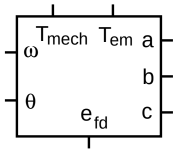
syncmc_1.ece



Attributes

```
  mainnodes: a b c
  outvar:
+    ia=cur(a)_of_sm0
+    ib=cur(b)_of_sm0
+    ic=cur(c)_of_sm0
+    id=id_of_sm0
+    iq=iq_of_sm0
+    vd=vd_of_sm0
+    vq=vq_of_sm0
+    psid=psid_of_sm0
+    psiq=psiq_of_sm0
+    psif=psif_of_sm0
+    psih=psih_of_sm0
+    psig=psig_of_sm0
+    psik=psik_of_sm0
  stparms:
+    psid_st_0=0
+    psiq_st_0=0
+    psif_st_0=0
+    psih_st_0=0
+    psig_st_0=0
+    psik_st_0=0
+    theta_st_0=0
+    omega_st_0=0
  main_var:
+   omega
+   tem
+   efd
+   theta
+   tmech
  iparms:
+   i_compute_strt=1
+   i_flag_network=1
  rparms:
+   xd=1.79
```

```
+    xq=1.71
+    xdp=0.169
+    xqp=0.228
+    xdpp=0.135
+    xqpp=0.2
+    ra=0.001
+    td0p=4.3
+    tq0p=0.85
+    td0pp=0.032
+    tq0pp=0.05
+    h0=0.05
+    d0=0.005
+    fb=50
+    f0=50
+    vg0=1.0
+    thetag0_deg=30
+    e_src=1.0
+    xl=0.5
+    r_parallel=100
+    ka_static=100
+    xc=0.5
+    r_line=0.05
+    k_hi=19.303
+    k_ila=34.929
+    k_lab=52.038
+    k_lbg=70.858
+    k_ge=2.82
+    d_h=0.2
+    d_i=0.2
+    d_la=0.2
+    d_lb=0.2
+    d_e=0.2
```

Description

`syncmc_1.ece` is a synchronous machine model with terminals `a`, `b`, `c`.

The following model equations are used.

$$
\begin{aligned}
i_a &= -(k_d\, i_d\, \cos\theta_1 + k_q\, i_q\, \sin\theta_1)\,, \\
i_b &= -(k_d\, i_d\, \cos\theta_2 + k_q\, i_q\, \sin\theta_2)\,, \\
i_c &= -(k_d\, i_d\, \cos\theta_3 + k_q\, i_q\, \sin\theta_3)\,, \\
v_d &= k_1\left[v_a\, \cos\theta_1 + v_b\, \cos\theta_2 + v_c\, \cos\theta_3\right], \\
v_q &= k_2\left[v_a\, \sin\theta_1 + v_b\, \sin\theta_2 + v_c\, \sin\theta_3\right], \\
\psi_d &= x_d''\, i_d + a_{1d}\, \psi_h + a_{2d}\, \psi_f\,, \\
\psi_q &= x_q''\, i_q + a_{1q}\, \psi_k + a_{2q}\, \psi_g\,, \\
T_{\mathrm{em}} &= \psi_d\, i_q - \psi_q\, i_d\,, \\
\frac{d\psi_d}{dt} &= -\omega\omega_B\, \psi_q - \omega_B(r_a i_d + v_d)\,, \\
\frac{d\psi_q}{dt} &= \omega\omega_B\, \psi_d - \omega_B(r_a i_q + v_q)\,, \\
\frac{d\psi_f}{dt} &= -\frac{\psi_f}{\tau_d'} + \frac{\psi_d}{\tau_d'} + c_{1d} e_{fd}\,, \\
\frac{d\psi_h}{dt} &= -\frac{\psi_h}{\tau_d''} + \frac{\psi_d}{\tau_d''}\,, \\
\frac{d\psi_g}{dt} &= -\frac{\psi_g}{\tau_q'} + \frac{\psi_q}{\tau_q'} + c_{1d} e_{fd}\,, \\
\frac{d\psi_k}{dt} &= -\frac{\psi_k}{\tau_q''} + \frac{\psi_q}{\tau_q''}\,, \\
\frac{d\theta}{dt} &= \omega\omega_B\,, \\
\frac{d\omega}{dt} &= -e_2\omega + e_4\left(T_{\mathrm{mech}} - T_{\mathrm{em}}\right).
\end{aligned}
$$

In the above equations,

$\theta_1 = \theta$, $\theta_2 = \theta - 2\pi/3$, $\theta_3 = \theta + 2\pi/3$,

$k_1 = k_d = \sqrt{2/3}$, $k_2 = k_q = \sqrt{2/3}$, $k_3 = k_0 = \sqrt{1/3}$,

$a_{1d} = \dfrac{x_d' - x_d''}{x_d'}$,

$a_{1q} = \dfrac{x_q' - x_q''}{x_q'}$,

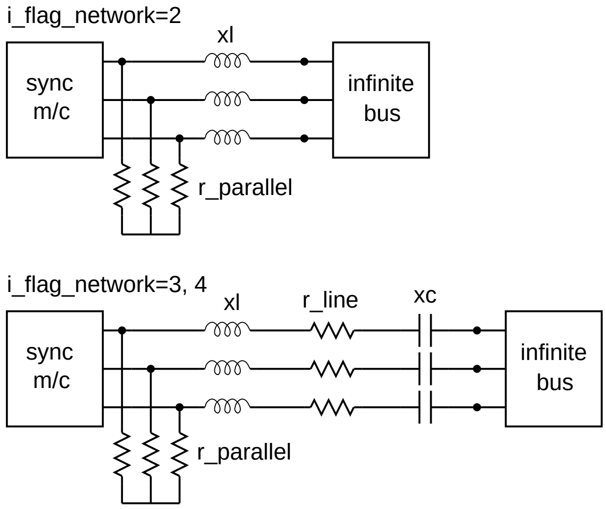
$a_{2d} = \dfrac{x_d - x_d'}{x_d}\,\dfrac{x_d''}{x_d'}$,

$a_{2q} = \dfrac{x_q - x_q'}{x_q}\,\dfrac{x_q''}{x_q'}$,

$\omega_B = 2\pi f_B,$

$a_0 = 2\,h_0,\ e_2 = d_0/a_0,\ e_4 = 1/a_0.$

Circuits involving a synchronous machine generally require the values of certain state variables to be computed and imposed before a transient simulation is carried out. If that is not done, the machine may never get started (i.e., ω (p.u.) may remain stuck at 0). Computation of these state variables is performed internally in `syncmc_1.ece` as follows.



When the integer parameter `i_compute_strt` is specified as `1`, the start-up values of the state variables are computed within this template and are supplied to other elements in the circuit through a Fortran common block.

The state variable values depend on the network connected to the synchronous machine. `i_flag_network` specifies the type of network connected to the machine, as shown in the figure. If this flag is specified as `4`, the synchronous machine is assumed to be driven by prime mover elements. (In that case, `syncmc_delta.gme` should be used in the circuit instead of `syncmc_1.ece`). Note that `r_parallel` and `r_line` are specified as per unit values. The line capacitance and inductance values are specified as `xc` and `xl`, the per unit values of $X_c = 1/\omega C$ and $X_l = \omega L$, respectively.

AC behaviour is not implemented.