



# Produce Traceability Initiative Best Practices for Direct Print

(Revision 1.0)

## About This Best Practice Guideline

*Best practices* are generally accepted, informally-standardized techniques, methods or processes that have proven themselves over time to accomplish given tasks. The idea is that with proper processes, checks and testing, a desired outcome can be delivered more effectively with fewer problems and unforeseen complications. In addition, a "best" practice can evolve to become better as improvements are discovered. The Produce Traceability Initiative (PTI) is a voluntary U.S. produce initiative. The best practice documents are the recommendations created and agreed to by all facets of the produce industry supply chain and PTI Leadership Council.

Consent between trading partners may replace specific recommendations as long as the minimum traceability information requirements are met in good faith.

## Revision History

This section itemizes the changes from the last published Best Practice.

<u>Version No.</u>	<u>Date of Change</u>	<u>Changed By</u>	<u>Summary of Change</u>
1.0	12/16/11	PTI Direct Print Task Force, Subgroup of Technology Working Group (TWG)	Document created

## Objectives

The purpose of this document is to provide assistance for suppliers (i.e., grower/shipper/manufacturer) in becoming PTI compliant with regard to barcode print quality/grading. This assistance is in the form of technical information and best practices within this document.

## **Introduction**

A large number of suppliers currently use direct mark equipment for labeling directly on corrugated kraft (brown), white bleached, and white printed. These suppliers have found that the symbol contrast between brown kraft boxes and black barcodes lowers the overall grade to less than 1.5. However, bleached kraft or white printed boxes on brown kraft can provide enough contrast for PTI compliant direct print GS1-128 barcodes assuming one uses high resolution, well-maintained and monitored direct print equipment. In order to meet PTI guidelines, a GS1-128 barcode with a quality/grading of 1.5 (“C”) or better is recommended to be on every case.

## **Direct Print Methods for Barcodes & Definitions**

1. **Drop on Demand High Resolution Inkjet:** An inkjet printing system uses print heads containing piezo electric arrays which, when energized, emit droplets of ink onto the presented surface (typically a corrugated carton). These droplets can be arranged to print text, logos, and barcodes. The control system for these print heads is typically processor based, and can accept data input from a number of sources, including but not limited to a keyboard, scanner, scale, database, network, or other intelligent devices.
2. **Thermal Inkjet (TIJ):** The Thermal Inkjet incorporates a heater located in the floor of an ink channel near the exit nozzle. A liquid-to-vapor-transition results in a volume expansion of the heated liquid.
3. **Industrial Laser Coding:** This method uses CO2 laser technology to mark products by producing intense pulses of light that are deflected to form characters. Laser coding is achieved by removing material or a coating from the product or packaging, or by changing the surface of the substrate.
4. **Digital Tissue Stencil Process:** A master stencil is created via a digital process which includes the required barcode. The stencil is affixed to an inked rotary drum, where the cartons are printed in a flat form. This is an off line process, also known as Mimeography.

NOTE: This type of printing process must comply with the GS1 Standards for GS1-128 barcode labeling.

## **Technical Specifications**

Below is a summary of print quality grading parameters. Details are found in the ISO Print Quality Standard, ISO/IEC 15416 and the GS1 General Specifications.

1. ISO Print Quality Grading Chart - Barcode verifiers provide grades that report against the ISO Standard ISO/IEC 15416 and conform to ISO/IEC 15426-1.

<b>ISO/IEC Grade</b>	<b>ANSI Letter Equivalent</b>	
≥ 3.5	A	
≥ 2.5 and < 3.5	B	
≥ 1.5 and < 2.5	C	
≥ 0.5 and < 1.5	D	<b>Does not conform to the GS1 Standards for the GS1-128 barcode</b>
< 0.5	F	

2. Printing guide for darkness, contrast, dimensional tolerances.
3. Parameters for GS1/ISO Print Quality Grading<sup>1</sup>
  - a. List of nine specific areas that affect print quality and their definitions can be found in ISO/IEC 15416 or the AIM (Association for Automatic Identification and Mobility<sup>2</sup>) Layman's Guide to ANSI, CEN, and ISO Bar Code Print Quality Documents
    - i. Edge Determination (ED)
    - ii. Minimum Reflectance ( $R_{MIN}$ )
    - iii. Minimum Edge Contrast ( $EC_{MIN}$ )
    - iv. Symbol Contrast (SC)
    - v. Modulation (MOD)
    - vi. Defects (DEF)
    - vii. Decodability (DEC)
    - viii. Decode (DCD)
    - ix. Quiet Zones (QZ)

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<sup>1</sup> Details and definitions for the nine parameters on print quality can be found in Section 3 of AIM Layman's Guide ANSI-CEN-ISO and Section 5.4 of ISO/IEC 15416 (2000) ED1

<sup>2</sup> AIM Website: [www.aimglobal.org/](http://www.aimglobal.org/)

## Levels Needed to Achieve Minimum Print Quality Grading

Specifics for the nine parameters needed to achieve a 1.5 overall print quality grade:

Grade	ED	R <sub>MIN</sub>	EC <sub>MIN</sub>	SC	MOD	DEF	DEC	DCD	QZ
4.0	PASS	≤ 0.5 * R <sub>MAX</sub>	≥ 15%	≥ 77.5%	≥ 75%	≤ 12.5%	≥ 68%	PASS	PASS
3.0				≥ 62.5%	≥ 65%	≤ 17.5%	≥ 56%		
2.0				≥ 47.5%	≥ 55%	≤ 22.5%	≥ 43.5%		
1.5				≥ 40%	≥ 50%	≤ 25%	≥ 37%		
1.0				≥ 30%	≥ 45%	≤ 27.5%	≥ 31%		
0.0	FAIL	> 0.5 * R <sub>MAX</sub>	< 15%	< 10%	< 35%	> 32.5%	< 19%	FAIL	FAIL

## Methods for Print Quality Grading

1. The individual scan grade is the lowest grade obtained for any of the print quality parameters contained above. For example, if a grade of 4.0 (A) or Pass is received for all print quality parameters except for Modulation, which received a grade of 2.0 (C). The lowest of the grades for the following parameters equals the individual scan grade.

Scan Grade	ED	R <sub>MIN</sub>	EC <sub>MIN</sub>	SC	MOD	DEF	DEC	DCD	QZ
2.0	PASS	4.0	4.0	4.0	2.0	4.0	4.0	PASS	PASS

2. There are commercially available print quality verifiers that report against the ISO Print Quality and GS1 System of Standards. The verifier should inspect the quality of the barcode image via the ISO/IEC 15416 methodology and the verifier itself should conform to ISO/IEC 15426. For more information see the section below, in Print Quality Testing Process #4 of this document on Print Quality Standards.

## Operational Challenges

1. Size of Barcode
2. Maintenance and Adjustments
3. Conveyor Requirements
  - a. Consistency of distance to application surface
  - b. Smoothness of the conveyance (Belt vs. Roller)
4. Types of Inks

5. Print Surface
  - a. Direct print to the corrugate box
  - b. Direct print onto a film or alternate transfer material to the corrugate box
  
6. Type of Box (Kraft vs. White Box)
  - a. Corrugated board (alternately known as containerboard, liner, and sometimes incorrectly referred to as cardboard) is primarily produced in both a brown color known as kraft, and varying shades of white. Kraft normally has a brown, textured surface. Typically, manufacturers of the basic kraft papers used in corrugated production do not use brightness or reflection as a measured attribute of their material, so the color or reflectance of the surface is highly variable between paper mills and manufacturing runs. The fibers of the paper also produce a surface texture that can alternate between dark and light. Combined with the surface color and reflectance variations, when corrugated, the combined papers can exhibit a “washboard” surface with high and low areas corresponding to the flutes of the corrugated medium.
  - b. The color or reflectance of a kraft liner can affect the ability of an inkjet or direct-print system to produce a conforming barcode image. This can produce a lighter and darker image due to variation in printing method. White liners do not tend to suffer from this issue, so for the most part, unless they are manufactured from highly recycled fibers that absorb ink instead of allowing it to sit cleanly upon the surface, they are fairly good at providing a good surface for inkjet image application.
  - c. Corrugate board (also known as cardboard and fiberboard) usually has a brown, textured surface. The brown surface reduces the contrast. The light value of the brown surface can fluctuate greatly from one batch of corrugate to the next. The fibers of the paper produce a surface texture alternating between lighter and darker areas. This may also lead to defects. The surface is normally slightly fluting. If barcodes are printed onto this surface, some bars are more heavily printed at the top of the fluting, making them wider than other bars. *Source: GSI Barcode Verification for Linear Symbols, Version 4.3, May 2009*
  - d. The reflectance value of the brown kraft surface will vary from production batch to batch, typically within a range of 27-33%, when measured via the methodology described in ISO/IEC 15416. Refer to section ‘Levels Needed to Achieve Minimum Print Quality Grading’ of this document for more information.

## **Print Quality Testing Process**

1. It is strongly recommended that an internal barcode print quality verification schedule be developed, and that verification data be tracked and recorded for future reference in case of a customer inquiry.

2. Internal Print Quality Process

- a. How Often - The frequency of the barcode inspection will depend upon the vendor and their determination of the needs of the printing process. (An ISO 9002 quality system is an example.) On one hand a low level statistical (once every 2 hours for instance) may be appropriate while another printing process may have so many variables a 100% inline inspection process may be advised.
- b. Tracking results

3. Methods of Print Verification

- a. This is the responsibility of the printer. A variety of contact and non-contact systems are available with the biggest requirement that the system be ISO 16426 compliant.

4. To simulate an example, a calculated Overall Symbol Grade is usually based on ten or more individual scan grades received below and the average of their resultant scan grades. The number of scans may be determined by the frequency highlighted above in #2. For explicit detail on barcode print quality verification, please refer to *ISO/IEC 15416 and the AIM Layman’s Guide to ANSI, CEN, and ISO Bar Code Print Quality Documents* in the “References” section at the end of this document.

Scan Grade	ED	R <sub>MIN</sub>	EC <sub>MIN</sub>	SC	MOD	DEF	DEC	DCD	QZ
2.0	PASS	4.0	4.0	4.0	2.0	4.0	4.0	PASS	PASS
1.2	PASS	4.0	4.0	4.0	1.2	4.0	4.0	PASS	PASS
2.4	PASS	4.0	4.0	4.0	2.4	4.0	4.0	PASS	PASS
2.1	PASS	4.0	4.0	4.0	2.1	4.0	4.0	PASS	PASS
1.9	PASS	4.0	4.0	4.0	1.9	4.0	4.0	PASS	PASS
1.8	PASS	4.0	4.0	4.0	1.8	4.0	4.0	PASS	PASS
2.2	PASS	4.0	4.0	4.0	2.2	4.0	4.0	PASS	PASS
2.4	PASS	4.0	4.0	4.0	2.4	4.0	4.0	PASS	PASS
2.4	PASS	4.0	4.0	4.0	2.4	4.0	4.0	PASS	PASS
2.1	PASS	4.0	4.0	4.0	2.1	4.0	4.0	PASS	PASS

Overall Grade	ED	R <sub>MIN</sub>	EC <sub>MIN</sub>	SC	MOD	DEF	DEC	DCD	QZ
2.1	PASS	4.0	4.0	4.0	2.1	4.0	4.0	PASS	PASS

## **Best Practices for Drop On-Demand High Resolution Inkjet Printers**

1. Select a printer that provides adequate code integrity features (i.e., helps ensure you print the correct information on the correct case at the correct time) and operate to leverage those features.
  - a. Take advantage and maintain discipline on password features to appropriately limit access to printer functions;
  - b. To the degree allowed by the printer, limit the amount of operator engagement at the printer to minimum necessary – most errors are introduced through message selection or editing errors; and
  - c. Where possible, operate the printer accessing a database (message database, ERP, other) for messages and any variable information (e.g., lot number) instead of manual message select or edit.
2. Operate and maintain the printer according to manufacturer instructions, particularly with regard to regular preventative maintenance.
3. The case must be transported on a conveyor, which supplies smooth movement of the product as it passes the print heads.
  - a. Examples of conveyors that are capable of providing smooth movement include:
    - i. Flatbed belt conveyor – this conveyor uses a belt conveyor running across a flat plate. A seamless belt can be used to help prevent unwanted movement of the case or encoder.
    - ii. Table Top/Chain conveyor – This is a conveyor system based on a close-fitting, multiflex plastic chain.
  - b. Examples of conveyors that are not suited for high resolution inkjet barcoding:
    - i. Roller conveyors – Either powered or gravity
    - ii. Skate conveyors
    - iii. Belt over roller conveyors
  - c. Work with your printing supplier to determine the best solution for your application.
4. Encoders are recommended to ensure the printer can adjust to any variations in the conveyor speed.
  - a. The mounting structure and position of the encoder is critical.
  - b. The encoder must be mounted at a location that accurately mimics the speed of the conveyor belt at the print head.

5. Guide rails are necessary to accurately and consistently present the carton to the print heads for marking.
  - a. In some instances, it may be necessary to install a print head slide system to allow the print head to maintain a consistent distance from the print surface.
  - b. Print head slides may be beneficial when carton sizes and shapes are inconsistent.
  
6. Reduce or eliminate any vibration at the print head.
  - a. Any vibration at the print head may cause degradation in print quality.
  - b. If print heads are mounted directly to the conveyor, vibration can be transferred from the conveyor to the print head. A way to eliminate this vibration transference is to use floor mount stands.
    - i. Floor mount stands should be of solid construction to prevent motion.
    - ii. Floor mount stands should be permanently fastened to the floor.

## **Working with Printer Dots Per Inch (DPI) and Mils**

Selecting the correct X-dimension based on printer resolution.

- a. The quality of a printed barcode is directly related to the density or resolution of a printer. An image is applied to a substrate based on a series of dots, or pixels being activated. The more pixels available on a printer, the clearer the image.
  
- b. Print heads are typically available in five different pixel densities. See table below for more information on pixel sizes:

<b>Pixel Density (dpi)</b>	<b>Pixel Size (mils)</b>	<b>Rounded (mils)</b>	<b>Pixel Size (mm)</b>
152	6.5789	7	0.1671
203	4.9261	5	0.1251
300	3.3333	4	0.0847
406	2.4631	3	0.0626
600	1.6667	2	0.0423

- c. Be sure to get the printer that best suits your needs. For example, you may want to print a GS1-128 barcode with an X-dimension of 0.015", or 15 mils. In this case, you would need a printer with at least a 152-dpi print head. An X-dimension barcode may be measured in mils, which is 1/1000th of an inch. If you need to print a barcode having a 15 mil X-dimension, then the width of the narrowest bar in the barcode would be 15/1000ths of an inch wide.
  
- d. In order to develop the barcode, you need to know the printer pixel resolution, or width of each dot created by the print head to make sure that the barcode may be printed. These dots, or pixels are measured in *mils* where an inch is 1000/1000 mils.



- e. Evaluating a 203-dpi print head:
- i. Divide 1000 by the print head resolution (203 dpi) to determine the actual pixel size.

$$1000 \div 203 = 4.926$$

- ii. Rounding up, we determine that the pixel size is **5 mils**.
- iii. Therefore, if you want to print a 15-mil barcode, a 203-dpi print head would work. Each dot is 5 mils, turn three of them on, and you have 15 mils.

## **Communicating Variances**

Consent between trading partners may replace specific recommendations as long as the minimum traceability information requirements are met in good faith.

## **References**

- **ISO/IEC 15416:2000** Information technology – Automatic identification and data capture techniques – Barcode print quality test specification – Linear symbols.  
[www.iso.org/iso/catalogue\\_detail?csnumber=27659](http://www.iso.org/iso/catalogue_detail?csnumber=27659)
- **ISO/IEC 15426-1:2006** Information technology – Automatic identification and data capture techniques – Bar code verifier conformance specification – Part 1: Linear symbols.  
[www.iso.org/iso/iso\\_catalogue/catalogue\\_tc/catalogue\\_detail.htm?csnumber=43643](http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=43643)
- **The Layman`s Guide to ANSI, CEN, and ISO Bar Code Print Quality Documents**  
[www.aimglobal.org/estore/ProductDetails.aspx?productID=288](http://www.aimglobal.org/estore/ProductDetails.aspx?productID=288)
- **GS1 General Specifications**, [www.gs1.org/barcodes/technical/genspecs](http://www.gs1.org/barcodes/technical/genspecs)