

# Equations

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$$I_{\text{Kto}} = [G_{\text{Kto}} a_{\text{Kto}}^3 i_{\text{Kto}} (1 - f_{\text{Kto}}) + G_{\text{Kto,p}} a_{\text{Kto,p}}^3 i_{\text{Kto,p}} f_{\text{Kto}}] (V - E_K)$$

$$\frac{da_{\text{Kto}}}{dt} = \alpha_a (1 - a_{\text{Kto}}) - \beta_a a_{\text{Kto}}$$

$$\frac{di_{\text{Kto}}}{dt} = \alpha_i (1 - i_{\text{Kto}}) - \beta_i i_{\text{Kto}}$$

$$\frac{da_{\text{Kto,p}}}{dt} = \alpha_{ap} (1 - a_{\text{Kto,p}}) - \beta_{ap} a_{\text{Kto,p}}$$

$$\frac{di_{\text{Kto,p}}}{dt} = \alpha_{ip} (1 - i_{\text{Kto,p}}) - \beta_{ip} i_{\text{Kto,p}}$$

$$\alpha_a = 0.18064e^{0.03577(V+33.0)}$$

$$\beta_a = 0.3956e^{-0.06237(V+33.0)}$$

$$\alpha_i = \frac{0.00152e^{-(V+15.5)/7.0}}{0.067083e^{-(V+35.5)/7.0}}$$

$$\beta_i = \frac{0.00095e^{(V+35.5)/7.0}}{0.051335e^{(V+35.5)/7.0} + 1}$$

$$\alpha_{ap} = 0.18064e^{0.03577(V+17.0)}$$

$$\beta_{ap} = 0.03956e^{-0.06237(V+17.0)}$$

$$\alpha_{ip} = \frac{0.000152e^{-(V+7.5)/7.0}}{0.067083e^{-(V+27.5)/7.0} + 1}$$

$$\beta_{ip} = \frac{0.00095e^{(V+27.5)/7.0}}{0.051335e^{(V+27.5)/7.0} + 1}$$

$$\begin{aligned}
I_{\text{Kslow1}} &= [G_{\text{Kslow1}} f_{\text{Kslow1}} + G_{\text{Kslow1,p}}(1 - f_{\text{Kslow1}})] a_{\text{Kslow1}} i_{\text{Kslow1}} (V - E_K) \\
\frac{da_{\text{Kslow1}}}{dt} &= \frac{a_{ss} - a_{\text{Kslow1}}}{\tau_{\text{aKslow1}}} \\
\frac{di_{\text{Kslow1}}}{dt} &= \frac{i_{ss} - i_{\text{Kslow1}}}{\tau_{\text{iKslow1}}} \\
a_{ss} &= \frac{1}{1 + e^{-(V+22.5)/7.7}} \\
i_{ss} &= \frac{1}{1 + e^{(V+45.2)/5.7}} \\
\tau_{\text{aKslow1}} &= \frac{6.1}{e^{0.0629(V+40.0)} + e^{-0.0629(V+40.0)}} + 2.058 \\
\tau_{\text{iKslow1}} &= 803.0 - \frac{18.0}{1 + e^{(V+45.2)/5.7}}
\end{aligned}$$

$$\begin{aligned}
I_{\text{Kslow2}} &= G_{\text{Kslow2}} a_{\text{Kslow2}} i_{\text{Kslow2}} (V - E_K) \\
a_{\text{Kslow2}} &= a_{\text{Kslow1}} \\
\frac{di_{\text{Kslow2}}}{dt} &= \frac{i_{ss} - i_{\text{Kslow2}}}{\tau_{\text{iKslow2}}} \\
\tau_{\text{iKslow2}} &= 5334.0 - \frac{4912.0}{1 + e^{(V+45.2)/5.7}} = 5334.0 - 4912.0 i_{ss}
\end{aligned}$$

$$\begin{aligned}
I_{\text{Kss}} &= G_{\text{Kss}} a_{\text{Kss}} (V - E_K) \\
\frac{da_{\text{Kss}}}{dt} &= \frac{a_{ss} - a_{\text{Kss}}}{\tau_{\text{aKss}}} \\
\tau_{\text{aKss}} &= \frac{1235.5}{e^{0.0862(V+40.0)} + e^{-0.0862(V+40.0)}} + 13.17
\end{aligned}$$

$$\begin{aligned}
I_{\text{Kto}} &= [G_{\text{Kto}} a_{\text{Kto}}^3 i_{\text{Kto}} (1 - f_{\text{Kto}}) + G_{\text{Kto,p}} a_{\text{Kto,p}}^3 i_{\text{Kto,p}} f_{\text{Kto}}] (V - E_K) \\
\frac{da_{\text{Kto}}}{dt} &= \alpha_a (1 - a_{\text{Kto}}) - \beta_a a_{\text{Kto}} \\
\frac{di_{\text{Kto}}}{dt} &= \alpha_i (1 - i_{\text{Kto}}) - \beta_i i_{\text{Kto}} \\
\frac{da_{\text{Kto,p}}}{dt} &= \alpha_{ap} (1 - a_{\text{Kto,p}}) - \beta_{ap} a_{\text{Kto,p}} \\
\frac{i_{\text{Kto,p}}}{dt} &= \alpha_{ip} (1 - i_{\text{Kto,p}}) - \beta_{ip} i_{\text{Kto,p}} \\
\alpha_a &= p_9 e^{p_7(V+p_1)} \\
\beta_a &= p_{10} e^{-p_8(V+p_1)} \\
\alpha_i &= \frac{p_{11} e^{-(V+p_2)/p_6}}{p_{12} e^{-(V+p_2+p_3)/p_6}} \\
\beta_i &= \frac{p_{13} e^{(V+p_2+p_3)/p_6}}{p_{14} e^{(V+p_2+p_3)/p_6} + 1} \\
\alpha_{ap} &= p_9 e^{p_7(V+p_1-p_4)} \\
\beta_{ap} &= p_{10} e^{-p_8(V+p_1-p_4)} \\
\alpha_{ip} &= \frac{p_{11} e^{-(V+p_2-p_5)/p_6}}{p_{12} e^{-(V+p_2+p_3-p_5)/p_6} + 1} \\
\beta_{ip} &= \frac{p_{13} e^{(V+p_2+p_3-p_5)/p_6}}{p_{14} e^{(V+p_2+p_3-p_5)/p_6} + 1}
\end{aligned}$$

$$\begin{aligned}
I_{\text{Kslow1}} &= [G_{\text{Kslow1}} f_{\text{Kslow1}} + G_{\text{Kslow1,p}} (1 - f_{\text{Kslow1}})] a_{\text{Kslow1}} i_{\text{Kslow1}} (V - E_K) \\
\frac{da_{\text{Kslow1}}}{dt} &= \frac{a_{ss} - a_{\text{Kslow1}}}{\tau_{a\text{Kslow1}}} \\
\frac{di_{\text{Kslow1}}}{dt} &= \frac{i_{ss} - i_{\text{Kslow1}}}{\tau_{i\text{Kslow1}}} \\
a_{ss} &= \frac{1}{1 + e^{-(V+p_1)/p_4}} \\
i_{ss} &= \frac{1}{1 + e^{(V+p_2)/p_5}} \\
\tau_{a\text{Kslow1}} &= \frac{p_6}{e^{p_7(V+p_3)} + e^{-p_6(V+p_3)}} + p_8 \\
\tau_{i\text{Kslow1}} &= p_9 - \frac{p_{10}}{1 + e^{(V+p_2)/p_5}}
\end{aligned}$$

$$I_{\text{Kslow2}} = G_{\text{Kslow2}} a_{\text{Kslow2}} i_{\text{Kslow2}} (V - E_K)$$

$$a_{\text{Kslow2}} = a_{\text{Kslow1}}$$

$$\frac{di_{\text{Kslow2}}}{dt} = \frac{i_{ss} - i_{\text{Kslow2}}}{\tau_{i\text{Kslow2}}}$$

$$\tau_{i\text{Kslow2}} = p_1 - p_2 i_{ss}$$

$$I_{\text{Kss}} = G_{\text{Kss}} a_{\text{Kss}} (V - E_K)$$

$$\frac{da_{\text{Kss}}}{dt} = \frac{a_{ss} - a_{\text{Kss}}}{\tau_{a\text{Kss}}}$$

$$\tau_{a\text{Kss}} = \frac{p_1}{e^{p_2(V+40.0)} + e^{-p_2(V+40.0p_3^{\text{Kslow1}})}} + p_3$$