1. PROJECT

ROOT_OBJECTS
--|examples_AADL/IMA\IMAFlightSystem|--,
--|examples_AADL/IMA\FlightControlSystem|--,
--|examples_AADL/IMA\FCSTypes|--,
--|examples_AADL/IMA\HWPlatform|--,
--|examples_AADL/Common\ARINC653|--

END

1.1. Project Description

FLIGHT CONTROL SYSTEM

This model is directly inspired from the Flight Control System example provided in APPENDIX B
of the Requirements Engineering Management Handbook, DOT/FAA/AR-08/32, June 2009.
Authors: David L. Lempia and Steven P. Miller, Rockwell Collins, Inc.

The system being specified is a portion of an FCS. The FCS compares the measured Aircraft Attitude
to a Reference Attitude and generates Flight Director (FD) Guidance commands that are displayed as visible cues,
i.e., the FD, on the left and right Primary Flight Displays (PFD). The Pilot or Copilot can manually fly the aircraft
to follow the FD to achieve the Reference Attitude. The Pilot or Copilot can clear the FD from the PFDs,
turn the FD back on, and synchronize the Reference Attitude to the current Aircraft Attitude.

The FCS also provides an AP Function that the Pilot or Copilot can request. When the AP Function is engaged,
the FCS generates Actuator Commands that will prompt the aircraft control surfaces to fly the aircraft
to the Reference Attitude.
While the AP Function is engaged, the Pilot or Copilot can initiate control wheel steering, which suspends the AP Function,
allowing the Pilot or Copilot to manually fly the aircraft to a new attitude, and then resume the AP Function
using the new attitude as the Reference Attitude.

In addition to the FD, the PFDs also display whether the AP Function is engaged, if the AP Function has failed,
and if the FCS has failed.

1.2. List of Requirements

EA-AHS-1
EA-AHS-2
EA-AHS-3
EA-AHS-4
EA-CSA-1

EA-CSA-2

EA-CSA-3

EA-CSA-4

EA-PFD-1

EA-PFD-2

EA-PFD-3

EA-PFD-4

REQ-AP-1

REQ-AP-2

REQ-AP-3

REQ-FCS-1

REQ-FCS-2

REQ-FCS-3

REQ-FCS-4

REQ-FCS-5

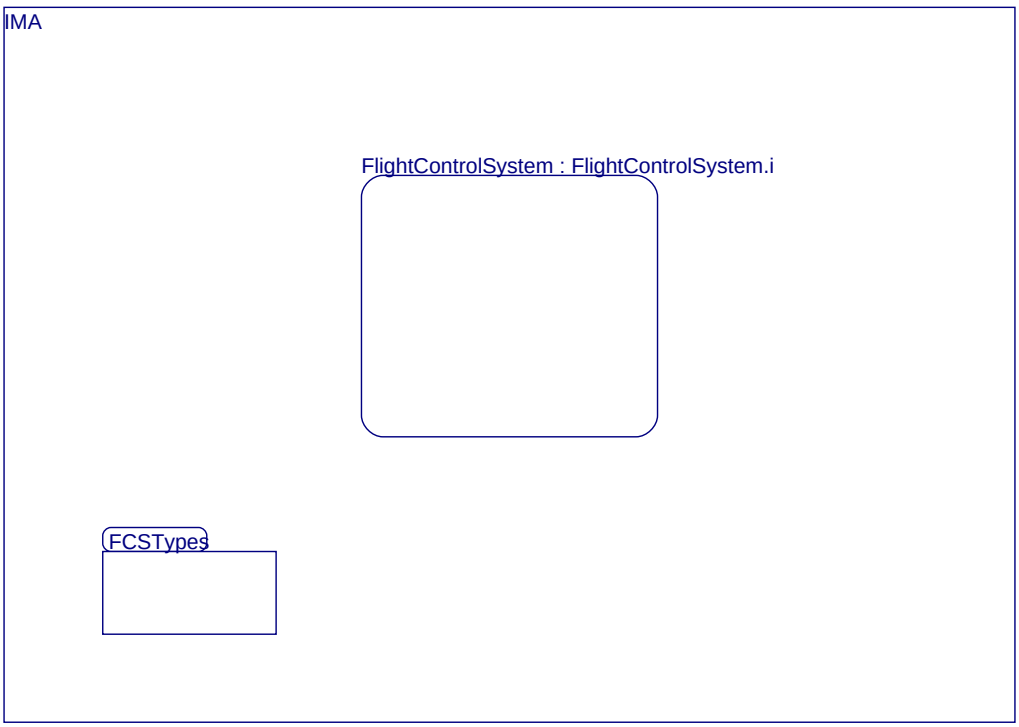
REQ-FG-1

REQ-FG-2

REQ-FG-3

REQ-FG-4

1.3. AADL Diagram

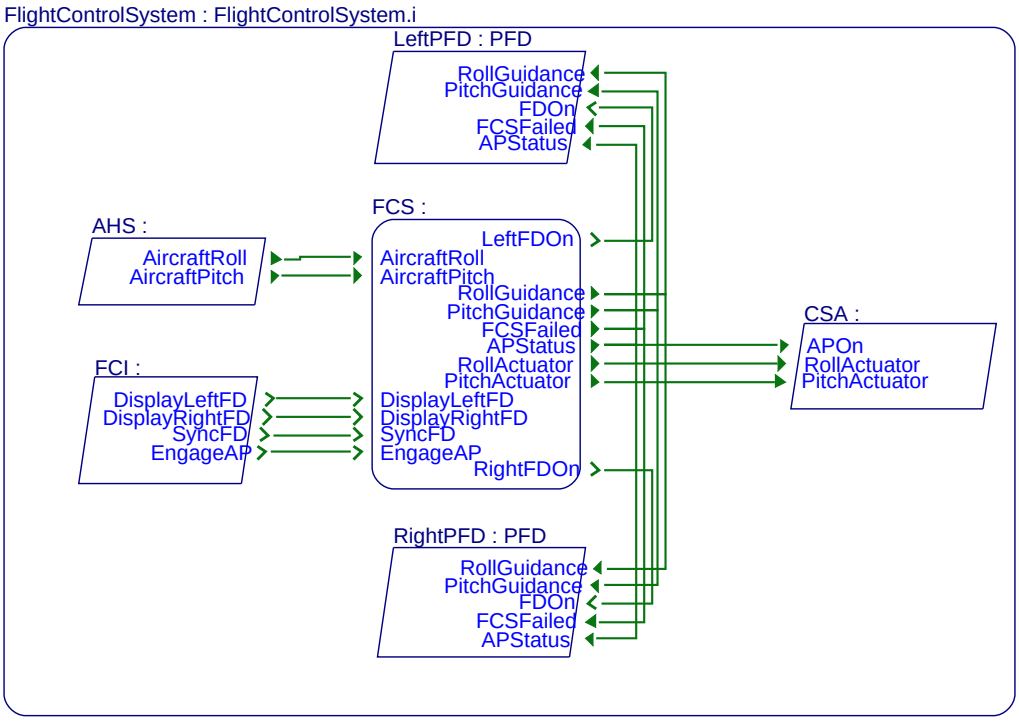


2. SYSTEM FlightControlSystem IS

2.1. DESCRIPTION

2.1.1. PROBLEM

2.1.1.1. AADL Diagram



2.1.2. FEATURES

3. SYSTEM FCS IS

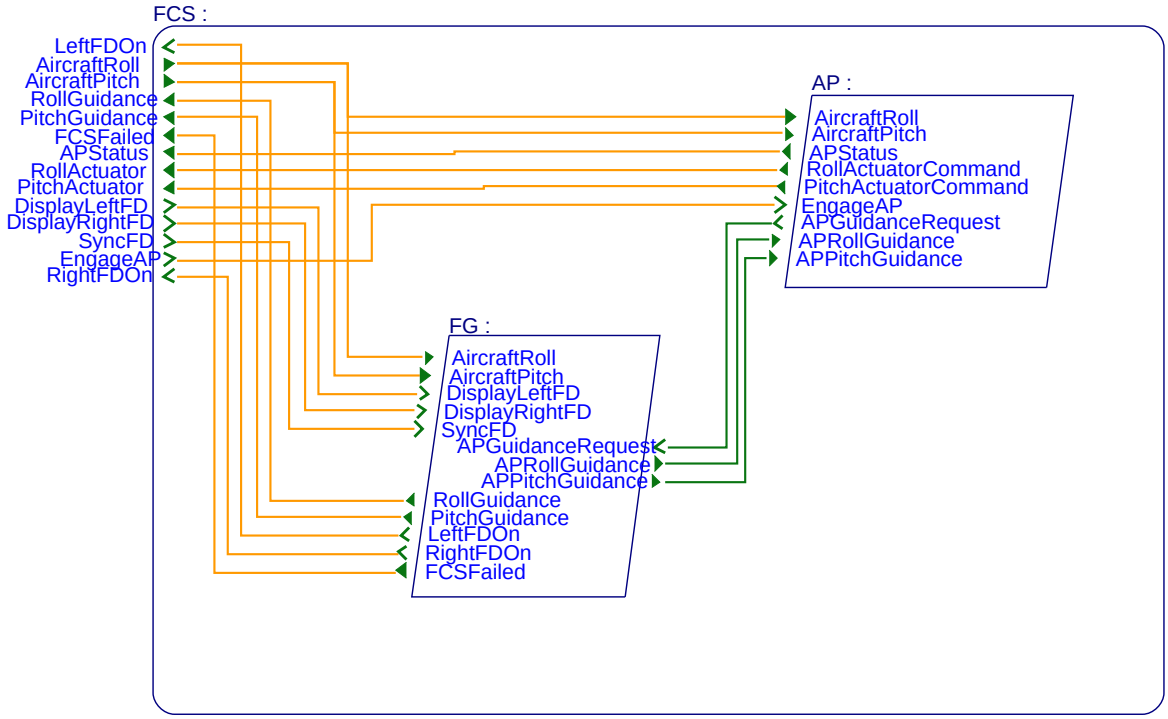
3.1. DESCRIPTION

3.1.1. PROBLEM

3.1.1.1. Statement of the Problem (text)

For the purpose of the example, the Flight Control System is only decomposed down to the Flight Guidance (FG) and Autopilot (AP) Functions.

3.1.1.2. AADL Diagram



3.1.2. FEATURES

3.1.2.1. LeftFDOn

3.1.2.2. AircraftRoll

3.1.2.3. AircraftPitch

3.1.2.4. RollGuidance

3.1.2.4.1. Feature Description

This is a primary function of the FCS.

The PFD uses the FD Guidance commands to position the FD to show the Pilot and Copilot how to fly the aircraft to the Reference Attitude.Desired roll angle of the aircraft:

Real [-45.0..45.0] Degrees

0° indicates wings level

-X° indicates X° bank to the left

+X° indicates X° bank to the right

Covered requirements:

(cf.REQ-FCS-1)

3.1.2.5. PitchGuidance

3.1.2.5.1. Feature Description

This is a primary function of the FCS.

The PFD uses the FD Guidance commands to position the FD to show the Pilot and Copilot how to fly the aircraft to the Reference Attitude.

Desired pitch angle of the aircraft:

Real [-45.0..45.0] Degrees

0° indicates level flight

-X° indicates X° nose up

+X° indicates X° nose down

Covered Requirements:

(cf.REQ-FCS-1)

3.1.2.6. FCSFailed

3.1.2.6.1. Feature Description

If the FCS has failed, the FD must be cleared and the Pilot and Copilot notified that the FCS Function has failed. This is typically indicated by the PFD.

(cf.REQ-FCS-3)

3.1.2.7. APStatus

3.1.2.7.1. Feature Description

The current status of the AP Function must be displayed to the Pilot and Copilot

to ensure they know when the AP Function is controlling the aircraft.

(cf.REQ-FCS-5)

3.1.2.8. RollActuator

3.1.2.8.1. Feature Description

This is a primary function of the FCS. The CSA use the Actuator Commands to fly the aircraft

to the Reference Attitude when the AP Function is on.

(cf.REQ-FCS-4)

3.1.2.9. PitchActuator

3.1.2.9.1. Feature Description

This is a primary function of the FCS. The CSA use the Actuator Commands to fly the aircraft

to the Reference Attitude when the AP Function is on.

(cf.REQ-FCS-4)

3.1.2.10. DisplayLeftFD

3.1.2.11. DisplayRightFD

3.1.2.12. SyncFD

3.1.2.12.1. Feature Description

The FCS sets the Reference Attitude when the Pilot or Copilot requests the FCS to synchronize

the Reference Attitude to the current attitude or to engage the AP Function.

(cf.REQ-FCS-2)

3.1.2.13. EngageAP

3.1.2.13.1. Feature Description

The FCS sets the Reference Attitude when the Pilot or Copilot requests the FCS to synchronize

the Reference Attitude to the current attitude or to engage the AP Function.

(cf.REQ-FCS-2)

3.1.2.14. RightFDOn

4. PROCESS FCI IS

4.1. DESCRIPTION

4.1.1. PROBLEM

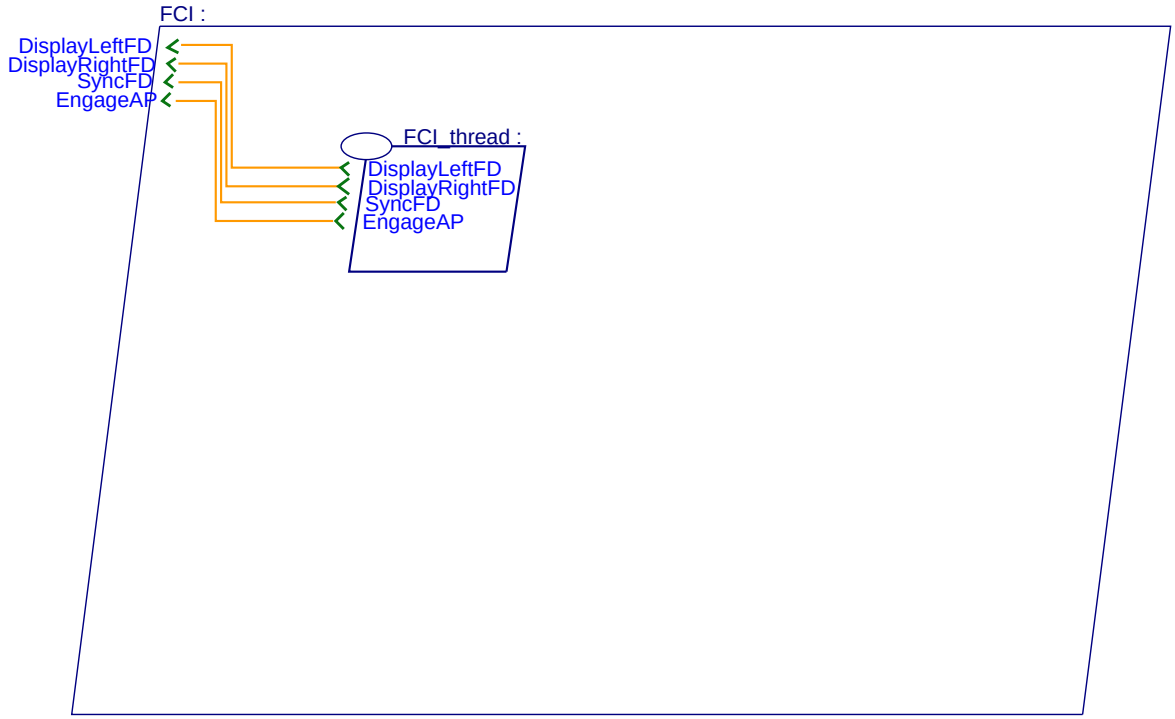
4.1.1.1. Statement of the Problem (text)

Flight Crew Interface:

The FCI provides the inputs from the Pilot and the Copilot that affect the behavior of the FCS.

No environmental assumptions are made.

4.1.1.2. AADL Diagram



4.1.2. FEATURES

4.1.2.1. DisplayLeftFD

4.1.2.1.1. Feature Description

Command to display or clear the FD to the Pilot and Copilot.

(Boolean)

4.1.2.2. DisplayRightFD

4.1.2.3. SyncFD

4.1.2.3.1. Feature Description

Command to set Reference Attitude to current Aircraft Attitude.

(Boolean)

4.1.2.4. EngageAP

4.1.2.4.1. Feature Description

Command to activate or deactivate the AP Function.

(Boolean)

5. PROCESS CSA IS

5.1. DESCRIPTION

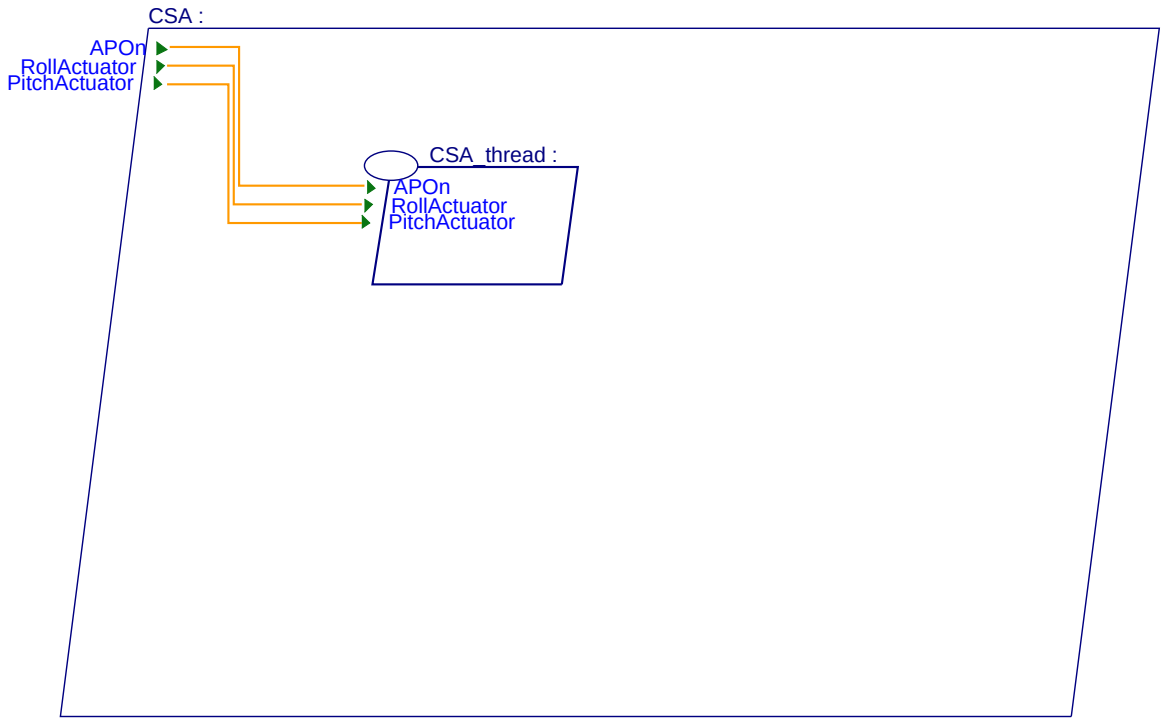
5.1.1. PROBLEM

5.1.1.1. Statement of the Problem (text)

Control Surface Actuators:

The CSA positions the aircraft control surfaces based on the Actuator Commands generated by the FCS to hold the aircraft to the Reference Attitude.

5.1.1.2. AADL Diagram



5.1.2. FEATURES

5.1.2.1. APOn

5.1.2.1.1. Feature Description

Indication whether the AP Function is on and the Actuator Commands will be used:

False, True

5.1.2.2. RollActuator

5.1.2.2.1. Feature Description

Commanded rate of roll actuator:

Real [-20.0..20.0] ° surface/ second

0 : no change of control surfaces

-X: left wing down.

+X : right wing down

Environmental Assumptions:

Specified by aircraft manufacturer as the range necessary to adequately control the aircraft. (cf.EA-CSA-1)

Controllability analysis shows that a resolution of 0.1° surface/second is necessary to maintain control of the aircraft. (cf.EA-

5.1.2.3. PitchActuator

5.1.2.3.1. Feature Description

Commanded rate of pitch actuator:

Real [-20.0..20.0] ° surface/ second

0 : no change of control surfaces

-X : nose up

+X : nose down

Environmental Assumptions:

Specified by aircraft manufacturer as the range necessary to adequately control the aircraft. (cf.EA-CSA-3)

Controllability analysis shows that a resolution of 0.1° surface/second is necessary to maintain aircraft control. (cf.EA-CSA-4

6. PROCESS AHS IS

6.1. DESCRIPTION

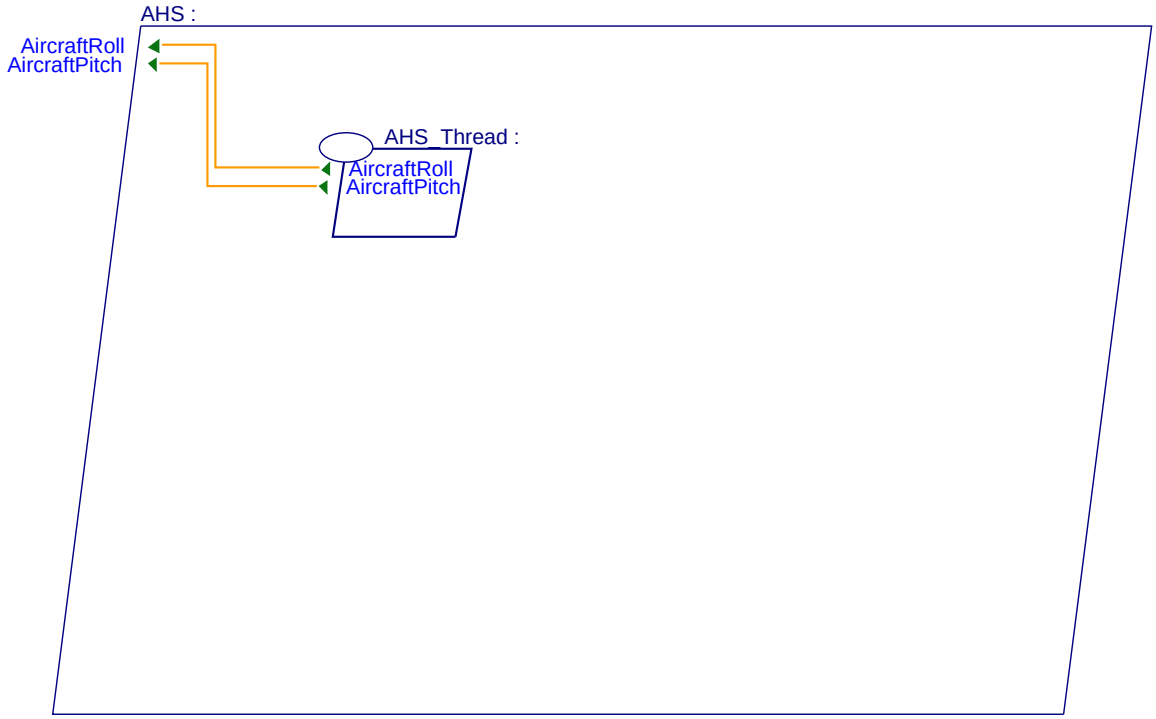
6.1.1. PROBLEM

6.1.1.1. Statement of the Problem (text)

Attitude Heading System:

The AHS provides the current Aircraft Attitude to the FCS.

6.1.1.2. AADL Diagram



6.1.2. FEATURES

6.1.2.1. AircraftRoll

6.1.2.1.1. Feature Description

Current roll angle of the aircraft:

Real [-180.0..179.9] Degrees

0° indicates wings level

-X° indicates X° bank to the left

+X° indicates X° bank to the right

Environmental assumptions:

The AHS will provide true roll of the aircraft, which can take on any value in the full range of motion of the aircraft. (cf.EA-AH

Accuracy to ensure that the displayed aircraft attitude moves smoothly on the PFD and to ensure the FCS computes the Actuator Commands and FD Guidance commands with the necessary accuracy. (cf.EA-AHS-2)

6.1.2.2. AircraftPitch

6.1.2.2.1. Feature Description

Current pitch angle of the aircraft:

Real [-180.0..179.9] Degrees

0° indicates level flight

-X° indicates X° nose up

+X° indicates X° nose down

Environmental assumptions:

The AHS will provide true pitch of the aircraft, which can take on any value in the full range of motion of the aircraft. (cf.EA-A

This accuracy is needed to ensure that displayed aircraft attitude moves smoothly on the PFD and to ensure the FCS comp the Actuator Commands and FD Guidance commands with the necessary accuracy. (cf.EA-AHS-4)

7. PROCESS LeftPFD IS

7.1. DESCRIPTION

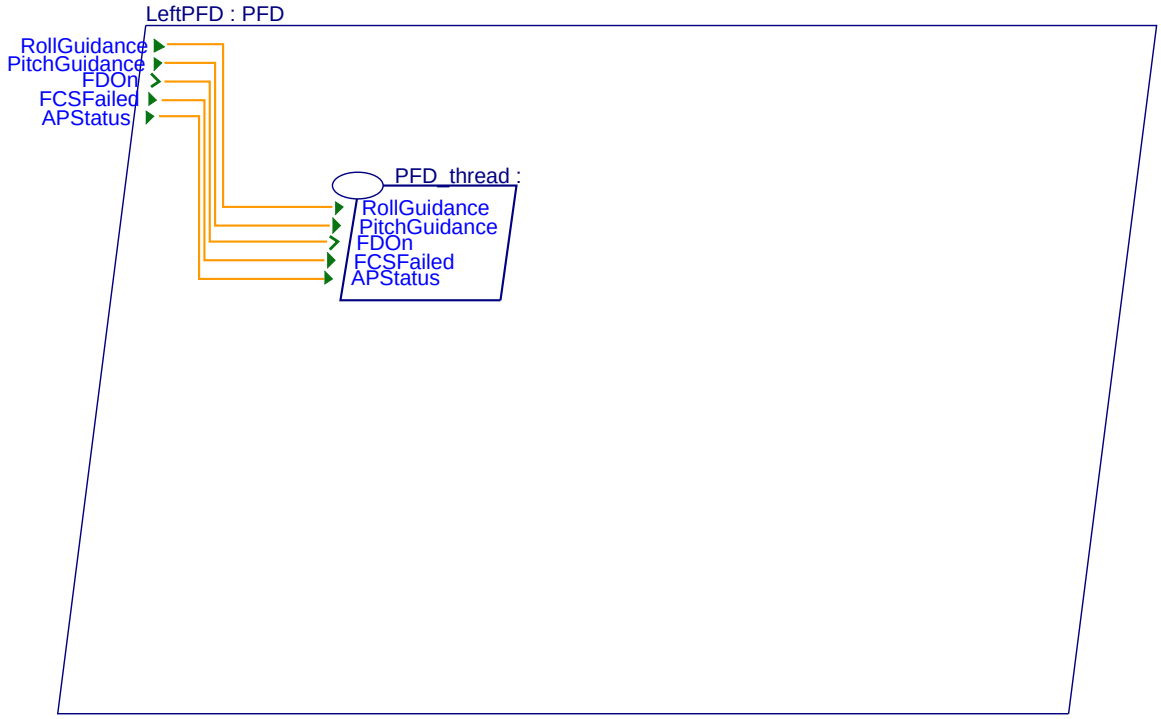
7.1.1. PROBLEM

7.1.1.1. Statement of the Problem (text)

Primary Flight Display:

The Left and Right PFD shows the FD, FCS Failed indication, and the AP Status.

7.1.1.2. AADL Diagram



7.1.2. FEATURES

7.1.2.1. RollGuidance

7.1.2.1.1. Feature Description

Desired roll angle of the aircraft:

Real [-45.0..45.0] Degrees

0° indicates wings level

-X° indicates X° bank to the left

+X° indicates X° bank to the right

Environmental Assumptions:

Specified by aircraft manufacturer as the maximum range for the Roll Guidance. (cf.EA-PFD-1)

Resolution to achieve smooth movement of the FD during control wheel steering. (cf.EA-PFD-2)

7.1.2.2. PitchGuidance

7.1.2.2.1. Feature Description

Desired pitch angle of the aircraft:

Real [-45.0..45.0] Degrees

0° indicates level flight

-X° indicates X° nose up

+X° indicates X° nose down

Environmental Assumptions:

Specified by aircraft manufacturer as the maximum range for the Pitch Guidance. (cf.EA-PFD-3)

Resolution to achieve smooth movement of the FD during control wheel steering. (cf.EA-PFD-4)

7.1.2.3. FDOn

7.1.2.3.1. Feature Description

Indication if FD is to be displayed:

False : Do not display FD

True :Display FD

7.1.2.4. FCSFailed

7.1.2.4.1. Feature Description

Indication if FCS is failed:

False : FCS is functioning

True :FCS is failed

7.1.2.5. APStatus

7.1.2.5.1. Feature Description

Status of AP Function:

Failed : AP Function is failed

Off • : AP Function is off

On : AP Function is on

8. PROCESS RightPFD IS

8.1. DESCRIPTION

8.1.1. PROBLEM

8.1.1.1. Statement of the Problem (text)

Primary Flight Display:

The Left and Right PFD shows the FD, FCS Failed indication, and the AP Status.

8.1.2. FEATURES

8.1.2.1. RollGuidance

8.1.2.1.1. Feature Description

Desired roll angle of the aircraft:

Real [-45.0..45.0] Degrees

0° indicates wings level

-X° indicates X° bank to the left

+X° indicates X° bank to the right

Environmental Assumptions:

Specified by aircraft manufacturer as the maximum range for the Roll Guidance. (cf.EA-PFD-1)

Resolution to achieve smooth movement of the FD during control wheel steering. (cf.EA-PFD-2)

8.1.2.2. PitchGuidance

8.1.2.2.1. Feature Description

Desired pitch angle of the aircraft:

Real [-45.0..45.0] Degrees

0° indicates level flight

-X° indicates X° nose up

+X° indicates X° nose down

Environmental Assumptions:

Specified by aircraft manufacturer as the maximum range for the Pitch Guidance. (cf.EA-PFD-3)

Resolution to achieve smooth movement of the FD during control wheel steering. (cf.EA-PFD-4)

8.1.2.3. FDOn

8.1.2.3.1. Feature Description

Indication if FD is to be displayed:

False : Do not display FD

True :Display FD

8.1.2.4. FCSFailed

8.1.2.4.1. Feature Description

Indication if FCS is failed:

False : FCS is functioning

True :FCS is failed

8.1.2.5. APStatus

8.1.2.5.1. Feature Description

Status of AP Function:

Failed : AP Function is failed

Off • : AP Function is off

On : AP Function is on