. It may require a calibration prior to the measurement. The program may not show the same speed when another software is running on the same computer, which also requires resources of that computer. Another uncertainty is how to trigger the virtual LED panel. There can be variable delays between when the trigger signal is sent to the computer and when the computer begins updating the “virtual LED panel”. A software solution needs to address these problems otherwise it is not suitable for measurements related to this document.

B.3 Timing device position for focal plane shutter and rolling shutter

This subclause describes the positions of the chart and timing device when the exposure timing of the sample camera that has a focal plane shutter or a rolling shutter that differs depending on the image location. If the camera has a rolling shutter only this chart layout is intended to be used for cameras with a readout speed for an entire frame faster than 1/10 of a second.

Depending on the timing device used two setups are possible.

If the timing device does not allow to simultaneously measure the time lag and the readout speed:

The timing devices are positioned in two diagonal corners, and shorter time duration between the measurement start time (power switch, pre-capture point, and capture point) and the measurement end time (exposure start) is adopted as measured value. Alternatively, measurement is performed with the timing device positioned in one of diagonal corners of the shooting image, then with the timing device positioned in other diagonal corner. The shorter time duration between measurement start time (power switch, pre-capture point, and capture point) and measurement end time (exposure start) is adopted as measured value.

Prior to the measurement, it should be ensured that the timing device (such as LED) is exposed appropriately. The shutter speed and positions may be changed if necessary.

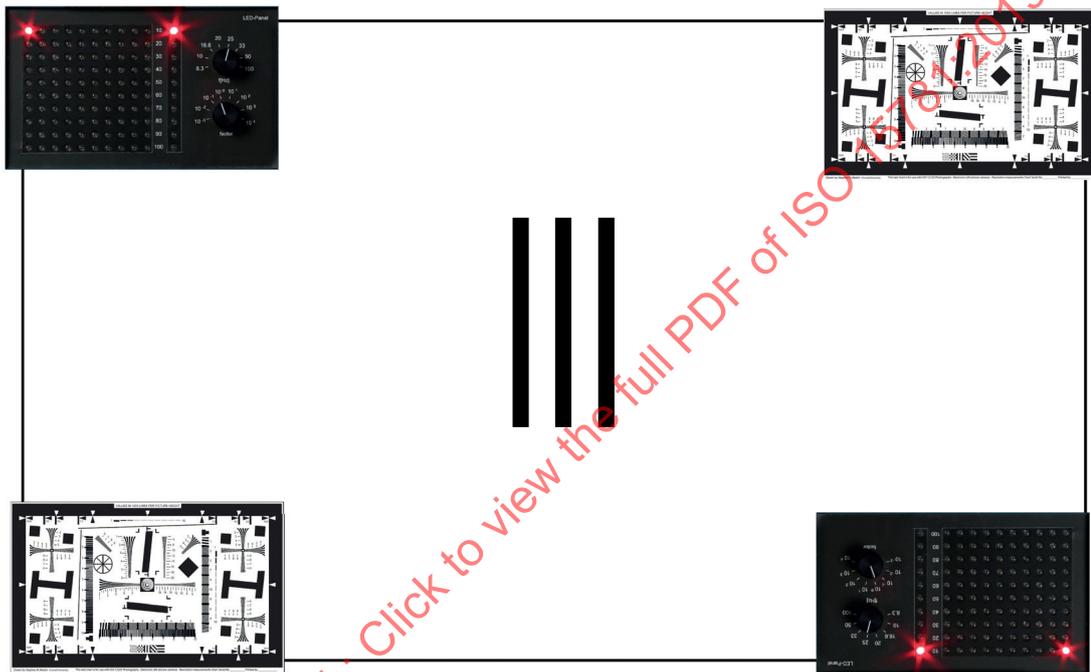


Figure B.6 — Example of positioning charts and timing devices

An ISO 12233 chart with a height of 20 cm is positioned in the diagonal corners of the three-line chart with a height of 80 cm. Furthermore, the timing devices are positioned in the other diagonal corners. The two timing devices need to be synchronized and the accuracy of the synchronization should be smaller than 1 ms (see [Figure B.6](#)).

NOTE By intention the timing device in the lower right corner is turned 180° to ensure that the starting LED is as close to the image corner as possible and captures the beginning of the exposure.

If the timing device allows to simultaneously measure the time lag and the readout speed:

Only one timing device is necessary. As for the previous setup, it is positioned in a corner, preferably the one where the integration starts. The time lag measurement can be corrected with readout speed multiplied by the relative position of the timing device in the field.

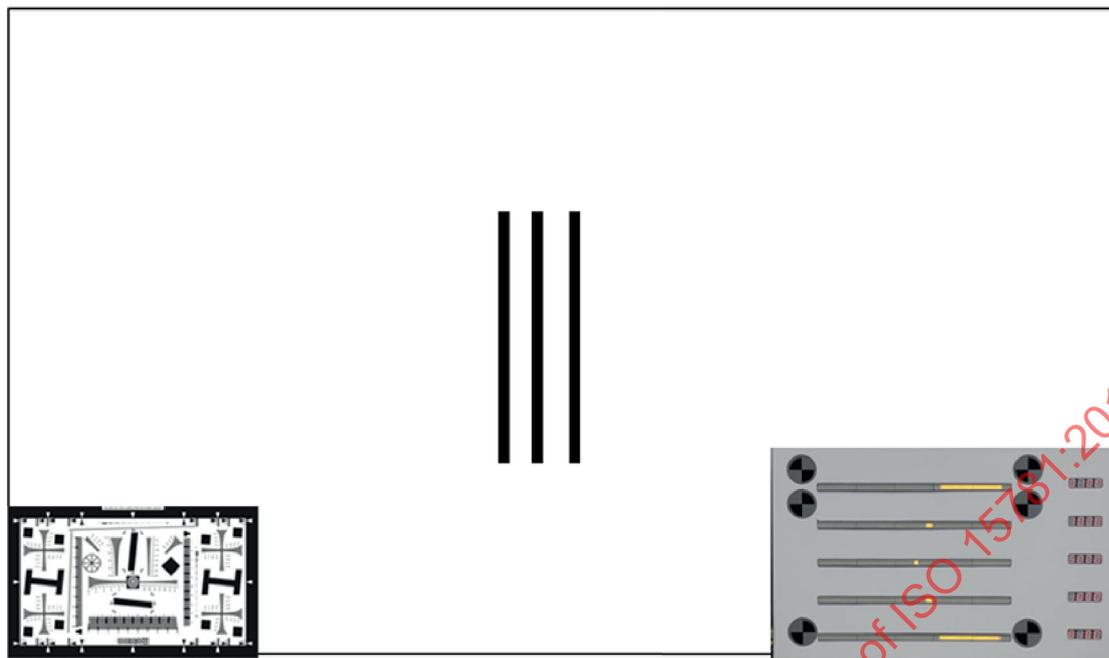


Figure B.7 — Example of positioning charts and a timing device that allow to simultaneously measure the time lag and the readout speed

As for the previous setup, ISO 12233 chart with a height of 20 cm is positioned in the diagonal corners of the three-line chart with a height of 80 cm.

Annex C (informative)

Measurement with internal controls

C.1 General

This annex describes examples for measuring each time lag using control signals inside the digital still camera. A typical digital still camera consists of components as shown in [Figure C.1](#). The time lag can be measured by measuring the differences among each control signal during the time between the moment the input signal becomes active and the moment the exposure starts, using a timing measurement device such as an oscilloscope.

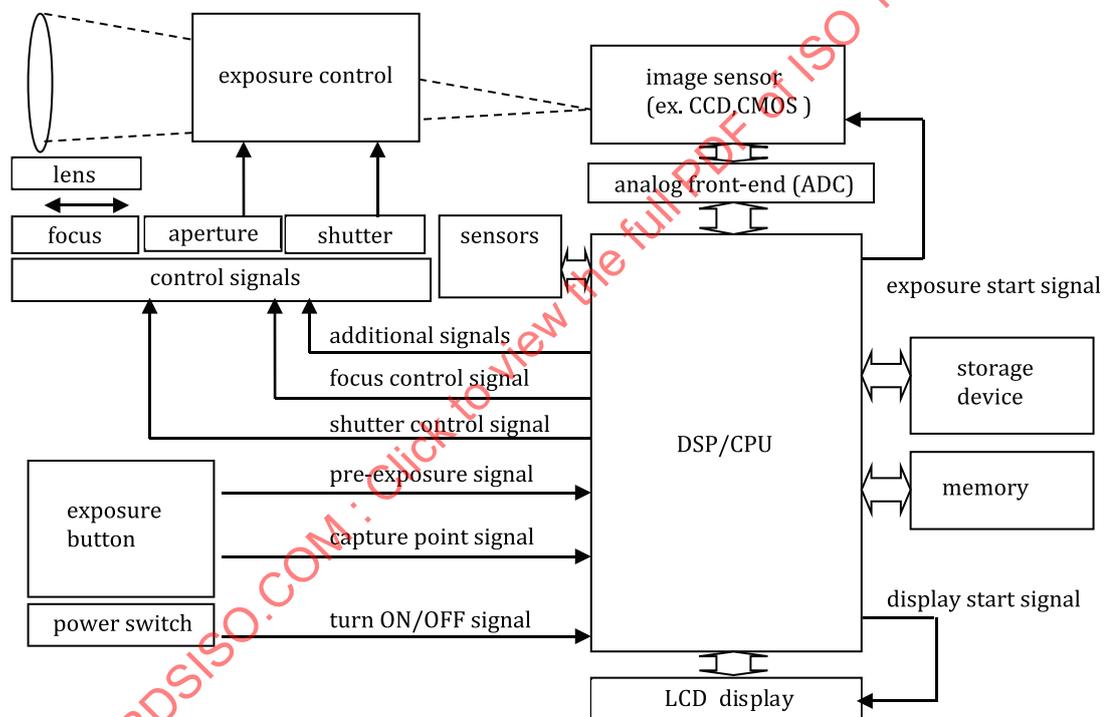


Figure C.1 — Block diagram of a standard digital still camera

C.2 Start point (measurement start point)

The power switch input signal may be used for the camera power-on signal in the start-up time lag measurement (see “power switch” in [Figure C.1](#)).

A camera has generally an exposure button that has pre-capture point and capture point. The signal of the pre-capture point can be used as a “start point” of the measure of shooting time lag and the signal of the capture point can be used as a “start point” of the measure of shutter release time lag.

C.3 Exposure point (exposure start point)

C.3.1 General

The exposure of some digital cameras is started by resetting the charge of the image sensor, whether the digital camera has a mechanical shutter, that blocks the light, or not. For such digital cameras, the exposure start point is determined by the signal that resets the charge of image sensor as described in C.3.2 and the exposure of other digital cameras is controlled by a mechanical shutter as described in C.3.3.

Whether the focus is achieved or not can be determined by observing signals such as the focus control signal.

C.3.2 Exposure start point of image sensor shutter

For a digital camera in which exposure is started by resetting the charge of image sensor, the moment when the exposure start signal is provided can be used as the exposure start point. Because the exposure starts in a very short time after being provided the exposure start signal which resets the electric charges in the image sensor. Figures C.2, C.3 and C.4 show measurement points for such digital cameras.

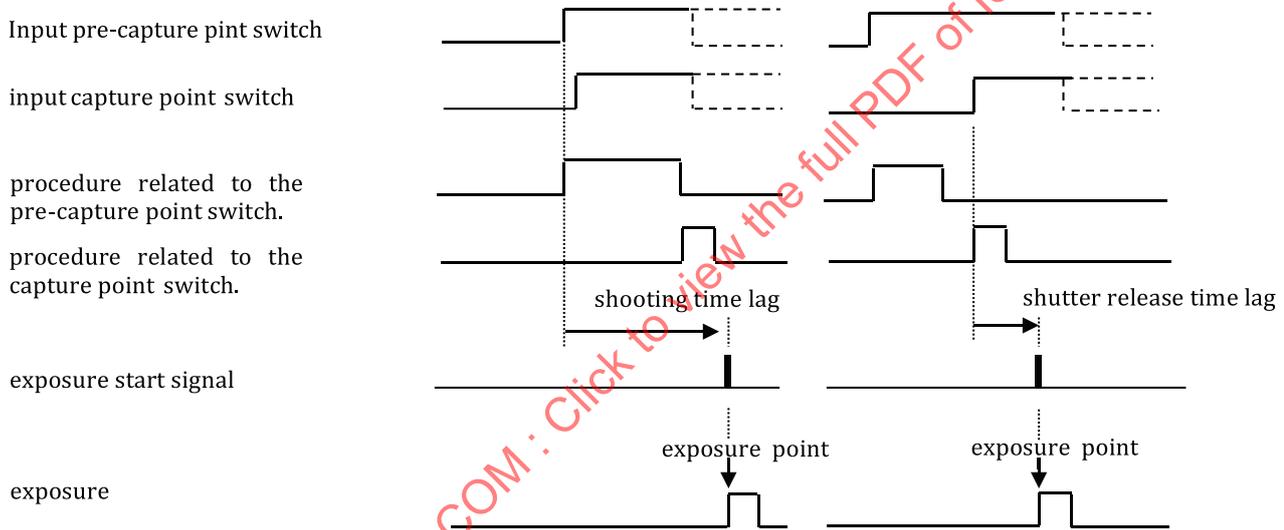


Figure C.2 — Measurement point of shooting time lag and shutter release time lag

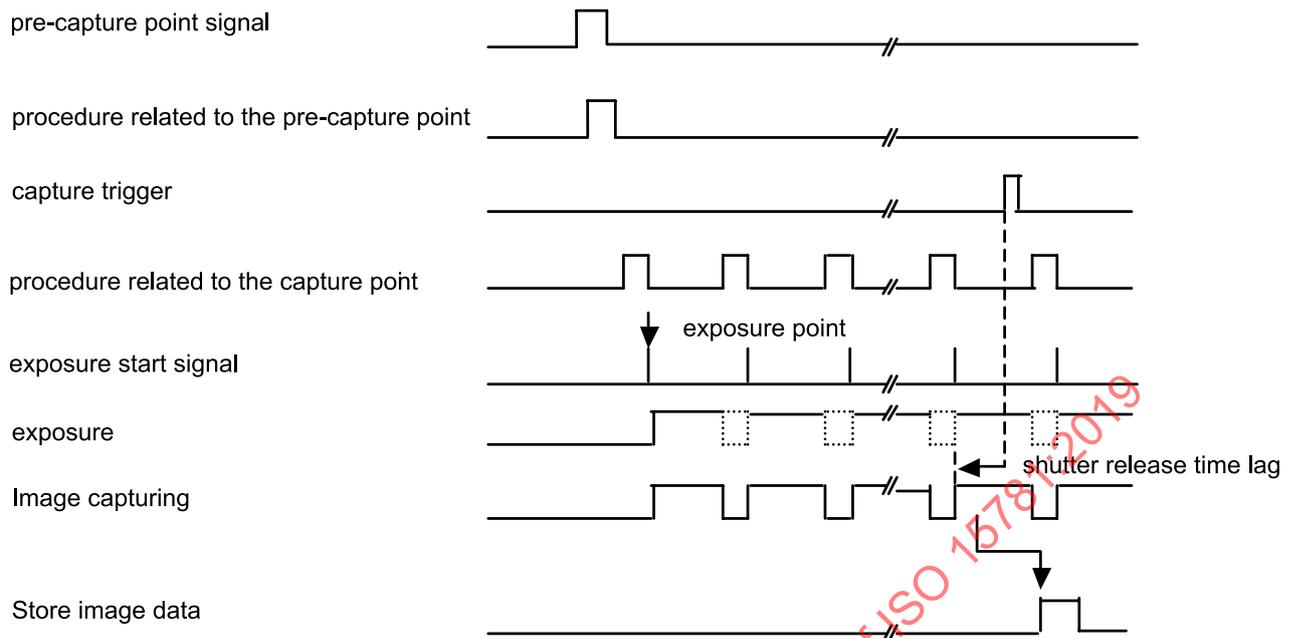


Figure C.3 — Measurement point of shutter release time lag

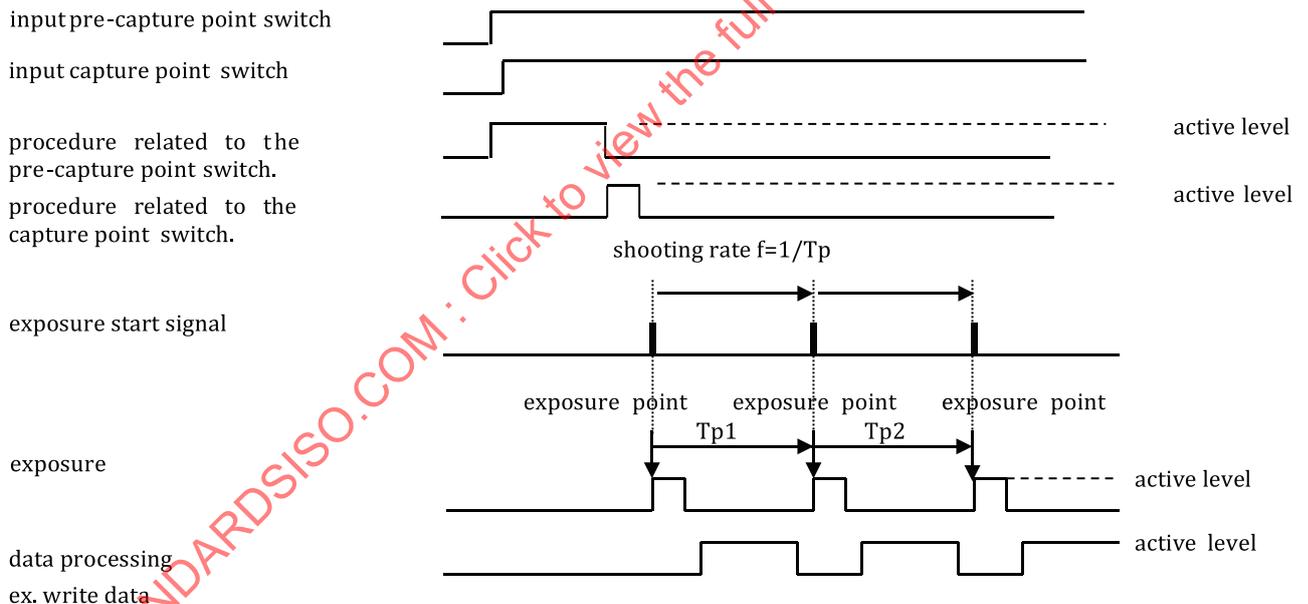


Figure C.4 — Measurement point of shooting rate

C.3.3 Exposure start point of mechanical shutter

The exposure of some digital cameras is controlled by “mechanical shutter”. For such digital cameras, the correct exposure start point cannot be determined directly by the control signals inside the cameras, including the exposure start signal, because the mechanical shutter will be activated with a time delay (t_d) after being provided the exposure start signal: “shutter control signal”. The relation between “shutter control signal” and “delay time” is described in the [Figure C.5](#), [C.6](#) and [C.7](#).

There is a highly accurate measurement method to measure the exposure start point (exposure point). The exposure state of an actual exposure frame can be obtained by observing the movement of the mechanical shutter with a high-speed camera.

NOTE It can also be possible to trigger an LED device (see Annex B) with the appropriate signal and use the target as described in Annex B.

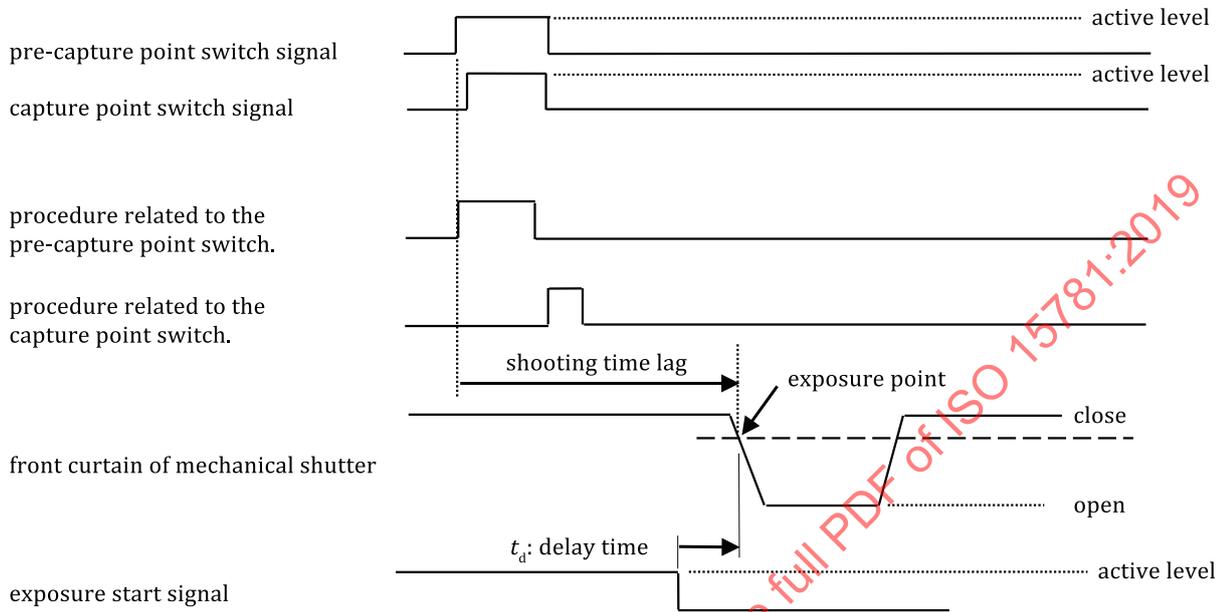


Figure C.5 — Measurement point of shooting time lag (mechanical shutter)

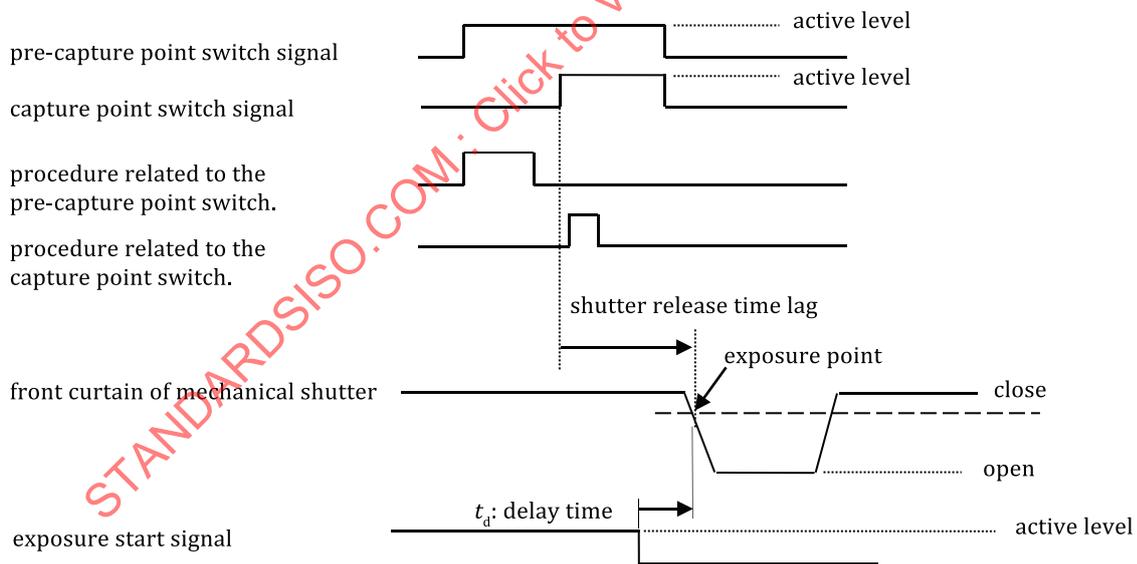


Figure C.6 — Measurement point of shutter release time lag (mechanical shutter)

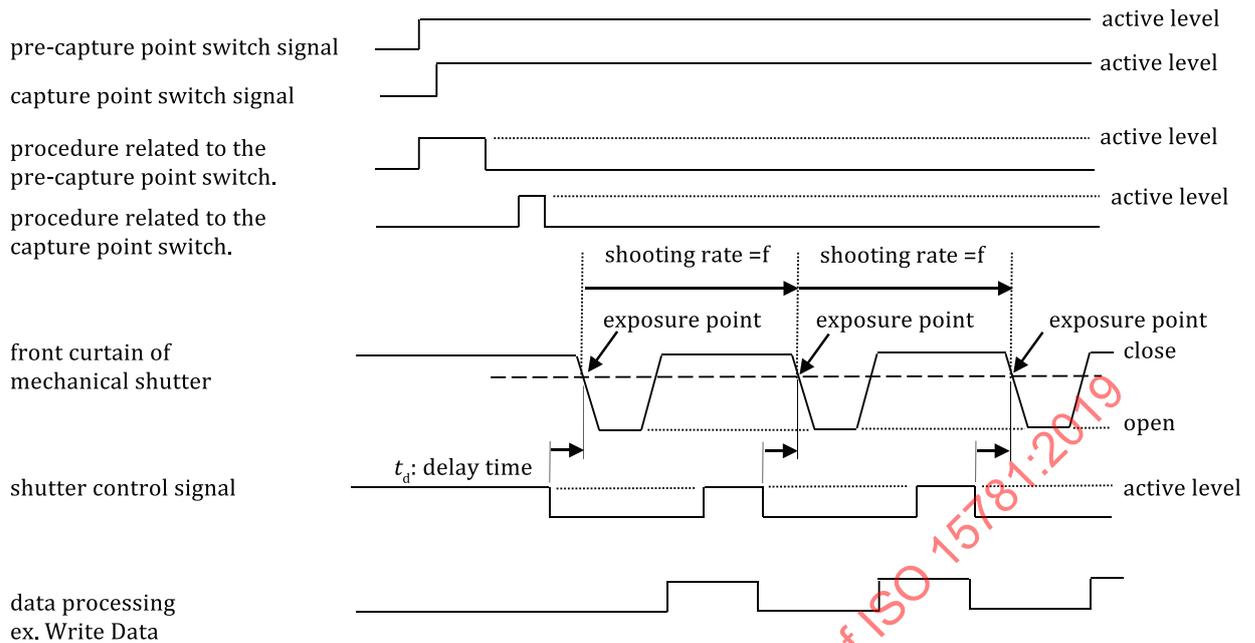


Figure C.7 — Measurement point of shooting rate (mechanical shutter)

C.4 Identifying standby state (measuring start-up time lag)

C.4.1 General

If the shooting images can only be checked through an optical viewfinder, or if the initial setting of the product is image display device off in the camera with both an optical viewfinder and image display unit, only the time between switching the power on and the moment pre-capture is accepted can be measured.

In other cases where the shooting image cannot be checked through an optical viewfinder, or the initial setting of the product is image display device on in the camera with both optical viewfinder and image display unit, the time between switching the power on and the moment pre-capture is accepted and the time between switching the power on and the moment the viewfinder image (through-image) is displayed should both be measured.

C.4.2 Measuring the time until pre-capture is accepted

The point when the system initialization is completed can be regarded as the standby state because it is generally equal to the point when pre-capture is accepted. [Figure C.8](#) shows the measurement points.

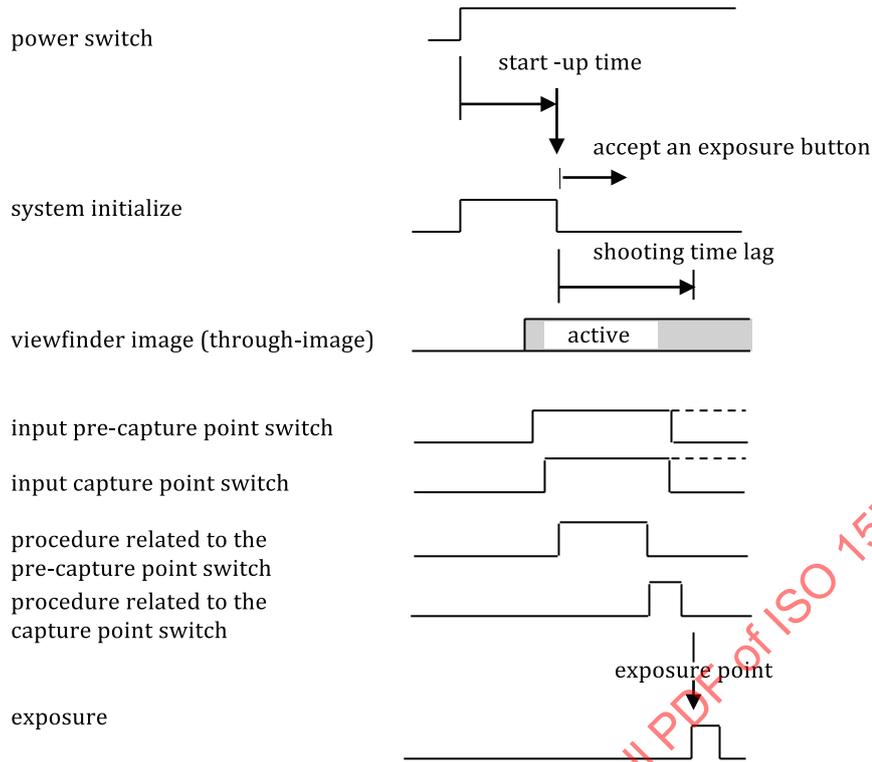


Figure C.8 — Measurement point of start-up time lag when the time until the pre-capture signal can be accepted is longer than the time until the viewfinder image (through image) is displayed

C.4.3 Measuring the time until the viewfinder image (through-image) is displayed

The signal to display the image picked up by the image sensor to the display unit may be used as the point where the viewfinder image (through-image) is displayed. [Figure C.9](#) shows the measurement points.

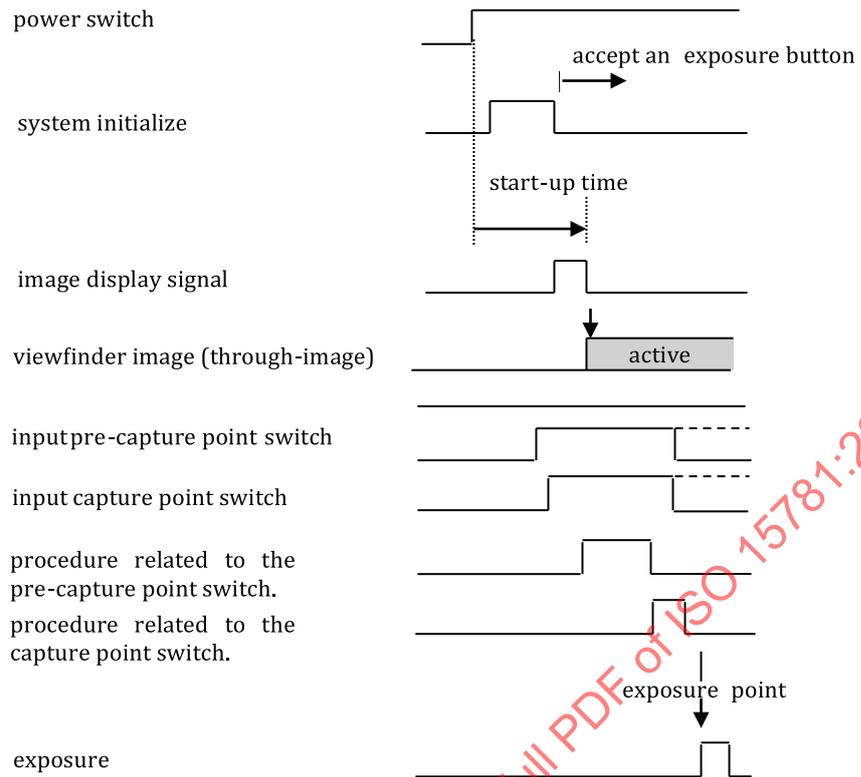


Figure C.9 — Measurement point of start-up time lag when the time until the viewfinder image is displayed is longer than the time until pre-capture can be accepted

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Annex D (informative)

Examples of reporting the result

This annex describes examples for the statement of test reports. [Table D.1](#) gives examples of information for common conditions. [Tables D.2, D.3, D.4, D.5](#) and [D.6](#) give examples of reports for each measurement.

Table D.1 — Example of information for common conditions

Camera	XYZ
Serial number	1234567
Firmware version	Version 1.00
Lens	1:2,8 60 mm
Memory card type ^a	XY ultra fast 70×
Memory card size ^a	4 GB
Number of recorded pixels ^a	3 000 × 2 000 pixel
Illumination of the test scene ^a	1 000 lx
Power supply	Lithium ion battery
Measurement method	External (electromagnetic finger)

^a Omissible if described in each measured item.

Table D.2 — Example of report for shooting time lag

Capture mode (e.g. portrait, sports)	Factory setting
Shooting distance	1,32 m
Focal length	Wide or 40 mm
Exposure time	10 ms
Focus mode	High speed mode
Different result for first image	No
Memory type	XY ultra fast 70×
Memory size	4 GB
Number of recorded pixels	3 000 × 2 000 pixel
Illumination of the test scene	1 000 lx
Measurement method	External
Shooting time lag	0,6 s

Table D.3 — Example of report for shooting time lag with continuous auto focus

Capture mode (e.g. portrait, sports)	Factory setting
Shooting distance	1,32 m
Defocus chart distance	200 mm
Focal length	Wide or 40 mm
Exposure time	10 ms
Focus mode	Continuous auto focus
Different result for first image	No
Memory type	XY ultra fast 70×

Table D.3 (continued)

Memory size	4 GB
Number of recorded pixels	3 000 × 2 000 pixel
Illumination of the test scene	1 000 lx
Activation method of the camera	Pressing camera button on device
Measurement method	External
Ratio of images that are obviously out of focus	7 %
Shooting time lag	0,6 s

Table D.4 — Example of report for shutter release time lag

Capture mode (e.g. portrait, sports)	Factory setting
Shooting distance	1,98 m
Focal length	60 mm
Measurement method	Internal
Shutter release time lag	0,015 s or 15 ms

Table D.5 — Example of report for start-up time lag

Capture mode (e.g. portrait, sports)	Factory setting
Memory type	Internal memory
Memory size	4 GB
Flash	OFF
Illumination of the test scene	1 000 lx
Power supply	Lithium ion battery
Measurement method	Internal
Measurement point	Time until pre-capture can be accepted
Start-up time lag	1,3 s

Table D.6 — Example of report for shooting rate

Capture mode (e.g. portrait, sports)	Sports burst mode
Memory type	XY ultra fast 70×
Memory size	4 GB
Number of recorded pixels	3 000 × 2 000 pixel
Quality	JPEG lowest compression
Number of images at highest speed	Until card full
Illumination of the test scene	1 000 lx
Measurement method	External
Shooting rate	4,4 images per second