

InterNational Committee for Information Technology Standards
INCITS Secretariat, Information Technology Industry Council (ITI)
1250 Eye St. NW, Suite 200, Washington, DC 20005
Telephone 202-737-8888; Fax 202-63-4922
email: ncits@itic.org

Information Technology: Conformance Testing Methodology Standard for Biometric Data Interchange Format Standards - Part 2 – Fingerprint Minutia Conformance Testing Methodology

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Submitted by:

Editor: Greg Cannon (561-622-3953)

Co-editor: John Campbell (613-843-1908)

greg.cannon@crossmatch.com

john@bionbiometrics.com

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1 Introduction

The INCITS M1 Minutia Interchange Format provides an industry standard to allow for fingerprint minutia extracted with one vendor's algorithm to be useful to another vendor's matching algorithm. There is a natural desire to assure that a vendor's minutia based fingerprint processes conforms to this standard.

For the purposes of this standard, conformance will be tested as described in Part 1 of this multipart standard. There will be conformance testing for Level 1 (Data Format Conformance), Level 2 (Internal Consistency Checking), and Level 3 (Content Checking).

A particular fingerprint minutia template can be considered in conformance to the specification. In this case, a minutia template can be parsed and examined to assure that the data layout is consistent with the specification. A process that transforms fingerprint images into fingerprint minutia can conform to this specification by producing conformant minutia. IA process that assesses the similarity of fingerprints can conform to this specification by accepting as input conformant minutia.

This test specification is intended to act as a non-implementation biased test suite to expose where a given process does not conform to the ANSI-INCITS 378-2004 fingerprint minutia interchange format. Specifically this document will:

- a) Provide a framework for Minutia Interchange Format testing activities so that it is clear what will be tested and what the sequence of the test activities will be.
- b) Define the scope of the testing.
- c) Ensure that there is not any unnecessary duplication of testing effort.
- d) Document a consistent and maintainable test case style

2 Objective

It is proposed that this standard:

- a) Establish a framework for Conformance Testing Methodology for vendors of products and services that utilize the ANSI INCITS 378-2004 standard.
- b) Define requirements and guidelines for specifying conformance test suites and related test methods for measuring conformity of products and services to the ANSI INCITS 378-2004 standard.
- c) Define test procedures to be followed before, during, and after conformance testing.

3 Scope

This document specifies the testing activities required to assure a vendor's application or service's conformance to the Minutia Interchange Format. After reading this document, a user should be able to:

- a) Setup an environment to run tests
- b) Run tests and log results
- c) Understand what the tests are testing

4 Normative References

4.1 Existing Standards

4.1.1 Core Set of Standards

1. NISTIR 6529-A, Common Biometric Exchange Formats Framework (CBEFF)
2. ANSI/INCITS 378 – Information Technology - Finger Minutiae Format for Data Interchange
3. ANSI/INCITS 381 – Information Technology - Finger Image Format for Data Interchange

5 Mandatory Features to be tested for a Format

5.1.1 Record Length

The length of entire record shall be encoded in big endian format in the next bytes. If the length is less than 65535, then the next 2 bytes shall have the length encoded. If the length is greater or equal to 65535, then the next 2 bytes shall be 0x00,0x00, followed by a 4 byte length encoded in Big Endian format.

5.1.2 Capture Equipment Compliance

The most significant bit of the next 2 bytes shall specify the compliance of the scanner used to take input images. The bit shall only be set to a 1 if and only if the scanning equipment is FBI Appendix F Certified.

5.1.3 Scanned Image Size

The next 4 bytes shall provide the image size information. The image sizes shall not be 0. They shall correspond to the images used for extraction. For multiple views, the scanned image size shall be the maximum dimension of all the input images used to create the multiple minutia. The horizontal image size shall not be larger than $2^{14} - 1$.

5.1.4 Scanned Image Resolution

The next 4 bytes shall provide the image resolution information. The image resolution shall not be 0. They resolutions shall correspond to the images used for extraction. Images with unequal resolution should be scaled (or their minutia scaled) so that all extracted features correspond to the same resolution.

5.1.5 Number of views

The number of views shall be encoded into the next byte. It must be at least one, and shall correspond to the total number of distinct minutia sets contained in the total record.

5.2 View Record Header

5.2.1 View Number

The next byte's 4 most significant bits shall contain the view number associated with the previous byte's position. The first view for a particular position shall be 0. There shall be no view for a given position with a duplicate view number.

5.2.2 Impression Type

The byte's 4 least significant bits shall contain the impression type for the encoded fingerprint. It shall be a number between 0 and 9. It shall correspond to the fingerprint information provided at extract.

5.2.3 View Quality

The next byte shall encode the quality of the encoded fingerprint. It shall be the number 254 to indicate unsupported quality, or a number between 0 and 100 to correctly relate to the quality of the encoded fingerprint.

5.2.4 Minutia Data

There shall be 6 bytes for every minutia point encoded in the fingerprint.

5.2.4.1 Minutia X Location

The next 14 bits shall encode the horizontal pixel location of the corresponding minutia point. This shall be between 0 and the encoded image width encoded in the header. The orientation of the location shall be from left to right.

5.2.4.2 Minutia Y Location

The next 2 bits shall be 0. The next 14 bits shall encode the vertical pixel location of the corresponding minutia point. This shall be between 0 and the encoded image height encoded in the header. The orientation of the location shall be from top to bottom.

5.2.4.3 Minutia Angle

The next byte shall contain a number between 0 and 179. 0 shall represent a direction from left to right, with increasing values at 2 degree increments counter clockwise from that direction.

5.2.4.4 Minutia Quality

The next byte shall contain a quality metric for the minutia. A zero shall be used to indicate undetermined quality, else the byte shall contain a number between 1 and 100.

5.3 Extension Length

The next two bytes shall contain the total extended length for this encoded fingerprint. For fingerprints that are not encoded with any proprietary or standard extensions, the 2 bytes shall be encoded with 0x00, 0x00.

Annex A – Level 1 and 2 Assertions for INCITS 378-2004

The specific test assertions required for Level 1 and 2 conformance testing of INCITS 378-2004, Finger Minutiae Format for Data Interchange are listed in the Table below.

Test	Field	Operator	Operands	Conditional	References	Level
1	Format Identifier	EQ	0x464D5200		6.4.1	1
2	Version	EQ	0x20323000		6.4.2	1
3	Record Length	EQ	26 - 65535	YES	6.4.3	1
3.1	Record Length	GTE	65536	YES	6.4.3	1
3.2	Record Length	EQ	Total Bytes Read		6.4.3	2
3.3	Record Length	EQ	Total Bytes Expected (Note 1)	YES	6.4.3	2
4	CBEFF PID Owner	NEQ	0		6.4.4	1
5	CBEFF PID Type	NONE			6.4.4	
6	Capture Equipment Compliance	NONE			6.4.5	
7	Capture Equipment ID	NONE			6.4.6	
8	Image Size X	NONE			6.4.7	
9	Image Size Y	NONE			6.4.8	
10	Resolution X	NEQ	0		6.4.9	1
11	Resolution Y	NEQ	0		6.4.10	1
12	Number of Finger Views	EQ	1-176 (Note 2)		6.4.11, 6.5.1.2	1
12.1	Number of Finger Views	EQ	Views Read		6.4.11	2
13	Reserved	EQ	0		6.4.12	1
14	Finger Position	EQ	0 - 10		6.5.1.1	1
15	View Number	C	Next Finger View (Note 3)	YES	6.5.1.2	2
16	Impression Type	EQ	0 - 3, 8, 9		6.5.1.3	1
17	Finger Quality	EQ	0 - 100		6.5.1.4	1

18	Number of Minutiae	EQ	Minutiae Read		6.5.1.5, 6.5.2	2
19	Minutiae Type	EQ	0, 1, 2		6.5.2.1	1
20	Minutiae Position X	LTE	Image Size X		6.5.2.2	2
21	Minutiae Position Y	LTE	Image Size Y		6.5.2.2	2
22	Minutiae Position	C	(Note 4)			2
23	Minutiae Angle	EQ	0 - 179		6.5.2.3	1
24	Minutiae Quality	EQ	0 – 100		6.5.2.4	1
25	Extended Data Block Length	EQ	Bytes Read		6.6.1.1	2
25.1	Extended Data Block Length	EQ	Bytes Expected (Note 5)	YES	6.6.1.1	2
26	Type of Extended Data Area	EQ	0x0001 – 0x0002, 0x0100 – 0xFFFF		6.6.1.2 ¹	1
27	Length of Extended Data Area	GTE	4		6.6.1.3	1
27.1	Length of Extended Data Area	EQ	Bytes Read	YES	6.6.1.3	2
28	Ridge Extraction Method	EQ	0 - 2		6.6.2.1	1
29	Minutiae Index 1	C	(Note 6)		6.6.2	2
30	Minutiae Index 2	C	(Note 7)		6.6.2	2
30.1	Minutiae Index 2	C	(Note 8)	YES	6.6.2	2
31	Ridge Count	EQ	0 (Note 9)	YES	6.6.2.1	1
32	Core Information Type	EQ	0, 1		6.6.3.1	1
33	Core Reserved	EQ	0		6.6.3.2	1
34	Number of Cores	EQ	Cores Read		6.6.3.2	2
35	Core Position X	LTE	Image Size X		6.6.3.3	2
36	Core Position Y	LTE	Image Size Y		6.6.3.3	2
37	Core Angle	EQ	0 - 179		6.6.3.4	1
38	Delta Information Type	EQ	0, 1		6.6.3.5	1

¹ Note that this condition assumes the current text of 6.6.1.2 is correct and not Table 3, since Table 3 specifically disallows certain vendor specified values as Reserved, but this is incompatible with the concept of a vendor specified value.

39	Number of Deltas	EQ	Deltas Read		6.6.3.6	2
40	Delta Position X	LTE	Image Size X		6.6.3.7	2
41	Delta Position Y	LTE	Image Size Y		6.6.3.7	2
42	Delta Angle 1	EQ	0 - 179		6.6.3.8	1
43	Delta Angle 2	EQ	0 - 179		6.6.3.8	1
44	Delta Angle 3	EQ	0 - 179		6.6.3.8	1

A.1 Test Notes

A.1.1 Note 1 (3.3) – {Record Length} EQ {Total Bytes Expected}

The following calculation will be evaluated once the {Extended Data Block Length} field for the last finger view has been parsed successfully (not having reached an End-of-File marker prematurely). In the event that an End-of-File marker is reached prematurely this test will be marked as having failed, but no value of {Total Bytes Expected} will be produced.

The initial value of SUMBYTES below will correspond to the length of the BIR header in bytes (26 or 30).

```
FOR I = 1 TO {Number of Finger Views}
    SUMBYTES = SUMBYTES + 6 + ({Number of Minutiae} * 6)
    SUMBYTES = SUMBYTES + {Extended Data Block Length}
END
```

{Total Bytes Expected} = SUMBYTES

A.1.2 Note Note 2 (12) – {Number of Finger Views}

This test will pass if the value of {Number of Finger Views} is less than or equal to the sum of all possible finger positions (11) permitted by the standard multiplied by the maximum number of views per finger (16).

A.1.3 Note 3 (15) – {View Number}

As each finger view from the BIR is read, a counter, {Next Finger View}, for the corresponding finger position (if valid) is incremented and compared to {View Number}. The test shall pass if {Next Finger View} is equal to {View Number}.

A.1.4 Note 4 (22) – {Minutiae Position}

Though not explicitly defined in the standard, all minutiae within a finger view should have unique X/Y coordinates to avoid potential interoperability issues. This test shall pass if the {Minutiae Position} is a unique pair of minutiae X/Y coordinates within the finger view.

A.1.5 Note 5 (25.1) – {Extended Data Block Length} EQ {Bytes Expected}

As the individual extended data areas are read, the {Length of Extended Data Area} parameter for each one will become known. The sum of these is {Bytes Expected} for the extended data block, in accordance with Section 6.6.1.1 of the base standard. The test shall pass if the length is zero for a record that has no extended data.

A.1.6 Note 6 (29) – {Minutiae Index 1}

If {Minutiae Index 1} corresponds with the first ridge count in a Four-neighbor or Eight-neighbor group, or if the {Ridge Extraction Method} is zero (0), the test shall pass if the index is between 1 and {Number of Minutiae}. Otherwise, the test shall pass only if the index is the same value as {Minutiae Index 1} of the first ridge count in the same Four-neighbor or Eight-neighbor group.

A.1.7 Note 7 (30) – {Minutiae Index 2}

If the {Ridge Extraction Method} is zero (0), the test shall pass if the index is between 1 and {Number of Minutiae}, and if the index is not equal to {Minutiae Index 1}. If the {Ridge Extraction Method} is one (1) or two (2) then the test shall pass if the index is between 0 and {Number of Minutiae}.

A.1.8 Note 8 (30.1) – {Minutiae Index 2}

This test is only evaluated if {Minutiae Index 2} is not zero (0) and the {Ridge Extraction Method} is not zero (0). Each ridge count within the same Four-neighbor or Eight-neighbor group should refer to the same center minutiae, {Minutiae Index 1}, and a neighboring minutiae, {Minutiae Index 2}, from a different quadrant or octant. Thus, this test shall pass if {Minutiae Index 2} is unique within the same Four-neighbor or Eight-neighbor group.

A.1.9 Note 9 (31) – {Ridge Count2}

This test is only evaluated if {Minutiae Index 2} is zero (0) and {Ridge Extraction Method} is not zero (0). This test shall pass if {Ridge Count} is zero.

A.2 Other Notes of Testing Interest

A.2.1 Big Endian-ness

All multi-byte fields are encoded with the most significant byte first, and the least significant byte last.

A.2.2 Capture Equipment Compliance

The most significant bit of the 4 bit field shall only be set if the scanning equipment used was FBI Appendix F Certified.

A.2.3 Scanned Image Size

The horizontal image size shall not be larger than $2^{14} - 1$. The vertical image size shall not be larger than $2^{16} - 1$.

A.2.4 Duplicate View Numbers

There shall be no view for a given position with a duplicate view number.

A.2.5 Undetermined View Quality

A fingerprint view with undetermined quality shall be encoded with the number 254.

A.2.6 Horizontal Orientation

The orientation of the minutia location information shall be from left to right.

A.2.7 Vertical Orientation

The orientation of the minutia location information shall be from top to bottom.

A.2.8 Angular Orientation

The orientation of the minutia angular information shall be from counter clockwise referenced from a direction of left to right.