PHILIPS

Accessories

Power Charging Technology White Paper

TPV Technology Group, April 2024

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1 Charging Standard Evolution

1.1 Wired charging standard

Introduction

Traditional devices only support charging of 5W (5V/1A) or 12W (5V/2.4A). With the evolution of devices, it requires more and more power to charge quickly to shorten charging time of new devices. So the industry released new fast charging standard.

Quick Charge (QC) from Qualcomm

	QC 1.0	QC 2.0	QC 3.0	QC 4.0/QC 4.0+	QC 5
Voltage/Current	5 V 2A	Class A: 5V/2A, 9V/2A, 12V/1.5 A (Mainstream) Class B: 5V/9V/12V/20V	Class A: 3.6~12V, dynamic (3.6V~6.5V/3A, 6.5V~9V/2A, 9V~12V/1.5A, Mainstream) Class B: 3.6~20V	5~9 V (5V/5.6A, 9V/3A)	3.3~20V/ 3~5A
Max power	10W	18W (Mainstream), no much 24W in market	18W (Mainstream), no much 24W/36W in market	28W	100W
Release year	2013	USB-A/USB-C	USB-A/USB-C	USB-C	USB-C
Wall charger output interface	USB-A	USB-A/USB-C	USB-A/USB-C	USB-C	USB-C
Device input interface	Micro USB	Micro USB/USB-C	Micro USB/USB-C	USB-C	USB-C

Power Delivery (PD) from USB-IF

	PD 1.0	PD 2.0	PD3.0/PD3.0 PPS	PD 3.1
Voltage/Current	/	5V/3A, 9V/3A, 15V/3A, 20V/2.25A, 20V/3A, 20V/5A	5V/3A, 9V/3A, 15V/3A, 20V/2.25A, 20V/3A, 20V/5A PPS: 3.3-5.9V/3A, 3.3-11V/3A, 3.3-16V/3A, 3.3-21V/3A, 3.3-21V/5A	5V/3A, 9V/3A, 15V/3A, 20V/2.25A, 20V/3A, 20V/5A PPS: 3.3-5.9V/3A, 3.3-11V/3A, 3.3-16V 3A, 3.3-21V 3A, 3.3-21V 5A EPR: 28V/5A, 36V/5A, 48V/5A AVS: 15-28V/5A, 15-36V/5A, 15-48V/5A
Max power	10W	100W	100W	240W
Release year	2012	2014	2015/2017	2021
Wall charger output interface	USB-A/USB-B	USB-C	USB-C	USB-C
Device input interface	USB-C	USB-C	USB-C	USB-C

Universal Fast Charging Specification (UFCS) from China Fast Charging Alliance

Voltage	5V programmable	10V programmable	20V programmable	30V programmable
Voltage range	3.4V ~ 5.5V	5.5V ~ 12V	12V ~ 21V	21V ~ 36V
Power range (P)	Current I: A			
P= 20W	3 ≤ 1	2 ≤ 1	/	/
20W ≤ P ≤ 40W	3 ≤ 1	2 ≤ 1	/	/
40W ≤ P ≤ 65W	3 ≤ 1	3 ≤ 1	/	/
65W ≤ P ≤ 90W	3 ≤ 1	3 ≤ 1	/	/
90W ≤ P ≤ 120W	/	3 ≤ 1	3 ≤ 1	/
120W ≤ P ≤ 150W	/	3 ≤ 1	3 ≤ 1	/
150W ≤ P ≤ 200W	/	3 ≤ 1	3 ≤ 1	/
200W ≤ P	/	3 ≤ 1	3 ≤ 1	/

* / means in this power range, no this voltage output can be accepted.

1.2 Wireless charging standard

Wireless charging make it more convenient to charge devices without charging cable. The industry released below popular wireless charging standard.

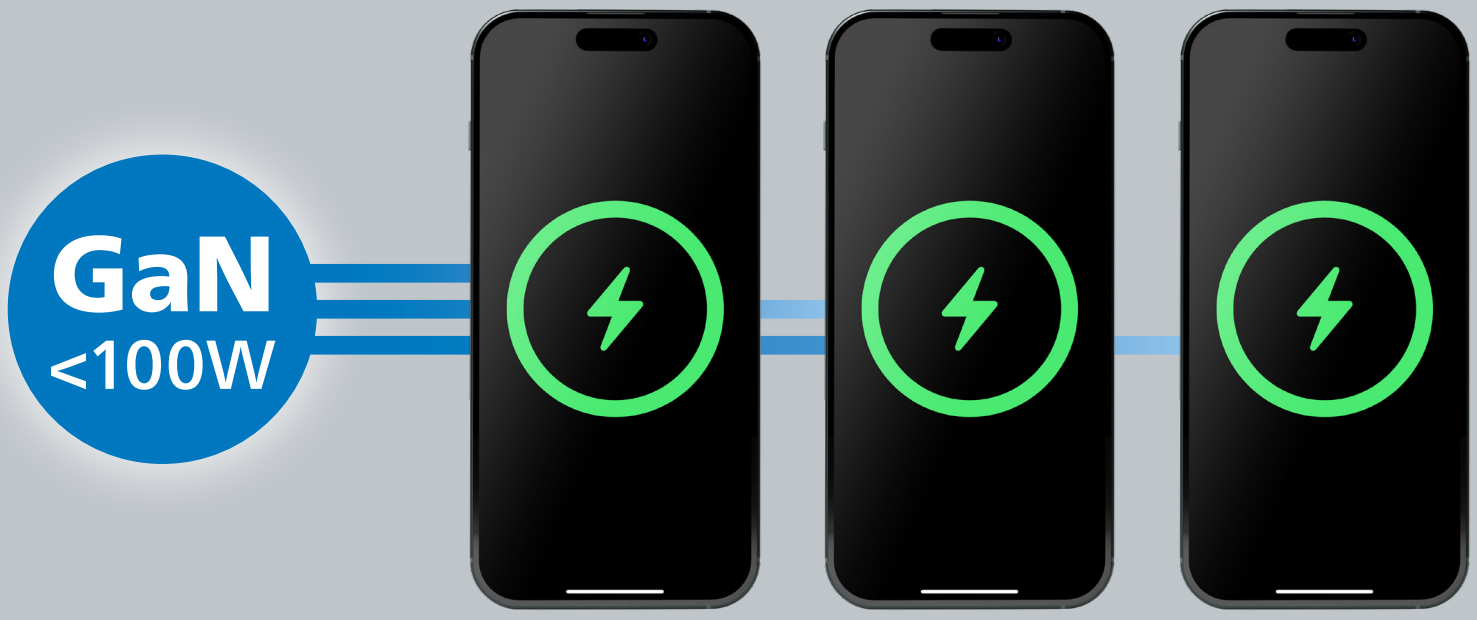
	Qi	Qi 2	MagSafe	
Developed by	WPC(Wireless Power Consortium)		Apple	
Charging power	Up to 15W	Up to 15W	Up to 15W	Up to 25W
Support Magnetic	No	Yes	Yes	Yes
Support devices	Qi enabled devices	Qi enabled devices Qi 2 enabled devices (e.g. iPhone 15 series)	iPhone 12 /13/14 /15 series	iPhone 16 series
Certification Logo				

* Qi can accept up to 15W (for Samsung while can only support 7.5W for iPhone) in v1.33 (the last version before jump to qi2)
** Qi2 will only support 10W for Samsung while can support 15W for iPhone. qi 2 will support 25W in v2.2 and will publish in 2025
*** New 25W MagSafe module is not yet open (i.e. only apple MagSafe charger can support, not other brand yet but expect Belkin might have as 1st one)

1.3 Power charging material

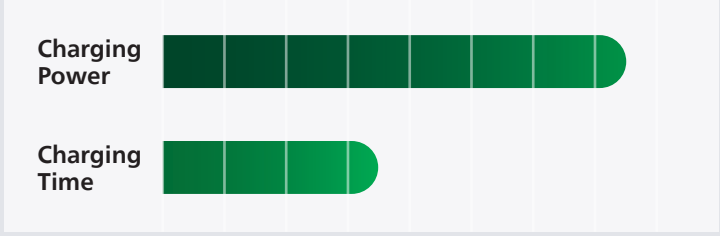
Silicon (Si), Gallium-nitride (GaN), and Silicon-carbide (SiC) are 3 major material for semconductor industry , which provide different characters for power charge management ICs. GaN and SiC are enabling higher levels of power density and efficiency compared to traditional silicon metal-oxide semiconductor field-effect transistors (MOSFETs).

	Si	GaN	Sic
Drain-Source Voltage (Higher value, more durable to high voltage)	40 ~ 400V	Up to 650V	Up to 1700V
Thermal conductivity (Higher value, higher working temperature, smaller output power loss)	1.5 W/cmK	1.3 W/cmK	5 W/cmK
Safety	Low	Middle	High
Life cycle	1~2 years	2~4 years	3~5 years



When charging 2 or more power hungry devices with GaN charger, charging speed is relatively slower compared with SiC charger because each device is not getting full charging power, which increases charging time.

In contrast, SiC chargers are able to maintain full charging power, matching the maximium charging capacity of the device, hence increase charging speed and lower charging time.

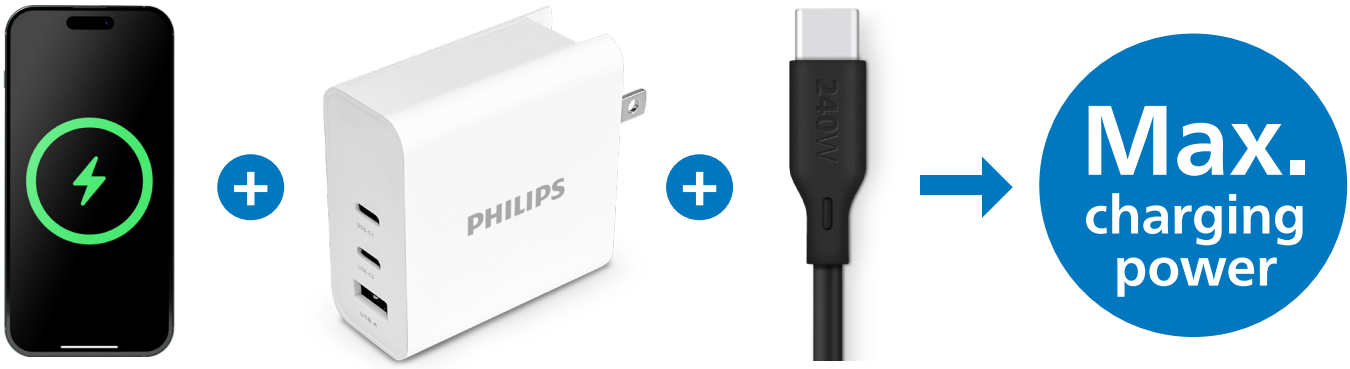


2 Application

2.1 Choosing the right charger

Consumers could enjoy the full fast charging experience by selecting the right combination of charger and charging cable, also check the charging specification of your device in order to make to best purchase decision.

Platform/Brand	Apple	Android	Microsoft	Other USB devices
Device	iPhone/iPad/Macbook	Smartphone	Laptop	Camera/Headphones/ Wireless speaker
Specifications	iPhone 8-iPhone 14 support PD18-27W iPad from Y2015 support PD 10-30W MacBook from Y2015 support PD 29-140W	Was mostly standard 5V/1A (max. 2A) using Micro USB, Now most of the Android devices are using USB-C with QC/PD	Was with different connectors. Now most new laptops are using USB-C	Was mostly standard 5V/1A using Micro USB. Now some new devices are using USB-C
Conncetion to devices	Lightning/USB-C	USB-C	USB-C	Micro USB/USB-C
Conncetion to chargers	USB-A/USB-C	USB-A/USB-C	USB-C	USB-A/USB-C
Charger connectors	USB-A/USB-C	USB-A/USB-C	USB-C	USB-A/USB-C
Power required	iPhone: Min 5W iPad: Min 10W Macbook: Min 29W Accept higher watt depends on devices	Min 5W Accept higher watt depends on devices	Most use 65W charger depends on devices	Min 5W Accept higher watt depends on devices



65W
device

≥65W
Charger

≥65W
charging cable

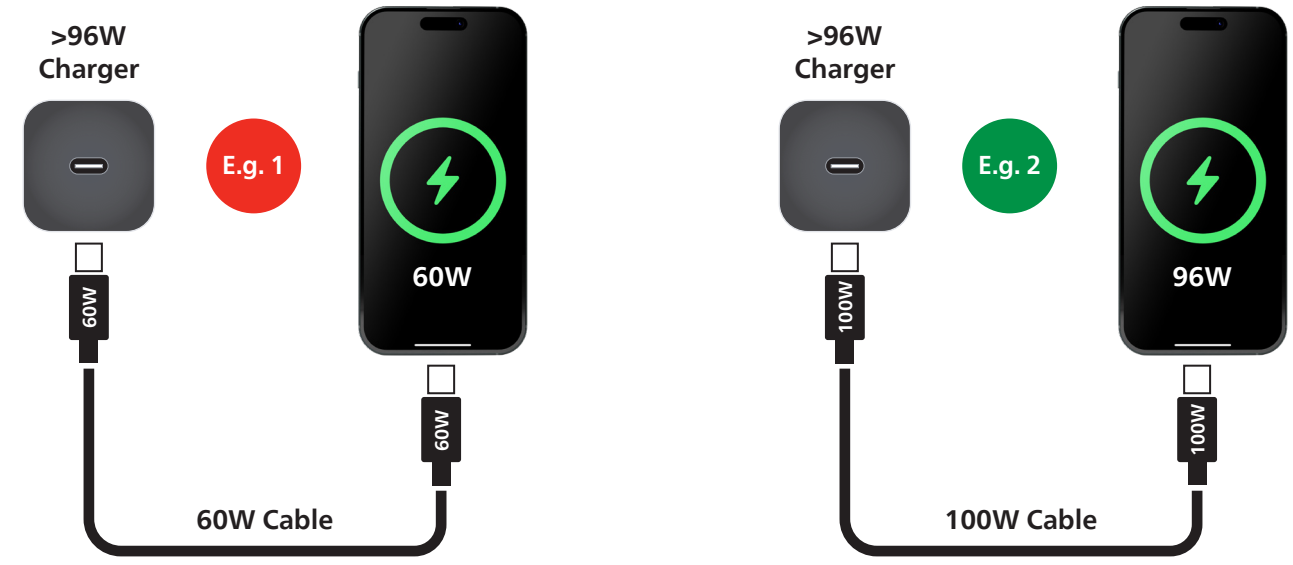
2.2 Choosing the right cable

USB cable specification

USB Cable	Power can be supported	Data Speed(if built-in)	Remark
USB-C to USB-C	240W	USB4.0, 40Gbps USB3.2, 20Gbps USB3.1, 10Gbps USB3.0, 5Gbps USB2.0, 480M	Max. 5A ; Mark "xx watt" at terminal of cable
	180W		Max. 5A ; Mark "xx watt" at terminal of cable
	140W		Max. 5A ; Mark "xx watt" at terminal of cable
	100W		Max. 5A ; Mark "xx watt" at terminal of cable
	65W		Max. 3A
	60W		Max. 3A
	45W		Max. 3A
	27W		Max. 3A
	20W		Max. 3A
	18W		Max. 2A
	15W		Max. 3A
	10W		Max. 2A
USB-C to Lightning	20W	USB 2.0, 480M	Max. 3A
	18W		Max. 3A
	10W		Max. 2A
USB-A to USB-C	18W	USB3.1, 10Gbps USB3.0, 5Gbps USB2.0, 480M	Max. 3A
	10W		Max. 2A
USB A - Lightning	18W	USB 2.0, 480M	Max. 3A
	10W		Max. 2A
USB-A to Micro-USB	18W	USB 2.0, 480M	Max. 3A
	10W		Max. 2A

Present situation

Assume you got a 140W GaN charger and bought a USB C to USB C charging cable, but found that charging the laptop was very slow.



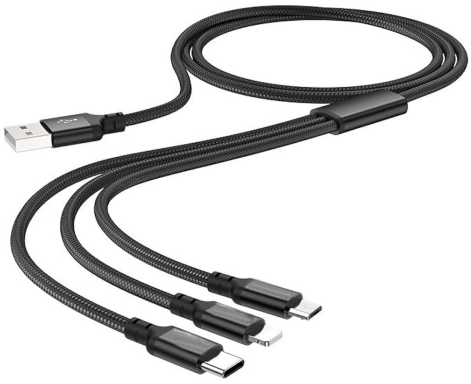
Device not capable to be charged with full 96W due to slow cable

Device charging in full 96W with the right cable

Pick the right 3-in-1 Cable

1. Alarm

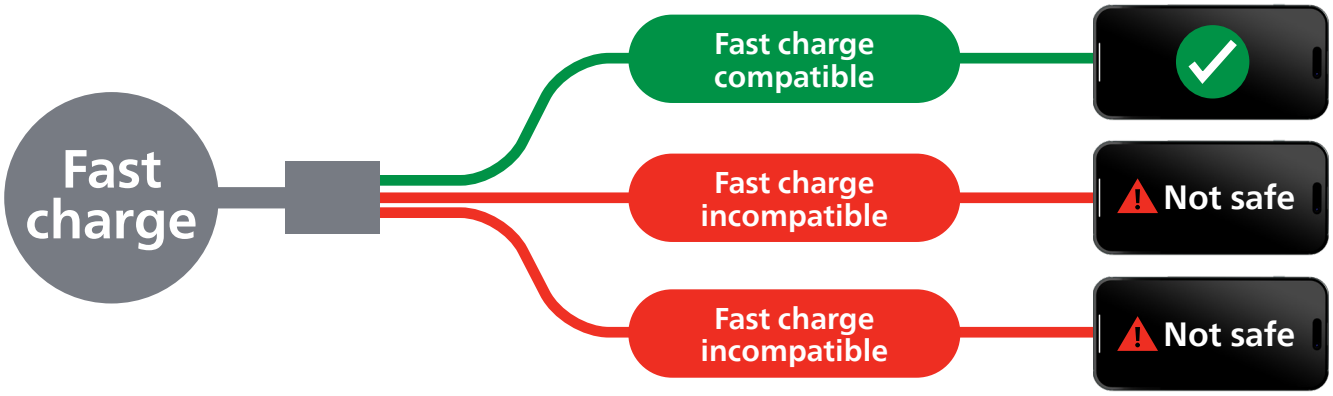
Your skins might get burned if using these 3-in-1 cable.



2. Why?

• When charging three devices at the same time, it is equivalent to connecting the three devices in parallel. The voltage received by their interfaces is the same.

• If one of the wires is a mobile phone that supports fast charging, the other two wires are connected to a Bluetooth headset or power bank that does not support fast charging. At this time, in order to meet the demand for fast charging, the mobile phone will negotiate with the charger to increase the charging voltage. The charger couldn't tell that three devices were connected. It thought it was just a fast charging device charging.



3. Conclusion

It's remommended strongly for end-user to use below kind of 3-in-1 cable for safer experience.

USB cable line-up

Best

Better

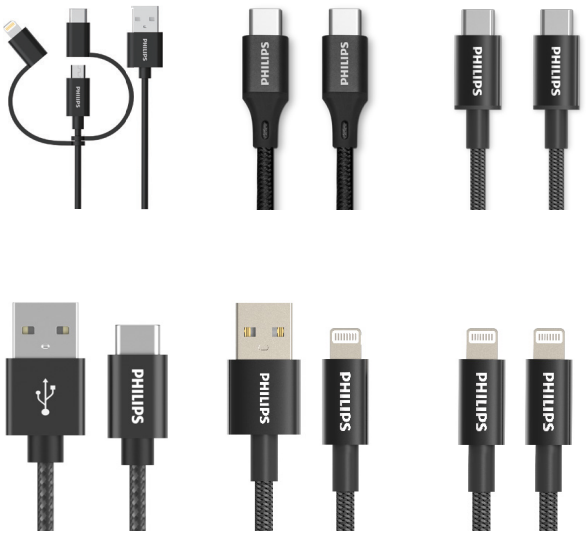
Good

Existing

2024

65-240W: Marked

≤60W(3A): No marking



Fast charging wattage indication

To guide the consumer choosing the right cable, maximum wattage supported will be indicated on the cable, either with silk screen or in-mold, we also offer premium products with built-in display updating charging speed in realtime.

Silkscreen **In-mold** **Built-in display**

Remark:

From charging power view, USB PD, QC4.0 and above, PPS etc. protocols for higher power(≥96w), the port comes to “USB-C”.

From data transfer speed, USB3.2 and above, Thunderbolt3 and above for higher data rate(≥10Gbps), the port comes to “USB-C”.