DRAFT INTERNATIONAL STANDARD

ISO/IEC DIS 29158

ISO/IEC JTC **1**/SC **31**

Secretariat: **ANSI**

Voting begins on:
2020-01-22

Voting terminates on:
2020-04-15

Information technology — Automatic identification and data capture techniques — Direct Part Mark (DPM) Quality Guideline

Technologies de l'information — Techniques automatiques d'identification et de capture de données — Ligne directrice de qualité du marquage direct sur pièce (DPM)

ICS: 35.040.50

This document is circulated as received from the committee secretariat.

Reference number
ISO/IEC DIS 29158:2020(E)

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO/IEC 29158 was prepared by Technical Committee ISO/TC JTC 1, *Information Technology*, Subcommittee SC 31, *Automatic identification and data capture techniques*.

Introduction

Direct Part Marking (DPM) is a technology whereby, generally, an item is physically altered to produce two different surface conditions. This alteration can be accomplished by various means including, but not limited to, dot peen, laser mark, ink jetting, and electro-chemical etch. The area of the alteration is called "the mark." The area that includes the mark and background as a whole, when containing a pattern defined by a bar code symbology specification, is called "a symbol."

When light illuminates a symbol, it reflects differently depending on whether it impinges on the background of the part or on the physical alteration. In most non-DPM bar code scanning environments, light is reflected off a smooth surface that has been coloured to produce two different diffuse reflected states. The DPM environment generally does not fit this model because the two different reflected states depend on at least one of the states having material oriented to the lighting such that the angle of incidence is equal to the angle of reflection. Sometimes the material so oriented produces a specular (mirror like) reflectance that results in a signal that is orders of magnitude greater than the signal from diffuse reflectance.

In addition, from the scanner point-of-view, some marking and printing methods generate dots and are not capable of producing smooth lines. This is important for symbologies such as Data Matrix which is specified to contain smooth continuous lines but is sometimes marked with disconnected dots in a DPM applications.

Current specifications for matrix symbologies and two-dimensional print quality are not exactly suited to reading situations that have either specular reflection or unconnected dots or both. Additionally symbologies specified to consist of smooth continuous lines may appear with unconnected dots. This is intended to act as a bridge between the existing specifications and the DPM environment in order to provide a standardized image based measurement method for DPM that is predictive of scanner performance.

As with all symbology and quality standards, it is the responsibility of the application to define the appropriate parameters of this guideline for use in conjunction with a particular application.

Information technology — Automatic identification and data capture techniques — Direct Part Mark (DPM) Quality Guideline

1 Scope

This standard is an engineering document intended for verifier manufacturers and application specification developers.

This standard describes modifications which are to be considered in conjunction with the symbol quality methodology defined in ISO/IEC 15415 and a symbology specification. It defines alternative illumination conditions, some new terms and parameters, modifications to the measurement and subsequent grading of certain parameters and the reporting of the grading results.

This standard was developed to assess the symbol quality of direct marked parts, where the mark is applied directly to the surface of the item and the reading device is a two-dimensional imager.

When application specifications allow, this method may also be applied to symbols produced by other methods. This is appropriate when direct part marked (DPM) symbols and non-DPM symbols are being scanned in the same scanning environment. The symbol grade is reported as a DPM grade rather than as an ISO/IEC 15415 grade.

2 Normative references

ISO/IEC 15415, *Information technology — Automatic identification and data capture techniques — Bar code symbol print quality test specification — Two-dimensional symbols*

ISO/IEC 19762, *Information technology — Automatic identification and data capture (AIDC) techniques — Harmonized vocabulary*

3 Terms and definitions

The terms and definitions given in ISO/IEC 19762, ISO/IEC 15416 and ISO/IEC 15415 apply, together with the following:

3.1 MLcal

Mean of the light lobe from a histogram of the calibrated standard.

3.2 MLtarget

Mean of the light lobe from the final grid-point histogram of the symbol under test.

3.3 Reference Symbol

High-contrast printed calibration card for which results are traceable back to national or international standards and for which the supplier supplies a calibration certificate.

3.4 Rcal

Reported reflectance value, Rmax, from a calibration standard.

3.5 Rtarget

Measured percent reflectance of the light elements of the symbol under test relative to the calibrated standard. Rtarget is graded and reported as the parameter named “Minimum Reflectance”.

3.6 SRcal

System Response parameters (such as exposure and/or gain) used to create an image of the calibration standard.

3.7 SRtarget

System Response parameters (such as exposure and/or gain) used to create an image of the symbol under test.

3.8 Stick

Line segment comprised of image pixels that is used to connect areas of the same colour that are near to each other.

3.9 T1

Threshold created using a histogram of the defined grey-scale pixel values in a circular area 20 times the aperture size in diameter, centred on the image centre using the algorithm defined in Annex A.

3.10 T2

Threshold created using the histogram of the reference grey-scale image pixel values at each intersection point of the grid using the method defined in Annex A.

4 Symbols (and abbreviated terms)

CM	Cell Modulation
CC	ell Contrast
FPD	Fixed pattern damage
LED	Light emitting diode
MD	MeanDark
TCL	Tilted coaxial lighting and camera position

5 Overview of methodology

5.1 Process differences from ISO/IEC 15415

All parameters in the symbology and print quality specifications apply except for:

— A different method for setting the image contrast.

— A different method for creating the binary image.

— A new method for choosing the aperture size.

— An image pre-process methodology for joining disconnected modules in a symbol (where applicable).

— A different process for determining the Modulation and Reflectance Margin parameter renamed Cell Modulation.

— A different process for determining the Symbol Contrast parameter which has been renamed Cell Contrast.

— A different process for computing Fixed Pattern Damage

— A new parameter called Minimum Reflectance (Rtarget).

Axial Nonuniformity, Grid Nonuniformity and Unused Error Correction are applied with their continuous grading grades as defined in Annex C, so long as 15415 does not provide information on continuous grading for these parameters. If/when 15415 does provide continuous grading on these parameters, that information will be used. This standard explains how to both specify and report quality grades in a manner complementary to, yet distinct from, the method in ISO/IEC 15415.

5.2 Lighting

Lighting environments shall be reported according to chapter 6.2 and 10.2. The chosen lighting environment shall be selected under recognizing the properties of the mark and the scanning equipment / environment.

5.3 Tilted coaxial lighting and camera position (TCL).

DPM applications that uses a geometrical mark which is peened, drilled or carved into a surface. Reading camera and unidirectional illumination are located at a coaxial position with a known fixed tilt angle and object rotation angle and position.

To read dot-peened codes, there are multiple reading setups possible. This standard defines several camera and lighting setups in order to address various dot peen geometries.

This specific TCL environment is focussing on the system response of the mark (e.g., the image a camera sees). SAE Standard AS9132[1] takes a different approach to specify the mark geometry.

Figure 1 illustrates the setup. The essential parameter is the camera reading angle. Typical camera reading angles include 30°, 45° or 60° in relation to the plane of the mark.

Note The camera angle is defined in a compatible way to the lighting angle of ISO/IEC15415 (Figure 3).

Note Within the dot peen industry, it is common to specify the stylus angle which is twice the camera angle given in Figure 1.

Note In practice, the condition "coaxial lighting" may be implemented by an approximate setup like a high distance ring. The light angle tolerance of +/- 3 degrees should be respected.

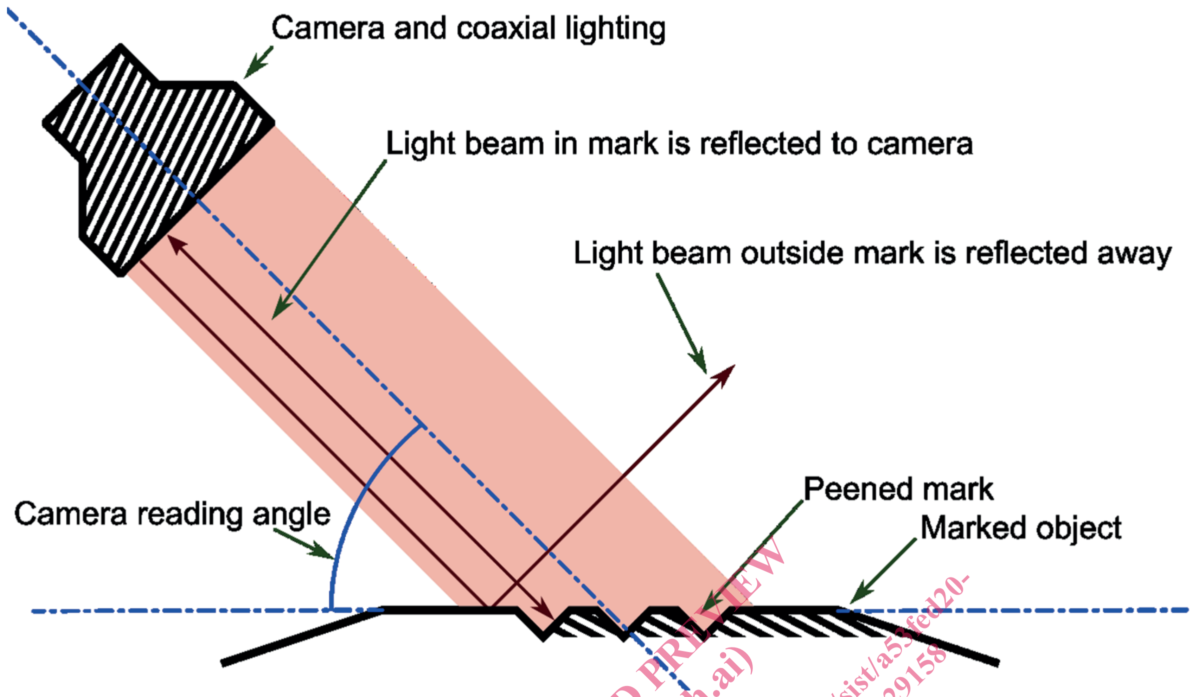

Figure 1 — Tilted coaxial lighting and camera setup

This setup is referenced by the abbreviation "TCL" in the following text.

It is not feasible to grade this setup with a camera angle of 90°. The result will not be significant for this application, as other features of the marked object are measured.

Note that a general purpose verifier device may not cover this application, as it requires a special construction.

6 Obtaining the image

Image capture technology and methods are described in this chapter.

6.1 Camera position and Symbol orientation

6.1.1 Symbol placement

Camera to object position is described in this chapter. By default, the horizontal and vertical axis of the symbol are parallel to a line formed by the edge of the image sensor within +/- 3 degrees (i.e. no rotation). This symbol orientation should be maintained unless an application specification requires or allows a different orientation. An application specification may specify a different symbol rotation. Since the symbol rotation is determined after decoding, the actual rotation angle should be reported so that the setup can be reproduced easily. In applications in which the rotation angle is specified, the rotation angle shall be reported to confirm conformance to specified requirements.

The part is placed such that the symbol is in the centre of the field of view.

6.1.2 Camera position in a 90 degree camera angle set up

The camera is positioned such that the plane of the image sensor is parallel to the plane of the symbol area. This is identical to a 90° camera angle.

6.1.3 TCL setup

Within the TCL setup, camera and symbol position differs in the following points:

- The camera is positioned in the camera angle defined by the application
- The raw image is geometrically transformed to correspond to a test image with a virtual camera position with 90° camera angle, as described in Annex B.
- The symbol rotation angle needs to be specified by the application and shall be respected by +/-5°.

6.2 Lighting environments

The lighting environment is specified by the application. This shall include a direction specifier or an angle or both. The format is an extension of the angle specifier used in ISO/IEC 15415. Several examples are given in the following subsections.

6.2.1 Perpendicular coaxial (90)

The symbol is illuminated with diffuse light such that the specular reflection from the entire field of view is uniform.

6.2.2 Diffuse off-axis (D)

A diffusely reflecting dome is illuminated from below so that the reflected light falls non-directionally on the part and does not cast defined shadows. This is commonly used for reading curved parts. The angle specifier shall be D.

This lighting is also called dome lighting.

6.2.3 Four direction (angle Q)

Light is aimed at the part at the given angle +/- 3 degrees from the plane of the surface of the symbol from four sides such that the lines describing the centre of the beams from opposing pairs of lights are co-planar and the planes at right angles to each other. One lighting plane is aligned to be parallel to the line formed by a horizontal edge of the image sensor to within +/- 5 degrees. The lighting shall illuminate the entire symbol area with uniform energy. The angle specifier shall be angle Q.

Examples are: 45Q (angle equal 45°) or 30Q (angle equal 30°).

6.2.4 Two direction (angle T)

Light is aimed at the part at the given angle +/- 3 degrees from two sides. The light may be incident from either of the two possible orientations with respect to the symbol. The lighting plane is aligned to be parallel to the line formed by one edge of the image sensor to within +/- 5 degrees. The lighting shall illuminate the entire symbol area with uniform energy. The angle specifier shall be "angle T".

Examples are: 45T (angle equal 45°) or 30T (angle equal 30°).

Since there are two possible orientations in this setup (above and below, and left and right) the particular orientation actually used should be reported. The reporting method may be to indicate the location of the lights with respect to the symbol such as “north-south” when the light is incident from above and below the natural “top” and “bottom” of a symbol. The orientation of a symbol is known after decoding and related to the normal orientation of a symbol as specified in its Symbology Specification (e.g. a Data Matrix symbol’s natural orientation has the solid borders on left and bottom, and for QR code the normal orientation has Finder Patterns in the upper left, lower left and upper right corners but not lower right corner.)

