Functional Roll Autopilot Testing via Simulink Report Generator

Software in-the-loop

MathWorks

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Abstract

This report captures results of high-level requirements-based testing of a Simulink model. User specified test cases with time-dependent input values were developed. Expected output values were established. The model was executed with specified inputs, and results were compared against expected outputs. Pass/fail criteria were established and evaluated for each test case.

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Chapter 1. Model Description

This is the closed loop test harness model.

This is the model being tested, representing the Detailed Design that satisfies the High-Level Requirements.

Chapter 2. Design Requirements

Requirements for the Logic Controller section are defined in the Word document 'do178b_autopilot_requirements.docx'. *do178b_autopilot_requirements.docx* [matlab:winopen('do178b_autopilot_requirements.docx');]

Chapter 3. High-Level Requirements Testing

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Test Requirements

The roll autopilot has seven requirements, corresponding to 20 iterations over the

1) All limit check elements in an iteration must pass

2) All iterations must pass

Limit Checks

The limit checks are contained in the Verification_Blocks subsystem in the test harness model do-178b_dhc2.

For all tests the roll angle minimum is -33 degrees and the roll andgle maximum is 33 degrees.

For all tests the roll rate minimum is -6.6 degrees and the roll rate maximum is 6.6 degrees.

For all tests the aileron minimum is -15 degrees and the aileron maximum is 15 degrees.

The dynamic roll response limits vary with each of the test iternations and this will be plotted in the test report along with the actual response.

This is the subsytem with the Verification Blocks.

Chapter 4. Results

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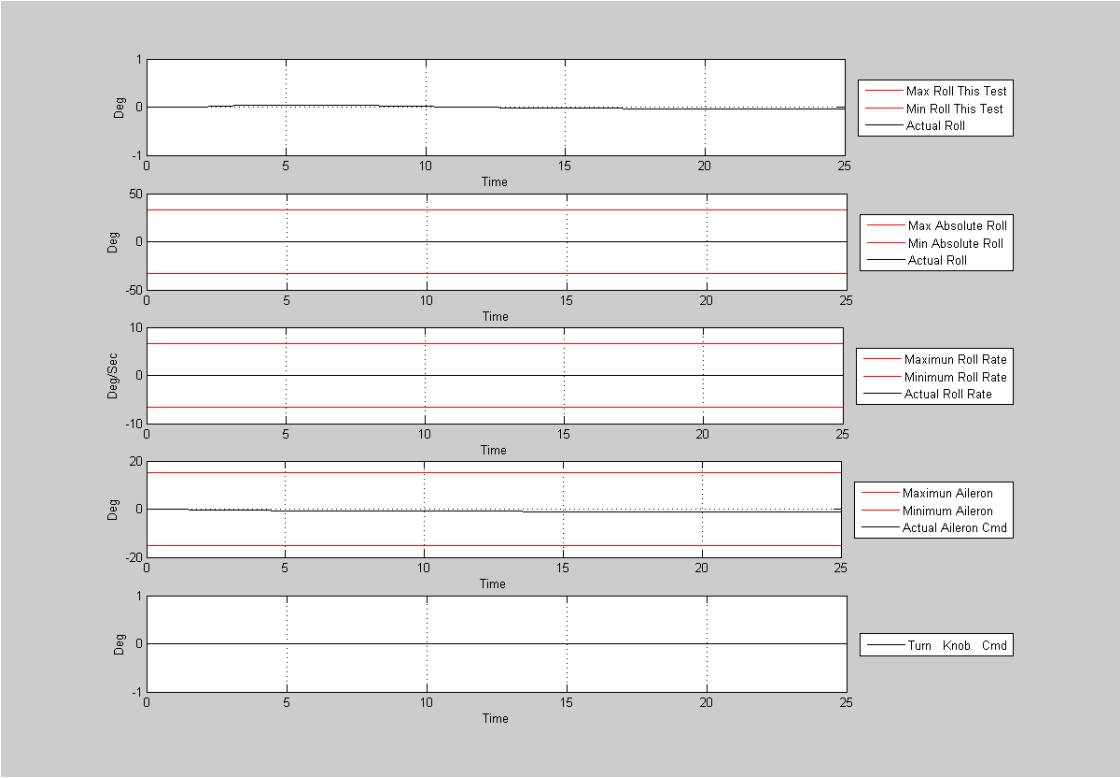
Test Iteration

```
Test Iteration #1

Requirement being tested: 1.1. Roll Autopilot Engage Control, 1.2. Roll Hold Mode,

Engage roll hold with an initial 0 degree bank angle and turn knob at 0 degree.

The bank angle should be controlled to 0 degrees with a 1 degree tolerance.

Trimmed roll angle = 0
```

Plots and Results.



Roll Response PASSED

Maximum Roll Angle PASSED

Maximum Roll Rate PASSED

Maximum Aileron Angle PASSED

Test Iteration

Test Iteration #2

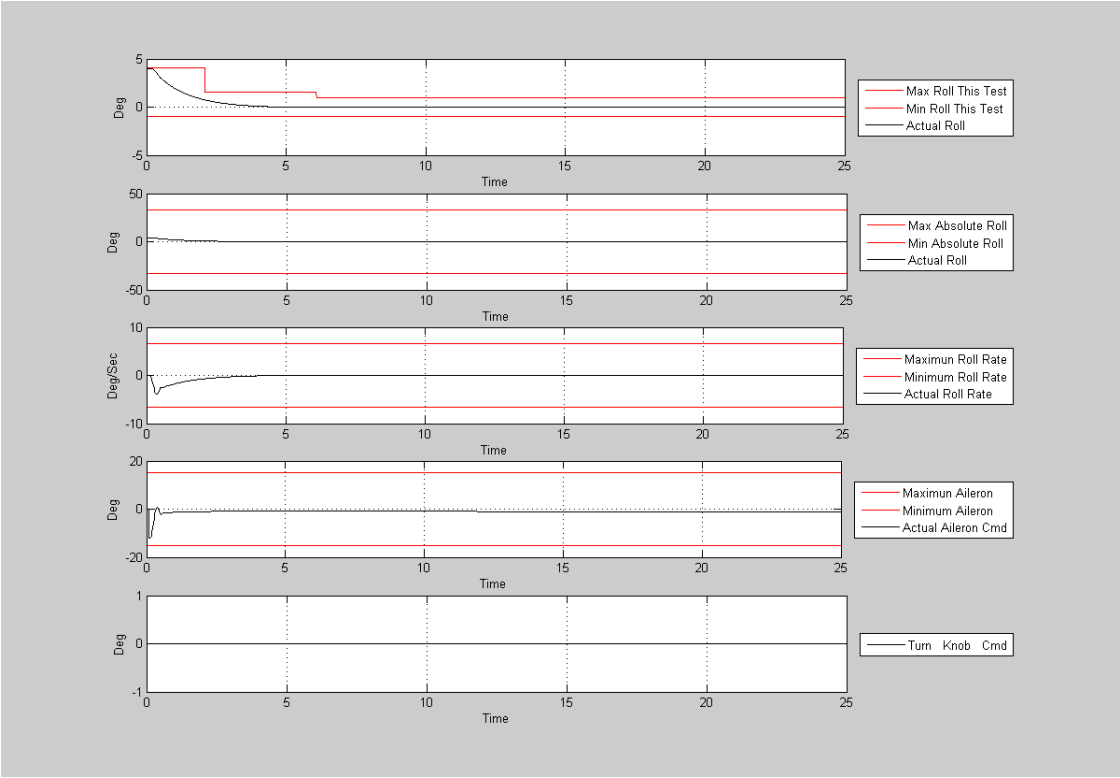
Requirement being tested: 1.1. Roll Autopilot Engage Control, 1.2. Roll Hold Mode,

Engage roll hold with an initial +4 degree bank angle and turn knob at 0 degree.

The bank angle should be controlled to 0 degrees with a 1 degree tolerance.

Trimmed roll angle = 4

Plots and Results.



Roll Response PASSED

Maximum Roll Angle PASSED

Maximum Roll Rate PASSED

Maximum Aileron Angle PASSED

Test Iteration

Test Iteration #3

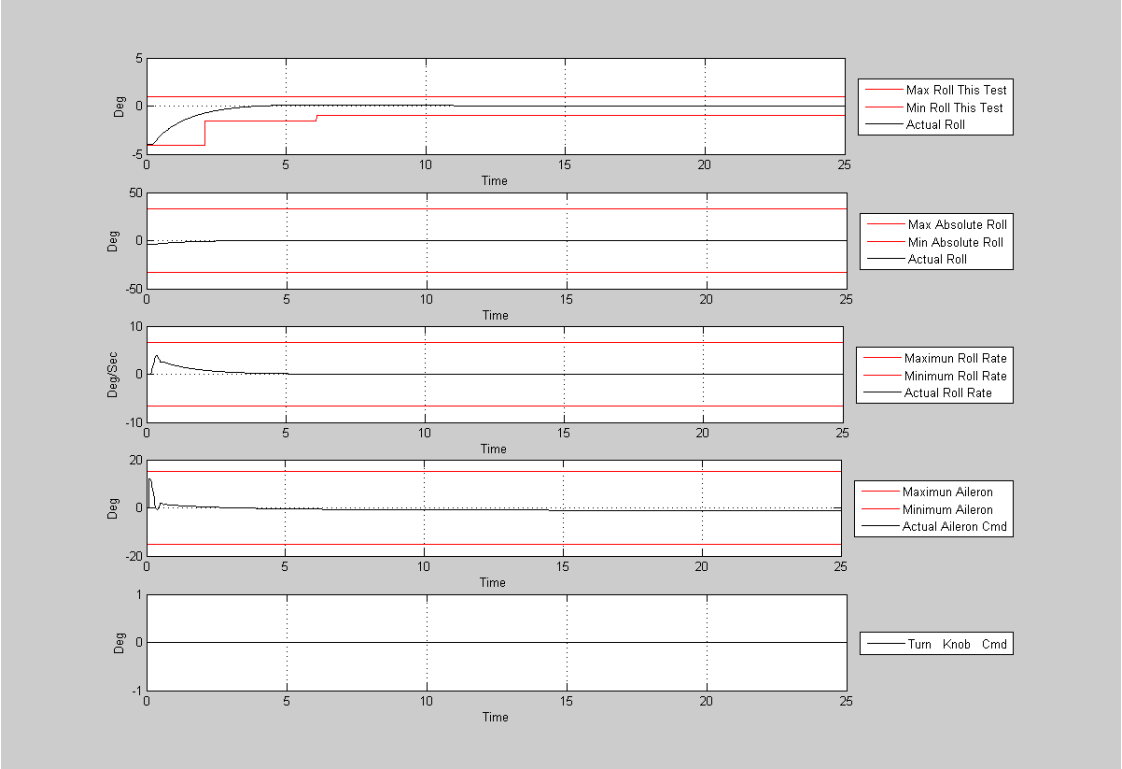
Requirement being tested: 1.1. Roll Autopilot Engage Control, 1.2. Roll Hold Mode,

Engage roll hold with an initial -4 degree bank angle and turn knob at 0 degree.

The bank angle should be controlled to 0 degrees with a 1 degree tolerance.

Trimmed roll angle = -4

Plots and Results.



Roll Response PASSED

Maximum Roll Angle PASSED

Maximum Roll Rate PASSED

Maximum Aileron Angle PASSED

Test Iteration

Test Iteration #4

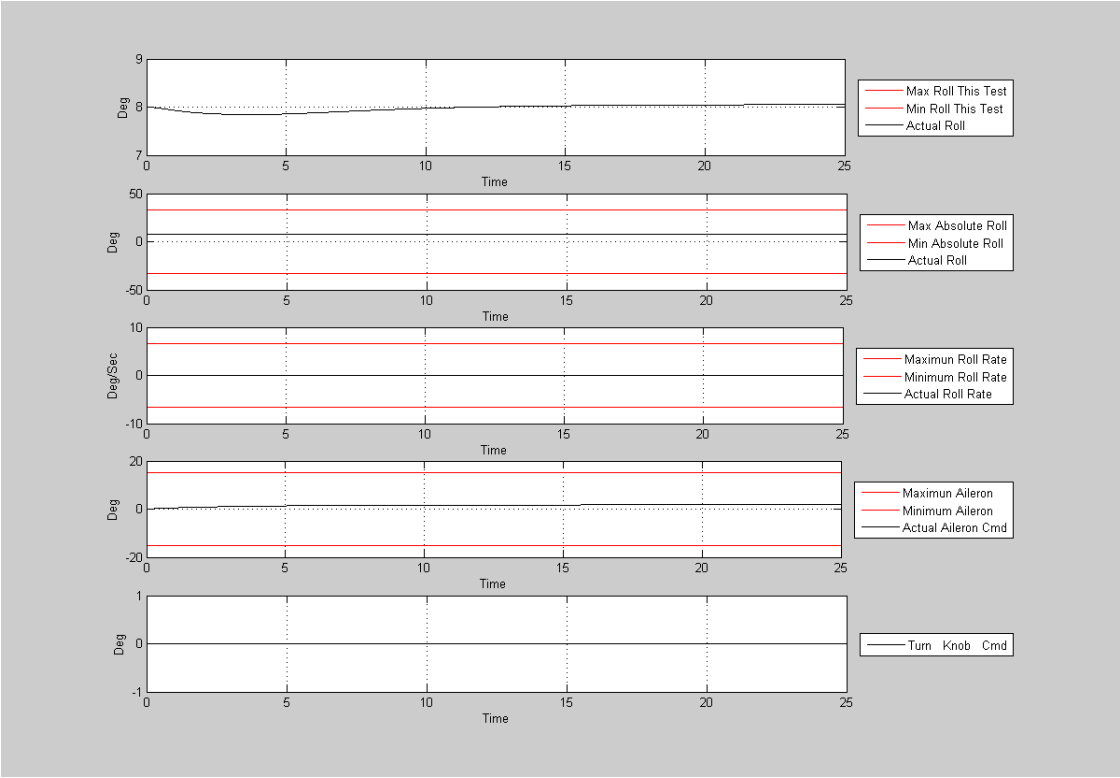
Requirement being tested: 1.1. Roll Autopilot Engage Control, 1.2. Roll Hold Mode,

Engage roll hold with an initial +8 degree bank angle and turn knob at 0 degree.

The bank angle should be controlled to 8 degrees with a 1 degree tolerance.

Trimmed roll angle = 8

Plots and Results.



Roll Response PASSED

Maximum Roll Angle PASSED

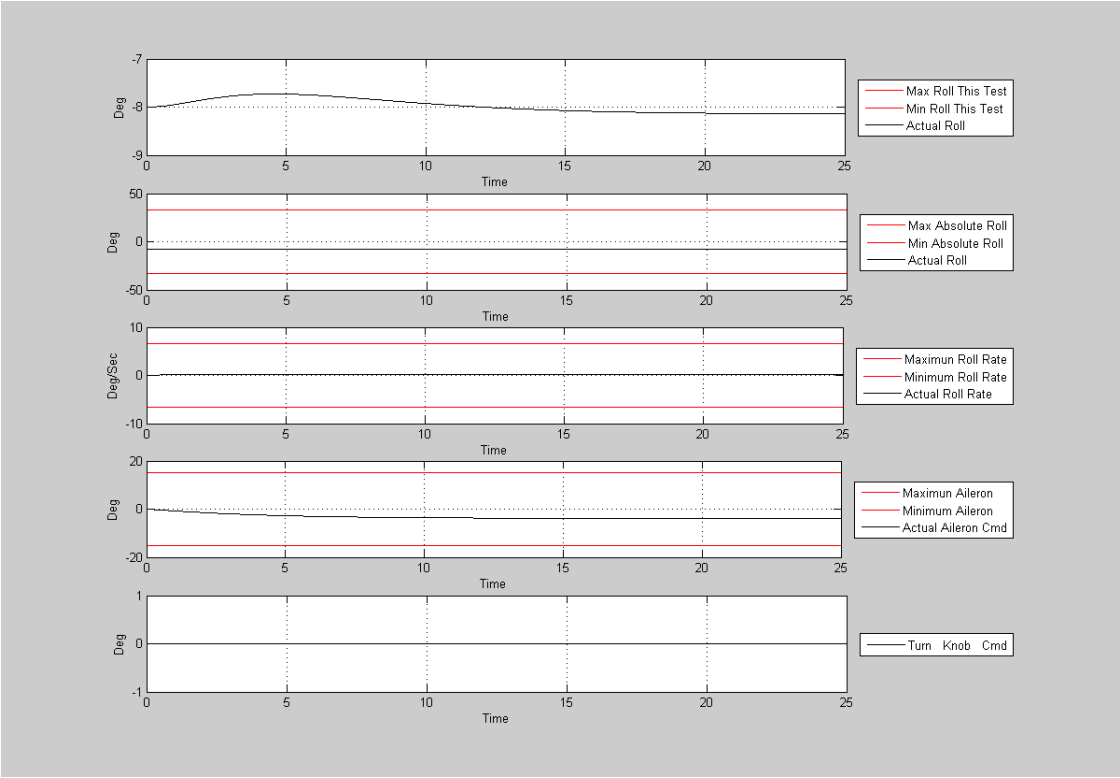
Maximum Roll Rate PASSED

Maximum Aileron Angle PASSED

Test Iteration

```
Test Iteration #5

Requirement being tested: 1.1. Roll Autopilot Engage Control, 1.2. Roll Hold Mode,

Engage roll hold with an initial -8 degree bank angle and turn knob at 0 degree.

The bank angle should be controlled to -8 degrees with a 1 degree tolerance.

Trimmed roll angle = -8
```

Plots and Results.



Roll Response PASSED

Maximum Roll Angle PASSED

Maximum Roll Rate PASSED

Maximum Aileron Angle PASSED

Test Iteration

Test Iteration #6

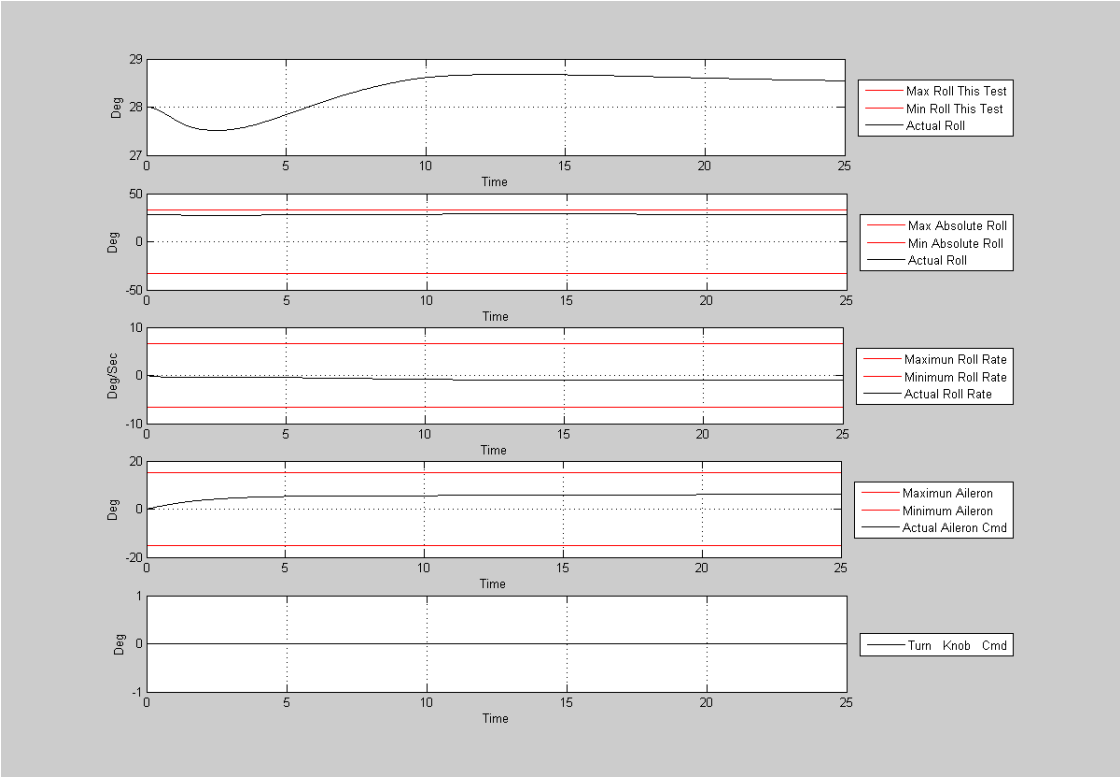
Requirement being tested: 1.1. Roll Autopilot Engage Control, 1.2. Roll Hold Mode,

Engage roll hold with an initial +28 degree bank angle and turn knob at 0 degree.

The bank angle should be controlled to 28 degrees with a 1 degree tolerance.

Trimmed roll angle = 28

Plots and Results.



Roll Response PASSED

Maximum Roll Angle PASSED

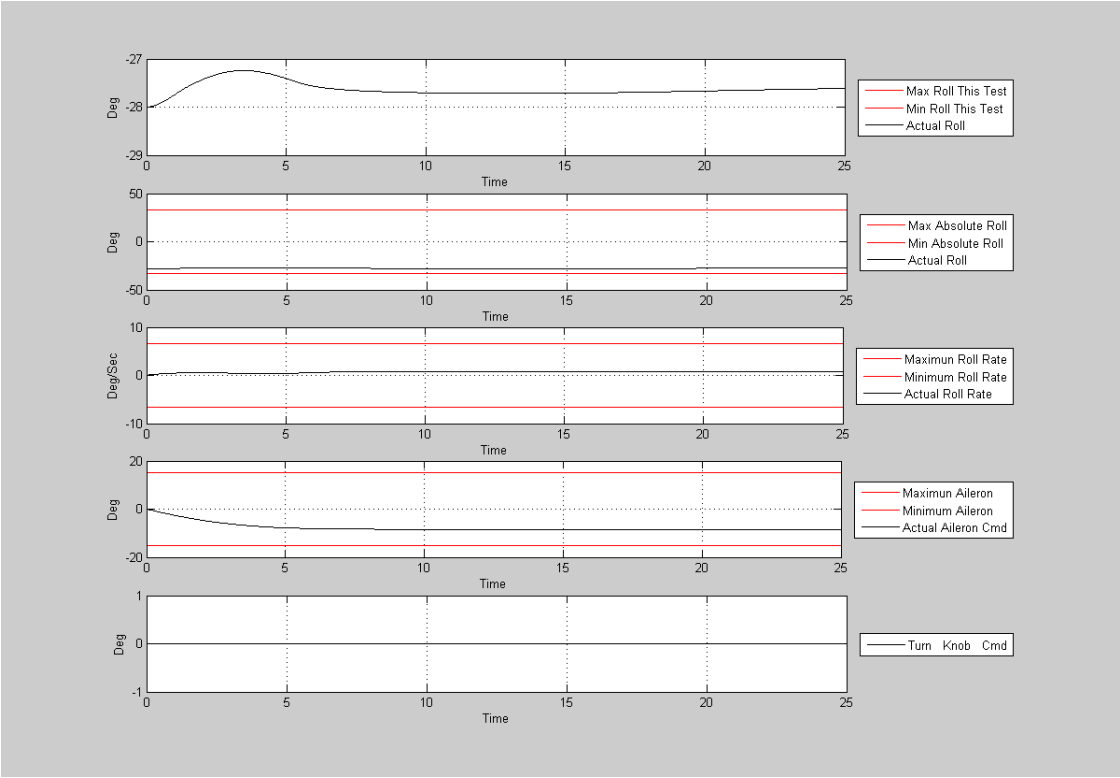
Maximum Roll Rate PASSED

Maximum Aileron Angle PASSED

Test Iteration

```
Test Iteration #7

Requirement being tested: 1.1. Roll Autopilot Engage Control, 1.2. Roll Hold Mode,

Engage roll hold with an initial -28 degree bank angle and turn knob at 0 degree.

The bank angle should be controlled to -28 degrees with a 1 degree tolerance.

Trimmed roll angle = -28
```

Plots and Results.



Roll Response PASSED

Maximum Roll Angle PASSED

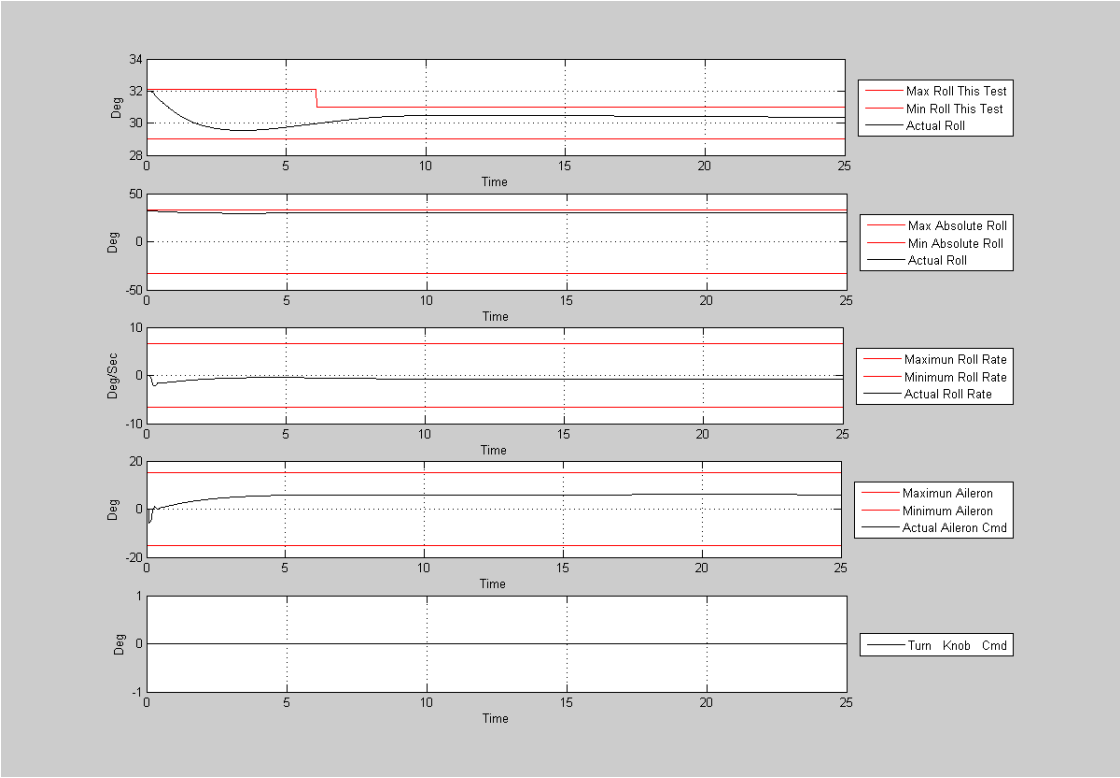
Maximum Roll Rate PASSED

Maximum Aileron Angle PASSED

Test Iteration

```
Test Iteration #8

Requirement being tested: 1.1. Roll Autopilot Engage Control, 1.2. Roll Hold Mode,

Engage roll hold with an initial +32 degree bank angle and turn knob at 0 degree.

The bank angle should be controlled to 30 degrees with a 1 degree tolerance.

Trimmed roll angle = 32
```

Plots and Results.



Roll Response PASSED

Maximum Roll Angle PASSED

Maximum Roll Rate PASSED

Maximum Aileron Angle PASSED

Test Iteration

Test Iteration #9

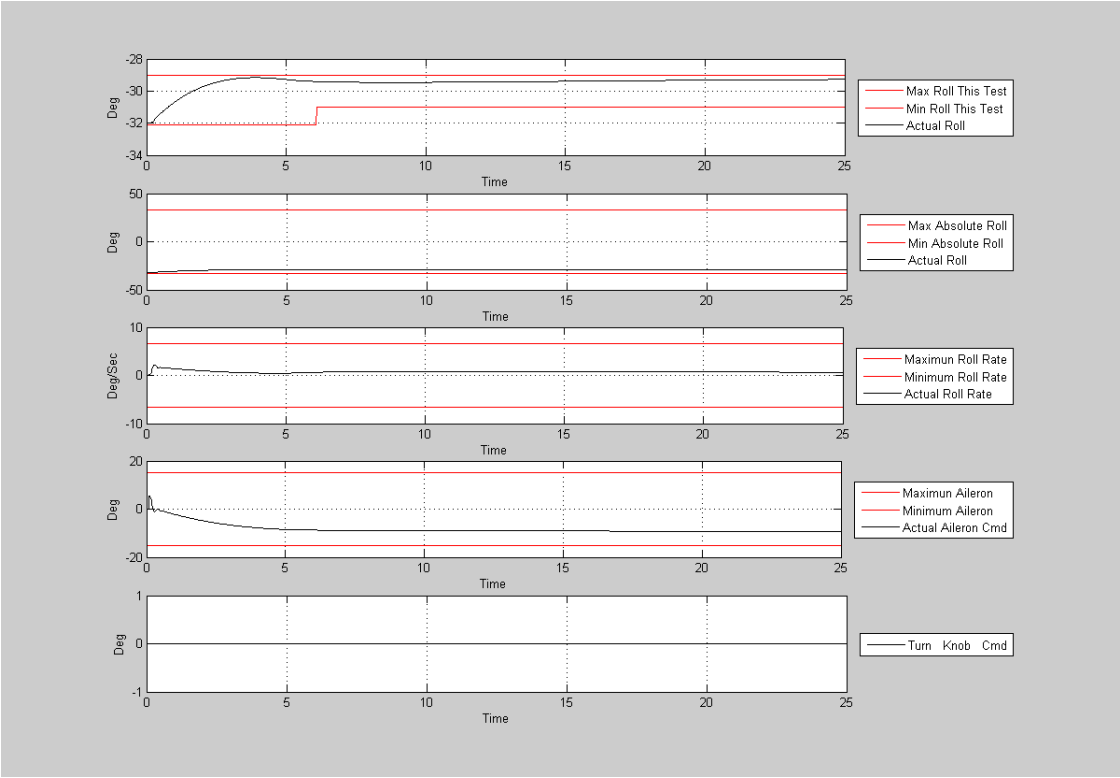
Requirement being tested: 1.1. Roll Autopilot Engage Control, 1.2. Roll Hold Mode,

Engage roll hold with an initial -32 degree bank angle and turn knob at 0 degree.

The bank angle should be controlled to -30 degrees with a 1 degree tolerance.

Trimmed roll angle = -32

Plots and Results.



Roll Response PASSED

Maximum Roll Angle PASSED

Maximum Roll Rate PASSED

Maximum Aileron Angle PASSED

Test Iteration

Test Iteration #10

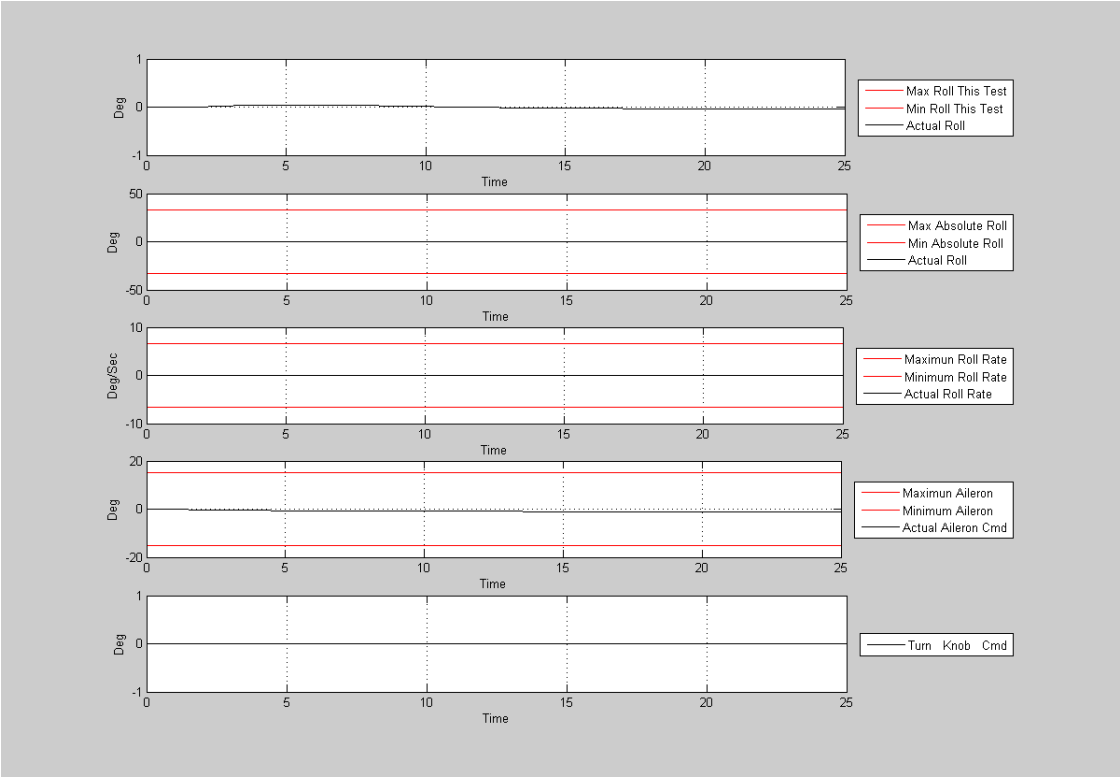
Requirement being tested: 1.1. Roll Autopilot Engage Control, 1.2. Roll Hold Mode,

Engage roll hold with an initial 0 degree bank angle and turn knob at 0 degree.

The bank angle should be controlled to 0 degrees with a 1 degree tolerance.

Trimmed roll angle = 0

Plots and Results.



Roll Response PASSED

Maximum Roll Angle PASSED

Maximum Roll Rate PASSED

Maximum Aileron Angle PASSED

Test Iteration

Test Iteration #11

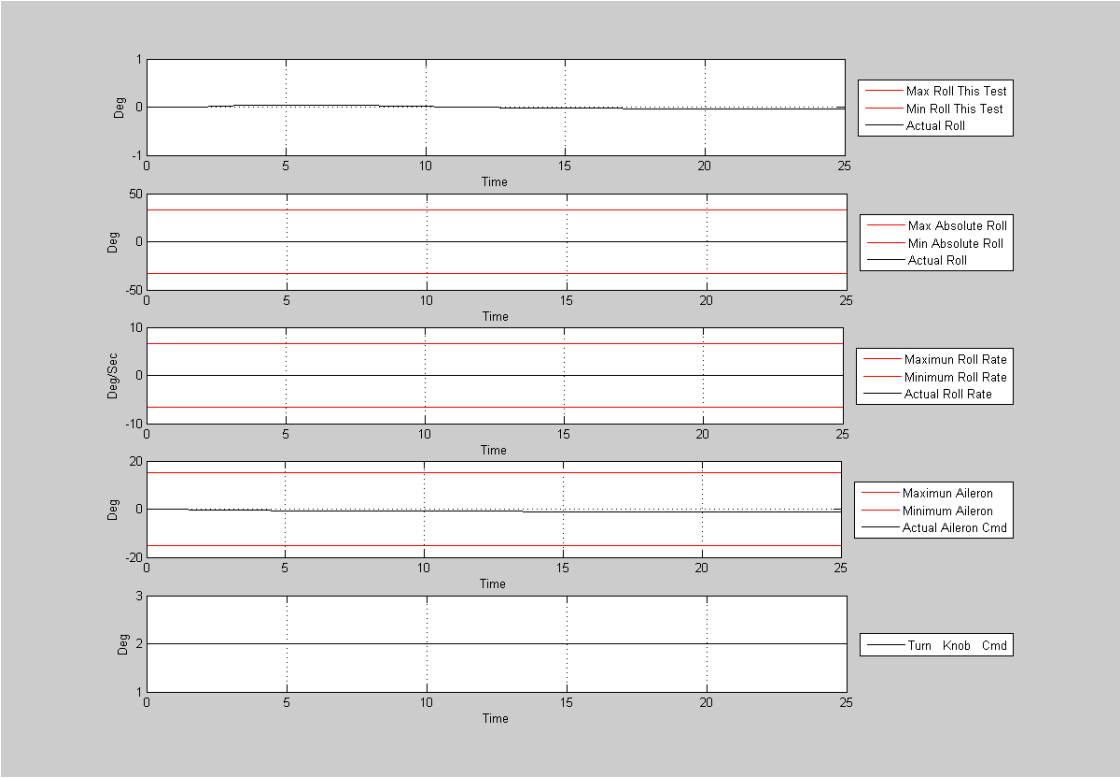
Requirement being tested: 1.1. Roll Autopilot Engage Control, 1.2. Roll Hold Mode,

Engage roll hold with an initial 0 degree bank angle and turn knob at +2 degree.

The bank angle should be controlled to 0 degrees with a 1 degree tolerance.

Trimmed roll angle = 0

Plots and Results.



Roll Response PASSED

Maximum Roll Angle PASSED

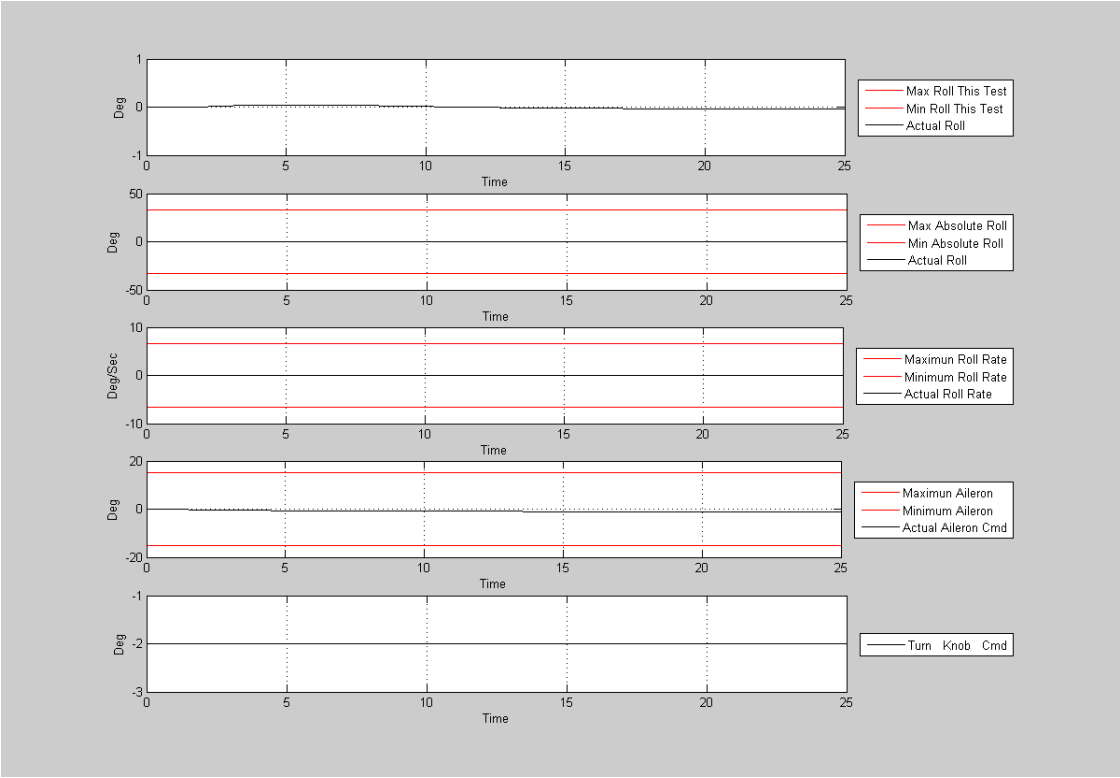
Maximum Roll Rate PASSED

Maximum Aileron Angle PASSED

Test Iteration

```
Test Iteration #12

Requirement being tested: 1.1. Roll Autopilot Engage Control, 1.2. Roll Hold Mode,

Engage roll hold with an initial 0 degree bank angle and turn knob at -2 degree.

The bank angle should be controlled to 0 degrees with a 1 degree tolerance.

Trimmed roll angle = 0
```

Plots and Results.



Roll Response PASSED

Maximum Roll Angle PASSED

Maximum Roll Rate PASSED

Maximum Aileron Angle PASSED

Test Iteration

Test Iteration #13

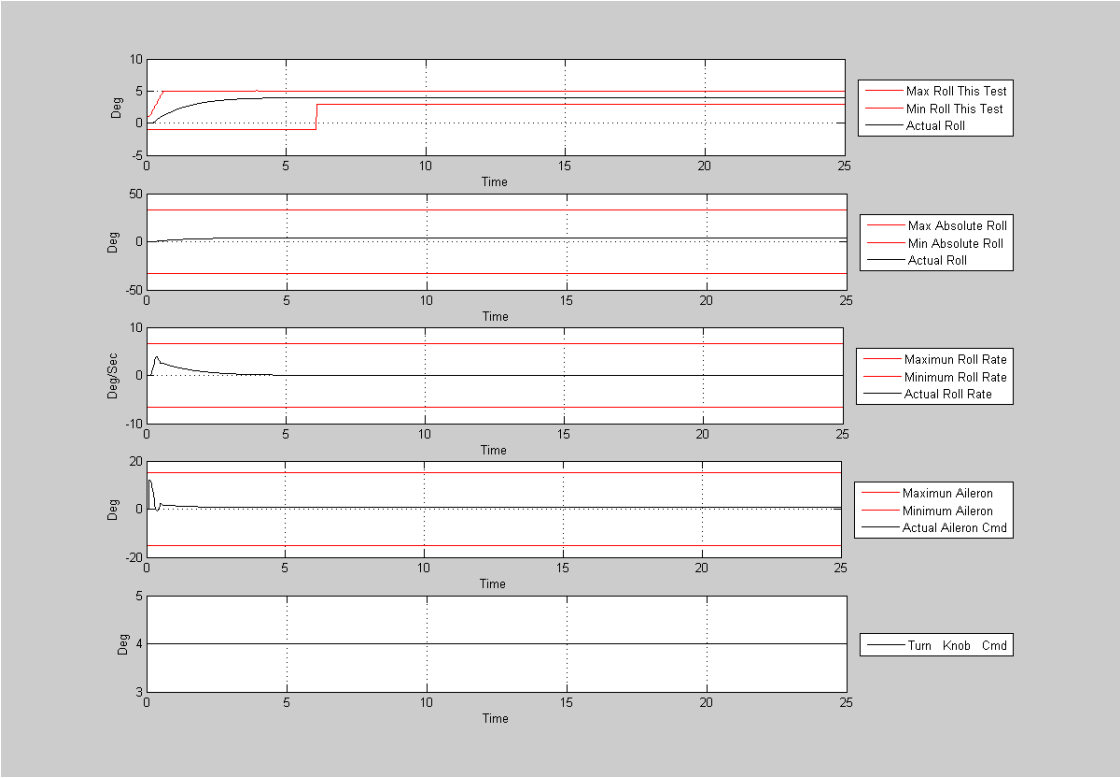
Requirement being tested: 1.1. Roll Autopilot Engage Control, 1.2. Roll Hold Mode,

Engage roll hold with an initial 0 degree bank angle and turn knob at +4 degree.

The bank angle should be controlled to +4 degrees with a 1 degree tolerance.

Trimmed roll angle = 0

Plots and Results.



Roll Response PASSED

Maximum Roll Angle PASSED

Maximum Roll Rate PASSED

Maximum Aileron Angle PASSED

Test Iteration

Test Iteration #14

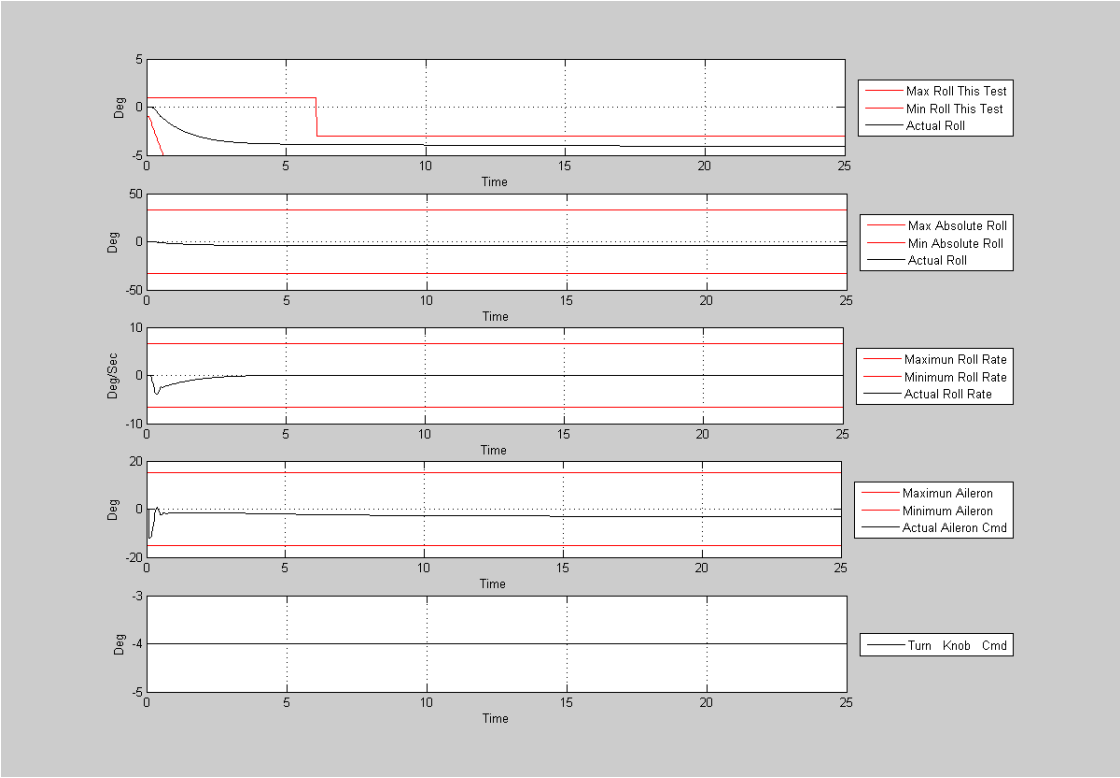
Requirement being tested: 1.1. Roll Autopilot Engage Control, 1.2. Roll Hold Mode,

Engage roll hold with an initial 0 degree bank angle and turn knob at -4 degree.

The bank angle should be controlled to -4 degrees with a 1 degree tolerance.

Trimmed roll angle = 0

Plots and Results.



Roll Response PASSED

Maximum Roll Angle PASSED

Maximum Roll Rate PASSED

Maximum Aileron Angle PASSED

Test Iteration

Test Iteration #15

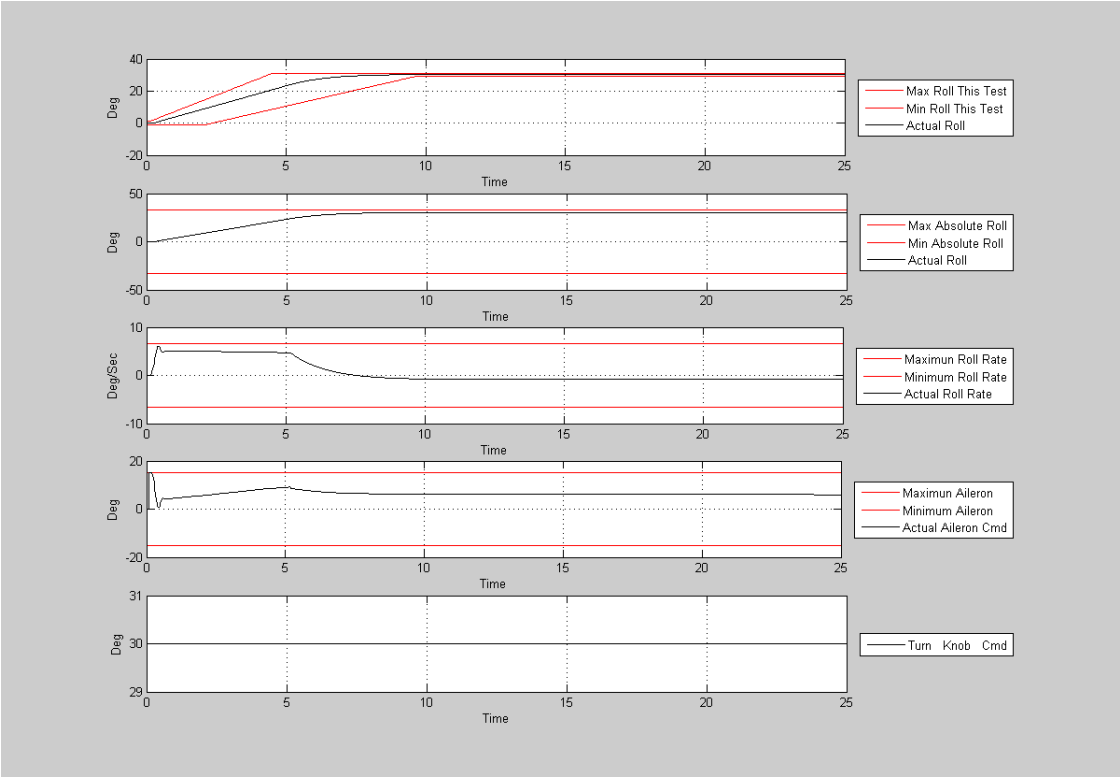
Requirement being tested: 1.1. Roll Autopilot Engage Control, 1.2. Roll Hold Mode,

Engage roll hold with an initial 0 degree bank angle and turn knob at +30 degree.

The bank angle should be controlled to +30 degrees with a 1 degree tolerance.

Trimmed roll angle = 0

Plots and Results.



Roll Response PASSED

Maximum Roll Angle PASSED

Maximum Roll Rate PASSED

Maximum Aileron Angle PASSED

Test Iteration

Test Iteration #16

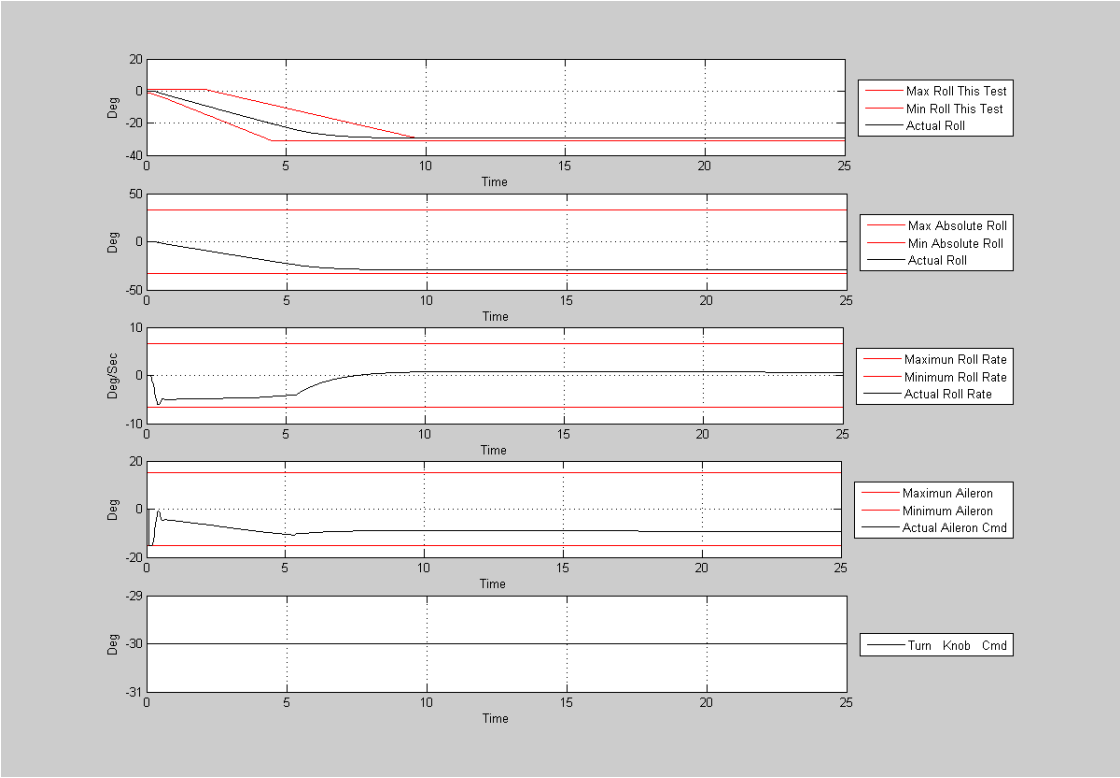
Requirement being tested: 1.1. Roll Autopilot Engage Control, 1.2. Roll Hold Mode,

Engage roll hold with an initial 0 degree bank angle and turn knob at -30 degree.

The bank angle should be controlled to -30 degrees with a 1 degree tolerance.

Trimmed roll angle = 0

Plots and Results.



Roll Response PASSED

Maximum Roll Angle PASSED

Maximum Roll Rate PASSED

Maximum Aileron Angle PASSED

Test Iteration

Test Iteration #17

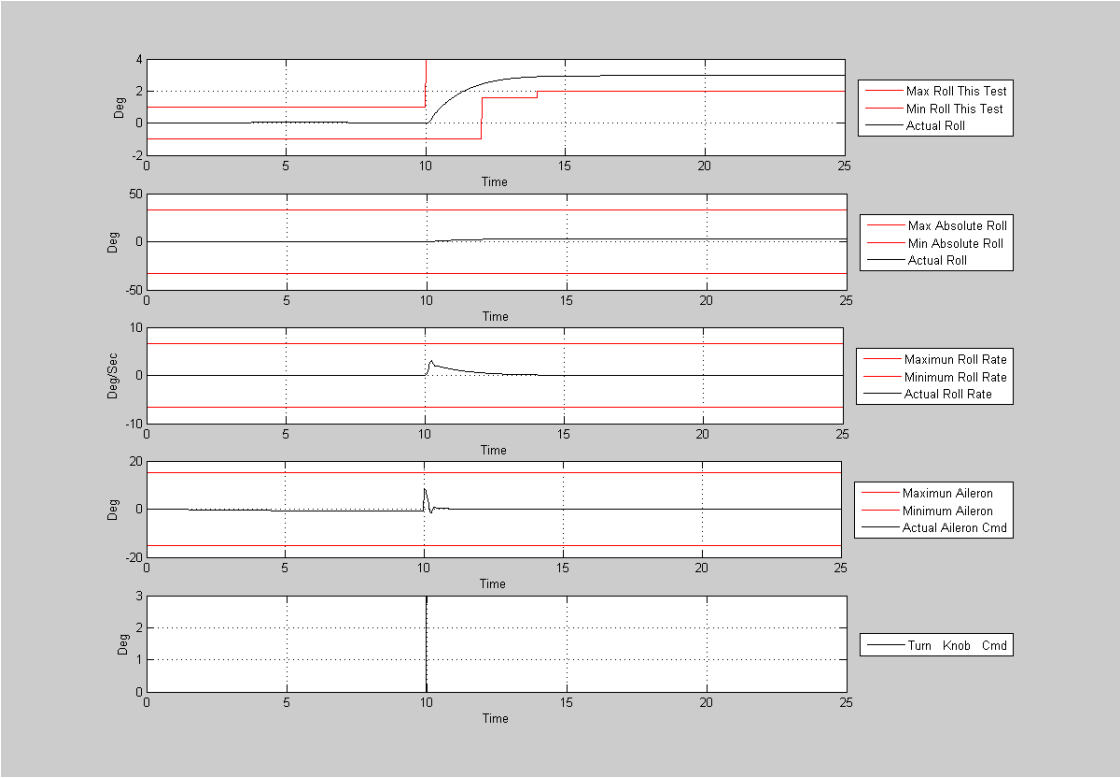
Requirement being tested: 1.4. Roll Performance

Engage roll hold with an initial 0 degree bank angle and turn knob at 0 degree, th

The roll should have a maximum rise time of 2 seconds, maximum 1 degree overshoot

Trimmed roll angle = 0

Plots and Results.



Roll Response PASSED

Maximum Roll Angle PASSED

Maximum Roll Rate PASSED

Maximum Aileron Angle PASSED

Test Iteration

Test Iteration #18

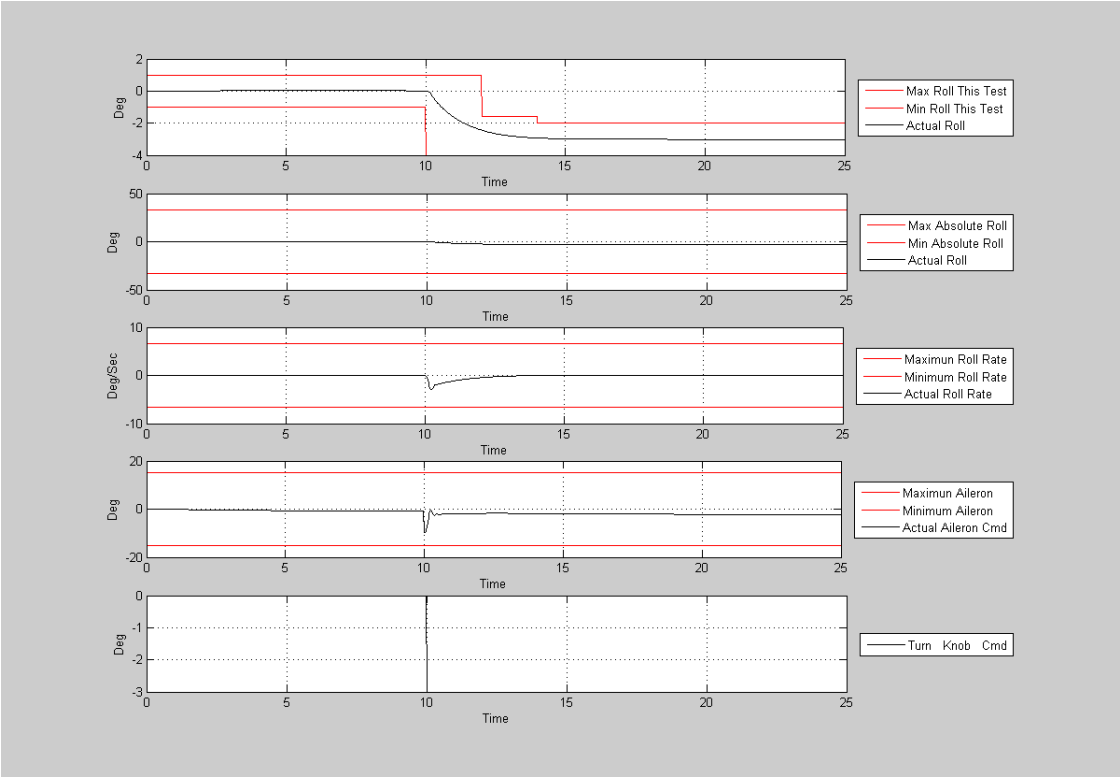
Requirement being tested: 1.4. Roll Performance

Engage roll hold with an initial 0 degree bank angle and turn knob at 0 degree, th

The roll should have a maximum rise time of 2 seconds, Maximum 1 degree overshoot

Trimmed roll angle = 0

Plots and Results.



Roll Response PASSED

Maximum Roll Angle PASSED

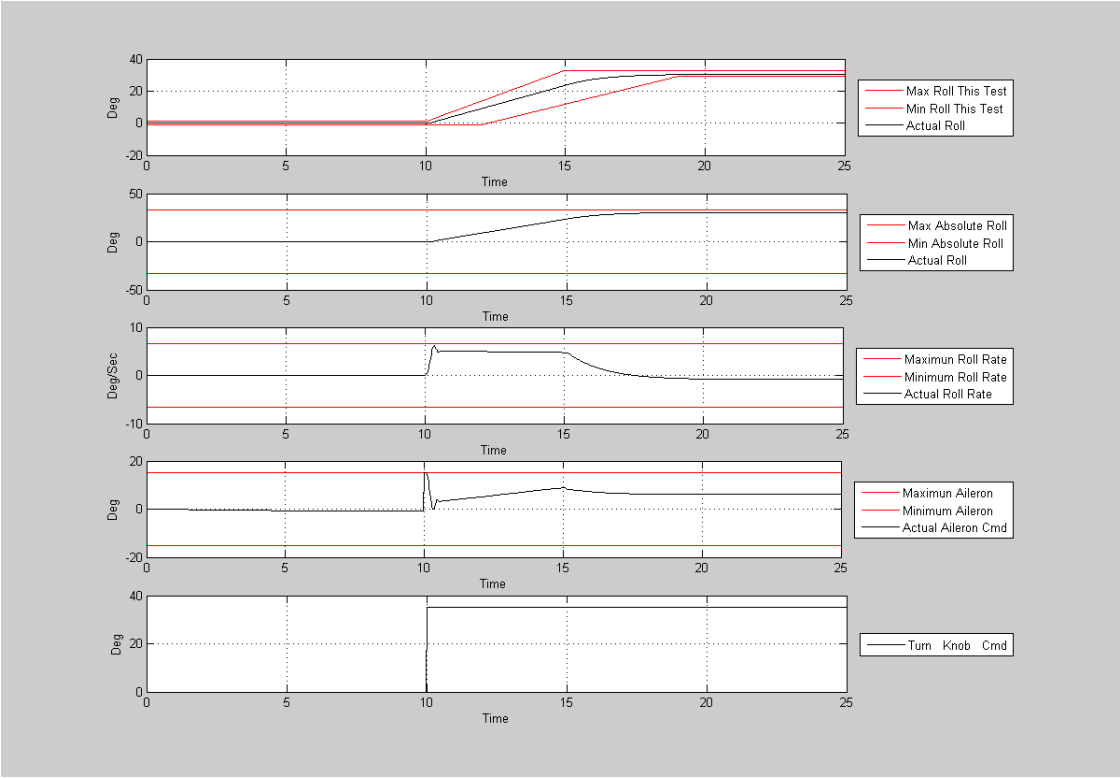
Maximum Roll Rate PASSED

Maximum Aileron Angle PASSED

Test Iteration

```
Test Iteration #19

Requirement being tested: 1.5. Roll Rate Limit, 1.6. Roll Angle Limit, 1.7. Ailero

Engage roll hold with an initial 0 degree bank angle and turn knob at 0 degree, th

The roll should have a maximum rate of 6.6 deg/sec, a final bank angle of 30 degre

Trimmed roll angle = 0
```

Plots and Results.



Roll Response PASSED

Maximum Roll Angle PASSED

Maximum Roll Rate PASSED

Maximum Aileron Angle PASSED

Test Iteration

Test Iteration #20

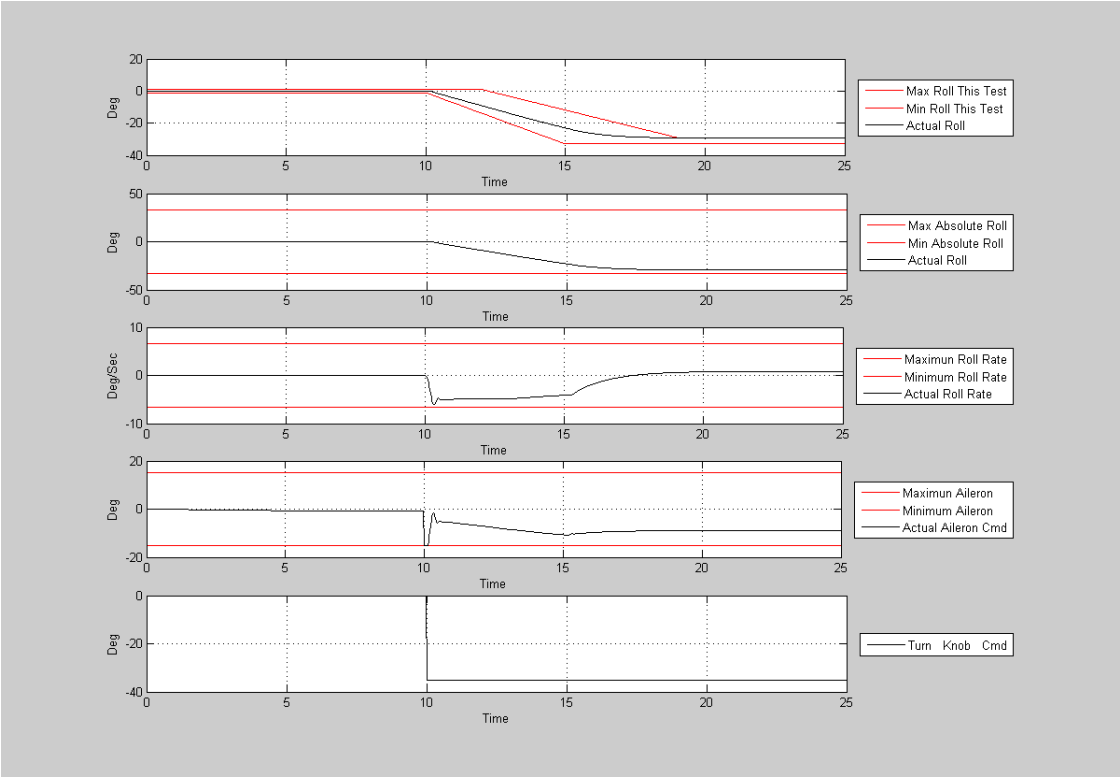
Requirement being tested: 1.5. Roll Rate Limit, 1.6. Roll Angle Limit, 1.7. Ailero

Engage roll hold with an initial 0 degree bank angle and turn knob at 0 degree, th

The roll should have a maximum rate of 6.6 deg/sec, a final bank angle of -30 degr

Trimmed roll angle = 0

Plots and Results.



Roll Response PASSED

Maximum Roll Angle PASSED

Maximum Roll Rate PASSED

Maximum Aileron Angle PASSED

Chapter 5. Conclusions

PASSED since all 20 iterations passed.