

Detailed Design Description (DDD)

Terma case

Document Identification: F-DDD-2014-V1

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1 Revision history

Date	Ver. No	Author	Contact	Description
17-Feb-2014	1.0	-	-	Initial version

2 Stakeholders

Name	Role	Contact
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3 Subcontracter Information

A subcontractor will be used to develop and manufacture the pod and any additional climate control protection as described in Requirement 29 and 41 in the document F-SRS-2014-V1 . The subcontractor will be Group G.

4 Scope

4.1 Identification

4.2 System-overview

The goal of the system is to protect the aircraft from enemy incoming missiles by deploying flares and chaffs. It also provides threat information to the information computer, which interacts with the pilot. It is possible for a technician to load the system with chaffs and flares. During the preparation phase before the missions, the system informs the technicians about the current amount of chaffs and flares present on the aircraft.

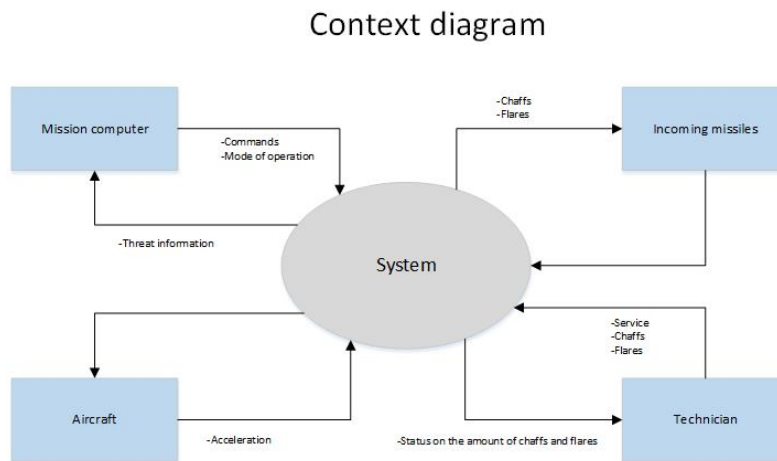


Figure 1: Context diagram

4.3 Document overview

5 System-wide design decisions

System-wide design decisions for the system were made as part of the preliminary design effort. The team evaluated potential system-wide design issues and conducted analysis on how the system and its components would behave under different environmental conditions. The design focuses on the different states the systems has, the hardware and software that will be a part of the aircraft.

States of the system

The system will have different states depending on what is set as input to the cockpit unit by the mission computer. The system has three distinct states:

- Automatic: The system automatically detects and deploys the payload without the pilots interaction
- Semi-automatic: The system detects the enemy missile but it asks for the pilots consent before deploying the payload

- Manual: The pilot has to select the desired payload and deploy it himself.

Safety lock to prevent dispensing on ground

The system has a built in safety feature which will prevent deployment of the payload when the plane is not airborne. This will be possible by requesting information about the actual altitude of the aircraft from the mission computer.

Detection and action upon incoming threats

We are using the missile warning system (MWS) to detect incoming missiles. Incoming missiles are considered an input in this design where the payload deployment system will respond to this input by deploying the payload if the missile is close enough to the aircraft. The payload is located in the pod that is mounted on the aircraft.

Communicating with the pilot

The cockpit unit is responsible for the communication between the pilot and the system. This communication uses the mission computer as a link and the communication will therefore be purely digital.

Loading chaffs and flares

The payloads or more specific: chaffs and flares, has to be loaded manually to the magazines of the pod before take-off. A flap is present on the pod through which the chaffs and flares can be loaded by a technician.

Physical characteristics of relevant components:

Cockpit unit

The cockpit control unit will be located in the cockpit of the aircraft. The device will be as compact as possible by the current technology in order to allow more space for other devices. The role of the cockpit control unit is to be the bridge between the mission computer and the missile warning system.

Pod

The physical dimensions of the pod cannot exceed $0.5 \times 0.5 \times 5$ meter. The pod will have the same color as the rest of the aircraft in order to blend in with the environment. The pod will have a correct aerodynamic shape in such a way that it will create as little drag as possible so it will have minimum effect on the aircrafts speed. Moreover, the weight of the pod cannot exceed 270 kg. The pod contains three different components:

- Dispenser
- Magazines
- MWS

This means that the total size of those three components cannot exceed neither the inner dimensions nor the total weight of the pod.

6 System architectural design

6.1 System components

6.1.1 Component overview

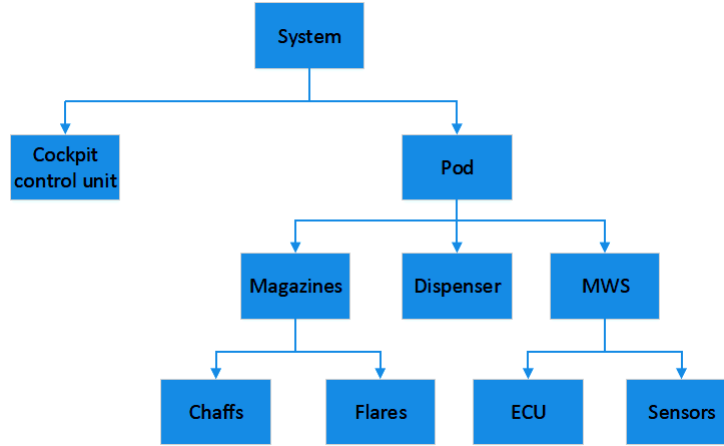


Figure 2: Overview of components

- Cockpit Control Unit (ID: CCU)
- Pod (ID: POD)
 - Dispenser (ID: DIS)
 - Magazines (ID: MAG)
- MWS (ID: MWS)
 - ECU (ID: ECU)
 - Sensors (ID: SEN)

6.1.2 Detailed component description

This section describes all system components and their connection to the requirements.

Cockpit Control Unit

The Cockpit Control Unit (CCU) shall provide all necessary data to the aircraft mission computer.

- The CCU is responsible for switching between the three defined modes when receiving the respective signal from the aircraft mission computer (Req. No. 1-4).
- The CCU shall be able to turn power ON and OFF for the dispensing system and the MWS (Req. No. 7).
- The system shall be able to erase sensitive data upon input from a discrete zeroize signal from aircraft and the zeroize signal shall be received by the CCU (Req. No. 25-26).

- The system shall provide the aircraft mission computer with status information and built-in test results (Req. No. 15).
- The system status on individual LRU level shall be provided by cockpit unit (Req. No. 17).

POD

The pod is a detachable compartment on an aircraft for carrying chaffs and flares. The pod also holds the dispenser, magazines and the MWS.

- The pod structure must be functional when exposed to steady state acceleration levels of 4g forward, 2.5g backward, 22g upward or 10g downward.
- The weight of the pod cannot exceed 270 kg (Req. No. 28).
- The pod shall be operational at temperatures of maximum 134 degree Celcius on outer skin and 152 degree Celcius on leading edge for maximum 3 minutes (Req. No. 29).
- The pod shall be operational at temperatures of maximum 95 degrees Celcius on outer skin and 152 degrees Celcius on leading edge for a maximum of 25 minutes (Req. No. 41).
- The physical dimensions of the pod cannot exceed 0.5×0.5×5 meter (Req. No. 35).

Dispenser

The dispenser is the mechanism in which the magazines are installed.

- The dispenser shall be able to dispense forwards, downwards and sideways (Req. No. 6).
- The system shall be able to dispense a minimum of two payloads within 0.1 sec (Req. No. 8).
- The system shall be able to dispense a pattern of payloads programmable by the customer (Req. No. 9).

Magazines

The magazines contain the chaffs and flares.

- The pod shall include eight standard magazines (Req. No. 5).
- The magazines shall be stored at no lower than -10 degrees Celcius and no higher than 70 degrees Celcius (Req. No. 26).

Chaffs and flares

The chaffs and flares are the payload of the system. They are to be dispensed from the magazines.

- The aircraft has to be loaded with the payloads before takeoff (Req. No. 36).

Missile Warning System

The missile warning system (MWS) consists of an Electronic Control Unit and six sensors.

- The aircraft has to be loaded with the payloads before takeoff (Req. No. 36).

Electronic Control Unit

- The Electronic Control Unit (ECU) provides threat information in inertial format and the direction of the threat is relative to north (Req. No. 14).

Sensors

The sensors are responsible for detecting incoming missiles (threats).

6.2 Concept of execution

Figure. 3 provides an overview of the signals and protocols used in the system. The aircraft communicates with the cockpit unit using MIL-STD-1553-B. The same standard is used between the cockpit unit and the missile warning system (MWS).

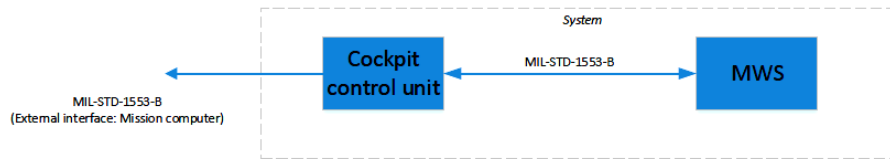


Figure 3: System signal overview

Figure. 4 provides an overview of the components comprising the system. The system has two major parts; the cockpit unit and the pod. The pod contains the MWS and components for handling and dispensing the payload.

6.3 Interface design

There are different ways in which a system interact with its environment and the other systems. The interaction happening at the various boundaries are called the system's external interfaces. The boundaries between individual components inside the system are called system's internal interfaces.

The external and internal identification can fall into different types such as: electrical, mechanical, real-time data transfer and storage-and-retrieval of data. All the interfaces illustrated in figure. 5.

6.3.1 External interfaces

External interfaces are the interaction between the missile and the sensors, chaffs/flares and the dispensers, cockpit control unit and the aircraft computer, and lastly the pilot and the computer.

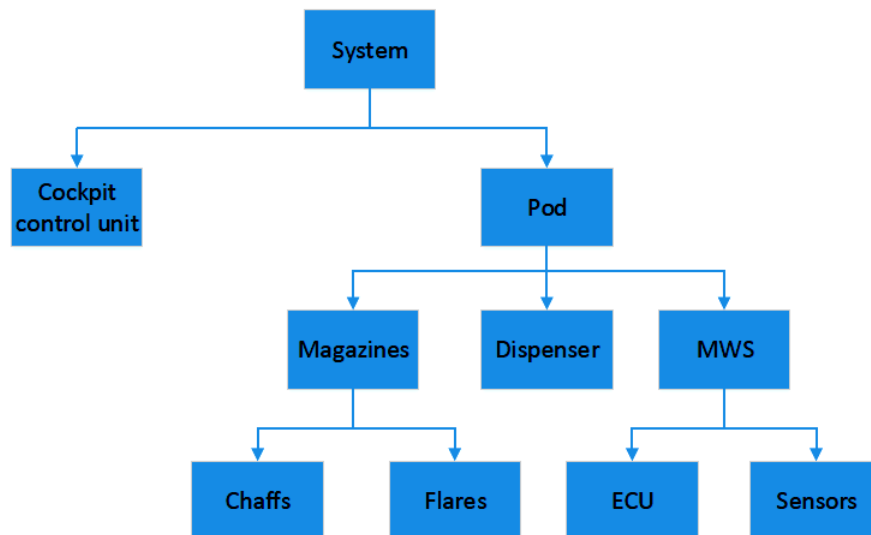


Figure 4: Hierarchical overview of system

- Interface identification and diagrams.
The system interfaces listed and identified on table. 1.
- Project-unique identifier of interface
The unique identification listed under table. 2.

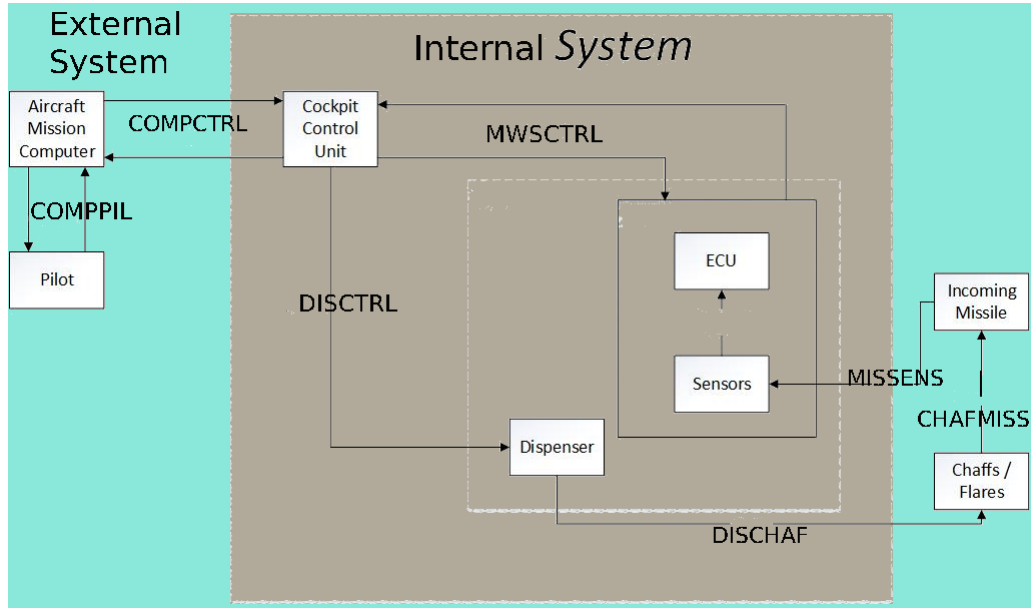


Figure 5: Signal Flow Diagram

Table 1: External interface units

Interface name	Identification	Endpoint A	Endpoint B	Standard
Computer Pilot interaction	E-IF-COMPPIL	Mission computer/ Pilot	Pilot/Mission computer	
Computer control	E-IF-COMPCTRL	Cockpit unit/ Mission computer	Mission computer/Cockpit unit	
Missile sensor input	E-IF-MISSENS	Cockpit unit	MWS	
Chaffs/flares missile disturbance	E-IF-CHAFMISS	Chaffs and flares	Incoming missile	
Dispenser Chaffs control	E-IF-DISCHAF	Dispenser	Chaffs and flares	

Table 2: External Interface Elements

Type	Interaction medium	data element	communication methods	protocols	physical compatibility
Incoming missile					
Chaffs and flares					
Aircraft Mission Computers					
System Operators					
Maintenance					
Support					
System Housing					
Shipping and handling					

6.3.2 Internal interfaces

This section describes the internal interfaces. The system interfaces can be seen on figure 5. The internal interfaces are listed in Table 3.

Table 3: Internal interfaces

Interface name	Identification	Endpoint A	Endpoint B	Standard
MWS Control	I-IF-MWSCTRL	Cockpit control unit	MWS	MIL-STD-1553-B
Dispenser Control	I-IF-DISCTRL	Cockpit control unit	Dispenser assembly	MIL-STD-1553-B
Pod power control	I-IF-PODPWR	Cockpit control unit	Dispenser assembly and MWS	N/A (electrical)

I-IF-MWSCTRL

This real-time data transfer interface connects the cockpit control unit and missile warning system (MWS) in the pod. The interface is used to extract threat information from the MWS. The interface also provides the MWS with aircraft navigation data. Communication on this interface is formatted as specified by MIL-STD-1553-B.

The data exchanged through this interface can be seen below:

- Threat data (MWS \rightarrow Cockpit control unit)
 - Direction relative to north
 - Size
 - Velocity
- Aircraft navigation data (Cockpit control unit \rightarrow MWS)
 - Altitude
 - Heading
 - Position data

The physical layer is defined by the MIL-STD-1553-B standard.

I-IF-DISCTRL

This real-time data transfer interface connects the cockpit control unit and the dispenser assembly in the pod. The interface is used to control payload dispensing. The data on this connection flows only from the cockpit control unit to the dispenser assembly. Communication on this interface is formatted as specified by MIL-STD-1553-B. Any data transaction on this interface is command to fire containing the following data:

- Direction to dispense (forwards, downwards, left, right) relative to aircraft heading.

- Payload selection (chaffs/flares)
- Pattern to fire

The physical layer is defined by the MIL-STD-1553-B standard.

I-IF-PODPWR

This electrical signal connects from the cockpit unit to the dispenser assembly and the MWS in the pod. When asserted, this signal enables power to the dispenser assembly and MWS. When not asserted, the power is off.

7 Requirements traceability

In this section the traceability matrix for the system is presented. From this it is possible to make the connection from the system requirements to the system design components.

Requirement No.	Components	Hierarchy level						
		1	2			3		
		Cockpit unit	Pod	Dispenser	MWS	Magazines	Chaffs	Flares
1		x						
2		x		x		x	x	x
3		x		x		x	x	x
4		x		x		x	x	x
5			x					
6			x					
7		x		x	x			
8				x				
9		x		x		x	x	x
11		x						
12		x			x			
13		x			x			
14		x						
15		x						
16		x						
17		x						
18		x			x			
20		x						
21		x	x					
22		x						
23		x		x				
24		x						
25		x						
26						x		
27			x					
28			x					
29			x					
30		x		x				
31					x			
35			x					
36			x			x	x	x
37		x						
38		x	x	x	x	x	x	x
39							x	x
40							x	x
41			x					

Figure 6: Traceability matrix