Measuring Energy Consumption, Performance and Capabilities of ICT and CE Products
**Introduction**

Ecma developed and published the world’s first environmentally conscious design standard (ECD) for the ICT & CE industries in 2003 as ECMA-341. This Standard is aimed at the designer and provides pragmatic advice on how to reduce the environmental footprint of a product at the design stage.

ECMA-341 was offered to the IEC (International Electro-technical Committee) for conversion into an IEC standard. IEC TC108 set up a Project Team (PT62075) to complete this work. This Standard is now available as IEC 62075.

Whilst ECMA-341 includes the definitions of low power modes and generic energy saving guidance for designers of ICT & CE products, this Standard complements that guidance by defining a methodology on how to measure the energy efficiency of a product whilst taking into account its performance and capabilities.

Although this Standard’s title allows covering all ICT and CE products this initial edition covers desktop and notebook computers only with a media rich and office productivity workload.

Future editions may take into account additional operating systems and workloads for computers and also to broaden in scope to other ICT and CE products.

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This Ecma Standard has been adopted by the General Assembly of June 2008.
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1 **Scope**

Although the title is broader in scope, this edition of the Standard applies to:
- desktop computers
- notebook computers

that are marketed as final products and are hereafter referred to as the Unit Under Test (UUT).

Additionally, this edition of the Standard applies to the following list of workloads
- office productivity
- media rich

defined in 5.2 and running under an Operating System that is either principally designed for, or at least configured for, desktop or notebook use.

This Standard defines how to evaluate and report energy consumption, performance and capabilities being the vital factors for the energy efficient performance (EEP) of the UUT. Additionally it provides a standardised results reporting format.

This Standard requires the user to measure and record a set of energy, power, time, and capability results (using a Benchmark), not a single metric of energy efficiency. This Standard does not set any pass/fail criteria for the UUT. Users of the reported results (regulators, customers etc) may define such criteria.

This standard does not provide specifications for a Benchmark.

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2 **Conformance**

The user of this Standard shall meet all “shall” requirements in Clause 6.

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3 **Normative references**

None.

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4 **Definitions**

4.1 **Benchmark**

software that exercises the UUT with a Workload to measure energy consumption and performance and that enumerates and reports UUT capabilities

4.2 **Duty cycle**

4.2.1 **Benchmark duty cycle**

time a UUT spends in each of its activity modes as measured by the Benchmark

4.2.2 **User defined duty cycle**

time a UUT spends in each of its activity modes as defined by the user

4.3 **Energy use**

amount of energy used by a UUT measured from the mains power source over a given period of time and measured in kWh

4.4 **Performance**

the speed a UUT can complete a Workload when compared to the Benchmark reference unit
4.5 **Workload**
defined set of activities

4.6 **UUT (Product)**
unit under test (also referred to as product)

5 **Specifications for the UUT**

5.1 **Computer classifications**

5.1.1 **Desktop computer**
A personal computer where the main unit is intended to be located in a fixed location, often on a
desk or on the floor. Desktops are not designed for portability and utilize an integrated or
external monitor, keyboard, and mouse.

5.1.2 **Notebook computer**
A personal computer designed specifically for portability and to be operated for extended
periods of time without a direct connection to an ac power source. Notebook computers must
utilize an integrated monitor (may be touch sensitive) and be capable of operation off an
integrated battery or other notebook power source. In addition, most notebook computers use
an external power supply and have an integrated keyboard and pointing device.

5.2 **Activity Modes**

**Off Mode:** The power consumption level in the lowest power mode which cannot be switched off
(influenced) by the user and that may persist for an indefinite time when the UUT is connected to
the main electricity supply and used in accordance with the manufacturer’s instructions. Off mode
is similar to “ACPI state S5”.

**Sleep Mode:** The mode that the UUT is capable of entering automatically after a period of
inactivity or by manual selection. A UUT with sleep capability can “wake” in response to network
connections or user interface devices or an internally generated condition. Sleep mode is similar
to “ACPI state S3”.

**Idle Mode:** The mode in which the operating system and other software have completed loading,
and activity is limited to those basic applications that the system starts by default.

**Active mode:** The mode in which the UUT is executing a workload.

5.3 **Computer workloads**

5.3.1 **Office productivity workload**
A Workload designed primarily for office (home or business) applications such as word
processing, email, web browsing, accounting, etc.

5.3.2 **Media rich workload**
A Workload designed primarily for entertainment purposes such as listening to music, watching
videos, editing audio, pictures, video, etc.

**Note**
Although the Media rich workload could be used on products designed for gaming applications, this
workload is not intended to exercise many of the special capabilities of this category of personal
computers.

5.4 **Core components**
The UUT shall at least contain the following components:

- Central Processing Unit (CPU)
- Graphics Processing Unit (GPU)
- Memory (volatile)
6 Procedure

6.1 Workflow
The user shall follow this workflow:

1. Select the appropriate Benchmark (6.2)
2. Decide on the computer workload for the UUT (5.3 and 6.3)
3. Select the appropriate meter (6.4 and Annex B)
4. Set up and run the test (6.5 and Annex A)
5. Decide on the Duty Cycle for the UUT (6.6)
6. Record the results (6.7 and Annex C)

Figure – 6.1: Workflow

6.2 Selecting a Benchmark
The User shall select a Benchmark registered at: [http://www.ecma-international.org/publications/standards/Benchmark.htm](http://www.ecma-international.org/publications/standards/Benchmark.htm) suited for intended use of the UUT as specified at: [http://www.ecma-international.org/publications/Standards/Criteria.htm](http://www.ecma-international.org/publications/Standards/Criteria.htm). The User shall record the name of the selected benchmark per Annex C.

6.3 Decide on the UUT Workload
The User shall decide whether the primary use of the UUT is an
- Office productivity workload
- Media rich workload.

6.4 Meter requirements
For energy and power measurements, a meter that meets the requirements in Annex B shall be used.

6.5 Test system set up
The user shall follow the requirements as detailed in Annex A.

6.6 Decide on the Duty Cycle
The User shall determine whether a user defined duty cycle is to be used. He shall report the benchmark duty cycle in a format as described in Annex C together with the user defined duty cycle as appropriate.
6.7 **Recording and presenting the results**

All results shall be presented in a manner clearly showing the workload used and in a format as indicated in Annex C.
Annex A
(normative)

Test set up

The test shall be set up per the example below.

1. The UUT shall be configured in its “as shipped” default state and at a minimum contain all core components as defined in 5.4.
2. For notebook computers, the battery shall be either removed or charged to 100 % before test starts.
3. Whether the monitor is switched on or off shall be determined by the user. It is recommended that this decision is carried out in conjunction with an assessment of intended use of the test results.

Testing conditions

| Supply Voltage: | North America/Taiwan: 115 (± 1 %) Volts AC, 60 Hz (± 1 %)  
Europe/Australia/New Zealand: 230 (± 1 %) Volts AC, 50 Hz (± 1 %)  
Japan: 100 (± 1 %) Volts AC, 50 Hz (± 1 %)/60 Hz (± 1 %)  
NOTE For products rated for > 1.5 kW maximum power, the voltage range is ± 4 % |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Harmonic Distortion (THD) (Voltage):</td>
<td>&lt; 2 % THD (&lt; 5 % for products which are rated for &gt; 1.5 kW maximum power)</td>
</tr>
<tr>
<td>Ambient Temperature:</td>
<td>23°C ± 5°C</td>
</tr>
<tr>
<td>Relative Humidity:</td>
<td>10 – 80 %</td>
</tr>
</tbody>
</table>
Annex B
(normative)

Meter specifications

The power meter used in conjunction with this Standard shall include the following attributes:

- Power resolution of 1 mW or better
- An available current crest factor of 3 or more at its rated range value; and
- Lower bound on the current range of 10 mA or less.
- Have a frequency response of at least 3 kHz; and
- Be calibrated with a standard that is traceable internationally.
- Be able to average power accurately over any user selected time interval (this is usually done with an internal math’s calculation dividing accumulated energy by time within the meter, which is the most accurate approach). Or, alternatively, the meter shall be capable of integrating energy over any user selected time interval with an energy resolution of less than or equal to 0.1 mWh and integrating time displayed with a resolution of 1 second or less.
- Provide a control and logging interface that the Benchmark uses to allow logging of the data onto a control system.

Accuracy of power measurement

Measurements of power of 0.5 W or greater shall be made with an uncertainty of less than or equal to 2 % at the 95 % confidence level. Measurements of power of less than 0.5 W shall be made with an uncertainty of less than or equal to 0.01 W at the 95 % confidence level. The power measurement instrument shall have a resolution of:

- 0.01 W or better for power measurements of 10 W or less;
- 0.1 W or better for power measurements of greater than 10 W up to 100 W; and
- 1 W or better for power measurements of greater than 100 W.

All power measurements shall be in watts and rounded to the second decimal place. For power measurements greater than or equal to 10 W, three significant figures shall be reported.
Annex C
(normative)

Results reporting format

Results from this test methodology shall be presented in the following order:

1. Product description
2. Benchmark details
3. Results
   A. Energy consumption
   B. Performance score
   C. Capabilities
4. Test conditions
5. Declaration

Under each of the headings noted above the following minimum set of information shall be reported. The format listed below is an example format only; the user should use the format of his choice.

1. **Product description**

   Manufacturer _________________________________________________________________________

   UUT Code / Model Number _________________________________________________________________________

   UUT Workload: Productivity workload ☐ Media rich workload ☐

   UUT Type: notebook computer ☐ Desktop Computer ☐

   Operating System: Windows ☐ Mac OS ☐

   Operating system version details _________________________________________________________________________

   Display: Off ☐ On ☐

   If display on: Size ______ Brightness ___ cd/m² ___ Resolution ______

   Vendor ______ HD Ready (Yes/No) ______ Refresh rate ______

   Interface type: VGA ☐ HDMI ☐ DVI ☐ Other ☐

   Operating System Power policy applied during test (e.g. power save, balanced, performance etc)________

   BIOS (or equivalent) vendor and version number _________________________________________________________________________

   Motherboard model and version number _________________________________________________________________________
2. **Benchmark details**

Benchmark name  
Benchmark version  

3. **Results**

3A  **Energy consumption**

Benchmark duty cycle reported results

<table>
<thead>
<tr>
<th></th>
<th>Active</th>
<th>Idle</th>
<th>Sleep</th>
<th>Off</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power (W) – Average</td>
<td>n/a</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy (Wh)</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Measurement Time (s)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

User defined duty cycle calculated results

<table>
<thead>
<tr>
<th></th>
<th>Active</th>
<th>Idle</th>
<th>Sleep</th>
<th>Off</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy (Wh)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extrapolated time (h)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Extrapolated time is Measured time multiplied by a factor defined by the user.

Power supply efficiency levels:

<table>
<thead>
<tr>
<th>Load (%)</th>
<th>Efficiency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3B  **Performance score results**

Performance Score  

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 3C Capabilities

<table>
<thead>
<tr>
<th></th>
<th>CPU</th>
<th>Video/Graphics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vendor</strong></td>
<td></td>
<td><strong>Vendor</strong></td>
</tr>
<tr>
<td><strong>Name</strong></td>
<td></td>
<td><strong>Model Number / Name</strong></td>
</tr>
<tr>
<td><strong>Model Number</strong></td>
<td></td>
<td><strong>Memory Size</strong></td>
</tr>
<tr>
<td><strong>Number of Cores</strong></td>
<td></td>
<td><strong>Resolution</strong></td>
</tr>
<tr>
<td><strong>Core Frequency</strong></td>
<td></td>
<td><strong>Bus Type</strong></td>
</tr>
<tr>
<td><strong>Bus Frequency</strong></td>
<td></td>
<td><strong>Driver revision number</strong></td>
</tr>
<tr>
<td><strong>L1 Cache</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>L2 Cache</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>L3 Cache</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Volatile Memory (e.g. DRAM)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th><strong>Audio</strong></th>
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</thead>
<tbody>
<tr>
<td><strong>Size (Mb)</strong></td>
<td></td>
<td><strong>Vendor</strong></td>
</tr>
<tr>
<td><strong>Array Capacity</strong></td>
<td></td>
<td><strong>Model</strong></td>
</tr>
<tr>
<td><strong>Speed</strong></td>
<td></td>
<td><strong>Definition</strong></td>
</tr>
<tr>
<td><strong>Family (E.G. DDR2, 3 etc)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Number devices</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Storage

**Quantity Hard Drives**

<table>
<thead>
<tr>
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<th>Drive #1</th>
<th>Drive #2</th>
<th>Drive #3</th>
<th>Drive #4</th>
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</thead>
<tbody>
<tr>
<td><strong>Vendor &amp; Version</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Model</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Capacity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Speed</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Link Power management supported?</strong></td>
<td>If yes, note type</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Quantity Optical Drives

<table>
<thead>
<tr>
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<th>Drive #1</th>
<th>Drive #2</th>
<th>Drive #3</th>
<th>Drive #4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vendor &amp; version</td>
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<td></td>
<td></td>
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<tr>
<td>Model</td>
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<td></td>
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<tr>
<td>Capacity</td>
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<td></td>
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</tr>
<tr>
<td>Speed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Link Power management supported? If yes, note type</td>
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</table>

### Quantity other storage devices

<table>
<thead>
<tr>
<th>Device type</th>
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<th></th>
</tr>
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<tbody>
<tr>
<td>Vendor &amp; Version</td>
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</tr>
<tr>
<td>Model</td>
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</tr>
<tr>
<td>Capacity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

### Quantity Network (wired and wireless) devices

<table>
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<th>Network type</th>
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</tr>
</thead>
<tbody>
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<td>Vendor &amp; Version</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bus Interface</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capable speed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tested speed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Other system capabilities

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

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4. **Test Conditions**

Sample size tested:__________

Name of meter used:__________
### Test Conditions

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage:</td>
<td></td>
</tr>
<tr>
<td>Total Harmonic Distortion (THD) (Voltage):</td>
<td></td>
</tr>
<tr>
<td>Ambient Temperature:</td>
<td></td>
</tr>
<tr>
<td>Relative Humidity:</td>
<td></td>
</tr>
</tbody>
</table>

5. **Declaration**  
Signed________________________________________________  
Date______________________________________________
Annex D
(informative)

Bibliography

IEEE 1621: Standard for User Interface Elements in Power Control of Electronic Devices Employed in Office/Consumer Environments

IEC 62075: Audio/Video, Information and Communication Technology Equipment - Environmentally Conscious Design

Energy Star V5.0, Draft 1 (February 22, 2008)

ACPI (Advanced Configuration and Power Interface) specification

IEC 62301 Ed 1.0: Measurement of Standby Power

ISO 554-1976: Standard atmospheres for conditioning and/or testing specifications.