



G7 System Certification Application Data Sheet

G7 Calibrator™

The IDEAlliance Print Properties Working Group has established a certification process for G7 Systems. In accordance with this process The G7 System Certification Program is designed to evaluate the ability of a candidate system to calibrate a printing device to meet the G7 greyscale definition using four 1-D Curves within the tolerances outlined in this document. All evaluations are based on the parameters of the G7 Specification (draft 2008). The following information is intended to assist producers and consumers in the use of the vendor system as specified for creating the four 1-D Curves.

Manufacturer

G7 Calibrator is a production of:

[Certification Seal Here](#)

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Product

G7 Calibrator™

G7 Calibrator is a cross-platform command line utility for Windows, Mac OS X, Linux and Android operating systems. It is designed to be called from a command line using a batch file or script, or as a background task from within another application. It can also be called as a library, although that features requires a dedicated front-end application. As a command line tool, it can be easily integrated into virtually any four-color process workflow with minimal disruption. It can work with virtually any spectral or colorimetric measurement instrument, including those installed on-printer (such as the Mutoh SpectroVue instrument); and, it can create test charts dynamically to accommodate virtually any patch layout requirements. It is offered as a printer calibration tool. It can be used to identify optimum primary ink limits, calibrate a printer to G7 aims, generate appropriate G7 compliant CMYK curve data for import into an existing RIP system (or to be used as the 1D LUTs in an ICC profile, and/or as curve data for Adobe Photoshop®). It can also be used to verify G7 compliance, and to generate iterated curves to bring a previously calibrated machine back into compliance should it drift (due to ink, media and/or environmental changes that can occur during a production run). It is primarily

designed to work with inkjet and other digital print technologies, although the software is compatible with virtually any four-color process device.

Testing Instructions (procedures)

Printing the Test Target(s)

To print the test target for this test, we had to first determine an ideal patch layout for the selected instrument. In this case, we used a layout for a Mutoh SpectroVue. The following options/parameters were selected:

Pad Chart to Complete Last Row = NO

This adds extra blank patches to the end of the last row, as needed, so that the total number of patches is evenly divisible by the number of patches per row.

Flip CGATS Index on Chart Horizontal = YES

A CGATS formatted file is generated with each chart so that the Calibrator software can match the measure data taken from the instrument to the correct patches.

Depending on the order in which the patches are measured, this index may need to be flipped either horizontally, vertically or both.

Flip CGATS Index on Chart Vertically = YES

See Above.

Compress Chart Image Data = LZW

By default, the chart will be generated as an LZW-compressed TIFF file. If the RIP software being used to print the chart does not support LZW compression, other options are PackBits and None (no compression).

Flip Chart Image Horizontal = YES

This flips the physical chart image along the horizontal axis, to accommodate different instrument measurement orientations.

Flip Chart Image Vertically = YES

See Above.

Set Patch Gap Width = 4 mm

This sets a vertical gap between each patch in mm, from zero (no gap) to 5 mm (max). The gap can be white (empty) or it can contain a color demarcation.

Generate PDF Chart = NO

This option will generate a PDF version of the chart.

Insert Horizontal Gap = YES

This inserts a horizontal gap between patch rows, with the same gap width as the vertical gap width defined above.

Patch Width = 20 mm

This is the standard patch width for the Mutoh SpectroVue on-printer spectrophotometer. This can be any integer value between 5 and 30 mm.

Chart Resolution = 180 dpi

This sets the image resolution at which the chart will be generated. It can be any integer value between 100 and 800 dpi.

Chart Type = G7 Grayscale Chart (Short)

There are multiple charts the Calibrator software can generate, including grayscale calibration charts, linearization and ink limit charts, verification charts and process control color bars. For this test, the short (smallest number of patches) G7 calibration chart was used. Expanded charts are also available with addition and/or redundant patches for different (noisier) print environments.

Print Width = 891 mm

Charts can be generated for print widths of 100 to 2590 mm (102 inches). For this test, a 36 inch print width was selected (891 mm taking into account printer margins). This is entirely printer and instrument dependent. The Calibrator software will use this print width value to determine the optimal number of columns and rows necessary to print all patches.

Ink Limits = C:100, M:100, Y:100, K:100

The use of ink limits is generally required for most inkjet devices. Ink limits may be applied directly to the chart when the chart image is generated, or set within the RIP software. In the former case, the Calibrator software will automatically build the ink limits into the calibration curves. In the latter case, the software will assume the user will handle this within their RIP or profile generation software.

Column Ordered = NO (Row Ordered)

Patch ID labels in the CGATS data file can be listed sequentially in row or column order. Default is column order (YES).

Maximum Ink Limit = 300

Many materials cannot support a maximum 300 percent ink when printing a process gray gradient. However, setting the primary ink limits to less than 100 percent each to minimize oversaturation of the process gray gradient strip can result in less than optimum primary solid density. Setting a maximum ink limit below 300 avoids oversaturation of the process gray gradient while allowing the primaries to achieve maximum density (up to 100 percent coverage solids).

Generate Calibration Chart to User-Selected Location

Output files = Chart.TIF, Chart.CGATS, Chart.MEASURE (patch layout definition file for SpectroVue instrument).

Measuring the Target(s)

Print the calibration chart from the RIP software. If the ink limits were applied to the chart by the Calibrator software, turn off all color management in the RIP. Otherwise, enable primary ink limits in the RIP but leave linearization null and secondary ink limits disabled.

Loading Measurement Files into G7 Calibrator

Measuring the chart should produce a measure data file in CGATS format. Open this file and the Chart.CGATS file with the options listed below. The options and parameters selected were appropriate for this test:

Interpolation = NO

The interpolation parameter can reduce the number of calculations performed by interpolating intermediate calculations rather than performing them directly. While setting this to YES will improve performance (especially on slower 32-bit CPUs) it also sacrifices some degree of accuracy.

Apply Curves to Verification Chart = YES

The verification chart is generated (using the same parameters as those used to generate the calibration chart above) automatically after the calibration curves are calculated. The verification chart is used to verify the accuracy of the calibration curves, and can be used by the calibrator software to reiterate the curve data (regenerate the calibration curves with higher precision). The curves may be applied directly to the verification chart when it is generated, or by the RIP software.

Calibration Curve Output Resolution = HIGH

The options are HIGH (5 percent, 21 values) or LOW (10 percent, 11 values). The curve output resolution defines the number of curve values the Calibrator software calculates directly; all other points in a curve (to 1 percent resolution) are fitted.

CMY (Process) Black Point = G7

This parameter sets the designated process black point target and subsequent intermediate step targets. The default is the G7 specification. Additional options are Native CMY (Process) Black and Native K Black. These options do not change the L* target (which is always based on the native process black) nor do they change the NPDC target values, but they do change the a,b target values (ΔF).

Anchor Curves at 1.0 = YES

By default, the Calibrator software will attempt to adjust the process black solid to achieve an a,b value as close to the selected black point target as possible (see above). This may yield curves that do not extend all the way to 1.0 (100 percent primary solids). If this is not desirable, the curves can be forced to 1.0. When this is performed, some minimal curve fitting will be applied between 90 and 100 percent process black to minimize unnatural curve shapes.

Error Calculation Method = CIE76

This selects the formula used to calculate the amount of chromatic error between actual and desired values. Options include CIE76, CIE94 and CIE2000. CIE76 is the quickest calculation method, and the software default.

Auto Fit Curves = NO

This option will produce very smooth curves, by fitting an artificial curve to each of the calculated ink values. This will produce very smooth gradients; but the results may not be as accurate as the individually calculated ink values.

Smooth Input Data = NO

This option applies a smoothing function to the measurement data, to compensate for instrument noise. Using a larger (expanded) calibration patch set can also minimize the impact of noise and improve calibration accuracy.

Iterate New Curve Data = YES

This option causes the Calibrator software to generate an iterated set of calibration curves after analyzing the verification chart measurement data. The iterated curves do not need to be used; they will not overwrite the original curves but will instead be archived in a separate folder. However, if the verification test fails or if G7 compliance is marginal (less than optimal) the user may replace the original curves with the iterated curves without needing to reprocess the measurement data.

Smooth Output Curves = YES / 1

This option applies a simple smoothing function to the output data (calibration curves), with minimal impact on the calculated values. The smoothing parameter may be set between 1 and 5, with 5 applying the most dramatic smoothing and 1 applying the least. For most purposes, 1 or 2 is sufficient.

Output Curve Resolution = 1 Percent

The output curves are generated to a comma delimited format for easy import into other applications. They may be generated to a CGATS formatted file as well. Output resolution options are 1, 2, 5 and 10 percent.

Adjusting Parameters

Print the verification chart from the RIP software. If the calibration curves were pre-applied to the chart by the Calibrator software, turn off all color management in the RIP. Otherwise, import the curve data into the RIP and enable their use. Although RIP packages vary, in most cases leave linearization null and secondary ink limits disabled.

Measure the verification chart. Measuring the chart should produce a measure data file in CGATS format. Open this file and the Verification.CGATS file with the same options listed above. This will produce a verification summary:

```
Run Time Stamp: 20:58:36 21/09/2014

White Point CIELAB:      85.33,  -0.48,   2.47 |  0.0000
CMY Black Point CIELAB: 29.23,  -0.49,  -0.50 |  1.0509
K Black Point CIELAB:   26.21,   1.50,   1.49 |  1.1410

Target Black Point: G7 Default
Interpolate Results: No
Output Step: 21
Anchor Cures to 1.0: Yes
Auto-fit Curve Data: No
Smoothing Filter Level: 1
Ink Limits (K): 100.0%, (C): 100.0%, (M): 100.0%, (Y): 100.0% | Max: 300.0%

K Gradient Results:
HC: 0.220 | 0.223 (0.25), HR: 0.469 | 0.473 (0.50), SC: 0.785 | 0.783 (0.75)
Min. dL: 0.0000, Avg. dL: 0.1411, Max. dL: 0.5181
Weighted Avg. dL: 0.1255 (1.50), Weighted Max. dL: 0.5181 (3.00)
K Gradient: PASS

CMY Gradient Results:
HC: 0.244 | 0.251 (0.25), HR: 0.509 | 0.512 (0.50), SC: 0.796 | 0.795 (0.75)
Min. dL: 0.0000, Avg. dL: 0.1863, Max. dL: 0.5929
Weighted Avg. dL: 0.1594 (1.50), Weighted Max. dL: 0.5929 (3.00)
Min. dCh: 0.0000, Avg. dCh: 0.3645, Max. dCh: 0.9378
Weighted Avg. dCh: 0.2832 (1.50), Weighted Max. dCh: 0.7323 (3.00)
CMY Gradient: PASS

Primary ab Coordinates and Hue:
Cyan:    -32.37 -33.38 | 225.88
Magenta:  56.29  -4.48 | 355.45
Yellow:   -3.47  73.21 |  92.72
Red:      52.30  33.37 |  32.54
Green:   -50.30  23.41 | 155.04
Blue:     9.47 -35.37 | 284.99

Spectrophotometer Accuracy:
Dmin dE, dL: 0.0000 | 0.0000
Dmax dE, dL: 0.0000 | 0.0000
KCMY dE(00): 0.0000 | 0.0000, 0.0000, 0.0000
Instrument Assessment: Excellent
```

If the Iterate New Curve Data option was set to YES, an iterated (updated) set of curves will have been generated, along with a new (iterated) verification chart and accompanying CGATS data file. If the verification results are unacceptable, the new iterated curves can be used to overwrite the originals and the iterated verification chart can be checked for improvement. Any number of iterations can be performed at any time to maintain calibration tolerances as tight as possible.

Applying Parameters in the Printing System

Calibration curve data will be either imported into the RIP software to replace the conventional linearization curves (CMYK) or will be incorporated into the ICC profile as a set of 1D LUTs. Either way, the system should not be linearized prior to calibration, as calibration is meant to replace linearization not augment it.

Saving the G7 Calibrator Session

All pertinent data is automatically saved into the Verification.CGATS file. Using this file, the calibration curves can be regenerated and/or iterated and updated at any point in the future.

Verification by Physical Print Testing

Printing a “Verification” Target

After generating the calibration curves, the verification target is printed from the RIP software; SAi FlexiPRINT SE Mutoh Edition comes bundled with all Mutoh ValueJet sign printers, and may be upgraded to FlexiPRINT DX Mutoh Edition as part of the FlexiPRINT/SpectroVue color bundle (DX RIP upgrade, SpectroVue on-printer spectrophotometer, and ColorVerify Pro with G7 Calibrator software).

To import and verify the calibration curves generated with the Calibrator software, using FlexiPRINT DX, perform the following steps:

1. Launch the FlexiPRINT RIP software.
2. Start the Color Profiler.
3. Select the Create ICC Output Profile option.
4. Configure the print settings for the desired print mode.
5. Configure the attributes in Profile Setup (media name, profile name, etc.).
6. Select and configure driver options for the desired print mode.
7. Click Save to generate the profile folder.
8. Click Next to proceed to the Ink Limits dialog.
9. If the ink limits are set in the Calibrator software, leave these at 100 percent each for C, M, Y and K.
10. Click Next to proceed to the Linearization dialog.
11. Click the Import button to import the G7 calibration curves generated in the steps outlined above. DO NOT PERFORM LINEARIZATION.
12. Click Next to proceed to the Secondary Ink Limits dialog; DO NOT ADJUST.
13. Click Save to save the calibration curves. These curves will now be applied by the RIP just as it would have applied linearization.
14. Switch to the FlexiPRINT Server window.
15. Select Add Job.. to open the Verification.TIF file, or alternatively drag the Verification.TIF file onto the FlexiPRINT Server window so that it lands in the print queue (drag and drop).

16. Highlight the Verification.TIF file in the print queue by right clicking on it one time. Select Job Properties..
17. Click the Color Management tab in the Job Properties dialog.
18. Form the Color Correction drop down menu, select No Color Correction.
19. Click Send to process and print the verification chart.
20. Measure the verification chart using the SpectroVue instrument, or with any appropriate third-party instrument.
21. Follow the directions above to process the verification measurement data and generate the summary report (page 6).

Measuring the Verification Target

To measure the verification target after printing, using the Mutoh SpectroVue on-print spectrophotometer, launch the Mutoh ColorVerify process control software, and proceed directly to the verification step. After the measurement data has been obtained, follow the directions above to process the verification measurement data and generate the summary report (page 6).

Analyzing Results

G7 Calibrator™ Tolerances

Using the 2010 G7 System Certification sample test files and the Analysis Instructions (see above) or the IDEAlliance Validation Process (see below), G7 Calibrator will achieve tolerances equal to or lower than the following.

Metric	Average	Maximum
ΔF^* (CMY only)	≤ 1.5	≤ 3
ΔL^* (CMY & K)	≤ 1.5	≤ 3

Table 1: G7 Calibrator tolerances for 2010 sample test files

Note: Because the current G7 System Certification method uses a simulation process that eliminates print-to-print variation, and because the sample data provided by IDEAlliance for G7 System Certification is highly uniform, G7 Calibrator can produce extremely low delta errors with those specific data files. Higher errors should be expected when calibrating live printing devices, depending on the characteristics and variability of each printing system.

IDEAlliance Validation Process

To validate that the G7 calibration process has been successful, a target consisting of two gray scales having the CMYK patch values listed in *Appendix A*: shall be printed through the calculated correction curves using the same print settings in use when the calibration was calculated.

Validating NPDC (CMY and K scales)

To validate NPDC correction, both the K-only scale and the CMY-only scale shall be measured with a densitometer or spectrophotometer and the relative neutral density (ND) values (measured in the “K” or “Visual” channel) shall be recorded for each patch. To obtain relative ND values, either the measuring device shall be zeroed on the substrate, or the white patch neutral density value shall be subtracted from itself and all other patches.

The (relative) ND values shall be converted to (relative) L* by the standard CIE formula in *Appendix B*:

The Delta L* (ΔL^*) error shall be computed for each patch compared to target values on file with IDEAlliance by the formula in *Appendix B*:

The average and maximum ΔL^* must not exceed the IDEAlliance Tolerance values in **Table 2**, below.

Validating Gray Balance (CMY scale only)

To validate gray balance correction, the CMY-only scale shall be measured with a spectrophotometer and the a* and b* values recorded for each patch.

The Delta F* (ΔF^*) error shall be computed for each patch compared to target values on file with IDEAlliance by the formula in *Appendix B*:

The average and maximum ΔF^* must not exceed the IDEAlliance Tolerance values in **Table 2**, below.

IDEAlliance Tolerances

Metric	Average	Maximum
ΔF^* (CMY only)	≤ 1.5	≤ 3
ΔL^* (CMY & K)	≤ 1.5	≤ 3

Table 2: IDEAlliance required tolerances

Appendix A:

P2P patch values

Column 4 (K only)

C%	M%	Y%	K%
0	0	0	0
0	0	0	1.96
0	0	0	3.92
0	0	0	5.88
0	0	0	7.84
0	0	0	10.2
0	0	0	14.9
0	0	0	20
0	0	0	25.1
0	0	0	30.2
0	0	0	34.9
0	0	0	40
0	0	0	45.1
0	0	0	49.8
0	0	0	54.9
0	0	0	60
0	0	0	65.1
0	0	0	69.8
0	0	0	74.9
0	0	0	80
0	0	0	85.1
0	0	0	89.8
0	0	0	94.9
0	0	0	98.04
0	0	0	100

Table 3: CMYK percentage values in column 4 of the P2P target

P2P patch values

Column 5 (CMY only)

C%	M%	Y%	K%
0	0	0	0
1.96	1.18	1.18	0
3.92	2.77	2.77	0
5.88	4.15	4.15	0
7.84	5.61	5.61	0
10.2	7.41	7.41	0
14.9	11	11	0
20	14.9	14.9	0
25.1	18.8	18.8	0
30.2	22.91	22.91	0
34.9	26.78	26.78	0
40	30.98	30.98	0
45.1	35.48	35.48	0
49.8	39.82	39.89	0
54.9	44.71	44.71	0
60	49.8	49.8	0
65.1	54.9	54.9	0
69.8	60.16	60.16	0
74.9	66.07	66.07	0
80	71.77	71.77	0
85.1	78.06	78.06	0
89.8	84.61	84.61	0
94.9	92.2	92.2	0
98.04	96.86	96.86	0
100	100	100	0

Table 4: CMYK percentage values in column 5 of the P2P target

Appendix B:

Formulae

Converting ND to L*

$$Y = 1/10^{ND}$$

$$\text{If: } Y > (6/29)^3$$

$$L^* = 116 \times Y^{1/3} - 16$$

Else:

$$L^* = 116 \times (841/108 \times Y + 4/29) - 16$$

Calculating Delta L* (ΔL^*)

$$\Delta L^* = (L^*_{\text{sample}} - L^*_{\text{target}})$$

Calculating Delta F* (ΔF^*) – also known as Delta-ab

$$\Delta F^* = ((a^*_{\text{sample}} - a^*_{\text{target}})^2 + (b^*_{\text{sample}} - b^*_{\text{target}})^2)^{1/2}$$

Appendix C:

Verification Instructions (using VPR module)

The optional VPR module allows adjustments calculated by G7 Calibrator to be tested without making a second physical print. For this a characterization target (e.g. IT8.7/4) must have been printed and measured at the same time as the P2P, ideally on the same sheet of material.

NOTE: Results determined by the VPR process may differ slightly from results obtained by physical print testing, due to printing and measuring variations between the first and second prints, or variations between the characterization target and the P2P target.

1. In the same G7 Calibrator session used to create the curves being verified, click **Virtual Print Run** to launch the VPR module.
2. In the **Run (curves to be applied)** tab select the calibration run used to create the calibration curves. (Note that all variables in the **Create Curves** window - such as number of control points, **Gray Balance Options**, etc., must not have changed.)
3. In the **Target data to be curved:** list, select the same P2P target data file used to create the curves.
4. In the **Training Target (Optional):** list, select the measurement file from the characterization target (e.g. IT8.7/4) printed at the same time as the P2P target. (*When applying VPR to a P2P target, the training target is NOT OPTIONAL*).
5. In the **Curving Method** area, select **Curve Lab values (retains CMYK values and target type)**.
6. Set the **Precise / Smooth** slider to **Precise**.
7. Click **Curve & Export...** and save the VPR-adjusted P2P data.
8. Click the + (Plus symbol) at the bottom of the **Calibration Runs** list to create a new run (called by default **Run 2 – Verification**).
9. Either drag the VPR-adjusted P2P data into the **Measurements** list, or click on the + (Plus symbol) below the list and browse for the file.
10. Select the **Analyze** tab and then select the **G7** sub-tab.
11. In the **Analyze – G7** window the **Results** table shows the average and maximum Delta L* (ΔL^*) values for the K-only and CMY gray scales (P2P columns 4 and 5). Also shown are the Delta F* (ΔF^*) (also known as Delta-ab (Δab)) for the CMY gray scale (P2P column 5). These values can be compared to the ΔL^* and ΔF^* tolerances shown in the chart in **Analyzing Results**.