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# Graphic technology — Printing from digital data across multiple technologies —

Part 1:
## Principles

*Technologie graphique — Impression à partir de données numériques via des technologies multiples —*

*Partie 1: Principes*

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# Foreword

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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.

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ISO 15339-1 was prepared by Technical Committee ISO/TC 130, *Graphic technology.*

ISO 15339 consists of the following parts, under the general title *Graphic technology — Printing from digital data across multiple technologies*:

— *Part 1: Principles*

— *Part 2: Characterized reference printing conditions - 2013*

# Introduction

ISO 15339 is based on the premise that in the printing and publishing industry, electronic data is the intermediary for content storage and exchange throughout production including copy preparation, job assembly, proofing, and process colour printing. It further assumes that data preparation can be largely process independent and that choice of the printing process or processes to be used for final production will be based primarily on run length requirements and substrates to be used. There are a variety of tools in place to both define the relationship of digital data to printed colour for specific instances of printing and to manipulate data such that similar results can be obtained between and among different printing processes (ISO/TS 10128). These specific instances of printing are typically described by colour characterization data, which is the relationship between CMYK input data and colour measured on the printed sheet. Where such a set of colour characterization data is used as a reference, it is referred to as a characterized reference printing condition (CRPC).

When producing printed colour reproductions it is important that the organizations responsible for material preparation, colour separation, proofing, and printing are all working to a common set of parameters that uniquely define the intended visual characteristics of the final printed product. Such an agreement enables the correct production of suitable input data and subsequent production of proofs from these data. The purpose of a proof is to simulate the visual characteristics of the finished print product as closely as possible prior to production printing.

There is a unique relationship between ink, substrate, and printing process that limits the maximum chroma of the solids of the printing colorants and therefore limits the range of colours (colour gamut) that can be achieved for particular combinations. While special inks can be used, the commonly available ink pigments seem to be used across all traditional ink processes. While toner and ink-jet systems have different colorant constraints than traditional ink processes, they tend to mimic traditional ink processes aims and they will be treated as a variation of traditional ink processes. The achievable chroma range (gamuts) of ink-on-paper characterized reference printing conditions can generally be bracketed between cold-set printing on newsprint on the small end and by printing on gloss coated stocks (on a variety of processes) on the large end. Between these limits there is significant overlap of process/substrate combinations. The number of intermediate characterized reference printing conditions that are logical to define between smallest and largest is in part a function of the tolerances to which printing is expected to conform to the intended characterized reference printing condition. However, the intermediate characterized reference printing conditions also need to represent common widely used printing conditions and that was the determining factor for the selection of printing conditions listed in Part 2 of ISO 15339. In addition a characterized reference printing condition 7 is included to represent a possible exchange space for large gamut processes that exceed the colour gamut of characterized reference printing condition 6 and therefore need a larger reference gamut.

The data sets defined in ISO 15339-2 are those associated with the initial publication of ISO 15339. It is the intent of ISO TC130 that if changes in, or additions to. these data sets are needed in the future they will be documented in added parts of ISO 15339 so that changes in the data sets are possible without loosing traceability to earlier data sets.

A colour characterization data set is required for each characterized reference printing condition specified. Because these data sets can be used as the reference for any printing process, they will not be aligned with the typical TVI and trapping associated with any specific process. The values selected represent a compromise between all processes – in effect virtual printing on a virtual printing system.

It is important to realize that digital data can be encoded as already separated CMYK or can consist of un-separated data (typically in an RGB colour space) with supplementary information (ICC colour profiles, etc) defining the colour it is intended to be on the printed sheet. Such un-separated data plus the associated supplementary data is sometimes referred to as "virtual CMYK" data. All data is to be encoded according to one of the PDF/X specifications (Parts of ISO 15930) or to allow the necessary metadata which identifies the intended characterized reference printing condition to be included.

The colour of the printing substrate is a critical component of the colour appearance of a printed image (it behaves like a 5th colour). With the current widespread use of optical brightening agents (OBA) substrate colour is defined in terms of its apparent reflectance under D50 illumination (see ISO 3664). For halftone images the colour of the substrate contributes mostly in the area not covered by ink. ISO 13655 provides a reasonably effective method to adjust tristimulus data of measured halftone areas for moderate changes in substrate colour. ISO 15339 is based on the assumption that the colour characterization data can be adjusted (fine tuned) for the range of normal substrate colours expected and that different characterized reference printing conditions are not required for moderate differences in substrate colour.

Although density, tone value increase, gray balance, etc. are individually important tools for the printing and publishing industry, in this International Standard they are assumed to be part of process control and not printing definition. They need to be considered in developing reference colour characterization data sets and need to be used where applicable as part of local site ongoing process control.

Gray balance in particular is a useful tool for the control of a running press. Modern characterization data and profile evaluation tools allow identification of the CMY values associated with the neutral (achromatic) tone scale and the single colour tone value scales for that colour characterization data set. Using the values derived from the colour characterization data, rather than any a priori values, is the recommended input for process control aims used to control a printing process intended to conform to a particular characterized reference printing condition.

Annex C provides a description of the process independent workflow that is the basis for the concepts embodied in ISO 15339.

# Graphic technology — Printing from digital data across multiple technologies — Part 1: Principles

## 1   Scope

This part of ISO 15339 establishes principles for the use of colour characterization data as the definition of the intended relationship between input data and printed colour for copy preparation, job assembly, proofing, and graphic arts production printing.  Additional Parts of ISO 15339 specify a limited number of characterized reference printing conditions that span the expected range of colour gamuts used for the production of printed material from digital data, regardless of printing process used. The procedure to be used to adjust colour characterization data for the normally expected range of substrate colour Is specified.

## 2   Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/TS 10128, *Graphic technology — Methods of adjustment of the colour reproduction of a printing system to match a set of characterization data*

ISO 12642-2, *Graphic technology — Input data for characterization of 4-colour process printing — Part 2: Expanded data set*

ISO 13655, *Graphic technology — Spectral measurement and colorimetric computation for graphic arts images*

ISO 15930 (all parts), *Graphic technology — Prepress digital data exchange using PDF*

ISO 15076-1, *Image technology colour management — Architecture, profile format and data structure — Part 1: Based on ICC.1:2010*

CGATS/IDEAlliance TR 015, *Graphic technology — Graphic technology — Methodology for Establishing Printing Aims Based on a Shared Near-neutral Gray-scale*

## 3   Terms and definitions

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

**3.1**
**colour characterization data**
tabulation of data that represents the relationship between device code values (eg:CMYK) and the colour (CIELAB) produced on the printed sheet by those values in a specific printing process

**3.2**
**colour profile**
set of transforms, encoded according the rules of ISO 15076-1, that convert data between (to and from) device space and profile connection space

Note 1 to entry: The transforms contained within a colour profile can include manipulation of gamut compression/expansion, tone reproduction, colour separation, black printer creation, printing limitations (e.g. total data area), etc.

**3.3**
**gamut**
the (mostly convex) hull in CIELAB space which contains all printable colours (and no others) for a substrate and printing process.

Note 1 to entry: For comparison purposes the CIELAB values of the primaries and secondaries along with the substrate are often an adequate (sparse) definition of a colour gamut, although a more complete definition can be given by the surface values of the measurements of a target like the one contained in ISO 12642-2.

**3.4**
**characterized reference printing condition (CRPC)**
identified printing condition and its colour characterization data that is used as the aim for a particular printing task (job)

**3.5**
**process independent**
independent of the printing process (offset, flexography, gravure, etc.) to be used for production of printed material

**3.6**
**identified printing condition**
printing condition documented in a national or international standard or industry publication in a way that allows it to be replicated by an industry practitioner

# 4 Requirements

## 4.1 Principles and assumptions

One of the key principles upon which this International Standard is based is that colour content data can be adjusted such that any printing processes, that can achieve a specified colour gamut, can produce the within-gamut image colours specified by the appropriate reference colour characterization data. This allows printing aims to be process independent.

A second principle is that process control aims and tools should be based (extracted from) on the reference colour characterization data selected and not based on a priori assumptions. Many of the parameters used in process control such as tone value increase, gray balance, etc. are contained within, or can be derived from, the colour characterization data chosen as reference. Local site tools can also be used for initial setup processes, but these need to be based on the known differences between the colour characterization data aims and the colour characterization of the actual printing system being used.

Where similar characteristics, such as tone reproduction, are desired between different characterized reference printing conditions (different colour gamuts) these need to be built into the colour characterization data associated with these characterized reference printing conditions. Characterized reference printing conditions, and their associated colour characterization data, can be thought of as a virtual printing system (press) and as such the characterization data can be manipulated mathematically to fine tune results to achieve smoothness, uniformity and/or other characteristics.

The key requirement for successful application of these principals is that the reference colour characterization data and the characterization data for the printing system being used shall have the same gamut and be sufficient to allow the necessary data adjustment. (see ISO/TS 10128 for recommended procedures to implement such data adjustment)

## 4.2 Data encoding

In the absence of other prior agreement, electronic colour content data to be used as the intermediate storage and exchange media between copy preparation, job assembly, proofing, and printing shall be encoded in accordance with a part of ISO 15930. Any deviation from this, such as encoding in ISO 12639 or in some other format, shall be according to prior agreement by all parties, and shall include communication of the reference characterization data of the intended printing condition and, as necessary, a colour profile to transform any data not supplied in the process colour model of the reference.

## 4.3 Data preparation

All print elements shall be prepared either as device code values or as colorimetrically defined data. However, both types of data if present in print elements shall be prepared for a single characterized reference printing condition. This condition shall be provided in the PDF/X output intent in the case of an ISO 15930 exchange, or shall be communicated by mutually agreed upon methods in other situations. Unless otherwise agreed between sender and receiver, the characterized reference printing condition shall be one of the data sets defined in a part of ISO 15339.

## 4.4 Characterized reference printing conditions and colour characterization data

The characterized reference printing conditions associated with ISO 15339 are contained in additional Parts of ISO 15339. This approach was taken to allow ISO TC130 to change or update characterized reference printing conditions without revising or invalidating characterized reference printing conditions that might have been used as the basis for existing printing work.

The data sets defined in ISO 15339-2 are those associated with the initial publication of ISO 15339. If changes in, or additions to these data sets are needed in the future, they will be documented in added parts of ISO 15339.

It is important to note that these characterized reference printing conditions are based on the ink colours and 2-colour overprints defined in the various parts of ISO 12647 with corrections for substrate colour differences. However, for alternate printing processes that do not use colorants that align with the hue angles of these characterization data sets, these colour values may be simulated by the appropriate combination of the colorants available, assuming the colour gamut of those colorants encompasses the gamut of the characterized reference printing condition selected. For convenience this part of ISO 15339 will continue to refer to single-colour solids, two-colour overprints, etc recognizing that alternate printing systems may simulate these values using appropriate combinations of available colorants.

All colorimetry should be measured, according to ISO 13655 M1 with white backing. Where the substrate is non-fluorescent M1 data are identical to M0 data and M0 data may be used as M1 data. If M1 data is not available, M0 data converted to M1 is sufficient (see Annex A). M1 data over white backing shall be provided.

The characterized reference printing conditions shown in ISO 15339-2 have been selected to be near the middle of both the general class of printing that is expected to make use of each characterized reference printing condition and the colour of the substrates used. It is expected that adjustments for substrate colour (see 4.6) will allow each characterized reference printing condition to meet a wide variety of needs and be independent of the "printing" process to be used.

## 4.5 Use selection criteria for choice of characterized reference printing condition

It is anticipated that the printing industry (with support from the ink and paper organizations) will begin to develop tables of substrate types and printing processes that will support and/or be most appropriate for each of the characterized reference printing conditions. Where the same content is to be reproduced by more than one process or on more than one substrate a gamut common to the multiple needs should be selected. Where only a single substrate and printing system is to be used, the typical choice should be the largest gamut that choice will support.

The chosen characterized reference printing condition shall be used as the basis for design and content creation.

Communication of the intended printing condition between all parties (preparation, proofing, and printing) only needs to identify ISO 15339 and the gamut to be used along with information relating to any limitations of the intended printing process that need to be considered during preparation, proofing, or printing.

Not all printing processes that can achieve the same colour gamut are subject to the same limitations. Offset, gravure, flexography, electrophotographic, ink-jet, etc., each have limitations that may have to be considered in the final data preparation for printing. These typically include limitations of total ink coverage, minimum and maximum printable dot sizes, etc. Should general guidance be needed, additional parts of ISO 15339 can be prepared to assist in the communication or standardization of the handling of such limitations.

## 4.6   Adjustment of data for substrate colour differences

The characterization data contained in ISO 15339-2 are all based on the CMYK characterization target defined in ISO 12642-2. The substrate colour is therefore given in data element 1 of each data set.

Where the printing substrate to be used has a colour that differs from that of the reference printing condition selected for data preparation and data exchange by less than 2 CIEDE2000 the data may be used without modification.

Where the printing substrate to be used has a colour that differs from the characterized reference printing condition selected for data preparation and data exchange by more than 2 but less than 5 CIEDE2000 the method defined in Annex A (see also ISO 13655) shall be used to adjust the data before proofing and printing. Where substrate adjustment is done this fact and the CIELAB values of the intended substrate shall be communicated to all involved.

Where the difference in substrate colour is greater than 5 CIEDE2000, this correction may be used but the user is cautioned that special colour characterization data might be required which is beyond the scope of ISO 15339..

NOTE    When data adjustment is done using the tristimulus correction technique defined in Annex A, the "colour" of all data points in the colour characterization data set are changed — including the aim values for the single colour solids.

Where characterization data is exchanged that has been modified for changes in substrate colour, that information shall be communicated with the color reference printing condition data.

## 4.7   Alternate printing reference

Where one of the sets of reference colour characterization data defined in the additional parts of ISO 15339 are not appropriate for the intended printing because of the inks, paper, or printing process to be used, prior agreement should be obtained between all parties involved before copy preparation work is started and the colour characterization data to be used and any colour management profiles shall be communicated with the job content files.

## 4.8   Colour profiles

The use of colour profiles is an important part of the data preparation process and colour profiles with specific characteristics are often specified by industry trade associations to restrict and provide more commonality in user input. It is important that colour characterization data and colour management profiles are not confused. While profiles are based on characterization data they also contain additional data processing information. Profiles are required when data is transformed into, or from, CMYK and other working colour spaces. According to ISO 15076-1, an output device profile is required to contain tags that define the transforms between profile connection space and the device values (and reverse) for perceptual, saturation, and colorimetric intents. In addition the transforms include gamut mapping, colour separation methodologies, tone reproduction, and process limits such as tone value sum. These determine the device-space values that will be created from input data linked through profile connection space. Therefore many profiles can be created for