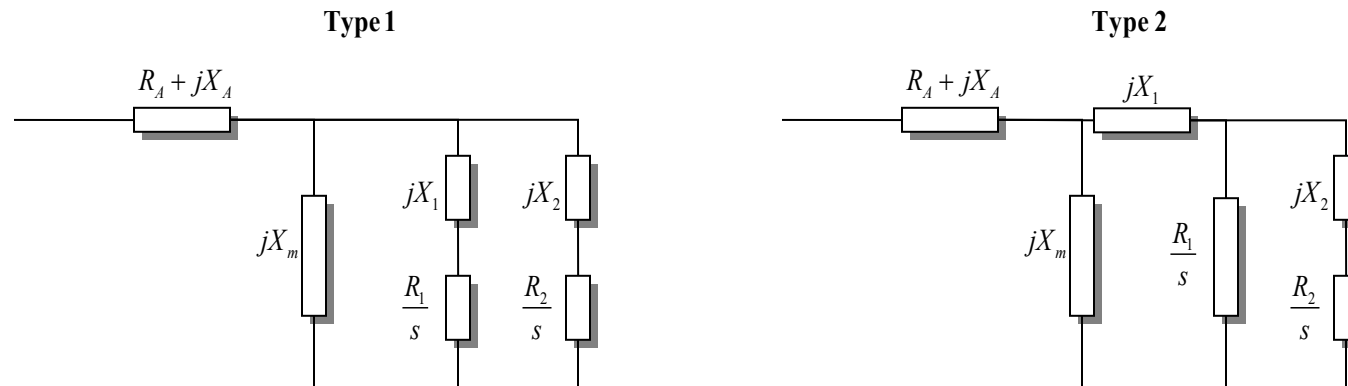


Load Characteristic CIM5

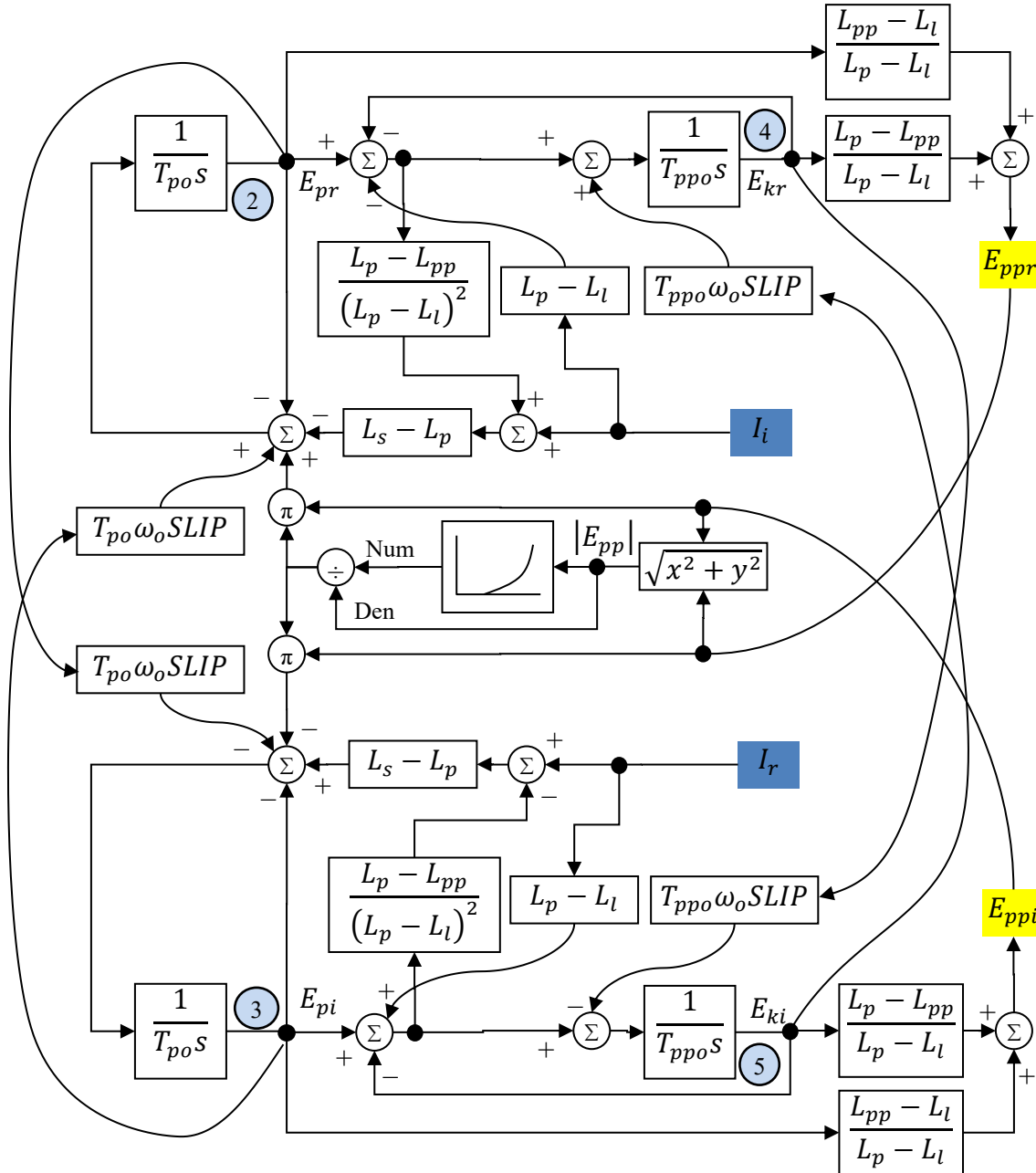
Load Characteristic CIM5 Induction Motor Load Model



Impedances on Motor MVA Base

- To model a single cage motor, set $R_2 = X_2 = 0$
- When $MBASE = 0$, motor $MVABase = PMULT * MW \text{ load}$. When $MBASE > 0$, motor $MVABase = MBASE$
- Load Torque = $T(1+\Delta\omega)^D$
- For motor starting $T = T_{NOM}$. For online motors, T is calculated during initialization
- $V1$ is the per unit voltage level at which the relay will pickup. The relay must then stay below $V1$ for a time of $T1$ (in cycles) at which point the relay will trip. The motor will then open after the breaker delay TB (in cycles)

For the block diagram is used to simulate the dynamics. Note that if ($L_p = L_{pp}$) or ($T_{ppo}=0$), then this represents a single-cage motor and the state $E_{ppr} = E_{pr}$ and $E_{ppi} = E_{pi}$.



Mechanical Equation

$$\omega = 1 - SLIP$$

$$T_{elec} = E_{ppr}I_r + E_{ppi}I_i$$

$$(1) \quad \frac{d\omega_r}{dt} = \frac{1}{2H} (T_{elec} - T_{Mech}(\omega_r))$$

T_{Mech} is given and is often a function of rotor speed ω_r

Network Interface Equations

$$StatorCurrent = I_r + jI_i$$

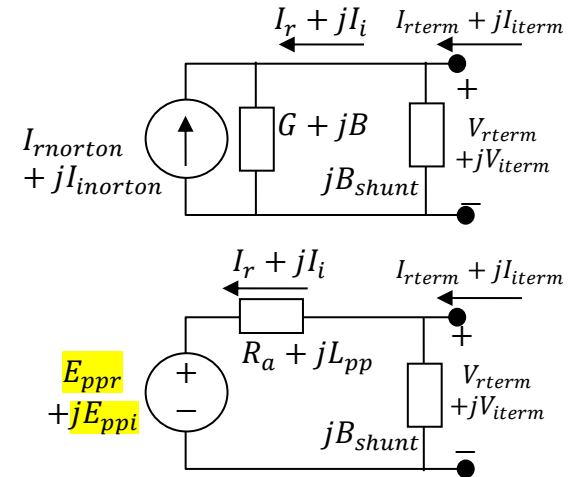
$$Z_{source} = R_s + jL_{pp}$$

$$Y_{source} = \frac{1}{R_s + jL_{pp}} = G + jB$$

$$V_{source} = (E_{ppr} + jE_{ppi})$$

$$\begin{pmatrix} I_{rnorton} \\ +jI_{inorton} \end{pmatrix} = (E_{ppr} + jE_{ppi})(G + jB)$$

$$I_r + jI_i = \text{Motor Current}$$



B_{shunt} is determined as part of model initialization

To convert from the equivalent circuit model to the block diagram model, you use the following conversions.

To model a single cage motor, set $L_{pp} = L_p$ and $T_{ppo} = 0$ when using the block diagram input parameters, or set $R2 = X2 = 0$ when expressing using circuit parameters. (Note: In reality you'd set $R2$ and $X2$ as infinite, but setting them to zero just automatically causes the software to treat them as infinite).

	Double Cage Type 1	Single Cage Type 1	Double Cage Type 2	Single Cage Type 2
R_a	R_a	R_a	R_a	R_a
L_s	$Xa + Xm$	$Xa + Xm$	$Xa + Xm$	$Xa + Xm$
L_l	Xa	Xa	Xa	Xa
L_p	$Xa + \frac{1}{\frac{1}{Xm} + \frac{1}{X1}}$	$Xa + \frac{1}{\frac{1}{Xm} + \frac{1}{X1}}$	$Xa + \frac{1}{\frac{1}{Xm} + \frac{1}{X1}}$	$Xa + \frac{1}{\frac{1}{Xm} + \frac{1}{X1}}$
L_{pp}	$Xa + \frac{1}{\frac{1}{Xm} + \frac{1}{X1} + \frac{1}{X2}}$	Same as L_p	$Xa + \frac{1}{\frac{1}{Xm} + \frac{1}{X1} + \frac{1}{X2}}$	Same as L_p
T_{po}	$\frac{X1 + Xm}{\omega_o R1}$	$\frac{X1 + Xm}{\omega_o R1}$	$\frac{X1 + X2 + Xm}{\omega_o R2}$	$\frac{X1 + Xm}{\omega_o R1}$
T_{ppo}	$\frac{X2 + \frac{X1 * Xm}{X1 + Xm}}{\omega_o R2}$	0	$\frac{1}{\frac{1}{X1 + Xm} + \frac{1}{X2}} \cdot \frac{1}{\omega_o R1}$	0