3K04 Deliverable 1: Documentation

Group 33

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2 Abbreviations

CCS - Cardiac Conduction System

DCM - Device Controller-Monitor

GPIO - General Purpose Input Output

GUI - Graphical User Interface

PWM - Pulse Width Modulation

2.1 Bradycardia Operating Abbreviations

Category	**Chambers Paced**	**Chambers Sensed**	**Response to Sensing**	**Rate Modulation**
Letters	O-None A-Atrium V-Ventricle D-Dual	O-None A-Atrium V-Ventricle D-Dual	O-None T-Triggered I-Inhibited D-Tracked	R-Rate Modulation

Table 1: Bradycardia Operating Abbreviations

3 Part 1

3.1 Introduction

It is hard to understate the importance of the human heart. The heart is the core part of the cardiovascular system; supplying nutrients and oxygen to all the cells and removing carbon dioxide, especially to vital organs such as the brain, it is imperative for it to be working flawlessly and harmoniously at all times. Unfortunately, however, cardiovascular diseases are a leading cause of death globally, many of which are caused from complications with abnormal heart rhythms. A pacemaker is an implantable device capable of sending timed electrical impulses causing contractions at appropriate intervals. Understanding the operation and design of this life saving device will aid in developing more efficient and reliable cardiac assistive technology.

The purpose of this project is to design and implement a system that operates a cardiac pacemaker under specified modes. This project will be accomplished through an understanding of embedded systems and through engineering principles of software development.

The scope of this deliverable is to design and implement the embedded pacemaker software, driver software and user interface for the DCM while updating and maintaining documentation.

3.2 Requirements

- Overall system requirements (summarized from provided specification documents). It can be informal or semi-formal.
- Mode-specific requirements: AOO, VOO, AAI, VVI.

3.2.1 DCM Requirements

The user shall be capable of the following:

- Utilizing and managing windows for display of text and graphics.
- Processing user positioning and input buttons.
- Displaying all programmable parameters for review and modification.
- Visually indicating when telemetry is lost due to the device being out of range or noise.
- Vndicating when a different PACEMAKER device is approached than was previously interrogated

3.3 Design

In this section, you want to expand on the design decisions based on the requirements. You should be specific about your system design and how the various components relate together.

- System architecture (major subsystems, hardware hiding, pin mapping).
- Programmable parameters (rate limits, amplitudes, pulse widths, refractory periods, etc.).
- Hardware inputs and outputs (signals sensed, signals controlled).

- State machine design for each pacing mode (with diagrams if applicable). You can also use a tabular method.
- Simulink diagram
- Screenshots of your DCM, explaining its software structure

You should also be explicit on how your design decisions map directly to the requirements.

3.4 Simulink Design

3.4.1 Overall Design

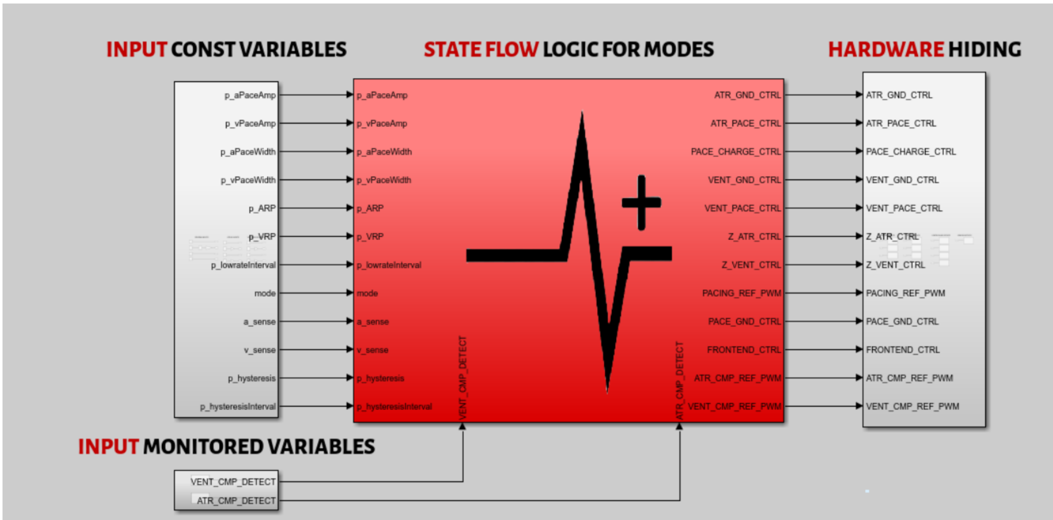

Figure 1: Overall Simulink Mapping

The Pacemaker architecure can be split up into 4 main modules, input constant variables, input monitor variables, stateflow logic for modes, and hardware hiding. Figure 1 below shows the overarcing workflow of the system:

3.4.2 Input Constant Variables

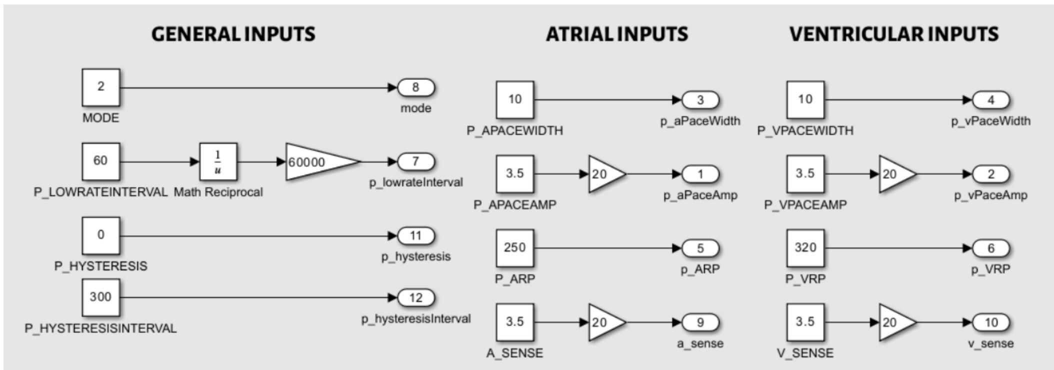

Figure 2: Constant Input Variables

In the above image, Figure 2, we find changeable variables relating to pacemaker operation. For general inputs, the changeable variables are:

- **Mode -** Refers to bradycardia operating modes, e.g AOO, VOO, AAI and VVI.
- **Low Rate Interval -** The number of generated pace pulses per minute.
- **Hysteresis Pace -** When enabled, a longer period is waited before pacing after sensing an event.
- Hysteresis Interval

The modfiable atrial variables are:

- Pace Width
- Pace Amplitude
- ARP
- Sense

The modifiable ventricular variables are:

- Pace Width
- Pace Amplitude
- VRP
- Sense

3.4.3 Monitored Input Variables

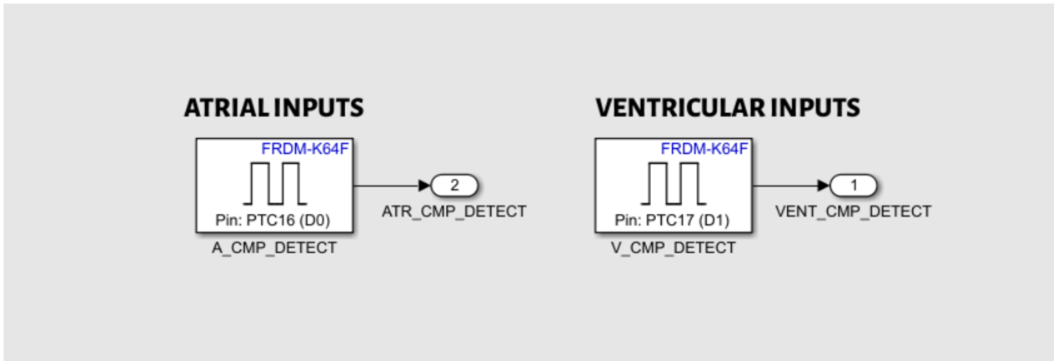

Figure 3: Monitored Input Variables

The monitored input variables can be seen in the above Figure 3.

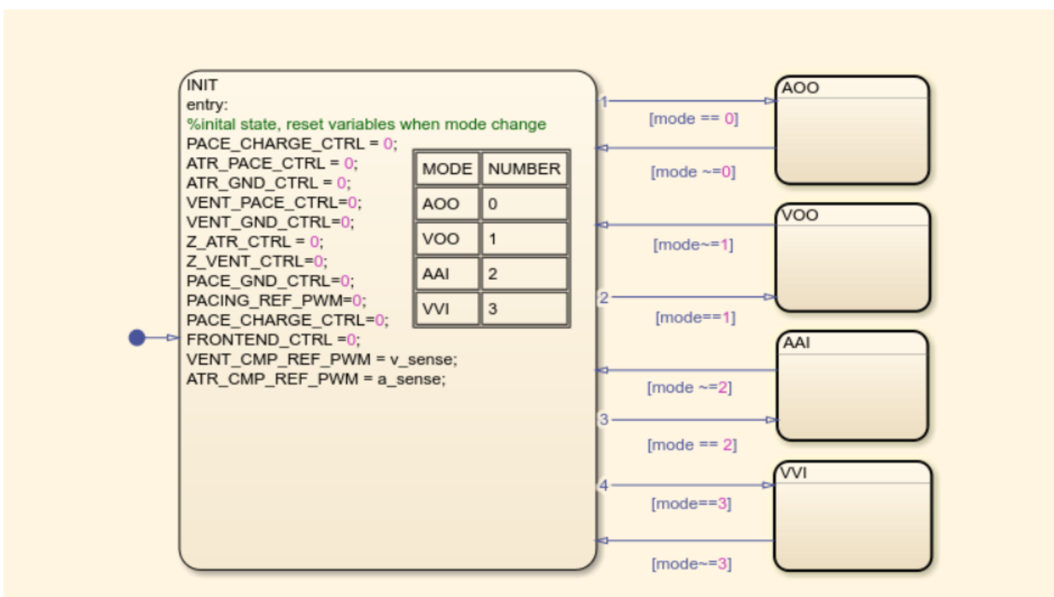

Figure 4: Stateflow Modules

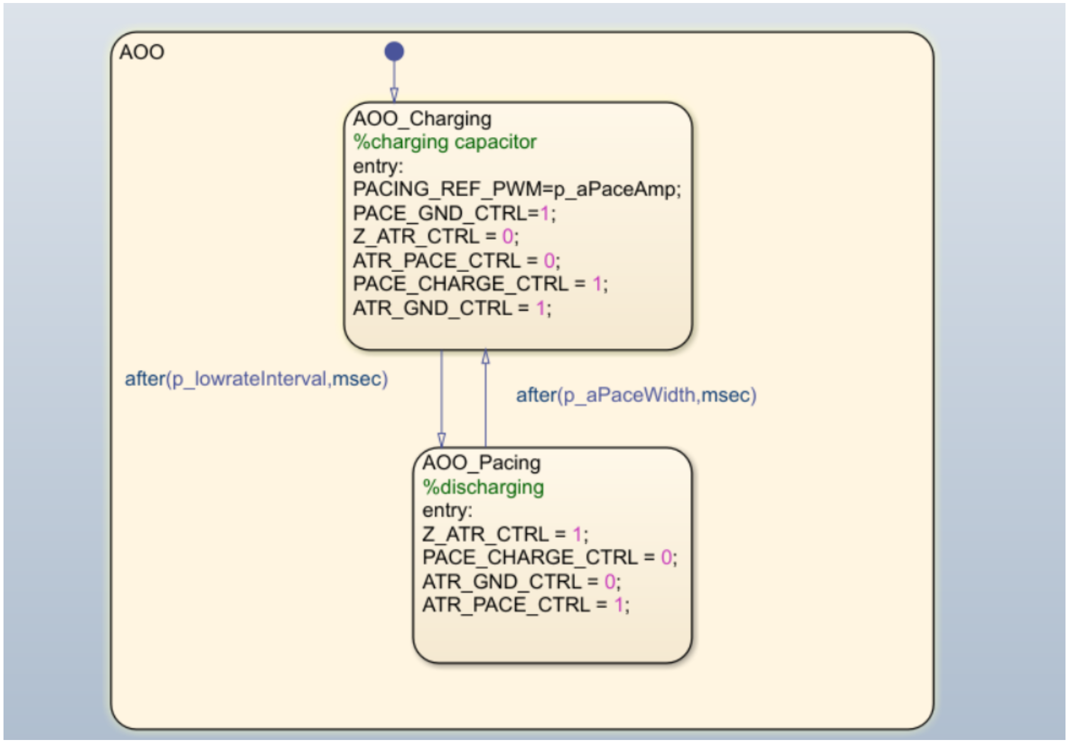

Figure 5: AOO Stateflow Model

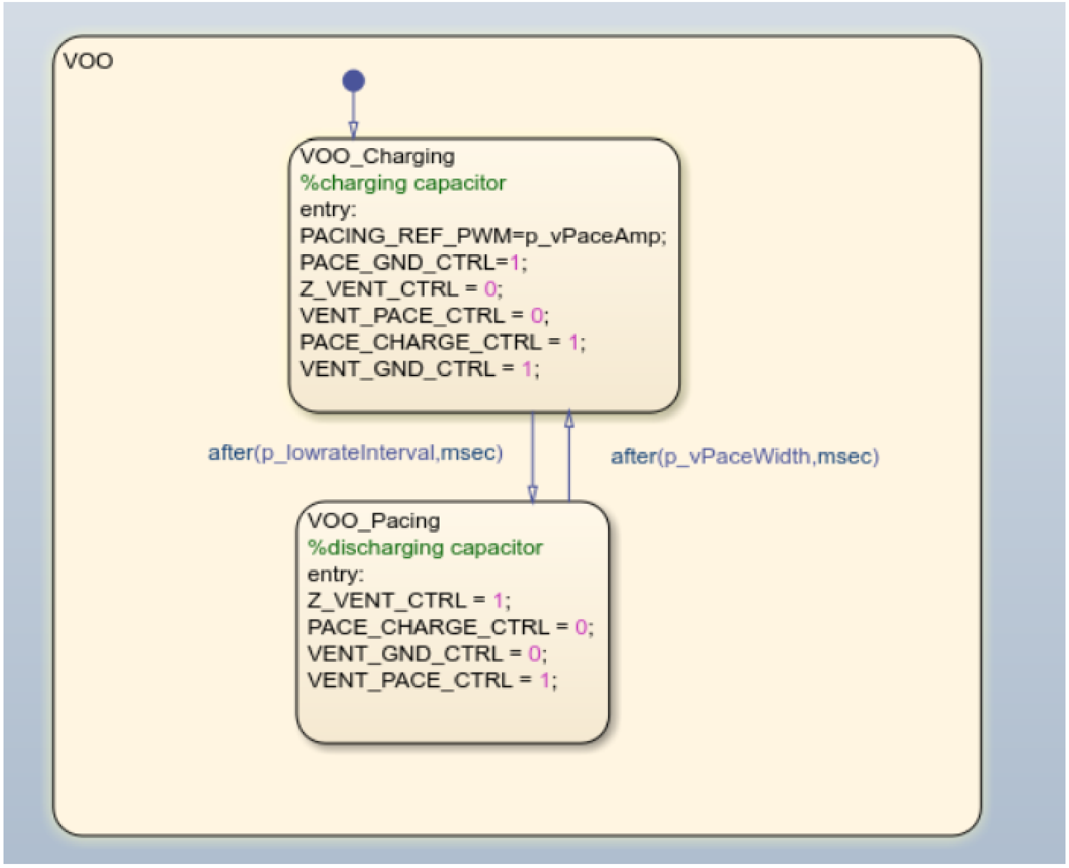

Figure 6: VOO Stateflow Model

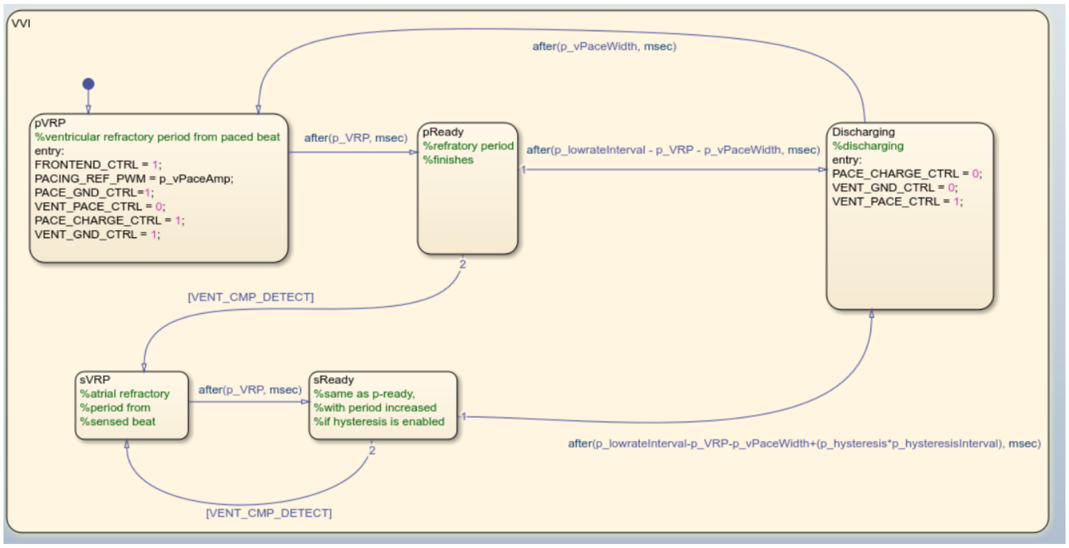

Figure 7: VII Stateflow Model

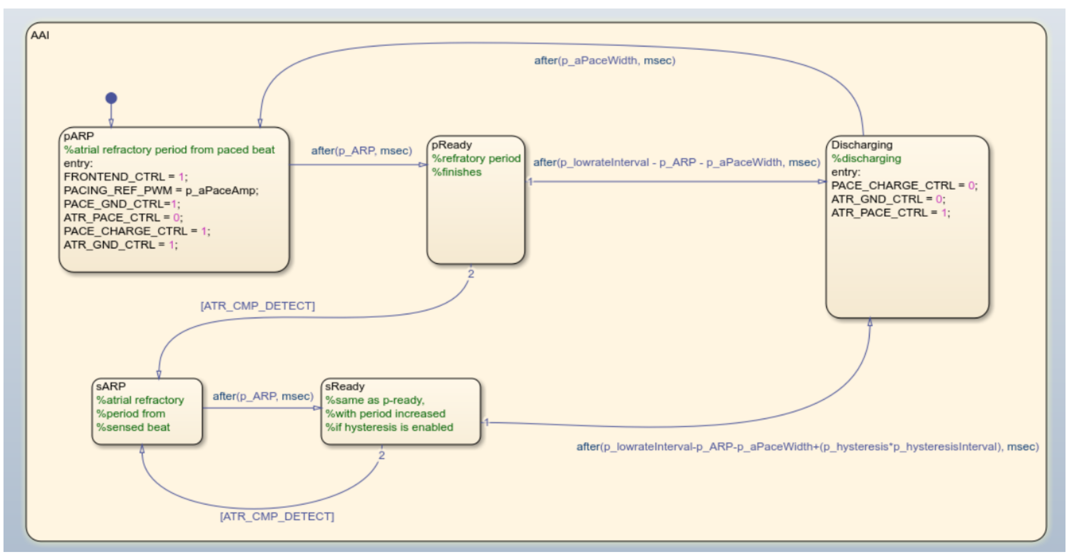

Figure 8: AAI Stateflow Model

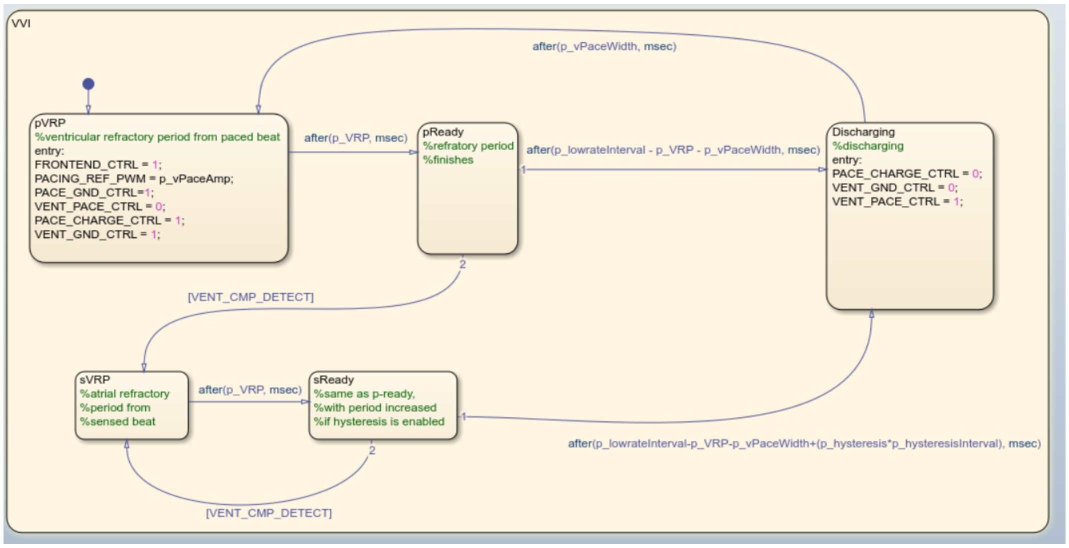

Figure 9: VVI Stateflow Model

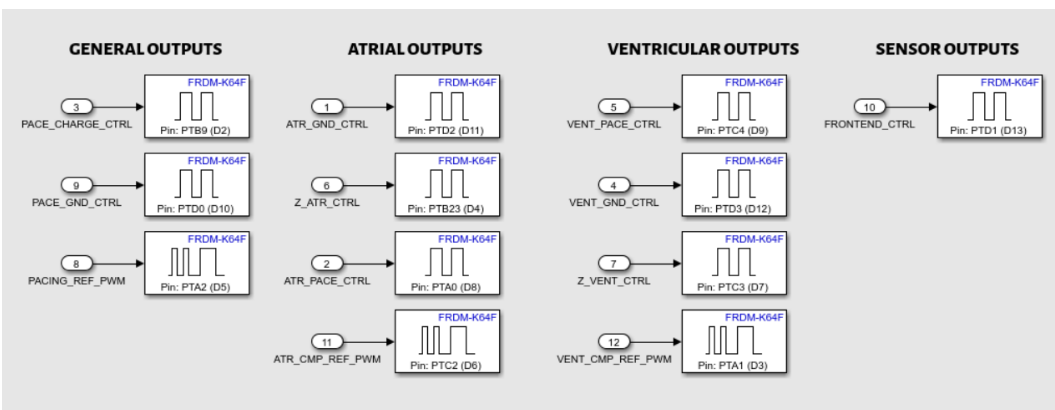

Figure 10: Hardware Hiding of Model

4 Part 2

4.1 Requirements Potential Changes

Identify which requirements may evolve in the next deliverable (e.g., adding more modes, communication, new parameters).

4.2 Design Decision Potential Changes

List design choices that may need revisiting (e.g., choice of libraries, interface design, architecture).

4.3 Module Description

- Purpose of the component
- Key functions/methods (public vs internal)
- Global or state variables (if any)
- Interactions with other components

4.4 Testing

Document test cases for each module. Each test case should include:

1. Purpose of the test
2. Input conditions
3. Expected output
4. Actual output
5. Result (Pass/Fail)

For instance, on the DCM side, you should test registration and login, parameter input validation, and mode selection and data storage/retrieval. This is not a complete list, depending on your system, you will need to test other components.

4.5 GenAI Usage

Provide a summary of any usage of GenAI in developing the model, DCM or writing this section. If you did not use GenAI tools at all, state that.

5 General Notes

- This is a general outline based on the Deliverable 1 handout. You should make sure everything listed in the handout it is included.
- Use screenshots of Simulink diagrams and DCM interface where appropriate.
- Ensure the requirements are traceable to design and test cases.
- Be concise and make things clear.
- You can add other sections, and you can also decide not to use this structure, however, I am including the main general sections we will expect to see.