Manual for Using Memristor Models

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Note: Before running any simulation we recommend using the MATLAB model for proper parameter selection.

1. Download both: MemristorGui.fig, MemristorGui.m for MATLAB

2. Run MemristorGui in MATLAB prompt.

The next steps apply both for MATLAB and for SPICE users:

3. Choose the Memristor model (other option are not allowed) :

    0. Linear Ion Drift
    1. Simmons Tunnel Barrier
    2. TEAM – Threshold Adaptive Memristor
    3. Nonlinear Ion Drift
    4. VTEAM – Voltage ThrEshold Adaptive Memristor

4. Choose the window (other options are not allowed):

    0. No window
    1. Jogelkar window
    2. Biolek window
    3. Prodromakis window
    4. Kvatinsky window (TEAM/VTEAM models)

5. In case the selection is Team model specify the I-V relation:

    0. Linear I-V =>   V=IR
    1. Nonlinear I-V => V=IR*exp(..)

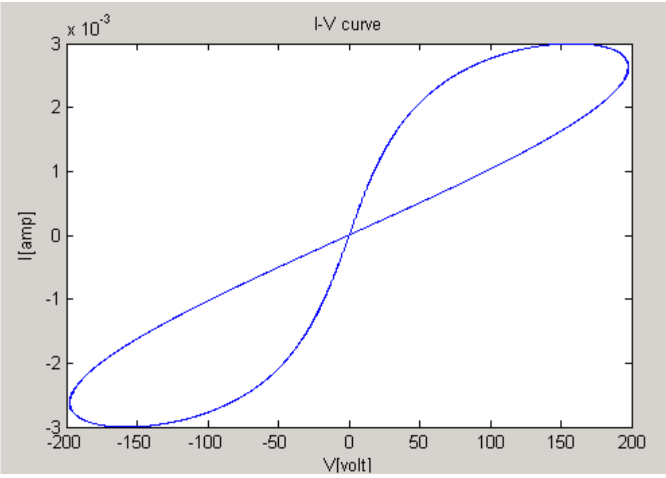
6. Select the desired parameters (the parameters are described in the end of this document).

In the table below we include the suggested parameters.

Parameters		Linear Ion Drift	Simmons Tunnel Barrier	Nonlinear Ion Drift	TEAM	VTEAM
Name [Units]	**Description**					
Frequency [Hz]	Source frequency (Sine input)	2	2e6	2	2e6	50e6
Source amp	Source amplitude	0.003 [A]	0.003 [A]	1 [V]	0.003 [A]	1 [V]
Ron [Ohm]	Memristor's minimum resistance	100	100		100	50
Roff [Ohm]	Memristor's maximum resistance	2e5	2e5		2e5	1000
D [m]	Physical width of the memristor	10e-09	3e-09		3e-09	3e-09
V_threshold [V]	Threshold voltage (for linear ion drift models, originally threshold was not included in the Linear ion drift model, added in order to suit the physical expected behavior of the memristor)	0	0		0	
uv [m^2/Vsec]	Linear ion mobility for linear ion drift model	10e-14				
P_coeff	The value of p in the window functions	2		1	2	2
Initial state [0:1]	The initial state of the state variable	0.5	0.5	0.5	0.5	0.5
j	j in Prodomakis window function	1		1	1.5	1.5
Alpha	Alpha in nonlinear ion drift			2		
Beta	Beta in nonlinear ion drift			9		
C	χ in nonlinear ion drift			0.01		
g	γ in nonlinear ion drift			4		
n	n in nonlinear ion drift (odd positive integer)			13		
q	q in nonlinear ion drift (odd positive integer)			13		
a	a in nonlinear ion drift			4		
a_on [m]	Upper bound of undoped region (Simmons tunnel barrier)		2e-09		2.3e-09	2e-09
a_off [m]	Lower bound of undoped region (Simmons tunnel barrier)		1.2e-09		1.2e-09	1.2e-09
i_on [A]	Threshold current in TEAM/ i_{on} in Simmons tunnel barrier		8.9e-06		-1e-06	
i_off [A]	Threshold current in TEAM/ i_{off} in Simmons tunnel barrier		115e-06		1e-06	
v_on [V]	Threshold voltage in VTEAM					-0.2
v_off [V]	Threshold voltage in VTEAM					0.02
c_on [m/s]	State derivative coefficient for Simmons tunnel barrier		40e-06			
c_off [m/s]	State derivative coefficient for Simmons tunnel barrier		3.5e-06			
b [A]	Normalized current for Simmons tunnel barrier		500e-06			
X_c [m]	Normalized length for Simmons tunnel barrier		107e-12		107e-11	107e-11
k_on [m/sec]	k_{on} in TEAM				-8e-13	-10
k_off [m/sec]	k_{off} in TEAM				8e-13	5e-4
x_on [m]	Lower bound of undoped region (TEAM)				0	0
x_off [m]	Upper bound of undoped region (TEAM)				D=3e-09	D=3e-09
alpha_off	Nonlinearity power coefficient for TEAM				3	1
alpha_on	Nonlinearity power coefficient for TEAM				3	3
Num of cycles	The number of source cycles to simulate in MATLAB					
model	The required model – 0,1,2,3	0	1	3	2	4
window_type	The required window function – 0,1,2,3,4	2 – Biolek	not needed	2 – Biolek	4 – Kvatinsky	0 – no window
dt	Numeric simulation time step (for virtuoso).	When running a transient Simulation (ADEXL), always declare “dt” in the Memristor the same as max_step size in transient simulation. Usually dt should be 3 orders less than 1/f. for Example: f=2Hz, dt~1e-03.				
W_multiplied	A normalization for the state variable (for virtuoso)	1e9	1e9	1	1e9	1e9
P_window_noise	A small noise in order to avoid boundary problems in window functions (for virtuoso)	1e-18	1e-18	1e-18	1e-18	1e-18

7. Plot state Variable and I-V curve and Change the parameters till you get the wanted I-V relation (unfortunately, the GUI does not support figure export to file).

For example:



8. Apply the same parameters on SPICE Memristor.

Opening a Memristor model in SPICE tool (e.g., CADENCE Virtuoso):

1. Download Memristor.va
2. Open Virtuoso (Cadence).
3. Create new Library and Cellview. File -> new - >Cellview. Choose the type of the Cellview to be VerilogA. To a Blank .va file, Copy the code from Memristor.va to the new Cellview. Exit “insert” mode with Esc and save and create new Symbol by entering “:wq”. You can edit the symbol and draw a memristor symbol.
4. Open new Schematic and add Memristor instance from the library you created it above.
5. Connect the wanted Design.
6. In order to change the Memristor model or settings (in Virtuoso), press Q on the Memristor and on the CDF parameter to view select VerilogA.