**Strelka Flight Computer State Machine Logic Specification**

This document outlines the state machine logic taking place on the Strelka Flight Computer. The primary purpose of the state machine is to deploy drogue and main parachutes at the correct times in flight. All states other than burnout require the completion of the previous states to be executed.

**Sensor internal filtering**

The ASM330 and BMX055 contain internal low pass filtering on their outputs for the accelerometer and gyroscopes.

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| --- | --- | --- | --- |
| **Sensor** | **Device** | **Cut-off frequency (Hz)** | **Sample rate (Hz)** |
| ASM330 | Accelerometer | 66.67 | 6667 |
| ASM330 | Gyroscope | 154 | 6667 |
| BMX055 | Accelerometer | 62.5 | 125 |
| BMX055 | Gyroscope | 64 | 100 |

**Launch detection**

The vehicle can only detect launch when the following elements are satisfied:

1. The vehicle is no greater than 30 degrees from vertical. The logic will still register a valid angle if the flight computer is upside down to prevent failure if the user installs the flight computer in an inverted orientation.
2. The magnitude of the acceleration vector is greater than a preset threshold of 1.2g defined by LAUNCH\_ACCEL\_THRESHOLD. Before threshold comparison, this acceleration value is passed through a median filter which samples 10 readings at a rate of 100Hz. The purpose of this median filter is to reduce the chance that a shock applied to the vehicle from wind or handling of the rocket will cause it to detect launch.

**Burnout detection**

Burnout detection is not a flight critical criterion for the state machine to function. This means that no further states require burnout detection to occur. This is with the aim of reducing the number of failure points within the logic of the state machine.

The vehicle can only detect burnout when any of the following elements are satisfied:

1. The x-axis (body) accelerometer has registered an acceleration less than -0.5g defined by BURNOUT\_ACCEL\_THRESHOLD.
2. The time elapsed since launch is greater than the MAX\_MOTOR\_BURN\_TIME of 10 seconds.

**Apogee detection**

The vehicle can only detect apogee when the following element(s) are satisfied:

1. The vehicle has measured a vertical velocity lower than 1m/s defined by APOGEE\_DETECT\_VELOCITY\_THRESHOLD. The vertical velocity is calculated by taking the first order time derivative of the vertical position of the rocket. This vertical position is calculated from the onboard barometric pressure sensor readings.

**Main deploy altitude detection**

Determination of main deployment altitude is done by comparing the current altitude from ground level to the threshold of 300m defined by MAIN\_DEPLOY\_ALTITUDE. If it is below the threshold, the main deployment is initiated. The ground level altitude is calculated by subtracting the launch altitude from the current altitude measured by the barometer.

**Landing detection**

The vehicle detects landing by taking the derivative of the vertical altitude derived from the read barometric pressure and determines when the value is under a speed (magnitude) threshold. The vertical velocity is calculated at a rate of 40Hz defined by VERTICAL\_VELOCITY\_DETECT\_FREQ. The calculated value is then passed into an exponential low pass filter with a cut-off frequency of 0.1Hz. The result is compared to a threshold of 1m/s (magnitude) defined by LANDING\_SPEED\_THRESHOLD.

**Demonstration of nominal flight operation during test**

Flight states:

Idle on pad – 0

Launch – 1

Burnout – 2

Apogee – 3

Main deployment – 4

Landed – 5