Pyramidal cell model:

Adaptive exponential integrate-and-fire model
with leak, AMPA and GABA conductance

$$\begin{aligned} C_{mP}\frac{dV_m}{dt} =& -g_{LP}(V_m - E_{LP}) \\ &+ g_{LP}\triangle T_P e^{\frac{V_m-\theta_P}{\triangle T}} - w_P \\ &- g_{AMPA}z(V_m - E_{Exc}) \\ &- g_{GABA}z(V_m - E_{Inh}) \end{aligned}$$

$$\tau_{wP}\frac{dw_P}{dt} = a_P(V_m - E_{LP}) - w_P$$

if V_m reaches θ_P:
$V \to V_{resP}$ and stays there for t_{refP} and
$w_P \to w_P + b_P$ (spike adatpation)

where:
$g_{LP} = 4.33 * 10^{-3}\mu S$
$\tau_{mP} = 60ms$
$C_{mP} = \tau_{mP} * g_{LP}$
$E_{LP} = -70mV$
$\triangle T_P = 2mV$
$\theta_P = -50mV$
$g_{AMPA} : \tau_{PExc}\frac{dg_{AMPA}}{dt} = -g_{AMPA}$
$g_{GABA} : \tau_{PInh}\frac{dg_{GABA}}{dt} = -g_{GABA}$
$(\tau_{PExc} = 10ms, \tau_{PInh} = 3ms)$
$E_{Exc} = 0mV$
$E_{Inh} = -70mV$
$z = 1nS$
$\tau_{wP} = 300ms$
$a_P = -0.8nS$
$b_P = 0.04nA$
treshold: $\theta_P + 10\triangle T_P = -30mV$
reset: $V_{resP} = -53mV$
refactory: $t_{refP} = 5ms$

Basket cell model:

Integrate-and-fire model
with leak, AMPA and GABA conductance

$$\begin{aligned} C_{mB}\frac{dV_m}{dt} =& -g_{LB}(V_m - E_{LB}) \\ &- g_{AMPA}z(V_m - E_{Exc}) \\ &- g_{GABA}z(V_m - E_{Inh}) \end{aligned}$$

if V_m reaches θ_B:
$V \to V_{resB}$ and stays there for t_{refB}

where:
$g_{LB} = 5 * 10^{-3}\mu S$
$\tau_{mB} = 14ms$
$C_{mB} = \tau_{mB} * g_{LB}$
$E_{LB} = -70mV$
$g_{AMPA} : \tau_{BExc}\frac{dg_{AMPA}}{dt} = -g_{AMPA}$
$g_{GABA} : \tau_{BInh}\frac{dg_{GABA}}{dt} = -g_{GABA}$
$(\tau_{BExc} = 3ms, \tau_{PInh} = 1.5ms)$
$E_{Exc} = 0mV$
$E_{Inh} = -70mV$
$z = 1nS$
treshold: $\theta_B = -50mV$
reset: $V_{resB} = -64mV$
refactory: $t_{refB} = 0.1ms$

Snapses:

Synapses are modelled as an instantaneous rise of the synaptic conductance $g_{syn}(t)$ from 0 to $\bar{g}_{syn}$ at time t_0, followed by an exponential decay, with a time constant τ.

$$g_{syn}(t) = \bar{g}_{syn}exp(\frac{t - t_0}{\tau})$$

Connections:

Pyramidal cell population (excitatory): 4000 neuron
Basket cell population (inhibitory): 1000 neuron

Connection type	weight	sparseness	delay
Exc → Exc	*learned*	0.16	3 ms
Exc → Inh	4.5 nS	0.15	3 ms
Inh → Exc	0.15 nS	0.4	1.5 ms
Inh → Inh	0.25 nS	0.4	1.5 ms

+ External input (to the pyramidal cell population):
PoissonGroup with 5 Hz firing rate (weight = 5 nS)