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SERIES L: CONSTRUCTION, INSTALLATION AND
PROTECTION OF CABLES AND OTHER ELEMENTS OF
OUTSIDE PLANT

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

Recommendation ITU-T L.1001



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External universal power adapter solutions for stationary information and communication technology devices

Summary

Recommendation ITU-T L.1001 provides requirements for a universal power adapter solution (UPA) for stationary information and communication technology (ICT) devices that will reduce the number of power adapters that are produced by widening their application by more devices, thus enabling their reuse and increasing their life expectancy.

The solution also aims to reduce energy consumption. The longer the life cycle and possibility of avoiding device duplication reduces the demand on raw materials and limits the amount of e-waste.

The universal power adapter solution for stationary ICT equipment is designed to serve the vast majority of ICT devices.

History

| Edition | Recommendation | Approval | Study Group |
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Ecodesign, energy efficiency, power adapter, power supply.

FOREWORD

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Introduction

This Recommendation defines the requirements for a universal power adapter solution for ICT devices. It also takes into consideration energy efficiency, emissions reduction and the use of scarce and raw materials.

It is estimated [b-GeSI-ITU-T Study] that the widespread adoption of an energy-efficient universal power adapter solution for ICT devices will result in more than a 50 per cent reduction in standby energy consumption, that together with even greater energy savings due to more efficient AC/DC converters, will contribute to the reduction of CO₂ emissions.

The universal power adapter solution will achieve several objectives: it will be more convenient for consumers to power their ICT devices from any available universal power adapter and it will enable the sharing of power adapters between ICT devices, and they can be used for existing and future ICT devices. This will reduce the number of duplicate single-use power adapters considerably.

The environmental impact of any universal power adapter solution should be considered over its entire life cycle and that the transition towards a universal power adapter solution does not aim to replace 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.

This Recommendation is designed to ensure that the universal power adapter solution operates within the recognized current and voltage safety parameters by adopting existing ICT device technologies and by taking into account operators, manufacturers and associations working within the market.

It should be noted that life expectancy, safety, electromagnetic compatibility (EMC) and environmental issues have been considered in this Recommendation.

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 in the cost of fossil fuels 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 or 24 V to 5 V. This solution is also considered for home DC networks in developed countries (see appendices I and V).

Multi-output UPA solutions could be built based on a single DC output interface that will improve user experience by reducing the amount of power adapter blocks, wires and AC plugs. This additionally reduces the environmental impact by using less material and offering the higher efficiency of an adapter rated for higher power. The ICT devices can be sold just with the detachable cable or with the end connector adapter.

Recommendation ITU-T L.1001

External universal power adapter solutions for stationary information and communication technology devices

1 Scope

This Recommendation defines the requirements for a universal power adapter (UPA) solution designed for ICT devices for stationary (non-portable) use.

This Recommendation takes into consideration improvements in energy efficiency, greenhouse gas (GHG) emission reductions, and optimization in the use of scarce and raw materials.

The UPA is an external power adapter that interfaces to the low-voltage input of an ICT device by converting the AC mains voltage to a low DC voltage output.

A UPA is applicable to stationary ICT devices at home, where normal operation requires a permanent connection to a household AC power source.

Stationary means that the ICT device does not have an integral battery as the primary power source and would not be expected to be transported by the user on an everyday basis in normal operation. However, it includes ICT devices with battery backup in case of power supply failure.

UPA does not provide any charge control for rechargeable batteries.

This Recommendation is complementary to [ITU-T L.1000] and aims to cover the widest range possible of ICT devices for stationary use within the defined voltage and power ranges. It considers basic configurations and general requirements for the UPA and their interfaces, including cables, connectors, voltage, current, ripple, noise, energy efficiency, safety, electromagnetic compatibility, resistibility and eco-environmental specifications.

Future revisions could include compatibility with [ITU-T L.1200] DC interfaces or with safety extra-low voltage (SELV) DC to maximize efficiency and use of the UPA. These DC sources can be made available on renewable energy systems or on power sockets that may be found in transportation systems (boats, trains, planes, buses, etc.).

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.

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- [ITU-T L.1000] Recommendation ITU-T L.1000 (2011), *Universal power adapter and charger solution for mobile terminals and other hand-held ICT 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.*
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3 Definitions

3.1 Terms defined elsewhere

None.

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 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 one on the AC mains side.

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

3.2.4 hiccup mode: This is an overcurrent protection mode for the power supply which stops the power supply following an overcurrent incident and then intermittently attempts to restart the supply.

3.2.5 power adapter: A device that converts the mains AC power voltage at the input to a low DC power voltage at the output or which converts the DC power source, e.g., from a photovoltaic source to another low-voltage DC power output.

3.2.6 power adapter block: A block which includes a power adapter.

3.2.7 universal power adapter solution: A family of universal power adapters (UPAs) that defines the power supply solution for different ICT devices.

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

| | |
|------|------------------------------------|
| AC | Alternating Current |
| ADSL | Asymmetric Digital Subscriber Line |
| CTI | Comparative Tracking Index |

| | |
|------|--|
| DC | Direct Current |
| EMC | Electromagnetic Compatibility |
| EUT | Equipment Under Test |
| FET | Field Effect Transistor |
| GHG | Greenhouse Gas emission |
| GPON | Gigabit Passive Optical Network |
| ICT | Information and Communication Technology |
| I-V | Current-Voltage |
| ONT | Optical Network Termination |
| ONU | Optical Network Unit |
| POL | DC/DC Point of Load Converter |
| POS | Point of Sale |
| p-p | peak to peak |
| PSE | Product Safety and Electrical appliance and material |
| PTI | Proof Tracking Index |
| PV | Photovoltaic |
| SCCP | Short Chain Chlorinated Paraffin |
| SELV | Safety Extra-Low Voltage |
| STB | Set-Top Box |
| UPA | Universal Power Adapter |
| UPTI | Universal Power and Telecom Interface |
| USB | Universal Serial Bus |
| VDSL | Very high speed Digital Subscriber Line |

5 Conventions

None.

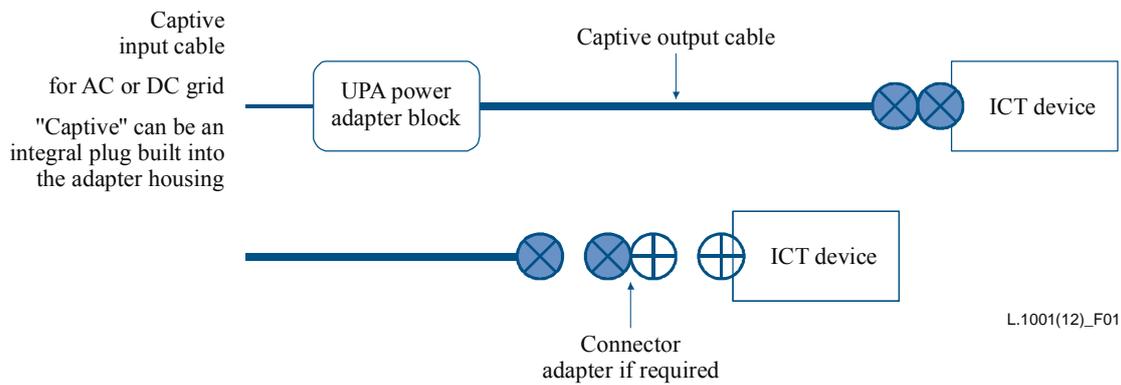
6 Universal power adapter solutions

6.1 Basic configuration

Figure 1 shows the basic configuration of the universal power adapter (UPA) solution for stationary use. The basic UPA configuration consists of a UPA with a captive (non-detachable) input cable and a captive output cable to the ICT device (captive input can be a plug integrated within the adapter housing).

Another option is a UPA with more than one output defined in a basic configuration.

NOTE 1 – Other configurations with a detachable cable for stationary use are possible, but require further study. Appendix V shows several configurations with a detachable cable that can be used in transportation systems or in solar-power applications.



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Figure 1 – Basic UPA configuration and connector change option

Each UPA configuration is shown with a 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 2 – To allow more flexibility and reduce the number of UPA categories (see Table 1), an identification pin could be used to identify the UPA configuration.

NOTE 3 – Appendix I contains information on research that has been performed on SELV DC room distribution using renewable energy sources and storage for powering ICT devices.

NOTE 4 – UPAs could have input compliance with the [ITU-T L.1200] DC interface.

6.2 ICT devices adopting the UPA

The UPA, as defined in this Recommendation, shall be used to power ICT devices for stationary use. Applicable ICT devices include VDSL modems, ADSL modems, home gateways, routers GPON/ONUs, fixed telephones, facsimiles, etc.

In cases where ICT devices include internal batteries, the UPA does not provide charging functions.

NOTE 1 – Battery-equipped ICT devices should contain battery control functions compliant with functional battery safety standards.

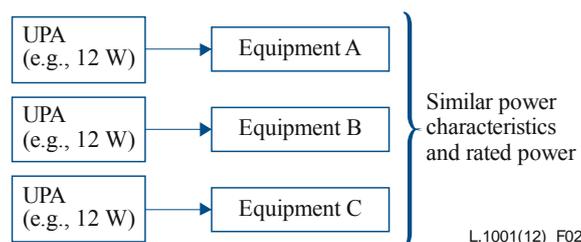
A UPA could power other ICT devices that have similar power requirements such as external hard disks, computer monitors, point of sale (POS) card readers, etc., if their power input interface is compatible with the specifications in this Recommendation.

ICT devices in [ITU-T L.1000] are not covered in this Recommendation.

In case of a multi-output UPA option, the sum of the maximum power on all outputs must not exceed 249 W.

NOTE 2 – The basic functions of a UPA are:

- a) a UPA is available for different equipment for stationary use (Figure 2)
- b) a UPA is available for equipment whose rated power is less than the capacity of the UPA (Figure 3).



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Figure 2 – Compatibility function for one UPA shown with several devices with similar power characteristics

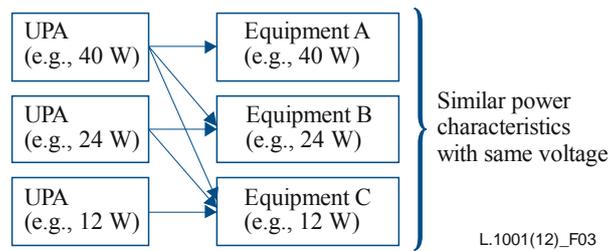


Figure 3 – Power compatibility function of a UPA (example based on a 12 V UPA)

NOTE – The compatibility function should be compliant with the efficiency target (i.e., UPA power should be comparable to the ICT requirement).

6.3 Compatibility with powered ICT equipment

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

NOTE – In [IEC 60950-1] the requirement is on input overcurrent protection.

In addition, an appropriate overcurrent protection device (e.g., fuse) should be included in the DC input circuit of the powered ICT equipment.

While the UPA can sense its own short-circuit or failure condition, it cannot sense a malfunction of the ICT device.

Figure 4 shows how the rated current and power of the ICT device relate to those of the UPA. An overcurrent condition of the UPA shall be at least 105% of the rated current. The variability of characteristics due to the tolerance of the UPA components shall be taken into account (e.g., temperature drift and reliability of the overcurrent protection device (e.g., fuse)).

ICT devices should be designed to ensure coordination between UPA power output capabilities and fuse characteristics (Appendix IV gives an example of various dimensioning effects). Proper design will help to detect when there is a failure and prevent damage to ICT equipment.

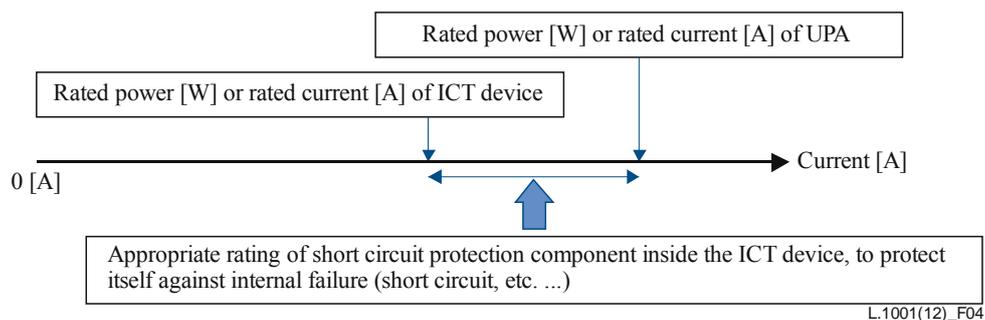


Figure 4 – Relationship between rated current of ICT device and UPA output

7 General requirements

7.1 Power adapter interface

7.1.1 Voltage/current definitions

Table 1 defines the UPA categories based on their output power interface (voltage, current and power) for different types of ICT products designed for stationary use. Each category is defined with examples of the ICT device types.

Table 1 – Categories of UPA and typical ICT devices covered

| Category | Example of ICT device types | Voltage [V] | Current [A] | Power [W] |
|----------|---|-------------|-------------|-----------|
| 1a | ONU, ONT, etc. | 5 | 1 | 5 |
| 1b | Ethernet hub/switch, modem, ONU, ONT, etc. | 5 | 2.4 | 12 |
| 2a | Modem, ONU, ONT, small home gateway, etc. | 12 | 0.5 | 6 |
| 2b | Modem, ONT, medium home gateway, etc. | 12 | 1 | 12 |
| 2c | Medium/complex home gateway | 12 | 2 | 24 |
| 2d | Home networking equipment (STB with hard disk etc.) | 12 | 3.3 | 40 |
| 2e | Network access storage, games, multimedia equipment | 12 | 5 | 60 |

NOTE – It is expected that the trend of energy consumption in ICT devices will lead to lower UPA power requirements and an eventual reduction of categories of stationary UPAs given in the table.

7.1.2 Output DC plug and connectors

The following DC connector requirements at the interface between the UPA and ICT devices have been aligned to those defined in ETSI standards [ETSI TS 102 874-2] to [ETSI TS 102 874-6] except for the 5 V UPA, where use of the micro USB connector was added.

1) Type 1a: 5V@1A –USB micro B.

NOTE 1 – In order to avoid customer confusion, an indication on the product or information in the manual of the UPA should caution against connecting the UPA to ICT devices which are out of the scope of this Recommendation (e.g., mobile terminals).

2) Type 1b: [ETSI TS 102 874-3] – 5V@2.4A –barrel connector – internal diameter 1.7 mm, external diameter 4 mm.

NOTE 2 – Micro USB extended support of a current up to 3A is under study by the USB forum and by IEC.USB is currently limited to 1.5 A and micro-USB to 1.7 A in USB standards, but it is estimated that 2.4 A will be necessary in the future.

3) Type 2a: 12V@0.5A –barrel connector – internal diameter 1.3 mm, external diameter 3.4 mm.

4) Type 2b: [ETSI TS 102 874-2] –12V@1A – barrel connector – internal diameter 2.1 mm, external diameter 5.5 mm.

5) Type 2c: [ETSI TS 102 874-4] –12V@2A – barrel connector – internal diameter 1.95 mm, external diameter 4.95 mm.

6) Type 2d: [ETSI TS 102 874-6] –12V@3.3A – barrel connector – internal diameter 1.98 mm, external diameter 6 mm.

7) Type 2e: [ETSI TS 102 874-5] – 12V@5A – barrel connector – internal diameter 3 mm, external diameter 6.5 mm.

National regulations may override the choice of connectors defined above.

NOTE 3 – To allow reuse of UPAs, it is possible to use a connector adapter with a higher power UPA to connect an ICT device designed to work with a UPA of a lower power category.

NOTE 4 – Some countries or manufacturers would like a target solution with a single connector type per voltage level (e.g., 5 V, 12 V). This would require an international standard to obtain the maximum environmental and user benefit. Some countries have already partially implemented such solutions (e.g., in Japan there is one connector for 5 V and another one for 12 V, but without pin identification). In that case it is possible to reuse the existing adapter with common 5 V or 12 V connectors or by using the proper adapter to connect the ICT device.

NOTE 5 – Some computer manufacturers are using barrel connectors with identification pins to set the correct voltage. For example, the IEEE P1823 UPAMD group is defining a new connector with the signal interface to set electrical parameter such as voltage and current. This connector is designed for use on stationary and portable electronic devices.

7.1.3 UPA input interfaces

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

[ITU-T L.1200] defines a DC power interface applicable to ICT devices.

NOTE – A DC connector applicable to the [ITU-T L.1200] interface is being developed at IEC.

7.1.4 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] type C7. The UPA shall need a class II requirement of [IEC 60950-1].

Safety class 2 is required because:

- It guarantees a higher resistibility and safety for users, in particular since the reliability of the safety ground on the grid socket is not always of sufficient quality or even available at all. In developing countries (but also in developed countries), the safety grounding is not even compulsory within the electrical wiring in homes. Furthermore, it is a common experience when travelling abroad to use power socket adapters that have no ground pins or insulated ground pins.
- It reduces the size, the weight, the volume and the amount of materials of the cable.
- 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).

7.1.5 DC output power interface characteristics

The UPA is required to 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 $\pm 5\%$ @ rated voltage |
| | Ripple voltage | Within $\pm 2\%$ @ rated voltage [IEC 62684] |
| | Drooping characteristic | See Annex C |
| | Inrush current characteristics | [ETSI TS 102 874 -2] to [ETSI TS 102 874 -6] depending on the category of the UPA |
| | Start-up characteristics | ETSI TS 102 874 -2 to [ETSI TS 102 874 -6] depending on the category of the UPA |

The rated voltage is 5 V or 12 V as defined in Table 1.

Annex C gives details of the output DC voltage characteristics to respect.

7.1.6 Ripple and noise voltage measurement

The ripple voltage and noise standard values shall be set within 2% of the rated voltage (i.e., 100 mVp-p at 5 V and 240 mVp-p at 12 V). The measurement of ripple shall be carried out using section 6.3 of [IEC 62684].

The EUT 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 5.

For a basic test of the UPA for stationary ICT use, one single value of 10 μF at 5 V and 47 μF at 12 V might be used, independently of the value of the current.

A 0.1 μF 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 to represent the input capacitance of the powered device.

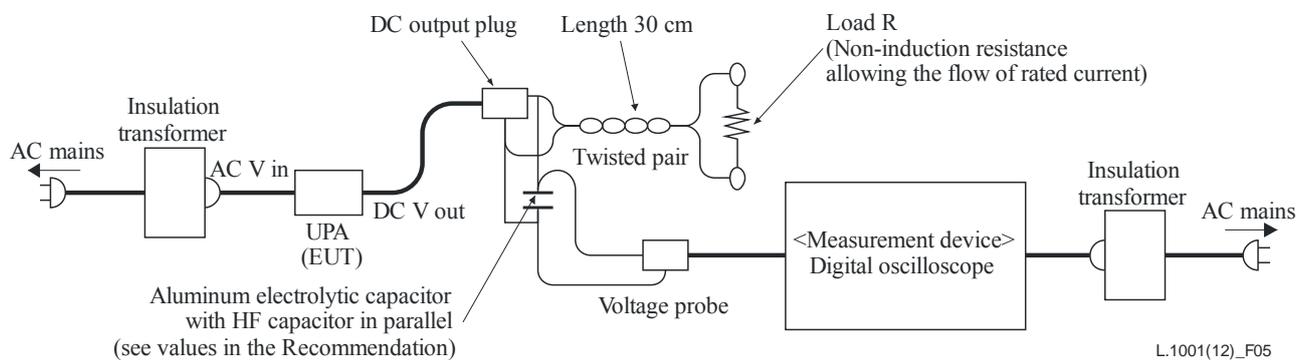


Figure 5 – Measurement method

7.1.7 Solar power for powering ICT devices

Use of renewable energy (e.g., solar) as an energy source shall 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 the UPA.

NOTE 1 – The general principles of a low-voltage and extra low-voltage DC distribution network using solar energy are described in Appendix I.

NOTE 2 – DC power with an interface up to 400 V [ITU-T L.1200] could be used in the range of 260-400 V in a solar energy system without an inverter.

7.2 Energy efficiency requirements

7.2.1 No-load power consumption

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

Target solution: No-load power consumption shall be below 0.03 W in 5 V UPAs and below 0.075 W for 12 V UPAs, independently of the rated power of the adapter. Detailed values are given in Table 3.

Transitional solution: No-load power consumption of the UPA shall be below 0.15 W regardless of the rated power of the adapter.

Values for transitional solution and target are given in Table 3.

7.2.2 Power efficiency

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

The efficiency requirements of the UPA are given in Table 3.

The efficiency of the UPA 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.

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 be experiencing 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 10%-100%, the UPA efficiency shall not be lower than the value required at 10% load.

Table 3 – No-load power and efficiency requirements of the adapter block in UPA solutions

| Category | Voltage | Current | Power | Transitional solution | | | Target solution | | |
|----------|---------|---------|-------|-----------------------|--|------------------------|----------------------------|--|------------------------|
| | | | | No-load power (W) | Average efficiency at 25, 50, 75 and 100% load | Efficiency at 10% load | No-load power (W) (Note 2) | Average efficiency at 25, 50, 75 and 100% load | Efficiency at 10% load |
| 1a | 5V | 1A | 5W | 0.15 | 68.2% | 58.2% | 0.03 | 73.7% | 68.7% |
| 1b | 5V | 2.4A | 12W | 0.15 | 74.8% | 64.8% | 0.03 | 80.0% | 75.0% |
| 2a | 12V | 0.5A | 6W | 0.15 | 73.4% | 63.4% | 0.075 | 78.9% | 73.9% |
| 2b | 12V | 1A | 12W | 0.15 | 77.8% | 67.8% | 0.075 | 83% | 78% |
| 2c | 12V | 2A | 24W | 0.15 | 82.1% | 72.1% | 0.075 | 86.3% | 81.3% |
| 2d | 12V | 3.3A | 40W | 0.15 | 85.3% | 75.3% | 0.075 | 87.6% | 82.6% |
| 2e | 12V | 5A | 60W | 0.15 | 87.0% | 77% | 0.075 | 88% | 83% |

The target values will come in force three years after the official publication of this Recommendation.

The no-load consumption and efficiency should reach even stricter targets as technical solutions appearing on the market show this to be feasible (see Appendix II).

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

7.3 Safety and environmental requirements

7.3.1 Safety requirements

Safety requirements of clause 6.3 of [ITU-T L.1000] shall apply to UPAs covered by this Recommendation, with the following additional requirements.

All UPAs should fulfil the safety class II requirements of [IEC 60950-1] (only the two-pronged mains connector is required). All UPAs should be compliant with standards and regulations for battery-equipped loads.

All UPAs supplied with a detachable AC cable shall provide a standard socket terminated in per IEC 60320 C7 (polarized).

The safe surface temperature limit of [IEC 60950-1] must be ensured on the surface of the AC adapter under the internal component fault.

The UPA for stationary ICT devices must comply with the electrical safety requirements of [IEC 60950-1] and should comply with [ISO/IEC Guide 51] and [IEC Guide 104].

The safety risks of UPAs must be assessed following [ISO/IEC Guide 51] and [IEC Guide 104] in normal, abnormal conditions, component failure and user misuse (e.g., electrical safety should be ensured when dropping a glass of water on a UPA, in addition to no smoke and no fire).

Appendix III gives an example of detailed safety, functional or lifetime environmental tests in Japan.

7.3.2 Environmental tests

In addition to safety, functional tests or life expectancy 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. [IEC 60950-1] defines a temperature test but not the simulation of the transport and package failure.

Appendix III gives an example of detailed safety, functional or lifetime environmental tests in Japan.

7.4 EMC requirements

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

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

The environmental impact assessment of UPAs should be based upon Recommendation [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 Eco-design 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 the unnecessary use of resources, emissions and production of e-waste, it is considered important to define also weight limits for each UPA class. Cables do not have to be considered in estimating the weight.

- 5 and 6 W UPA (Classes 1a and 2a) should weigh no more than 70 g
- 12W UPA (Class 1b and 2b) should weigh no more than 100 g
- 24W UPA (Class 2c) should weigh no more than 160 g
- 40W UPA (Class 2d) should weigh no more than 200 g
- 60W UPA (Class 2e) should weigh no more than 240 g.

For UPAs of all categories with enhanced resistibility to overvoltage higher than 2.5 kV, the weight may be higher than the limit above.

7.6.2 Life expectancy

The UPA should be designed for a 10 year expected life expectancy when operating at maximum output power, at a 25°C average temperature and under any conditions of humidity, and 7 years at 35°C, to reduce e-waste and allow more reuse.

Appendix III gives an example of detailed safety, functional or lifetime environmental tests in Japan.

7.7 Other specified items

In addition, for all categories, [ETSI ES 202 874-1] is applicable.

ETSI specifications [ETSI TS 102 874-2], [ETSI TS 102 874-3], [ETSI TS 102 874-4], [ETSI TS 102 874-5] and [ETSI TS 102 874-6] apply to the corresponding categories of UPA, as defined in annexes A and B.

It is intended to cover the following main specification items: AC input requirement, power output requirements (voltage, current, short circuit), performance requirements (turn-on delay time, hold-up time, brownout and recovery, maximum open circuit voltage, overshoot at turn-on, turn-off, output transient response, rise-time), temperature and humidity in storage, transport and use phase.

Annex A

ETSI standard corresponding to the 12 V UPA for stationary use categories 2b, 2c, 2d, 2e

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

These Category 2 UPAs shall comply with ETSI standards as follows:

Category 2b: [ETSI TS 102 874-2] (type 2a CPS)

Category 2c: [ETSI TS 102 874-4] (type 2b CPS)

Category 2d: [ETSI TS 102 874-5], apart from the different rated current value in ETSI (type 2c CPS)

Category 2e: [ETSI TS 102 874-6] (type 2d CPS).

Annex B

ETSI standard corresponding to the 5 V UPA for stationary use for devices other than those covered by ITU-T L.1000

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

These UPAs shall comply with ETSI standards as follows:

Category 1b: [ETSI TS 102 874-3], apart from the slightly different rated current value of 2.4 A (type 1 CPS).

Annex C

DC output characteristics

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

Figure C.1 indicates the UPA voltage and current operating ranges.

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 C.1 and classes and type of overcurrent mode operation defined in Table C.1.

Overcurrent mode should be chosen from Table C.1.

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

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

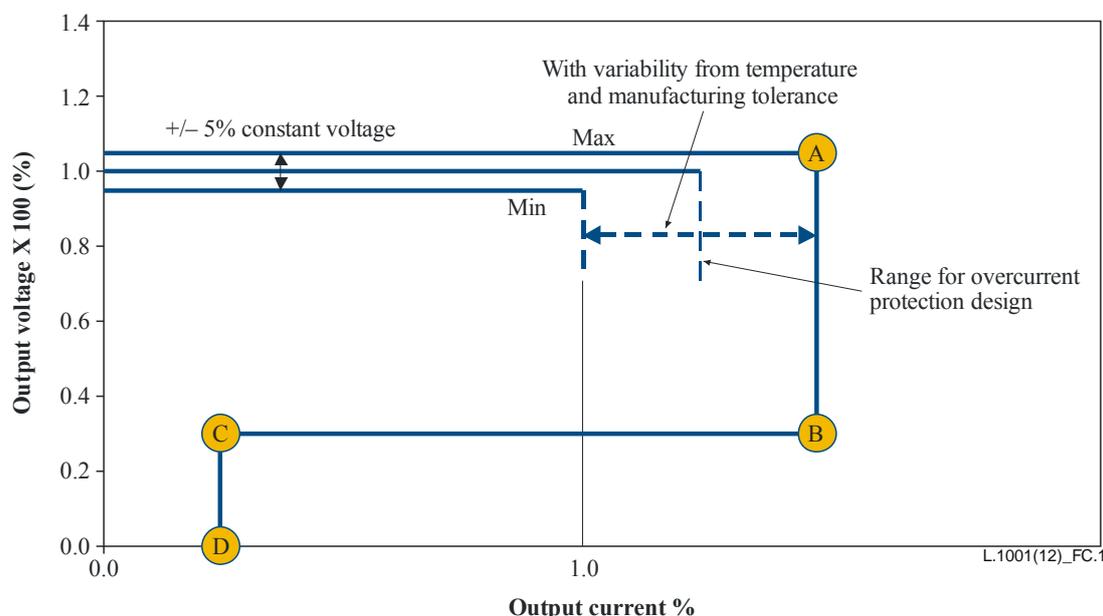


Figure C.1 – Voltage-current operating area

Figure C.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 the UPA and 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.

Table C.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 the UPA 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, the UPA 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 C.1 to avoid lock out and design the load characteristic of the equipment.

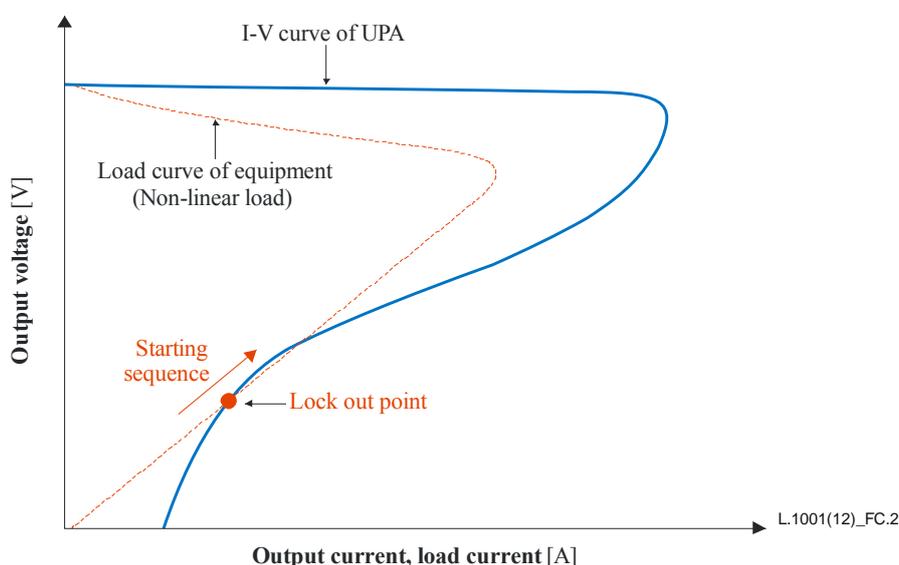


Figure C.2 – "Lock out" mechanism

NOTE – The following guidance is provided to ensure ICT device compatibility with the UPA (see also Appendix IV):

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

Appendix I

Low-voltage DC network characteristics and requirements

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

This appendix introduces a low-voltage DC network architecture that can use the grid or renewable energy to offer autonomy based on a backup battery or other storage means. It is still under research with a focus on optimizing efficiency, the number of converters and the reduction of energy for grid use while giving local autonomy through the use of renewable energy sources and energy storage.

I.1 Simple SELV hybrid solar system with battery DC bus

This architecture is based on an SELV bus on to which power sources are connected (e.g., grid power supply, battery, PV system) and user loads.

- New devices can be connected directly to the DC bus so they should be designed to operate with input voltages in the full range from 18 V to –28V.
- Existing devices require a point of load converter for compatibility, e.g., conversion from 18 V to 28 V to the defined UPA voltages of Table 1.

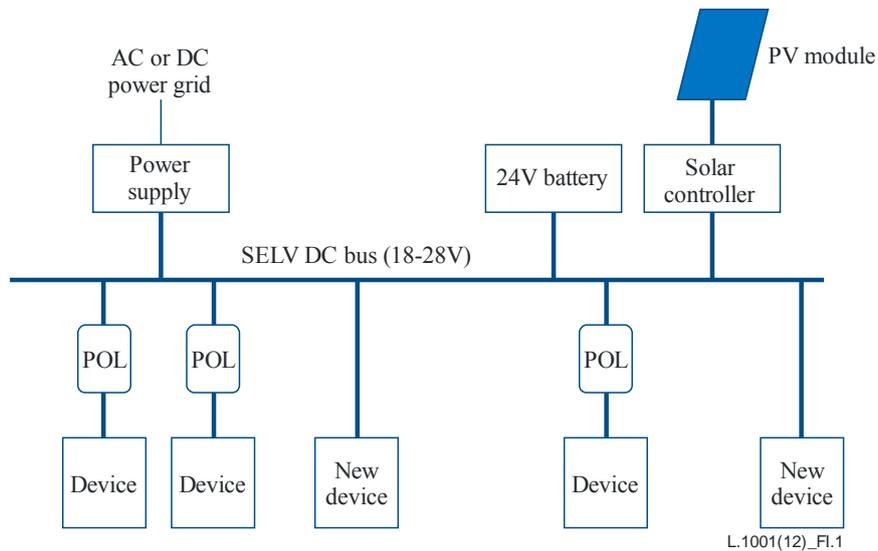
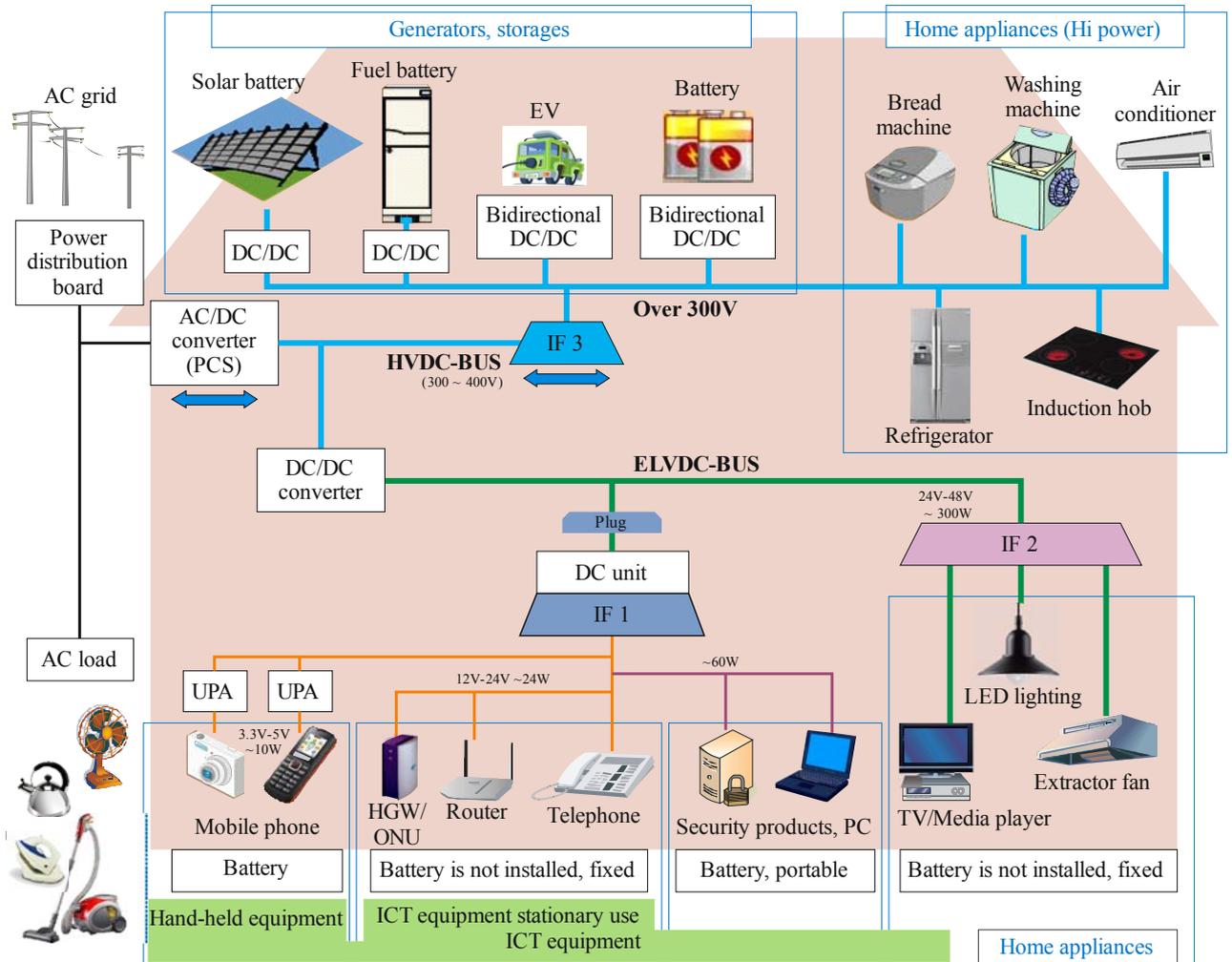


Figure I.1 – Example of 18-28 V DC network for solar PV + battery system + AC or DC power supply

I.2 Greengrid@home DC distribution architecture

The home DC distribution system shown in Figure I.2 is discussed in the Green Grid Platform at Home Alliance, a voluntary organization in Japan (<http://ggpah.org/>).



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PCS: Power conditioning system
 HVDC: High voltage DC
 ELVDC: Extra low voltage DC
 UPA: Universal power adapter
 IF: Interface

Figure I.2 – Home DC distribution system

I.3 SELV DC home power network with regulation

The architecture shown in Figure I.3 is slightly different from those in Figures I.1 or I.2 because it may include a regulation of output voltage on the SELV distribution. The SELV distribution can be partly star or bus and can include DC/DC and DC/AC to power existing devices with a voltage input outside the main voltage range of the distribution.

A primary SELV DC bus can also be seen on the source and storage input side, but the energy sources and storage are out of the scope of this Recommendation.

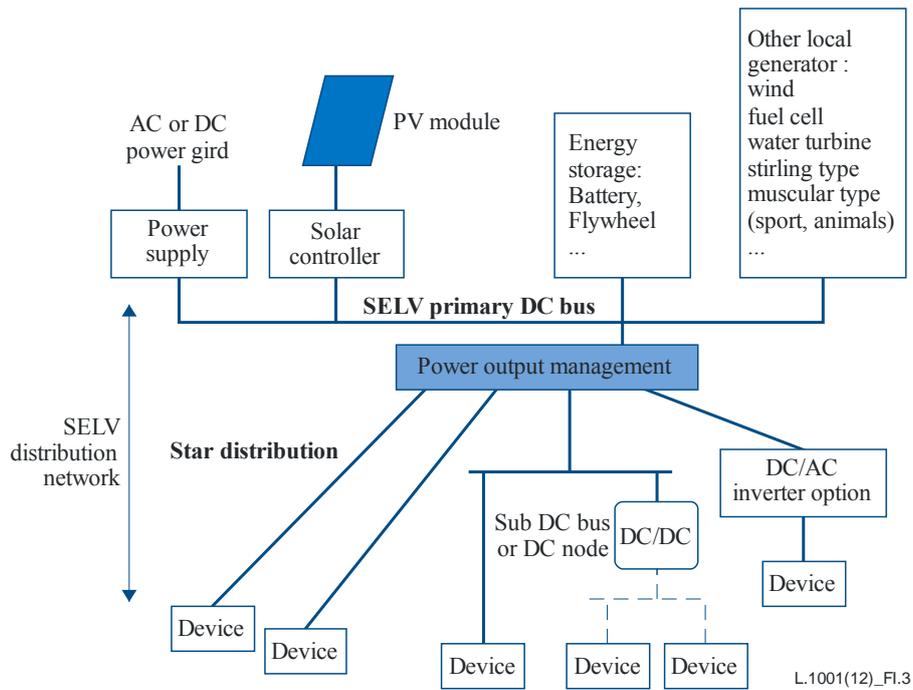


Figure I.3 – Home DC distribution system

I.4 Historical review

A universal power and telecom interface (UPTI) based on low 12 V SELV DC was introduced in the IEEE Intelec 1999 conference by France Telecom and Alcatel in consideration of the enormous increase of the number of low power fixed, portable and mobile devices used everywhere.

Appendix II

Efficiency trend in some regions

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

II.1 Japan

The following table gives the assessment scale of the Japanese ecology guidelines for the ICT industry in Japan. All the external power supplies should comply with the five stars by 2012. This assessment scale will be revised at the end of 2012.

Figure of merit: Average conversion efficiency $\eta = (\eta_{25} + \eta_{50} + \eta_{75} + \eta_{100})/4$ (II.1)

Po = Nameplate output power (W).

| Assessment scale | Rate of reduction vs power consumption at NR | Average conversion efficiency η (defined in formula II.1) |
|------------------|--|--|
| ★★★★★ | $n \geq 30\%$ | $\eta \geq 70.7 + 5.00 \cdot \ln(Po)$ |
| ★★★★ | $20\% \leq n < 30\%$ | $67.7 + 5.46 \cdot \ln(Pno) \leq \eta < 70.7 + 5.00 \cdot \ln(Po)$ |
| ★★★ | $10\% \leq n < 20\%$ | $64.8 + 5.88 \cdot \ln(Pno) \leq \eta < 67.7 + 5.46 \cdot \ln(Po)$ |
| ★★(Includes NR) | $0\% \leq n < 10\%$ | $62.2 + 6.26 \cdot \ln(Pno) \leq \eta < 64.8 + 5.88 \cdot \ln(Po)$ |
| ★ | (Normative reference not achieved) | $\eta < 62.2 + 6.26 \cdot \ln(Po)$ |

II.2 Europe

Article 6 of the European Commission Regulation (EC) 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:

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

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:

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

$$\text{and } \eta = 89\% \text{ for } Po > 10.0 \text{ W}$$

II.3 China

- 1) For single voltage external AC-DC and AC-AC power supplies. At present the implemented and published standard is GB 20943-2007 (Minimum allowable values of energy efficiency and evaluating values of energy conservation for single voltage external AC-DC and AC-AC power supplies) in China. But revision work to the standard began in 2011. The minimum allowable and evaluating values of average efficiency and no-load power will be improved. A comparison between GB 20943-2007 and GB 20943-201x of the revision draft follows:

- Minimum allowable values of average efficiency:

| Draft of 201x edition | | 2007 edition | |
|---------------------------|-----------------------------------|---------------------------|------------------------------------|
| Output rated power (Po) W | Minimum average efficiency | Output rated power (Po) W | Minimum average efficiency |
| $0 < P_o < 1$ | $\geq 0.5 \times P_o$ | $0 < P_o < 1$ | $\geq 0.39 \times P_o$ |
| $1 \leq P_o \leq 51$ | $\geq 0.09 \times \ln P_o + 0.55$ | $1 \leq P_o < 49$ | $\geq 0.107 \times \ln P_o + 0.39$ |
| $51 < P_o \leq 250$ | ≥ 0.85 | $49 \leq P_o \leq 250$ | ≥ 0.82 |

- Maximum allowable values of no-load power:

| Draft of 201x edition | | 2007 edition | |
|---------------------------|-------------------------------------|---------------------------|-------------------------------------|
| Output rated power (Po) W | Maximum active power with no load W | Output rated power (Po) 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 |

- Evaluation of average efficiency values

| Draft of 201x edition | | | 2007 edition | |
|---------------------------|--------------------|--------------------------------------|---------------------------|-----------------------------------|
| Output rated power (Po) W | Product type | Minimum average efficiency | Output rated power (Po) W | Minimum average efficiency |
| $0 < P_o \leq 1$ | Standard Models | $\geq 0.480 \times P_o + 0.140$ | $0 < P_o < 1$ | $\geq 0.49 \times P_o$ |
| | Low-voltage models | $\geq 0.497 \times P_o + 0.067$ | | |
| $1 < P_o \leq 49$ | Standard models | $\geq 0.0626 \times \ln P_o + 0.622$ | $1 \leq P_o < 49$ | $\geq 0.09 \times \ln P_o + 0.49$ |
| | Low-voltage models | $\geq 0.0750 \times \ln P_o + 0.561$ | | |
| $49 < P_o \leq 250$ | Standard Models | ≥ 0.870 | $49 \leq P_o \leq 250$ | ≥ 0.84 |
| | Low-voltage models | ≥ 0.860 | | |

- Evaluating values of no-load power

| Draft of 201x edition | | 2007 edition | |
|---------------------------|-------------------------------------|---------------------------|-------------------------------------|
| Output rated power (Po) W | Maximum active power with no load W | Output rated power (Po) W | Maximum active power with no load W |
| 0 < Po ≤ 10 | AC-AC:0.5 | 0 < Po ≤ 10 | 0.5 |
| | AC-DC:0.3 | | |
| 10 < Po ≤ 250 | 0.5 | 10 < Po ≤ 250 | 0.75 |

2) The power adapter of mobile telecommunication terminals have to be compliant with YD/T 1591, the adapter for output rated voltage is 5V 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

Environmental tests required for maintaining safety over the whole lifetime of the UPA

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

This appendix gives an example of Japanese environmental tests needed for maintaining safety of the UPA throughout its lifetime, i.e., from manufacturing to transportation, storage and malfunction.

III.1 Basic test

Table III.1 lists the environment test items, test procedures, severity and criteria.

Table III.1 – Environmental tests

| Item | Test procedure | Severity | Criteria |
|---------------------------------|--|---|--|
| Heat and humidity cycle | [IEC 60068-2-38] Basic environmental testing procedures, Part 2-38: Tests – Test Z/AD: Composite temperature/humidity cyclic test | [IEC 60068-2-38] Figure 2a 24-h cycle with low-temperature sub-cycle | After 3 cycles and 10 cycles. AC adapter should not catch fire, emit smoke, exhibit distortion or discolouring, should maintain isolation or stop during fault, and should satisfy its performance. |
| Keeping and transport tolerance | [b-IEC 60068-2-30] Basic environmental testing procedures, Part 2-30: Tests – Test Db: Damp heat, Cyclic (12 + 12 hour cycle) Test procedure (2) | [b-IEC 60068-2-30] 4.2-(2) Ambient Temp. 55°C, 6 cycles | After test. AC adapter should not catch fire, emit smoke, exhibit distortion or discolouring, and should maintain isolation, or stop during fault, and should satisfy its performance. |
| Heat shock | [b-IEC 60068-2-14] Environmental testing, Part 2-14: Tests – Test N: Change of temperature | Storage Temp. maximum and minimum 5 cycles (storage Temp. maximum and minimum) | After test. AC adapter should not catch fire, emit smoke, exhibit distortion or discolouring, and should maintain isolation or stop during fault. It is recommended to satisfy its performance. |
| Hydrogen sulphide test | [b-IEC60068-2-43] Basic environmental testing procedures, Part 2-43: Tests – Test Kd: Hydrogen sulphide test for contacts and connections | Concentration: from 10 to 15 ppm Testperiod: 21 days | After test. AC adapter should not catch fire, emit smoke, exhibit distortion or discolouring, and should maintain isolation or stop during fault. It is recommended to satisfy its performance. |

Table III.1 – Environmental tests

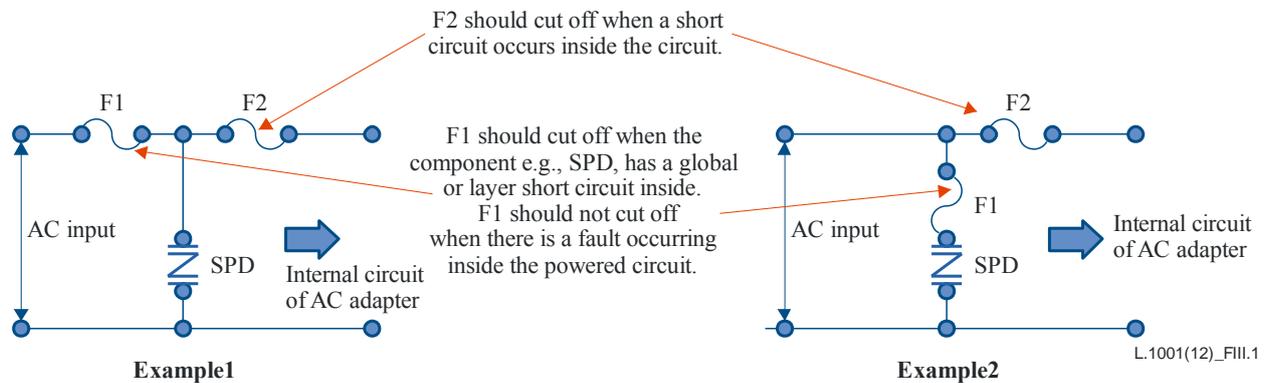
| Item | Test procedure | Severity | Criteria |
|-----------------------------------|---|--|---|
| High temp. and humidity bias test | [b-IEC60068-2-78] Environmental testing, Part 2-78: Test Cab: Damp heat, steady state | +40°C ±2°C, 93% ± 3%RH No condensation, rated power, 10 days | After test. AC adapter should not catch fire, emit smoke, exhibit distortion or discolouring, and should maintain isolation, or stop during fault. It is recommended to satisfy its performance. |
| Saltmist test | [b-IEC60068-2-52] Environmental testing, Part 2-52: Tests – Test Kb: Salt mist, cyclic (sodium chloride solution) | Temperature: 23°C±2°C, humidity from 45% to 55%RH Water with salt: 5% ± 1%, ph: 6.5~7.2, 2 h +22 h, 3 cycles | After 3 cycles and 120 h. AC adapter should not catch fire, emit smoke, exhibit distortion or discolouring, and should maintain isolation, or stop during fault. It is recommended to satisfy its performance. |
| Water resistance | AC adapter is squirt water | Volume of water: 180 cc with 1% salt Height of squirt: 30 cm in vertical direction | After test, enclosure is wiped with cloth. After 10 min, 30 min, 2 days, and 3 weeks, AC adapter should not catch fire, emit smoke, exhibit distortion or discolouring, and should maintain isolation, or stop during fault. It is recommended to satisfy its performance. |
| Free fall (packaging) | [b-ISO 4180] Packaging freight to satisfy its performance | Level2 (60 cm, 10 times) | Safety function of AC adapter should operate after test. AC adapter should satisfy its performance. |
| Vibration (packaging) | [b-ISO 4180] Packaging freight to satisfy its performance | Acceleration: ±0.75 G Frequency: 5~50 Hz Test time: 60 min | After test. AC adapter should not catch fire, emit smoke, exhibit distortion or discolouring, and should maintain isolation or stop during fault. It should satisfy its performance. |
| Surface temperature of enclosure | AC adapter is operating under rated power with blanket | AC adapter is operating under rated power with blanket and maintain heat balance. | Surface temperature of enclosure should not exceed 95°C under normal and abnormal conditions. If surface temperature exceeds 95°C, AC adapter should stop and should not catch fire, emit smoke, or exhibit distortion or discolouring. |

III.2 Additional information on IEC60950 application to this Recommendation

The DC interface is considered as an SELV interface.

The components that exhibit short mode and partial short mode faults, e.g., FET and varistor, may cause fire and smoke.

Clause 2.7.3 of [IEC 60950-1] describes the selection of current fuses for protection against short circuit current in the distribution circuit and excessive current in the load circuit. Figure III.1 shows how to select the appropriate fuse.



SPD : Surge protective device

Figure III.1 – Example for mounting a current fuse for a protection layer short circuit

NOTE – Some countries requires more safety items than in [IEC60950-1], e.g., by referring to UL1950, CSA 22.2 Nr950, CB certification, PSE (Japanese). An example is given for the materials for enclosure and electrical tracking.

The following table gives some more requirements on materials for enclosure and electrical plug tracking resistibility.

| Item | Requirement | Related standards |
|--|----------------------------------|------------------------------|
| Materials of enclosure | Flammability class V0 | UL |
| Electrical plug tracking resistibility | ***<CTI<*** or ***<PTI<*** | [IEC60950-1] [b-IEC60112] |

NOTE 1 – CTI or PTI should be set by considering the input voltage used in each country because the required CTI or PTI depends on the input voltage of the UPA.

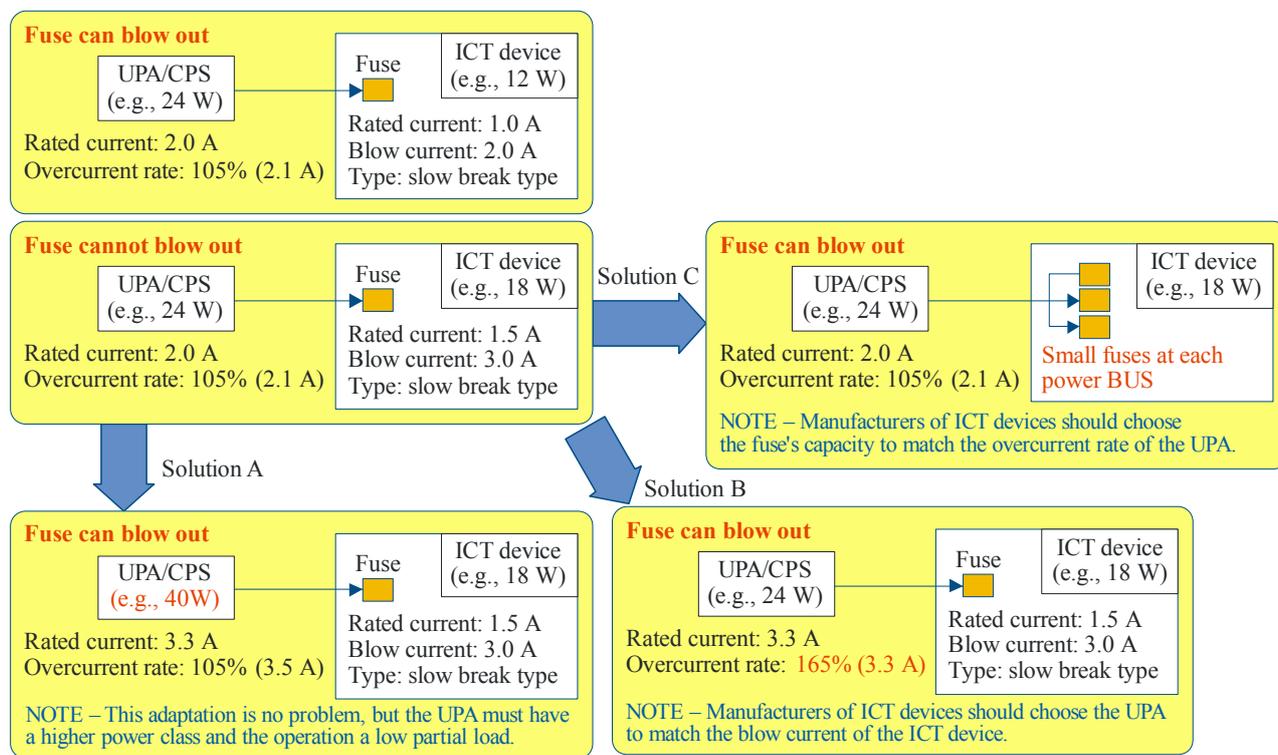
NOTE 2 – The insulation coordination is described in [b-IEC 60664-1] and the common protection against electric shock in [b-IEC 61140]

Appendix IV

Example of dimensioning effect on fuse coordination

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

This appendix gives an example of the relationship between the overcurrent rate of the UPA and the blow current of a fuse in ICT devices.



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NOTE – In a general setting for fuses in electrical circuit design of ICT devices like telecommunication equipment in premises, derating is set to around $\frac{1}{2}$ the blow out current because of temperature drift and reliability.

Figure IV.1 – UPA overcurrent rate and fuse coordination

Appendix V

Configurations of UPA solutions equipped with detachable cables

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

Configurations of UPA solutions equipped with detachable cables for stationary use that differ from the basic configuration are possible, but further study is required; in particular, on a universal connector on UPA output. This appendix shows some of the configurations with detachable cables that can be used in transportation or in solar applications.

Configuration A: UPA with captive input cable and detachable output cable.

Configuration B: UPA with detachable input and output cables.

Configuration C: UPA solution through an output detachable cable from an SELV DC source such as a renewable energy power system (e.g., PV + battery) or DC socket with transportation means (car, bus, train, boat, plane, etc.). See Appendix I.

Configuration D: UPA with multiple outputs and detachable cable.

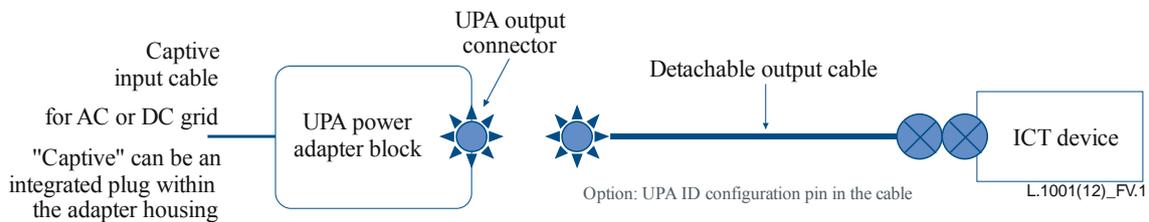


Figure V.1 – Configuration A – Captive input and detachable output cables

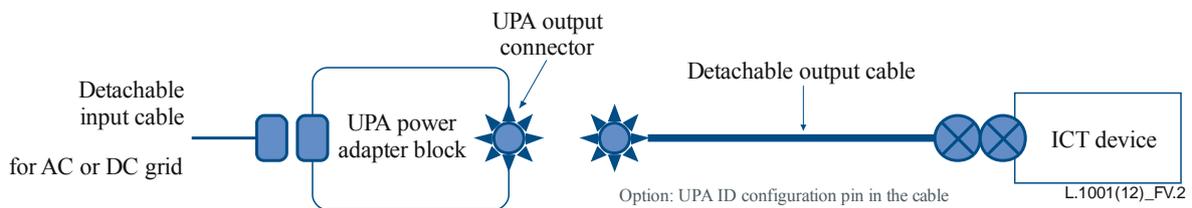


Figure V.2 – Configuration B – Detachable input and output cables

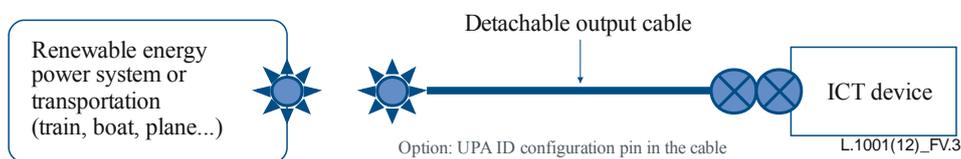


Figure V.3 – Configuration C – Output cable detachable from an SELV DC source

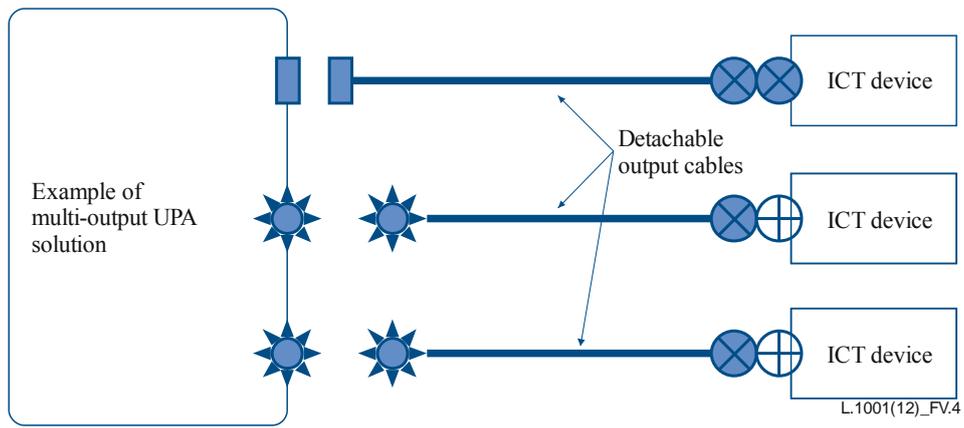


Figure V.4 – Configuration D – Multiple detachable output cables

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