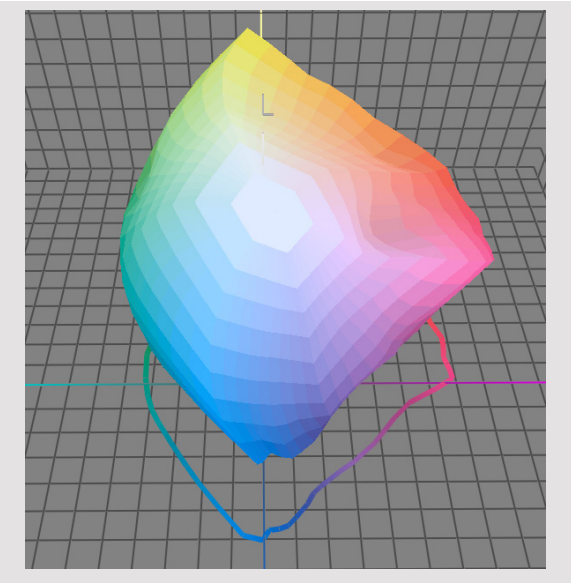
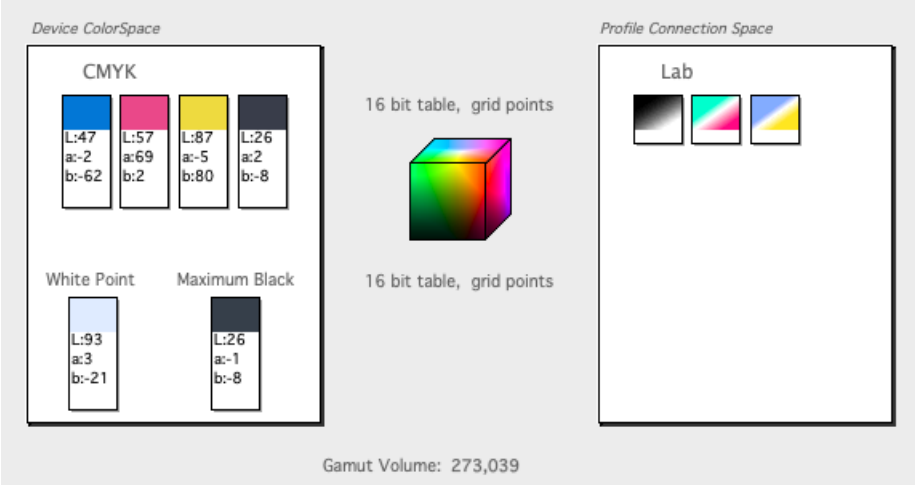
The HP Color Tools System Provides a Good Baseline

The HP Stitch Dye Sublimation printer with HP Color Tools is a unique printing platform that simplifies the creation and control of color calibrated print environments. HP CLC (closed loop color calibration) is a unique system that yields acceptable ink limits and ink channel linearization. The HP Color Tools Easy Profiling System is simple to follow. Profile options are set automatically, so the process is substantially foolproof. The profile produces pleasing skin tones and commercially acceptable colors. The grayscale appears correct to the eye.

Gamut size is dependent on a number of conditions including ink limits, fabric, transfer paper, heat press, and even the humidity in the print shop. A typical soft-knit HP Color Tools profiles will have a L*a*b* gamut volume of 250,000 to 325,000. Here are the statistics and a graph from a soft knit fabric profile developed using HP Color Tools.



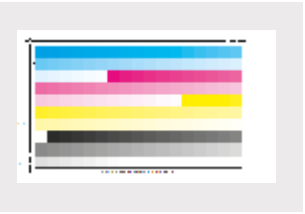


Conclusion:

The HP Color Tools method meets baseline commercial standards for color quality and gamut.

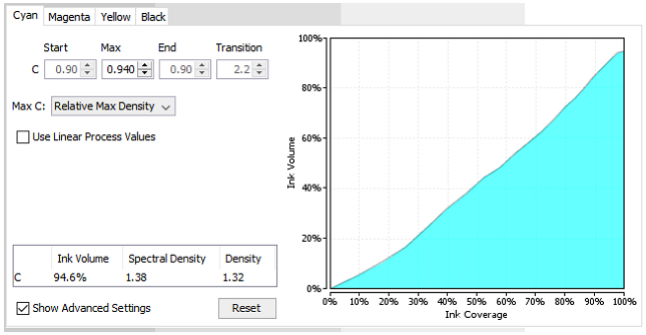
Baseline Density Linearity using CLC

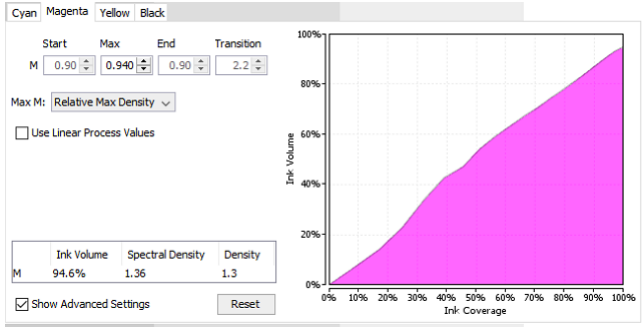
To establish a baseline, the HP Stitch S300 was calibrated using only the on-board CLC system. That system sets CMYK channel limits and also establishes linearization.



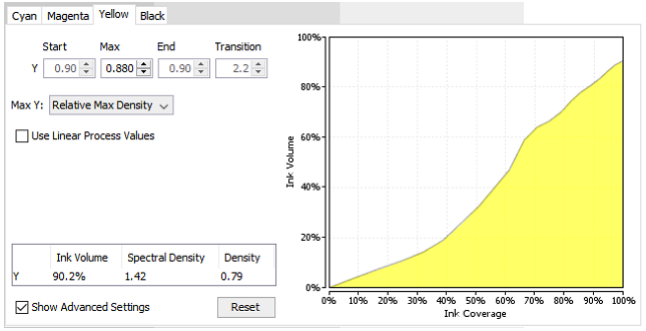
To test the effectiveness of the linearization, 40 color patches were printed for each color. Each patch had 2.5% more ink than the previous until 100% ink was reached. This set of patches was printed with no profile and no ink restrictions in the RIP. Then a spectrophotometer was used to read the patches and produce spectral data for analysis.

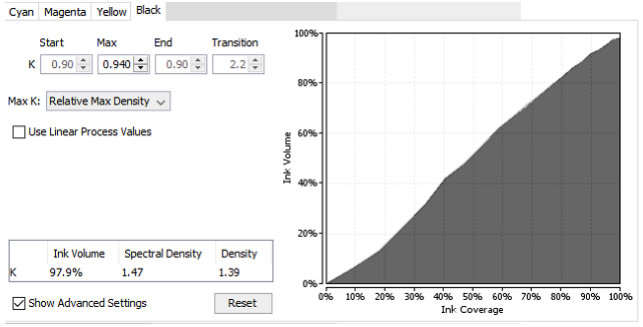
Linearization was very smooth for each color. The calibration is well within the bounds of the requirements necessary for building a good profile.





Conclusion: The automatic HP Stitch calibration produces very linear ink density curves. Any minor deviations from linearity are easily handled by the profiler.





The Limits of CLC Calibration

The following sections explore the CLC calibration as it applies to dye sublimation.

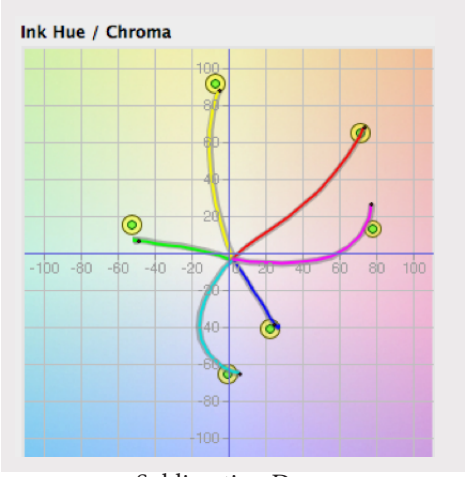
CMYK Channel Limiting

Optimal individual CMYK channel limits will result in the highest quality color gamut both in terms of overall size and color quality.

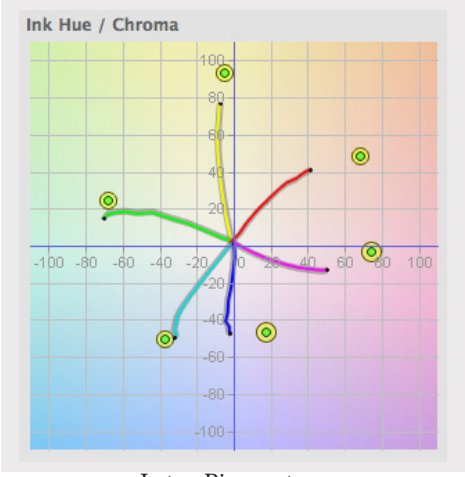
Perfect color dye sublimation ink does not exist. Dyes change color, or hook, as they become more concentrated. This contrasts with pigments, which maintain a very stable hue at all levels of concentration. The multidimensional color shifting phenomenon inherent in dyes makes channel limiting for dye sublimation ink challenging.

Notice the differences in the dye sublimation hue as the chroma changes for each of the CMY channels. The winding curves illustrate the limits and challenges with dye sub ink (and dyes in general). It is not possible to eliminate these hooks or shifts, but it is possible to limit the cyan, magenta, and yellow ink so that chroma for each of cyan, magenta, and yellow is maximized. This will result in the widest possible range of color that can be printed accurately with an ICC profile.

The black ink poses a slightly different problem If the black channel restriction is set too high, it causes loss of color gamut in the profile. This is due to assumptions built into the GCR and grayscale algorithms in profiling software. For this reason, cutting black below its maximum chroma may be required to get the best overall color gamut and deepest composite blacks.



Sublimation Dyes



Latex Pigments

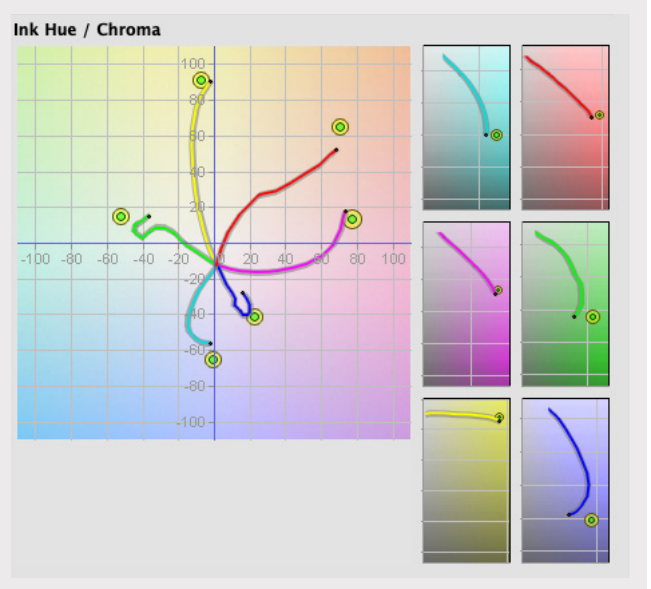
CLC Ink Channel Limits

The first, and most critical step for achieving good CMYK channel limits is to properly select the Ink Percent for the media on the HP Stitch printer. Various choices are offered based on the print resolution selected for the media.

The HP Stitch S300 was calibrated using only the CLC system.

The hue-chroma graph on this page was created using data from a G7 P2P51 target printed on the S300. These target was printed with no profile and no ink restrictions in the RIP. The only calibration was on-board the printer.

Notice that the yellow is essentially a straight line. In the mid range yellow is shifting slightly towards blue and green. This shift is small and as more yellow is used, the color becomes purer yellow. In practical terms this means yellow can be used from 0% ink up to its limit with very little impact on color.



Actual Hue Chroma Graph from HP Stitch S300 using on-board Calibration

Next consider magenta. Pure magenta ink goes straight to the right at a slight downward angle. But dye sublimation ink dips slightly towards blue then hooks towards red. The CLC calibration exhibits the standard magenta dye sublimation hook but falls a little short of the desired maximum ink limit.

Finally, focus on cyan. A perfect cyan goes in a straight line running at a 45-degree angle down and to the left. The cyan deviates from this in two important ways. First the cyan has less overall chroma than the magenta and yellow. Second, the cyan changes rapidly from pure cyan to blue and finally starts to turn purple. The CLC calibration for cyan falls short of the vertical axis, whereas the preference is for it to cross the axis.

Conclusion: The automatic HP Stitch calibration produces CMYK channel limits that fall short of the ideal for dye sublimation. While this calibration on the printer is an impressive achievement for HP, it presents challenges when trying to meet the requirements of color critical dye sublimation applications.

Channel Limits and Profile Gamut

The following sections outline the advanced quality method (AQ130) that can increase the color gamut and accuracy. AQ130 was developed to provide fine tuned control over CMYK channel settings. This level of control may be required in color critical situations. Additionally, AQ130 can serve as a foundation for matching the color output of competitive printers.

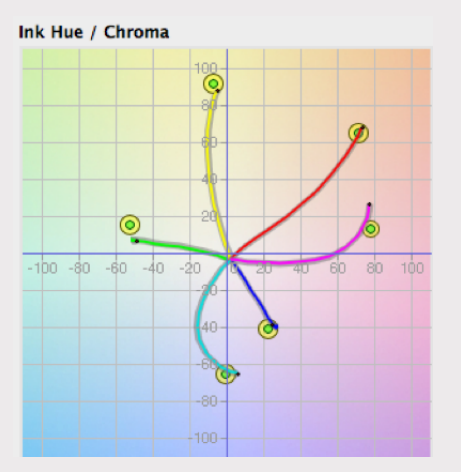
CMYK Channel Limiting

Optimal individual CMYK channel limits will result in the highest quality color gamut both in terms of overall size and color quality.

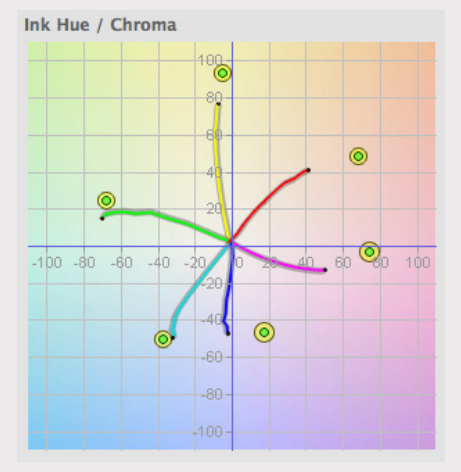
Perfect color dye sublimation ink does not exist. Dyes change color or hook as they become more concentrated as compared to pigments which maintain a very stable hue at all levels of concentration. This makes channel limiting for dye sublimation ink challenging.

Notice the differences in the dye sublimation hue as the chroma changes for each of the CMY channels. The winding curves illustrate the limits and challenges with dye sub ink (and dyes in general). It is not possible to eliminate these shifts, but it is possible to limit the cyan, magenta, and yellow ink so that chroma for each of cyan, magenta, and yellow is maximized. This will result in the widest possible range of color that can be printed accurately with an ICC profile.

Black ink poses a slightly different problem If the black channel restriction is set too high, there can be a loss of color gamut in the profile. This is due to the ways dyes combine to yield color and assumptions built into the GCR and grayscale software profiling algorithms. For this reason, cutting black below its maximum chroma may be required to get the darkest blacks and the maximim color gamut.



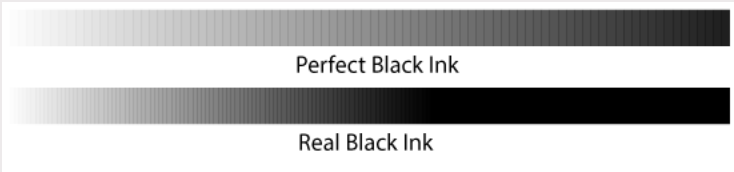
Sublimation Dyes



Latex Pigments

How Black Contributes to Gamut

Suppose we have a printed scale made with “real” black ink. Unlike the “perfect” ink represented by your computer screen, the eye does not perceive the “real” ink as moving evenly from light to dark.



Example of grayscale with perfect black compared to real black ink.

The following two Kodak Shirley Card Images illustrate the impact of using “real” black ink a compared to “perfect” black ink to print a typical black and white image.

The calibration built into the HP CLC system and the linearization in RIP software corrects for the uneven density shifts in the black ink when viewed in isolation. But these adjustments do not fully correct the perceived grayscale when a composite CMYK black is printed or when black is used to add depth to other colors, such as dark red.

Perfect black ink | Real black ink

In the case of composite black, the addition of black dye sublimation ink beyond an optimal point can cause the perceived density to decrease rather than increase as expected. In this example, the use of 80% black ink produces a darker black than 100% black ink. It will also produce deeper reds, blues, and greens.

CMY + 80%K | CMY + 100%K

We have seen that limiting the black ink to less the the minimum L* or density value can actually increase the density of the composite black and increase the overall gamut. A Black Dye Sub Calibration target has been developed to assist in limiting the black ink. This target is being tested and will be made available with instructions once it is validated.

AQ130: Advanced Quality Stitch Print Environment Method

The AQ130 method yields a larger, more optimal ICC profile for HP Stitch for clients with critical color requirements.

Step 1: Use 130% Ink on the Printer

The CMYK channel limits on the Stitch are not optimal when using the 100% ink setting on the Stitch. In general, the Cyan is cut back too much and the black is not cut back enough.

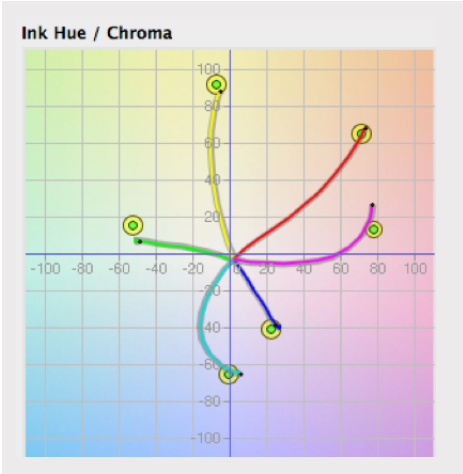
By setting the ink percent to 130 (or greater), the CMYK channel limits can be managed by the RIP. When this method is used, the CMYK linearization also needs to be managed by the RIP. Press curves can be used to further calibrate the ink channels. Finally, an external ICC profile, not generated by the HP Color Tools, is required.

Step 2: Use the RIP Software to Set the Channel Limits

This table presents approximate L*a*b* values that are recommended goals - not standards - for dye sub ink on soft-knit fabric. Do not treat them as pass-fail objectives.

Color	L*	a*	b*
C	40	-1	-65
M	53	77	13
Y	88	-7	90
K	22	0	0

Set the Cyan channel limit so the hue chroma curve just crosses the vertical axis. Make the a* value slightly negative. Cyan is near max chroma at that point so the L* value will be near a minimum.



The aim for the Magenta is to maximize the a* value. If the Magenta limit is too high, the a* values get smaller and the L* values start to reverse.

Yellow ink has a big influence on printed color. Make sure the ink is limited before the L* values start to reverse.

IMPORTANT NOTE APPLICABLE TO ERGOSOFT:

Make sure the CMYK channel dot gain is set to 20 in Ergosoft prior to printing the linearization patch sets. Ergosoft automatically restricts the ink channels to max chroma. This is OK for CMY but can be 2% to 4% too high for K.

Optional Step 3: Use Press Curves to Correct the Calibration

This is an optional step. For clients with Ergosoft, third party G7 Calibration software is required. In other RIPs such Onyx and Caldera a license upgrade may be required.

AQ130: Example of a Profile Built on top of an AQ130 Calibration

The AQ130 method yields a larger, more optimal ICC profile for HP Stitch for clients with critical color requirements.

Profile Inspector

AQ130 Stats

Overview | Header Fields | Tag Table | Curves | Statistics | Errors/Warnings

Gamut Volume: 379,216

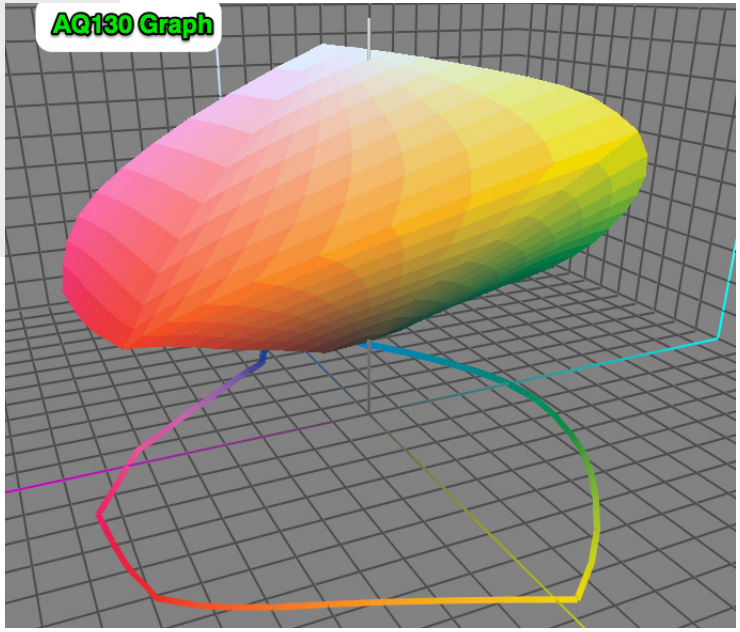
Training Data Available: Yes

Ink Statistics:

Rendering Intent	Black Start	Max Black	Total Ink
Perceptual	3.8	96.8	363.8
Saturation	3.7	96.6	363.6
Relative Colorimetric	3.5	97.0	365.4
Absolute Colorimetric	1.0	97.0	365.4

Ink Color / ISO 12647-2 compliance:

Ink	ISO Lab ref	This Profile	dE-00 diff
Cyan	55.0, -37.0, -50.0	39.3, 2.2, -62.0	24.13
Magenta	48.0, 74.0, -3.0	52.3, 74.9, 18.3	9.87
Yellow	91.0, -5.0, 93.0	87.2, -3.7, 86.5	2.79
Black	16.0, 0.0, 0.0	25.7, 4.0, -7.9	10.56



Acknowledgements

The following people contributed to information and methods included in this report:

Anthony (Tony) Quinn, Application Architect, HP Americas. anthony.quinn@hp.com

Tommy Martin, Application Architect, HP Americas. anthony.quinn@hp.com

Roy Bohnen, Digital Printer Color Expert and Consultant, Color Onsite. roy@coloronsite.com

We are grateful for the resources provided by HP, including printers, software, and technical assistance.

Perry Schwartz, VistaLogics. perry@vistalogics.com