How to Build a Simple Stateflow Model

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EECS 461: Embedded Control Systems

Introduction

- This set of slides will show you how build a simple model using Simulink and Stateflow.

- We will use 32-bit Matlab release 2011b, the same version of Matlab as currently used in the EECS 461 Embedded Control Lab.

- Instructions for installing 32-bit Matlab 2011b on your laptop are contained in the "Course Logistics" document on CTools

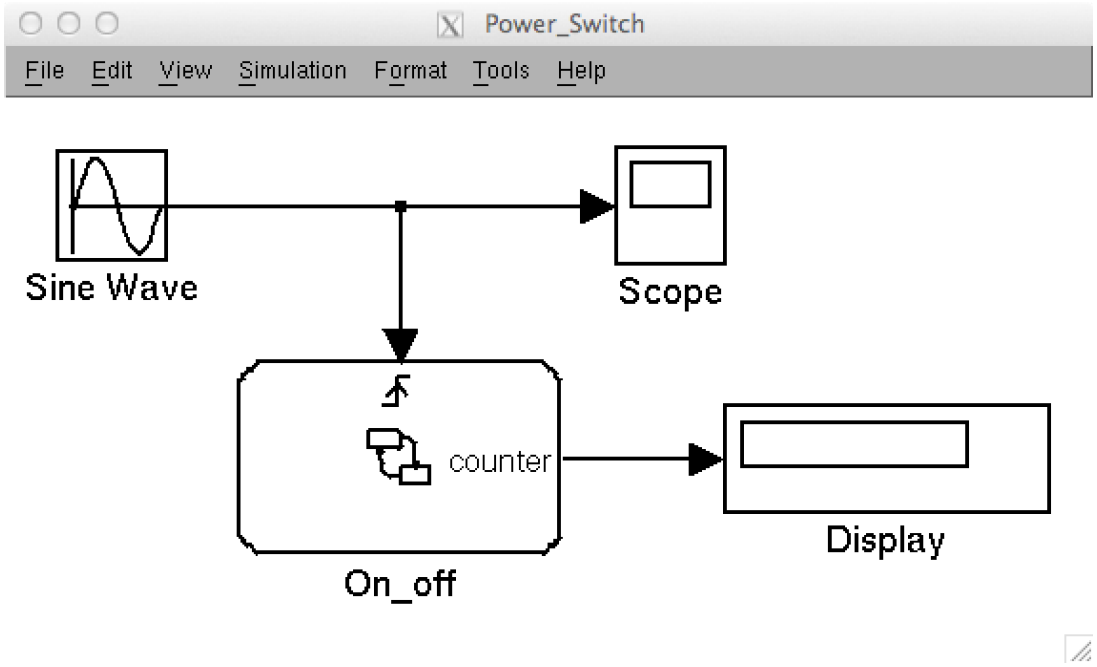
- Recently Matlab has changed from models with a .mdl suffix to models with a .slx suffix. (The underlying software is different, and enables additional features.)

- If you insist on using a more recent version of Matlab, and you want me to examine your model for debugging, then you should save your model as a .mdl file In Matlab 2011b. Look for a "save as" command, or perhaps an "export" command. (Different versions of Matlab do this differently.)

Power Switch Simulink Model

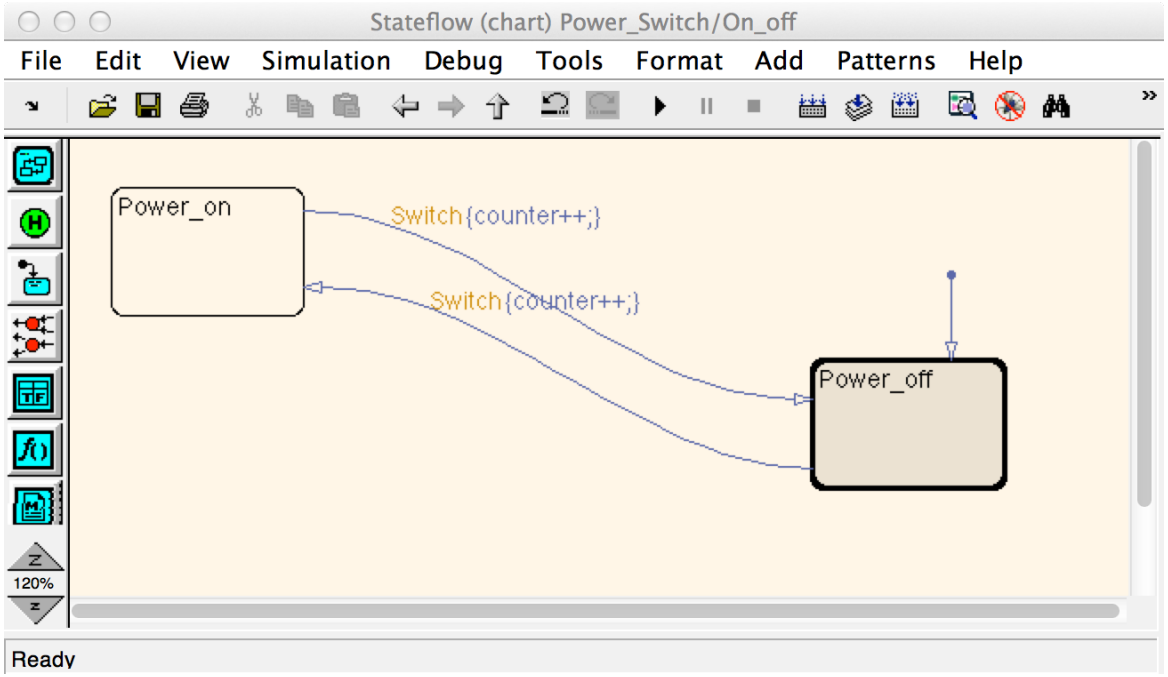
- Simulink model of a power switch that toggles on and off at zero crossing of a sine input.

- At each switch, a counter is incremented

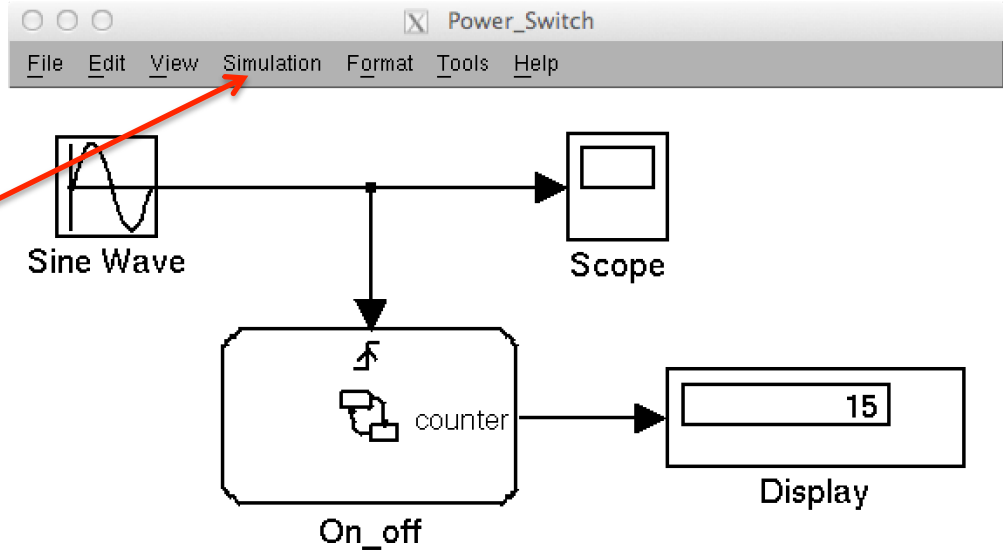


Inside the State Chart

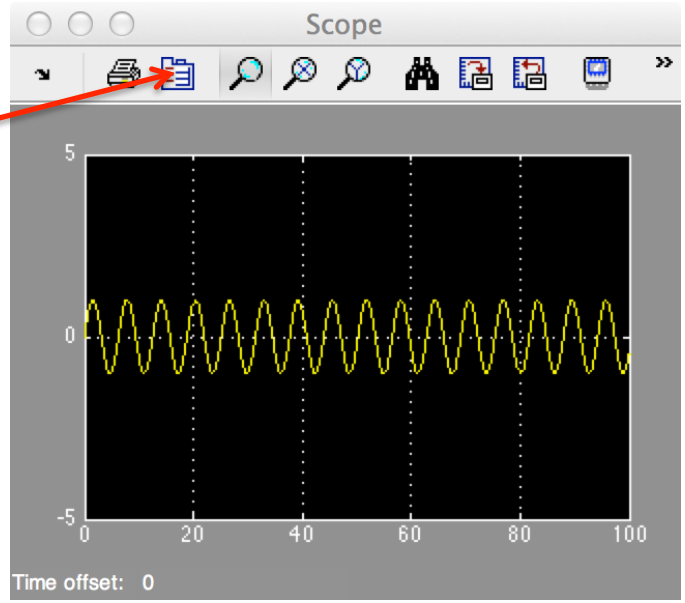
- Two states of the power switch: on and off
- Transitions between the States happen whenever the event "switch" occurs.
- When a transition occurs, the variable "counter" is incremented
- By default, the initial state is "off"



To Run Simulation



- Open Scope by clicking on it
- Run simulation by selecting “start” from the Simulation menu



- If the Scope does not display the entire sine waveform, go to the Scope parameters menu, navigate to the History submenu, and turn off the “Limit data points” option.

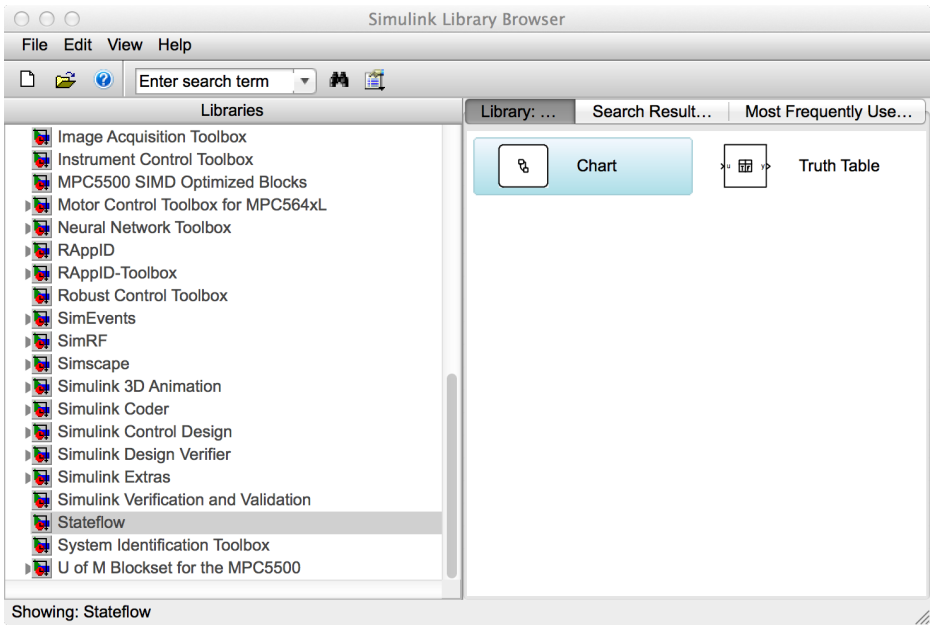
- Change the size or colors of the plotted lines using the Graphics submenu

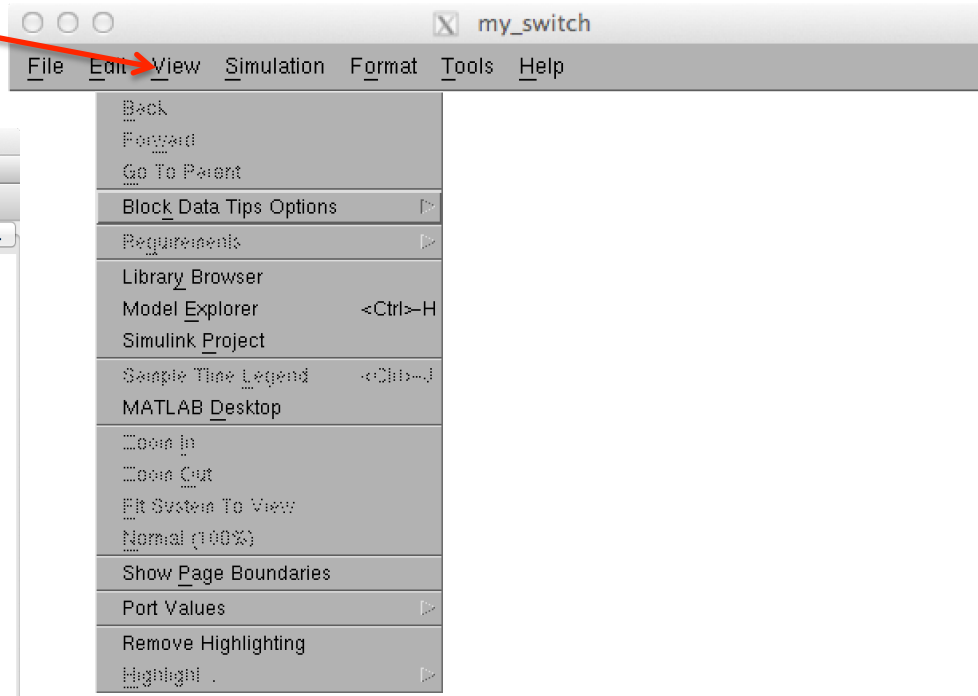
Create Simulink Model

- Create a new Simulink model by selecting File/New/Model

in the Matlab command window.

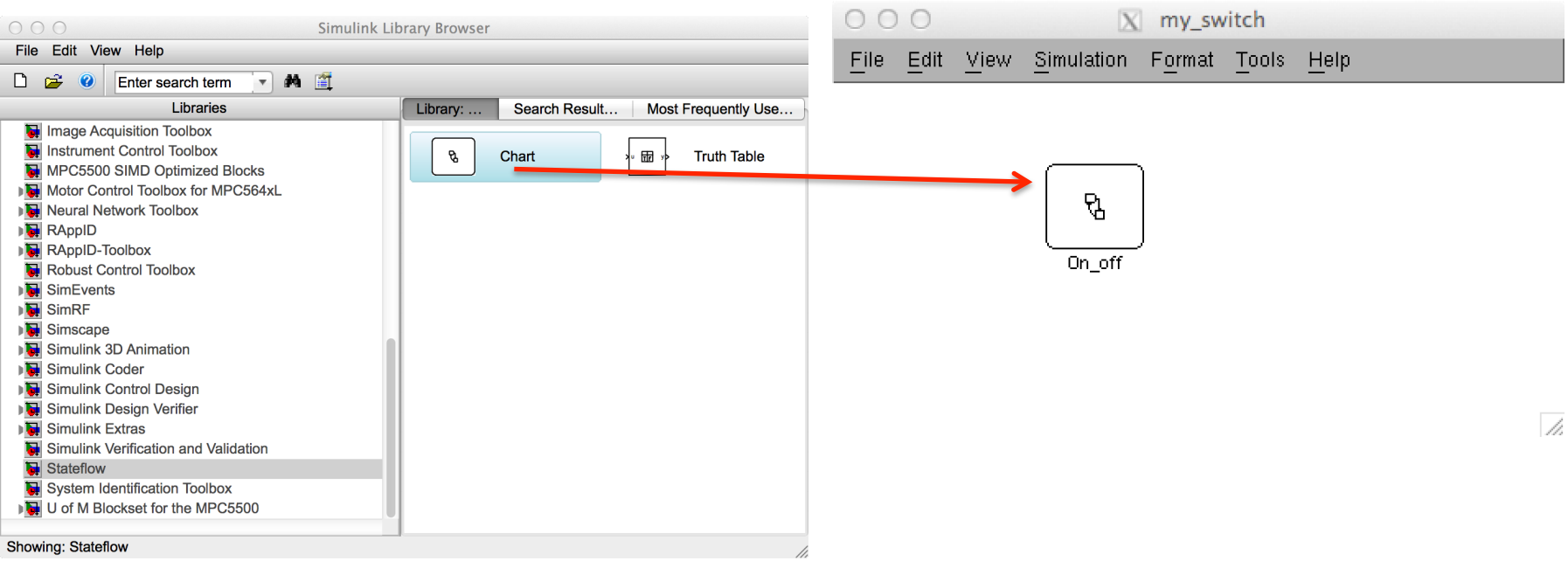
- Save the model with a name, e.g. “my_switch”
- In the View Menu, select “Library Browser” and navigate down to Stateflow





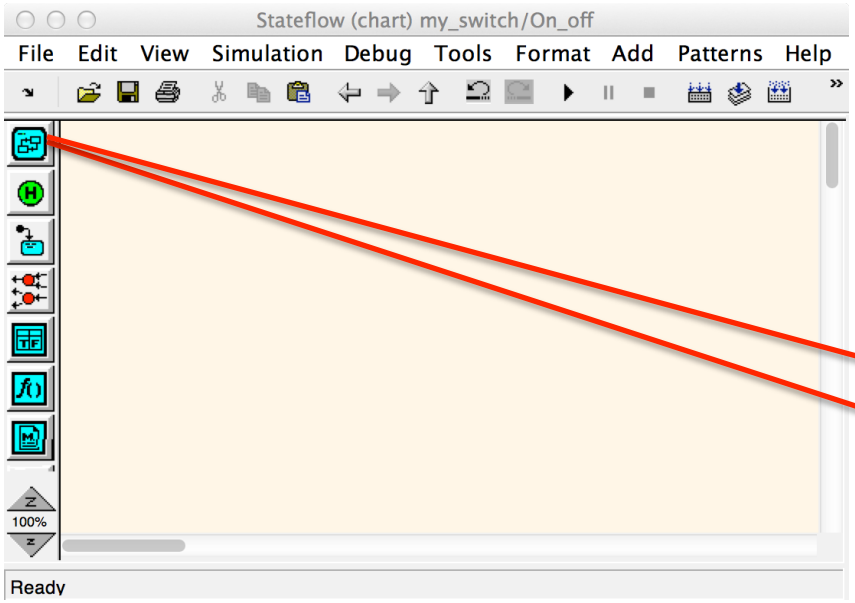
Add Statechart to Simulink Model

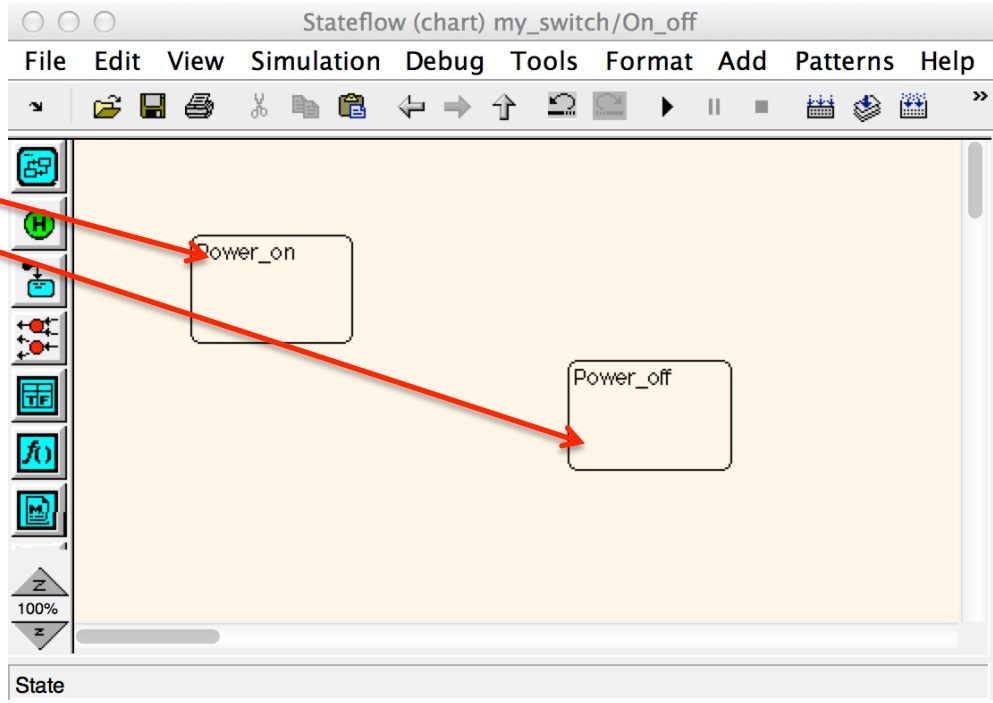
- Drag Statechart to the Simulink model
- Change name from “Chart” to “On_off”



Adding States to a Statechart

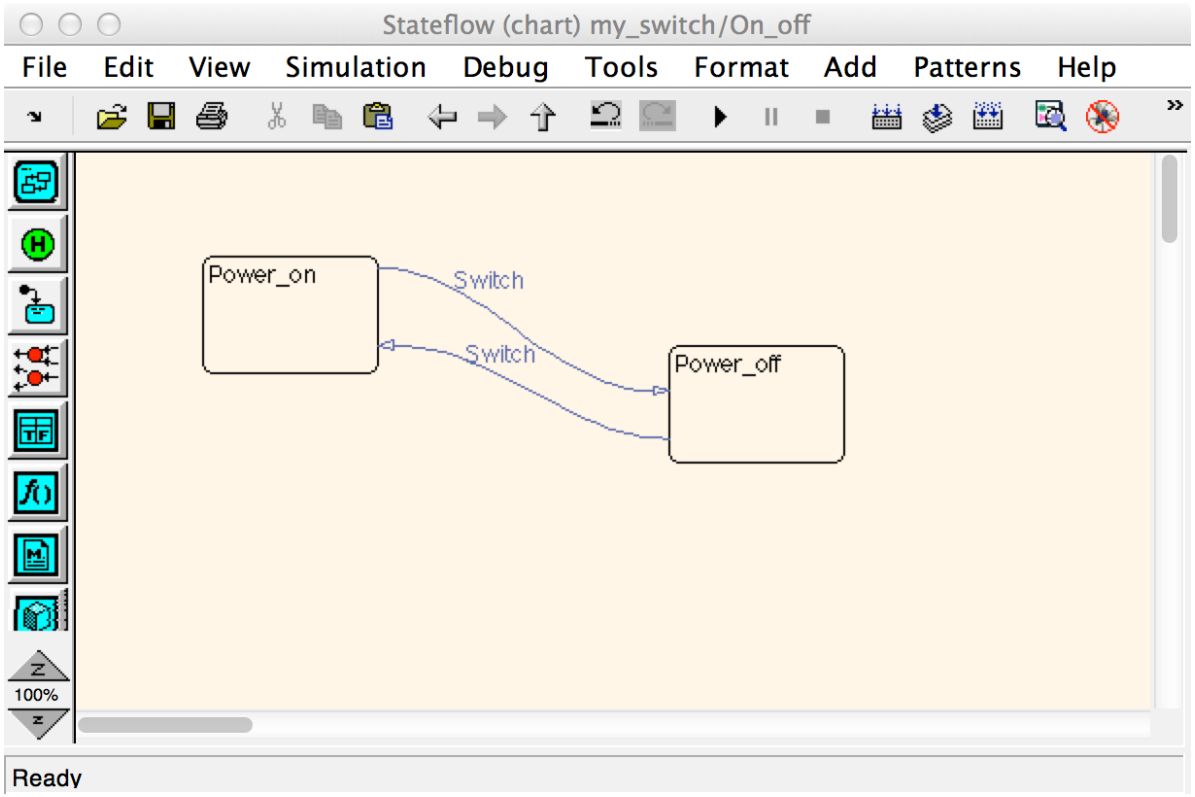
- Open Statechart “On_off” by double-clicking
- Drag two states from the menu at left into the chart.
- Name them “Power_on” and “Power_off” by editing the ? In the upper left corner
- NOTE: to delete a state, highlight it and select “Cut” from the “Edit” menu





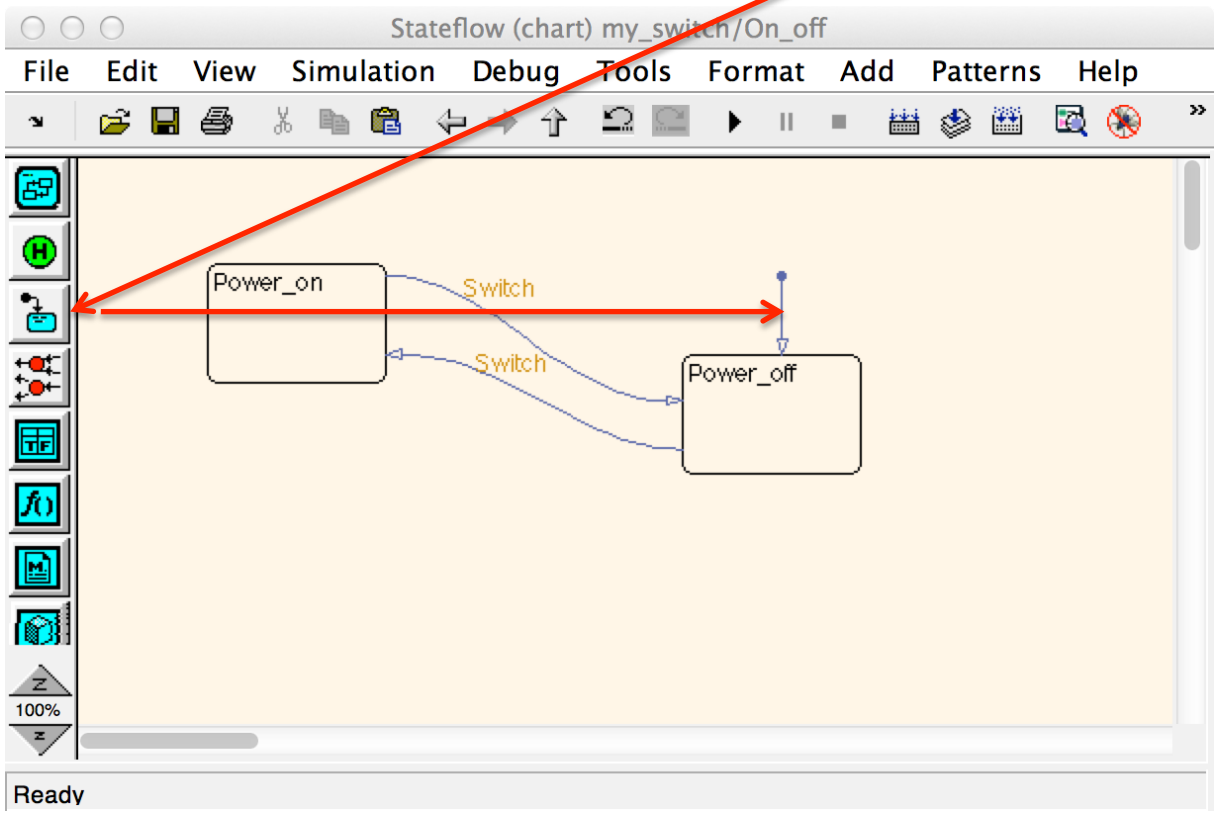
Creating Transitions between States

- To create a transition between states, hold the cursor over the border of the starting state – it will turn into crosshairs.
- Hold down the mouse button drag the mouse to the terminal state – this will create a transition (denoted by an arrow) connecting the states
- Click on the transition and replace the resulting ? with the name of the event that causes the transition.



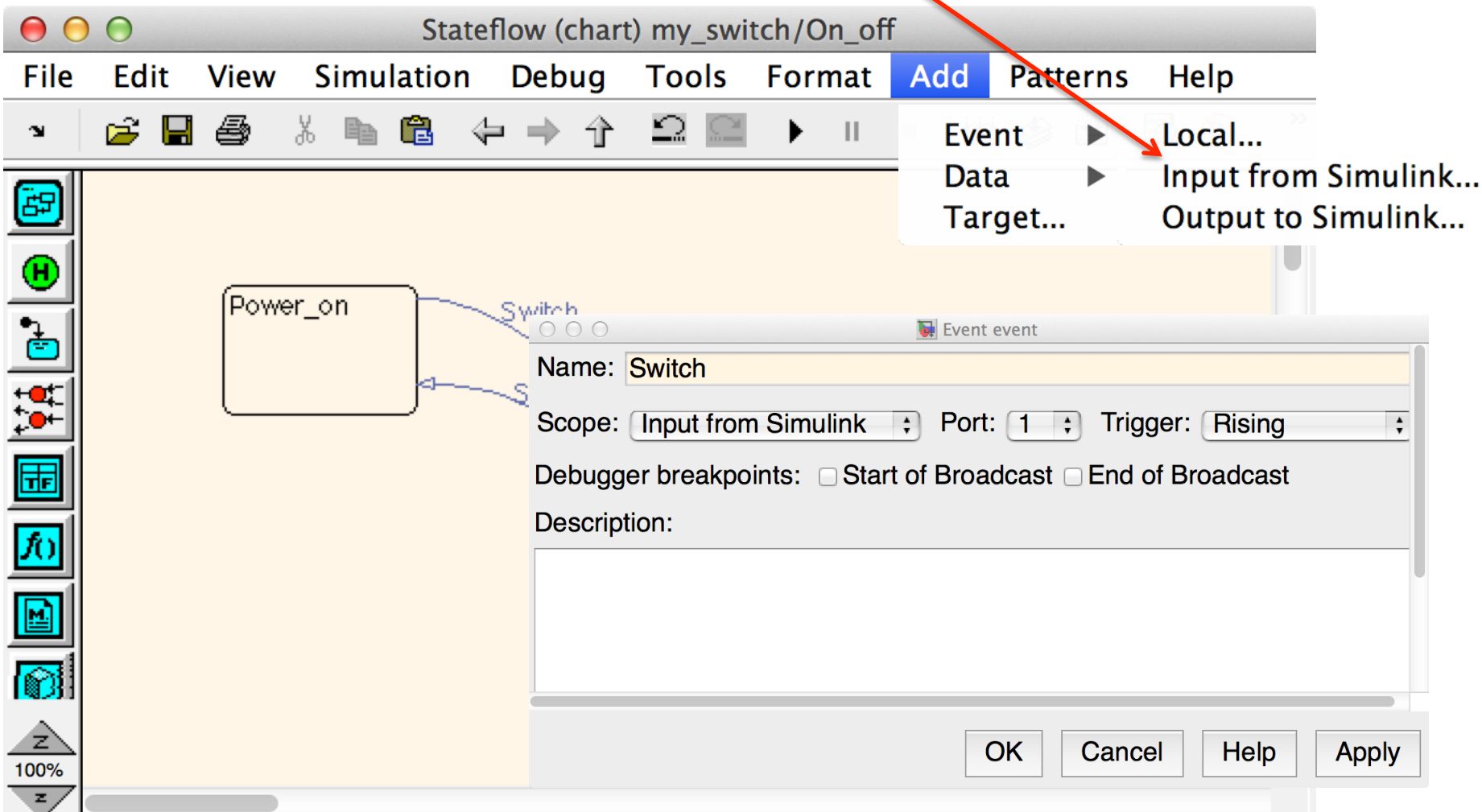
Add a Default Transition

- Specify the initial state (Power_off in this case) by adding a default transition



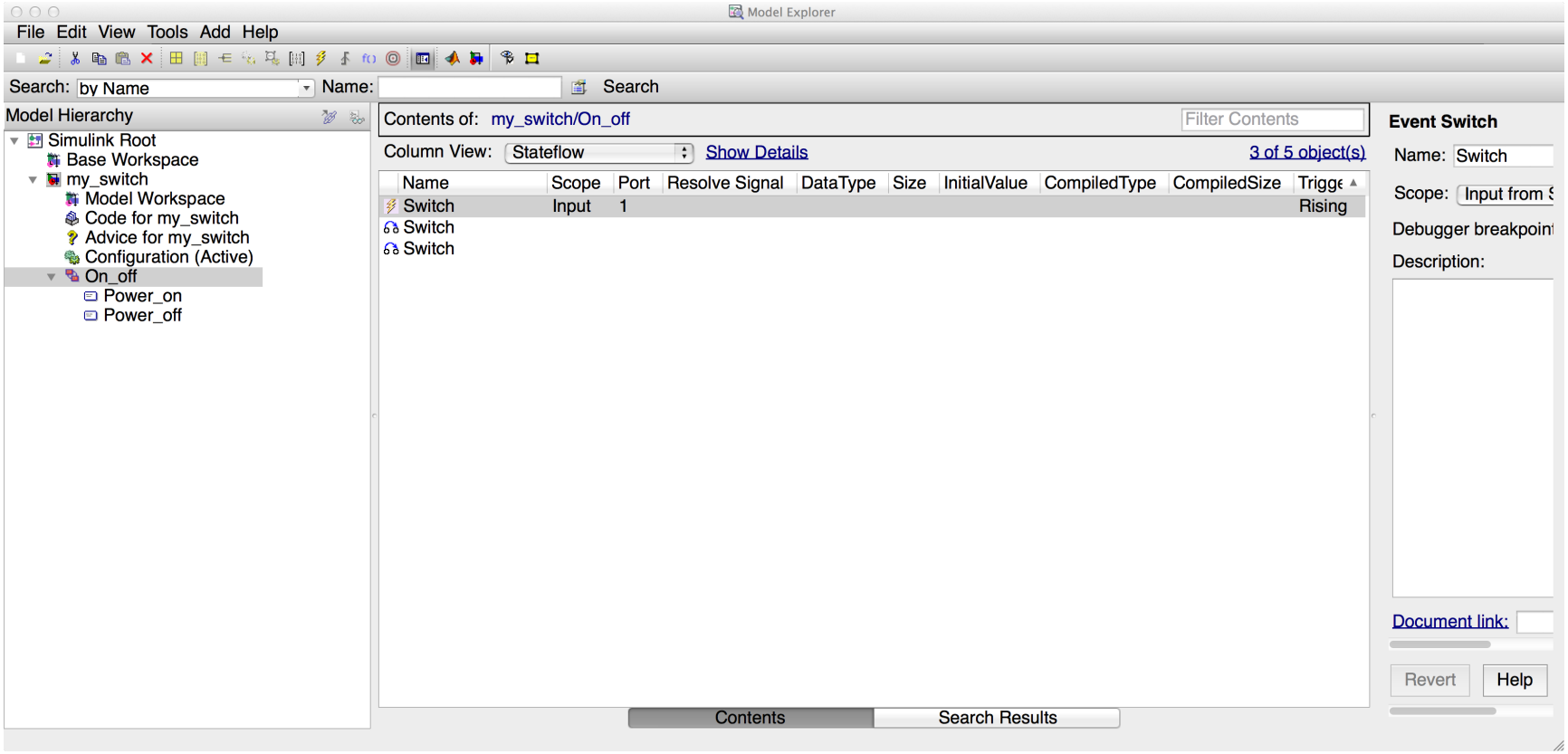
Adding an Event

- Add an event that is “Input from Simulink”
- A window will open allowing you to name the event (call it Switch), and to specify what triggers the event. In our case, use rising edges of a sine wave.
- If you add multiple events input from Simulink, the Port menu will have more than option.



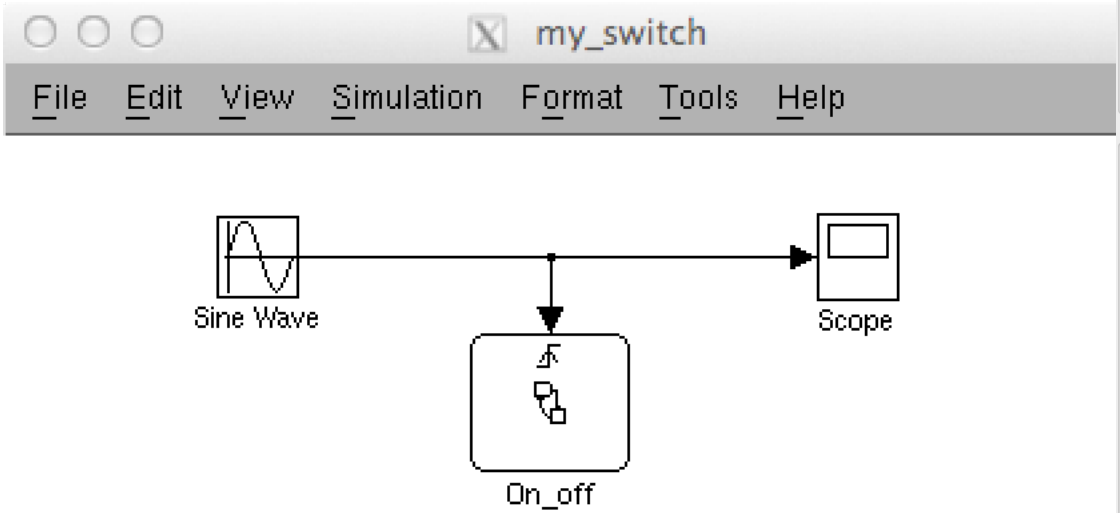
The Model Explorer

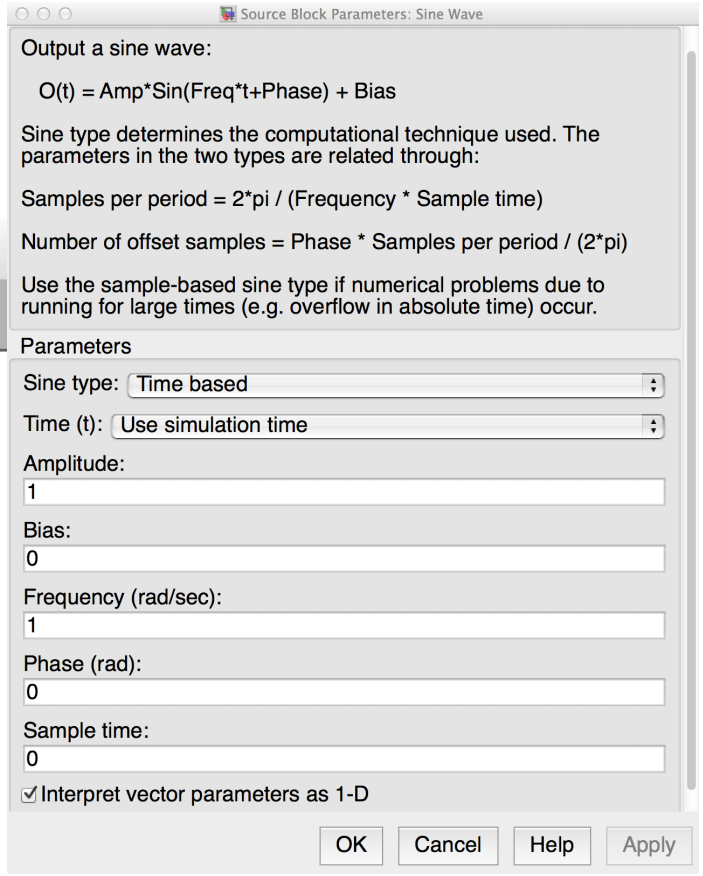
- Open the Model Explorer by selecting the Tools/Explore option from the Statechart menu
- This menu allows you to edit the event you have just defined, and to add new events
- On a small screen, you may need to scroll the menu left and right to see the “Trigger” option



Adding the Sine Input

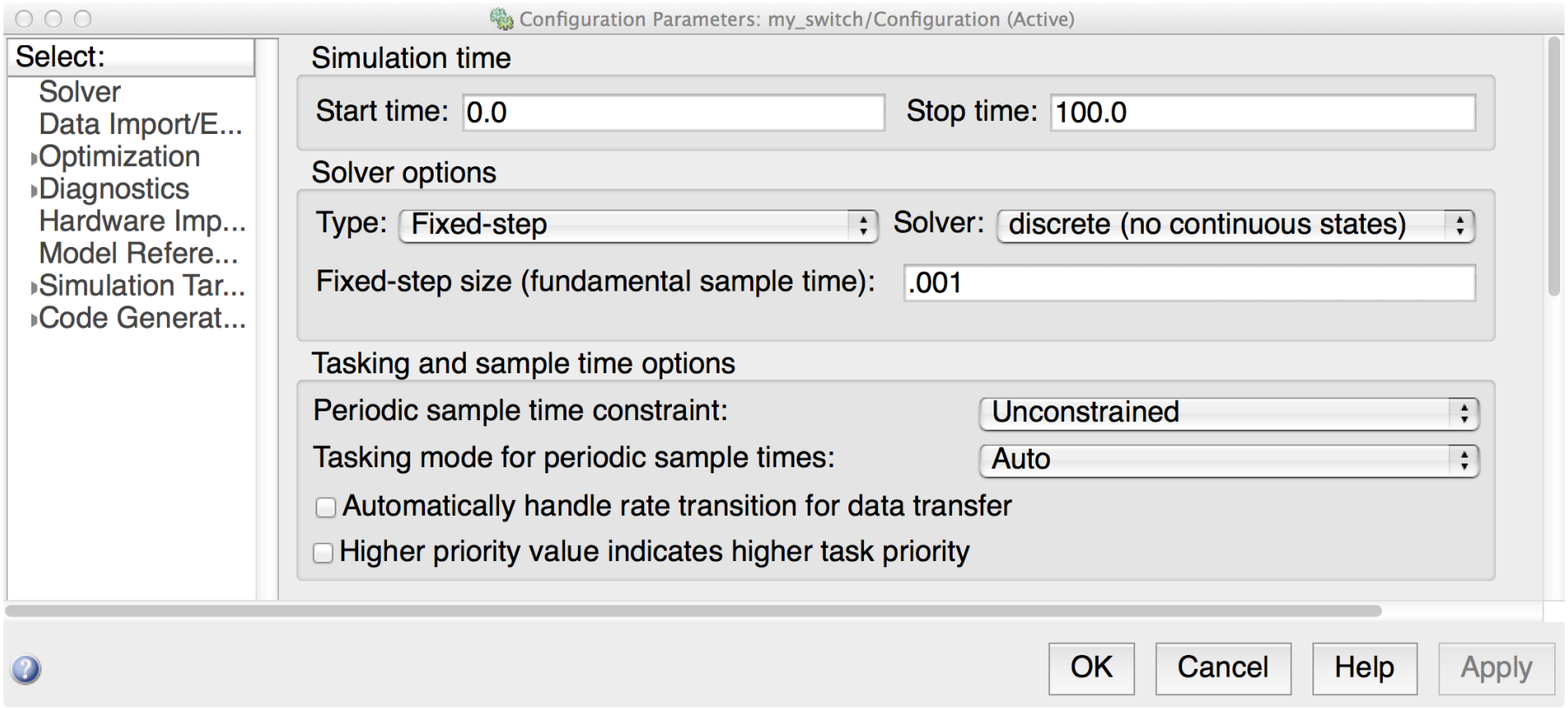
- Return to the top-level Simulink diagram
- The Statechart “On-off” now has an arrow entering it.
- Add a Sine Wave input from the View/Library Browser/Sources menu
- Add a Scope from the View/Library Browser/Sinks menu
- Use the mouse to connect these blocks.
- Double click on the Sine Wave block and specify the parameters as shown.





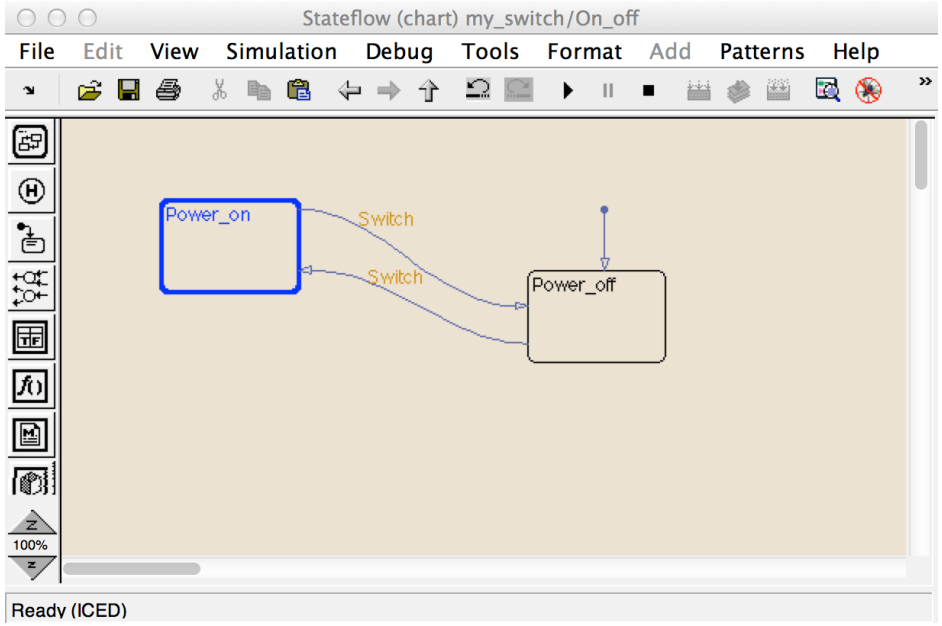
Configuration Parameters

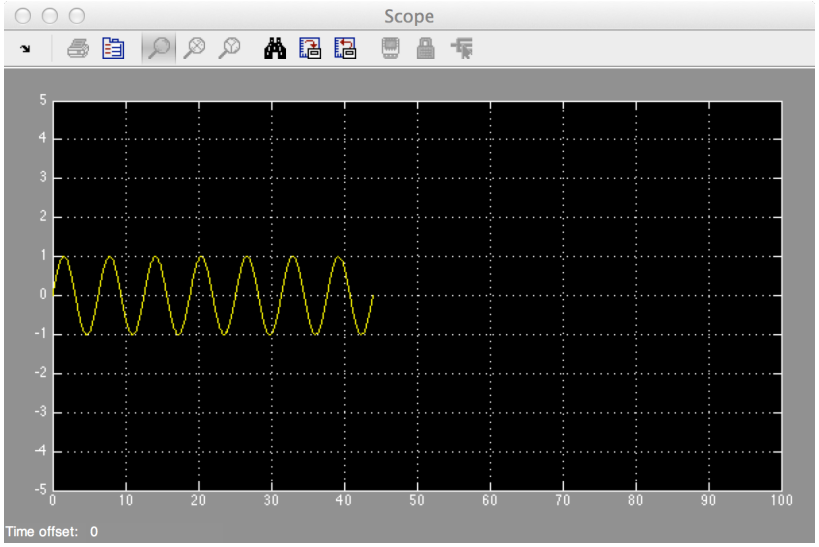
- From the Simulink model “my_switch”, select Simulation/Configuration Parameters/Solver
- Specify Start time = 0; Stop time = 100; Fixed Step Solver with Step size 0.001;
- Use a discrete solver since we only have states that take discrete values (on or off)
- Apply the changes and close the window.



Running the Simulation

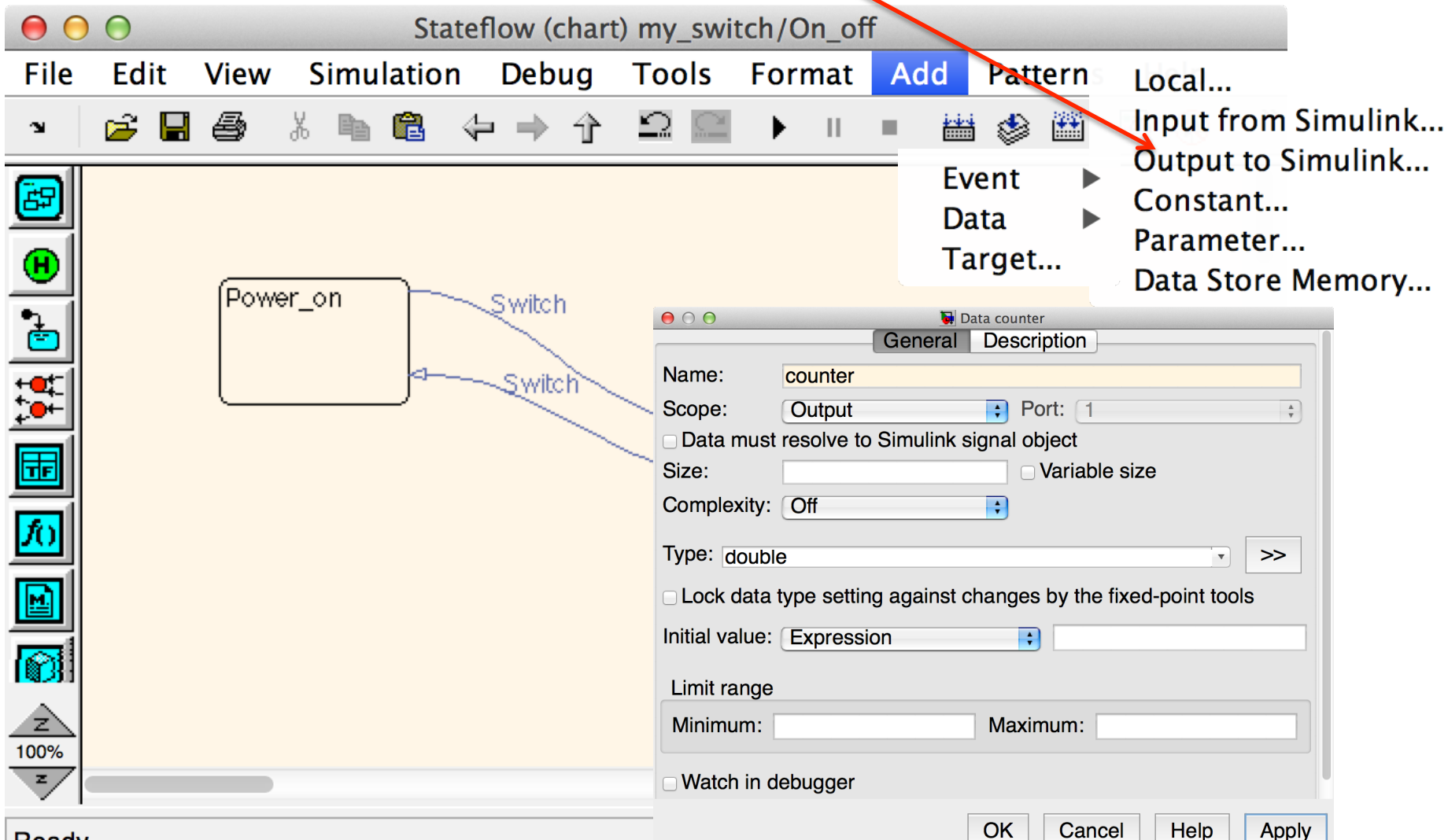
- Execute the simulation by selecting Simulation/Start
- The state changes from “Power_on” to “Power_off” at each rising zero crossing of the sine wave.





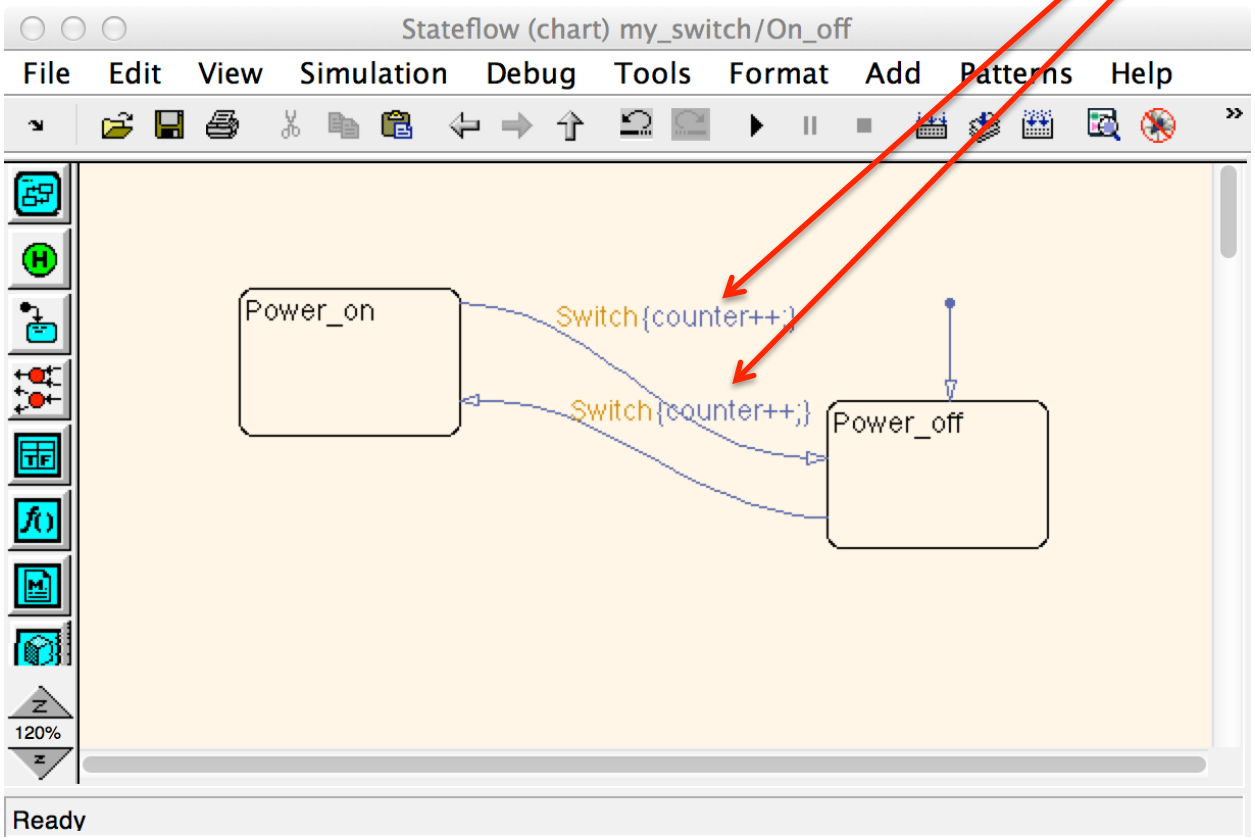
Counting Transitions

- Add data that is “Output to Simulink”
- A window will open allowing you to name the data (call it “counter”), and to specify its data type: leave it set to the default “double”.
- Leave “initial value” blank to use the default value of zero



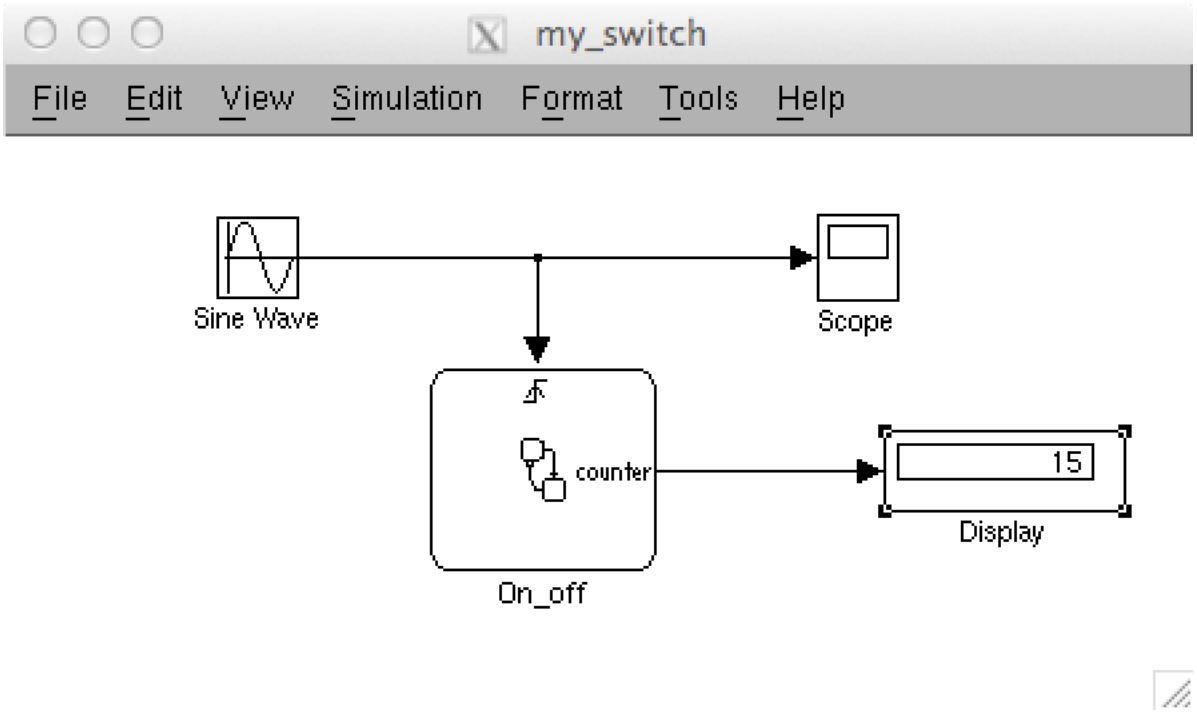
Increment the Counter

- Increment the counter every time the event “Switch” occurs by placing “counter++” in curly braces following each occurrence of Switch
- Don’t forget to use a semicolon to prevent the value of counter from being printed to the screen each time it is incremented.



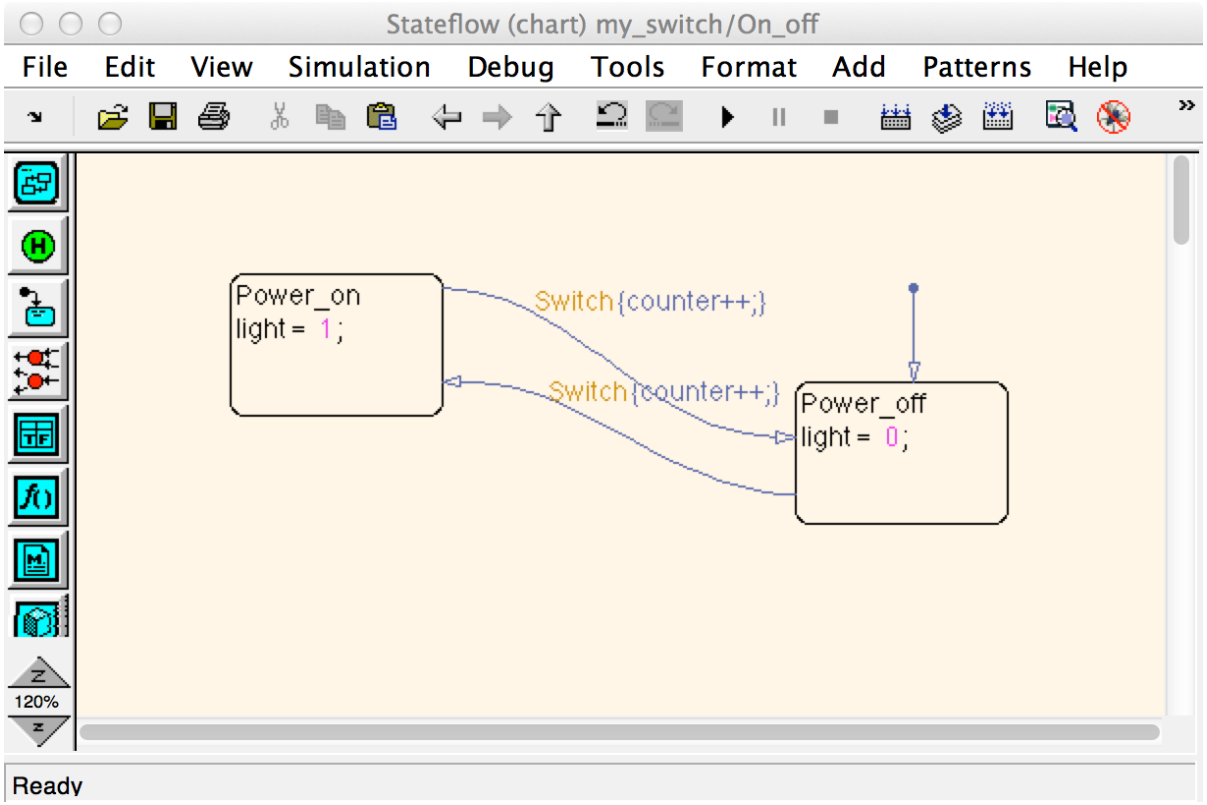
Count the Transitions

- Add a display block from the View/Library Browser/Sinks menu



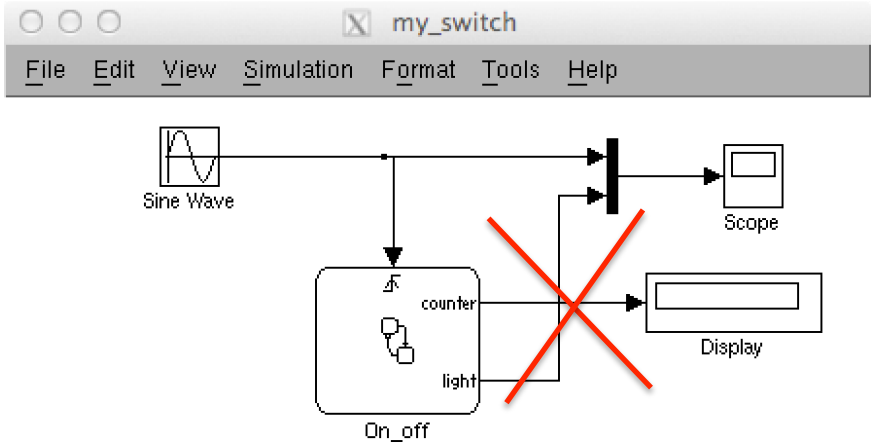
Toggle a Bit

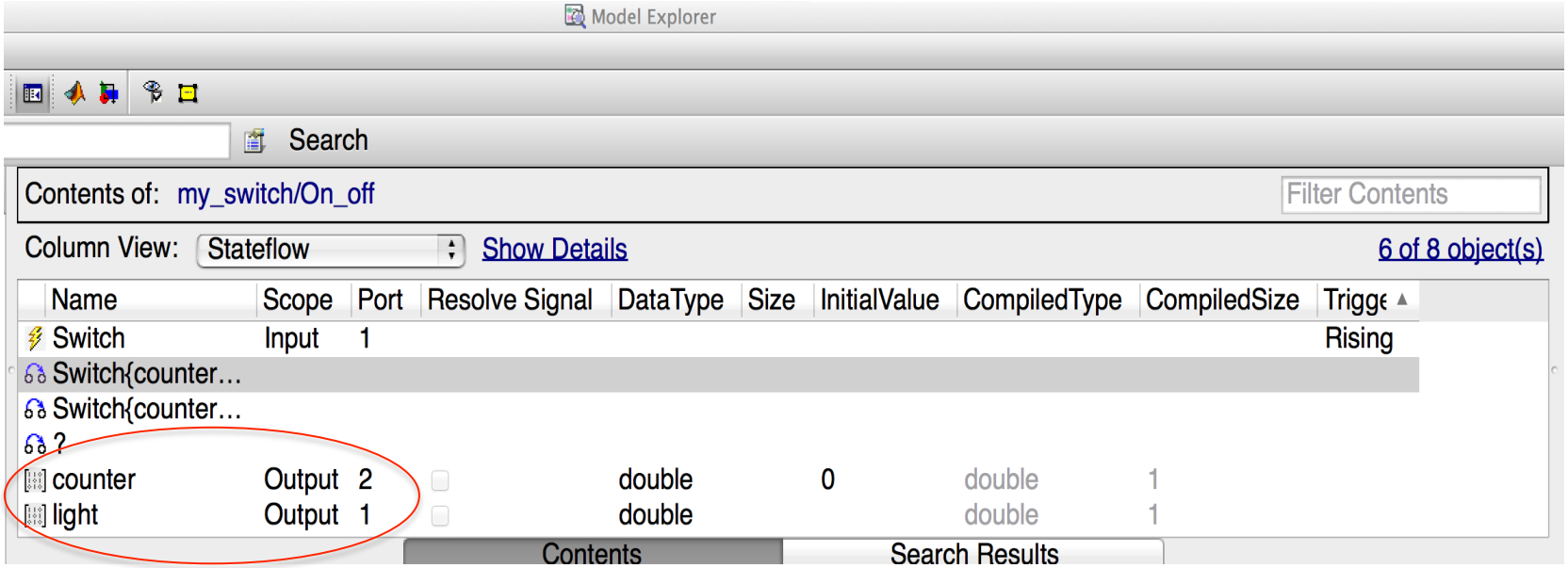
- Add a new data variable “light”: initial value 0, data type double
- Set “light = 0;” in the Power_off state
- Set “light = 1;” in the Power_on state



Change Port Values

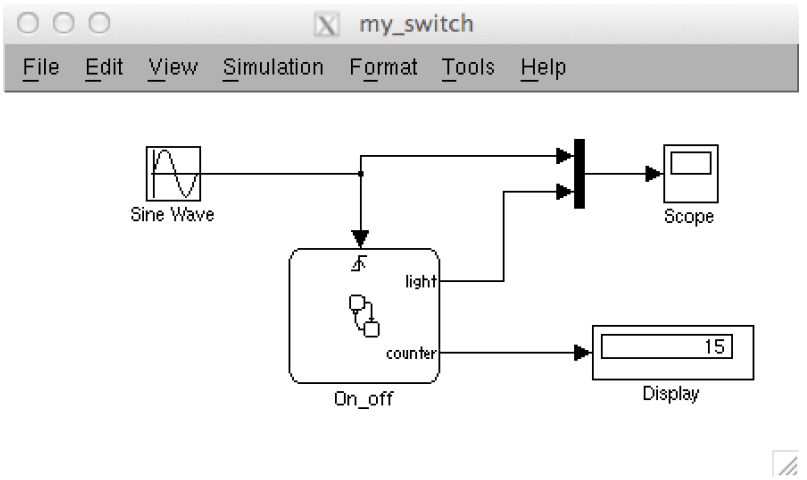
- The output “light” is assigned port 2 by default
- To connect it to the scope requires signal flow lines to cross → bad modeling practice.
- To make model more readable, change port value for “light” from 2 to 1
- Note port value for “counter” is now 2





Display a Square Wave

- Connect the output “light” to the scope used to display the sine wave using a “Mux” block from the Library Browser/Signal Routing Menu



- Running the simulation shows a square wave that toggles between 0 and 1 at rising zero crossings of the sine wave

- To make thicker lines on the plots, double-click the Scope. In the Parameters/Graphics menu, set linewidths to 2.