

APPENDIX F: FBI/CJIS IMAGE QUALITY SPECIFICATIONS

1.0 Scope and Purpose

These specifications apply to: (1) systems that scan and capture fingerprints¹ in digital, softcopy form, including hardcopy scanners such as tenprint card scanners, and live scan devices, altogether called “fingerprint scanners”; and (2) systems utilizing a printer to print digital fingerprint images to hardcopy called “fingerprint printers.” These specifications provide criteria for ensuring the image quality of fingerprint scanners and printers that input fingerprint images to, or generate fingerprint images from within, the NGI system.

Digital softcopy images obtained from fingerprint scanners must have sufficient quality to allow the following functions to be performed: (1) conclusive fingerprint comparisons (identification or non-identification decision), (2) fingerprint classification, (3) automatic feature detection, and (4) overall Automated Fingerprint Identification System (AFIS) search reliability. The fingerprint comparison process requires a high-fidelity image. Finer detail, such as pores and incipient ridges, are needed because they can play an important role in the comparison.

The fingerprint examiners in the FBI/CJIS environment will depend upon softcopy-displayed images of scanned fingerprints to make comparisons, but will also need to accept and utilize hardcopy images in certain instances. For example, some contributors may print cards from live scan or card scan systems for submission to the FBI/CJIS. These hardcopy prints will be obtained from printers that include printing algorithms optimized for fingerprints. The printer’s principal function is to produce life-size prints of digital fingerprints that have met FBI/CJIS format requirements and provide sufficient print quality to support fingerprint comparisons (i.e., support identification or non-identification decisions).

The image quality requirements covered in the following Section 2 for fingerprint scanners, Section 3 for fingerprint identification flats, Section 4 for fingerprint printers, Section 5 for mobile scanners, and Section 6 for fast-track requirements have associated test procedures that are described in detail in the Test Procedures document (see Appendix F References).

These test procedures will be used by the FBI/CJIS principally for certification of fingerprint systems; they may also be used in acceptance testing and in performance capability demonstrations as an indication of capability to perform. Equipment shall be tested to meet the requirements in normal operating modes (e.g., scanners shall not be tested at slower-than-normal operating speeds in an attempt to meet geometric accuracy specifications). A vendor may recommend alternate testing methods if the test procedures given in this appendix are not applicable or cannot be applied to the particular system under test.

¹ The term “fingerprint” in this appendix may also include palm print, whole hand print, or a print from other parts of the human body.

2.0 Finger/Palm Print Scanner

The fingerprint scanner must be capable of producing images that exhibit good geometric fidelity, sharpness, detail rendition, gray-level uniformity, and gray-scale dynamic range, with low noise characteristics. The images must be true representations of the input fingerprints without creating any significant artifacts, anomalies, false detail, or cosmetic image restoration effects.

The scanner's final output resolution in both sensor detector row and column directions shall be in the range: $(R-0.01R)$ to $(R+0.01R)$ and shall be gray-level quantized to eight bits per pixel (256 gray-levels). The magnitude of "R" is either 500 pixels per inch (ppi) or 1,000 ppi; a scanner may be certified at either one or both of these resolution levels. The scanner's true optical resolution shall be greater than or equal to R.

A scanner intended to scan standard 8.0 by 8.0 inch tenprint cards (e.g., applicant fingerprint card type FD-258 or FD-249) shall be capable of capturing an area of at least 5.0 by 8.0 inches, which captures all 14 printblocks, either each printblock as a separate image or all printblocks together as a single image. In terms of individual printblocks, Table F-1 gives the minimum capture sizes applicable to both card scan and live scan systems, with the exception that, when scanning fingerprint cards, the card form dimensions take precedence.

Table F-1 Minimum Capture Sizes

Image	Width (inches)	Height (inches)
Roll Finger	1.6*	1.5
Plain Thumb	1.0	2.0
Plain 4-Fingers (Sequence Check)	3.2	2.0
Plain 4-Fingers (Identification Flat)	3.2	3.0
Full Palm	5.5**	8.0
Half Palm	5.5**	5.5**
Writer's Palm	1.75	5.0

* Live scanner must be capable of capturing at least 80% of full roll arc length, where full roll arc length is defined as arc length from nail edge to nail edge.

** 5.0" impressions will be accepted, although not preferred

The practice of "stitching" together images that were not captured simultaneously is prohibited. Individual images with the proper position code should be transmitted by the contributor. For example, non-simultaneous plain image captures from the two individual thumbs should be submitted as two individual image records with position codes 11 and 12 instead of being submitted as a single image record with position code 15. In this example, submitting individual images for each thumb avoids the masking of sequence errors. Another example is the submission of full palm print images. If the upper and lower palms are captured separately, they should be submitted as individual images using position codes 25 and 26 for the right hand or position codes 27 and 28 for the left hand. Under no circumstances should upper and lower palm images be stitched together and submitted as full palm impressions (position code 21 or 23), as the geometric relationship between minutiae is altered within the stitched image, which affects matching accuracy.

2.1 Linearity

Requirement:

When measuring a stepped series of uniform target reflectance patches (e.g., step tablet) that substantially cover the scanner's gray range, the average value of each patch shall be within 7.65 gray-levels of a linear, least squares regression line fitted between target reflectance patch values (independent variable) and scanner output gray-levels (dependent variable).

Background:

All targets used in Image Quality Specifications (IQS) compliance verification are expected to be scanned with the scanner operating in a linear input/output mode. Linearity enables valid comparisons of test measurements with requirements (e.g., a system's spatial frequency response in terms of Modulation Transfer Function (MTF) is, strictly speaking, a linear systems concept). Linearity also facilitates comparisons between different scanners through the "common ground" concept. In atypical cases, a small amount of smooth, monotonic nonlinearity may be acceptable for the test target scans (i.e., when it is substantially impractical and unrepresentative of operational use) to force linearity on the scanner under test (e.g., some live scan devices). Linearity is not a requirement for the operational or test fingerprint scans, which allows for processing flexibility to overcome inadequate tonal characteristics of fingerprint samples.

2.2 Geometric Accuracy

Requirement (across-bar):

When scanning a multiple, parallel bar target, in both vertical bar and horizontal bar orientations, the absolute value of the difference between the actual distance across parallel target bars and the corresponding distance measured in the image shall not exceed the following values for at least 99.0 percent of the tested cases in each printblock measurement area and in each of the two orthogonal directions.

For 500-ppi scanner:

$$D \leq 0.0007, \quad \text{for } 0.00 < X \leq 0.07$$

$$D \leq 0.01X, \quad \text{for } 0.07 \leq X \leq 1.50$$

For 1,000-ppi scanner:

$$D \leq 0.0005, \quad \text{for } 0.00 < X \leq 0.07$$

$$D \leq 0.0071X, \quad \text{for } 0.07 \leq X \leq 1.5$$

Where:

$$D = |Y - X|$$

X = actual target distance

Y = measured image distance

D, X, Y are in inches

Requirement (along-bar):

When scanning a multiple, parallel bar target, in both vertical bar and horizontal bar orientations, the maximum difference in the horizontal or vertical direction, respectively, between the locations of any two points within a 1.5-inch segment of a given bar image shall not exceed 0.016 inches for at least 99.0 percent of the tested cases in each printblock measurement area and in each of the two orthogonal directions.

Background:

In this Section 2.2, the phrase: “multiple, parallel bar target” refers to a Ronchi target, which consists of an equal-width bar and space square wave pattern at 1.0 cy/mm, with high contrast ratio and fine edge definition. This target is also used to verify compliance with the scanner resolution requirement given in Section 2.0 of this appendix.

Across-bar geometric accuracy is measured across the imaged Ronchi target bars that substantially cover the total image capture area. The 500-ppi requirement corresponds to a positional accuracy of ± 1.0 percent for distances between 0.07 and 1.5 inches and a constant ± 0.0007 inches (1/3 pixel) for distances less than or equal to 0.07 inches. The 1,000-ppi requirement corresponds to a positional accuracy of ± 0.71 percent for distances between 0.07 and 1.5 inches and a constant ± 0.0005 inches (1/2 pixel) for distances less than or equal to 0.07 inches.

This measurement procedure is also used to verify the ppi resolution requirement given in Section 2.0 of this appendix.

Along-bar geometric accuracy is measured along the length of an individual Ronchi target bar in the image. For a given horizontal bar, for example, the maximum difference between bar center locations (in vertical direction), determined from bar locations measured at multiple points along a 1.5” bar segment length, is compared to the maximum allowable difference requirement (analogously for vertical bar). This requirement is to ensure that pincushion or barrel distortion over the primary area of interest (i.e., a single fingerprint) is not too large.

2.3 Spatial Frequency Response

Requirements:

The spatial frequency response shall be measured using a continuous tone sine wave target denoted as MTF measurement unless the scanner cannot obtain adequate tonal response from this target, in which case a bi-tonal bar target shall be used to measure the spatial frequency response, denoted as Contrast Transfer Function (CTF) measurement. When measuring the sine wave MTF, it shall meet or exceed the minimum modulation values given in Table F-2 in both the detector row and detector column directions and over any region of the scanner’s field of view. When measuring the bar CTF, it shall meet or exceed the minimum modulation values defined by equation 2-1 or equation 2-2 (whichever applies) in both the detector row and detector column directions and

over any region of the scanner's field of view. CTF values computed from equations 2-1 and 2-2 for nominal test frequencies are given in Table F-3. None of the MTF or CTF modulation values measured at specification spatial frequencies shall exceed 1.05.

The output sine wave image or bar target image shall not exhibit any significant amount of aliasing.

Table F-2 MTF Requirement Using Sine Wave Target

Frequency (cy/mm)	Minimum Modulation for 500 ppi Scanner	Minimum Modulation for 1000 ppi Scanner	Maximum Modulation
1	0.905	0.925	1.05 at all frequencies
2	0.767	0.856	
3	0.694	0.791	
4	0.598	0.732	
5	0.513	0.677	
6	0.437	0.626	
7	0.371	0.579	
8	0.312	0.536	
9	0.255	0.495	
10	0.200	0.458	
12		0.392	
14		0.336	
16		0.287	
18		0.246	
20		0.210	

Note: Testing at 7 and 9 cy/mm is not a requirement if these frequency patterns are absent from the sine wave target.

Table F-3 Requirement Using Bar Target (Nominal Test Frequencies)

Frequency (cy/mm)	Minimum Modulation for 500 ppi Scanner	Minimum Modulation for 1000 ppi Scanner	Maximum Modulation
1.0	0.948	0.957	1.05 at all frequencies
2.0	0.869	0.904	
3.0	0.791	0.854	
4.0	0.713	0.805	
5.0	0.636	0.760	
6.0	0.559	0.716	
7.0	0.483	0.675	
8.0	0.408	0.636	
9.0	0.333	0.598	
10.0	0.259	0.563	
12.0		0.497	
14.0		0.437	
16.0		0.382	
18.0		0.332	
20.0		0.284	

Note: Testing at or near 7 and 9 cy/mm is a requirement when using a bar target.

It is not required that the bar target contain the exact frequencies listed in Table F-3; however, the target does need to cover the listed frequency range and contain bar patterns close to each of the listed frequencies. The following equations are used to obtain the specification CTF modulation values when using bar targets that contain frequencies not listed in Table F-3.

500-ppi scanner, for $f = 1.0$ to 10.0 cy/mm:

$$\text{CTF} = 3.04105\text{E-}04 * f^2 - 7.99095\text{E-}02 * f + 1.02774 \text{ (eq.2 - 1)}$$

1,000-ppi scanner, for $f = 1.0$ to 20.0 cy/mm:

$$\text{CTF} = -1.85487\text{E-}05 * f^3 + 1.41666\text{E-}03 * f^2 - 5.73701\text{E-}02 * f + 1.01341 \text{ (eq.2 - 2)}$$

Background:

For MTF assessment, the single, representative sine wave modulation in each imaged sine wave frequency pattern is determined from the sample modulation values collected from within that pattern. The sample modulation values are computed from the maximum and minimum levels corresponding to the “peak” and adjacent “valley” in each sine wave period. For a sine wave image, these maximum and minimum levels represent the image gray-levels that have been locally averaged in a direction perpendicular to the sinusoidal variation and then mapped through a calibration curve into target reflectance space. Sample image modulation in target reflectance space is then defined as:

$$\text{modulation} = (\text{maximum} - \text{minimum}) / (\text{maximum} + \text{minimum})$$

The calibration curve is the curve of best fit between the image gray-levels of the density patches in the sine wave target and the corresponding target reflectance values. [It is assumed that sine wave target modulations and target density patch values are supplied by the target manufacturer.] The scanner MTF at each frequency is then defined as:

$$\text{MTF} = \text{peak image modulation} / \text{target modulation}$$

For CTF assessment, the modulations are determined directly in image space, normalized by the image modulation at zero frequency, instead of using a calibration curve. The scanner CTF at each frequency is then defined as:

$$\text{CTF} = \text{peak image modulation} / (\text{zero frequency image modulation})$$

The bar target must contain at least 10 parallel bars at each of the higher spatial frequencies (~50% Nyquist to Nyquist frequency), which helps to ensure capture of optimum scanner – target phasing and aids investigation of potential aliasing. The bar target must also contain a very low frequency component (i.e., a large square, bar, or series of bars) whose effective frequency is less than 2.5 percent of the scanner's final output resolution. This low frequency component is used in normalizing the CTF; it must have the same density (on the target) as the higher frequency target bars.

The upper limit of 1.05 modulation is to discourage image processing that produces excessive edge sharpening, which can add false detail to an image.

Aliasing on sine wave images or bar images may be investigated by quantitative analysis and from visual observation of the softcopy-displayed image.

2.4 Signal-to-Noise Ratio (SNR)

Requirement:

The white signal-to-noise ratio (SNR) and black signal-to-noise ratio shall each be greater than or equal to 125.0 in at least 97.0 percent of respective cases within each printblock measurement area.

Background:

The signal is defined as the difference between the average output gray-levels obtained from scans of a uniform low reflectance and a uniform high reflectance target, measuring the average values over independent 0.25 by 0.25 inch areas within each printblock area. The noise is defined as the standard deviation of the gray-levels in each of these quarter-inch measurement areas. Therefore, for each high reflectance, low reflectance image pair there are two SNR values, one using the high reflectance standard deviation and one using the low reflectance standard deviation. To obtain a true measure of the standard deviation, the scanner is set up such that the white average gray-level

is several gray-levels below the system's highest obtainable gray-level and the black average gray-level is several gray-levels above the system's lowest obtainable gray-level.

2.5 Gray-Level Uniformity

Requirement – adjacent row, column uniformity:

At least 99.0 percent of the average gray-levels between every two adjacent quarter-inch-long rows and 99.0 percent between every two adjacent quarter-inch-long columns within each imaged printblock area shall not differ by more than 1.0 gray-levels when scanning a uniform low-reflectance target and shall not differ by more than 2.0 gray-levels when scanning a uniform high-reflectance target.

Requirement – pixel-to-pixel uniformity:

For at least 99.9 percent of all pixels within every independent 0.25 by 0.25 inch area located within each imaged printblock area, no individual pixel's gray-level shall vary from the average by more than 22.0 gray-levels when scanning a uniform high-reflectance target and shall not vary from the average by more than 8.0 gray-levels when scanning a uniform low-reflectance target.

Requirement – small area uniformity:

For every two independent 0.25 by 0.25 inch areas located within each imaged printblock area, the average gray-levels of the two areas shall not differ by more than 12.0 gray-levels when scanning a uniform high-reflectance target and shall not differ by more than 3.0 gray-levels when scanning a uniform low-reflectance target.

Background:

Measurements are made over multiple, independent test areas on a printblock-by-printblock basis. (For a live scanner, the entire capture area is normally considered a single printblock area). To obtain a true measure of the standard deviation, the scanner is set up such that the white average gray-level is several gray-levels below the system's highest obtainable gray-level and the black average gray-level is several gray-levels above the system's lowest obtainable gray-level.

2.6 Fingerprint Image Quality

The scanner shall provide high quality fingerprint images; the quality will be assessed with respect to the following requirements.

Requirement – Fingerprint Gray Range:

At least 80.0 percent of the captured individual fingerprint images shall have a gray-scale dynamic range of at least 200 gray-levels, and at least 99.0 percent shall have a dynamic range of at least 128 gray-levels.

Background:

Card and live scan systems at a booking station have some control over dynamic range on a subject-by-subject or card-by-card basis (e.g., by rolling an inked finger properly or by adjusting gain on a livescanner). However, with central site or file conversion systems where a variety of card types and image qualities are encountered in rapid succession, automated adaptive processing may be necessary. The eight-bits-per-pixel quantization of the gray-scale values for very low contrast fingerprints needs to more optimally represent the reduced gray-scale range of such fingerprints, but without significant saturation. The intent is to avoid excessively low contrast images without adding false detail.

Dynamic range is computed in terms of number of gray-levels present that have signal content, measuring within the fingerprint area and substantially excluding white background and card format lines, boxes, and text.

For card scanners, compliance with these dynamic range requirements will be verified using a statistically stratified sample set of fingerprint cards assembled by the FBI/CJIS. The test fingerprint card set may include cards with difficult-to-handle properties (e.g., tears, holes, staples, glued-on photos, or lamination) for testing card scanners that have automatic document feeder mechanisms. For live scanners, compliance will be verified with sets of livescans produced by the vendor.

Requirement – Fingerprint Artifacts and Anomalies:

Artifacts or anomalies detected on the fingerprint images that are due to the scanner or image processing shall not significantly adversely impact support to the functions of conclusive fingerprint comparisons (identification or non-identification decision), fingerprint classification, automatic feature detection, or overall Automated Fingerprint Identification System (AFIS) search reliability.

Background:

The fingerprint images will be examined to determine the presence of artifacts or anomalies that are due to the scanner or image processing; assessment may include measurements to quantify their degree of severity and significance. Image artifacts or anomalies such as the following non-inclusive list may be investigated.

- jitter noise effects
- sharp truncations in average gray-level between adjacent printblocks
- gaps in the gray-level histograms (i.e., zero pixels in intermediate gray-levels) or clipping to less than 256 possible gray-levels
- imaging detector butt joints
- noise streaks
- card bleed-through
- gray-level saturation

Requirement – Fingerprint Sharpness and Detail Rendition:

The sharpness and detail rendition of the fingerprint images, due to the scanner or image processing, shall be high enough to support the fingerprint functions stated in Section 1, paragraph 2.

Background:

Fingerprint sharpness and detail rendition that is due to the scanner or image processing may be investigated by employing suitable, objective image quality metrics, as well as by visual observation of the softcopy-displayed image.

3.0 Identification Flats

Traditional fingerprint sets contain both rolled and plain fingerprint images. The rolled impressions support the search processing and identification functions and the plain impressions are used primarily for sequence verification. Fingerprinting systems designed for “Identification Flats” civilian background checks capture a single set of plain impressions. This single set of plain impressions must support finger sequence verification, search processing, and identification. Image quality has historically been a challenge for civil background checks. Some programs require a large number of relatively low-volume capture sites, which makes training difficult. A key goal for identification flats scanners is to reduce the need for training so that inexperienced users consistently capture quality fingerprint images.

The identification flats scanner shall meet all of the requirements stated in Section 2 of this appendix as well as the following requirements.

Requirement – Capture Protocol:

The system shall provide a simple capture protocol.

Background:

A simple capture protocol supports the inexperienced user’s ability to more consistently capture high quality fingerprints. Identification flats collection systems will be evaluated for their ability to produce a very small rate of failure to enroll in an operational setting. Systems with a minimum capture area of 3.2 inches (width) by 3.0 inches (height) that can capture four fingers simultaneously in an upright position will be considered in compliance with the simple capture protocol requirement. Other capture approaches will require specific testing and documentation.

Requirement – Verifiable Finger Sequence Data:

The method of capturing the fingers shall result in very low probability of error in the finger numbers.

Background:

The fingerprinting system's capture protocol will be evaluated for its ability to capture verifiable finger sequence data. Based on the Ohio WebCheck National trial systems with a minimum capture area of 3.2 inches (width) by 3.0 inches (height) that capture the left four fingers simultaneously, the right four fingers simultaneously and the two thumbs simultaneously (4-4-2) in an upright position will be considered in compliance with the finger sequence requirements. Other capture approaches will require specific testing and documentation.

4.0 Fingerprint Printer

Requirement:

The fingerprint printer, consisting of a printer and specialized print algorithm, must be capable of producing hardcopy images that exhibit good geometric fidelity, sharpness, detail rendition, gray-level uniformity, and gray-scale dynamic range characteristics, with low noise, no significant creation of false detail, and with the capability to support magnified viewing of the print without breakup of the virtual fingerprint image presented to the eye. This printer is expected to provide high throughput, good repeatability, good print permanency characteristics, and low cost per copy. A typical fingerprint printer is a gray-scale laser printer² with 1,200 black/white dots per inch resolution combined with a printing algorithm that typically includes image contrast and printer gamma/highlight/lowlight adjustments, image rescaling, and an error diffusion model with randomized dot dither printing applied to the rescaled image.

The print system's principal function is to produce life-size prints of digital fingerprints that have met FBI/CJIS format requirements as specified in EBTS and ANSI/NIST-ITL and to provide sufficient print quality to support fingerprint comparisons (i.e., support identification or non-identification decisions). The printer should also have the capability to print gray-scale mugshots and property/evidence photos (not necessarily using a fingerprint printing algorithm), as well as print black and white documents containing text and graphics, onto 8.5 x 11.0 inch paper.

A required printer resolution is 500 ppi, which produces the required life-size print when the input digital fingerprint is 500 ppi or when a 1,000-ppi digital fingerprint is down-scaled to 500 ppi prior to printing. In both cases, all other 500-ppi printer requirements must also be met.

Background:

Verification of the specific performance requirements in Section 4 of this appendix is accomplished by evaluating the printer's output print of an FBI/CJIS-designated test set of digitized fingerprints and FBI/CJIS-designated digital test target. Requirements compliance verification is performed by a combination of visual assessments of the test prints (aided by visual instruments) and computer-aided assessments of scanned digital images of the test prints. With respect to those requirements that depend on assessments of print scans for compliance verification, the scan resolution is

2 In this appendix, "laser printer" refers to a type of printer in which a laser beam "draws" an electrostatic image of an input signal onto a drum. Toner (typically dry powder) is then transferred to the charged areas of the drum, which then transfers the toner onto paper, where it is fused by heat, creating a black/white/gray image.

expected to be twice the required gray-scale print resolution (e.g., a print with 500-ppi resolution is scanned at 1,000 ppi) and the scanner is expected to be setup in a calibrated linear input/output, grayscale reflectance capture mode.

4.1 Spatial Frequency Response

Requirement:

The printer shall provide sufficient spatial frequency response to support visually resolving the required printer resolution in orthogonal directions on the print.

Background:

Resolution verification is performed by printing high-contrast digital bar targets and visually inspecting the print under magnification. (When employing a laser printer with a fingerprint printing algorithm, it is recognized and accepted that the effective resolution may vary in complex image areas such as a fingerprint.) The resolution limit is a single point on the spatial frequency response curve; the entire curve may be measured by scanning the print of an appropriate target, performing appropriate computer-aided assessment on the scan, and comparing results to a minimally acceptable spatial frequency response curve.

4.2 Gray-Levels

Requirement:

At least 16 gray-levels shall be visually distinguishable on the print.

Background:

Visual observation of the print of a digital target containing a step tablet is used to verify the 16- gray-level requirement. A higher number of gray-levels is expected to be distinguishable by appropriate computer-aided assessment of the scanned image of the print.

4.3 Dynamic Range

Requirement:

The printer shall have the capability to print an input digital image gray range of at least 130, excluding print black saturation and print white saturation.

Background:

The print of a digital step tablet is scanned, each pixel's output gray-level value is converted to the corresponding print reflectance value, and the average print reflectance value within each step is computed. A plot of step average print reflectance versus input digital step tablet gray-level must

result in a gray range of at least 130, excluding any saturation on the low end (print black reflectance) and high end (print white reflectance). (The scanner output gray-level to print reflectance conversion is established by generating the scanner's input/output curve using a calibrated step tablet.)

4.4 Geometric Accuracy and Print Scale

Requirement (across-bar):

When printing a digital bar target containing multiple, parallel bars, the absolute value of the difference between the measured distance across parallel bars on the print and the correct distance on the print shall not exceed the values given in Table F-4 for at least 97 percent of the tested "short distance" and "medium distance" cases in each direction (vertical and horizontal).

Table F-4 Printer Geometric Accuracy Requirements

Distance (D)	Distance Range (X)	Comment
$D \leq 0.001$	$0.00 < X \leq 0.07$	Short distance
$D \leq 0.015X$	$0.07 < X \leq 1.50$	Medium distance
$D \leq 0.010X$	$4.75 < X \leq 8.00$	Long distance

Table Note: $D = |Y - X|$
 X = correct distance = digital target pixels / required print resolution
 Y = measured distance on print
 D, X, Y are in inches

The average of all "medium distance" test cases, in each direction, shall not exceed the corresponding values of D given in Table F-4.

The average of all "long distance" test cases, in each direction, shall not exceed the corresponding values of D given in Table F-4.

Requirement (along-line):

Straight target lines printed parallel to or at a 45-degree angle to the paper or card edges shall be straight on the print with no significant waviness, bow, or "staircasing."

Background:

The across-bar requirement corresponds to a positional accuracy of ± 1.5 percent for distances greater than 0.07 inches and less than or equal to 1.5 inches and a constant ± 0.001 inches for distances less than or equal to 0.07 inches. With a 500 ppi-required print resolution, a digital bar target with a period of 18 pixels is used, which corresponds to a bar frequency of $500 / (25.4 \times 18)$ cy/mm on the print, when printed life-size. The measured distance on the print can be obtained by scanning the print and applying computer-assisted assessment on the resulting digital image. The requirement takes into account the geometric errors inherent in a good quality scanner. For

life-size printing, the print scale error is measured over a distance in the 0.07 to 1.50 inch range. Print scale error is equal to: (correct distance - measured distance) / correct distance. For lifesize printing at 500 ppi, a 1.5 percent allowable error in distance, measured in inches, is equivalent to an allowable print ppi error equal to ± 7.5 ppi.

The along-line requirement can be assessed visually, aided (e.g., by a straight-edge and magnifying lens).

4.5 Noise

Requirement:

For a required printer resolution of 500 ppi, the noise magnitude shall be less than 0.120 at each average print reflectance level when noise magnitude is defined as the standard deviation of print reflectance values within an area on the print corresponding to a constant gray-level on the input digital target. (Print reflectance is measured in fractional units: 0.0 to 1.0 range.)

Background:

A digital step tablet is printed, the print is scanned at 1000 ppi, each pixel's output gray-level value is converted to the corresponding print reflectance value, and the standard deviation of print reflectance values within each step is computed. The scanner output gray-level to print reflectance conversion is established by generating the scanner's input/output curve using a calibrated step tablet.

4.6 Print Polarity and Color

Requirement:

The printed fingerprints shall appear as dark gray-to-black ridges on a light gray-to-white background.

4.7 Print Permanence

Requirement:

The printed fingerprints shall not smear or smudge with normal handling.

4.8 Print Stability

Requirement:

Both the fingerprints and the card stock or paper on which they are printed shall retain their visually neutral (black, white, gray) color over time.

4.9 Hazardous Materials

Requirement:

The prints shall not produce any health hazard as a result of handling. They shall not produce any noxious, annoying, or unpleasant odors when accumulated in large numbers and handled in areas having limited ventilation.

Background:

Requirements 4.7 (print permanence), 4.8 (print stability), and 4.9 (hazardous materials) are met by standard laser printers.

4.10 Fingerprint Prints

4.10.1 Print Types Requirements

Requirement:

The printer shall have the capability to print a set of individual livescans or previously scanned, individual inked fingerprints, life-size and in their correct printblock locations, onto a standard tenprint fingerprint card (fingerprint card type FD-258), or print onto blank 8.0 by 8.0 inch card stock, or print onto blank 8.5 x 11.0 inch plain paper. In the case of printing fingerprints onto blank card stock or blank paper, the printer shall also print the printblock boundary lines and labeling that normally appears on a standard tenprint card.

The printer shall have the capability to print a previously scanned tenprint card in its entirety and life-size onto blank 8.0 x 8.0 inch card stock or onto blank 8.5 by 11.0 inch plain paper.

NOTE: Printer margins for any printblock when printed on 8.0 x 8.0 inch card stock may not exceed 10% of the image width dimensions. For an image 1.6 inches wide, this means a margin of 0.16 inches or less. In worst case, truncation of card edges is acceptable. Any shrinkage resulting in image reduction is unacceptable.

The printer shall have the capability to print a single fingerprint magnified up to five times beyond life-size onto 8.5 by 11.0 inch plain paper.

When printing in tenprint card format onto tenprint card stock, blank card stock, or plain paper, the printer shall also have the capability to print labels, bar chart, step tablet, and finger condition codes, all on the same print with the fingerprints. Figure 8 illustrates the printing of this auxiliary information. Sections 4.10.2 through 4.10.5 of this appendix give the detailed requirements.

4.10.2 Labels

Requirement:

When printing fingerprints in tenprint card format, the printing process shall have the capability to print a character string of scanner information within the left four finger plain impression printblock and a character string of printer information within the right four finger plain impression printblock. Each character string shall be printed along the top inside edge of the respective printblock in a type font and size that is large enough for human readability without the aid of a magnifier and small enough so as not to unduly impinge on fingerprint structure.

The scanner information string shall include the scanner make, model number, and serial number, if available, and/or similar information on the scanner system. The printer information string shall include the printer make, model number, and serial number, if available, and shall include similar information on the fingerprint printing algorithm, if available, and shall include the date and time of printing.

The scanner and printer character strings shall be printed without a background, border, or any other type of added surround.

Background:

Information for the scanner string can typically be obtained from the EBTS Type-2 record field identified as "IMA 2.067 – Image Capture Equipment," which includes scanner system make, model number, and serial number.

A printer is certified as a combination of a specific brand/model printer and fingerprint printing algorithm; the latter may also have a name or version designation.

Character string printing: a solid background (e.g., white) to the character string is unacceptable because it would unnecessarily obliterate some parts of fingerprints on some images. Individual characters with no background that overprint the fingerprint would obliterate a much smaller proportion of the fingerprint and are acceptable. Printing the character strings in an open space created by offsetting printblocks 6-10 from printblocks 11-14 is unacceptable because it changes the dimensions of the standard tenprint card format, and it cannot adequately accommodate fingerprints that stray across printblock boundaries.

Proper text size typically would correspond to a height of a numeral or upper case letter being in the range: 0.067 inches to 0.095 inches.

4.10.3 Bar Chart

Requirement:

When printing fingerprints in tenprint card format, the printing process shall have the capability to

print a bar chart consisting of equally spaced horizontal black bars and vertical black bars printed at the required printer resolution.

The bar chart shall be positioned at the top edge within the right thumb plain impression printblock and shall have a maximum width of 0.8 inches and a maximum height of 0.125 inches. The bar chart shall contain at least 10 parallel bars in each direction, vertical and horizontal, with a bar length of at least 0.0625 inches (not necessarily the same number of bars, or same bar length, in the two directions).

An optional, uniform mid-grey-level patch may be included between the horizontal and vertical bar components.

The bar chart shall be printed without border or any other type of added surround.

Background:

For a 500-ppi printer requirement, the limiting frequency is 250 cycles per inch, which implies that 250 black bars per inch are printed, where the 0.002-inch width of an individual bar is equal to the width of the white space between two bars.

If a mid-gray patch between the vertical and horizontal bar patterns appears to have the same overall gray-level on the print as the two bar patterns, then this may indicate that the printer gamma/highlight/lowlight settings are optimum and/or that the printer toner supply was adequate for printing.

4.10.4 Step Tablet

Requirement:

When printing fingerprints in tenprint card format, the printing process shall have the capability to print a step tablet, consisting of two adjacent horizontal bands, each band having 16 gray-levels. The top band should progressively darken from left to right and the bottom band should progressively darken from right to left. The 16 digital input gray-levels corresponding to one band shall be identically the same as for the other band, and both bands shall substantially cover the total gray-level range. This step tablet shall be positioned at the top edge within the left thumb plain impression printblock and shall have a total width between 0.5 inches and 0.8 inches and a total height between 0.0625 inches and 0.125 inches.

The step tablet shall be printed without border or any other type of added surround.

Background:

If the top band and bottom band appear “balanced” on the print (i.e., the same mid-gray level appears in the middle of both the top and bottom bands) then this may indicate that the printer gamma/highlight/lowlight settings are optimum.

4.10.5 Finger Condition Codes

Requirement:

When printing fingerprints in tenprint card format, the printing process shall have the capability to notate the presence of an abnormal finger condition in the appropriate printed fingerprint block for those cases where the EBTs Type-2 record field identified as “AMP” (amputated or bandaged) is available and/or for those cases where similar information is available from other sources, such as a state system (possibly with other notation codes).

4.10.6 Fingerprint Quality

Requirement:

The printer shall produce sufficient print quality to allow usable viewing of life-size fingerprint prints under magnification to support fingerprint comparisons (i.e., identification or non-identification decisions). The print image shall maintain its sharpness and detail rendition structure up to at least 4X magnification to the extent that ridges and ridge joints, bifurcations, and terminations that exist in the input digital image to the printer can be substantially discerned by the human observer on the output print without being “lost in the noise.” In addition, the printing process shall not create significant false detail (e.g., it shall not create ridges where none existed in the input digital image).

Background:

Assessment of the requirement is performed by visual inspection of the print augmented by appropriate quantitative analysis of the scanned print.

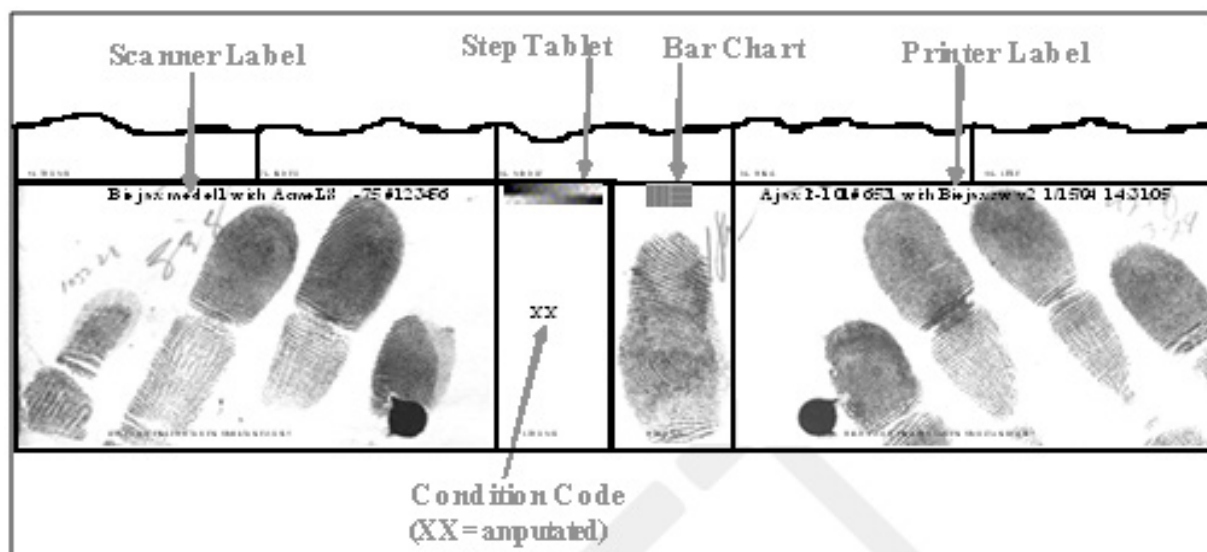


Figure 8 Auxiliary Information Printed in Tenprint Card Format Print (Example Text)

5.0 Mobile ID

A mobile identification device is a live scanner viewed in the context of a portable biometric acquisition station (i.e. one that is not intended to be stationary and hardwired to a much larger system used for comparing or matching biometric samples). Since mobile devices may satisfy a variety of collection modalities with differing image size and accuracy requirements, a set of Fingerprint Acquisition Profiles (FAP) for fingerprint images has been developed. Table F-5 summarizes the image sizes and IQS specification requirements relevant for each image interchange profile allowed by the FBI/CJIS for an RPIS transaction.

Requirement – Image Size/Impression Type:

For a given FAP, the minimum image dimensions and full range of simultaneous number of fingers specified in Table F-5 shall be met. The device shall be able to collect flat impressions. Rolled acquisition is optional.

Requirement – Image Quality:

As indicated in Table F-5, two IQS specification requirements are supported for mobile ID scanners. When the IQS specification requirement is PIV, then all requirements in Personal Identity Verification (PIV) Image Quality Specifications for Single Finger Capture Devices shall be met. When the IQS specification requirement is Appendix F, then all the requirements in Section 2 of this document shall be met.

Background:

FAP 30 and lower are for single finger sensors and are primarily for identification/verification, while FAP 40 and above support simultaneous image capture which is faster, reduces sequence errors and produces higher quality images for both enrollment and identification searches. The FBI/CJIS recommends that acquisition devices meet a minimum of FAP 30 to allow the following functions to be performed: (1) automatic feature detection; (2) fingerprint classification; (3) overall AFIS search reliability; and (4) conclusive fingerprint comparisons. Agencies submitting RPIS transactions should select a FAP level based on their specific requirements.

Table F-5 Mobile ID IQS Requirements

Fingerprint Acquisition Profile (FAP)	Minimum Image Dimensions (WxH in inches)	IQS Specification Requirements	Simultaneous # of Fingers
10	0.5 x 0.65	PIV	1
20	0.6 x 0.8	PIV	1
30	0.8 x 1.0	PIV	1
40	1.6 x 1.5	PIV	1-2
45	1.6 x 1.5	App F	1-2
50	2.5 x 1.5	App F	1-3

Fingerprint Acquisition Profile (FAP)	Minimum Image Dimensions (WxH in inches)	IQS Specification Requirements	Simultaneous # of Fingers
60	3.2 x 3.0	App F	1-4

NOTE: Although the RISC will accept submissions from Mobile Fingerprint Scanners that do not meet these requirements, the FBI/CJIS Division reserves the right to enforce these, or any other, scanner requirements deemed necessary to meet accuracy levels established by the FBI/CJIS Division's Advisory Policy Board. NGI RISC participants should refer to the FBI/CJIS Biometric Specification (www.fbibiospecs.org) IAFIS Certified Products List/Mobile ID Category for a list of mobile identification devices which have been certified by the FBI/CJIS as tested and in compliance with the FBI/CJIS's Next Generation Identification (NGI) initiatives and Integrated Automated Fingerprint Identification System (IAFIS) Image Quality Specifications (IQS). The certification process is not intended to endorse one product over a competitor's product but merely to certify that the product meets FBI/CJIS standards and that, between two products that meet FBI/CJIS standards, the FBI/CJIS does not recommend one over the other.

6.0 Fast-Track Certification

First, to review, full certification testing is required when:

- An uncertified livescan device is presented together with suitable SW such that the combination prospectively meets all IQS requirements.
- A hardcopy scanner or printer (typically a COTS product) is presented together with suitable SW such that the combination prospectively meets all IQS requirements. (The specific SW may be sold separately from the COTS HW, but only the specific HW/SW combination is certified.)
- Substantive modifications are made to an already-certified device. For example, the sensor or optics is changed, the capture area is expanded, the signal processing is substantively changed, or a 500 ppi-certified device is extended for operation at 1000 ppi.

Fast track certification testing is sufficient when:

- A vendor adds "value" to an already certified device by, for example, integrating additional SW and/or HW and repackaging the combination to create a Value-Added Reseller (VAR) label system. However, if there is a reasonable expectation that the added SW, HW, or repackaging will affect the image quality performance of the original certified device, then full certification testing would be required.
- A vendor makes relatively minor modifications to a previously certified device. For example, a membrane is added to (or deleted from) a certified livescanner, an automatic document feeder is added to a certified manual-feed cardscanner, or a 1000 ppi-certified scanner is operated at 500 ppi using the same optics, sensor, and illumination.

Table F-6 presents the test data requirements for some common fast track certification scenarios; for test requirements for other scenarios, contact the FBI/CJIS. In addition to the test data, the vendor seeking fast track certification must provide a written statement to the FBI/CJIS (letter or e-mail) affirming that the previously certified fingerprint device has not been changed with respect to device functions, hardware, firmware, or software that could reasonably be expected

to affect image quality performance.³ Specific to a scanner, the optics and optical layout, sensor, illumination, image capture electronics, and signal processing have not been changed and the maximum capture area has not been increased.

No certification testing is necessary when:

- The original recipient of a certification wishes to change the model name and there are no other changes to the certified product.
- The original recipient of a certification wishes to repackage the device if there is a reasonable expectation that the repackaging will not affect the image quality performance of the device. All device HW/SW components that may affect image quality performance must remain the same as they were when originally certified. For example, repackaging a device into a ruggedized cabinet or repackaging a floor-standing device as a desktop device by separating out the host computer would not necessarily require further testing, but changing the optical path or optical train of elements to accommodate the repackaging would normally require retesting.
- A reseller of a certified device wishes to sell the device under its own label or under the original label. The certified device must remain intact, unmodified, and as a stand-alone product with no added HW/SW. If relabeled by reseller, the certification is only valid when that label does in fact contain the originally certified device (i.e., no blanket certification for rebrands).⁴
- An end user receives a certified device to be used “as is” without modification (an end-user does not need its own certification).

³ Except for inherent image quality changes in specific situations, e.g., when recertifying a 1000 ppi scanner at 500 ppi.

⁴ If there is no Fast Track testing, the device will not be listed under the resellers name in the FBI certification list. Instead it will remain listed / certified under the original vendor and device name. A separate reseller listing requires some Fast Track data.

Table F-6 Fast Track Certification Procedures (Common Scenarios)

Fast Track Certification	Type	Test Data to be Provided to FBI/CJIS	Requirements Compliance within Appendix F
Livescanner	Vendor A incorporates vendor B's certified device into vendor A's value-added system. Vendor adds (or deletes) platen membrane to certified device.	Livescans from 5 subjects (10 rolls and 4 plains, each subject) Sinewave or bar target scans (target supplied by vendor) and livescans from 5 subjects (10 rolls and 4 plains, each subject).	Section 2.6 Sections 2.1, 2.3, and 2.6
Cardscanner	Vendor A incorporates vendor B's certified device into vendor A's value-added system.	Ten 10-print card scans (cards supplied by FBI/CJIS)	Section 2.6
Cardscanner with Automatic Document Feeder (ADF)	Vendor recertifies manual card scanner for use with ADF.	100 10-print card scans (cards supplied by FBI/CJIS)	Section 2.6
Printer	Vendor A incorporates vendor B's certified device into vendor A's value-added system.	Print of printer test target (target supplied by FBI/CJIS)	all subsections under section 4.0 pertaining to digital test target
1000 ppi fingerprint scanner as 500 ppi fingerprint scanner	Vendor recertifies its own fingerprint scanner in alternate operating mode.	Cardscanner: Sinewave target scans (target supplied by vendor) and ten 10-print card scans (cards supplied by FBI/CJIS) Livescanner: Sinewave or bar target scans (target supplied by vendor) and livescans from 5 subjects (10 rolls and 4 plains, each subject)	Sections 2.1, 2.3, and 2.6

Appendix F - Definition of Terms:

HW – Hardware, which may include firmware

SW – Software, which may include firmware

COTS – Commercial-Off-The-Shelf product

Vendor – generic term to include Original Equipment Manufacturer (OEM), reseller, VAR, product assembler, systems integrator, and similar.

Full IQS Certification – a complete set of test data covering all IQS requirements is submitted.

Fast Track IQS Certification – a partial set of test data covering defined IQS requirements is submitted.

APPENDIX F - REFERENCES

Mobile ID Device Best Practice Recommendation and Specification, Aug 2009, National Institute of Standards and Technology (NIST), available at <http://fingerprint.nist.gov/mobileid>

Personal Identity Verification (PIV) Image Quality Specifications for Single Finger Capture Devices, FBI/CJIS Biometric Specifications, 10 July 2006, available at <http://www.fbibiospecs.org/fbibbiometric/docs/pivspec.pdf>

Test Procedures for Verifying IAFIS Image Quality Requirements for Fingerprint Scanners and Printers, v1.4, MITRE Technical Report MTR050016R7, Feb 2013.

NIST Special Publication 500-290 - Data Format for the Interchange of Fingerprint, Facial, and Other Biometric Information, January 2011, National Institute of Standards and Technology (NIST), available at http://www.nist.gov/itl/iad/ig/ansi_standard.cfm