Bar code Verifier Conformance Specifications

Using the INTEGRA-9000

From:
Label Vision Systems, Inc. (LVS)

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INTRODUCTION

Printed bar code quality was first addressed by the Uniform Code Council (UCC) using UPC symbols. Then in 1990 the American National Standard Institute (ANSI) published the first manual for Bar Code Print Quality (ANSI X3.182-1990). This document outlines the parameters of bar code print quality based upon the optics of a bar code scanning system. These parameters were now to be tested with respect to the analog electronic signal generated by the optical image detector found within all scanners. This analog electronic signal was now to be called a Scan Reflectance Profile (SRP). Grade quality for any given label would now be based upon formulas surrounding the SRP.

ANSI updated their document in 1995. At the same time, the Committee for European Normalization (CEN) and the International Standards Organizations (ISO) published their version of printed bar code quality. (Document number: EN 1635)

In the year 2000, ANSI, CEN, and ISO decided to publish one document designed to unify all bar code quality specifications throughout the world. The document number is: ISO/IEC 15416:2000(E). This document is what we use today and is recognized by UCC, AIAG, HIBCC, and EAN.

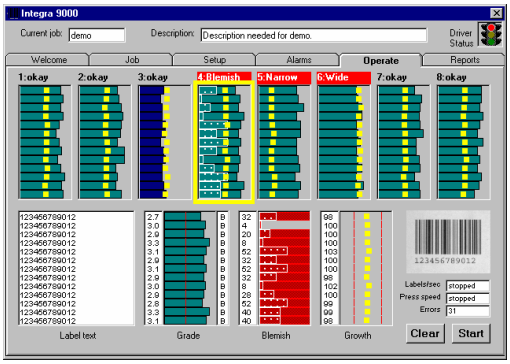
The INTEGRA-9000 is a vision based "on-line" bar code verification system. Correlation to the ISO/IEC standards is imperative. This documentation provides our customers with all correlation methods used in following the ISO/IEC 15416:2000(E) standards.

In the process of correlating the INTEGRA -9000 vision based system to the ISO/ANSI standards, a set of Primary Calibration Standard labels purchased from Applied Image, Rochester, NY were used. This process of correlation was completed at the factory. There is no need to recalibrate to the Primary Calibration Standards again. However, a Secondary Calibration Standard label should be used weekly. Each system comes with a Contrast Calibration Label, a Certificate of Compliance, and a Secondary Calibration Label. The Secondary Calibration Label was made by Applied Image and is sold to the consumer through the UCC. They can be contacted at:

Uniform Code Council
8163 Old Yankee Street Suite J
Dayton, Ohio 45458
937-435-3870

Figure:1

INTEGRA-9000 ***OPERATE SCREEN***



STATIC verses. DYNAMIC VERIFICATION

There are two kinds of verifiers, static and dynamic. A "static" verifier is one that is used to verify the quality of a bar code symbol which is not in motion. In other words, it is being checked "off-line". A "dynamic" verifier is one that is used to verify the quality of a bar code symbol while it is in motion or "on-line".

The INTEGRA-9000 is a dynamic verification system. It is used to check the quality of bar code symbols as they are being printed. Speeds greater than 1000 feet per minute have been achieved. It is capable of grading 480 different bar code symbols per second in any orientation. A "real-time" (See Figure: 1) graph is displayed on a computer monitor that gives the operator full knowledge of over-all grade quality as they are being printed. If and when the printing process begins to deviate in quality, the INTEGRA-9000 reports this trend as it happens. The operator can then make an adjustment to the printing process…...correct the problem….and continue to print quality labels…...with little or no "downtime".

The INTEGRA-9000 software does not recognize motion. Bar code label images are collected as a whole. The number of scans it uses to determine a grade depends on the height of bar code. A typical 100% UPC label will be scanned 150 times at any speed and in any orientation providing the bars of the code are perpendicular to the field of view. Every .006" of bar height is checked for quality. This system identifies the quality of labels in motion as if it was being done "statically".

TARGET LABEL

The INTEGRA-9000 requires the first label to be seen at the beginning of a job run must be of a known ISO/ ANSI grade. This causes software to understand what is considered "normal" under the conditions presented to the camera at the time a job is being run. Variances in ambient light, frequency of light, iris setting, focus setting, changes in light linearity, object size are all taken into consideration at the point of SETUP. After calibration is set during the SETUP mode, all known variables are understood and "normal" is defined.

During this calibration SETUP, the INTEGRA 9000 will evaluate the "target label" and establish its ISO/ANSI grade. An independent certified verifier is used to check the same label and the two results are compared. If they do not agree, then (if necessary), a manual entry can be made to teach software the corrected ISO/ANSI value.

WARNING: ***Dynamically testing the quality of bar code symbols accurately depends greatly upon how software defines the TARGET LABEL. Using the two verifier approach allows the operator to know that the INTEGRA-9000 has been set up properly. Without this approach the operator can inadvertently set up software to teach the INTEGRA-9000 wrong values.***

LIGHT SOURCE and APERTURE

Vision based systems use a diffuse light source and then use an array of tightly spaced horizontal pixels mounted on a chip (CCD CHIP) to examine the reflected image. And, with vision, the aperture is called by a different name. It is called the iris. The iris controls the amount of light entering the CCD chip. The iris must be adjusted according to a Contrast Calibration Label supplied with the system. This teaches the INTEGRA - 9000 system to correlate light intensity to the established Standards according to the measured bar width. This aperture adjustment is done automatically during the SETUP of all jobs.

The ISO/ANSI standards state that the wavelength of a diffuse light source must be suited to the intended scanning environment. The INTEGRA -9000 will use a DC Fluorescent white light source, a xenon strobe white light, with a Wratten 26 red filter. Each customer will be different depending on their needs.

A xenon strobe is used to eliminate the effects of motion for high speed applications which might exceed 300 feet per minute. A DC Fluorescent light source is used in applications where the web speed is less than 300 feet per minute.

The SCAN REFLECTANCE PROFILE

The bar code image is focused on the video camera's array of horizontal pixels. These small pixels (12 microns square) create a string of DC levels that represent the bars and spaces of the bar code image. Wand based systems would call this string of data a Scan Reflectance Profile (SRP). In the world of vision it is called a Video Signal Profile (VSP). The SRP and the VSP are the same thing.

The video camera should have a horizontal pixel count greater than 760 pixels in order to obtain data resolute enough to measure high density bar code labels.

With a camera, lens, and linear light source, a VSP is generated for every .006 inch of bar height. The VSP is then sent to the microprocessor for decoding. With vision, the actual x-dimension (smallest bar width in a bar code image) for a given label does not really change. By using different lenses a 2 mil label is no different than a 20 mil label. Since laser based systems are limited in their resolution, certain attention must be given to the measured x-dimension with respect to the resolution of the intended scanning environment. In other words, the INTEGRA-9000 system can correlate any size bar width label, but that doesn't mean the intended reading device has the resolution capable of seeing it.

The SRP is what all verification software uses to inspect quality. With a wand based system, the SRP is obtained by moving the wand (called scanning) somewhat quickly through the bar and spaces of the bar code image. This presents many challenges to operators who are trying to understand bar code quality since no two scans are alike. No two operators will scan the same. Too fast, too slow, too much of an angle, or too much of a jerky motion are some of many problems associated with wand based verification. It is also impossible for a wand based verifier to scan bar code labels as it would be scanned at the grocery store. Nearly all retail stores now use vision (CCD) or laser technology. With the addition of two-dimensional coding, verifiers of the future will all be vision based.
A Scan Reflectance Profile (SRP) can be represented as an X-Y graph. X would represent a measurement of time while Y would represent the amplitude of reflected light. Points and distances along the X-axis are completely relative.

The Y-axis of the SRP is a measurement of reflectivity. A wand based system will measure the highest possible point (white) as 100% reflectivity. The lowest possible point is 0% reflectivity (black). The points and distances along the Y-axis are absolute, not relative.

ISO/ANSI established the following list of measurements to determine bar code symbol quality. Next to the measurement indicates which axis (X-Y chart) of the Scan Reflectance Profile is being measured.

1. Edge determination
2. Reflectance minimum (Y-axis)
3. Edge contrast minimum (Y-axis)
4. Symbol contrast (Y-axis)
5. Modulation (Y-axis)
6. Defects (Y-axis)
7. Decodability (X-axis)
8. Decode
9. Overall grade

EDGE DETERMINATION

The ISO/ANSI formula for Edge Determination is directly related to the placement of the Global Threshold. The Global Threshold (GT) is defined as a DC voltage level positioned on a SRP or a VSP half way between the highest reflectance DC level and the lowest reflectance DC level. Software for the INTEGRA-9000 modulates the GT in order to establish an absolute level of reflectance. We call this a Managed Global Threshold (MGT) and is the heartbeat of the LVS system. MGT is better explained later.

The Global Threshold is placed at a DC position to this formula.

$$GT = Rmin + SC/2$$

If the GT is at this position and the bar code label image meets the decodability requirements then it is decodable and considered to PASS the Edge Determination test.

Software evaluates Edge Determination every .006 inch of bar height

MINIMUM REFLECTANCE

The ISO/ANSI formula for Minimum Reflectance is based on the DC amplitude difference between the greatest value of reflectance (spaces) and the smallest value of reflectance (bars) as observed in a SRP. It passes if the smallest value of reflectance is less than or equal to 50% of the greatest value. LVS software uses a MANAGED GLOBAL THRESHOLD (MGT) as established during SETUP.

Any reflectance value deviation from "normal" will be detected and, consequently, will vary the Symbol Grade Score. "Normal" is defined as the level of reflectance obtained from the ISO/ANSI verified TARGET LABEL during SETUP. The INTEGRA-9000 does not grade Minimum Reflectance as a PASS or FAIL, it is reported as a defect when software compares it to what is "normal". This is a Y-axis measurement. But, if a label degraded to where the minimum reflectance is greater than half of maximum reflectance, then the VSP could never duplicate what was measured during SETUP, and therefore report an "F" GRADE.

Software checks for minimum reflectance every .006 inch of bar height.

MANAGED GLOBAL THRESHOLD (MGT)

The Managed Global Threshold is the key to the Integra-9000 process of verification. This method allows software to monitor the Y-axis positive and negative peaks of the VSP and reports any changes form what was determined as "normal" during SETUP. Another name for MGT is SWEEP. When a bar code symbol begins to have problems (Y-axis problems), it is first to show at the extreme peaks, both positive and negative, of the VSP. Software spends most of its time monitoring these peaks.

MINIMUM EDGE CONTRAST

The ISO/ANSI formula for Minimum Edge Contrast is based on the smallest DC amplitude of a bar/space Transition as observed in a SRP/VSP. It is a Y-axis measurement. If the deviation is greater than 15% it is considered a PASS. Our system will report an "F" grade for any edge contrast level less than 15%. The "Managed Global Threshold" (MGT) method of measurement is used to establish edge contrast deviation percentages.

Software checks for Minimum Edge Contrast every .006 inch of bar height.

SYMBOL CONTRAST

Symbol contrast is measured the same way Minimum Edge Contrast was measured. It is a Y-axis measurement and is based on the absolute measurement established during SETUP. The amount of sweep measured on the "target label" is how symbol contrast is defined. Any minute change in symbol contrast will be detected at the positive and negative peaks of the SRP then deducted from the symbol grade score. The percentage of undecodable lines caused by the reduced amplitude of the SRP will follow ISO/ANSI's contrast grade percentages very closely.

Software checks for deviations in Symbol Contrast every .006 inch of bar height.

MODULATION

Modulation is ratio of the minimum edge contrast to Symbol contrast inside an SRP. The grade scale for modulation was established during SETUP. It is a Y-axis measurement. Modulations changes are first noticed at the positive and negative peaks of the SRP. This is very similar to Symbol Contrast. Symbol contrast errors will change a multitude of peak amplitudes, where as when Modulation errors occur, only one or two peaks are effected. Software is trained to monitor both types of errors. These changes in modulation affect the overall percentages very close to the ISO modulation percentages. Due to the differences in scales used to determine the ISO/ANSI grades, Modulation errors will be reported slightly higher than actuality.

Software checks for deviations in Modulation every .006 inch of bar height. It will grade according to specifications about 10% harder than recommended. This condition is created because software is trying to follow Symbol contrast, Decodability, and Modulation at the same time.

DECODE

Decode is a Pass / Fail measurement. This rule applies to not only making sure that a bar code symbol can be decoded but also whether the check digit routine is consistent with the rules set up for standard check digits or specially developed check digit routines.

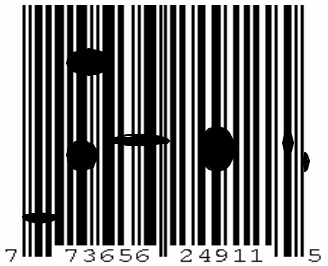
Software checks for Decode every .006 inch of bar height.

DEFECTS

Another unique quality for the INTEGRA -9000 is in its ability to detect all types of blemishes large or small that affect the decode rate of a given label. It is a Y-axis measurement. If the TARGET label used during setup of the INTEGRA -9000 software indicates that there should be 200 decodes per label, then any blemish defect larger than .006 inch would decrease the decode rate by a percentage equal to the height of the defect. The ISO/ANSI GRADE labels made by Applied Images contain calibrated labels that help define what is an acceptable "spot" or "void" defect size. The INTEGRA-9000 does not use this scale of measurement and will not grade the Primary Calibration Standards according to a sliding scale from A (4.0) to F (.5). Instead, software is trained to sound an alarm on "any" defect level detected that is greater than 5% of the bar height. The actual level is set up by the operator during the SETUP process.

The Primary Calibration labels made by Applied Image for "spots" and "voids" were made by creating a "spot" or "void" as a line along the entire bar height of the symbol. In this way, no matter where the operator would scan across the calibration label, a "spot" or "void" error would be found. Due to this one-dimensional approach to ISO/ANSI verification that wands inherently have, it is easy to see why the "spot" and "void" calibration standards were made in this manner. But, a traditional wand or laser based verifier cannot detect a "real" spot or void. A "real" spot or void would cause that line of bar code data to be undecodable. A standard verifier will not report whether the scanned line was good or bad. It doesn't even know it exists. Vision based verification is a two-dimensional process. In the two-dimensional world of vision, "real" spots or voids are called "blemishes". Vision systems look at bar code data contiguously and will know when a line of bar code data is "not" decodable.

The INTEGRA-9000 system checks every .006 inch of bar height for blemishes. The acceptable size for a blemish error is defined during SETUP.



This is an A GRADE label according to verification standards. A verifier cannot detect these ink marks.

DECODABILITY

Decodability is a measure of how close the bar and space widths match ideal values and is an X-axis measurement. ISO/ANSI specifies a different algorithm for each symbology. The INTEGRA 9000 measures the decodability from the sums of adjacent bars and spaces, and implement special algorithms for UPC digits 1,2,7, and 8.

The lookup table used to convert a microprocessor count to an element width will also includes 5 bits (32 possible values) for decodability. The INTEGRA 9000 remembers the worst decodability seen for the entire scan line.

Code 39 and CodaBar have a space called the inter-character gap. The ISO/ANSI specification for decodability does not look at the gap, but the INTEGRA 9000 does. If the gap is more than 1X, then the system will give the symbol a lower grade.

The measurement of Decodability is checked every .006 inch of bar height.

QUIET ZONES

Quiet Zones are a measurement of uniform light contrast, adjacent to the outer edges of the left and right guard bars. This is a Pass / Fail measurement and is an intricate part of what software needs to see in order to decode a particular symbology.

Software checks for presence of a Quiet Zone every .006 inch of bar height.

OVERALL SYMBOL GRADE

The INTEGRA 9000 system cannot define individual problems associated with the SRP/VSP for a given label. It can only determine that its overall Symbol Grade is not how the "target symbol" measured. A line score is determined for each scan line. The line score is a number between 0 and 32. Undecoded scan lines get a line score of 0. Decoded scan lines get a score between 1 (worst) and 32 (best). This is a linear scale and correlates to the ISO/ANSI standards.

The sum of all line scores is called the "symbol score". If a symbol was perfect, it would be equal to 32 times the height of the symbol. Typically, the number is somewhere between 15 and 20 times the height of the symbol.

The INTEGRA-9000 software will see a 100% U.P.C. bar code symbol about 150 times. Since software checks for bar code quality every .006 inch of bar height, we can multiply 150 times .006 inch. This equals to .9 inch which is what a 100% U.P.C. label should measure. This means that software will see this label 150 times at 10 feet per minute or at 1000 feet per minute. It will see the label this many times whether it is in a "ladder" or "picket fence" orientation. According to ISO specifications a verifier needs to scan a bar code symbol 10 times in order to get an accurate picture of bar code quality. The INTEGRA-9000 goes well beyond ISO requirements. Even a truncated UPC label measuring .25 inches would be scanned over 40 times, at any press speed, and in any orientation.

TRUNCATION / BAR HEIGHT

The INTEGRA-9000 measures and checks for the presence of a bar code symbol every .006 inch of bar height. During SETUP, software determines the height of a bar code label by counting how many lines were decoded. A truncated problem will show up as a "blemish". Software can be set to sound an alarm when a bar code label becomes truncated by more than 5%.

OPACITY

For the printing industry OPACITY is defined as the property of a material which allows you to see through a printed label substrate. The INTEGRA 9000 can be used to check for OPACTIY by placing a half black and half white background behind the "job label". Any changes in OPACITY would then be detected as a change in contrast.

A background plate could also be made to appear like the product the label is being used on. SETUP would see the different looking background due to OPACITY and the operator would determine what level of decode rate would be acceptable. Any deviation from "normal" due to OPACITY issues would be tracked.

REPORTED ERRORS AVAILABLE DURING OPERATIONS

The INTEGRA-9000 “Operations Screen” will show the Label Text and trend analysis for ISO/ANSI Grade, Blemish Percent, and Bar Growth / Shrinkage Percent for up to 8 different bar code symbols on one computer screen. Software is set to handle up to 60 different bar code symbols per second, per lane.

Alarms can be set for the following:

No duplicates
Mismatch errors
Checksum errors
Sequence errors
ISO/ANSI grade errors
Blemish errors
Bar shrinkage errors
Bar growth errors
Missing label errors
Good read indicator

Software maintains a REPORTS LOG for all symbols read. It will list the Job number, Job start / stop time, what the ISO/ANSI grade was for every label and what kind of error was detected, and each line of data is date and time stamped.

END

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