Sample Intent Specification: Altitude Switch

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Preface

The following example is taken from a specification by Steven Miller at Rockwell Collins of an altitude switch. His specification is part of a draft paper titled "Modeling Software Requirements for Embedded Systems." His methodology, however, is quite different from that being demonstrated in this document.

Contents

Level 1

System-Level Goals, Requirements, Constraints

Introduction

The Altitude Switch is a reusable component that turns power on to a Device of Interest (DOI) when the aircraft crosses a particular altitude. The first implementation will only turn power on when the aircraft descends below the altitude, but a switch that is activated upon ascent through the altitude may be required in the future and therefore it is included in the specification of levels 1 and 2 of this intent specification. This will allow the reuse of these levels for future product family members. The ASW receives altitude information from a variety of sensors and computes an estimate of the aircraft's true altitude. It then determines whether or not to power on the DOI.

This example problem was derived from a specification by Steve Miller at Rockwell-Collins. Minor changes have been made to better demonstrate the intent specification methodology. Because of the simplicity of the device, this intent specification is realtively trivial in some parts, particularly the desscription of the system design principles (Level 2). For a better example of the information found on this level, the reader is referred to our TCAS II Intent Specification.

Historical Perspective

The history of this device and its development is unknown to me.

Eniron ment

There will be four types of devices in the environment with which the altitude switch must communicate. The actual types and number of each device can vary for each product in the family.

Dev:DO(I)erest he DOI may be any aircraft component that can receive an electronic signal to control its operation.

: Environmental assumption

[EA].1
The DOI will be capable of providing inform(on or offout its status)
or there will be some other independent way to determine its status.

Watchdog er: A watchdog timer will be used to detect:

1. Failure of the altitude switch or
2. The inability of the altitude switch to determine the aircraft altitude within a given period of time

and to take action in those events.

Digital)(ster There may be one or more digital altimeters that report the aircraft altitude.

Analog)(ster T here may be one or more analog altimeters that report the aircraft altitude.

Operato

[OP.]1
The pilot shall take appropriate action when the altitude switch fails.

[OP.2]
The pilot shall inhibit the operation of the altitude switch when . . . .

[OP.2]
The pilot shall reset the altitude switch when . . . .

Human Interface Requirements

[1.1]
There shall be a means for the pilot to inhibit the operation of the ASW.

[1.2]
There shall be a means for the pilot to reset the ASW.

[1.3]
The pilot shall be informed about any failure of the altitude switch.

Functional Goals

[G.1]
The altitude switch shall turn on a DOI when the aircraft decends below or ascends above (passes through) a threshold altitude (→1.4, 1.5).

[G.2]
Failure of the ASW to perform its function shall be indicated to the pilot (→1.6, 1.7, 1.8)

[G.3]
The pilot shall be able to inhibit the operation of the ASW (→1.9, 1.10).

High Level Functional Requirements

[1.4]
The ASW shall turn power on to a DOI when the aircraft ascends below or ascends above a threshold altitude (ALT) above ground level (G.1) (↓2.1).

> ASSUMPTION: The specification is to be reusable and describe a family of products and therefore the appropriate altitude (ALT) will be determined for each ASW implementation.

> [1.4.1]
> If the DOI is powered off after the aircraft descends below the altitude threshold, the ASW shall not reapply power to the DOI unless the aircraft again descends below the threshold altitude.
>
> > RATIONALE: This requirement provides hysteresis so the altitude switch is not continually powered on and off while the aircraft is flying at the threshold altitude.

[1.5]
The ASW shall receive altitude information from one or more sensors and compute an estimate of the aircraft's true altitude from this information (G.1) (↓2.2).

> ASSUMPTION: Each product will possibly have different numbers and types of altitude sensors.

[1.6]
The ASW shall detect a fault under the following conditions (G.2):

a. The DOI fails to turn on in a period of TIME-A after power is applied (↓2.??).

> ASSUMPTION: The time in which the device will have been determined to have failed after receiving a command to turn on will depend upon the device and the aircraft design and must be set for each product family member.

b. The altitude cannot be determined within a period of TIME-B from the 2.(↓?? last valid altitude determination).

c. An internal ASW failure is detec2.(↓??ed).

[1.7]
Detection of a fault shall be indicated by failure of the ASW to strobe a watch(dog timer G.2) (↓??).

> ASSUMPTION: Failure of the watchdog to be strobed within a deadline will result in separate hardware illuminating a fault indicator lamp in the cockpit.

[1.8]
The ASW shall assume its initial state when a reset signal is receG(ived 2) (↓2.??).

> ASSUMPTION: All previous information about altitude or faults obtained during the period when the ASW is inhibited will be discarded once the reset occurs. The reset will be used by the pilot to clear fault indications and try again.

[1.9]
If the ASW receives an inhibit signal, it shall not turn the device on nor indica(te a fault G.3) ↓2.??).

> ASSUMPTION: The inhibit will be used by the pilot to prevent the DOI from being turned on even though the altitude threshold has been crossed.

[1.]10
The inhibit condition shall reG(main on until the pilot turns it off 3) (↓2.??).

System Limitations

TBD

System Design Constraints

Non-Safety Related

[C1]
The altitude switch shall not apply power to the DOI if the DOI is already powered on.

> Rationale: I do not know the reason for this restriction.

[C2]
The ASW must operate independently from any operator action except for reset and inhibit.

> Rationale: The ASW function should not add to operator workload. In addition, failure to turn on the device should not be subject to operator error.

Safety Related

Because this is simply a component within a larger system, safety requirements cannot be determined. If the ASW is used to determine when to add air freshener to the cabin ventilation system before landing, then there are no safety-related constraints. If it is used to lower the landing gear, then it would be safety-critical and may have some specific constraints on its behavior. Safety-related constraints may need to be added and validated after a hazard analysis has been performed for the specific system in which the altitude switch is to be used.

Hazard Analysis

A hazard analysis cannot be performed without information about how the ASW will be used. For example, if turning on the DOI (or failing to do so) is hazard increasing, then the design might require all altitude-reporting devices to agree the threshold has been crossed. If the ASW output is hazard decreasing, then the design might require only one of the altimeters show the threshold has been crossed. Level 2 (↓?? contains several optional designs) that can be linked to the hazard analysis when the environment in which the ASW is determined and a hazard analysis completed.

Because of this limitation, each member of the altitude switch product family will need to be evaluated for safety when the ASW usage and the specific environment in which it will be used is determined. This analysis may identify safety-related design constraints that must be enforced in the design.

Validation

No validation of these requirements has been done. Ifej this were a real pro ct, they would be reviewed by engineering, the potential customer, and perhaps marketing.

Level 2

System Design Principles

System Component Environment

The external components will interface with the altitude switch in the following manner

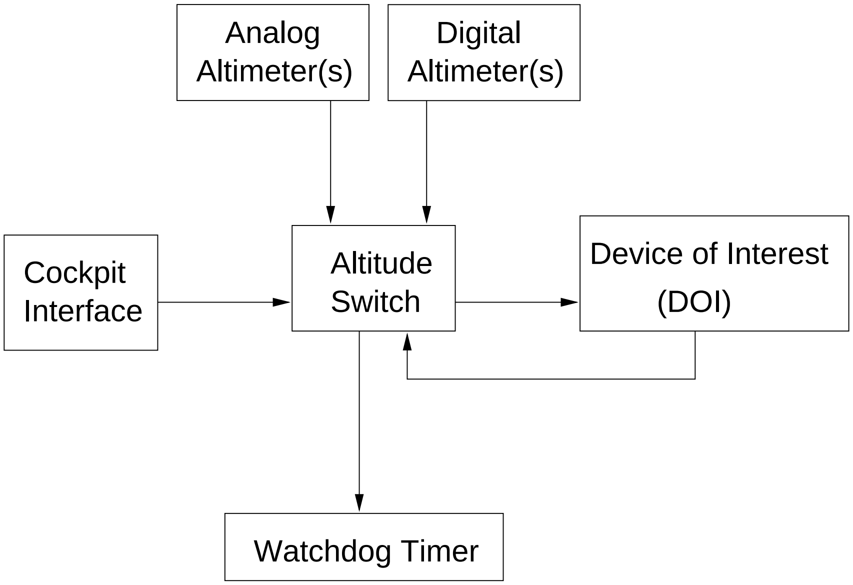


Figure 2.1 The ASW system components and environment

The analog altimeter value will range from 0 to 4000 feet AGL with a precision of 0.1 feet. However, due to the high cost and low reliability of D/A converters, the value will be sensed as a binary value (above or below the threshold).

If the digital altimeter value is outside its legitimate range, values above or below the minimum and maximum values, respectively will be mapped into the respective minimum or maximum and treated as valid values.

Assumption: The reason for this decision should be provided here.

ASW Loigc

Altitude Determination

[2.]1
The decision to power on the DOI will be based on an estimate of the aircraft1s(↑true altitude 4).

> Assumption: The aircraft will always have a single true altitude and the environment of the altitude switch will have the capability to provide the information necessary to obtain a reasonable estimate of that altitude.

[2.2]
The algorithm for determining the altitude is likely to change, depending on the safety analysis. Four alternative agorithms are provided here and may be implemented in different products, depending on the specific use of the ASW (↑. 5). The initial product will use the lowest valid altitude.

[2.2.]1
Lwest d lAitude: T he altitude is taken as the lowest valid 3.(↓altitude reported altitude). If no valid altitude is available, the altitude will be assumed to be undeterminable.

> Assumption: This algorithm will be used when the ASW is used to indicate that the aircraft has descended below a threshold altitude. 1The use of this algorithm is most appropriate when) reliability th(eis more important than safety ction of turning on the DOI is not safety-related) *or* (2) turning on the DOI is a safety-increasing action for the aircraft as a whole.

[2.2.2]
HVighest d lAitude: T he altitude is taken as the highest valid

(↓Naltitude reported *ot implemented in current product*). If no valid altitude is reported, the altitude will be assumed to be undeterminable.

> Assumption: This algorithm will be used when the ASW is used to indicate that the aircraft has ascended above a threshold altitude. The use of this algorithm is most appropriate when reliability is the(e a more important than safety ction of turning on the DOI is not safety-related) or turning on the DOI is a safety-increasing action for the aircraft as a whole.

[2.2.3]
aMjority dlAltitude: Whether the aircraft is below or above the threshold will be determined by a magjrity vote of the valid altitudes reported. If there is no magjrity, then the altitude will be assumed to (↓Nbe indeterminate *ot implemented in current product*).

> Assumption: This algorithm could be used for either ascending above or descending below a threshold altitude. The use of this algorithm is most appropriate when turning on the DOI is safety-decreasing and inadvertent operation of the DOI is unsafe.

[2.2.]4
Most Conservative algorithm: T he altitude will be determinable only if all altimeters agreed that the aircraft is below or above the threshold altitude. There must be at least N valid altitudes reported or the altitude is treated (↓Nas indeterminate *ot implemented in current product*).

> Assumption: This algorithm will be used under the conditions that the operation of the ASW and turning on the DOI is safety-decreasing and that turning on the DOI under the wrong conditions could endanger the continued safe flight of the aircraft. In this case, safety is more important than reliability.

[2.3]
Reported altitude information will be considered to be obsolete after AGE seconds (↑1.1 6).

Turning on the DOI

The power-on signal should remain on once the aircraft passes through the threshold until the ASW receives an indication that the DOI that it has turned on, even if the aircraft crosses the threshold again.

Assumption: This requirement provides hysteresis so that the DOI is not continually turned on and off if the aircraft flies right at the threshold altitude.

Fault Detection

[2.]4
Three types of faults shall be detec1te(d↑ 6): an internal fault, the failure of the DOI to turn on, and the failure of the altimeters.

[2.4.5]
Internal failures refers to internal hardware faults. The faults to be detected will be determined by the engineers.

[2.4.6]
Detected faults will be reported by failing to strobe the watchdog timer (1↑. 7).

Inhibiting and Resetting ASW Operation

I(nhibit ↑1.9)

[2.5]
When the inhibit is on, the ASW shall not issue any commands to power on the DOI.

[2.6]
When the inhibit is on, the ASW shall not indicate a fault.

[2.7]
All other ASW functions shall be unaffected by the inhibit signal.

Re(set ↑1.8)

[2.8]
The reset signal shall return the ASW to its initial state.

[2.9]
If the ASW operation is inhibited when the reset signal is received, the ASW shall be returned to its initial state but the inhibit on operation will remain until the pilot cancels it.

Rationale: There may be reasons for the pilot to reset the ASW while still wanting its operation to be inhibited. If the reset causes an indirect mode transition from inhibited to not inhibited, there is a possibility for mode confusion (the pilot thinks operation is inhibited when it is not). To avoid this possibility, the pilot must explicitly turn off the inhibit independently from the reset switch.

Pilot–A SW Iarfe ce

Controls

The reset and inhibit controls are 2(→independent x). When the inhibit is removed, the state of the ASW is affected only in so much as reporting faults and turning on the DOI is again allowed.

A reset does not affect the status of the inhibit, which will remain in the state in which it was when the reset is pushed.

Displays

A fault indicator light will illuminate when a fault is detected. Responsibility for turning this light on and off lies outside the altitude switch.

Pilot Tasks and Procedures

Reset and inhibit are independent. To turn off the inhibit, the pilot must push the inhibit. Reset will not reverse the inhibit.

Verification and Validation

The simplicity of the algorithms may preclude the need for rigorous scientific validation at this level.

Verification Test plan System test must include ...

Level 3

Blackbox Bemba

Communication and Interface

Input messages to the ASW contain the altitude and status from an Analog Radio Altimeter, the alitude and status from two Digital Radio Altimeters, inhibit and reset signals, and the DOI status.

One output message contains a power-on signal to the DOI and a second output message results in the strobing of a watchdog timer.

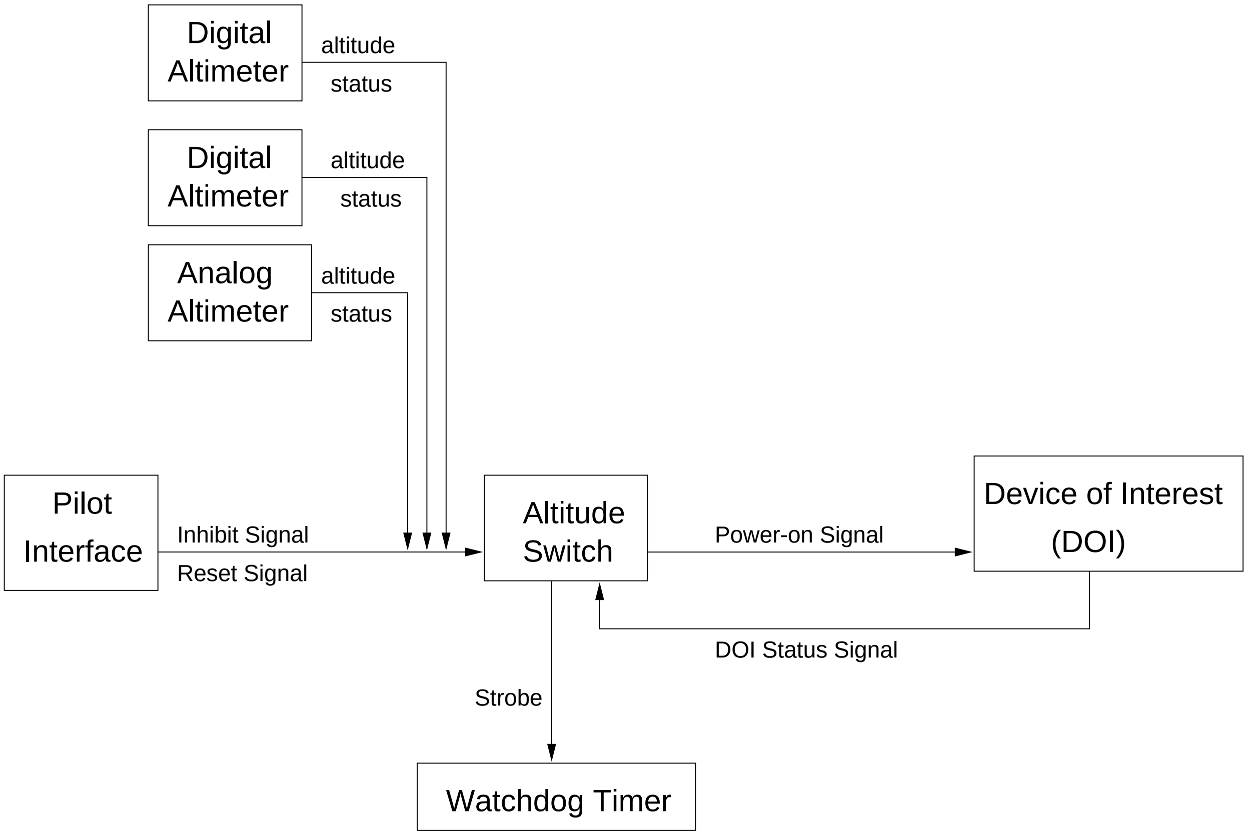


Figure 2.2:Communication Between Components

Message Contents

Digital Altimeter →ASW:

1. **Status signal** denoting whether the altitude data has failed, does not exist, is normal, or is test data.
2. **Altitude Data:** Range will be from -20 to 2500 feet AGL with a precision of 0.1 feet. Values below -20 will be treated as an altitude valid value of -20 feet and those above 2500 will be treated as a value of 2500 feet.

Analog Altimeter →ASW:

1. **status signal** denoting whether the analog altitude data is *valid* or *invalid* (????).
2. **Altitude Data** will have a value denoting that the aircraft is *above* or *below* the threshold. (??).

Cockpit Interface →ASW

1. **Inhibit** signal (on or off)
2. Reset signal (T or F)

DOI →ASW: (on status signal)

ASW →DOE: Power-on command

ASW →Watchdog Timer: Strobe

Flightwc Beaiba Requiremesnt

gebtspec This section would contain the pilot tasks and procedures. These mi
RSFTBLoperational task models.

Pilot-ASW Interface

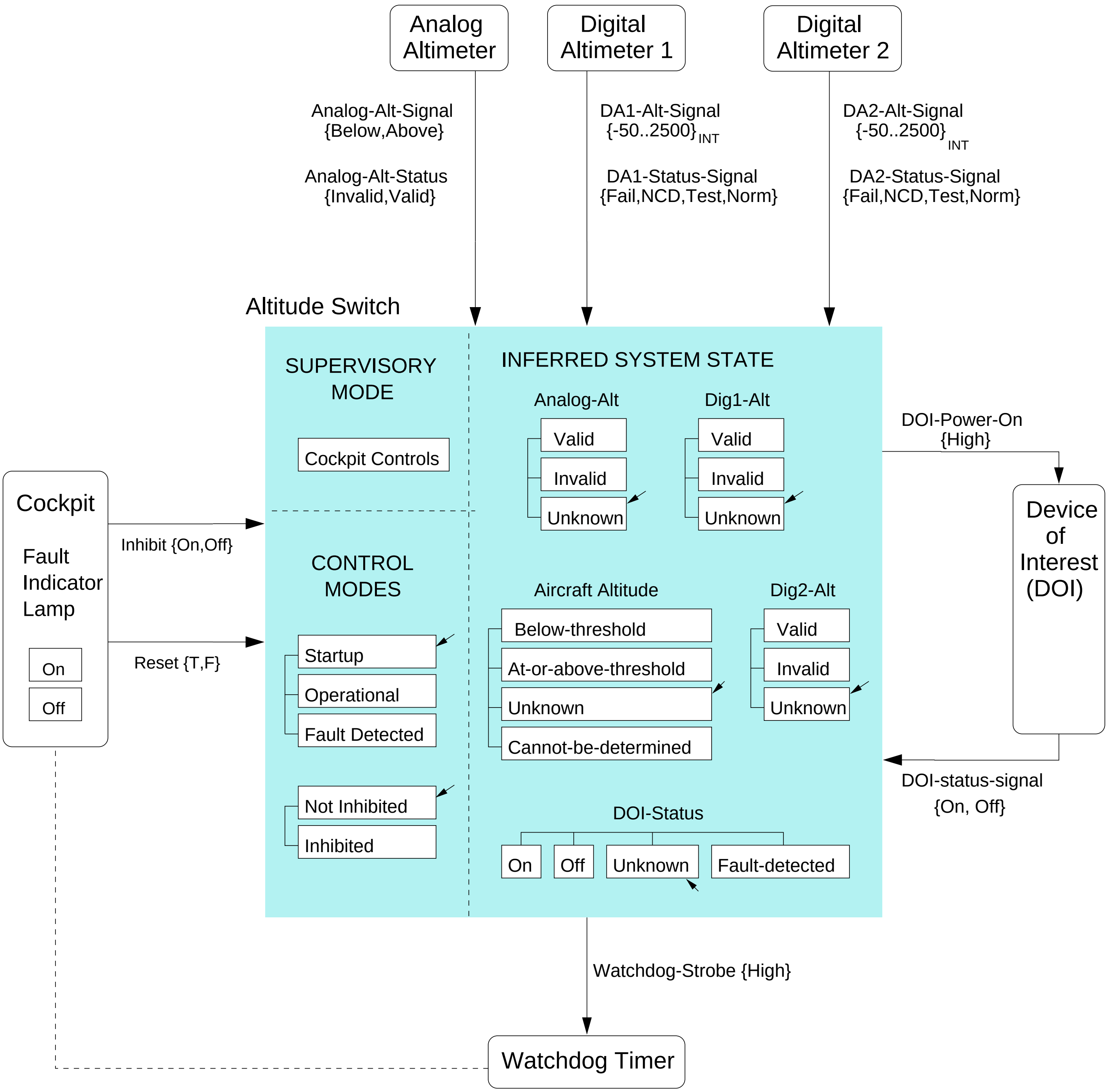
Controls

The pilot shall have a reset switch and an inhibit button. The inhibit button will light up to indicate that the ASW has been inhibited.

Displays

A fault indicator lamp will light in the cockpit to indicate that the watchdog timer has timed out and a fault has occurred in the altitude switch.

ASW Blackxb Beinoa


Analog Altimeter
Digital Altimeter 1
Digital Altimeter 2
Analog-Alt-Signal {Below,Above}
Analog-Alt-Status {Invalid,Valid}
DA1-Alt-Signal {-50..2500}INT
DA1-Status-Signal {Fail,NCD,Test,Norm}
DA2-Alt-Signal {-50..2500}INT
DA2-Status-Signal {Fail,NCD,Test,Norm}
Altitude Switch
SUPERVISORY MODE
Cockpit Controls
CONTROL MODES
Startup
Operational
Fault Detected
Not Inhibited
Inhibited
INFERRED SYSTEM STATE
Analog-Alt
Valid
Invalid
Unknown
Dig1-Alt
Valid
Invalid
Unknown
Aircraft Altitude
Below-threshold
At-or-above-threshold
Unknown
Cannot-be-determined
Dig2-Alt
Valid
Invalid
Unknown
DOI-Status
On
Off
Unknown
Fault-detected
Cockpit
Fault Indicator Lamp
On
Off
Inhibit {On,Off}
Reset {T,F}
DOI-Power-On {High}
Device of Interest (DOI)
DOI-status-signal {On, Off}
Watchdog-Strobe {High}
Watchdog Timer

Output Command

DOI-Power-On

Destination: DOI

Acceptable Values: {high}

Initiation Delay: 0 milliseconds

Completion Deadline: 50 milliseconds

Exception-Handling: (What to do if cannot issue command within deadline time)

Feedback Information:

Variables: DOI-status-signal

Values: high (on)

Relationship: Should be on if ASW sent signal to turn on

Min. time (latency): 2 seconds

Max. time: 4 seconds

Exception Handling: DOI-Status changed to Fault-Detected

Reversed By: Turned off by some other component or components. Do not know which ones.

Comments: I am assuming that if we do not know if the DOI is on, it is better to turn it on again, i.e., that the reason for the restriction is simply hysteresis and not possible damage to the device.

This product in the family will turn on the DOE only when the aircraft descends below the threshold altitude. Only this page needs to change for a product in the family that is triggered by rising above the threshold.

References: ↑ ↓

CONTENTS

= discrete signal on line PWR set to high

TRIGGERING CONDITION

Control Mode	Operational	T
	Not Inhibited	T
State Values	DOI-Status = On	F
	Altitude = Below-threshhold	T
	Prev(Altitude) = At-or-above-threshold	T

Output Command

Watchdog-Strobe

Destination: Watchdog Timer

Acceptable Values: high signal (on)

Min-Time-Between-Outputs: 0

Max-Time-Between-Outputs: 200_{PERIOD} msec

Exception-Handling:

Feedback Information: None

Reversed By: Not necessary

Comments:

References:

CONTENTS

= High signal on line WDT

TRIGGERING CONDITION

Operating Mode	Operational	T		
	Startup		T	
	Inhibited			T
State Values	Time <= (Time sent Watchdog Strobe) + 200 msec	T		T
	DOI-Status = Fault-detected	F		
	Time >= (Time entered Altitude.Cannot-be-determined) + 2 $_{DL}$ secs.	F		

Operating Mode

ASW

Description:

Comments: No information about how an internal fault is detected, what types detected, etc.

References:

Appears in: DOI-power-on, Watchdog-strobe

DEFINITION

= Startup

Powerup	T

= Operational

Controls.Reset = T	T			
Startup		T	T	T
Analog-Alt = Valid		T		
Dig-Alt1 = Valid			T	
Dig-Alt2 = Valid				T

= Internal-Fault-Detected

Internal-fault -detected	T	
Startup		T
Time >= Time entered Startup + 3 secs		T

.

State Value

DOI-Status

Obsolescence: 2 seconds

Exception-Handling: Goes into unknown state

Description:

Comments: There is nothing in the requirements that says what to do if a power-off message is sent and no status message is received from the DOI within 2 seconds. I decided it was safest to have this indicate a possible fault so the watchdog will time out and light the fault indicator lamp in the cockpit.

References:

Appears in: DOI-Power-On, Watchdog-Strobe

DEFINITION

= On

DOI-status-signal = On	T

= Off

DOI-status-signal = Off	T

= Unknown

Powerup	T		
Controls.Reset = T		T	
DOI-status-signal = obsolete			T

= Fault-Detected

Time >= (Time sent DOI-Power-On Message) + 2 seconds	T	T
DOI-status-signal = Off	T	
Time > Time received DOI-status-signal + 2 seconds		T

Column 1: Sent power on message but DOI did not turn on
Column 2: Sent power on message but never got feedback

State Value

Altitude

Obsolescence: 2 seconds

Exception-Handling: Because the altitude-status-signals change to obsolete after 2 seconds, altitude will change to Unknown if all input signals are lost for 2 seconds.

Description:

Comments:

References:

Appears in: DOI-Power-On

DEFINITION

= Unknown

Powerup	T		
Controls.Reset		T	
Analog-ALT = Unknown			T
Dig-Alt1 = Unknown			T
Dig-Alt2 = Unknown			T

= Below-threshold

Analog-Valid-and-Below	T		
Dig1-Valid-and-Below		T	
Dig2-Valid-and-Below			T

= At-or-above-threshold

Analog-Valid-and-Above	T	T	T	F	T	F	F
Dig1-Valid-and-Above	T	T	F	T	F	T	F
Dig2-Valid-and-Above	T	F	T	T	F	F	T

= Cannot-be-determined

Analog-Alt = Invalid	T
Dig-Alt1 = Invalid	T
Dig-Alt2 = Invalid	T

State Value

Analog-Alt

Obsolescence: 2 seconds

Exception-Handling: Will change to unknown when analog-alt-signal becomes obsolete (more than 2 seconds elapse since last message from Analog Altimeter)

Description:

Comments:

References:

Appears in: Altitude

DEFINITION

= Valid

Analog-Alt-Status = Valid	T

= Invalid

Analog-Alt-Status = Invalid	T

= Unknown

Analog-Alt-Status = Obsolete	T		
Powerup		T	
Controls.Reset = T			T

State Value

Dig-Alt1

Obsolescence: 2 seconds

Exception-Handling: Will change to unknown when DA1-Status-Signal becomes obsolete (more than two seconds elapse since last mesage from Digital Altimeter 1).

Description:

Comments:

References:

Appears in: Altitude

DEFINITION

= Valid

DA1-Status-Signal = Norm	T

= Invalid

DA1-Status-Signal = {Fail, NCD, Test}	T

= Unknown

DA1-Status-Signal = Obsolete	T		
Powerup		T	
Controls.Reset = T			T

State Value

Dig-Alt2

Obsolescence: 2 seconds

Exception-Handling: Will change to unknown when DA2-Status-Signal becomes obsolete (more than two seconds elapse since last mesage from Digital Altimeter 2).

Description:

Comments:

References:

Appears in: Altitude

DEFINITION

= Valid

DA2-Status-Signal = Norm	T

= Invalid

DA2-Status-Signal = {Fail, NCD, Test}	T

= Unknown

DA2-Status-Signal = Obsolete	T		
Powerup		T	
Controls.Reset = T			T

Input Value

DOI-Status-Signal

Source: DOI

Type: Enumerated

Possible Values (Expected Range): {On, Off}

Exception-Handling:

Arrival Rate (Load): ??

Min-Time-Between-Inputs:
Max-Time-Between-Inputs:

Obsolescence: 2 seconds

Exception-Handling: Assumes value Obsolete

Description:

Comments:

References:

Appears in: DOI-status

DEFINITION

= FIELD (Status in DOI-Status-Message)

Receive DOI-Status-Message FROM DOI	T

= PREV (DOI-Status-Signal)

Receive DOI-Status-Message FROM DOI	F
Time <= Time (DOI-Status-Message arrived) + 2 seconds	T

= Obsolete

Receive DOI-Status-Message FROM DOI	F	
Time > Time (DOI-Status-Message arrived) + 2 seconds	T	
Powerup		T

Input Value

Analog-Alt-Status

Source: Analog Altimeter

Type: Enumerated

Possible Values (Expected Range): {Invalid, Valid}

Exception-Handling:

Arrival Rate (Load): ??

Min-Time-Between-Inputs:
Max-Time-Between-Inputs:

Obsolescence: 2 seconds

Exception-Handling: Assumes value Obsolete

Description:

Comments:

References:

Appears in: Analog-Alt

DEFINITION

= FIELD (Status in Analog-Alt-Message)

Receive Analog-Alt-Message FROM Analog-Altimeter	T

= PREV (Analog-Alt-Status)

Receive Analog-Alt-Message FROM Analog-Altimeter	F
Time <= Time (Analog-Alt-Message arrived) + 2 seconds	T

= Obsolete

Receive Analog-Alt-Message FROM Analog-Altimeter	F	
Time > Time (Analog-Alt-Message arrived) + 2 seconds	T	
Startup		T

Input Value

Analog-Alt-Signal

Source: Analog Altimeter

Type: Enumerated

Possible Values (Expected Range): {Above, Below}

Exception-Handling:

Arrival Rate (Load): ??

Min-Time-Between-Inputs:
Max-Time-Between-Inputs:

Obsolescence: 2 seconds

Exception-Handling: Assumes value Obsolete

Description:

Comments:

References:

Appears in: Altitude

DEFINITION

= FIELD (Altitude in Analog-Alt-Message)

Receive Analog-Alt-Message FROM Analog-Altimeter	T

= PREV (Analog-Alt-Signal)

Receive Analog-Alt-Message FROM Analog-Altimeter	F
Time <= Time (Analog-Alt-Message arrived) + 2 seconds	T

= Obsolete

Receive Analog-Alt-Message FROM Analog-Altimeter	F	
Time > Time (Analog-Alt-Message arrived) + 2 seconds	T	
Powerup		T

Input Value

DA1-Status-Signal

Source: Digital Altimeter 1

Type: Enumerated

Possible Values (Expected Range): {Fail, NCD, Test, Norm}

Exception-Handling:

Arrival Rate (Load): ??

Min-Time-Between-Inputs:
Max-Time-Between-Inputs:

Obsolescence:2 seconds

Exception-Handling: Assumes value Obsolete

Description:

Comments: Four possible values can be sent signifying Failure Warning, No Computed Data, Functional Test, and Normal Operation.

References:

Appears in: Dig-Alt1

DEFINITION

= FIELD (Status in DA1-Message)

Receive DA1-Message FROM Digital-Altimeter-1	T

= PREV (DA1-Status-Signal)

Receive DA1-Message FROM Digital-Altimeter-1	F
Time <= Time (DA1-Message arrived) + 2 seconds	T

= Obsolete

Receive DA1-Message FROM Digital-Altimeter-1	F	
Time > Time (DA1-Message arrived) + 2 seconds	T	
Powerup		T

Input Value

DA1-Alt-Signal

Source: Digital Altimeter 1

Type: integer

Possible Values (Expected Range): -20..2500

Exception-Handling: Values below -20 are treated as -20 and values above 2500 as 2500

Units: ??

Granularity: ??

Arrival Rate (Load): ??

Min-Time-Between-Inputs:
Max-Time-Between-Inputs:

Obsolescence: 2 seconds

Exception-Handling:

Description:

Comments:

References:

Appears in: Altitude

DEFINITION

= FIELD (Altitude in DA1-Message)

Receive DA1-Message FROM Digital-altimeter-1	T

= PREV (DA1-Alt-Signal)

Receive DA1-Message FROM Digital-altimeter-1	F

= Obsolete

Receive DA1-Message FROM Digital-Altimeter-1	F	
Time > Time (DA1-Message arrived) + 2 seconds	T	
Powerup		T

Input Value

DA2-Status-Signal

Source: Digital Altimeter 1

Type: Enumerated

Possible Values (Expected Range): {Fail, NCD, Test, Norm}

Exception-Handling:

Arrival Rate (Load): ??

Min-Time-Between-Inputs:
Max-Time-Between-Inputs:

Obsolescence: 2 seconds

Exception-Handling: Assumes value Obsolete

Description:

Comments: Four possible values can be sent signifying Failure Warning, No Computed Data, Functional Test, and Normal Operation.

References:

Appears in: Dig-Alt2

DEFINITION

= FIELD (Status in DA2-Message)

Receive DA2-Message FROM Digital-Altimeter-2	T

= PREV (Dig2-Status-Signal)

Receive DA2-Message FROM Digital-Altimeter-2	F
Time <= Time (DA2-Message arrived) + 2 seconds	T

= Obsolete

Receive DA2-Message FROM Digital-Altimeter-2	F	
Time > Time (DA2-Message arrived) + 2 seconds	T	
Powerup		T

Input Value

DA2-Alt-Signal

Source: Digital Altimeter 2

Type: integer

Possible Values (Expected Range): -20..2500

Exception-Handling: Values below -20 are treated as -20 and values above 2500 as 2500

Units: ??

Granularity: ??

Arrival Rate (Load): ??

Min-Time-Between-Inputs:
Max-Time-Between-Inputs:

Obsolescence: 2 seconds

Exception-Handling:

Description:

Comments:

References:

Appears in: Altitude

DEFINITION

= FIELD (Altitude in DA2-Message)

Receive DA2-Message FROM Digital-altimeter-2	T

= PREV (DA2-Alt-Signal)

Receive DA2-Message FROM Digital-altimeter-2	F

= Obsolete

Receive DA2-Message FROM Digital-Altimeter-2	F	
Time > Time (DA2-Message arrived) + 2 seconds	T	
Powerup		T

Control Input

Inhibit

Source: Cockpit Inibit Button

Type: Enumerated

Possible Values (Expected Range): {on, off}

Arrival Rate (Load):

Min-Time-Between-Inputs:
Max-Time-Between-Inputs:

Obsolescence: None

Description:

Comments:

References:

Appears in: ASW

DEFINITION

= FIELD (Value in Inhibit-Message)

Receive Inhibit-Message from Cockpit	T

= PREV (Inhibit)

Receive Inhibit-Message from Cockpit	F

= Obsolete

Powerup	T

Control Input

Reset

Source: Cockpit Reset Button

Type: Signal

Possible Values (Expected Range): {High}

Arrival Rate (Load):

Min-Time-Between-Inputs:
Max-Time-Between-Inputs:

Obsolescence: Not applicable (lasts only one step)

Description:

Comments:

References:

Appears in: Analog-Alt, DOI-Status, Altitude, Analog.Alt, Dig-Alt1, Dig-Alt2, ASW

DEFINITION

= True

Receive Inhibit Signal	T

= False

Prev (Reset) = True	T	
Powerup		T

Macro

Analog-Valid-and-Below

Description:

Comments:

References:

Appears in: Altitude2

DEFINITION

Analog-alt = Valid	T
Analog-Alt-Signal = below	T

Macro

Analog-Valid-and-Above

Description:

Comments:

References:

Appears in: Altitude2

DEFINITION

Analog-alt = Valid	T
Analog-Alt-Signal = above	T

Macro

Dig1-Valid-and-Below

Description:

Comments:

References:

Appears in: Altitude2

DEFINITION

Dig1-alt = Valid	T
DA1-Alt-Signal < 2000$_{\text{THRES}}$	T

Macro

Dig1-Valid-and-Above

Description:

Comments:

References:

Appears in: Altitude2

DEFINITION

Dig-Alt1 = Valid	T
DA1-Alt-Signal >= 2000$_{\text{THRES}}$	T

Macro

Dig2-Valid-and-Below

Description:

Comments:

References:

Appears in: Altitude2

DEFINITION

Dig2-alt = Valid	T
DA2-Alt-Signal < 2000_{THRES}	T

Macro

Dig2-Valid-and-Above

Description:

Comments:

References:

Appears in: Altitude2

DEFINITION

Dig-Alt2 = Valid	T
DA2-Alt-Signal >= 2000_{THRES}	T

Verification and Validation

Test Plan

Level 4
Design Representation

Environment

Physical Interfaces

Inputs

Analog Radio Altimeter Inputs

The representation of the radio altitude will be in the form of a single bit, i.e., bit 0Aoz Register 3. in bit 0 will denote the altitude is aboe the threshold and a rcaft is bbeilto w0 twhiell dtehnreosthoeld. air

The altitude status signal will be put into bit 1eoAf Rzegister 3. aintdhiat the alvnaanlisog altitude ac iavlid while a one will indi te the avlatlidt.ude signal is

Digital Radio Altimeter Inputs

The digital altimeter word will be read fromy the bus and put into memor address ... The data wilbl ibte 2 stored form 17 . The altitude will be in bi1t3s 29 with the sign in bit 29. The digital altitude status wil be in b3i0ts 31 with the following interpretation

31	bf 30	**Values**	**Meaning**
0	0	FAIL	Warining
0	1	NCD	NoCotmaputed D
1	0	TEST	Functional Test
1	1	NORM	NOpormal eration

DOItaStatus

A single bit where 0b mDeOaIns ot the p owered on while 1b mDeOaIns the is powered on.

Inhibit

A single bit where 0b means do not inhibit the ASW while 1b means to inhibit the ASW.

Reset

The reset signal shall be a single bit with the value 0b denoting not to reset the ASW and 1b meaning that ASW should be reset.

Outputs

DOI Power

One bit with the meaning TBD

Watchdog Timer

The watchdog timer message shall consist of a single bit with 0b meaning do not strobe the watchdog timer and 1b denoting that the watchdog timer should be strobed.

Pilot A SW Interface Design

Description of physical design, placement, etc.

Software Design Specification

Hardware Design Specification

Verification and Validation

Level 5
Physical Implementation

Aircraft Flight Manual Entries

Training

Physical Interface

The implemented RNC using an 429 of the ARINC-bus are de the ARINC- 429 standard information specifications ord ARINC. This se a SWt Chai

ARINC- words are 32 bits long. eed, each bit is presented in 83 ± 2.5% using a 12 , 60 ± 2.5% using a 14. 5 Mhz clock bit half of the bit n. The .4 (riod 5% sec) to present a signal high or low half. The se 5% sec)). The interword gap is at least four bit times (333 sec)

Each bit is presented through two lines labeled line 1 and line 0. A 1b is presented as a signal high on line 1 and a signal low on line 0. A 0b is presented as a signal low on line 1 and high on line 0. b oth lines indi tes ( ) or interword gap high or low signal on both lines should not o

Line 0	**Line 1**	*Meaning*
Null	Null	No Data
Hi	Low	0
Low	Hi	1

The ARINC words with o el is

32	31..30	29	28..13	12	11	10..9	8..1
P	SM	S	DATA	PAD	FTI	SDI	LABEL

: hdels for the RT

P	Bit 32 is set to ensure odd parity
SM	Bits 31 contain the Status matrix (SM) : are interpreted as | 31 | 30 | Meaning | | 0 | 0 | Failure Warning | | 0 | 1 | No Computed Data | | 1 | 0 | Functional Test | | 1 | 1 | Normal Operation |
S	Bit 29 contains the sign (S) is interpreted as 0 for a positi altitude and 1 for a negati altitude.
DATA	Bits 28 contain the altitude as en complement fraction of 8192 feet, where the decimal point is to the left of bit 28. Note that a 1 in bit 16 thus represents an actual value of 1 and a 1 in bit 15 represents a ½.
LABEL	Bits 8 contain the octal label (164 0011 10)b

Inputs

Analog Radio Altimeter Inputs

The analog radio altimeter provides a scaled estimate of the altitude as a voltage level.

The analog radio altitude shall be converted by AAW hardware into a discrete AAA signal on line with a high indicating that the aircraft is below the ASW threshold altitude. The hardware shall also generate a discrete AAV with a high logic indicating that the analog altitude is valid.

[A wiring diagram would be helpful here.]

Digital Radio Altimeter Inputs

The 2 $_{DAnum}$ digital radio altitudes shall be received on ARINC $_{DAnum}$ A low speed buses (pins P32) shall be on DA and bus 2 shall be on DA2 lines and ARINC words shall be assembled by the software-in ARINC 429 words with octal label 164 should be accepted.

If an acceptable altitude is not seen on the bus for more than a RECSH number of seconds, the bus shall be treated as inactive

The digital altimeter reports altitude as a signed integer that represents a fran of 8.192 feet.

DOItSatus

ThDOItatus shall b ecedre STareades signal on line - with high indicating thLatOIphe owered on.

Inbih t

The inhibit signal shall be recedsignal dis line 1Hhigh ASWiting that the should be inhibited.

Reset

edThe reset signal shall be re reast asignal on liSe R withigh -indicating thASWhe should be reset to its initial state.

Outputs

DOI Powver

ThASW shall turn power on to thDOI retesetting the line PWR to high.

WatchTiger

(Ubown

Software

Verification

TBD

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Glossary

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