

USB D+ D- Input Current Limit Detection for BQ2419x, BQ2429x, BQ2589x, BQ25898x, BQ2560x, and BQ2561x



Ning Tang

ABSTRACT

This application report provides USB D+/D- input current limit detection capability comparison among single cell switching battery charger devices including BQ2419x, BQ2429x, BQ2589x, BQ25898x, BQ2560x, and BQ2561x. This document can assist design engineers with selecting the most suitable IC for their USB input current limit detection needs.

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1 USB Battery Charging Specification 1.2 (BC1.2)

The USB Battery Charging Specification 1.2 (BC1.2) specification defines the mechanisms to permit USB devices to draw current higher than standard USB current such 500 mA for USB2.0, 900 mA for USB3.0. Through the mechanism defined in the BC1.2 spec, devices can draw up to 1.5 A of current. The detection and the advertisement of the higher current capable ports are done through USB2.0 D+ and D- lines upon connection. There are three charging ports defined in the BC1.2 spec:

- Dedicated Charging Port (DCP)
- Charging Downstream Port (CDP)
- Standard Downstream Port (SDP)

Table 1-1 shows the most common USB 1.2 port types.

Table 1-1. USB BC1.2 Port Types

Port Definition	Examples	Output Current
SDP (Standard Downstream Port)	Laptop USB port	5 V at 100mA (USB 2.0) 5 V at 500 mA (USB2.0) 5 V at 900 mA (USB3.0)
DCP (Dedicated Charging Port)	USB Wall adapter	5 V at 500 mA to 1.5 A
CDP (Charging Downstream Port)	Audio Docking Station	5 V at 900 mA to 1.5 A

2 HVDCP, USB Type-C, and USB PD

To achieve fast charging, high voltage (9 V/12 V) adapter with USB compatibility (5 V) is required. TI refers such adapters as HVDCP (High Voltage Dedicated Charging Port) in general. Several companies have proprietary handshake to achieve this goal. It also includes TI-defined proprietary handshake MaxCharge™.

When DCP is detected, the charger can initiate adjustable high-voltage adapter handshake including MaxCharge and so on. The handshake connects combinations of voltage source(s) and/or current sink on D+/D- to signal input source to raise output voltage from 5 V to 9 V / 12 V with up to 1.5 A current capability.

Table 2-1 shows other popular USB D+/D- input current limit detection types.

Table 2-1. Other Popular USB D+/D- Input Current Limit Detection Types

Port Definition	Examples	Output Current
Non-Standard Adapters	Certain market adapters	5 V at 1 A / 2.1 A / 2.4 A
HVDCP (High Voltage Dedicated Charging Port)	MaxCharge™ adapter	5 V / 9 V / 12 V at 1.5 A
USB Type-C at 1.5 A	-	5 V / 1.5 A
USB Type-C at 3 A	-	5 V / 3 A
USB PD (Power Delivery)	-	Up to 20 V / Up to 5 A

3 Input Current Limit Detection Capability Comparison

Table 3-1 shows D+/D- input current limit detection capability comparison among single cell switching battery charger devices.

Table 3-1. USB D+/D- Input Current Limit Detection Capability Comparison

USB D+/D- detection	Devices
SDP (USB100, USB500), DCP, CDP	BQ24190, BQ24195/L
SDP (USB100, USB500), DCP, Non-Standard Adapters (3 options)	BQ24297
SDP (USB500), DCP, Non-Standard Adapters (3 options)	BQ24295
SDP (USB500), DCP, Non-Standard Adapters (4 options)	BQ25601D, BQ25600D, BQ25611D
SDP (USB500), DCP, Non-Standard Adapters (4 options) (Standalone single-cell chargers with ILIM pin)	BQ25606, BQ25616
SDP (USB500), DCP, CDP, Non-Standard Adapters (4 options), HVDCP	BQ25890, BQ25895
SDP (USB500), DCP, CDP, Non-Standard Adapters (4 options), HVDCP, Programmable D+/D- Drivers for Non-Standard Adapter handshake	BQ25890H, BQ25898D

4 BQ24190, BQ24195, and BQ24195L

The BQ24190, BQ24195, and BQ24195L can detect SDP, DCP and CDP shown in Table 4-1.

Table 4-1. BQ24190, BQ24195, and BQ24195L USB D+/D- Detection

D+/D- Detection	OTG	Input Current Limit
0.5 sec timer expired in DCD (D+/D- floating)	-	100 mA
USB host	Low	100 mA
USB host	High	500 mA
Charging port	-	1.5 A

5 BQ24295

Besides USB500 and DCP, the device can also detect three types of non-standard adapters as shown in [Table 5-1](#).

Table 5-1. BQ24295 USB D+/D- Detection

D+/D- Detection	Input Current Limit
0.5 sec timer expired in DCD (D+/D- floating)	Proceed to non-standard adapter detection
USB host	500 mA
Charging port	3 A

When DCD 0.5 sec timer expires, the non-standard adapter detection is used to distinguish three different divider bias conditions on D+/D- pins. When non-standard adapter is detected, the input current limit (REG0[2:0]) is set based on [Table 5-2](#) and REG08[7:6] is set to 10 (Adapter port). If non-standard adapter is not detected, REG08[7:6] is set to 00 (Unknown) and the input current limit is set in REG0[2:0] to 500mA by default.

Table 5-2. BQ24295 Non-Standard Adapter Detection

Non-Standard Adapter	D+ Threshold	D- Threshold	Input Current Limit
Divider 1	$V_{\text{adpt1_lo}} < V_{\text{D+}} < V_{\text{adpt1_hi}}$ For VBUS = 5 V, typical range $2.4 \text{ V} < V_{\text{D+}} < 3.1 \text{ V}$	$V_{\text{D-}} < V_{\text{adpt1_lo}}$ or $V_{\text{D-}} > V_{\text{adpt1_hi}}$ For VBUS = 5 V, typical range $V_{\text{D-}} < 2.4 \text{ V}$ or $V_{\text{D-}} > 3.1 \text{ V}$	2.0 A
Divider 2	$V_{\text{adpt2_lo}} < V_{\text{D+}} < V_{\text{adpt2_hi}}$ For VBUS = 5 V, typical range $0.85 \text{ V} < V_{\text{D+}} < 1.5 \text{ V}$	NA	2.0 A
Divider 3	$V_{\text{D+}} < V_{\text{adpt3_lo}}$ or $V_{\text{D+}} > V_{\text{adpt3_hi}}$ For VBUS = 5 V, typical range $V_{\text{D+}} < 2.4 \text{ V}$ or $V_{\text{D+}} > 3.1 \text{ V}$	$V_{\text{adpt3_lo}} < V_{\text{D-}} < V_{\text{adpt3_hi}}$ For VBUS = 5 V, typical range $2.4 \text{ V} < V_{\text{D-}} < 3.1 \text{ V}$	1 A

6 BQ24297

Comparing to BQ24295, BQ24297 can also detect USB100 as shown in [Table 6-1](#).

Table 6-1. BQ24297 USB D+/D- Detection

D+/D- Detection	OTG	Input Current Limit
0.5 sec timer expired in DCD (D+/D- floating)	-	Proceed to non-standard adapter detection
USB host	Low	100mA
USB host	High	500mA
Charging port	-	3A

When DCD 0.5 sec timer expires, the non-standard adapter detection is used to distinguish three different divider bias conditions on D+/D- pins. When non-standard adapter is detected, the input current limit (REG0[2:0]) is set based on [Table 6-2](#) and REG08[7:6] is set to 10 (Adapter port). If non-standard adapter is not detected, REG08[7:6] is set to 00 (Unknown) and the input current limit is set in REG0[2:0] to 500 mA by default.

Table 6-2. BQ24297 Non-Standard Adapter Detection

Non-Standard Adapter	D+ Threshold	D- Threshold	Input Current Limit
Divider 1	$V_{\text{adpt1_lo}} < V_{\text{D+}} < V_{\text{adpt1_hi}}$ For VBUS = 5 V, typical range $2.4 \text{ V} < V_{\text{D+}} < 3.1 \text{ V}$	$V_{\text{D-}} < V_{\text{adpt1_lo}}$ or $V_{\text{D-}} > V_{\text{adpt1_hi}}$ For VBUS = 5 V, typical range $V_{\text{D-}} < 2.4 \text{ V}$ or $V_{\text{D-}} > 3.1 \text{ V}$	2.0 A
Divider 2	$V_{\text{adpt2_lo}} < V_{\text{D+}} < V_{\text{adpt2_hi}}$ For VBUS = 5 V, typical range $0.85 \text{ V} < V_{\text{D+}} < 1.5 \text{ V}$	NA	2.0 A
Divider 3	$V_{\text{D+}} < V_{\text{adpt3_lo}}$ or $V_{\text{D+}} > V_{\text{adpt3_hi}}$ For VBUS = 5 V, typical range $V_{\text{D+}} < 2.4 \text{ V}$ or $V_{\text{D+}} > 3.1 \text{ V}$	$V_{\text{adpt3_lo}} < V_{\text{D-}} < V_{\text{adpt3_hi}}$ For VBUS = 5 V, typical range $2.4 \text{ V} < V_{\text{D-}} < 3.1 \text{ V}$	1 A

7 BQ25890 and BQ25895

The BQ25890 and BQ25895 can detect BC1.2, non-standard adapters and HVDCP (MaxCharge™) as shown in [Table 7-1](#), [Table 7-2](#), and [Table 7-3](#).

Table 7-1. Input Current Limit Setting from D+/D- Detection

D+/D- Detection	Input Current Limit
USB SDP (USB500)	500 mA
USB CDP	1.5 A
USB DCP	3.25 A
Divider 3	1 A
Divider 1	2.1 A
Divider 4	2.4 A
Divider 2	2 A
MaxCharge	1.5 A
Unknown Adapter	500 mA

Table 7-2. Non-Standard Adapter Detection

Non-Standard Adapter	D+ Threshold	D- Threshold	Input Current Limit
Divider 1	V_{D+} within V_{2P7_VTH}	V_{D-} within V_{2P0_VTH}	2.1 A
Divider 2	V_{D+} within V_{1P2_VTH}	V_{D-} within V_{1P2_VTH}	2 A
Divider 3	V_{D+} within V_{2P0_VTH}	V_{D-} within V_{2P7_VTH}	1 A
Divider 4	V_{D+} within V_{2P7_VTH}	V_{D-} within V_{2P7_VTH}	2.4 A

Table 7-3. HVDCP (Adjustable High Voltage Adapter) D+/D- Output Configurations

Adjustable High Voltage Handshake	D+	D-	Output
MaxCharge (12 V)	I_{1P6MA_ISINK}	V_{3p45_VSRC}	12 V
MaxCharge (9 V)	V_{3p45_VSRC}	I_{1P6MA_ISINK}	9 V

8 BQ25890H and BQ25898D

Similar to BQ25890 and BQ25895, the BQ25890H/BQ25898D also provides independent controlled voltage output drivers on D+ and D- pins to interface or emulate non-standard adapters when input source is plugged-in or OTG mode is enabled.

For detailed explanations on the D+/D- drivers, refer to the corresponding reference designs [Optimizing Efficiency by Handshaking Adjustable Adapters and Battery Chargers Reference Design](#) and [Handshaking Between Adjustable HVDCP Adapters and Battery Chargers Reference Design](#).

9 BQ25601D, BQ25600D, and BQ25611D

Besides USB500 and DCP, the devices can also detection 4 types of non-standard adapters shown in [Table 9-1](#) and [Table 9-2](#).

Table 9-1. Input Current Limit Setting from D+/D– Detection

D+/D- Detection	Input Current Limit
USB SDP (USB500)	500 mA
USB DCP	2.4 A
Divider 3	1 A
Divider 1	2.1 A
Divider 4	2.4 A
Divider 2	2 A
Unknown Adapter	500 mA

Table 9-2. Non-Standard Adapter Detection

Non-Standard Adapter	D+ Threshold	D- Threshold	Input Current Limit
Divider 1	V_{D+} within V_{2P7_VTH}	V_{D-} within V_{2P0_VTH}	2.1 A
Divider 2	V_{D+} within V_{1P2_VTH}	V_{D-} within V_{1P2_VTH}	2 A
Divider 3	V_{D+} within V_{2P0_VTH}	V_{D-} within V_{2P7_VTH}	1 A
Divider 4	V_{D+} within V_{2P7_VTH}	V_{D-} within V_{2P7_VTH}	2.4 A

10 BQ25606 and BQ25616

The USB input current limit detection capability for BQ25606/BQ25616 are the same as BQ25601D/BQ25600D/BQ25611D. The only difference is that BQ25606 and BQ25616 are standalone chargers without host control. The input current limit for BQ25606 and BQ25616 is determined by ILIM pin when the input adapter is detected as unknown.

Table 10-1. Input Current Limit Setting from D+/D– Detection

D+/D- Detection	Input Current Limit
USB SDP (USB500)	500 mA
USB DCP	2.4 A
Divider 3	1 A
Divider 1	2.1 A
Divider 4	2.4 A
Divider 2	2 A
Unknown Adapter	Set by ILIM pin

Table 10-2. Non-Standard Adapter Detection

Non-Standard Adapter	D+ Threshold	D- Threshold	Input Current Limit
Divider 1	V_{D+} within V_{2P7_VTH}	V_{D-} within V_{2P0_VTH}	2.1 A
Divider 2	V_{D+} within V_{1P2_VTH}	V_{D-} within V_{1P2_VTH}	2 A
Divider 3	V_{D+} within V_{2P0_VTH}	V_{D-} within V_{2P7_VTH}	1 A
Divider 4	V_{D+} within V_{2P7_VTH}	V_{D-} within V_{2P7_VTH}	2.4 A

11 Summary

The single cell switching battery charger devices including BQ2419x, BQ2429x, BQ2589x, BQ25898x, BQ2560x and BQ2561x follows the USB Battery Charging Specification 1.2 (BC1.2) and may detect certain types of standard and non-standard adapters through USB D+/D- lines. These devices can work with 5 V input USB Type-C® charging, but they cannot detect USB Type-C adapters. A USB interface is needed to support USB Type-C charging solutions. In addition, these devices cannot detect USB PD (Power Delivery) adapters.

12 References

Unless otherwise noted, all documents are available for download at www.ti.com.

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15. Texas Instruments, [Handshaking Between Adjustable HVDCP Adapters and Battery Chargers](#) application report.

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