KONICA MINOLTA

KONICA MINOLTA ACCURIOJET KM-1 SERIES

CMYK COLOUR GAMUT AND COMMON COLOUR APPEARANCE

WHITEPAPER

AccurioJet KM-1 series

Giving Shape to Ideas

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INTRODUCTION

Based on technologies Konica Minolta has amassed from its creation of digital printing, Konica Minolta has developed the AccurioJet KM-1 series, a digital printing press that incorporates a new patented UV ink, high-performance inkjet print heads and system processing technologies. Applying these proprietary technologies, Konica Minolta has realised high image quality, flexibility, stability and high productivity essential to the functions of a production machine. The superb functions and reliability of AccurioJet KM-1 series offer new merits such as the creation of new business, strengthening of relationships with clients and "rationalisation of production processes and business[1].

The AccurioJet KM-1 series is based on a B2+ sheet fed lithographic press coupled with the advantages of LED UV Inkjet process. The AccurioJet KM-1 series has the following capabilities:

- Fully automatic duplex printing, enabling reliable versioning and personalisation on both sides of the sheet with extremely accurate duplex registration;
- Maximum paper size 585 x 750 mm, with a maximum printing size of 575 x 735 mm, a maximum substrate thickness of 0.6 mm simplex and 0.45 mm duplex;
- 1,200 x 1,200 dpi provide the basis for superior print quality;
- Totally dry sheets due to the UV LED drying system in the press, permitting any instant online or offline finishing operation;
- High up-time compared to many other digital printing technologies;
- Outstanding colour stability and consistency across the B2 sheet and from sheet to sheet over a print run;
- Extended colour gamut compared to lithographic CMYK printing;
- Ability to print on a variety of different substrates, including standard offset litho grades of coated and uncoated offset litho stocks and some plastics with no pre-coating required, hence no expensive in-line coating or pre-coated 'inkjet' papers are needed;
- The AccurioJet KM-1 series has a speed of 3,000 sheets per hour, 1,500 perfected.

The main purpose of this White Paper is to investigate, test and record data on the AccurioJet KM-1 series colour stability, ability to print to recognised international print standards, on a print run of 500. Also the printed sheet stability during the run is analysed, across the printed sheet as well as from the grip edge to the back edge of the sheet. The AccurioJet KM-1 series's CMYK colour gamut will also be examined as well as the AccurioJet KM-1 series software for PDF file handling.

In an era of intense competition Konica Minolta[2] understands that brand equity is key to a company's success; this is one of the key reasons that the AccurioJet KM-1 series was developed. Businesses spend substantial sums on developing and protecting brand equity, and a number of factors define the success or otherwise of a brand. One of the most critical elements is colour. The findings of a recent survey carried out by Pantone® confirm that colour affects buying behaviours and the perception of product quality:

- 56% of adults indicate that they reach past the first product on the shelf if the packaging is discoloured
- 66% of adults agree that they take colour into consideration when making purchases
- 25% of adults agree colours help inform them about product quality
- 50% of adults agree that higher quality products have higher quality packaging
- 67% of adults take colour into consideration when making product purchases
- 37% of adults like to buy products with attractive and stylish packaging[3]

It is clear from the Pantone® survey that a brand's colour consistency is paramount in the perception of quality and superiority of a product. According to a 2007 University of Loyola, Maryland, study, colour plays a significant role in the consumer's ability to recognise brands. This study revealed that colour increases brand recognition by up to 80% and found that a colour associated with a brand and reproduced inconsistently on packaging can adversely impact the consumer's decision to purchase a product. Inconsistent colour can also create a perception among consumers that a product has been on the shelf too long, or in some parts of the world, that the product is not authentic. The long-term effect is that it can dampen consumer trust in the brand[4].

Additional research conducted by the Secretariat of the Seoul International Colour Expo, documented relationships between colour and marketing. When asked to approximate the importance of colour when buying products, 84.7% of survey respondents stated that colour accounts for more than half of the factors considered important for choosing products. This research also revealed that people make a subconscious judgement about a product within 90 seconds of viewing it, and that 60% to 90% of their assessment is based on colour alone[5].

Konica Minolta states that they are at "the forefront of colour reproduction technology, helping to ensure that our clients' brands are continually printed to exacting standards, using cutting edge technology"[6]. The objective of this White Paper is to report on the Konica Minolta AccurioJet KM-1 series printing capabilities.

This White Paper is based on the results and measurements of four days of intensive testing, which were carried out at AccurioJet KM-1 series demonstration centre in Hannover, Germany. This White Paper will also look at how the AccurioJet KM-1 series fits into a commercial printer's production workflow with regard to the need to have a common appearance across offset litho, other digital presses and the AccurioJet KM-1 series.

KM-1 SERIES COLOUR MANAGEMENT AND COLOUR WORKFLOWS

The digital front end (DFE) supplied with the AccurioJet KM-1 series has all the colour management tools and control one would expect. This for example includes the ability to accept and use both normal device and substrate ICC Profiles with a simulation profile, as well as ISO 12647-2 printing condition and device link profiles, which link the device and substrate profile with the simulation profile.

The colour management tools allow for RGB to CMYK conversions, including to the maximum CMYK gamut of the device and the chosen substrate, with full control over areas such as rendering intents and black point compensation. It is also possible to turn off colour management in the DFE in order to use 3rd party colour servers to prepare the colour managed files, normally PDFs, submitted to the press.

Ink optimising methods such as GCR (grey component replacement) and TAC (total area coverage of ink) can be used in these types of colour managed workflows to reduce ink usage, without affecting colour gamut and colour and image quality.

Operator's colour management knowledge and training

To use the KM-1 series to best effect, a good knowledge of colour management, ISO printing standards and process control is needed by prepress staff and operators, together with defined and documented colour management workflows for the paper, boards and substrates used.

Colour management knowledge and the correct colour managed workflows will ensure the correct colour managed PDF for the KM-1 series. Investing in staff and the training needed will ensure that the press returns the productivity and quality of which it is capable. As stated by Peter Drucker: "If you think training is expensive, try ignorance"[7].

ACCURIOJET KM-1 SERIES COLOUR GAMUT

The AccurioJet KM-1 ICC Profile created for the Magno Silk substrate was analysed by comparing this ICC Profile to the ISOCoated_v2_eci ICC Profile, using ColorThink Pro software[8]. Figure 1 demonstrates the colour gamut of the AccurioJet KM-1 assessed to the ISO Coated v2 ICC Profile in 3D. Figure 2 shows the colour gamut of the AccurioJet KM-1 assessed to the ISO Coated v2 ICC Profile in 2D.

The wire mesh displays the AccurioJet KM-1 colour gamut; the solid area represents ISO Coated v2. The ISO Coated v2 Profile comfortably fits within the AccurioJet KM-1 series colour gamut and only the Cyan reaches the edge of the AccurioJet KM-1 series colour gamut.

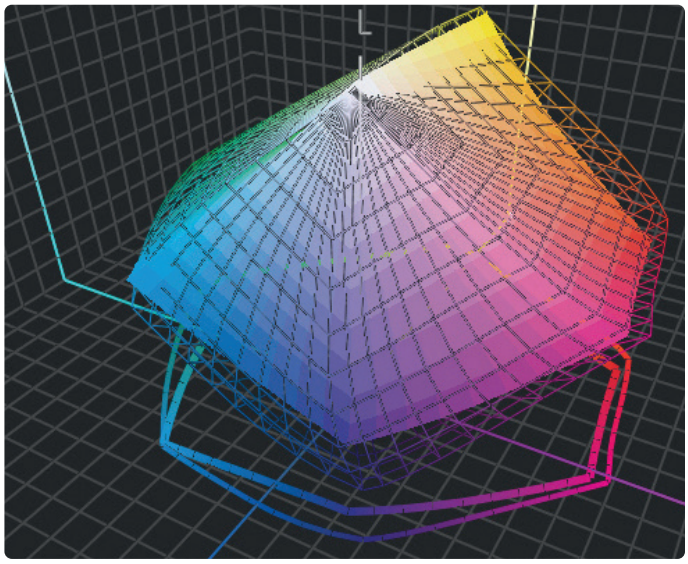


Figure 1: AccurioJet KM-1 ICC Profile assessed to the ISO Coated v2 ICC Profile in 3D

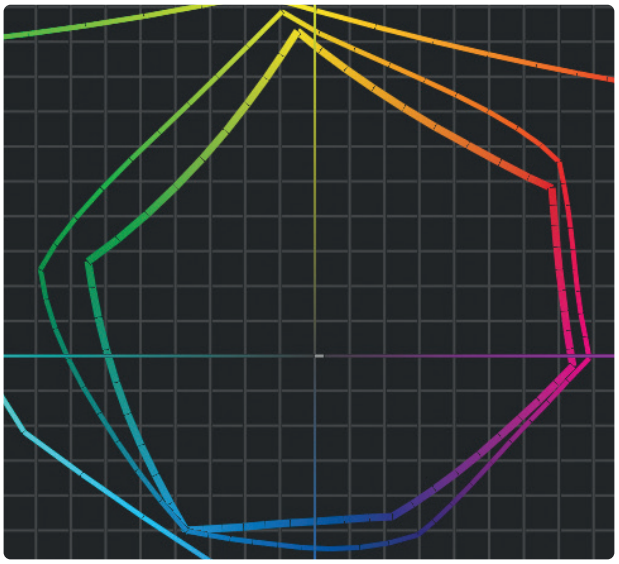


Figure 2: AccurioJet KM-1 ICC Profile assessed to the ISO Coated v2 ICC Profile in 2D

Figure 3 shows the larger gamut volume as measured by the Color Think software of the AccurioJet KM-1 Colour gamut, together with the CIE Lab figures for White Paper and CMYK inks. Figures 4 and 5 show the gamut volume for the ISO Coated v2 (FOGRA 39L) ICC Profile and PSO Coated v3 (FOGRA 51) ICC Profile as well as the CIE Lab figures for White Paper and CMYK inks.

The measured gamut volume of ISO Coated v2 is 402,279, PSO coated v3 is 393,479 and the gamut volume of the AccurioJet KM-1 on coated paper is 557,963. More importantly, the larger gamut of the AccurioJet KM-1 covers all the outer gamut areas of current ISO 12647-2 ICC Profiles. The native colour gamuts of the press for coated and uncoated papers are larger than standard offset litho CMYK gamuts. So the issue here is not the standard question, can it match offset litho? The question is, what standards and colour specifications can it emulate accurately?

To check how wide the AccurioJet KM-1 series Colour gamut is, the AccurioJet KM-1 ICC Profile created for Claro Silk was compared to the Adobe1998 RGB ICC Profile, again using ColorThink Pro software. Figure 6 shows the AccurioJet KM-1 ICC Profile fitting inside the Adobe1998 RGB ICC Profile in 3D, whilst Figure 7 shows the same profiles in 2D.

Figure 8 shows the Adobe1998 ICC Profile as well as the AccurioJet KM-1 ICC Profile and ISO Coated v2 ICC Profile in 2D.

Figure 3: AccurioJet KM-1 ICC Profile CIE L*a*b* values and gamut volume

Figure 4: ISO Coated v2 ICC Profile CIE L*a*b* values and gamut volume

Figure 5: PSO Coated v3 ICC Profile CIE L*a*b* values and gamut volume

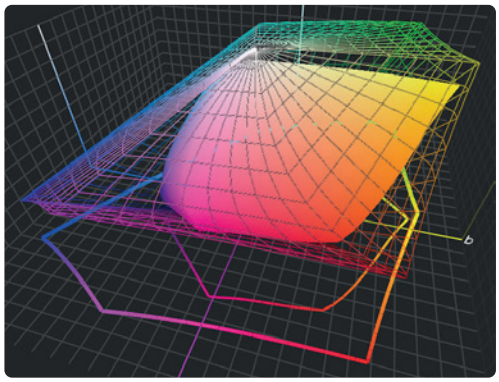


Figure 6: AccurioJet KM-1 ICC Profile assessed to Adobe1998 ICC Profile in 3D

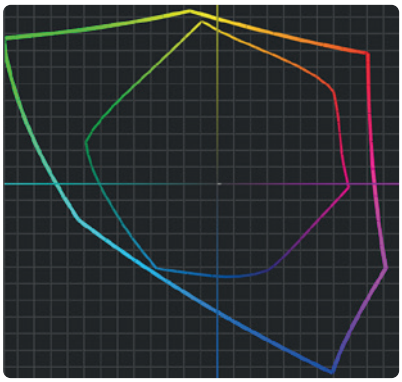


Figure 7: AccurioJet KM-1 ICC Profile assessed to Adobe1998 ICC Profile in 2D

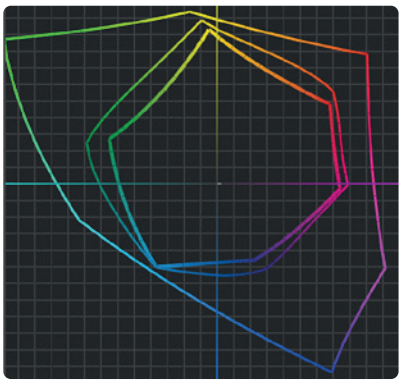


Figure 8: Adobe1998 ICC Profile assessed to AccurioJet KM-1 ICC and ISO Coated v2 ICC Profile in 2D

AccurioJet KM-1 series Pantone matching

Figures 1 to 8 clearly demonstrate that the AccurioJet KM-1 has a significantly extended colour gamut compared to conventional CMYK printing. This gives the AccurioJet KM-1 series a considerable advantage against conventional CMYK printing, for example in photo book printing and Pantone® matching.

To investigate Pantone® colour matching on the AccurioJet KM-1 series, the AccurioJet KM-1 and ISO Coated v2 ICC Profiles were analysed using X-Rite's PantoneLIVE Visualizer software[9].
The PantoneLIVE Visualizer software uses a selected ICC Profile and compares, evaluates and visualises colours across multiple substrates and printing technologies. Three different Pantone® libraries were checked for ΔE_{00} tolerances: using the AccurioJet KM-1 ICC Profile created for Claro Silk paper and the ISO Coated v2 ICC Profile:

- Pantone+ Solid Coated
- Pantone+ Pastels
- Pantone+ Neons

Figure 9 demonstrates the Pantone+ Solid Coated Library using absolute and relative colorimetric employing the AccurioJet KM-1 ICC Profile created for Claro Silk.

Figure 10 demonstrates the Pantone+ Solid Coated Library using absolute and relative colorimetric employing the FOGRA 39L ICC.

Figure 11 demonstrates the Pantone+ Pastels and Neons Library using absolute and relative colorimetric employing the AccurioJet KM-1 ICC Profile created for Claro Silk.

Figure 12 demonstrates the Pantone+ Pastels and Neons Library using absolute and relative colorimetric employing the FOGRA 39L ICC.

Pantone+ Solid Coated Library using the AccurioJet KM-1 ICC Profile created for Claro Silk

Absolute Colorimetric		Relative Colorimetric	
Count	2,040	Count	2,040
Best ΔE_{00}	0.013 (Pantone 2318 C)v	Best ΔE_{00}	0.016 (Pantone 203 C)
Worst ΔE_{00}	8.245 (Pantone Violet C)	Worst ΔE_{00}	8.489 (Pantone Violet C)
Average ΔE_{00}	1.072	Average ΔE_{00}	0.834
Average ΔE_{00} of best 10%	0.070	Average ΔE_{00} of best 10%	0.067
$\Delta E_{00} \leq 1.0$	1,412 (69.2%)	$\Delta E_{00} \leq 1.0$	1,591 (78.0%)
$\Delta E_{00} \leq 1.5$	1,555 (76.2%)	$\Delta E_{00} \leq 1.5$	1,691 (82.9%)
$\Delta E_{00} \leq 2.0$	1,652 (81.0%)	$\Delta E_{00} \leq 2.0$	1,764 (86.5%)
$\Delta E_{00} \leq 2.5$	1,726 (84.6%)	$\Delta E_{00} \leq 2.5$	1,821 (89.3%)
$\Delta E_{00} \leq 3.0$	1,798 (88.1%)	$\Delta E_{00} \leq 3.0$	1,872 (91.8%)

Figure 9: Pantone+ Solid Coated Library using the AccurioJet KM-1 Claro Silk ICC Profile ΔE values

Pantone+ Solid Coated Library using the FOGRA 39L ICC Profile

Absolute Colorimetric		Relative Colorimetric	
Count	2,040	Count	2,040
Best ΔE_{00}	0.058 (Pantone 2203 C)	Best ΔE_{00}	0.033 (Pantone 158 C)
Worst ΔE_{00}	13.101 (Pantone 2738 C)	Worst ΔE_{00}	14.020 (Pantone 2735 C)
Average ΔE_{00}	2.389	Average ΔE_{00}	1.988
Average ΔE_{00} of best 10%	0.269	Average ΔE_{00} of best 10%	0.269
$\Delta E_{00} \leq 1.0$	1,029 (50.4%)	$\Delta E_{00} \leq 1.0$	1,166 (57.2%)
$\Delta E_{00} \leq 1.5$	1,127 (55.2%)	$\Delta E_{00} \leq 1.5$	1,280 (62.7%)
$\Delta E_{00} \leq 2.0$	1,212 (59.4%)	$\Delta E_{00} \leq 2.0$	1,374 (67.4%)
$\Delta E_{00} \leq 2.5$	1,314 (64.4%)	$\Delta E_{00} \leq 2.5$	1,462 (71.7%)
$\Delta E_{00} \leq 3.0$	1,396 (68.4%)	$\Delta E_{00} \leq 3.0$	1,551 (76.0%)

Figure 10: Pantone+ Solid Coated Library using the FOGRA 39L ICC Profile ΔE values

Pantone+ Pastels and Neons Libraries using the AccurioJet KM-1 ICC Profile created for Claro Silk

Absolute Colorimetric		Relative Colorimetric	
Count	210	Count	210
Best ΔE_{00}	0.067 (Pantone 9582 C)	Best ΔE_{00}	0.020 (Pantone 9262 C)
Worst ΔE_{00}	10.640 (Pantone 804 C)	Worst ΔE_{00}	10.077 (Pantone 907 C)
Average ΔE_{00}	2.097	Average ΔE_{00}	1.274
Average ΔE_{00} of best 10%	0.127	Average ΔE_{00} of best 10%	0.082
$\Delta E_{00} \leq 1.0$	105 (50.0%)	$\Delta E_{00} \leq 1.0$	158 (75.2%)
$\Delta E_{00} \leq 1.5$	137 (65.2%)	$\Delta E_{00} \leq 1.5$	170 (81.0%)
$\Delta E_{00} \leq 2.0$	149 (71.0%)	$\Delta E_{00} \leq 2.0$	173 (82.4%)
$\Delta E_{00} \leq 2.5$	155 (73.8%)	$\Delta E_{00} \leq 2.5$	175 (83.3%)
$\Delta E_{00} \leq 3.0$	158 (75.2%)	$\Delta E_{00} \leq 3.0$	178 (84.8%)

Figure 11: Pantone+ Pastels and Neons Libraries using the AccurioJet KM-1 Claro Silk ICC Profile ΔE values

Pantone+ Pastels and Neons Libraries using the FOGRA 39L ICC Profile			
Absolute Colorimetric		Relative Colorimetric	
Count	210	Count	210
Best ΔE_{00}	0.330 (Pantone 801 C)	Best ΔE_{00}	0.154 (Pantone 801 C)
Worst ΔE_{00}	14.637 (Pantone 80v5 C)	Worst ΔE_{00}	11.591 (Pantone 805 C)
Average ΔE_{00}	3.504	Average ΔE_{00}	2.347
Average ΔE_{00} of best 10%	0.489	Average ΔE_{00} of best 10%	0.408
$\Delta E_{00} \leq 1.0$	67 (31.9%)	$\Delta E_{00} \leq 1.0$	118 (56.2%)
$\Delta E_{00} \leq 1.5$	83 (39.5%)	$\Delta E_{00} \leq 1.5$	139 (66.2%)
$\Delta E_{00} \leq 2.0$	99 (47.1%)	$\Delta E_{00} \leq 2.0$	150 (71.4%)
$\Delta E_{00} \leq 2.5$	118 (56.2%)	$\Delta E_{00} \leq 2.5$	156 (74.3%)
$\Delta E_{00} \leq 3.0$	129 (61.4%)	$\Delta E_{00} \leq 3.0$	160 (76.2%)

Figure 12: Pantone+ Pastels and Neons Libraries using the FOGRA 39L ICC Profile ΔE values

It is clear from the above figures that the AccurioJet KM-1 has a significant advantage in reproducing Pantone+ spot colours to the FOGRa 39L ICC Profile, compared to conventional CMYK printing. To simplify the above data: using relative colorimetric, the AccurioJet KM-1 can reproduce 86.5% (1,764) of the Pantone+ spot colour library with a $\Delta E_{00} \leq 2$, compared to 67.4% (1,374) using the FOGRA 39L standard. This enables the AccurioJet KM-1 to reproduce an additional 19.1% (390) of the Pantone+ spot colour library.

MATCHING OFFSET LITHOGRAPHIC STANDARDS

Users of the AccurioJet KM-1 series are many, underlining how diverse the appeal is for this technology. Users from the book, online, plastic card, photo merchandising, commercial and package printing sectors have invested in the AccurioJet KM-1 series as a replacement or addition to sheet-fed offset litho presses, thus taking advantage of all the extra benefits outlined in the executive summary.

As can be seen in Section 4, the AccurioJet KM-1 series covers all the various regional iterations of ISO 12647/2 2007 and 2013, the offset litho standard printing conditions. This ISO standard, while not a digital printing based standard, has become the de facto 'common colour appearance' specification in mixed printing technology production.

The ICC profiles based on this standard, such as ISO coated v2 (Fogra 39), PSO coated v3 (Fogra 51), GraCOL 2013 CRPC6, and Japan Color coated 2011, are used as simulation profiles when digital press needs to match offset litho.

The AccurioJet KM-1 series can accurately match to the above regional coated profiles from Europe, USA and Japan and the associated uncoated CMYK profiles, using the DFE colour management tools together with accurate device/substrate profiles. As the AccurioJet KM-1 series can match all of the local variations of ISO 12747-2, it can ensure that brand colours and images can be matched from region to region, as well as ensuring a common colour appearance to offset litho and other digital presses that can match the chosen standard or ICC Profile.

Important for some markets such as photo colour books, the AccurioJet KM-1 series can print to the maximum gamut of the press, using an RGB workflow and the device/substrate profile as the simulation profile.

The importance of device/substrate ICC Profiles

However good or large the native colour gamut of the AccurioJet KM-1 series is, the key to using this gamut and the chosen simulation ICC Profile is the device/substrate profile, which describes the native gamut. This ICC Profile describes the way the AccurioJet KM-1 prints on a paper, board or other substrate. So a device/substrate profile is needed for each paper, board or other substrates used.

Each substrate has differing properties, which affect the way the ink interacts with the substrate surface. This includes the whiteness, OBA (Optical Brightener Agent)[10] added to make paper appear 'whiter', surface, i.e. coated or uncoated, absorbency etc. Any one of these factors can change the printed appearance, thus creating the need for differing device profiles.

Device ICC Profiles are easily created in the AccurioJet KM-1 series digital front end and interact with the ICC simulation profile to match the printing condition or standard required.

TESTING PROCEDURES

Colin Osborne MBE, who is Head of Colour Management at Konica Minolta Marketing Services, undertook the print colour quality and stability evaluation. He is at the forefront of Colour Management and has over 40 years experience of print, has a Distinction in City & Guilds 518 Machine Printing, and holds a BSc. degree in Colour Science. His dissertation "Establishing and Implementing a Global Colour Management Policy for a Print Management Company" won the University of Leeds, Colour Science Department[11] J P Ward Award for the best dissertation of the year. Part of the dissertation was published in Surface Coatings International[12], the Journal of The Oil & Colour Chemists' Association[13]. Colin also sits on the UK ISO TC 130 Graphics Arts Committee[14] (this committee oversees and produces ISO print standards such as ISO 12647), and the BPIF Colour Quality Scheme Steering Committee[15].

To validate the testing and ensure impartiality, the services of Paul Sherfield[16] were used. Paul runs the consultancy company, The Missing Horse, and is well known in the printing and pre-media industry. He has considerable knowledge of digital workflows, with a special expertise on the business reasoning behind such systems. Paul is active in a number of industry groups including the ISO TC 130 Printing Standards Committee and is chair of the BPIF Steering Group for ISO 12647/2. He is also a regular speaker at seminars and conferences. Alongside Colin Osborne and Paul Sherfield was a Konica Minolta AccurioJet KM-1 operator.

Substrate

The substrate used for the evaluation was 200gsm Claro Silk[17], supplied by Antalis[18]. Claro Silk is FSC®[19] (mixed sources) certified coated fine paper, two sided coated, wood free ECF pulp, with a silk surface. The recommended printing condition specified by Antalis is FOGRA 39 characterisation data[20], with the ISO Coated v2 ICC Profile[21]. Claro Silk is suitable for the following print applications and is appropriate for all existing halftone methods:

- Offset Litho printing
- Screen printing
- Dry toner printing
- UV printing
- Embossing
- Foil blocking
- Laminating
- Folding
- Die-cutting

Claro Silk has the following optical properties, as specified in Figure 13.

Claro Silk Optical Properties

GMS	Paper Shade White Backing	Paper Shade Black Backing	Opacity ISO 2471	Brightness ISO 2470-2	CIE Whiteness ISO 11475	Thickness ISO 534	Gloss Tappi ISO 8254-1	Roughness PPS ISO 8791-4
200	L* 96.14 a* 0.99 b* -5.83	L* 95.73 a* 0.95 b* -6.01	100	100	127	148 mic	32	2

Figure 13: Claro Silk optical properties

Figure 14: X-Rite eXact Spectrophotometer

Figure 15: X-Rite i1 2 Pro Spectrophotometer

Spectrophotometers

Two spectrophotometers were used in the colour analysis: an X-Rite eXact[22] and an X-Rite i1 2 Pro[23]. Both of these spectrophotometers were configured with the following settings:

- Illuminant: D50
- Netprofile: Enabled
- Physical Filter: No Filter
- Observer Angle: 2°
- White Base: Absolute White
- Colour Scale: ΔE*2000 (KL 1.00 KC 1.00 KH 1.00)
- M0 Measuring Mode

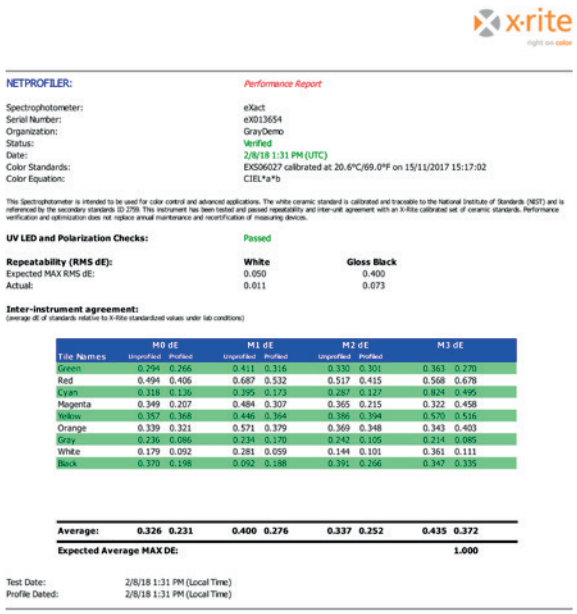
The ΔE*2000 (ΔE^*_{00}) has been recommended by ISO 13655:2009 as being the calculation for small colour differences.

The ΔE^*_{00} equation takes the form:

$$\Delta E^*_{00} = \sqrt{\left(\frac{\Delta L'}{k_L S_L}\right)^2 + \left(\frac{\Delta C'}{k_C S_C}\right)^2 + \left(\frac{\Delta H'}{k_H S_H}\right)^2 + R_T \frac{\Delta C'}{k_C S_C} \frac{\Delta H'}{k_H S_H}}$$

Figure 16: ΔE*2000 (ΔE^*_{00}) equation

The eXact spectrophotometer was used in conjunction with X-Rite Color i™QC software. The X-Rite i1 2 Pro spectrophotometer was used in combination with Bodoni pressSIGN software, as discussed in Section 6.5. Colour Management Evaluation Software.



x-rite

NETPROFILER: *Performance Report*

Spectrophotometer: eXact
Serial Number: ex013654
Organization: GrayDemo
Status: Verified
Date: 2/8/18 1:31 PM (UTC)
Color Standards: EXS06027 calibrated at 20.6°C/69.0°F on 15/11/2017 15:17:02
Color Equation: CIEL*a*b

This Spectrophotometer is intended to be used for color control and advanced applications. The white ceramic standard is calibrated and traceable to the National Institute of Standards (NIST) and is referenced by the secondary standards ID 2759. This instrument has been tested and passed repeatability and inter-unit agreement with an X-Rite calibrated set of ceramic standards. Performance verification and optimization does not replace annual maintenance and recertification of measuring devices.

UV LED and Polarization Checks: Passed

Repeatability (RMS dE):	**White**	**Gloss Black**
Expected MAX RMS dE:	0.050	0.400
Actual:	0.011	0.073

Inter-instrument agreement:
(average dE of standards relative to X-Rite standardized values under lab conditions)

	M0 dE		M1 dE		M2 dE		M3 dE	
Tile Names	Unprofiled	Profiled	Unprofiled	Profiled	Unprofiled	Profiled		
Green	0.294	0.266	0.411	0.316	0.330	0.301	0.363	0.270
Red	0.494	0.406	0.687	0.532	0.517	0.415	0.568	0.678
Cyan	0.318	0.136	0.395	0.173	0.287	0.127	0.824	0.495
Magenta	0.349	0.207	0.484	0.307	0.365	0.215	0.322	0.458
Yellow	0.357	0.368	0.446	0.364	0.366	0.394	0.570	0.516
Orange	0.339	0.321	0.571	0.379	0.369	0.348	0.343	0.403
Gray	0.236	0.086	0.234	0.170	0.242	0.106	0.214	0.095
White	0.179	0.092	0.281	0.059	0.144	0.101	0.361	0.111
Black	0.370	0.198	0.092	0.188	0.391	0.266	0.347	0.335
Average:	**0.326**	**0.231**	**0.400**	**0.276**	**0.337**	**0.252**	**0.435**	**0.372**
Expected Average MAX DE:								**1.000**

Test Date: 2/8/18 1:31 PM (Local Time)
Profile Dated: 2/8/18 1:31 PM (Local Time)

Figure 17: X-Rite NetProfiler certificate

Netprofiler® calibration

NetProfiler® provides the ability to verify, calibrate and certify the measurement performance of a spectrophotometer to a virtual standard. NetProfiler® software calibrates X-Rite spectrophotometers using a combination of software and certified printed colour standards. The physical standards are measured and compared to an established virtual standard via the Internet and a profile is generated, thus ensuring consistency in measurement and spectral data exchange[24]. The spectrophotometer should be calibrated on a monthly basis. Once calibrated, a certificate can be produced, as seen in Figure 17.

Inter-agreement instrument test

To check the performance of the eXact and the i1 2 Pro spectrophotometers, an inter-agreement instrument test was carried out prior to the AccurioJet KM-1 and HP Indigo 12000 testing. The results can be seen in Figure 18. A NetProfiler tile card was used as the colour reference; the eXact spectrophotometer was used as control against the i1 Pro 2. X-Rite SpectroEye and KM FD-7 spectrophotometers were used as a reference.

NetProfiler calibration tile	eXact	i1 2 Pro	i1 2 Pro ΔE_{00}	SpectroEye	SpectroEye ΔE_{00}	FD-7	FD-7 ΔE_{00}
Purple	L* 21.26 a* 26.21 b. -45.58	L* 21.79 a* 25.68 b* -44.77	0.38	L* 21.53 a* 26.05 b* -44.80	0.39	L* 21.21 a* 26.30 b* -45.70	0.05
Blue	L* 42.24 a* -16.12 b* -52.7	L* 42.30 a* -16.69 b* -52.16	0.31	L* 42.11 a* -15.70 b* -52.99	0.24	L* 42.23 a* -16.33 b* -52.80	0.11
Burgundy	L* 35.16 a* 54.13 b* 20.53	L* 36.15 a* 52.46 b* 18.40	1.30	L* 35.24 a* 54.55 b* 20.83	0.16	L* 35.12 a* 52.51 b* 20.05	0.47
Green	L* 51.45 a* -62.57 b* -2.00	L* 51.57 a* -61.45 b* -1.92	0.36	L* 51.32 a* -62.42 b* -2.14	0.15	L* 51.30 a* -62.70 b* -2.15	0.17
Yellow	L* 89.40 a* -0.91 b* 103.04	L* 89.82 a* -0.50 b* 99.55	1.04	L* 89.46 a* -0.59 b* 102.47	0.19	L* 89.35 a* -0.76 b* 101.82	0.23
Orange	L* 80.76 a* 27.92 b* 104.79	L* 81.04 a* 27.68 b* 99.83	1.02	L* 80.71 a* 28.37 b* 104.55	0.25	L* 80.72 a* 27.83 b* 104.28	0.09
White (paper colour)	L* 95.51 a* -0.11 b* 2.59	L* 95.37 a* 0.02 b* 2.82	0.29	L* 95.14 a* -0.06 b* 2.39	0.29	L* 95.15 a* -0.10 b* 2.23	0.38
Light Grey	L* 58.06 a* 1.74 b* 5.91	L* 58.04 a* 1.84 b* 6.00	0.14	L* 58.05 a* 1.84 b* 5.82	0.16	L* 57.81 a* 1.76 b* 5.64	0.31
Mid Grey	L* 42.23 a* 2.24 b* 6.47	L* 42.33 a* 2.34 b* 6.52	0.16	L* 42.21 a* 2.37 b* 6.49	0.17	L* 41.88 a* 2.28 b* 6.26	0.36
Dark Grey	L* 31.15 a* 2.50 b* 6.98	L* 31.32 a* 2.61 b* 6.90	0.21	L* 30.76 a* 2.65 b* 6.86	0.28	L* 30.91 a* 2.54 b* 6.67	0.38
Black	L* 8.56 a* -0.48 b* -0.26	L* 8.70 a* -0.22 b* -1.01	0.83	L* 8.77 a* -0.36 b* -0.79	0.56	L* 8.16 a* -0.28 b* -0.92	0.75
Magenta	L* 42.16 a* 71.13 b* -5.52	L* 42.54 a* 71.03 b* -5.37	0.35	L* 42.38 a* 71.31 b* -5.21	0.24	L* 42.06 a* 71.09 b* -5.91	0.18
Pink	L* 47.80 a* 73.54 b* 19.31	L* 48.14 a* 73.39 b* 19.17	0.34	L* 48.03 a* 73.68 b* 19.54	0.24	L* 47.74 a* 73.39 b* 18.84	0.20
Average ΔE_{00}			**0.51**	**0.25**			**0.28**

Figure 18: Inter-agreement test results

Colour management evaluation software

Two colour management software solutions were utilised: Bodoni pressSIGN© v8.3.0[25] and X-Rite Color i™QC Print v9.8.20.[26] pressSIGN® was used to test for compliance and sheet stability to ISO 12647-2, FOGRA 39 ICC Profile. To comply with the ISO standard, the printed sheet must be within tolerance of the Tonal Value Increase (TVI) curve, the ΔE tolerance of CMYK primaries, the overprint values, the ink trapping and the grey balance as stated by the ISO 12647-2 standard.

A copy of the pressSIGN® report PDF file can be seen in Figure 20. Figure 19 shows a screen grab of the software.

Color i™QC Print software was also utilised and enabled a full report of colour variance and stability. Using a variety of colour spaces, illuminants, colour differences as well as pass and fail attributes, which gives extra functionality to a spectrophotometer, the data generated by Color i™QC software is extensive. Figure 21 shows a Color i™QC screen grab.

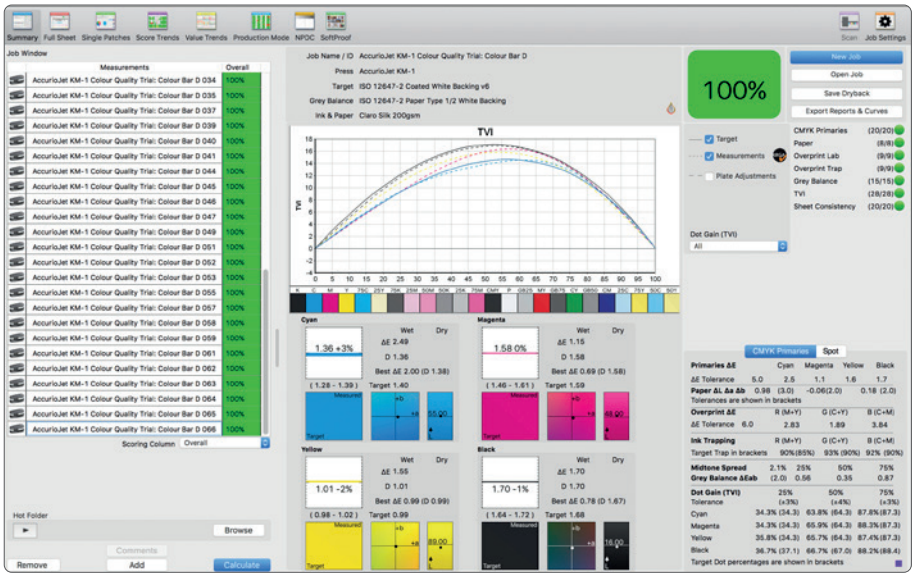


Figure 19: pressSIGN® screengrab

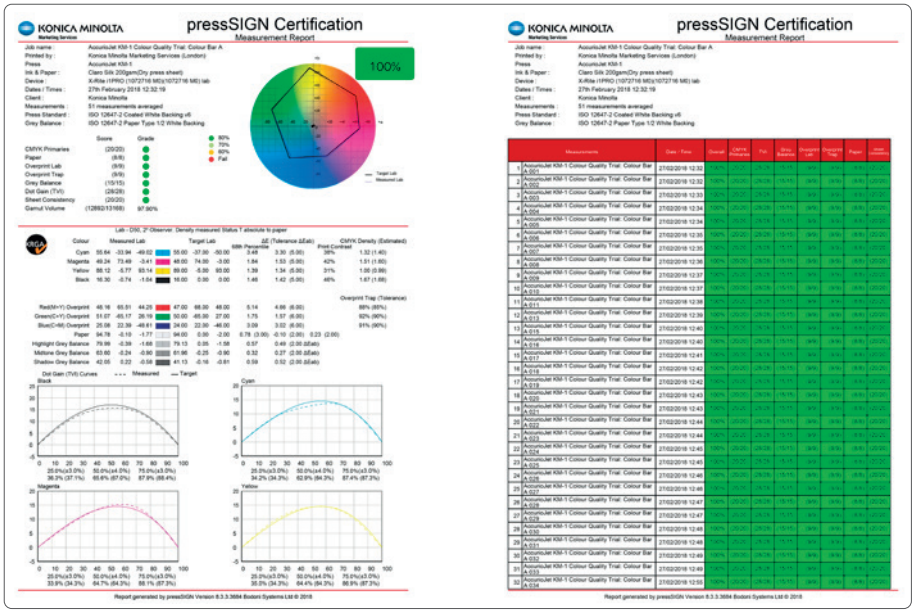


Figure 20: pressSIGN® PDF report

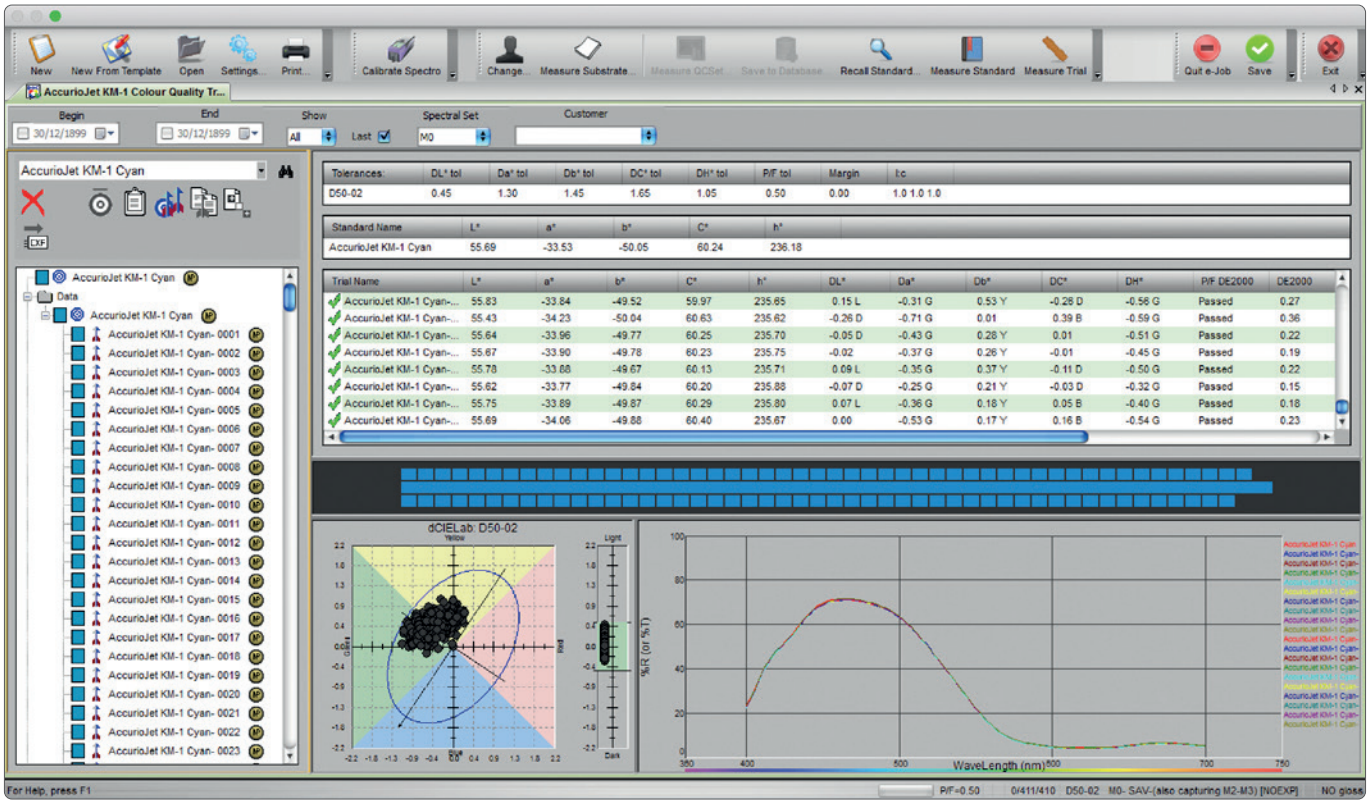


Figure 21: Color i™QC screen grab

The Color i™QC software shows a variety of data interfaces, which can be customised;
the seven interfaces have been highlighted in Figure 22.

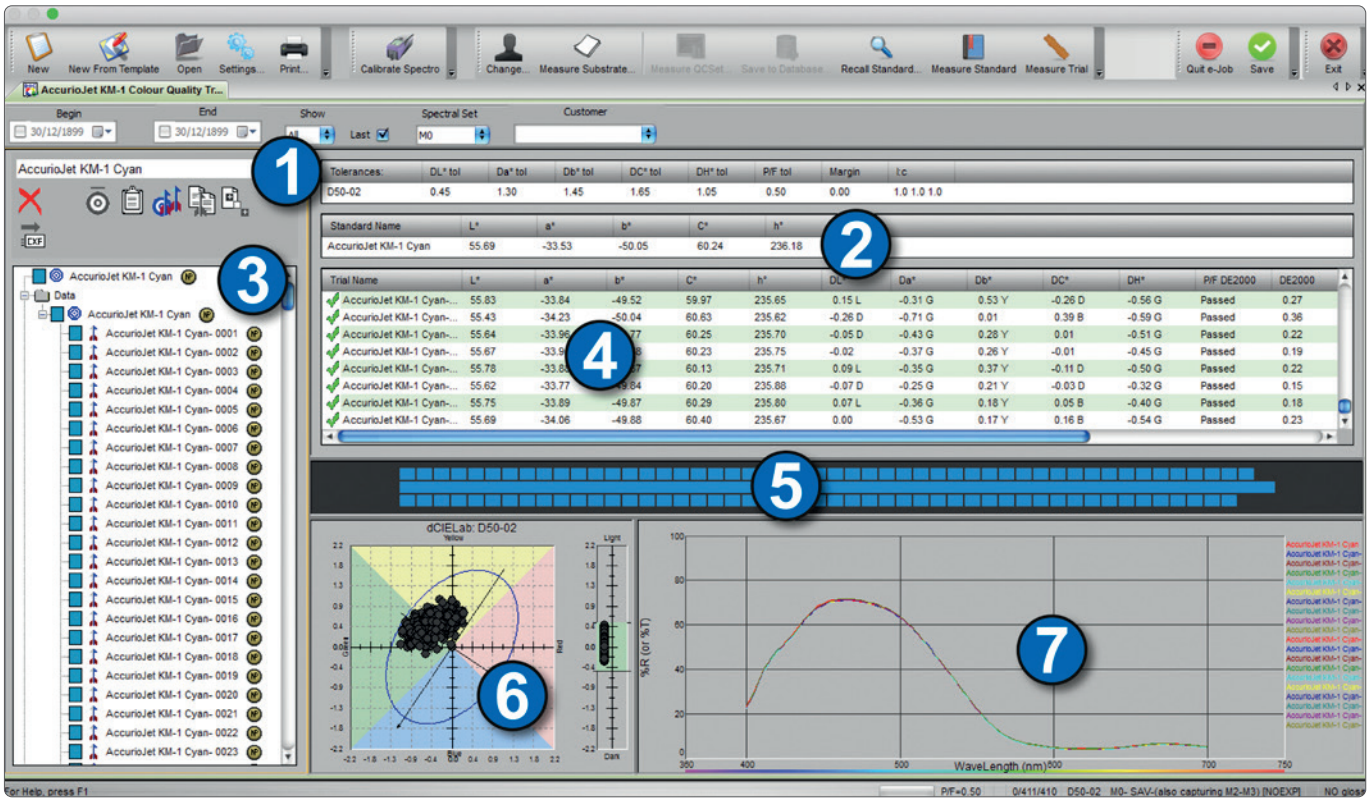


Figure 22: Color i™QC screen grab elements

The seven interfaces consist of the following:

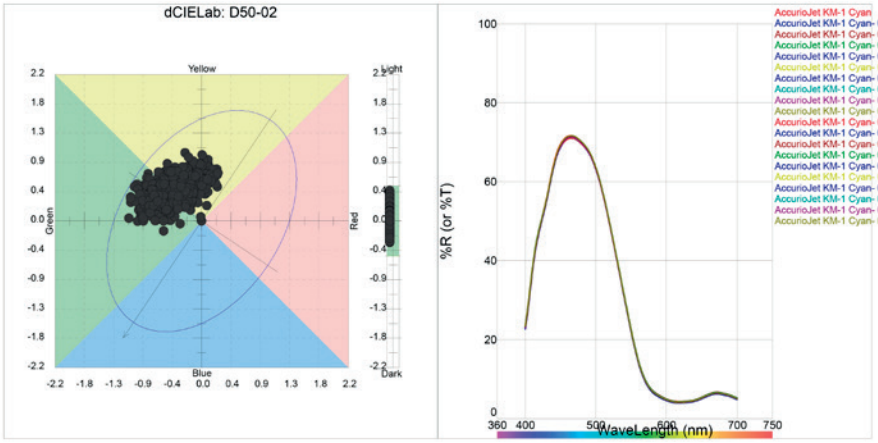
1. Tolerances are listed as well as spectrophotometer settings: D50 illuminant, 2° observer angle, M0 measuring mode, pass and fail tolerance 0.20, and margin range 0.10. If a reading were to be taken on a spectrophotometer, the operator would only be able to see the ΔE_{00} value.
2. Standard name, and full CIE L*a*b* coordinates
3. Listing of the standard and number of measurements in the trial as well as that against which the trial was measured. Also a NetProfiler icon is visible, signifying that the readings were taken on a NetProfiled device.
4. Trial name and number of readings are listed along with the ΔL*, Δa*, Δb*, ΔC*, Δh*, ΔE* and ΔE_{00} for each reading. Also shown is whether or not the measurement has passed or failed the specified tolerance. A green tick or red cross also signifies this. Other data recorded are the strength of the ink as a percentage compared to the standard, the date and time of the measurements, as well as the metamerism values achieved by comparing the D50 illuminant to D65 and D50 to CWF. There is also the option to input comments. There are many other options, such as different colour spaces and standards, many of which are for use in the paint, automotive, plastics and textile industries.
5. Visual simulation of the standard and the trial. Again, this option can be customised.
6. The system shows the standard and how the trials fit within the tolerance of the CIE L*a*b* colour space. The L* axis is also shown to the right.
7. The spectral curve is also shown in the visible light spectrum. Each trial measurement can be highlighted and, if right clicked, further details are shown as figures on the spectral curve.

With Color i™QC, customised reports can be produced and saved as a PDF file, as shown in Figure 23.

QC 27/02/2018 20:55:02

Konica Minolta Marketing Services

AccurioJet KM-1 Cyan



Tolerances:	DL* tol	Da* tol	Db* tol	DC* tol	DH* tol	P/F tol	Margin	l:c
D50-02 [D65-02 , F02-10 (CWF)]	0.45	1.30	1.45	1.65	1.05	0.50	0.00	1.0 1.0 1.0

Standard Name:	L*	a*	b*	C*	h*
AccurioJet KM-1 Cyan	55.69	-33.53	-50.05	60.24	236.18

Trial Name	L*	a*	b*	C*	h*	DL*	Da*	Db*	DC*	DH*	P/F DE2000	DE2000	% Strengt	MI-(1,3)	MI-(1,2)	Date/Time
AccurioJet KM-1 Cyan	55.85	-33.56	-49.65	59.93	235.94	0.16 L	-0.04 G	0.40 Y	-0.31 D	-0.25 G	Passed	0.20	96.79	0.04	0.11	27/02/2018 16:01:42
AccurioJet KM-1 Cyan	55.65	-33.54	-49.98	60.19	236.14	-0.03 D	-0.01	0.06 Y	-0.04 D	-0.04 G	Passed	0.04	100.08	0.02	0.02	27/02/2018 16:02:00
AccurioJet KM-1 Cyan	55.73	-33.67	-49.78	60.10	235.93	0.04 L	-0.14 G	0.27 Y	-0.14 D	-0.27 G	Passed	0.12	99.41	0.05	0.05	27/02/2018 16:01:52
AccurioJet KM-1 Cyan	55.70	-33.70	-49.88	60.20	235.96	0.01	-0.17 G	0.17 Y	-0.04 D	-0.23 G	Passed	0.10	99.83	0.03	0.04	27/02/2018 16:02:06
AccurioJet KM-1 Cyan	55.89	-33.47	-49.64	59.87	236.01	0.21 L	0.06 R	0.41 Y	-0.37 D	-0.18 G	Passed	0.23	96.10	0.05	0.12	27/02/2018 16:02:13
AccurioJet KM-1 Cyan	55.67	-33.45	-49.81	60.00	236.12	-0.02	0.08 R	0.23 Y	-0.24 D	-0.06 G	Passed	0.07	98.79	0.04	0.07	27/02/2018 16:02:17
AccurioJet KM-1 Cyan	55.74	-33.65	-49.74	60.05	235.92	0.05 L	-0.13 G	0.31 Y	-0.18 D	-0.28 G	Passed	0.13	98.68	0.04	0.09	27/02/2018 16:02:22
AccurioJet KM-1 Cyan	55.78	-33.81	-49.80	60.19	235.82	0.09 L	-0.29 G	0.25 Y	-0.04 D	-0.38 G	Passed	0.18	99.84	0.08	0.03	27/02/2018 16:02:27
AccurioJet KM-1 Cyan	55.86	-33.57	-49.58	59.88	235.90	0.17 L	-0.04 G	0.46 Y	-0.36 D	-0.29 G	Passed	0.22	96.26	0.06	0.14	27/02/2018 16:02:47
AccurioJet KM-1 Cyan	55.90	-33.52	-49.40	59.70	235.84	0.21 L	0.00	0.64 Y	-0.54 D	-0.36 G	Passed	0.28	95.39	0.07	0.17	27/02/2018 16:02:53
AccurioJet KM-1 Cyan	55.70	-33.58	-49.77	60.04	235.99	0.01	-0.06 G	0.28 Y	-0.20 D	-0.20 G	Passed	0.10	99.07	0.03	0.07	27/02/2018 16:03:01

Figure 23: Color i™QC PDF report

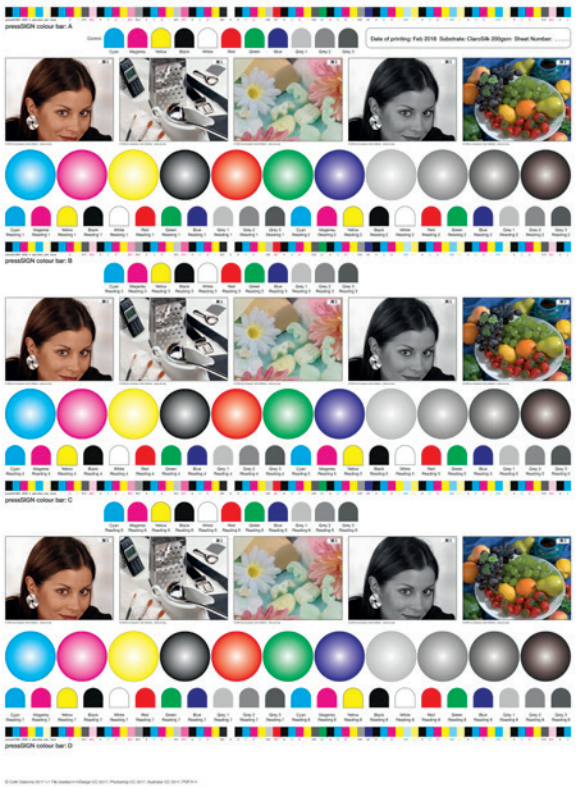


Figure 24: Test sheet

Test sheet

The printed sheet has been designed to enable an ISO 12647-2 verification using Bodoni pressSIGN® software. For colour stability and uniformity, Color i™QC software was used; the test sheet can be seen in Figure 24.

The analysis consisted of the following four features, which involved the use of:

1. Full width pressSIGN colour bars, located in four locations, (this not only enabled data to be taken across the width of the sheet, but also from the grip edge to the back edge of the sheet)
2. A visual check of images for skin tones and grey balance.
3. A visual check of colour gradation.
4. Measurement of solid cyan, magenta, yellow, black, red, green, blue, ISO 12647 standard light, midtone and three-quarter greys (in total 103 readings were taken per sheet).

Print run

The print run consisted of a run of 500 copies, (with spectrophotometer readings taken from printed sheet number one, number 10 and every 10 sheets, 51 sheets in total). The test report was compiled with 92 spectrophotometer readings per sheet in total 4,692 spectrophotometer readings were taken.

PRINT QUALITY TEST RESULTS

AccurioJet KM-1 pressSIGN results

Before measurements began on all tests, both spectrophotometers were calibrated; this exercise was repeated upon the start of any new set of measurements. For example, i1 2 Pro was calibrated before the readings of pressSIGN Colour Bar A were taken, as well as the spectrophotometer calibration for pressSIGN® Colour Bars B, C and D. This process was repeated with the eXact calibration on the Cyan, Yellow, Magenta, Black, Red, Green, Blue, Light Grey, Mid Grey and Dark Grey swatches.

The prediction was that the AccurioJet KM-1 would be able to achieve the specifications of the ISO 12647-2; ISO Coated v2 standard. The results of the test were outstanding, with every measurement scoring 100%. Not only on pressSIGN Colour Bar A, but also on pressSIGN Colour bars B, C and D as well as 100% on all 51 sheets measured. Therefore, the test print run of 500 sheets not only achieved 100% accuracy on all areas of the sheet, but also throughout the length of the print run. Figure 25 shows the pressSIGN® target report for colour bar A.

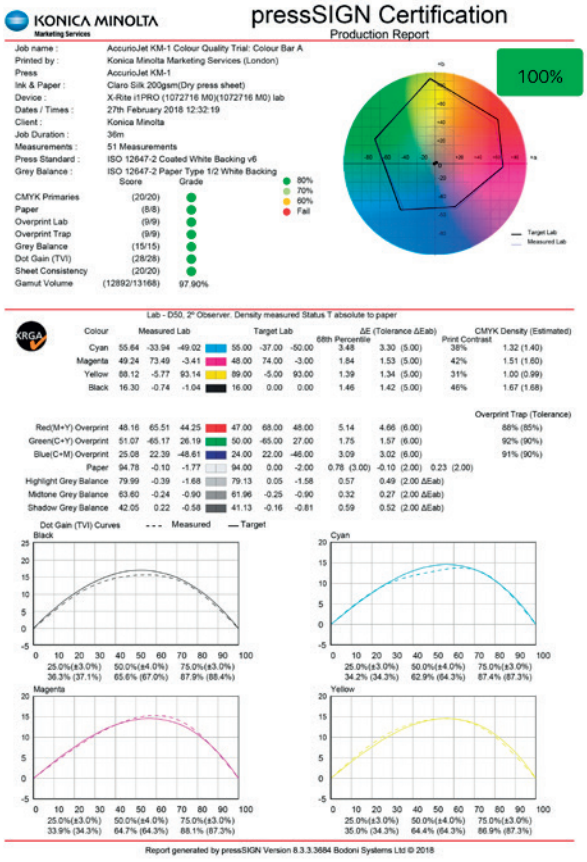


Figure 25: pressSIGN colour bar A target report

AccurioJet KM-1 Color i™QC results

Again, it was predicated that the AccurioJet KM-1 series would have very low ΔE_{00} tolerances. But once again, the AccurioJet KM-1 results were exceptional with the following statistical analysis on the cyan, magenta, yellow, black, red, green, light grey, mid grey and dark grey swatches, as demonstrated in Figure 26.

AccurioJet KM-1 Color i™QC Statistical Analysis

Swatch Colour	Average ΔE_{00}	Standard Dev. ΔE_{00}	Minimum ΔE_{00}	Maximum ΔE_{00}	Range ΔE_{00}
Cyan	0.36	0.09	0.02	0.59	0.57
Magenta	0.50	0.20	0.06	0.99	0.93
Yellow	0.22	0.10	0.03	0.43	0.40
Black	0.57	0.22	0.04	0.45	0.96
Red	0.63	0.36	0.04	1.40	1.36
Green	0.54	0.18	0.06	1.10	1.04
Blue	0.69	0.26	0.13	1.29	1.16
Light Grey	0.49	0.24	0.02	1.18	1.16
Mid Grey	0.97	0.35	0.13	1.85	1.72
Dark Grey	0.96	0.51	0.15	2.67	2.52
Combined Aver.	0.59	0.25	0.05	1.19	1.17

Figure 26: Color i™QC AccurioJet KM-1 swatch statistical analysis

CONCLUSION

The AccurioJet KM-1 series produced outstanding test results showing 100% compliance to ISO 12647-2, not only during the print test run of 500 sheets, but also 100% compliance across all areas of the printed sheet.

To demonstrate how good the AccurioJet KM-1 series colour stability and ISO compliance to a set printing standard is, in this case ISO 12647-2: ISO Coated v2, ten Ten FOGRA certified Epson digital proofs were measured using the same parameters as used on the AccurioJet KM-1 test sheets. As expected, the Bodoni pressSIGN® readings scored 100%.

The Color i™QC readings of the cyan, magenta, yellow, black, red, green, blue, light grey, mid grey and dark grey statistical analysis can be seen in Figure 27.

Epson FOGRA Certified Digital Proof Color i™QC Statistical Analysis

Swatch Colour	Average ΔE_{00}	Standard Dev. ΔE_{00}	Minimum ΔE_{00}	Maximum ΔE_{00}	Range ΔE_{00}
Cyan	0.46	0.27	0.04	1.06	1.02
Magenta	0.29	0.12	0.09	0.64	0.55
Yellow	0.34	0.09	0.12	0.60	0.48
Black	0.68	0.23	0.18	1.33	1.15
Red	0.66	0.17	0.34	1.08	0.74
Green	0.50	0.34	0.07	1.22	1.15
Blue	0.52	0.29	0.12	1.24	1.12
Light Grey	0.51	0.19	0.07	1.11	1.04
Mid Grey	0.90	0.26	0.32	1.34	1.02
Dark Grey	0.84	0.25	0.14	1.37	1.23
Combined Aver.	0.57	0.22	0.14	1.09	0.95

Figure 27: Epson FOGRA certified digital proof Color i™QC statistical analysis

Figure 28 illustrates the combined average ΔE_{00} of the cyan, magenta, yellow, black, red, green, blue, light grey, mid grey and dark grey swatches of the AccurioJet KM-1 and the Epson FOGRA certified digital proofs using Color i™QC and the variations between the two.

AccurioJet KM-1 and Epson FOGRA Certified Digital Proof Color i™QC Combined ΔE00 Statistical Analysis

Device	Average ΔE_{00}	Standard Dev. ΔE_{00}	Minimum ΔE_{00}	Maximum ΔE_{00}	Range ΔE_{00}
AccurioJet KM-1 series combined swatch averages	0.59	0.25	0.05	1.19	1.17
Epson FOGRA certified digital proof combined swatch averages	0.57	0.22	0.14	1.09	0.95
ΔE_{00} variation between the two devices	**0.02**	**0.03**	**0.09**	**0.10**	**0.12**

Figure 28: AccurioJet KM-1 and Epson FOGRA Proof combined ΔE_{00} statistical analysis

The statistical analysis between the AccurioJet KM-1 and the Epson FOGRA certified digital proofs; cyan, magenta, yellow, black, red, green, blue, light grey, mid grey and dark grey swatches, using color i™QC, shows a minuscule improvement with the Epson digital proofs, as would be expected for a calibrated digital proofing device. But the variation really is minor and in case of the Average ΔE_{00} 0.02 is outside the measuring repeatability of a spectrophotometer. Visually, the ΔE_{00} differences are so small, they would not be visible to the human eye.

This report validates the AccurioJet KM-1 series as an outstanding digital printing press that surpasses other digital printing devices currently in the market. The AccurioJet KM-1 series colour management is exceptional, providing repeatable colour on a consistent basis, with the capability to match to any standard CMYK ICC Profile, such as ISO 12647, GRACoL, Japan SWOP etc.

This report, together with the advantages listed in the executive summary of this White Paper make the AccurioJet KM-1 series a 'must see' press when looking for inkjet presses or B2+ sheet fed digital presses.

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