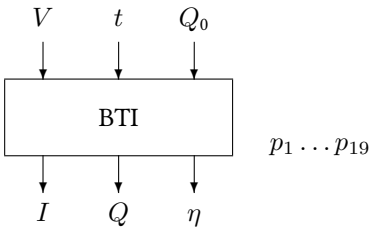
Block BTI

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





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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 coeffiecient (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 coffiecient (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

$$I_\mathrm{m} = \begin{cases} b_\mathrm{w} Q_\mathrm{n}(1-F) & \text{if } F < F_\ell \\ b_\mathrm{w} Q_\mathrm{n}(1-F_\ell) & \text{else} \end{cases}$$

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

$$\eta = \begin{cases} a_\mathrm{w} & \text{if } I \leq I_\mathrm{m} \\ a_\mathrm{w} I_\mathrm{m}/I & \text{else} \end{cases}$$

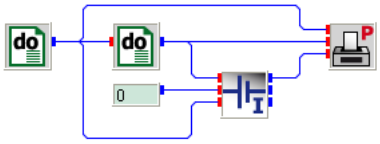
Using this efficiency, the capacity of the next timestep ($Q_{\mathrm{t}+\boxtimes\mathrm{t}}$) is calculated from

$$Q_{\mathrm{t}+\boxtimes\mathrm{t}} = Q_\mathrm{t} + \left(\eta I - \frac{q_\mathrm{s} Q}{100 t_\mathrm{s}}\right) \Delta t$$

where

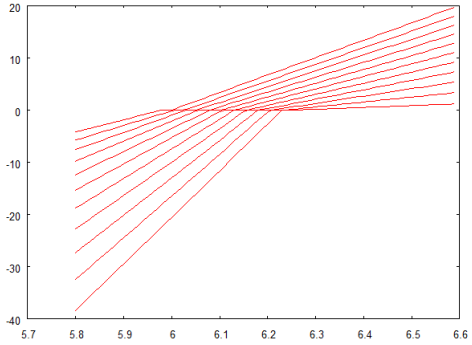
a_w	Wood parameter

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 of 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.