**Item Definition**

**Functional Safety Model of Conventional Cruise Control (CC) System**

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Table of Contents

[To-do list 60](#_Toc432510061)

[Figure List 61](#_Toc432510062)

[Table List 62](#_Toc432510063)

[Abbreviations and terms 63](#_Toc432510064)

[1. Purpose and scope 64](#_Toc432510065)

[1.1 Purpose 64](#_Toc432510066)

[1.2 Scope 64](#_Toc432510067)

[2. State of this document 66](#_Toc432510068)

[3. Related documents 67](#_Toc432510069)

[3.1 Document requirements 67](#_Toc432510070)

[3.2 Inputs 67](#_Toc432510071)

[Related 67](#_Toc432510072)

[4. Authors 68](#_Toc432510073)

[5. Approver 69](#_Toc432510074)

[6. Conventions 70](#_Toc432510075)

[7. System 71](#_Toc432510076)

[7.1 Functionality 71](#_Toc432510077)

[7.1.1 Purpose 71](#_Toc432510078)

[7.1.2 Scope 71](#_Toc432510079)

[7.1.3 Function description for the CC subsystem 73](#_Toc432510080)

[7.1.4 Non-Functional requirements 73](#_Toc432510081)

[7.1.5 Requirements from other systems and environment 73](#_Toc432510082)

[7.1.6 Requirements on other systems and environment 73](#_Toc432510083)

[7.2 System/subsystem/sub-subsystem split-up 75](#_Toc432510084)

[7.2.1 Functional allocation for subsystem/sub-subsystem 75](#_Toc432510085)

[7.2.2 Functional state diagram 78](#_Toc432510086)

[7.2.3 Functional traceability 78](#_Toc432510087)

[7.3 Operation modes, system states and operational situations 79](#_Toc432510088)

[7.3.1 Operational Modes for the CCCS 79](#_Toc432510089)

[7.3.2 Vehicle states corresponding to CCCS 80](#_Toc432510090)

[7.3.3 Operational Situation corresponding to CCCS 80](#_Toc432510091)

[7.3.4 Operational Situation based on vehicle location 80](#_Toc432510092)

[7.3.5 Operational Situation based on vehicle movement 81](#_Toc432510093)

[7.4 Assumptions and constraints 81](#_Toc432510094)

[7.4.1 Assumptions 82](#_Toc432510095)

[7.4.2 Constraints 82](#_Toc432510096)

[8 Annexure A 83](#_Toc432510097)

[9 Annexure B: Functional Requirement Details 85](#_Toc432510098)

[10 Annexure C: Functional Requirements Traceability Matrix 100](#_Toc432510099)

[10.1 Derived functional requirements 100](#_Toc432510100)

[11 Annexure E: Functional Architecture Traceability Matrix 101](#_Toc432510101)

[11.1 Functional components satisfying functional requirements 101](#_Toc432510102)

[11.2 Functional system states satisfying functional requirements 102](#_Toc432510103)

[12 Annexure F: Version History 103](#_Toc432510104)

[13 Annexure G: Reviewing this document 104](#_Toc432510105)

# To-do list

# Figure List

[Figure 1 : Cruise control system – associated components 65](#_Toc432601311)

[Figure 2 : Scope of CC system 72](#_Toc432601312)

[Figure 3 : BDD diagram of CC system 76](#_Toc432601313)

[Figure 4 : ibd of the CC System 77](#_Toc432601314)

[Figure 5 : CC system state diagram 78](#_Toc432601315)

[Figure 6 : Operating Modes CC system 79](#_Toc432601316)

[Figure 7 : Vehicle states for the CC system 80](#_Toc432601317)

[Figure 8 : Operation situation based on vehicle location 81](#_Toc432601318)

[Figure 9: Operation situation based on vehicle movement 81](#_Toc432601319)

# Table List

[Table 1 : Document status types 66](#_Toc432603838)

[Table 2 : Document Requirements 67](#_Toc432603839)

[Table 3 : Input documents 67](#_Toc432603840)

[Table 4 : Related documents 67](#_Toc432603841)

[Table 5 : Authors 68](#_Toc432603842)

[Table 6 : Approvers 69](#_Toc432603843)

[Table 7 : FR01 86](#_Toc432603844)

[Table 8 : FR02 87](#_Toc432603845)

[Table 9: FR03 88](#_Toc432603846)

[Table 10: FR04 88](#_Toc432603847)

[Table 11 : FR05 89](#_Toc432603848)

[Table 12 : FR06 90](#_Toc432603849)

[Table 13 : FR07 91](#_Toc432603850)

[Table 14: FR08 91](#_Toc432603851)

[Table 15 : FR09 92](#_Toc432603852)

[Table 16 : FR10 93](#_Toc432603853)

[Table 17 : FR11 94](#_Toc432603854)

[Table 18 : FR12 95](#_Toc432603855)

[Table 19 : FR13 95](#_Toc432603856)

[Table 20 : FR14 96](#_Toc432603857)

[Table 21 : FR15 97](#_Toc432603858)

[Table 22 : FR16 97](#_Toc432603859)

[Table 23 : FR17 98](#_Toc432603860)

[Table 24 : FR18 98](#_Toc432603861)

[Table 25 : FR19 99](#_Toc432603862)

# Abbreviations and terms

BDD: Block Definition Diagram

CEM: Central Electronic Module

ECM: Engine Control Module

SWM: Steering Wheel Module

BCM: Brake Control Module

DIM: Digital Information Module

HAN: Hogeschool van Arnhem en Nijmegen University of Applied Sciences

# Purpose and scope

## Purpose

* + 1. The objective of the item definition is to obtain a thorough understanding of a conventional cruise control system (CCCS), its functionality, interfaces with other (sub) systems and its environment (users, physical, functional and non-functional) so that the required phases of the safety lifecycle can be completed.
		2. The item definition has been created as per relevant patents, documents and diagrams obtained from the internet and HAN Automotive department.

## Scope

* + 1. The scope of this document is limited to the CC (sub) system as given in the description provided by HAN.
		- Functional requirements, which explains the functionality of the CC system.
		- Functional architecture that explain the allocation of FR to functional components and the interfaces with other sub-systems that include the preliminary architecture elements.
		- Operation situations states and modes of the CC, which explains the situations and modes that the CC will be used in.
		1. The CC system is a part of the advance driver assistance systems. The item definition will describe the functionality and allocation of the CC system

**

Figure 3 : Cruise control system – associated components

* + 1. The CC system is associated with the following functional components
		- Driver Interface
		- Vehicle data acquisition system
		- Powertrain components
		- Cruise control module
		1. The CC system is associated with the following physical components (*refer figure1*)
		- Driver input buttons in steering column [3/131, 3/254]
		- Engine control module [ECM]
		- Wheel speed sensor [3/9]
		- Brake and clutch pedal sensor [BCM]
		- Central electronic module [CEM]
		- Throttle sensor
		- Throttle actuator [6/120]
		- Driver information module [DIM]

# State of this document

* 1. This document is in the **draft** status

|  |  |
| --- | --- |
| **Status** | **Description** |
| Draft | The document is under construction. |
| Revised | The document is altered (e.g. by adding or deleting material). |
| Amended | The document is changed (e.g. not by adding or deleting material, but changing material e.g. in case of a fault) or the document is reviewed |
| Approved | The document is approved. |

Table 11 : Document status types

# Related documents

* 1. Remark: Adding related documents is only allowed by appending at the end of the current related documents table (see also paragraph 6.4)

## Document requirements

Document requirements are requirements that apply to this document only. They can be referenced by the X\_Req identifier.

|  |  |  |  |
| --- | --- | --- | --- |
| **Index** | **Unique filename** | **Title of the document** | **File location** |
| N.A. | N.A. | N.A. | N.A. |

Table 12 : Document Requirements

## 3.2 Inputs

Input documents are documents that are needed in order to complete the content of this document. The can be referenced by X\_IN identifier .

|  |  |  |  |
| --- | --- | --- | --- |
| **Index** | **Unique filename** | **Title of the document** | **File location** |
| 1\_IN | Volvo\_c30\_wiring\_doc | Regeleenheden overzicht benamingen | SVN |
| 2\_In | Volovo\_cruise control | Cruise control for motor vehicles | SVN |
| 3\_IN | Overview\_cruise control | CC\_regeling | SVN |
| 4\_In | FSM\_SE\_BreakDown\_BRACE\_v2.pdf | Functional safety for commercial vehicles and mobile machinery using systems engineering | SVN |

Table 13 : Input documents

## Related

Related documents are documents that are not necessarily needed in order to complete the contents of this document. The can be referenced by X\_Rel identifier.

|  |  |  |  |
| --- | --- | --- | --- |
| **Index** | **Unique filename** | **Title of the document** | **File location** |
| N.A. | N.A. | N.A. | N.A. |

Table 14 : Related documents

# Authors

* 1. The authors’ clause contains the names of people who have contributed to this document.

|  |  |
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| **Organization** | BRACE Automotive/ TU/e student |
| **Role** | Author |
| **Function** | Internship/Project member |

|  |  |
| --- | --- |
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| **Initials** | BEJ |
| **Organization** | BRACE Automotive/ HAN Automotive student |
| **Role** | Author |
| **Function** | Graduation thesis/Project member |

Table 15 : Authors

# Approver

The approver clause contains the names of the people who approve this document.

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| --- | --- |
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| **Organization** | BRACE Automotive |
| **Role** | Approver |
| **Function** | Cluster leader functional safety |

|  |  |
| --- | --- |
| **Authors (approvers)** | Marcel Romijn |
| **Initials** | RM |
| **Organization** | BRACE Automotive |
| **Role** | Approver |
| **Function** | Cluster leader On-Board diagnostics |

Table 16 : Approvers

# Conventions

* 1. Each paragraph in this document had its own identifier: the paragraph identifier. This identifier is generated based on the clause (e.g. 1.1 Purpose clause) that the paragraph is in and an auto incremented number with starting value `1`. The auto incremented numbers are printed in bold, while the clause numbers are shaded.
	2. For every new paragraph, the paragraph identifier is placed on the left side and at the same height equal to the starting point of that new paragraph.
	3. If applicable, an external reference for a paragraph can be given on the footer of the document. This external reference typically refers to the source or origin of the paragraph in question. Footnotes can also be used for the purpose of external references.
	4. Adding related documents to the related documents table (see clause 3) is only allowed by appending at the end of the current related documents table. This way, the reference index identifier can be used to make (persistent) links to the related documents table throughout the whole document. Appending new related documents at the end will not change the index identifier of already existing related documents.
	5. Links to paragraph identifiers in text will be formatted as shaded clause number with normal paragraph identifier (e.g. see paragraph 6.5). Links to related documents will not be made by the paragraph identifier, but by means of the reference index number (e.g. see reference 1). The reference index number will not be formatted as bold. Cites from the bibliography are done by square brackets (e.g. see [X]).
	6. Reviewing of this document is done by posting the comments/remarks in spreadsheet from linking each time the comment/remark to the paragraph identifier or table or figure in question. The review comments/remarks will always be applicable to a certain version of this file; therefore the version number of this document should always be mentioned. More information about this can be found in annexure 13.

# System

## Functionality

7.1.1 This section describes the functional behaviour and architecture of the CC system. The functions will be described by functional requirements which will correspondingly allocated to functional blocks and system states. The functional architecture also describes the interface between CC system and other (sub) systems.

### 7.1.1 Purpose

* + - 1. The purpose of the CC is described in the highest level functional requirement.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Alias** | FR01 | **Req.Type** | «functional Requirement» | **Status** | Proposed |
| **Description** |
| The cruise control system should maintain the speed of the vehicle upon the drivers demand |
| **Rationale** |
| Based on the input from the driver, the cruise control system should be able to validate the input and maintain the speed of the vehicle by manipulating the output power from the engine. The cruise control will initially be in off state when the car is started and will go into the off state (Irrespective of the current state) when the ignition is switched off. |

### 7.1.2 Scope

7.1.2.1 The system only consists of functionality with respect to the CC. The system is allocated as a sub system of the driver assistance systems. The figure below shows the CC system marked in green.

Figure 4 : Scope of CC system

### 7.1.3 Function description for the CC subsystem

7.1.3.1 The CC system functions are described and modelled in SysML functional requirements. The SysML requirements diagram is displayed in Annexure A. the diagram shows functional requirements (Light Green) derived from a higher abstraction level (Dark Green).

7.1.3.2 The requirements are marked with an id (FRxx) which links the diagram to a detailed description of functionality in

* Annexure A and B: Functional requirements details
* Annexure C: Functional requirements traceability matrix
* Annexure D: Functional Architecture traceability matrix information

### 7.1.4 Non-Functional requirements

7.1.4.1 The non-functional requirements are out of scope of this project and hence they will not be considered.

### 7.1.5 Requirements from other systems and environment

7.1.5.1 None

### 7.1.6 Requirements on other systems and environment

* + - 1. The powertrain system should be capable of interpreting the signal from the cruise control for the actuator.
			2. The powertrain system should be capable of interpreting the signal from the cruise control for the actuator.
			3. The powertrain should be capable of interpreting the request of the CC in order of accelerate or decelerate (engine brake).
			4. The Control units, actuators and sensors should be able to withstand the weather conditions like:
		- Warm
		- Cold
		- Dry
		- Wet
		- Sandy conditions
			1. The engine should be able to limit the torque to protect itself from mechanical damage and stalling.
			2. The ESR should be able to work without using the abs brake system
			3. The control units should be able to deliver the information for the CC system without delay.
			4. The transmission should be able to handle the torque that’s coming out of the engine an deliver it to the wheels.
			5. Signals of cruise control system should have lesser priority compared to ABS, ESP, Airbag and other important emergency system signals

## System/subsystem/sub-subsystem split-up

* + 1. This section displays the functional blocks and a system state which satisfies the defined functional requirements.

### 7.2.1 Functional allocation for subsystem/sub-subsystem

7.2.1.1 As displayed in Annexure D, the functional blocks of CC system satisfying the FR’s are shown in Figure 3. The green marked block represents the pure functionality of CC system.

Figure 5 : BDD diagram of CC system

7.2.1.2 The internal organization of the CC system is also specified as an ibd in Figure 4.



Figure 6 : ibd of the CC System

### Functional state diagram

* + - 1. The safe state determination of the CC system is shown in Figure 5. When the CC is in the active state and driver presses the brake and/or the clutch pedal, the CC system will go to the safe state. Additionally when the driver wishes to put the CC system in standby mode or wishes to manually switch it off, the system will go to the safe state.



Figure 7 : CC system state diagram

### Functional traceability

* + - 1. The above defined functional architecture, system and states satisfy the functional requirements as stated in the traceability matrix as found in Annexure D of this document.
* Functional components satisfying functional requirements
* Functional system and CC states

## Operation modes, system states and operational situations

* + 1. To provide a clear understanding of the situational use of the CC system in context of the vehicle input for the situational analysis (to perform the HARA) needs to be defined.
		2. The situational analysis requires the following concepts in respect to the CC system
* Operational mode – by the driver or automatically by systems logic selected functional state of a system or element.
* Vehicle state – The state of the vehicle.
* Operational situation – such as driving situations, vehicle usage scenarios, environmental conditions, training, experience and ability of the driver.

## 7.3.1 Operational Modes for the CCCS

7.3.1.1 Figure 6 displays the use case diagram including the Operating modes existing for the CCCS system



Figure 8 : Operating Modes CC system

## 7.3.2 Vehicle states corresponding to CCCS

* + - 1. Figure 7 displays the use case diagram including the Vehicle states corresponding to the use of the CCCS.



Figure 9 : Vehicle states for the CC system

## Operational Situation corresponding to CCCS

7.3.3.1 This clause contains:

* Generic operational situation based on vehicle location
* Generic operational situation based on vehicle movement
* System specific operational situation

### 7.3.4 Operational Situation based on vehicle location

7.3.4.1 Figure 7 displays the CCCS corresponding Operational Situations in the context of vehicle location.



Figure 10 : Operation situation based on vehicle location

### 7.3.5 Operational Situation based on vehicle movement

7.3.5.1 Figure 8 displays the CCCS corresponding Operational Situations in the context of vehicle movement.



Figure 11: Operation situation based on vehicle movement

## 7.4 Assumptions and constraints

## 7.4.1 Assumptions

* It is assumed that the engine is able to deliver the requesting torque that the CCS demands
* It is assumed that the CCS is able to communicate back and forth with ABS and ESP system
* It is assumed that the Wheel sensors are responsible for the actual vehicle speed
* It is assumed that the engine and CCS is able to deliver the requesting torque when encounters a disturbance (slope and cross wind).
* It is assumed that the CCS does not use the brake for decreasing the speed.
* It is assumed that the buttons on the steering wheel is the only way to control the CCS
* It is assumed that the environment doesn`t influence the goal of the CCS

## 7.4.2 Constraints

7.4.2.1 The constraints concerning other functions, systems and components and constraints, effects of the system behavior on other systems, the environment of the system including the interactions are as follows:

* The constraints concerning the effect of the item behavior on other items, which is the environment of the item, including interactions.
* Constraints in behavior expected from the item
* Constraints concerning other items and elements are determined

7.4.2.2 The constraints concerning other functions follows:

* The system is not able to directly use the brakes.
* The CCS has no influents on the gear selection.
* The CCS system can only receive information from other systems; the CCS only can request an torque from the engine.
* The CCS is not able to adjust the speed when approaching the car in front of the vehicle(ACCS)
* The CCS is not able to resume the set speed after braking. This need to be requested by the controls on the steering wheel.
* The CCS only work above 30kph

## Annexure A

## 9 Annexure B: Functional Requirement Details

### 9.1 FR01

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Alias** | FR01 | **Req.Type** | «functionalRequirement» | **Status** | Proposed |
| **Description** |
| The cruise control system should maintain the speed of the vehicle upon the drivers demand |
| **Rationale** |
| Based on the input from the driver, the cruise control system should be able to validate the input and maintain the speed of the vehicle by manipulating the output power from the engine. The cruise control will initially be in off state when the car is started and will go into the off state (Irrespective of the current state) when the ignition is switched off. |
| **Originator:** | **Priority** | **Date** |
| avinash.varadarajan | Medium | 9/30/2015 11:26:27 AM |
| **Dependencies:** |
| **«satisfy»**Source: : Cruise Control SystemTarget: **FR01**: The cruise control system should maintain the speed of the vehicle upon the drivers demand**«deriveReqt»**Source: **FR11**: The cruise control system can only enter the active state when it is already in the Standby or deactivated state. Similarly, the system can enter the deactive or standby state when it is in the active state.Target: **FR01**: The cruise control system should maintain the speed of the vehicle upon the drivers demand**«deriveReqt»**Source: **FR10**: The driver should be able to revive the cruise control from standby mode.Target: **FR01**: The cruise control system should maintain the speed of the vehicle upon the drivers demand**«deriveReqt»**Source: **FR09**: The system shall display to the user whether the system is in the ON condition.Target: **FR01**: The cruise control system should maintain the speed of the vehicle upon the drivers demand**«deriveReqt»**Source: **FR08**: The cruise control cannot be activated when the brake pedal is depressed.Target: **FR01**: The cruise control system should maintain the speed of the vehicle upon the drivers demand**«deriveReqt»**Source: **FR07**: The cruise control should be automatically deactivated when the cruise control is active and the vehicle speed falls below 30km/h.Target: **FR01**: The cruise control system should maintain the speed of the vehicle upon the drivers demand**«deriveReqt»**Source: **FR06**: The cruise control can enter the active state only when the vehicle speed is above 30 km/hTarget: **FR01**: The cruise control system should maintain the speed of the vehicle upon the drivers demand**«deriveReqt»**Source: **FR05**: The driver shall be able to kill the ignition in case of any undesirable events.Target: **FR01**: The cruise control system should maintain the speed of the vehicle upon the drivers demand**«deriveReqt»**Source: **FR19**: The control systems should be deactivated when the clutch pedal is pressedTarget: **FR01**: The cruise control system should maintain the speed of the vehicle upon the drivers demand**«deriveReqt»**Source: **FR04**: The driver should be able to put the cruise control in standby mode.Target: **FR01**: The cruise control system should maintain the speed of the vehicle upon the drivers demand**«deriveReqt»**Source: **FR03**: The driver should be able to manually deactivate the system.Target: **FR01**: The cruise control system should maintain the speed of the vehicle upon the drivers demand**«deriveReqt»**Source: **FR02**: The driver should be able to activate the cruise control system manually.Target: **FR01**: The cruise control system should maintain the speed of the vehicle upon the drivers demand |

Table 17 : FR01

### 9.2 FR02

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Alias** | FR02 | **Req.Type** | «functionalRequirement» | **Status** | Proposed |
| **Description** |
| The driver should be able to activate the cruise control system manually. |
| **Rationale** |
| The driver should be able to change the cruise control into an active state by using the driver interface. This will allow the cruise control system to manipulate the engine actuator. |
| **Originator:** | **Priority** | **Date** |
| avinash.varadarajan | Medium | 9/15/2015 2:50:02 PM |
| **Dependencies:** |
| **«satisfy»**Source: : Driver InterfaceTarget: **FR02**: The driver should be able to activate the cruise control system manually.**«satisfy»**Source: : CC\_OnTarget: **FR02**: The driver should be able to activate the cruise control system manually.**«deriveReqt»**Source: **FR12**: The driver should be able to set the desired speed.Target: **FR02**: The driver should be able to activate the cruise control system manually.**«deriveReqt»**Source: **FR13**: The driver should be able accelerate manually when the cruise control is ON.Target: **FR02**: The driver should be able to activate the cruise control system manually.**«deriveReqt»**Source: **FR02**: The driver should be able to activate the cruise control system manually.Target: **FR01**: The cruise control system should maintain the speed of the vehicle upon the drivers demand |

Table 18 : FR02

### 9.3 FR03

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Alias** | FR03 | **Req.Type** | «functionalRequirement» | **Status** | Proposed |
| **Description** |
| The driver should be able to manually deactivate the system. |
| **Rationale** |
| Irrespective of the current state of the cruise control system, the driver should be able to put the cruise control system in off state. |
| **Originator:** | **Priority** | **Date** |
| avinash.varadarajan | Medium | 9/16/2015 2:13:26 PM |
| **Dependencies:** |
| **«satisfy»**Source: : Driver InterfaceTarget: **FR03**: The driver should be able to manually deactivate the system.**«deriveReqt»**Source: **FR16**: The driver should be able to deactivate the cruise control system using the console buttonTarget: **FR03**: The driver should be able to manually deactivate the system.**«deriveReqt»**Source: **FR17**: The driver shall deactivate the cruise control by depressing the brake pedal.Target: **FR03**: The driver should be able to manually deactivate the system.**«deriveReqt»**Source: **FR03**: The driver should be able to manually deactivate the system.Target: **FR01**: The cruise control system should maintain the speed of the vehicle upon the drivers demand |

Table 19: FR03

### 9.4 FR04

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Alias** | FR04 | **Req.Type** | «functionalRequirement» | **Status** | Proposed |
| **Description** |
| The driver should be able to put the cruise control in standby mode. |
| **Rationale** |
| The driver should be able to put the cruise control in the standby mode, where the control of the vehicle is temporarily transferred to the driver. The standby state can only be reached through driver input. |
| **Originator:** | **Priority** | **Date** |
| avinash.varadarajan | Medium | 9/15/2015 2:23:35 PM |
| **Dependencies:** |
| **«satisfy»**Source: : StandbyTarget: **FR04**: The driver should be able to put the cruise control in standby mode.**«deriveReqt»**Source: **FR18**: The cruise control should remeber the vehicle speed at which the system is deactivated.Target: **FR04**: The driver should be able to put the cruise control in standby mode.**«deriveReqt»**Source: **FR04**: The driver should be able to put the cruise control in standby mode.Target: **FR01**: The cruise control system should maintain the speed of the vehicle upon the drivers demand |

Table 20: FR04

### 9.5 FR05

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Alias** | FR05 | **Req.Type** | «functionalRequirement» | **Status** | Proposed |
| **Description** |
| The driver shall be able to kill the ignition in case of any undesirable events. |
| **Rationale** |
| There should be an emergency switch for the driver to kill the test vehicle's ignition in case of undesirable situations arising. |
| **Originator:** | **Priority** | **Date** |
| avinash.varadarajan | Medium | 9/15/2015 3:06:16 PM |
| **Dependencies:** |
| **«satisfy»**Source: : Energy Buffer (Battery)Target: **FR05**: The driver shall be able to kill the ignition in case of any undesirable events.**«satisfy»**Source: : Powertrain ComponentsTarget: **FR05**: The driver shall be able to kill the ignition in case of any undesirable events.**«satisfy»**Source: : CC\_OffTarget: **FR05**: The driver shall be able to kill the ignition in case of any undesirable events.**«deriveReqt»**Source: **FR05**: The driver shall be able to kill the ignition in case of any undesirable events.Target: **FR01**: The cruise control system should maintain the speed of the vehicle upon the drivers demand |

Table 21 : FR05

### 9.6 FR06

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Alias** | FR06 | **Req.Type** | «functionalRequirement» | **Status** | Proposed |
| **Description** |
| The cruise control can enter the active state only when the vehicle speed is above 30 km/h |
| **Rationale** |
| The active state of the cruise control can only be reached when the vehicle speed is above 30 km/h. When the vehicle is below the threshold speed, the system should override any request to put the cruise control in an active state from the driver.  |
| **Originator:** | **Priority** | **Date** |
| avinash.varadarajan | Medium | 9/16/2015 4:16:17 PM |
| **Dependencies:** |
| **«satisfy»**Source: : Processing UnitTarget: **FR06**: The cruise control can enter the active state only when the vehicle speed is above 30 km/h**«satisfy»**Source: : Cruise Control SystemTarget: **FR06**: The cruise control can enter the active state only when the vehicle speed is above 30 km/h**«satisfy»**Source: : Vehicle Speed UnitTarget: **FR06**: The cruise control can enter the active state only when the vehicle speed is above 30 km/h**«satisfy»**Source: : CC\_EngageTarget: **FR06**: The cruise control can enter the active state only when the vehicle speed is above 30 km/h**«deriveReqt»**Source: **FR06**: The cruise control can enter the active state only when the vehicle speed is above 30 km/hTarget: **FR01**: The cruise control system should maintain the speed of the vehicle upon the drivers demand |

Table 22 : FR06

### 9.7 FR07

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Alias** | FR07 | **Req.Type** | «functionalRequirement» | **Status** | Proposed |
| **Description** |
| The cruise control should be automatically deactivated when the cruise control is active and the vehicle speed falls below 30km/h. |
| **Rationale** |
| When the speed of the vehicle falls below 20 km/h while the cruise control is in the active state, the cruise control should go into the de-active state, giving the control back to the driver. |
| **Originator:** | **Priority** | **Date** |
| avinash.varadarajan | Medium | 9/15/2015 2:57:53 PM |
| **Dependencies:** |
| **«satisfy»**Source: : Logic UnitTarget: **FR07**: The cruise control should be automatically deactivated when the cruise control is active and the vehicle speed falls below 30km/h.**«satisfy»**Source: : Logic UnitTarget: **FR07**: The cruise control should be automatically deactivated when the cruise control is active and the vehicle speed falls below 30km/h.**«satisfy»**Source: : Cruise Control SystemTarget: **FR07**: The cruise control should be automatically deactivated when the cruise control is active and the vehicle speed falls below 30km/h.**«satisfy»**Source: : Vehicle Speed UnitTarget: **FR07**: The cruise control should be automatically deactivated when the cruise control is active and the vehicle speed falls below 30km/h.**«satisfy»**Source: : CC\_disengage (safe state)Target: **FR07**: The cruise control should be automatically deactivated when the cruise control is active and the vehicle speed falls below 30km/h.**«deriveReqt»**Source: **FR07**: The cruise control should be automatically deactivated when the cruise control is active and the vehicle speed falls below 30km/h.Target: **FR01**: The cruise control system should maintain the speed of the vehicle upon the drivers demand |

Table 23 : FR07

### 9.8 FR08

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Alias** | FR08 | **Req.Type** | «functionalRequirement» | **Status** | Proposed |
| **Description** |
| The cruise control cannot be activated when the brake pedal is depressed. |
| **Rationale** |
| The cruise control cannot enter the active state when the brake pedal is pressed. Any input to put the cruise control in active state should be overridden by the system. |
| **Originator:** | **Priority** | **Date** |
| avinash.varadarajan | Medium | 9/16/2015 2:46:07 PM |
| **Dependencies:** |
| **«satisfy»**Source: : Logic UnitTarget: **FR08**: The cruise control cannot be activated when the brake pedal is depressed.**«satisfy»**Source: : Cruise Control SystemTarget: **FR08**: The cruise control cannot be activated when the brake pedal is depressed.**«satisfy»**Source: : Braking SystemTarget: **FR08**: The cruise control cannot be activated when the brake pedal is depressed.**«satisfy»**Source: : CC\_disengage (safe state)Target: **FR08**: The cruise control cannot be activated when the brake pedal is depressed.**«deriveReqt»**Source: **FR08**: The cruise control cannot be activated when the brake pedal is depressed.Target: **FR01**: The cruise control system should maintain the speed of the vehicle upon the drivers demand |

Table 24: FR08

### 9.9 FR09

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Alias** | FR09 | **Req.Type** | «functionalRequirement» | **Status** | Proposed |
| **Description** |
| The system shall display to the user whether the system is in the ON condition. |
| **Rationale** |
| When the cruise control is in the active state, it should be indicated to the driver through the driver interface. |
| **Originator:** | **Priority** | **Date** |
| avinash.varadarajan | Medium | 9/15/2015 3:02:53 PM |
| **Dependencies:** |
| **«satisfy»**Source: : Driver InterfaceTarget: **FR09**: The system shall display to the user whether the system is in the ON condition.**«satisfy»**Source: : Cruise Control SystemTarget: **FR09**: The system shall display to the user whether the system is in the ON condition.**«satisfy»**Source: : CC\_EngageTarget: **FR09**: The system shall display to the user whether the system is in the ON condition.**«satisfy»**Source: : ResumeTarget: **FR09**: The system shall display to the user whether the system is in the ON condition.**«deriveReqt»**Source: **FR09**: The system shall display to the user whether the system is in the ON condition.Target: **FR01**: The cruise control system should maintain the speed of the vehicle upon the drivers demand |

Table 25 : FR09

### 9.10 FR10

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Alias** | FR10 | **Req.Type** | «functionalRequirement» | **Status** | Proposed |
| **Description** |
| The driver should be able to revive the cruise control from standby mode. |
| **Rationale** |
| When the cruise control is in the de-active state, the driver should be able to activate the cruise control system by using the driver interface. |
| **Originator:** | **Priority** | **Date** |
| avinash.varadarajan | Medium | 9/15/2015 2:51:32 PM |
| **Dependencies:** |
| **«satisfy»**Source: : Driver InterfaceTarget: **FR10**: The driver should be able to revive the cruise control from standby mode.**«satisfy»**Source: : StandbyTarget: **FR10**: The driver should be able to revive the cruise control from standby mode.**«satisfy»**Source: : ResumeTarget: **FR10**: The driver should be able to revive the cruise control from standby mode.**«deriveReqt»**Source: **FR10**: The driver should be able to revive the cruise control from standby mode.Target: **FR01**: The cruise control system should maintain the speed of the vehicle upon the drivers demand |

Table 26 : FR10

### 9.11 FR11

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Alias** | FR11 | **Req.Type** | «functionalRequirement» | **Status** | Proposed |
| **Description** |
| The cruise control system can only enter the active state when it is already in the Standby or deactivated state. Similarly, the system can enter the deactive or standby state when it is in the active state. |
| **Rationale** |
| This requirement prevents the driver from overriding the system with repeated inputs. For example, the cruise control should ignore the request from driver to active the cruise control when it is already in the active state and vice versa. |
| **Originator:** | **Priority** | **Date** |
| avinash.varadarajan | Medium | 9/16/2015 4:24:21 PM |
| **Dependencies:** |
| **«satisfy»**Source: : Logic UnitTarget: **FR11**: The cruise control system can only enter the active state when it is already in the Standby or deactivated state. Similarly, the system can enter the deactive or standby state when it is in the active state.**«satisfy»**Source: : Cruise Control SystemTarget: **FR11**: The cruise control system can only enter the active state when it is already in the Standby or deactivated state. Similarly, the system can enter the deactive or standby state when it is in the active state.**«satisfy»**Source: : CC\_EngageTarget: **FR11**: The cruise control system can only enter the active state when it is already in the Standby or deactivated state. Similarly, the system can enter the deactive or standby state when it is in the active state.**«satisfy»**Source: : CC\_disengage (safe state)Target: **FR11**: The cruise control system can only enter the active state when it is already in the Standby or deactivated state. Similarly, the system can enter the deactive or standby state when it is in the active state.**«deriveReqt»**Source: **FR11**: The cruise control system can only enter the active state when it is already in the Standby or deactivated state. Similarly, the system can enter the deactive or standby state when it is in the active state.Target: **FR01**: The cruise control system should maintain the speed of the vehicle upon the drivers demand |

Table 27 : FR11

### 9.12 FR12

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Alias** | FR12 | **Req.Type** | «functionalRequirement» | **Status** | Proposed |
| **Description** |
| The driver should be able to set the desired speed. |
| **Rationale** |
| The input to the system from the driver should be through the driver interface. This will be the reference input to the controller. |
| **Originator:** | **Priority** | **Date** |
| avinash.varadarajan | Medium | 9/15/2015 2:54:18 PM |
| **Dependencies:** |
| **«satisfy»**Source: : Driver InterfaceTarget: **FR12**: The driver should be able to set the desired speed.**«satisfy»**Source: : CC\_EngageTarget: **FR12**: The driver should be able to set the desired speed.**«deriveReqt»**Source: **FR14**: The driver shall be able to decrease the vehicle speed by using the driver interface.Target: **FR12**: The driver should be able to set the desired speed.**«deriveReqt»**Source: **FR15**: The driver shall be able to increase the Vehicle speed by using the driver interfaceTarget: **FR12**: The driver should be able to set the desired speed.**«deriveReqt»**Source: **FR12**: The driver should be able to set the desired speed.Target: **FR02**: The driver should be able to activate the cruise control system manually. |

Table 28 : FR12

### 9.13 FR13

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Alias** | FR13 | **Req.Type** | «functionalRequirement» | **Status** | Proposed |
| **Description** |
| The driver should be able accelerate manually when the cruise control is ON. |
| **Rationale** |
| Even when the cruise control is in the active state, the driver should be able to accelerate the vehicle through the accelerator pedal. For this temporary moment of time, the cruise control system should return the control to the driver. When the accelerator pedal is free from driver input, the cruise control system should return to its previously remembered active state. |
| **Originator:** | **Priority** | **Date** |
| avinash.varadarajan | Medium | 9/15/2015 2:53:54 PM |
| **Dependencies:** |
| **«satisfy»**Source: : Driver InterfaceTarget: **FR13**: The driver should be able accelerate manually when the cruise control is ON.**«satisfy»**Source: : CC\_EngageTarget: **FR13**: The driver should be able accelerate manually when the cruise control is ON.**«deriveReqt»**Source: **FR13**: The driver should be able accelerate manually when the cruise control is ON.Target: **FR02**: The driver should be able to activate the cruise control system manually. |

Table 29 : FR13

### 9.14 FR14

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Alias** | FR14 | **Req.Type** | «functionalRequirement» | **Status** | Proposed |
| **Description** |
| The driver shall be able to decrease the vehicle speed by using the driver interface. |
| **Rationale** |
| The CC system shall obtain input from the driver for the reference speed through the driver interface. |
| **Originator:** | **Priority** | **Date** |
| avinash.varadarajan | Medium | 9/15/2015 2:59:07 PM |
| **Dependencies:** |
| **«satisfy»**Source: : Driver InterfaceTarget: **FR14**: The driver shall be able to decrease the vehicle speed by using the driver interface.**«satisfy»**Source: : Vehicle Speed UnitTarget: **FR14**: The driver shall be able to decrease the vehicle speed by using the driver interface.**«satisfy»**Source: : CC\_EngageTarget: **FR14**: The driver shall be able to decrease the vehicle speed by using the driver interface.**«deriveReqt»**Source: **FR14**: The driver shall be able to decrease the vehicle speed by using the driver interface.Target: **FR12**: The driver should be able to set the desired speed. |

Table 30 : FR14

### 9.15 FR15

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Alias** | FR15 | **Req.Type** | «functionalRequirement» | **Status** | Proposed |
| **Description** |
| The driver shall be able to increase the Vehicle speed by using the driver interface |
| **Rationale** |
| The CC system shall obtain input from the driver for the reference speed through the driver interface. |
| **Originator:** | **Priority** | **Date** |
| avinash.varadarajan | Medium | 9/15/2015 2:58:33 PM |
| **Dependencies:** |
| **«satisfy»**Source: : Driver InterfaceTarget: **FR15**: The driver shall be able to increase the Vehicle speed by using the driver interface**«satisfy»**Source: : Vehicle Speed UnitTarget: **FR15**: The driver shall be able to increase the Vehicle speed by using the driver interface**«satisfy»**Source: : CC\_EngageTarget: **FR15**: The driver shall be able to increase the Vehicle speed by using the driver interface**«deriveReqt»**Source: **FR15**: The driver shall be able to increase the Vehicle speed by using the driver interfaceTarget: **FR12**: The driver should be able to set the desired speed. |

Table 31 : FR15

### 9.16 FR16

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Alias** | FR16 | **Req.Type** | «functionalRequirement» | **Status** | Proposed |
| **Description** |
| The driver should be able to deactivate the cruise control system using the console button |
| **Rationale** |
| The driver should be able to put the cruise control system in off state by using the driver interface |
| **Originator:** | **Priority** | **Date** |
| avinash.varadarajan | Medium | 9/16/2015 2:37:54 PM |
| **Dependencies:** |
| **«satisfy»**Source: : Driver InterfaceTarget: **FR16**: The driver should be able to deactivate the cruise control system using the console button**«satisfy»**Source: : CC\_disengage (safe state)Target: **FR16**: The driver should be able to deactivate the cruise control system using the console button**«deriveReqt»**Source: **FR16**: The driver should be able to deactivate the cruise control system using the console buttonTarget: **FR03**: The driver should be able to manually deactivate the system. |

Table 32 : FR16

### 9.17 FR17

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Alias** | FR17 | **Req.Type** | «functionalRequirement» | **Status** | Proposed |
| **Description** |
| The driver shall deactivate the cruise control by depressing the brake pedal. |
| **Rationale** |
| The driver should be able to put the cruise control system in off state when the brake pedal is depressed. The cruise control can again become active only when the driver wishes to reactivate the system. Also, when the system is deactivated, it should remember the set speed before going into the off state. |
| **Originator:** | **Priority** | **Date** |
| avinash.varadarajan | Medium | 9/15/2015 2:50:46 PM |
| **Dependencies:** |
| **«satisfy»**Source: : Braking SystemTarget: **FR17**: The driver shall deactivate the cruise control by depressing the brake pedal.**«deriveReqt»**Source: **FR17**: The driver shall deactivate the cruise control by depressing the brake pedal.Target: **FR03**: The driver should be able to manually deactivate the system. |

Table 33 : FR17

### 9.18 FR18

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Alias** | FR18 | **Req.Type** | «functionalRequirement» | **Status** | Proposed |
| **Description** |
| The cruise control should remember the vehicle speed at which the system is deactivated. |
| **Rationale** |
| Whenever the cruise control enters the de-active state, it should remember the speed set before entering the de-active state. This value will be cleared from the system only when the cruise control system goes to the 'off' state |
| **Originator:** | **Priority** | **Date** |
| avinash.varadarajan | Medium | 9/16/2015 2:31:41 PM |
| **Dependencies:** |
| **«satisfy»**Source: : Memory BlockTarget: **FR18**: The cruise control should remeber the vehicle speed at which the system is deactivated.**«satisfy»**Source: : Cruise Control SystemTarget: **FR18**: The cruise control should remeber the vehicle speed at which the system is deactivated.**«satisfy»**Source: : CC\_disengage (safe state)Target: **FR18**: The cruise control should remeber the vehicle speed at which the system is deactivated.**«deriveReqt»**Source: **FR18**: The cruise control should remeber the vehicle speed at which the system is deactivated.Target: **FR04**: The driver should be able to put the cruise control in standby mode. |

Table 34 : FR18

### 9.19 FR19

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Alias** | FR19 | **Req.Type** | «functionalRequirement» | **Status** | Proposed |
| **Description** |
| The control systems should be deactivated when the clutch pedal is pressed |
| **Rationale** |
| Whenever the cruise control system detects the clutch pedal is pressed, it should go into the de-active state. This will transfer the control of the vehicle to the driver. |
| **Originator:** | **Priority** | **Date** |
| avinash.varadarajan | Medium | 9/30/2015 11:22:05 AM |
| **Dependencies:** |
| **«satisfy»**Source: : Logic UnitTarget: **FR19**: The control systems should be deactivated when the clutch pedal is pressed**«satisfy»**Source: : Cruise Control SystemTarget: **FR19**: The control systems should be deactivated when the clutch pedal is pressed**«satisfy»**Source: : Powertrain ComponentsTarget: **FR19**: The control systems should be deactivated when the clutch pedal is pressed**«satisfy»**Source: : CC\_EngageTarget: **FR19**: The control systems should be deactivated when the clutch pedal is pressed**«deriveReqt»**Source: **FR19**: The control systems should be deactivated when the clutch pedal is pressedTarget: **FR01**: The cruise control system should maintain the speed of the vehicle upon the drivers demand |

Table 35 : FR19

## 10 Annexure C: Functional Requirements Traceability Matrix

### 10.1 Derived functional requirements

 

## 11 Annexure E: Functional Architecture Traceability Matrix

### 11.1 Functional components satisfying functional requirements



###

### 11.2 Functional system states satisfying functional requirements



## 12 Annexure F: Version History

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Version** | **Change description** | **Status** | **Authors** | **Date** | **Remarks** |
| 0.1 | Initial Document to verify the approach followed and  | Draft | AVV,BJ | 30/09/15 | General remarks on diagram readability and models. Positive appraisal towards the ID document |