

## Paper 139-28

## Exporting SAS/GRAPH® Output: Concepts and Ideas

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**ABSTRACT**

This document is designed to help you understand the basic factors that affect the quality of an image exported from SAS/GRAPH. This paper focuses on exporting graphics to two very popular destinations: the web and Microsoft Office.

**INTRODUCTION**

The information in this document can help you choose an appropriate format for exporting your graphs to other applications, and enhance your code to maximize the appearance of the graph. Examples in this document focus on several popular formats including: GIF, JPEG, PNG, PDF, EMF, CGM, and RTF.

**BASIC CONCEPTS OF EXPORTING**

The available export formats vary in their ability to store a high quality image. Properties that affect image quality include the storage method, resolution, and fonts. But first things first.

**TYPES OF FORMATS**

A format is a standardized file for transporting information electronically. There are several methods available in the SAS system for storing information in one of the standard formats including the many SAS/GRAPH device drivers and the ODS destinations. Both the format and the methods in SAS can impose limitations on the content of the file.

Export formats generally fall into one of two categories: graphics formats and document formats. Graphics formats, such as GIF and EMF, are designed to store graphic images and very little text such as titles and labels. Document formats like PDF and RTF are designed to store text such as tables in addition to graphic images. With document formats you can create output that combines text and graphics. A document format may store graphics information directly or it may link to or embed the image in a graphics format. When creating a document, you should also consider the method and format used to store the graphs.

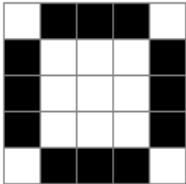
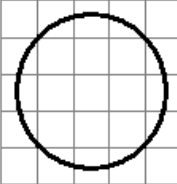
Most graphics formats were designed to contain only one image. Some graphics formats and most document formats can store multiple images or pages per file. Whether these multiple images or pages can be retrieved depends on the abilities of the importing software.

In general, document formats are created in SAS with the ODS destinations, while graphics formats are created using SAS/GRAPH device drivers. However, there are exceptions.

**STORAGE METHODS**

Graphics formats store images using either colored pixels or descriptions of each object in the image. For example, a circle drawn on a 5x5 grid may be described by the pixel shading or by the instructions to create the circle, as depicted in Table 1.

**Table 1: Storing Graphs**

	Pixel Shading	Instructions
Sample Image		
Sample Data	WBBBB BWWWB BWWWB BWWWB WBBBB	origin=(3,3) radius=2

The first method creates a bitmap, or *raster* image. The second method creates a *vector* image.

Vector images are generally preferred because they can more accurately describe rounded shapes such as circles and text. Objects in the graph, including text, can usually be edited after the graphs are imported. Editing raster images is more difficult or may not be allowed by the importing software. Because there is no information to associate different sets of pixels as different objects, the image would need to be edited pixel by pixel.

Because of the different methods used to describe the objects in an image, resizing a vector image will not degrade its quality, whereas resizing a raster image generally will. The clarity of a vector image is determined by the output device. The clarity of a raster image is dependent in part on the total number of pixels in the image.

**RESOLUTION**

Resolution is defined as the number of pixels per unit (inches or centimeters) in a image, and is usually perceived as the most important factor in image quality. When more pixels are used to define an object in a raster image, the shape is more accurate. There are actually two different resolutions that should be considered: spatial and output.

Spatial resolution is the number of pixels-per-unit of the image itself; it is the inherent size of the image. For example, a 4x6 inch image that contains 1200x1800 pixels has a resolution of 300 pixels per inch (1200/4=300, 1800/6=300). With formats such as PNG or JPEG you can vary the pixel-to-unit ratio to create higher resolution images.

Some formats, notably GIF, do not store a spatial resolution. These images contain a set number of pixels, but the number of pixels per inch (ppi) is determined by the output device. This means that changing the number of pixels also changes the size of the image, and the same image may display at different sizes on different output devices. For example, a GIF image with 900x900 pixels appears small on a computer with the screen size set to 1200x1080, but it is very large on a system set to use a 640x480 display area.

**FONTS**

From a SAS perspective, fonts fall into two major categories: software fonts and hardware fonts. The software fonts are the fonts SAS created; they are available with every installation of SAS on every operating system with every graphics format.

Hardware fonts are fonts native to a particular format; they are the fonts the format was designed to use. For example, the CGM and PDF formats recognize PostScript fonts. EMF is a Windows-based format, so it recognizes the Windows TrueType fonts. Raster formats such as GIF, JPEG, and PNG rely on system information to create output, so these formats use the same fonts as the system display.

The advantages of using hardware fonts are many. Vector formats store text in a hardware font simply as text; for example the letter 'a' is stored as an 'a'. If written in a software font, the 'a' would be stored as a set of lines. See Table 2.

**Table 2: Storing Text**

Hardware Font	Software Font	Software Font (Lines emphasized)
a	a	a

As a result, the software text may not appear as crisp and the file size may become larger. Using hardware fonts in vector-format files produces clearer results and reduces the overall file size.

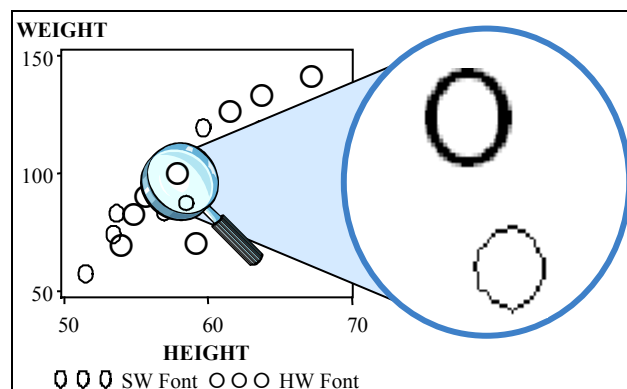
Using hardware fonts is also advantageous for the raster formats because of the way the text is rendered. When a letter is written in a software font to a raster format, the letter is mapped over the pixels in the output and the covered pixels are colored in completely. The resulting blocky, stair-step effect is known as aliasing. With hardware fonts, the fill coloration is varied so pixels that are only partially covered are given a different intensity. This effect is called anti-aliasing. Table 3 shows an example of the effect of anti-aliasing on a greatly enlarged image of the small letter 'a'.

**Table 3: Anti-aliasing**

Original Letter	Normal (aliased)	Anti-aliased
a	a	a

Although the solid-filled and anti-aliased images contain the same number of pixels, the anti-aliased letter appears more accurate. This effect is particularly important for small text heights and low-resolution images such as those used for graphics on the web.

Hardware fonts also use hints to improve the appearance of the text. Hints are additional instructions provided with a font to produce more accurate output at low resolutions or very small text heights. Figure 1 illustrates the advantages of hinting when plotting circles.



**Figure 1: Hinting**

In the zoomed inset, the circle on the top was created using a hardware font while the circle on the bottom was created using a SAS software font. As you can see, the SAS software fonts do not support anti-aliasing.

To find what fonts are native to a particular graphics file format, you can use the GDEVICE procedure to list the fonts supported by the associated device driver. For example:

```
proc gdevice catalog=sashelp.devices nofs;
  list <DeviceDriverName>;
run;quit;
```

This code will produce a list of Chartype entries to the Output window or file. Sometimes only one font, DMSFont, is listed. This means the format recognizes any system font as a hardware font.

On operating systems such as MVS that do not have system fonts, graphics formats that recognize these fonts as hardware fonts were limited to using only the SAS software fonts. Beginning with Version 9.1, SAS includes a method for rendering hardware fonts through the new FreeType font rendering engine. FreeType can be used to render TrueType, PostScript, and other font types on all the operating systems SAS runs on.

This new feature has many implications. Raster formats that normally recognize system fonts will have access to at least two TrueType fonts that are installed by SAS on all systems, so their output may take advantage of anti-aliasing and hinting in low-resolution output formats. Vector formats that can embed fonts, such as PDF, will be able to support partial and full font embedding for non-standard fonts. Other vector formats, such as EMF are able to measure the characteristics of proportional fonts and more accurately design their output.

To be able to take full advantage of this new feature, two TrueType fonts, SAS Monospace and SAS Monospace bold, are always installed by SAS on all operating systems. Information about the fonts and the locations of the font files is stored in the SAS Registry. More fonts can be added to the Registry as desired using the new FONTREG procedure. The general syntax is:

```
proc fontreg mode=<add/replace/all>
  msglevel=<verbose/terse>;
  fontpath "LOCATION";
run;quit;
```

The MODE lets you add any fonts not already listed in the Registry or forcibly add all the available fonts, even if this means replacing existing entries. The message level, MSGLEVEL, lets you specify the type of messages you want to receive about the fonts. Terse information includes the name of the font file and whether the font was successfully added to the Registry; verbose lists more information about the font, including the available styles, weights, and encodings.

The FONTPATH specifies the location of the font files you want to read. Using this statement, FONTREG will attempt to read all available files in the specified directory. You could also choose to import specific file types such as TrueType or Type1 (PostScript) fonts using the TRUETYPE or TYPE1 statements instead.

## COMMON EXPORT FORMATS

The following sections discuss in greater detail the properties and limitations of several commonly used formats and the associated SAS/GRAPH device drivers.

### STATIC GRAPHICS FORMATS FOR THE WEB

Popular formats for storing web graphics include:

GIF	Graphics Interchange Format
JPEG	Joint Photographic Experts Group File Interchange Format
PNG	Portable Network Graphics

Each of these formats is a raster format. GIF was designed to convey relatively simple images such as graphs or logos. JPEG was developed to convey relatively complex images, such as photographs. PNG is a relatively new format designed to combine the best attributes of JPEG and GIF, and is generally the preferred format.

For example, both GIF and PNG use lossless compression methods to reduce the overall file size when storing the image. This means the quality of the image is not impacted when the information is compressed. With JPEG, the compression is lossy: some degradation is tolerated in order to reduce the size of the file. The effects of the compression may be noticeable in simple images stored at low resolutions in the JPEG format; these images may appear more blurry than if they were stored as a PNG or GIF file. The JPEG format allows a variable compression-to-quality ratio, where the compression can be decreased to increase the quality of the image, and the size of the file. Control over the compression-to-quality ratio is not available from SAS/GRAPH.

The GIF format is unusual in that it can store multiple images in the same file. This file, known as an *animated GIF* file, can play back each image sequentially, like a short movie. Information on creating such images is available on the SAS/IntrNet<sup>®</sup> website. Although you may append multiple images to the same GIF file with SAS/GRAPH, the images will only display properly if the image is created as an animated GIF. Typically only web browsers are capable of displaying all the images in an animated GIF file.

As mentioned earlier, the GIF format is restricted to display resolution, whereas the PNG and JPEG formats support variable spatial resolutions. However, when used for web graphics the resolution of images in any of these formats must be at display resolution, about 100ppi. This is because web browsers always use output resolution, not spatial resolution, to size the image. An image with a higher spatial resolution will become larger when displayed in a browser. For example, an image with 1200x900 pixels that is created at 300dpi will be 4x3 inches in size. If shown at display resolution, 95dpi, the image will expand to 9.5x12.5 inches. Although methods exist to constrain the image to its

actual size in the browser, reducing the image this way often results in a loss of quality and information.

Because static web images must be created at display resolution, it is recommended that hardware fonts be used to maximize the appearance of text in these formats. When generated on Windows systems, the GIF, JPEG, and PNG formats will recognize any of the Windows TrueType fonts as hardware fonts. On Unix systems, these formats can use the display fonts, typically PostScript fonts, that are provided by an Xserver. In Version 9.1, each of these formats can use fonts provided by the FreeType engine to produce better quality text on any operating system.

To create high resolution images for display on the web, consider the PDF format. The Portable Document Format is a document format based on the PostScript printing language. Acrobat Reader software, available from Adobe Systems, is required to be able to display PDF documents, and can be used to display these files directly in the web browser.

Because it is based on the PostScript printing language, the PDF format recognizes the Base 14 PostScript fonts by default. These fourteen fonts can be used for output from any operating system SAS runs on because it is the Reader that renders the text in these fonts, not SAS. PDF also benefits from the new FreeType rendering engine in Version 9.1. With FreeType you can partially or fully embed fonts in the PDF file so they do not need to be installed on the recipient's system to display properly.

As a document format, PDF allows you to easily combine graphs and text in the same output file. The PDF format also supports page layout features not available through HTML. Technical support document TS-659 provides more information and examples of creating PDF files. This document is available online from the SAS website; see the References at the end of this document for the location.

### GRAPHICS FORMATS FOR MICROSOFT OFFICE

In addition to recognizing many raster formats such as GIF, JPEG, and PNG, Microsoft Office can import many vector formats including:

EMF	Enhanced Windows MetaFile
CGM	Computer Graphics Metafile

The Enhanced Windows Metafile format is the newer version of the Windows MetaFile format (WMF). Both were developed by Microsoft to be used on Windows systems, and both support TrueType fonts. No additional setup is required to import EMF files into Microsoft Office.

Beginning with Version 7, it is possible to create EMF files from SAS on non-Windows systems. On these systems, the number of available TrueType fonts is limited to those included with the EMF device driver. This list is greatly expanded by the addition of the new FreeType support in Version 9.1.

The Computer Graphics Metafile format is a cross-platform format that generally uses PostScript fonts. The CGM import filter in Microsoft Office recognizes the Base 14 PostScript fonts and will remap them to similar TrueType fonts when the graph is imported. The CGM import filter is not included with the default installation of Office; it must be added during a custom installation or setup.

A common complaint with CGM files is the resulting size of the imported graph. The Microsoft Office import filter imposes a maximum size of 4x4 inches (10.2x10.2 cm) on some CGM images. Regardless of the settings in the SAS session, the image will be reduced in size when imported. This restriction is imposed on CGM images that use abstract-scaling to define

objects in the graph, similar to specifying percentages. These types of CGM images have no inherent size.

CGM files can also use metric, or absolute, scaling to define objects in the graph. These metric-scaled images have an inherent size, and Microsoft Office maintains this size when the image is imported. Traditionally SAS/GRAPH has exported only abstract-scaled CGM files, so the size of these files was always restricted to 4x4 inches by Office. Beginning in Version 9.0, it is possible to create metric-scaled images from SAS, so CGM images can now be imported at actual size.

Since Version 7 of SAS, two device drivers, CGMOF97L and CGMOF97P, have been available to export abstract-scaled CGM files to Microsoft Office. Two new device drivers were added to Version 9.0 to export metric-scaled CGM images: CGMOFML and CGMOFMP. All of these device drivers include the Base 14 hardware fonts recognized by the Microsoft Office CGM import filter. Because this import filter is virtually unchanged between Office 97, Office 2000, and Office XP, these four device drivers are recommended for exporting CGM files to each of these releases of Office.

The CGM format is one of the few graphic file formats capable of storing multiple images per file, and it is possible to create such files from SAS/GRAPH whenever the output is generated by a single procedure. Microsoft Office 97 was able to import these images using its advanced import filter. This additional filter was activated using a macro in Microsoft Word, but this macro does not work correctly in Office 2000 or Office XP. Also, the advanced import filter would not import all the images at once, so each image from the file must be imported individually. It takes the same number of steps to import multiple pictures from one CGM file as it does to import them from multiple CGM files. For these reasons, it is recommended that graphs exported to Microsoft Office be stored in separate CGM files.

To be able to import many graphics images into Office in a single step, use the Rich Text Format. RTF is a document format recognized by many word processors including Microsoft Word. This format stores graphic images internally in one of several file formats such as EMF or PNG, but the format will not store CGM graphs. From SAS, the ODS RTF destination can store images using the PNG, JPEG, SASEMF, or ActiveX device drivers.

The RTF document will honor an images spatial resolution, so within this file format it is possible to create high-resolution PNG and JPEG images. Remember that the higher the resolution, the larger the file size.

More information and examples for exporting SAS/GRAPH files to Microsoft Office are given in technical support document TS-674. This document is available online from the SAS website; see the References at the end of this document for the location.

### EXAMPLE

Unless stated otherwise, the code in these examples can run in Version 7 or higher of SAS on any operating system. Please note that system-specific information, particularly the FILENAME statement, has been excluded from the examples.

The following code produces the simple vertical bar chart shown in Figure 2:

```
goptions device=png gsfname=output
gsfmode=replace xmax=3 in ymax=3 in;
proc gchart data=sample;
vbar season /
sumvar=sales
midpoints="Spring" "Summer" "Fall" "Winter"
;
run;quit;
```

The small values for the XMAX and YMAX parameters size this output to fit within the columns of this document. You can specify larger values to create output at any size. Also notice the MIDPOINTS option sets the order of the bars.

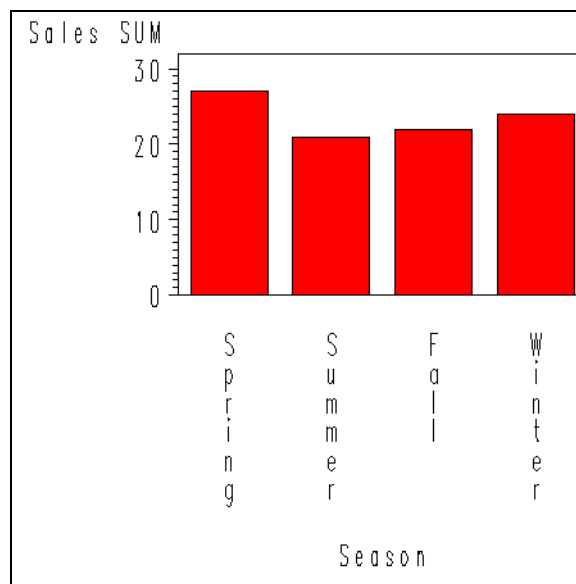


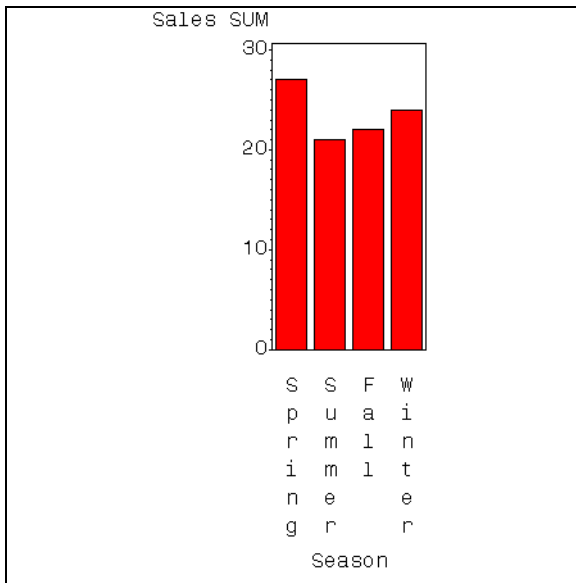
Figure 2. Default graph.

This is just the plain, vanilla output. Now we can spice it up.

The parameters we can specify vary by the output format used; this is particularly true for fonts but is also true for other aspects of the graph. First, let's improve the text by specifying a TrueType font. The following code creates the image shown in Figure 3.

```
goptions device=png gsfname=output
gsfmode=replace xmax=3 in ymax=3 in;
goptions ftext="SAS Monospace" htext=5pct;
proc gchart data=sample;
vbar season /
sumvar=sales
midpoints="Spring" "Summer" "Fall" "Winter"
;
run;quit;
```

You may know that TrueType fonts are specific to PC systems, so this font specification will only work on Windows systems for SAS releases previous to 9.1. The text height is specified here using percentages, but in Release 8.0 or higher you can use the point size specification, such as HTEXT=12pt.

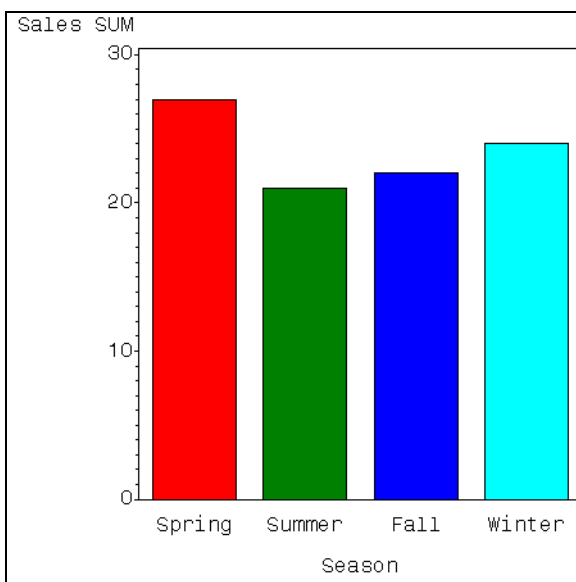


**Figure 3.** Graph with a hardware font for all text.

Notice the properties of the font have affected the rest of the output, specifically the width of the bars. We can widen the bars and make them more distinct by adding the WIDTH, PATTERNID, and COUTLINE options to the VBAR statement.

```
goptions device=png gsfname=output
gsfmode=replace xmax=3 in ymax=3 in;
goptions ftext="SAS Monospace" htext=5pct;
proc gchart data=sample;
vbar season /
sumvar=sales
midpoints="Spring" "Summer" "Fall" "Winter"
patternid=midpoint
width=15
coutline=black
;
run;quit;
```

So now we have output like Figure 4.

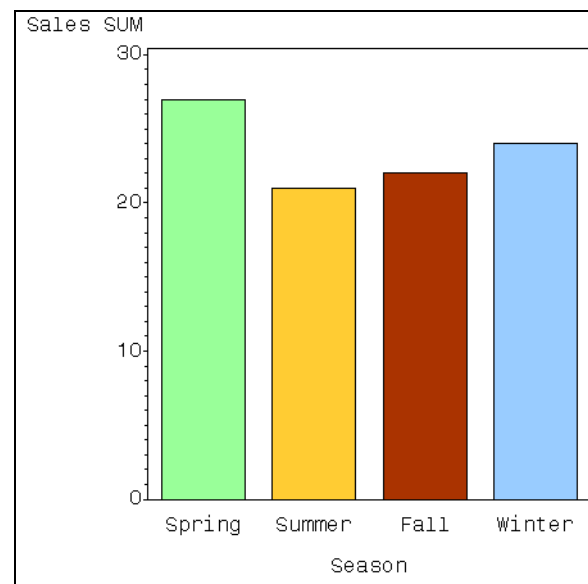


**Figure 4.** Adding PATTERNID, WIDTH, and COUTLINE.

Another adjustment might be to modify the colors used. The colors are expressed as hex values in RGB notation.

```
goptions device=png gsfname=output
gsfmode=replace xmax=3 in ymax=3 in;
goptions ftext="SAS Monospace" htext=5pct;
pattern1 value=solid color=cx99ff99;
pattern2 value=solid color=cxffcc33;
pattern3 value=solid color=cxaa3300;
pattern4 value=solid color=cx99ccff;
proc gchart data=sample;
vbar season /
sumvar=sales
midpoints="Spring" "Summer" "Fall" "Winter"
patternid=midpoint
width=25
coutline=black
;
run;quit;
```

This output is shown in Figure 5.

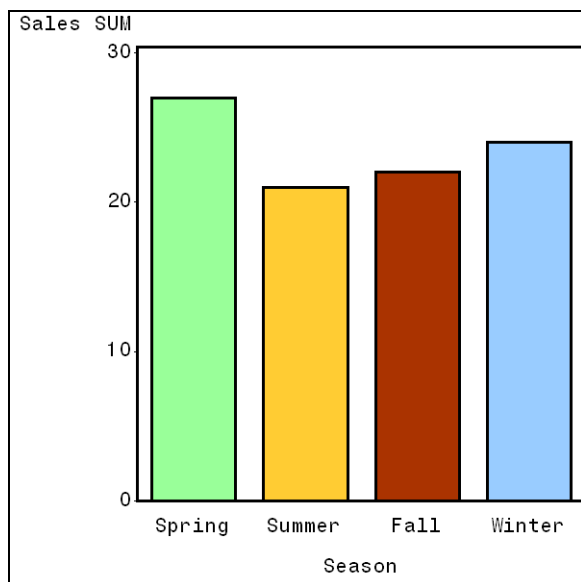


**Figure 5.** Adding pattern statements.

If the PNG file is not being used on the web, you could increase the resolution to 300dpi as follows:

```
goptions device=png gsfname=output
gsfmode=replace xmax=3 in ymax=3 in
xpixels=900 ypixels=900;
goptions ftext="SAS Monospace" htext=5pct;
pattern1 value=solid color=cxb4b4b4;
pattern2 value=solid color=cx444444;
pattern3 value=solid color=cx7c7c7c;
pattern4 value=solid color=cxeeeeee;
proc gchart data=sample;
vbar season /
sumvar=sales
midpoints="Spring" "Summer" "Fall" "Winter"
patternid=midpoint
width=25
coutline=black
;
run;quit;
```

The high resolution output is shown in figure 5.



**Figure 5.** High-resolution output.

The ratio of pixels-to-inches sets the resolution of the image to 300ppi. You could set the resolution even higher, but exceeding the resolution of the output device (printer) is not recommended. Remember that the higher the resolution, the larger the file size.

## CONCLUSION

The concepts and recommendations discussed in this document can guide you in choosing an appropriate format and method for exporting information from the SAS system to the web, Microsoft Office, and other software applications.

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