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Incorporating corrigenda April 2012 and August 2013



BSI Standards Publication

Information technology — Biometric data interchange formats

Part 4: Finger image data

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National foreword

This British Standard is the UK implementation of ISO/IEC 19794-4:2011+A2:2015, incorporating corrigendum April 2012. It supersedes BS ISO/IEC 19794-4:2011+A1:2013 which is withdrawn.

BS ISO/IEC 19794-4:2005 has been reinstated to support existing deployments that currently incorporate its provisions, including travel documents. It will remain current along with BS ISO/IEC 19794-4:2011+A2:2015.

The start and finish of text introduced or altered by amendment is indicated in the text by tags. Tags indicating changes to ISO/IEC text carry the number of the ISO/IEC amendment. For example, text altered by ISO/IEC amendment 1 is indicated by A1 A1.

The UK participation in its preparation was entrusted to Technical Committee IST/44, Biometrics.

A list of organizations represented on this committee can be obtained on request to its secretary.

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**Information technology — Biometric data
interchange formats —**

**Part 4:
Finger image data**

*Technologies de l'information — Formats d'échange de données
biométriques —*

Partie 4: Données d'image du doigt



Reference number
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Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

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

The main task of the joint technical committee is to prepare International Standards. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75% of the national 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 and IEC shall not be held responsible for identifying any or all such patent rights.

ISO/IEC 19794-4 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 37, *Biometrics*.

This second edition cancels and replaces the first edition (ISO/IEC 19794-4:2005). It reflects the harmonization across the second generation of ISO/IEC 19794. Clause 8 has been technically revised and contains descriptions of the harmonized general and representation headers. Annex A is under development and will contain an amendment for conformance testing methodology for this part of ISO/IEC 19794. Annex B contains capture device certifications for capturing finger image data. Annex C has been technically revised. Annex D describes conditions for capturing finger image data, and Annex E contains the WSQ Gray-scale fingerprint image compression specification. The former Annex A “Image Quality Specification” has been removed.

ISO/IEC 19794 consists of the following parts, under the general title *Information technology — Biometric data interchange formats*:

- *Part 1: Framework*
- *Part 2: Finger minutiae data*
- *Part 3: Finger pattern spectral data*
- *Part 4: Finger image data*
- *Part 5: Face image data*
- *Part 6: Iris image data*
- *Part 7: Signature/sign time series data*
- *Part 8: Finger pattern skeletal data*
- *Part 9: Vascular image data*
- *Part 10: Hand geometry silhouette data*
- *Part 11: Signature/sign processed dynamic data*
- *Part 13: Voice data*
- *Part 14: DNA data*

Introduction

In the forensic community, the capture and transmission of fingerprint images has been a common choice for the exchange of fingerprint information used by Automatic Fingerprint Identification Systems (AFIS) for the identification of individuals. However, little to no fingerprint information is being exchanged between equipment from different vendors in the biometric user verification and access community. This has been due in part to the lack of agreement between vendors on the amount and type of information to capture, the method of capture, and the information to be exchanged.

ISO/IEC 19794 is a series of International Standards being developed by ISO/IEC JTC 1/SC 37 that supports interoperability and data interchange among biometric applications and systems. The series specifies requirements that solve the complexities of applying biometrics to a wide variety of personal recognition applications, whether such applications operate in an open systems environment or consist of a single, closed system. Additional information regarding the series is provided in ISO/IEC 19794-1.

This part of ISO/IEC 19794 is intended for those applications requiring the exchange of raw or processed fingerprint and palm images that may not necessarily be limited by the amount of resources required for data storage or transmitting time. It can be used for the exchange of scanned fingerprints containing detailed image pixel information. This part of ISO/IEC 19794 can also be used to exchange processed fingerprint image data containing considerably fewer pixels per inch and/or a lesser number of grayscale levels. This is in contrast to other parts of ISO/IEC 19794 used for exchanging lists of fingerprint characteristics such as minutiae, patterns, or other variants. These formats require considerably less storage than a fingerprint image. However, by using any of the other parts of ISO/IEC 19794, information recorded in one standard format cannot be used by algorithms designed to operate with another type of information. In other words, minutiae data records cannot be compared with pattern skeletal data comparison subsystems.

Although the minutiae, pattern, or other approaches produce different intermediate outputs, all shall initially capture a reasonably high quality fingerprint image before reducing the size of the image (in bytes) or developing a list of characteristic data from the image. Use of the captured or processed image can provide interoperability among vendors relying on minutiae-based, pattern-based or other algorithms. As a result, data from the captured finger image offers the developer more freedom in choosing or combining comparison algorithms. For example, an enrolment image may be stored on a contactless chip located on an identification document. This will allow future verification of the holder of the document with systems that rely on either minutiae-based or pattern-based algorithms. Establishment of an image-based representation of fingerprint information will not rely on pre-established definitions of minutiae, patterns or other types. It will provide implementers with the flexibility to accommodate images captured from dissimilar devices, varying image sizes, spatial sampling rates, and different grayscale depths. Use of the fingerprint image will allow each vendor to implement their own algorithms to determine whether two fingerprint records are from the same finger.

A1 Annex A addresses conformance testing to this part of ISO/IEC 19794. Annex A is distinct from ISO/IEC 29109-4, which addresses conformance testing to ISO/IEC 19794-4:2005. **A1**

A2 Additionally, this part of the ISO/IEC standard supports both binary and XML encoding, to support a spectrum of user requirement. With XML, this part will meet the requirements modern IT architectures. With binary encoding this part will also be able to be used in bandwidth or storage constrained environments. Annex F specifies the schema that XML encoded finger image records must conform to, and Annex G provides an example of a valid XML encoded finger image record. **A2**

Information technology — Biometric data interchange formats —

Part 4: Finger image data

1 Scope

This part of ISO/IEC 19794 specifies a data record interchange format for storing, recording, and transmitting the information from one or more finger or palm image areas. This can be used for the exchange and comparison of finger image data. It defines the content, format, and units of measurement for the exchange of finger image data that may be used for enrolment, verification, or identification of a subject. The information consists of a variety of mandatory and optional items, including scanning parameters, compressed or uncompressed images and vendor-specific information. This information is intended for interchange among organizations that rely on automated devices and systems for identification or verification purposes based on the information from finger image areas. Information compiled and formatted in accordance with this part of ISO/IEC 19794 can be recorded on machine-readable media or may be transmitted by data communication facilities.

[A₁] This part of ISO/IEC 19794 also specifies elements of conformance testing methodology, test assertions, and test procedures as applicable to this part of ISO/IEC 19794. It establishes test assertions pertaining to the structure of the finger image data format (Type A Level 1 as defined in ISO/IEC 19794-1:2011 AMD 1), test assertions pertaining to internal consistency of the types of values that may be contained within each field (Type A Level 2 as defined in ISO/IEC 19794-1:2011 AMD 1), and semantic test assertions (Type A Level 3 as defined in ISO/IEC 19794-1:2011 AMD 1).

The conformance testing methodology specified in this part of ISO/IEC 19794 does not establish:

- tests of other characteristics of biometric products or other types of testing of biometric products (e.g. acceptance, performance, robustness, security),
- tests of conformance of systems that do not produce data records conforming to the requirements of this part of ISO/IEC 19794. **[A₁]**

2 Conformance

[A₂] A binary data record conforms to this part of ISO/IEC 19794 if it satisfies all the format requirements with respect to its structure, data values, relationships among its fields, and with respect to relations between its fields and the underlying input that are specified throughout clause 8 of this part of ISO/IEC 19794.

An XML document conforms to this part of ISO/IEC 19794 if it satisfies the format requirements with respect to its structure, with respect to relations among its fields, and with respect to relations between its fields and the underlying input that are specified within Annex F of this part of ISO/IEC 19794.

A system that produces biometric data records is conformant to this part of ISO/IEC 19794 if all biometric data records that it outputs conform to this part of ISO/IEC 19794 (as defined above) as claimed in the Implementation Conformance Statement associated with that system. A system does not need to be capable of producing biometric data records that cover all possible aspects of this part of ISO/IEC 19794, but only those that are claimed to be supported by the system in the Implementation Conformance Statement (ICS). **[A₂]**

[A₂] A system that uses biometric data records is conformant to this part of ISO/IEC 19794 if it can read, and use for the purpose intended by that system, all biometric data records that conform to this part of ISO/IEC 19794 (as defined above) as claimed in the Implementation Conformance Statement associated with that system. A system does not need to be capable of using biometric data records that cover all possible aspects of this part of ISO/IEC 19794, but only those that are claimed to be supported by the system in an Implementation Conformance Statement (ICS).

Biometric data interchange format conformance tests conform to this part of ISO/IEC 19794 if they satisfy all of the normative requirements set forth in Annex A. Specifically, all Level-1, Level-2 and Level-3 tests shall use the assertions defined in Table A.2 and Table A.3 of clause A.3 in conformity with the concept and rules set in ISO/IEC 19794-1:2011 AMD 1.

Implementations of this part of ISO/IEC 19794 tested according to the specified methodology shall be able to claim conformance only to those biometric data record (BDB) requirements specified in this part of ISO/IEC 19794 that are tested by the test methods established by this methodology.

Implementations of this part of ISO/IEC 19794 do not necessarily need to conform to all possible aspects of this part of ISO/IEC 19794, but only to those requirements that are claimed to be supported by the implementation in an implementation conformance statement (ICS), filled out in accordance with Annex A of ISO/IEC 19794-1:2011 AMD 1 and Table A.1 of clause A.2 of this part of ISO/IEC 19794. **[A₂]**

3 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.

[A₂] <http://www.w3.org/XML/Schema> **[A₂]**

ISO/IEC 10918-1, *Information technology — Digital compression and coding of continuous-tone still images: Requirements and guidelines*

ISO/IEC 15444 (all parts), *Information technology — JPEG 2000 image coding system*

ISO/IEC 15948, *Information technology — Computer graphics and image processing — Portable Network Graphics (PNG): Functional specification*

ISO/IEC 19794-1:2011, *Information technology — Biometric data interchange formats — Part 1: Framework*

ISO/IEC 29794-1, *Information technology — Biometric sample quality — Part 1: Framework*

4 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 19794-1 and the following apply.

4.1

capture device spatial sampling rate

number of pixels per unit distance used by a sensor or scanning device to initially capture an image

4.2

fingerprint image

area of friction skin on the fleshy surface of a finger located horizontally between the two edges of the fingernail and vertically between the first joint and the tip of a finger

NOTE It contains a unique pattern of friction ridge and valley information commonly referred to as a “fingerprint”.

4.3

image spatial sampling rate

number of pixels per unit distance in the image

NOTE This may be the result of processing a captured image. The original captured scanned image may have been subsampled, scaled, down-sampled, or otherwise processed.

4.4

palm

friction ridge skin on the side and underside of the hand

4.5

plain fingerprint image

image captured from a finger placed on a platen without any rolling movement

4.6

rolled fingerprint image

image captured that is located between the two edges of the fingernail

NOTE This type of image is typically acquired using a rolling motion from one edge of the fingernail to the other.

4.7

vertical rolls

fingerprint images that have been captured by rolling a finger vertically from the slap position over the finger tip to the nail

NOTE This is in contrast to horizontal rolls, which are captured by horizontal rolling from the nail over the slap position to the other side of the nail as described in the definition for “rolled fingerprint image”.

5 Abbreviated terms

For the purposes of this document the following abbreviations and those given in ISO/IEC 19794-1 apply.

ppcm	pixels per centimetre
ppi	pixels per inch
TIR	Total Internal Reflection

6 Data conventions

6.1 Byte and bit ordering

Each item of information, field, or logical record shall contain one or more bytes of data. Within a record all multibyte quantities are represented in Big-Endian format. That is, the more significant bytes of any multibyte quantity are stored at lower addresses in memory than less significant bytes. The order for transmission shall also be the most significant byte first and least significant byte last. Within a byte, the order of transmission shall be the most significant bit first and the least significant bit last. All numeric values are fixed-length unsigned integer quantities.

6.2 Scan sequence

It is not the purpose of this part of ISO/IEC 19794 to specify the orientation of the finger (or palm), the method of scanning, or the order of scanning used to capture the image. However, each image as presented in accordance with this format standard shall appear to have been captured in an upright position and approximately centered horizontally in the field of view. The recorded image data shall appear to be the result of a scanning of an impression of a fingerprint. The scanning sequence (and recorded data) shall appear to have been captured from left-to-right, progressing from top-to-bottom of the fingerprint or palm print. Figure 1 illustrates the recording order for the scanned image. For the purpose of describing the position of each pixel within an image to be exchanged, a pair of reference axes shall be used. The origin of the axes, pixel location (0,0), shall be located at the upper left-hand corner of each image. The x-coordinate (horizontal) position shall increase positively from the origin to the right side of the image. The y-coordinate (vertical) position shall increase positively from the origin to the bottom of the image.

7 Image acquisition requirements

7.1 General

Image capture requirements are dependent on various factors including the application, the available amount of raw pixel information to retain or exchange, and targeted performance metrics. As a result of these factors, the image capture operation will be associated with a combination of image acquisition parameters settings described below.

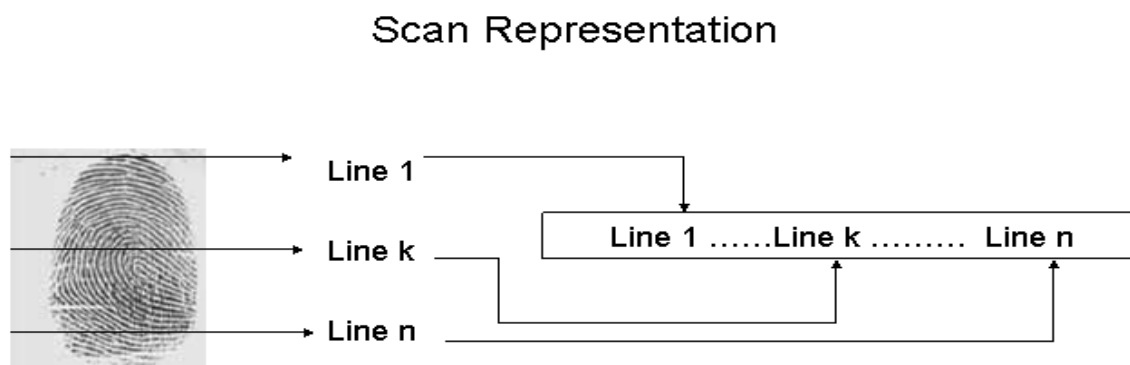


Figure 1 — Order of scanned lines

7.2 Pixel aspect ratio

The finger image shall be represented using square pixels, in which the horizontal and vertical dimensions of the pixels are equal. Any difference between these two dimensions should be within 1%. That is, the ratio of horizontal to vertical pixel dimensions should be between 0,99 and 1,01.

7.3 Bit-depth

The grayscale precision of the pixel data shall be specified in terms of the bit-depth or the number of bits used to represent the grayscale value of a pixel. A bit-depth of 3 provides 8 levels of grayscale; a depth of 8 provides 256 levels of gray. For grayscale data, the minimum value that can be assigned to a "black" pixel shall be zero. The maximum value that can be assigned to a "white" pixel shall be the grayscale value with all of its bits of precision set to "1". However, the "blackest" pixel in an image may have a value greater than "0" and the "whitest" pixel may have a value less than its maximum value. For example, the range of values for a "white" pixel with 5 bits of precision shall be 31 or less. The range of values for a "white" pixel using 8 bits of precision shall be 255 or less. The bit-depth may range from 1 to 16 bits.

7.4 Grayscale data

Grayscale finger image data shall be stored, recorded, or transmitted in either compressed or uncompressed form. The image data portion of a record for an uncompressed grayscale image shall contain a set of raw pixel information. Using a bit-depth of 8 bits (256 grayscale levels) each pixel shall be contained in a single byte. Pixel values with a depth of less than eight bits shall be stored and transmitted in a packed binary format. Increased precision for pixel values greater than 255 shall use two unsigned bytes to hold up to sixteen-bit pixels with values in the range of 0-65535. The encoding of a compressed grayscale image shall be the output of the appropriate grayscale compression algorithm specified in Table 9. Upon decompression the grayscale value for each pixel shall be represented in the same manner as pixels in an uncompressed image.

7.5 Dynamic range

The image grayscale shall be encoded using the agreed precision necessary to meet the dynamic range requirement for a specific application. It is assumed that the precise requirements of the application are known.

7.6 Capture device spatial sampling rate

Grayscale fingerprint images to be captured shall be acquired by an image capture device operating at a specific scanning spatial sampling rate. As the spatial sampling rate used in the image capture process is increased, more detailed ridge and structure information for processing becomes available. For minutiae and small feature based algorithms, use of the higher spatial sampling rate enhances the detection of more closely spaced features that may not be detected using the minimum spatial sampling rate.

7.7 Image spatial sampling rate

The spatial sampling rate of the image data formatted and recorded for interchange may be the scan spatial sampling rate of the image or it may have been sub-sampled, scaled, down-sampled, or otherwise processed to produce a form for representing the ridge and valley structure areas of the fingerprint.

7.8 Fingerprint image location

This part of ISO/IEC 19794 is designed to accommodate both plain (flat) or rolled fingerprint images. Biometric systems perform better if the volar pad of the finger is centered both horizontally and vertically in the image capture area. Therefore, when capturing a fingerprint image, the center of the fingerprint image should be located in the approximate center of the image capture area.

For multiple finger verification and/or identification purposes, there are currently fingerprint scanner devices that will acquire images of multiple fingers during a single capture cycle. These devices are capable of capturing the plain impressions from two, three, or four adjacent fingers of either hand during a single scanning. The plain impressions from the two thumbs or two index fingers can also be captured at one time. Therefore, with three placements of the fingers on a device's scanning surface all ten fingers from an individual shall be acquired in three scans – right four fingers, left four fingers, and two thumbs. For these multi-finger captures, half of the captured fingers should be located to the left of the image center and the other half of the fingers to the right of the image center.

7.9 Palm image location

This part of ISO/IEC 19794 is also designed to accommodate images from the palm of the hand or from the side of the hand opposite the thumb also known as the "writer's palm". Most comparison subsystems perform better if the flat or fleshy part of the palm or writer's palm is centered both horizontally and vertically in the image capture area. Therefore, when capturing a palmpoint image, the center of the palm or writer's palm image area should be located in the approximate center of the image capture area. The palm itself may be captured as one entity, or various pieces of it can be captured as single images such as the thenar (fleshy part behind the thumb), hyperthenar (fleshy area opposite the thumb), or interdigital (area of the palm directly beneath the four fingers).

8 Finger image record format

8.1 Record structure

This part of ISO/IEC 19794 defines the composition of the finger image record. Each record shall pertain to a single subject and shall contain at least one representation for each of one or more fingers, multiple fingers (single image records), or palms. Figure 2 illustrates the record structure for the finger image record format.

Figure 3 details the order of fields in the record and the length of each field. The fields in white indicate mandatory fields. Shaded fields indicate optional information.

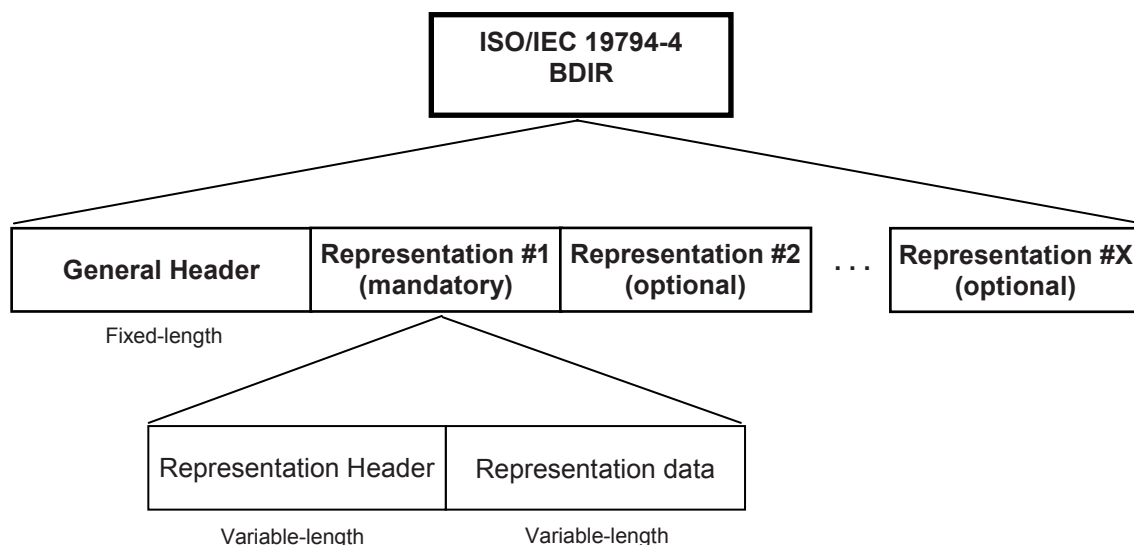


Figure 2 — Finger image record structure

The organization of the record format is as follows:

- A single fixed-length (16-byte) general record header containing information about the overall record, including the number of finger/palm images represented and the overall record length in bytes;
- A single finger record for each single finger, multi-finger, or palm image representation consisting of:
 - A variable length finger image representation header containing information pertaining to the data for a single finger, multi-finger, or palm image;
 - NOTE1 For each quality block of information recorded, the length will be increased by 5 bytes.
 - NOTE2 If any of the finger image representations contain a device certification block, then the length of each finger representation header shall be a minimum of a 42-byte header.
 - NOTE3 For each device certification block of information recorded the length will be increased by 3 bytes.
 - A variable-length finger image representation body containing
 - Compressed or uncompressed image data representation for a single, multi-finger, or palm image; and
 - Optional extended data describing finger segmentation (in the case of multi-finger images), annotation, and comments.

Annex C provides an example of the application of this part of ISO/IEC 19794. It illustrates the completion of required data fields for both the general record header and the finger image record.

8.2 Finger image general header

8.2.1 Required fields

Table 1 lists the fields included in the general record header. As this is a fixed-length header, information shall be included for each field within the header.

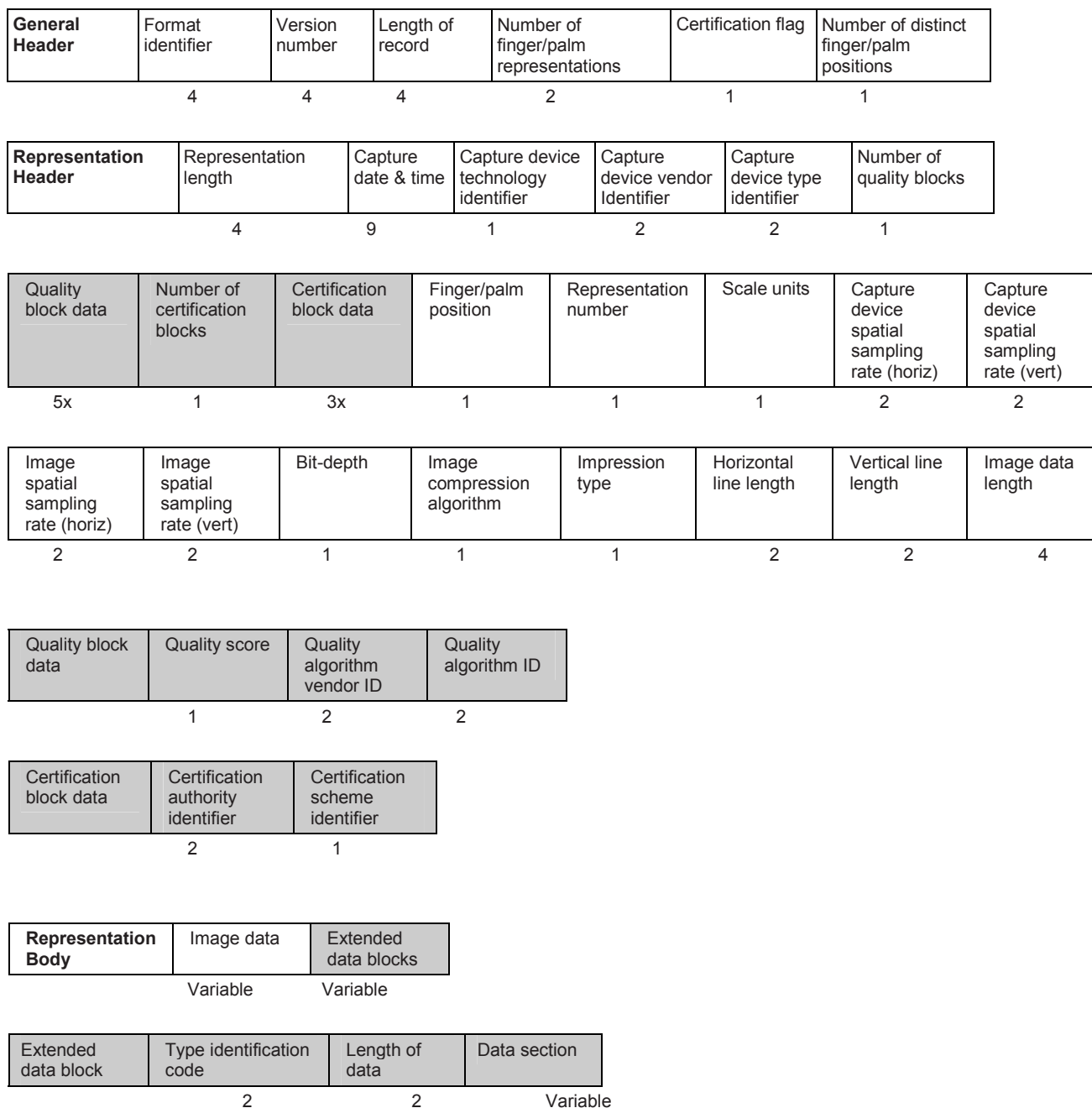


Figure 3 — Order and size of fields in the finger image record

8.2.2 Format identifier

The format identifier shall be recorded in four bytes. The format identifier shall consist of three characters "FIR" followed by a zero byte as a NULL string terminator.

8.2.3 Version number

The number for the version of this part of ISO/IEC 19794 used for constructing the BDIR shall be placed in four bytes. This version number shall consist of three ASCII numerals followed by a zero byte as a NULL

Table 1 — General record header

Field	Size	Valid values	Notes
Format identifier	4 bytes	464952 _{Hex} ('F' 'I' 'R' 00 _{Hex})	"FIR" – Finger Image Record
Version number	4 bytes	30323000 _{Hex} ('0' '2' '0' 00 _{Hex})	"020"
Length of record	4 bytes	57 to (2 ³² -1)	Includes all finger/palm representations, quality blocks and certification blocks ¹⁾
Number of finger/palm representations	2 bytes	1 to 672	[(14 finger positions) + (11 multiple finger positions) + (17 palm codes)] * 16 = 672 possible representations
Certification flag	1 byte	0, 1	Indicates the presence of any device certification blocks within the representation headers
Number of distinct fingers/palm positions	1 byte	>=1	Number of fingers or palms represented

string terminator. The first and second character will represent the major version number and the third character will represent the minor revision number. Upon approval of this specification, the version number shall be "020" – Version 2 revision 0.

8.2.4 Length of record

The length (in bytes) of the entire BDIR shall be recorded in four bytes. This count shall be the total length of the BDIR including the general record header and one or more representation records. The length of the record is dependent on several factors.

8.2.5 Number of finger/palm representations

The total number of representation records contained in the BDIR shall be recorded in two bytes. A minimum of one representation is required. In cases where there is more than one representation of any finger or palm, this number will be greater than the number of fingers or palms.

8.2.6 Device certification flag

The one-byte certification flag shall indicate whether each representation header includes a certification record. A value of 00_{Hex} shall indicate that none of the representations contains a certification record. A value of 01_{Hex} shall indicate that all representations contain a certification record.

NOTE A certification record that is present may contain 0 certifications (in that case the number-of-certifications field in the certification record has the value 0).

1) If Certification flag (General Header) = 0

$$\text{Length} = 16 + \sum_{1}^{\text{Number of Representations}} (41 + 5 * (\# \text{QualityBlocks}) + \text{SizeOfImageData} + \text{SizeOfExtendedData})$$

If Device Certification Flag (General Header) = 1

$$\text{Length} = 16 + \sum_{1}^{\text{Number of Representations}} (42 + 5 * (\# \text{QualityBlocks}) + 3 * (\# \text{Certification blocks}) + \text{SizeOfImageData} + \text{SizeOfExtendedData})$$

8.2.7 Number of distinct finger/palm positions

The number of fingers or palms included in the record shall be recorded in one byte. Multiple fingers acquired by a single capture and contained in the same image are counted as a single finger image.

EXAMPLE 1 If a record contains two images of a right index finger (position code 2 in Table 6) and two images of a left index finger (position code 7 in Table 6) then the value encoded by this clause would be 2. The number of representations encoded by clause 8.2.5 would be 4.

EXAMPLE 2 If a record contains two images of a right index finger (position code 2 in Table 6), one image of the left index and middle fingers (position code 43 in Table 7), and one image of the right four fingers (position code 13 in Table 6) then the value encoded by this clause would be 3. The number of representations encoded by clause 8.2.5 would be 4.

8.3 Finger/palm image representation header

8.3.1 Required fields

A finger or palm representation header shall start each section of finger data providing information for that representation of a single finger image, multi-finger image, or palm image. For each such image there shall be one finger header record accompanying the representation of the image data. The finger header shall occupy a minimum of 41 or 42 bytes as described below (depending on the certification flag in the general header). The compressed or uncompressed image data for that image representation shall immediately follow the header portion. Additional representations (including the header portion) will be concatenated to the end of the previous representation data. Table 2 is a list of the entries contained in the header preceding each block of finger/palm image data. Table 3 lists the finger/palm image data and various types of extended data associated with a finger representation.

Table 2 — Finger image representation header record

Field	Size	Valid values	Notes
Representation length	4 bytes	41 _{Hex} to FFFFFFFF _{Hex}	Denotes the length in bytes of the representation including the representation header fields
Capture date and time	9 bytes	See ISO/IEC 19794-1	The capture date and time field shall indicate when the capture of this representation stated in Coordinated Universal Time (UTC). The capture date and time field shall consist of 9 bytes. Its value shall be encoded in the form given in ISO/IEC 19794-1.
Capture device technology identifier	1 byte	0 to 20	The capture device technology ID shall be encoded in one byte. This field shall indicate the class of capture device technology used to acquire the captured biometric sample. A value of 00Hex indicates unknown or unspecified technology. See Table 4 for the list of possible values.
Capture device vendor identifier	2 bytes	0000 _{Hex} to FFFF _{Hex}	The capture device vendor identifier shall identify the biometric organization that owns the product that created the BDIR. The capture device algorithm vendor identifier shall be encoded in two bytes carrying a CBEFF biometric organization identifier (registered by IBIA or other approved registration authority). A value of all zeros shall indicate that the capture device vendor is unreported.

Field	Size	Valid values	Notes
Capture device type identifier	2 bytes	0000 _{Hex} to FFFF _{Hex}	The capture device type identifier shall identify the product type that created the BDIR. It shall be assigned by the registered product owner or other approved registration authority. A value of all zeros shall indicate that the capture device type is unreported. If the capture device vendor identifier is 0000 _{Hex} , then also the capture device type identifier shall be 0000 _{Hex} .
Quality record	1 to 1,276 bytes (1 to 1 + (255 * 5))	See Table 5 in ISO/IEC 19794-1:2011 for more details	A quality record shall consist of a length field followed by zero or more quality blocks. The length field shall consist of one byte. It shall represent the number of quality blocks as an unsigned integer. Each quality block shall consist of – a quality score, – a quality algorithm vendor identifier, and – a quality algorithm identifier. A quality score should express the predicted comparison performance of a representation. A quality score shall be encoded in one byte as an unsigned integer. Allowed values are – 0 to 100 with higher values indicating better quality, – 255, i.e. ff_{Hex}, for indicating that an attempt to calculate a quality score failed. The quality algorithm vendor identifier shall identify the provider of the quality algorithm. The quality algorithm vendor identifier shall be encoded in two bytes carrying a CBEFF biometric organization identifier (registered by IBIA or other approved registration authority). A value of all zeros shall indicate that the value for this field is unreported. The quality algorithm identifier shall identify the vendor's quality algorithm that created the quality score. It shall be assigned by the provider of the quality algorithm or an approved registration authority. The quality algorithm identifier shall be encoded in two bytes. A value of all zeros shall indicate that the value for this field is unreported.
Certification record	0 to 766 bytes (1 to 1 + (255 * 3))	See ISO/IEC 19794-1	The certification record only exists if the certification flag in the general header has a value of 1. A certification record shall consist of a length field followed by zero or more certification blocks. The length field shall consist of one byte. It shall represent the number of unique certification blocks as an unsigned integer.

Field	Size	Valid values	Notes
			Each certification block shall consist of – a certification authority identifier and – a certification scheme identifier. The certification authority identifier shall identify a certification authority that has carried out a certification according to a certification scheme. The certification authority identifier shall be encoded in two bytes carrying a CBEFF biometric organization identifier (registered by IBIA or other approved registration authority). The certification scheme identifier shall identify a certification scheme according to which a certification has been carried out. The certification scheme identifier shall be encoded in one byte. See Table 5 for the list of certification scheme identifiers.
Finger/palm position	1 byte	0 to 10; 13 to 15; 20 to 36; 40 to 50	See Table 6 through 9
Representation number	1 byte	0 to 15	
Scale units	1 byte	1 to 2	Pixels/Inch or pixels/cm
Scan spatial sampling rate (horiz)	2 bytes	0 to $(2^{16}-1)$	Dependent upon the scanner
Scan spatial sampling rate (vert)	2 bytes	0 to $(2^{16}-1)$	Dependent upon the scanner
Image spatial sampling rate (horiz)	2 bytes	$\leq$ Scan Spatial sampling rate (horiz)	Quality level dependent
Image spatial sampling rate (vert)	2 bytes	$\leq$ Scan Spatial sampling rate (vert)	Quality level dependent
Bit-depth	1 byte	1 to 16 bits	2 – 65535 gray levels
Image compression Algorithm	1 byte	$\{A_1\}$ 0 to 6 $\{A_1\}$	See Table 9
Impression type	1 byte	0 to 15; 20 to 29	See Table 10
Horizontal line length	2 bytes	0 to $(2^{16}-1)$	Dependent on the sensor used
Vertical line length	2 bytes	0 to $(2^{16}-1)$	Dependent on the sensor used
Image data length	4 bytes	0 to $(2^{32}-58)$	Number of bytes for the compressed/uncompressed image data

8.3.2 Representation length

The representation-length field denotes the length in bytes of the representation including the representation header fields.

Table 3 — Image and extended data

Data Type	Field	Size	Valid Values	Notes
Image Data	Finger/palm image data	$< 2^{32} - 1$ bytes		Compressed or uncompressed image data
Extended Data Blocks	Type identification code	2 bytes	0001 _{Hex} to FFFF _{Hex}	Segmentation, annotation, comment, or vendor specific data
	Length of data	2 bytes	0004 _{Hex} to FFFF _{Hex}	
	Data section	(Length of data)-4 bytes		Values $> 0100_{Hex}$ are vendor specific extended data

8.3.3 Capture date-time

The capture date and time field shall indicate when the capture of this representation started in Coordinated Universal Time (UTC). This field is not intended to encode the time the record was instantiated. The capture date and time field shall be encoded in accordance to the requirements given in ISO/IEC 19794-1.

8.3.4 Capture device technology ID

The capture device technology ID shall be encoded in one byte. This field shall indicate the class of capture device technology used to acquire the captured biometric sample. See Table 4 for a list of capture device technologies. A value of 00_{Hex} indicates unknown or unspecified technology.

Table 4 — Capture device technology

ID	Capture device technology
0	Unknown or unspecified
1	White light optical TIR
2	White light optical direct view on platen <i>Note: Card scanner should encode their technology type as "white light optical direct view on platen"</i>
3	White light optical touchless
4	Monochromatic visible optical TIR
5	Monochromatic visible optical direct view on platen
6	Monochromatic visible optical touchless
7	Monochromatic IR optical TIR
8	Monochromatic IR optical direct view on platen
9	Monochromatic IR optical touchless
10	Multispectral optical TIR
11	Multispectral optical direct view on platen
12	Multispectral optical touchless
13	Electro luminescent
14	Semiconductor capacitive
15	Semiconductor RF
16	Semiconductor thermal
17	Pressure sensitive
18	Ultrasound
19	Mechanical
20	Glass fiber

8.3.5 Capture device vendor identifier

The capture device vendor identifier shall identify the biometric organization that owns the product that created the BDIR. The capture device algorithm vendor identifier shall be encoded in two bytes carrying a CBEFF biometric organization identifier (registered by IBIA or other approved registration authority). A value of all zeros shall indicate that the capture device vendor is unreported.

8.3.6 Capture device type identifier

The capture device type identifier shall identify the product type that created the BDIR. It shall be assigned by the registered product owner or other approved registration authority. A value of all zeros shall indicate that the capture device type is unreported.

8.3.7 Finger/palm image quality

8.3.7.1 General

The quality information of the overall finger image data shall be recorded in one or more five-byte blocks. Each of these blocks shall pertain to a specific quality/vendor/algorithm evaluation. Figure 4 illustrates the placement and recording of multiple quality blocks.

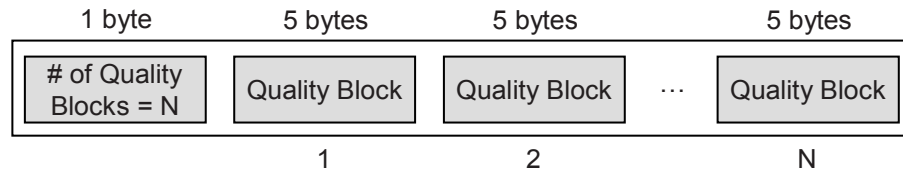


Figure 4 — Image quality layout

8.3.7.2 Number of quality Blocks

The first byte is mandatory and shall contain the number of blocks of quality information of the overall finger image data. Subsequent 5-byte blocks shall contain the specific quality/vendor/algorithm information for each quality/vendor/algorithm evaluation. A value of zero (0) means that no attempt was made to assign a quality score. In this case, no Quality Blocks are present.

8.3.7.3 Quality score

The quality score, as defined in ISO/IEC 29794-1, shall be recorded in the first byte of each of the five-byte blocks. It shall be a quantitative expression of the predicted verification performance of the biometric sample. Valid values for Quality Score are integers between 0 and 100, where higher values indicate better quality. A value of 255 is to handle a special case that indicates a failed attempt to calculate a quality score.

8.3.7.4 Quality algorithm vendor ID

To enable the recipient of the quality score to differentiate between quality scores generated by different algorithms, the provider of quality scores shall be uniquely identified by the next two bytes. This Vendor ID shall be registered with the International Biometrics Industry Association (IBIA).

8.3.7.5 Quality algorithm ID

The remaining two bytes shall specify an integer product code assigned by the vendor of the Quality Algorithm ID. It indicates which of the vendor's algorithms (and version) was used in the calculation of the quality score and shall be within the range of 0 to 65535. Multiple quality scores calculated by the same algorithm (same vendor ID and algorithm ID) shall not be present in a single representation.

8.3.8 Capture device certifications

8.3.8.1 General

This multi-byte block contains information to indicate the compliant certification procedures that were used to test the biometric capture equipment used. The certification record shall consist of a length field followed by zero or more 3-byte certification blocks. Each certification block shall consist of a certification authority identifier, and a certification scheme identifier.

If the device certification flag in the general header has a value of 00_{Hex}, no capture device certification information shall be present in any of the representation header records for that finger image record.

8.3.8.2 Number of certifications

The first byte is mandatory and shall contain the number of certification blocks as an unsigned integer for the capture device.

8.3.8.3 Certification authority ID

The first two bytes of each block contain the CBEFF biometric organization identifier of the certification authority (registered by IBIA or other approved registration authority). This is the agency that certifies a device according to a particular certification scheme identifier.

8.3.8.4 Certification scheme identifier

This last byte of the block shall identify a certification scheme used to certify the capture device. A list of current certification scheme identifiers is contained in Table 5.

Table 5 — Identifiers for certification schemes specified in the annexes

Certification scheme Identifier	Annex
00 _{Hex}	Reserved by SC 37 for future use
01 _{Hex}	0 — Image quality specification for AFIS systems
02 _{Hex}	0 — Image quality specification for personal verification
03 _{Hex}	0 — Requirements and test procedures for optical fingerprint scanners
04 _{Hex} to FF _{Hex}	Reserved by SC 37 for future use

8.3.9 Finger/palm position

This 1-byte field shall contain the finger/palm position code. Code 0 is reserved for an unknown finger or fingers. Codes 1-10 from Table 6 should be used for single fingers. Codes 13 and 14 are used for the images containing four fingers from the right hand and left hand respectively. Table 7 lists finger position codes for common 2-finger and 3-finger combinations. Code 15 accommodates the simultaneous capture of two thumbs, while code 46 accommodates the simultaneous capture of the two index fingers. For multiple-finger captures that have missing fingers the extended data annotation may be used (See Clause 8.4.4).

Codes for palm images are found in Table 8. For full palms the captured area should extend from the "wrist bracelet" through the second joint of the fingers. Similarly, the captured area of the upper palm should extend from immediately below the interdigital area through the second joint of the fingers. The lower palm will cover the area from the "wrist bracelet" through the interdigital area.

8.3.10 Representation number

This one byte field shall contain the specific image representation number associated with the image data (finger, multi finger or palm image data).

8.3.11 Scale units

This field shall specify the units used to describe the scanning and image spatial sampling rates of the image. A 01_{Hex} in this field indicates pixels per inch, or a 02_{Hex} indicates pixels per centimeter.

NOTE This field refers to the metric inch that is not an ISO metric. The intention was to enable entries in fields according to Clause 8.3.12 to Clause 8.3.15 that are integer numbers (e.g. 500 dpi) and to avoid for many existing systems floating point numbers in or rounding errors of the corresponding value in the metric system.

Table 6 — Finger position codes

Finger position	Finger code
Unknown	0
Right thumb	1
Right index finger	2
Right middle finger	3
Right ring finger	4
Right little finger	5
Left thumb	6
Left index finger	7
Left middle finger	8
Left ring finger	9
Left little finger	10
Plain right four fingers	13
Plain left four fingers	14
Plain thumbs (2)	15

Table 7 — Multiple finger position codes

Finger position	Finger code
2-Finger Combinations	
Right index and middle	40
Right middle and ring	41
Right ring and little	42
Left index and middle	43
Left middle and ring	44
Left ring and little	45
Right index and Left index	46
3-Finger Combinations	
Right index and middle and ring	47
Right middle and ring and little	48
Left index and middle and ring	49
Left middle and ring and little	50

8.3.12 Capture device spatial sampling rate (horizontal)

This 2-byte field shall specify the rounded scanning spatial sampling rate used in the horizontal direction. The scale units field will determine whether the value is pixels per inch or pixels per centimeter.

8.3.13 Capture device spatial sampling rate (vertical)

This 2-byte field shall specify the rounded scanning spatial sampling rate used in the vertical direction. The scale units field will determine whether the value is pixels per inch or pixels per centimeter.

Table 8 — Palm codes

Palm position	Palm code
Unknown palm	20
Right full palm	21
Right writer's palm	22
Left full palm	23
Left writer's palm	24
Right lower palm	25
Right upper palm	26
Left lower palm	27
Left upper palm	28
Right other	29
Left other	30
Right interdigital	31
Right thenar	32
Right hypothenar	33
Left interdigital	34
Left thenar	35
Left hypothenar	36

8.3.14 Image spatial sampling rate (horizontal)

This 2-byte field shall specify the rounded image spatial sampling rate used in the horizontal direction. The scale units field will determine whether the value is pixels per inch or pixels per centimeter. It should be noted that certain combinations of scan and image pixel spatial sampling rate values may result in overlapping pixels or spaces between pixels in the captured image.

8.3.15 Image spatial sampling rate (vertical)

This 2-byte field shall specify the rounded image spatial sampling rate used in the vertical direction. The scale units field will determine whether the value is pixels per inch or pixels per centimetre. It should be noted that certain combinations of scan and image pixel spatial sampling rate values may result in overlapping pixels or spaces between pixels in the captured image.

8.3.16 Bit-depth

This 1-byte field shall contain the number of bits used to represent a pixel. This field shall contain an entry of 01_{Hex} to 10_{Hex}.

8.3.17 Image compression algorithm

This 1-byte field shall specify the method used to record the uncompressed or compressed grayscale images. Table 9 lists the available storage options and compression algorithms that may be used. Uncompressed image data shall be recorded in an unpacked or packed form. When using the unpacked option for grayscale pixels greater than eight bits, each pixel shall be recorded in a pair of bytes right justified.

When the compression algorithm code is 2, a certified version of the Wavelet Scalar Quantization (WSQ) algorithm as described in Annex E shall be used to compress 8-bit, 197 ppcm (500 ppi) grayscale images, and shall be limited to a 15:1 compression ratio²⁾. WSQ shall not be used to compress images scanned at 394 ppcm (1000 ppi).

2) Certification information for the WSQ algorithm can be found at <http://fingerprint.nist.gov/wsq>.

Table 9 — Compression algorithm codes

Code	Compression Algorithm	Normative Reference	Allowed Spatial Sampling
0	None – No bit-packing	N/A	All
1	None – Bit packed	N/A	All
2	WSQ	IAFIS_IC-0110 Annex E	197 ppcm
3	JPEG (lossy)	ISO/IEC 10918-1	For legacy data 197 ppcm only
4	JPEG 2000 (lossy)	ISO/IEC 15444	394 ppcm
5	JPEG 2000 (lossless)	ISO/IEC 15444	197 ppcm or 394 ppm
6	PNG	ISO/IEC 15948	All

The compression algorithm code of 3 indicates that the JPEG compression algorithm as described in ISO/IEC 10918-1 has also been used to compress the 8-bit, 197 ppcm (500 ppi) grayscale images. However, JPEG shall not be used for new applications. It is retained in this part of ISO/IEC 19794 to allow previously collected JPEG images to be encoded.

When the compression algorithm code is 4, fingerprint/palmprint images scanned at 394 ppcm (1000 ppi) with a bit-depth of 8 bits, shall be compressed using the JPEG 2000 algorithm as described in ISO/IEC 15444. When this algorithm is used, then the JPEG 2000 profile settings as specified in the "Profile for 1000ppi Fingerprint Compression" should be incorporated. For the case where the compression algorithm code is 5 then the ISO/IEC 15948 PNG algorithm shall be used to compress the image.

NOTE The recommendation is that JPEG 2000 compression be limited to 15:1 for 394 ppcm (1000 ppi) images. This compression ratio should be considered as a maximum value and where bandwidth and/or storage permits, lower levels of compression will result in higher quality images, especially where devices with smaller image sensors are used. Images scanned at 197 ppcm (500 ppi), if compressed should use WSQ compression and the compression ratio shall be limited to 15:1; above 197 ppcm (500 ppi), JPEG 2000 compression is recommended. No recommendations are being made for compression of other image spatial sampling rates.

8.3.18 Impression type

The impression type of the finger or palm image shall be recorded in this one byte field. The codes for this byte are defined in Table 10. Nonlive entries refer to images scanned from cards or other media. Live-scan contactless refers to image capture devices that do not depend upon the surface of a finger making contact with a scanner platen.

8.3.19 Horizontal line length

This two-byte binary field shall be used to specify the number of pixels contained on a single horizontal line of the transmitted image.

Table 10 — Finger and palm impression codes

Code	Description
0	Live-scan plain
1	Live-scan rolled
2	Nonlive-scan plain
3	Nonlive-scan rolled
4	Latent impression
5	Latent tracing
6	Latent photo
7	Latent lift
8	Live-scan swipe
9	Live-scan vertical roll
10	Live-scan palm
11	Nonlive-scan palm
12	Latent palm impression
13	Latent palm tracing
14	Latent palm photo
15	Latent palm lift
20	Reserved by SC 37 for future use
21	Reserved by SC 37 for future use
22	Reserved by SC 37 for future use
23	Reserved by SC 37 for future use
24	Live-scan optical contactless plain
25	Reserved by SC 37 for future use
26	Reserved by SC 37 for future use
27	Reserved by SC 37 for future use
28	Other
29	Unknown

8.3.20 Vertical line length

This two-byte binary field shall be used to specify the number of horizontal lines contained in the transmitted image.

8.3.21 Image data length

This 4-byte field shall contain the length (expressed as the number of bytes) of the compressed or uncompressed image data contained in this representation. It is used to provide a pointer around the compressed image data to the first byte in the extended data field or to the next representation.

8.3.22 Finger/palm image data

This field shall contain the grayscale image data formatted and recorded in accordance with the image compression algorithm.

8.4 Extended data

8.4.1 Extended data block function

This clause of the finger representation is open to placing additional data that may be used by the comparison system. The size of this section shall be kept as small as possible, augmenting the image data stored in the standard image data section. The extended data for each finger representation shall immediately follow the

standard image data for that finger representation. More than one extended data area may be present for each finger representation. The individual extended data length fields are used as indices to parse the extended data.

NOTE The extended data area cannot be used alone, without the standard portion of the Image record.

While the extended data area allows for inclusion of proprietary data within the image format, this is not intended to allow for alternate representations of data that can be represented in open manner as defined in this part of ISO/IEC 19794. The intention of this part of ISO/IEC 19794 is to provide interoperability.

NOTE The total length of the extended data is obtained by: $\text{Length_extended_data} = \text{Representation_length} - \text{Representation_header_length} (41/42 \text{ bytes}) - \text{Image_Data_Length}$. In order to detect whether additional extended data blocks are available, the number of bytes read from the representation have to be subtracted from the representation length, and if the result is positive, there is, at least, an additional extended data block.

8.4.2 Extended data block structure

8.4.2.1 Type identification code

This field shall have a length of two bytes. It shall identify the format of the extended data area when this area is present. A value of zero in both bytes is a reserved value and shall not be used. A value of zero in the first byte, followed by a non-zero value in the second byte, shall indicate that the extended data section has a format defined in this part of ISO/IEC 19794; currently, only segmentation, annotation, and comment formats are specified (refer to clauses 8.4.3, 8.4.4, and 8.4.5). A non-zero value in the first byte shall indicate a vendor-specified format with a code maintained by the vendor. Refer to Table 11 for a summary of the Extended Data Area Type Identification Codes.

Table 11 — Extended data area type codes

First byte	Second byte	Identification
00 _{Hex}	00 _{Hex}	Reserved by SC 37 for future use
00 _{Hex}	01 _{Hex}	Segmentation
00 _{Hex}	02 _{Hex}	Annotation
00 _{Hex}	03 _{Hex} to FF _{Hex}	Comment
01 _{Hex} to FF _{Hex}	00 _{Hex} to FF _{Hex}	Vendor specific extended data

8.4.2.2 Length of data

The length of the extended data section shall be recorded in two bytes. This value is used to skip to the next extended data type identification field if the comparison subsystem cannot decode or use this data. This length field includes the count of the length and type identification fields (four bytes total).

8.4.2.3 Data section

The data field of the extended data is defined and formatted by the type identification code used by the equipment that is generating the finger image record, or by common extended data formats contained in this part of ISO/IEC 19794 for segmentation, annotation, or comment.

8.4.3 Segmentation data format

If the extended data type identification code is 0001_{Hex}, the extended data section contains segmentation and image quality data for each segment of the flat fingerprint image. This extended data section provides a measure of estimated correctness regarding the accuracy of the location of the segmented finger(s) within the multi-finger slap image, information regarding the image quality for each of the segmented fingers, and the locations for each of the image segments of the individual fingers. Table 12 lists the required fields for the segmentation extended data section.

8.4.3.1 Segmentation quality assessment algorithm owner and algorithm ID

The value of the segmentation shall be interpreted in view of the method used to assess the correctness of the segmentation. Therefore, the segmentation quality assessment algorithm's supplier (owner) and specific identity (ID) are contained in the next four bytes. The segmentation quality assessment algorithm owner's ID is the 16-bit format owner value assigned by the IBIA. The last two bytes shall contain a specific identifier for the segmentation quality assessment algorithm. This field contains the binary representation of the integer product code and should be within the range 1 to 65535. This value is assigned by the algorithm owner, who may also choose to register it with the IBIA. Values of all 00_{Hex} for each of these bytes indicate that segmentation owner and algorithm ID are unreported.

Table 12 — Segmentation data

Field		Section	Size	Valid Values	Notes
Segmentation quality assessment algorithm owner and algorithm ID		8.4.3.1	4 Bytes		Segmentation quality assessment algorithm owner and algorithm ID IBIA Assigned; Owner Assigned algorithm ID (Optional IBIA Registered)
Segmentation quality score		8.4.3.2	1 Byte	0-100, 254, or 255	254 – Quality not reported 255 – Quality computation failed
Finger image quality algorithm and Owner ID		8.4.3.3	4 Bytes	0000 _{Hex} to FFFF _{Hex} 0000 _{Hex} to FFFF _{Hex}	Quality algorithm vendor ID IBIA Assigned; Owner Assigned (Optional IBIA Registered)
Number of segments		8.4.3.4	1 Byte	0,1,2,3,4,255	
Finger Segment Data 1 to 4	Finger position	8.4.3.5.2	1 Byte	0 to 10	Refer to Table 6
	Finger quality	8.4.3.5.3	1 Byte	0-100,254, or 255	254 – Quality not reported 255 – Quality computation failed
	Number coordinates	8.4.3.5.4	1 Byte	2 to 99	There shall be 2 or more pairs of coordinates.
	Coordinates (4 to 99)	X-coordinate	2 Bytes	0 to 2 ¹⁶ -1	
		Y- coordinate	2 Bytes	0 to 2 ¹⁶ -1	
	Finger orientation	8.4.3.5.5	1 Byte	0 to 255	

8.4.3.2 Segmentation quality score

This field shall be a measure of estimated correctness regarding the accuracy of the location of the segmented finger. It contains the binary representation of the integer segmentation quality score between 0 and 100 assigned to the image data by a quality algorithm. Higher values indicate better quality. An entry of “255” shall indicate a failed attempt to calculate a quality score. An entry of “254” shall indicate that no attempt to calculate a segmentation quality score was made.

8.4.3.3 Finger image quality algorithm and owner ID

Values of biometric sample quality shall be interpreted in view of the method used to assess the quality. Therefore, the quality assessment algorithm's supplier (owner) and specific identity (ID) are contained in the next four bytes. The first two bytes shall contain the ID of the quality algorithm owner. This is the 16-bit format owner value assigned by the IBIA. The last two bytes shall contain a specific identifier for the quality assessment algorithm. This field contains the binary representation of the integer product code and should be within the range 1 to 65535. This value is assigned by the organization, and may be registered with the IBIA. Values of all 00_{Hex} for each of these bytes indicate that quality algorithm and vendor ID is unreported.

8.4.3.4 Number of segments

This 1-byte field shall contain the number of finger segments that follow. If an image is multi-finger impression then the value shall be 0. If a segmentation attempt failed then the value shall be 255.

8.4.3.5 Finger Segment Data

8.4.3.5.1 General

The following fields shall be present for each of the segmented finger images present. Each finger segment shall be defined by finger position, image quality, the number of points used to define the segment and the coordinates of each point. For rectangular bounding boxes, the number of coordinates points will be four, and the rectangle should be co-linear with the axis of the finger.

8.4.3.5.2 Finger position

The first information item for each finger segment is the finger number as chosen from Table 6.

8.4.3.5.3 Finger quality

The second byte shall be a quantitative expression of the predicted comparison performance of the biometric sample. This value is calculated by the algorithm identified in clause 8.4.3.3. This item contains the image quality score between 0 and 100 assigned to the image data by a quality algorithm. Higher values indicate better quality. A value of 255 shall indicate a failed attempt to calculate a quality score. A value of 254 shall indicate that no attempt to calculate a quality score was made.

8.4.3.5.4 Number of coordinate pairs

The third byte shall specify the number of points or vertexes used to enclose the segmented image. For a finger segment enclosed by an n-sided polygon, this byte shall contain a value between 4 and 99. The usual case is a value of four indicating a rotated rectangle.

The order of the vertices shall be in their consecutive order around the perimeter of the polygon, either clockwise or counterclockwise. No two vertices may occupy the same location. The polygon side defined by the last subfield and the first subfield shall complete the polygon. The polygon shall be a simple, plane figure with no sides crossing and no interior holes. Each vertex of the rectangle or polygon shall be represented by a pair of coordinates.

8.4.3.5.4.1 X-Coordinate

Two bytes shall be used to contain the horizontal pixel offset to the right relative to the origin positioned in the upper left corner of the image.

8.4.3.5.4.2 Y-Coordinate

Two bytes shall be used to contain the vertical pixel offset down relative to the origin positioned in the upper left corner of the image.

8.4.3.5.5 Finger orientation

This one byte field shall encode the angle between the longitudinal axis of the finger and the horizontal axis to the right. The integer value encoded shall be the physical estimate of the angle in degrees divided by $1.40625 = 360/256$. The longitudinal axis of the finger is defined to be positive in the direction from the interphalangeal creases to the fingerprint tip. Figure 5 illustrates the measurement of the the finger orientation for fingers 07 through 10.

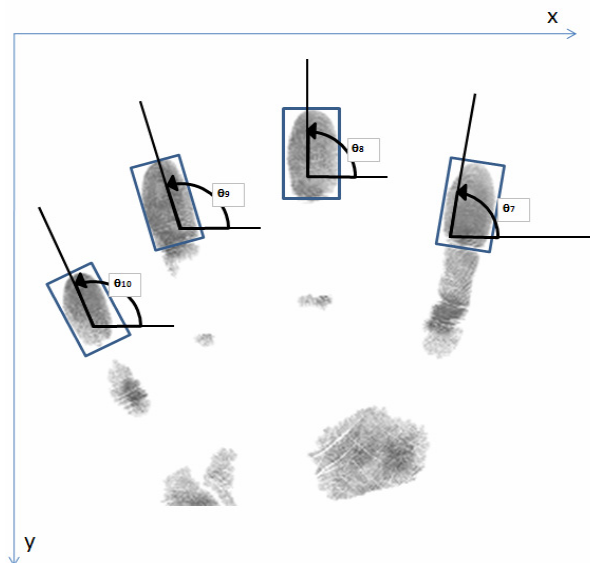


Figure 5 — Finger orientation for segmentation

8.4.4 Annotation data format

If the extended data type identification code is 0002_{Hex}, the extended data section contains annotation information. This format is provided to contain optional information about the fingerprints contained in a larger fingerprint image such as a 2 or 4 finger slap image. Table 13 summarizes the annotation data fields.

Table 13 — Annotation data

Field		Section	Size	Valid Values	Notes
Number of annotations		8.4.4.1	1 Bytes	1 to 4	
Annotation 1 or more	Finger Position	8.4.4.2	1 Byte	0 to 10; 13 to 15; 40 to 50 20 to 36	See Tables 6 to 8
	Annotation Code	8.4.4.3	1 Byte	1 or 2	01 _{Hex} for amputated finger 02 _{Hex} for unusable image

8.4.4.1 Number of annotations

This one-byte field shall contain the number of annotations that follow. Each annotation will consists of two information items.

8.4.4.2 Finger position

This byte shall contain the finger position number as chosen from Table 6 through Table 8.

8.4.4.3 Annotation code

This byte shall contain the code 01_{Hex} for an amputated finger and code 02_{Hex} for a bandaged or otherwise unable to print finger.

8.4.5 Comment data format

If the extended data type identification code is 0003_{Hex}, the extended data section contains ASCII text information associated with the captured image or subject supplying the image. The comment is inputted by the individual generating the fingerprint or palmprint record. A null terminator for the ASCII string is not necessary, as the length is provided.

9 Registered format type identifiers

The registration listed in Table 14 has been made with the CBEFF Registration Authority (see ISO/IEC 19785-2) to identify the finger image record format. The format owner is ISO/IEC JTC 1/SC 37 with the registered format owner identifier 257 (0101_{Hex}).

Table 14 — Format Type Identifiers

CBEFF BDB format Type identifier	Short name	Full object identifier
7 (0007 _{Hex})	Finger-image	{iso(1) registration-authority(1) cbeff(19785) biometric-organization(0) jtc1-sc37(257) bdbs(0) finger-image(7)}

Annex A (normative)

Conformance testing methodology

A.1 Introduction

This normative annex specifies elements of conformance testing methodology, test assertions, and test procedures as applicable to this part of biometric data interchange format standard. Specifically, it establishes

- test assertions of the structure of the finger image data format as specified in this Part of ISO/IEC 19794 (Type A Level 1 as defined in ISO/IEC 19794-1:2011 AMD 1),
- test assertions of internal consistency by checking the types of values that maybe contained within each field (Type A Level 2 as defined in ISO/IEC 19794-1:2011 AMD 1),
- tests of semantic assertions (Type A Level 3 as defined in ISO/IEC 19794-1:2011 AMD 1).

This normative annex does not establish

- test assertions on other characteristics of biometric products (e.g. acceptance, performance, robustness, security),
- conformance test assertions on systems that do not produce finger image record as specified in this part of ISO/IEC 19794.

The conformance testing methodology specified in ISO/IEC 19794-1: 2011 AMD 1 shall apply. The content of the tables below is based on ISO/IEC 19794-1:2011, AMD 1 and shall only be used in the context of that conformance testing methodology.

A.2 Table of requirements

The normative requirements specified in this Part of ISO/IEC 19794 are listed in Table A.1, which extends over multiple pages. The supplier of the IUT should explain which optional components of the standard are supported and the testing laboratory shall note the results of the test.

35 (0023 _{Hex})	XML-finger-image	{iso(1) registration-authority(1) cbeff(19785) biometric-organization(0) jtc1-sc37(257) bdb(0) XML-finger-image(35)}
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Table A.1 – Table of requirements

Requirement Identifier	Governing section	Requirement Summary	Level	Status	Binary Format Applicability	XML Format Applicability	IUT Support	Supported Range	Test Result
Finger image general header									
R-1.	8.1	Each record shall pertain to a single subject.	3C	O-1	Y	Y		N/A	N/A
R-2.	8.1	Each record shall contain at least one representation for each of one or more fingers, multiple fingers (single image records), or palms	3C	O-1	Y	Y		N/A	N/A
R-3.	8.2.1	Information shall be included for each field	1	M	Y	Y			

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Requirement Identifier	Governing section	Requirement Summary	Level	Status	Binary Format Applicability	XML Format Applicability	IUT Support	Supported Range	Test Result
		within the header.							
R-4.	8.2.2 Table 1	The format identifier shall be recorded in four bytes.	1	M	Y	N			
R-5.	8.2.2 Table 1	The format identifier shall consist of three characters "FIR" (0x464952) followed by a zero byte as a NULL string terminator. Therefore, the format identifier shall be 0x46495200.	1	M	Y	N		N/A	
R-6.	8.2.3 Table 1	The Version Number shall be recorded in four bytes.	1	M	Y	N		N/A	
R-7.	8.2.3 Table 1	This version number shall consist of three ASCII numerals "020" (0x30323000) followed by zero byte as a NULL string terminator.	1	M	Y	N		N/A	
R-8.	8.2.4 Table 1	The length (in bytes) of the entire image data record shall be recorded in four bytes. Valid values are 57 to $(2^{32}-1)$	2	M	Y	N			
R-9.	8.2.4	This length of entire record shall be total length of the general record header and one or more representation records.	2	M	Y	N			
R-10.	8.2.5 Table 1	The total number of finger image representations contained in the finger image data record shall be recorded in two bytes. Valid values are 1 to 672.	1,2	M	Y	N			
R-11.	8.2.5	A minimum of one representation is required.	1	M	Y	Y			
R-12.	8.2.6 Table 1	The one-byte certification flag shall indicate whether each representation header includes a certification record. Valid values are 00 _{Hex} and 01 _{Hex} .	1	M	Y	N			
R-13.	8.2.6	A value of 00 _{Hex} shall indicate that none of the representations contains a certification record.	2	M	Y	N			
R-14.	8.2.6	A value of 01 _{Hex} shall indicate that all representations contain a certification record.	2	M	Y	N			
R-15.	8.2.7	The number of finger or palm images included in the	1	M	Y	N			

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Requirement Identifier	Governing section	Requirement Summary	Level	Status	Binary Format Applicability	XML Format Applicability	IUT Support	Supported Range	Test Result
	Table 1	record shall be recorded in one byte. Valid values are 1 to FF _{HEX} .							
Finger image representation header									
R-16.	8.3.1	A finger or palm representation header shall start each section of finger data providing information for that representation of a single finger image, multi-finger image or palm image.	3C	O-1	Y	N		N/A	N/A
R-17.	8.3.1	For each such image there shall be one finger header record accompanying the representation of the image data.	2	M	Y	N		N/A	
R-18.	8.3.1	The representaion header shall occupy a minimum of 41 bytes (assuming no certification blocks and no quality blocks are present). Otherwise, it shall be 42+ 5*num_quality_block+ 3*num_certification_block	2	M	Y	N			
R-19.	8.3.1	The compressed or uncompressed image data for that image representation shall immediately follow the image representation header.	3C	O-1	Y	N		N/A	N/A
R-20.	8.3.1	Subsequent image representations (including the image representation header) will be concatenated to the end of the previous image representation.	3C	O-1	Y	N		N/A	N/A
R-21.	8.3.2 Table 2	The four-byte representation length field shall contain the length in bytes of the finger representation including the representation header fields. The minimum length is 41.	2	M	Y	N			
R-22.	8.3.3 Table 2	Capture date-time field shall indicate the date and time the representation was captured. This field is not intended to encode the time the record was instantiated.	3C	O-1	Y	Y			
R-23.	8.3.3 Table 2	Capture time field shall be encoded in accordance to the requirements given in	1	M	Y	N			

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Requirement Identifier	Governing section	Requirement Summary	Level	Status	Binary Format Applicability	XML Format Applicability	IUT Support	Supported Range	Test Result
		Part 1 of this standard. Parts of the capture date and time that are unknown shall be filled with FF _{Hex} , or FFFF _{Hex} for two-byte components and all subsequent components shall be unknown.							
R-24.	8.3.4 Table 4	The one-byte capture device technology ID shall contain the entry chosen from Table 4 to indicate the technology type used by the capture device. Valid values are 0 to 20.	1	M	Y	N			
R-25.	8.3.5 Table 2	The capture device vendor ID shall be recorded in two bytes.	1	M	Y	N			
R-26.	8.3.5 Table 2	The capture device vendor ID shall identify the biometric organisation that owns the product that created the biometric record (BDIR) and shall be registered with the IBIA or other approved registration authority. A value of all zeros shall indicate that the capture device vendor is unreported.	3B	M	Y	Y			
R-27.	8.3.6 Table 2	This capture device type ID shall be recorded in two bytes.	1	M	Y	N			
R-28.	8.3.6 Table 2	This capture device type ID shall identify the product type that created the biometric record and shall be assigned by the registered biometric record product owner or other approved registration authority. A value of all zeros shall indicate that the capture device type is unreported.	3C	O-1	Y	Y			N/A
R-29.	8.3.7.1	The quality information of the overall finger image data shall be recorded in one or more five-byte blocks.	1	M	Y	N			
R-30.	8.3.7.1	Each of these blocks shall pertain to a specific quality/vendor/algorithm evaluation.	2	M	Y	Y			
R-31.	8.3.7.2	The first byte of the quality	2	M	Y	N			

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Requirement Identifier	Governing section	Requirement Summary	Level	Status	Binary Format Applicability	XML Format Applicability	IUT Support	Supported Range	Test Result
	Table 2	record is mandatory and shall contain the number of subsequent quality blocks. Valid values are 0 to 255.							
R-32.	8.3.7.2 Table 2	Subsequent 5-byte blocks shall contain the specific quality/vendor/algorithm information for each quality/vendor/algorithm evaluation.	1,3B	M	Y	N			
R-33.	8.3.7.2 Table 2	A value of zero (0) means that no attempt was made to assign a quality score. In this case, no Quality Blocks are present	2	M	Y	N			
R-34.	8.3.7.3 Table 2	The quality score shall be recorded in the first byte of each of the five-byte quality blocks. Valid values for quality score are integers between 0 and 100, and 255.	1	M	Y	N			
R-35.	8.3.7.3 Table 2	The quality score shall be the quantitative expression of the predicted verification performance of the biometric sample, per ISO/IEC 29794-1. For valid values 0 to 100, higher values shall indicate better quality.	3C	O-1	Y	Y			N/A
R-36.	8.3.7.3 Table 2	An entry of "255" shall indicate a failed attempt to calculate a quality score.	3C	O-1	Y	N			N/A
R-37.	8.3.7.4 Table 2	The provider of quality scores shall be uniquely identified by bytes 2 and 3 of the 5-byte quality block.	1	M	Y	N			
R-38.	8.3.7.4 Table 2	This Vendor ID shall be registered with the International Biometrics Industry Association (IBIA).	3B	M	Y	Y			
R-39.	8.3.7.5 Table 2	Bytes 4 and 5 of the 5-byte quality block shall specify an integer product code assigned by the vendor of the Quality Algorithm ID. It indicates which of the vendor's algorithms (and version) was used in the calculation of the quality score and shall be within the range of 0 to 65535.	1	M	Y	N			
R-40.	8.3.7.5 Table 2	Multiple quality scores calculated by the same	2	M	Y	Y			

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Requirement Identifier	Governing section	Requirement Summary	Level	Status	Binary Format Applicability	XML Format Applicability	IUT Support	Supported Range	Test Result
		algorithm (same vendor ID and algorithm ID) shall not be present in a single representation.							
R-41.	8.3.8.1 Table 2	The certification record shall consist of a length field followed by zero or more 3-byte certification blocks. Each certification block shall consist of a certification authority identifier and a certification scheme identifier.	2	M	Y	N			
R-42.	8.3.8.1 Table 2	If the certification block flag in the general header has a value of 00 _{Hex} , no capture device certification information shall be present in any of the representation header records for that finger image record.	2	M	Y	N			
R-43.	8.3.8.2 Table 2	The first byte of the certification record is mandatory and shall contain the number of 3-byte certification blocks for the capture device. Valid values are 0 to 255.	1,2	M	Y	N			
R-44.	8.3.8.3	The first two bytes of each 3-byte certification block shall contain the certification authority identifier agency or organization that certified the device according to a particular capture device quality specification.	1	M	Y	N			
R-45.	8.3.8.3	The Certification Authority Identifier shall be registered by the IBIA or other approved registration authority.	3C	O-1	Y	Y			N/A
R-46.	8.3.8.4 Table 5	The 3rd and last byte of certification block shall identify a certification scheme identifier used to certify the capture device as listed in Table 5.	1	M	Y	N			
R-47.	8.3.9 Table 2 Tables 6-8	The one-byte finger or palm position field shall contain the finger or palm position code. Valid values are 0-10, 13-15, 20-36, and 40-50.	1	M	Y	N			
R-48.	8.3.10 Table 2	The one-byte representation number shall contain the specific image	2	M	Y	N			

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Requirement Identifier	Governing section	Requirement Summary	Level	Status	Binary Format Applicability	XML Format Applicability	IUT Support	Supported Range	Test Result
		representation number associated with the image data (or finger, multi finger or palm image data).							
R-49.	8.3.11 Table 2	Scale units field shall specify the units used to describe the scanning and image spatial sampling rate of the image.	3C	O-1	Y	Y			
R-50.	8.3.11 Table 2	Valid values (for scale units) are 01 _{Hex} (indicating pixels per inch), or 02 _{Hex} (indicating pixels per centimetre).	1	M	Y	N			
R-51.	8.3.12 Table 2	The two-byte capture device spatial sampling rate (horizontal) shall specify the rounded scanning spatial sampling rate used in the horizontal direction.	3C	O-1	Y	Y			
R-52.	8.3.13 Table 2	The two-byte capture device spatial sampling rate (vertical) shall specify the rounded spatial sampling rate used in the vertical direction.	3C	O-1	Y	Y			
R-53.	8.3.14 Table 2	The two-byte image spatial sampling rate (horizontal) shall specify the rounded image spatial sampling rate used in the horizontal direction. Valid values are values smaller or equal to device spatial sampling rate (horizontal).	2	M	Y	Y			
R-54.	8.3.15 Table 2	The two-byte image spatial sampling rate (vertical) shall specify the rounded image spatial sampling rate used in the vertical direction. Valid values are values smaller or equal to device spatial sampling rate (vertical).	2	M	Y	Y			
R-55.	8.3.16 Table 2	The one-byte bit-depth field shall contain the number of bits used to represent a pixel. This field shall contain an entry of 01 _{Hex} (=1) to 10 _{Hex} (=16).	1	M	Y	Y			
R-56.	8.3.17 Table 9	The one-byte image compression algorithm field shall specify the method used to record the uncompressed or	1,2	M	Y	N			

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Requirement Identifier	Governing section	Requirement Summary	Level	Status	Binary Format Applicability	XML Format Applicability	IUT Support	Supported Range	Test Result
		compressed grayscale images. Valid values are 0 to 6 as listed in Table 9.							
R-57.	8.3.17 Table 9	If compression algorithm code is 0, for grayscale pixels greater than eight bits, each pixel shall be recorded in a pair of bytes right justified.	3C	O-1	Y	Y			
R-58.	8.3.17 Table 9	When the compression algorithm code is 2, a certified version of the Wavelet Scalar Quantization (WSQ) algorithm as described in Annex E shall be used	3C	O-1	Y	Y			
R-59.	8.3.17 Table 9	WSQ compression for 8-bit, 197 ppcm (500 ppi) grayscale images shall be limited to a 15:1 compression ratio.	2	M	Y	Y			
R-60.	8.3.17	WSQ shall not be used to compress images scanned at 394 ppcm (1000 ppi).	2	M	Y	Y			
R-61.	8.3.17	JPEG shall not be used for new applications.	2	M	Y	Y			
R-62.	8.3.17	Fingerprint/palm print images scanned at 394 ppcm (1000 ppi), if compressed, shall be compressed using the JPEG 2000 algorithm as described in the ISO Standard 15444.	2	M	Y	Y			
R-63.	8.3.17	When JPEG 2000 is used, the JPEG 2000 profile settings as specified in the "Profile for 1000ppi Fingerprint Compression" normative reference are required to be incorporated.	3C	O-1	Y	Y			N/A
R-64.	8.3.17	If compression algorithm is 5, the ISO/IEC 15948 PNG algorithm shall be used.	2	M	Y	Y			
R-65.	8.3.18 Table 10	The impression type code of the finger or palm image shall be recorded in one byte. Valid values are 0 to 15, and 20 to 29.	1 3C	M O-1	Y	N			
R-66.	8.3.19	The two-byte horizontal line length field shall be used to specify the number of pixels contained on a single horizontal line of the transmitted image.	2	M-2	Y	Y			
R-67.	8.3.20	The two-byte vertical line	2	M-2	Y	Y			

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