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Graphic technology — Determination of the energy consumption of digital printing devices including transitional and related modes

Technologie graphique — Détermination de la consommation d'énergie des dispositifs d'impression numérique en modes transitoires et connexes

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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).

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).

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For an explanation of 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 www.iso.org/iso/foreword.html.

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

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The energy requirement of digital production printing devices varies considerably across technologies, output formats, and productivity and quality expectations. Run length influences the overall energy usage, so the energy consumption of devices used for relatively short run lengths is accompanied by the relatively high amounts of transitional energy, including surge power, required to complete the print run. Operating transitions contribute to the overall energy profile throughout the course of operations, with frequent interventions between production printing modes.

As a proportion of the overall energy requirement for short run length jobs, transitional energy, including the surge energy, and waiting energy, including preparatory maintenance, will be substantial. This means that in order for the graphics industry to have accurate energy consumption data, directions are required to assist stakeholders in making accurate calculations for digital production printing devices, whose modes, other than production printing mode, play a significant role in the comprehensive energy consumption. This includes digital printing machines used to produce sign and display work, commemorative prints, photo books and similar high-value, on-demand print in narrow and wide formats.

This document provides directions for measuring any format of digital production press, whose modes, other than production printing mode, play a significant role in the comprehensive energy consumption.

This document can be used to compare the energy efficiency figures for different machine set ups: best-quality (slowest), highest-productivity (fastest) or other alternative combinations.

Application of this document provides the energy efficiency figures that correspond to the energy consumption for a digital printing device. These values can be used to inform the individual production scenarios covering different shifts, printing materials and other factors typical of the graphic arts.

Energy usage is generally estimated according to the connected load of a machine. The connected load is the machine's potential maximum power consumption. But calculated values do not necessarily reflect the machine's energy consumption. Actual energy consumption often differs significantly from estimated values. Power consumption data across devices can therefore not be accurately compared, since the calculations are unlikely to have followed a common framework that takes into account the influence of peripheral equipment such as IR or UV dryers. Nor can they accommodate differences in measurement cycles.

The universal availability of verifiable energy consumption data will enable print machinery buyers, printers and their customers to assess the power consumption of machines. However, the user of this document should understand that the effectiveness of power does not determine acceptable quality levels for the output that customers may require or expect. Power consumption is an important part of all the output requirements and quality expectation. This data can be used in life cycle analyses (LCA) and to calculate the carbon footprint of a printing system and of printed matter. Energy efficiency can be reported in various ways, such as the number of prints printed per kWh. This information can be used to:

— provide data for the LCA of a printing device;

— assess the power consumption and energy efficiency of digital printing production machines and peripheral devices;

— estimate operating costs for investment planning;

— benchmark the energy efficiency of digital production presses;

— calculate the CO_2 footprint of printed matter;

— encourage the energy efficiency improvements of digital printing devices over time;

— provide data to enable companies to claim environmental subsidies;

— provide data for carbon offsetting purposes.

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

This document can be used to determine the energy efficiency of any format of digital production press, whose modes, other than production printing mode, play a significant role in the comprehensive energy consumption.

Care should be taken when comparing the results obtained from this document that the devices being compared were set up to produce the same print quality using comparable types of printing technology, process and device configurations.

Graphic technology — Determination of the energy consumption of digital printing devices including transitional and related modes

1 Scope

This document provides directions for measuring and calculating the electricity consumption of any format of digital production press, whose modes, other than production printing mode, play a significant role in the comprehensive energy consumption. It excludes digital presses designed to print substrates other than paper or plastic and conventional printing presses fitted with digital inkjet printing heads.

It can be used to compare the energy efficiency figures for different machine combinations: best-quality (slowest), highest-productivity (fastest) or other alternative combinations.

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
digital printing machine
digital printing device
digital press
machine used in commercial/industrial applications where the printing image is produced in the machine from data stored in digital form and transferred to the substrate without the use of a printing plate

[SOURCE: ISO 12643-2:2010, 3.9, modified — "digital printing device" and "digital press" have been added to the term.]

3.2
electrical energy
E
electricity 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:

$$E = \int_{t1}^{t2} u(t) \times i(t)\, dt$$

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

3.3
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 (Ws), kilowatt-hours (kWh) or watt-hours (Wh).

3.4
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.

[SOURCE: ISO 20690:2018, 3.3]

3.5
operational power consumption
power consumption of a machine in a defined operating condition or operational mode

Note 1 to entry: Typical operating modes are sleep, print-ready and production (also known as active mode).

3.6
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 units are watts (W) and kilowatts (kW).

3.7
power meter
power analyser, which records voltages and currents as continuous values to determine power parameters

Note 1 to entry: These are high-precision devices designed for industrial use.

3.8
sleep mode
period when a printing machine is switched on, not running and operating with lower power than print-ready mode

Note 1 to entry: A reduced power state that a printing device automatically enters after a set period of inactivity (a.k.a. default delay time). 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.

3.9
print-ready mode
period when a printing machine is switched on with all assembled components (pre- and post-processing units) prepared to deliver outputs in the shortest time after a print order is given, compared with other waiting modes, such as sleep mode or off mode

3.10
production print mode
steady production print mode
period when a printing machine is printing live jobs

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

3.11
RIP
raster image processor which converts data into a raster bit stream or bitmap

3.12
machine combination
software, hardware and print media which has a direct influence on the resulting print image quality

EXAMPLE Best-quality combination = device configuration (hardware) + substrate (media) + print mode (software).

Note 1 to entry: RIP and print mode 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.

3.13
device configuration
physical hardware equipment included in a given production line

[SOURCE: ISO 20690:2018, 3.14]

3.14
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 for which the press is being used

3.15
alternative device configuration
physical hardware configuration differing from the basic device configuration

[SOURCE: ISO 20690:2018,3.16]

3.16
print mode
collection of settings, that are used to control a given device configuration via software (RIP) to enable, disable or otherwise influence the operation of that device

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

3.17
alternative print mode
collection of settings different from the print modes used for obtaining the best-quality or best-productivity combinations and used for defining additional combinations

3.18
imposition
fitting of test images (with no change to size) into the screen, sheet or unit length without overlapping

[SOURCE: ISO 20690:2018, 3.19]

3.19
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.

[SOURCE: ISO 20690:2018, 3.20]

3.20
nominal energy efficiency
E_{nom}
number of printed equivalent A4 pages or m^2 per kWh, measured in cruising state of production print mode, excluding the first page

Note 1 to entry: The number of output pages and the corresponding integral power are measured over the specified time.

3.21
effective energy efficiency
E_{eff}
number of printed equivalent A4 pages or m^2 per kWh, whose energy covers not only production print mode but also other relevant modes, such as print-ready, sleep, transitional and maintenance modes

3.22
transitional mode
start-up mode
period connecting two stable modes with different average power consumptions, i.e. “off mode and print-ready mode”, “sleep mode and print-ready mode” and “print-ready mode and production print mode”

3.23
maintenance mode
period required to maintain quality of devices, conducted regularly, for example prior to starting production print

3.24
first page print time
FPPT
number of seconds or minutes between the initiation of the job and the completion of the first cut sheet print or the completion of the first unit-page print imposed across the width of roll paper

Note 1 to entry: FPPT is measured from a stable condition of the relevant mode. For example, print-ready mode after the completion of a previous job may need a considerable time to stabilize because the heating unit needs several minutes for cooling to a stable, ready condition. If FPPT were measured before cooling off, the measured value could be shorter than that measured from a stable print-ready state, creating inconsistencies.

Note 2 to entry: In small format devices, FPPT is known as “first print out time” (FPOT). See ISO/IEC 17629:2014.

3.25
warm-up time
time required by the printing device to warm up from off mode, given by the difference in FPPT between off mode and print-ready mode

3.26
recovery time
time required by the printing device to recover from sleep mode given by the difference in FPPT between sleep mode and print-ready mode

3.27
copy
test form 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.

3.28
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").

3.29
image quality 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 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 adjustments during printing to ensure print quality, where the devices continue moving without delivering any printouts.

3.30
unit under test
UUT
the digital printing device which is being measured

3.31
dummy print
preliminary job conducted in order to bring the UUT to print-ready mode

3.32
trailing edge
ridge line of printed cut sheet or imposed image form on roll paper, situated at the end along the transportation direction

3.33
job structure
typical work flow of the printing press per period (e.g. day) with power consumption levels along sequential modes

3.34
tonal coverage
cumulative colourant percentage

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

Note 1 to entry: Typical coverage 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[11]]

4 General conditions

4.1 Condition, age and machine configuration

How much power a digital printing device and peripheral devices uses 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–25 °C, and

— relative air humidity: 45 %–60 %.

Measurement of the operational climate parameters shall be made immediately before the start of the power measurement at a distance of 1 m from the front side of the paper input, 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 the two required machine combinations, best-quality and best-productivity. These two combinations shall be used for printing and measuring, to reflect the influence of the digital press's configuration on its power consumption and energy efficiency data.

— **Best-quality (BQ) 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 colourants of the system shall be used.

— **Best-productivity (BP) 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.

— **Alternative (AL) 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 or changing the print resolution) and shall be reported as an alternative combination so as not to be confused with the mandatory best-quality or best-productivity combinations.

On a monochrome printing device, monochrome printing is not considered to be an AL combination and is to be tested in both BQ and BP combinations, if possible.

Electrophotographic processes have significantly fewer parameters affecting energy efficiency than inkjet printing. However, printing systems are available that allow for a change in print image quality, for example by adding a further colourant. If the printing press to be evaluated does not allow for a meaningful separation between BQ and BP, one machine configuration may be used. This machine combination shall be labelled best-quality/best-productivity (BQ/BP).

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

A PDF file of the output image shall be attached to the test report to show the test has been conducted with suitable image quality.

To demonstrate that prints are of adequate quality, colour accuracy should fulfil the requirements of ISO 12647-8:2012, 5.2. This ensures that the required ink coverage is used for test prints. However, this test does not fully measure the colour accuracy of the printing system.

4.2 Connection conditions

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

Measurements may be performed on more than one outlet. Typical connection points are:

— main printing unit (main switch cabinet);

— paper feeder;

— paper delivery unit;

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

— digital front end (RIP); and

— 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 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. Although for an outside temperature of about 30 °C the device is constantly in operation, it might run only a fraction of the time when the outside temperature is 10 °C or less. In order to account for this effect, the power consumption can be estimated for two temperatures that represent different (cooler or warmer) climates. To accomplish this, one would conduct power measurements or deduce the power based on the manufacturer data sheet provided for temperatures around 10 °C and 20 °C. When performing power measurements, the recommended measurement time is at least 1 hour.

4.3 Printing conditions and operational modes

4.3.1 General

The printing conditions, including the substrate used, shall be based on the machines' BQ and BP combinations and may also cover AL machine combinations. All combinations should be documented in conformance with Annex A (measurement data sheet).

For printing, an unscaled one-page PDF test form shall be used. Any image can be used for the power consumption measurement, as long as its contents represent practical commercial images with an area coverage up to 40 % per channel, calculated by using tone value data as defined in ISO 12647-1. It is advisable to use recognized test forms, such as that in ISO/IEC 24734:2014, B.2. 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 a PDF file of the printed image 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 the printed area or number of pages.

Large format presses, including those designed to accommodate continuous-form media greater than or equal to 406 mm wide, are designed for A2 media and larger[9]. Duplex printing may be used by means of the optional print modes or accessories and the associated reporting 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 will 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 five minutes. In any event the measurement time shall not be less than one minute.

NOTE When a measurement time shorter than five min satisfies consistency criteria and gives the same result as the five-min measurement, the shorter time measurement is considered to be reliable.

The print modes described in this clause shall be identified for the printing system to be tested and the energy consumed for all existing modes shall be reported. Transitions between modes shall be measured and reported.

4.3.2 Measurements referred to in ISO 20690 as well as in this document

4.3.2.1 General

The measurement of operational power consumption for this document should be consistent with the principles of measurement as outlined in ISO 20690:2018, Annex B.

4.3.2.2 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. The average power (kW) consumed in this mode shall be measured and reported.

4.3.2.3 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.

Where a sleep mode is supported by the press, the average power (kW) consumed in this mode shall be measured and reported.

Where a sleep mode is not supported the report shall indicate this.

4.3.2.4 Print-ready

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

For many users the printer may spend a significant proportion of its time in this mode. The average power (kW) consumed in this mode shall be measured and reported.

4.3.2.5 Production print (BQ)

The printing mode selected by the manufacturer or user of the UUT for use when highest-quality printing is required.

The average of two measurements of the nominal energy efficiency during printing (A4 pages or m^2 per kWh) shall be measured and reported.

4.3.2.6 Production print (BP)

The printing mode selected by the manufacturer or user of the UUT for use when acceptable print quality is required at high speed.

The average of two measurements of the E_{nom}(A4 pages or m^2 per kWh) shall be measured and reported.

4.3.3 Additional measurements required for this document to estimate comprehensive energy consumption

4.3.3.1 Maintenance

Many printer manufacturers recommend that day-to-day maintenance tasks are performed, such as quality check, calibration, replacing element and wiping. In some cases, these tasks consume significant energy and so may be important when calculating effective energy efficiency, reflecting comprehensive energy consumption.

Where the manufacturer recommends routine maintenance operations, the energy (kWh) consumed for each operation shall be measured and reported.

The frequency with which each maintenance operation is required to be performed, for example for each print run, daily or weekly, shall be reported.

4.3.3.2 Transition from off to print-ready

The press shall be turned on and a page (or set of pages) printed as described in 4.5.3.2.2.

The energy *E* (expressed with Wh, as the amounts are small) consumed over the period from turning on the printer until the printer is ready for printing shall be measured and reported, along with warm-up time, namely the time from turning the press on to when the printer is ready.

The power consumed for this transition is measured so that users can decide when it is more cost-effective to switch the printer off.

4.3.3.3 Transition from sleep to print-ready

When the press is in sleep mode, a page (or set of pages) shall be printed as described in 4.5.3.2.3 and the energy *E* (expressed with Wh, as the amounts are small) consumed over the period from making the print request until the UUT reaches print-ready shall be measured and reported. Recovery time, namely the time measured from making the print request to print-ready shall be reported.

The power consumed for this transition is measured so that users can decide when it is more cost-effective to switch the printer off.

4.3.3.4 Transition from print-ready to FPPT

When the press is in print ready mode, a page (or set of pages) shall be printed as described in 4.5.3.2.1 and the total energy (expressed with Wh, as the amounts are small) consumed over the period from making the print request until the FPPT shall be measured and reported. The time from making the print request to FPPT shall be reported.

In cases where the printer is used for many jobs with short run-lengths, the energy used in this mode may be significant.

4.4 Measuring conditions

The power meters shall fulfil the following requirements:

— type: power line analyser with data logging capacity;

— measurement parameters: voltage, current;

— accuracy: ±3 %[10].

The measurement device type, model and age shall be documented. Valid test or calibration certificates shall be reported. The power meter shall measure voltage and current to compute the active power (P). 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 above requirements to measure voltage and current are to ensure that hand-held power clamp meters are not used.

4.5 Test procedures

4.5.1 General

The following procedures are based on typical modes of digital printing devices such as off, sleep, print- ready, production print (BQ) and production print (BP). Some digital printing devices may not implement all designated modes. In such cases, only the existing modes shall be tested.

The UUT shall acclimatize to room temperature according to the manufacturer's recommendations. If no information is available, the UUT shall acclimatize for 1 h or more before the commencement of power measurement testing. The duration of the acclimatization (h) shall be reported.

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

Power measurement of any production print modes shall be repeated at least twice. For other print waiting and transitional modes, one power measurement test is sufficient.

The test file shall be suitable for printing on the output paper size without scaling or cropping. The test file used for the test run shall be reported.

For large-format printing devices, A4, Letter or A3 test images shall be imposed for output. The ratio of image area to large-format output area, namely the imposition rate, shall be reported along with production measures (power consumption, productivity, energy efficiencies). The imposition rate is a part of the testing condition, as determined by the layout of test images and not the inherent parameter attributable to the UUT.

4.5.2 Power measurement for production print mode

4.5.2.1 Job definition for production print

Job length shall correspond to at least 5 min of continuous printing. The actual measurement time (min) shall be reported. If image quality adjustment procedures take place during the measurement cycle, they shall be part of the evaluation and reported.

For large-format devices, the output area corresponding to at least 5 min of continuous printing includes plural A4/Letter images according to the imposition rate.

Print settings shall be selected according to BQ and BP combinations.

For digital printing devices whose BQ or BP distinction is ambiguous, a single representative machine combination may be used. As a single representative machine combination, default setting (i.e. as shipped) is recommended. If a setting other than default is used, the difference should be reported.

AL machine combinations are allowed (for example for print service providers interested in specific process variations, such as drying). AL machine combinations are handled (measured, evaluated and reported) in the same manner as described for BQ and BP.

4.5.2.2 Power measurement for production print mode

1) Conduct a minimum job dummy print run so that the UUT is in print-ready mode.

2) Wait 10 min before sending a print job to the UUT in print-ready mode and start recording time (h) and energy (Wh). Stop recording once the final trailing edge of the total output has exited the printing machine. This is the last page print time <LPPT>. If the UUT transits to sleep mode before 10 min, change the transition time to over 10 min. If it is not adjustable, wait the maximum time instead of 10 min, which shall be reported.

3) Calculate the average power P (W) using energy E (Wh) and corresponding time Δt (h) between the first page print time <FPPT> and the last page print time <LPPT>.

4) Calculate the continuous print productivity S (ppm) using number of output pages N corresponding to Δt of 3).

5) Calculate the E_{nom} (A4 1 000 pages/kWh) from the energy E (Wh) and number of output pages N corresponding to Δt of 3).

6) If the UUT is still in print-ready mode, then repeat 2) to 5). If the UUT might not be in print-ready mode, then repeat 1) to 5).

7) Compare the two results of E_{nom}.

8) If the two E_{nom} values satisfy 5 % consistency, then proceed to 12). See NOTE 1.

9) If they fail to satisfy 5 % consistency and the UUT is still in print-ready mode, then repeat 2) to 5) one more time. If the UUT might not be in print-ready mode, then repeat 1) to 5).

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 shall not be used in the following calculations of E_{nom} but shall be used for comprehensive energy consumption calculation as 5 %-inconsistent data. See NOTE 2.

11) If the results of the second and the third tests fail to satisfy 5 % consistency and the UUT is still in print-ready mode, repeat 2) to 5) one more time to get the third and the fourth test results. If the UUT might not be in print-ready mode, then repeat 1) to 5). Repeat this procedure at the maximum of five times until the last two test results satisfy 5 % consistency, which shall be adopted for the calculation of 12). If 5 % consistency is not satisfied even at the fifth run, all 5 %-inconsistent data shall be reported and used for the comprehensive energy consumption calculation.

12) Averaging two results, P (W), S (ppm) and E_{nom} (A4 1 000 pages/kWh) shall be determined.

13) For 5 %-inconsistent data in 11), production print power P (W), S (ppm) and unstable nominal energy efficiency ($E_{unstable}$) shall be determined. This data, together with E_{nom} values, will be used to estimate comprehensive energy consumption.

14) Repeat 1) to 13) corresponding to BQ combination and BP combination. If both combinations exist, two test suites 1) to 13) are required for each combination.

15) If only a single combination (BQ/BP, e.g. default) exists, one test run 1) to 13) is required.

The test flow from 1) to 15) is shown in Figure 1.

NOTE 1 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 E_{nom}).

NOTE 2 5 %-inconsistent data refers to such a condition, where the heating or drying unit has reached the prescribed temperature, but its surroundings are still cold, thus thermal equilibrium has not yet been attained. This condition will disappear after printing for long enough.

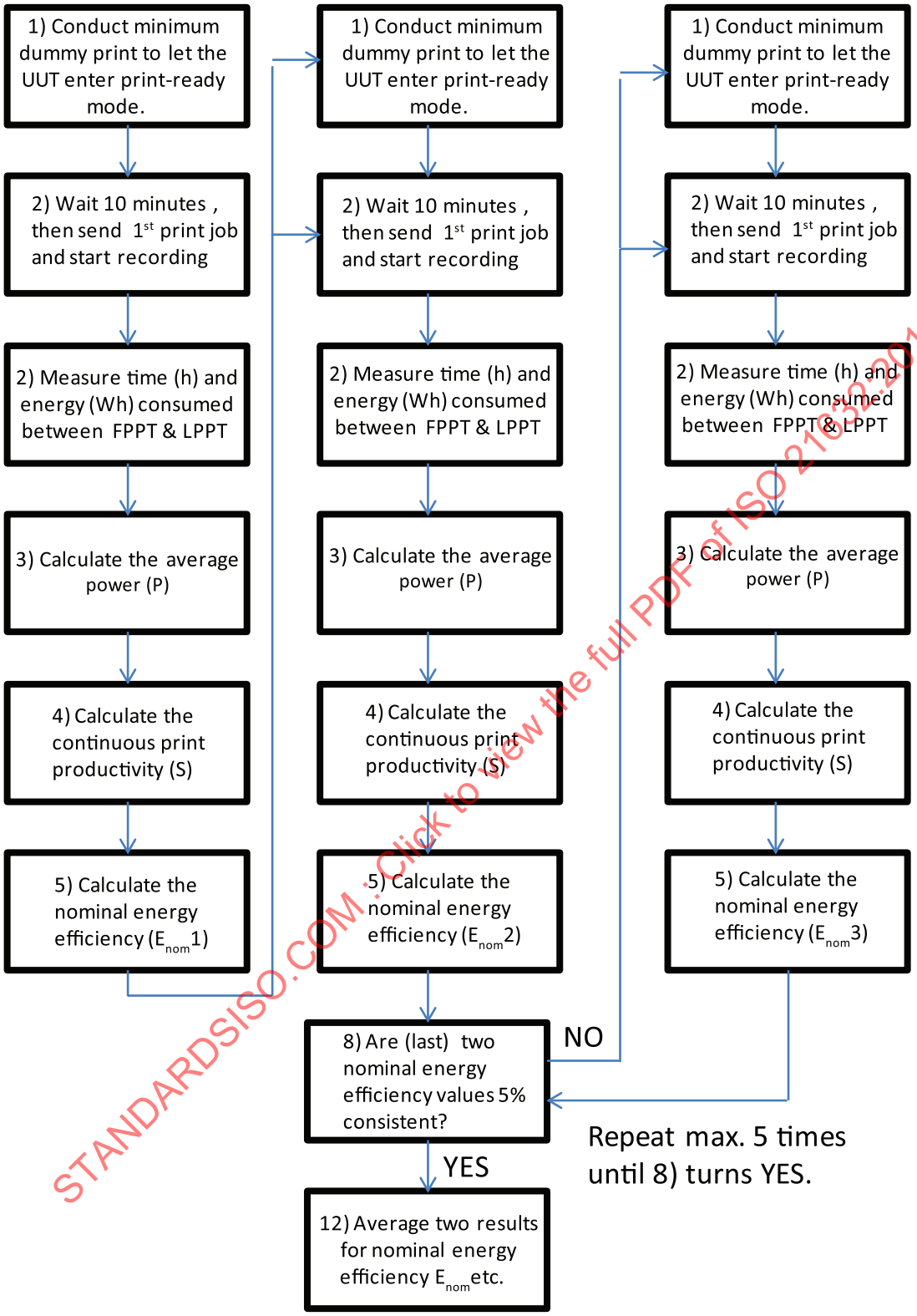


Figure 1 — Production printing power measurement

4.5.3 Procedures to determine power consumption of other relevant modes for the calculation of comprehensive energy consumption of the digital printing device

4.5.3.1 Power measurement for print waiting modes

4.5.3.1.1 Power measurement of off mode

1) Start power measurement in off mode and record E (Wh) and t (h) for 5 min.

2) From the recorded E and t data, calculate off power P (W) by dividing E by t.

NOTE Information concerning small format devices: If plural power switches exist, off mode is defined as a state where all power switches are turned off. In hard-off cases (two-pole disconnection), the power consumption of off mode is zero (0 W). However, for one-pole disconnection or soft-off switch, some power is consumed in off mode, also known as plug-in off mode, where 0 W can be attained only when the plug is disconnected from the mains.

4.5.3.1.2 Power measurement of print-ready mode

1) Conduct minimum-job dummy print and let the UUT enter print-ready mode. Then record E (Wh) and t (h) for 5 min.

2) From the recorded E and t data, calculate print-ready power P (W) by dividing E by t.

If 5 min cannot be ensured because of too short a default delay time to sleep, record energy/time for the maximum possible period.

4.5.3.1.3 Power measurement of sleep mode

1) Conduct minimum-job dummy print and let the UUT enter through print-ready mode ultimately to sleep mode. Then record E (Wh) and t (h) for 5 min.

2) From the recorded E and t data, calculate sleep power P (W) by dividing E by t.

If plural sleep modes exist with different power consumption, power measurement is conducted for each sleep mode to designate each power.

If 5 min cannot be ensured because of too short a default delay time to off mode, energy is recorded for the maximum possible time.

4.5.3.1.4 Power measurement of maintenance mode

1) Check the service manual to see if the printing device needs day-to-day maintenance conducted by the operator before starting production print.

2) If no such maintenance is required, the following procedures shall be skipped.

3) If maintenance is required, confirm the contents of maintenance.

4) Maintenance shall be started in print-ready mode.

5) When maintenance activity commences, start recording t (h) and E (Wh).

6) After conducting test prints, maintenance will be finished. The t (h) and E (Wh) data between 5) and 6) shall be recorded.

7) The average power consumption P (W) shall be calculated by dividing E by t.

8) Maintenance power consumption P as well as maintenance time duration t shall be reported.

4.5.3.2 Power measurement of transitional modes

4.5.3.2.1 Power measurement for transition from print-ready to FPPT

1) Conduct minimum-job dummy print and wait until a stable print-ready mode is reached (e.g. for small format EP it is typically reached at the latest at 50 seconds after the printed output has reached the goal), then send the test file corresponding to the minimum job to the UUT, starting E (Wh) and t (h) measurement at the same time. See NOTE 1, NOTE 2 and NOTE 3.

2) Measure t (h) and E (Wh) at the time point, where the printed output has reached the goal. This is the FPPT from print-ready t_{ready} and the first-print print energy from print-ready E_{ready} respectively.

3) If there is 5 %-inconsistent data [see 4.5.2.2 10)], corresponding t_{ready} and E_{ready} shall be reported. If there are several 5 %-inconsistent runs, all such data shall be counted for the comprehensive energy consumption calculation as long as it affects the production printing mode under estimation.

NOTE 1 For small-format devices, a minimum job corresponds to one page. For large-format devices, it corresponds to one sheet for cut-sheet or to unit of pages for roll paper. See Figure 2 to Figure 4.

NOTE 2 Refer to ISO/IEC 17629:2014, Annex F for the procedures to find stable print-ready condition.

NOTE 3 For cut sheet, the goal corresponds to the time point where the trailing edge of the sheet has exited from the printing device. For roll paper, it corresponds to the time point where the trailing edge of unit of pages has reached the take-up roll. See Figure 2 to Figure 4.

4.5.3.2.2 Power measurement for transition from off to print-ready

1) The UUT shall acclimatize for 1 h or more. The duration of acclimatization (h) shall be reported.

2) Turn on the power and immediately send the test file corresponding to minimum job to the UUT, starting E and t measurement at the same time.

3) Measure t (h) and E (Wh) at the time point, where the printed output has reached the goal. Subtract 4.5.3.2.1 2) t_{ready} (h) from this time, giving the warm-up time. Likewise, subtract 4.5.3.2.1 2) E_{ready} (Wh) from this energy, giving the energy from off to print-ready: $E_{warm\text{-}up}$.

4) If there is 5 %-inconsistent data [see 4.5.2.2 10)], corresponding t_{ready} and E_{ready} shall be reported. In this case 5 %-inconsistent t_{ready} and E_{ready} shall be subtracted likewise as described in 3).

4.5.3.2.3 Power measurement for transition from sleep to print-ready

1) Conduct minimum-job dummy printing and wait until the UUT enters sleep mode after the default delay time, then wait a further 60 min before sending the test file corresponding to minimum job to the UUT, starting E and t measurement at the same time. Print order timing is the starting point of the E and t measurements.

2) Measure time t (h) and E (Wh) at the time point, where the printed output has reached the goal. Subtract 4.5.3.2.1 2) t_{ready} (h) from this time, giving the recovery time. Likewise, subtract 4.5.3.2.1 2) E_{ready} (Wh) from this energy, giving the energy from sleep to print-ready: $E_{recovery}$.

3) If there is 5 %-inconsistent data [see 4.5.2.2 10)], corresponding t_{ready} and E_{ready} shall be reported. In this case 5 %-inconsistent t_{ready} and E_{ready} shall be subtracted likewise as described in 2).

If multiple sleep modes exist with different power consumption, power measurement shall be conducted for each different sleep mode to designate a corresponding power value.

4.5.3.2.4 Power measurement for transition from production print to print-ready

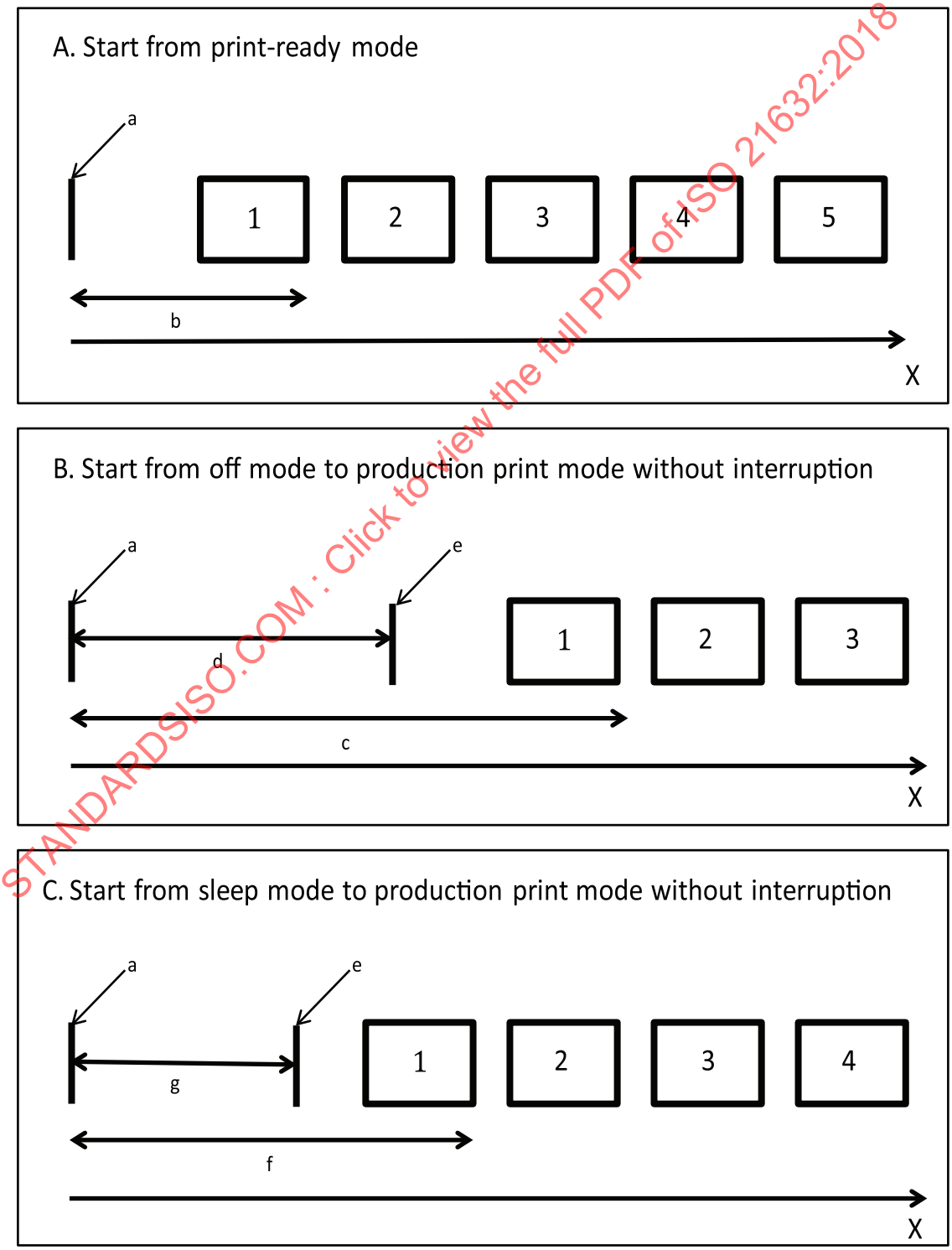
1) When the trailing edge of the last page(s) of production print mode has reached the target point, start measurement of the transition from production print to print-ready.

2) Measure t (h) and E (Wh) at the time point when the UUT reaches stable print-ready mode, which is attained when mechanical movement of, for example, transportation rollers or cooling fans has stopped.

NOTE Stable print-ready mode is characterized by the fact that FPPT shows the same value, when measured from that mode.

4.5.3.2.5 Illustrations of transitional mode measurement

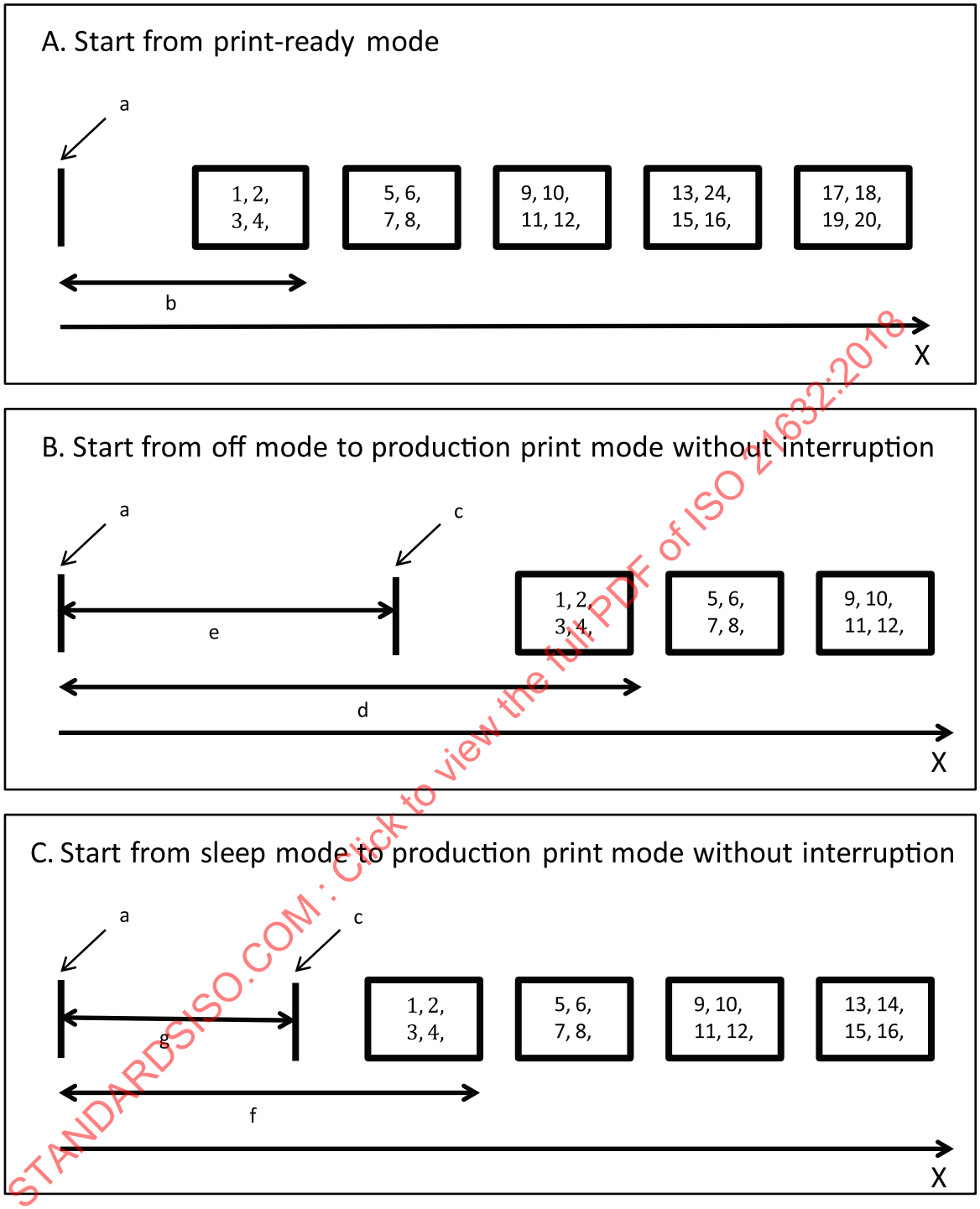
The above procedures 4.5.3.2.1, 4.5.3.2.2 and 4.5.3.2.3 are illustrated in Figure 2 to Figure 4 for different types of devices.



Key

X	time, *t*
1 to 5	number of each output page on respective cut sheet
a	Print start.
b	FPPT 1, i.e. FPPT from print-ready mode.
c	FPPT 2, i.e. FPPT from off mode.
d	Warm-up time, i.e. difference between FPPT 1 and FPPT 2.
e	Print-ready mode reached.
f	FPPT 3, i.e. FPPT from sleep mode.
g	Recovery time, i.e. difference between FPPT 1 and FPPT 3.

Figure 2 — FPPT vs. various starting modes for small format cut sheet device



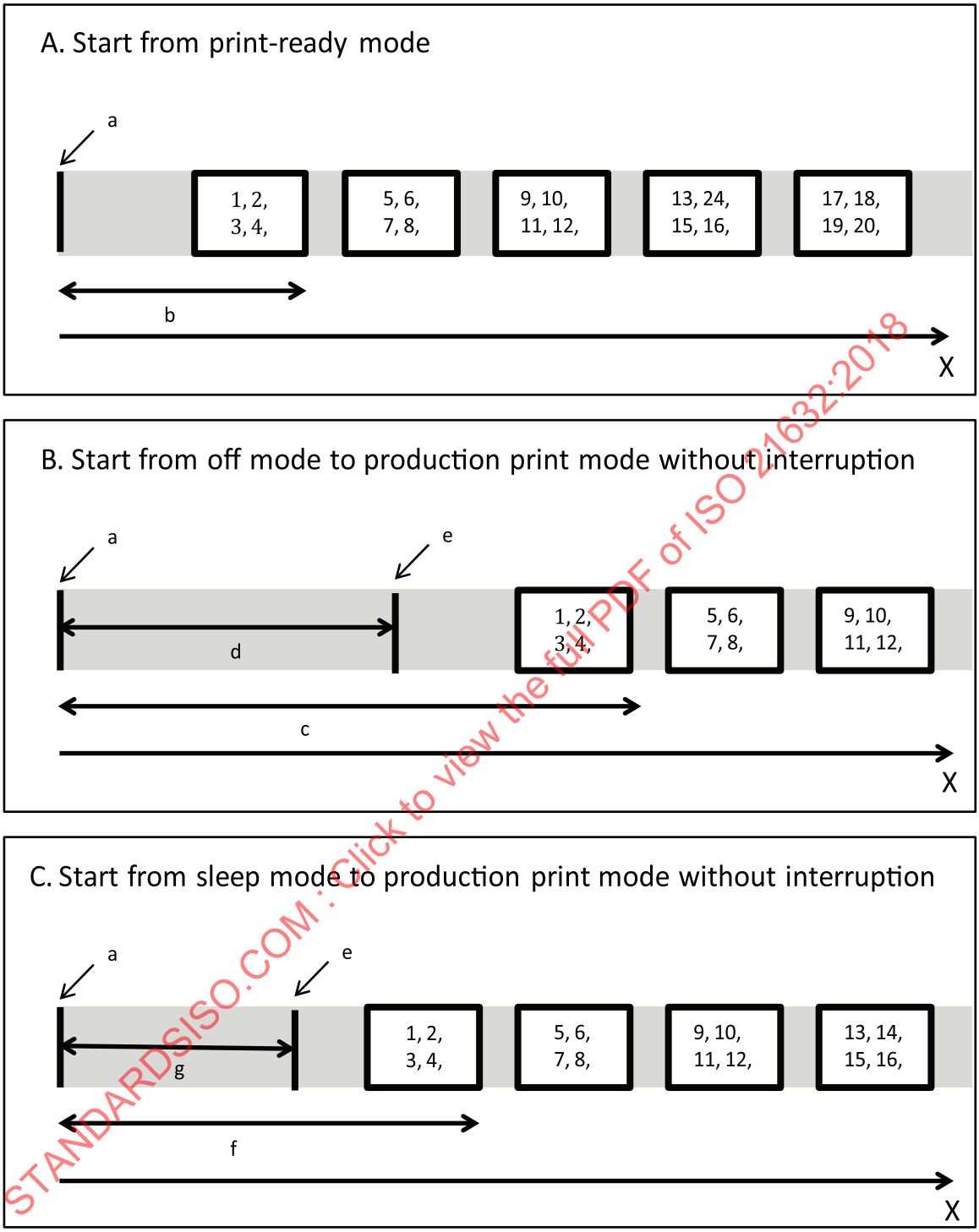
Key

X	time, *t*
1 to 16	number of imposed pages on output sheets
a	FPPT 1, i.e. FPPT from print-ready mode.
c	Print-ready mode reached.
d	FPPT 2, i.e. FPPT from off mode.
e	Warm-up time, i.e. difference between FPPT 1 and FPPT 2.
f	FPPT 3, i.e. FPPT from sleep mode.

g Recovery time, i.e. difference between FPPT 1 and FPPT 3.

Figure 3 — FPPT vs. various starting modes for large format cut sheet device

NOTE Four A4 pages per large format page are assumed for explanation purposes. In this case, FPPT represents the first A4-four-page print time.



Key

X	time, *t*
1 to 20	number of output imposed pages on roll paper
a	Print order.
b	FPPT 1, i.e. FPPT from print-ready mode.
c	FPPT 2, i.e. FPPT from off mode.
d	Warm-up time, i.e. difference between FPPT 1 and FPPT 2.
e	Print-ready mode reached.
f	FPPT 3, i.e. FPPT from sleep mode.

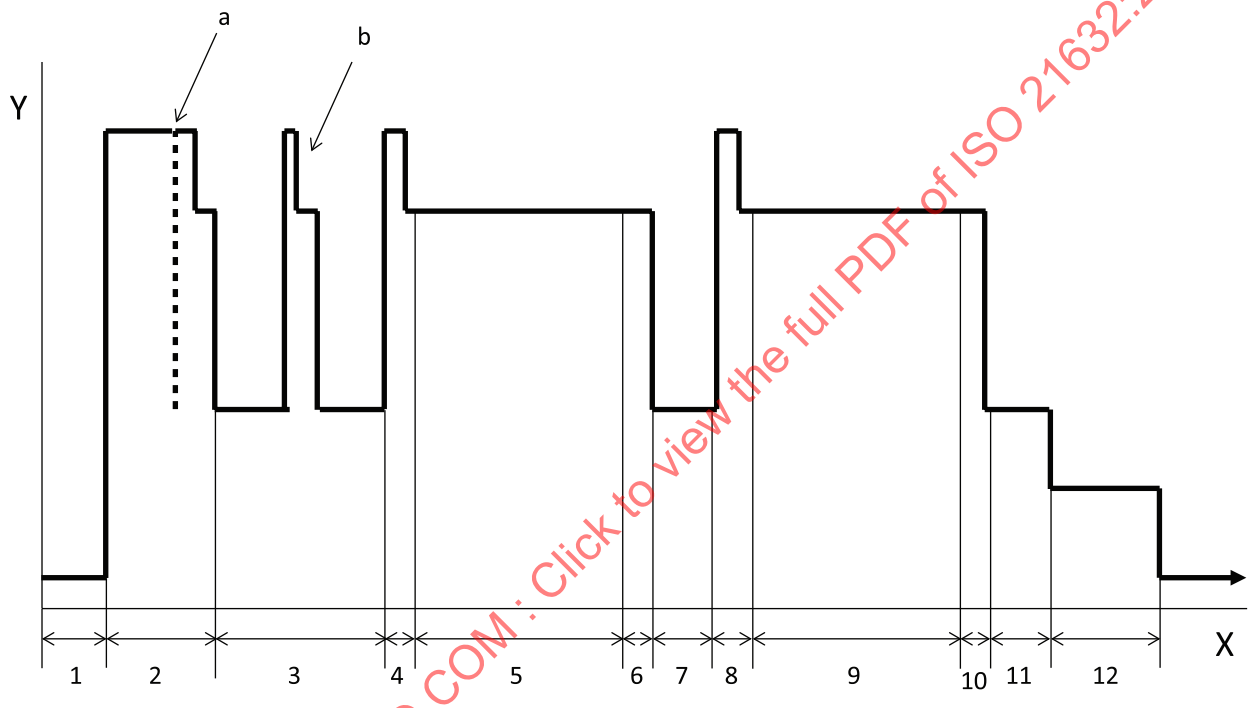
g Recovery time, i.e. difference between FPPT 1 and FPPT 3.

Figure 4 — FPPT vs. various starting modes for large format roll paper device

NOTE Four A4 pages per large format page are assumed for explanation purposes. The grey belt represents continuously fed roll paper. In this case, FPPT represents the first A4-page print time, defined by the time point, when the large format page trailing edge reaches the paper take-up roll.

4.5.4 Combined test flow

The power measurement tests described in the preceding 4.5.2 and 4.5.3 can be conducted independently. However, tests may also be conducted in a continuing series. An example of the combined test flow for one machine combination is shown in Figure 5.



Key

X	time, *t*	7	print-ready
Y	power, *P*	8	production print 2 (transition)
1	off	9	production print 2
2	start-up	10	production print 2(transition)
3	maintenance	11	print-ready
4	production print 1 (transition)	12	sleep
5	production print 1	a	Print-ready mode reached.
6	production print 1 (transition)	b	Test print.

Figure 5 — Example of combined test flow for one machine combination

Explanation for each mode a to l is given in the following Table 1.

Table 1 — Explanation of each mode

Key	Mode name	Power measurement duration	Start time	End time	N.B.
1	Off	5 min	Arbitrary time point	5 min after start time	UUT is kept in off mode as long as manufacturer's recommendations. See 4.5.1.
2	Start-up (transition)	FPPT from Off	Main power switch on + Print order (1 page)	Trailing edge of first page(s) reaches exit point.	
3	Maintenance	Duration T min as specified in user's manual	End of 2	T min after start time	This mode is skipped for UUT, for which specific maintenance is not required.
4	Production print 1 (transition)	FPPT from print-ready	Print order initiated	Trailing edge of first page(s) reaches exit point.	Print order includes number of pages, which corresponds to at least 5-min continuous printing excluding 1st page(s).
5	Production print 1	At least 5 min after 1st page(s)	Trailing edge of first image(s) reaches exit point.	Trailing edge of last page(s) reaches exit point.	In some case, production print 1 represents cold-start data, which is not used for E_{nom} calculation but used for comprehensive energy consumption calculation. In such a case, production print 3 is conducted. See 4.5.2.2 9).
6	Production print 1 (transition)	Measurement needed for UUT, whose power gradually levels off to print-ready	Trailing edge of last page(s) reaches exit point.	Additional mechanical movement stops, e.g. transportation rollers, cooling fans, etc.	After the last page has exited from UUT, it may need some time to level off to stable print-ready mode, e.g. cooling fan may continue rotation after exit of the last page.
7	Print-ready	5 min	Arbitrary time point after reaching stable print-ready mode	5 min after start time	In general, digital presses need considerable time for the fuser (heater) to cool down to ambient temperature. As test procedure requires, Production print 2 starts from 10-min print-ready duration after production print 1. Therefore, production print 2 is considered to start under warmed-up condition.
8	Production print 2 (transition)	Same as 4	Same as 4	Same as 4	This is considered to be a repeat of 4. If production print 1 is cold-start case, production print 2 may give significantly different data. See 4.5.2.2 9).

Table 1 *(continued)*

Key	Mode name	Power measurement duration	Start time	End time	N.B.
9	Production print 2	Same as 5	Same as 5	Same as 5	This is considered to be a repeat of 5. If production print 1 is a cold-start case, production print 2 may give significantly different data. See 4.5.2.2 9).
10	Production print 2 (transition)	Same as 6	Same as 6	Same as 6	
11	Print-ready	No measurement required	End of production print 2	Start of sleep mode after default delay time	
12	Sleep	5 min	Arbitrary time point after the UUT enters sleep mode	5 min after start time	This mode is skipped for UUT without sleep mode. For UUT with sleep mode, it will enter sleep mode after residing in print-ready mode for a specified delay time.

4.6 Calculation and documentation of measurement results

4.6.1 General

Based on the recorded power consumption as defined in 4.5, the relevant operational modes as defined in 4.3 shall be identified. Finding the exact start and end times for each operational mode can be done according to Table 1. Average power consumption can be calculated by dividing the integral power value of each mode by the relevant time as described in Table 1.

Based on the actual printed area (number of pages or area in m^2) and the consumed energy over the identified time period, the nominal energy efficiency (E_{nom}: gross value, partial) for the production modes used shall be calculated and the effective energy efficiency (E_{eff}: net value, total) for the modes used (off, production print, sleep, print-ready, transition, maintenance) shall be conditionally calculated, if a specific job structure is given, namely the time duration for all relevant modes; see an example in Annex B.

Using the output of this document and specifying job structure, the carbon footprint of print media products, as defined in ISO 16759, can be calculated; see an example in Annex C.

For the repeated print job the calculated power consumption data shall be averaged. The data shall then be scaled to the relevant reference unit. The functional unit is m^2 for large format printing systems including the imposition rate and the number of A4 or letter pages is the functional unit for small format production presses.

The reporting for each digital printing press shall contain the E_{nom} and, if applicable, the E_{eff} (defined in m^2/kWh for large format systems or numbers of A4 pages or Letter/kWh for small format presses) for BQ and BP machine combinations. Depending on the productivity S, either 1 or 1 000 A4 or Letter pages should be used for reporting.

The measurement results, which this document specifies to report, shall be documented together with the machine combination, the measurement conditions and the selected process parameters. In the test report it shall be clearly described that the measurement has been conducted according to this document. Examples of test report formats and measurement data format are shown in Annex A.

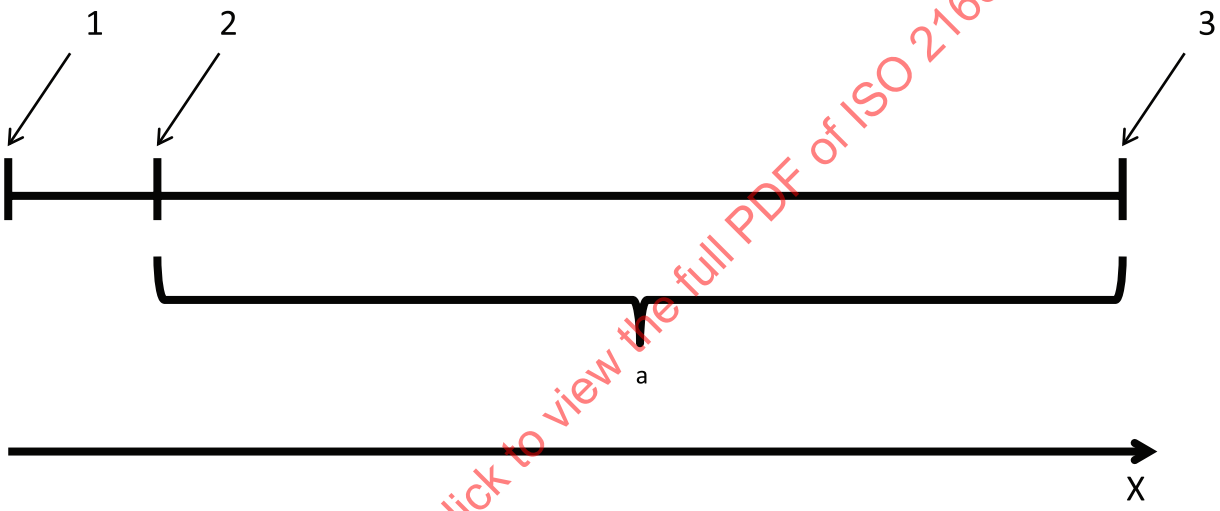
AL machine combinations (machine combinations other than BQ or BP) may be tested and reported additionally. In this case the same reporting model shall be used.

Although the functional unit for printed matter produced 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 also be shown. (Output Area × imposition rate) / (A4 or Letter) area = an approximate equivalent of A4 or Letter pages.

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

4.6.2 Formulae for the average power P, the average productivity S and the nominal energy efficiency E_{nom} during continuous production printing

A test run schematic is shown in Figure 6, which shows a sequence of time points for the relevant events.



Key

X time, t
1 print start
2 FPPT
3 LPPT
a Confirm the time from FPPT to LPPT is 0,084 h, i.e. 5 min, or more.

Figure 6 — Test run schematics

Formula (1) expresses in W the average power P during steady production mode, i.e. within the time frame between FPPT and LPPT.

$$P = \frac{E}{t} \tag{1}$$

where

E is the energy consumption value expressed with the unit Wh;

t is the time expressed with the unit h.

Formula (2) expresses the average productivity S during steady production mode, i.e. the period between FPPT and LPPT, and is the actual speed in pages per minute (ppm).

$$S = \frac{N}{60 \times t} \tag{2}$$

where

t is the time expressed with unit;

N is the actual number of printed pages.

NOTE The average productivity S is generally equal to the nominal speed value. However, If image quality adjustment is conducted during continuous production print, SP becomes lower than the nominal speed value.

The nominal energy efficiency E_{nom} is given by the Formula (3).

$$E_{nom} = \frac{N}{E} \tag{3}$$

When the average productivity S (ppm) and the nominal energy efficiency E_{nom} (1 000 A4 pages/kWh) are known, the corresponding average power P (W) is readily grasped by the Formula (4).

$$P = \frac{60 \times S}{E_{nom}} \tag{4}$$

4.6.3 Rounding rule of data to be reported

Measured values may be documented with figures having as many digits as the tester prefers. However, the reported/declared data shall be rounded to two significant figures. When rounded, the ultimate value shall not be higher than the value before rounding, e.g. energy efficiency figures shall be rounded down, and power consumption figures shall be rounded up.

EXAMPLE E_{nom} 2 163,8 pages/kW shall be rounded down to 2 100 pages/kW. P 2,163 2 kW shall be rounded up to 2,2 kW.

4.7 Calculation of comprehensive daily energy consumption based on a typical job structure using power measurement values

4.7.1 Power measurement values

As specified in 4.6 Calculation and documentation of measurement results, power values for each mode of the digital printing device are acquired in a list, generally shown in Table 2, Table 3, Table 4 and Table 5.

Table 2 — Average power consumption of waiting modes

Waiting mode	Off	Print-ready	Sleep
P (W)	P_1	P_2	P_3

Table 3 — Average power consumption of transitional modes

Transitional mode	From off to print-ready	From print-ready to FPPT	From sleep to print-ready
P (W)	P_4	P_5	P_6

If no sleep mode is available for the printing device, “NA” should be put in the corresponding boxes.

Table 4 — Average power consumption for production print modes of measured machine combination

Machine combination	BQ	BP	BQ/BP	AL
P (W)	$P_7/P_{7'}$	$P_8/P_{8'}$	$P_9/P_{9'}$	$P_{10}/P_{10'}$

BQ and BP are mostly for large format printing devices, whereas BQ/BP is mostly for small format printing devices. AL-is for other combinations than BQ, BP or BQ/BP, e.g. duplex production printing of small format devices.

$P_{7'}$ and other similar notations refer to 5 %-inconsistent data e.g. for the first job of the day, where e.g. surge power occurs.

Table 5 — Average power consumption of other mode

Other mode	Maintenance
P (W)	P_{11}

4.7.2 Typical job structure

A typical job structure should be given for calculating the comprehensive daily energy consumption of the printing device. It should define such parameters of the actual printing as follows:

— from which mode the print job starts: off, sleep, print-ready or mixture of these, and

— how many jobs are conducted in a day.

Based on the parameter definition, the allotment is decided for the time duration of relevant modes, as shown in Table 6, Table 7, Table 8 and Table 9.

Table 6 — Daily time duration for waiting modes

Waiting mode	Off	Print-ready	Sleep
t (h)	t_1	t_2	t_3

Table 7 — Daily time duration for transitional modes

Transitional mode	From off to print-ready	From print-ready to FPPT	From sleep to print-ready
t (h)	t_4	t_5	t_6

If Sleep mode is not available for the printing device, t_3 and t_6 should be zero.

Table 8 — Daily time duration for production print modes of measured machine combination

Machine combination	BQ	BP	BQ/BP	AL
t (h)	t_7	t_8	t_9	t_{10}

If Simplex BQ/BP is the only mode for typical job structure, t_7, t_8 and t_{10} should be zero.

Table 9 — Daily time duration for other mode

Other mode	Maintenance
t (h)	t_{11}

The sum of all *ti* values shall be 24 hours or day.

4.7.3 Calculation of daily energy consumption

The comprehensive daily energy consumption Z (Wh/day) is generally given by the Formula (5):

$$Z = \sum_{1}^{11} Pi \times ti \tag{5}$$

where

Pi is the power expressed in W, shown in Table 2 to Table 5;

ti is the time expressed in h, shown in Table 6 to Table 9.

Refer to more detailed example shown in Annex B.

4.7.4 Calculation of effective energy efficiency

The effective energy efficiency E_{eff} (1 000 × A4/kWh) over the defined time frame (e.g. 1 day) is calculated by the Formula (6):

$$E_{\text{eff}} = N/Z \tag{6}$$

where

N is the A4-equivalent number of printed paged per day, expressed with 1 000 A4 pages;

Z is the comprehensive energy consumption per day, expressed with kWh.

Annex A
(informative)

Measurement data sheet

Table A.1 shows an example of test report format, where specified items to be reported are covered. Table A.2 shows an example of measurement data format, which can be used to overview relevant data in detail.

Table A.1 — Example of test report format

Test report: Energy consumption of digital printing device in accordance with ISO 21632											
Main printing unit information											
Manufacturer					Rated speed						
Printer model name					Format (maximum media size/weight)						
Print method (EP/IJ)					Year of manufacture						
Colour					Maintenance records						
Power source: phase (1/3), Hz, voltage					Print counts						
Connection point (check units to measure with separate power meter)											
Main printing unit (main switch cabinet)		Paper feeder unit		Paper delivery unit		External cooling unit (directly attributed to the printing system)		Digital front end (RIP)		Viewing cabinet	
x											
Production print mode conditions											
Combination	Simplex/ duplex	Resolution [dpi]	Productivity [ppm] or [m^2/h]	Colourants	Substrate (size/ weight/ sort)	Passes	Drying/ curing	Ink-type	Print file	Roll paper imposition rate	
BQ											
BP											
BQ/BP											
AL											

Table A.1 *(continued)*

Other modes (check modes to measure)							
Waiting mode			Maintenance mode	Transition mode			
Off	Print- ready	Sleep		Off to print-ready	Sleep to print- ready	Print- ready to FPPT	Production to print-ready

Measurement device			
Power meter for;	Type	Model	Test/calibration certificate (valid date)
Main printing unit			
Paper feeder unit			
Paper delivery unit			
External cooling unit			
Digital front end			
Viewing cabinet			

Ambient conditions			
Temperature	°C to °C	Relative humidity	% to %

Measurement results											
	Production mode			Waiting mode			Transition mode				
	BQ	BP	BQ/BP	Off	Print-ready	Sleep	Maintenance mode	Off to print-ready	Sleep to print-ready	Print-ready to FPPT	Production to print-ready
Measurement time	min	min	min	min	min	min	min	s	s	s	s
Ave. Power	W	W	W	W	W	W	W	W	W	W	W
1st measurement (inconsistent data)	W	W	W							W	

Table A.1 *(continued)*

wherein external cooling unit power	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 printing press		Estimated power consumption		Method used for estimation
e.g. centralized pressure unit				

	BQ	BP	BQ/BP	AL
P (ppm or m^2/hr)				
E_{nom} (A4/kWh or m^2/kWh)				
E_{eff} (A4/kWh or m^2/kWh)				

* Rounded to two significant figures. In the case of roll paper, m^2 value is multiplied by the imposition rate, e.g. if the imposition rate is 80 %, the ultimate average × [m^2/kWh] is converted to 0,8 × [m^2/kWh].

** This item is accompanied by the corresponding job structure to be shown in a separate sheet.

Printed image			
Name of test form		Tonal coverage	%
A representative printed image (A4, Letter or A3) is attached to this test report as a PDF document.			
Measurement conducted at			

Place		Time		Date	