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Graphic technology — Determination of the operating power consumption of digital printing devices

Technologie graphique — Lignes directrices pour déterminer la consommation électrique des dispositifs d'impression numérique

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 130, *Graphic technology*.

Introduction

Estimates of operating costs for digital printing devices often include a calculation of energy consumption. However, energy efficiency comparisons are currently impossible to make, as there is no standard reference for their calculation.

It is common industry practice to estimate energy usage based solely on the connected load of a machine. This is not a very reliable method, however, as this means that, in many cases, the calculated values (e.g. 70 % of the power consumption) do not reflect the actual usage of the machine and its energy consumption[7]. Actual energy consumption often differs significantly from the estimated values[8]. Using these methods, power consumption data across devices can, therefore, not be compared, since the calculations have not followed a common framework that takes into account the influence of peripheral equipment such as IR or UV dryers and measurement cycles. This document provides requirements for the measurement of the parameters needed to estimate the energy efficiency (e.g. 1 000 A4 sheets/kWh) that correspond to the actual energy consumption for a defined machine combination.

This document specifies a method for the estimation of energy efficiency for digital production printing presses, also known as professional digital printing presses. It is up to the manufacturer of a digital printing system to declare whether it is suitable for use as a digital production printing press and, in such cases, this document is applicable.

Specifications to calculate the energy consumption of conventional sheet-fed and web-fed offset machines[5] and office equipment[6] exist and are widely used. This document is therefore, not applicable for the calculation of energy efficiency of conventional sheet-fed and web-fed offset printing machines, or for office equipment.

The universal availability of accurate and verifiable energy consumption data will enable printing machinery buyers, printers and their customers to assess the energy efficiency of digital production printing presses. However, the user of this document should understand that the effectiveness of power does not dictate quality acceptance levels of the expected output that a customer may require. Power consumption is an important part of all the output requirements and quality standards necessary for maintaining the quality and repeatability required by the print buyer. Energy efficiency can be reported in various ways, such as the number of prints printed per kWh, or as the amount of energy required in kWh to produce a specific number of prints. This information can be used to

— assess the power consumption and energy efficiency of machines including peripheral devices,

— estimate operating costs for investment planning,

— benchmark energy efficiency of digital production presses,

— measure energy efficiency improvements of digital printing devices over time or for dedicated process variations, and

— provide data to enable companies to claim environmental subsidies, when replacing equipment with more energy efficient equipment.

This document defines how to calculate the electrical energy requirements and thus the energy efficiency of digital printing devices.

When comparing the results obtained from this document, care should be taken that the devices being compared were set up to produce the same print quality using comparable types of printing technology, process and device configurations. This document may not be suitable for all devices, such as those resulting from continuous developments. It is intended to be revised as the technology evolves.

Graphic technology — Determination of the operating power consumption of digital printing devices

1 Scope

This document provides requirements and recommendations for measuring the electricity consumption of small-format and wide-format digital production presses printing in different modes of operation. It is intended for use on equipment that has been declared by the manufacturer to be suitable for use as a digital production printing press.

This document provides a means to compare the energy efficiency figures according to two or more characteristic machine combinations: Best Quality (BQ), Best Productivity (BP) or other combinations.

This document is not suitable for determining the power consumption of individual device components such as servos, fans, compressors, control boards and so on. It excludes digital presses designed to print textiles intended for clothing or machines, which similarly depend on additional processes to produce the printed product, such as ceramics.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60204-1, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
electrical energy
E
equivalent to electrical energy converted to other forms of energy (power, light, heat) for the operation of machines and devices

Note 1 to entry: Electricity generated in this way is calculated using the following formula:

$$E = \int_{t_1}^{t_2} u(t) \times i(t) dt$$

where $u(t)$ and $i(t)$ are the instantaneous values of voltage and current.

3.2
energy usage
power required for the operation of a given process over time

Note 1 to entry: Energy usage or electric energy consumption is typically measured in watt seconds, kilowatt-hours or watt-hours; Symbol Ws, kWh or Wh.

3.3
connected load
theoretically possible maximum power consumption of a machine, which can be expected when components of the printing machine are running at maximum load

Note 1 to entry: The connected load is the power specified by the manufacturer and used to rate the electrical power supply of the printing house (power rating, fuse rating, cable cross section). This ensures fail-safe operation of the machine under any possible operating condition. Determination of the connected load value has not been uniformly regulated so machine manufacturers handle it differently.

Note 2 to entry: The connected load should not be used to calculate a device's actual power consumption. This is always lower, and in most applications, it is significantly lower.

3.4
operational power consumption
power consumption of a machine in a defined operating condition (operational mode)

Note 1 to entry: Active power, reactive power and apparent power are distinct operational power consumptions. Typical operating modes are Sleep, Print Ready and Production (also known as active mode).

3.5
active power
P
power available for conversion into other types of power

Note 1 to entry: Mechanical, thermal or chemical power. In general, the active power of a consumer in a periodic AC voltage system can be determined with the formula

$$P = 1/T \int_0^T u(t) \times i(t) dt$$

where T is the desired period.

Note 2 to entry: standard unit: watt, kilowatt; symbol: W, kW.

3.6
reactive power
Q
power caused by inductive, capacitive and non-sinusoidal consumers placing additional burden on supply network

Note 1 to entry: Standard unit: volt ampere reactive; Symbol: var, kvar.

3.7
apparent power
S
geometric sum of *active power*, *P*, (3.5) and *reactive power*, *Q*, (3.6) and/or the product of the effective values of voltage and current

Note 1 to entry: It can be calculated as follows:

$$S = U_{\text{eff}} \times I_{\text{eff}}$$

Note 2 to entry: With non-ohmic consumers, the apparent power is always higher than the active power. The electrical connections ought to be sized analogously to the apparent power that can be transferred.

Note 3 to entry: Standard unit: volt ampere, kilovolt-ampere; Symbol: VA, kVA.

3.8
power meter
power analyser, which records voltages and currents as continuous values to determine power parameters

Note 1 to entry: For example, active, apparent and/or reactive power by numerical integration.

Note 2 to entry: These are high precision devices designed for industrial use.

3.9
Sleep mode
period when printing machine is switched on, not printing and operating with lower power than that of Print Ready mode

Note 1 to entry: A reduced power state that a printing device automatically enters after a set period of inactivity. Sleep mode permits operation of all product features (including maintenance of network connectivity), albeit with a possible delay to transition into Print Ready or production mode.

3.10
Print Ready mode
period when printing machine is switched on with all assembled components (pre and post processing units) ready to print immediately

3.11
production mode
period when printing machine is printing live jobs

Note 1 to entry: A production mode is characterized by a stable power consumption, when the printing machine is printing in a representative and typical fashion.

Note 2 to entry: The production mode is also known as the steady production mode.

3.12
Raster Image Processor
RIP
device or piece of software which converts coded character data and/or vector data into a raster bit stream (bitmap)

[SOURCE: ISO 12637-2:2008, 2.115, modified]

3.13
machine combination
software, hardware and print media having a direct influence on the resulting print image quality

EXAMPLE BQ combination = device configuration (hardware) + substrate (media) + print mode (software)

Note 1 to entry: *RIP* (3.12) and *print mode* (3.17) settings are examples of machine combination.

Note 2 to entry: When the settings depend heavily on the RIP and printing technology, the machine combination can also be referred to as the digital printing combination.

3.14
device configuration
physical hardware equipment included in a given production line

3.15
basic device configuration
standard hardware equipment configuration as defined by the manufacturer, owner or user of the device for the type of printed products or market that the press is being used

3.16
alternative device configuration
physical hardware configuration differing from the basic device configuration

3.17
print mode
collection of settings, that are used to control a given device configuration via software (RIP) to enable, disable or otherwise affect the operation of that device

EXAMPLE Using four colours on a machine capable of seven colours, varying the resolution, changing the speed, enabling duplex printing.

3.18
alternative print mode
collection of settings different to the print modes used for obtaining the Best Quality (BQ) or Best Productivity (BP) combinations, and used for defining additional combinations

3.19
imposition
fitting of the maximal number of test images (with no change to size) into the screen, sheet or unit length without overlapping

3.20
imposition rate
ratio between the area of the imposed test images and the total area of the screen, sheet or unit length paper

Note 1 to entry: In this document, the imposition rate is used to calculate the equivalent A4 or Letter pages printed on larger paper formats, regardless of the original image size.

3.21
copies
number of given test forms printed on a substrate, regardless of being printed simplex or duplex

EXAMPLE 100 copies = 100 test forms printed on 100 sheets (simplex) or 50 sheets (duplex) or 100 images of the test form imposed on the given substrate.

3.22
consistency check
method for determining the stability and validity of two sequential measurements before averaging the results

EXAMPLE 5% consistency is satisfied when the first result value A and the second result value B meet $0,95 \leq 2A/A+B \leq 1,05$, where result value means reporting value (e.g. XX pages/kWh for Energy Efficiency).

3.23
image quality adjustment
IQ adjustment
modifications made during printing to ensure print image quality that forces the printing system to pause production for a short period of time

Note 1 to entry: Image quality (IQ) adjustments depend on many parameters, such as test form area coverage or required quality level.

Note 2 to entry: Some printing devices will make image quality (IQ) adjustments during printing to ensure print quality, where the devices continue moving without delivering any printouts.

3.24
energy efficiency
ratio or other quantitative relationship between an output of performance, service, goods or energy, and an input of energy

EXAMPLE The energy efficiency of a digital press is reported in m^2/kWh for large format systems or numbers of A4 pages per kWh.

[SOURCE: ISO 50001:2011, 3.5.3, modified]

3.25
tonal coverage
cumulative colorant percentage

EXAMPLE A full sheet of 100 % deep black in CMYK has a tonal coverage = 400. The colorant coverage is defined by the tone value <data> as defined in ISO 12647-1[1].

Note 1 to entry: Typical coverages based on one colour plane are: Light – 1 % to 9 %, Medium – 10 % to 35 %, Heavy – 36 % above.

[SOURCE: XJDF-Specification-2.0 Draft 2017-05-11]

4 General conditions

4.1 Condition, age and machine combination

How much power a digital printing device and peripheral devices consume is subject to many influences such as the selected print mode, equipment characteristics and their condition, ambient conditions, selected print speed, additional machine settings and the printing substrates used, especially their drying requirements.

The operational climate should comply with the following conditions, and the actual conditions shall be documented.

— Temperature: 20 °C to 25 °C

— Relative air humidity: 45 % to 60 %

Measurement of the operational climate parameters shall be made for the period of printing to be measured for at least three times throughout the print run, including at the start and at the end of the power measurement at a distance of 1 m to the front side of the sheet feeder or roller unit, at a height of 1,60 m above floor level.

The manufacturer, owner or user of a printing system shall determine a basic or standard device configuration that can be used for testing. Where possible, two printing modes Best Quality and Best Productivity shall be identified. Where this is not possible, a single mode shall be used BQ/BP. For the purpose of this test, these print modes shall be used for printing and measuring to reflect their influence on its power consumption and energy efficiency data. Combining the selected device configuration with the chosen print mode and substrate results in the following machine combinations.

— **Best Quality combination:** The manufacturer, owner or user of a printing system shall select a device configuration, print mode and substrate for achieving the best possible saleable print quality. All colorants of the system shall be used.

— **Best Productivity combination:** The manufacturer, owner or user of a printing system shall use the same device configuration as used in the Best Quality combination, with a print mode and substrate for achieving the highest possible saleable productivity.

— **Best Quality/Best Productivity combination:** Where the differentiation between a Best Quality and a Best Productivity combination cannot be made, the manufacturer, owner or user of a printing system shall use a device configuration with a print mode and substrate for achieving the typical compromise between Best Quality and Best Productivity.

— **Supplemental combination:** Using the same device configuration, alternative print modes are allowed (e.g. monochrome printing of a colour test page on a colour device, printing with four colours on a device capable of seven colours, changing the print resolution, etc.) and shall be reported as a Supplemental combination, and labelled such as not to be confused with the mandatory Best Quality or Best Productivity combinations.

NOTE 1 On a monochrome printing device, monochrome printing is not considered to be a Supplemental combination, and is intended to be tested in both BQ and BP, or a BQ/BP combination.

The absolute colour accuracy shall be measured and reported by using a control strip according to ISO 12647-8:2012, 5.2[4] for all combinations. All patches of the control wedge need to be measured and reported, (see A.3). Compliance to 12647-8[4] is not required.

NOTE 2 The colour accuracy is tested in order to ensure that a minimum level of print image quality is achieved, and is not intended as a full test of colour accuracy.

NOTE 3 Colour accuracy of monochrome printers is evaluated using a monochrome test page. Such a test page[9] can be created following the principles of ISO 15930 (PDF/X) and using a monochrome (Gray) output intent.

Electrophotographic processes have significantly fewer parameters affecting energy efficiency compared to inkjet printing. However, printing systems are available that allow for a change in print image quality, e.g. by adding a further colorant. If the printing press to be evaluated does not allow for a meaningful separation between Best Quality and Best Productivity, one machine combination may be used. This machine combination shall be labelled Best Quality/Best Productivity (BQ/BP).

All equipment needed to produce printed sheets shall be included in the assessment.

Alternative device configurations may include additional pre-handling or post-handling, or print and output enhancement equipment (e.g. sheeting, folding, binding, additional colours, substrate enhancement or manipulation), under the condition that the additional equipment is built-in as part of the production line (in-line). Any alternative device configurations shall be seen and reported as a different device configuration and tested in both a Best Quality and Best Productivity combination as defined by the user of this document.

4.2 Connection conditions

Digital printing systems incorporating pre-processing and post-processing units, shall use 1-phase or 3-phase connection, 50 Hz to 60 Hz and 100 V to 650 V. The power supply quality and the voltage tolerance shall comply with IEC 60204-1 or equivalent.

Measurements shall be performed on all outlets used by the printing system. Typical connection points are:

— main printing unit (main switch cabinet);

— paper feeder of the press;

— paper delivery unit;

— external cooling units that can be directly attributed to the printing system;

— digital front end (RIP);

— viewing cabinet.

All units that are required for printing but that can't be attributed directly to the printing press (e.g. a centralized pressure, air conditioning or cooling system) shall be estimated using averaged power consumption values provided by the manufacturer. The method used and the results shall be reported.

For units which can be directly attributed but for which power consumption varies with outside temperatures, the actual temperature shall be reported. The average annual energy consumption based on an average temperature of 10 °C and 20 °C should also be reported.

EXAMPLE A chiller or air conditioning unit, mounted on the roof of a printing site, might be connected directly or indirectly to a press, but its power consumption relies on the outside temperature. While for an outside temperature of about 30 °C, with the device constantly in operation, it might run only a fraction of that time during outside temperatures of about 10 °C or less. In order to account for this effect, the power consumption can be estimated for two temperatures that provide orientation for different (cooler or warmer) ambient. To accomplish this, one would conduct power measurements or deduce the power measurement based on manufacturer data sheet provided for the temperatures around 10°C and 20°C. When performing power measurements, the recommended measurement time is at least 1 h.

