

## **User Documentation for wiring the cortical simulation 2D version**

Mike Sikora

November, 2006

This version of the wiring procedures has retained the same calling conventions as the 1D version where possible. The Layer V and Layer II/III Pyramidals and the inhibitory cells are placed on four coincident 2 dimensional matrices. The orthogonal distances between cells are equal and diagonal distances are calculated as a hypotenuse.

The matrices can be of any size with the X dimension defined as 'X\_DIM' and the Y dimension as 'Y\_DIM' These two parameters are most conveniently defined in the init file before the other files are called. Each cell type's position is defined by its index within the its respective 2D array- PL5[X\_DIM][Y\_DIM], PL2[X\_DIM][Y\_DIM], IPL2[X\_DIM][Y\_DIM] and IPL5[X\_DIM][Y\_DIM]

Inhibitory cells, being fewer in number than Pyramidals, use a sparse matrix. The new wiring functions for the inhibitory cells do not require a location parameter as the position is defined within the matrix array.

Feed forward /back functions have been generalized . There are fewer functions than in the 1D version. The placement of a FeedX can be anywhere on the coincident matrices and is defined by the parameters Fsx and Fsy.

There are 5 *categories* of procedures for wiring the somatosensory cortex simulation *remain the same*:

1. Pyramidal to Pyramidal
2. Inhibitory to Pyramidal
3. Pyramidal to Inhibitory
4. Inhibitory to Inhibitory
5. Feed-forward and feedback

### **Gaussian distribution**

#### **1. Pyramidal to Pyramidal connections**

*The calling convention for these functions has not changed from the 1D version.*

There are 4 Pyramidal to Pyramidal procedures:

```
VtoV()      -Connects Layer V to Layer V Pyramidals
VtoII()     -Connects Layer V to Layer II/III Pyramidals
IItoII()    -Connects Layer II/III to Layer II/III Pyramidals
IItoV()     -Connects Layer II/III to Layer V Pyramidals
             this procedure not currently used
```

The calling parameters are:

**XtoX( maxW, WSC, seg, rtype, minD, DSC )**

maxW - Maximum synaptic weight  
WSC - weight space constant  
seg - target segment  
rtype - receptor type [0=AMPA, 1=NMDA]  
minD - Minimum delay  
DSC - delay space constant

The target segment (seg) refers to the postsynaptic cell type:

Layer V Pyramidal Cells:

Apical compartments 0-4

Basal 5-7

Soma 8

Layer II/III Pyramidal Cells:

Apical compartments 0-3

Basal 4-6

Soma 7

## **2. Inhibitory to Pyramidal connections**

There remain 3 Inhibitory to Pyramidal procedures:

IL5toV() -Connects Layer V inhibitory cells to Layer V Pyramidals  
IL2toV() -Connects Layer II/III inhibitory cells to Layer V Pyramidals  
IL2toII() -Connects Layer II/II inhibitory cells to Layer II/III Pyramidals

***The calling convention has changed from the old version:***

**XtoX(seg, rtype, maxW, WSC, maxP, minD, DSC)**

seg - target segment  
rtype - receptor type [2=GABAa, 3=GABAb]  
maxW - Maximum synaptic weight  
WSC - weight space constant  
minD - Minimum delay  
DSC - delay space constant

### 3. Pyramidal to Inhibitory connections

There are 3 Pyramidal to Inhibitory procedures

ItoIL2() -Connects Layer II/III Pyramidal cells to a single Layer II inhibitory cell  
VtoIL5() -Connects Layer V Pyramidal cells to a single Layer V inhibitory cell  
ItoIL5() -Connects Layer II/III Pyramidal cells to a single Layer V inhibitory cell

*The calling convention has changed from the old version:*

**XtoX(maxW, WSC, minD, DSC, rtype)**

maxW - Maximum synaptic weight

WSC - weight space constant

minD - Minimum delay

DSC - delay space constant

rtype - receptor type [0=AMPA, 1=NMDA]

### 4. Inhibitory to Inhibitory connections

*The calling convention for these functions has not changed from the 1D version.*

IL2toIL2() -Connect Layer II/III inhibitory cells to themselves  
IL5toIL5() -Connect Layer V inhibitory cells to themselves

The calling parameters are:

**XtoX(maxW, WSC, minD, DSC, rtype)**

maxW - Maximum synaptic weight

WSC - weight space constant

minD - Minimum delay

DSC - delay space constant

rtype - receptor type [2=GABAa, 3=GABAb]

Inhibitory cells do not self-inhibit.

### 5. Feed-forward and feedback connections

*The calling convention has changed from the old version and there are fewer procedures:*

*The Feed procedures now use a Gaussian distribution for weight and delay. The position of the Feed is determined by the global variables FSx and Fsy. These are best set in the initialization file. The FeedX() object used is now a parameter to the procedure.*

#### **a. Feed to Pyramidal cells-----**

FeedtoII()      - feed to Layer II/III pyramidal  
FeedtoV()       - feed to Layer V pyramidal

#### **FeedtoX(seg, rtype, maxW, WSC minD, DSC, fobj)**

seg       - target segment  
rtype     - receptor type [0=AMPA,1=NMDA]  
maxW - Maximum synaptic weight  
WSC     - weight space constant  
minD    - Minimum delay  
DSC     - delay space constant  
fobj     - a FeedX object (eg. FF,FF2,FB)

#### **b. Feed to Inhibitory cells-----**

FeedtoIL2()     - feed to Layer II inhibitory cells  
FeedtoIL5()     - feed to Layer V inhibitory cells

The calling parameters are:

#### **FeedtoX(rtype, maxW, WSC minD, DSC, fobj)**

rtype     - receptor type [0=AMPA,1=NMDA]  
maxW - Maximum synaptic weight  
WSC     - weight space constant  
minD    - Minimum delay  
DSC     - delay space constant  
fobj     - a FeedX object (eg. FF,FF2,FB)

.

---

## Uniform Random Distribution

Uniform random distribution functions are implemented and are defined over synaptic weight and delay by a minimum and maximum. The naming convention parallels the Gaussian functions but is preceded by a “U\_” ;eg. `vtoV()` becomes `U_vtoV()`.

### 1. Pyramidal to Pyramidal connections

There are 4 Pyramidal to Pyramidal procedures:

```
U_VtoV()      -Connects Layer V to Layer V Pyramidals
U_VtoII()     -Connects Layer V to Layer II/III Pyramidals
U_IItoII()    -Connects Layer II/III to Layer II/III Pyramidals

U_IItoV()     -Connects Layer II/III to Layer V Pyramidals
```

*The calling convention for these functions has not changed from the 1D version*

#### **U\_XtoX ( MinW, MaxW , seg, rtype, MinD, MaxD )**

minW -Minimum synaptic weight  
maxW - Maximum synaptic weight  
seg - target segment  
rtype - receptor type [0=AMPA, 1=NMDA]  
minD - Minimum delay  
maxD -Maximum delay

### 2. Inhibitory to Pyramidal connections

There are 3 Inhibitory to Pyramidal procedures:

```
U_IL5toV()    -Connects Layer V inhibitory cells to Layer V Pyramidals
U_IL2toV()    -Connects Layer II/III inhibitory cells to Layer V Pyramidals
U_IL2toII()   -Connects Layer II/II inhibitory cells to Layer II/III
Pyramidals
```

*The calling convention has changed from the old version:*

#### **U\_ILxtoX(seg, rtype, MinW, MaxW, MinD, MaxD)**

seg - target segment  
rtype - receptor type [2=GABAa, 3=GABAb]  
minW -Minimum synaptic weight  
maxW - Maximum synaptic weight  
minD - Minimum delay  
maxD -Maximum delay

### 3. Pyramidal to Inhibitory connections

There are 3 Pyramidal to Inhibitory procedures

U\_ILtoIL2() -Connects Layer II/III Pyramidal cells to a single Layer II inhibitory cell  
U\_VtoIL5() -Connects Layer V Pyramidal cells to a single Layer V inhibitory cell  
U\_ILtoIL5() -Connects Layer II/III Pyramidal cells to a single Layer V inhibitory cell

*The calling convention has changed from the old version:*

**U\_XtoILx(MinW, MaxW, rtype, MinD, MaxD)**

MinW -Minimum synaptic weight  
maxW - Maximum synaptic weight  
rtype - receptor type [0=AMPA, 1=NMDA]  
minD - Minimum delay  
maxD -Maximum delay

### 4. Inhibitory to Inhibitory connections

There are 2 Inhibitory to Inhibitory procedures:

U\_IL2toIL2() -Connect Layer II/III inhibitory cells to themselves  
U\_IL5toIL5() -Connect Layer V inhibitory cells to themselves

*The calling convention for these functions has not changed from the 1D version.*

**U\_ILxtoILx(MinW, MaxW, MinD, MaxD, rtype )**

minW -Minimum synaptic weight  
maxW - Maximum synaptic weight  
minD - Minimum delay  
maxD -Maximum delay  
rtype - receptor type [2=GABAa, 3=GABAb]

## 5. Feed-forward and feedback connections

*The calling convention has changed from the old version and there are fewer procedures*

### a. Feed to Pyramidal cells-----

UFeedtoII()            -feed to Layer II/III pyramidals  
UFeedtoV()            -feed to LayerV pyramidals

The calling parameters are:

**UFeedtoX(seg, rtype, MinW, MaxW, MinD, MaxD, fobj )**

seg            - target segment  
rtype          - receptor type [0=AMPA,1=NMDA]  
MinW          -Minimum synaptic weight  
MaxW          -Maximum synaptic weight  
MinD          -Minimum delay  
MaxD          -Maximum delay  
fobj          - a FeedX object (eg. FF,FF2,FB)

### b. Feed to Inhibitory cells-----

UFeedtoIL2()          -feed to Layer II inhibitory cells  
UFeedtoIL5()          -feed to Layer V inhibitory cells

The calling parameters are:

**UFeedtoX(rtype, MinW, MaxW, MinD, MaxD ,fobj)**

rtype          - receptor type [0=AMPA,1=NMDA]  
MinW          -Minimum synaptic weight  
MaxW          -Maximum synaptic weight  
MinD          -Minimum delay  
MaxD          -Maximum delay  
fobj          - a FeedX object (eg. FF,FF2,FB)