A special VFG-GLV Test Target for PostScript output devices

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Abstract

Different test patterns for the use with PostScript output devices like laser printes and laser film exposing units are described. Such test patterns are used for calibration, resolution, spot size, control of exposing light beam, density uniformity, and different screen angle stability. Initially a test target was developed to determine the geometric accuracy of PostScript devices.
This test target was also used to carry out quality tests on different PostScript output devices available after DRUPA 90 and CeBIT 91.
Using the collected information a new digital test target was designed.
The purpose and correct use of such a test target will be explained in this paper and recently reached results will be discussed.

Introduction

Finding an adequate tool for testing postscript laser exposing units and their performance has long been a problem.The different commercially available test targets used in the past did not completely satisfy the necessary requirements: maximum number of test functions on one test target. objective numbers printed out with the test target and cost effective implementation.

System Concepts

Several systems have RIPs that run in a PC and can provide big systems functionally at small system prices for the desktop publishing environment. These complete image and typesetting systems can typically be provided on a PC-basis, with page composition, halftoning and RIP-software. PostScript compatibility is today a simple necessity. Looking in different levels following statements can be made: 300dpi is well suited to internal documentation with text and line graphics, that 300 dpi can't produce a halftone worthy for reproduction, — even 600dpi won't really produce the master vou want.The rule-of thumb for halftones is 10 to 1, that is, you can get a good 55 line per inch screen if you have a 600 dpi printer, — but not even weekly newspapers would settle for a coarse 55 line screen anymore. 800 or 1000 dpi could get you an 85 or 105 line per inch screen, but with 1200 dpi or more on silver halide films, magazine quality 133 line per inch screens are the beginning for a satisfying quality also in a desktop setting.

Overall Target Feature Descrption

To quantify the image quality of a print or copy the following points are very important for almost all possible technologies:
— Resolution
— Uniformity of the solids
— Uniformity of the tints
— Amount of reproducable gray steps

— Halftone reproducability
— Continuouts tone reproduction
— Color accuracy
— Color differentiation in hue
— Edge accuracy
— Sharpness of typefaces
— Reproduction of all type characters

The following features are primarily important:

Text legibility, resolution, focus

As a general rule, human eye legibility requires 9 to 10 scan lines per character, optical character recognition (OCR) needs 12 to 14 scan lines. The user will be able to read a 4 pt text at 300 dpi, a 5 pt text at 240 dpi. Poor character legibility indicates poor focus or poor CCD Modulation transfer response. In addition to text, the user may check the resolution wedges where a multidude of lines produce gradual change in line density from 60 to 400 lines per inch. According to the sampling theory, the maximum image resolution is half of the scanning resolution. Poor resolution readings can indicate poor focus or CCD response and especiallv by exposing units to big laser spot size. Other important features are darkness ranges, the target should include a gray scale block with a special number of density steps.Shading distortion especially non-uniformity across the page. Density uniformity is also another important point for a good functioning test target. Further parameters for testing are: sensitivity range, exact halftoning, moire tendencies, vertical resolution linearity, which can be checked by noting any disruption in the straightness of a diagonal line connecting the two corners of a target. Also aspect ratio is very important by examining the roundness of circles or not distorted rectangle lines across a target. Two other important points have to be mentioned for desingning a good test target: The amount of objective and subjective test elements have to be very well balanced.

1. Subjective evaluation — dependend of the test person
2. Objective evaluation — densitometric evaluation, numbers for resolution or other figures for downloading time a.s.o.

Basic functions using a simple full page bit map
There are three different types of material that one might want to print on page: text, image, and vector graphics. This separation comes naturally from the way we produced documents in the past.

Character generation
In the context of a full bit map, creating characters amounts to setting the propery binary digits to 1's at the proper place in the bit map to represent the shape of the desired character.

Font patterns are usually stored in the printer controller in some form of read only storage (ROM) or downloaded from the controlling computer into the controllers RAM storage. In either case, the patterns are available in the printers controllers storage space as binary valued objects. Using bit maps, character generation amounts to copying the character patterns from the font storage area of the computers memory to the proper position in the full bit map. One technique is to save the patterns in an extension to the full page bit map that will not be printed. Another method for storing the character patterns in the computer memory is having each character stored as a distinct linear sequence of computer words.

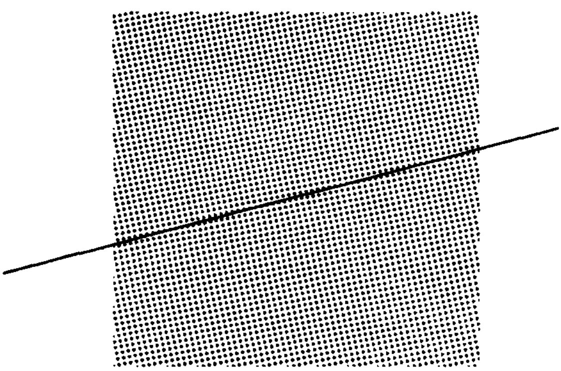
Image generation
In its simplest form, image generation in a page printer controller is just a matter of taking a bit map from the driving computer and placing it into the controllers full page bit map for printing,

One source of image data is photographs. When these pictures are scanned into a computer the usual technique is to represent the range of blackness between white and solid black as a number to represent its gray value (level) . For example 0 may represent black, 255 may represent white and the numbers in between each represent a corresponding value between black and white.

Grahics generation
The simplest grahic object is a straight line. A description of the desired line is supplied to the printer controller using a page description language and it is the controllers job to turn the proper bits to 1 in the full page bit map to make the image line. A line can be specified by a starting point, and a thickness or width. As with the discussion of character generation, we will talk about this process in terms of pels and pel positions since these are the things with which the printer controller must ultimately deal. However, keep in mind that it is preferable in many cases that the page discription language provide dimensions at a more abstract level than printers pels, for example, inches and fractions of inches.

Using the full bit map to print

Once the desired image is formed in the full page bit map, it is used to drive the printing mechanism controlling were black dots are generated and where they are not. The simplest way is to arrange for the computers words P, P plus 1, P plus 2, . . . to be accessed, serialized and the resulting bit string used to control the on/off mechanism of the device. The simplest schemes are where each word of the computer memory provides successive bits for printing and there is some regularity to the sequences of adresses needed to obtain successive words. The more difficult way is to print in »swaths« of rows or columns where each swath is more than one pel high, such as on a wire matrix printer.



The PostScript RT technology cannot yield any screen angle at any screen frequency.

PostScript quality considerations

The PostScript® page description language was developed to be device-independent. The goal was to print with any device at any resolution anywhere. In general, this idea works fine for a wide range of output devices, especially if only text and graphics output is generated.

Quality factors for the output of PostScript files have to consider two main factors:

1. Software quality: The quality of the RIP converting the PostScript code into pixels for the output device
2. Hardware quality: Here we consider the quality of the output device: resolution, spot size, periodic and random noise, positioning accuracy

Software quality

Testing the software quality was not the aim of the test target. Nevertheless, as software routines can help against hardware problems, some tests were included with the test target to allow for checking printer calibration.

Software quality again can be seen in three different ways:

1. Text rendering. This concernces the rendering of characters. The latest type rasterizer is the Adobe ATM (Type Manager) which gives excellent text rendering even on low-res devices.
2. Graphics rendering.
3. Image rendering.

If we consider high-quality halftone image output quality consideration become more important.

First, there is a tradeoff between the screen frequency and the number of gray steps in an image that can be outputted correctly. The test target will generate a fountain fill so that maximum number of reproducable gray steps can be made visible.

There are also some problems concerning the screen angles of the output devices. The 1990-vintage output devices, using RT (locked Rational Tangens) screen angles cannot deliver any screen angles you want. Until the recent cross-licensing-deals between Hell, Optronics, Linotype and Adobe, the patents for high-quality screen angles were in hands of Hell. Adobe could not use these patents.

These screen angles, however, are of vital importance for high-quality color separations. Unless they are used, moiré effects degrade the quality of the output.

Screen problems nowadays are a combined software/hardware problem. They should be solved with Level II PostScript. Tests for the screen angles are included in the VFG-GLV test target.

Hardware

The VFG-GLV test target will test an output device:

— Resolution, adressability and spot size: These are the main quality factors

- Spot positioning. The uniformity of spot positioning is essential for giving uniform screens. If the spot positioning varies in x or y, jitter may result, deteriorating the quality of the output.
- Random and periodic noise: These are mainly mechanic problems. If the drum is vibrating, the spacing between the output lines will vary. A periodic noise will give a moiré pattern.

Note that all quality factors are dealing with the whole system of hardware, software and developing process. Sometimes it will be easy to notice a quality problem but it may be very hard to find the reason for it.

How the test target was developed

The VFG-GLV test target was developed using direct PostScript programming. Being a device-independent page description language there are some problems writing device-specific code. Certain PostScript-commands however, are device-specific. They are not recommended by Adobe to be used for standard output, but they are very useful for the use in a test target.
Let us consider the following code sequence of the VFG-GLV test target:

```
%Resolution Nach: BlueBook
/resmatrix matrix defaultmatrix def
/res
  72 0 resmatrix dtransform
  dup mul exch dup mul add sqrt
def
```

The defaultmatrix operator was not designed by Adobe to give the resolution of an output device. It is a device specific function. The next few lines actually print the nominal screen frequency and the nominal resolution of the device:

```
%Aufloesung ausdrucken
6.5 cm 14.5 cm moveto (Resolution - dpi: ) show
9 cm   14.5 cm moveto res cvi 10 string cvs show
```

More printer parameters
PostScript devices can give some internal information with the use of special variables. In the testform we used standard code to get the nominal screen frequency and the version of the PostScript interpreter running on the device:

```
%Rasterfunktion holen
currentscreen /sfunc exch def
```

```
pop /sfreq exch def
```

together with

```
%sfreq
6.5 cm 15.0 cm moveto (Screen - lpi: ) show
9 cm   15.0 cm moveto sfreq 20 string cvs show
```

print the screen frequency. The next few lines print the version of the PostScript interpreter using the PostScript function version:

```
%PostScript-Version
12 cm 15.5 cm moveto (Version: ) show
13.2 cm 15.5 cm moveto version show
```

These examples show one very interesting feature of a *PostScript* test target. The printing unit is forced to print informations it has gathered during the execution of the program, in this case, the version of the PostScript-Software running.

Resolution

To test the resolution of the output device, one device specific function of PostScript is used. The operator setlinewidth sets the linewidth. With the code segment:

```
0 setlinewith
```

you can achieve a linewidth of 1 pixel, again a device-specific output. Adobe does not recommend this operator for practical use, as it is device-dependent. Again, for the use with a test target it gives us the ability to test the actual resolution and spot size.

As a PostScript output device is locked to single pixels, rounding differences caused problems in our first test targets, giving some sort of a software moiré. With a special lock-to-pixel function, adaptated from the »Real-World-PostScript« book, we could compensate the software problems, so that the test will show hardware quality.

```
%Snap-funktion (RealWld: S 62)
/stp
{ transform round .25 add exch
          round .25 add exch itransform
} bind def
```

Settransfer

The PostScript settransfer function allows the user to map the gray maps according to the specific output device so that a 10 % tint will be a 10 % tint on final output. Some software already allows for calibration of the output device.

The test target will print a set of gray. A densitometric evaluation of these grays will show if the output device needs calibration.

Speed

Speed is a very important quality parameter. However, it is impossible to get relevant speed information by using a test target. There are two speed tests included in the VFG-GLV test target: Zeit 1 for type; Zeit 2 for graphics rendering. These values measure the speed of the RIP.

For practical use, we recommend to test the output speed with sample pages of everyday use. Only they can give relevant speed information.

VFG_PTF1 and VFG_PQF1

Actually there are two PostScript test targets in the VFG-GLV PostScript test target kit. Both perform very well for different uses:

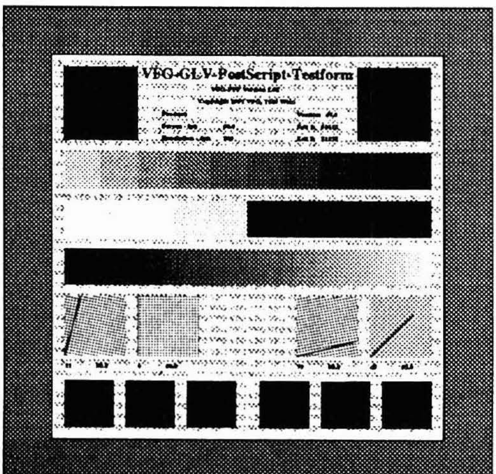
VFG_PTF1 (VFG-GLV PostScript-Testform 1)

This test target was developed to test the overall performance of a laser output device. It is helpful to test the print quality of many output devices and help compare them.

The PTF is a large (20x20 cm) test target and designed for standalone use.

The tests included are:

1. Device information: Resolution and screen frequency, PostScript version
2. Speed tests: Zeit 1: Type rendering; Zeit 2: graphics rendering. Both times give very rough speed tests and should be cross-checked with sample pages out of everyday work.
3. Density: for densitometric evaluation
4. Output accuracy: The test target should be 20x20 cm. Inaccuracy should be given in percent for x and y.
5. Screens: shows 10 to 100 %.
6. Extremes: shows 1 to 5 % and 95 to 99 %.
7. Fountain screen: shows the tradeoff
8. Screen angles: visual and numerical control
9. Resolution and spot size for x and y: any black field shows that spot size does not match the given resolution (i.e. positioning accuracy)
10. A 50 % screen shows the uniformity of the output. Any patterns that show reveal inaccuracy of the mechanical parts of the output device. This test is intented for subjective evaluation.



PTF: VFG-GLV PostScript test target (Original size: 20x20 cm)

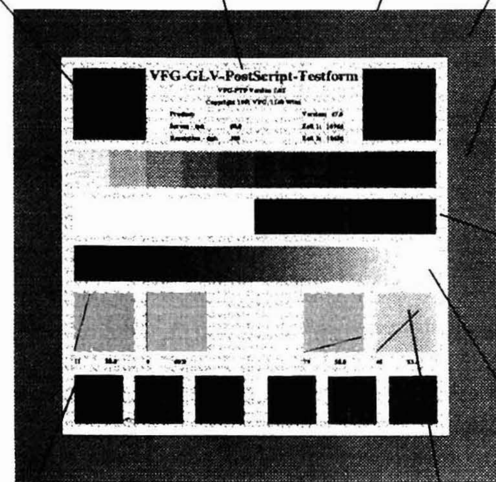
Test 1: Device information
The device prints the internal setups for screen angle and screen widt, the product name if available and the PostScript version.

Test 2: Speed tests
Zeit 1:shows the speed for the text output of this test target
Zeit 2: shows the speed for graphics output of this test target.
Both values are to be considered as very rough speed tests. They do not give any information for speed in practical use.

Test 3: Density
For measurement of the densiy of the tested device. For densitometric evaluation.

Test 4: Output Accuracy
Measure the length and heigth of the test target. It should be 20 cm each. You can then calculate an accuracy error in percent.

Test 10: Jitter
A 50 % screen shows the uniformity of the output. Regular and irregular errors show very well as patterns on this test. For subjective evaluation.



Test 5: Screens
Screens in steps of 10%
This test gives a good overall quality of the quality of the transfer function. If there are differences between the actual and the correct screen, output device calibration is recommended.

Test 6: Screen extremes
Test #6 shows, if the device can deliver tints of 1 to 5 and 95 to 99 %. This test shows minimum and maximum available tint.

Test 7: Fountain
The smoother this fountain is rendered, the better the output for images. For subjective evalutation. On low-res devices you can also count the steps on this gray scale and give an objective result.

Test 9: Resolution and Spotsize
This test outputs 1-pixel-lines in x and y.
It shows the ability of the output device to give the nominal resolution. If the leftmost test field is black, the spotsize of the laser beam is more than one pixel wide.

Test 8: Screen Angles
This test shows if the traditional screen angles 15, 0, 75, 45 degrees are delivered correctly. It gives a rectangular test field for subjective evaluation and the measured angles for objective evaluation. The more the screen angles match with the traditional angles, the better the quality of the output.

VFG_PQF1 (VFG-GLV Testform zur Qualitätssicherung)

This test target was developed to maintain quality of an output device. It can be used to supervise the output quality of the typesetter at your service bureau or to maintain the quality of your own typesetter.

The PQF test target is a very small one and designed to be used together with PageMaker, Ventura Publisher or XPress page makeup software.

As it is very small — intended to be put on the border of a PageMaker page to show output quality —, PQF contains only the following tests:

1. Device information: Resolution and screen frequency
2. Speed test: Gives the time used to render the whole test target.
3. Density: for densitometric evaluation
4. Output accuracy.
5. Screens: Same as PTF, but shows only 20, 40, 60 and 80 %
6. Extremes: Same as PTF, but smaller
7. Not included
8. Screen angles: only visual control, not numerical
9. Resolution and spot size: same as PTF, but smaller
10. Not included

References

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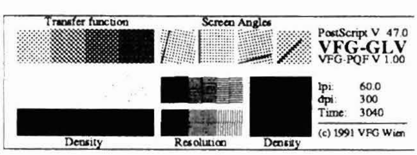

PQF: VFG-GLV PostScript test target for quality maintenance. (actual size)