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INTERNATIONAL STANDARD

NORME INTERNATIONALE

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Interoperability specifications and communication method for external power supplies used with computing and consumer electronics devices

Spécifications d'interopérabilité et méthode de communication pour les alimentations externes utilisées avec les dispositifs informatiques et les dispositifs électroniques grand public

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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INTEROPERABILITY SPECIFICATIONS AND COMMUNICATION METHOD FOR EXTERNAL POWER SUPPLIES USED WITH COMPUTING AND CONSUMER ELECTRONICS DEVICES

FOREWORD

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This document has been prepared by technical area 18: Multimedia home systems and applications for end-user networks, of IEC technical committee 100: Audio, video and multimedia systems and equipment. It is an International Standard.

This second edition cancels and replaces the first edition published in 2016. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) title is changed from *Identification and communication interoperability method for external power supplies used with portable computing devices*;
b) Clause 4, *EPS interoperability based on USB technologies*, is added;
c) Clause 5, *EPS specification*, adds hardware and protection requirements; overvoltage protection is changed from optional to normative;

d) Annex B and Annex C are added, providing an explanation of the design features in USB Power Delivery that enhance reliability and an explanation of the concepts of charge rate and power.

The text of this International Standard is based on the following documents:

CDV	Report on voting
100/3463/CDV	100/3540B/RVC

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

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- replaced by a revised edition, or
- amended.

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INTRODUCTION

The objective of this document is to enable common charging interoperability of external power supplies (EPSs) used with the increasing variety of computing and consumer electronics devices that implement IEC 62680-1-3 (USB Type-C®[1] Cable and Connector Specification) and IEC 62680-1-2 (USB Power Delivery). Broad market adoption of this document is expected to make a significant contribution to the global goals of consumer convenience and re-usability of power supplies by expanding common charging interoperability across different product categories while preserving backwards compatibility with the installed base of billions of IEC 62680 compliant devices worldwide.

This document specifies the minimum technical requirements for interoperability and includes recommendations for EPS functionality when used with computing and electronics devices. The approach taken by this document, focused on enabling common charging interoperability, can allow manufacturers to innovate in aspects such as technical design, system performance, and energy efficiency. Furthermore, common charging interoperability enables manufacturers to design specific EPSs that match the requirements of target devices (functionality, cost, etc.) and use cases, while at the same time enabling consumers to use the EPS for charging other IEC 62680 compliant devices, across various product types.

IEC 62680-1-3 adoption is well underway in global markets for a wide range of devices using as much as 100 W, including notebook computers, tablets, smartphones, small form-factor desktop computers, and other consumer electronics devices. This document enables the reporting of the identity and power characteristics of power sources (EPSs and other Sources) supported by IEC 62680-1-3 (USB Type-C) and specifies interoperability guidelines when using IEC 62680-1-2 (USB Power Delivery). The method for identification of a specific power source can enable equipment manufacturers to ensure compliant operation using these specifications and promotes data communication that can be used by the device to predict and mitigate interoperability concerns when an unfamiliar or incompatible EPS is connected to the device. EPS power delivery applications can in the future extend beyond 100 W given updates to IEC 62680 that appropriately address the needs of higher-power products in the computing and consumer device market.

This document also provides important information regarding consumer safety, system reliability as well as relevant global standards and regulatory compliance.

Other international and regional standards, and government policies for "universal" or "common power adapters" that reference this document are expected to take into account open technical and regulatory compliance issues that are associated with untested or arbitrary combinations of EPSs and devices such as those identified in Annex A, as well as the limitations and issues with approaches to define "common chargers" in meeting market needs. For clarity, this document focuses on interoperability specifications in order to support global industry in developing safe, convenient, environmentally conscious, and end-to-end interoperable charging solutions that meet regulatory compliance and market requirements.

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[1] USB4™ and USB Type-C® are trademarks of the Universal Serial Bus Implementers Forum (USB-IF). This information is given for the convenience of users of this document and does not constitute an endorsement by IEC.

INTEROPERABILITY SPECIFICATIONS AND COMMUNICATION METHOD FOR EXTERNAL POWER SUPPLIES USED WITH COMPUTING AND CONSUMER ELECTRONICS DEVICES

1 Scope

This document defines common charging interoperability guidelines for power sources (external power supplies (EPSs) and other Sources) used with computing and consumer electronics devices that implement IEC 62680-1-3 (USB Type-C Cable and Connector Specification).

This document defines normative requirements for an EPS to ensure interoperability; in particular, it specifies the data communicated from a power source to a device (Figure 1) and certain safety elements of the EPS, cable, and device. While the requirements focus of this document is on the EPS and the behaviour at its USB Type-C connector interface, it is also important to comprehend cable assembly and device capabilities and behaviours in order to assure end-to-end charging interoperability. This document does not apply to all design aspects of an EPS. This document does not specify regulatory compliance requirements for aspects such as product safety, EMC or energy efficiency.

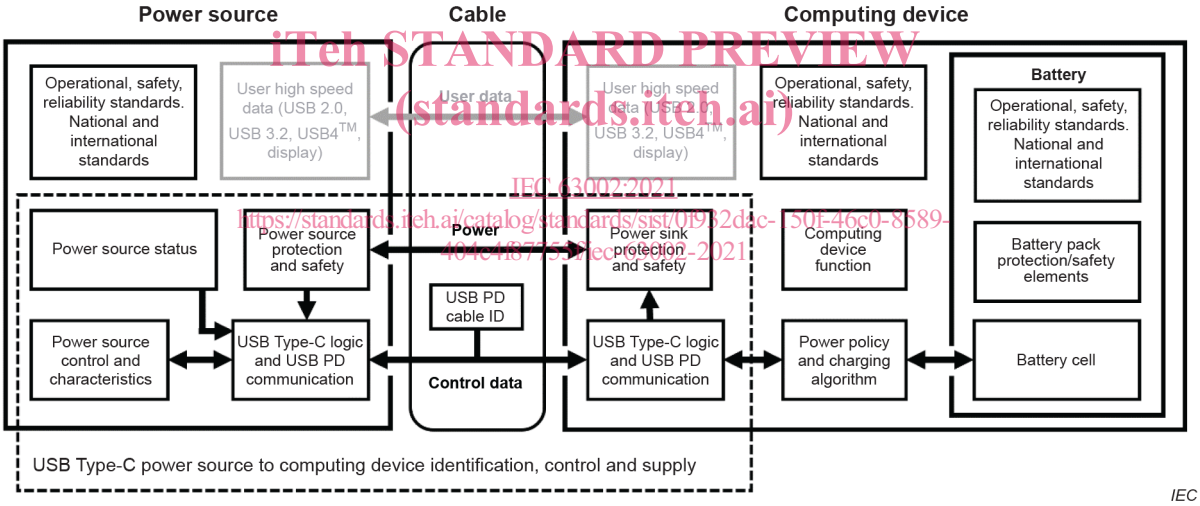

Figure 1 – Scope of the identification, communication and control method

This document provides recommendations for the behaviour of a device when used with a power source compliant with this document. It specifies the minimum hardware specification for an EPS implementing IEC 62680-1-3. This document also specifies the data objects used by a charging system utilizing IEC 62680-1-2 to understand the identity, design and performance characteristics, and operating status of an external power supply. IEC 62680-1-2 focuses on power delivery applications ranging to 100 W for a variety of computing and consumer electronics devices including notebook computers, tablets, smartphones, small form-factor desktops, monitor displays and other related multimedia devices.

This document relies on established mechanical and electrical specifications, and communication protocols specified by IEC 62680-1-2 and IEC 62680-1-3. These specifications support methods for establishing the best performing interoperability between untested combinations of EPS and devices with the aim of improving consumer satisfaction.

Information describing the USB charging interoperability model, overview of USB Type-C and USB Power Delivery specifications, and factors for charging performance are also provided to support implementation of this document.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60950-1, *Information technology equipment – Safety – Part 1: General requirements*

IEC 60990, *Methods of measurement of touch current and protective conductor current*

IEC 62368-1:2018, *Audio/video, information and communication technology equipment – Part 1: Safety requirements*

IEC 62680-1-1, *Universal Serial Bus interfaces for data and power – Part 1-1: Common components – USB Battery Charging Specification, Revision 1.2*

IEC 62680-1-2:2021, *Universal Serial Bus interfaces for data and power – Part 1-2: Common components – USB Power Delivery specification*

IEC 62680-1-3, *Universal Serial Bus interfaces for data and power – Part 1-3: Common components – USB Type-C Cable and Connector Specification*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1.1
vendor identification
VID
unique 16-bit unsigned value assigned by the USB-IF to a given vendor

3.1.2
power source
power supply
Source
device designed to comply with IEC 62680-1-2 that supplies power over V_{BUS}

EXAMPLE A USB connector on a PC, laptop computer, vehicle, AC outlet, docking station, battery pack, or EPS.

3.1.3
Sink
power sink
device designed to comply with IEC 62680-1-2 that receives and consumes power over V_{BUS}

EXAMPLE A computing device.

Note 1 to entry: Sometimes referred to as the device.

3.1.4
external power supply
EPS
power source contained in a separate physical enclosure external to the device casing and designed to convert mains power supply to lower DC voltage(s) for the purpose of powering the device

EXAMPLE A charging block.

3.1.5
Programmable Power Supply
PPS
optional capability in IEC 62680-1-2 where a device (Sink) can adaptively adjust the EPS (Source) output voltage in small increments and set maximum current within its advertised range

3.1.6
Fixed Supply
power source whose output voltage is regulated

Note 1 to entry: Standardized voltages in IEC 62680-1-2:2021 are 5 V, 9 V, 15 V and 20 V.

3.1.7
USB PD power
PDP
nominal power capacity of the charger defined by IEC 62680-1-2 for use to indicate to consumers

Note 1 to entry: The PDP rating is indicated both on the USB charger certification logo and within the USB PD source capabilities advertisement to the Sink. For any given PDP rating, the minimum capabilities in terms of supported voltages and currents are deterministic, as defined in IEC 62680-1-2.

3.1.8
charging cable
cable used between the EPS and device to be charged

Note 1 to entry: The cable connection to the EPS is a USB Type-C plug in accordance with IEC 62680-1-3. The cable connection to the device can be either a USB Type-C plug, a legacy USB plug (e.g. USB Micro-B in accordance with IEC 62680-2-2), or a non-USB device-specific connection (either permanent or detachable). Charging cables can be application-specific to enable interoperability between the USB Type-C-based EPS defined by this document and both existing and future devices and including devices that are not able to accommodate USB Type-C receptacles, e.g. smart watches.

3.1.9
captive cable
permanently attached cable
cable that has a USB Type-C plug on one end and is either hard-wired into a device on the other end or has a device-specific plug on the other end

Note 1 to entry: When a device-specific plug is used on one end, the cable can be detachable in a physical sense but is considered "functionally captive" to the device given it does not use a USB-defined connector on the device end but otherwise functions as a USB device. This definition has remained the USB definition since it was originally specified in IEC 62680-2-1 (USB 2.0).

3.2 Abbreviated terms

AC alternating current
CC configuration channel
CRC cyclic redundancy check
DC direct current
EMC electromagnetic compatibility
EMI electromagnetic interference
EPS external power supply
IoC contracted operating current
LPS limited power source
OEM original equipment manufacturer
OVP overvoltage protection
PDO power data object
PFC power factor correction
PDP USB PD Power
PID product identification
PPS Programmable Power Supply
VAC volts alternating current
USB universal serial bus
USB PD universal serial bus power delivery
USB-IF Universal Serial Bus Implementers Forum
VID vendor identification

4 EPS interoperability based on USB technologies

4.1 Overview

Clause 4 describes the USB common charging interoperability model and provides a summary of the USB Type-C and USB Power Delivery technologies specified in IEC 62680-1-3 and IEC 62680-1-2, respectively.

4.2 General

Since its introduction over 20 years ago, USB charging technology has consistently provided 5 V DC power and relied on a common USB Standard-A connector on the power source. When used with defined legacy cables and adapters, USB Type-C-based power sources, including those that source higher voltages, remain electrically and mechanically interoperable with previous generation USB devices, while enabling new capabilities for devices that have evolved to align with these new capabilities.

Figure 2 illustrates the USB EPS charging application model consisting of the EPS (Source) with a USB Type-C receptacle, the device to be charged (Sink) and the charging cable connecting the device to the EPS. This model also enables compatibility with devices that are based on legacy USB connectors, have a permanently attached cable, or use a cable that is device specific. Several usage examples demonstrating end-to-end charging interoperability based on this comprehensive model are presented in Annex D.

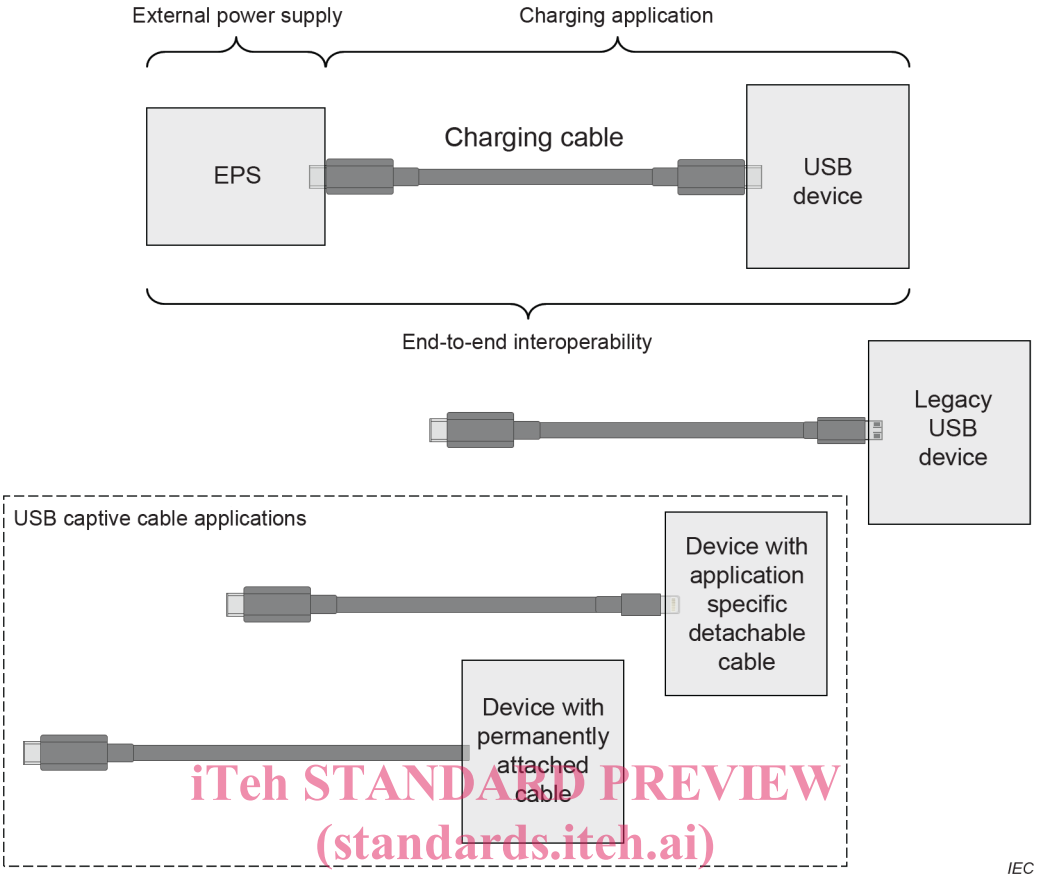

Figure 2 – USB EPS charging application model

In Figure 2, the last two devices illustrated align with the USB definition of a captive cable assembly – supporting these device usage configurations enables USB to support charging interoperability across a wider variety of applications that implement a non-USB standard receptacle or connector for any number of usage or design reasons but otherwise function as USB devices. Examples of these applications include a smartphone that has a non-USB receptacle and a USB power bank that incorporates a permanently attached cable for user convenience.

This charging model for USB Type-C is fundamentally the same as the previous generation USB charging model consisting of an EPS with a USB Standard-A receptacle which is the basis for charging interoperability specified in IEC 62684 [1][2]. This USB Standard-A EPS model will continue to be supported even with new devices which are based on USB Type-C receptacles since USB-defined transition cables and adapters are readily available to enable basic charging interoperability.

2 Numbers in square brackets refer to the Bibliography.

4.3 USB standard charging summary and interoperability

Table 1 summarizes the standard charging modes defined by USB specifications, including the applicable USB connectors for each of the defined power modes. While the USB Type-C connector is functionally compatible with all existing USB power options, the older USB Standard-A and USB Micro-B cannot support some advanced USB Type-C dedicated power modes – these power modes are indicated in the lower portion of the table. As read down the table rows, each subsequent power mode is required to support backward-compatibility with all of the power modes above it – in this way, USB-defined interoperability between newer power sources is readily assured with older power sinks given that an appropriate cable or adapter is used (as indicated in the Interoperability column and the table notes).

Table 1 – USB standard power modes and charging interoperability

IEC specification	Power mode	Applicable receptacle connectors	Voltage	Current	Interoperability
IEC 62680-2-1 [2] IEC 62680-2-2 [3] IEC 62680-2-3 [4]	USB 2.0[a]	USB Standard-A (Source) USB Micro-B[b] (Sink) USB Type-C (Source or Sink)	5 V	0,5 A	Forward compatibility supported using USB Standard-A to USB Type-C cables or USB Micro-B to USB Type-C adapters. Backward compatibility supported using USB Type-C to USB Micro-B cables.
IEC 62680-3-1 [5]	USB 3.0, USB 3.1, USB 3.2[a]	USB Standard-A (Source) USB Micro-B[b] (Sink) USB Type-C (Source or Sink)	5 V	0,9 A	
IEC 62684 [1]	USB BC 1.2	USB Standard-A (Source) USB Micro-B[c] (Sink) USB Type-C (Source or Sink)	5 V	Up to 1,5 A	
IEC 62680-1-3	USB Type-C Current at 1,5 A	USB Type-C (Source or Sink)	5 V	1,5 A	Functionally compatible with USB BC 1.2 compatible Sinks up to 1,5 A. Backward compatibility in BC 1.2 mode supported using USB Type-C to USB Micro-B cables.
IEC 62680-1-3	USB Type-C Current at 3,0 A	USB Type-C (Source or Sink)	5 V	3 A	Functionally compatible with USB BC 1.2 compatible Sinks up to 1,5 A Backward compatibility in BC 1.2 mode supported using USB Type-C to USB Micro-B cables.
IEC 62680-1-2	USB Power Delivery (USB PD)	USB Type-C (Source or Sink)	Configurable up to 20 V	Configurable up to 5 A[d]	USB4™ uses USB PD as its power mode.

[a] These specifications do not explicitly define charging support requirements. When USB data ports also support charging, the current capabilities of these ports are typically based on what is defined for a USB port operating in its high power configured state, i.e. 500 mA for USB 2.0.

[b] While less common, USB Standard-B and USB Mini-B are also applicable for a Sink.

[c] While less common, USB Micro-AB is also applicable for a Sink.

[d] Power transfer over 3 A requires use of an electronically marked 5 A cable if EPS is a detachable cable design.

Annex B provides further detail on the robustness and interoperability characteristics of USB Type-C and USB Power Delivery solutions.

4.4 USB Type-C® Current

The USB Type-C Current power mode is based on a regulated 5 V power source with up to 3 A operation. This power mode uses a simple analogue method over the USB Type-C Configuration Channel (CC) interface for a Source to advertise its available current to a Sink. A USB Type-C Source may advertise default USB Type-C Current (500 mA or 900 mA, based on the version of the USB port and cable), USB Type-C Current at 1,5 A or USB Type-C Current at 3 A. An EPS shall indicate USB BC 1.2 compatibility on the port such that a device (Sink) that doesn't recognize USB Type-C Current modes but is compatible with USB BC 1.2 can still draw 1,5 A.

4.5 USB Power Delivery (USB PD)

Power transfer at other than 5 V or over 3 A shall comply with IEC 62680-1-2 (USB Power Delivery). USB Power Delivery standardizes the discovery, configuration and functional operation of more capable USB Type-C power sources and battery chargers. The USB PD protocol, operating as a digital communication over the USB Type-C CC interface, enables a predictable, reliable user experience based on a common set of robust mechanisms and communication exchanges between the USB Source and the Sink. The comprehensive set of power delivery methods supported by the USB PD protocol enables a broad range of battery charging approaches and profiles that are specific to the design and operation of the device being charged (the Sink) – this enables device designs to evolve and innovate while the capabilities of a USB PD-based charger can remain a constant.

USB PD protocol is used to provide system control, error detection and handshaking. The four required steps for enabling power delivery are:

1) Source offers its capabilities.
2) Sink requests from the offered capabilities.
3) Source accepts the request.
4) Source indicates that it is ready to provide power.

USB PD protocol can also be used for reporting the status (overcurrent protection, overtemperature protection, overvoltage protection, etc.) of the Source.

The USB PD protocol specifies two principal modes of power transfer that can be implemented by a USB PD Source.

– Fixed Supply operation: Provides a set of selectable fixed voltage and current combinations. IEC 62680-1-2 defines voltages that include 5 V, 9 V, 15 V and 20 V. The Source can offer as much as 5 A, depending on the cable current rating and selected voltage.
– Programmable Power Supply (PPS) operation: Provides granular control of voltage or a maximum regulated source current limit. In PPS mode, the integrity of the connection is continually monitored and absence of a handshake message between Source or Sink forces the connection to lower safe power level. PPS places the burden of regulation in the Source instead of in the Sink, allowing the Sink to better manage thermal rise during higher power battery charging, which aids in lowering touch temperatures. Standard-defined voltage ranges for PPS PDOs are nominally aligned with the defined Fixed Supply PDOs (5 V, 9 V, 15 V and 20 V) with a range minimum of 3,3 V and maximum of 5,9 V, 11 V, 16 V and 21 V, respectively. The Source could offer as much as 5 A, depending on the cable current rating and selected voltage.