Verification Method of Vibratory Apparatus

For

CIPA DC-X011-2024

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

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Verification Method of Vibratory Apparatus

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-011-2024 **Measurement and Description Method for Image Stabilization Performance of Digital Cameras (Optical System)**, as well as measurement accuracy of intrinsic image degradation amount and total image degradation amount (or measured handheld blur amount) as given in Section 4-2-8 **Handheld Blur Measurement Software** in the above standard. (Hereinafter, CIPA Standard DC-011-2024 **Measurement and Description Method for Image Stabilization Performance of Digital Cameras (Optical System)** will be abbreviated to just **CIPA Standard DC-011-2024**.)

As this document conforms with CIPA Standard DC-011-2024, 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-011-2024, as well as measurement accuracy of intrinsic image degradation amount and total image degradation amount (or measured handheld blur amount) as given in Section 4-2-8 **Handheld 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, Measurement II, and Measurement III, three methods for verifying performance of the vibratory apparatus used to measure image stabilization performance in accordance with CIPA Standard DC-011-2024, as well as measurement accuracy of intrinsic image degradation amount and total image degradation amount (or measured handheld blur amount) as given in Section 4-2-8 **Handheld 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, at the center of the image, using a test waveform that mimics camera vibration from camera shake.

This method measures, at the center of the image, the image degradation amount for images captured when the image stabilization function is OFF with a camera shaken by the vibratory apparatus. It evaluates how closely the measured handheld blur amount as calculated from the image degradation amount matches the reference handheld blur amount as calculated from the average vibration angle of the test waveform.

Measurement III:

Evaluates how the vibratory apparatus performs at the corner of the image (position at image height 60%) using a sine wave similar to the amplitude of camera vibration caused by a camera shake component rotating about the optical axis.

This method measures, at the corner of the image (position at image height 60%), the image degradation amount for images captured when the image stabilization function is OFF with a camera shaken by the vibratory apparatus. It evaluates how closely the measured handheld blur amount as calculated from the image degradation amount matches the reference handheld blur amount as calculated from the average vibration angle of the test waveform.

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

Also, evaluations for measurement accuracy of intrinsic image degradation amounts and total image degradation amounts (or measured handheld blur amount) as given in CIPA Standard DC-011-2024 Section 4-2-8 **Handheld Blur Measurement Software** must meet the performance marks set for Measurement II and Measurement III.

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) Image clipping software with manual and instructions for use
5) Handheld Blur Measurement Software (FindsBlur) with manual and instructions for use
6) CIPA Handheld 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-011-2024 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 Angles of Composed Yaw/Pitch Component

These are the average values for the vibration angles of the composed yaw and pitch components at each shutter speed when the camera is shaken using 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 reference image degradation 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-011-2024 Measurement and Description Method for Image Stabilization Performance of Digital Cameras (Optical System)

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.

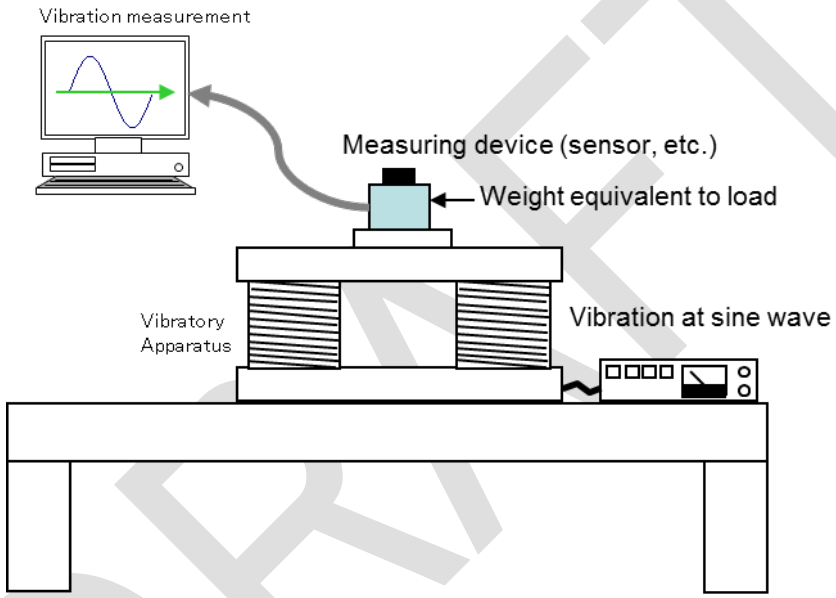


Figure 4-1: Overview of Measurement I

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 the yaw, pitch, and roll directions simultaneously in accordance with the instructions in Table 4-2-1b and Table 4-2-1c. 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: Combination of waveforms (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
Roll	e	a	b	c	d

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

	Pattern 6	Pattern 7	Pattern 8	Pattern 9	Pattern 10	Pattern 11
Yaw	c	d	c	d	-	-
Pitch	d	c	-	-	c	d
Roll	-	-	d	c	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

The temperature and humidity shall be 23°C ± 2°C and 30 to 70%. 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 1-11 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 the respective waveform measurements is 90 degrees or less for the combinations of patterns 6-11. (See Figure 4-4b)

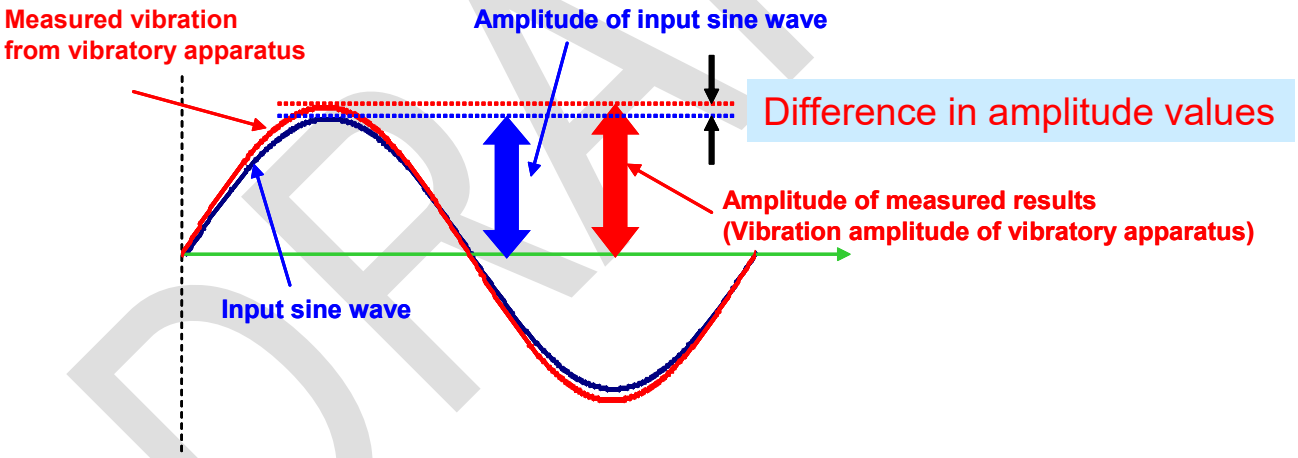


Figure 4-4a: Illustration of amplitude differences

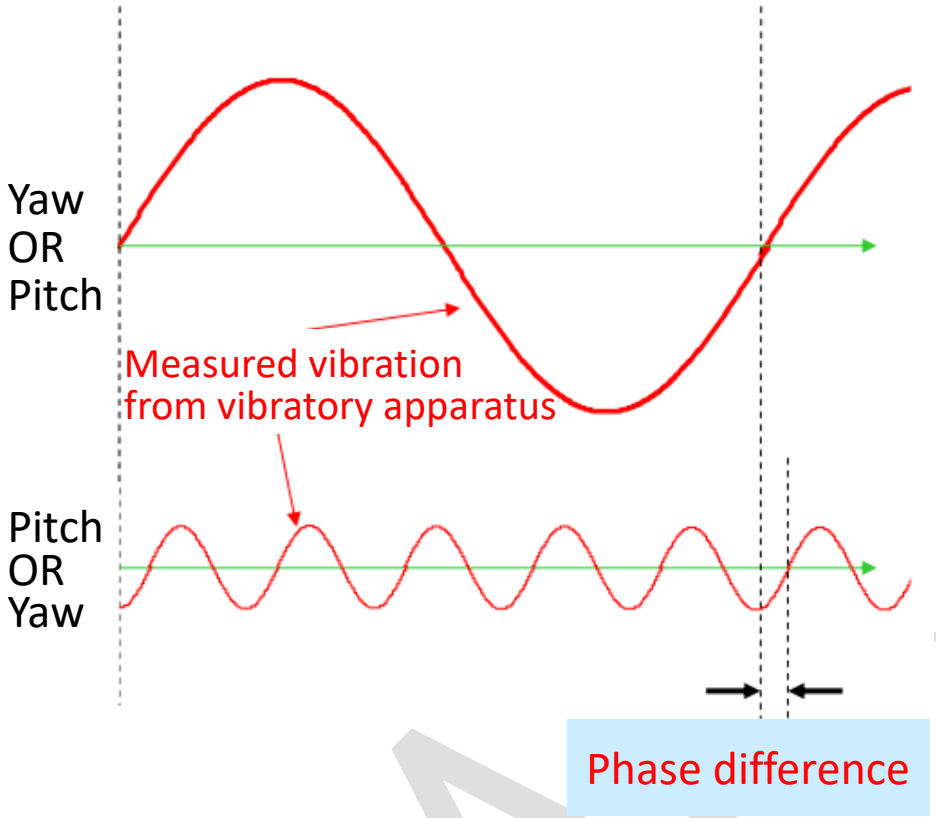


Figure 4-4b: Illustration of phase differences

5. Measurement II

5-1 Preconditions

The evaluation of the vibratory apparatus in Measurement II shall be in accordance with Section 5-2 Equipment and Environment for Measurement, Section 5-3 Settings of Camera to be Measured and Section 5-4 Measurement Procedures. The number of measurements taken is left to the discretion of the measurer, but all measurement results shall be used without selecting only those that are desirable.

Figure 5-1 provides an overview of the measurement method.

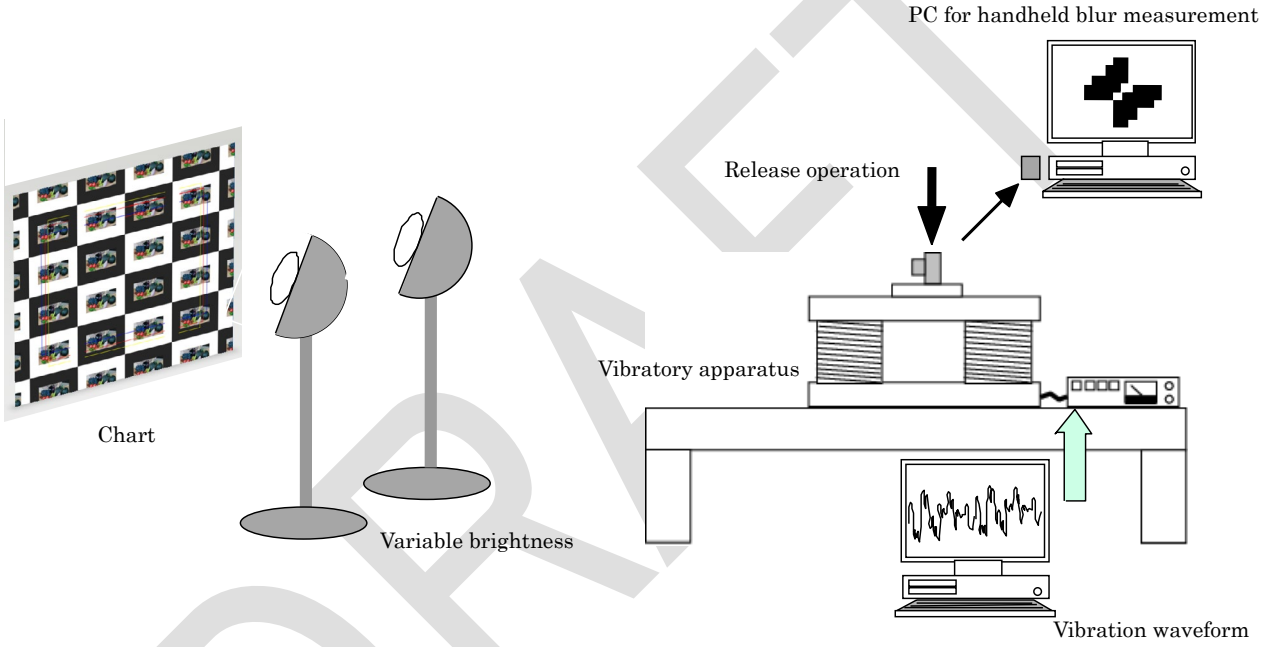


Figure 5-1: Overview of Measurement II and Measurement III

Measurement II is also used when verifying measurement accuracy of intrinsic image degradation amount and total image degradation amount (or measured handheld blur amount) as given in CIPA Standard DC-011-2024 Section 4-2-8 **Handheld 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-011-2024 Section 4-2 **Equipment and Environment for Measurement**.

5-2-1 Handheld Blur Measurement Chart

CIPA handheld 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.

The vibration waveforms adopted in this standard are vibrations that rotate on the rotational axes of yaw, pitch, and roll. Therefore, the positional relationship between the center of rotation of the vibratory apparatus and the optical axis of the camera to be measured at the time of mounting affects the vibration measurement results.

Therefore, to ensure measurement condition alignment, preferably the center of rotation of the vibration table and the optical axis of the lens are aligned in the horizontal and vertical directions in the plane orthogonal to the optical axis.

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. The yaw and pitch vibration waveforms of test waveforms TWB-H and TWB-L are illustrated in Figure 5-2-3a, and the average vibration angles of the composed yaw and pitch components are illustrated 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.

Each test waveform uses the biaxial components of yaw and pitch, and the yaw and pitch components are excited simultaneously. Refer to Figure 6-3a in CIPA Standard DC-011-2024 for handheld 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.

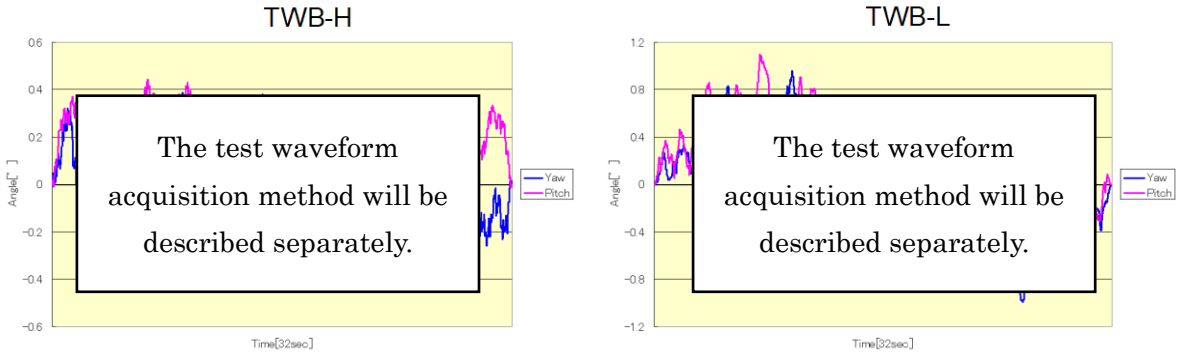


Figure 5-2-3a: Yaw and pitch vibration waveforms of test waveforms TWB-H (left) and TWB-L (right)

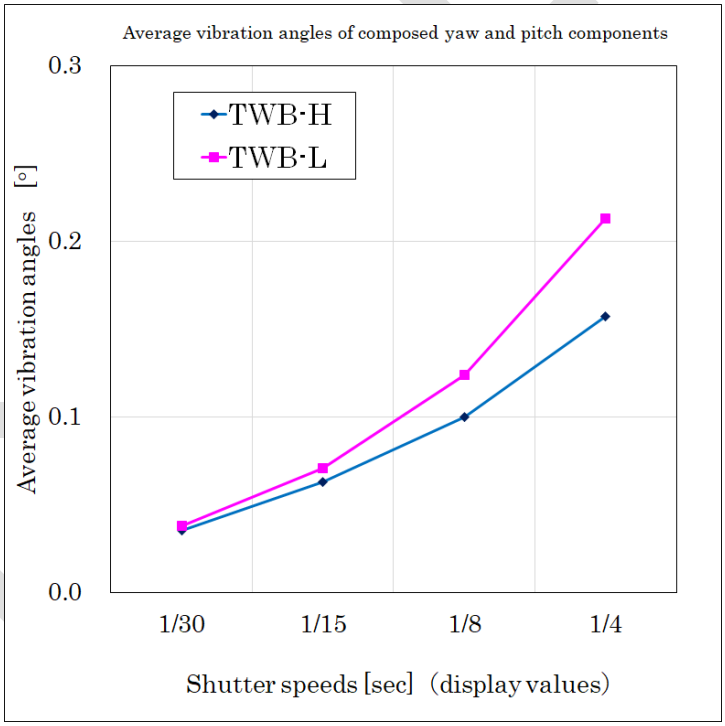


Figure 5-2-3b: Average vibration angles of composed yaw and pitch components of test waveforms

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	—	—	—

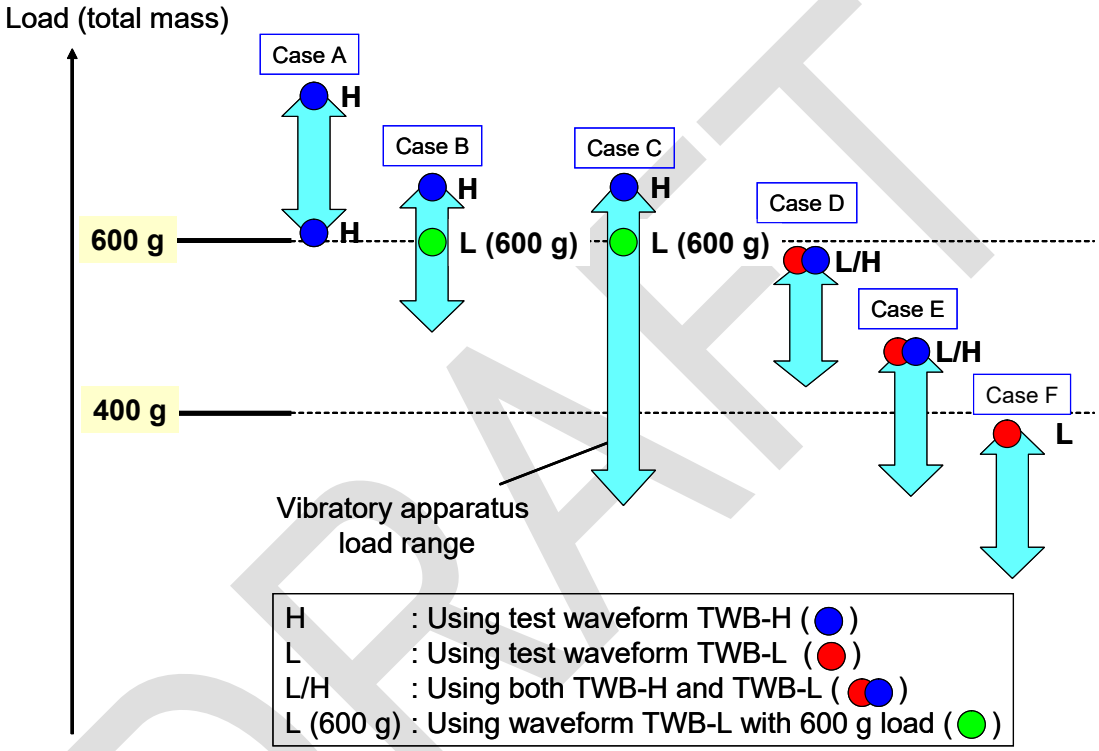


Figure 5-2-3c: Test waveform and load combinations

5-2-4 Shooting Distance

The shooting distance should be such that the range shown by the lines for each aspect ratio in Figure 4-2-1a of CIPA Standard DC-011-2024 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 Handheld Blur Measurement Software

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

However, the handheld blur measurement software is specified to calculate the image degradation amounts at the white and black edges near the center of the image. Therefore, as a pre-processing step, it is necessary to clip the captured image, centering the clips about the areas subject to image degradation amount calculation. Specifically, with use of the provided image clipping software, portions of the image of the CIPA handheld blur measurement chart corresponding to the center and four positions in diagonal directions at image height 60% are clipped, and these partial images are stored in five different folders. This image clipping process may be performed using in-house software.

The image degradation amounts are then calculated by the handheld blur measurement software using the images in each folder obtained by clipping partial images at the center.

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, shall 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 shall 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-011-2024 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 reference image degradation amount in step 3 of Section 5-4-2 **Measuring Image Degradation Amount Based on Live Shooting** from the shooting conditions. The conversion factor (fr) used here is a value equivalent to the 35mm film equivalent focal length f used to calculate the yaw/pitch theoretical handheld blur amounts as given in step 2 of Section 4-5-1 **Calculation of Basic Values Required to Calculate Image Stabilization Performance** of CIPA Standard DC-011-2024. 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)

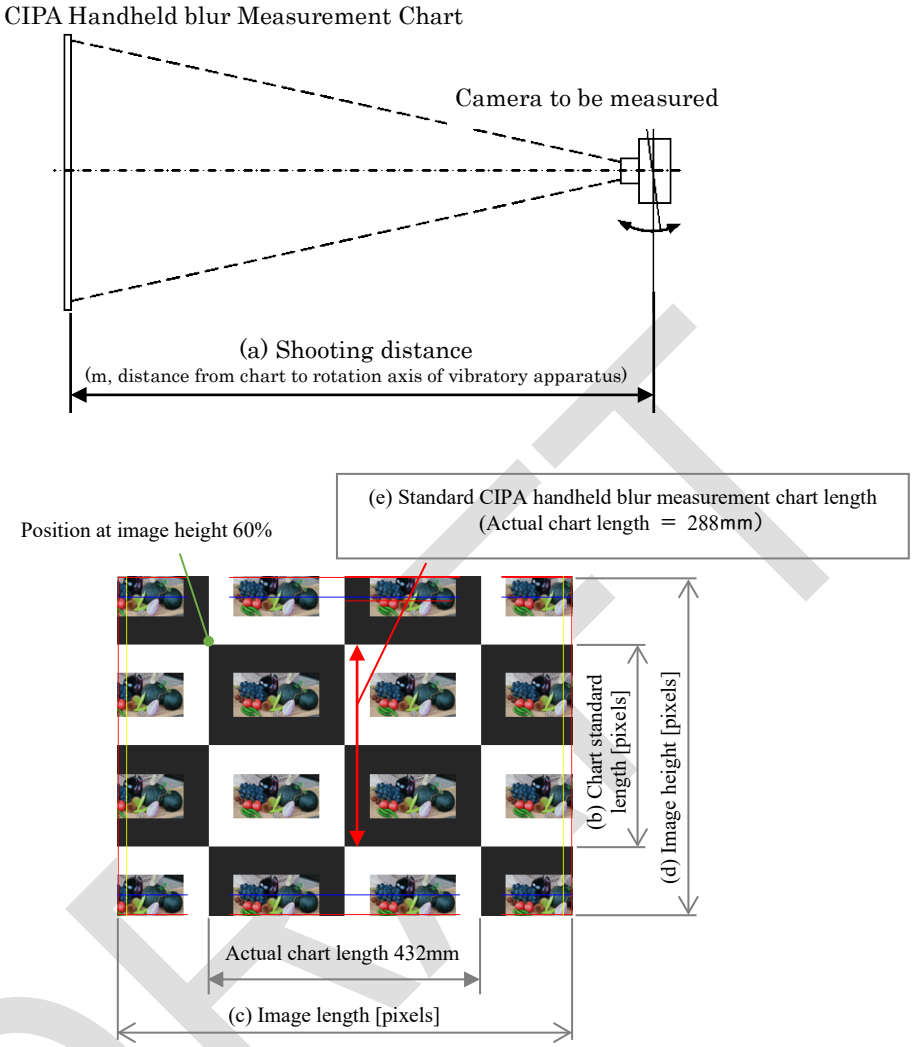
Shooting distance (m, distance from CIPA handheld blur measurement chart to rotation axis of vibratory apparatus) ...(a)

Chart standard length for captured image (pixels) ...(b)

Width for captured image (pixels) ...(c)

Height for captured image (pixels) ...(d)

Standard CIPA handheld blur measurement chart length (= 288 mm) ...(e)



$$Conversion\ Factor\ (fr) = Shooting\ Distance\ (a)[\mathrm{m}] \times \frac{Chart\ standard\ \ lengt\,h\ (b)[pixels]}{Chard\ standard\ \ lengt\,h\ (e)[mm]} \times \frac{\sqrt{24^2+36^2}[mm]}{\sqrt{Image\ \ widt\,h\ (c)^2+Image\ \ heig\,ht\ (d)^2[pixels]}} \times 10^6$$

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

5-4-2 Measuring Image Degradation 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**, the camera shall be shaken using the vibratory apparatus and how close the measured handheld blur amount is to the reference handheld blur amount shall be measured. The measurement position on the CIPA handheld blur measurement chart is one white and black edge portion positioned at the center. 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:

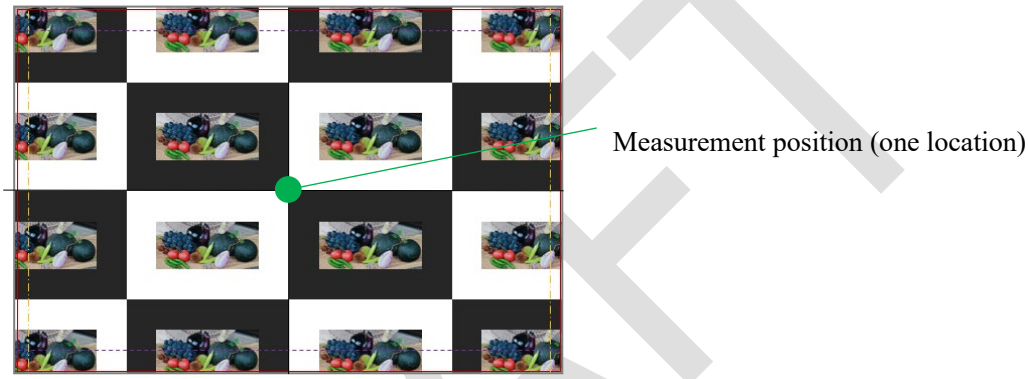


Figure 5-4-2: Measurement position (one location at the center) of Measurement II

1) Measure the intrinsic image degradation amount for the camera following the procedure outlined in Section 4-4-1 **Measurement of Intrinsic Image Degradation Amount** in CIPA Standard DC-011-2024. 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** Total Image Degradation **Amount (in the Cases of Section 4-2-6 Selection Criteria I and II)** in CIPA Standard DC-011-2024, 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 image degradation 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. While there is no specified upper limit for number of images taken, all images shall be used without selecting only those that are desirable.
3) Calculate the reference image degradation amount using the intrinsic image degradation amount measured in step 1 and the test waveform average vibration angle used in vibration in step 2. The calculation method of the reference image

degradation amount shall be in accordance with step 3 of Section 4-5-1 **Calculation of Basic Values Required to Calculate Image Stabilization Performance** in CIPA Standard DC-011-2024. If calculating theoretical handheld 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 f.

4) With the method explained in Section 4-5-2 **Method of Converting Intrinsic image degradation amount and Measured** Image Degradation **Amount into 35mm Film Equivalent Values** of CIPA Standard DC-011-2024, convert the measured image degradation amount measured in step 2 to a 35mm film equivalent image degradation 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-011-2024, calculate the reference handheld blur amount and measured handheld blur amount from the reference image degradation amount and measured image degradation 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 Image Degradation 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:

- At the center of the CIPA handheld blur measurement chart, the difference between the measured handheld blur amount and reference handheld blur amount, obtained from the measurements in Section 5-4-2, is ±10% or less of the reference handheld blur amount at shutter speeds of 1/30, 1/15, 1/8, and 1/4 (seconds) on the camera to be measured.

  The corners of the image at 60% are not judged.

If there is bias in shot timing, the values of measured handheld blur amount will vary regardless of vibratory apparatus performance. As such, when the difference between measured handheld blur amount and reference handheld 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.

6. Measurement III

6-1 Preconditions

The evaluation of the vibratory apparatus in Measurement III shall be in accordance with Section 6-2 **Equipment and Environment for Measurement**, Section 6-3 **Settings of Camera to be Measured**, and Section 6-4 **Measurement Procedures**. The number of measurements taken is left to the discretion of the measurer, but all measurement results shall be used without selecting only those that are desirable.

Figure 5-1 provides an overview of the measurement method.

6-2 Equipment and Environment for Measurement

The equipment and environment for measurement, excluding the details below, shall conform to the CIPA Standard DC-011-2024 Section 4-2 **Equipment and Environment for Measurement**.

6-2-1 Handheld Blur Measurement Chart

The handheld blur measurement chart shall be in accordance with Section 5-2-1 **Handheld Blur Measurement Chart**.

6-2-2 Mounting of Camera to be Measured on Vibratory Apparatus

The mounting of the camera shall be in accordance with Section 5-2-2 **Mounting of Camera to be Measured on Vibratory Apparatus**.

6-2-3 Test Waveforms (Sine Waves) and Loads during Evaluation

For Measurement III, the test waveforms are sine waves about the optical axis. The combination of frequencies and amplitudes are shown in Table 6-2-3.

Table 6-2-3: Combinations of frequencies and amplitudes of sine waves used in Measurement III

Waveform	Frequency [Hz]	Amplitude of sine wave excited by vibration table ± W [deg]	Theoretical handheld blur amount [μm] = 2 x Lr x tanW
P1	1	± 0.5	226.5 (with conversion factor Lr [mm]＝ 12.980)
P2	1	± 0.2	90.6 (with conversion factor Lr [mm]＝ 12.980)

6-2-4 Shooting Distance

The shooting distance shall be in accordance with Section 5-2-4 **Shooting Distance**.

6-2-5 Handheld Blur Measurement Software

The handheld blur measurement software shall be in accordance with Section 5-2-5 **Handheld Blur Measurement Software**.

However, the handheld blur measurement software is specified to calculate the image degradation amounts at the white and black edges near the center of the image. Therefore, as a pre-processing step, it is necessary to clip the captured image, centering the clips about the areas subject to image degradation amount calculation. Specifically, with use of the provided image clipping software, portions of the image of the CIPA handheld blur measurement chart corresponding to the center and four positions in diagonal directions at image height 60% are clipped, and these partial images are stored in five different folders. This image clipping process may be performed using in-house software.

The image degradation amounts are then calculated by the handheld blur measurement software using the images in each folder obtained by clipping partial images at four positions at image height 60%.

6-2-6 Loads

The test weight shall be the upper limit load supported by the vibratory apparatus. The total of the camera to be measured mounted on the vibratory apparatus and the weight to be added shall be adjusted so that it reaches the upper limit load.

6-3 Settings of Camera to be Measured

The settings shall be in accordance with Section 5-3 Settings of Camera to be Measured.

6-4 Measurement Procedures

6-4-1 Calculating Conversion Factor (Lr)

Pre-calculate the conversion factor (Lr) for calculating the reference image degradation amount in step 3 of Section 6-4-2 **Measuring Image Degradation Amount Based on Live Shooting from the shooting conditions**. The conversion factor (Lr) used here is a value equivalent to the 35mm film equivalent distance L, from the center of the image to the measurement point, used to calculate the roll theoretical handheld blur amount as given in step 2 of Section 4-5-1 **Calculation of Basic Values Required to Calculate Image Stabilization Performance** of CIPA Standard DC-011-2024. This distance L is the height of the position at image height 60%. The shooting distance shall be adjusted so that the distance L is within 60 ± 3% during shooting.

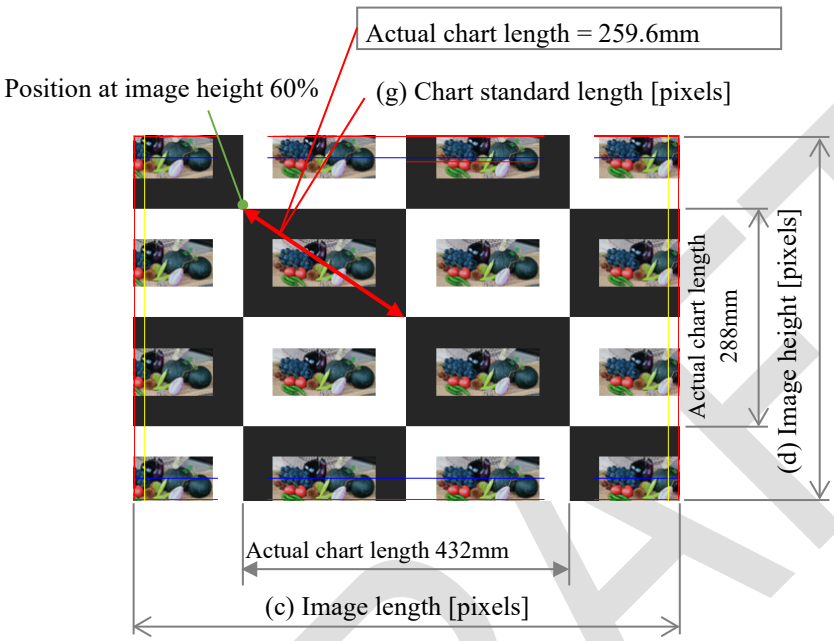
The values required to calculate the conversion factor (Lr) are (c) through (h) below, and the calculation method is shown in Figure 6-4-1.

Values Required to Calculate Conversion Factor (Lr)

Width for captured image [pixels] ...(c)

Height for captured image [pixels] ...(d)

Chart standard length for captured image [pixels] ...(g)



$$\text{Conversion factor (Lr) [mm]} = \text{Chart standard length (g) [pixels]} \times \frac{\sqrt{24^2+36^2}\,[\text{mm}]}{\sqrt{\text{Image width (c)}^2 + \text{Image height (d)}^2}\,[\text{pixels}]}$$

Figure 6-4-1: Calculation method of conversion factor (Lr)

6-4-2 Measuring Image Degradation Amount Based on Live Shooting

As stated in Section 6-3 **Settings of Camera to be Measured**, with image stabilization set to OFF on the camera to be measured, the camera shall be shaken using the vibratory apparatus and how close the measured handheld blur amount is to the reference handheld blur amount shall be measured. The measurement positions on the CIPA handheld blur measurement chart are four white and black edge portions positioned at the corners on diagonal lines at image height 60%. The shutter speeds of the camera to be measured should be an integer multiple of 1 [second] to ensure proper exposure. The specific procedure is outlined below:

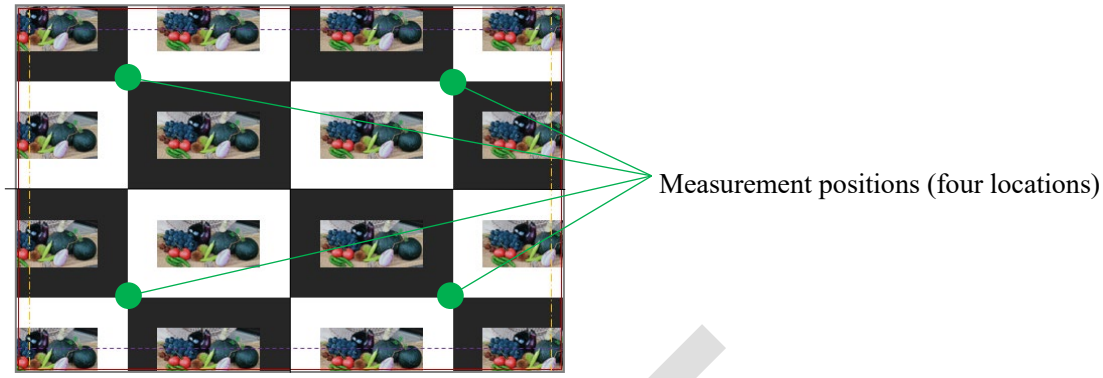


Figure 6-4-2: Measurement positions (four locations around) of Measurement III

1) Measure the intrinsic image degradation amount of the camera to be measured according to the procedure described in CIPA Standard DC-011-2024 Section 4-4-1 **Measurement of Intrinsic Image Degradation Amount**. The shutter speeds of the camera to be measured should be an integer multiple of 1 [second] to ensure proper exposure.
2) Follow the procedure described in Section 4-4-2 **Measurement of** Total Image Degradation **Amount** (in the case of Section 4-2-6 Selection Criteria I and II) in CIPA Standard DC-011-2024, and shake the camera to be measured (but with the image stabilization function OFF) with the two types of waveforms described in Section 6-2-3 **Test Waveforms to measure the measured image degradation amount**. The shutter speed of the camera to be measured is the shutter speed used in step 1. At least 100 images are to be captured. While there is no specified upper limit for number of images taken, all images shall be used without selecting only those that are desirable.
3) Calculate the reference image degradation amount from the intrinsic image degradation amount measured in step 1 and the angle of the amplitude of the test waveform used in vibration in step 2 (equivalent to the average vibration angle). The calculation method of the reference image degradation amount shall be in accordance with step 3 of Section 4-5-1 **Calculation of Basic Values Required to Calculate Image Stabilization Performance** in CIPA Standard DC-011-2024. However, when calculating the roll theoretical handheld blur amount (μm), use the conversion factor (Lr) calculated in Section 6-4-1 **Calculating Conversion Factor (Lr)** instead of the 35mm film equivalent distance L from the center of the image to the measurement point.
4) With the method described in Section 4-5-2 **Method of Converting Intrinsic image degradation amount and Measured** Image Degradation Amount into 35mm Film Equivalent Values of CIPA Standard DC-011-2024, convert the measured image degradation amount measured in step 2 to a 35mm film equivalent image degradation amount.

5) From the reference image degradation amount and measured image degradation amount calculated in steps 3 and 4, calculate the reference handheld blur amount and measured handheld blur amount with the method described in steps 5 and 6 of Section 4-5-1 **Calculation of Basic Values Required to Calculate Image Stabilization Performance** of CIPA Standard DC-011-2024.

Repeat the above steps 1 through 5 above with the different waveforms described in Section 6-2-3 Test Waveforms.

6-5 Judging Measurement Results

Measurement results from Section 6-4-2 **Measuring Image Degradation Amount Based on Live Shooting** are deemed to have satisfied the Measurement III evaluation if they satisfy the performance requirement described below.

Obtain the measured handheld blur amount corrected in accordance with Table 6-5-1 Correction method of measured value of Measurement III. The reason for correction is that the vibration waveform is a sine wave, not a roll waveform, and the calculated image degradation amount is shifted. The correction compensates for this shift.

Table 6-5-1: Correction method of measured value of Measurement III

Measured handheld blur value N [μm]	Correction factor		Corrected measured handheld blur amount [μm] = N x A x B
	Correction factor A with respect to limit of image degradation amount calculation software	Modification factor B unique to single sine wave vibration	
P(1)	0.8	1.05	P(1) x 0.8 x 1.05
P(2)			P(2) x 0.8 x 1.05

- With each of the two types of waveforms described in Section 6-2-3 **Test Waveforms**, when the shutter speed of the camera to be tested is an integer multiple of 1 [second] with proper exposure at four white and black edge areas positioned on diagonal lines at image height 60% of the CIPA handheld blur measurement chart, (1) and (2) are to be satisfied.

(1) The difference between the corrected measured handheld blur amount and reference handheld blur amount, obtained from the measurements in Section 6-4-2, is ±50% or less of the reference

handheld blur amount at each of the four locations.

(2) Additionally, the difference between the average measured value at the four locations and the reference handheld blur amount is ±10% or less of the reference handheld blur amount.
Measurement results are not judged at the center. The reason is that, in principle, roll blur is not present at the center and cannot be evaluated.

If there is bias in shot timing, the values of measured handheld blur amount will vary regardless of vibratory apparatus performance. As such, when the evaluation is not satisfied even though there are not any deficiencies in the vibratory apparatus, settings on the camera to be measured, or conversion factor (Lr) calculations, etc., check that there is no bias in shot timing and re-measure.

Verification Method of Vibratory Apparatus

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