

Standards Related to Digital Imaging of Pictorial Materials

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The successful creation and maintenance of digital images depends on a complex network of formal technical standards and consensus-based best-practice guidelines. This resource list focuses on the formal standards. To help you monitor new technology developments, the list cites specialized Web sites for finding standards and describes the organizations most involved in developing and maintaining digital imaging standards. Digital project managers can also use this list for help in selecting practical tools such as targets to ensure effective scanning and file preservation.

Two tables cite specific standards related to digitizing photographs and digital storage. The listings offer insight into the technical issues involved in digital imaging hardware and software. You can digitize pictures and store the images without reading all of the standards, but you will want to make sure that the tools you select have incorporated the standards. The standards cover terminology definitions, specifications for opto-electronic conversion function, resolution, noise, dynamic range, speed, viewing conditions, and color management as well as project management and quality control.

For information about descriptive metadata, such as MARC and MODS, and other kinds of standards used at the Library of Congress, see <http://www.loc.gov/standards/>.

Disclaimer. The Library of Congress does not maintain most of these sites. Users should direct concerns about these links to their respective site administrators or webmasters.

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Search Services for Standards

Specialized search services are available to help you locate formally approved and developing digital standards as well as many other kinds of standards.

NSSN, <http://www.nssn.org/search.html>

“NSSN [National Resource for Global Standards] contains over 250,000 references to standards from more than 600 developers worldwide.” Profiles of developers and technical committees are also available. You can search for standards by subject keyword, document number, title word, responsible committee, and developer name.

TechStreet, <http://www.techstreet.com/>

TechStreet, produced by Thomson Scientific, covers digital imaging as part of its “Information Technology” section. The site provides access to “more than 300,000 industry codes and standards aggregated from over 350 leading Standards Developing Organizations (SDOs).”

WSSN, <http://www.wssn.net/WSSN/index.html>

“World Standards Services Network (WSSN) is a network of publicly accessible World Wide Web servers of standards organizations around the world. Through the Web sites of its members, WSSN provides information on international, regional and national standardization and related activities and services.” The “structured index” links to the publication catalogs of many standards organizations.

Organizations that Develop and Maintain Digital Imaging Standards

General standards bodies, such as ISO, as well as groups focused on imaging participate in the development of standards related to the digitization of pictures. This section lists the major organizations involved in national and international imaging standards. By visiting their Web sites you can read about existing standards, purchase or download documentation, and learn about new initiatives. To find the committees and working groups most relevant to pictures, look for phrases such as “electronic imaging,” “photography,” and “still images.”

AIIM (Association for Information and Image Management), <http://www.aiim.org/>

“AIIM Standards is comprised of twenty-plus committees and working groups. Over 80 of AIIM's standards, recommended practices, and technical reports have been drafted and approved by ANSI.”

C24, Electronic Imaging committee, <http://www.aiim.org/standards.asp?ID=24820>

ANSI (American National Standards Institute), <http://www.ansi.org/>

“ANSI is a private non-profit organization that administers and coordinates the U.S. voluntary standardization system. Its mission is to enhance U.S. global competitiveness and the American way of life by promoting, facilitating, and safeguarding the integrity of the voluntary standardization system. ANSI is the official U.S. representative to the world's leading standards bodies; the International Organization for Standardization (ISO) ...”

I3A (International Imaging Industry Association), <http://www.i3a.org/index.html>

“The central forum for the development and advancement of open standards within the imaging industry;” formed by the merger of the Digital Imaging Group (DIG) and the Photographic and Imaging Manufacturers Association (PIMA). “I3A's technical committees encompass all aspects of imaging, from traditional silver-halide photography to advanced digital still picture imaging to recycling of photographic materials and more. To date, there are approximately 300 ANSI and 250 ISO standards on imaging.”

Working Group 18: Electronic Still Picture Imaging contributes to ISO TC42,
<http://www.i3a.org/wg18.html>

ICC (International Color Consortium), <http://www.color.org/>

“The International Color Consortium was established in 1993 by eight industry vendors for the purpose of creating, promoting and encouraging the standardization and evolution of an open, vendor-neutral, cross-platform color management system architecture and components. The outcome of this co-operation was the development of the ICC profile specification.”

ISO (International Organization for Standardization), <http://www.iso.org>

“ISO is a network of the national standards institutes of 146 countries.” “The work is carried out by experts on loan from the industrial, technical and business sectors which have asked for the standards, and which subsequently put them to use. These experts may be joined by others with relevant knowledge, such as representatives of government agencies, consumer organizations, academia and testing laboratories.”

Technical Committee 42: Photography (ISO TC42),
<http://www.iso.org/iso/en/stdsdevelopment/tc/tclist/TechnicalCommitteeDetailPage.TechnicalCommitteeDetail?COMMID=1603> (Includes list of more than 150 published standards. For draft standards, go to the committee’s “Technical Programme” page.)

NISO (National Information Standards Organization), <http://www.niso.org/index.html>

“A non-profit association accredited by the American National Standards Institute (ANSI), identifies, develops, maintains, and publishes technical standards to manage information in our changing and ever-more digital environment. NISO standards apply both traditional and new technologies to the full range of information-related needs, including retrieval, re-purposing, storage, metadata, and preservation.”

Photographs: Digitization Standards and Guidelines

Many formal and de facto standards influence the digitization of photographs. The table below reflects the key factors that affect digital image capture and display: Terminology, Opto-Electronic Conversion Function, Resolution, Noise, Dynamic Range, Speed, Viewing Conditions, Color, Project Management, and Quality Control. You can identify the sponsoring organizations through the document numbers. The organization acronyms are explained in the previous section. Codes distinguish draft documents in different stages of development: WD (Working Draft); CD (Committee Draft); DIS (Draft International Standard); FDIS (Final Draft International Standard).

The table is an expanded and updated version of: Don Williams, “Debunking Specsmanship: Progress on ISO/TC42 Standards for Digital Capture Imaging Performance” (Paper presented at the Image Processing, Image Quality, Image Capture, Systems Conference [PICS], Rochester, NY, May 13-16, 2003), 78. (Used with permission.)

Subject	Document Number
Terminology	
Photography -- Electronic still-picture cameras – Terminology	ISO 12231:1997
Photography -- Electronic still-picture imaging – Terminology	ISO/FDIS 12231.2. July 2004

Subject	Document Number
Data Dictionary - Technical Metadata for Digital Still Images (Draft standard for trial use.)	NISO Z39.87-2002 AIIM 20-2002
Opto-Electronic Conversion Function	
Photography -- Electronic still-picture cameras -- Methods for measuring opto-electronic conversion functions (OECFs)	ISO 14524:1999
Resolution	
Photography -- Electronic still-picture cameras -- Resolution measurements	ISO 12233:2000
Photography -- Electronic scanners for photographic images -- Spatial resolution measurements -- Part 1: Scanners for reflective media	ISO 16067-1:2003
Photography -- Electronic scanners for photographic images -- Spatial resolution measurements -- Part 2: Film scanners	ISO16067-2 Sept. 2004
Resolution as it relates to Photographic & Electronic Imaging (Resolution definition and application for evaluation of photographic and electronic systems.)	ANSI/AIIM TR26-1993
Noise	
Photography -- Electronic still picture imaging -- Noise measurements	ISO 15739:2003
Dynamic Range	
Photography -- Electronic scanners for photographic images -- Dynamic range measurements	ISO 21550 Sept. 2004
Speed	
Photography -- Electronic still-picture cameras -- Determination of ISO speed	ISO 12232:1998
Photography -- Digital still cameras -- Determination of exposure index, ISO speed ratings, standard output sensitivity, and recommended exposure index	ISO/DIS 12232 July 2004
Viewing Conditions	
Viewing Conditions—Graphic technology and photography	ISO 3664:2000
Color	
Graphic technology and photography -- Colour characterisation of digital still cameras (DSCs) – Part 1: Stimuli, metrology and test procedures	ISO/CD 17321-1 October 2003
Graphic technology and photography -- Colour characterisation of digital still cameras (DSCs) – Part 2: Methods for determining transforms from raw DSC to scene-referred image data\	ISO/CD 17321-2 December 2003
Photography and graphic technology – Extended colour encodings for digital image storage, manipulation and interchange – Part 1: Architecture and requirements	ISO 22028-1:2004
File format for color profiles, version 4.1 [Revision of ICC.1:1998:09]	Specification ICC.1: 2003-09
Graphic technology -- Prepress digital data exchange -- Colour targets for input scanner calibration	ISO 12641:1997
Graphic Technology – Color transmission target for input scanner calibration	ANSI IT8.7/1-1993 (R1999)
Graphic Technology – Color Reflection Target for input scanner calibration	ANSI IT8.7/2-1993 (R1999)
Project Management	
Electronic Imaging Request for Proposal (RFP) Guidelines	ANSI/AIIM TR27-1996

Subject	Document Number
RLG Guidelines for Creating a Request for Proposal for Digital Imaging Services, 1998, http://www.rlg.org/en/pdfs/RFPGuidelines.pdf	
Human & Organizational Issues for Successful EIM System Implementation	ANSI/AIIM TR35-1995
Quality Control	
Recommended Practice for Quality Control of Image Scanners. Provides procedures for ongoing quality control of image scanners, including incorporation of targets.	ANSI/AIIM MS44-1988 (R1993)
Sampling Procedures and Tables for Inspection by Attributes. Includes tightened, normal and reduced plans. (American Society for Quality)	ANSI/ASQ Z1.4-2003
Sampling Procedures and Tables for Inspection by Variables for Percent Nonconforming (American Society for Quality)	ANSI/ASQ Z1.9-2003
Introduction to Attribute Sampling (American Society for Quality)	ANSI/ASQC S2-1995
Sampling Procedures for Inspection by Attributes of Images in Electronic Image Management (EIM) & Micrographics Systems. Provides guidance in selecting a sampling procedure	ANSI/AIIM TR34-1996

Storage Standards and Guidelines: Media, Formats, Repositories

Storing digital images effectively requires standards related to the storage media, such as CD-ROMs, and the file formats, such as TIFF. The table below also includes examples of guidelines that recommend functional requirements for digital image repositories.

Subject	Document Number
Storage Media	
Imaging Materials -- Compact Discs (CD-ROM) -- Method for Estimating the Life Expectancy Based on the Effects of Temperature and Relative Humidity	ISO 18921:2002
Imaging Materials -- Polyester Base Magnetic Tape - Storage Practices	ISO 18923:2000
Imaging Materials -- Optical Disc Media - Storage Practices	ISO 18925:2002
Imaging Materials -- Life Expectancy of Magneto-Optic (MO) Disks - Method for Estimating, Based on Effects of Temperature and Relative Humidity	ANSI/PIMA IT9.26-1997
Guidelines for the Use of Media Error Monitoring & Reporting Techniques for the Verification of Information Stored on Optical Digital Data Disks	ANSI/AIIM TR39-1996
<i>Care and Handling of CDs and DVDs – A Guide for Librarians and Archivists</i> , by Fred R. Byers. Gaithersburg, MD: National Institute of Standards and Technology, and Washington, DC: Council on Library and Information Resources, 2003. http://www.clir.org/pubs/reports/pub121/pub121.pdf	
File Formats for long-term storage	
Graphic technology – Prepress Digital Data Exchange – Tag Image File Format for Image Technology (TIFF/IT)	ISO 12639:2004
Facsimile Coding Schemes and Coding Control Functions for Group 4 Facsimile Apparatus Recommendation T.6, Volume VII, Fascicle VII.3, Terminal Equipment and Protocols for Telematic Services, The International Telegraph and Telephone Consultative Committee (CCITT), Geneva, Switzerland, 1988. (Common name: Group 4 compression)	ITU-T Recommendation T.6 1988

Subject	Document Number
Repository	
Reference Model for an Open Archival Information System (OAIS) – Consultative Committee for Space Data Systems http://www.classic.ccsds.org/documents/pdf/CCSDS-650.0-B-1.pdf	
Trusted Digital Repositories: Attributes and Responsibilities (An RLG-OCLC Report, May 2002) http://www.rlg.org/longterm/repositories.pdf	

Targets

Targets are tools that help establish and maintain quality control in the production and preservation of digital images. Targets can be used to benchmark digitization systems by helping to determine the capture capability of a scanner. They can ensure consistency in image production during a digital imaging project. When linked with batches of images, targets can also be used for preservation of the resulting digital images by serving as additional documentation of the imaging process.

Unfortunately, the piecemeal availability of targets, only some of which include software, continues to make it hard for project managers to locate appropriate targets. Two articles that provide valuable assistance in identifying targets for digital projects are:

Williams, Don, "Selecting a Scanner." In *Guides to Quality in Visual Resource Imaging*. Mountain View, CA: Research Libraries Group (RLG), Council on Library and Information Resources (CLIR), and the Digital Library Federation (DLF), 2000, <http://www.rlg.org/visguides/>.

Rieger, Oya Y. "Establishing a Quality Control Program." In *Moving Theory into Practice Digital Imaging for Libraries and Archives*, edited by Anne R. Kenney and Oya Y. Rieger, 61-83. Mountain View, CA: 2000.

Targets are available in specific designs for different kinds of equipment (e.g., a digital camera) and to represent different formats of materials being scanned (e.g., transparencies or prints). They can help to test the following elements in digital reproduction.

Digital Reproduction Element	Target
Resolution	Sine wave pattern or knife-edge target (MTF)
Noise	Gray scale step (wedge) target or uniform gray patch
Dynamic range	Gray scale step (wedge) target
Flare	Uniform gray patch
Artifacts	Gray scale step (wedge) target or resolution charts or halftone patterns
Tone reproduction	Gray scale step (wedge) target (OECF)
Color reproduction	Color reproduction target

Some experts recommend the inclusion of grayscale targets within the digital image of each photograph. Anne Kenney notes in her article on digital benchmarking that “Tonal reproduction is still difficult to define precisely but it is receiving a great deal of attention. A growing number of institutions argue strongly for the use of grayscale targets with every scan and the recording of density values in the digital files to facilitate the use of tonal metric information in subsequent presentation and preservation of digital materials.” Franziska Frey cautions in her article on measuring quality of digital masters that “Reproducing the gray scale correctly does not necessarily result in optimal reproduction of the images; however, if the gray scale is incorrect, the image will not look good. The gray scale is used to protect the archive's investment in the digital scans. Having a calibrated gray scale associated with the image not only makes it partly possible to go back to the original stage after transformations but facilitates the creation of derivatives.”

Sources for Targets

A variety of targets are available from different sources, some with accompanying software to assist in interpreting the results of the targets. A selection of target and software providers is listed here. Target and software development is ongoing so currently listed targets may be discontinued as new targets are developed.

AIIM, <http://www.aiim.org/>

Example: The ANSI/AIIM X440 Scanner Test Target Set includes two process ink gamut, ten copies of AIIM scanner targets and one IEEE facsimile test chart. For use in conjunction with document AIIM MS44-1988 (R1993): Quality Control – Digitizing equipment. (Targets are also available individually as X441, X442 and X443.)

A&P International (Prescott, WI), <http://www.pressenter.com/~apintl/iscantar.html>

Example: PM-189 Scanner Test Targets for resolution as recommended by AIIM in MS44-1988 (R1993).

Applied Image Group / Imaging, <http://imaging.appliedimage.com/ttargets-digital.htm>

Example: QA-62 and QA-72 Spatial Resolution test charts.

Edmund Industrial Optics (EO), <http://www.edmundoptics.com/>

Examples: Sinusoidal patterns (MTF), grayscale, ISO 12233 Resolution chart, and Macbeth Color Checker.

Kodak Corporation, <http://www.kodak.com/>

Example: Kodak Q-60 targets: “Scanner color characterization targets produced in accordance with ANSI IT8.7/1 (transmission) and IT8.7/2 (reflection) Standards (or ISO 12641)...” and Kodak color separation guide and gray scale (Q13 and Q14).

Mitre Corporation, <http://www.mitre.org/>

Example: Free *sinemtf* software measures MTF from digital images of sine patterns, <http://www.mitre.org/tech/mtf/index.html>.

Precision Optical Imaging: (<http://www.precisionopticalimaging.com/>)

Example: ISO 12233 and OECF targets (see “Standards”).

Scion Corporation, <http://www.scioncorp.com/>

Example: Sine patterns.

Sine Patterns LLC, <http://www.sinepatterns.com/>

Example: Sine patterns and OECF targets.

Usage Examples for Targets in Digitization Projects

Detailed descriptions of target usage:

Williams, Don, “Selecting a Scanner.” In *Guides to Quality in Visual Resource Imaging*. Mountain View, CA: Research Libraries Group (RLG), Council on Library and Information Resources (CLIR), and the Digital Library Federation (DLF), 2000, <http://www.rlg.org/visguides/>.

Rieger, Oya Y. “Establishing a Quality Control Program.” In *Moving Theory into Practice: Digital Imaging for Libraries and Archives*, edited by Anne R. Kenney and Oya Y. Rieger, 61-83. Mountain View, CA: 2000.

Additional examples:

D’Amato, Donald. “Imaging Systems: the Range of Factors Affecting Image Quality.” In *Guides to Quality in Visual Resource Imaging*. Mountain View, CA: Research Libraries Group (RLG), Council on Library and Information Resources (CLIR), and the Digital Library Federation (DLF), 2000, <http://www.rlg.org/visguides/>.

Frey, Franziska. “Measuring Quality of Digital Masters.” In *Guides to Quality in Visual Resource Imaging*. Mountain View, CA: Research Libraries Group (RLG), Council on Library and Information Resources (CLIR), and the Digital Library Federation (DLF), 2000, <http://www.rlg.org/visguides/>.

Frey, Franziska S., and James M. Reilly. *Digital Imaging for Photographic Collections Foundations for Technical Standards*. Rochester, NY: Image Permanence Institute, Rochester Institute of Technology, 1999. Also available online at http://www.rit.edu/~661www1/sub_pages/digibook.pdf.

International Federation of Library Associations and Institutions (IFLA) and the International Council on Archives (ICA). *Guidelines for Digitization Projects for Collections and Holdings in the Public Domain, Particularly those held by Libraries and Archives*. IFLA, March 2002, draft, <http://www.ifla.org/VII/s19/pubs/digit-guide.pdf>.

Kenney, Anne R. “Digital Benchmarking for Conversion and Access.” In *Moving Theory into Practice Digital Imaging for Libraries and Archives*, eds. Anne R. Kenney and Oya Y. Rieger. Mountain View, CA: Research Libraries Group [RLG], 2000, 42, 24-60.

Technical Advisory Service for Images. *Scanners*, c2002-2004, <http://www.tasi.ac.uk/advice/creating/scanners.html>.