BRITISH STANDARD

BS ISO/IEC 19794-2:2005 +A1:2010
Incorporating corrigenda November 2009 and September 2014

Information technology — Biometric data interchange formats —

Part 2: Finger minutiae data

ICS 35.040

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Full document details: BS ISO/IEC 19794-2:2005+A1:2010

National foreword

This British Standard is the UK implementation of ISO/IEC 19794-2:2005+A1:2010, incorporating corrigenda November 2009 and September 2014. It supersedes BS ISO/IEC 19794-2:2005, which is withdrawn.

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⟩.

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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.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard, having been prepared under the direction of the DISC Board, was published under the authority of the Standards Committee and comes into effect on 17 October 2005

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ISBN 978 0 580 84255 9

Amendments/corrigenda issued since publication

Date	Comments
31 January 2010	Implementation of ISO/IEC corrigendum November 2009
30 June 2010	Implementation of ISO/IEC amendment 1:2010
30 September 2014	Implementation of ISO/IEC corrigendum September 2014: Clause E5, paragraphs 3 and 4 under Figure E.31 updated

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INTERNATIONAL STANDARD

ISO/IEC 19794-2

First edition
2005-09-15

Information technology — Biometric data interchange formats —

Part 2: Finger minutiae data

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

Partie 2: Données du point caractéristique du doigt

Reference number
ISO/IEC 19794-2:2005(E)

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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 19794-2 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 37, *Biometrics*.

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*

The following parts are under preparation:

— *Part 7: Signature/sign behavioral data*

— *Part 8: Finger pattern skeletal data*

Vascular image data, hand geometry silhouette data, and signature/sign processed dynamic data will from the subjects of future Parts 9, 10 and 11, respectively.

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Introduction

In the interest of implementing interoperable biometric recognition systems, this part of ISO/IEC 19794 establishes a data interchange format for minutiae-based fingerprint capture and recognition equipment. Representation of fingerprint data using minutiae is a widely used technique in many application areas.

This part of ISO/IEC 19794 defines specifics of the extraction of key points (called *minutiae*) from fingerprint ridge patterns.

Ten types of data formats are then defined:

— two for general storage and data interchange; one of minutiae data only and one including also standardised extended data;

— two normal-size format types without record header for use in card-based systems — one with ridge endings represented by valley skeleton bifurcation points and one with ridge endings represented by ridge skeleton end points;

— two compact-size format types without record header for use in card-based systems — one with ridge endings represented by valley skeleton bifurcation points and one with ridge endings represented by ridge skeleton end points;

— two normal-size format types with record header for use in card-based systems — one with ridge endings represented by valley skeleton bifurcation points and one with ridge endings represented by ridge skeleton end points;

— two compact-size format types with record header for use in card-based systems — one with ridge endings represented by valley skeleton bifurcation points and one with ridge endings represented by ridge skeleton end points.

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Information technology — Biometric data interchange formats —

Part 2:
Finger minutiae data

1 Scope

This part of ISO/IEC 19794 specifies a concept and data formats for representation of fingerprints using the fundamental notion of minutiae. It is generic, in that it may be applied and used in a wide range of application areas where automated fingerprint recognition is involved. This part of ISO/IEC 19794 contains definitions of relevant terms, a description of how minutiae shall be determined, data formats for containing the data for both general use and for use with cards, and conformance information. Guidelines and values for matching and decision parameters are provided in an informative annex.

2 Conformance

A system conforms to this part of ISO/IEC 19794 if it satisfies the mandatory requirements herein for extraction of minutiae from a fingerprint image as described in Clause 6 and the generation of a minutiae data format as described in Clause 7 (for general data interchange use) or Clause 8 (for use with cards). Since any finger minutiae extraction and matching algorithm supporting the described finger minutiae data interchange formats may be used, interoperability testing is of extreme importance, especially for environments in which components of different manufacturers interact. In ISO/IEC 19795 "Information technology - Biometric performance testing and reporting," test methodologies and performance testing of biometric data interchange formats are outlined. The application specific policies and relevant standards will determine the requirements for conformance testing and evaluation affecting levels of interoperability.

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.

ISO/IEC 7816-11:2004, *Identification cards — Integrated circuit cards — Part 11: Personal verification through biometric methods*

[AC1] ISO/IEC 19784-1:2006, *Information technology — Biometric application programming interface — Part 1: BioAPI specification*

ISO/IEC 19785-1:2006, *Information technology — Common Biometric Exchange Formats Framework — Part 1: Data element specification*

ISO/IEC 19785-2:2006, *Information technology — Common Biometric Exchange Formats Framework — Part 2: Procedures for the operation of the Biometric Registration Authority*

ISO/IEC 19785-3:2007, *Information technology — Common Biometric Exchange Formats Framework — Part 3: Patron format specifications* [AC1]

4 Terms and definitions

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

4.1
algorithm
a sequence of instructions that tell a biometric system how to solve a particular problem. An algorithm will have a finite number of steps and is typically used by the biometric engine (i.e., the biometric system software) to compute whether a biometric sample and template are a match.

[AC1] *Footnote delete* [AC1]

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4.2
biometrics
[automated] recognition of [living] persons based on observation of behavioral and biological (anatomical and physiological) characteristics.

4.3
biometric
pertaining to the field of biometrics.

4.4
biometric data
data encoding a feature or features used in biometric verification.

4.5
biometric Information template
a constructed data object in a card containing information needed by the outside world for a verification process, see ISO/IEC 7816-11

4.6
biometric sample
information obtained from a biometric device, either directly or after further processing.

4.7
biometric system
an automated system capable of:
1. capturing a biometric sample from an end user;
2. extracting biometric data from that sample;
3. comparing the biometric data with that contained in one or more reference templates;
4. deciding how well they match; and
5. indicating whether or not an identification or verification of identity has been achieved.

4.8
capture
the process of taking a biometric sample from an end user.

4.9
cell
a rectangular region defined by a uniform and non-overlapping division of the image.

4.10
comparison
the process of comparing a biometric sample with a previously stored reference template or templates.

4.11
claimant
a person submitting a biometric sample for verification or identification while claiming a legitimate or false identity.

4.12
core
a core is the topmost point on the innermost recurving ridgeline of a fingerprint. Generally, the core is placed upon or within the innermost recurve of a loop.

4.13
database
any storage of biometric templates and related end user information.

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4.14
delta
a delta is that point on a ridge at or nearest to the point of divergence of two type lines, and located at or directly in front of the point of divergence.

4.15
end user
a person who interacts with a biometric system to enroll or have his/her identity checked. Contrast with “User”.

4.16
enrollment
the process of collecting biometric samples from a person and the subsequent preparation and storage of biometric reference templates representing that person's identity.

4.17
extraction
the process of converting a captured biometric sample into biometric data so that it can be compared to a reference template; sometimes called "characterization".

4.18
friction ridge
the ridges present on the skin of the fingers and toes, the palms and soles of the feet, which makes contact with an incident surface under normal touch. On the fingers, the unique patterns formed by the friction ridges make up fingerprints.

4.19
identification / identify
the one-to-many process of comparing a submitted biometric sample against all of the biometric reference templates on file to determine whether it matches any of the templates and, if so, the identity of the enrollee whose template was matched. The biometric system using the one-to-many approach is seeking to find an identity amongst a database rather than verify a claimed identity. Contrast with ‘Verification’.

4.20
latent
a fingerprint collected from an intermediate surface, rather than directly via a live capture from the finger itself.

4.21
live capture
The process of capturing a biometric sample by an interaction between an end user and a biometric system.

4.22
live-scan print
a fingerprint image that is produced by scanning or imaging a live finger to generate an image of the friction ridges.

4.23
match / matching
the process of comparing a biometric sample against a previously stored template and scoring the level of similarity.

4.24
minutia (single) minutiae (pl)
friction ridge characteristics that are used to individualize a fingerprint. Minutiae occur at points where a single friction ridge deviates from an uninterrupted flow. Deviation may take the form of ending, bifurcation, or a more complicated “composite” type.

4.25
population
The set of end-users for the application.

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4.26
record
the template and other information about the end-user (e.g. access permissions).

4.27
resolution
the number of pixels (picture elements) per unit distance in the image of the fingerprint.

4.28
ridge bifurcation
the minutia assigned to the location at which a friction ridge splits into two ridges or, alternatively, where two separate friction ridges combine into one.

4.29
ridge ending
the minutia assigned to the location at which a friction ridge terminates or, alternatively, begins. A ridge ending is defined as the bifurcation of the adjacent valley - the location at which a valley splits into two valleys or, alternatively, at which two separate valleys combine into one.

4.30
ridge skeleton endpoint
the minutia assigned to the location at which a ridge skeleton ends. A ridge skeleton endpoint is defined as the ending of the skeleton of a ridge.

4.31
skeleton
the single-pixel-wide representation of a ridge or valley obtained by successive symmetric thinning operations. The skeleton is also known as the medial axis.

4.32
swipe
a method of fingerprint collection where the finger is manually moved across a one-dimensional sensor to produce the two-dimensional image.

4.33
template / reference template
data, which represents the biometric measurement of an enrollee, used by a biometric system for comparison against subsequently submitted biometric samples. NOTE - this term is not restricted to mean only data used in any particular recognition method, such as template matching.

4.34
typeline
the two innermost ridges that start parallel, diverge, and surround or tend to surround the pattern area.

4.35
user
the client to any biometric vendor. The user must be differentiated from the end user and is responsible for managing and implementing the biometric application rather than actually interacting with the biometric system.

4.36
valley
the area surrounding a friction ridge, which does not make contact with an incident surface under normal touch; the area of the finger between two friction ridges.

4.37
valley bifurcation
the point at which a valley splits into two valleys or, alternatively, where two separate valleys combine into one.

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4.38
verification / verify
the process of comparing a submitted biometric sample against the biometric reference template of a single enrollee whose identity is being claimed, to determine whether it matches the enrollee's template. Contrast with 'Identification'.

5 Symbols and abbreviated terms

BIT	Biometric Information Template
CBEFF	Common Biometric Exchange Formats Framework
DO	Data Object
FAR	False Acceptance Rate
FRR	False Rejection Rate
RCE	Ridge Count Extraction
RFU	Reserved for Future Use

6 Minutiae Extraction

6.1 to 6.7 define the placement of minutiae on the fingerprint. Compatible minutiae extraction is required for interoperability between different finger matchers for the purposes of matching an individual against a previously collected and stored finger record. The interoperability is based on defining the finger minutiae extraction rules, record formats and card formats that are common to many finger matchers for acceptable matching accuracy, while allowing for extended data to be attached for use with equipment that is compatible with it.

6.1 Principle

Establishment of a common feature-based representation must rest on agreement on the fundamental notion for representing a fingerprint. Minutiae are points located at the places in the fingerprint image where friction ridges end or split into two ridges. Describing a fingerprint in terms of the location and direction of these ridge endings and bifurcations provides sufficient information to reliably determine whether two fingerprint records are from the same finger.

The specifications of minutia location and minutia direction described below accomplish this. See Figure 1 for an illustration of the definitions below.

6.2 Minutia Type

Each minutia has a "type" associated with it. There are two major types of minutiae: a "ridge skeleton end point" and a "ridge skeleton bifurcation point" or split point. There are other types of "points of interest" in the friction ridges that occur much less frequently and are more difficult to define precisely. More complex types of minutiae are usually a combination of the basic types defined above. Some points are neither a ridge ending nor a bifurcation. This standard therefore defines additionally a type named "other", which shall be used in such a way that the matching conditions specified in 6.6 apply. The "other" minutiae type shall not be used for minutiae that are ridge endings or ridge bifurcations.

Therefore, the following types are distinguished:

- ridge ending (also identifiable as a valley skeleton bifurcation point);
- ridge bifurcation
- other.

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A ridge ending may — alternatively — be regarded as a valley bifurcation depending on the method to determine its position (see below). The format type of the biometric information template indicates the use of ridge endings or valley bifurcations.

6.3 Minutia Location

The minutia location is represented by its horizontal and vertical position. The minutiae determination strategy considered in this document relies on skeletons derived from a digital fingerprint image. The ridge skeleton is computed by thinning down the ridge area to single pixel wide lines. The valley skeleton is computed by thinning down the valley area to single pixel wide lines. If other methods are applied, they should approximate the skeleton method, i.e. location and angle of the minutia should be equivalent to the skeleton method.

6.3.1 Coordinate System

The coordinate system used to express the minutiae of a fingerprint shall be a Cartesian coordinate system. Points shall be represented by their X and Y coordinates. The origin of the coordinate system shall be the upper left corner of the original image with X increasing to the right and Y increasing downward. Note that this is in agreement with most imaging and image processing use. When viewed on the finger, X increases from right to left as shown in Figure 1. All X and Y values are non-negative.

The X and Y coordinates of the minutiae shall be in pixel units, with the spatial resolution of a pixel given in the “X Resolution” and “Y Resolution” fields of the format. X and Y resolutions are stated separately.

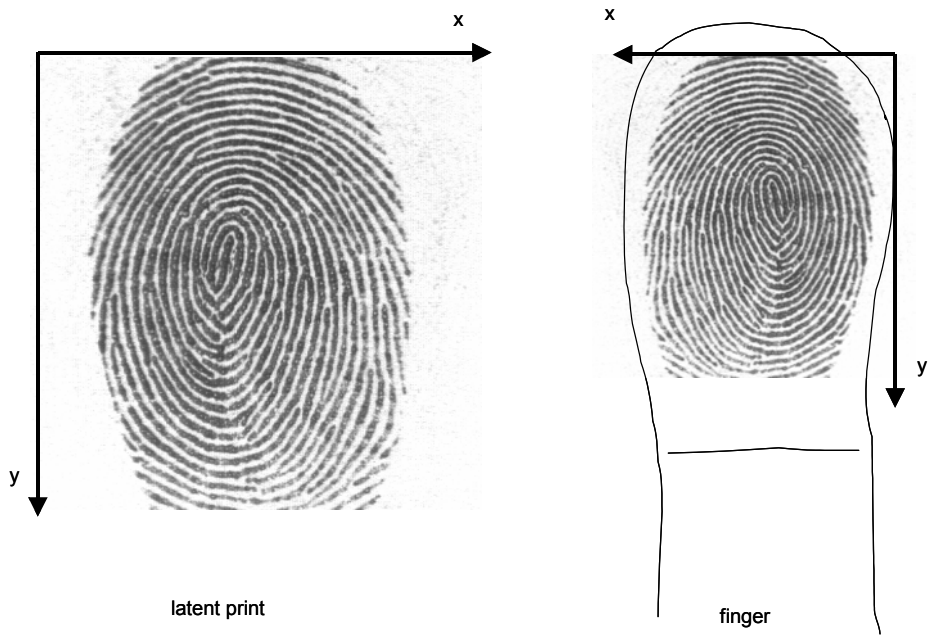

Figure 1 - Coordinate system

For the finger minutiae record format, the resolution of the coordinate system is specified in the record header, see 7.3.8 and 7.3.9. For the finger minutiae card format, the resolution of the X and Y coordinates of the minutia shall be in metric units. The granularity is one bit per one hundredth of a millimeter in the normal format and one tenth of a millimeter in the compact format:

1 unit = 10^{-2} mm (normal format) or 10^{-1} mm (compact format).

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6.3.2 Minutia Placement on a Ridge Ending (encoded as Valley Skeleton Bifurcation Point)

The minutia for a ridge ending shall be defined as the point of forking of the medial skeleton of the valley area immediately in front of the ridge ending. If the valley area were thinned down to a single-pixel-wide skeleton, the point where the three legs intersect is the location of the minutia. In simpler terms, the point where the valley Y's, or (equivalently) where the three legs of the thinned valley area intersect (see Figure 2).

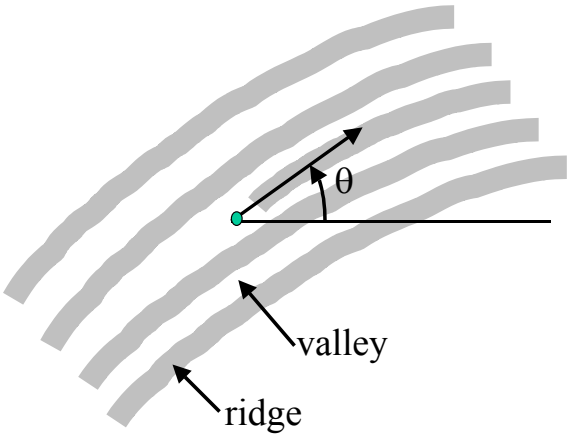

Figure 2 - Location and direction of a ridge ending (encoded as valley skeleton bifurcation point)

6.3.3 Minutia Placement on a Ridge Bifurcation (encoded as a Ridge Skeleton Bifurcation Point)

The minutia for a ridge bifurcation shall be defined as the point of forking of the medial skeleton of the ridge. If the ridges were thinned down to a single-pixel-wide skeleton, the point where the three legs intersect is the location of the minutia. In simpler terms, the point where the ridge "Y"'s, or (equivalently) where the three legs of the thinned ridge intersect (see Figure 3).

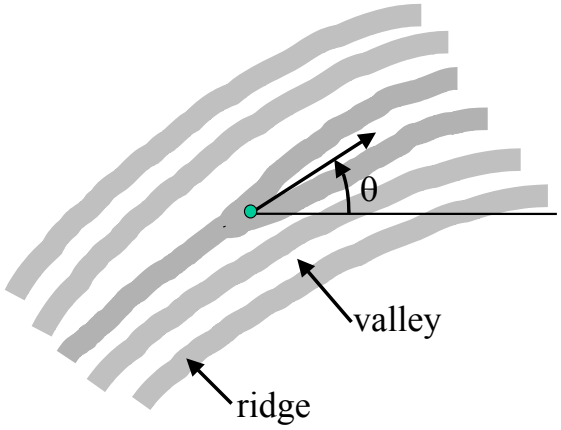

Figure 3 - Location and direction of a ridge bifurcation (encoded as ridge skeleton bifurcation point)

6.3.4 Minutia Placement on a Ridge Skeleton Endpoint

The minutia for a ridge skeleton endpoint shall be defined as the center point of the ending ridge. If the ridges in the digital fingerprint image were thinned down to a single-pixel-wide skeleton, the position of the minutia would be the coordinates of the skeleton point with only one neighbor pixel belonging to the skeleton (see Figure 4).

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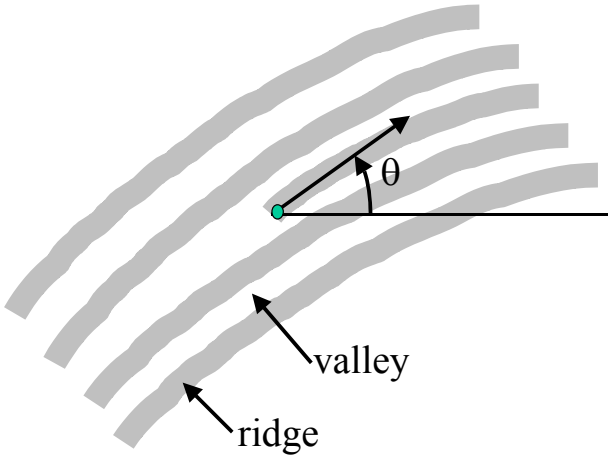

Figure 4 - Location and direction of a ridge skeleton endpoint

6.3.5 Minutia Placement on Other Minutia Types

For minutia other than a bifurcation or ridge ending the position and angle calculations shall be done in such a way that the matching conditions in 6.5 apply.

6.3.6 Usage of the Minutia Placement by the Record Formats and the Card Formats

The record formats use

- ridge ending and ridge bifurcation points.

The card formats use

- ridge ending and ridge bifurcation points, or

- ridge skeleton end points and ridge bifurcation points

depending on the specific algorithms implemented. In case of on-card matching, a card will request from the card usage system biometric verification data in the format compliant to its algorithm. The requested format is either implicitly known to the card usage system or can be retrieved in the Biometric Information Template, which contain the CBEFF data elements format owner and format type – see ISO/IEC 19785-1 and ISO/IEC 7816-11.

6.4 Minutia Direction

6.4.1 Angle Conventions

The minutia angle is measured increasing counter-clockwise starting from the horizontal axis to the right.

In the record formats, the angle of a minutia is scaled to fit the granularity of 1.40625 (360/256) degrees per least significant bit.

The angle coding for the card formats differ for the normal size and the compact size formats; refer to 8.1 and 8.2.

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6.4.2 Minutia Direction of a Ridge Ending (encoded as Valley Skeleton Bifurcation Point)

A ridge ending (encoded as valley skeleton bifurcation point) has three arms of valleys meeting in one point. Two valleys enclosing the ridge ending line encompass an acute angle. The direction of a valley bifurcation is defined by the mean direction of their tangents and is measured as the angle the tangent forms with the horizontal axis to the right (see Figure 2).

6.4.3 Minutia Direction of a Ridge Bifurcation (encoded as Ridge Skeleton Bifurcation Point)

A ridge bifurcation (encoded as ridge skeleton bifurcation point) has three arms of ridges meeting in one point. Two ridges enclosing the ending valley encompass an acute angle. The direction of a ridge bifurcation is defined by the mean direction of their tangents and is measured as the angle the tangent forms with the horizontal axis to the right (see Figure 3).

6.4.4 Minutia Direction of a Ridge Skeleton End Point

The direction of a ridge skeleton endpoint is defined as the angle that the tangent to the ending ridge encompasses with the horizontal axis to the right (see Figure 4). Ridge skeleton end points are only used in one type of the card formats, whereas in the other type ridge ending and ridge bifurcation is used as in the record format.

6.5 Core and Delta Placement and Direction

Core and delta points are designated points of interest in a fingerprint. A fingerprint may have 0, 1 or more than 1 cores and 0, 1 or more than 1 deltas. Core and delta position and direction are defined as follows.

Core position: If there are ridge endings enclosed by the innermost recurving ridgeline, the ending nearest to the maximal curvature of the recurving ridgeline defines the core position. If the core is a u-turn of a ridgeline not enclosing ridge endings, the valley end defines the core position.

Core direction: If the core has a discernible angle of direction, it shall be recorded in the core information, since this characterizes the type of core. The angle of a core is defined by the angle of the tangent to the ridge lines that are closest to the core position; the direction measured points towards the open side of the concave ridge.

Delta position: Three points of divergence are each placed between the two ridges at the location where the ridges begin to diverge; that is, where the ridges that have been parallel or nearly parallel begin to spread apart as they approach the delta. The position of the delta is defined by the spatial mean of these three points.

Delta direction: For all observable divergences the angle is defined by the direction of the tangent before the pair of ridges beings to diverge. The angle shall point from divergent towards parallel ridge lines; that is, the angles shall point outwards from the delta.

Core and delta point placement is illustrated in Figure 5.

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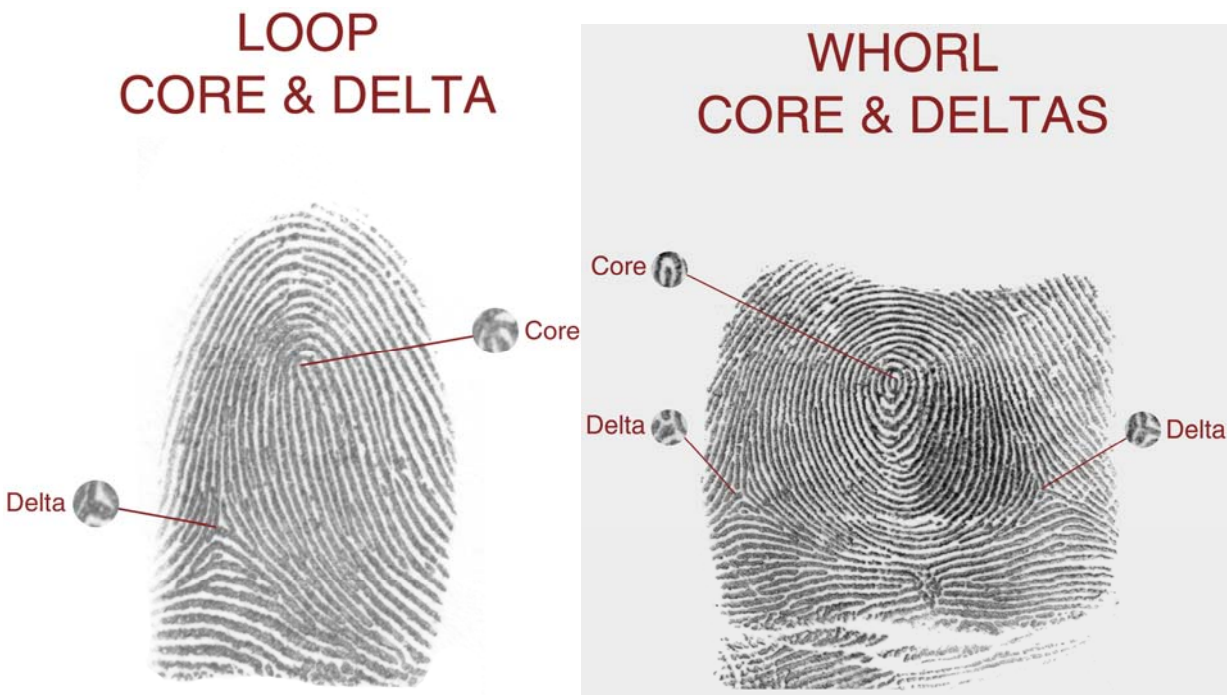

Figure 5 - Example Core and Delta placement

6.6 Minutia Type Matching

In a matching process, the different minutia types shall be matched according to the following Table 1. Matchers may choose to assign lower weights (or importance) to a match of type 00 to 01 or 10, than to a match of type 00 to 00, 01 to 01, or 10 to 10.

Table 1 - Minutia Type Matching

Type of verification minutia	Match with type of reference minutia
00	00, 01, 10
01	00, 01
10	00, 10
00 = other 01 = ridge ending (encoded as valley skeleton bifurcation point), or ridge skeleton end point, see note 10 = ridge bifurcation (encoded as ridge skeleton bifurcation point)	

NOTE - Whether ridge ending or bifurcation is meant depends on the format type.

6.7 Encoding of multibyte quantities

All multibyte quantities are represented in Big-Endian format; that is, the more significant bytes of any multi-byte quantity are stored at lower addresses in memory than (and are transmitted before) less significant bytes. All numeric values are fixed-length integer quantities, and are unsigned quantities.

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7 Finger Minutiae Record Format

7.1 Introduction

The minutiae record format shall be used to achieve interoperability between finger matchers providing a one-to-one verification. The minutia data shall be represented in a common format, containing both basic and extended data. With the exception of the Format Identifier and the Version number for the standard, which are null-terminated ASCII character strings, all data is represented in binary format. There are no record separators or field tags; fields are parsed by byte count.

7.2 Record Organization

The organization of the record is as follows:

- A fixed-length (24-byte) record header containing information about the overall record, including the number of fingers represented and the overall record length in bytes;
- A Single Finger record for each finger, consisting of:
- A fixed-length (4-byte) header containing information about the data for a single finger, including the number of minutiae;
- A series of fixed-length(6-byte) minutia descriptions, including the position, type, angle and quality of the minutia;
- One or more “extended” data areas for each finger, containing optional or vendor-specific information.

7.3 Record Header

There shall be one and only one record header for the minutiae record, to hold information describing the type and characteristics of device that generated the minutia data.

7.3.1 Format Identifier

The Finger Minutiae Record shall begin with the three ASCII characters “FMR” followed by a zero byte as a NULL string terminator.

7.3.2 Version Number

The version number for the version of this standard used in constructing the minutiae record shall be placed in four bytes. This version number shall consist of three ASCII numerals followed by a zero byte as a NULL string terminator. The first and second character will represent the major revision number and the third character will represent the minor revision number.

The version number is “ 20” (an ASCII space followed by an ASCII ‘2’ and an ASCII ‘0’).

7.3.3 Length of Record

The length of the entire record shall be recorded in four bytes.

7.3.4 Capture Equipment Certifications

This field contains four bits used to indicate that the capture equipment used to capture the original fingerprint image was compliant with a standard certification method for such equipment. Currently, only two bits are defined. If the most significant bit is ‘1’, the original capture equipment was certified to be compliant with the specifications in Annex B, copied from the US Federal Bureau of Investigation’s Image Quality Specifications, Appendix F. The least significant of the four bits is reserved for a future ISO finger image capture equipment certification. The two additional bits are reserved for future image quality certifications.

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7.3.5 Capture Device Type ID

The capture device type ID shall be recorded in twelve bits. This ID is used to identify the type or model of capture device used to acquire the original biometric sample. A value of all zeros will be acceptable and will indicate that the capture device type ID is unreported. The vendor determines the value for this field, if not regulated otherwise in an application context. Applications developers and users may obtain the values for these codes, as well as the model(s) corresponding to a particular ID, from the vendor. Reporting the capture device type ID is optional but recommended. The value "unreported" may not be allowable in some applications.

7.3.6 Size of Scanned Image in X direction

The size of the original image in pixels in the X direction shall be contained in two bytes.

7.3.7 Size of Scanned Image in Y direction

The size of the original image in pixels in the Y direction shall be contained in two bytes.

7.3.8 X (horizontal) resolution

The resolution of the minutiae coordinate system shall be recorded in two bytes having the units of pixels per centimeter. The value of the X resolution shall not be less than 98.45 pixels per centimeter (250 pixels per inch).

7.3.9 Y (vertical) resolution

The resolution of the minutiae coordinate system shall be recorded in two bytes having the units of pixels per centimeter. The value of the Y resolution shall not be less than 98.45 pixels per centimeter (250 pixels per inch).

7.3.10 Number Of Finger Views

The total number of finger views contained in the minutiae record shall be recorded in one byte. In cases where there is more than one view of any finger, this number will be greater than the number of fingers.

7.3.11 Reserved Byte

This field is reserved for future use, and to align the end of the record header on a long-word (four byte) boundary. For the current version of the standard, this field shall be set to zero.

7.4 Single Finger Record Format

7.4.1 Finger Header

A finger header shall start each section of finger data providing information for that finger. There shall be one finger header for each finger contained in the finger minutiae record. The finger header will occupy a total of four bytes as described below. Note that it is permissible for more than one finger record to represent the same finger, with (presumably) different data, perhaps in the private area.

7.4.1.1 Finger Position

The finger position shall be recorded in one byte. The codes for this byte shall be as defined in Table 2 (imported from ANSI/NIST-ITL 1-2000, see Bibliography).

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Table 2 - Finger Position Codes

Finger position	Code
Unknown finger	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

7.4.1.2 View Number

The view number shall be recorded in four bits. If more than one finger minutiae record in a general record is from the same finger, each minutiae record shall have a unique view number. The combination of finger location and view number shall uniquely identify a particular minutiae record within a general record. Multiple finger minutiae records from the same finger shall be numbered with increasing view numbers, beginning with zero. Where only one finger minutiae record is taken from each finger, this field shall be set to 0.

7.4.1.3 Impression Type

The impression type of the finger images that the minutiae data was derived from shall be recorded in four bits. The codes for this byte are shown in Table 3. These codes are compatible with Table 4 of ANSI/NIST-ITL 1-2000, “Data Format for the Interchange of Fingerprint Information”, with the addition of the “swipe” type. The “swipe” type identifies data records derived from image streams generated by sliding the finger across a small sensor. Only codes 0 through 3 and 8 shall be used; the “latent” codes are not relevant for this standard.

Table 3 - Impression Type Codes

Description	Code
Live-scan plain	0
Live-scan rolled	1
Nonlive-scan plain	2
Nonlive-scan rolled	3
Latent impression	*4*
Latent tracing	*5*
Latent photo	*6*
Latent lift	*7*
Swipe	8

7.4.1.4 Finger Quality

The quality of the overall finger minutiae data shall be between 0 and 100 and recorded in one byte. This quality number is an overall expression of the quality of the finger record, and represents quality of the original image, of the minutia extraction and any additional operations that may affect the minutiae record. A value of 0 shall represent the lowest possible quality and the value 100 shall represent the higher possible quality. The numeric values in this field will be set in accordance with the general guidelines contained in 2.1.42 of ISO/IEC 19784-1:—[2)], *Information technology — Biometric application programme interface — BioAPI specification*. The matcher may use this value to determine its certainty of verification.

2) To be published.

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7.4.1.5 Number of Minutiae

The number of minutiae recorded for the finger shall be recorded in one byte.

7.4.2 Finger Minutiae Data

The finger minutiae data for a single finger shall be recorded in blocks of six bytes per minutia. The order of the minutiae is not specified.

7.4.2.1 Minutia Type

The type of minutia will be recorded in the first two bits of the upper byte of the X coordinate. There will be two bits reserved at the beginning of the upper byte of the Y coordinate for future use. The bits “00” will represent a minutia of “other” type, “01” will represent a ridge ending and “10” will represent a ridge bifurcation.

7.4.2.2 Minutia Position

The X coordinate of the minutia shall be recorded in the rest of the first two bytes (fourteen bits). The Y coordinate shall be placed in the lower fourteen bits of the following two bytes. The coordinates shall be expressed in pixels at the resolution indicated in the record header. Note that position information shall be present for each minutia, regardless of type, although position for minutiae of type “other” is vendor defined.

7.4.2.3 Minutia Angle

The angle of the minutia shall be recorded in one byte in units of 1.40625 (360/256) degrees. The value shall be a non-negative value between 0 and 255, inclusive. For example, an angle value of 16 represents 22.5 degrees. Note that angle information shall be present for each minutia, regardless of type, although angle for minutiae of type “other” is vendor defined.

7.4.2.4 Minutia Quality

The quality of each minutia shall be recorded in one byte. The quality figure shall range from 100 as a maximum to 1 as a minimum. In interoperable use, only the relative values of minutia quality values is meaningful; there is no guaranteed relationship between minutiae quality values assigned by different equipment suppliers. Any equipment that does not supply quality information for individual minutia shall set all quality values to 0.

7.5 Extended Data

The extended data section of the finger minutiae record is open to placing additional data that may be used by the matching equipment. The size of this section shall be kept as small as possible, augmenting the data stored in the standard minutiae section. The extended data for each finger view shall immediately follow the standard minutiae data for that finger view and shall begin with the Extended Data Block Length field. More than one extended data area may be present for each finger and the extended data block length field will be the summation of the lengths of each extended data segment. The data block length is used as a signal for the existence of the extended data while the individual extended data length fields are used as indices to parse the extended data. Note that the extended data area cannot be used alone, without the standard portion of the minutiae record.

While the extended data area allows for inclusion of proprietary data within the minutiae format, this is not intended to allow for alternate representations of data that can be represented in open manner as defined in this standard. In particular, ridge count data, core and delta data or zonal quality information shall not be represented in proprietary manner to the exclusion of the publicly defined formats in this standard. Additional ridge count, core and delta or zonal quality information may be placed in a proprietary extended data area if the standard fields defined below are also populated. The intention of this standard is to provide inter-operability.

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