

## SBML Model Report

# Model name: “Izhikevich2004-SpikingNeurons\_thresholdVariability”



May 5, 2016

## 1 General Overview

This is a document in SBML Level 2 Version 4 format. This model was created by Enuo He<sup>1</sup> at July 16<sup>th</sup> 2007 at 9:41 a. m. and last time modified at February 25<sup>th</sup> 2015 at 11:18 a. m. Table 1 shows an overview of the quantities of all components of this model.

Table 1: Number of components in this model, which are described in the following sections.

Element	Quantity	Element	Quantity
compartment types	0	compartments	1
species types	0	species	0
events	4	constraints	0
reactions	0	function definitions	0
global parameters	8	unit definitions	0
rules	2	initial assignments	0

## Model Notes

This a model from the article:

**Which model to use for cortical spiking neurons?**

Izhikevich EM. IEEE Trans Neural Netw.2004 Sep;15(5):1063-70. [15484883](#),

**Abstract:**

We discuss the biological plausibility and computational efficiency of some of the most useful

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models of spiking and bursting neurons. We compare their applicability to large-scale simulations of cortical neural networks.

The model is according to the paper *Which Model to Use for Cortical Spiking Neurons?* Figure 1 (O) threshold variability has been reproduced by MathSBML. The ODE and the parameters values are taken from the a paper *Simple Model of Spiking Neurons* The original format of the models are encoded in the MATLAB format existed in the ModelDB with Accession number 39948

Figure 1 are the simulation results of the same model with different choices of parameters and different stimulus function or events.  $a=0.03$ ;  $b=0.25$ ;  $c=-60$ ;  $d=4$ ;  $V=-64$ ;  $u=b \cdot V$ ;

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## 2 Unit Definitions

This is an overview of five unit definitions which are all predefined by SBML and not mentioned in the model.

### 2.1 Unit substance

**Notes** Mole is the predefined SBML unit for substance.

**Definition** mol

### 2.2 Unit volume

**Notes** Litre is the predefined SBML unit for volume.

**Definition** l

### 2.3 Unit area

**Notes** Square metre is the predefined SBML unit for area since SBML Level 2 Version 1.

**Definition** m<sup>2</sup>

### 2.4 Unit length

**Notes** Metre is the predefined SBML unit for length since SBML Level 2 Version 1.

**Definition** m

## 2.5 Unit time

**Notes** Second is the predefined SBML unit for time.

**Definition** s

## 3 Compartment

This model contains one compartment.

Table 2: Properties of all compartments.

Id	Name	SBO	Spatial Dimensions	Size	Unit	Constant	Outside
cell			3	1	litre	<input checked="" type="checkbox"/>	

### 3.1 Compartment cell

This is a three dimensional compartment with a constant size of one litre.

## 4 Parameters

This model contains eight global parameters.

Table 3: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
a			0.03		<input checked="" type="checkbox"/>
b			0.25		<input checked="" type="checkbox"/>
c			−60.00		<input checked="" type="checkbox"/>
d			4.00		<input checked="" type="checkbox"/>
Vthresh			30.00		<input checked="" type="checkbox"/>
i			0.00		<input type="checkbox"/>
v			−64.00		<input type="checkbox"/>
u			−16.00		<input type="checkbox"/>

## 5 Rules

This is an overview of two rules.

### 5.1 Rule $v$

Rule  $v$  is a rate rule for parameter  $v$ :

$$\frac{d}{dt}v = 0.04 \cdot v^2 + 5 \cdot v + 140 - u + i \quad (1)$$

### 5.2 Rule $u$

Rule  $u$  is a rate rule for parameter  $u$ :

$$\frac{d}{dt}u = a \cdot (b \cdot v - u) \quad (2)$$

## 6 Events

This is an overview of four events. Each event is initiated whenever its trigger condition switches from `false` to `true`. A delay function postpones the effects of an event to a later time point. At the time of execution, an event can assign values to species, parameters or compartments if these are not set to constant.

### 6.1 Event `event_0000001`

**Trigger condition**

$$v > V_{\text{thresh}} \quad (3)$$

**Assignments**

$$v = c \quad (4)$$

$$u = u + d \quad (5)$$

### 6.2 Event `event_0000002`

**Trigger condition**

$$((\text{time} > 10) \wedge (\text{time} < 15)) \vee ((\text{time} > 80) \wedge (\text{time} < 85)) \quad (6)$$

**Assignment**

$$i = 1 \quad (7)$$

### 6.3 Event `event_0000003`

**Trigger condition**

$$(\text{time} > 70) \wedge (\text{time} < 75) \quad (8)$$

**Assignment**

$$i = -6 \quad (9)$$

## 6.4 Event `event_0000004`

### Trigger condition

$$((\text{time} \geq 15) \wedge (\text{time} \leq 70)) \vee (\text{time} \geq 85) \quad (10)$$

### Assignment

$$i = 0 \quad (11)$$

SBML<sup>2</sup>TeX was developed by Andreas Dräger<sup>a</sup>, Hannes Planatscher<sup>a</sup>, Dieudonné M Wouamba<sup>a</sup>, Adrian Schröder<sup>a</sup>, Michael Hucka<sup>b</sup>, Lukas Endler<sup>c</sup>, Martin Golebiewski<sup>d</sup> and Andreas Zell<sup>a</sup>. Please see <http://www.ra.cs.uni-tuebingen.de/software/SBML2LaTeX> for more information.

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