Verification Method of Vibratory Apparatus

For

CIPA DC-X011-2012

Measurement and Description Method for Image Stabilization Performance of Digital Cameras (Optical Method),

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Contents

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1. Introduction

This document specifies the method for verifying performance of the vibratory apparatus used in measuring image stabilization performance in accordance with CIPA Standard DC-X011-2012 **Measurement and Description Method for Image Stabilization Performance of Digital Cameras (Optical Method)**, as well as measurement accuracy of bokeh offset amount and measured comprehensive bokeh amount (or measured motion blur amount) as given in Section 4-2-8 **Motion Blur Measurement Software** in the above standard. (Hereinafter, CIPA Standard DC-X011-2012 **Measurement and Description Method for Image Stabilization Performance of Digital Cameras (Optical Method)** will be abbreviated to just **CIPA Standard DC-X011-2012**.)

As this document conforms with CIPA Standard DC-X011-2012, it is has been written assuming knowledge of the terms and measurement procedures for image stabilization performance defined therein. Refer to the standard for further explanation on all terms and measurement procedures for image stabilization performance not present in this document.

2. Scope

This document specifies the method for verifying performance of the vibratory apparatus used in measuring image stabilization performance in accordance with CIPA Standard DC-X011-2012, as well as measurement accuracy of bokeh offset amount and measured comprehensive bokeh amount (or measured motion blur amount) as given in Section 4-2-8 **Motion Blur Measurement Software** in the above standard. It is not applicable for any other measuring apparatuses or measuring procedures.

3. Overview of Verification Method

3-1 Basic Approach

Defined below are Measurement I and Measurement II, two methods for verifying performance of the vibratory apparatus used to measure image stabilization performance in accordance with CIPA Standard DC-X011-2012, as well as measurement accuracy of bokeh offset amount and measured comprehensive bokeh amount (or measured motion blur amount) as given in Section 4-2-8 **Motion Blur Measurement Software** in the above standard.

Measurement I:

Evaluates basic performance of the vibratory apparatus based on sine waves of differing frequencies and amplitudes.

This method measures the amplitude and phase characteristics of vibrations from the apparatus. For amplitude characteristics, it evaluates how well the vibration amplitude of the input waveform matches that produced by the vibratory apparatus. For phase characteristics, it evaluates the vibration phase lag at a specified frequency.

Measurement II:

Evaluates how the vibratory apparatus performs with complex vibrations, such as vibration waveforms, using a test waveform that mimics camera vibration from camera shake.

This method measures the bokeh amount for images captured with a camera shaken by the vibratory apparatus. It evaluates how closely the measured motion blur amount as calculated from the bokeh amount matches the reference motion blur amount as calculated from the average vibration angle of the test waveform.

Measurement II is also used to verify measurement accuracy of bokeh offset amount and measured comprehensive bokeh amount (or measured motion blur amount) as given in CIPA Standard DC-X011-2012 Section 4-2-8 **Motion Blur Measurement Software.**

Evaluations for vibratory apparatuses used to measure image stabilization in the standard must meet the performance marks set for both Measurement I and Measurement II.

Also, evaluations for measurement accuracy of bokeh offset amounts and measured comprehensive bokeh amounts (or measured motion blur amount) as given in CIPA Standard DC-X011-2012 Section 4-2-8 **Motion Blur Measurement Software** must meet the performance marks set for Measurement II.

3-2 Loads Shaken by the Vibratory Apparatus

Mechanical components and motor specifications for the vibratory apparatus may vary significantly depending on the mass (load) of the object to be shaken. There will likely be a great difference in cost and development requirements for vibratory apparatuses made to accommodate wide load ranges and those for more limited load ranges. There is no guarantee that accommodating wide load ranges will meet the purpose or interests of the measurer. Therefore, it is assumed that a specific load will be

set for each vibratory apparatus, and this verification method is to take the load range into account for evaluations.

3-3 Documents, Data, Software and Charts Provided by CIPA

CIPA will provide the following documents, data, software and charts for verification:

1) This document
2) Two (2) test waveforms
3) Two (2) average vibration angles
4) Motion Blur Measurement Software (FindsBlur) with manual and instructions for use
5) CIPA Motion Blur Measurement Chart (for additional fee)

3-4 Disclaimer

All claims and actions taken against vibratory apparatus performance or specifications are the sole responsibility of the supplier or measurer, even for apparatuses designed and manufactured to satisfy predetermined performance with this verification method.

3-5 Definition of Terms

Definitions of terms used in this document are described below. Terms defined in CIPA Standard DC-X011-2012 are not described in this document. Please refer to the standard for definitions.

3-5-1 Loads

Load refers to the total mass of the camera body, lenses and other attachments shaken by the vibratory apparatus. If, for example, the load range is 300 g to 1 kg, this means that the vibratory apparatus can vibrate objects with a total mass between 300 g and 1 kg.

3-5-2 Test Waveforms TWB-H and TWB-L

The test waveforms used in Measurement II. TWB-H and TWB-L are two test waveforms made to resemble the vibration from camera shake. Which is used depends upon the load range shaken by the vibratory apparatus.

The TWB-H and TWB-L files are in text format, named TWB-H-xxx.txt and TWB-L-xxx.txt, respectively. Test waveforms are provided as angle data changing in the time direction for a length of 32 seconds. Data sampling frequency is 500Hz. The

‘xxx’ in the test waveform file names is a 3-digit number giving the waveform version. If a test waveform has been revised, version differences are managed with these numbers.

3-5-3 Average Vibration Angle

These are the average values for the vibration angles at each shutter speed when the camera is shaken at the test waveforms TWB-H and TWB-L.

Average vibration angle data files are in text format, with the file corresponding to TWB-H named TAVA-1-xxx.txt and that corresponding to TWB-L named TAVA-2-xxx.txt.

Again, the ‘xxx’ in the file names is a 3-digit number giving the version number. The 3 digits are used to manage the files, corresponding with the test waveform revisions.

3-5-4 Conversion Factor (fr)

The number used to calculate estimated comprehensive bokeh amount with Measurement II.

3-6 Referenced Standards

3-6-1 Referenced Standards

- CIPA DCG-002 Specification Guideline for Digital Cameras
- CIPA DCG-005 Measurement and Description Methods for Weight and Dimensions of Digital Cameras
- CIPA Standard DC-X011-2012 Measurement and Description Method for Image Stabilization Performance of Digital Cameras (Optical Method)

3-6-2 Response to Revision of Reference Standards

If specifications referred to by this standard are revised, response will be as follows:

・For specifications and guidelines managed by CIPA, revised editions shall be followed.

・For other specifications, this standard shall be followed in principle until revised.

4. Measurement I

4-1 Preconditions

Vibratory apparatus evaluations with Measurement I are to follow Section 4-2 **Equipment and Environment for Measurement** and Section 4-3 **Measurement Procedures**.

The number of measurements taken is left up to the discretion of the measurer, but the measurer is not permitted to selectively choose which measurements to use.

An overview of the measurement method is shown below in Figure 4-1.

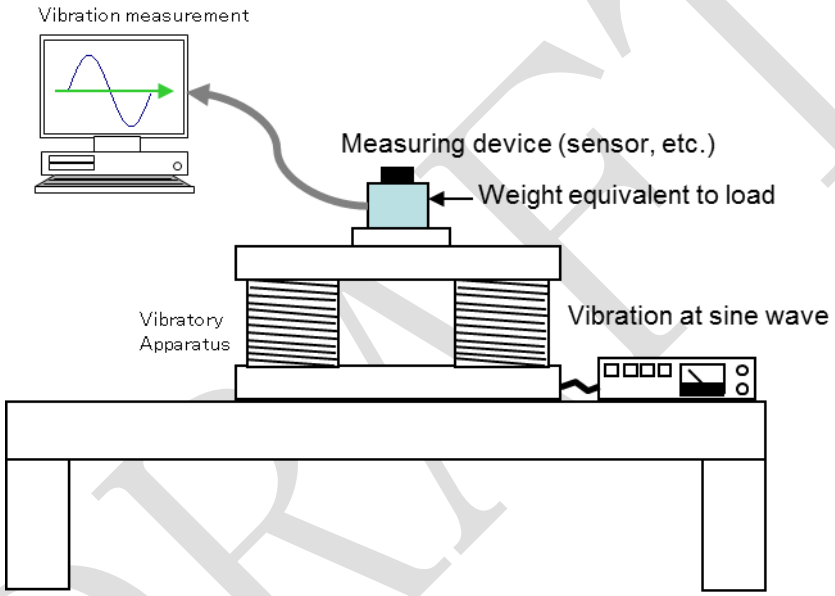


Figure 4-1: Overview of Measurement I

4-2 Equipment and Environment for Measurement

4-2-1 Sine Waves and Combinations Used in Evaluation

Measurement I uses sine waves with the frequencies and amplitudes shown in Table 4-2-1a to evaluate the amplitude and phase characteristics of the vibratory apparatus. During the evaluation, the load is shaken in both the yaw and pitch directions simultaneously. Table 4-2-1b shows the combination of frequencies and amplitude for evaluating amplitude characteristics, and Table 4-2-1c shows that for evaluating phase characteristics.

Table 4-2-1a: Combinations of sine wave frequency and amplitude used in evaluations

	Frequency (Hz)	**Amplitude** (deg: ±)	**Angular Velocity** (deg/sec)
a	**0.1**	**2**	**1.26**
b	**0.5**	**2**	**6.28**
c	**1**	**1**	**6.28**
d	**5**	**0.2**	**6.28**
e	**10**	**0.1**	**6.28**

Table 4-2-1b: Yaw and pitch combinations (for amplitude characteristic evaluation)

	Pattern 1	Pattern 2	Pattern 3	Pattern 4	Pattern 5
Yaw	a	b	c	d	e
Pitch	c	d	e	a	b

Table 4-2-1c: Yaw and pitch combinations (for phase characteristic evaluation)

	Pattern 6	Pattern 7
Yaw	c	d
Pitch	d	c

4-2-2 Measuring Devices

This specification does not specify the device to be used for measuring the vibrational state of the vibratory apparatus. Therefore, the measurer is to use the optimal means according to his measuring environment, whether it be angle sensors, angular velocity sensors (gyroscopes), rotary encoders, laser displacement sensors or other devices. A combination of multiple devices is also acceptable. However, the measuring device used should be accurate enough to leave no doubt of the measurement results.

4-2-3 Temperature and humidity

Temperature and humidity shall be 23 ±2°C and 30 - 70%, respectively. Measurement may be performed under other conditions as long as there is no room for doubt.

4-3 Measurement Procedures

Successively mount objects equivalent to the maximum and minimum weights of the target load range to the vibratory apparatus and shake them in patterns 1-7 as given in Section 4-2-1 **Sine Waves and Combinations Used in Evaluation**. Next, measure the vibrational states using a device given in Section 4-2-2 **Measuring Devices**. If any

sensors or other devices are mounted to the vibratory apparatus for measurement, include their mass to the load.

4-4 Judging Measurement Results

If the procedure given in Section 4-3 **Measurement Procedures** is followed with objects equivalent to the maximum and minimum weights of the target load range mounted to the vibratory apparatus and shaken, measurements meeting the following performance guidelines are deemed to have satisfied the Measurement I evaluation:

- There is less than ±5% difference between the measured amplitude values and that of the input sine wave for all combinations for patterns 1-5. (See Figure 4-4a)
- The phase difference in yaw and pitch measurements is 90 degrees or less for the combinations for Patterns 6 and 7. (See Figure 4-4b)

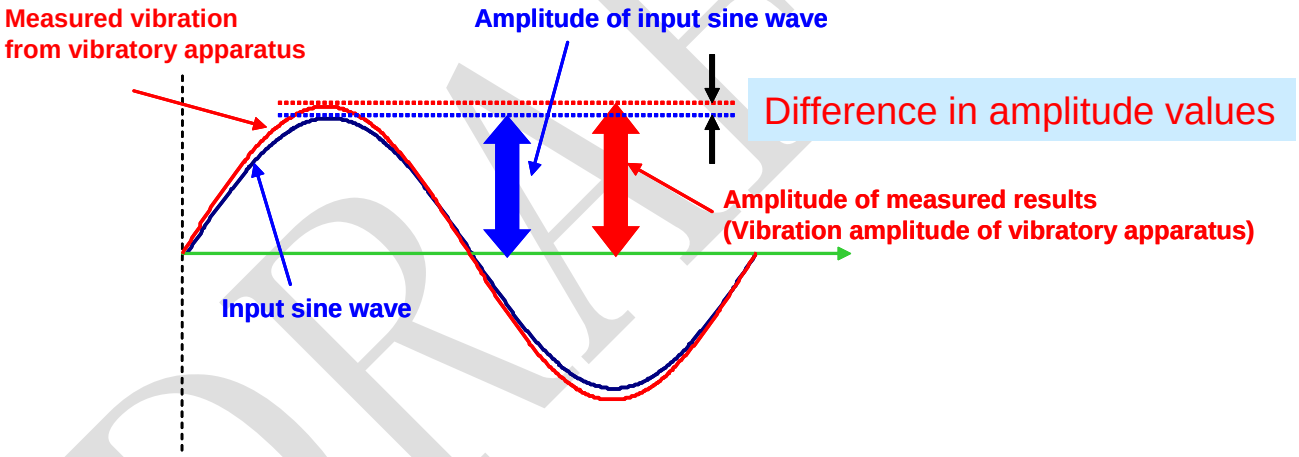


Figure 4-4a: Illustration of amplitude differences

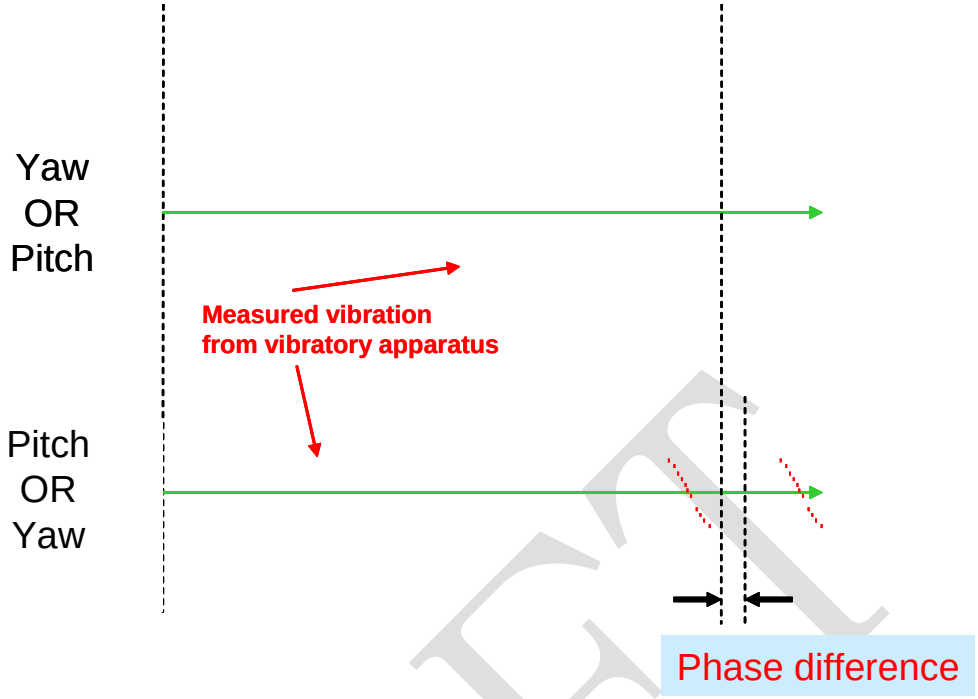


Figure 4-4b: Illustration of phase differences

5. Measurement II

5-1 Preconditions

Vibratory apparatus evaluations with Measurement II are to follow Section 5-2 **Equipment and Environment for Measurement**, Section 5-3 **Settings of Camera to be Measured and Section 5-4 Measurement Procedure**. The number of measurements taken is left up to the discretion of the measurer, but the measurer is not permitted to selectively choose which measurements to use.

An overview of the measurement method is shown below in Figure 5-1.

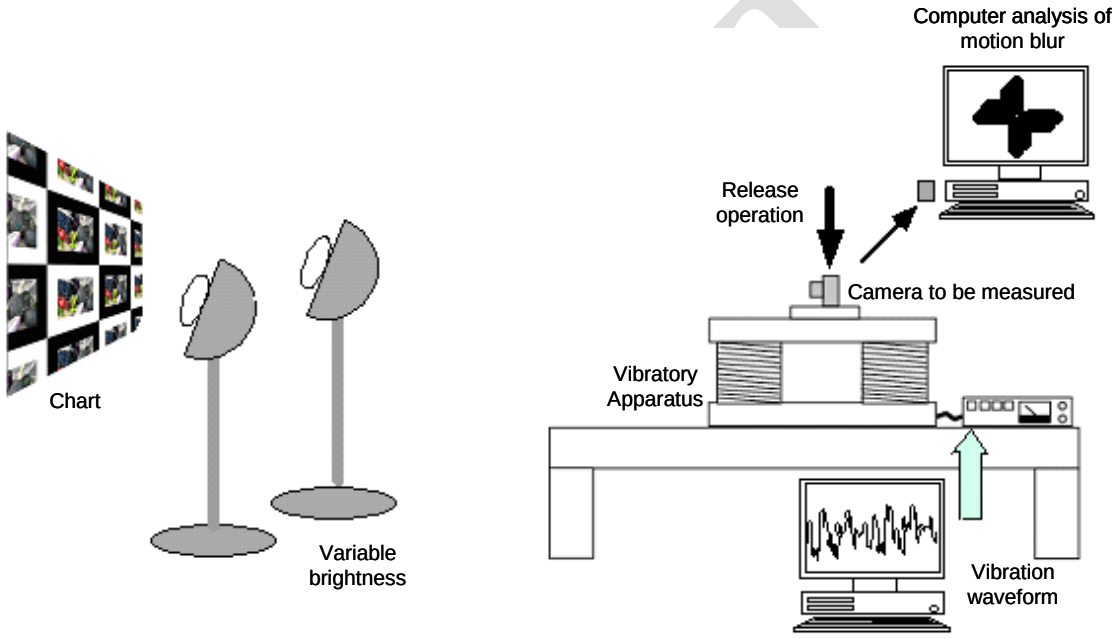


Figure 5-1: Overview of Measurement II

Measurement II is also used when verifying measurement accuracy of bokeh offset amount and measured comprehensive bokeh amount (or measured motion blur amount) as given in CIPA Standard DC-X011-2012 Section 4-2-8 **Motion Blur Measurement Software**. Measurements are to follow Section 5-2 **Equipment and Environment for Measurement** and Section 5-3 **Settings of Camera to be Measured**. The number of measurements taken is left up to the discretion of the measurer, but the measurer is not permitted to selectively choose which measurements to use.

5-2 Equipment and Environment for Measurement

Other than the details given below, measuring equipment and environment are to

comply with the provisions of CIPA Standard DC-X011-2012 Section 4-2 **Equipment and Environment for Measurement**.

5-2-1 Motion Blur Measurement Chart

CIPA motion blur measurement chart shall be used when performing Measurement II.

5-2-2 Mounting of Camera to be Measured on Vibratory Apparatus

When mounting a camera to be measured on a vibratory apparatus, vibration of the vibratory apparatus and that of the camera mounted on the vibratory apparatus have to match.

When measuring a camera with a long-barrel lens, such as is found on high-powered zoom lenses, vibrations of the camera body and lens may not match. This is because the excitation induces strain in the lens, which prevents the applied vibration from being correctly transmitted to the lens. Thus, when measuring a camera with a long-barrel lens, fix not only the camera body but also the lens to the vibratory apparatus, or take other measures to ensure that the lens and camera body vibrations match.

5-2-3 Test Waveforms TWB-H and TWB-L and Loads during Evaluation

Measurement II is to be taken using either one of test waveform TWB-H or TWB-L or both waveforms. Test waveforms TWB-H and TWB-L are given in Figure 5-2-3a, and their average vibration angles are given in Figure 5-2-3b.

The combinations for the test waveforms and loads in accordance with the load ranges for the vibratory apparatus are given in Table 5-2-3a and Figure 5-2-3c.

Both test waveforms are composed of the biaxial components of pitch and yaw. Vibrations shake in both the pitch direction and yaw direction simultaneously. Refer to Figure 6-3a in CIPA Standard DC-X011-2012 for motion blur in the yaw and pitch directions.

Further, vibration waveforms can be revised as necessary to reflect changes in camera shape, how pictures are taken, and the associated development of image stabilization technology. Test waveforms can also be revised along with such changes.

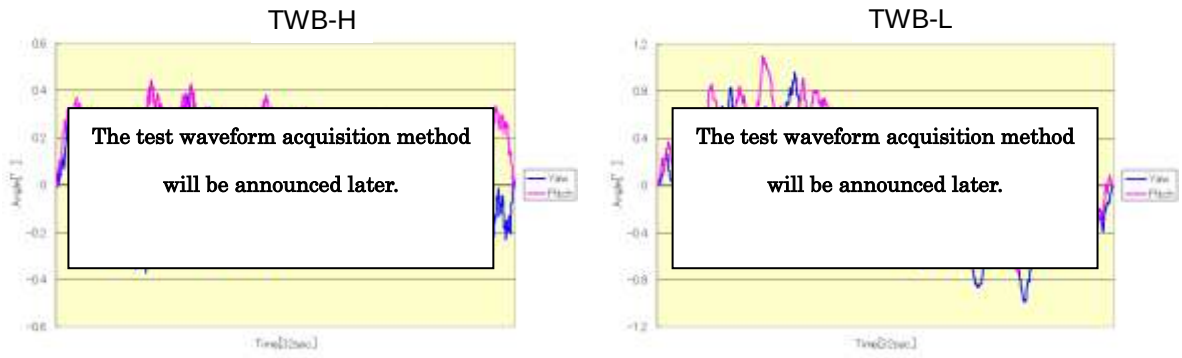


Figure 5-2-3a: Test waveforms TWB-H (left) and TWB-L (right)

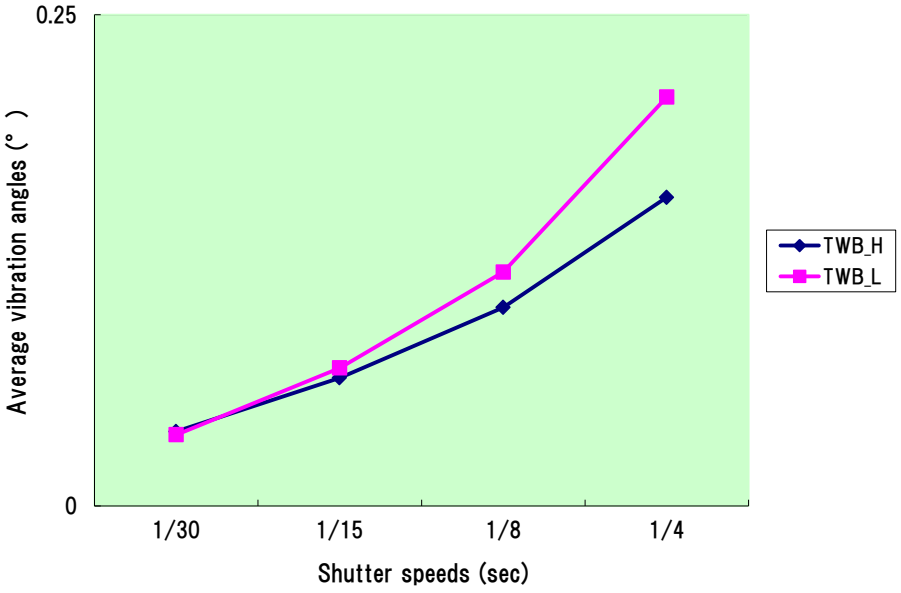


Figure 5-2-3b: Test waveform average vibration angles

Table 5-2-3a: Test waveform and load combinations

Case	Vibratory Apparatus Load Range			Test Waveform and Load Used			
	≥600 g	400 - 600 g	< 400 g	TWB-L	TWB-H	TWB-L	TWB-H
A	Max-min			—	Max load	—	Min load
B	Max	Min		—	Max load	600 g	—
C	Max	-	Min	—	Max load	600 g	—
D		Max-min		Max load	Max load	—	—
E		Max	Min	Max load	Max load	—	—
F			Max-min	Max load	—	—	—

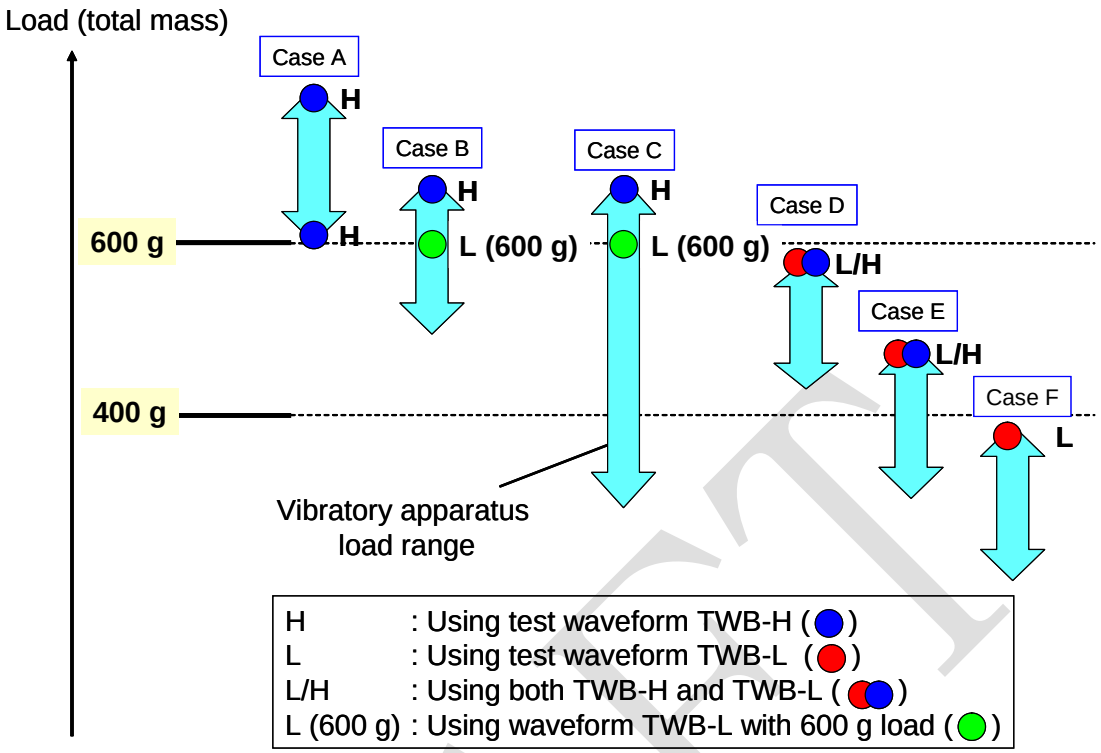


Figure 5-2-3c: Test waveform and load combinations

5-2-4 Shooting Distance

The shooting distance should be such that the range shown by broken red lines in Figure 4-4-1 of CIPA Standard DC-X011-2012 can be shot to approximately fill the whole picture frame. This distance is about 20 times the 35mm film equivalent focal length.

5-2-5 Motion Blur Measurement Software

The bokeh offset amounts and measured comprehensive bokeh amounts for images of the CIPA motion blur measurement chart taken according to Section 5-4 **Measurement Procedures** are to be quantified using FindsBlur, the motion blur measurement software provided by the CIPA.

Note however that the camera settings or measurement environment may prevent you from obtaining appropriate measurements even using this software. If there are any doubts regarding the results of a measurement, review the camera settings and measurement environment before re-measuring or taking other such measures.

5-2-6 Loads

Referring to the load ranges given in Table 5-2-3a and Figure 5-2-3c, mount an object of equivalent weight to the load on the vibratory apparatus before measuring. The total

mass of the camera as mounted on the vibratory apparatus is to be included in the load.

5-3 Settings of Camera to be Measured

Other than the details given below, settings for the camera to be measured are to comply with the provisions of CIPA Standard DC-X011-2012 Section 4-3 **Settings of Camera to be Measured**.

5-3-1 Image Stabilization Mode

Image stabilization is to be set to OFF.

5-3-2 Image Quality Mode (Compression Ratio)

Set the camera to its highest resolution mode (with the lowest compression ratio).

5-3-3 Image Quality Mode (The Number of Recording Pixels)

Set the camera to be measured to its highest number of recording pixels. Do not use settings which exceed the effective number of pixels of the image sensor due to pixel interpolation, image processing or other effects.

5-3-4 Focal Length Settings for the Camera to be Measured

Set to a 35mm film equivalent of approximately 100 mm.

5-3-5 Aspect Ratio

There is no specific set aspect ratio, but pixel interpolation, image processing and other effects which change aspect ratio are prohibited.

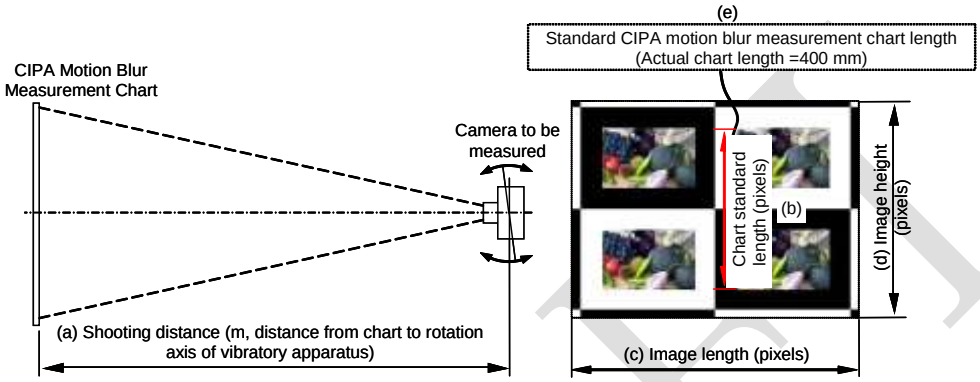
5-4 Measurement Procedures

5-4-1 Calculating Conversion Factor (fr)

Pre-calculate the conversion factor (fr) for calculating estimated comprehensive bokeh amount in step 3 of Section 5-4-2 **Measuring Bokeh Amount Based on Live Shooting** from the shooting conditions. The conversion factor used here is a value equivalent to the 35mm film equivalent focal length used to calculate theoretical motion blur amount as given in item 2 of CIPA Standard DC-X011-2012 Section 4-5-1 **Calculation of Basic Values Required to Calculate Image Stabilization Performance**. The values needed to calculate the conversion factor are given as (a)-(e) below. The calculation method is shown in Figure 5-4-1.

Values needed to calculate the conversion factor (fr)

Shooting distance (m, distance from CIPA motion blur measurement chart to rotation axis of vibratory apparatus) ...(a)
Chart standard length for captured image (pixels) ...(b)
Width for captured image (pixels) ...(c)
Height for captured image (pixels) ...(d)
Standard CIPA motion blur measurement chart length (= 400 mm) ...(e)



$$Conversion\ Factor\ (fr) = Shooting\ Distance\ (a)_{[m]} \times \frac{\text{Chart standard length (b) [pixels]}}{\text{Chart standard length (e)}_{[mm]}} \times \frac{\sqrt{24^2 + 36^2}_{[mm]}}{\sqrt{\text{Image width (c)}^2 + \text{Image height (d)}^2}_{[pixels]}} \times 10^6$$

Figure 5-4-1: Method for calculating conversion factor (fr)

5-4-2 Measuring Bokeh Amount Based on Live Shooting

As stated in Section 5-3 **Settings of Camera to be Measured**, set image stabilization to OFF on the camera to be measured. At each of the test waveform and load combinations in Section 5-2-3 **Test Waveforms TWB-H and TWB-L and Loads during Evaluation**, shake the camera using the vibratory apparatus and measure how close the measured motion blur amount is to the reference motion blur amount. The shutter speeds of the camera to be measured are 1/30, 1/15, 1/8 and 1/4 (seconds). The specific procedure is outlined below:

1) Measure the bokeh offset amount for the camera following the procedure outlined in Section 4-4-1 **Measurement of Bokeh Offset Amount** in CIPA Standard DC-X011-2012. At this time, the shutter speed of the camera to be measured is to be one of the four given above.
2) Following the procedure given in Section 4-4-2 **Measurement of Measured Comprehensive Bokeh Amount (in the Cases of Section 4-2-6 Selection Criteria I and II)** in CIPA Standard DC-X011-2012, set image stabilization on

the camera to be measured to OFF and shake it with either test waveform TWB-H or TWB-L. From here, measure the measured comprehensive bokeh amount. The shutter speed of the camera to be measured is the shutter speed used in step 1 above and at least 200 images are to be captured. There is no upper limit to how many images should be captured, but the measurer is not permitted to selectively choose which images to use.

3) Calculate the estimated comprehensive bokeh amount using the bokeh offset amount measured in step 1 and the test waveform average vibration angle used in vibration in step 2. Calculate estimated comprehensive bokeh amount following step 3 in 4-5-1 **Calculation of Basic Values Required to Calculate Image Stabilization Performance** in CIPA Standard DC-X011-2012. If calculating theoretical motion blur amount (μm), use the conversion factor (fr) calculated in Section 5-4-1 **Calculating Conversion Factor (fr)** instead of the 35mm film equivalent focal length.
4) With the method explained in Section 4-5-2 **Method of Converting Bokeh Offset Amount and Measured Comprehensive Bokeh Amount into 35mm Film Equivalent Values** of CIPA Standard DC-X011-2012, convert the measured comprehensive bokeh amount measured in step 2 to a 35mm film equivalent bokeh amount.
5) Using the methods explained in steps 5 and 6 of Section 4-5-1 **Calculation of Basic Values Required to Calculate Image Stabilization Performance** of CIPA Standard DC-X011-2012, calculate the reference motion blur amount and measured motion blur amount from the estimated comprehensive bokeh amount and measured comprehensive bokeh amount as calculated in steps 3 and 4, respectively.

Change the shutter speed of the camera to be measured and repeat steps 1 through 5 above.

5-5 Judging Measurement Results

Measurement results from Section 5-4-2 **Measuring Bokeh Amount Based on Live Shooting** at each of the test waveform and load combinations indicated in Section 5-2-3 **Test Waveforms TWB-H and TWB-L and Loads during Evaluation** are deemed to have satisfied the Measurement II evaluation if they satisfy the following performance requirement:

- The difference between the measured motion blur amount and reference motion blur amount from the measurements in Section 5-4-2 is less than ±10% at shutter speeds of 1/30, 1/15, 1/8, and 1/4 (seconds) on the camera to be measured.

If there is bias in shot timing, the values of measured motion blur amount will vary regardless of vibratory apparatus performance. As such, when the difference between measured motion blur amount and reference motion blur amount is more than 10% even though there are not any deficiencies in the vibratory apparatus, settings on the camera to be measured, or conversion factor calculations, etc., check that there is no bias in shot timing and re-measure.