Software Development - 3K04

Assignment 2 - Testing

Instructor: Dr. Alan Wassyng

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Group 7 - “Group 4”

Adam Cool	400032857	coola
Andrew Rehkopf	001412499	rehkopaz
Evan Gagich	400027794	gagiche
Ibrahim Tannir	001204850	tanniri
Michael Henry	400011728	henrym1
Michael Soosaipillai	400034820	soosaipm
Moshiur Howlader	001316948	howlam

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1 Introduction

Testing is performed to check the completeness of code based on a specific list of requirements or specifications. The overall goal is not to fix every single bug in the program but to find situation that could negatively affect the program. Testing helps finds defects created by the programmer during development, gain confidence in and provide information about the quality of the program. Testing and verification can also lead to the ability to maintain code and find potential problematic error before they become harmful. The expected values of the output should come from your requirements.

There are two types of testing, black box testing and white box testing. Black box testing is putting a black box over your system and getting outputs based on input values; the input values comes from the system requirements. White box testing tests internal errors of structure and operation rather than functionality. Testing and verification are two very important parts of any program and can prevent costly and problematic errors if done correctly. Testing is conducted in a variety of settings including LabView's myRIO or Matlab simulation.

2 Part 1 - Pacemaker

2.1 MyRio Testing on Board (Part 3)

All tests are performed using VVI and AAI with 120BPM pace rate. The following test cases are done on the board using myRio.

Input in Text File	Expected Output	Actual Output	Result
30	3 Ventricle or Atrium pulses between each heartbeat, but no pulse during the beat.	Atrium failed to pace however Ventricle paced properly and correctly detected the pace	Fail for Atrium, Pass for Ventricle
60	1 pulse between each heartbeat, but no pulse during the beat.	Atrium failed to pace however Ventricle paced properly and correctly detected the pace	Fail for Atrium, Pass for Ventricle
90	1 pulse 0.5 seconds after the heartbeats.	Atrium failed to pace however Ventricle paced properly and correctly detected the pace	Fail for Atrium, Pass for Ventricle
120	The pacemaker should not pulse	No pace from either chamber	Pass
57	2 pulse 0.5 and 1 seconds after the heartbeat and then the pacing gets shifted.	Atrium failed to pace however Ventricle paced properly and correctly detected the pace	Fail for Atrium, Pass for Ventricle
74	2 pulse 0.5 seconds after the heartbeat and then the pacing gets shifted.	Atrium failed to pace however Ventricle paced properly and correctly detected the pace	Fail for Atrium, Pass for Ventricle

Additional cases probed using the Oscilloscope. These tests were conducted on all rate adaptive modes

Test Case	Expected Output	Actual Output	Result
60 BPM lower rate, 120 BPM upper rate (VVOR), 2 ms PW	Pace should occur at lower rate until stimulation applied then raise to medium rate then upper rate	Pace and LED indicator rate increases however lower rate is not 60 BPM	Pass for rate adaptivity, fail for correct pace rate.
60 BPM lower rate, 120 BPM upper rate (AAOR), 2 ms PW	Pace should occur at lower rate until stimulation applied then raise to medium rate then upper rate	LED indicator rate increases however no paces seen	Pass for rate adaptivity, fail for correct pace.
60 BPM lower rate, 120 BPM upper rate (VVIR), 2 ms PW	Pace should occur at lower rate until stimulation applied then raise to medium rate then upper rate, no pace should occur upon detection of simulated pace	LED indicator rate increases, pace rate increases upon stimulation appears to react to simulated paces	Pass however timing still wrong.
60 BPM lower rate, 120 BPM upper rate (AAIR), 2 ms PW	Pace should occur at lower rate until stimulation applied then raise to medium rate then upper rate, no pace should occur upon detection of simulated pace	LED indicator rate increases upon stimulation still no pace seen on oscilloscope	Pass for rate adaptivity fail for everything else

2.1.1 Conclusion

It is evident that the appropriate functionality occurs for ventricle pacing however atrium pacing fails in almost all test cases. Rate adaptivity appears to be working for ventricle however it is unclear whether it is correct for atrium as no pace can be observed.

2.2 Simulation Testing

These tests were conducted using Matlab Simulink simulation and results were probed using the scope function block.

Test Case	Expected Output	Actual Output	Result
Pace mode VVO, 60 BPM, 2 ms PW	Pace of 2ms width every 1000ms	Ventricle pace occurs at 1000ms for 2 ms	Pass
Pace mode AAO, 60 BPM, 2 ms PW	Pace of 2ms width every 1000ms	Atrium pace occurs at 1000ms for 2 ms	Pass
Pace mode VVI, 60 BPM, 2 ms PW Induced pace all the time	No paces	No paces	Pass
Pace mode VVI, 60 BPM, 2 ms PW No induced paces	Pace of 2ms width every 1000ms	Ventricle pace occurs at 1000ms for 2 ms	Pass
Pace mode AAI, 60 BPM, 2 ms PW Induced pace all the time	No paces	No paces	Pass
Pace mode AA, 60 BPM, 2 ms PW No induced paces	Pace of 2ms width every 1000ms	Atrium pace occurs at 1000ms for 2 ms	Pass
Correct Pacing mode and settings (VVO 60 BPM, 2 ms PW) at start-up	Pace of 2ms width every 1000ms	Pace occurs at 1000ms for 2 ms	Pass
Probe all PWM settings to ports for correctness	Proper amplitudes and threshold voltages should be seen	The correct amplitudes are seen	Pass
Probe all calculated beat rates in milliseconds (ex. 60 BPM = 1 Second)	Correct beat period	Beat period of 1000ms seen for 60 BPM	Pass

2.2.1 Conclusion

All elements of design are working correctly in simulation.

2.3 Serial Receive Testing

These tests were conducted using the coded board and the DCM particular rates and modes were set to LEDs so that the result of the serial transmission can be confirmed to be right.

Test Case	Expected Output	Actual Output	Result
Change mode to AAO from start up of VVO	LED turns red to blue	LED turns red to blue	Pass
Change mode to VVOR from start up of VVO	LED remains blue and flashes green upon pace (rate adaptivity is visible)	Mode change and rate adaptivity working	Pass
Check that correct upper rate of 120 is received	LED Turns green	Green LED on	Pass
Check that correct amplitude of 4500 mv is received	LED Turns green	Green LED on	Pass
Check that amplitude of 4500 mv is converted to PWM right	LED Turns green	Green LED on	Pass
Check that BPM of 60 is converted to beat period of 1000 ms	LED Turns green	Green LED on	Pass
Check that pacing is done at correct rate which was sent as 60 BPM	Pace every 1000ms	Pace occurs roughly every 2000 ms	Fail

2.3.1 Conclusion

All elements of serial receiving occurs properly however the serial receive block appears to destroy the accuracy of pacing rates (nearly halves them).

3 Part 2 - DCM

3.1 DCM Parameter Check

The user's input is checked to be valid prior to sending. To reduce the length of this section, the cases are written here and applied to each parameter (upper rate, lower rate, atrium amplitude, etc)

Test Case	Expected Output	Actual Output	Result
Value below acceptable range	Warning Comes up, no changes saved	Warning Comes up, changes not sent or saved	Pass
Value above acceptable range	Warning Comes up, no changes saved	Warning Comes up, changes not sent or saved	Pass
Value in acceptable range	Parameters saved and transmitted	Parameters saved and transmitted	Pass

3.1.1 Conclusion

DCM successfully filters input to standards applied.

3.2 DCM Electrogram

The DCM egram is enabled when the pacemaker is functioning and the results are explored. Unfortunately due to a serial issue, these results almost entirely fail.

Test Case	Expected Output	Actual Output	Result
VVO Mode, Ventricle Egram	Voltage of ventricle appears on egram graph	Only zero values appear	Fail
VVO Mode, Atrium Egram	Voltage of atrium appears on egram graph	Only zero values appear	Fail
No egram enabled	Egram window hidden	Egram window hidden	Pass

3.2.1 Conclusion

It is evident that the electrogram does not work as expected.

4 Conclusion

There is quite evidently serious problems with the pacemaker when placed onto the board. These issues do not appear in simulation however make the pacemaker completely dysfunctional when coded to the board. We need to take steps to find the source of these problems.