

**Linearization, Ink Limiting and Profiling
Procedures**

for the ColorBurst RIP

and Epson UltraChrome and K3 Inksets

(Pro Version 7.50L for Windows)

Michael E. Fox
Michael Fox Photography
<http://www.michaelfoxphoto.com>

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Table of Contents

1.	Introduction.....	4
2.	Using an Existing ColorBurst Environment	5
2.1	Choosing an Existing Environment	5
2.1.1	Purpose.....	5
2.1.2	Procedure	5
2.2	Re-linearizing an Existing Environment.....	5
2.2.1	Purpose.....	5
2.2.2	Procedure	5
3.	Creating and Using a New ColorBurst Environment	7
3.1	Preparing a new Environment File	7
3.1.1	Purpose.....	7
3.1.2	Methodology	7
3.1.3	Procedure	7
3.1.3.1	Select One of the Supplied Configurations.....	7
3.1.3.2	Set Printer Options Appropriately	7
3.1.3.3	Turn OFF Linearization	8
3.1.3.4	Turn OFF Ink Limiting	8
3.1.3.5	Turn OFF ICC.....	8
3.2	Linearization of the New Environment.....	9
3.2.1	Purpose.....	9
3.2.2	Methodology	9
3.2.3	Procedure	9
3.2.3.1	Print the Lin Target.....	9
3.2.3.2	Read the Lin Target with ColorBurst SpectralVision.....	10
3.2.3.3	Evaluate the Linearization Data.....	10
3.2.3.4	Make Ink Primary Adjustments	11
3.2.3.5	Re-Print the Lin Target	11
3.2.3.6	Re-Read the Lin Target.....	11
3.2.3.7	Re-Evaluate the Linearization Data	11
3.2.3.8	Repeat the Cycle as Necessary	11
3.2.3.9	Set Baseline Values.....	12
3.2.3.10	Turn ON Linearization.....	12
3.3	Total Ink Limiting in ColorBurst.....	13
3.3.1	Purpose.....	13
3.3.2	Methodology	13
3.3.3	Procedure	13
3.3.3.1	Print the Ink Limit Test Chart.....	14
3.3.3.2	Evaluate the Ink Limit Test Chart.....	14
3.3.3.3	Aim for no less than 300 Total Ink Limit	15

3.3.3.4	Turn ON Ink Limiting.....	16
3.4	Profiling the New Environment.....	17
3.4.1	Purpose.....	17
3.4.2	Methodology.....	17
3.4.3	Procedure.....	17
3.4.3.1	Print Profile Patches.....	17
3.4.3.2	Measure the Color Patches.....	18
3.4.3.3	Create the Profile.....	18
3.4.3.4	Evaluate the Profile.....	18
3.4.3.5	Adjust the Color Profiling Software Settings.....	18
4.	When to Re-Linearize / Re-Profile.....	20
4.1	Reasons to Re-Linearize.....	20
4.2	Reasons to Re-Profile.....	20

1. Introduction

The ColorBurst RIP is, in my opinion, the best RIP available for fine art print making. It produces excellent results with both color and black and white work.

The ColorBurst RIP was originally written for the Windows platform. It has been updated and expanded many times with many new features. Over time, the user interface became something less than intuitive. While the RIP produced exceptional results, a first time user typically had a problem figuring out just what to do since the initial set-up information was spread across many different dialogs and there is no wizard.

ColorBurst addressed this problem for the Queue Series of RIP products. The X-Photo and X-Proof products have a revamped user interface. But the Layout Series of RIP products (Pro, PrePress and ProLab) still maintain the older, less intuitive user interface. At some point in the future, I'm sure ColorBurst will update the interface on these products as well.

The ColorBurst documentation for the Layout series is also not as helpful as it could be. Therefore, while learning how to use the RIP, I found that I needed to take lots of notes. Each time I talked to the ColorBurst technical team to clarify a particular detail, I wrote down their answer.

What follows is a summary of my notes organized in a straightforward "do this, then do that," step-by-step approach. After reading the notes, it should be obvious that it's actually pretty simple to set up the RIP. But, since these step-by-step instructions are not in the documentation, I present them here to help others avoid the delays that I experienced in getting started.

The information here came from a combination of reading the manual, performing the operations, and asking the ColorBurst people for details on how or why a particular step is done a certain way. These steps work extremely well for me. Therefore, I believe everything here to be correct. If you find an error or omission or something that's not very clear, I'd be appreciative of a quick email telling me about it. If and when I have the time, I'll add the update to the document.

2. Using an Existing ColorBurst Environment

The easiest and fastest way to get started with the ColorBurst RIP is to use one of the existing environments. ColorBurst has supplied excellent profiles for a number of popular papers, along with the RIP environment files used when the profiles were created. Decide on a profile and matching environment which matches the paper you want to use and the DPI setting on the printer that you prefer.

2.1 *Choosing an Existing Environment*

2.1.1 Purpose

Select an environment file that matches the desired printer and paper combination.

2.1.2 Procedure

- From the main menu, select: Printer Setup > Load ...
- Navigate to the \env directory in the ColorBurst RIP installation directory
- Navigate to the sub-directory for the particular printer you are using
- Note that the environment files indicate the printer type, paper type, dpi setting, and either matte black (MK) or photo black (PK) ink.
- Select the environment that matches your paper type and desired printer characteristics

2.2 *Re-linearizing an Existing Environment*

2.2.1 Purpose

The profiles supplied by ColorBurst are excellent and provide high dMax, wide gamut, excellent neutrals, and low metamerism. These profiles were made using the supplied environments but were obviously not made on your particular printer. Therefore, in order to make your particular printer behave just like the one that was profiled, you need to re-linearize the environment to your particular printer's characteristics. After that, your printer will behave just like the printer that was used to make the profile. Therefore, the profile will be perfectly valid for your particular printer.

2.2.2 Procedure

- Turn off ICC, Ink Limiting, and Linearization options
- Print the lin target
- Measure the lin target
- Save the data to a .lin file in the appropriate \lin subdirectory
- In the Linearization dialog, select “Allow linearization” and “Use chroma based linearization”
- Next to the Linearization file text box, click the “Find” button and select the linearization data file you just saved
- The “Original” values displayed are the max values from the lin data file that you just opened
- The “Desired” values are the values that were used by ColorBurst when profiles were created for your type of printer.
- Check to see if all of the “Original” values are higher than their corresponding “Desired” values.
 - If all of the “Original” values are higher than the “Desired” values:
 - Click on the “OK” button.
 - This will save the linearization data for your particular printer to the environment. The RIP will then linearize its output to the desired values.
 - DO NOT click on the “Set Baseline Values”. This would change the “Desired” values for this environment to new values and would invalidate the profile.
 - If one or more of the “Original” values are lower than the “Desired” values:
 - Go to the per-channel ink limits and increase the particular channel’s value by 2%
 - Reprint the lin chart, save it, measure it, and open the new lin data in the Linearization dialog.
 - Continue this process until all “Original” values are higher than the “Desired” values. Then follow the process above.
- After you leave the Linearization Option dialog, Linearization will be on.
- Turn on Ink Limiting and ICC
- Save the environment

The RIP and printer are now re-linearized and will perform just like the printer that was used to make supplied profiles. Use this environment along with any of the desired profiles which are intended for use with this environment.

3. Creating and Using a New ColorBurst Environment

ColorBurst supplies profiles and environment files for many popular papers. As they work on new papers, the appropriate files are posted on the ColorBurst website. But if a profile and environment file do not exist for the desired printer setting and paper combination, you will need to create your own. One of the strengths of the ColorBurst RIP is the user's ability to manipulate the RIP's settings to achieve the best possible profile.

3.1 *Preparing a new Environment File*

3.1.1 Purpose

- Prior to linearization, ink limiting and profiling, the printer and RIP configuration must be in a known state with all of these features turned off.

3.1.2 Methodology

- The simplest way to get started is to pick one of the existing printer environments that most closely matches the printer/paper/ink combination you intend to use, then turn off the various customizations for linearization, ink limiting and ICC profiling
- Then save the configuration as a new, custom environment

3.1.3 Procedure

3.1.3.1 Select One of the Supplied Configurations

- Printer Setup > Select Printer Setup
- Navigate the ColorBurst directory tree.
- Find the directory for the particular printer
- Then select the printer environment file that represents the paper, ink (PK = Photo Black; MK = Matte Black) and DPI that you intend to use

3.1.3.2 Set Printer Options Appropriately

- Options > Printer Options
- Make sure the printer options such as the printer port, paper type and layout area are correct for your particular set-up

3.1.3.3 Turn OFF Linearization

- Options > Linearization Options > General
 - Allow linearization = Unchecked = OFF

3.1.3.4 Turn OFF Ink Limiting

- Options > Color Adjustments > Adjustments
 - Max. Ink for Cyan = 100%
 - Max. Ink for Magenta = 100%
 - Max. Ink for Yellow = 100%
 - Max. Ink for Black = 100%
- Options > Color Adjustments > Ink Limits
 - Enable ink limiting = Unchecked = OFF

3.1.3.5 Turn OFF ICC

- Options > ICC Profile Options > General
 - Enable ICC profile color management = Unchecked = OFF

3.2 Linearization of the New Environment

3.2.1 Purpose

- Linearization insures that the printer lays down the right amount of ink at each required level, from the lightest to the darkest color, and that each step from light to dark is evenly spaced.
- Linearization and ink limiting are the two main steps in calibrating the printer to a known and repeatable behavior
- Once the printer is properly calibrated, the printer can be profiled
- From that point on, only re-linearization is occasionally necessary; the profile does not need to be updated as long as the printer is maintained with the same linearization

3.2.2 Methodology

- For many ink sets, as more and more ink is laid down, at some point the chroma values and the density values may actually reverse. That is, after some peak is reached, more ink will only cause there to be less color intensity and density on the paper. This is true of Epson Ultrachrome inks as well as others
- For other ink sets, as more and more ink is laid down, the chroma and density values continue to rise and no peak is reached on one, some or all channels. This is true of the Epson K3 ink set.
- The main point is to find the ideal maximum for each channel. This may be the point where the chroma or density reverses, or it may be a point where the increase in chroma or density is minimal, after which, lots more ink only produces a little more chroma or density.
- The process is iterative. The linearization file is printer, measured and evaluated. Adjustments to the ink limits for each primary ink color are made, then the process is repeated. When an ideal value is reached, the baseline linearization values are set and saved.

3.2.3 Procedure

3.2.3.1 Print the Lin Target

- Verify that the environment is correct for Linearization
 - Set Linearization = OFF
 - Set Ink Limiting = OFF
 - Set Color Adjustments to 100% for all Primaries
 - It may save some time to begin with the primary ink limits already set in an existing printer environment
 - In this case, the primaries can be left at less than 100% and then adjusted up or down to match the particular printer

- However, if you haven't done this before, it is instructive to understand how the process works and to see, first hand, examples of the Lin chart printed with different settings.
 - So, if doing this for the first time, it is best to start with all primaries at 100%
 - Set ICC = OFF
 - Print the Lin Target
 - [ColorBurst Directory]
 - Profiling Tools & Docs
 - Linearization and Profiling Targets
 - [select appropriate target for your instrument type]

3.2.3.2 Read the Lin Target with ColorBurst SpectralVision

- Allow the target sufficient time to dry
 - Since this test produces rather large jumps in ink % (5%), it is not so critically important that the color completely stabilized. Just make sure that the ink is dry enough to measure accurately. I typically allow 10 to 15 minutes.
- Read in the target and save the Lin file data in the appropriate ColorBurst\Lin\

3.2.3.3 Evaluate the Linearization Data

- For Ultrachrome inks, evaluate the linearization data to determine where the chroma and/or density values either reverse.
- For K3 inks, the values will probably not peak and reverse. So look for the point where more and more ink produces very little difference.
- Use the “Use Chroma based linearization” checkbox to switch between density and chroma measurements. Use the “Data Points” tab to view the linearization data.
- Use Method 1 – Chroma Linearization for InkJet printers with Ultrachrome and K3 inks
- The following are target values.
 - Target values for Epson 4000 with Ultrachrome inks on Premium photo-type papers (Premium Luster, Premium SemiMatte) are as follows:
 - C = 2.0 density, peak chroma
 - M = 1.75 density, peak chroma
 - Y = 1.15 density, 105 chroma
 - K = 2.0+ density, peak chroma
 - Target values for Epson 4800 with K3 Inks on Premium photo papers
 - Cyan = 1.8 density, 70 chroma
 - Magenta = 1.5 density, 80 chroma
 - Yellow = 1.1 density, 100 chroma
 - Black = 1.8 density, 85 chroma
 - Target values for Epson 4800 with K3 Inks on Matte papers
 - Cyan = 60 chroma

- Magenta = 75 chroma
 - Yellow = 100 - 105 chroma
 - Black = 80 chroma
- The idea is to have the peak or target value occur at the 95% to 100% row
- Note the row where the target or peak occurs for each primary
- Turn OFF linearization
- Close the linearization Options dialog
- Save the printer environment

3.2.3.4 Make Ink Primary Adjustments

- Open the Color Adjustments dialog box
- Adjust the per-ink percentages appropriately in order to achieve the above targets
- For example, if the ink is currently set at 100%, and the target value occurred at the 60% row, set the ink to 60%. If the ink is currently set to 80%, and the target value occurred at the 70% row, set the ink to 56 (80 x 0.70).
- Save the Printer Environment

3.2.3.5 Re-Print the Lin Target

- Set the environment for Linearization
 - Set Linearization = OFF
 - Set Ink Limiting = OFF
 - Color Adjustments are set according to the previous step
 - Set ICC = OFF
- Print the Lin Target

3.2.3.6 Re-Read the Lin Target

- Let the target dry for the proper amount of time
- Re-read and resave the file.

3.2.3.7 Re-Evaluate the Linearization Data

- The data points for the Lin target should now have their peaks or target values at the 95% to 100% row of the linearization data.
- If color adjustments need to be modified again, then do so.
 - Then reprint, re-read and re-evaluate the Lin target.

3.2.3.8 Repeat the Cycle as Necessary

- Continue the cycle until the Lin target data points exhibit the right characteristics:

3.2.3.9 Set Baseline Values

- After the above cycle is completed, and the Lin file shows the right characteristics, we will set the Baseline Values
- The Baseline Values are selected automatically by the RIP software when the “Set Baseline Values” button is pressed. The values are chosen to be slightly less than the peak or max values. This is so that small variations in the ink/paper which might produce slightly lower chroma values will still be able to produce at least the baseline values during the Re-Linearization process
- In order to set Baseline Values, the following settings should be in effect:
 - Linearization is ON
 - Chroma-based Linearization is ON
 - Cancel job on linearization error is ON
- Make sure the Lin Data file is in the ColorBurst Lin directory tree. That is, make sure it is in one of the directories below the ColorBurst Lin directory.
- Press the Copy button
- Make sure the default directory is the ColorBurst Lin directory. If it is not, then press Find and set it to the /Lin directory
- Press Set Baseline Values
- Save the printer environment

3.2.3.10 Turn ON Linearization

- At this point, Linearization is ON
- Make sure that Ink Limiting and ICC are still OFF
- Save the printer environment

3.3 Total Ink Limiting in ColorBurst

3.3.1 Purpose

- The purpose of setting (total) Ink Limiting in the RIP is to insure that the combination of multiple inks to form deep blacks does not put too much ink on the paper. Too much ink can cause runs, blurriness and other problems.
- The purpose of Ink Limiting in the RIP is NOT to eliminate dry banding. Dry banding are the dull lines that appear in the darkest color patches. These lines are in the direction of the print head movement – back and forth across the paper and perpendicular to the paper path.
- Dry banding will be eliminated later using the ink limiting functions of the printer profile. The profiling software's ink limiting will be more sophisticated than the simple ink limiting being set here. The printer profile will later be adjusted to eliminate dry banding.

3.3.2 Methodology

- The Ink Limiting Chart is printed.
- For the older, all neutral ink limit chart:
 - The columns (labeled 100K, 90K, etc.) indicate how much black ink is used. The rows, (labeled 200, 300, etc.) indicate how much total ink is used. For example, in row 400, column 100K, the box represents 400% ink – 100% from each of C, M, Y and K. In row 390, column 90K, the box is created with 390% ink – 90% of max from K, and 100% of C, M, and Y.
 - The chart is evaluated to find the first box in the 100K column which is not smudged, puddled, blurry or otherwise distorted. Dry banding is o.k. If the box is less than row 400, make sure that the boxes in the 90K and 80K columns are also o.k. Pick the row number as the ink limiting value.
- For the newer multi-color ink limit chart
 - Evaluate the various color patches to determine where the ink no longer gets any darker.
 - For critical evaluation, a densitometer or spectrophotometer can be used.
 - If one row tops out significantly before the other rows, you might consider going back and lowering the offending primary channel

3.3.3 Procedure

3.3.3.1 Print the Ink Limit Test Chart

- Check the environment
 - Linearization is ON
 - Ink Limiting is OFF
 - ICC is OFF
- Print the target

3.3.3.2 Evaluate the Ink Limit Test Chart

- Goal
 - All RIPs perform only a fairly crude method of ink limiting when compared to what can be done in the profiling software. This is because the profiling software has the input of the various color patches while the RIP does not. This allows the profiling software to be more intelligent about how it controls ink. So, it's best to use as little ink limiting as possible in the RIP
 - However, in order to help the profiling software determine the maximum density patches and to produce a profile with good smoothness in the dark colors, it's best to get the RIP total ink limit as close as possible to the correct value.

ColorBurst has been using a total ink limit test chart comprised of all neutral patches. They will soon be introducing a multi-color ink limit chart that helps you to determine exactly which color channels are the limiting factor for the total ink limit. Depending on which chart you have, the procedure is slightly different.

3.3.3.2.1 *Evaluating the Original, All-Neutral Ink Limit Chart*

- What to look for
 - Look for patches that are still wet when the ink limit chart is done printing
 - Look for bleeding or blurry borders. This is an indication that ink may bleed from one patch to the next when the profiling patches are printed.
 - You should see (or measure) the patches getting darker until, at some point, they don't get any darker. That's your limit.
 - Do NOT worry about dry banding
 - Horizontal lines visible when a light is shined at an angle
 - IMPORTANT – it is NOT the goal of the RIP to eliminate dry banding. This will be done with the profile. But it is useful to see where it occurs since it may save some time in picking a starting point for the ink limit number in the profiling software.
- Where to look for it
 - Start at the 400% row
 - If the patch is not good move down the 390 row
 - Continue to move down until you hit a row where the 100K, 90K AND 80K patches are ALL good
 - The name of that row is the ink limit percent

- Set the Total Ink Limit
 - Enter that row number from the Ink Limit Test Chart as the value in the Color Adjustments > Ink Limits > Total Ink Limit

3.3.3.2.2 *Evaluating the New, Multi-Color Ink Limit Chart*

- ColorBurst has a new multi-color ink limit chart that will be included in future versions of the RIP. If you are a ColorBurst customer and want to use the new chart, they'll probably send it to you if you ask politely. ☺
- Evaluate each row of the ink chart.
- Locate where each row stops getting any darker
- Use a densitometer or spectrophotometer if available or, just evaluate by eye
- The number at the top is the total ink limit
- If one row hits maximum before the other rows, then you may want to reduce the offending primary channel. This will likely cause you to gain gamut in the darker colors while losing some gamut in the highly saturated mid-tones. You'll need to ask which colors are more likely to be needed with your particular type of images
- To figure out the offending channel, start with the row in the chart that reaches maximum at the lowest total ink limit. The offending channel is one of the two colors listed to the left of that row. To determine which one, look at the other two rows. The row that reaches maximum first contains one of the same two colors. That's the color channel that you may decide to reduce.
- Example:
 - Say that the M+Y row reaches maximum before the other two rows.
 - So you need to determine whether M or Y is the limiting factor
 - Check the C+Y and the C+M row. Let's say that the C+Y row is the next one to reach maximum.
 - Since Y is in both these rows, the offending channel must be Y
 - Now, you need to decide. Is it more important to get more deep/dark colors or is it more important to have really saturated yellows, oranges and yellow-greens?
 - If you lower the Y channel's individual limit, then you will be able to set a higher total ink limit which will allow you to produce more saturated dark colors at the expense of very bright yellows.

3.3.3.3 **Aim for no less than 300 Total Ink Limit**

- If you find that the total ink limit needs to be over than 300, then you should probably consider going back to the linearization process and lowering the primaries
- This is because rich, dark colors are made up of a combination of all inks. If the per channel limits are high, then too much ink will be put down in the blends. More ink will actually reduce dMax.
- Reducing the per channel limits, when done properly, can have a negligible impact on gamut, while insuring a much darker dMax
- Leave the Black Ink Limit set at the default of 100% for Epson K3 Inks. This insures that Black is never limited below 100%.

3.3.3.4 Turn ON Ink Limiting

- After the above test is completed, turn ON Ink Limiting
- At this point, the configuration is:
 - Linearization is ON
 - Chroma based Linearization is ON
 - Ink Limiting is ON
 - ICC is still OFF
- Save the printer environment

3.4 Profiling the New Environment

3.4.1 Purpose

A printer profile describes the gamut (range) of colors that are reproducible by the printer/paper/ink combination. Printer profiles are essential for accurate, color-managed workflows.

This section is not intended to be a fully detailed description of how to create the best printer profiles. It is only intended to convey useful information regarding interaction between the RIP and the profiling software. Complete details of an optimized profiling process are best left to a separate discussion.

3.4.2 Methodology

- Some general rules of thumb can be applied to the profiling process
- The profile patches are printed with ICC turned off in the RIP.
- Printing multiple sets of patches allows the measurements to be averaged
- The profile patches are measured with a spectrophotometer and, optionally, averaged
- The profile is generated
- The profile is tested using known neutrals and other test targets
- The profile is adjusted/edited to dial-in the neutrals and desired densities and to eliminate dry banding.

3.4.3 Procedure

3.4.3.1 Print Profile Patches

- In general, more is better when it comes to the number of profiling patches.
 - Using the custom generated patches which are created by the profiling software seems to be the method that everyone agrees on – at least for ink jets
 - Some experts (including the famed Bill Atkinson) argue that several thousand patches are needed. This is because no printer is 100% perfectly linear. Bill's profiles have been recognized by professional labs and even Epson as being the best available. More patches results in larger profiles but these are not usually a problem with today's abundance of memory.
- Make sure ICC is off in the RIP
- Print the profile patches multiple times. I usually print them 3 times.
- Insure that they are sufficiently dry

- I've heard varying accounts regarding when the colors are completely stable.
- Colorburst is churning out things for the masses and they don't have time to wait so they don't
- I've read elsewhere that it takes 24-48 hours for Ultrachrome inks to completely stabilize. Others argues that a few hours is sufficient
- In my mind, the profile is something that's made once and will be used for a long time. I'd rather get it absolutely right. So I'll wait the 24-hours.
- It might be useful to measure a few patches at regular intervals to see at which point the color stabilize. I know others have done this. I just don't know what their specific result was.

3.4.3.2 Measure the Color Patches

- Read in all three sets and average the result
- Monaco Profiler
 - Be sure to save the session so that the profiling data can be used over and over again later
- Gretag Macbeth ProfileMaker Pro
 - Use the Measure Tool
 - The measure tool allows averaging and saving the results so that the measurements can be used over and over to run different profiling scenarios later

3.4.3.3 Create the Profile

- The profile is created and saved using the normal procedures for the particular software being used.

3.4.3.4 Evaluate the Profile

- The profile is evaluated by printing known test targets using the new profile.
- The test targets are then measured to determine how well the profile is performing.
 - Neutrals are checked along the gray ramp from white to black
 - Densities, particularly for middle gray and other important values are measured
 - Dry banding is checked using very dark blacks

3.4.3.5 Adjust the Color Profiling Software Settings

At this point, the profiling software settings are adjusted to produce the most accurate profile. Again, the specifics of what to measure and how to make the adjustments is left to a different discussion. Some general observations are listed below.

- GCR
 - In general, use as much black as possible. Even though black inks are usually not exactly neutral, it is generally better to use more black ink than less black ink.
 - More black ink means less CMY combination. In Epson Ultrachrome inks, the Yellow ink tends to exhibit the most metamerism so it's best to limit it where possible.
 - For B&W prints, the GCR curve should be a straight line from 0,0 to 100,100. This minimizes the use of the other colors so that they are only for adjusting for the slight-non-neutral black ink
 - For color prints, the GCR curve will usually need to be more aggressive than the profiling software default. With the K3 inkset, which include the light, light black, a 45-degree straight line can be used here as well to maximize black and minimize metamerism.
- Ink Limiting
 - The total ink limit in the profile is usually very close to the total ink limit in the RIP. You can experiment with higher or lower profile ink limits and higher or lower %K settings to see which result gives you the best overall profile in terms of: overall accuracy, gamut size, Dmax, etc.

4. When to Re-Linearize / Re-Profile

4.1 *Reasons to Re-Linearize*

How aggressive you want to be about linearization is dependent on how precisely you want to control your output quality and how much different changes affect that accuracy. Some reasons for re-linearizing are:

- Change paper roll
- Change ink cartridge
- Update firmware
 - A recent firmware update caused everything to change on my printer. I needed to modify the color adjustments for max ink which meant new linearization baseline values and a new profile.
- It's been a long time since you last linearized the printer

4.2 *Reasons to Re-Profile*

One advantage of using a RIP is that as long as you maintain good linearization, you don't need to re-profile the printer. Re-linearizing will bring the printer back into calibration with where it was when it was profiled. Some reasons to re-profile are:

- Re-linearization is not possible
 - Baseline values are no longer achievable or you desire to set different baseline levels
 - Firmware update (sometimes)
- Different profile settings are desired
 - Different GCR, gamut mapping, and other settings
- New profiling software features
 - Each new version of profiling software usually adds features or improves the accuracy of the profiles generated by that package.