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**Access, Terminals, Transmission and Multiplexing (ATTM);
External Common Power Supply for Customer Premises Network and Access Equipment;
Part 7: Adaptive and multiple output power supplies based on USB Type C connector and USB PD support**

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Access, Terminals, Transmission and Multiplexing (ATTM).

Modal verbs terminology

In the present document "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

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Executive summary

The present document provides background information about USB Type C connector and USB PD 3.0 support referenced in Directive (EU) 2022/2380 [i.1], the successive version PD 3.1, and assist users to understand the specific characteristics of USB-C with PD support, and select suitable sources and chargers, for their equipment.

Introduction

Directive (EU) 2022/2380 [i.1] will apply for the European market from 28 December 2024 for portable devices with a USB-C® charging port. The Directive will apply for laptops from 28 April 2026.

With the introduction of the USB-C interface with USB Power Delivery (PD) function, USB-C becomes the standard for smartphone, tablet charging and connection.

The USB Power Delivery (PD) options are wide ranging, and the requirements to achieve full compatibility and to ensure safety for chargers and smartphones and tablets can be challenging with the maximum voltage, current and power.

The potential issue for using USB-A existing and older chargers, sources, with adapters or cables to Type-C sinks, is that a Type-C sink expects up to 3 A at 5 V (15 W), while USB-A existing and older chargers may provide for example only 1, or 21 A (5 or 10,5 W) or even less. 240 W will require suitable cables as USB-C to prevent overheating and/or failure of at least the charger. The complexity and high-power ability require technical advice and precautions to avoid overload, overheating, damage and burns.

NOTE: USB-C® and USB Type-C® are registered trademarks of the USB-IF.

1 Scope

The present document provides background information on the USB-C interface and associated USB Power Delivery functions, with a focus on technical aspects.

The present document intends to help users to understand the implications of USB PD on USB-C, to understand their behaviour, and to help to procure and deploy USB PD supporting systems, and prevent safety issues.

2 References

2.1 Normative references

Normative references are not applicable in the present document.

2.2 Informative 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.

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

The following referenced documents may be useful in implementing an ETSI deliverable or add to the reader's understanding, but are not required for conformance to the present document.

[i.1] Directive (EU) 2022/2380 of the European Parliament and of the Council of 23 November 2022 amending Directive 2014/53/EU on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment (Text with EEA relevance).

[i.2] EN IEC 62680-1-3:2021: "Universal serial bus interfaces for data and power - Part 1-3: Common components - USB Type-C® Cable and Connector Specification".

[i.3] USB-IF specification USB Type-C® with USB PD 3.0 support.

[i.4] USB-IF specification USB Type-C® with USB PD 3.1 support.

3 Definition of terms, symbols and abbreviations

3.1 Terms

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

multisource: source with multiple ports, e.g. multiport charger

sink: device consuming power across a USB-C® interface, where applicable with USB PD support

socket: USB Type-C® receptacle

source: device delivering power across a USB-C® interface, where applicable with USB PD support

type-C: USB Type-C® with USB PD 3.0 support (≤ 60 / 100 W)

type-C(3.1): USB Type-C® with USB PD 3.1 support (≤ 144 / 240 W)

3.2 Symbols

Void.

3.3 Abbreviations

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

PD	Power Delivery according to the USB PD set of specifications
PPS	Programmable Power Supply

NOTE: As included in the USB PD 3.1 specification **[**i.4**]**.

USB BC 1.2	USB Battery Charging 1.2
USB 3.x	USB-IF specifications regarding the signal transfer rate across USB interfaces
USB-IF	USB Implementers Forum

4 EU Regulation, and defining standards and specifications

4.1 European Directive 2022/2380

Directive (EU) 2022/2380 [i.1] requires compliance with EN IEC 62680-1-3:2021 [i.2], which is based on USB-IF specification USB Type-C® with USB PD 3.0 support [i.3].

4.2 Type-C characterisation

Type-C socket and connector:

The Type-C socket and connector are compact, rotation symmetry:

- with 2 x 10 contacts with respect to the familiar basic USB-A equivalent;
- less delicate than asymmetric USB-A micro, and open symmetric equivalents.

Type-C used for powering and charging equipment:

- Type-C meets 'fast charging' for smartphones and tablets, also allowing many other types of devices to be powered and/or charged; it also allows a multi-function adapter over a single Type-C to simultaneously charge, power and communicate e.g. connect a USB-A memory key.

Other use of Type-C:

- Inherits legacy USB applications, in an interim period requiring USB-A to Type-C converters and converter cables. Type-C's compact design and connector symmetry, and its enhanced capabilities according to USB 3.x, make it attractive as a de-facto external connection for applications including video and LAN signals.
- Adaptive and multiple output power supplies and powered devices based on USB Type C with USB PD support.

5 Challenges and precautions

5.1 Challenges and precautions when using Type-C sources and sinks

Type-C represents differences versus the USB-A. Type-C is more compact, and 40 times (with USB PD 3.1 96 times) more powerful, as illustrated in Table 5-1.

Table 5-1: USB, evolution of voltages, currents and power levels

Specification	Maximum voltage	Maximum current	Maximum power
USB 2.0	5 V	500 mA	2,5 W
USB 3.0 / 3.1	5 V	900 mA	4,5 W
USB BC 1.2	5 V	1,5 A	7,5 W
USB Type-C 1.2	5 V	3 A	15 W
USB PD 3.0	20 V	3 / 5 A	60 / 100 W (see note 1)
USB PD 3.1	48 V	3 / 5 A	144 / 240 W (see note 2)
NOTE 1: 100 W is possible with 5 A current, requiring special and coded cables. NOTE 2: 240 W is possible with 5 A current, requiring special and coded cables.			

USB-IF kept USB in the name of Type-C. The naming USB-C® and USB Type-C® may not sufficiently warn the users that Type-C is a different, more powerful and far more complex type of USB.

5.2 Precautions when using the Type-C specifications

a) Minimal 15 W (3 A at 5 V) reserved for each port (less is not negotiable), including 15 W (3 A at 5 V) for USB-A ports if provided.

b) Adding sinks changes the operating conditions, which may require re-negotiation (as far as possible) for already connected ports, and that may lead to:

   i) unexpected behaviour, including an interruption in power delivery;

   ii) lower performance when ports' power levels are (re-)negotiated down;

   iii) risk for overloading of the multisource.

5.3 The behaviour of multisource

For most multiport sources, e.g. a multiport charger, the behaviour when an additional sink is connected is not specified.

The connection of an additional sink changes the operating conditions, resulting in:

a) re-negotiation of the power provisioning parameters for at least some ports;

b) a short interruption of power on all ports may be expected to start the re-negotiations; this may affect devices without batteries that are powered by a multisource; examples could be network devices such as LAN and USB hubs;

c) the re-negotiations are device dependent and may have other unexpected consequences: adding an additional sink, even a sink with a low power requirement, may lead to previously connected sinks to be provided less or no power, and this may be dependent on the order of the ports;

d) the precise behaviour of a multiport source may not be documented in the specifications; however, it is possible to observe, learn and document the behaviour, including the ordering of the ports in re-negotiations, by 'trial and error'.

Annex A:
How to select a Type-C source (charger)

1) Check on the sink(s) to be charged or powered for the required combination(s) of V / A / W.

2) Choose by preference a charger from a reliable source, with CE marking, with clear references to USB PD, PPS, etc., even better with Type-C certification and labelling.

3) Choose a charger:

   a) Single port charger: at least of 15 W, by preference of 15, 27, 45 of 60 W, as these can deliver the maximum 3 A current at each voltage supported (see Table A-1).

   b) For multiport chargers: at least of 15 W for every port (including USB-A ports if provided), and preferably a total maximum power equal to the aggregate maximum power of all ports.

Table A-1: Preferred Type-C source (charger) power levels for single port charger

Power	5 V	9 V	15 V	20 V
15 W	3 A	–	-	-
27 W	3 A	3 A	-	-
45 W	3 A	3 A	3 A	-
60 W	3 A	3 A	3 A	3 A

Annex B:
Usage of USB-C and USB-A

Power:

1) No longer with a maximum power of 7,5 W, now with a power of up to 100 or 240 W (the power of a 'slow cooker'), there is an increasing risk of burns, burning and fire.

USB-A to USB-C:

2) To charge a smartphone or tablet, a charger with USB-A with a maximum current of 3 A (or higher), with a cable USB-A to USB-C, is recommended and has a positive impact on the lifetime of the batteries.

3) For USB-A chargers with a maximum current of less than 3 A, ensure the maximum current requested by the sink, the device to be charged, stays below that of the charger (see Annex C).

Multisource chargers / power supplies:

4) It is recommended to use with devices without batteries, such as LAN and USB hubs, either a dedicated source, or, in case of powered by a multisource, a semi-static configuration of the latter.

5) For most multiport sources, e.g. a multiport charger, the behaviour when an additional sink is connected is not specified or documented; however, it is possible to observe, learn and document the behaviour, including the ordering of the ports in re-negotiations, by 'trial and error'.

Annex C:
USB-C with USB PD (re-)negotiation mechanism issues

USB PD is using for the negotiation and establishment of the power parameters to be used a variant of the basic negotiation: **multiple offer > accept one or reject.**

This (re-)negotiation takes place:

- for a port supporting USB PD when a sink is connected;
- on a multisource it may take place for a connection or disconnection of a source on just any port: typically, the power to all ports is interrupted to force re-negotiation of the power parameters.

These issues can be identified with the overall specifications for the USB PD (re-)negotiation mechanism:

1) Lack of requirement for sinks to specify not only maximum but also minimum power requirements:
   a) The Directive requires both to be declared.
2) Lack of knowledge on the sink other acceptable options:
   a) the source displays all its currently available options, on a given port in the negotiation;
   b) the sink, however, only chooses one of these options, without indication of other possible options;
   c) also, the specifications mentioned under 1) are unknown and not communicated to the source.
3) In case a multisource maximum aggregated power is less than the sum of the maximum power of each port, the negotiation for the different ports has to be done in series; however, the sequence in which ports are entering negotiating is not required to be specified.

Use case examples:

- Assume a multisource with 3 USB-C ports with USB PD support - A, B, C - that are (re-)negotiated in the order A, B, C.
- The total power, the sum of the power on the ports A, B and C together, is limited to 90 W.

EXAMPLE 1:

- Not knowing the specifications of smartphone, tablet and multisource, including the order of (re-)negotiation:
  - Connected to port B is a smartphone that can charge at 15 or 27 or 45 W.
  - Connected to port C is a tablet that charges only at 45 W.
- Connecting headphones that charge at 10 W to port A has the following effect:
  - The power to all ports is interrupted to force re-negotiation of ports B and C.
  - First port A negotiates with the headphone a 10 W charging.
  - Next port B re-negotiates with the smartphone a 45 W charging.
  - Next port C is unable to negotiate the 45 W with the tablet, the tablet is no longer served.

EXAMPLE 2:

- Knowing the specifications of smartphone, tablet and multisource, including the order of (re-)negotiation:
  - Connected to port C is a smartphone that can charge at 15 or 27 or 45 W
  - Connected to port B is a tablet that charges only at 45 W

- Connecting headphones that charge at 10 W to port A has the following effect:
  - The power to all ports is interrupted to force re-negotiation of ports B and C.
  - First port A negotiates with the headphone a 10 W charging.
  - Next port B re-negotiates with the tablet 45 W charging.
  - Next port C re-negotiates with the smartphone 27 W charging.

Annex D:
USB-C with USB PD power technical requirements

Sources supporting Type-C specifications are required to meet the following power technical requirements:

Table D-1: Recommended Categories of UPAs

Category	Example of device types	Voltage [V]	Current [A]	Power [W]
XS	mobile and handheld device	5 and 9	3	27
S	Netbooks, tablets	5, 9 and 15	3	45
M	Thin notebooks and Low-end laptops	5, 9, 15 and 20	3	60
L	Medium power laptops	5, 9, 15 and 20	5	100
XL	High-end laptops	5, 9, 15, 20 and 28	5	140
YL	Gaming laptops, large screen TV	5, 9, 15, 20, 28 and 48	5	240
NOTE 1: The device types listed in column 2 are just examples. NOTE 2: The power rating indicates the amount of power the source is capable to deliver to at least one of its USB-C ports. NOTE 3: In case of a multisource, the total (aggregated) power of the UPA can be up to the sum of the power available at each of its ports.				

Table D-2: No-load power and efficiency requirements for sources covered under Table D-1

Category	Voltage	Current	Power	Target solution		
				No-load power (W)	Average efficiency at 5 V and 25 %, 50 %, 75 % and 100 % Pmax load	Efficiency at 10 % load
XS	5 and 9	3	27	0,1	84 %	74 %
S	5, 9 and 15	3	45	0,1	84,6 %	74,6 %
M	5, 9, 15 and 20	3	60	0,21	84,7 %	74,7 %
L	5, 9, 15 and 20	5	100	0,21	84,7 %	74,7 %
XL	5, 9, 15, 20 and 28	5	140	0,21	84,7 %	74,7 %
YL	5, 9, 15, 20, 28 and 48	5	240	0,21	84,7 %	74,7 %

Annex E:
Current and power management

1) Current and power limiting also over a USB-C® interface, with or without USB PD, should in normal operation be left to the sink, the power consuming device:

   a) When limiting current and power is taking place at the source (the device delivering power over a USB-C® and where applicable with USB PD support) it is a situation of overloading: the source's overloading protection is available and should provide a sharp cut-off to avoid overheating and damage of both source and sink.

   b) When the source does not limit the current and power in a controlled way, then there is a risk of overheating and damage.

   c) To avoid situations of overloading it is therefore necessary that the source (the power adapter / charger) has sufficient aggregated current and power capacity in all possible situations.

Annex F: Bibliography

- https://www.europarl.europa.eu/news/en/press-room/20220930IPR41928/long-awaited-common-charger-for-mobile-devices-will-be-a-reality-in-2024.
- Directive 2022/2380 - Amendment of Directive 2014/53/EU on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment.
- Common charger agreement – Challenges and perspectives for European Standardization.
- https://usb.org/developers.
- https://usb.org/compliance.

Annex G:
Change history

Date	Version	Information about changes
2022-10	V0.0.1	Early draft
2024-10	V0.0.2	Stable draft; WI changed to TR in view of EU Regulation
2024-12	V0.0.3	Final draft for approval

History

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