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Technical Report

**Environmental Engineering (EE);
Safety Extra Low Voltage (SELV) DC power supply network for ICT devices with energy storage and grid or renewable energy sources options**

Reference
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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Environmental Engineering (EE).

Modal verbs terminology

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Introduction

With the massive development and convergence of Telecom and IT, there are more and more customer Premises Equipment such as ICT devices terminals and home network. Each of them requires an electric adapter and an AC plug to be powered. That creates a forest of cables and energy losses, so the need of mutualising power at the level of a room with a SELV DC network has appeared with the benefit of reducing the amount of adapters and plugs, reducing by the way quantity of material used (plastic, copper, electronic) and thus reducing electronic wastes.

In addition this will allow simpler reuse of the output of this common power supply for new ICT devices by using the universal power adapters for fixed devices as standardized by ETSI and recommended by ITU-T. There would also be a significant saving on power consumption from a better efficiency on a wide range of power and reduced no load power losses.

For each of USB-A charger avoided by connecting a USB-A detachable charging cable to the DC network, it has been roughly assessed for 1 Billion units, a potential saving of 100 000 tons of power supply material, and 2 TWh consumption, 1 million tons of CO_2 emission each year.

Other benefits are offered to users in the zone or room where the SELV DC networks operate such as autonomy by the battery and grid energy cost reduction by using renewable energy sources, PV being the easiest to install having a very long lifetime.

Moreover, it is an enabler and extender of telecom service use in emerging countries where there is no electricity grid and it brings at the same time some additional electricity for other use such as lighting with LEDs.

Finally, the SELV distribution is the natural extension in rooms of the Building 400 VDC distribution when it will be widely spread as it seems to be a useful complement to distribution AC to offer more resilience to disaster and improve efficiency and use of renewable energy at building level in smart cities and micro grids.

1 Scope

The present document specifies a Safety Extra Low Voltage DC power supply unit for powering at home or in public area (stores, hotels, railway stations, etc.) any ICT devices equipped with DC input or any ICT adapter with DC input compliant with EN 300 132-3-1 [i.17].

It gives information on:

- architecture with multi-outputs or DC network and powering area (room, zone);
- input and output voltage interface;
- configuration of interface voltage;
- optimization of efficiency and cost by mutualising several devices on the same DC power system;
- compatibility with future building using the up to 400 VDC power interface defined in EN 300 132-3-1 [i.17];
- integrated power shutdown management, to save energy as much as possible;
- reliability;
- EMC and resistibility;
- power autonomy to enable standalone power of ICT in case of crisis (electric grid failure, climatic crisis, earthquake, etc.);
- possibility to use renewable energy especially in emerging countries with no grid or of poor quality grid: which input interface, and how to make the sizing?
- possibility to power devices other than ICT such as low power light which highly increases life quality and sustainable development;
- some information on product safety;
- ecodesign principles with assessment of gains in mass of material use, energy and CO2 emission.

The present document also gives an overview of other existing standards in the field.

The detailed description of power generators and power converters or controllers are out of the scope.

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

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NOTE: While any hyperlinks included in this clause were valid at the time of publication ETSI cannot guarantee their long term validity.

2.1 Normative references

The following referenced documents are necessary for the application of the present document.

Not applicable.

2.2 Informative references

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] Recommendation ITU-T L.1000: "Universal power adapter and charger solution for mobile terminals and other hand-held ICT devices".

[i.2] Recommendation ITU-T L.1001: "External universal power adapter solutions for stationary information and communication technology devices".

[i.3] Recommendation ITU-T L.1002 "External universal power adapter solutions for portable information and communication technology devices".

[i.4] "Code of Conduct on Energy Efficiency of External Power Supplies": European Commission Directorate-General JRC Joint Research Centre Institute for Energy and Transport Renewable Energy Unit.

[i.5] ETSI EN 302 099: "Environmental Engineering (EE); Powering of equipment in access network".

[i.6] Recommendation ITU-T K.74: "EMC, resistibility and safety requirements for home network devices".

[i.7] IEC 61000-3-2: "Electromagnetic compatibility (EMC) -Part 3-2: Limits -Limits for harmonic current emissions (equipment input current less than or equal to 16 A per phase)".

[i.8] IEC 60038: "IEC standard voltages".

[i.9] IEC 60950-1: "Information technology equipment - Safety - Part 1: General requirements".

[i.10] ETSI EN 300 132-2: "Environmental Engineering (EE); Power supply interface at the input to telecommunications and datacom (ICT) equipment; Part 2: Operated by -48 V direct current (dc)".

[i.11] IEC 60896 series: "Stationary lead-acid batteries".

[i.12] ETSI ES 202 336 (all parts): "Environmental Engineering (EE); Monitoring and control interface for infrastructure equipment (Power, Cooling and environment systems used in telecommunication networks)".

[i.13] IEC 60364-4-41: "Low-voltage electrical installations - Part 4-41: Protection for safety -Protection against electric shock".

[i.14] IEC 62430: "Environmentally conscious design for electrical and electronic products".

[i.15] ETSI TS 103 199: "Environmental Engineering [EE]; Life Cycle Assessment (LCA) of ICT equipment, networks and services; General methodology and common requirements".

[i.16] Recommendation ITU-T L.1410: "Environmental impact Assessment method for goods network and service".

[i.17] ETSI EN 300 132-3-1 (V2.1.1): "Environmental Engineering (EE); Power supply interface at the input to telecommunications and datacom (ICT) equipment; Part 3: Operated by rectified current source, alternating current source or direct current source up to 400 V; Sub-part 1: Direct current source up to 400 V".

[i.18] IEEE UPAMD™ P1823™: "Universal Power Adapter for Mobile Device".

[i.19] IEC TC 100: "Project P1683 of Technical Specification of "Universal charger for PC".

[i.20] Recommendation ITU-T K.66: "Protection of customer premises from overvoltages and overcurrents".

[i.21] ISO 11898-3: "Road vehicles -- Controller area network (CAN) -- Part 3: Low-speed, fault-tolerant, medium-dependent interface".

[i.22] Recommendation ITU-T K.21: "Resistibility of telecommunication equipment installed in customer premises to overvoltages and overcurrents".

[i.23] EU directive on charger efficiency and no load power Energy Star V2.

[i.24] Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal.

[i.25] IEC 60320-1: "Appliance couplers for household and similar general purposes - Part 1: General requirements".

[i.26] ISO 14040: "Environmental management -- Life cycle assessment -- Principles and framework".

[i.27] ISO 14044: "Environmental management -- Life cycle assessment -- Requirements and guidelines".

[i.28] "The first thousand optimized solar BTS stations of Orange group, A very positive experience full of learning", Didier Marquet Orange et alii., IEEE Intelec 2011 Amsterdam.

[i.29] "Spread of DC power in telecom/data centres and homes/offices with renewable energy and energy autonomy" Didier Marquet (Orange), Toshimitsu Tanaka (NTT-f), Kensuke Murai, Tanaka Toru, Tadatoshi Babasaki (NTT), IEEE/Intelec 2013 Hamburg.

[i.30] Darnel study, "External AC-DC Power Supplies: Economic Factors, Application Drivers, Architecture/Packaging Trends, Technology and Regulatory Developments", Tenth Edition, Feb 2011.

[i.31] GSMA 2010: "Green Power for Mobile", Bi-annual Report November 2010.

[i.32] ITU-D: "ICT 2011 development outlook".

[i.33] "New power supply optimiSed for new telecom networks and services Didier Marquet et alii, France Telecom CNET, Jean-Paul Gabillet et alii ALCATEL-CIT", IEEE Intelec 1999 Copenhagen.

[i.34] Recommendation ITU-T K.85: "Requirements for the mitigation of lightning effects on home networks installed in customer premises".

[i.35] IEC 62619: "Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for large format secondary lithium cells and batteries for use in industrial applications".

[i.36] Emerge Alliance®.

NOTE: Available at: http://www.emergealliance.org/.

[i.37] Green Grid Platform At Home voluntary organization in Japan.

NOTE: Available at http://ggpah.org/.

[i.38] GeSI-ITU-T Study 2012, An Energy-aware Survey on ICT Device Power Supplies.

NOTE: Available at http://www.itu.int/ITU-T/climatechange/report-ict-device.html.

[i.39] CENELEC EN 55022: "Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement".

[i.40] CENELEC EN 55024: "Information technology equipment - Immunity characteristics - Limits and methods of measurement".

3 Abbreviations and symbols

3.1 Symbols

For the purposes of the present document, the following symbols apply:

I	current
Pu	Useful Power of the load
R	resistance
U	voltage

3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AC	Alternating Current
ASCII	American Standard Code for Information Interchange
CAN	Controller Area Network
CMOS	Complementary Metal Oxyde Semiconductor
CPE	Customer Premises Equipment
CPS	Common Power Supply
DC	Direct Current
DIN	Deutsches Institut für Normung
GGPAH	Green Grid Platform At Home
GHG	Green House Gas
HF	High Frequency
ICT	Information and communications technology
LCA	Life Cycle Assessment
MPPT	Maximum Power Point Tracker
MTBF	Mean Time Between Failure
NTT	Nippon Telegraph and Telecom
PC	Personal computer
PoE	Power over Ethernet
PSU	Power Supply Unit
PV	PhotoVoltaïc
PWM	Pulse-width modulation
RH	Relative Humidity
SCCP	Short Chain Chlorinated Paraffins
SELV	Safety Extra Low Voltage
UCPS	Universal Common Power Supply
UPA	Universal Power Adapter.
UPAMD™	Universal Power Adapter for Mobile Devices
VAC	Volt in Alternating Current
VDC	Volt in Direct Current
XML	eXtended Mark-up Language

4 General architecture of a CPE SELV DC network

Many studies are showing the extension of the use of ICT terminals in Customer Premises all over the world. For example the ITU-D outlook [i.32] is showing that Telecom network and terminals are developing in Emerging countries faster than the electric grid.

For the mobile network a GSMA study [i.31] and for example an IEEE/intelec 2011 paper [i.28] have shown that the massive deployment would be more based on renewable energy and single legacy Diesel generator could be replaced by hybrid power system. As a consequence of this fast Telecom network development, there is an increased need of electricity in customer premises, that can bring at the same time more comfort and social benefit, such as low power consumption lighting for emerging countries. The universal adapter solution already promoted for powering ICT devices Recommendation ITU-T L.1000 [i.1], Recommendation ITU-T L.1001 [i.2] or Recommendation ITU-T L.1002 [i.3] ensures the compatibility with renewable energy systems such as those based on PV modules, either small system in SELV voltage and these Recommendations introduce compliance of the chargers with EN 300 132-3-1 [i.17] at building level. IEEE/intelec paper 2013 [i.29] is showing a possible start of wide spread of these solutions.

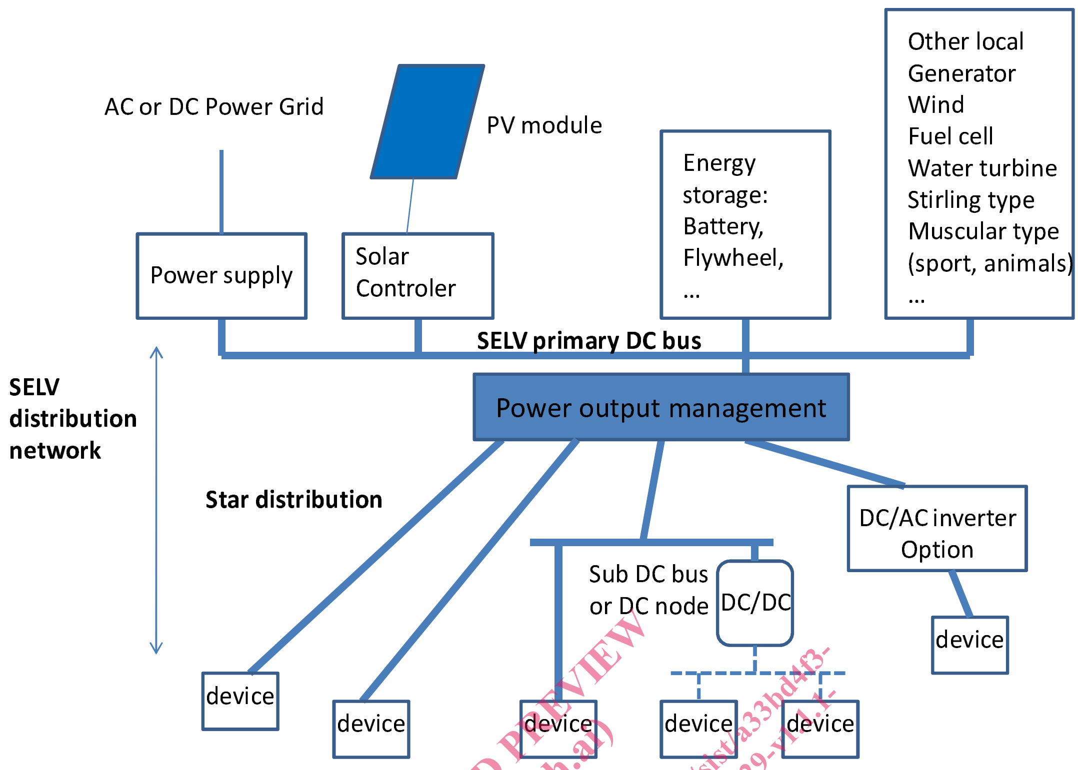
As in many homes there is not only one terminal but several, and because there is a need of shared charging points for users (public or private), it appears that a DC network solution could be an optimized solution. It was already stated as already presumed in IEEE/Intelec 1999 paper [i.33].

Other solutions based on AC inverter using for example DC from solar PV module or battery allow the use of AC adapter but the efficiency and reliability is poor. Even if the up to 400 VDC interface is possible for complete swap of the distribution inside buildings but it seems there is also a space for a more optimized and progressive zone or room lower voltage DC network. The best solution for safety is a SELV voltage lower than 60 VDC in compliance to IEC 60364-4-41 [i.13]. The DC voltage level, would depend on the environment where it is used (e.g. dry or wet). For maximal safety, it seems better to keep this limit for wet area not at the maximum value of 120 VDC. 30 VDC limit is even better for human safety if there is a serious risk of water ingress.

Considering the increasing need of security and availability of ICT, this solution can also in developed countries. Japan has an initiative on that in greengrid@home [i.37]. There will be compatibility with up to 400 VDC network.

In addition, a SELV DC network mainly for telecom, health and safety ICT can bring at the same time a back-up possibility for more autonomy and less failure of sensible ICT devices while reducing the use of fossil energy resources and the CO2 emission and other environmental or human risks.

Figure 1 is presenting the general architecture of a home SELV DC grid able to power home CPE equipment. It can also be applied in other customer premises: small office, commercial or business building. Not all possible voltage converters are represented, refer to DC distribution network description list in this clause.



NOTE 1: This architecture can include also an optional reverse power feeding module connected to the DC distribution network compliant with EN 302 099 [i.5].

NOTE 2: DC/DC Converter on sub DC bus or DC nodes are called POL.

Figure 1: Architecture of a SELV DC power system and distribution grid solution in CPE

This architecture takes into account other studies and ongoing standardization:

- Darnel study on charger and power supply, [i.30]
- Emerge Alliance® 24 V distribution for lighting and ICT device in office or commercial building rooms [i-36]
- ITU-T SG5 L.1000 [i.1], L1001 [i.2], L.1002 [i.3]
- IEEE UPAMD™ P1823™ [i.18]
- IEC TC 100 P1683 [i.19] on universal interface for computers [i.19]
- SELV home power distribution in Japan Green Grid Platform At Home [i.37]

Refer to annex B for more details.

The power generating system includes:

- A primary SELV DC bus where are connected: energy storage, primary power supply using DC or AC grid, generators and output power distribution management system.
- A SELV DC distribution network feeding power to loads directly or through DC/DC and sub distribution.

NOTE 1: The input liaison of the controller to the external sources (grid, PV, wind generator, etc.) is out of the scope of this CPE primary distribution.

NOTE 2: The DC grid is compliant with EN 300 132-3-1 [i.17], and should be compliant with future standards for DC safety and DC plugs under definition by IEC.