INTERNATIONAL STANDARD

ISO 19084

First edition
2015-12-15

Photography — Digital cameras — Chromatic displacement measurements

Photographie — Caméras numériques — Mesurages du déplacement chromatique

Reference number
ISO 19084:2015(E)

© ISO 2015



COPYRIGHT PROTECTED DOCUMENT

© ISO 2015, Published in Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

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

Contents

Page

Foreword ... **iv**
Introduction ... **v**
1 Scope ... **1**
2 Terms and definitions ... **1**
3 Test conditions and methods ... **1**
3.1 General ... 1
3.2 Apparatus and hardware ... 1
3.2.1 Lighting ... 2
3.2.2 Test chart ... 2
3.3 Arrangement of measuring equipment ... 4
3.3.1 Reflective test chart ... 4
3.3.2 Transmissive test chart ... 4
3.3.3 Positioning of the camera ... 5
3.4 Image/camera settings ... 6
4 Analytical approach ... **6**
4.1 General ... 6
4.2 Determination of displacement ... 6
4.2.1 Dot chart ... 6
4.2.2 V pattern chart ... 7
4.3 Chromatic displacement (CD) ... 8
4.3.1 Numerical definition ... 8
4.4 Radial chromatic displacement (RCD) ... 9
4.4.1 Numerical definition ... 9
5 Presentations of results ... **10**
5.1 Chromatic displacement ... 10
5.2 Radial chromatic displacement ... 11
Annex A (informative) **Extracting the dots from the target** ... **13**
Bibliography ... **14**

© ISO 2015 – All rights reserved

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 on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 42, *Photography*.

© ISO 2015 – All rights reserved

Introduction

Digital still camera images sometimes experience a type of artefact known as chromatic displacement. These artefacts generally appear as colour fringe at boundaries that separate dark and light features. This International Standard defines this type of artefact as chromatic displacement regardless of the source. In the case of multi-sensor digital still cameras, chromatic displacement may be caused by optical, mechanical and electrical factors. In the case of single sensor digital still cameras, there are almost no mechanical and electrical factors, so the chromatic displacement is mainly generated by optical factors and artefacts caused by a mosaic colour filter array. Optical aberrations include lateral chromatic aberration, longitudinal chromatic aberration and comatic aberration.

Lateral chromatic aberration arises when the size of an image changes with the wavelengths of light. Because of this, lateral chromatic aberration is more conspicuous at the peripheral part of the image. Lateral chromatic aberration is rotationally symmetric in an ideal case; however this might not be the case due to manufacturing tolerances.

Longitudinal chromatic aberration arises when the back focus changes with the wavelength of light. Unlike lateral chromatic aberration, longitudinal chromatic aberration may be conspicuous not only in the peripheral part of the image but also in the central portion of the image.

Chromatic displacement by comatic aberration arises when the characteristic of a comatic aberration changes with the wavelengths of light. This phenomenon, known as purple fringe or a colour fringe, is conspicuous at the peripheral part of the image like lateral chromatic aberration. In many cases, comatic aberration can be reduced by using a larger lens f-number (smaller aperture).

Chromatic displacement is emphasized or reduced by image processing.

To measure chromatic displacement, IEC 61146-2 is established by IEC and CIPA DCG-002-2012 based on IEC 61146-2 is also established by CIPA. Furthermore, P1858 - *Standard for Camera Phone Image Quality(CPIQ)* is being developed by IEEE.

This International Standard defines two methods for measuring, the Chromatic displacement and Radial chromatic displacement. Chromatic displacement measures total chromatic displacement encompassing all factors as provided by IEC 61146-2 and CIPA DCG-002-2012. Radial chromatic displacement which measures optical aberration is based on a method developed by the CPIQ and is a main factor in the chromatic aberration of a single sensor digital still camera.

© ISO 2015 – All rights reserved

Photography — Digital cameras — Chromatic displacement measurements

1 Scope

This International Standard specifies the definition of chromatic displacement for digital still cameras, test patterns, measurement conditions and methods, so as to enable the comparison of the results of measurement.

The methods of measurement are designed to enable the assessment of the performance of digital still cameras by using image data output by the digital still cameras.

This International Standard does not specify the allowable amount of chromatic displacement.

2 Terms and definitions

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

2.1
chromatic displacement
shift in location of features of different colours in the output image caused by optical, mechanical, electrical and image processing factors

Note 1 to entry: Optical factor include lateral chromatic aberration, longitudinal chromatic aberration, characteristic comatic aberration and others.

Note 2 to entry: It is the displacement of the red (R) and the blue (B) channel in relation to the green (G) channel in an output image.

Note 3 to entry: Chromatic displacement is evaluated by measuring the chromatic displacement in the lateral direction in the image.

2.2
radial chromatic displacement
radial shift in location of different colours in the output image caused by the optical factor called lateral chromatic aberration that may then be influenced by mechanical, electrical and image processing factors

3 Test conditions and methods

3.1 General

The measurement shall be carried out using the digital signals of the output images from the digital still camera with which the test chart is captured.

The following measurement conditions should be used as nominal conditions when measuring the chromatic displacement of a digital still camera. If it is not possible or appropriate to achieve these nominal operating conditions, the actual operating conditions shall be listed along with the reported results.

3.2 Apparatus and hardware

Each test chart shall be specified, together with the lighting conditions such as illuminance, luminance and colour temperature of illumination.

© ISO 2015 – All rights reserved

3.2.1 Lighting

Colour temperature of illumination shall be 5 700 K ± 1 000 K. This International Standard does not require a specific illumination level. A level between 1 000 lx to 2 000 lx (in the case of transmissive chart, between 318 cd/m^2 to 637 cd/m^2) is recommended. Special measurement purposes may require other levels. Non-uniformity in illuminance (or luminance) on the chart shall be less than 10 %. The light source(s) should be positioned to provide uniform illumination and produce no glare or specular reflections from the target.

3.2.2 Test chart

3.2.2.1 General

Examples of the test charts are shown in Figure 1 and Figure 2. They can be either reflective test charts or transmissive test chart. The black pattern such as dots or Vs shall represent less than 20 % of the total surface of the image. The chart contrast level should at least be 40:1 and not be higher than 10 000:1.

3.2.2.2 Dot chart

The dot chart contains black circular dots placed on a perfectly regular square grid on a uniform white background. Chromatic displacement and radial chromatic displacement are calculated by measuring the centre positions of the circular dots. The size and the number of dots should be adjusted depending on the number of pixels of the camera and the shooting distance. In the image of the chart, the number of dots on a 4:3 image should be no less than 20 × 15 dots and the diameter of each dot shall be no less than 10 pixels. For a detailed description on how to determine the dots and dot centres in the chart, see 4.2.1.

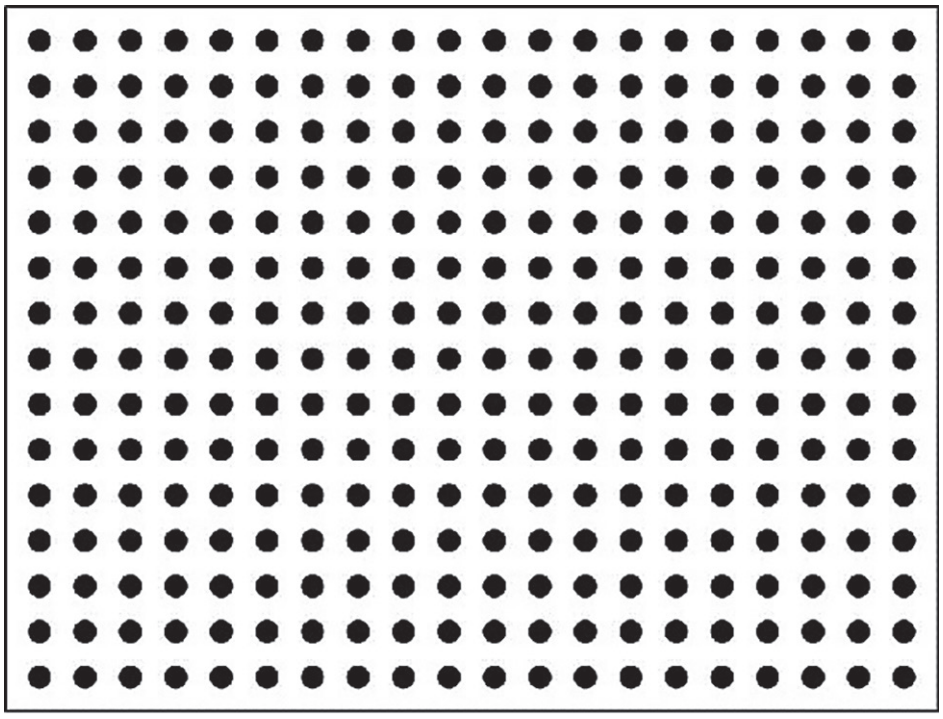


Figure 1 — Dot chart

NOTE ISO 17850, Geometric distortion measurement also adopts the dot chart. Use of the dot chart may reduce the workload required for camera characterization.

© ISO 2015 – All rights reserved

3.2.2.3 V pattern chart

The V pattern chart enables the displacement to be measured in both the horizontal and vertical directions by only measuring the displacement at reproduced positions in only the horizontal direction. The method for extracting the geometric values is described in 4.2.2.

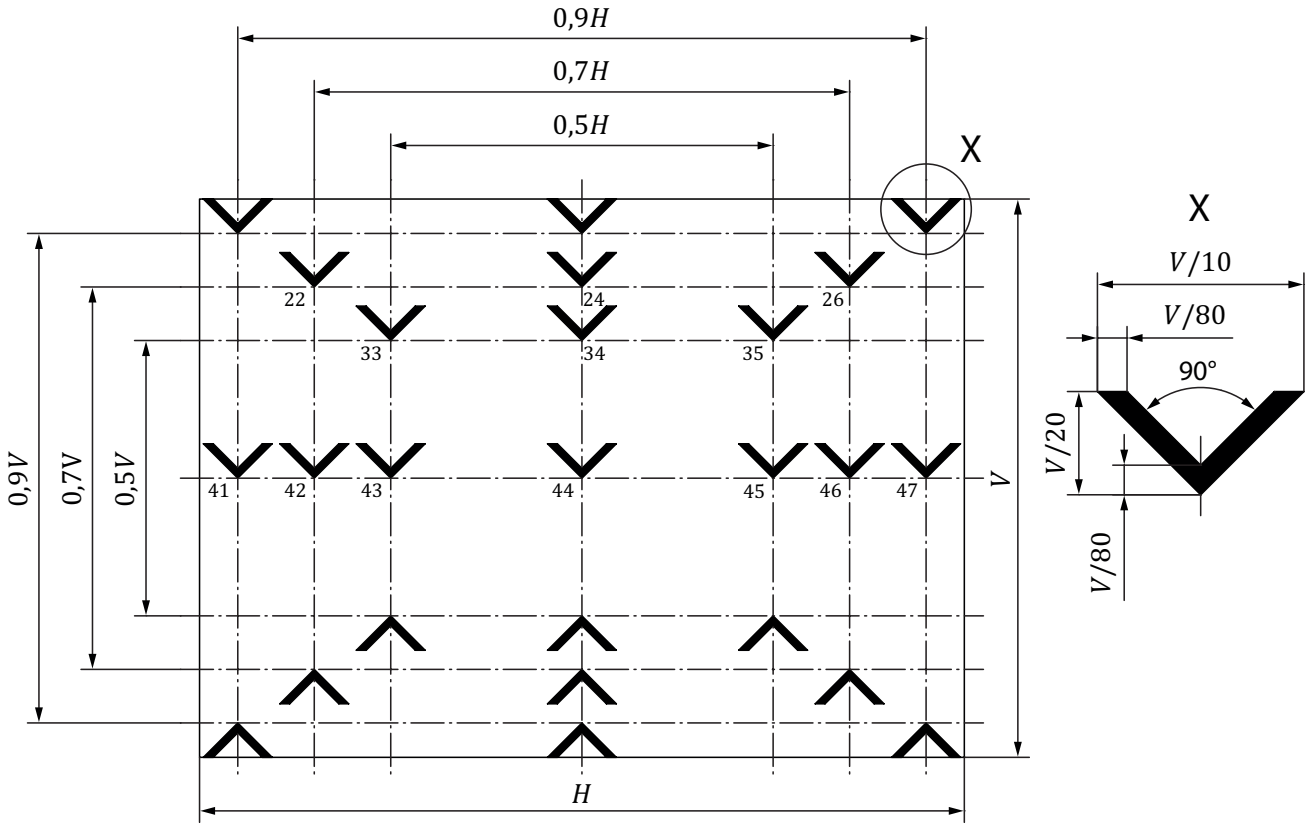


Figure 2 — V pattern chart

3.2.2.4 Requirement for the chart planarity

Non-planarity can be caused by bending of a chart.

Requirement for the chart planarity is:

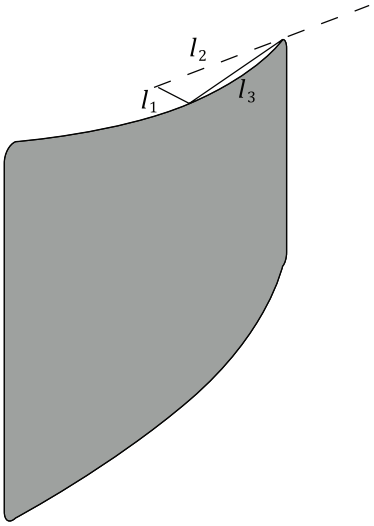
Surface deviation which is a height or depth from the reference plane (indicated as bending "l_1" in Figure 3) shall be less than 1,5 % of the width of the chart.

NOTE The required accuracy for a specific measurement sets the requirement for the chart planarity as follows.

For small bending, "l_3" is equal to half the width of the chart to which all numbers are normalized. If bending "l_1" occurs in a chart the effective chart width seen by the camera is "l_2". The difference between l_3 and l_2 causes the deviation in % measured due to the bending of the chart and is calculated by $(1 - l_2/l_3) \times 100$.

The International Standard requirement for local geometric distortion measurement should be a maximum error of 0,045 % due to deviation in planarity of the chart. This equals a maximum deviation in planarity of 3 %. And 3 % of half the width equals to 1,5 % of the full width of the chart.

© ISO 2015 – All rights reserved



Deviation in [%]	l_1 / l_3	l_2 / l_3 = cos (sin^{-1} l_1 / l_3)	Deviation of measured distortion in %
0,5	0,005	0,999 987	0,001 3
1	0,01	0,999 950	0,005 0
2	0,02	0,999 800	0,020 0
3	0,03	0,999 550	0,045 0
4	0,04	0,999 200	0,080 0
5	0,05	0,998 749	0,125 1
6	0,06	0,998 198	0,180 2
8	0,08	0,996 795	0,320 5
9	0,09	0,995 942	0,405 8
10	0,1	0,994 987	0,501 3

Figure 3 — Explanation for the chart planarity and its effect on measured value

3.3 Arrangement of measuring equipment

3.3.1 Reflective test chart

The arrangement of the measuring equipment for a reflective test chart shall be set up as shown in Figure 4. The camera shall be positioned such that it casts no shadow on the chart. The background of the test chart shall be matte black wall or black surround.

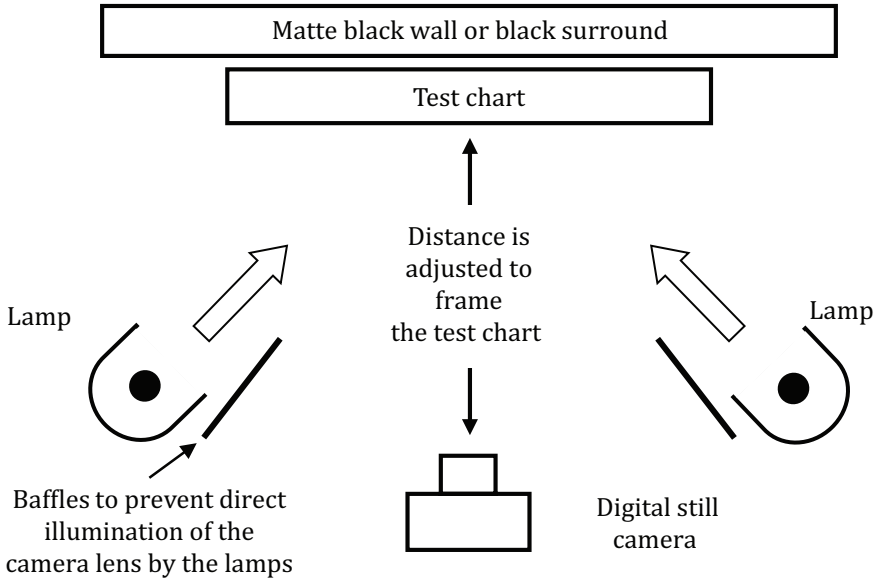


Figure 4 — Arrangement of measuring equipment for reflective test chart

3.3.2 Transmissive test chart

The arrangement of the measuring equipment for a transmissive test chart shall be set up as shown in Figure 5. Instead of a light box, an integrating sphere may be used. Regardless of which light source is used, the illumination shall be diffuse and uniform on the chart plane consistent with the requirement in 3.2.1.

© ISO 2015 – All rights reserved

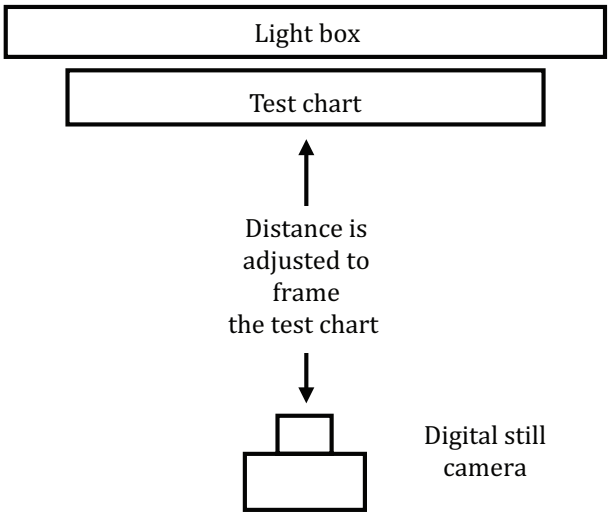


Figure 5 — Arrangement of measuring equipment for transmissive test chart

3.3.3 Positioning of the camera

The chart needs to be orthogonal to the optical axis. The alignment can be performed using a mirror set up on the target plane (i.e. parallel to the target plane) as shown in Figure 6.

Pan, tilt and laterally displace the camera position to the left, right, up and down until the centre point of the taking lens in the image of the camera in the viewfinder is at the image centre.

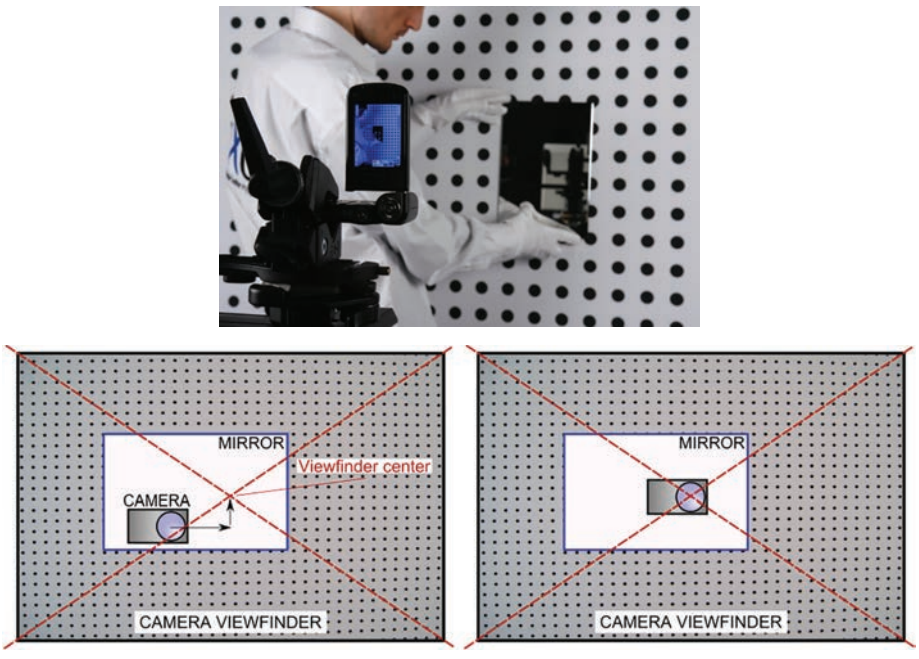


Figure 6 — Alignment of the camera with the target plane using a mirror

If the mirror is not available or the positioning method is not applicable, a manual alignment using the lines of dots in the chart shall be performed so that the intersection of the central horizontal and vertical lines of the dots is in the centre of the image. For each horizontal line, the lines shall be oriented parallel to the horizontal image borders meaning that the line shall be at the same image height for the same distances from the vertical centre of the image.

© ISO 2015 – All rights reserved

3.4 Image/camera settings

The camera should be set for auto-exposure and the mean digital value in the image shall be reported. If exposure adjustment is available, exposure should be adjusted to give a mean value of the whole chart between 110 and 160. The mean value is calculated on the output image including black pattern and white background. The image should not be clipped in either bright or dark parts of the chart. White balance should be adjusted to render the centre of the image as neutral as possible. The focusing shall be such that the centre of the image is in focus.

Chromatic displacement is strongly affected by camera settings, such as the f-number, the focal length, and the distance to the object, and these settings should be set preferentially to their factory shipping values. Depending on the purpose of the measurement, the camera settings, such as ISO sensitivity and other image settings, may be adjusted in the following manner:

ISO sensitivity and exposure time may be adjusted so that no visible noise or no banding caused by light source flicker is observed in image. The aperture number and focal length shall be reported along with the ISO sensitivity and the exposure time. More precisely, the ISO sensitivity of the camera may be set to the minimum so as to minimize noise.

The user settings such as colour and contrast may be deactivated. If possible, compression and sharpness should be set to their minimum values. If colour encoding is not sRGB, for example opRGB, it shall be reported.

4 Analytical approach

4.1 General

As the first step for each of the test chart objects the horizontal and vertical distances between the green and the red channel (ΔR_{H_i}, ΔR_{V_i}) and the green and the blue channel (ΔB_{H_i}, ΔB_{V_i}) need to be determined (see Figure 7).

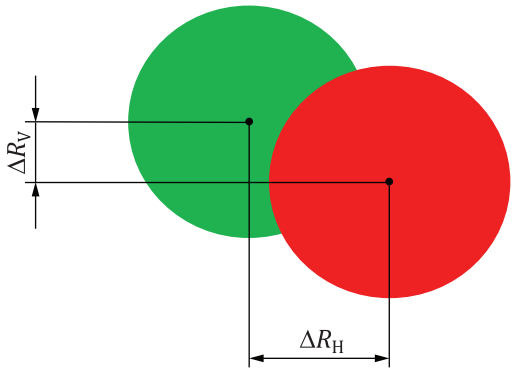


Figure 7 — ΔR_H and ΔR_V

4.2 Determination of displacement

4.2.1 Dot chart

The following are the steps of the measurement:

— extract the dots;

— determine precisely the position of the centre of the dots;

— determine the ΔR_{H_i}, ΔR_{V_i} by comparing the position of the red or blue dots with the position of green dots.

© ISO 2015 – All rights reserved