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SERIES L: ENVIRONMENT AND ICTS, CLIMATE  
CHANGE, E-WASTE, ENERGY EFFICIENCY;  
CONSTRUCTION, INSTALLATION AND PROTECTION  
OF CABLES AND OTHER ELEMENTS OF OUTSIDE  
PLANT

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**External universal power adapter solutions for  
portable information and communication  
technology devices**

Recommendation ITU-T L.1002



ITU-T L-SERIES RECOMMENDATIONS

**ENVIRONMENT AND ICTS, CLIMATE CHANGE, E-WASTE, ENERGY EFFICIENCY; CONSTRUCTION,  
INSTALLATION AND PROTECTION OF CABLES AND OTHER ELEMENTS OF OUTSIDE PLANT**

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## Recommendation ITU-T L.1002

### External universal power adapter solutions for portable information and communication technology devices

#### Summary

Recommendation ITU-T L.1002 defines the requirements, and provides guidelines on the environmental aspects, of universal power adapter solutions (UPA) designed for use with portable information and communication technology (ICT) devices. It is complementary to Recommendations ITU-T L.1000 and ITU-T L.1001 and aims to cover the widest possible range of ICT devices for portable use within identified voltage and power ranges. It firstly describes basic configurations of UPAs, consisting of a power adapter block with a detachable input cable and a detachable output cable to the ICT device. Then, it defines different general recommendations for UPAs and their interfaces, including cables, connectors, voltage, current, ripple noise, energy efficiency, no-load power, safety, electromagnetic compatibility, resistibility and eco-environmental specifications. All the recommendations have been set with the aim to reduce e-waste and increase usability.

#### History

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## Introduction

This Recommendation<sup>1</sup> defines the requirements, and provides guidelines on the environmental aspects, of universal power adapter solutions (UPA) designed for use with portable information and communication technology (ICT) devices. It also takes into consideration energy efficiency, emissions reduction and the use of scarce and raw materials.

Power supplies are a contributory factor to the increasing electricity consumption of households in Europe [b-CLASP]. The impact assessment for the ecodesign regulation on external power supplies calculated an increase in energy consumption from about 7.3 TWh in 2010 to about 7.5 TWh in 2020 (business as usual scenario). According to [b-EPS CoC] savings are expected to be 1.04 TWh in 2020. Only a part of these external power supplies (EPSs) would be UPAs used with portable ICT devices.

Considering [b-IEA] on standby mode consumption, given the average of 0.3 W to 0.5 W in no-load consumption of EPS, with a new value of 0.1 W savings would be in the order of some TWh/year/billion for portable UPAs following the requirement of this Recommendation.

The best approach for UPAs is to achieve several objectives: convenience for consumers to power their portable ICT devices from any available UPA or from other common interfaces through a detachable cable; while ensuring consumer safety, device protection and system reliability.

The direct current (DC) detachable cable has the same replacement possibility as for the alternating current (AC) detachable cable reducing a lot of e-waste as the common failure mode is the same, and the rupture of the wire at the output of the adapter case, due to frequent cable rolling. Detachable cable solutions can enable the sharing of power adapters among the existing and future ICT portable devices where such a solution is adopted. This will enable a market opportunity to reduce the number of duplicate portable power adapters.

It is noted that the environmental impact of any universal power adapter solution should be considered over its entire life cycle and that the transition towards universal power adapter solutions does not aim to replace the existing adapters immediately, as billions of them are currently in use and billions of external power adapters are being introduced for new devices or to replace old ones. Any universal power adapter solution is expected to be time limited as continual development provides a more efficient solution to meet the requirements for future innovative products. Solutions focused on common charging interoperability can avoid longevity limitations associated with universal power adapter solutions. (see the section on [IEC 63002] in Appendix I). This Recommendation focuses on universal power adapter solutions that operate within identified current and voltage ranges of common mobile product categories in market.

It should be noted that lifetime, safety, electromagnetic compatibility (EMC) and environmental issues have been considered in the drafting of this Recommendation.

Appendix IV identifies future work that is needed to address arbitrary combinations.

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<sup>1</sup> The United States of America requested that the following be appended to this Recommendation:

NOTE 1 – This Recommendation is intended to not conflict with or supersede existing regulatory requirements and international/regional/national standards.

NOTE 2 – Hold-up time is not a requirement needed for UPAs for mobile devices which have internal battery systems. [CISPR 22 Class B] compliance is inherently met when a battery is installed.

NOTE 3 – For lifetime requirements, further studies on the test conditions and test methods are required to analyse the effects of various parameters (e.g., temperature, use).

NOTE 4 – [b-IEC TS 62700] recognizes that UPA-side barrel connectors are not internationally standardized and current and future market trends for detachable/captive cables need further consideration.

It is important to propose a low voltage DC interface to directly power ICT devices, especially for emerging countries that show fast mobile and Internet development despite the absence of a reliable AC grid. Considering the rapid increase of the cost of fossil fuel used in engine generators and the reduction of the cost of renewable energy sources, this kind of energy solution is developing fast and is among the main enablers of ICT deployment in such regions. The use of DC is much more efficient and increases the overall reliability as it allows removing the DC/AC inverters and insulated AC/DC adapters. A simple (and low cost) detachable cable could then be sufficient to power ICT devices. In some cases, only a DC/DC converter with very high efficiency would be used to adapt voltage, e.g., 12 V or 24 V to 5 V. This solution is also considered in developed countries for home DC networks (see appendices I and V of [ITU-T L.1001]).



## Recommendation ITU-T L.1002

### External universal power adapter solutions for portable information and communication technology devices

#### 1 Scope

This Recommendation defines the requirements, and provides guidelines on the environmental aspects, of universal power adapter solutions (UPA) designed for use with portable information and communication technology ICT (ICT) devices.

UPAs covered by this Recommendation are those that are used with the devices with voltage and power levels identified in clause 7.1.1.

This Recommendation does not cover UPAs defined in [ITU-T L.1000] and [ITU-T L.1001].

This Recommendation provides requirements and guidelines for energy efficiency and no load power. It aims to reduce greenhouse gas (GHG) emissions to optimize the use of scarce and raw materials and to enable a long product lifetime to reduce e-waste generation.

The considered UPA does not provide any charge control for rechargeable batteries.

The load full charging function in the portable device, if present, is not within the scope of this Recommendation.

This Recommendation describes basic configurations and general requirements for UPAs and their interfaces, including cables, connectors, voltage, current, ripple, noise, energy efficiency, safety, electromagnetic compatibility, resistibility and eco-environmental specifications.

Market issues associated with: counterfeit products or untested combinations of ICT devices and UPAs are not within the scope of this Recommendation.

#### 2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

- [ITU-T K.21] Recommendation ITU-T K.21 (2015), *Resistibility of telecommunication equipment installed in customer premises to overvoltages and overcurrents*.
- [ITU-T K.44] Recommendation ITU-T K.44 (2016), *Resistibility tests for telecommunication equipment exposed to overvoltages and overcurrents – Basic Recommendation*.
- [ITU-T K.74] Recommendation ITU-T K.74 (2015), *EMC, resistibility and safety requirements for home network devices*.
- [ITU-T K.85] Recommendation ITU-T K.85 (2011), *Requirements for the mitigation of lightning effects on home networks installed in customer premises*.
- [ITU-T L.1000] Recommendation ITU-T L.1000 (2011), *Universal power adapter and charger solution for mobile terminals and other handheld ICT devices*.
- [ITU-T L.1001] Recommendation ITU-T L.1001 (2012), *External universal power adapter solutions for stationary information and communication technology devices*.

- [ITU-T L.1200] Recommendation ITU-T L.1200 (2012), *Direct current power feeding interface up to 400 V at the input to telecommunication and ICT equipment.*
- [ITU-T L.1410] Recommendations ITU-T L.1410 (2014), *Methodology for environmental life cycle assessments of information and communication technology goods, networks and services.*
- [EN 50563] CENELEC EN 50563 (2011), *External A.C. – D.C. and A.C. – A.C. power supplies – Determination of no-load power and average efficiency of active modes.*
- [IEC 60038] IEC 60038 (2009), *IEC standard voltages.*
- [IEC 60068-2-38] IEC 60068-2-38 (2009), *Environmental testing – Part 2-38: Tests – Test Z/AD: Composite temperature/humidity cyclic test.*
- [IEC 60320-1] IEC 60320-1 (2015), *Appliance couplers for household and similar general purposes – Part 1: General requirements.*
- [IEC 60335-1] IEC 60335-1 (2010), *Household and similar electrical appliances – Safety – Part 1: General requirements.*
- [IEC 60950-1] IEC 60950-1 (2005), *Information technology equipment – Safety – Part 1: General requirements.*
- [IEC 61000-3-2] IEC 61000-3-2 (2014), *Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current  $\leq 16$  A per phase).*
- [IEC 61000-4-11] IEC 61000-4-11 (2004), *Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests.*
- [IEC 62282-5-1] IEC 62282-5 (2012), *Fuel cell technologies – Part 5-1: Portable fuel cell power systems – Safety.*
- [IEC 62301] IEC 62301 (2011), *Household electrical appliances – Measurement of standby power.*
- [IEC 62368-1] IEC 62368-1 (2014-02), *Audio/video, information and communication technology equipment – Part 1: Safety requirements.*
- [IEC 62680-1-2] IEC 62680-1-2 (2016), *Universal serial bus interfaces for data and power – Part 1-2: Common components – USB Power Delivery specification.*
- [IEC 62680-1-3] IEC 62680-1-3 (2016), *Universal serial bus interfaces for data and power – Part 1-3: Universal Serial Bus interfaces – Common components – USB Type-C™ Cable and Connector Specification.*
- [IEC 62680-2-1] IEC 62680-2-1 (2015), *Universal serial bus interfaces for data and power – Part 2-1: Universal Serial Bus Specification, Revision 2.0.*
- [IEC 62684] IEC 62684 (2011), *Interoperability specifications of common external power supply (EPS) for use with data-enabled mobile telephones.*
- [IEC 63002] IEC 63002 (2016), *Identification and communication interoperability method for external power supplies used with portable computing devices.*
- [IEC-CISPR 22] IEC-CISPR 22 (2008), *Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement.*
- [IEC-CISPR 24] IEC-CISPR 24 (2010), *Information technology equipment – Immunity characteristics – Limits and methods of measurement.*

### 3 Definitions

#### 3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

**3.1.1 safety extra-low voltage circuit:** Secondary circuit that is so designed and protected that under normal operating conditions and single fault conditions, its voltages do not exceed a safe value. ([IEC 62282-5-1]).

NOTE 1 to entry – For commercial, industrial and telecommunication applications, the SELV voltage limits provided in [IEC 60950-1] are applicable. For household applications, the SELV voltage limits in [IEC 60335-1] (2010) shall be used.

NOTE 2 to entry – The limit values of voltages under normal operating conditions and single fault conditions (see 1.4.14 of [IEC 60950-1]) are specified in 2.2 of [IEC 60950-1]. See Table 1A of [IEC 60950-1].

NOTE 3 to entry – This definition of a SELV circuit differs from the term "SELV system" as used in [IEC 61140].

**3.1.2 functional earthing:** Earthing of a point in equipment or in a system, which is necessary for a purpose other than Safety ([IEC 60950-1]).

#### 3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

**3.2.1 captive cable:** A cable integral to the universal power adapter (UPA).

**3.2.2 detachable alternating current (AC) cable:** A detachable cable used to connect the power adapter to the alternating current (AC) mains for powering through two connectors, one on the universal power adapter (UPA) side and the other on the AC mains side.

**3.2.3 detachable direct current (DC) cable:** A detachable direct current (DC) cable connects the power adapter to the information and communication technology (ICT) device for powering through two connectors, one on the universal power adapter (UPA) side and the other on the ICT device side.

**3.2.4 hiccup mode:** Hiccup mode is a power supply overcurrent protection mode which stops power output followed by trying to restart the power supply intermittently.

**3.2.5 power adapter:** A device that converts the mains alternating current (AC) power voltage at the input to the low direct current (DC) power voltage at the output, or one that converts DC power source, e.g., from photo voltaic source to another low voltage DC power output.

**3.2.6 power adapter block:** A block that includes a power adapter.

**3.2.7 universal power adapter solutions:** External power adapters that are designed to provide power to different information and communication technology (ICT) devices.

**3.2.8 safety extra-low voltage (SELV) DC:** A DC voltage in a circuit respecting the condition defined for a safety extra-low voltage circuit.

### 4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

AC Alternating Current

CoC Code of Conduct

DC	Direct Current
EMC	Electromagnetic Compatibility
EPS	External Power Supply
EUT	Equipment Under Test
GHG	Greenhouse Gas emission
HF	High Frequency
ICT	Information and Communication Technology
IT	Information Technology
I-V	Current-Voltage
MTBF	Mean Time Between Failure
OEM	Original Equipment Manufacturer
PoE	Power over Ethernet
PoL	Power over Line
p-p	peak to peak
PV	Photo Voltaic
SELV	Safety Extra-Low Voltage
TV	Television
UPA	Universal Power Adapter
USB	Universal Serial Bus
XML	extensible Markup Language

## 5 Conventions

None.

## 6 Universal power adapter solutions

A UPA is an external power adapter that interfaces with the low voltage input of an ICT device by converting the alternating current (AC) mains voltage to a low direct current (DC) voltage output.

A UPA is applicable to portable ICT devices at home/office where normal operation, including device internal battery recharge, requires a connection to a household (e.g., residential household) distribution where it may happen that the earth connection is of poor quality.

The UPAs considered in this Recommendation will be able to power portable ICT devices that are able to operate while being disconnected from the grid using power from their internal battery and when connected to a wide range of power grids with different voltage and quality.

Furthermore, UPAs have enough power to allow device use while recharging the internal device battery.

The portable ICT devices considered are in a power range above the power range covered by [ITU-T L.1000] for mobile devices.

For user comfort and to reduce the number of UPAs and consequent e-waste, these devices includes portable computers and their portable peripherals, hubs, projectors, printers, scanners, loudspeakers, screens, additional battery packs, etc.

They may also include any equipment which has a power interface covered by this Recommendation i.e., portable television (TV), video images and their battery chargers, etc.

A UPA is applicable to portable ICT devices at home/office where normal operation, including device internal battery recharge, requires a connection to AC.

This Recommendation is complementary to [ITU-T L.1000] and [ITU-T L.1001] and aims to cover the widest possible range of UPAs for ICT devices for portable use within the defined voltage and power ranges. It should not ignore a wide variability of power distribution and source types found in different countries. DC power solutions are considered for the same reasons as in [ITU-T L.1000]. The safety extra-low voltage (SELV) DC interface brings user comfort through universality and also reduces e-waste through cable replacement possibility. DC interface allows a highly efficient, reliable, simple and safe solution for using small solar energy systems without AC inverters in emerging countries. This also covers other SELV DC sources compliant with this Recommendation that could be found in transportation means: cars, buses, trains, planes, etc. An optional input compliance to up to 400 V DC [ITU-T L.1200] is proposed to maximize the efficiency and use of UPAs in locations where these interface are used (telecom/data centres, green buildings, DC micro-grids).

Guidance on other aspects not covered by this Recommendation, when UPAs are used for powering portable computers, can be found in [b-IEC TS 62700]. [b-IEC TS 62700] is not a completed international standard and describes areas requiring further consideration.

## 6.1 Basic configuration

Figure 1 describes the basic configuration of universal power adapter (UPA) solutions used for portable devices. The basic UPA configuration consists of a UPA with a detachable input cable (captive input can be a mains plug integrated in the adapter housing) and a detachable output cable to the ICT device.

A detachable DC cable is required for UPAs as the DC cable is generally the weakest point of the portable UPA and the main point of failure. Adapters which have captive cables, in case of failure of the latter, require all the rest of the equipment and in particular its active part, to be discarded, adding up unnecessary e-waste and cost for the users. Furthermore, the detachable cable enables more reuse and an increased lifetime which is the main aim of this Recommendation.

For higher power categories (above 60 W), adapters designed and tested with end-products may optionally use captive cables if needed to support system-level robustness and technical performance requirements. Nevertheless, detachable cables are strongly recommended for these categories.

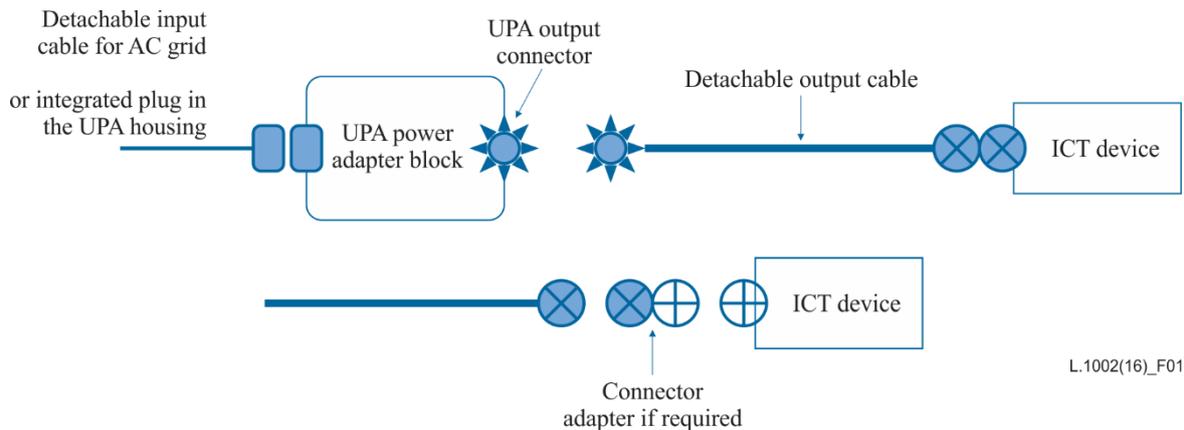
NOTE – Where captive cables are used, care has to be taken to minimize the chances of failure described above. The cables and connecting sleeve have to be particularly resistant to frequent winding/unwinding by the user.

For UPA power classes, e.g., those used for portable computer, new multi-output solutions are spreading into the market. Such solutions may offer a USB Type-A connector in addition to the main UPA output power interface (which also may be a USB Type-C™ connector). A UPA that offers USB Type-C receptacles as specified in [IEC 63002], [IEC 62680-1-2] and [IEC 62680-1-3] can serve the needs of charging devices in the power range of [ITU-T L.1000] as well as the needs of devices in the power range of this Recommendation.

UPAs which intend to support USB type C specifications will follow the technical requirements and recommendations that are specified by [IEC 62680-1-2], [IEC 62680-1-3] and [IEC 63002].

This improves user comfort as a vast majority of users have multiple portable devices. This feature reduces the need for users to have multiple different power adapters, which directly saves materials, and indirectly is more user friendly as it avoids the need for an additional AC socket or AC strip

installation. In addition, this can save energy as the power efficiency of a higher power UPA is often higher than the efficiency of a smaller one, and the no-load power with a single UPA is reduced.



**Figure 1 – Basic UPA configurations and connection options**

Each UPA configuration can use an optional connector adapter between the cable connector and the input of the device (Figure 1).

All UPA configurations are shown in this Recommendation with a power adapter block.

NOTE 1 – To allow more flexibility and reduce the number of different UPA categories, an identification pin could be used to identify the UPA capabilities (typically its maximum current) (see Figure 1). However, market interoperability issues will occur without common methods for identification and communication of capabilities. These issues can be mitigated for external adapters and device combinations that in future will adopt the IEC interoperability standards [IEC62680-1-2], [IEC 62680-1-3] and [IEC 63002] based on USB type C.

NOTE 2 – Appendix I contains information on using SELV DC directly from renewable energy small systems to power ICT devices through detachable cables and on possible UPA input compliance with [ITU-T L.1200] up to 400 V DC interface, which may increase universality in the future.

## 6.2 ICT devices usage with UPAs

The portable ICT devices that may adopt UPAs are those defined in clause 6.

No overlap with [ITU-T L.1000] is expected as only ICT devices requiring higher input power than the power range covered by [ITU-T L.1000] for mobile and hand-held devices are to be covered.

Among the considered portable ICT devices are those able to operate while being disconnected from the grid using power from their internal battery. All equipment has to be able to operate when connected to a wide range of power grids with different voltages and quality and with any quality of earth connection.

The charging control function is not part of UPAs.

UPAs could power other ICT devices that have similar power requirements if their power input characteristics are compatible with one of the categories defined in this Recommendation.

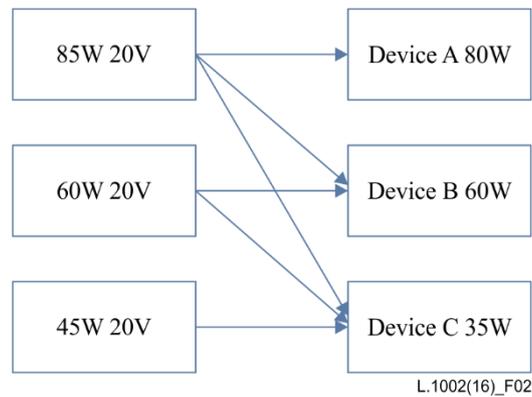
ICT devices that are used with power adapters compliant with [ITU-T L.1000] are not covered in this Recommendation but UPAs defined in this Recommendation can have [ITU-T L.1000] power outputs.

UPAs allow ICTs to have a direct connection to SELV DC by using the detachable DC cable for enabling the highest efficiency, the safest and the simplest use in emerging countries using small solar energy solutions. This also covers other SELV DC source compliance with this Recommendation as there is a trend to extend USB 5 V plugs to higher than 5 V DC. This

Recommendation does not permit proprietary means for negotiating voltages above 5 V DC as IEC [IEC 62680-1-2], [IEC 62680-1-3] and [IEC 63002] provide standardized mechanisms with appropriate robustness and safety.

NOTE 1 – The basic functions of UPAs are:

- a) UPAs can power different ICT devices.
- b) UPAs that are designed with fixed output voltage are (see Table 1) available for ICT devices whose rated power is less than the capacity of UPA (Figure 2).



**Figure 2 – Power compatibility function of UPAs with fixed output voltage (example based on 20 V UPAs)**

NOTE 2 – In order to optimize efficiency, it is recommended that UPAs that have fixed output voltages and power ratings be matched with the same power rated ICT devices.

Improper combinations of UPAs with ICT devices (for example use of 60 W ICT with 40 W UPA) can result in incompatibility or reduced performance. Adopters of this Recommendation should be aware of these and provide appropriate information to users to avoid any risk of damage on ICT devices.

UPAs that implement [IEC 62680-1-2], [IEC 62680-1-3] and [IEC 63002] support a UPA interface with multiple output voltages capability and a negotiation mechanism for providing an appropriate voltage to the ICT device, and a negotiation mechanism that allows an ICT device to negotiate a power contract with a UPA with a lower rating than that of the device. This allows the user to trade off the UPA rating against the charging time.

### 6.3 Compatibility with powered ICT equipment

Taking into consideration the ICT power rating, the correct UPA must be selected to comply with applicable electrical safety standards and codes (see [IEC 60950-1], [IEC 62368-1]).

NOTE – If the UPA complies with the Limited Power Sources defined in [IEC 60950-1] and/or [IEC 62368-1], the ICT does not need to implement active input overcurrent protection. However, if the ICT device's power source is undetermined, it is recommended that the ICT device incorporates overcurrent protection or an appropriate fire enclosure. The ICT device shall comply with the requirements of [IEC 60950-1] and/or [IEC 62368-1].

While UPAs can sense its own short-circuit or failure condition, it cannot sense a malfunction of the ICT device except the ones leading to an overcurrent condition.

An overcurrent condition of UPAs shall comply with the requirements of [IEC 60950-1]. Otherwise, it is recommended that overcurrent be set to be to at least 130% of the rated current, with a minimum time duration of 15 ms.

## 7 General requirements

### 7.1 Power adapter interface

#### 7.1.1 Voltage/current definitions

The power interface in 5 V for portable devices shall be compliant to the USB specification in [IEC 62680-2-1], [IEC 62680-1-2], [IEC 62680-1-3] and [IEC 63002], as appropriate.

Table 1 recommends the UPA categories based on their output power interface (voltage, current and power) for different types of ICT products designed for portable use. Each category is defined with examples of the ICT device types. Table 1 reflects the most common categories available on the market.

UPAs shall be designed considering that after switch-on of the source, the output voltage shall respect the value covered under Table 1, within 3 s maximum, under all load conditions.

The hold-up time shall be stated as more than 10 ms at the minimum AC working voltage following the [IEC 63002] and [61000-4-11] requirement and test methodology.

UPAs compliant with [IEC 63002] should follow the guidance for hold-up time as specified in [IEC 63002] clause 4.3.3 and Annex D.5.

Guidance on other aspects of Table 1 UPAs not covered by this Recommendation can be found in [b-IEC TS 62700], paragraph 4 (Electrical specifications).

UPAs which intend to support USB Type-C specifications shall follow the power technical requirements and recommendations as specified in [IEC 62680-1-2], [IEC 62680-1-3] and [IEC 63002].

**Table 1 – Recommended categories of UPAs**

Category	Example of ICT device types	Voltage [V]	Current [A]	Power [W]
Small 1	5 V mobile and handheld device not covered by [ITU-T L.1000] scope	5	1.5 to 3	7.5 to 15
Small 2	Netbooks, tablets	12	2.5	30
Small 3	Thin notebooks	20	2.25	45
Medium	Low-end laptops	20	3	60
Big	High-end laptops	20	4.25	85

NOTE 1 – The trend of lower energy consumption in ICT devices is leading to lower UPA power requirements and in view of this a possible reduction of categories.  
NOTE 2 – 20 V nominal is consistent with 18-21 V ICT devices inputs.  
NOTE 3 – The example of ICT device types listed in column 2 are just explanatory examples, the device type can have UPAs of different categories.

Industry is evolving very fast to develop new solutions. If future developed UPAs are not included in the classes defined in Table 1, such UPAs shall respect the requirements of this Recommendation as far as the applicable points are concerned.

#### 7.1.2 Output DC plug and connectors

The DC connector types at the interface between the UPA and ICT devices are selected between those widely used in the portable computer market. It is recommended for the interface to implement [IEC 62680-1-2], [IEC 62680-1-3] and [IEC 63002] the USB type C connector, to support broad reusability and interoperability.

For fixed output voltage UPAs a third wire for signalling in addition to power wires could be used to guarantee optimal matching and performance adaptation between the power source and ICT devices. It should be used only if required to adapt the power and avoid instability. See possible considerations in clause 5 of [b-IEC TS 62700].

### 7.1.3 DC cables

The cable fire resistance shall comply with the requirements of [IEC 60950-1] and chapter 6 tests 3.2 and 3.3 as referred to in [b-ITU-T L.1005].

The length of the DC cable should preferably be higher than 1.7 m for 12 V and 20 V categories.

NOTE 1 – This minimum length based on ergonomic design is recommended to allow the adapter to lay on the floor with a horizontal AC cable to the wall socket and allow connection to the device without a risky diagonal cable but with a horizontal section of cable to the rear of the device, and then a vertical section from the table to the adapter laying on the floor. It is common to find a DC cable about 2 m long and AC cable about 1 m long on an ergonomically designed adapter from major manufacturers. In addition, the detachable AC and DC cables can be chosen to match some specific user requirements.

The voltage loss at the maximum current shall be lower than 0.75 V.

NOTE 2 – This voltage loss is defined by USB specifications for 5 V output.

To avoid excessive use of resources (copper), the DC cable of the higher current UPA categories could be limited in length. The DC cable extension options are possible in case of specific requirements.

Care has to be taken when there is no electronic method for identifying the rated current of the cable in order to prevent the user from configuring a system using a lower current-rated cable between a higher rated UPA and a higher rated ICT device.

#### UPA side

The connector on the UPA side shall be either:

- a) For 12 V UPA – barrel connector – internal diameter 1.95 mm, external diameter 4.95 mm  
For 20 V UPA – barrel connector – internal diameter 3.3 mm, external diameter 5.5 mm and having a third pin. An example of this connector is in clause 6.1 of [b-IEC TS 62700].

Or

- b) a connector that is compliant with USB type C defined in [IEC 62680-1-2], [IEC 62680-1-3] and [IEC 63002].

NOTE 1 – For point a) national regulations may override the choice of the connectors defined above.

NOTE 2 – Such UPA connectors may be suitable for use with ICT devices including devices that do not require specific identification and pin.

NOTE 3 – UPAs which intend to support USB specifications shall follow the technical connector requirements as specified in [IEC 62680-x].

#### Device side

The recommended connectors on the device side are the same as those on the UPA side. A detachable cable equipped with an additional interchange for widely adopted existing connectors is acceptable. This will allow broad and easy introduction of UPAs while allowing ICT equipment developers sufficient time to make a transition on their product towards the target solution.

NOTE – IEC has published [b-IEC TS 62700] which contains guidance for the definition of device connectors and the issues of the device electrical parameters (voltage, current, power requirement signals).

### 7.1.4 UPA input interfaces

The UPA input interface shall be in line with [IEC 60038], which defines international AC voltages and frequencies on low voltage AC grids.

### 7.1.5 AC connector at UPA side

For UPAs which have detachable AC cables, the AC connector (at the input of the power adapter block) shall comply with [IEC 60320-1] types C6, C8 and C14.

### 7.1.6 DC output power interface characteristics

Table 1 UPAs shall provide an output DC voltage and DC current with the main characteristics given in Table 2.

**Table 2 – DC output power interface characteristics**

Power characteristics interface	Voltage regulation	Within $\pm 5\%$ at rated voltage
	Ripple voltage	Within 4% p-p at rated voltage
	Drooping characteristic	See Annex A
	Inrush current characteristics	
	Start-up characteristics	

The rated voltage for Table 1 UPAs is 12 V and 20 V, as defined in Table 1.

The output DC voltage characteristics that shall be respected are given in Annex A.

### 7.1.7 Ripple and noise voltage measurement

The ripple voltage and noise standard values shall be set within 4% of rated voltage, measured p-p (i.e., 200 mVp-p at 5 V and 480 mVp-p at 12 V). The measurement of ripple shall be carried out using clause 6.3 of [IEC 62684].

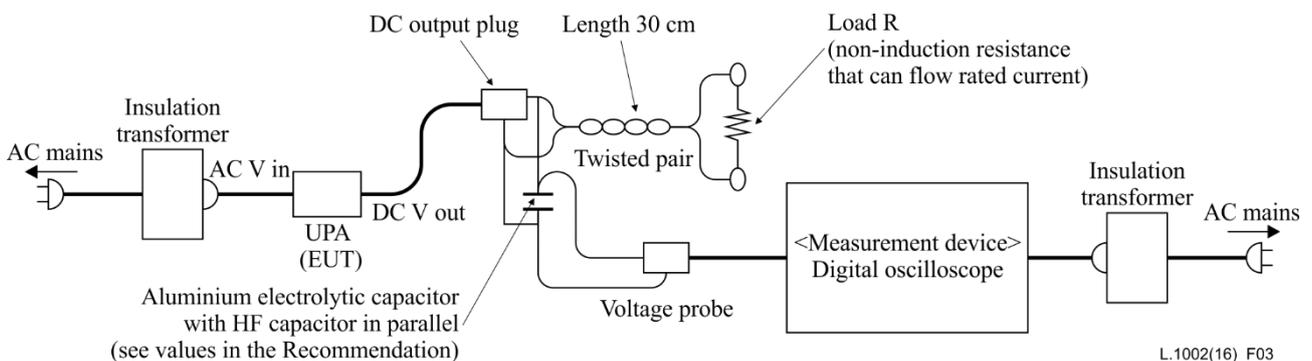
The UPA should be connected to the AC mains via an insulation transformer in order to minimize the influence of noise voltage from the AC mains. The output voltage of the DC output plug is measured with an oscilloscope with an aluminium electrolytic capacitor connected to the DC output terminal. The target values of ripple voltage and ripple noise voltage are shown in Table 2. The test circuit is presented in Figure 3.

For a basic test of UPA for stationary ICT use, one single value of 47  $\mu\text{F}$  might be used, independently of the value of the current.

A 0.1  $\mu\text{F}$  ceramic capacitor in parallel with the electrolytic capacitor ensures that impedance remains low in the high frequency range.

The ripple voltage test shall be done at 10%, 25%, 50%, 75% and 100% load and the bandwidth of the oscilloscope is set at over 20 MHz.

NOTE – To ensure a maximum relevance of the ripple test, it is recommended to use an aluminium electrolytic capacitor representing the input capacitance of the powered device.



**Figure 3 – Measurement method test circuit**

## 7.2 Energy efficiency requirements

### 7.2.1 No-load power consumption

The test shall be made in accordance with [IEC 62301] but with the AC and DC cables provided with the product [EN 50563].

Detailed values of no-load power consumption below 0.1 W (smaller UPAs) or 0.21 W (larger UPAs), depending on the rated power of the adapter are given in Table 3.

### 7.2.2 Power efficiency

The test shall be done in accordance with [EN 50563] with the AC and DC cables provided with UPA.

The efficiency requirements of UPAs are given in Table 3.

The efficiency of UPAs is defined for loads from 10% to 100% and measured at 10%, 25%, 50%, 75% and 100%.

The mean value has been calculated for each power category as the average of the efficiency measurements are made at 25%, 50%, 75% and 100% loads.

For USB Type-C UPAs, the efficiency is measured at the voltage that supports the adapter rating (i.e., the highest voltage level supported). Where the UPAs support lower voltages, the efficiencies at the corresponding lower power rating should not be worse than 90% of the efficiency required for that power value.

Modern ICTs are being designed to dynamically optimize their energy performance. Their consumption is increasingly variable and related to the dynamic behaviour (e.g., service, bit rate, etc.). UPAs will then experience loads in all the output power range. The requirement is then defined also for a 10% load condition to obtain satisfactory performances when the load is in the lower range.

With a load in the range of 25%-100%, the UPA efficiency shall not be lower than the value required at 25% load.

**Table 3 – No-load power and efficiency requirements of the adapter block in for UPAs solutions covered under Table 1**

Category	Voltage	Current	Power	Target solution		
				No-load power (W)	Average efficiency at 25%, 50%, 75% and 100% load	Proposed Efficiency at 10% load
Small 1	5 V	3 A	15 W	0.1	81.4%	71.4%
Small 2	12 V	2.5 A	30 W	0.1	86.9%	76.9%
Small 3	20 V	2.25 A	45 W	0.1	87.7%	77.7%
Medium	20 V	3 A	60 W	0.21	88%	78%
Big	20 V	4.25 A	85 W	0.21	88%	78%

NOTE – The proposed values on energy efficiency at 10% load are under consideration for future development, and these values are not mandatory for this version of this Recommendation.

The no-load target values recommended will become applicable three years after the official publication of this Recommendation. In the transitional period, targets for Small 1, Small 2 and Small 3 are set to 0.15 W and targets for Medium, Medium and Big are set to 0.25 W.

The no-load consumption and efficiency could reach even stricter targets as technical solutions appearing in the market show this as being feasible (see Appendix II).

The power factor of UPA defined by the current harmonic levels shall comply with [IEC 61000-3-2].

NOTE – The measurement at 10% load is made using the same method as for the other loads 25% to 100%.

### **7.3 Safety and environmental requirements**

#### **7.3.1 Safety requirements**

UPAs, in accordance with the definition of this Recommendation, must comply with product safety requirements of the applicable IEC product safety standard [IEC 60950-1] / [IEC 62368-1] and [ITU-T K.74].

All UPAs, including those utilizing functional ground, should fulfil the Class II equipment requirements of [IEC 60950-1]. All UPAs should be compliant with standards and regulations for battery-equipped loads. It is noted that some regulators may classify a UPA with functional ground as a Class I device due to connection with protective earth at the building wall outlet connection.

Class II equipment implementation is considered because the safety ground on the grid socket is not always available. In many countries the safety grounding is not even compulsory within the electrical wiring in homes. Furthermore, it is common practice when travelling abroad to use power socket adapters that have no ground pins or insulated ground pins.

Class I constructions should be considered as suitable for use in markets with provisioned ground.

A UPA equipped with a ground pin is considered to be in line with this Recommendation if the ground pin is a functional earthing point and from a safety point of view the UPA respects the Class II requirement of [IEC 60950-1].

Where national regulations exist, they override the content of this Recommendation.

#### **7.3.2 Environmental tests**

In addition to safety, functional tests or lifetime testing (see also clause 7.6.2) should follow [IEC 60068-2-38], which provides a composite test procedure, primarily intended for component type specimens, to determine, in an accelerated manner, the resistance of specimens to the deteriorative effects of high temperature/humidity and cold conditions. Furthermore, [IEC 60950-1] defines a temperature test but not the simulation of the transport and package failure.

### **7.4 EMC requirements**

UPAs, in accordance with the definition of this Recommendation, should comply with emission requirements described in [IEC-CISPR 22]. They should also comply with the immunity requirements described in [IEC-CISPR 24] and [ITU-T K.74]. The transition from [IEC-CISPR 22] to [IEC-CISPR 32] should be respected.

According to the regulations of some countries, UPAs need to be tested and certified for electromagnetic compatibility (EMC) together with the ICT devices with which they are intended to be used.

Where national regulations exist, they override the content of this Recommendation.

### **7.5 Resistibility requirements**

Resistibility tests and levels are given in [ITU-T K.44] and [ITU-T K.21].

The UPA resistibility requirements shall be in line with the basic test level.

Where the basic resistibility requirements are not sufficient due to environmental conditions, national regulations, economic and technical considerations, installation standards or grade of service requirements, network operators may request the enhanced or special resistibility requirements.

Guidance on the applicability of enhanced test levels and special levels is given in [ITU-T K.85].

## **7.6 Eco-environmental specification**

### **7.6.1 Ecodesign**

Ecodesign shall follow the general requirements of clause 6.6 of [ITU-T L.1000].

The environmental impact assessment of UPAs should be based upon [ITU-T L.1410].

#### **7.6.1.1 Eco-environmental requirements**

External power supplies represent a very significant percentage of the whole weight and material used for ICTs (estimated to be 10%-20%). As they share the majority of the solutions and materials, they are much more likely to be standardized than other ICTs. It is important to set requirements to materials and end-of-life compatibility to minimize their impact on the environment.

#### **7.6.1.2 Ecodesign criteria for electronics**

The requirement stated in clause 6.6.1.1 of [ITU-T L.1000] shall apply with the following modifications:

Further to what is stated in [ITU-T L.1000] and to minimize unnecessary use of resources, emissions and production of e-waste, it is considered important to define in future also weight limits for each UPA class.

For UPAs of all categories with enhanced resistibility to overvoltage higher than 2.5 kV, the weight may be higher than the limit for UPAs without enhanced resistibility.

### **7.6.2 Lifetime**

This requirement is intended to be applied to the AC/DC part of UPAs only including all electronic circuits (cables and plugs are excluded).

The initial value for lifetime parameters should be set at 5 years of continuous active use, i.e., when operating at a maximum average output power at a 25°C average temperature and under any conditions of humidity (not condensing), and for a lifetime of 3 years of elevated ambient temperature continuous active use, i.e., when operating at a maximum average output power at a 35°C average temperature.

## **7.7 Other requirements**

Examples of further requirements, found in [b-IEC TS 62700], are intended to be guidance complementing this Recommendation. These requirements for example, refer to output short circuit requirements, performance requirements (brownout and recovery, maximum open circuit voltage, overshoot at turn-on, turn-off), temperature and humidity in storage, transport and use phase.

It is noted that two-pronged pins allow much higher compatibility between countries (e.g., in Europe there are seven different AC grounded configurations, but only two non-grounded configurations).

## Annex A

### DC output characteristics

(This annex forms an integral part of this Recommendation.)

Figure A.1 indicates possible voltage and current operating ranges of UPAs.

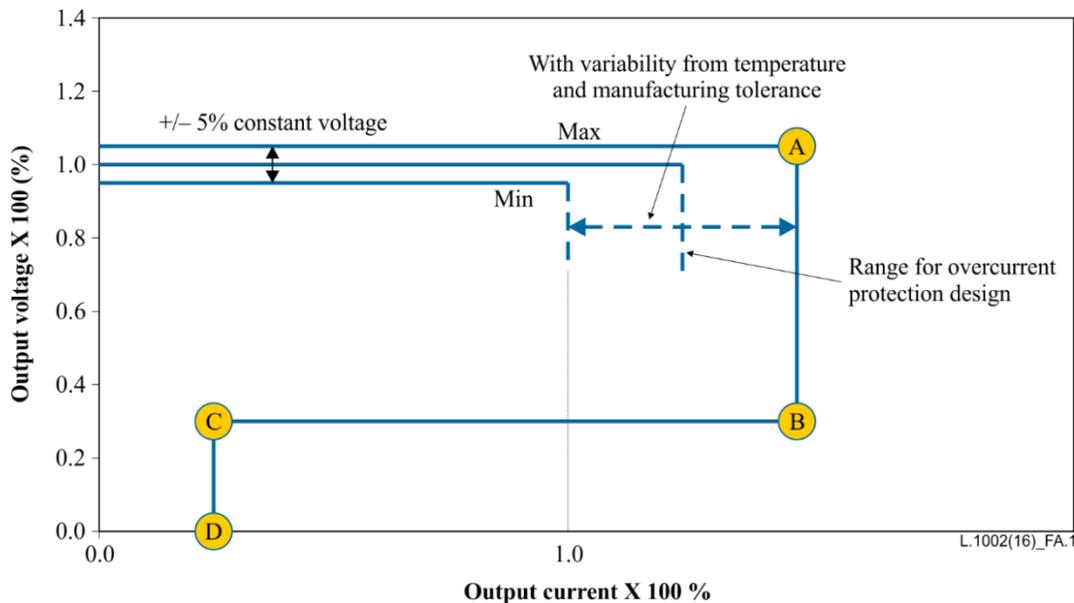
The DC output voltage is measured at the output connector of the DC cable.

For DC output characteristics, the following information should be clearly stated in a test report: DC current-voltage curve (I-V curve), points A, B, C and D indicated in Figure A.1 and classes and type of overcurrent mode operation defined in Table A.1.

Overcurrent mode should be chosen from Table A.1.

If "constant power mode" is chosen, it is strongly recommended to combine it with the "hiccup mode" in order to prevent hazardous operation.

The output voltage of UPAs should stay within the limits defined in Figure A.1 (nominal voltage  $\pm 5\%$ ) under a load of 0% to 100% of the rated power. This does not cover fast dynamic changes.



**Figure A.1 – Voltage-current operating area**

Figure A.1 shows the points that should be clearly determined in the output I-V curves, i.e., the limited current characteristics as follows:

- Point A: maximum output current at maximum output voltage. This is used to design the protection coordination between a UPA and the ICT equipment.
- Point B: minimum output voltage at maximum output current. This is used to design the ICT equipment and to avoid its "lock-out" in its starting sequence. This defines the power supplied to the fault point inside the ICT equipment.
- Point C: inflection point. This is also used to avoid "lock-out" in the starting sequence of the equipment.
- Point D: convergence point. This is also used to avoid "lock-out" in the starting sequence of the equipment.

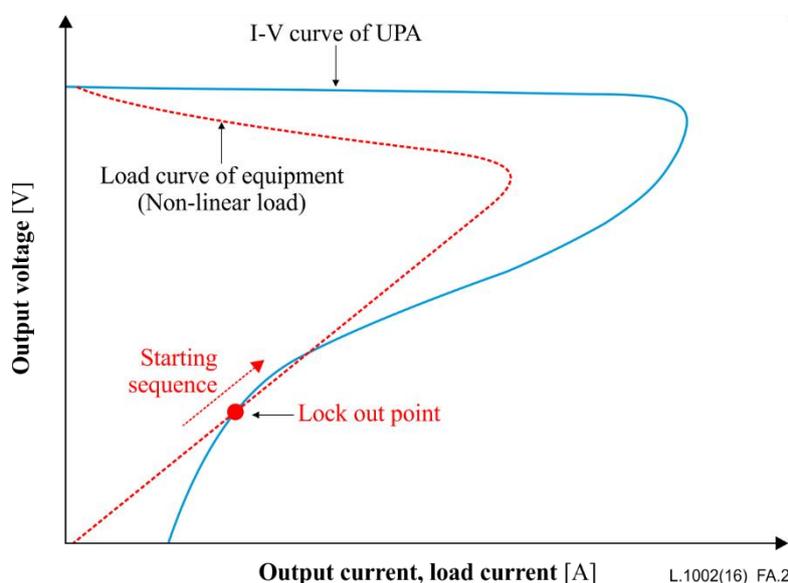
The voltages corresponding to points B and C in Figure A.1 are not intended to be prescriptive.

**Table A.1 – Classes of overcurrent mode**

No.	Type of overcurrent mode operation
1	Constant current mode operation
2	Foldback current mode operation
3	Cut-off mode operation
4	Constant power mode operation
5	Hiccup mode operation
6	Combination from class1 to class5

### Explanation of "lock out"

The DC output current and voltage characteristics of UPAs should be coordinated with the load curve of equipment. If the I-V curve of the UPA crosses the load curve of the equipment during equipment start-up, UPAs might not start the equipment. In general, this is called "lock out". The equipment designer should design load characteristics avoiding "lock out". The designer requires the information for points A, B, C and D in Figure A.1 to avoid "lock out" and design the load characteristics of the equipment.



**Figure A.2 – "Lock out" mechanism**

NOTE – The following guidance is provided to ensure ICT device compatibility with UPAs:

- The ICT device should have overcurrent protection against internal short circuits, e.g., a fuse.
- The formula expressing the relation between a UPA and ICT device power is as follows:  
Maximum output current or power of a UPA > Normal operation current or power of ICT device.
- The maximum current of a UPA should be able to activate the overcurrent protection (e.g., blow the fuse) inside the ICT device when the current of a UPA exceeds the rated value of the overcurrent protection.
- The load characteristic of the ICT equipment at start-up and operation should be within the range of the output current versus the output voltage curve of a UPA.
- The dynamic load characteristics of the ICT device at start-up and operation should be within the dynamic load characteristics of a UPA.
- When starting up the ICT device, the load characteristic of the ICT device should avoid "lock-out".

## Appendix I

### **Trends and solutions to reduce the UPA category and adapt to DC voltage interfaces for renewable energy and batteries**

(This appendix does not form an integral part of this Recommendation.)

Some trends can help to reduce the category of UPAs. This reduction can be attributed to device and energy efficiency optimization with DC power distributions in homes, buildings and transportation, simplified use of renewable energy and back-up batteries and simple or standardized solution of voltage auto-setting solutions.

#### **Next generation common charging interoperability solutions based on USB technologies**

[IEC 63002] is an international standard for the common charging interoperability of mobile devices. [IEC 63002] will build on the global adoption of USB technologies for smartphone and small-device charging and data interoperability and leverage the latest USB Type-C™ and USB-PD technologies ([IEC 62680-1-3] and [IEC 62680-1-2]) to enable charging interoperability across a broader range of mobile product categories. [IEC 63002] provides specifications and guidelines for charging interoperability to improve reusability and longevity of adapters and devices, safety, power savings and other aspects important for end-user satisfaction. Additionally, charging use cases without power adapters can also be supported). [IEC 63002] does not take the approach of specifying "universal" or common product adapters because of open issues associated with arbitrary combinations and limitations. Instead the standard focuses on interoperability specifications in order to support the global industry in developing interoperable charging solutions that meet regulatory compliance.

#### **Trends to DC voltage standards**

Mobile and hand-held terminals are using 5 V [ITU-T L.1000], homes/building terminals (boxes, switches, modems) are using 5 V or 12 V, e.g., Emerge Alliance has specified a 24 V DC ceiling distribution in offices.

New trends in battery voltage and distribution in cars, home storage for photovoltaic (PV) systems, and power over Ethernet (PoE) seem to converge to a voltage of about 48V to reduce losses in the long distribution wires. Devices are then efficiently powered by power over line (PoL) converters.

The high power distribution at the home or building level is moving to increase to up to a 400 V DC power feeding interface for the highly efficient use of renewable energy and energy storage. In ICT buildings (telecom centres or data centres or business buildings) the up to 400 V DC interface is specified in [ITU-T L.1200] for servers and telecom or IT network equipment.

For a more detailed understanding, the home/building DC distribution trends can be found in Appendix I of [ITU-T L.1001].

The up to 400 V DC plugs and wall sockets [b-IEC 62735-1] for the DC input detachable cable are under standardization in IEC TC 23B.

#### **Solar power for powering ICT devices**

Use of renewable energy (e.g., solar) as a source of energy should follow the general requirements of clause 6.2.3 of [ITU-T L.1000].

For solar power in countries where the grid is not available or is of poor quality, the following possibilities exist:

- The solar energy system provides the AC power and the UPA can be used without change.
- The solar energy system provides the DC power with an electrical interface compatible with UPAs.

NOTE 1 – DC power with an up to 400 V interface [ITU-T L.1200] could be used in the range of 260-400 V in a solar energy system without an inverter.

NOTE 2 – Where national regulations exist, they override the content of this Recommendation.

## Appendix II

### Efficiency trends in some regions

(This appendix does not form an integral part of this Recommendation.)

#### II.1 Europe

The European Code of Conduct (CoC) on external power supplies (EPS) is a voluntary measure that aims at defining quality targets that are more challenging than a business-as-usual scenario, but which are still achievable.

The main targets contained in the [b-CoC EPS] are shown in Tables II.1, 2 and 3.

**Table II.1 – Targets no-load power consumption**

Rated output power (P <sub>no</sub> )	No-load power consumption	
	January 2014	January 2016
> 0.3 W and < 49 W	0.150 W	0.075 W
> 49 W and < 250 W	0.250 W	0.150 W
Mobile handheld battery driven and < 8 W	0.075 W	0.075 W

**Table II.2 – Energy-efficiency criteria for active mode for UPAs excluding external UPAs**

Rated output power (P <sub>no</sub> )	Minimum four point average efficiency in active mode		Minimum efficiency in active mode at 10% load of full rated output current	
	January 2014	January 2016	January 2014	January 2016
$0.3 \leq W \leq 1$	$\geq 0.500 \times P_{no} + 0.146$	$\geq 0.500 \times P_{no} + 0.169$	$\geq 0.500 \times P_{no} + 0.046$	$\geq 0.500 \times P_{no} + 0.060$
$1 < W \leq 49$	$\geq 0.0626 \times \ln(P_{no}) + 0.646$	$\geq 0.071 \times \ln(P_{no}) - 0.00115 \times P_{no} + 0.670$	$\geq 0.0626 \times \ln(P_{no}) + 0.546$	$\geq 0.071 \times \ln(P_{no}) - 0.00115 \times P_{no} + 0.570$
$49 < W \leq 250$	$\geq 0.890$	$\geq 0.890$	$\geq 0.790$	$\geq 0.790$

"ln" refers to the natural logarithm. Efficiencies to be expressed in decimal form: an efficiency of 0.88 in decimal form corresponds to the more familiar value of 88% when expressed as a percentage.

**Table II.3 – Energy-efficiency criteria for active mode for UPAs**

Rated output power (P <sub>no</sub> )	Minimum four point average efficiency in active mode		Minimum efficiency in active mode at 10% load of full rated output current	
	January 2014	January 2016	January 2014	January 2016
$0.3 \leq W \leq 1$	$\geq 0.500 \times P_{no} + 0.086$	$\geq 0.517 \times P_{no} + 0.091$	$\geq 0.500 \times P_{no}$	$\geq 0.517 \times P_{no}$
$1 < W \leq 49$	$\geq 0.0755 \times \ln(P_{no}) + 0.586$	$\geq 0.0834 \times \ln(P_{no}) - 0.0011 \times P_{no} + 0.609$	$\geq 0.072 \times \ln(P_{no}) + 0.500$	$\geq 0.0834 \times \ln(P_{no}) - 0.00127 \times P_{no} + 0.518$
$49 < W \leq 250$	$\geq 0.880$	$\geq 0.880$	$\geq 0.780$	$\geq 0.780$

"ln" refers to the natural logarithm. Efficiencies to be expressed in decimal form: an efficiency of 0.88 in decimal form corresponds to the more familiar value of 88% when expressed as a percentage.

### European Commission regulations

Article 6 of the European Commission (EC) Regulation No 278/2009 of 6 April 2009 refers to the following indicative benchmarks:

#### a) No-load condition

The lowest available no-load condition power consumption of external power supplies can be approximated by:

$$0.1 \text{ W or less, for } P_o \leq 90 \text{ W}$$

#### b) Average active efficiency

The best available active average efficiency of external power supplies according to the most recent available data (status January 2008) can be approximated by:

$$0.090 \ln P_o + 0.680, \text{ for } 1.0 \text{ W} \leq P_o \leq 10.0 \text{ W, i.e., } \eta > 82\% \text{ above } 5 \text{ W}$$

$$\text{And } \eta = 89\% \text{ for } P_o > 10.0 \text{ W}$$

## II.2 China

- 1) For single voltage external AC-DC and AC-AC power supplies: Whilst this document was in draft form, the implemented and published standard in China was [b-GB 20943-2007]. However, revision work on the standard began in 2011. The minimum allowable and evaluating values of average efficiency and no-load power have been improved. A comparison between [b-GB 20943-2007] and [b-GB 20943-2013] is reported in Table II.4, Table II.5, Table II.6 and Table II.7:

**Table II.4 – Minimum allowable values of average efficiency**

2013 edition		2007 edition	
Output rated power ( $P_o$ ) W	Minimum average efficiency	Output rated power ( $P_o$ ) W	Minimum average efficiency
$0 < P_o < 1$	$\geq 0.5 \times P_o$	$0 < P_o < 1$	$\geq 0.39 \times P_o$
$1 \leq P_o \leq 51$	$\geq 0.09 \times \ln P_o + 0.55$	$1 \leq P_o < 49$	$\geq 0.107 \times \ln P_o + 0.39$
$51 < P_o \leq 250$	$\geq 0.85$	$49 \leq P_o \leq 250$	$\geq 0.82$

**Table II.5 – Maximum allowable values of no-load power**

2013 edition		2007 edition	
Output rated power ( $P_o$ ) W	Maximum active power with no load W	Output rated power ( $P_o$ ) W	Maximum active power with no load W
$0 < P_o \leq 250$	0.5	$0 < P_o \leq 10$	0.75
		$10 < P_o \leq 250$	1.0

**Table II.6 – Evaluation of average efficiency values**

2013 edition			2007 edition	
Output rated power (P <sub>o</sub> ) W	Product type	Minimum average efficiency	Output rated power (P <sub>o</sub> ) W	Minimum average efficiency
0 < P <sub>o</sub> ≤ 1	Standard models	$\geq 0.480 \times P_o + 0.140$	0 < P <sub>o</sub> < 1	$\geq 0.49 \times P_o$
	Low-voltage models	$\geq 0.497 \times P_o + 0.067$		
1 < P <sub>o</sub> ≤ 49	Standard models	$\geq 0.0626 \times \ln(P_o) + 0.622$	1 ≤ P <sub>o</sub> < 49	$\geq 0.09 \times \ln P_o + 0.49$
	Low-voltage models	$\geq 0.0750 \times \ln(P_o) + 0.561$		
49 < P <sub>o</sub> ≤ 250	Standard models	$\geq 0.870$	49 ≤ P <sub>o</sub> ≤ 250	$\geq 0.84$
	Low-voltage models	$\geq 0.860$		

**Table II.7 – Evaluating values of no load power**

2013 edition		2007 edition	
Output rated power (P <sub>o</sub> ) W	Maximum active power with no load W	Output rated power (P <sub>o</sub> ) W	Maximum active power with no load W
0 < P <sub>o</sub> ≤ 10	AC-AC:0.5	0 < P <sub>o</sub> ≤ 10	0.5
	AC-DC:0.3		
10 < P <sub>o</sub> ≤ 250	0.5	10 < P <sub>o</sub> ≤ 250	0.75

2) The power adapter of mobile telecommunication terminals have to be compliant with [b-YD/T 1591], the adapter for output rated voltage is 5 V and output rated power less than 12.5 W. The average efficiency and no-load power requirement is as follows:

- Average efficiency

For a rated output current less than 550 mA,

$$\text{Average efficiency} \geq 0.0626 \cdot \ln(P_{no}) + 0.622$$

For a rated output current not less than 550 mA,

$$\text{Average efficiency} \geq 0.0750 \cdot \ln(P_{no}) + 0.561$$

- No-load power < 150 mW.

## Appendix III

### Possible evolution of DC connectors

(This appendix does not form an integral part of this Recommendation.)

This appendix contains information on the possible future evolution of DC connectors.



**Figure III.1 – Example of multi-pin barrel connector**

DIN connectors could be a choice of connector as they are already used in medical power adapters.

NOTE – In case other barrel connector types are needed, power jack barrel connectors that are able to work at 30 V DC and 7.5 A are available with a protective level (IP code) of IP 68 as defined in [b-IEC 60529]. Some are compliant with [b-JEITA RC-5320A].

A future target for connectors could be a principle of a simple multi-pin possibly flat connector with one pin for each voltage among the 12 V, 16 V, 20 V and 24 V with a single return pin, each pin being designed for 5 A rated (see example on Figure III.1).

The chosen connectors should comply with [b-IEC 60664-1] that defines an operating voltage and the creepage distance and air-gap conditions. The UPA output connector standards used in this appendix should be preferred when proposing the same power interface in cars and other means of transportation, to connect to the DC detachable cable.

NOTE – It is recommended that an anti-arcing solution for higher current range be used, e.g., > 3 A (a connector lock by magnet or position click), or any solution avoiding operations with too small metal surface contact and very small air-gaps (e.g., arc blow magnet, spring to mechanically extended air gap etc.).

## **Appendix IV**

### **Areas for further development**

(This appendix does not form an integral part of this Recommendation.)

Notebook computers are historically designed to meet unique market requirements and specific purposes. Each AC adapter is paired accordingly with a targeted notebook. Specific combinations of original equipment manufacturer (OEM) supplied AC adapters and notebook computers are then tested and certified as a system in compliance with most existing regulations and standards.

This approach is mandated by current certification and conformity assessment schemes affecting the end product, but it also has the added benefit of reducing the use of poorly designed adapters; it promotes consumer satisfaction, safety and product reliability. Combinations of AC adapters and notebook computers that have not undergone this testing and certification process may present functional and regulatory compliance problems in areas including safety and EMC. This affects the end product and, therefore, the end user.

Moreover, failures in the field can reasonably be expected to lead to performance, warranty and liability issues that will impact the end product brand. This subject is for further study and development.

The open issues identified in [IEC TS 62700] Annexes A, C, D, E should be considered.

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