

# LiFePO<sub>4</sub> Battery

## Simplified SPICE Behavioral Model

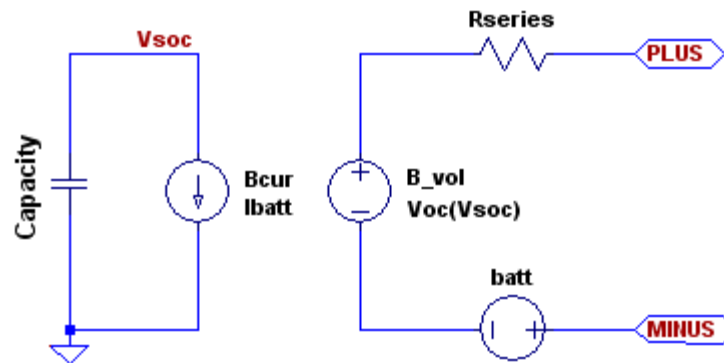
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# 1. Benefit of the Model

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- The model enables circuit designer to predict and optimize battery runtime and circuit performance.
- The model can be easily adjusted to your own battery specifications by editing a few parameters that are provided in the datasheet.
- The model is optimized to reduce the convergence error and the simulation time

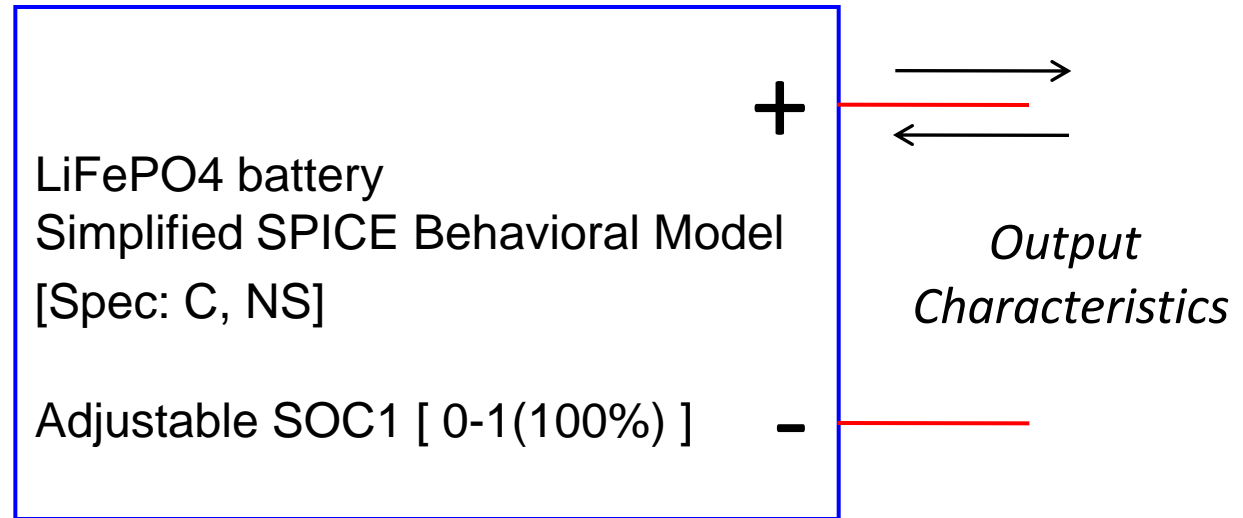
## 2. Model Feature



Equivalent circuit of LiFePO4 Battery model

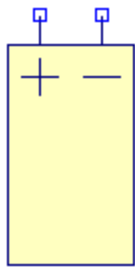
- This *LiFePO4 Battery Simplified SPICE Behavioral Model* is for users who require the model of a LiFePO4 Battery as a part of their system.
- *Battery Voltage ( $V_{bat}$ ) vs. Battery Capacity Level (SOC) Characteristic*, that can perform battery charge and discharge time at various current rate conditions, are accounted by the model.
- As a simplified model, the effects of cycle number and temperature are neglected.

# 3. Concept of the Model



- The model is characterized by parameters:  $C$ , which represent the battery capacity and  $SOC1$ , which represent the battery initial capacity level.
- *Open-circuit voltage* ( $V_{OC}$ ) vs.  $SOC$  is included in the model as an analog behavioral model (ABM).
- $NS$  (*Number of Cells in series*) is used when the LiFePO4 cells are in series to increase battery voltage level.

# 4. Parameter Settings



**U1**  
**LIFEPO4\_BATTERY**  
**C=100 SOC1=1**  
**NS=1 TSCALE=1**

(Default values)

## Model Parameters:

**C** is the amp-hour battery capacity [Ah]

- e.g. C = 50, 100, or 200 [Ah]

**SOC1** is the initial state of charge in percent

- e.g. SOC1=0 for an empty battery (0%), SOC1=1 for a full charged battery (100%)

**NS** is the number of cells in series

- e.g. NS=1 for 1 cell battery, NS=2 for 2 cells battery (battery voltage is double from 1 cell)

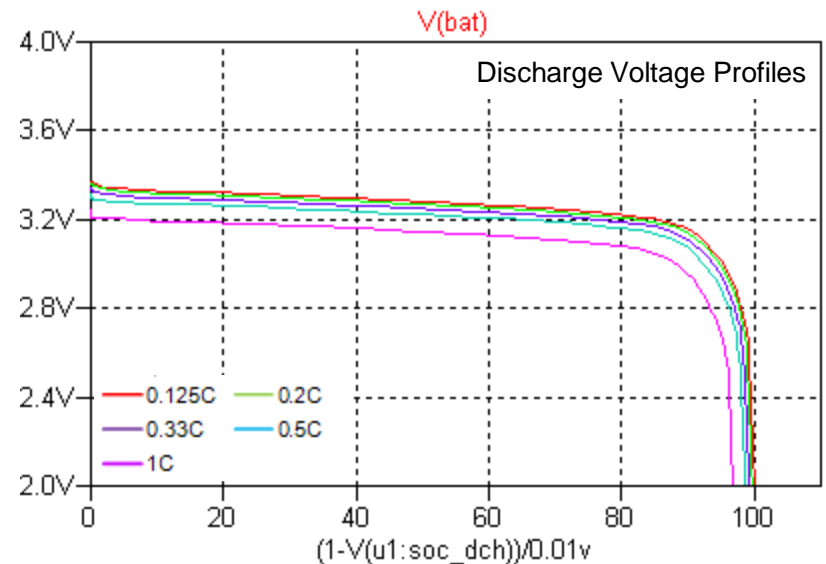
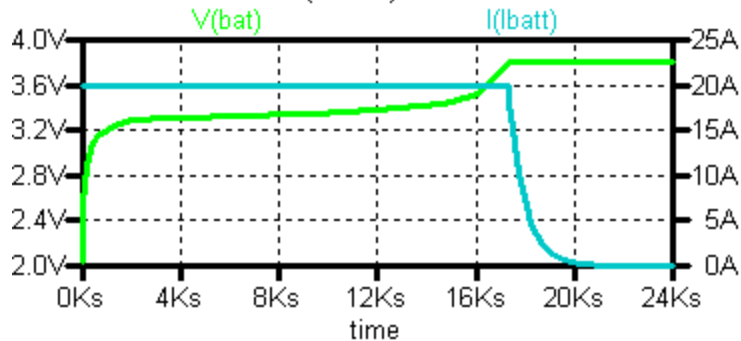
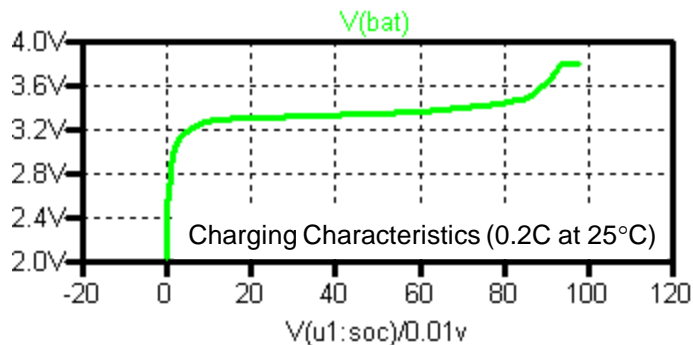
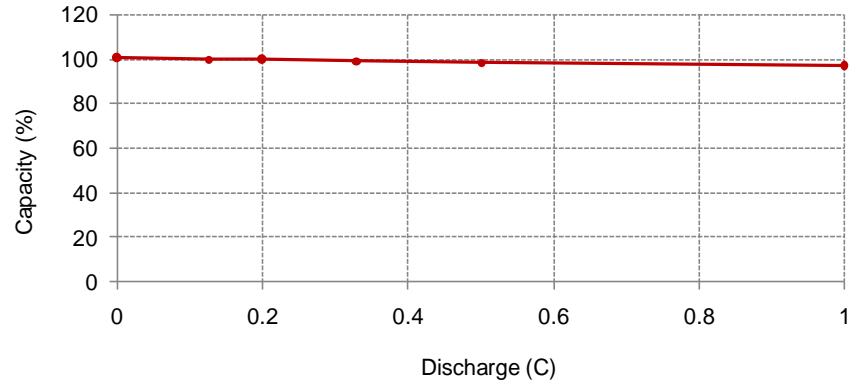
**TSCALE** turns TSCALE seconds (in the real world) into a second (in simulation)

- e.g. TSCALE=60 turns 60s or 1min into a second, TSCALE=3600 turns 3600s or 1h into a second,

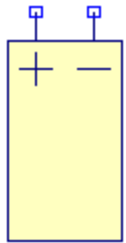
- From the LiFePO4 Battery specification, the model is characterized by setting parameters C, SOC1, NS and TSCALE.

# 5. LiFePO4 Battery Model Characteristic

Cell Voltage (NS=1)	3.2V
Over-charge Voltage	3.8V
Discharge Cut-off Voltage	2V
Internal Resistance	1.51mΩ



# 6. LiFePO4 Battery Specification (Example)



**U1**  
**LIFEPO4\_BATTERY**  
**C=100 SOC1=1**  
**NS=4 TSCALE=1**

LiFePO4 needs 4 cells to reach this voltage level

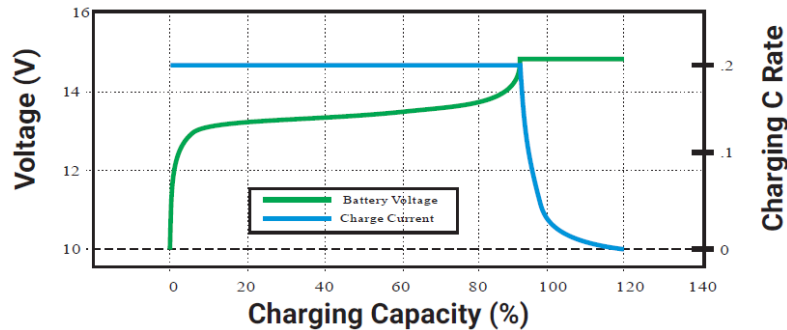
Nominal Voltage		12.8V
Rated Capacity	Typical	100Ah (Constant Current of 0.33C)
Max Current	Charge	80A
	Discharge	100A
Discharge Cut-off Voltage		10V

- The battery information refer to a battery part number PSL-BTP-121000 of Power-Sonic.

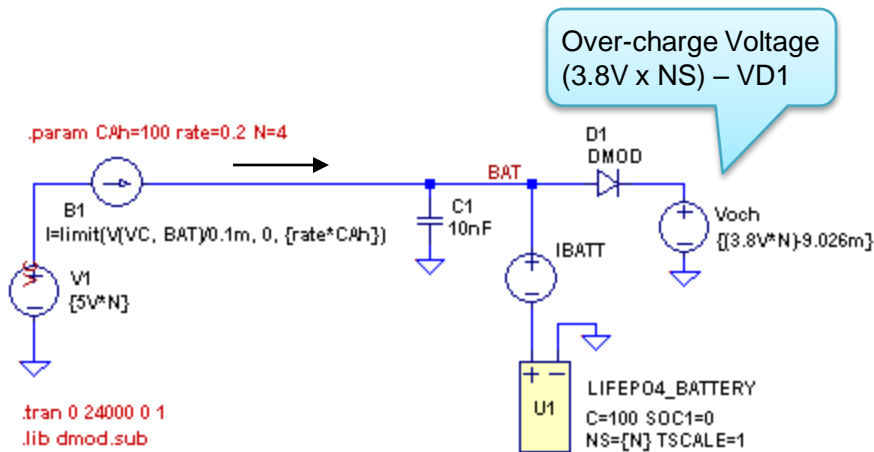
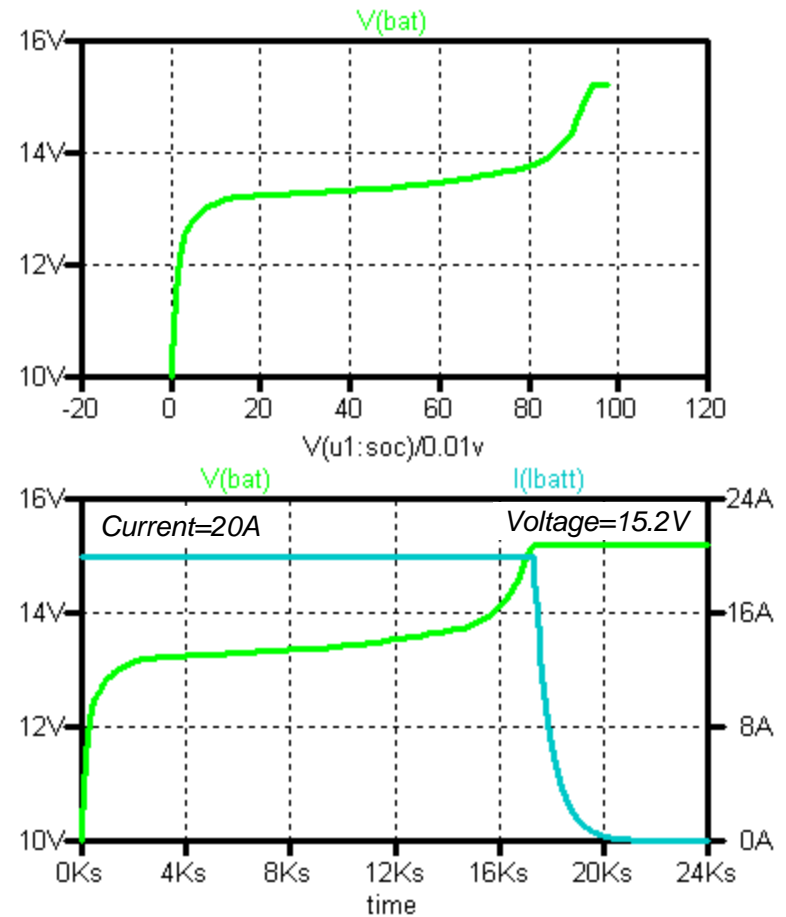


# 6.1 Charge Time Characteristic

Measurement

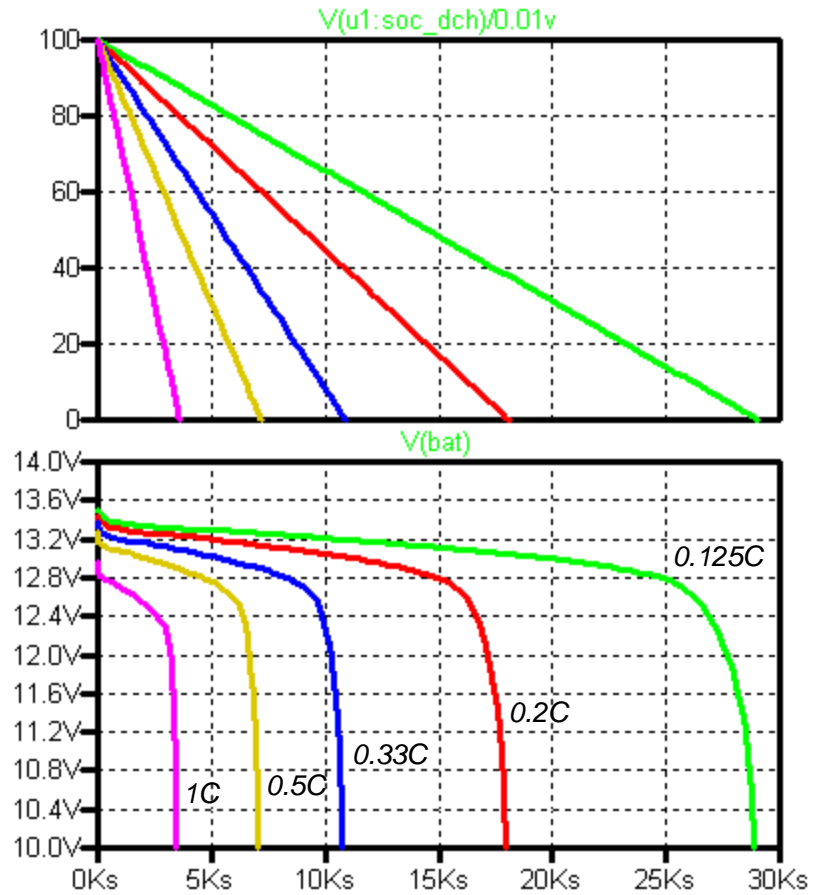
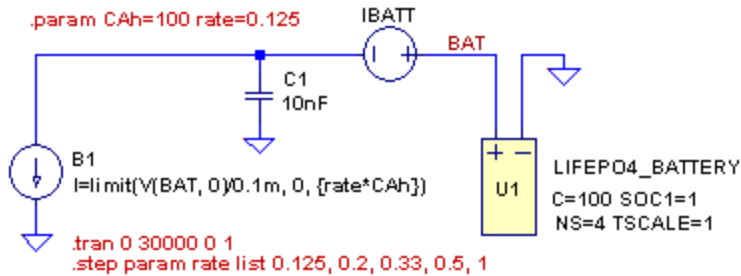


Simulation



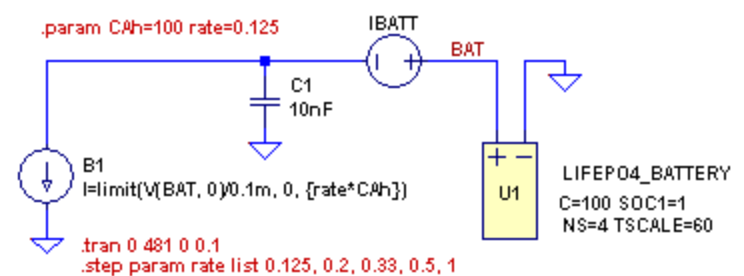
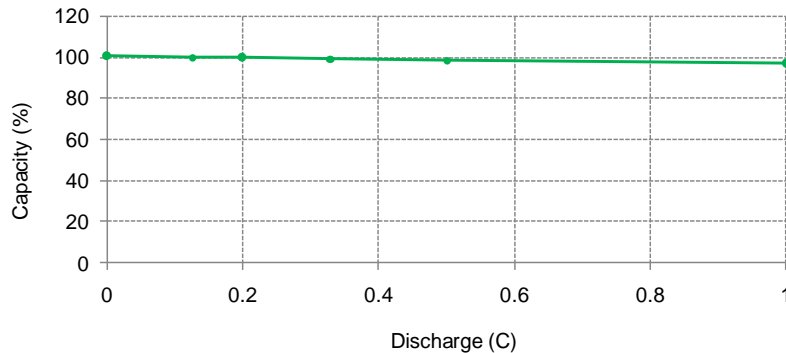
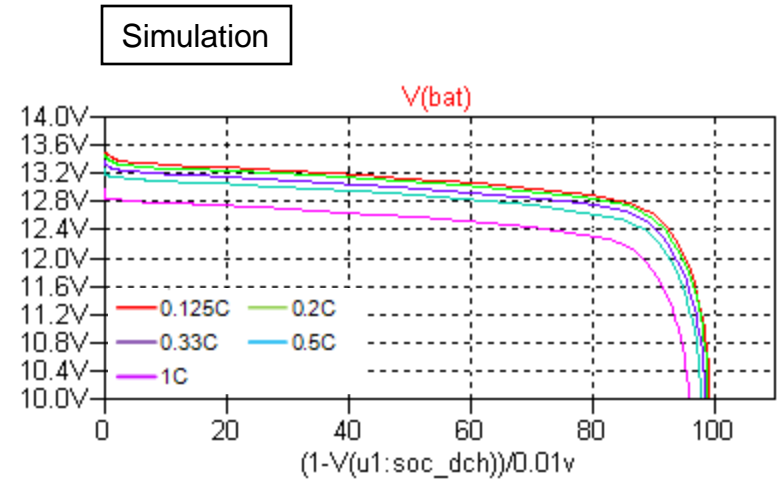
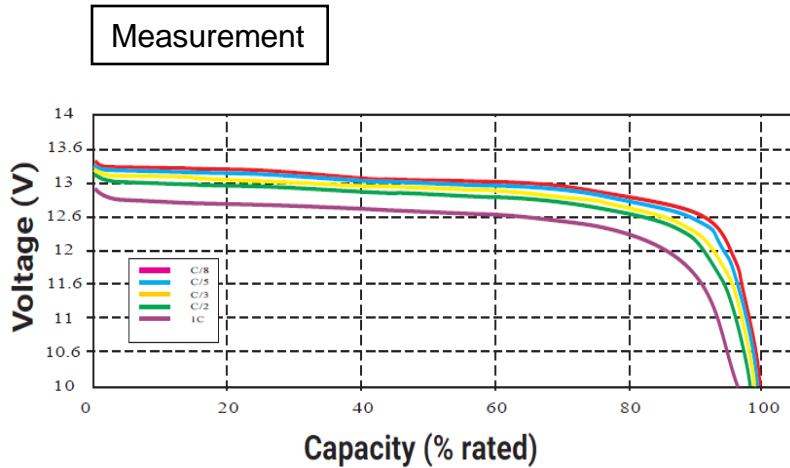
# 6.2 Discharge Time Characteristic

Battery voltage vs. Time are simulated at 0.125C, 0.2C, 0.33, 0.5C and 1C discharge rates



# 6.3 $V_{bat}$ vs. Capacity Characteristic

Battery voltage vs. Capacity(%) are simulated at 0.125C, 0.2C, 0.33C, 0.5C and 1C discharge rates



# Simulation Index



## Simulations

LiFePO4 Battery Model Characteristic.....

Charge\_Time (x1\_T1)

Discharge\_Time (x1\_T1)

LiFePO4 Battery Specification (Example)

Charge Time Characteristic.....

Charge\_Time (x4\_T1)

Discharge Time Characteristic.....

Discharge\_Time (x4\_T1)

$V_{bat}$  vs. Capacity Characteristic.....

Discharge\_SOC (x4\_T60)