LiFePO4 Battery

Simplified SPICE Behavioral Model

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Contents

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1. Benefit of the Model

- 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

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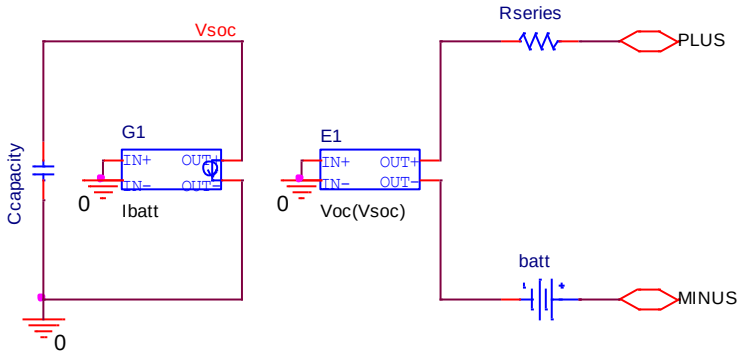
2. Model Feature



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.

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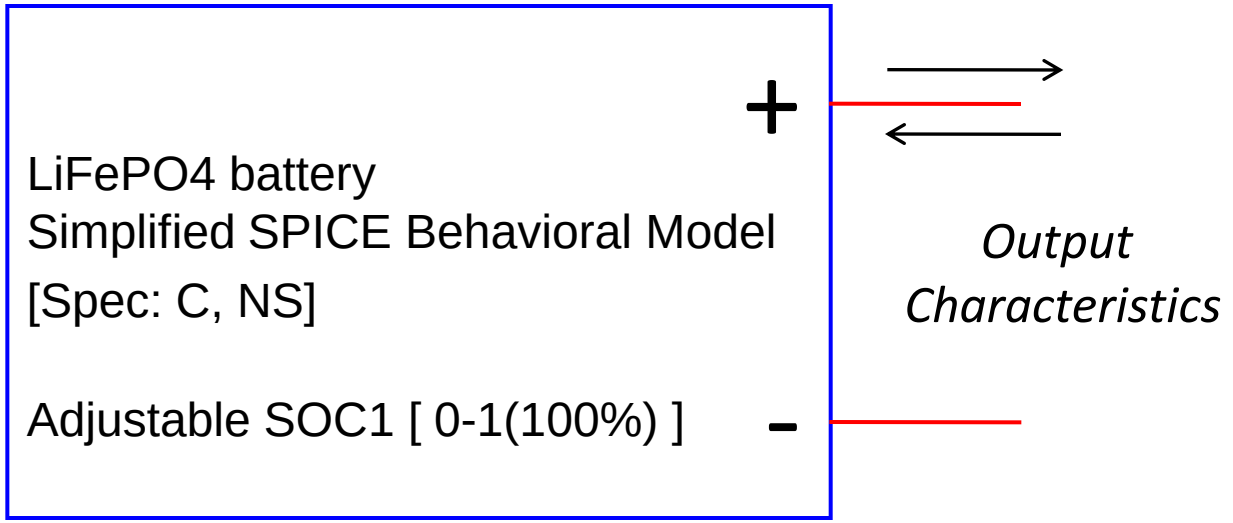
3. Concept of the Model



- 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.

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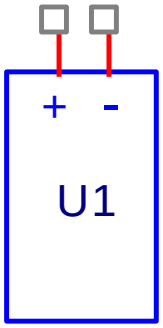
4. Parameter Settings



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.

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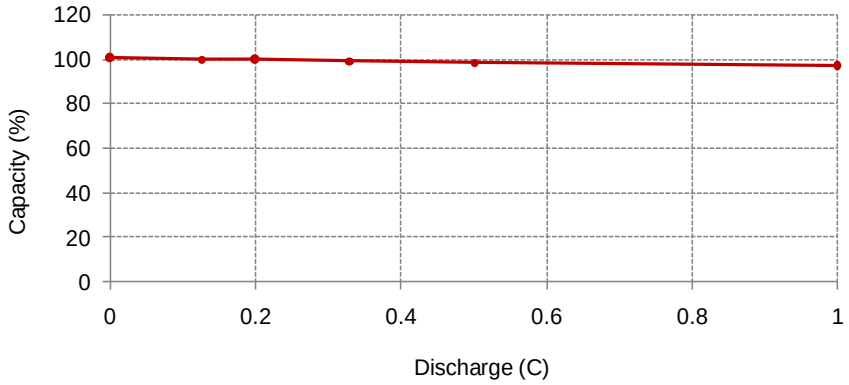
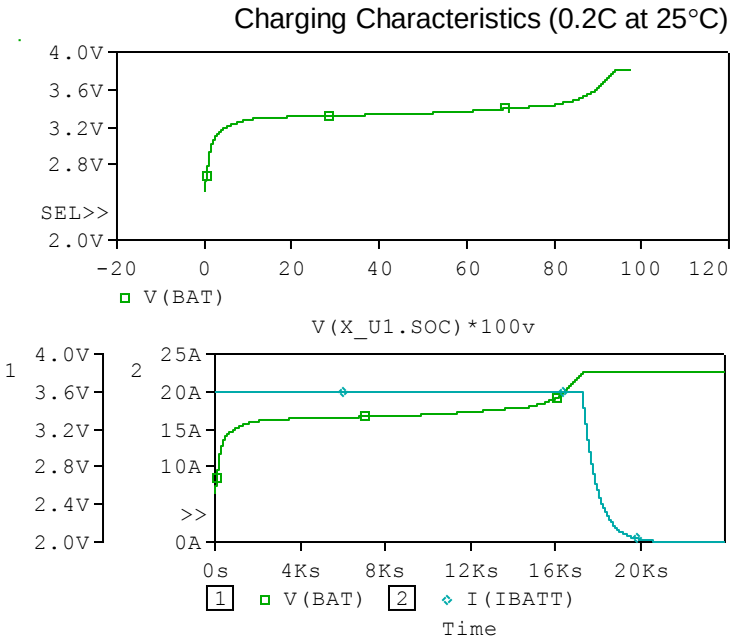
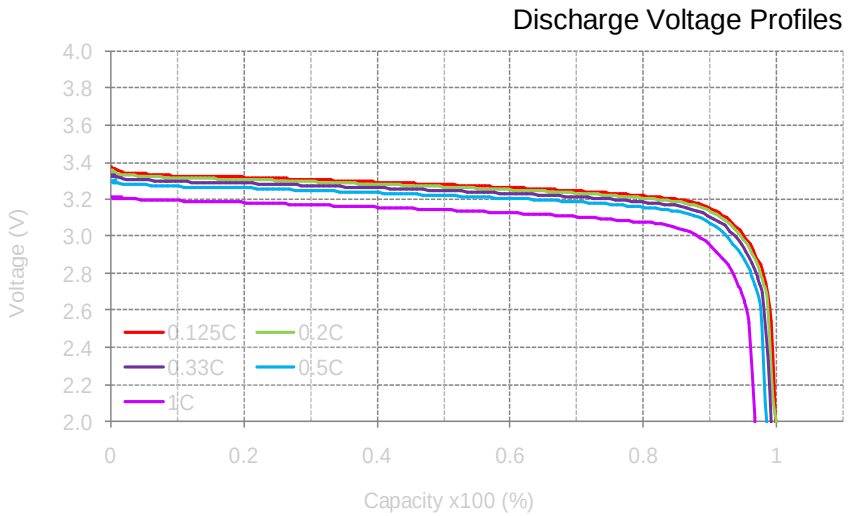
5. LiFePO4 Battery Model Characteristic

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







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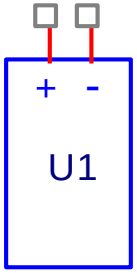
6. LiFePO4 Battery Specification (Example)



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.

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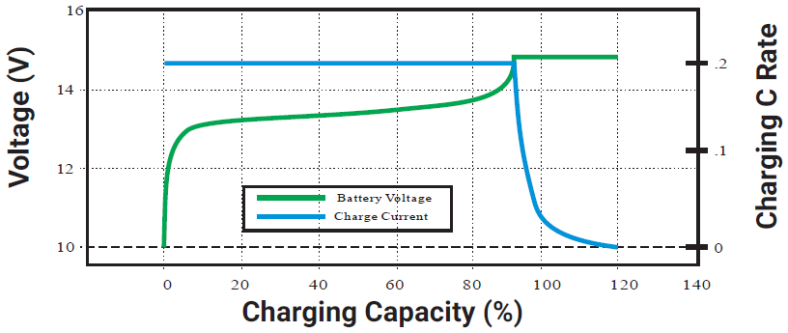
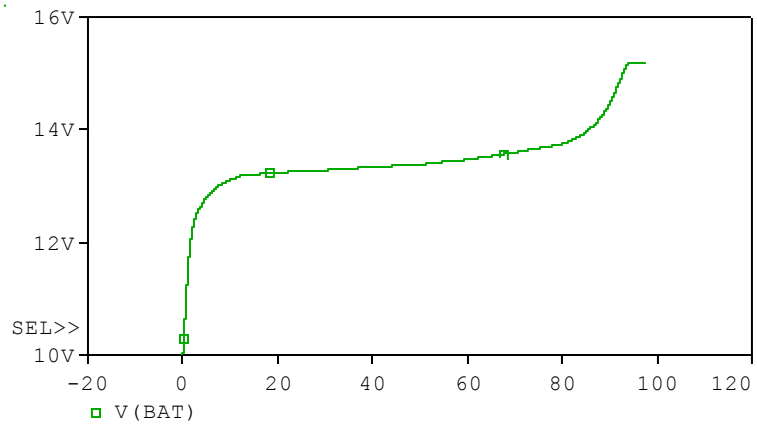
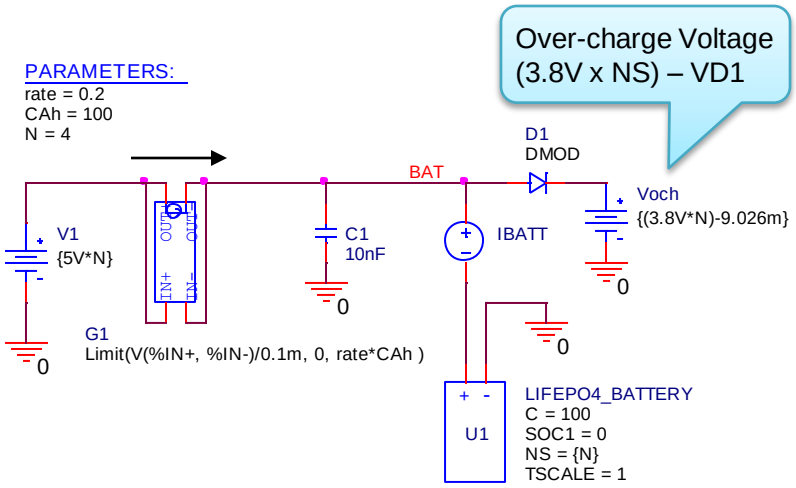
6.1 Charge Time Characteristic

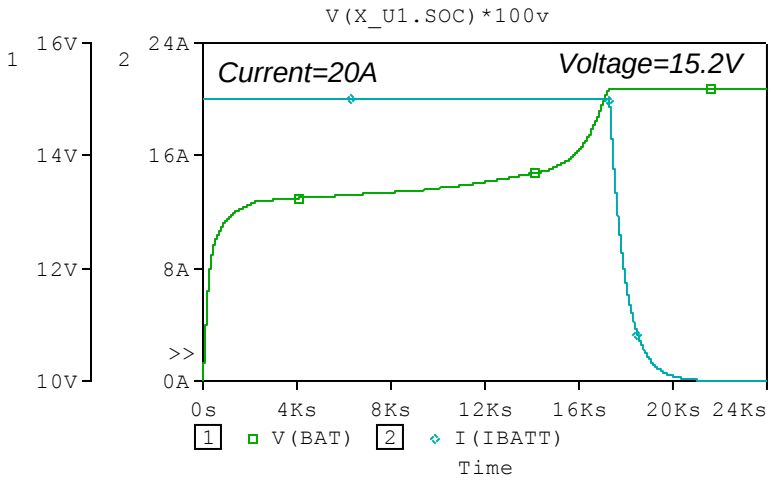
Measurement



Simulation







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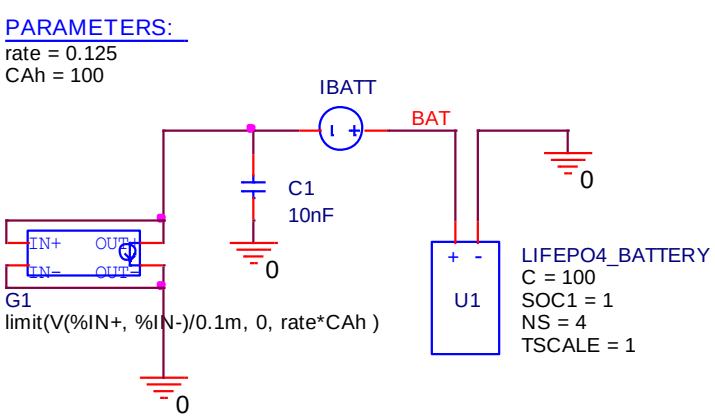
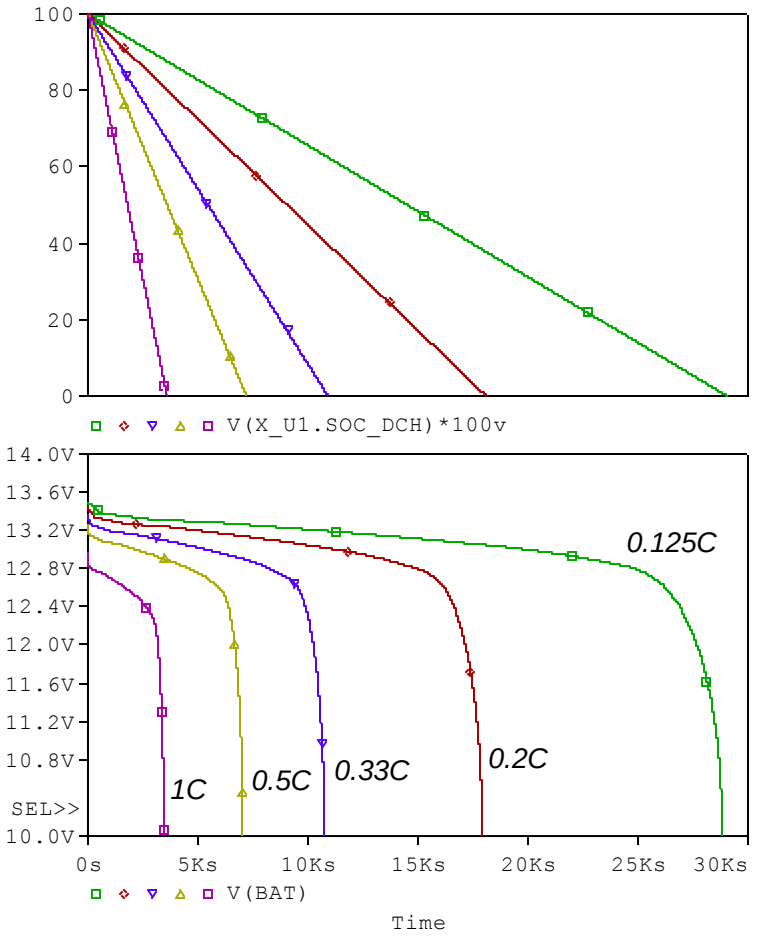
6.2 Discharge Time Characteristic

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





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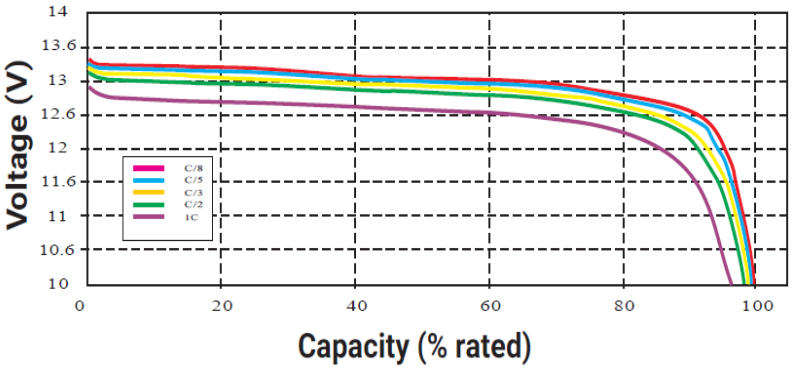
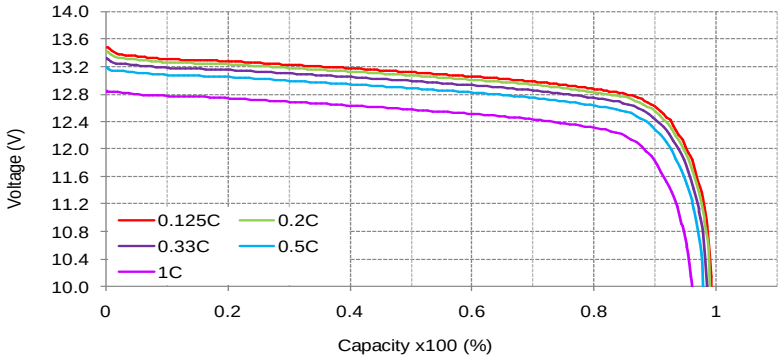
6.3 V_{bat} vs. Capacity Characteristic

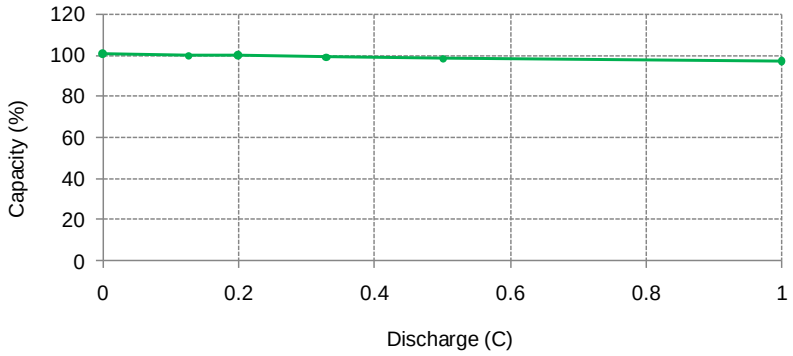
Battery voltage vs. Capacity(%) are simulated at 0.125C, 0.2C, 0.33, 0.5C and 1C discharge rates

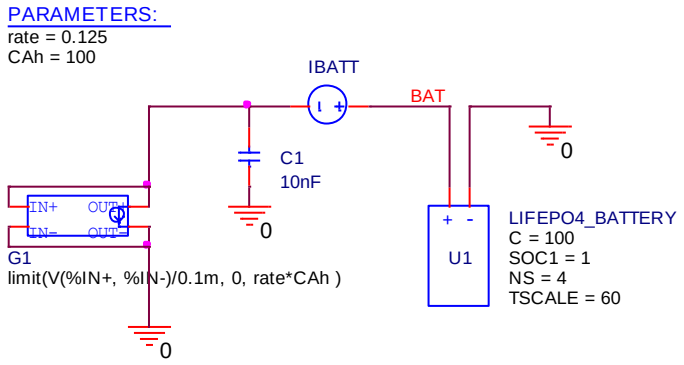
Measurement



Simulation







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Discharge Time Characteristic.....	Discharge_Time (x4_T1)
V_{bat} vs. Capacity Characteristic.....	Discharge_SOC (x4_T60)

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