American National Standard

for Information Systems –

Data Format for the Interchange of Fingerprint Information

ANSI/NIST-CSL 1-1993

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American National Standard
for Information Systems –

Data Format for the Interchange of Fingerprint Information

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American National Standard

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Contents

Tables

Figures

Annexes

Foreword (This foreword is not part of American National Standard ANSI/NIST-CSL 1-1993.)

Federal, state, and local law enforcement and related criminal justice agencies have procured or are in the process of procuring Automated Fingerprint Identification Systems (AFISs), live-scan fingerprint readers, and/or Image Storage and Retrieval (ISR) systems intended to facilitate the determination of the personal identity of a subject.

AFISs scan and store digital representations of fingerprint images from inked fingerprint cards. Live-scan readers scan the fingerprint image data directly from the subject's fingers. The scanned images are then processed to extract specific types of features from the images. Features from the scanned images are then compared against a masterfile containing features extracted from previously scanned images. The result of these comparisons is a list of potential candidate identifications. The actual identification is then made by a human examiner using images retrieved from the system or fingerprint cards.

To exchange fingerprint identification data effectively across jurisdictional lines or between dissimilar systems made by different manufacturers, a standard is needed to specify a common format for the data exchange. The data may be scanned images or the processed minutiae extracted by the system.

The Computer Systems Laboratory (CSL) of the National Institute of Standards and Technology (NIST) sponsored the development of this standard using the Canvass Method to demonstrate evidence of consensus.

This standard contains three annexes. Annex A is normative and is considered part of the standard; Annexes B and C are informative and are not considered part of the standard.

Suggestions for the improvement of this standard will be welcome. They should be sent to the attention of Fingerprint Standards, Data Storage Group, NIST, Building 225, Room A61, Gaithersburg, MD 20899.

The following organizations recognized as having an interest in the standardization of the data format for the interchange of fingerprint information were contacted prior to the approval of this revision of the standard. Inclusion in this list does not necessarily imply that the organization concurred with the submittal of the proposed standard to ANSI.

Abilene Police Department
AFR Consortium
AIMS, Inc.
Ann Arbor Police Department
Arizona Department of Public Safety
Aware, Inc.
Banner, Conrad S. (Consultant)
Bureau of Alcohol, Tobacco and Firearms
CAI/SISCO
California Department of Motor Vehicles
California State Department of Justice
Calspan Corporation
Charleston Police Department
Chicago Police Department
Cincinnati Regional Crime Information Center
City of Austin (TX) Police Department
Colorado Bureau of Investigation
Comnetix Computer Systems, Inc.
Concepts, Models, & Solutions
Connecticut State Police
Dallas Police Department
Defense Investigative Service
Delaware State Police
DERMALOG AFIS GMBH
Detroit Police Identification Section
Digital Biometrics, Inc.
Drug Enforcement Administration
EKTRON Applied Imaging
Federal Bureau of Investigation
Federal Bureau of Prisons
Fingermatrix, Inc.
Florida Department of Law Enforcement
Georgia Bureau of Investigation – AFIS Operations
Glendale Police Department
Grumman Data Systems
GTE Feceral Systems Division

Houston Police Department
Hughes Information Technology Company
IBM Federal Sector Division
Identicator Corporation
IDENTIX, Inc.
Illinois State Police
Immigration & Naturalization Service
Inset Systems, Inc.
Internal Revenue Service
International Association for Identification
Indianapolis Police Department
Kentucky State Police
King County (Washington) Police
Lakewood Colorado Police Department
Logicon
Los Angeles County Sheriff's Department
Los Angeles Police Department
Manchester Missouri Police Department
Martin Marietta Energy Systems
Maryland State Police Crime Laboratory
Metro Toronto Police
Miami Valley Regional Crime Laboratory
Michigan State Police
Minnesota Department of Public Safety
Missouri State Highway Patrol
MITRE Corporation
Moore Associates
National Conference of Appellate Court Clerks
NEC Technologies, Inc.
New Jersey State Police
New York State Division of Criminal Justice Services
North American MORPHO Systems, Inc.
North Carolina State Bureau of Investigation
Northover, Kevin (Consultant)
NOVARIS – Northern VA Regional Identification System
Optivision, Inc.
Peel Regional Police
Pennsylvania State Police
Pinellas County Sheriff's Office
PRC, Inc
Printrak International, Inc.
Productivity, Inc.
RDC Consulting
Riverside Sheriff's Department
Robert Stock Associates
Royal Canadian Mounted Police
Royal Oman Police
SAIC – Science Applications International Corporation
SEARCH Group, Inc.
Shelburne Police Department
Siemens Nixdorf Information Systems, Inc.
Soft Information, Inc.
St. Louis Regional Justice Information Service
State of Alaska
Sunnyvale Department of Public Safety
Tacoma Police Department
TASC
Texas Department of Public Safety
TRW Systems Integration Group
U.K. Home Office
U.S. Postal Inspection Service
Virginia State Police
Washington State Patrol
Western Identification Network
XImage Corporation

American National Standard
for Information Systems –

Data Format for the Interchange of Fingerprint Information

1 Scope, purpose, and application

1.1 Scope

This standard defines the content, format, and units of measurement for the exchange of information that may be used in the fingerprint identification of a subject. The information consists of a variety of mandatory and optional items, including related record data, digitized fingerprint information, and compressed or uncompressed images. This information is intended for interchange between criminal justice administrations or organizations that use automated fingerprint identification systems.

This standard does not define the characteristics of the software that shall be required to format the textual information or to compress and assemble the associated digital fingerprint image information. Typical applications for this software might include, but are not limited to, computer systems associated with a live-scan fingerprinting system, a workstation that is part of an Automated Fingerprint Identification System (AFIS), or an Image Storage and Retrieval system.

1.2 Purpose

Information compiled and formatted in accordance with this standard can be recorded on machine-readable media and may be transmitted over data communications facilities in lieu of a fingerprint card or a latent fingerprint. Law enforcement and criminal justice agencies may use it to exchange fingerprint images and related identification data.

1.3 Application

Systems claiming conformance with this standard shall be capable of transmitting and receiving Type-1 records and shall specify which other record types are implemented for transmitting, or receiving, or both. Record types not implemented shall be ignored.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this American National Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this American National Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

ANSI X3.4-1986(R1992), *Information systems – Coded character sets – 7-Bit American National Standard Code for Information Interchange (7-bit ASCII)*

ANSI X3.172-1990, *Information systems – Dictionary for information systems*

ANSI/EIA 538-1988, *Facsimile coding schemes and coding control functions for group 4 facsimile equipment*

ANSI/IAI 2-1988, *Forensic identification – Automated fingerprint identification systems – Glossary of terms and acronyms*

ISO 646-1983, *7-bit coded character set for information interchange*[1)]

[1)] Available from the American National Standards Institute, 11 West 42nd Street, New York, NY 10036.

ISO 8601-1988, *Data elements and interchange formats – Information interchange – Representation of dates and times*[1)]

National Crime Information Center (NCIC) Code Manual[2)]

3 Definitions

The following definitions and those given in ANSI/IAI 2 apply to this standard.

3.1 ANSI: Abbreviation for the American National Standards Institute, Inc.

3.2 logical record: A record independent of its physical environment; portions of one logical record may be located in different physical records, or several logical records or parts of logical records may be located in one physical record.

3.3 native scanning resolution: The nominal scanning resolution used by a specific AFIS, live-scan reader, or other image capture device and supported by the originator of the transmission.

3.4 p/in: Abbreviation for pixels per inch.

3.5 p/mm: Abbreviation for pixels per millimeter.

3.6 scanning resolution: The number of pixels per unit distance at which an image is captured (p/mm or p/in).

3.7 transaction: A command, message, or input record that explicitly or implicitly calls for a processing action.

3.8 transmitting resolution: The nominal number of pixels per unit distance (p/mm or p/in) of the transmitted image. The transmitting resolution may be the same as the scanning resolution for a particular image. On the other hand, the transmitting resolution may be less than the scanning resolution if the scanned image was subsampled, scaled, or interpolated before transmission.

4 Transmitted data conventions

4.1 Byte and bit ordering

Each information item, subfield, field, and logical record will contain one or more bytes of data. Within a file, the order for transmission of both the ASCII and the binary representations of bytes shall be 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. Figure 1 illustrates the order of transmission of the bytes and bits within a file.

4.2 Grayscale data

Grayscale image data may be transmitted in either compressed or uncompressed form.

The transmission of uncompressed grayscale images shall consist of pixels each of which shall be quantized to eight bits (256 gray levels) and shall be contained in a single byte. Each grayscale value shall be expressed as an unsigned byte. A value of *0* shall be used to define a black pixel and a value of 255 shall be used to define a white pixel.

The transmission of compressed grayscale images shall be the output of the appropriate grayscale compression algorithm specified. Upon decompression each pixel shall be considered as an unsigned eight-bit grayscale value. A black pixel shall have a value of zero and a white pixel a value of 255.

4.3 Binary data

Binary image data may be transmitted in either compressed or uncompressed form.

The transmission of uncompressed binary images shall consist of pixels, each of which shall be quantized to two levels (binary representation). A value of *0* shall be used to represent a white pixel and a value of *1* shall be used to represent a black pixel. For transmission of uncompressed binary images, eight pixels shall be left-justified and packed into a single unsigned byte. The most significant bit of the byte shall be the first of the eight pixels scanned.

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2) Available from the U.S. Department of Justice, Federal Bureau of Investigation, 10th Street and Pennsylvania Avenue, NW, Washington, DC 20535.

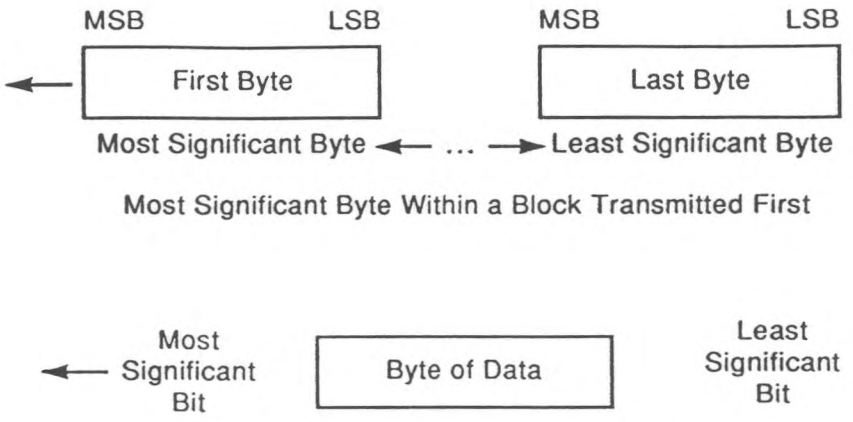

Figure 1 – Byte and bit ordering

The transmission of compressed binary images shall be the output of the binary compression algorithm specified by ANSI/EIA 538. Upon decompression, each pixel with a value of *0* shall be considered to be white and each pixel with a value of one shall be considered to be black.

4.4 Scan sequence

For each binary or grayscale image scanned and formatted, the transmitted scan sequence shall be assumed to have been left to right and top to bottom.

5 Image resolution requirements

5.1 Scanner resolution requirement

Binary and grayscale fingerprint images to be exchanged shall be captured by an AFIS, livescan reader, or other image capture device operating at a specific nominal scanning resolution. The minimum scanning resolution for this capture process shall be 19.69 p/mm ± 0.20 p/mm (500 p/in ± 5 p/in). Although a minimum scanning resolution is specified, a maximum value for scanning resolution is not specified by this standard. Scanning resolutions greater than this minimum value and with a tolerance of ±1% may be used.

5.2 Transmitting resolution requirement

Each image to be exchanged shall have a specific resolution associated with the transmitted data. This transmitting resolution does not have to be the same as the scanning resolution. However, the transmitting resolution shall be within the range of permissible values for the high-resolution or the low-resolution images. When an image is captured at a scanning resolution greater than the permissible upper limit of the transmitting resolution for that record type, the image shall be subsampled, scaled, or interpolated downward. This processing to produce a resultant resolution within the limits of the permissible transmitting resolutions for that record type shall be accomplished before transmission occurs.

For high-resolution binary and grayscale images, the preferred transmitting resolution shall be the same as the minimum scanning resolution of 19.69 p/mm ± 0.20 p/mm (500 p/in ± 5 p/in). However, any transmitting resolution within the range from the minimum scanning resolution to a value of 20.47 p/mm ± 0.20 p/mm (520 p/in ± 5 p/in) is permitted.

For low-resolution binary and grayscale images, the preferred transmitting resolution shall be half of the minimum scanning resolution or 9.84 p/mm ± 0.10 p/mm (250 p/in ± 2.5 p/in). However, any transmitting resolution within the range from half of the minimum scanning resolution to a value of 10.24 p/mm ± 0.10 p/mm (260 p/in ± 2.5 p/in) is permitted.

NOTE – Although the value of the transmitting resolution for high-resolution fingerprint images may range from 19.69 to 20.47 p/mm, any value other than the preferred resolution may require

Table 1 – Logical record types

Logical record contents	Type identifier
Transaction information	1
Descriptive text (user-defined)	2
Fingerprint image data (low-resolution grayscale)	3
Fingerprint image data (high-resolution grayscale)	4
Fingerprint image data (low-resolution binary)	5
Fingerprint image data (high-resolution binary)	6
Image data (user-defined)	7
Signature image data	8
Minutiae data	9

special processing for the classification and matching tasks. Therefore, it is recommended that if the transmitting resolution is greater than 19.69 p/mm, prior approval be obtained from the recipient agency or organization before transmission of the image occurs. A similar situation exists when low-resolution images are transmitted using a transmitting resolution of greater than the preferred transmitting resolution of 9.84 p/mm.

6 File description

This standard defines the composition of a file to be transmitted to an agency. As specified in this standard, certain portions of the transmission shall be in accordance with definitions provided by the receiving agency. This file shall contain one or more logical records, each corresponding to one of the nine available types of logical records. Each logical record is intended to convey a specific type of related information pertinent to the transaction itself or to the subject of the transaction.

Three of the logical records are designed to exchange ASCII information, while the remaining six contain binary data. The nine different types of logical records together with the identifier for each type are listed in table 1, Logical record types.

6.1 File format

A file shall contain all of the logical records for a single subject. The data in Type-1, Type-2, and Type-9 records shall be recorded in variable-length fields using the 7-bit American National Standard Code for Information Interchange (ASCII) as described in ANSI X3.4 and annex A. For purposes of future compatibility, the eighth (leftmost) bit shall have a value of zero. Most of these variable-length fields have a specified upper limit on size. For each Type-1, Type-2, and Type-9 record that is formulated, the fields contained within that record shall be numerically ordered. The content and order of the fields in Type-3, Type-4, Type-5, Type-6, Type-7, and Type-8 records are specified by this standard. These data shall be encoded and recorded as binary numbers.

6.2 File contents

Files to be exchanged shall always contain a Type-1 logical record that shall always be the first logical record within the file. Depending on the usage, the number of fingerprints available for processing, and the options that are selected, one or more additional records shall be present in the file. Table 2, Number of logical record types per transaction, lists the range or the number of records that may be

Table 2 – Number of logical records per transaction

Type of logical record	Ten-print inquiry	Latent inquiry	File maint-enance	Image request	Search response	Image request response
1	1	1	1	1	1	1
2	1	0–1	0–1	1	1	1
3	0–14	0	0–14	0	0–14	0–14
4	0–14	0–10	0–14	0	0–14	0–14
5	0–14	0	0–14	0	0–14	0–14
6	0–14	0–10	0–14	0	0–14	0–14
7	0	0–*N*	0–*N*	0	0–*N*	0–*N*
8	0–2	0	0–2	0	0–2	0–2
9	0–10	0–10	0–10	0	0	0

present in a file. These record counts are shown by logical record types and by the processing functions used for search inquiries, file maintenance, image request, and image responses. The ranges listed specify the minimum and maximum number of logical records that may be contained in the file. The mandatory inclusion of a logical record is indicated by an entry of "1" in table 2. An entry of "0" indicates the exclusion of that logical record type. The appearance of "0–*N*" in table 2 indicates that there are no limits on the number of records of that logical record type that may be contained in the file.

6.3 Image designation character (IDC)

With the exception of the Type-1 logical record, each of the remaining logical records present in a file shall include a separate field to contain the Image Designation Character (IDC). This IDC shall be used to relate information items in the file contents field of the Type-1 record to each logical record, and to properly identify and link together logical records that pertain to the same image. The value of the IDC shall be a sequentially assigned positive integer starting from zero and incremented by one. If two or more logical records are present in a file that are different representations of the same image, each of those logical records shall contain the same IDC.

Although there is no upper limit on the number of logical records that may be contained in a file, a minimum of two, and generally no more than 18 will be transmitted. A ten-print search inquiry may consist of a Type-1 record, a Type-2 record, 14 high-resolution grayscale image records, and two Type-8 records. The IDC included in each image record shall relate to a single image on the ten-print card. The IDC shall range from "0" to "17," which would include an IDC code for the Type-2 record. Within the same file, it is also possible that the same image may be represented by multiple logical record types. For example, if core and delta location information for the rolled impressions is requested, the transmission may also need to accommodate ten Type-9 records within the same file. For each image representing the ten finger positions, the same IDC would be used in both the Type-4 and Type-9 records present for that image.

Furthermore, zero or more Type-7 records may also be present. Each Type-7 logical record representing a unique image shall have a unique IDC.

7 Record description

7.1 Logical record types

7.1.1 Type-1 transaction record

A Type-1 logical record is mandatory and shall be used with each transaction. The Type-1 record shall provide information describing type and use of transaction

involved, a listing of each logical record included in the file, the originator or source of the physical record, and other useful and required information items.

7.1.2 Type-2 user-defined text record

Type-2 logical records shall contain user-defined fields providing identification and descriptive information about the subject of the fingerprint information.

7.1.3 Type-3 low-resolution grayscale record

Type-3 logical records shall contain, and be used to exchange low-resolution grayscale fingerprint image data that was scanned at no less than the minimum scanning resolution and then subsampled, scaled, or interpolated. The resultant transmitting resolution shall be within the bounds of the permissible transmitting resolutions for low-resolution fingerprint images.

The low-resolution grayscale fingerprint image data contained in the Type-3 logical record may be in compressed form. There may be up to 14 of these Type-3 records in a file; ten rolled impressions of the individual fingers, two plain impressions of the thumbs and two plain impressions of the four simultaneously obtained remaining fingers of each hand.

7.1.4 Type-4 high-resolution grayscale record

Type-4 logical records shall contain, and be used to exchange high-resolution grayscale fingerprint image data that was scanned at no less than the minimum scanning resolution. If the scanning resolution is greater than the upper limit of the permissible transmitting resolution, the scanned data shall be subsampled, scaled, or interpolated. The resultant transmitting resolution shall be within the bounds of the permissible transmitting resolutions for high-resolution fingerprint images.

The high-resolution grayscale fingerprint image data contained in the Type-4 logical record may be in compressed form. There may be up to 14 of these Type-4 records in a file; ten rolled impressions of the individual fingers, two plain impressions of the thumbs and two plain impressions of the four simultaneously obtained remaining fingers of each hand.

7.1.5 Type-5 low-resolution binary record

Type-5 logical records shall contain, and be used to exchange low-resolution binary fingerprint image data that was scanned at no less than the minimum scanning resolution and then subsampled, scaled, or interpolated. The resultant transmitting resolution shall be within the bounds of the permissible transmitting resolutions for low-resolution fingerprint images.

The low-resolution binary fingerprint image data contained in the Type-5 logical record may be in compressed form. There may be up to 14 of these Type-5 records in a file; ten rolled impressions of the individual fingers, two plain impressions of the thumbs and two plain impressions of the four simultaneously obtained remaining fingers of each hand.

7.1.6 Type-6 high-resolution binary record

Type-6 logical records shall contain, and be used to exchange high-resolution binary fingerprint image data that was scanned at no less than the minimum scanning resolution. If the scanning resolution is greater than the upper limit of the permissible transmitting resolution, the scanned data shall be subsampled, scaled, or interpolated. The resultant transmitting resolution shall be within the bounds of the permissible transmitting resolutions for high-resolution fingerprint images.

The high-resolution binary fingerprint image data contained in the Type-6 logical record may be in compressed form. There may be up to 14 of these Type-6 records in a file; ten rolled impressions of the individual fingers, two plain impressions of the thumbs and two plain impressions of the four simultaneously obtained remaining fingers of each hand.

7.1.7 Type-7 user-defined image record

Type-7 logical records shall contain user-defined image data, pertaining to the subject, which is not elsewhere specified or described in this standard. The parameters and types of images to be exchanged are undefined by this standard and shall be agreed upon between the sender and recipient. This record type is included to handle miscellaneous images such as those pertaining to palms, wrists, toes, soles, etc.

7.1.8 Type-8 signature record

Type-8 logical records shall contain, and be used to exchange scanned high-resolution binary or vectorized signature image data. If scanned, the resolution of the image data shall be no less than the minimum scanning

Table 3 – Information separators

ASCII	Position	Description
FS	1/12	Separates logical records of a file
GS	1/13	Separates fields of a logical record
RS	1/14	Separates multiple data entries (subfields) of an information field
US	1/15	Separates individual information items of the field or subfield

resolution. If necessary, the scanned image data shall be subsampled, scaled, or interpolated to fall within the limits of the transmitting resolution requirement. The resultant transmitting resolution shall be within the bounds of the permissible transmitting resolutions for the high-resolution fingerprint images. Vectorized signature data shall be expressed as a series of binary numbers.

There may be up to two of these Type-8 signature records in a file. Each Type-8 record shall contain image data representing the signature of the person being fingerprinted or of the official taking the fingerprints.

7.1.9 Type-9 minutiae record

Type-9 logical records shall contain, and be used to exchange geometric and topological minutiae-based fingerprint and related information about a single finger. Each record shall represent the processed image data from which the location and orientation descriptors of extracted minutiae characteristics are listed. There may be from zero to ten Type-9 records in the logical file. Each of these Type-9 logical records shall contain the minutiae data read from a single fingerprint.

7.2 Record format

For each type of logical record, several information fields shall be present. Data entries within information fields may be further subdivided into information items that are used to convey different aspects of the data contained in that field.

7.2.1 Information separators

In the Type-1, Type-2, and Type-9 records, mechanisms for delimiting information items within a field, fields within a logical record, and multiple occurrences of certain of these data and logical records shall be implemented by use of the four ASCII information separators. These information separators are defined in ANSI X3.4, and are described in the code table in annex A. These characters are used to separate and qualify information in a logical sense. Viewed in a hierarchical relationship, the File Separator (FS) is the most inclusive and it is used to separate logical records. This is followed by the Group Separator (GS), the Record Separator (RS), and finally the Unit Separator (US).

Table 3 lists these ASCII separators, the column/row position in the ASCII table shown in annex A, and a description of their use within this standard. These separators shall be in addition to any other symbols, punctuation, or delimiters as specified in this standard.

The four characters shall be used only as separators of data items, and only one of them may be used between any two data items. A US character cannot immediately precede an RS character; an RS cannot immediately precede a GS; and a GS cannot immediately precede an FS character. Annexes B (Use of information separator characters) and C (An example of the use of the standard) illustrate the use of these information separator characters.

7.2.2 Record layout

For Type-1, Type-2, and Type-9 records, each information field that is used shall be numbered in accordance with this standard. The format of each field shall consist of a field number followed by a colon (:), followed by the information item(s) appropriate to that field. For Type-1 and Type-9 logical records,

field numbers have the format T.xx, where "T" is the logical record type (chosen from table 1) and "xx" is a sequentially assigned field number within that record type. For the Type-2 logical record, field numbers have the format T.xxx, where "T" is the logical record type (chosen from table 1) and "xxx" is a sequentially assigned field number within that record type. Subfields within a field shall be separated by the RS character. Individual information items within a field or subfield shall be separated by the US character. In addition to the identifying number, information fields shall be separated from other information fields by the ASCII control character, Group Separator, GS. Where the information for any nonmandatory field is unavailable, that field shall be omitted.

Type-3, Type-4, Type-5, Type-6, Type-7, and Type-8 records shall be recorded as ordered binary fields. The length of the entire record shall be specified by the record length field contained in the record itself.

In contrast to the Type-1, Type-2, and Type-9 records, neither the field identifier number, nor its following colon, shall be used in Type-3 through Type-8 logical records. Furthermore, as all the field lengths of these six records are either fixed or specified, none of the four separator characters (US, RS, GS, or FS) shall be interpreted in any Type-3, Type-4, Type-5, Type-6, Type-7, or Type-8 record.

8 Type-1 transaction record

8.1 Fields for Type-1 transaction record

The following paragraphs describe the data contained in fields for the Type-1 logical record. Each field shall begin with the number of the record type followed by a period followed by the appropriate field number followed by a colon. Annex C contains an example of the use of the standard, which illustrates the layout for a Type-1 logical record.

8.1.1 Field 1.01: Logical Record Length (LEN)

This mandatory ASCII field shall contain the total count of the number of bytes in this Type-1 logical record. Field 1.01 shall begin with "1.01:", followed by the length of the record including every character of every field contained in the record and the information separators. The GS character shall separate the length code of Field 1.01 from the next field.

NOTE – Although it may not always be explicitly repeated in the remainder of this standard, use of separators within Type-1, Type-2, and Type-9 records shall always be observed. Multiple information items within a field or subfield shall be separated by the US separator, multiple subfields shall be separated by the RS separator, and information fields shall be separated by the GS separator.

8.1.2 Field 1.02: Version Number (VER)

This mandatory four-byte ASCII field shall be used to specify the version number of the standard implemented by the software or system creating the file. The format of this field shall consist of four numeric characters. The first two characters shall specify the major version number. The last two characters shall be used to specify the minor revision number. The initial revision number for a version shall be "00". The entry in this field for this 1993 approved standard shall be "0200". The original 1986 standard would be considered the first version or "0100".

8.1.3 Field 1.03: File Content (CNT)

This mandatory field shall list each of the logical records in the logical file by record type. It also specifies the order in which the remaining logical records shall appear in the logical file. It shall consist of one or more subfields. Each subfield shall contain two information items describing a single logical record found in the current logical file. The subfields shall be entered in the same order in which the logical records shall be transmitted. When more than one subfield is used, the RS separator character shall be entered between the subfields.

The first subfield shall relate to this Type-1 transaction record. The first information item within this subfield shall be the single character indicating that this is a Type-1 record consisting of header information (the numeral "1" selected from table 1).

The second information item of this subfield shall be the sum of the Type-2 plus Type-3 plus Type-4 plus Type-5 plus Type-6 plus Type-7 plus Type-8 plus Type-9 records contained in this logical file. This number is also equal to the count of the remaining subfields of Field 1.03. The US separator character shall be entered between the first and second information items.

The remaining subfields of Field 1.03 pertaining to Type-2, Type-3, Type-4, Type-5, Type-6, Type-7, Type-8, and Type-9 records contained in the file shall each be comprised of two information items. The first information item shall be a single character chosen from table 1, which states the record type. The second information item shall be the IDC associated with the logical record pertaining to that subfield. The IDC shall be a positive integer equal to or greater than zero. The US character shall be used to separate the two information items.

8.1.4 Field 1.04: Type of Transaction (TOT)

This mandatory field shall contain an identifier, designating the type of transaction and subsequent processing that this logical file should be given.

NOTE – Type of Transaction shall be in accordance with definitions provided by the receiving agency.

The last character of this field shall be a GS separator character used to separate Field 1.04 from the next field.

8.1.5 Field 1.05: Date (DAT)

This mandatory field shall contain the date that the transaction was initiated. The date shall appear as eight digits in the format CCYYMMDD. The CCYY characters shall represent the year of the transaction; the MM characters shall be the tens and units values of the month; and the DD characters shall be the day in the month. For example, 19920601 represents June 1, 1992. The complete date shall not exceed the current date.

8.1.6 Field 1.06: Priority (PRY)

When this field is used, it shall contain a single information character to designate the urgency with which a response is desired. The values shall range from 1 to 4, with "1" denoting the highest priority. The default value shall be "4" if no value is indicated.

8.1.7 Field 1.07: Destination Agency Identifier (DAI)

This mandatory field shall contain the identifier of the administration or organization designated to receive the transmission. The size and data content of this field shall be defined by the user and be in accordance with the receiving agency.

8.1.8 Field 1.08: Originating Agency Identifier (ORI)

This mandatory field shall contain the identifier of the administration or organization originating the transaction. The size and data content of this field shall be defined by the user and be in accordance with the receiving agency.

8.1.9 Field 1.09: Transaction Control Number (TCN)

This mandatory field shall contain the Transaction Control Number as assigned by the originating agency. A unique control number shall be assigned to each transaction. For any transaction that requires a response, the respondent shall refer to this number in communicating with the originating agency.

8.1.10 Field 1.10: Transaction Control Reference (TCR)

This field shall be used in responses to refer to the Transaction Control Number of a previous transaction involving an inquiry or other action that required a response.

8.1.11 Field 1.11: Native Scanning Resolution (NSR)

This mandatory field shall specify the nominal scanning resolution of the AFIS or other image capture device supported by the originator of the transmission. This field permits the recipient of this transaction to send response data at a transmitting resolution tailored to the NSR (if it is able to do so) or to the minimum scanning resolution. This field shall contain five bytes specifying the native scanning resolution in pixels per millimeter. The resolution shall be expressed as two numeric characters followed by a decimal point and two more numeric characters (e.g., 20.00). This field is needed because the interchange of fingerprint information between systems of the same manufacturer may, in some instances, be more efficiently done at a transmitting resolution equal to the native scanning resolution of the system rather than at the minimum scanning resolution specified in this standard.

8.1.12 Field 1.12: Nominal Transmitting Resolution (NTR)

This mandatory field shall specify the nominal transmitting resolution for the image or images being transmitted. This field shall contain five bytes specifying the transmitting resolution in pixels per millimeter. The resolution shall be expressed as two numeric characters followed by a decimal point and two more numeric characters (e.g., 20.00). The transmitting resolution shall be within the range specified by the transmitting resolution requirement.

8.2 End of Type-1 logical record

Immediately following the last information field in the Type-1 logical record, an FS separator character shall be used to separate it from the next logical record. This FS character shall replace the GS character that is normally used between information fields.

9 Type-2 user-defined text record

Type-2 logical records shall contain textual information relating to the subject of the transaction and shall be represented in an ASCII format.

9.1 Fields for Type-2 logical records

The first two data fields of the Type-2 record are defined by this standard. Remaining fields of the record shall conform to the requirements set forth by the agency to whom the transmission is being sent.

9.1.1 Field 2.001: Logical Record Length (LEN)

This mandatory ASCII field shall contain the length of the logical record specifying the total number of bytes, including every character of every field contained in the record.

9.1.2 Field 2.002: Image Designation Character (IDC)

This mandatory field shall be used to identify the user-defined text information contained in this record. The IDC contained in this field shall be the IDC of the Type-2 logical record as found in the file content field of the Type-1 record.

9.1.3 Fields 2.003–2.999: User-Defined Fields for Type-2 Logical Record

Individual fields required for given transaction types, including field size and content, shall conform to the specifications set forth by the agency to whom the transmission is being sent.

9.2 End of Type-2 logical record

Immediately following the last information field in the Type-2 logical record, an FS separator shall be used to separate it from the next logical record. This FS character shall replace the GS character that is normally used between information fields.

10 Type-3 low-resolution grayscale image record

Type-3 logical records shall contain low-resolution grayscale fingerprint image data. The fingerprint image data shall have been scanned at no less than the minimum scanning resolution and then subsampled, scaled, or interpolated. Alternatively, provided that it is no less than the minimum scanning resolution, the native sampling resolution may be used and the image processed such that the resulting transmitting resolution is within the range specified by the transmitting resolution requirement for low-resolution images. When the image data is obtained from a live-scan reader, it shall be the grayscale subsampled, scaled, or interpolated output of the live-scan fingerprint scanner and not a rescan of a hard copy fingerprint image.

10.1 Fields for Type-3 logical record

When there are one or more Type-3 logical records, entries shall be provided in nine ordered and unnumbered fields. The first eight fields are fixed length and total 18 bytes. These fields precede the image data contained in field 9. The size of field 9 is 18 bytes less than the value specified in the LEN field.

10.1.1 Logical Record Length (LEN)

This mandatory four-byte binary field shall occupy bytes one through four. It shall contain the length of the logical record specifying the total number of bytes, including every byte of all nine fields contained in the record.

10.1.2 Image Designation Character (IDC)

This mandatory one-byte binary field shall occupy the fifth byte of a Type-3 record. It shall be used to identify the image data contained in this record. The IDC contained in this field shall be a binary representation of the IDC found in the file content field of the Type-1 record.

10.1.3 Impression Type (IMP)

This mandatory one-byte binary field shall occupy the sixth byte of a Type-3 record. The code selected from table 4, describing the manner by which the fingerprint image information was obtained, shall be entered in this field.

10.1.4 Finger Position (FGP)

This mandatory fixed-length field of 6 binary bytes shall occupy the 7th through 12th byte positions of a Type-3 record. It shall contain possible finger positions beginning in the leftmost byte of the field (byte seven of the record). The decimal code number corresponding to the known or most probable finger position shall be taken from table 5 and entered as a binary number right justified and left zero filled within the eight-bit byte. Table 5 also lists the maximum image area that can be transmitted for each of the 14 possible finger positions. Up to five additional finger positions may be referenced by entering the alternate finger positions in the remaining five bytes using the same format.

If fewer than five finger position references are to be used, the unused bytes shall be filled with the binary equivalent of "255". The code "0" (for "Unknown Finger") shall be used to reference every finger position from one through ten.

10.1.5 Image Scanning Resolution (ISR)

This mandatory one-byte binary field shall occupy the 13th byte of a Type-3 record. It shall contain a binary value of *0* if half the minimum scanning resolution is used and *1* if half the native scanning resolution is used.

10.1.6 Horizontal Line Length (HLL)

This mandatory two-byte binary field shall occupy the 14th and 15th bytes of the Type-3 record. It shall be used to specify the number of pixels contained on a single horizontal line of the transmitted image.

Table 4 – Impression type

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

Table 5 – Finger position code and maximum size

Finger position	Code	Maximum image area mm^2
Unknown finger	0	1845
Right thumb	1	1845
Right index finger	2	1640
Right middle finger	3	1640
Right ring finger	4	1640
Right little finger	5	1640
Left thumb	6	1845
Left index finger	7	1640
Left middle finger	8	1640
Left ring finger	9	1640
Left little finger	10	1640
Plain right thumb	11	2400
Plain left thumb	12	2400
Plain right four fingers	13	6800
Plain left four fingers	14	6800

10.1.7 Vertical Line Length (VLL)

This mandatory two-byte binary field shall occupy the 16th and 17th bytes of the Type-3 record. It shall be used to specify the number of horizontal lines contained in the transmitted image.

10.1.8 Grayscale Compression Algorithm (GCA)

This mandatory one-byte binary field shall occupy the 18th byte of a Type-3 record. It shall be used to specify the type of grayscale

compression algorithm used (if any). A binary zero denotes no compression. Otherwise, the contents of this byte shall be a binary representation for the number allocated to the particular compression technique used by the interchange parties. The Federal Bureau of Investigation (FBI) will maintain a registry relating these numbers to the compression algorithms.

10.1.9 Image Data

This binary field shall contain all of the low-resolution grayscale image data. Each pixel of the uncompressed image shall be quantized to eight bits (256 gray levels) contained in a single byte. If compression is used, the pixel data shall be compressed in accordance with the compression technique specified in the GCA field. This completes the low-resolution image description for a single image.

10.2 End of Type-3 logical record

Since the Type-3 logical record is a defined and specified series of binary data fields, no additional bytes shall be transmitted to signify the end of this logical record type.

10.3 Additional low-resolution grayscale images

Up to 13 more images may be described within the logical file. For each additional image, a Type-3 logical record is required.

11 Type-4 high-resolution grayscale image record

Type-4 logical records shall contain high-resolution grayscale fingerprint image data that has been scanned at the minimum scanning resolution. Alternatively, the native scanning resolution may be used and the image processed such that the resulting transmitting resolution is within the range specified by the transmitting resolution requirement for high-resolution images. When the image data is obtained from a live-scan reader, it shall be the grayscale output of the live-scan fingerprint scanner and not a rescan of a hard-copy fingerprint image.

11.1 Fields for Type-4 logical record

When there are one or more Type-4 logical records, entries shall be provided in nine ordered and unnumbered fields. The first eight fields are fixed length and total 18 bytes. These fields precede the image data contained in field 9. The size of field 9 is 18 bytes less than the value specified in the LEN field.

11.1.1 Logical Record Length (LEN)

This mandatory four-byte binary field shall occupy bytes one through four. It shall contain the length of the logical record specifying the total number of bytes, including every byte of all nine fields contained in the record.

11.1.2 Image Designation Character (IDC)

This mandatory one-byte binary field shall occupy the fifth byte of a Type-4 record. It shall be used to identify the image data contained in this record. The IDC contained in this field shall be a binary representation of the IDC found in the file content field of the Type-1 record.

11.1.3 Impression Type (IMP)

This mandatory one-byte binary field shall occupy the sixth byte of a Type-4 record. The code selected from table 4, describing the manner by which the fingerprint image information was obtained, shall be entered in this field.

11.1.4 Finger Position (FGP)

This mandatory fixed-length field of six binary bytes shall occupy the 7th through 12th byte positions of a Type-4 record. It shall contain possible finger positions beginning in the leftmost byte of the field (byte seven of the record). The decimal code number for the known or most probable finger position shall be taken from table 5 and entered as a binary number right justified and left zero filled within the eight-bit byte. Up to five additional finger positions may be referenced by entering the alternate finger positions in the remaining five bytes using the same format. If fewer than five finger position references are to be used, the unused bytes shall be filled with the binary equivalent of "255". The code "0" (for "Unknown Finger") shall be used to reference every finger position from one through ten.

11.1.5 Image Scanning Resolution (ISR)

This mandatory one-byte binary field shall occupy the thirteenth byte of a Type-4 record. It shall contain a binary value of *0* if the mini-

mum scanning resolution is used and *1* if the native scanning resolution is used.

11.1.6 Horizontal Line Length (HLL)

This mandatory two-byte binary field shall occupy the 14th and 15th bytes of the Type-4 record. It shall be used to specify the number of pixels contained on a single horizontal line of the transmitted image.

11.1.7 V-ertical Line Length (VLL)

This mandatory two-byte binary field shall occupy the 16th and 17th bytes of the Type-4 record. It shall be used to specify the number of horizontal lines contained in the transmitted image.

11.1.8 Grayscale Compression Algorithm (GCA)

This mandatory one-byte binary field shall occupy the 18th byte of a Type-4 record. It shall be used to specify the type of grayscale compression algorithm used (if any). A binary *0* denotes no compression. Otherwise, the contents of this byte shall be a binary representation for the number allocated to the particular compression technique used by the interchange parties. The FBI will maintain a registry relating these numbers to the compression algorithms.

11.1.9 Image Data

This binary field shall contain all of the high-resolution grayscale image data. Each pixel of the uncompressed image shall be quantized to eight bits (256 gray levels) contained in a single byte. If compression is used, the pixel data shall be compressed in accordance with the compression technique specified in the GCA field. This completes the high-resolution image description for a single image.

11.2 End of Type-4 logical record

Since the Type-4 logical record is a defined and specified series of binary data fields, no additional bytes shall be transmitted to signify the end of this logical record type.

11.3 Additional high-resolution grayscale images

Up to 13 more images may be described within the logical file. For each additional image, a Type-4 logical record is required.

12 Type-5 low-resolution binary image record

Type-5 logical records shall contain low-resolution binary fingerprint image data. The fingerprint image data shall have been scanned at no less than the minimum scanning resolution and then subsampled, scaled, or interpolated. Alternatively, provided that it is no less than the minimum scanning resolution, the native scanning resolution may be used and the image processed such that the resulting transmitting resolution is within the range specified by the transmitting resolution requirement for low-resolution images. When the image data is obtained from a live-scan reader, it shall be the binarized, subsampled, scaled, or interpolated output of the live-scan fingerprint scanner and not a rescan of a hard-copy fingerprint image.

12.1 Fields for Type-5 logical record

When there are one or more Type-5 logical records, entries shall be provided in nine ordered and unnumbered fields. The first eight fields are fixed length and total 18 bytes. These fields precede the image data contained in field 9. The size of field 9 is 18 bytes less than the value specified in the LEN field.

12.1.1 Logical Record Length (LEN)

This mandatory four-byte binary field shall occupy bytes one through four. It shall contain the length of the logical record specifying the total number of bytes, including every byte of all nine fields contained in the record.

12.1.2 Image Designation Character (IDC)

This mandatory one-byte binary field shall occupy the fifth byte of a Type-5 record. It shall be used to identify the image data contained in this record. The IDC contained in this field shall be a binary representation of the IDC found in the file content field of the Type-1 record.

12.1.3 Impression Type (IMP)

This mandatory one-byte binary field shall occupy the sixth byte of a Type-5 record. The code selected from table 4, describing the manner by which the fingerprint image information was obtained, shall be entered in this field.

12.1.4 Finger Position (FGP)

This mandatory fixed-length field of 6 binary bytes shall occupy the 7th through 12th byte positions of a Type-5 record. It shall contain possible finger positions beginning in the left-most byte of the field (byte seven of the record). The decimal code number for the known or most probable finger position shall be taken from table 5 and entered as a binary number right justified and left zero filled within the eight-bit byte. Up to five additional finger positions may be referenced by entering the alternate finger positions in the remaining five bytes using the same format. If fewer than five finger position references are to be used, the unused bytes shall be filled with the binary equivalent of "255". The code "0" (for "Unknown Finger") shall be used to reference every finger position from one through ten.

12.1.5 Image Scanning Resolution (ISR)

This mandatory one-byte binary field shall occupy the 13th byte of a Type-5 record. It shall contain a binary value of *0* if half the minimum scanning resolution is used, and *1* if half the native scanning resolution is used.

12.1.6 Horizontal Line Length (HLL)

This mandatory two-byte binary field shall occupy the 14th and 15th bytes of the Type-5 record. It shall be used to specify the number of pixels contained on a single horizontal line of the transmitted image.

12.1.7 Vertical Line Length (VLL)

This mandatory two-byte binary field shall occupy the 16th and 17th bytes of the Type-5 record. It shall be used to specify the number of horizontal lines contained in the transmitted image.

12.1.8 Binary Compression Algorithm (BCA)

This mandatory one-byte binary field shall occupy the 18th byte of a Type-5 record. It shall be used to specify whether or not data compression is used. A binary *0* denotes no compression. A binary *1* denotes the use of the facsimile compression standard (ANSI/EIA 538) for the lossless compression and decompression of the image data.

12.1.9 Image Data

This field shall contain all of the low-resolution binary image data. Each pixel of the uncompressed image shall be quantized to two levels (binary representation). Uncompressed data shall be packed at 8 pixels per byte. If compression is used, the pixel data shall be compressed in accordance with the technique as specified in BCA field. This completes the low-resolution binary image description for a single image.

12.2 End of Type-5 logical record

Since the Type-5 logical record is a defined and specified series of binary data fields, no additional bytes shall be transmitted to signify the end of this logical record type.

12.3 Additional low-resolution binary images

Up to 13 more images may be described within the logical file. For each additional image, a Type-5 logical record is required.

13 Type-6 high-resolution binary image record

Type-6 logical records shall contain high-resolution binary fingerprint image data that has been scanned at the minimum scanning resolution. Alternatively, the native scanning resolution may be used and the image processed such that the resulting transmitting resolution is within the range specified by the transmitting resolution requirement for high-resolution images. When the image data is obtained from a live-scan reader, it shall be the binarized output of the live-scan fingerprint scanner and not a rescan of a hard-copy fingerprint image.

13.1 Fields for Type-6 logical record

When there are one or more Type-6 logical records, entries shall be provided in nine ordered and unnumbered fields. The first eight fields are fixed length and total 18 bytes. These fields precede the image data contained in field 9. The size of field 9 is 18 bytes less than the value specified in the LEN field.

13.1.1 Logical Record Length (LEN)

This mandatory four-byte binary field shall occupy bytes one through four. It shall contain the length of the logical record specifying the total number of bytes, including every byte of all nine fields contained in the record.

13.1.2 Image Designation Character (IDC)

This mandatory one-byte binary field shall occupy the fifth byte of a Type-6 record. It shall be used to identify the image data contained in this record. The IDC contained in this field shall be a binary representation of the IDC found in the file content field of the Type-1 record.

13.1.3 Impression Type (IMP)

This mandatory one-byte binary field shall occupy the sixth byte of a Type-6 record. The code selected from table 4, describing the manner by which the fingerprint image information was obtained, shall be entered in this field.

13.1.4 Finger Position (FGP)

This mandatory fixed-length field of six binary bytes shall occupy the 7th through 12th byte positions of a Type-6 record. It shall contain possible finger positions beginning in the leftmost byte of the field (byte seven of the record). The decimal code number for the known or most probable finger position shall be taken from table 5 and entered as a binary number right justified and left zero filled within the eight-bit byte. Up to five additional finger positions may be referenced by entering the alternate finger positions in the remaining five bytes using the same format. If fewer than five finger position references are to be used, the unused bytes shall be filled with the binary equivalent of "255". The code "0" (for "Unknown Finger") shall be used to reference every finger position from one through ten.

13.1.5 Image Scanning Resolution (ISR)

This mandatory one-byte binary field shall occupy the 13th byte of a Type-6 record. It shall contain a binary value of *0* if the minimum scanning resolution is used and *1* if the native scanning resolution is used.

13.1.6 Horizontal Line Length (HLL)

This mandatory two-byte binary field shall occupy the 14th and 15th bytes of the Type-6 record. It shall be used to specify the number of pixels contained on a single horizontal line of the transmitted image.

13.1.7 Vertical Line Length (VLL)

This mandatory two-byte binary field shall occupy the 16th and 17th bytes of the Type-6 record. It shall be used to specify the number of horizontal lines contained in the transmitted image.

13.1.8 Binary Compression Algorithm (BCA)

This mandatory one-byte binary field shall occupy the 18th byte of a Type-6 record. It shall be used to specify whether or not data compression is used. A binary *0* denotes no compression. A binary *1* denotes the use of the facsimile compression standard (ANSI/EIA 538) for the lossless compression and decompression of the image data.

13.1.9 Image Data

This field shall contain all of the high-resolution binary image data. Each pixel of the uncompressed image shall be quantized to two levels (binary representation). Uncompressed data shall be packed at eight pixels per byte. If compression is used, pixel data shall be compressed in accordance with the technique as specified in BCA field. This completes the high-resolution binary image description for a single image.

13.2 End of Type-6 logical record

Since the Type-6 logical record is a defined and specified series of binary data fields, no additional bytes shall be transmitted to signify the end of this logical record type.

13.3 Additional high-resolution binary images

Up to 13 more images may be described within the logical file. For each additional image, a Type-6 logical record is required.

14 Type-7 user-defined image record

Type-7 logical records shall contain user-defined image information relating to the subject of the transaction. This record type may be used to exchange image data that is not addressed elsewhere in this standard. Images pertaining to palms, wrists, toes, and soles

are examples of the usage for this record type. Scanned pixels may be either binary or grayscale output. Each grayscale pixel value shall be expressed as an unsigned byte. A value of *0* shall be used to define a black pixel and an unsigned value of 255 shall be used to define a white pixel. For binary pixels, a value of *0* shall represent a white pixel and a value of *1* shall represent a black pixel. If compression is used, the algorithm shall be the same as that specified for Type-3, Type-4, Type-5, and Type-6 logical records.

14.1 Fields for Type-7 logical record

The first two data fields of the Type-7 record are defined by this standard. Remaining fields of the record shall conform to the requirements set forth by the agency to whom the transmission is being sent.

The first two fields are fixed length and total five bytes. These fields shall precede one or more user-defined fields, including the image data, contained in the remainder of the record.

14.1.1 Logical Record Length (LEN)

This mandatory four-byte binary field shall occupy bytes one through four. It shall contain the length of the logical record specifying the total number of bytes, including every byte of all the fields contained in the record.

14.1.2 Image Designation Character (IDC)

This mandatory one-byte binary field shall occupy the fifth byte of a Type-7 record. It shall be used to identify the image data contained in this record. The IDC contained in this field shall be a binary representation of the IDC found in the file content field of the Type-1 record.

14.1.3 User-defined fields for Type-7 logical record

The remaining fields of the Type-7 logical record shall be user-defined. Individual fields required for a given transaction, such as field description, size, and content shall conform to the specifications set forth by the agency to whom the transmission is being sent.

14.2 End of Type-7 logical record

Since the Type-7 logical record is a defined and specified series of binary data fields, no additional bytes shall be transmitted to signify the end of this logical record type.

14.3 Additional user-defined image records

Additional images may be described within the logical file. For each additional image, a Type-7 logical record is required.

15 Type-8 signature image record

Type 8 logical records shall contain either scanned or vectorized signature data. Each Type-8 record shall cover an area of up to 1000 mm^2.

If scanned, the resolution shall be the minimum scanning resolution or the native sampling resolution, and the scan sequence shall be left to right and top to bottom. The scanned data shall be quantized to two levels (binary representation).

If vectorized signature data is present, it shall be expressed as a series of binary numbers.

15.1 Fields for Type-8 logical record

When there are one or two Type-8 logical records, entries shall be provided in seven ordered and unnumbered fields. The first six fields are fixed length and shall total 12 bytes. These fields shall precede the image data contained in field 7. The size of field 7 is determined from the LEN field of the record itself. The image data field is 12 bytes less than the value specified in the LEN field.

15.1.1 Logical Record Length (LEN)

This mandatory four-byte binary field shall occupy bytes one through four. It shall contain the length of the logical record expressed as the total number of bytes, including every byte of all seven fields contained in the record.

15.1.2 Image Designation Character (IDC)

This mandatory one-byte binary field shall occupy the fifth byte of the Type-8 record. It shall be used to identify the image data contained in the Type-8 record. The IDC contained in this field shall be a binary representation of the IDC found in the file content field of the Type-1 record.

15.1.3 Signature Type (SIG)

This mandatory one-byte binary field shall occupy the sixth byte of the Type-8 record. Its

value shall be '0000 0000' if the image is the subject's signature, or '0000 0001' if the image is the fingerprinting official's signature.

15.1.4 Signature Representation Type (SRT)

This mandatory one-byte binary field shall occupy the seventh byte of the Type-8 record. Its value shall be '0000 0000' if the image is scanned and not compressed, '0000 0001' if the image is scanned and compressed, and '0000 0010' if the image is vector data.

15.1.5 Image Scanning Resolution (ISR)

This mandatory one-byte binary field shall occupy the eighth byte of a Type-8 record. It shall contain a binary value of *0* if the minimum scanning resolution is used and *1* if the native scanning resolution is used. A value of *0* shall also be used if the image is vector data.

15.1.6 Horizontal Line Length (HLL)

This mandatory two-byte binary field shall occupy the ninth and tenth bytes of the Type-8 record. For scanned signature data, this field shall be used to specify the number of pixels contained on a single horizontal line of the transmitted signature image. For vectorized signature data, both bytes shall contain the value '0000 0000'.

15.1.7 Vertical Line Length (VLL)

This mandatory two-byte binary field shall occupy the 11th and 12th bytes of the Type-8 record. For scanned signature data, this field shall be used to specify the number of horizontal lines contained in the transmitted signature image. For vectorized signature data, both bytes shall contain the value '0000 0000'.

15.1.8 Signature Image Data

This field shall contain uncompressed scanned image signature data, compressed scanned image signature data, or vectorized image signature data. The entry contained in the SRT field shall indicate which form of the signature data is present.

15.1.8.1 Uncompressed Scanned Image Data

If the SRT field contains the value '0000 0000', then this field shall contain the uncompressed scanned image data for the signature. In uncompressed mode, the data shall be packed at eight pixels per byte.

15.1.8.2 Compressed Scanned Image Data

If the SRT field contains the value '0000 0001', then this field shall contain the scanned image data for the signature in compressed form using the facsimile compression algorithm described in ANSI/EIA 538.

15.1.8.3 Vectorized Image Data

If the SRT field contains the value '0000 0010', then this field shall contain a list of vectors describing the pen position and pen pressure of line segments within the signature. Each vector shall consist of five bytes.

The first two bytes of each vector shall contain the unsigned binary X coordinate of the pen position with the high order byte containing the most significant bits. The next two bytes shall contain the unsigned Y coordinate using the same convention to denote the most significant bits. Both the X and Y coordinates shall be expressed in units of 0.0254 mm (0.001 inches) referenced from the bottom leftmost corner of the signature. Positive values of X shall increase from left-to-right and positive values of Y shall increase from bottom-to-top.

An unsigned binary number between 0 and 255 contained in the fifth byte shall represent the pen pressure. This shall be a constant pressure until the next vector becomes active. A pressure of '0000 0000' shall represent a "pen-up" (or no pressure) condition. The binary value '0000 0001' shall represent the least recordable pressure for a particular device, while a value of '1111 1110' shall represent the maximum recordable pressure for that device. To denote the end of the vector list, a pressure value of '1111 1111' shall be inserted in this entry.

15.2 End of Type-8 logical record

Since the Type-8 logical record is a defined and specified series of binary data fields, no additional bytes shall be transmitted to signify the end of this logical record type.

15.3 Additional signature

One more signature may be described within the logical file. For this additional signature, a Type-8 logical record is required.

16 Type-9 minutiae record

Type-9 records shall contain minutiae data and related information about a single finger. There may be up to ten of these Type-9 records in a file, each of which shall be for a different finger.

16.1 Fingerprint information descriptors

16.1.1 Minutia type identification

This standard defines four identifier characters that are used to describe the type of any minutia. These are shown in table 6. A ridge ending shall be designated Type A. It occurs when a friction ridge begins or ends within the fingerprint and without splitting into two or more continuing ridges. The ridge must be longer than it is wide. A bifurcation shall be designated Type B. It occurs when a ridge divides or splits to form two ridges that continue past the point of division for a distance that is at least equal to the spacing between adjacent ridges at the point of bifurcation. A minutia shall be designated Type C, a compound type, when it is either a trifurcation (a single ridge that splits into three ridges) or a crossover (two ridges that intersect). When a minutia cannot be clearly categorized as one of the above three types, it shall be designated as undetermined, Type D.

Table 6 – Minutia types

Type	Description
A	Ridge ending
B	Bifurcation
C	Compound (trifurcation or crossover)
D	Type undetermined

16.1.2 Minutia numbering

Each minutia in the fingerprint shall be identified by assigning it an arbitrary index number. The numbering shall begin at one and be incremented by one for as many times as there are minutiae. This allows each minutia to be uniquely identified.

16.1.3 Minutia ridge counts

Ridge counts may be made from each minutia in a fingerprint to certain other minutiae. When this occurs, ridge counts between designated minutiae shall be associated with the applicable index numbers so as to ensure maintenance of the proper relationships.

16.1.4 Minutia coordinate system

The relative position of minutiae entered in Type-9 records shall be expressed as positive integers in units of 0.01 mm (0.000 39 in) in a Cartesian coordinate system located in Quadrant 1. In this coordinate system, values of X increase from left to right and values of Y increase from bottom to top. Values of both X and Y are equal to or greater than "0000" and are less than "5000". If the conversion to this coordinate system is from a system that normally centers the fingerprint image during the registration process, that center position shall be assigned the values X ≡ 2500, Y ≡ 2500. Figure 2 illustrates the defined coordinate system.

The relative orientation, Theta, of a ridge ending, a bifurcation, a compound or a minutia of undetermined type shall be expressed as positive integers in units of degrees. Theta shall be the angle between the horizontal axis of the coordinate system and the direction that a ridge ending points, assuming that a ridge ending is analogous to a pointing finger. A ridge ending that is formed by a ridge lying parallel to the X axis, and ending in the direction of increasing values of X, shall have an orientation of zero degrees. Counterclockwise rotation of this ridge about the ridge ending shall cause the value of Theta to increase.

A bifurcation may be converted to a ridge ending by logical inversion, that is, transposing the identity of ridges and valleys. The orientation of a bifurcation is expressed as if this inversion had occurred. This convention causes no significant change in the orientation of a minutia if it appears as a ridge ending in one impression of a fingerprint and as a bifurcation in another impression of the same fingerprint.

No orientation shall be assigned to compound or undetermined type minutiae; therefore, a value of "000" shall be entered for Theta in the Type-9 logical record entry.

The exact features or characteristics of a minutia that are used to establish its position and orientation are system dependent and outside the scope of this standard.

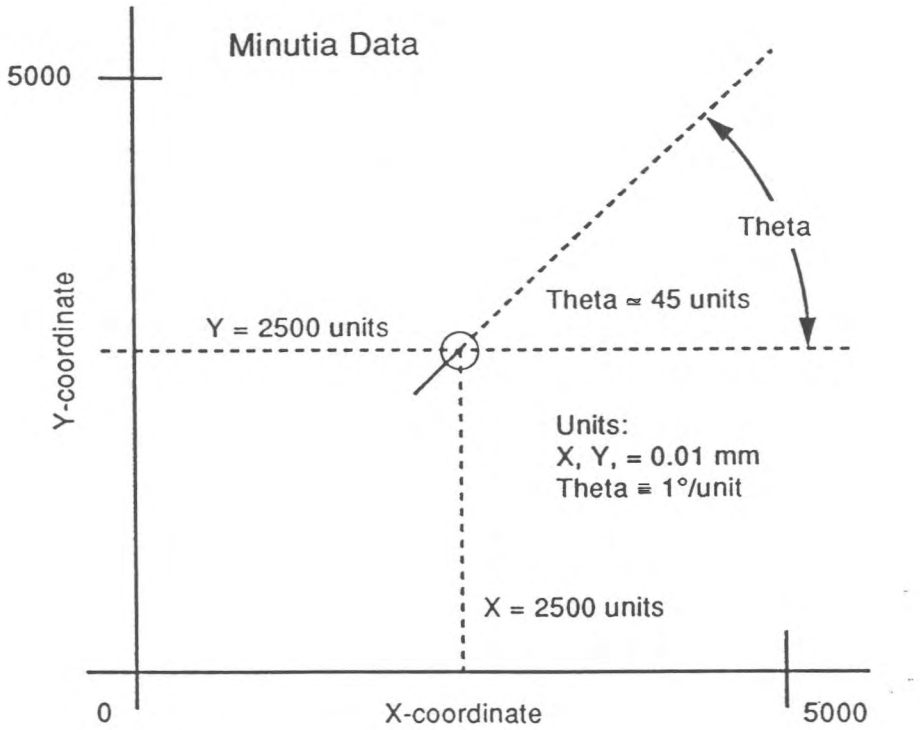

Figure 2 – Minutia coordinate system

16.2 Fields for Type-9 logical record

16.2.1 Field 9.01: Logical Record Length (LEN)

This mandatory ASCII field shall contain the length of the logical record specifying the total number of bytes, including every character of every field contained in the record.

16.2.2 Field 9.02: Image Designation Character (IDC)

This mandatory two-byte field shall be used for the identification and location of the minutiae data. The IDC contained in this field shall match the IDC found in the file content field of the Type-1 record.

16.2.3 Field 9.03: Impression Type (IMP)

This mandatory one-byte field shall describe the manner by which the fingerprint image information was obtained. The binary value of the proper code as selected from table 4 shall be entered in this field to signify the impression type.

16.2.4 Field 9.04: Minutiae Format (FMT)

This mandatory one-byte field shall be used to indicate whether the remainder of the record adheres to the standard or is user-defined. This field shall contain an "S" to indicate that the minutiae are formatted as specified by the standard Type-9 logical record field descriptions. This field shall contain a "U" to indicate that the minutiae are formatted in user-defined terms. If the minutiae record is formatted in user-defined terms, the remaining fields of this logical record may not be applicable.

16.2.5 Field 9.05: Originating Fingerprint Reading System (OFR)

The originator's designation or name for the particular fingerprint reading system that generated this record shall be placed in the first information item of this field. The second information item of this field shall be a single character to indicate the method by which the minutiae data was read, encoded, and recorded. The following coding shall be used: (1) "A", if the data was automatically read, encoded, and recorded without any possibility of human editing; (2) "U", if human editing was possible but unneeded; (3) "E", if the data was automatically read but manually edited before encoding and recording; (4) "M", if the data

manually read. The third information item is an optional, two-character, user-generated subsystem designator that uniquely identifies the originator's equipment.

16.2.6 Field 9.06: Finger Position (FGP)

This mandatory field shall contain a character designating the finger position that produced information in this Type-9 record. If the exact finger position cannot be determined, multiple finger positions may be entered, separated by the RS character. The first 11 entries of table 5 list the codes that shall be used for each finger.

16.2.7 Field 9.07: Fingerprint Pattern Classification (FPC)

This mandatory field shall contain the fingerprint pattern classification code. It shall contain two information items. The first information item shall indicate the source of the specific pattern classification code. It may be one chosen from table 7 or may be a user-defined classification code. This item shall contain a "T" to indicate that the pattern classification code is from table 7, or a "U" to indicate that the code is user defined. The second information item of this field shall contain the pattern classification code chosen from table 7 or a specific user-defined code. Reference finger classes shall be separated by the RS character.

16.2.8 Field 9.08: Core Position (CRP)

If this eight-character field is used, it shall contain the X and Y coordinate position of the core. The X and Y values shall be coded as a single 8-digit integer number comprised of the 4-digit X-coordinate concatenated with the 4-digit Y-coordinate using a format of XXXXYYYY.

16.2.9 Field 9.09: Delta(s) Position (DLT)

If this eight-character field is used, it shall contain the X and Y positional coordinates of each delta that is present on the fingerprint. The X and Y values shall be recorded in the same manner as was done for the core position coordinates. Multiple occurrences of delta positions shall be separated by the RS separator.

16.2.10 Field 9.10: Number of Minutiae (MIN)

This mandatory single-character field shall contain the count of the number of minutiae recorded for this fingerprint.

Table 7 – Pattern classification

Description	Code
Plain arch	PA
Tented arch	TA
Radial loop	RL
Ulnar loop	UL
Plain whorl	PW
Central pocket loop	CP
Double loop	DL
Accidental whorl	AW
Whorl, type not designated	WN
Right slant loop	RS
Left slant loop	LS
Scar	SR
Amputation	XX
Unknown or unclassifiable	UN

16.2.11 Field 9.11: Minutiae Ridge Count Indicator (RDG)

This mandatory single-character field shall be used to indicate the presence of minutiae ridge count information. A "0" in this field indicates that no ridge count information is available. A "1" indicates that ridge count information is available.

16.2.12 Field 9.12: Minutiae and Ridge Count Data (MRC)

This variable field length shall contain all of the individual minutiae and ridge count data associated with the current fingerprint impression. It shall be comprised of as many subfields as there are minutiae stated in the minutiae count in field 9.10. Each subfield shall be devoted to a single minutia and shall consist of multiple information items. The first two information items shall always appear; the appearance of others is system dependent. The information items are identified in the order that they shall appear. All information items shall be separated from the subsequent items by the US separator character.

16.2.12.1 Index number

The first information item shall be the index number, which shall be initialized to "1" and incremented by one for each additional minutia in the fingerprint. This index number serves to identify each individual minutia.

16.2.12.2 X, Y, and Theta values

The X and Y coordinates (two 4-digit values ranging from zero upward), and the Theta value (a 3-digit value between 000 and 359) shall comprise the second required information item. These three values shall be coded and recorded as a single 11-digit integer number corresponding to the concatenated X, Y, and Theta values, in that order. If the minutia is of Type C or Type D, the Theta value shall be recorded as "000".

16.2.12.3 Quality measure

If present, the third information item is an optional quality measure. Values shall range from "0" to "63". The value "0" shall indicate a manually encoded minutia. The value "1" shall indicate that no method of indicating a confidence level is available. Values between "2" and "63" shall indicate decreasing levels of confidence, with "2" meaning the greatest confidence.

16.2.12.4 Minutia type designation

The fourth information item is an optional minutia type designation. This shall be a single alphabetic character as chosen from table 6.

16.2.12.5 Ridge count data

The fifth information item is optional ridge count data. It shall be formatted as a series of subitems, each consisting of a minutia number and a ridge count. This information shall be conveyed by listing the identity (index number) of the distant minutia followed by a comma, and the ridge count to that distant minutia. Subitems shall be separated by a US character. This subitem may be repeated as many times as required for each minutia (subfield).

16.2.12.6 Record separator

A record separator character, RS, shall be used at the end of the information items to introduce the first information item concerning data for the next minutia. The process shall be continued until all of the minutia and ridge data have been entered into the field.

16.3 End of Type-9 logical record

Immediately following the last information field in the Type-9 logical record, an FS separator shall be used to separate it from the next logical record. This FS character shall replace the GS character separator that is normally used between information fields.

16.4 Additional minutiae records

Up to nine more fingers may be described within the logical file. For each additional finger, a Type-9 logical record, and an FS separator is required.

17 Another individual

If fingerprint data for another individual is to be recorded or transmitted, a new logical file shall be generated for that individual using the same format as described previously.

Annex A
(normative)

ANSI code for information interchange

b_7 ≡ MSB →						0	0	0	0	1	1	1	1
b_6 →						0	0	1	1	0	0	1	1
b_5 →						0	1	0	1	0	1	0	1
Bits	b_4 ↓	b_3 ↓	b_2 ↓	b_1 ↓	COLUMN → ROW ↓	0	1	2	3	4	5	6	7
	0	0	0	0	0	NUL	DLE	SP	0	@	P	`	p
	0	0	0	1	1	SOH	DC1	!	1	A	Q	a	q
	0	0	1	0	2	STX	DC2	"	2	B	R	b	r
	0	0	1	1	3	ETX	DC3	#	3	C	S	c	s
	0	1	0	0	4	EOT	DC4	$	4	D	T	d	t
	0	1	0	1	5	ENQ	NAK	%	5	E	U	e	u
	0	1	1	0	6	ACK	SYN	&	6	F	V	f	v
	0	1	1	1	7	BEL	ETB	'	7	G	W	g	w
	1	0	0	0	8	BS	CAN	(	8	H	X	h	x
	1	0	0	1	9	HT	EM	)	9	I	Y	i	y
	1	0	1	0	10	LF	SUB	*	:	J	Z	j	z
	1	0	1	1	11	VT	ESC	+	;	K	[	k	{
	1	1	0	0	12	FF	FS	,	<	L	\	l	|
	1	1	0	1	13	CR	GS	-	=	M	]	m	}
	1	1	1	0	14	SO	RS	.	>	N	^	n	~
	1	1	1	1	15	SI	US	/	?	O	_	o	DEL

Annex B
(informative)

Use of information separator characters

FN is the field number of a field within a Type-1 or Type-2 or Type-9 record.

IF is the information field associated with an FN.

II is the information item belonging to an IF.

SF is the subfield used for multiple entries of an II or an IF.

$\underset{S}{F}$ File separator – separates logical records.

$\underset{S}{G}$ Group separator – separates fields.

$\underset{S}{R}$ Record separator – separates subfields.

$\underset{S}{U}$ Unit separator character – separates information items.

The $\underset{S}{G}$ used between fields – the $\underset{S}{F}$ between logical records:

FN_j : IF $\underset{S}{G}$ FN_k: ... $\underset{S}{F}$ FN_l : IF $\underset{S}{G}$

For fields with more than one information item, the $\underset{S}{U}$ is used:

FN_j : II_a $\underset{S}{U}$ II_b $\underset{S}{G}$ FN_k ... $\underset{S}{F}$

For fields with multiple subfields, the $\underset{S}{R}$ is used:

FN_j : II_a $\underset{S}{U}II_b$ $\underset{S}{R}II_a$ $\underset{S}{U}II_b$ $\underset{S}{G}$ FN_k : SF $\underset{S}{R}$ SF $\underset{S}{G}$ FN ... $\underset{S}{F}$

Annex C
(informative)

An example of the use of the standard

	TYPE-1 RECORD
*LOGICAL RECORD LENGTH (LEN)	1.01:241$^{G}_{S}$
*VERSION NUMBER (VER)	1.02:0200$^{G}_{S}$
*FILE CONTENT (CNT)	1.03:1$^{U}_{S}$17$^{R}_{S}$2$^{U}_{S}$00$^{R}_{S}$4$^{U}_{S}$01$^{R}_{S}$4$^{U}_{S}$02$^{R}_{S}$4$^{U}_{S}$03$^{R}_{S}$4$^{U}_{S}$04$^{R}_{S}$4$^{U}_{S}$05$^{R}_{S}$4$^{U}_{S}$06$^{R}_{S}$4$^{U}_{S}$07$^{R}_{S}$4$^{U}_{S}$08$^{R}_{S}$4$^{U}_{S}$09$^{R}_{S}$4$^{U}_{S}$10$^{R}_{S}$4$^{U}_{S}$11$^{R}_{S}$4$^{U}_{S}$12$^{R}_{S}$4$^{U}_{S}$13$^{R}_{S}$4$^{U}_{S}$14$^{R}_{S}$8$^{U}_{S}$15$^{R}_{S}$8$^{U}_{S}$16$^{G}_{S}$
*TYPE OF TRANSACTION (TOT)	1.04:CAR$^{G}_{S}$
*DATE (DAT)	1.05:19920601$^{G}_{S}$
PRIORITY (PRY)	1.06:1$^{G}_{S}$
*DESTINATION AGENCY IDENTIFIER (DAI)	1.07:DCFBIWA6Z$^{G}_{S}$
*ORIGINATING AGENCY IDENTIFIER (ORI)	1.08:NY0303000SLAS01000$^{G}_{S}$
*TRANSACTION CONTROL NUMBER (TCN)	1.09:1234567890$^{G}_{S}$
TRANSACTION CONTROL REFERENCE (TCR)	1.10:2345678901$^{G}_{S}$
*NATIVE SCANNING RESOLUTION (NSR)	1.11:20.0000$^{G}_{S}$
*NOMINAL TRANSMITTING RESOLUTION (NTR)	1.12:20.0000$^{F}_{S}$
	TYPE-2 RECORD
*LOGICAL RECORD LENGTH (LEN)	2.01:811$^{G}_{S}$
*IMAGE DESIGNATION CHARACTER (IDC)	2.02:00$^{G}_{S}$
USER-DEFINED INFORMATION	(ASCII TEXT DATA)$^{F}_{S}$
	TYPE-4 RECORD
1ST TYPE-4 RECORD —	
LOGICAL RECORD LENGTH (LEN)	00 00 7B 5A (HEX)
IMAGE DESIGNATION CHARACTER (IDC)	01 (HEX)
IMPRESSION TYPE (IMP)	03 (HEX)
FINGER POSITION (FGP)	01 FF FF FF FF FF (HEX)
IMAGE SCANNING RESOLUTION (ISR)	01 (HEX)
HORIZONTAL LINE LENGTH (HLL)	0320 (HEX)
VERTICAL LINE LENGTH (VLL)	02EE (HEX)
GRAYSCALE COMPRESSION ALGORITHM (GCA)	01 (HEX)
IMAGE DATA	(GRAYSCALE IMAGE DATA FOR ROLLED IMPRESSION OF RIGHT THUMB)

* MANDATORY FIELDS

2ND TYPE-4 RECORD —

LOGICAL RECORD LENGTH (LEN)	00 00 75 30 (HEX)
IMAGE DESIGNATION CHARACTER (IDC)	02 (HEX)
IMPRESSION TYPE (IMP)	03 (HEX)
FINGER POSITION (FGP)	02 FF FF FF FF FF (HEX)
IMAGE SCANNING RESOLUTION (ISR)	01 (HEX)
HORIZONTAL LINE LENGTH (HLL)	0320 (HEX)
VERTICAL LINE LENGTH (VLL)	02EE (HEX)
GRAYSCALE COMPRESSION ALGORITHM (GCA)	01 (HEX)
IMAGE DATA	(GRAYSCALE IMAGE DATA FOR ROLLED IMPRESSION OF RIGHT INDEX FINGER)

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14TH TYPE-4 RECORD —

LOGICAL RECORD LENGTH (LEN)	00 01 03 7C (HEX)
IMAGE DESIGNATION CHARACTER (IDC)	0E (HEX)
IMPRESSION TYPE (IMP)	03 (HEX)
FINGER POSITION (FGP)	0E FF FF FF FF FF (HEX)
IMAGE SCANNING RESOLUTION (ISR)	01 (HEX)
HORIZONTAL LINE LENGTH (HLL)	060E (HEX)
VERTICAL LINE LENGTH (VLL)	0384 (HEX)
GRAYSCALE COMPRESSION ALGORITHM (GCA)	01 (HEX)
IMAGE DATA	(GRAYSCALE IMAGE DATA FOR PLAIN IMPRESSION OF THE FOUR FINGERS ON THE LEFT HAND)

TYPE-8 RECORD

1ST TYPE-8 RECORD —

LOGICAL RECORD LENGTH (LEN)	00 00 44 0E (HEX)
IMAGE DESIGNATION CHARACTER (IDC)	0F (HEX)
SIGNATURE TYPE (SIG)	00 (HEX)
SIGNATURE REPRESENTATION TYPE (SRT)	01 (HEX)
IMAGE SCANNING RESOLUTION (ISR)	01 (HEX)
HORIZONTAL LINE LENGTH (HLL)	05DC (HEX)
VERTICAL LINE LENGTH (VLL)	0187 (HEX)
SIGNATURE IMAGE DATA	(COMPRESSED IMAGE DATA OF THE SUBJECT'S SIGNATURE)

2ND TYPE-8 RECORD —

LOGICAL RECORD LENGTH (LEN)	00 00 3F A3 (HEX)
IMAGE DESIGNATION CHARACTER (IDC)	10 (HEX)
SIGNATURE TYPE (SIG)	01 (HEX)
SIGNATURE REPRESENTATION TYPE (SRT)	01 (HEX)
IMAGE SCANNING RESOLUTION (ISR)	01 (HEX)
HORIZONTAL LINE LENGTH (HLL)	05DC (HEX)
VERTICAL LINE LENGTH (VLL)	0187 (HEX)
SIGNATURE IMAGE DATA	(COMPRESSED IMAGE DATA OF THE SIGNATURE OF THE OFFICIAL TAKING THE PRINTS)