
Datacolor

ENVISION™ PrintCal

User's Guide



Datacolor ENVISION™ PrintCal User's Guide
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About PrintCal

Overview

Datacolor ENVISION, ENVISION^{PLUS} and ENVISION^{PRO} each include an option to print the contents of the Drawing Area using a calibrated printer. A properly calibrated printer prints an image having colors that closely match the color of the physical sample, and/or the electronic image.

Two types of calibrated printers can be used with Datacolor ENVISION products. The devices include printers that are used for Windows applications (Windows-driven printers), and RIP Printers. RIP printers are found on systems running third party applications software. Any printer that prints from a *spool* directory is considered to be an RIP-driven printer. These printers do not usually appear as a selection in the *Printers* folder found on Windows.



NOTES

To use an RIP printer with ENVISION software, you must use Windows 2000 or Windows XP Professional.

The installation and calibration procedures used for each printer type are similar. When these differences exist, both procedures are documented.

The procedure to enable the calibrated printer option is a three-step process:

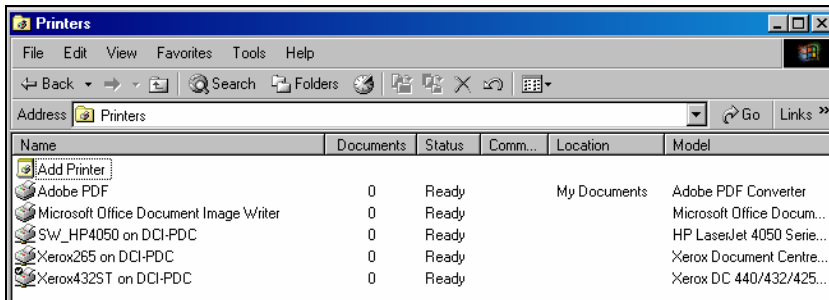
1. **Print the calibration sheets.** Using any Datacolor ENVISION program, the user must print a set of calibration sheets and send these to Datacolor for measurement. In addition to the sheets, you must provide information regarding the layout of the sheets, and the software settings used to generate the prints. This information is stored in an electronic file created when the sheets are printed.
2. **Datacolor generates the printer calibration data.** Datacolor will work with the sheets and information provided to generate a profile of the printer. This information is returned to you and transferred to the ENVISION program.
3. **Generate a *qualified* profile.** Using the profile provided by Datacolor, you will generate a qualified profile for the printer. This information adjusts the profile for use with a specific Illuminant/Observer combination. If you work with several different illuminants, you must generate a qualified profile for each illuminant you use.

Printer Installation

Overview

To print from Datacolor ENVISION, you must install the printer in Windows and then add the printer to the ENVISION program.

For **both Window and RIP printer types**, at least one printer driver must be recognized by Windows. When a printer driver is installed, it appears in the *Printers* folder. This folder is accessed from the Windows desktop by clicking **Start/Settings/ Printers**. It looks similar to the screen below:



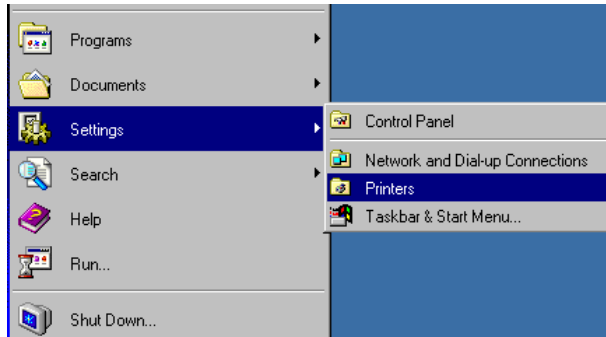
IMPORTANT

RIP Printers: The system must have at least one Windows printer installed to activate an RIP printer. You are not required to have this printer attached to the system. Use the instructions below to add a printer driver.

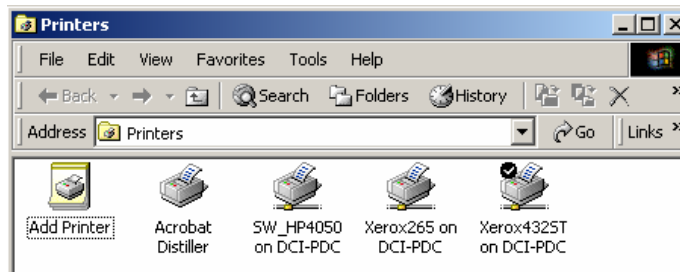
Windows Printers: The calibrated printer you are using must appear in this list. If it does not, you must add it using the procedure below.

To add a printer, do the following:

1. Click on the Windows **Start Menu**. The window below is displayed:



2. Select **Settings/Printer**. A list of the available printers appears:

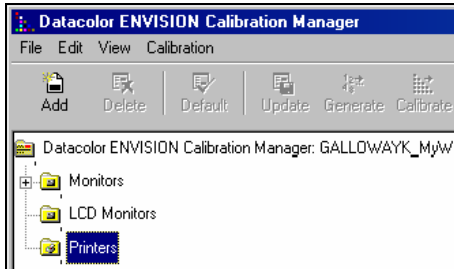


3. For *Windows* printers, you must select the printer driver for the calibrated printer you are adding. Click **Add Printer**. A wizard displays to guide you through the procedure. When you are finished, close the wizard.
4. For *RIP* printers, you can select any printer driver. If there are no printers in the folder, click **Add Printer**, and follow the wizard.

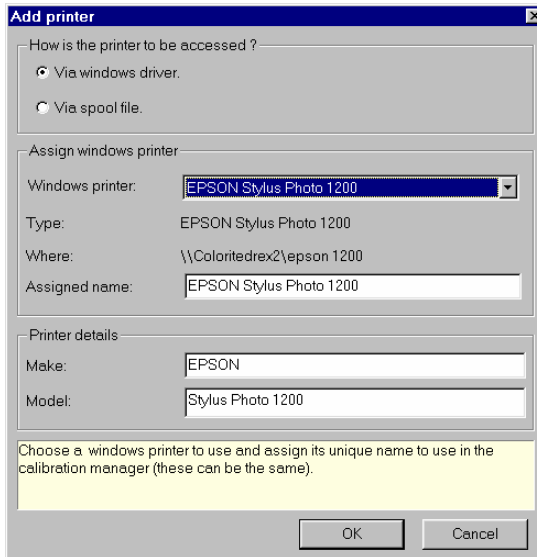
You are now ready to configure the ENVISION software for the calibrated printer.

Printer Configuration

1. In the ENVISION program, click on **File Menu, Calibration Manager**. A list of device folders (monitors, printers, etc.) is displayed:

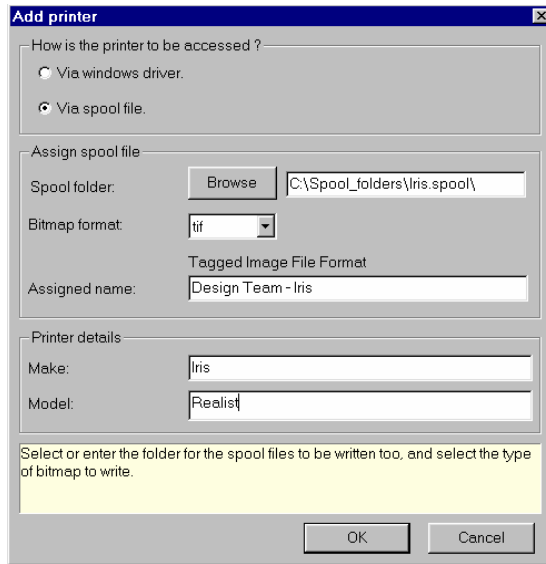


2. Click on the *Printer* folder to select it. Then click the **Add** button. The Add Printer dialog box displays.
3. Follow the steps below for the appropriate printer.
4. For *Windows Printers*, do the following:



- Click the radio button for **Via windows driver**.

- In the *Windows Printer* field, click the drop-down list and select the appropriate printer. The details of the printer will automatically be read from Windows.
 - In the *Assigned name* field, type a name for the printer.
 - In the *Printer details* section, the default information for the selected printer is displayed. Make any applicable changes.
 - When all selections/entries are made, click **OK** to install the printer.
5. For *RIP Printers*, do the following:



- Click the radio button for **Via spool file**.
- In the *Spool Folder* field, indicate the location (drive, directory, folder, etc.) where the spool file will be saved.
- In the *Bitmap Format* field, click the drop-down list arrow, and select the format in which images must be saved to the spool folder. This selection is based on the type of image your printer driver accepts. The list includes several standard graphics file formats.
- In the *Assigned name* field, type a name for the printer.
- In the *Printer details* section, enter the applicable information for your printer.

The new printer is installed, but it is not calibrated. You must calibrate the printer using the ENVISION software.

Printer Calibration

Overview

Calibrating the printer optimizes the color agreement between the monitor, the printed image and the physical sample. This section provides detailed instructions for calibrating your printer.

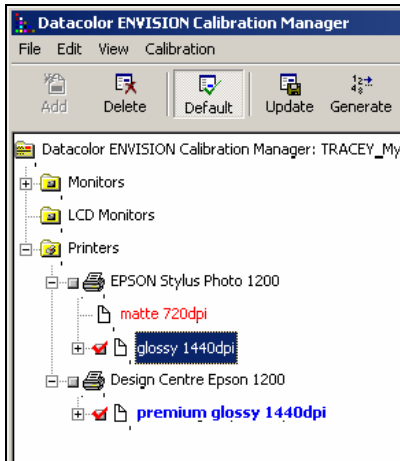


NOTE

There are some differences in the calibration procedure used for Windows printers and RIP printers. Where these differences exist, both procedures are documented.

Calibration Procedure

1. Click on **File Menu, Calibration Manager**. The printer should be installed and appear in the printer list.

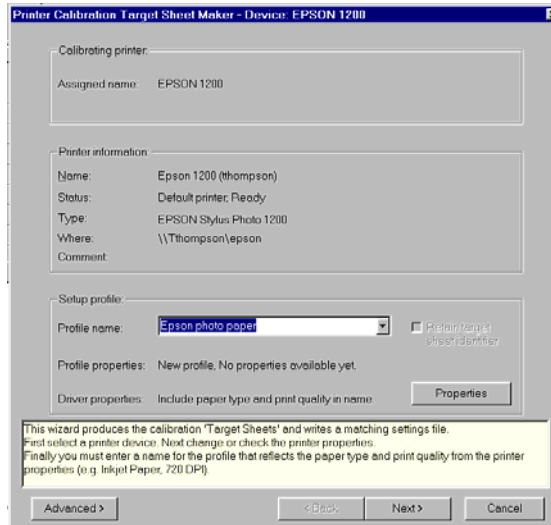


2. Select the printer to be calibrated.
3. Click on **Calibration Menu, Calibrate**. The Printer calibration target sheet maker window opens.

WARNING

Printer driver properties selected here **MUST** be identical to those used when printing. If the printer driver properties stored for calibration do not exactly match those used at run time, your prints will not match the intended color!

6. For *Windows Printers*, do the following:



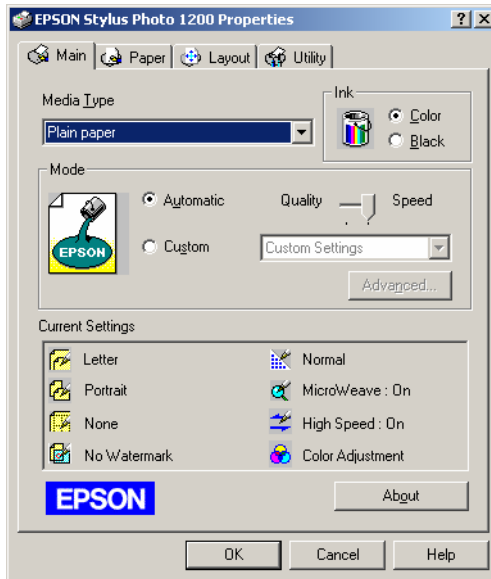
- Verify that the correct information appears in the *Calibrating Printer* and *Printer information* fields.
- **Profile Name.** Enter a profile name. The name should enable you to recreate the printer settings, paper, dpi, etc. that were used during calibration, e.g. Epson photo paper 720dpi.



NOTES

The **Advanced** button opens a window containing advanced options used by ENVISION. Contact your Applications Specialist before making changes to these settings.

- **Properties Button.** This option opens another dialog box containing settings for the printer.



These settings are based on the specific printer and paper that you are using. *Refer to the directions provided by the printer and the paper manufacturers when making these selections.*



NOTE

To insure the color consistency of a printed image, ***you must use the exact settings used for the printer calibration.*** If you do not, there will not be good color agreement between the print, the monitor and the physical sample.

7. For RIP Printers, do the following:



- Verify that the correct information appears in the *Calibrating Printer* and *Printer information* fields.
- In the *Profile Name* field, enter a profile name. The name should enable you to recreate the printer settings, paper, dpi, etc. that were used during calibration - e.g., Epson photo paper 720dpi.

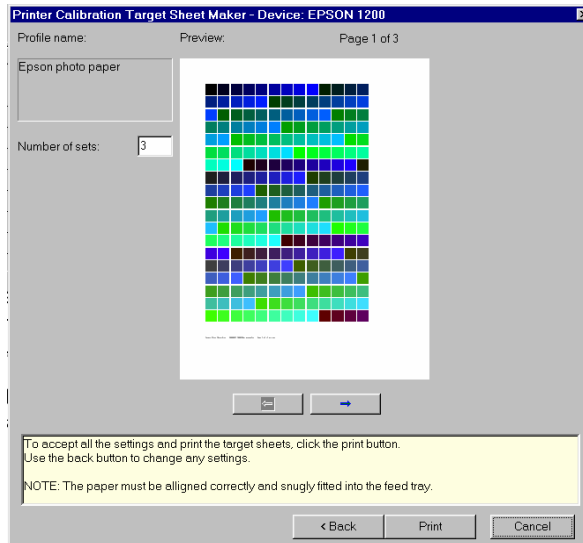


NOTES

The **Advanced** button opens a window with advanced options used by ENVISION. Contact your Applications Specialist before making changes to these settings.

There is no properties screen available for RIP printers.

8. When you have made all selections, click the **Next** button. The program displays a preview of the calibration sheets that will be printed.



9. Verify the following:

- The correct **paper** is in the printer.
- The correct **side** is up.
- You have loaded enough paper to complete the job.

You can calculate the number of required sheets by simply multiplying the number of sets by the number of pages in a set. You will need to add one extra sheet for the cover page.

- In the above example, 3 sets are selected, and each set contains 3 sheets.
- $3 * 3 = 9$. + 1 cover sheet = 10 sheets required in total.

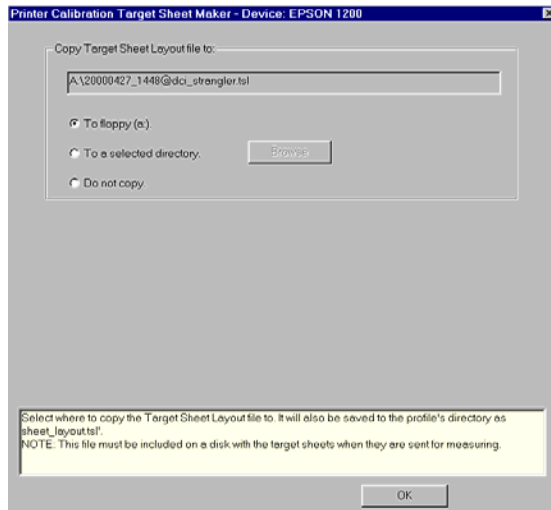


NOTE

Multiple sets are always required to eliminate any prints that are not representative of the printer performance.

10. Click the **Print** button to print the calibration sheets.

11. When the print is complete, you are prompted to save the calibration sheet file.



12. In the *Copy Target Sheet Layout file to* field, click the radio button that indicates where the file should be saved, and then click **OK** to save the file.
13. Carefully package the sheets and the diskette/CD containing the printer files.

WARNING

Be sure to observe any print drying times specified by the paper manufacturer, before packaging.

Be careful not to fold the sheets. They should be packaged in a flat, reinforced envelope.

14. Send the sheets and the data disk to the nearest ENVISION calibration center. Datacolor will return the final calibration data to the address you provide.



NOTE

You will need multiple profiles to characterize different printers, or different paper or ink selections used with a single printer.

Printer Calibration Data Installation

When Datacolor returns your calibration data, you are ready to complete the calibration process for your printer/paper configuration. It will be returned either by email (if you supplied an email address) or by regular mail. The file you receive will have the extension *.trm.

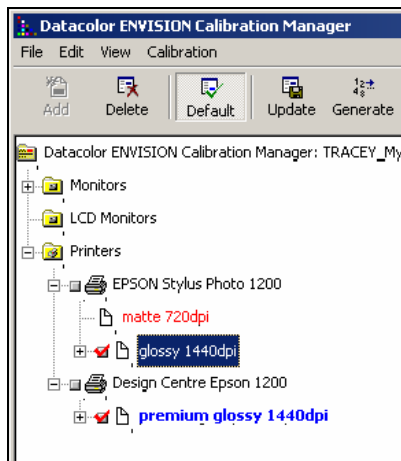


NOTE

There are some differences in the procedure used for Windows printers and RIP printers. Where these differences exist, both procedures are documented.

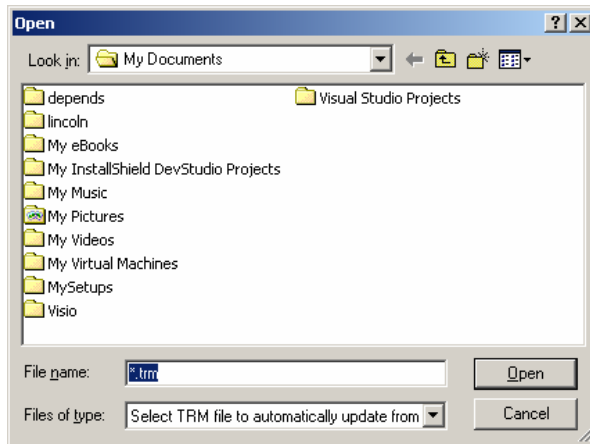
To complete the installation:

1. Place the media in the drive, and click **File Menu, Calibration Manager**. The Calibration Manager window opens.



2. Select the appropriate printer.
3. Click the **Update** button on the Calibration Manager toolbar.

The *Select File* dialog box is displayed.



4. Browse to the *.trm file, highlight it and click **Open**. The program installs the calibration information onto the system.



NOTE

If you have submitted multiple printed sets that represent different paper or ink types, you will receive multiple *.trm files. You will need to install and calibrate each file.

5. Once you have calibration information for the printer, you can generate profile information for the illuminants and observers used to view the prints. See *Generating Qualified Profiles in this guide for instructions*.

NOTES

Qualified Profiles Generation

Overview

This section describes how to generate qualified profiles for your printer using the Calibration Manager. This is the last step in the process of preparing a calibrated printer for use with the ENVISION program.

What is a Qualified Profile?

A device can have many profiles. In the case of a printer, a profile is a collection of information about the printer that is specific to the following conditions:

- The inks used
- The paper type used
- The printer settings used

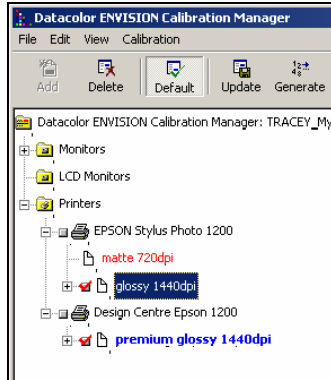
A profile is used to optimize the performance of the printer for a specific set of printing conditions. When any of these selections change, you will need to generate a new printer profile. A “qualified” profile is generated by applying specific Illuminant/Observer data to the profile. You will need to generate qualified profiles for each Illuminant/Observer combination you will be using.



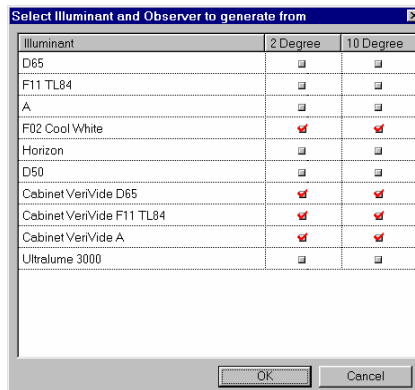
NOTE

This procedure is the same for both Windows and RIP printers.

1. Click on **File Menu, Calibration Manager** and select a profile that has previously been calibrated.



2. Click the **Generate** button on the toolbar. A qualified profile is required for each Illuminant/Observer combination you use to view your print:



3. Make the appropriate selection for the Illuminant and Observer options, and click **OK**.



NOTE

This procedure is repeated for each illuminant condition you use.

Qualified profiles for additional Illuminant/Observer combinations can be added at any time.

Printing With a Calibrated Printer

After you have generated a qualified profile, you are ready to print the images displayed in the ENVISION Drawing Area.



NOTE

There are some differences in the procedure used for Windows printers and RIP printers. Where these differences exist, both procedures are documented.

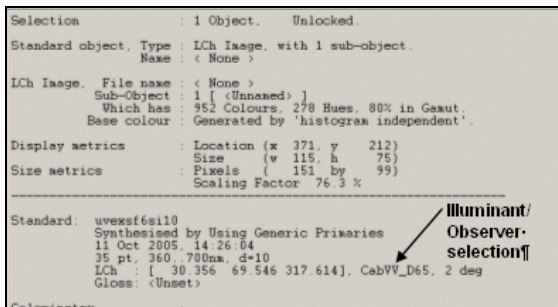
1. Click on **File Menu, Open** to select an image or environment file to be printed.



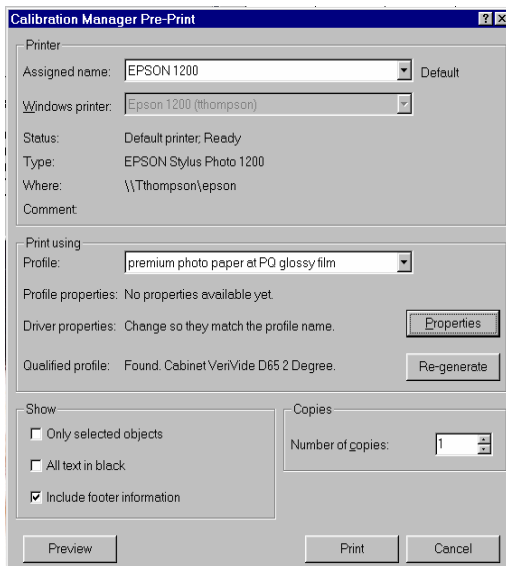
2. Verify that the illuminant selection is correct.
 - ENVISION BASIC users, check the title bar for the Illuminant condition.



- ENVISION PLUS/PRO users, press the space bar to display the information panel window.



3. Click **File Menu, Print**. The Calibration Manager, Preprint dialog box displays:
4. For *Windows Printers*, do the following:



- In the *Assigned Name* field, verify that the correct printer is selected. To change the selection, click the drop-down list arrow, and select the correct printer.
- In the *Profile* field, verify that the profile selected matches the paper and settings to be used.
- Click the **Properties** button to reset the printer properties to those used when the selected profile was calibrated.

IMPORTANT!!

You must use the same settings used for the printer calibration.

- For the *Qualified Profile* selection, a qualified profile matching the Illuminant/Observer combination selected should appear. See also *Generating a Qualified Profile in this guide for information on this step*.
- Click the **Re-generate** button only if the qualified profile is corrupted. When selected, it re-generates the qualified profile for the Illuminant/Observer combination selected.

- In the *Show* section, make your selection based upon the following:

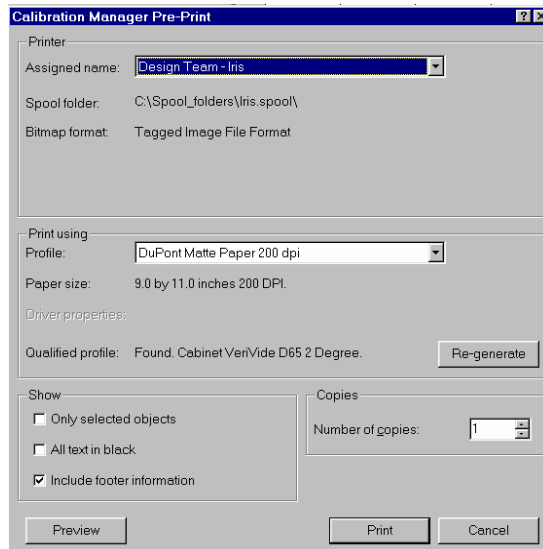
Only Selected Objects. Prints only the objects which have been selected in the drawing area.

All text in black. All text in the objects is printed in black, regardless of the color assigned to it.

Include Footer information. Prints the footer information on the copy. This information is very useful when troubleshooting printing problems.

- For the *Number of copies* field, indicate the the number of copies to be printed.

5. For RIP Printers, do the following:



- In the *Assigned Name* field, verify that the correct printer is selected. To change the selection, click the drop-down list arrow, and select the correct printer.
- In the *Profile* field, verify that the profile selected matches the paper and settings to be used.
- For the *Qualified Profile* selection, a qualified profile matching the Illuminant/Observer combination selected should appear. *See also Generating a Qualified Profile in this guide for information on this step.*

- Click the **Re-generate** button only if the qualified profile is corrupted. When selected, it re-generates the qualified profile for the Illuminant/Observer combination selected.
 - In the *Show* section, make your selection based upon the following:
 - Only Selected Objects.** Prints only the objects which have been selected in the drawing area.
 - All text in black.** All text in the objects is printed in black, regardless of the color assigned to it.
 - Include Footer information.** Prints the footer information on the copy. This information is very useful when troubleshooting printing problems.
 - For the *Number of copies* field, indicate the the number of copies to be printed.
6. When all selections/entries are made, click the **Preview** button. The image will be displayed, along with information about the color gamut available to the printer. *See also Previewing the Print, and Appendix, Gamut Mapping in this guide for an explanation of the gamut mapping information displayed in the Preview window.*
 7. Place the correct paper in the printer, with the correct side up. Click the **Print** button to start printing.

**NOTE**

The printing time depends on the size of the environment/image file, the speed of your processor, and the amount of memory on the system. It may take some time to complete.

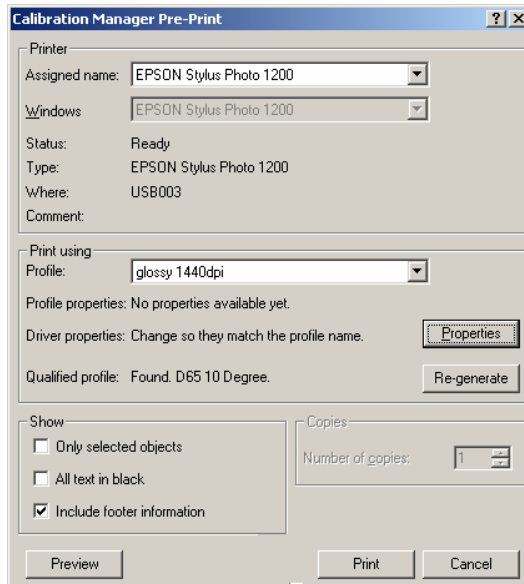
8. Allow the print to dry as specified by the paper manufacturer, and view it in a lighting cabinet under the illuminant for which you printed it.

See Calibration Manager in this guide for additional information on the Calibration Manager.

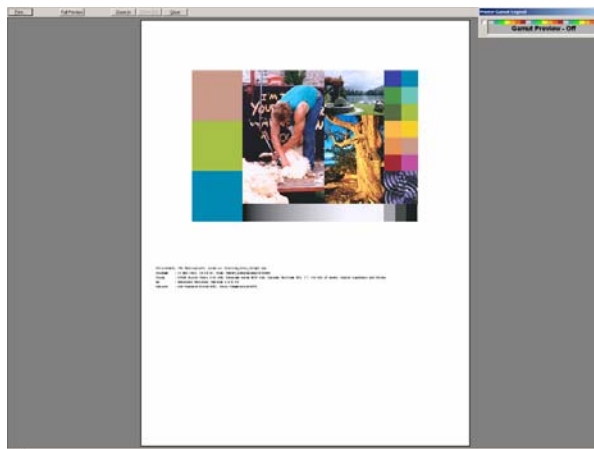
Previewing the Print

To preview the print, do the following:

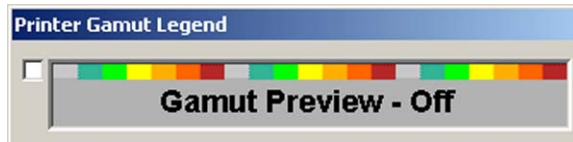
1. From the menu bar, click **File, Print**. The Calibration Manager Pre-Print dialog box displays.



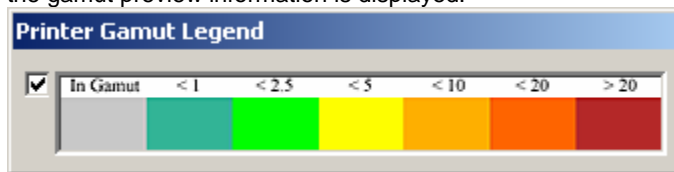
2. Click the **Preview** button. The print preview screen displays.



- In the upper right corner a gamut preview legend is displayed. When enabled, it shows which colors are out of the printer gamut, and how far out of gamut they fall. See also *Appendix, Gamut Mapping in this guide for an explanation of this feature.*



- Click in check box to enable/disable this option. When the box is checked, the gamut preview information is displayed.



- Click again to remove the check. When the check box is grayed out, the feature is not selectable.



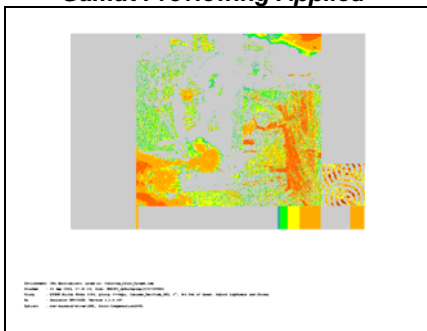
 **NOTE**

To make gamut mapping selectable do the following:

- Close the print preview.
 - Select **Display Environment, Set Gamut Mapping On.**
 - From the menu bar, click **File, Print/Preview.** The gamut preview should now be enabled.
-
-

When gamut previewing is applied, portions of the window may be colored gray, green, yellow, orange or red. Below is an example of the same image, with and without gamut previewing applied:

Gamut Previewing Applied



Gamut Previewing Not Applied



When gamut previewing is applied, portions of the screen may undergo a drastic color change. This change is used to identify those colors that will print incorrectly, because they are outside the gamut of the printer. The color applied to the "out-of gamut" areas indicates the general size of the color difference between the actual color, and the color that will be printed. Below is the legend for the color difference:

Color Code	Color Difference
Gray	In gamut
Dark Green	< 1.0 dE
Light Green	< 2.5 dE
Yellow	< 5.0 dE
Light Orange	< 10.0 dE
Dark Orange	< 20.0 dE
Red	> 20.0 dE



NOTES

The color gamut is different for each printer and paper type used.

The default color difference equation used is CMC.

Datacolor ENVISION Basic users cannot change the color difference equation. Datacolor ENVISION PLUS/PRO users can choose the color difference equation to be used. They are offered both CIEL *a*b* and CMC as options.

See also Datacolor ENVISION PLUS/PRO user's guide for instructions to change the selection for the color difference equation. See also

Appendix, Interpreting Color Differences in this guide for an explanation of the color differences displayed in the above table.

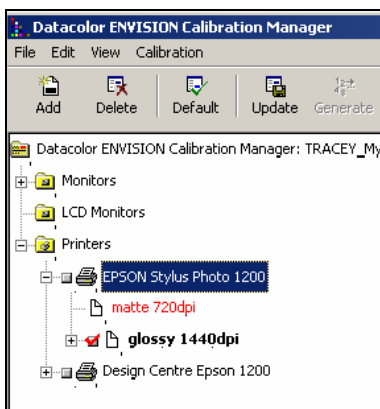
Printer Profile Sharing/Distribution

Because of the cost and time required to generate a printer profile, you may find it beneficial to distribute a calibration profile to all ENVISION systems that share a calibrated printer. This is achieved through an Import/Export option available in ENVISION. A profile can only be exported from inside the ENVISION program, and can only be shared with other ENVISION users. Exporting a printer exports **all** profiles **and** qualified profiles associated with that printer.

Exporting a Printer Profile

To export a printer profile to another user:

1. Open the ENVISION program, and Click **File Menu, Calibration Manager**.



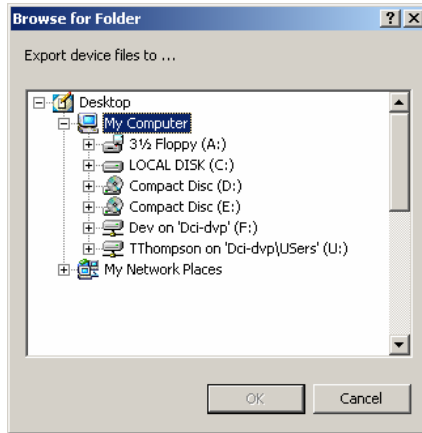
2. Highlight the printer to be used.



NOTE

In the example above there are 2 profiles for the *Epson Stylus Photo 1200*, “matte 720dpi” and “glossy 1440dpi”. When *EPSON Stylus Photo 1200* is exported, both profiles will be included.

3. Click **File Menu, Export**. A standard directory browser displays.

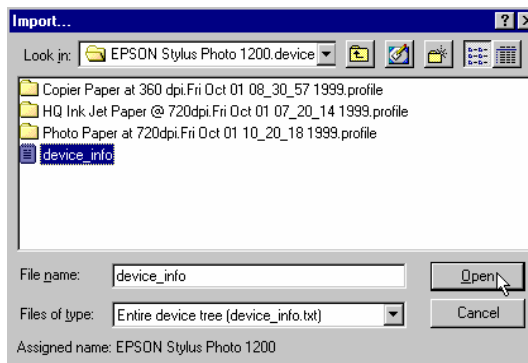


4. Highlight the folder to receive the printer profile. A shared network folder is a good choice, because it will be available to several users.

Importing a Printer Profile

To make a printer profile available for use, it must be imported by each ENVISION system using it. To import a printer profile:

1. From the Calibration Manager window, click **File Menu, Import**. A standard directory browser will be displayed
2. The standard file browser will prompt you to select the printer to import. Be sure that you are in the top level of the device directory as shown:

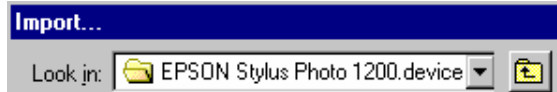


3. Open the **device_info.txt** file.



NOTES

The top level of a directory is named *.device:



If there is a name conflict with an existing printer, the printer being imported is renamed.

Printing with an Uncalibrated Printer

If you do not have a profile for a particular printer and paper, you can still produce a physical print. While this print will not be accurate for color, it can be helpful in showing the design or layout intent of an environment or image.



NOTE

All printers, calibrated and uncalibrated, must be added as a printer using the Calibration Manager to be available for printing ENVISION images. *See also Printer Installation, Configuring the Printer in ENVISION in this guide for instructions.*

Troubleshooting Color Prints

Overview

This section provides suggestions for consistently producing colored prints that visually agree with the physical samples, and/or images on a calibrated monitor.

Printer Maintenance

In order to maintain the quality of your color prints, the printer must be operated in a consistent fashion over an extended period of time. Basic steps should be taken to insure a high level of printer repeatability:

- The same type of ink and paper must be used. Always order the same part numbers. If part numbers change, it usually means that an ink or paper formulation has changed. You should re-calibrate the printer, and regenerate the qualified profiles if the part number changes.
- Limit the quantities of ink and paper purchased to an amount you can use before the expiration or "best-before" dates on the packets.
- Printer properties used for each calibrated print must match those used for the profile calibration. **These properties must checked each time you print.**

**NOTE**

Any changes to the printer settings, such as paper, orientation, dpi, etc. must be made from options within the ENVISION software. Global settings made in the Windows' printer folder are not always transferred to the ENVISION program.

- The printer should be located in an environment where a constant ambient temperature and relative humidity are consistently maintained.
- Verify that the print paper is properly oriented when loaded in the printer. Most papers have a specific front and back side. The paper manufacturer will provide instructions on how to determine the front of the paper. If prints are made on the reverse side of the paper, the printed colors may not be consistent.
- Paper should be stored according to instructions provided by the manufacturer. Specialty papers can be damaged by environmental factors such as light exposure, moisture, etc., affecting the color quality of the print.

Uneven/Striped Prints

Occasionally ink nozzles become clogged, or the printer runs out of a specific ink color. This usually results in uneven or striped prints. If this occurs,

- Verify that there is still ink in the cartridge.
- Clean the print head using instructions provided by the printer manufacturer. You may need to clean the heads several times before all the nozzles are fully clean.

Your printer will most likely include a test utility to allow you to print a test pattern. This test highlights any problems with the print heads. Refer to your printer manual for further assistance.

Printer Calibration

Below are some suggestions for practices that will insure the quality of the prints:

- Verify that you have set the printer properties correctly. Follow the recommendations provided by the printer manufacturer and paper manufacturer regarding settings.
- Assign a name to the profile that identifies the printer settings used when the profile is created. That will help you to use the correct settings when using the profile at a later time.

Determining Printer Recalibration

Unlike a monitor which must be calibrated daily, a printer profile only requires recalibration when something changes. Examples of this include:

- Changes to the ink or paper formulation.
- Adjustment or replacement of the print heads.

Below are suggestions for tracking the drift of the profile over time:

- Print an environment as soon as you have completed a calibration. This establishes a baseline that identifies what is normal for this calibration profile. If you print several copies, you can also judge the inherent repeatability of your printer.
- For those users that have a spectrophotometer, select an environment (or image) that contains large, solid patches of several colors, and print it. As soon as it is dry, measure each of the patches and store the measurements.

When you are working with a new printer profile, repeat this process daily. Compare the measurements of the first print to the current print, and perform a color difference evaluation. This will provide you with a quantitative measurement of the normal printer variability. Use this information to set a numeric repeatability tolerance for the prints, which represents normal performance.

Once you have set the tolerances, periodically reprint the same image, and measure the same areas of the print. When the color difference of a print exceeds this tolerance, you need to recalibrate the printer.

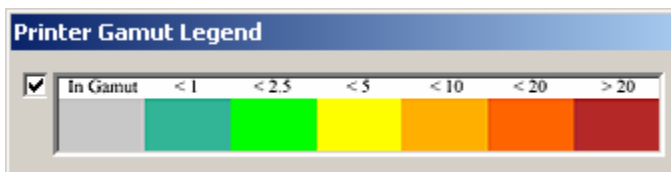
**NOTE**

You must allow sufficient drying time before any making any measurements or critical visual evaluations.

Print Preview and Gamut Assessment

It is good practice to preview a print before printing it. It is much faster and less expensive to catch and correct a problem before the print is made, rather than afterwards.

Enable the Gamut Preview option by checking the box. This allows you to see which colors cannot be reproduced using your printer/paper/dpi combination. The preview allows you to identify any out-of-gamut colors, and displays the colors that will be substituted.



Paper Selection

The overall quality of printed samples depends upon the paper(s) used for the printing. You should establish a substrate of choice, and always use it.

- Select the paper that best matches your needs. ENVISION printer calibration can be used equally well with matte or glossy papers.
- Printing on coated papers is generally more consistent than printing on uncoated papers. Some lower quality matte printing papers may produce inconsistent results. The calibration accuracy can never be better than the print-to-print repeatability of a printer/paper combination.
- When changing paper stock, select a high quality paper recommended by the printer manufacturer. Most manufacturers carry a range of high quality paper with both matte and gloss finishes.
- Most high quality papers include optical brighteners to make the paper look “whiter”. If the print is likely to be viewed under a light source containing significant ultra-violet light, you should consider using a paper that does NOT contain optical brighteners.

Assessing the Color Fidelity of a Print

- The calibration sheets must be completely dry PRIOR to visual evaluation. Printed colors change during the drying process and should be evaluated when they are completely dry. Print drying times vary depending on paper type. Follow the paper manufacturer's recommendation for drying time.
- The color of the print is corrected for the specific Illuminant/Observer combination selected at print time. Any critical visual evaluation of the color should be done using a light booth, containing the illuminant selected for the print. When comparing the print to a physical object, the objects should be placed either on the floor of the booth, or on a 45° shelf, depending on your standard evaluation procedure.
- Best results are obtained by cropping the print to remove any extraneous border that surrounds the area of interest. For example, leaving a white border around colors will make them appear darker than they really are.
- Prior to shipping the calibration sheets to Datacolor, examine the sets visually. If some chips appear to be different in color from one set to another, this will significantly affect the quality of the calibration. You should reprint the set(s) that exhibit problems.

Printing Objects to the Desired Size

The relative size, shape and position of objects in an ENVISION Environment are maintained when the environment is printed. To determine the size of object on the print:

- Compare its relative size and position within the environment against the printable area of the paper. The environment is always scaled to fill the printable area, regardless of whether the footer is printed.
- You may adjust the printed size by changing the printable area dimensions for your paper:
 - For Windows-driven printers, this is done by selecting a custom paper size with a windows print driver.
 - For RIP printers, this is done by changing the printable area dimensions of the RIP profile.

Print Stability

Printed samples do not maintain their color stability over a long period of time. Print stability varies with paper type, but generally deteriorates over a few weeks unless specially protected. Shielding the prints from exposure to UV light sources provides some protection. Use of “archival” quality papers and inks may also improve the stability of the prints. Calibrated prints should be made as required, and reprinted if required at a later date.

WARNING!

Color prints should ***never*** be used as physical standards for critical color comparisons. They are not stable over time, and the color (s) are often not close enough to the standard to be substituted.

Packing Calibration Sheets for Shipment

- Calibration sheets must be completely dry before packaging.
- Pack the target sheets in a rigid mailer or box so that they are not bent during shipping.
- Insert plain paper between the sheets to avoid scratching.
- Use a padded mailer to reduce the chance of the sheets being damaged.

Appendix

Gamut Mapping

Using calibrated devices (monitors or printers) improves the color agreement between a physical sample and the electronic image (displayed or printed). However, the monitors and printers that you use cannot display all of the colors found in the visible spectrum. The range of color a device is capable of producing is referred to as its “gamut”. When you reproduce colors using calibrated devices, color differences between the sample and the electronic image can still occur due to the gamut limitations of the device.

The ENVISION program includes a gamut-mapping feature that improves the color agreement between physical samples and electronic images. This feature identifies color(s) which falls outside the gamut of the device you are using. Using color technology principles and calculations, it finds the color closest to the target, which the device is capable of reproducing. This is referred to as *gamut mapping*.

When gamut mapping is not used, out-of-gamut colors continue be displayed, and do not appear as a gray or black area. The program simply sets the out-of-gamut colors to a minimum or maximum RGB value that the device can achieve. When you do not have a physical sample, you may not be able to detect visually whether the colors displayed are in- or out-of-gamut.

Considerations

When you are using gamut mapping, you must always keep in mind the following considerations:

- There may be many out-of-gamut colors that are mapped onto the same in-gamut color, removing intended differentiation.
- As a target color moves farther out of gamut, the mapped (closest in-gamut color) color becomes less representative of the target.
- For all out-of-gamut colors the substitute color should never be considered the correct color, since by definition it has been changed.
- Datacolor ENVISION reports the percentage of colors that are out-of-gamut.

Datacolor ENVISION users can find this information in the title bar:



Datacolor ENVISION PLUS/PRO users, tap the space bar to display the information panel. The gamut information is found at the bottom of the window:

```
Colorimetry      :  
XYZ              : [ 12.214  6.382 29.849]  
xyY             : [  0.252  0.132  6.382]  
Lab             : [ 30.356 51.367 -46.883]  
Luv            : [ 30.356 19.543 -67.882]  
LCh            : [ 30.356 69.546 317.614]  
Hunter Lab     : [ 25.262 43.233 -52.728]  
-----  
Monitor Reproduction : TRACEY_Monitor[CA100Plus]  
In Gamut?           : Inside Monitor Gamut  
Displayed Colour    : Quantized for monitor  
LCh                : [ 30.268 70.002 317.539]  
De CIE Lab        : DE(0.474), Dh(-0.090), DC*(0.457), DL*(-0.088), Da*(0.276), Db*(-0.375)  
-----  
Printer Reproduction : EPSON Stylus Photo 1200[glossy 1440dpi]  
In Gamut?           : *** OUT OF PRINTER GAMUT ***  
Gamut Mapped       : Adjust Lightness and Chroma  
LCh                : [ 30.217 65.067 317.614]  
De CIE Lab        : DE(4.481), Dh(0.000), DC*(-4.479), DL*(-0.139), Da*(-3.308), Db*(3.019)  
Printed Colour     : Quantized for Printer  
LCh                : [ 30.217 65.067 317.614]  
De CIE Lab        : DE(4.481), Dh(0.000), DC*(-4.479), DL*(-0.139), Da*(-3.308), Db*(3.019)
```

Method

There are several different approaches available to map out-of-gamut colors. Below is an explanation of each approach offered:

- **Closest dE** (preserving hue). Adjusts the color displayed to minimize the color difference (dE) without changing the hue. The resulting color may vary from the intended color in lightness (L), or color intensity (C), but the hue (h) will be the same. While this method produces the closest match, for those images with a large number of out-of-gamut colors, the calculation time may be noticeably longer.
- **Adjust Lightness and Chroma.** For out-of-gamut colors, lightness and chroma are proportionately adjusted to produce a color within the gamut. The resulting mapped color is typically a good approximation of closest possible color. This is the default selection.
- **Mark in Black.** All out-of-gamut colors are displayed as black. No attempt is made to select an alternative color that is close to the target. Some prefer this all-or-nothing approach, because it provides a high degree of confidence for the in-gamut colors. For out-of-gamut colors, an alternate method of communication is used.
- **Adjust Lightness.** Only the lightness of an out-of-gamut color is adjusted.
- **Reduce Chroma.** An out-of-gamut color is adjusted only by lowering the chroma of the color.



NOTE

Adjusting only one dimension of an out-of-gamut color, either lightness or chroma, is a very specialized method. These approaches are only helpful when it is critical that either the contrast or saturation of the print be preserved. They are not suitable for general use.

Gamut Mapping Differences—Monitor vs. Printer

When gamut mapping is enabled, it is applied to both monitors and printers. However, mapping information is displayed for a printer which is not available for monitors. Specifically:

- A gamut preview window is displayed for the printer application.
- Color differences between the target color and the mapped color are displayed for the printer application.

Neither of these displays is available when gamut mapping is applied to a monitor.

Interpreting Color Differences

Datacolor ENVISION includes a report regarding monitor performance that expresses values in terms of color differences. In the case of ENVISION, the differences reported are between settings for a reference color stored in the system, and the settings currently used to produce the same color on the monitor.

All color difference equations include a calculation of the differences between two colors for each three dimensions, or axes. Many equations report differences between the standard and current color along a 'red-green axis', a 'yellow-blue' axis and a 'lightness-darkness' axis.

Some equations report color differences using an alternate system that expresses the 3 dimensions of color space as hue (differences in color shade), chroma (differences in color intensity or saturation) and lightness. Every color difference equation calculates a DE value, which represents the overall color difference between the two colors.

Understanding the Numbers

Regardless of the color difference equation you use, color difference components are expressed as negative or positive distances between the current color and the reference color. However DE, the total color difference, is always a positive number.

Below is a table containing the color difference equations included in the Datacolor ENVISION program. It includes the name of the equation, and details of the color difference calculation it displays.

CIELab	
Color Space Model	Based on CIELAB color space model
Red-Green Difference	Da (+Da*) current color is redder than the reference color. (-Da*) current color is greener than the reference color.
Yellow-Blue Difference	Db (+Db*) current color is yellower than the reference color. (-Db*) current color is bluer than the reference color.
Lightness-Darkness Difference	DL (+DL*) current color is lighter than the reference color. (-DL*) current color is darker than the reference color.

Other Differences Displayed	<p>DC = Chroma (+DC*) current color is more saturated than the reference color. (-DC*) current color is less saturated than standard.</p> <p>DH. This represents the hue component of the color difference. Its sign (\pm) indicates the direction of the hue shift, which is dependent upon the color of the standard. Generally, the magnitude of the hue difference (rather than the direction) is typically a key indicator of the quality of the color match. Small DH values generally correspond to acceptable visual matches.</p>
Overall Color Difference	DE*

CIEL *C*H*

Color Space Model	CIELAB color space model
Red-Green Difference	N/A
Yellow-Blue Difference	N/A
Lightness-Darkness Difference	<p>DL (+DL*) current color is lighter than the reference color. (-DL*) current color is darker than the reference color.</p>
Other Differences Displayed	C (chroma) and H (hue) differences described under CIELab.
Overall Color Difference	DE

CMC

ColorSpace Model	CIE LAB color space model
Red-Green Difference	N/A
Lightness-Darkness Difference	<p>DL (+DL) current color is lighter than the reference color. (-DL) current color is darker than the reference color.</p>
Other Differences Displayed	C (chroma) and H (hue) differences described under CIELab.
Overall Color Difference	DE

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