Assignment 3
Part 1

Simulinkers
Group 8
December 13, 2017
SFWR ENG 3K04

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Introduction

This assignment is the final step in the process of our pacemaker project. The Simulink system now covers all the modes necessary to run the pace maker. The second part involves expanding the Device Controller Monitor (DCM) to accommodate these additional modes. Both the Simulink and the DCM were polished and improved from the previous step.

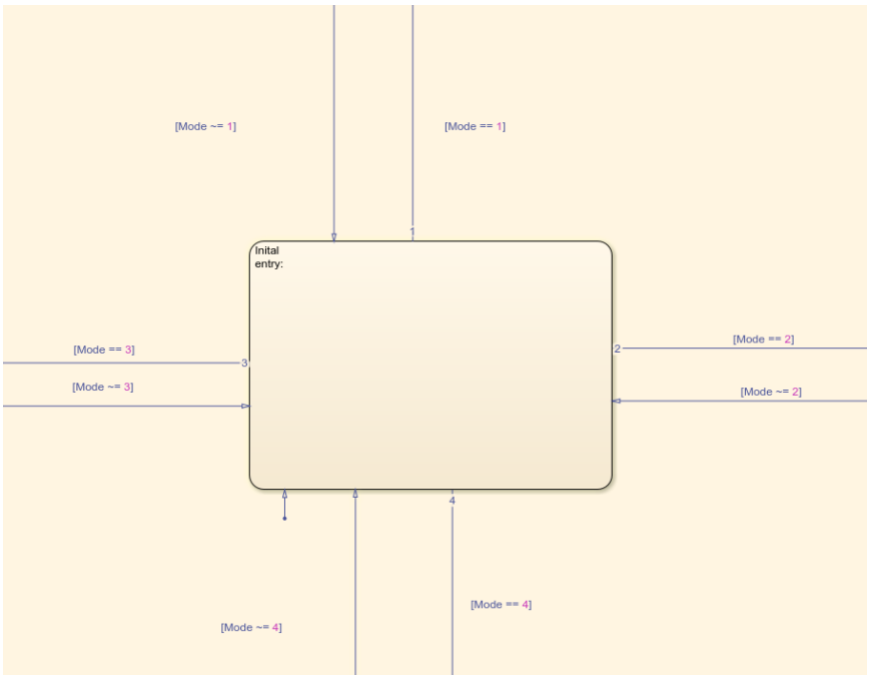
1: Requirements

The Simulink contains various modes including VVO, VVI, AAI and AAO. The VVO mode paces the ventricle while the AAO mode paces the atrium regardless of the heart beating or not. The VVI mode paced the ventricle and the AAI mode paced the atrium, only if the heart did not beat at the correct time to maintain a specific heart rate. It also included rate adaptive capability which alters the pulse given, if physical activity is sensed. The DCM was implemented to dynamically change between modes without restarting the device. This will allow the user to input the required specification for each mode and Simulink will determine which state to perform.

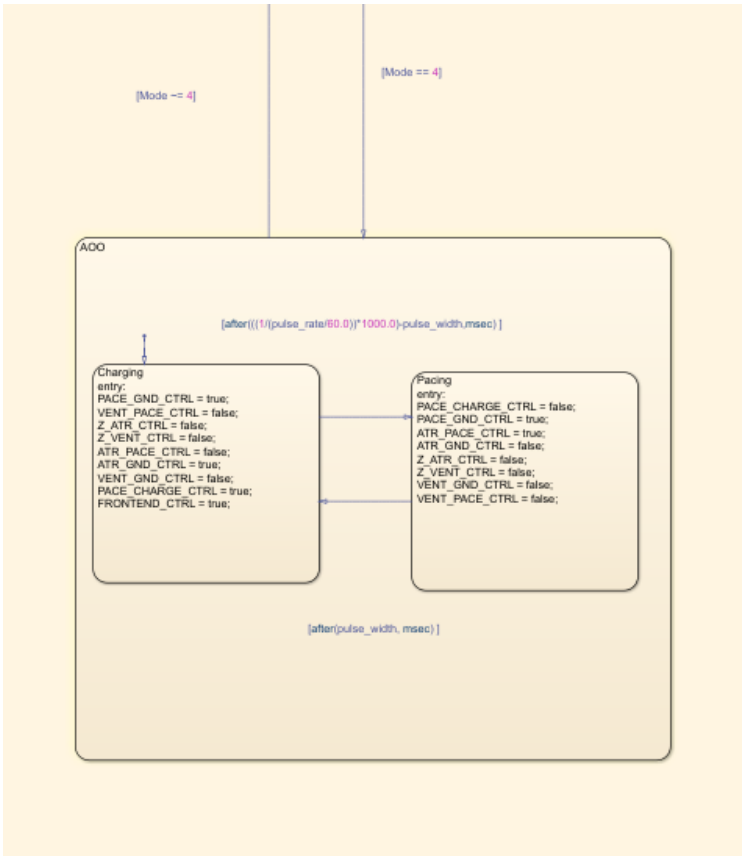
2: Design Decisions

Numerous design changes were made to this section of the assignment. Adding extra state flows for each mode and implementing the DCM serial communication to account for these extra modes. Essentially the DCM would send out an array that would contain the mode, lower rate limit, amplitude, pulse width and the refractory period. Simulink would use this information to determine the appropriate action to implement in the pacemaker

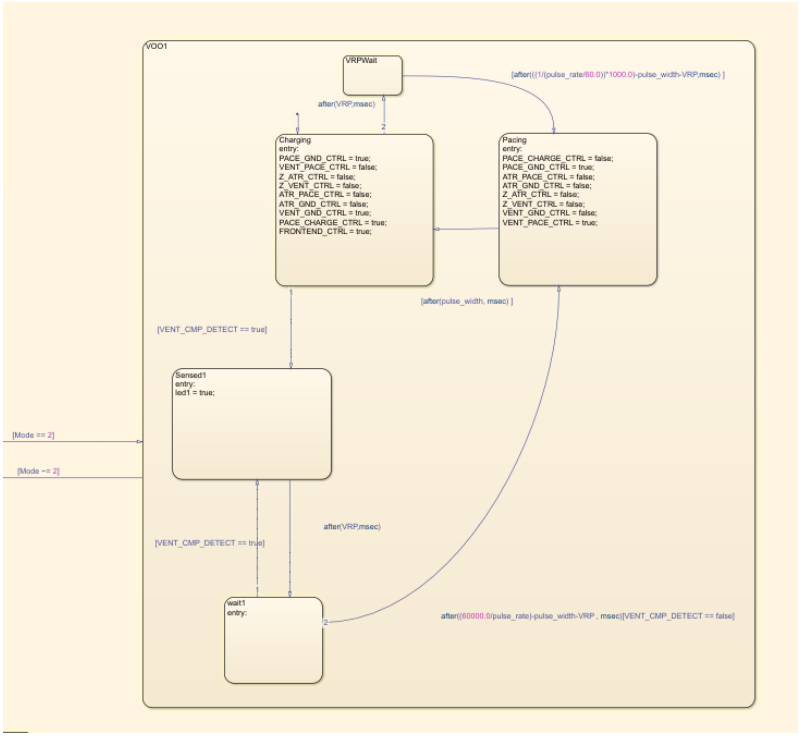
3: Simulink Diagram



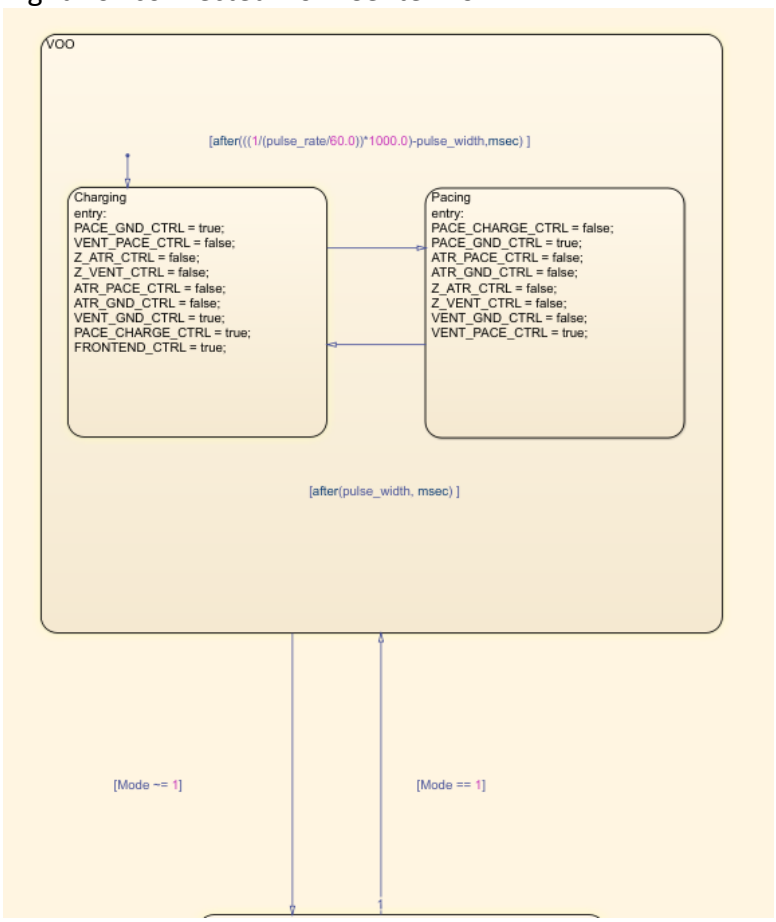
Center Box



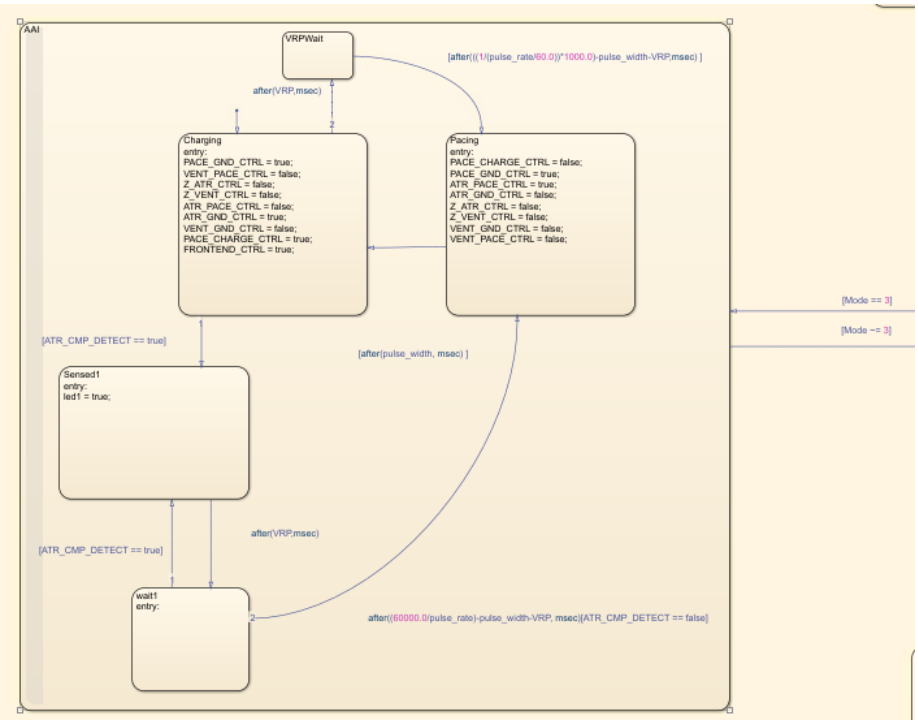
Lower Box connected from Center Box



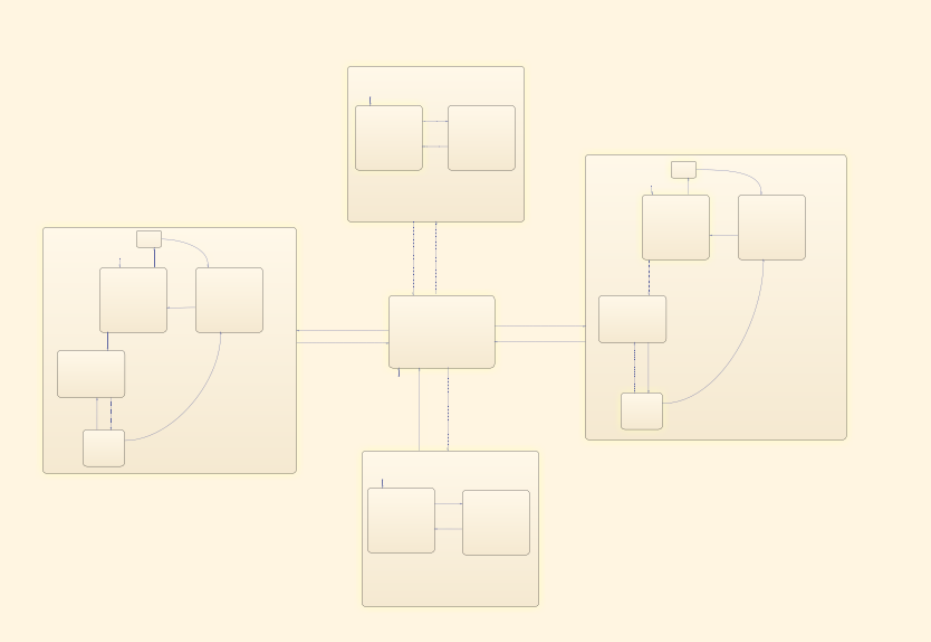
Right Box connected from Center Box

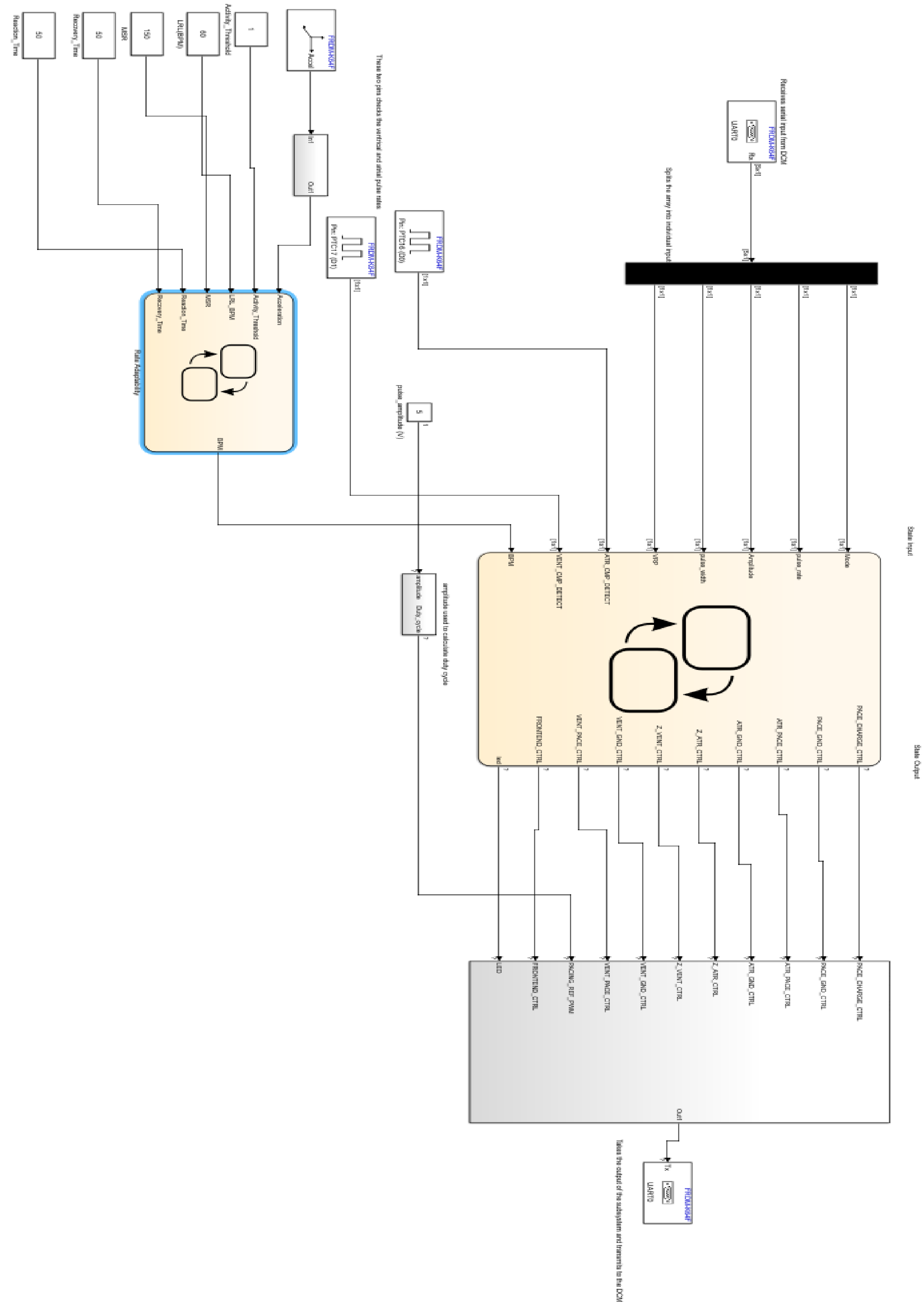


Top Box connected from Center Box



Left Box connected from Center Box


Full Diagram


Receives serial input from DCM
UART0
FRDM-K64F
Splits the array into individual input
These two pins checks the ventricle and atrial pulse rates
pulse_amplitude (V)
amplitude used to calculate duty cycle
State Input
State Output
Takes the output of the subsystem and transmits to the DCM

Explanation of Simulink:

From the DCM, an array of five values (1x5) is passed through to the demux block in Simulink. The demux block separates this array into individual values to pass as inputs. A design decision was made for the first element in the array to be an integer between one and four with each integer corresponding to one of the four modes: VOO, AOO, AAI and VVI. Two other inputs are from the two pins on the board that detect if the ventricle and atrium pulsed. The final input is BPM which accounts for rate adaptability.

The rate adaptability module has hardcoded values as well as the acceleration of the board and it outputs the BPM value. The acceleration is calculated within a subsystem. This subsystem takes in the 1x3 array that contain the acceleration in the x, y and z plane and passes it through a demux to separate the accelerations. The magnitude of the acceleration is found through calculations.

In the main chart, a few functions are happening. For the VOO and AOO mode, the states switch from charging and discharging as whether or not the heart beats is irrelevant for these modes. For VVI and AII, it is more complicated. It enters the charging state and then checks whether or not it detects the heart beats through VENT_CMP_DETECT for VVI and ATR_CMP_DETECT for AAI. If there is detection, it does not go to the discharge state. It flows to a sensed state and a LED turns on and then flows to a waiting state. If there is another detection, it loops back to the sense state. If not, it flows to the discharge state.