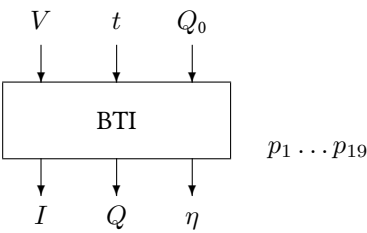


Block BTI

The BTI block calculates the output current of a battery, depending on voltage and state of charge.



Name	BTI
Function	se0019
Inputs	2 . . . 3
Outputs	3
Parameters	19
Strings	0
Group	S

Inputs

- 1 Voltage V / V
- 2 Time t / s (not evaluated in mode 2)
- 3 Capacity Q_0 / A h (used in mode 2 only)

Outputs

- 1 Current I / A
- 2 New capacity Q / A h
- 3 Charging efficiency η

Parameters

- 1 Mode
 - 0 The battery capacity depends on the battery parameters and the inputs of the block; initial value of the battery capacity is given by parameter number 5 (default).
 - 1 The battery capacity is given by input 3.
- 2 Number of cells in series N_s
- 3 Number of cells in parallel N_p
- 4 Nominal capacity Q_n A h

- 5 Initial value of battery capacity Q_0 / A h
- 6 Open circuit voltage charge V_{0c} / V
- 7 Electrolyte coefficient (charge) g_c / V
- 8 Inner resistance parameter (charge) ρ_c / Ω A h
- 9 Battery type coefficient (charge) M_c
- 10 Capacity coefficient (charge) C_c
- 11 Open circuit voltage (discharge) V_{0d} / V
- 12 Electrolyte coefficient (discharge) g_d / V
- 13 Inner resistance parameter (discharge) ρ_d / Ω A h
- 14 Battery type coefficient (discharge) M_d
- 15 Capacity coefficient (discharge) C_d
- 16 Wood parameter a_w
- 17 Wood parameter b_w
- 18 Wood parameter F_ℓ
- 19 Self discharge coefficient q_s / % of capacity per day

Strings

None

Description The model of the battery is based on the model of Shepherd. The relation between voltage V and current I for discharging ($I < 0$) the battery is

$$V = V_{0d} - g_d H + \rho_d \frac{I}{Q_n} \left(1 + M_d \frac{H}{C_d - H} \right)$$

where

- V_{0d} Open circuit voltage (discharge) / V
- g_d Electrolyte coefficient (discharge) / V
- ρ_d Inner resistance parameter (discharge) / Ω A h
- M_d Battery type coefficient (discharge)
- C_d Capacity coefficient (discharge)
- H Normalised depth of discharge $1 - Q/Q_n$

For charging the following equation is used

$$V = V_{0c} - g_c H + \rho_c \frac{I}{Q_n} \left(1 + M_c \frac{F}{C_c - F} \right)$$

where

- V_{0c} Open circuit voltage (charge) / V

g_c	Electrolyte coefficient (charge) / V
ρ_c	Inner resistance parameter (charge) [V h]
M_c	Battery type coefficient (charge)
C_c	Capacity coefficient (charge)
F	Normalised state of charge Q/Q_n

In case of charging an ampere hour efficiency η after Wood/Crutcher is used. The current at which gassing effects occur is defined through

$$I_m = \begin{cases} b_w Q_n (1 - F) & \text{if } F < F_\ell \\ b_w Q_n (1 - F_\ell) & \text{else} \end{cases}$$

where

b_w	Wood parameter
F_ℓ	Limiting state of charge / V
F	Normalized state of charge Q/Q_n
Q_n	Nominal capacity / A,h

Depending on the actual current I , the Wood-efficiency is defined as

$$\eta = \begin{cases} a_w & \text{if } I \leq I_m \\ a_w I_m / I & \text{else} \end{cases}$$

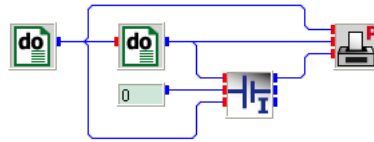
Using this efficiency, the capacity of the next timestep ($Q_{t+\Delta t}$) is calculated from

$$Q_{t+\Delta t} = Q_t + \left(\eta I - \frac{q_s Q}{100 t_s} \right) \Delta t$$

where

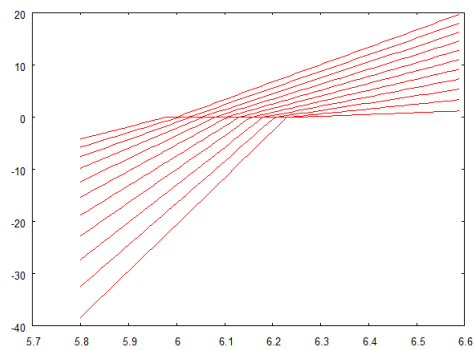
a_w	Wood parameter
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bti.vseit



Two nested **DO** blocks vary battery capacity (outer block) and voltage (inner block) from 0 to 100 Ah in steps of 10 Ah and 5.8 to 6.6 V in steps of 0.01 V, respectively. The time input of the **BTI** block is set to zero by a **CONST** block and is not evaluated because the capacity mode of the **BTI** block is set to “Battery capacity is given by input 3”.

A parametric plot block **PLOTP** is used to display the voltage-current characteristic of the battery.



See also Block **BTV**, **BCR**.