INTERNATIONAL STANDARD

ISO 20690

First edition
2018-02

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

Reference number
ISO 20690:2018(E)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
copyright@iso.org
www.iso.org

Published in Switzerland

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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.

4.3 Printing conditions and operational modes

4.3.1 General

The printing conditions, including the substrate used, shall be based on the machine's best quality and highest productivity modes, and may also cover additional machine operational modes. All modes shall be documented in conformance with Annex A.

For printing, an unscaled 1 page PDF test form shall be used. The test form shall contain technical and pictorial elements, with an area coverage up to 40 % per channel, calculated by using tone value data as defined in ISO 12647-1[1]. A colour wedge for conducting the absolute colour accuracy test according to ISO 12647-8:2012, 5.2[4] shall be used. The used colour wedge shall be part of the PDF test form. It is suggested to use recognized test forms, such as the Fogra test files (2016_ISO20690_ITR_Testfile.pdf, 2016_ISO20690A4_Testfile.pdf, 2016_ISO20690A3_Testfile.pdf)[9]. The PDF file for the test form shall be in A4, Letter or A3 format. The test form used shall be documented by means of an icon or miniature picture alongside the measurement data sheet. Two-sided printing (duplex) may also be used. When two-sided printing is used, the same image shall be printed on both sides of the sheet, and the printed pages shall be included in the calculation of printed area or number of copies.

NOTE The Fogra test charts reflect typical graphic arts use cases and therefore, have significantly more area coverage than typical direct mail applications.

Large format presses are defined as those designed for A2 media and larger, including those designed to accommodate continuous-form media greater than or equal to 406 mm wide. Duplex printing may be used by means of the optional machine combinations, and the reporting of such shall cover this in an unambiguous manner. For large format presses, the pages shall be imposed to fill at least 66 % of the total available substrate width. The imposition rate shall be taken into consideration (see 4.6).

For small and large format printing, unless it can be reliably demonstrated that the consistency criteria can be met in a shorter time, the continuous printing measurement time shall be at least 5 min. In any event, the measurement time shall not be less than 1 min, and the actual measurement time shall be reported.

For printing systems where no printing has started within 5 min, the measurement time shall be extended sufficiently to ensure that the average energy used is not significantly influenced by the energy consumed during the start-up period.

The print modes described in this clause shall be identified for the printing system to be tested, and the average power consumption for all supported non-printing operational modes shall be measured and reported.

4.3.2 Measurements required for energy efficiency

4.3.2.1 General

The average energy consumed during printing of pages (e.g. number of A4 pages for 1 kWh) shall be measured and reported. The actual measurement time used for the energy efficiency calculations shall be reported. Where image adjustment procedures take place during the measurement cycle, they shall be included in the evaluation and reported.

4.3.2.2 Print Production (Best Quality)

Printing mode recommended by the manufacturer, owner or user for use when highest quality printing is required.

4.3.2.3 Print Production (Best Productivity)

Printing mode recommended by the manufacturer, owner or user for use when acceptable print quality is required at high speed.

4.3.3 Measurements required for power consumption

4.3.3.1 General

The average power (kW) consumed in the following modes shall be measured and reported. If a mode is not supported by the press, it shall be indicated in the report.

4.3.3.2 Off

The printer is connected to the power supply but is switched off.

In some cases, power is used even when the printer is switched off, for example for a heater. The power used in this mode may be significant in cases where the printer is switched off overnight.

4.3.3.3 Print Ready

The printer is ready to print but printing has not yet been started.

For many users, the printer may spend a significant proportion of its time in this mode.

4.3.3.4 Sleep

A low-power mode where the printer can initiate printing corresponding to print requests, albeit with a possible delay.

This mode is measured so that users will know whether it is important to turn the printer off when it is not being used for a long time.

4.4 Measuring conditions

The power meters shall fulfil the following requirements listed in Table 1.

Table 1 — Requirements for the power meters

Type:	Power line analyser with data logging capability
Measurement parameters:	Voltage, current
Accuracy:	±3 %[10]

The measurement device type and model shall be documented. Valid test or calibration certificates shall be reported. The power meter shall measure voltage and current to compute the active power (W). The active power shall not be calculated by tabulated power factors or power consumption values.

The internal sampling rate of the measuring device for the current and voltage values shall be 5 kHz or higher. The recording frequency shall be one second or less, and the power consumption over time shall be reported.

NOTE A threshold of 5 kHz is commonly used in the industry since the bandwidth captures deviation from non-sinusoidal waveforms. 5 kHz is a common international practice for this purpose. The requirements in Table 1 to measure voltage and current are to ensure that hand-held power clamp meters are not used.

4.5 Measurement cycle

Connect the measurement device(s). Assure that machine is maintained according to the manufacturer's recommendation. The measurement cycle shall be conducted for machine combinations Best Quality and Best Productivity as follows:

1) Start recording (of all units).

2) After 5 min, switch on the printing press.

3) Setup the printing job for a machine combination (Best Quality, Best Productivity, Best Quality/Best Productivity or Supplemental).

4) Bring the press in Print Ready mode and retain there for circa 5 min.

5) Print test job for requested machine combination (ca. 5 min).

6) Bring the press in Print Ready mode and retain there for circa 5 min.

7) Reprint the print job one more time (ca. 5 min).

8) Calculate the energy efficiency (see 4.6) of the two print jobs and compare the two results.

9) If the two energy efficiency values satisfy ≤ 5 % consistency, then proceed to 11).

10) If they fail, proceed to 6), ensure that the press is in Print Ready mode and print the job again, and compare the 2nd and 3rd results for satisfying the 5 % consistency. Continue to repeat this sequence until the 5 % consistency is met, and then use the last two values for averaging, ignoring the previous values. It is recommended that the sequence 6) to 10) should be repeated a maximum of five times, but the actual number of repetitions shall be left up to the tester. However, if the consistency check has not been met after the maximum number of repetitions determined by the tester, the procedure shall be stopped and it shall be recorded that energy values are not stable enough to obtain accurate results.

11) If another machine combination is to be tested, proceed to 3) (see B.4).

12) Bring the press in Sleep mode and retain there for circa 5 min.

13) Turn press off and retain there for minimum of 5 min.

14) Stop recording.

The measurement cycle is also illustrated in Figure 1, where the pertinent machine combinations are termed production mode.

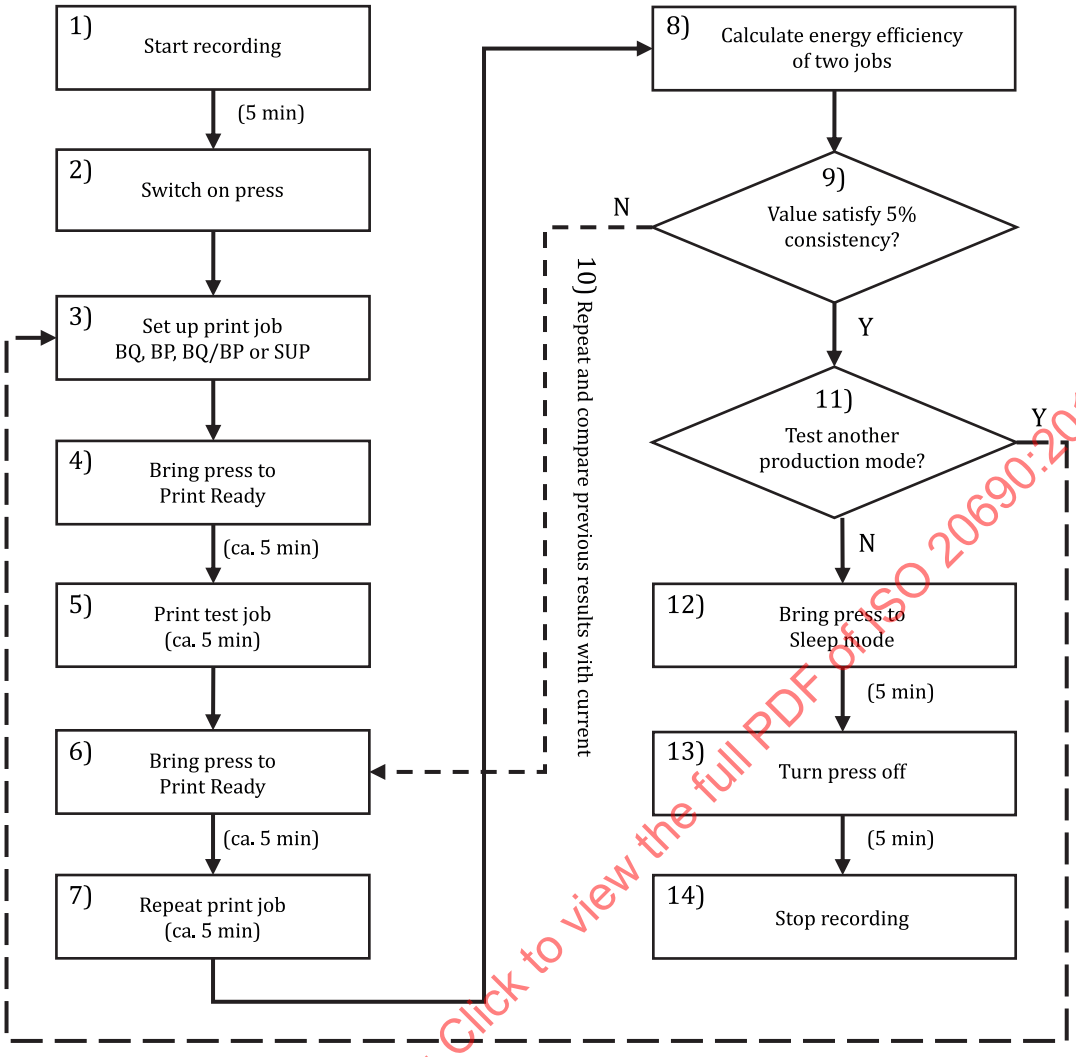
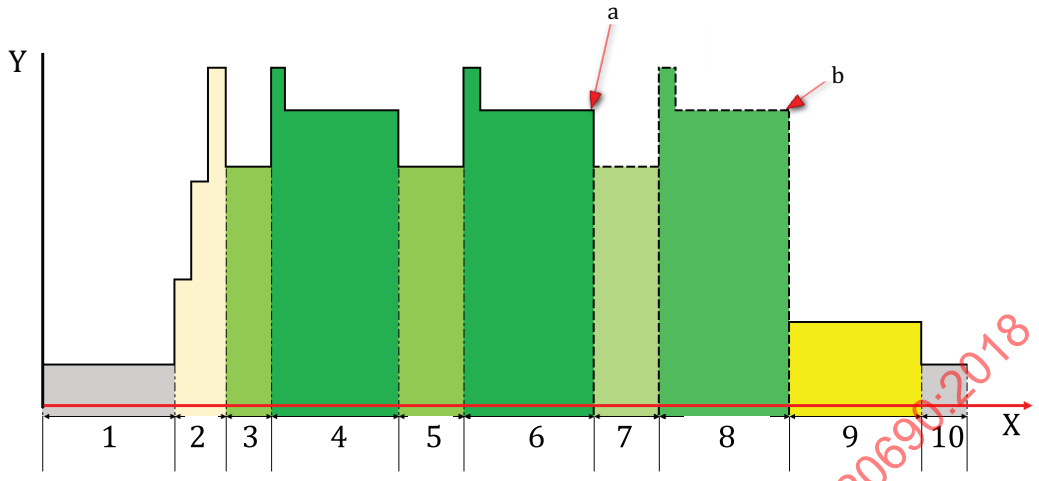


Figure 1 — Measurement cycle flowchart

This recording allows deducing the power consumption for Off, Sleep, Print Ready and machine combinations (see 4.6). For additional information, see Annex B. A time stamp shall be noted for each step to identify start and end time stamps for pertinent production and non-production modes. Average the power consumption results of the identifiable Off, Print Ready and Sleep modes and report. Average the energy efficiency results for the 2 runs that satisfy the 5 % consistency of each combination and report.

The print production measurement starts (time stamped) while the printer is in Print Ready mode and the print job is started. On some production printers, there may be a short power surge at the beginning of the print job, as shown in Figure 2. For this document, it is accepted that this surge data, if it exists, shall be included in the energy efficiency calculation. For those wanting to additionally exclude the initial power surge from the calculation, there are several methods, one of which is described in B.2.2 and the results shall be documented in addition to the normative requirements of this document if used.

However, one should understand that Figure 2 is a simplified drawing for explanation, and that during the print production, there may be several peaks, valleys and surges taking place as a result of various processes like image optimization, fuser energy fluctuations, fans/blowers for drying the ink, et cetera. The 5 % consistency check is made to ensure that the two consecutive test runs are similar, and that nothing atypical is taking place in one of those print runs to falsify the averaging.



Key

X	time, *t*	5	Print Ready
Y	power, *W*	6	BQ 2nd run
1	Off	7	Print Ready
2	start up	8	BQ 3rd run
3	Print Ready	9	Sleep
4	BQ 1st run	10	Off

a Check 1st and 2nd run for 5 % consistency. If fail, make 3rd run.

b Continue making additional runs comparing previous with current until 5 % consistency check is met.

Figure 2 — Example of test flow for one combination

All measurement points stated in 4.2 shall be measured at the same time with one or more measurement devices. If the machine or the peripheral devices are connected via transformers in order to obtain the connection parameters, the respective power loss shall be included in the value measured at the main switch cabinet or the value of the respective peripheral device.

4.6 Calculation and documentation of measurement results

Based on the recorded power consumption as defined in 4.5, the operational modes shall be identified. If an operational mode is not supported by the printing press to be tested, this mode shall be excluded. More information can be found in Annex B. Finding the exact start and end times for each operational mode can be done by a graphical evaluation or by using the recorded time stamps. Average power consumption can be calculated by dividing the integral power value of each mode by the time spent in that mode. For the supported and measured non-printing modes (Off, Sleep and Print Ready), the average of the power consumption shall be calculated. Since there is no printed output, there are no energy efficiency figures (only power consumption values) and so, the average power consumption shall be reported for these modes.

Based on the actual printed area (number of pages or area in m^2) and the consumed energy over the identified time period, the energy efficiency for the used production modes shall be calculated. For the repeated print job, the calculated power consumption data shall be averaged. The data shall then be scaled to the pertinent reference unit. The reference unit for produced printed matter (functional unit) is m^2 for large format printing systems including the imposition rate, and for small-format production presses, the number of A4 or letter sheets.

The reporting for each printing press shall contain the energy efficiency (defined in m^2/kWh for large format systems or numbers of A4 pages/kWh) for best quality and highest productivity machine combinations. Depending on the productivity, either 1 or 1 000 A4, A3, Letter pages (or equivalent m^2) should be used for reporting.

The measurement results shall be documented together with the machine combination, the measurement conditions and the selected process parameters in accordance with the format outlined in the measurement data sheet in Annex A.

Additional machine combinations (alternative device configurations) may be tested and reported additionally. In this case, the same reporting model shall be used.

Although the reference unit for produced printed matter on large format printing systems is m^2 with reference to the imposition rate, it is recommended that an A4 or Letter equivalent number should be shown in parenthesis. (Output area × imposition rate)/(A4 or Letter) area = an approximate equivalent of A4 or Letter pages.

EXAMPLE Output area 15 m^2 with an imposition rate 80 %, the equivalent A4 page number would be 192, (15 m^2 × 0,80 = 12 m^2/0,062 37 [A4 area] = 192,4). The equivalent Letter page number would be 199, (15 m^2 × 0,80 = 12 m^2/0,060 32 [Letter area] = 198,94).

Annex A
(normative)

Measurement data sheet

A.1 General

Based on the requirements defined in the main body, a report shall comprise three sections. The first section is intended to provide a summary of the measured power consumption and energy efficiency figures that can be provided in a data sheet, or to compare different presses. The second section describes basic information about the device configuration, machine combinations for each production mode, and test equipment that was used. The third section provides additional details that are needed to ensure a better understanding of how the test results were obtained and should be sufficient to allow them to be repeated by someone else.

A.2 Reporting power consumption and energy efficiency figures (first section)

A.2.1 General

The energy efficiency for the used production modes shall be reported in a table. The average power consumption values shall be added in the same table for the production modes and the tested non printing modes. The highest possible precision of measured values and the result of intermediate calculation shall be maintained, but for practical purposes, may be documented with lower precision. The reported energy efficiency and power consumption data shall be rounded to two significant figures.

The table shall contain the following main data:

— manufacturer;

— printer model name;

— test form name used and tonal coverage;

— colour (number of process colorants);

— average power consumption;

— energy efficiency.

A.2.2 Reporting (first section) examples

The following report examples in Tables A.1 to A.3 are provided as an informative template for use in creating reports of this document.

Table A.1 — Example of power consumption and energy efficiency reporting on a toner based light production printer

Manufacturer			Printer			Test form (tonal coverage)		Colour
Gutenprint			Runner1			Fogra A3 (119 %)		4C
Average power consumption						Energy efficiency (A4/kWh)		
Print Ready	Sleep	Off	BQ	BP	SUP	BQ	BP	SUP
780 W	N.A.	45 W	2 000 W	1 500 W	N.A.	1 500	2 500	N.A.

Table A.2 — Example of power consumption and energy efficiency reporting on a high speed continuous feed inkjet printer

Manufacturer			Printer		Test form (tonal coverage)	Colour
Heideltal			Speed2		Fogra A3 (TBD %)	Mono
Average power consumption					Energy efficiency (A4/kWh)	
Print Ready	Sleep	Off	BQ/BP	SUP	BQ/BP	SUP
2 200 W	200 W	5,0 W	18 kW	N.A.	3 000	N.A.

Table A.3 — Example of power consumption and energy efficiency reporting on a wide-format signage printer

Manufacturer			Printer		Test form (tonal coverage)	Colour
XXXXL			SignRunner1		Fogra A3 (119 %)	4C
Average power consumption					Energy efficiency (m^2/kWh)	
Print Ready	Sleep	Off	BQ/BP	SUP	BQ/BP	SUP
200 W	25 W	1,0 W	1 200 W	N.A.	9,0	N.A.

A.3 Main part of report (second section)

A.3.1 General

The main section shall comprise the following information:

— total operational hours as provided by the manufacturer;

— climatic conditions (relative humidity and temperature) during testing;

— year of manufacture;

— attached pre and post processing units.

Regarding the required machine combinations, the main section shall identify one of the three options.

— Best Quality and Best Productivity (2 combinations),

— Best Quality/Best Productivity (1 single representative combination), and

— Supplemental combination (may accompany the upper options).

For each combination, a description shall be added that allows for an easy understanding of the used combination. Here, the device configuration, the used substrate, and the software settings should be briefly summarized. For each combination, it shall be noted if one (simplex) or two-sided (duplex) printing was used.

Regarding the non-printing operational modes (Off, Print Ready and Sleep), the main section shall list the mode(s), for which a clear operating instruction is available. When this instruction is available, the operational mode shall be evaluated and reported by means of the average power consumption. The instruction shall be added to the report.

With respect to the used test form, the report shall list the name, the total area coverage, and the format of the used test form. For large format printing, as defined in this document, the imposition rate shall be listed.

The colour accuracy shall be reported for the OK-print by listing the ISO 12647-8[4] criteria namely, maximum and average CIELAB colour difference of all patches of the control wedge, maximum hue

distribution ΔH for CMYRGB and average ΔCh for composed grey patches. For monochrome printing conditions, the ΔH should be omitted.

The style of the main section is not further defined to allow flexible interpretation.

Table A.4 provides an example table of how to structure and present the required information.

A.3.2 Main section reporting example

Table A.4 — Main section

Operating power consumpton of digital printing devices per ISO 20690: Main Section									
manufacturer		Gutenprint			Maximum paper format		A3		
printer model name		Senefelder			year of manufacture		2010		
print method (EP/IJ)		Inkjet			operational hours		2000h		
Process colours		4 (CMYK)			Digital front end (RIP)		Rainbow V1.41		
power source: phase (1/3), Hz, voltage		3 Phase, 50 Hz, 380 - 400 V			Attached pre and post processing units		Feeder XX, roller YY		
Connection points (together covering all units required for printing)									
	main printing unit	paper feeder unit	paper delivery unit	digital front end (RIP)	Viewing station	Further units (compressor etc)	External units		
							not directly attributed to the printing system	directly attributed to the printing system, but depending on	
Present	x	x	x	x					
Connection	X								
Machine combination/configuration (device + susbtrate + print mode) + test form									
	Device configuration				Paper	Print mode			Test form
	simplex/ duplex	Additional equipment	process colorants	External Units that can't be attributed directly	substrate (size, weight)	Quality setting	imaging resolution [dpi]	Further information	test form (tonal coverage / imposition rate)
"Best Quality"	Simplex	None	4 (CMYK)	No	Pap (A3, 150g/m²)	"High"	1200		Fogra A3 (119 % / 100%)
"Best Productivity"					Fast paper (A3, 80 g/m²)	"Speed"	600		
"BQ/BP"	N. A.								
Supplemental ("BQ/BP")	Duplex	Binder X	Monochrome	No	Fiberplus (A4, 75 g/m²)	"Speed"	600		Fogra A4 (98% / 100%)
Supported non printing modes									
Off			Print Ready			Sleep			
Yes			Yes			Yes			
Measurement device(s) used									
	Model		Type		Manufacturer		Age	test/calibration	
Device 1	Modell: C.A 8332		Power quality analyser		Chauvin Arnoux		3	2017	
Device 2	N.A.								
Colour accuracy (no compliance necessary - for information only)									
	Paper ΔE	Mean ΔE	Max ΔE	ΔH Primaries	ΔCh composed grey	Comments			
"Best Quality"	2,5	1,9	8,5	2,4	1,5				
"Best Productivity"	5,7	3,5	12,5	3,2	2,4				
"BQ/BP"	N.A.								
Supplemental	1,3	0,9	6,5	omitted	2,9				
Ambient conditions									
Temperature		22°C			Relative Humidity		35%		
External units used									
wherein External	At actual outside temperature (XX °C)				Estimated value at 10 °C		Estimated value at 20°C		
Average W									
units that are required for printing but can't be attributed directly to the			estimated power consumption		method used for estimation				
e.g. centralized pressure unit									

A.4 Additional reporting information (third section)

The third section is for documenting additional detailed information about the test, or test configuration felt to be relevant for a better understanding of the test itself. As this is quite dependent on the tester/testing company or the device being tested, no attempts are made to suggest a structure for this section.

The list below provides an idea about what types of information might be contained in this section. Basically, it could contain just about anything that might be beneficial for the customer to understand the results of the test, providing information that will aid in repeating the test at a later date or suggestions on how to improve the document in a future revision.

— Explanation/diagrams/photos of the configuration.

— A test flow representing the used measurement cycle (see Figures 1 and 2). It should be accompanied by a table that lists start and stop times for all operational modes used.

— Details about the mounting of the measuring equipment.

— Additional details about device configurations or the combinations tested.

— Actual test data results

— Time intervals (actual measurement time) used for energy efficiency calculations.

— Problems encountered that could indicate that the results of the test are to be taken with caution, e.g. power stability problems or the number of times that the 5 % consistency check was made before consistency could be confirmed.

— Suggestions for future tests or improvement of the document in future reviews.

Annex B
(informative)

Operating power consumption measurement procedures for digital printing devices

B.1 General procedures

The following procedures are based on such typical modes of digital printing devices as Off, Sleep, Print Ready, and the print production modes Best Quality and Best Productivity. Some digital printing devices may not implement all designated modes. In such a case, only existing modes should be tested.

The **u**nit **u**nder **t**est (UUT) should be acclimated to room temperature according to the manufacturers' recommendations. In case no information is available, UUT should be acclimated for one hour or more before the commencement of power measurement test. The duration of acclimation time (hr) should be reported.

For power measurement, test duration time, as well as power sampling, time is specified for relevant modes.

Power measurements of Best Quality and Best Productivity should be repeated twice respectively.

The test file used should be suitable for printing on the output paper size, without scaling or cropping, and be reported.

In case of large-format printing devices, A4, Letter or A3 test images should be imposed on large format to be printed out. The ratio of image area against large-format output area, namely imposition rate, should be reported aside production measures (power consumption, productivity, energy efficiencies).

In the following measurements, the highest possible precision of measured values and the result of intermediate calculation shall be maintained, but for practical purposes, may be documented with lower precision. The reported energy efficiency and power consumption data shall be rounded to two significant figures.

NOTE Imposition rate is a part of testing condition, which is determined by layout of test images and not the inherent parameter attributable to the UUT.

B.2 Power measurement of print production mode

B.2.1 Job definition for print production

— For small and large format printing, unless it can be reliably demonstrated that the consistency criteria can be met in a shorter time, the continuous printing measurement time should be at least 5 min. In any event, the measurement time should not be less than 1 min.

— Print setting should be selected according to Best Quality (BQ) mode and Best Productivity (BP) mode.

— In case of digital printing devices whose BQ or BP distinction is difficult, a single representative print setting BQ/BP may be used.

— As a single representative print setting BQ/BP, default setting (i.e. as shipped) is recommended. In case any other setting should be used different from default setting, the difference should be reported.

— Supplemental combinations are allowed (in particular for print service providers that are interested in specific process variations, such as drying). The Supplemental combinations are handled (measurement, evaluation and reporting) in the same manner as described for BQ and BP.

— In case image adjustment procedures take place during the measurement cycle, they should be part of the evaluation and reported.

B.2.2 Power measurement for print production mode

1) Conduct minimum-job dummy print to let UUT enter Ready mode.

2) Send a print job to UUT in Ready mode and start recording time (hr) and energy (Wh) until the final trailing edge of the total output has reached the goal, namely the last page print time (LPPT).

3) Calculate the average power (W_1) using energy (Wh) and corresponding time Δt (hr) between the first page print time (FPPT) and the last page print time (LPPT).

4) Calculate continuous print productivity (P_1) using number of output pages (N_1) corresponding to Δt of 3).

5) Calculate energy efficiency (E_1: unit is A4 pages/kWh) from the energy (Wh) and number of output pages (N_1) corresponding to Δt of 3).

6) If UUT is still in Print Ready mode, then repeat 2) to 5) one more time.

7) Compare the two results of energy efficiency.

8) If the two energy efficiency values satisfy ≤ 5 % consistency, then proceed to 12).

9) If they fail to satisfy 5 % consistency and UUT is still in Print Ready mode, then repeat 2) to 5) one more time.

10) If the results of the second and the third tests satisfy 5 % consistency, adopt the second and the third test results for the calculation of 12). The first test results should not be used in the following calculations.

11) If the results of the second and the third tests fail to satisfy 5 % consistency and UUT is still in Print Ready mode, repeat 2) to 5) and 7) to 9) one more time to get the third and the fourth test results. It is recommended to continue to repeat this procedure for a maximum of five times or until the last two test results satisfy 5 % consistency, which should be adopted for the calculation of 12). However, the tester should decide the maximum repetitions that the consistency check can fail, before stopping the procedure and recording that the energy values are not stable enough to obtain accurate results.

12) Averaging two results, production power (W), continuous printing productivity (P) and energy efficiency (E) should be determined.

13) Repeat 1) to 12) corresponding to Best Quality and Best Productivity combinations. In case both combinations exist, two test suites 1) to 7) are required for each combination.

14) In case only a single mode (default setting) exists, one test run 1) to 12) is required.

If you are not sure that UUT is in Print Ready mode, then start the sequences described in 6), 9) and 11) from 1) with a dummy print job.

B.3 Power measurement for print waiting modes

B.3.1 Power measurement of Off mode

a) Start power measurement in Off mode and record *E* (Wh) and *t* (hr) for 5 min.