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Guideline for direct contact printing of bar code symbols on corrugated

Scope

This guideline document is intended to provide information on the direct contact printing of linear (2-dimensional) bar code symbols on corrugated board using printing equipment commonly available in the corrugated industry.

Typical symbologies direct printed on corrugated include the following:

- Interleaved Two of Five (ITF, ITF-14).
 - > Most frequently printed as ITF-14 and otherwise known as the “Corrugated Case Code,” “the Shipping Container Symbol”, or the “Warehouse Code.”
 - > This symbology may also be used by customers in a shortened form for their own internal distribution needs.
- UPC-A and UPC/EAN-13. These are the 12 and 13 character versions of the retail check out code.
- Code-128 (UCC/EAN-128).
- Code 39 (also known as Code 3 of 9).

Sophisticated multicolor corrugated board printing presses and pre-print liner presses have the capability to hold tighter dimensional tolerances when compared to conventional 2 and 3 color corrugated printing equipment. These more sophisticated printing presses, upon completion of successful trials, may be able to print smaller magnification factors of various bar codes than referenced in this document. The key requirement is trial and error to understand a given piece of printing equipment’s dimensional limitations. However, the notations on Print Contrast (Symbol Contrast) are applicable for all types of corrugated printing equipment from older 2-color presses to new multicolor pre-print presses.

Comments on ink jet printing on corrugated boxes are also included.

Definitions

ANSI	American National Standards Institute
EAN	European Article Numbering
UCC	Uniform Code Council

Safety precautions

If paper knives or cutting tools are used in sample preparation, appropriate care must be taken to prevent knife cuts. If verification devices have a laser light source, care must be taken to insure the light source is never directed at the human eye.

Printing plates

NOTE 1: Comments on printing plates are applicable to photopolymer and laser engraved rubber. For best results, molded rubber printing plates, even if available, should not be used for printing bar codes on corrugated.

- Bar code printing plates should be purchased such that the width of bars in the printing plate are delivered to the corrugated printer at a finished X bar dimension at the bottom range of the tolerance of the symbology, and magnification factor of that symbology, being printed. (See Note 2 below). The **finished bar width** is to be the dimension specified by the printer at $-0.000/+0.001$ in. (0.025 mm).

NOTE 2: This practice is necessary because direct contact printed bar code symbols “print” wider than the actual width of the bars in the printing plate **due to ink absorption (wicking) as well as distortion caused by the pressure of the impression cylinder against the substrate**. The difference between the nominal bar dimension and the specified bar width for printing plates is called Bar Width Reduction (BWR). Both wide and narrow bars have the same BWR. In addition, the bar code’s “spaces” in the printing plate are correspondingly wider than nominal by the same BWR dimension that is used to narrow the bars. The net result is that the overall symbol length of both the printing plate and the printed symbol meets the nominal dimension specified for the symbol. Ordering printing plates in the above described manner gives the printer nearly the entire tolerance of the symbol being printed to accommodate “print gain” (the growth in dimension between the actual bar width on the printing plate and the finished printed bar dimension) while still being dimensionally “in spec”.

Example: 100% magnification, Interleaved 2 of 5 (ITF) Symbol. The narrow bar dimension specification is 0.040 in. (1.016 mm) ± 0.012 in. (0.305 mm). Therefore, the narrow bars on the finished photopolymer printing plate should be 0.028 in. (7.11 mm) $-0.000/+0.001$ in. (0.025 mm).

NOTE 3: Another reason for ordering printing plates with bars at the full minus of the tolerance is that scanners tend to “read” bar codes with narrow bars more easily than they “read” bars that are “fat” (printed on the “wide” side of the tolerance).

NOTE 4: General printing plate wear should not affect bar width significantly. Any slight wear of the bar edges should be compensated for by the angle built into the relief of the printing plates.

- Bar code printing plates for direct contact printing the ITF Symbol on corrugated substrates must have a **bearer bar** that completely surrounds the bar code symbol and its “quiet zone.” (Ref. the joint EAN/UCC General Specification Rev. 6). While specifications for other bar codes do not require bearer bars, the use of bearer bars for direct contact printing of all types of bar codes is very strongly recommended in order to produce the best results.

NOTE 5: The nominal specified minimum dimension of the Quiet Zone for most symbologies is 10 times (10x) the nominal narrow bar dimensions for the symbol size and magnification factor being printed. There have been several instances of Quiet Zone failure based on squeeze out of the Bearer Bar. It is strongly recommended that corrugated printers specify a minimum Quiet Zone of 12 times (12x) the nominal narrow bar of the symbol being printed.

- It is the responsibility of the corrugated printer to specify to the printing plate maker whether or not the bar code is printed in the **picket fence** (bars parallel to the printing press direction) **or stepladder** (bars perpendicular to the printing press direction) configuration. The printing plate maker has the responsibility to manufacture the bar code printing plate to the corrugated printer’s specifications, taking into account any known accommodation for a “stretch factor” for the **stepladder** configuration.
- Because some corrugated customers supply printing plates to corrugated plants, plants receiving customer-supplied printing plates should communicate a clear understanding of the corrugated **printer’s specifications** (requirements) for bar code printing plates to their customers and in some instances their customers’ customers. Minimum sizes of the various codes that the corrugated printer will print and the finished printing plate bar dimensions specified for typical magnification factors of these bar codes should be included in such communication.

- The plate maker should always supply a “**proof**” of the bar code printing plate. The proof is useful to check off the human-readable characters. The customer should also sign off on the proof, affirming that the human-readable characters are those that are intended and which match the product being packaged.
- The finished bar code printing plate should be within ± 0.002 (0.050 mm) of the **caliper** (height) of the other printing plates in the mount (prior to mounting).
- **Durometer** of printing plates today is typically between 30 and 40 (Shore A units) and this range of durometer values has proven to work well on most substrates for direct contact printing bar codes on corrugated.
- With the use of liquid or sheet photopolymer printing plates, most issues with regard to ink acceptance, ink release, and substrate acceptance have worked themselves out. Should box plants have problems with ink transfer (insufficient, excess, or “wicking”), boxmakers, in addition to consulting with their ink and printing plate suppliers, should involve their liner supplier(s). It is possible that a high hold out substrate, common in some full bleached or highly sized liners, or very water absorbent liners, possible if sizing is insufficient, could be the root cause of the problem.
- **Film master** procurement, when required, is the responsibility of the printing plate supplier.

Today, many bar code images are produced on a computer and are transmitted directly to the printing plate making machinery. Whether a film master or a direct computer generated image is used, the responsibility of the printing plate maker is to produce the finished printing plate to the specifications of the corrugated printer as noted in the initial bullets of this section. The film master, when used, is part of the printing plate manufacturer’s process, not the box maker’s process.

Printing plates - areas of disagreement

There remain many areas of disagreement among corrugated printers regarding printing plate practices for Bar Code printing.

- Most corrugated printers do not mix photopolymer and rubber plates on the same mount, although some do without any apparent degradation in bar code quality.
- Most corrugated printers do not incorporate any new bar code printing plates into an existing mounted set of previously used printing plates (**slugging**). However, some corrugated printers use the mouter-proofer to build up the older plates so that all plates in the finished mount are at nominal ± 0.005 in. (0.127 mm).
- An alternative to slugging for one-color jobs (or where the total number of colors required is one less than the number of colors on the printing press) is to print the bar code on an unused printing station. Essentially, this turns a one-color job into a two-color job, even if both colors are the same
- Many corrugated printers advocate the use of **thin printing plates** plus the use of a compressible backing. The theory is that the compressible backing will provide some “give” as the printing plates make contact with the substrate, thereby minimizing bar width growth due to squeeze or deformation of the printing plate material during the printing process.

Other printers have experimented with thin printing plates mounted on a solid built-up backing to meet the overall plate thickness specification of the printing press cylinders. The theory here is that the reduced amount of material in thin plates will deform less than conventional height plates under operating conditions.

Yet many corrugated printers produce excellent bar codes with traditional 0.250 in. (6.350 mm) caliper printing plates with no special backing.

- Many corrugated printers believe that bar code quality deteriorates when symbology printing is done with the bars perpendicular to the press direction (stepladder configuration) or when the bars are printed perpendicular to the corrugated **flute direction**. In the former situation “stretch” is not perfectly controllable. In the latter situation, if the substrate has any “washboarding” (a controllable corrugator problem, not a printing problem) the bars may print wider at the crossing of each flute.
- Given the divergent viewpoints of corrugated printers on the subject of printing plates, it is not surprising that different plants develop different, yet successful, procedures with regard to printing bar codes. The recommendation with regard to printing plate practices is for each plant to document its successful practices and operate in accordance with those practices, even if extra expenditures for printing plates are necessary.
- Where customer involvement is required because customers provide printing plates, the documented practices should be shared with those customers so that printing plates meeting the plant’s specifications can be provided. When customers supply common printing plates to more than one corrugated supplier, a slightly different bar code printing plate may have to be supplied to each corrugated supplier for the same final print job.

Ink

- Users must specify and printers must use a color in combination with a substrate that will meet the Symbol Contrast requirements of the symbology being printed.

Example: The colors shown below (Ref: Flexo Color Guide for Printing Inks on Corrugated, Edition IX published by the Glass Packaging Institute), when printed using good quality ink, and when combined with the nominal reflectance range of natural kraft colored substrates, have been shown to be able to meet an ANSI “D” (.5/20/670) minimum grade for Symbol Contrast when printing the ITF-14 symbology.

Best

GCMI 90 Black
GCMI 30 Blue
GCMI 33 Blue
GCMI 39 Blue
GCMI 3086 Blue

Fair

GCMI 38 Blue
GCMI 387 Blue
GCMI 3213 Aqua
GCMI 2008 Green
GCMI 523 Brown

Good

GCMI 31 Blue
GCMI 32 Blue
GCMI 34 Blue
GCMI 300 Blue
GCMI 394 Blue
GCMI 20 Green
GCMI 21 Green
GCMI 24 Green
GCMI 25 Green

Marginal (Trial with customer before using)

GCMI 3229 Blue
GCMI 29 Green
GCMI 52 Brown

For White Top and full bleached substrates, a wider range of colors may be used. It is recommended that box plants go through a trial process to confirm that a given color will meet the ANSI Symbol Contrast requirements for the symbol being printed.

Many symbologies require an ANSI “C” [1.5/6 or 10 (depending on the Symbology)/670] grade as a passing grade. Symbols requiring an ANSI “C” as a passing grade cannot be printed on natural kraft colored liners and still meet
