

# Application Note

## Battery Simulator

Many portable electronic devices use rechargeable battery such as lithium ion or lithium polymer, nickel metal hydride (NiMH), or nickel cadmium (NiCd) battery. Many of these rechargeable devices have charger circuit built inside. For testing these electronic devices, [battery simulator](#) is often needed. To simulate these batteries, a battery simulator, typically a power source, emulates some of the battery characteristics. The most important characteristic is the ability to sink current when charged. When a battery is charged, it sinks current. Current is flow into the battery being charged.

Conventional power supply can only source current, but cannot sink current. Thus conventional power supply cannot effectively simulate a battery. Figure 1 and 2 show simplified diagrams for the difference between a conventional power supply and a battery simulator. Conventional power supply is depicted with a single NPN transistor allowing current to flow only in one direction – sourcing current. Battery simulator on the other hand can sink and source current as shown in Figure 2A. The top NPN transistor for sourcing current and the bottom PNP transistor is for sinking current.

A battery simulator can easily change the “battery” voltage by adjusting a knob. Compared to a real battery whose voltage is slowly change by charge or discharge. Thus battery simulator is a very useful instrument for testing battery-operated systems.

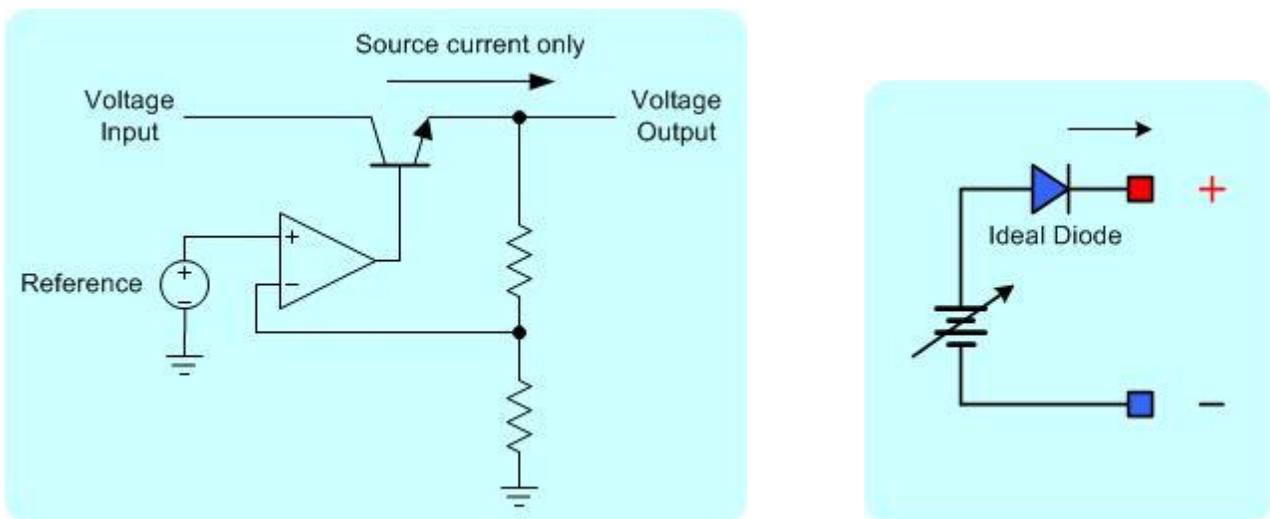


Figure 1. A) Simplified conventional power supply circuit. B) Equivalent circuit.

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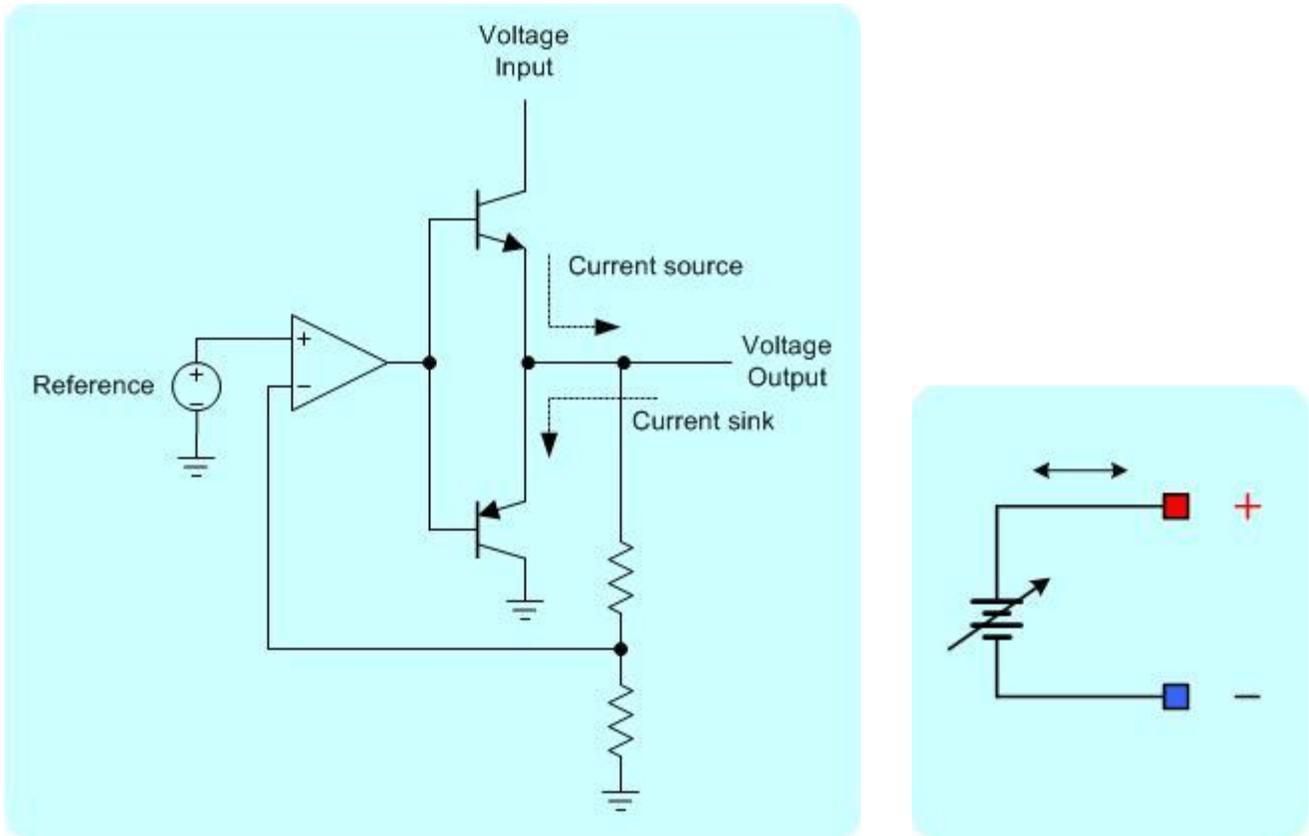


Figure 2. A) Simplified battery simulator circuit. B) Equivalent circuit.

## Battery Simulator Applications

### TS200 as a Battery Simulator

The TS200 modulated power supply can sink and source current the same way a real battery does. It features a DC OFFSET knob that can adjust the voltage to emulate battery voltage changes. It is especially useful for simulating a battery for charger circuit testing

### Battery Charger Testing

Most portable electronic devices have built-in charger that recharges the battery. During product development and final production testing, the charger circuit must be thoroughly tested to ensure its reliability and safely charges batteries. A battery simulator is the most valuable instrument for battery charger testing.

Battery simulator is often used to test the charger operation over the entire battery voltage (i.e. 0V to 4.2V). For example, a lithium ion battery normal operating voltage is 3.0V to 4.2V, but battery voltage also can be 0V to 3.0V if it is deeply discharged. The charger must be tested to ensure that it can charge a battery at any voltage within a limit. Using a battery simulator, you can easily simulate

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the battery to any voltage by adjusting the knob. You can measure the charging current at low battery voltage, less than 3V for Li+ battery, normal voltage 3V to ~4.2V, and high voltage greater than 4.2V to verify against its specification.

## Battery Simulator Advantages

Normally, it takes several hours to fully charge a real battery. For testing purpose, instead of waiting for the charger to charge a real battery, you can use a battery simulator to quickly vary the voltage to emulate the battery is being charged. At the same time you can observe and test the charger behavior to ensure it meets all of the specifications and safely charge the battery.

For example, lithium ion battery typically employed a CC/CV (constant current, constant voltage) charging method. At low battery voltage, less than 3.0V, the battery is being trickle charged a low current (one-tenth of the normal charge current). Between 3.0V and ~4.2V is the normal rapid charge current. When battery voltage reached 4.2V, it enters constant voltage mode where the battery voltage is held constant, but the charging current is slowly reduced. Figure 2 for shows the detail CC/CV lithium ion battery charging profile.

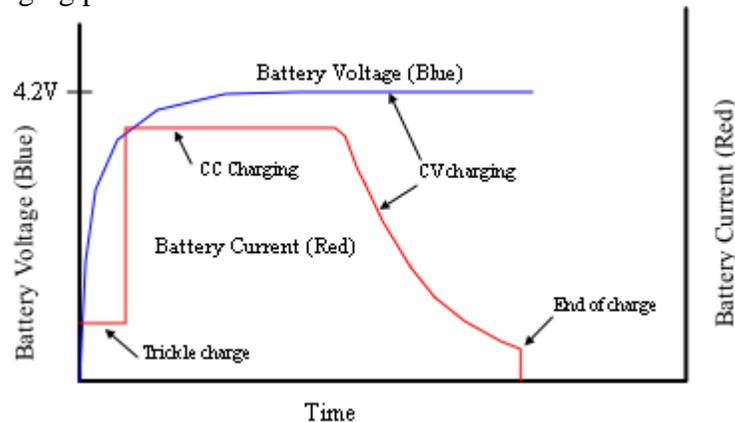


Figure 3. Lithium ion battery CC/CV charging profile.

## Emulating Battery Cells

The TS200 can emulate from multiple battery cells in series. See Table 1 below for the number of battery cell emulation.

Table 1. Selecting the TS250 and TS200 battery simulator

	Voltage Range	Lithium Ion	NiMH/NiCd	Alkaline	Lead-Acid
<b>TS250-4</b>	0 to +15V	1-3 cells	1-10 cells	1-9 cells	6V or 12V
<b>TS250-5</b>	0 to +30V	1-7 cells	1-20 cells	1-18 cells	6V/12V/24V
<b>TS250-6</b>	-6V to +45V	1-10 cells	1-28 cells	1-25 cells	6V/12V/24V
<b>TS200-4A</b>	0 to +15V	1-3 cells	1-10 cells	1-9 cells	6V or 12V
<b>TS200-2B</b>	-20V to +45V	1-10 cells	1-28 cells	1-25 cells	6V/12V/24V

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