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モバイルコンピューティング推進コンソーシアム
Mobile Computing Promotion Consortium

MCPC TR-021

Safety Design Guideline for USB Interface for Charging

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April 25, 2019

Mobile Computing Promotion Consortium
Technology committee

Change history

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July 1, 2015	1.00(E)	English translation version release
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Notice

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How do we distinguish binary, decimal and hexadecimal numbers?

For binary numbers, we append small letter “b” (e.g. 10b)).
For binary numbers, we insert a space after every four bits. (e.g. : 1000 0101 0010b).
For hexadecimal numbers, we append small letter “h” (e.g. : FFFFh and 80h).
All other numbers shall be considered to be written in decimal.

Key Words

- “May” means that something is recommended or optional at the free discretion of the vendor.
- “Should” means that although something is not essential, it is strongly recommended. When implementing, the vendor shall take this requirement into consideration and determine whether this is essential or not.
- “Shall” means that something is an essential requirement. For connectivity and specification compliance, the feature must be implemented, and is mandatory.

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- In general “Inc.,” “Corporation,” “Co., Ltd.,” have been excluded from company names.

Application note

It is indicating as follows, when indicating a case of the operation on a document. :

Application note : Case-of-the-operation entry

Table of Contents

List of Tables

List of Figures

1. Introduction

An USB interface is used as a power charge interface by many smaller peripherals, the Micro USB interface especially is widely implemented for smart phones, etc. and a USB Type-C (USB-C) interface is becoming common power charger interface.
When USB has become widely used as a charging interface, some problems have started to be recognized in the market, such as causing a charging terminal fire and a higher temperature due to inappropriate uses by consumers or inappropriate implementations of safety circuits in the products.
This Guideline specifies the technical parameters for charging smart phones and other equipment which support USB as a charging interface, to the improvement in charging safety, a charging terminal fire prevention, and the heat generation control for a Micro USB interface.

This Guideline is intended to serve as the baseline for a safety design of a charging interface. The test specifications for a safety design certification and user promotion activities for safe charging will be followed.

2. The case history of an accident at USB charging

These are the cases of accidents that occurred during USB charging.
The purpose of this document is to reduce the risk of such accidents.

i. The half short of a charging terminal
When conductive substances (ex. metal or moisture) attach to a connector terminal, or the resulting corrosion of the metal between connector terminals or between a connector terminal and a connector shell generates a half-energized state, the current that flows out of them may cause heat generation and fire .
In this Guideline, the term “charging terminal” includes both the power related terminals (Vbus, GND) of a Micro USB or USB-C connector and a connector shell.

ii. Short-circuit of the terminals by deforming a Micro USB or USB-C connector
Inadequate handling of a connector, a charging terminal and a connector body cause them deformed resulting short circuit.
There is a risk of generating high heart and fire when a short protection function is not implemented in charging adapter.

iii. Connection of an out-of-spec charging adapter and charging equipment
The electrical specifications of a charging adapter and charging equipment need to be matched. The charge cable that is specified or certified by a charging adapter and charging equipment must be used. Use of charging adapters or cables outside the specifications may generate higher heat and fire by the short circuit that is caused by electric mismatching or inappropriate insulation, or the impedance of a cable itself.

iv. Connecting a charging adapter without overcurrent and overvoltage protection
Charging with a charging adapter without overcurrent/overvoltage protection functions may generate higher heat and fire, when current beyond the capability of a charging adapter flows.

v. Smoke and Extraordinary Heat Generation of battery built-in equipment
In case that a temperature control and a discharge and charge control in an internal battery are not adequately performed or there is no safety measure in a built-in battery for a short circuit between poles, the battery may become in an abnormal state causing smoke and extreme heat.

3. USB Charger Functionality Outline

3.1 USB Charging Environment and the Scope of this Guideline

USB interface is the specifications which USB Implementers Forum developed to data communications by connecting host equipment (such as PC) with external devices using a cable. To connect small external devices without an external power supply, electric power can be supplied.

With the wide adoption of the USB interface to PCs, it is now used not only as a communication interface, but also as an electric power supply interface. It serves as a common power supply interface for small equipment such as smart phones.

Moreover, in the product market of power supply adapters and devices with a USB power supply capability, various kinds of implementations using its environment have showed up in the market. Under such variety of implementations, this Guideline covers the case as the most common use case at the time of publishing this Guideline.

In this Document, the category of the applicable devices shall be defined and the mechanisms etc. for each device shall be set out as follows;

1. Battery Charging Equipment;
   Equipment that supplies DC current to equipment to be charged.
   In the battery charging equipment herein, electric circuit parts that supply DC current to other equipment shall be deemed as the battery charging equipment as a matter of convenience.
   In case a charging cable and charging equipment do not separate (i.e. a captive cable), the charging cable shall be deemed as charging equipment as a matter of convenience.
2. Equipment to be Charged
   Equipment that supplies electricity with DC current to electric circuits in the equipment
   In the electric charging equipment herein, electric circuit parts that supply DC power from other equipment to the other electric circuits in the equipment shall be deemed as equipment to be charged.
3. Charging Cable;
   A cable and a connector that transmit the DC current generated at charging equipment to equipment to be charged.

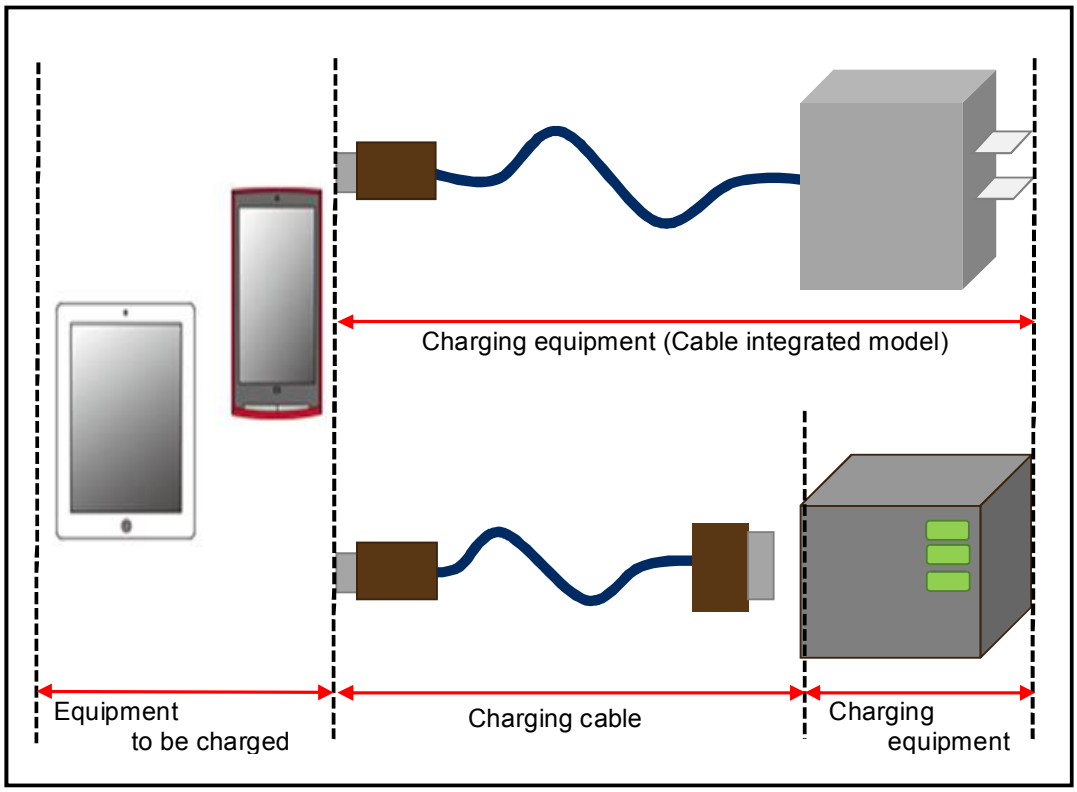

Figure 3-1 Charging Equipment, Charging Cable and Equipment to be Charged

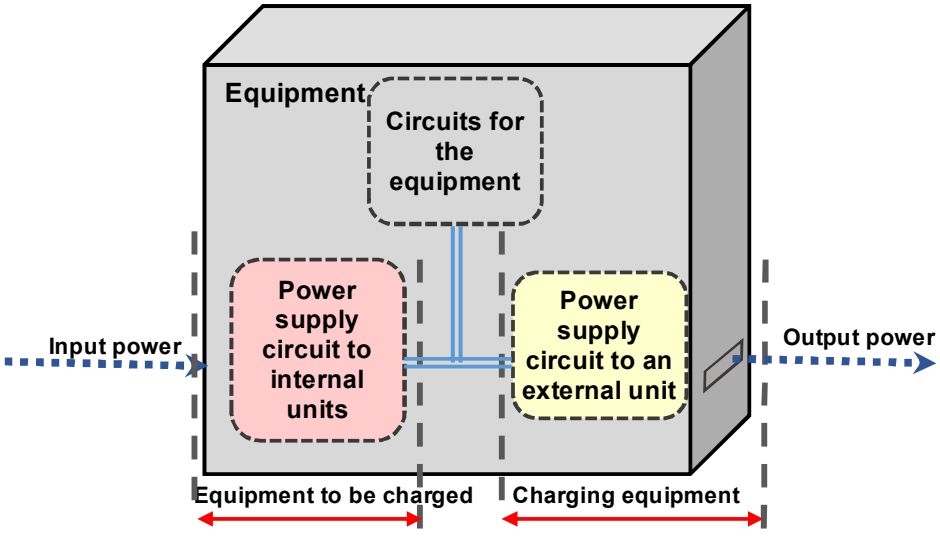

Figure 3-2 Equipment that incorporates both of charging circuits and circuits to be charged

Each category of the above equipment herein shall be defined as follows;

1 Battery charging equipment

1.1 AC Adapter --- Equipment that is linked with an AC power supply and supply DC power to equipment to be charged via a USB interface

1.2 Mobile battery --- Equipment that incorporates a battery, is intended to be carried for use and charge DC power from a battery to equipment to be supplied via a USB interface. That DC power supply part shall be defined as charging equipment.

1.3 Mobile smart equipment --- Equipment that incorporates a battery and is intended to be carried for use. In case DC power supply from a battery to equipment to be supplied via a USB interface can be made, the DC power supply part shall be defined as charging equipment. In this document, an existence and functionalities of electric circuits that do not serve to charge external equipment shall not limit the definition herein.
For example, a smart phone that has the functionality to supply power to external equipment and embeds electric circuits such as communication circuits in the equipment shall be categorized as this equipment.

1.4 Accessory socket adapter --- Equipment that is linked with a car accessory socket (or a power socket) and supply DC power to equipment to be charged via a USB interface.

1.5 Battery charging interface for an in-car equipment --- Among in-car battery charging interfaces or equipment, those that are for example embedded in a dashboard and are not intended to be detached for use by users.

2 Equipment to be charged

Equipment that can be charged with DC power from external equipment to its electric circuits or battery and is equipped with a USB interface for the power charge.

2.1 Mobile battery --- Equipment that incorporates a battery, is intended to be carried for use and charge DC power from a battery to equipment to be supplied via a USB interface. The power input part for power supply to the electric circuits in equipment and power charge to a battery is categorized as the equipment to be charged.

2.2 Mobile smart device --- In the equipment where a battery is built-in and is intended to carry for use, a DC power input part for battery charging to the equipment or to the battery itself is categorized as the equipment to be charged.
In this document, an existence and functionalities of electric circuits that do not serve to charge external equipment shall not limit the definition herein.
For example, a smart phone that has a battery charging functionality and embeds electric circuits such as communication circuits in the equipment shall be categorized as this equipment.

3 Battery Charging Cable

The ones that mount a USB micro B or USB-C connector as a DC power supply interface to equipment to be charged. So-called conversion adapter that does not mount a cable part shall also be included in the category.

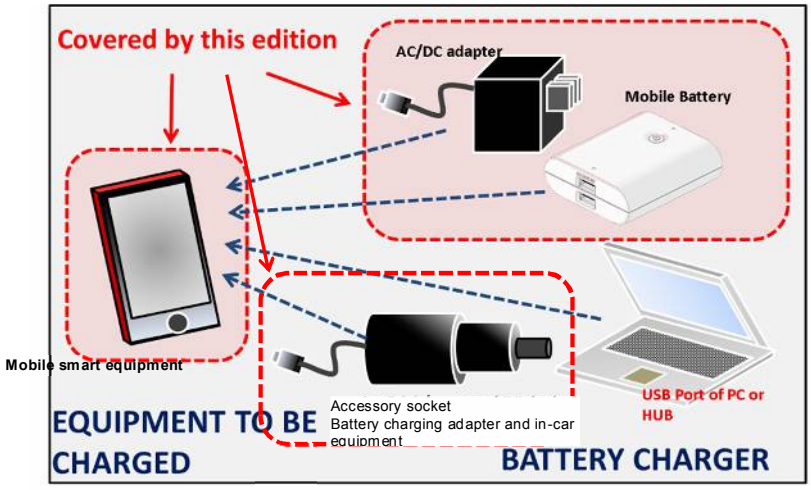

Figure 3-3 Examples of USB battery charging equipment and the scope in this Document

3.2 Overview on USB charging interface specification

Reference specifications **[BC1.2]**
A dedicated charging port (“Dedicated charging port, DCP”) is a port only for charge that does not support data communications. Power supplies without enumerations with hosts, such as an AC/DC adapter, are specified.
Charging equipment can draw 1.5A max from DCP and is identified by the short circuit of D+ and D- terminals.

Reference Specifications (Type C1.2)
A USB-C connector is a new connector that does not have differences in top or bottom connector shapes and host or device configuration. The battery charging parameters to Vbus were updated also. An identification method to enable up to 3A current while maintaining the output voltage of 5V to Vbus. For the identification, a newly defined CC pin is used.

Reference Specifications (USBPD3.0)
USB Power Delivery Revision3.0 specifications specify the parameters for supplying power via USB Vbus pins and the parameters and protocols to provide 15W (5V/3A) or more as its supply power and 5V or more as the output voltage to Vbus.

4. USB charging safety design specifications

4.1 Power supply input and output parameters

This parameter specifies the fundamental electric conditions over charging adapter.
The parameters do not directly enhance the safety of charges. However, they serve as important design guidelines for the fundamental safety base.

(1) Power adapter parameter
The parameter specifies a DC power supply which is sourced from AC power.
As a prerequisite, the regulation by the Electrical Appliance and Material Safety Law (**[EAMS]**) shall be observed for the parameters for AC/DC adapters.
This Guideline sets forth the recommended operating environments for safe and stable operations.

(2) USB output parameter
The parameter specifies a USB output to charging adapter.
In addition to the DCP support, this Guideline sets forth the recommended operating environments for safe and stable operations.

4.2 Combination of Battery Charging Equipment and Cable

In the following Chapter, the combination of battery charging equipment and a cable and the measurement points for various electrical characteristics are set forth.

4.2.1 Battery Charging Equipment without bundling Cable

USB receptacle connector (Type-A or USB-C) is mounted in a power output port of battery charging equipment and a cable is not bundled.

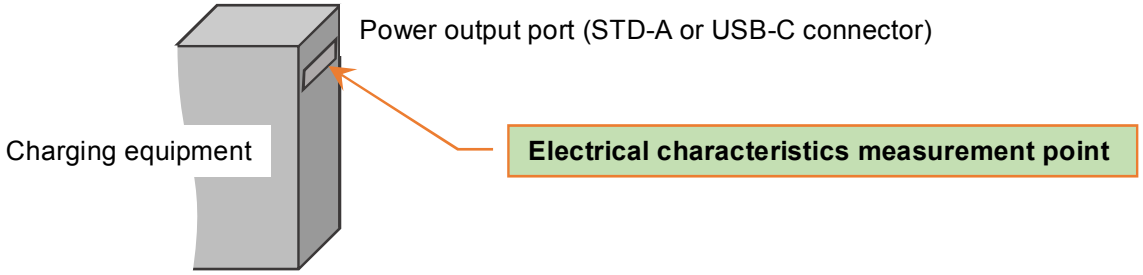

Figure 4-1 No bundling of battery charging cable

4.2.2 Integrated Battery Charging Equipment and Cable

Battery charging equipment and a cable are integrated, and the cable is not detachable (*in case of a captive cable).

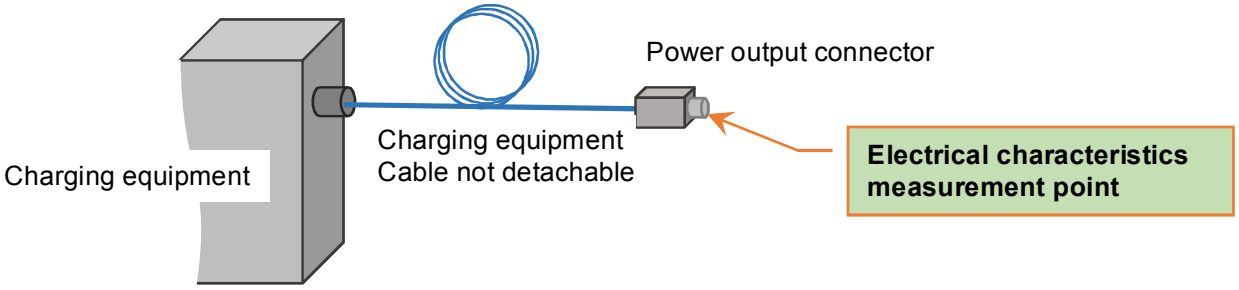

Figure 4-2 In case of captive cable (1)

4.2.3 Battery Charging Equipment and Cable connected by Proprietary Connector

Power charging equipment and a cable can be separated but the connector for the battery charging equipment and the cable is other than USB connector (Type-A or USB-C).

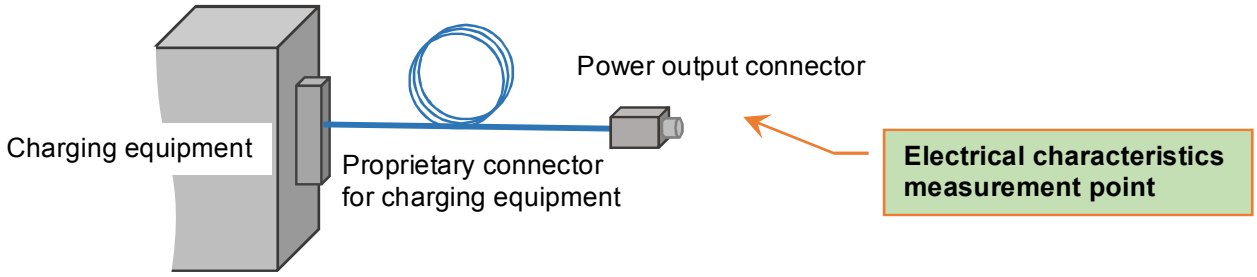

Figure 4-3 In case of captive cable (2)

4.2.4 Battery charging equipment and USB cable bundled

USB receptacle connector (Type-A or USB-C) is mounted and a cable is bundled.

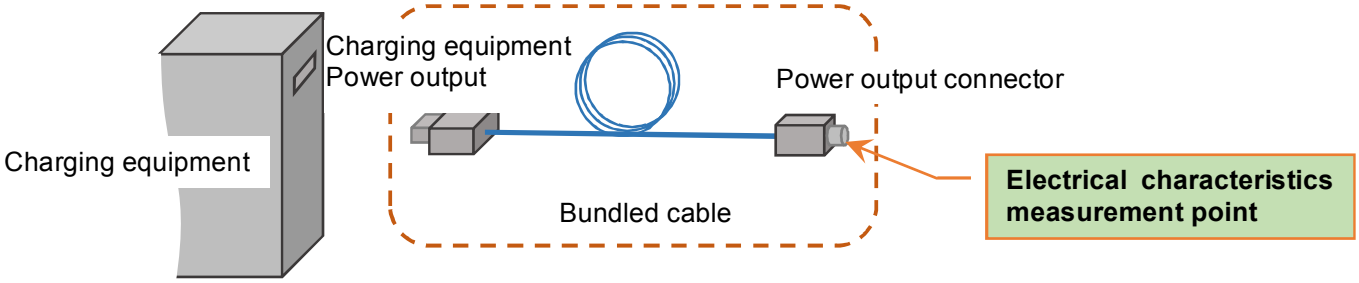

Figure 4-4 In case USB cable bundled

5. USB charge safety design parameter list

In this Chapter, equipment design is classified per functionality and the safe design parameters that are required for each functionality are set forth.
Refer to **Appendix C** per type of equipment for the leading bundled functionalities and reference parameters.

5.1 Parameters common to Equipment

In this Chapter, the parameters common to battery charging equipment and equipment to be charged are defined.

No.	Item	Specifications	Reference / Referred spec / Notes
CM1	Temperature rise in a portion where a user can touch during normal operations	For the equipment that is expected mainly to be installed in use, the surface temperature of the main part of a Charging Adapter shall be 70 ℃ or less. (Temperature rise ⊿T=40 degree max at the ambience temperature of 30 degree C.)	**[EAMS]** Applicable to the equipment category of ch.**C.1.1**,**C.1.2**,**C.1.5**
CM2	Temperature rise in a portion where a user can touch during normal operation continuously	The contact points with human body for each material of equipment that is expected to be used for a user to carry shall be less than the following ranges in temperature and contact duration. ■Metal ・50 degree C for 1 minute, 48 degree C for 10 minutes or 43 degree C for 8 hours. ■Glass and Ceramic ・56 degree C for 1 minute, 48 degree C for 10 minutes or 43 degree C for 8 hours ■Others such as resin ・60 degree C for 1 minute, 48 degree C for 10 minutes or 43 degree C for 8 hours	**[13732-1]** Refer to **[TR-023]** **Appendix C-1** for cautions Applicable to the equipment categories of ch.**C.1.3**,**C.1.4**,**C.1.6**
CM3	Fire prevention	The materials for equipment such as a case, cables or connectors that are used for IEC/UL60950 4.7.3.2 (UL4.7.3.4) Body, Bush-V1 or more, Cable VW1. Circuit board that mounts power units and major materials such as power control circuits except for the ones used for FPC shall support the flame-retardant grade equivalent to V0 of the UL Standard.	**[UL94]** **[60950-1]**

CM4	Safety considerations for a thermally closure environment without air flows (at DC maximum power output)	In the state of the maximum rating power output, ensure a safe operation in a thermally closure environment without air flows.	
CM5	Safety measures against heat retention (while equipment is charging)	Charging equipment such as a mobile battery in which a battery for a battery power source to equipment to be charged is built-in shall not become unstable even when retaining heat during charging the battery from the empty state to the full state.	
CM6	Sharpness of an edge of equipment	Test by a sharp edge tester *The specifications of a sharp edge tester and the test procedures shall conform to UL1439. No cut is produced that pierces of an external detection tape with 2 layers.	**[UL1439]**

Table 5-1Diagram 51 Parameters common to battery charging equipment

5.2 Parameters for Battery charging equipment AC power input

In this Chapter, the safety design parameters related to AC power input for battery equipment are defined;

No.	Item	Specifications	Reference / Referred spec / Notes
AC1	Rated input voltage	- AC/DC adapter : AC100V/240V - Other adapter: should comply with the specs of a connected device.	**[EAMS]** It should support up to 240V to accommodate overseas travel use cases.
AC2	Operating input voltage	- AC/DC adapter: 90V-264V - Other adapter: Allow ±10% margin to the specification requirements of a connection target.	
AC3	Rated input frequency	50/60Hz	**[EAMS]**
AC4	Insulation resistance	3 Mohm min	**[EAMS]**
AC5	Leakage current	250 uA max at the measurement circuit of IEC60950-1.	**[60950-1]**
AC6	Lightning surge	Conform to IEC61000-4-5 Level-3(Normal Mode and Common Mode)	**[61000-4-5]**

Table 5-2 Parameters for the equipment to input power

5.3 Charging Equipment DC power output parameters (Others than USBPD high-voltage operation)

In this Chapter, the safety design parameters in operating under BC1.2 or USB-C or USBPD at 5V output voltage are defined.

No.	Item	Specifications	Reference / Referred spec / Notes
OD1	Rated output Voltage (not USBPD Mode)	Depending on the configurations of charging equipment and cables, measurement points vary. In case of the charging equipment that has multiple ports for a power output, a measurement shall be made per power supply circuit inside the charging equipment. ■In case the configurations of charging equipment and cables are equivalent to ch.**4.2.1** At the end of a receptacle connector that is built-in within the range of a rated output power, 4.75V - 5.5V. **USB-C** ■In case the configurations of charging equipment and cables are equivalent to Chapter ch.**4.2.2**, **4.2.3** and **4.2.4**, 4.75-(0.75 x rated output Current/3)V~5.5V within the range of the rated output current, at the connector end that is connected to the equipment to be charged. In case a micro B to USB-C conversion cable or conversion adapter is bundled, an output voltage at the connector end of the conversion cable and conversion adapter shall also be measured.	Revised the upper limit of voltage at **[TYPEC1.2]**
OD2	Rated output current	The minimum requirements and more of rated output current should be provided.	
OD3	Overshoot in output voltage	6.0V max in the load change environment in the range of zero to a rated load.	**[BC1.2]** Section4.1.1(VCHG_OVRSHT=6.0V)

OD4	Undershoot in output voltage	V min in the load change environment in the range of the following conditions; 4.1- (0.75 x Rated Output Current /3) V or more In case however the battery charging equipment and cables correspond to ch.**4.2.1**, the value shall be 4.1 V or more. I_{DCP_LOW}~I_{DCP_MID} I_{DCP_MID}~I_{DCP_HI} definition I_{DCP_LOW}=0~30mA I_{DCP_MID}=30~100mA I_{DCP_HI}=100-mA~rated load	**[BC1.2] Section4.4.2** （VCHG_UNDSHT=4.1V）
OD5	Overvoltage protection	Do not exceed 9V max in the range of a zero to rated load condition.	**[BC1.2]** Section4.1.5 (VCHG_FAIL=9.0V) For the battery charging equipment equivalent to rated output voltage as **OD1**. Applicable to an output voltage of 5V.
OD6	Overcurrent protection	Implement overcurrent protection. The protection ensured within +30% max of a rated output current is recommended.	
OD7	Output short circuit protection	Implement output short circuit protection(s).	
OD8	Avoid energizing during the open state of a terminal	In case the configurations of the charging equipment correspond to ch.**4.2.1** or **4.2.4** and the connector in the charging equipment is USB-C, or the configurations of the charging equipment and cables correspond to ch.**4.2.2** or **4.2.3** and the connector in the equipment to be charges is USB-C. In case that equipment to be charged etc. or other units are not connected or CC line for USB-C becomes open, voltage shall not be output to a Vbus terminal.	**[TYPEC1.2]** Additional requirements for ch.**4.8.1.1** and **4.8.1.2**
OD9	Voltage for USB-C VCONN Terminal	For the charging equipment in which USB-C receptacle is mounted, the voltage output to a CC pin terminal as VCONN voltage shall not exceed voltage (5.5V) as defined in the right	**[TYPEC1.2] Table4-4**

		Specifications, when operating at the power charging protocols (i.e. BC1.2, USB-C and USBPD) by USB-IF as well as at the other power charging protocols.	
OD10	Protection from power output half short	■In case the configurations of charging equipment and cables are equivalent to ch.**4.2.1** Protection functionality shall be implemented to avoid smoke or fire, etc. in time for a minute resistance occurrence between charging terminals. ■In case the configurations of charging equipment and cables are equivalent to ch.**4.2.2**, **4.2.3** and **4.2.4**, If item **CA1** is supported at the Cable, this item is not mandated.	**Appendix B**

Table 5-3 DC power output parameter (5V)

5.4 Charging Equipment DC power output parameters (operating at USBPD high-voltage)

In this Chapter, the safety design parameters for DC output when operating beyond 5V in USBPD mode are defined.

No.	Item	Specifications	Reference / Referred spec / Notes
OH1	Rated output voltage	Under an unloaded status at the receptacle connector terminal that is mounted in battery charging equipment, the rated output voltage shall be within the range of ±5% of the USBPD setting value. In case of transition of USBPD setting voltage, the voltage overshoot and undershoot shall be within the range of +0.5V to -0.5V.	**[PD3.0] Table7-19** vSrcNew vSrcValid
OH2	Rated output current	Rated output current shall be provided.	
OH3	Overshoot of output voltage in load fluctuation	From zero-load to rated load condition, at the receptacle connector terminal that is mounted in battery charging equipment, the rated output voltage shall be within the range of +5% of the USBPD setting value.	**[PD3.0] Table7-19** vSrcNew
OH4	Undershoot of output voltage in load fluctuation	■In case configurations of battery charging equipment and cables correspond to the ch.**4.2.1,** From zero-load to rated load condition, at the receptacle connector terminal that is mounted in battery charging equipment, the rated output voltage shall be within the range of -5% of the USBPD setting value. ■In case the configurations of charging equipment and cables are equivalent to ch.**4.2.2**, **4.2.3** and **4.2.4**, At the connector terminals that are linked with equipment to be charged in the power range up to the rated output current. * for 3A cable USBPD setting value -5% - (0.75 x Rated output current / 3)V * for 5A cable USBPD setting value -5% - (0.75 x Rated output current / 5)V	**[PD3.0] Table7-19** vSrcNew

OH5	Support a CC line operation error during high-voltage operation	When a USBPD communication error is detected from equipment to be charged during a USBPD operation exceeding an output voltage of 5V and USBPD communications are not performed properly, the output voltage shall be returned to 5V or 0V.	**[PD3.0] 2.6.1, 6.8.2, 8.3.3.24.1** **[TYPEC1.2] 4.5.2.2.2**
OH6	Avoid energizing during the open state of a terminal	In case the configurations for charging equipment corresponds to ch.**4.2.1** or **4.2.4**, and the connector mounted to the charging equipment is USB-C, or the configurations for charging equipment and cables correspond to ch. **4.2.2** or **4.2.3** and the connector to be charged is USB-C. If there is no connection to equipment to be charged etc. or a CC line for USB-C becomes open, voltage shall not be output to a Vbus terminal.	**[TYPEC1.2]** Additional requirements for ch.**4.8.1.1** and **4.8.1.2**
OH7	Voltage for USB-C VCONN Terminal	For the battery charging equipment in which USB-C receptacle is mounted, the voltage output to a CC pin terminal as VCONN voltage shall not exceed voltage (5.5V) as defined in the right Specifications, when operating at the power charging protocols (i.e. USBPD) by USB-IF as well as at the other power charging protocols.	**[TYPEC1.2]** Table4-4

Table 5-4 DC power output parameter (Exceeding 5V)

5.5 Parameters for Cable and Connector

In this Chapter, safety design parameters for cable and connector or conversion cable are defined.

No.	Item	Specifications	Reference / Referred spec / Notes
CA1	Half short protection between charging terminals	Protection functionality shall be implemented to avoid smoke or fire, etc. in time for a minute resistance occurrence between charging terminals. If USB-C plugs are mounted in both ends of the cable, the same safety implementation shall be placed.	**Appendix B**
CA2	Grounding for plug shell	For a charging purpose only cable, a plug shell should not connect to GND in a direct current mode.	In case a USB-C connector is used, or a cable that supports data communications, this item is optional.
CA3	Support rated current for USB-C to TypeA/B conversion cable	The conversion cable or the conversion adapter in which the following item 1 or 2 configurations are used, CC pin for USB-C shall connect Rp to 56kΩ±20%. 1. USB-C plug and Type-A plug are embedded in both ends. 2. USB-C plus and Micro B receptacle are embedded in both ends.	**[TYPEC1.2]** 3.5.1, 3.5.2, 3.6.2, 4.11.1
CA4	Support both sides of USB-C connector	The cable with a USB-C plug in which a reversible plug is mounted shall be capable of charging power when inserted at either side of the plug to equipment to be charged.	

CA5	Voltage drop at cable and connector	■For a cable with the following implementation, the voltage drop when using 3A power shall be 750 mV or less. In case of a cable that supports 5A, the voltage drop when using 5A power shall be 750 mV or less. 1. Standalone cable with USB-C plugs at the both ends ■For a cable with the implementation of the following item 2 or 3, the voltage drop when using 1.5A power shall be 375 mV or less. 2. Conversion adapter that mounts a Type-A or Micro B connector and a USB-C connector 3. Standalone cable that mounts a Type-A and micro B plug at the both ends ■In case the configuration of charging equipment and a cable corresponds to the ch.**4.2**, refer to **OD1**.	

Table 5-5 Parameters for Cable and Connector

5.6 DC power input parameters

In this Chapter, safety design parameters when power from battery charging equipment or equipment to be charged is input from a USB interface is defined.

No.	Item	Specifications	Reference / Referred spec / Notes
DC1	(Reserved)		
DC2	Avoid corrosion in charging terminals	Do not output voltage to the Vbus in a USB receptacle when the device is not in the power source mode and a Charging adapter or equipment etc. is not connected.	
DC3	Protection from over-voltage input	When a voltage exceeding a rated value is loaded to an input terminal, instability shall be avoided. The instability means not to cause smoke or ignition, provided however the smoke that is caused by the activation of a protection circuit may not apply to this case.	
DC4	Protection from over-current input	An input power control circuit or an input power cut-off circuit shall be incorporated to prevent exceeding rated input current as the result of malfunction of a normal DC power input operation or of a main circuit inside the equipment.	

Table 5-6 Parameters for equipment to input DC power

5.7 Built-in battery parameter

In this Chapter, safety design parameters for equipment with a built-in battery are defined.

No.	Item	Specifications	Reference / Referred spec / Notes
BA1	Safety of battery in charging equipment	The safety check procedure as set out in either of the following rules and regulations shall be executed for battery charging equipment in which a battery, as a power source to equipment to be charged, is built-in. - Appendix 9 of Electrical Appliance and Material Safety Act - IEC62133-2 (Execute the forced internal short circuit test as set forth in the Chapter 7.3.9 except for polymer battery) - UL1642 The equipment categorized as so-called mobile batteries that is intended to supply its battery power to equipment to be charged shall execute the safety checking procedure for a battery as set out below; - Appendix 9 of Electrical Appliance and Material Safety Act	**[EAMS]** **[62133-2]** **[UL1642]**
BA2	Temperature monitor of batteries	Temperature of the embedded batteries in battery charging equipment as a source to equipment to be charged shall be monitored.	
BA3	Heat protection for embedded batteries	In case the equipment to be charged that incorporates batteries as a source to equipment to be charged has temperature in its battery exceeding the guarantee range of the operation, charging or discharging power from the said battery shall be stopped.	

Table 5-7 Parameters for embedded batteries

Appendix A. Reference specifications (Normative)

[13732-1]	ISO13732-1 Ergonomics of the thermal environment — Methods for the assessment of human responses to contact with surfaces — Part 1: Hot surfaces
[60950-1]	IEC60950-1 Information technology equipment – Safety – Part 1: General requirements
[61000-4-5]	IEC61000-4-5:Edition3 2014 Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test
[62133-2]	IEC62133-2 Edition 1.0 2017-02, Secondary cells and batteries containing alkaline or other non-acid electrolytes – Safety requirements for portable sealed secondary cells, and for batteries made from them, for use in portable applications – Part 2: Lithium systems
[BC1.2]	Battery Charging Specification Revision 1.2 by USB Implementers Forum
[PD3.0]	Universal Serial Bus Power Delivery Specification Revision3.0 by USB Implementers Forum
[TYPEC1.2]	Universal Serial Bus Type-C Cable and Connector Revision1.2 by USB Implementers Forum
[UL1642]	UL1642 5th Edition, 2013-3, UL Standard for Safety for Lithium Batteries
[UL1439]	Test for Sharpness of Edges on Equipment
[USB2.0]	Universal Serial Bus Specification Revision 2.0 by USB Implementers Forum
[USB3.1]	Universal Serial Bus Specification Revision 3.1 by USB Implementers Forum
[TR-023]	MCPC TR-023 Mobile Equipment Safety Design Guideline Version 2.00
[EAMS]	Electrical Appliance and Material Safety Law

Appendix B. Half short error and its counter measure examples

B.1 Examples for measures in charging adapter and cable

Examples of measures effective to battery charging equipment and battery charging cables are shown below;
Abnormal operations at a half-short-circuited error can be avoided by incorporating one or multiple measures such as this example or equivalent measures.

- As the connector that is linked with equipment to be charged may cause danger of a fire and a skin burn, the charging equipment should implement temperature protecting functionality in order to avoid abnormal heat generation in battery charging equipment or battery charging cables.
- Ensure the electrical circuit(V-I) properties of a charging adapter to avoid an abnormal heat generation upon generating half short at a charging terminal,.

[Examples]

- Enlarge the termination voltage for a drooping characteristic, or eliminate a drooping characteristic.

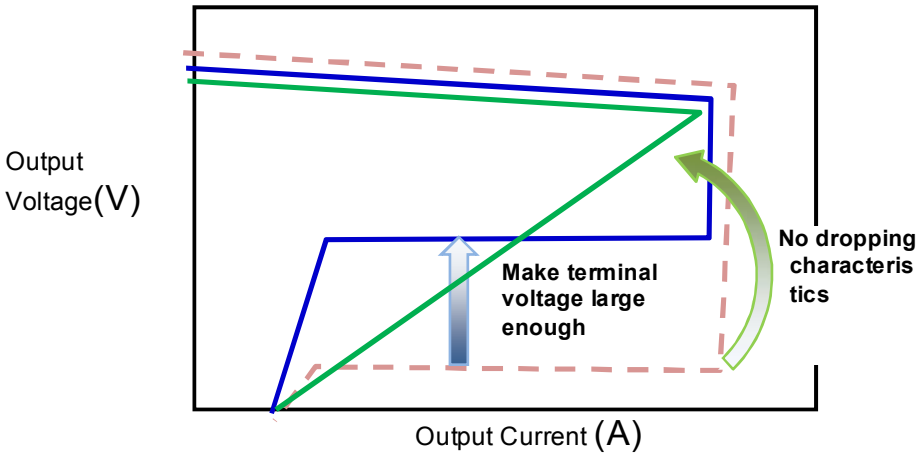

Figure B-1 Example of output dropping characteristics

(Reference) In the Chapter 7.1.4.3 and 10.2.3.2.1, the minimum voltage setting value as a USB Power Delivery and PPS operation is set out and can be expected to operate similarly to the terminal voltage of this dropping characteristics. Even for the battery charging equipment that does not incorporate a USB Power Delivery and PPS functionality, the above voltage can be used to be referred as the terminal voltage value for output dropping characteristics as set forth herein.

-The cycle of an automatic recovery (auto-restart) after entering a short protection must be long enough to avoid a frequent activation of the protection function, or no automatic recovery is supported.

・When equipment to be charged is not properly connected or foreign materials are detected in

connection, charging equipment shall stop its output.

Example

・If the Rd resistance value to a USB-C CC pin finds that equipment to be charged is not connected or an undefined RD value (or the voltage value of a CC pin) is detected, stop the output.

B.2 Examples for measures in charging equipment

- Even in case of occurrence of minute resistances in between charging terminals (especially in between a connector power source terminal and a connector shell), smoke and fire can be prevented by implementing the following (1) or (2) of the measures to the chargers as set forth in this Guideline. When USB USB-C connector is implemented, they are optional.

[Example (1) of the measures]

A capacitor is mounted between a connector shell and the GND electrode of a substrate, without directly grounding the conductive connector shell in the USB connector (receptacle) of equipment to a GND of a substrate. In addition, it is desirable to set a capacitance value in consideration of the influence over USB data communications.

[Example (2) of measures]

The PTC (Positive Temperature Coefficient) thermistor is mounted between a connector shell and a substrate GND electrode without directly grounding the conductive connector shell in the USB connector (receptacle) of equipment to GND in a substrate, When USB USB-C connector is implemented, they are optional.

Appendix C. Example of incorporated functionalities and reference parameters per equipment type

In this Chapter, the incorporating functionalities and the reference parameters per leading equipment that should be referred to are set forth.
However, the necessity to refer the equivalent parameters does not apply if the equipment does not incorporate the functionalities that are not set forth in this Chapter or does not incorporate the functionalities.

C.1 Examples of reference parameters per equipment

C.1.1 AC adapter

An AC adapter means the equipment that generates DC battery power to the equipment to be charged, using the power supply from an external AC power.
In case an DC power output supports USBPD and can supply power with voltage exceeding 5V, refer to the parameters in the Chapter **C.2.1** in addition to eh following parameters.

Equipment category	Common to equipment	Power input part	Internal inherent circuit	Power output part
AC adapter	CM1,CM3~CM4,CM6	AC1~AC6		OD1~OD9 When supporting USBPD, refer to C.2.1, too.

Table C-1 Reference parameters for AC adapter Accessory socket adapter

C.1.2 Accessory socket adapter

An accessory socket battery charging adapter means the device to convert the DC power from an accessory socket in a car as a source to DC battery power for equipment to be charged.
In case an DC power output supports USBPD and can supply power with voltage exceeding 5V, refer to the parameters in the Chapter **C.2.1** in addition to eh following parameters.

Equipment category	Common to equipment	Power entry part	Internal inherent circuit	Power output part
Accessory socket battery charging adapter	CM1,CM3,CM6	DC3~DC4		OD1~OD9 When supporting USBPD, refer to C.2.1, too.

Table C-2 Reference parameters for accessory socket and battery charging adapter

C.1.3 Mobile battery (DC input)

A mobile battery (DC input) means the equipment that has a built-in battery in the equipment and generates DC battery power for equipment to be charged, using the energy of the battery, and charges power via a USB interface from an external DC power.
In case an DC power output supports USBPD and can supply power with voltage exceeding 5V, refer to the parameters in the Chapter **C.2.1** in addition to eh following parameters.

Equipment category	Common to equipment	Power entry part	Internal inherent circuit	Power output part
Mobile battery (DC entry)	CM2~CM6 **(※)**	DC1~DC4	BA1~BA2	OD1~OD9 When supporting USBPD, refer to C.2.1, too.

(※) The equipment is assumed to be carried in use after battery charging from an external DC power to an internal battery, refer to CM2 as a temperature increase parameter that is common to equipment. In case of the equipment which is not assumed to carry for use, CM1 instead of CM2 shall be referred to.

Table C-3 Reference parameters for mobile battery (DC input)

C.1.4 Mobile battery (AC input)

A mobile battery (AC input) means the equipment that has a built-in battery in the equipment and generate DC battery power for equipment to be charged, using the energy of the battery or the power from an AC power source.
In case an DC power output supports USBPD and can supply power with voltage exceeding 5V, refer to the parameters in the Chapter **C.2.1** in addition to eh following parameters.

Equipment category	Common to equipment	Power entry part	Internal inherent circuit	Equipment category
Mobile battery (AC entry)	CM2~CM6 **(※)**	AC1~AC6	BA1~BA2	OD1~OD9 When supporting USBPD, refer to C.2.1, too.

(※) The equipment is assumed to be carried for use after battery charging from AC power to an internal battery, refer to CM2 as a temperature increase parameter that is common to equipment.
In case of the equipment which is not assumed to carry for use, CM1 instead of CM2 shall be referred to.

Table C-4 Reference parameters for mobile battery (AC input)

C.1.5 In-car battery charging port

The in-car battery charging port means the port that is equipped in a device for a car dashboard or in a DC output connector of a car body such as a dashboard.
The major difference from the Chapter **C.1.2** is that the said device is mounted to a dashboard or a rack or in a position where is not accessible by a user and is not assumed to be detached by a user in use.
In case an DC power output supports USBPD and can supply power with voltage exceeding 5V, refer to the parameters in the Chapter **C.2.1** in addition to eh following parameters.

Equipment category	Common to equipment	Power entry part	Internal inherent circuit	Power output part
In-car battery charging port (Built-in to dashboard)	CM1 (※)	DC3~DC4		OD1~OD9 When supporting USBPD, refer to C.2.1, too.

(※) In case the applicable devices are mounted to a dashboard or a rack, a flame retardant grade that substantially exceeds the grade for the materials of the dashboard and rack is not required.
The parameters for heat retention is not required for these device categories as this case does not fall under the actual use environment.

Table C-5 Reference parameters for in-car battery charging port

C.1.6 Mobile smart equipment

A mobile smart device is a generic term for a device that has a built-in battery in the device and can supply power to the electric circuits or to the battery in the device via a USB interface from an external DC power and of which the battery charging is not its main functionality.
There is a case in which DC power is supplied to equipment to be changed using the energy of a battery as a source.

Equipment category	Common to equipment	Power input part	Internal inherent circuit	Power output part
Mobile smart equipment	CM2~CM6	DC1~DC4	BA1~BA2	OD1~OD9(※) When supporting USBPD, refer to C.2.1, too.

(※) In case that power supply to an external equipment to be charged is possible.

Table C-6 Reference parameters for Mobile smart equipment

C.2 Example of parameters for high-voltage DC output

C.2.1 DC output exceeding 5V to support USBPD

In case an output power to equipment to be charged in each of the device categories supplies a voltage that exceeds 5V in referring to the USBPD specifications, the following parameters shall be additionally referred.

Equipment category	Common to equipment	Power entry part	Internal inherent circuit	Power output part
USBPD power output port incorporated				OH1~OH7

Table C-7 Reference parameters when supplying more than 5V output to support USBPD

C.3 Example of reference parameters per cable and conversion adapter

C.3.1 Battery charging cable without USB -C connector

It means the cable with a Type-A plug connector and a micro B plug connector at the both ends of a battery charging cable.

Equipment category	Type-A and Micro B connector	USB-C connector	Internal inherent circuit	Cable
Battery charging cable	CA1,(CA2),CA5			CA5

Table C-8 Reference parameters of a cable without USB-C connector

C.3.2 Battery charging cable with USB -C connector

It means the cable with a USB-C plug connector at the both ends of a battery charging cable or with a Type-A plug and USB-C plug connector.

Equipment category	Type-A and Micro B connector	USB-C connector	Internal inherent circuit	Cable
Battery charging cvable	(CA2)	CA1,CA3~CA5		CA5

Table C-9 Reference parameters of a cable with USB-C connector

C.3.3 Micro B USB-C conversion adapter

It means a cable with a micro B receptacle connector and a USB-C plug connector at both ends, or a dongle integrated with the both connectors.

Equipment category	**Type-A and Micro B connector USB-C connector**	**USB-C connector**	**Internal inherent circuit**	**Cable**
Conversion adapter (Micro B->USB-C)	CA1	CA3~CA5		

Table C-10 Reference parameters for micro B USB-C conversion adapter