Battery Charger Series

Linear Charger for Low Voltage Battery

BD71631QWZ

Lithium-ion Secondary Battery SLB Series

Charging Characteristics

The input voltage of the linear charger IC BD71631QWZ is 2.9V to 5.5V, and the charging voltage can be set from 2.0V to 4.7V using an external resistor. The charging current can be set up to 300mA using an external resistor, and the termination current can be set up to 10mA.

The characteristics of charging the small lithium-ion secondary battery SLB series (manufactured by Nichicon) using BD71631QWZ will be introduced.

Information about the SLB series is included at the time this application note Rev 001 was created.

For the latest product information, please contact the manufacturer Nichicon Corporation (nichicon.co.jp).

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Charging Settings and Application Circuit

As shown in Figure 1, the BD71631QWZ allows you to set the charging voltage (V_{CHG}), recharge voltage (V_{RECHG}), charging current (I_{CHG}), and termination current (I_{TERM}) using external resistors. It is possible to change the charging settings according to the battery specifications.

Charging starts when the battery voltage is lower than the pre-charge voltage (V_{PRE}), the charging current (I_{PRE}) flows. A constant current (CC) of $I_{CHG}/2$ flows through I_{PRE}.

When the battery voltage reaches the pre-charge voltage (V_{PRE}), constant current charging (CC charging) is performed using the charging current (I_{CHG}).

When the battery voltage reaches the charging voltage (V_{CHG}), it automatically changes to constant voltage charging (CV charging) and the charging current (I_{CHG}) decreases.

When the charging current (I_{CHG}) reaches the termination current (I_{TERM}), it enters the TOP-OFF state. After 15 seconds, it enters the DONE state, and the state transitions to Charge Stop.

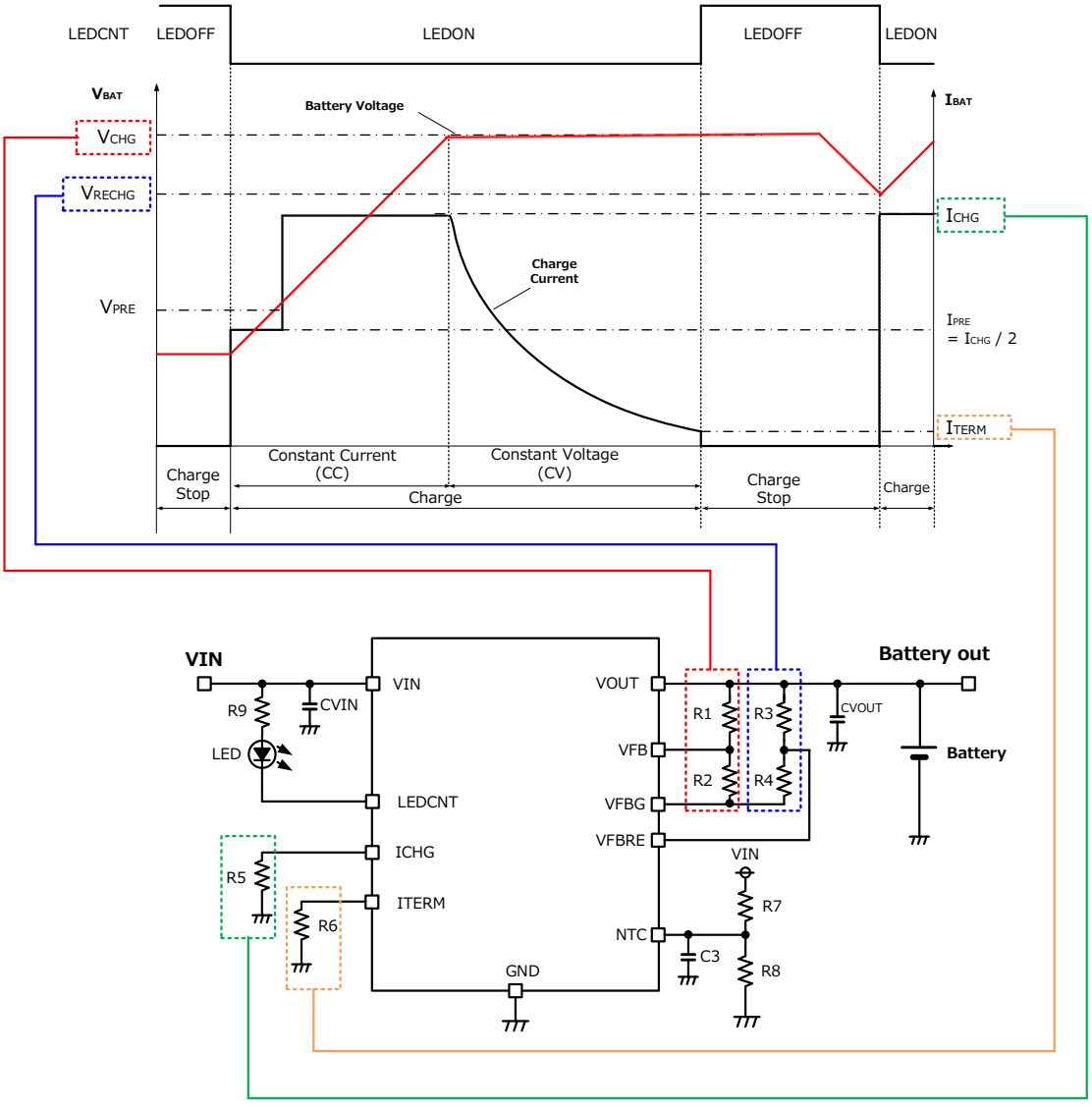

Figure 1: Charging profile and application circuit

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Peripheral Parts Settings

Setting the Charging Voltage (V_{CHG}) and Recharging Voltage (V_{RECHG})

Charging voltage (V_{CHG}) can be set using the following formula.

$$V_{CHG} = (R1 + R2\ )/R2 \times 0.6\ [V]$$

To set the recharge voltage (V_{RECHG}), resistors R3 and R4 are connected to the VFBRE terminal and are determined below.

$$V_{RECHG} = (R3 + R4)/R4 \times 0.6\ [V]$$

Regarding the Current Generated by External Resistance of VFB Pin and VFBRE Pin

An N-channel FET is built in between the VFBG and GND terminals.
Connecting the VIN pin turns on the N-channel FET and current flows from the battery to the external resistor.
When the VIN pin is disconnected, the N-channel FET is turned off and no current flows from the battery to the external resistor.
If recharging is disabled by connecting the VFBRE pin to GND, even if VIN is connected, the internal N-channel FET will be turned off once charging is complete and no current will flow to the external resistor.

Setting the Charging Current (I_{CHG})

Charging current (I_{CHG}) can be set using the following formula using external resistor R5.

$$I_{CHG} = (500000\ /\mathrm{R5}\ [\Omega])[\mathrm{mA}]$$

The usage range of charging current (I_{CHG}) is limited by the voltage between VIN and VOUT as described in Table 1.

Setting the Termination Current (I_{TERM})

The termination current (I_{TERM}) can be set using the following formula using external resistor R6.

$$I_{TERM} = (50000\ /\mathrm{R6}\ [\Omega])[\mathrm{mA}]$$

The termination current can be set from 50μA to 10mA using an external resistor.

NTC Terminal Resistance Settings

If a thermistor is not used, connect the NTC terminal to GND. If a thermistor is used, R7 and R8 in the application schematic are used. Please refer to page 9 of the data sheet.

LEDCNT Settings

This is a terminal for driving the LED. Be sure to connect the pull-up resistor to VIN. In this application note, R9 is 10kΩ.

Table 1. Settable charging current I_{CHG} setting conditions

	I_{CHG} conditions		
Input voltage (VIN)	2.9 V ≤ VIN ≤ 5.5 V	VIN ≥ 4 V	VIN ≥ 4 V
Voltage difference between input (VIN) and output (VOUT)	VIN - VOUT ≥ 0.3 V	VIN - VOUT ≥ 0.3 V	VIN - VOUT ≥ 1 V
Configurable charging current (I_{CHG})	≤ 30mA	≤ 100mA	≤ 300mA
Comment	If the input voltage range is 2.9 V ≤ VIN ≤ 5.5 V and (VIN - VOUT) is 0.3 V or more, it can be set up to 30 mA.	If the input voltage is VIN ≥ 4 V and (VIN -VOUT) is 0.3V or more, it can be set up to 100mA.	If the input voltage is VIN ≥ 4 V and (VIN -VOUT) is 1V or more, it can be set up to 300mA.

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Charging Example using SLB03070LR35

A setting example for charging SLB03070LR35 is shown below. The maximum voltage range is 2.8V, so consider the accuracy of the charging voltage of BD71631QWZ and set the charging voltage (V_{CHG}) to 2.7V. The nominal capacity of SLB03070LR35 is 0.35mAh and the maximum charging current at 20C rate is 7mA, so set the charging current (I_{CHG}) to 7mA. Set the recharge voltage (V_{RECHG}) to 2.48V.
Set the termination current (I_{TERM}) to 50µA so that charging is complete when the charging current reaches 50µA.

Table 2. Battery specification SLB03070LR35

Part number	SLB03070LR35 
Size Diameter	3.0 mm
Height	7.0 mm
Nominal voltage	2.4V
Voltage range Maximum charging voltage - end of discharge voltage	2.8 - 1.8V
Nominal capacity	0.35mAh
Max.charge / discharge current	7mA
(C rate)	(20C)
Temperature range	-30 to +60ºC
ESR (at 1kHz)	Max. 12 Ω
Energy density	17Wh/L
Weight	0.12g

Charging Settings

VIN=5V

V_{CHG}=2.7V	R1=560kΩ, R2=160kΩ
V_{RECHG}=2.48V	R3=470kΩ, R4=150kΩ
I_{CHG}=7mA	R5=75kΩ
I_{TERM}=50µA	R6=910kΩ

Charging starts from the battery's initial voltage of 1.410V. After continuing CC charging for 78 seconds, it automatically switches to CV charging. Charging will be completed after CV charging continues for 788s.

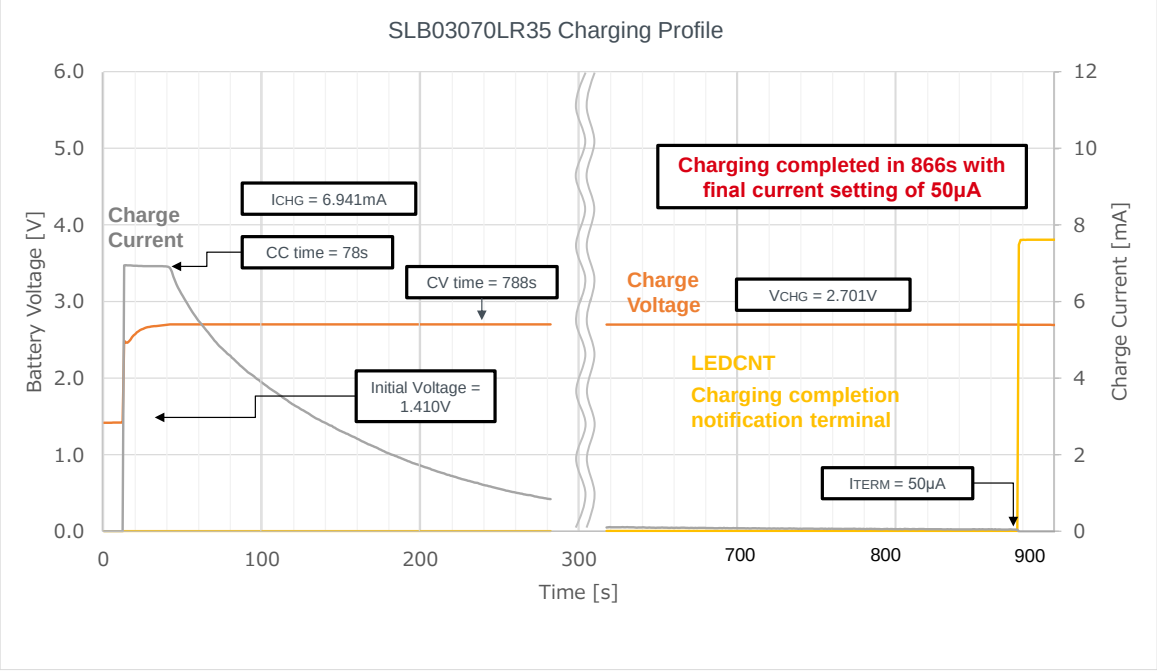

Figure 2. Charging example using SLB03070LR35

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Charging Example using SLB03090LR80

A setting example for charging SLB03090LR80 is shown below. The maximum voltage range is 2.8V, so consider the accuracy of the charging voltage of BD71631QWZ and set the charging voltage (V_{CHG}) to 2.7V. The nominal capacity of SLB03090LR80 is 0.8mAh and the maximum charging current at 20C rate is 16mA, so set the charging current (I_{CHG}) to 16mA. Set the recharge voltage (V_{RECHG}) to 2.48V. Set the termination current (I_{TERM}) to 50µA so that charging is complete when the charging current reaches 50µA.

Table 3. Battery specification SLB03090LR80

Part number	SLB03090LR80 
Size Diameter	3.3 mm
Height	9.0 mm
Nominal voltage	2.4V
Voltage range Maximum charging voltage - end of discharge voltage	2.8 - 1.8V
Nominal capacity	0.80mAh
Max.charge / discharge current	16mA
(C rate)	(20C)
Temperature range	-30 to +60ºC
ESR (at 1kHz)	Max. 8 Ω
Energy density	25Wh/L
Weight	0.12g

Charging Settings

VIN=5V

V_{CHG}=2.7V	R1=560kΩ、R2=160kΩ
V_{RECHG}=2.48V	R3=470kΩ、R4=150kΩ
I_{CHG}=16mA	R5=30kΩ
I_{TERM}=50µA	R6=910kΩ

Charging starts from the battery's initial voltage of 1.802V. After continuing CC charging for 138 seconds, it automatically switches to CV charging. Charging will be completed after CV charging continues for 2181s.

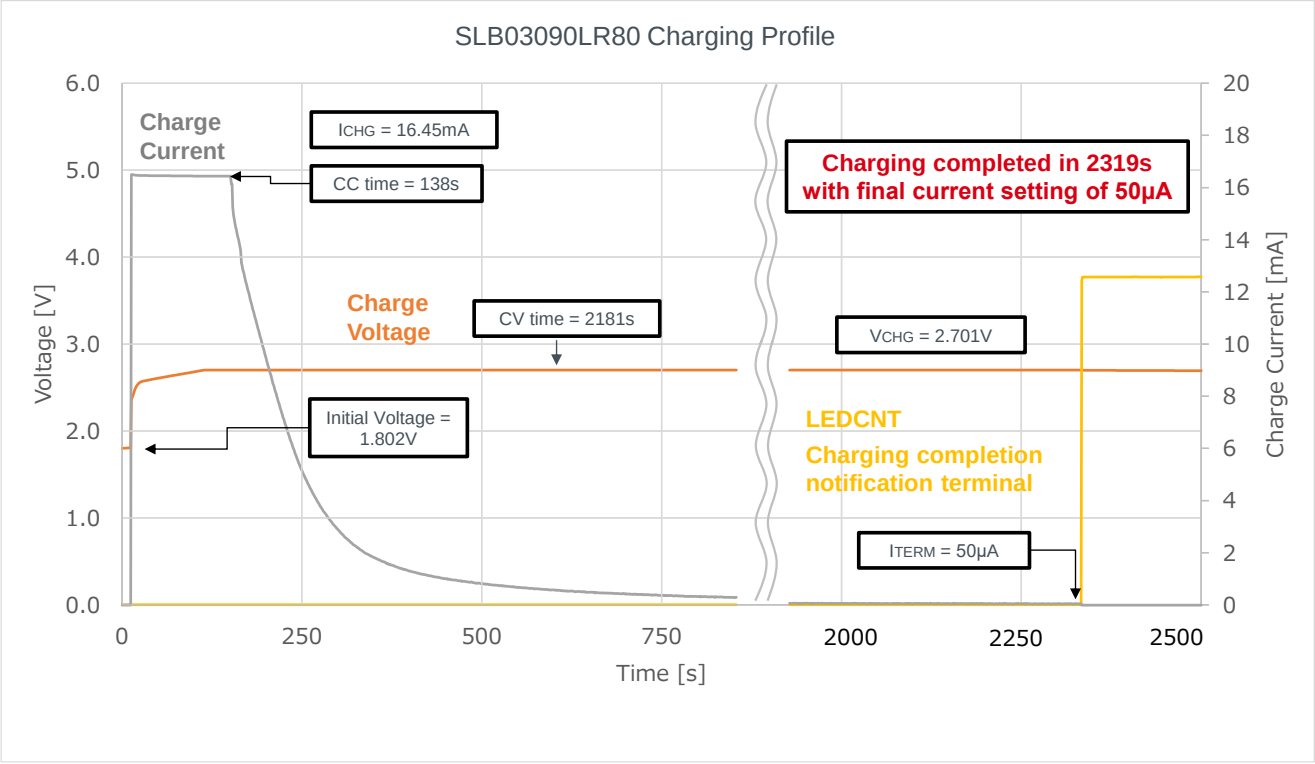

Figure 3. Charging example using SLB03090LR80

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Charging Example using SLB04255L040

A setting example for charging SLB04255L040 is shown below. The maximum voltage range is 2.8V, so consider the accuracy of the charging voltage of BD71631QWZ and set the charging voltage (V_{CHG}) to 2.7V. The nominal capacity of SLB04255L040 is 4mAh and the maximum charging current at 20C rate is 80mA, so set the charging current (I_{CHG}) to 80mA. Set the recharge voltage (V_{RECHG}) to 2.48V. Set the termination current (I_{TERM}) to 200µA so that charging is complete when the charging current reaches 200µA.

Table 4. Battery specification SLB04255L040

Part number	SLB04255L040 
Size Diameter	4.0 mm
Height	25.5 mm
Nominal voltage	2.4V
Voltage range Maximum charging voltage - end of discharge voltage	2.8 - 1.8V
Nominal capacity	4mAh
Max.charge / discharge current	80mA
(C rate)	(20C)
Temperature range	-30 to +60ºC
ESR (at 1kHz)	Max. 0.6 Ω
Energy density	30Wh/L
Weight	0.75g

Charging Settings

VIN=5V

VCHG=2.7V	R1=560kΩ、R2=160kΩ
VRECHG=2.48V	R3=470kΩ、R4=150kΩ
ICHG=80mA	R5=5.1kΩ+1.2kΩ(Series)
ITERM=200µA	R6=240kΩ

Charging starts from the battery's initial voltage of 1.825V. After continuing CC charging for 109 seconds, it automatically switches to CV charging. Charging will be completed after CV charging continues for 2146s.

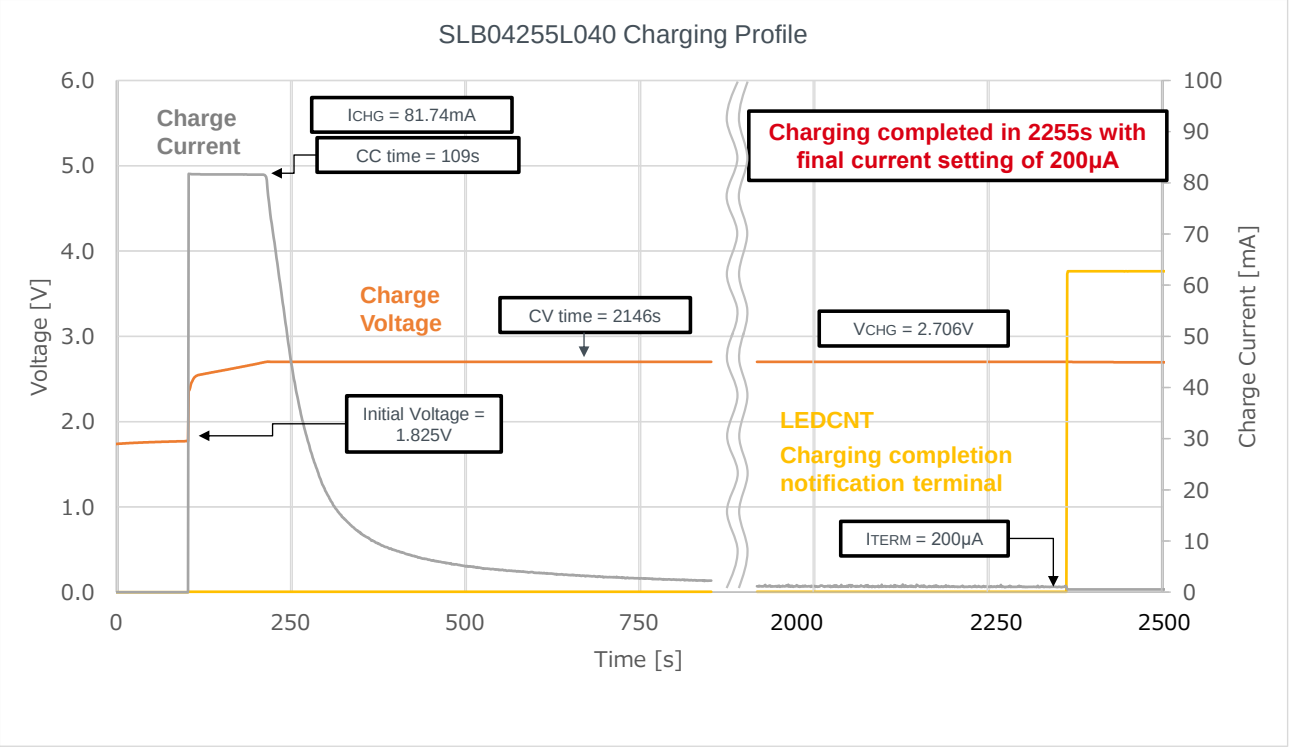

Figure 4. Charging example using SLB04255L040

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Charging Example using SLB08115L140

A setting example for charging SLB08115L140 is shown below. The maximum voltage range is 2.8V, so consider the accuracy of the charging voltage of BD71631QWZ and set the charging voltage (V_{CHG}) to 2.7V. The nominal capacity of SLB08115L140 is 14mAh and the maximum charging current at 20C rate is 280mA, so set the charging current (I_{CHG}) to 280mA. Set the recharge voltage (V_{RECHG}) to 2.48V. Set the termination current I_{TERM} to 700µA so that charging is complete when the charging current reaches 700µA.

Table 5. Battery specification SLB08115L140

Part number	SLB08115L140 
Size Diameter	8.0 mm
Height	11.5 mm
Nominal voltage	2.4V
Voltage range Maximum charging voltage - end of discharge voltage	2.8 - 1.8V
Nominal capacity	14mAh
Max.charge / discharge current	280mA
(C rate)	(20C)
Temperature range	-30 to +60ºC
ESR (at 1kHz)	Max. 0.24 Ω
Energy density	58Wh/L
Weight	1.2g

Charging Settings

VIN=5V

V_{CHG}=2.7V	R1=560kΩ、R2=160kΩ
V_{RECHG}=2.48V	R3=470kΩ、R4=150kΩ
I_{CHG}=278mA	R5=1.8kΩ
I_{TERM}=700µA	R6=68kΩ

Charging starts from the battery's initial voltage of 1.808V. After continuing CC charging for 85 seconds, it automatically switches to CV charging. Charging will be completed after CV charging continues for 2102s.

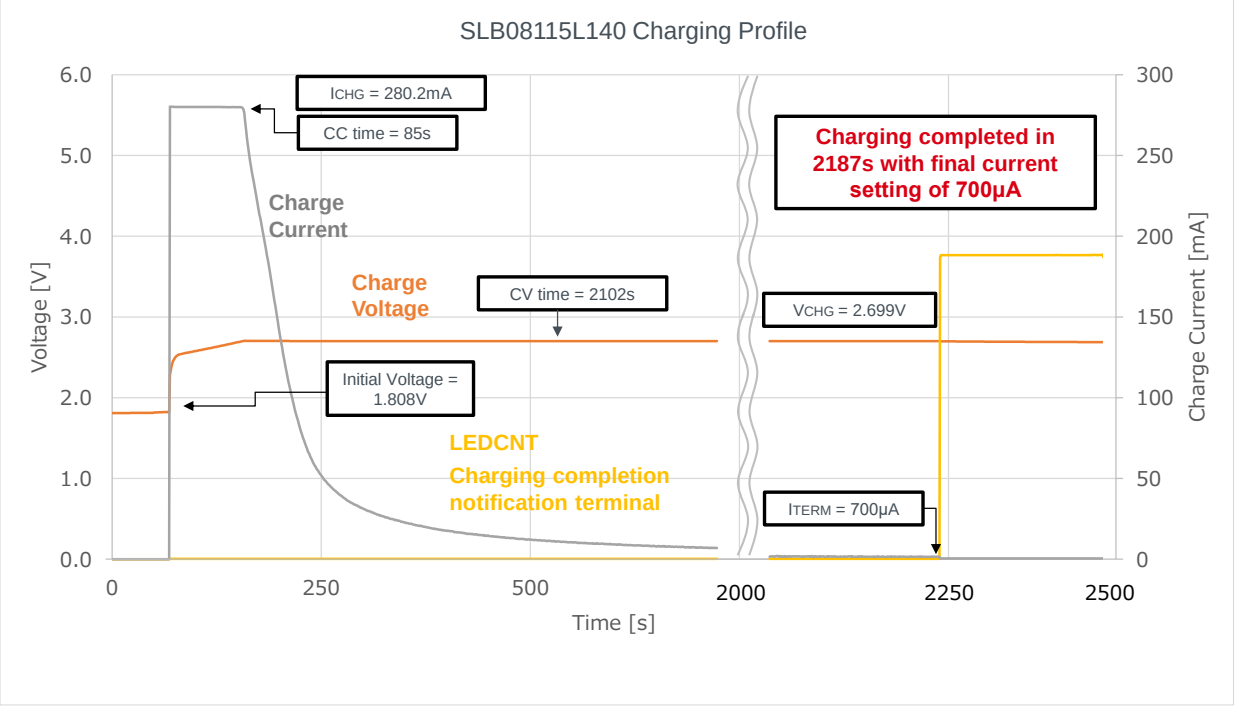

Figure 5. Charging example using SLB08115L140

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Revision History

Date	Revision Number	Description
20. Feb. 2024	001	Initial release

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