

Device Modeling Report

COMPONENTS: Lead-Acid Battery
PART NUMBER: MSE-100-6
MUNUFACTURER: GS YUASA



Bee Technologies Inc.

SPICE MODEL(1/2)

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*$
.SUBCKT MSE-100-6 Plus Minus PARAMS: cell=3 k=1 ns=1 tscale=3600 c=100 soc1=1
X_U1      1 OCVcharge ETABLE_CHARGE
X_U2      1 OCVdischarge ETABLE_DISCHARGE
E_eVch    18 MINUS VALUE { ns*cell*V(OCVcharge) }
E_evdch2  12 0 VALUE { ns*cell*V(OCVdischarge) }
E_eqt     13 0 VALUE { SOC1+0.01+(sdt(v(9))/(ns*cell*V(SOCm)/Tscale)) }
E_Erate   RATEDCH 0 VALUE { V(Idch)*2/(C*2) }
E_E1      IDCH 0 VALUE { IF( V(current)<0, -V(current), V(current) ) }
E_Erdch   7 5 VALUE { 1.05*V(current)*(
+ (0.12+(0.07/(SOC1+0.01-0.14)))*cell*ns/V(SOCm) ) }
E_eVdch   19 MINUS VALUE { ns*cell*V(OCVdischarge) }
E_eqt4    1 0 VALUE { limit(v(13),-1,1) }
E_Esocm   SOCM 0 VALUE { IF( V(current)<0
+ ,C*2*Limit(0.52031-0.47632*LOG10(V(RateDch)),0.4,1.01),C*2.02 ) }
E_Erch    6 4 VALUE { 2.5*V(current)*(
+ (0.0131+(0.0509/(1.06-SOC1+0.01)))*ns*cell/V(SOCm) ) }
E_evch2   11 0 VALUE { ns*cell*V(OCVcharge) }
E_evcalculsoc 9 0 VALUE { v(10)*V(current)*k/3600 }
E_ecurrent N888786 0 VALUE { I(V_vcurrent) }
R_Rcurrent N888786 CURRENT 1k
C_Ccurrent CURRENT 0 1u
V_vcurrent PLUS 8 0Vdc
V_Vrch    4 18 0Vdc
V_Vrdch   5 19 0Vdc
R_rs      MINUS 0 1u
X_Sch     CURRENT 0 6 8 SW1_Sch
X_Sch2    CURRENT 0 11 10 SW1_Sch2
X_Sdch    CURRENT 0 7 8 SW1_Sdch
X_Sdch2   CURRENT 0 12 10 SW1_Sdch2
.ENDS
*$
.SUBCKT ETABLE_CHARGE 1 2
R1 1 0 1G
E1 2 0 TABLE {V(1,0)}
+ (0.0000 1.9640) (0.0005 1.965) (0.0015 1.9670) (0.0017 1.9680)
+ (0.0667 1.9840) (0.1263 2.0020) (0.1950 2.0300) (0.2890 2.072)
+ (0.3500 2.100) (0.4908 2.1660) (0.6385 2.222) (1.0000 2.23001)
.ENDS ETABLE_CHARGE
*$
.SUBCKT ETABLE_DISCHARGE 1 2
R1 1 0 1G
E1 2 0 TABLE {V(1,0)}
+ (0.0000 0.0000) (0.00001 1.6800) (0.0005 1.6830) (0.0015 1.8100)
+ (0.0017 1.8300) (0.0667 1.9000) (0.1263 1.9320) (0.1950 1.9550)
+ (0.2890 1.9800) (0.3500 1.9940) (0.4908 2.0200) (0.6385 2.0340)
+ (0.7834 2.0440) (0.8117 2.0466) (0.8313 2.0470) (0.8707 2.0510)
+ (0.9000 2.0530) (1.0000 2.0600)
.ENDS ETABLE_DISCHARGE
*$

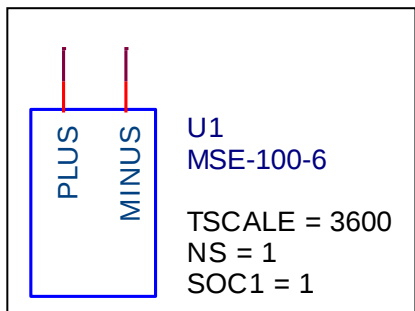
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SPICE MODEL(2/2)

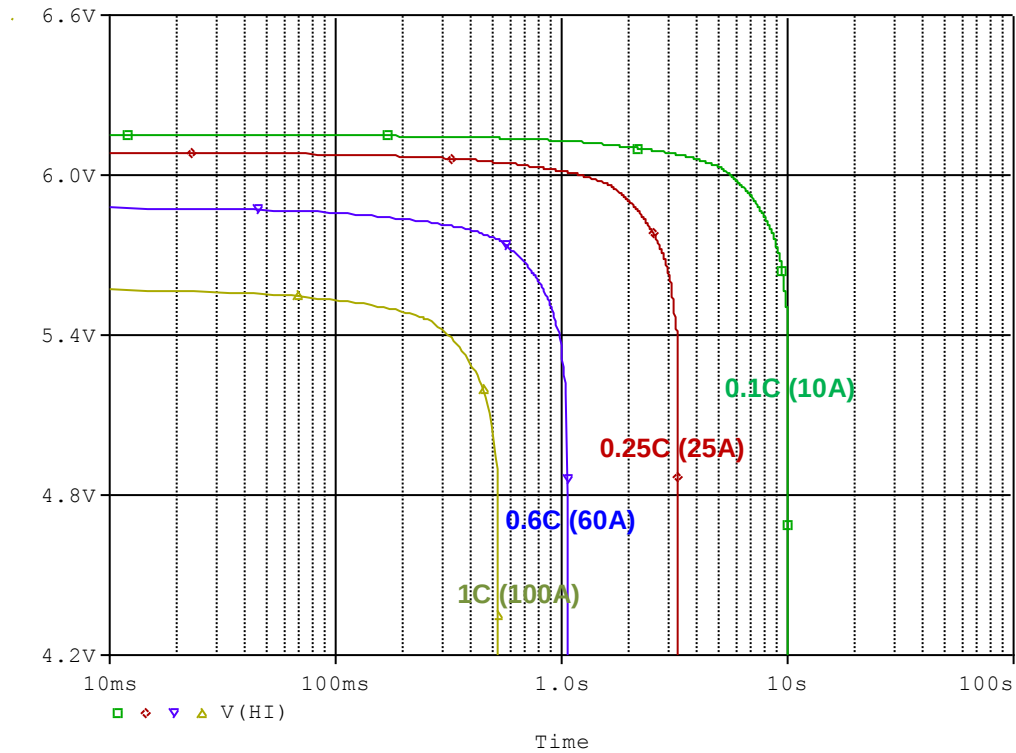
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*$
.subckt SW1_Sch 1 2 3 4
S_Sch      3 4 1 2 _Sch
RS_Sch      1 2 1G
.MODEL      _Sch VSWITCH Roff=10e6 Ron=10u Voff=-0.001m
Von=0.001m
.ends SW1_Sch
*$
.subckt SW1_Sch2 1 2 3 4
S_Sch2     3 4 1 2 _Sch2
RS_Sch2     1 2 1G
.MODEL      _Sch2 VSWITCH Roff=10e6 Ron=10u Voff=-0.001m
Von=0.001m
.ends SW1_Sch2
*$
.subckt SW1_Sdch 1 2 3 4
S_Sdch     3 4 1 2 _Sdch
RS_Sdch     1 2 1G
.MODEL      _Sdch VSWITCH Roff=10e6 Ron=10u Voff=0.001m Von=-
0.001m
.ends SW1_Sdch
*$
.subckt SW1_Sdch2 1 2 3 4
S_Sdch2    3 4 1 2 _Sdch2
RS_Sdch2    1 2 1G
.MODEL      _Sdch2 VSWITCH Roff=10e6 Ron=10u Voff=0.001m Von=-0.001m
.ends SW1_Sdch2
*$
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Circuit Configuration

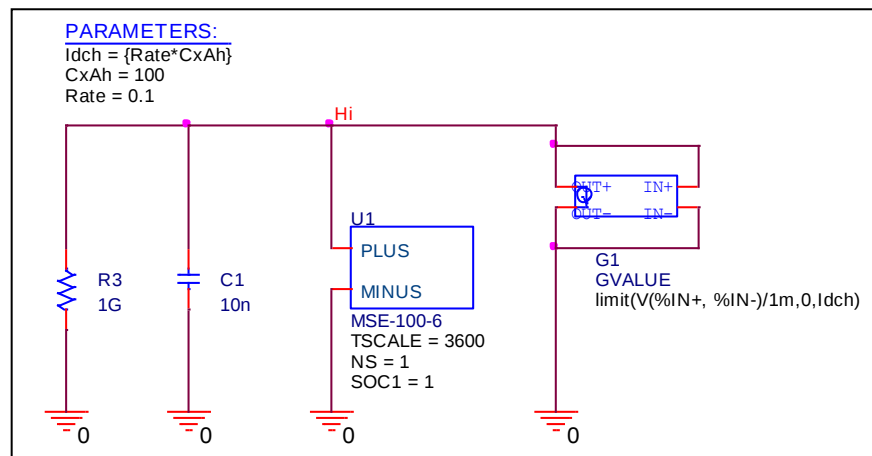


Discharge Characteristics

Circuit Simulation Result



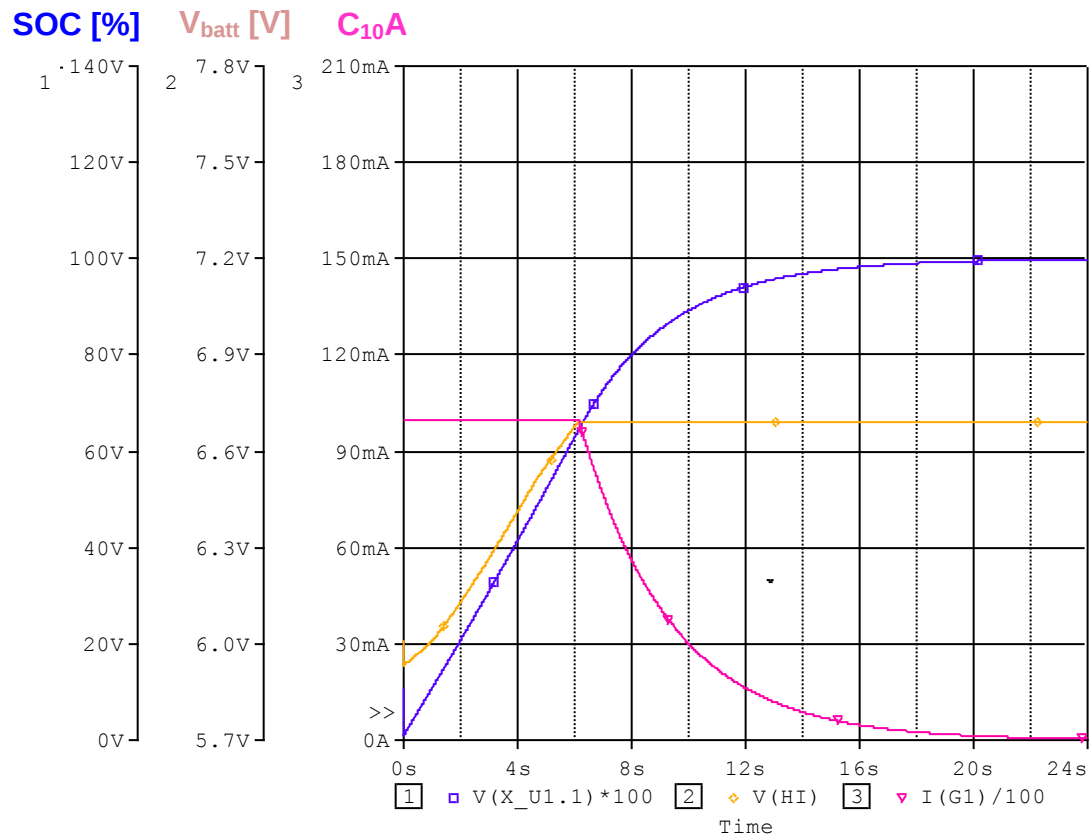
Simulation Circuit



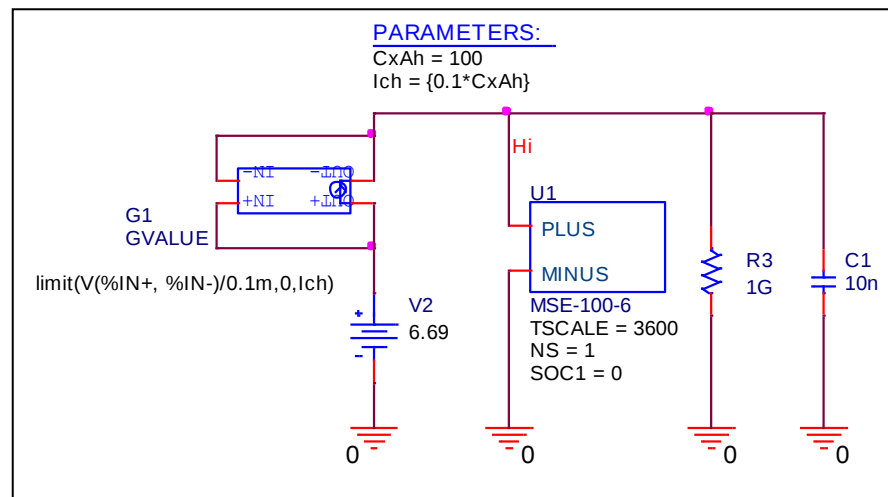
✖ To discharge from 100% of battery capacity, SOC1=1

Charge Characteristics

Circuit Simulation Result



Simulation Circuit



※ To charge from 0% of battery capacity, SOC1=0

Data Information

No. MSE-100-6	
Nominal voltage	6.0 [Vdc]
Capacity	100[Ah]@C ₁₀ , 65[Ah]@C ₁
Rated charge	0.1C ₁₀ A
Input voltage	6.69 [Vdc]
Charging time	24 [hours] @0.1C ₁₀ A