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1 INTRODUCTION

1.1 Purpose

A Feature Document (FD) document specifies **what** the feature shall do and how it shall behave from customer perspective. It should also provide reasoning and background **why** we have the feature in the vehicle.

To get more information about the concept of feature, function and component level abstraction refer to the Ford RE Wiki.

1.2 Scope

This Feature Document (FD) specifies the following features:

Feature ID	Feature Name	Owner	Reference
F000063	Ambient Lighting	Ralph Gemade	<add link="" vsem=""></add>

Table 1: Features described in this FD

1.3 Audience

The FD is written by the feature owner of <Feature / Feature Group Name>. All Stakeholders, i.e., all people who have a valid interest in the feature should read and, if possible, review the FD. It needs to be guaranteed, that all stakeholders have access to the currently valid version of the FD.

For the latest list of stakeholder of the feature and their influence refer to <VSEM Link>.

Refer to the Roles & Responsibilities page in the in the Ford RE Wiki for a list of common Ford roles and their responsibilities.

Stakeholder List

Name	CDSID	Role
Ralph Gemade	RGEMADE	Ambient Lighting Core Feature Owner
Elizabeth Wickey	EWICKEY	Core Ambient Lighting SME
Mohamed Fkili	MFKILI	Core Interior Lighting BCM Expert
Jeff Lossing	JLOSSING	Convenience Feature Engineer
Jeff Exell	JEXELL	Core APIM Engineer
Anthony Swisz	ASWISZ	Ambient Lighting UX Engineer
Steven Antilla	SANTILLA	Core Interior Lighting Supervisor
Herta Llusho	HLLUSHO	Core Feature Owner Supervisor - LMS
Ken Cunningham	KCUNNI16	Functional Safety TE

Name	CDSID	Role
Omar Saleh	OSALEH	Core Feature Owner - Approach Detection
Darnell Fuller	DFULLE45	Core Feature Owner – W/F
Walter Stephens	WSTEPHE1	Core Feature Owner - Enhanced Memory

1.4 Document Organization

1.4.1 DOCUMENT CONTEXT

Refer to the <u>Specification Structure page</u> in the <u>Ford RE Wiki</u> to understand how the FD relates to other Ford Requirements Documents and Specifications.

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1.4.2 DOCUMENT STRUCTURE

The structure of this document is explained below:

- **Section 1** Introduction how to use this document including responsibilities and requisite documents. Explains the terminology. Gives a clarification of the definitions, concepts and abbreviations used in the document.
- Section 2 Feature Description. States briefly the background and the purpose of the feature.
- **Section 3** Feature Context, which defines the boundaries of the feature.
- **Section 4** Feature Modeling. Contains Use Case, Driving Scenarios, State Charts to describe the functional behavior of the feature.
- Section 5 Feature Requirements. Lists functional and non-functional requirements of the feature.
- Section 6 Architecture. Shows the coarse architecture, which the feature requirements are deployed to.
- Section 7 Open issues
- Section 8 Traceability matrix
- Section 9 Revision history including a list of new or modified requirements. The requirements in this document are tagged, and this section contains different types of tables listing all, new, or changed
 - requirements by their title and page no.

1.5 References

1.5.1 FORD DOCUMENTS

List here all Ford internal documents, which are directly related to the feature.

Reference	Title	Doc. ID	Revision
[001]	Ambient Lighting Strategy	RQT-002004-022593	
[002]	Ford Welcome/Farewell and Lincoln Embrace Strategy	RQT-002004-704098	
[003]	Lincoln Embrace Ford Welcome Farewell	F001002	
[004]	Enhanced Memory	F000172	

1.5.2 EXTERNAL DOCUMENTS AND PUBLICATIONS

The list of external documents could include books, reports and online sources.

	Reference	Document / Publication
Ī	FMVSS 101	FMVSS101 Federal requirements have to be met by this feature

1.6 Terminology

#Hint: Terms, concepts and abbreviations used in the document can be defined and illustrated here. Note that changes to terms and/or concepts described in this section tend to cause major updates to this document.

1.6.1 **DEFINITIONS**

#Hint: The tables below have feature specific definitions and abbreviations. For additional, non-feature specific terms please refer to the <u>RE Glossary</u>

Definition	Description
Drive Phase	The driving condition defined by the ignition being in RUN/START and for variants configured with static sequential the sequence being complete.
Ramp ON	Smooth transition from off to a desired intensity at a configurable time rate
Ramp OFF	Smooth transition from a set intensity to OFF at a configurable time rate

Table 2: Definitions used in this document

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1.6.2 ABBREVIATIONS

Abbr.	Stands for	Description
AMBL	Ambient Lighting	The feature being described in this document

Table 3: Abbreviations

1.7 Notation

1.7.1 REQUIREMENTS TEMPLATES

Each requirement, use case or scenario in this specification shall follow the corresponding template given in the document template *Specification_Macros.dotm* on Wiki page <u>"Specification Templates"</u>. This document template also provides macros to insert the requirement templates. Refer to <u>"How to use the Specification Templates"</u> on how to enable the macros and the requirements templates in this specification.

The requirements macro and requirements templates also enable the import of the specification to VSEM (refer to "How to import specifications into VSEM as separate requirements").

1.7.1.1 Identification of requirements

The unique requirement ID given in the headline of any requirement follows the requirement throughout the development process. The requirement ID format follows a well-defined syntax.

All identifiers in a FD shall be composed of 5 parts:

- A leading letter F (= Feature).
- Followed by the feature name (typically an acronym)
- Followed by a letter indicating the category of requirement (whether it is a Scenario (=SC), a Use Case (=UC) or a Requirement (=R))
- Ending with the actual requirement number

Example:

F_PCL_R_00004

This is the fourth requirement on feature level for the feature Power Child

1.7.1.2 Requirements Attributes

The macros provided by <u>"Specification Templates"</u> add attributes to each requirement. This helps to classify requirements. The <u>list of available attributes</u> is given in the RE Wiki.

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2 FEATURE DESCRIPTION

2.1 Purpose and Overview of Feature

#Hint: Description of purpose and functionality of the feature. (non-formal text)

With the ambient lighting feature, a user can set the mood in the vehicle's cabin by selecting one of several different accent colors.

When activated ambient lighting illuminates foot wells, cup holders, and door release handles, etc., depending on the vehicle model. A user can also adjust brightness settings to further personalize the interior.



In multicolor variants equipped with door lights, Ambient Lighting is also capable of indicating a cabin door being ajar by activating the door's lights in a pre-configured color (Red).

Ambient Lighting also works to support experience features such as Welcome/Farewell, Rejuvenate, Purify.

Contextual Ambient Lighting Variant: Vehicles with a contextual ambient lighting system that associates certain specific ambient light colors to Drive Modes. When a user changes their Drive mode, along with the traditional Drive Mode related attributes, the user will also see orchestrated changes to their Instrument Cluster, HMI screen, and Ambient Lights. Users can choose to not have their Ambient Lights change with Drive Modes, either by picking the color they want or by turning OFF the 'Auto Ambient Light (AAL)' Toggle on the Drive Mode screen.

Feature Variants

Variant Name	Variant Description	Remarks
Lincoln	Variant for Lincoln brand vehicles with multicolor ambient lighting capability	
Ford Single Color	Variant for Ford brand vehicles (except S650 Mustang and prior) with single color ambient lighting capability	
Ford Multi Color	Variant for Ford brand vehicles (except S650 Mustang and prior) with multi-color ambient lighting capability	
Contextual Ambient Lighting	Variant for vehicles equipped with the SDM feature	

Table 4: Feature Variants

2.2 Regions & Markets

#Hint: Description of purpose and functionality of the feature.

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Market / Region Variant Name	North America	South America	Europe	MiddleEast/Africa	Asia / Pacific	China
Lincoln	Optional	Optional	Optional	Optional	Optional	Optional
Ford Single Color	Optional	Optional	Optional	Optional	Optional	Optional
Ford Multi Color	Optional	Optional	Optional	Optional	Optional	Optional
CAL	Optional	Optional	Optional	Optional	Optional	Optional

Table 5: Regions & Markets

2.3 Input Requirements

#Hint: Related legal requirements (especially laws and regulations) as well as national and international standards are required.

2.3.1 LEGAL REQUIREMENTS

FMVSS 101 - sec 5.3.4

2.3.2 TRUSTMARK REQUIREMENTS

2.3.3 INDUSTRY STANDARDS

ISO 26262 - The feature shall comply with Ford's implementation of Functional Safety

2.4 Assumptions & Constraints

#Hint: (Optional, Informal Text) A list of known assumptions concerning the effects of the feature's behavior on other features or elements as well as assumptions on the behavior expected by the feature.

Functional Safety: This list of assumptions shall be updated if additional assumptions are needed at a later stage, e.g., for the Hazard Analysis and Risk Assessment.

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3 FEATURE CONTEXT

3.1 Feature Context Diagram

#Hint: High level diagram of feature interactions with the environment, people or other feature or other external entities. Refer for details of this method to the **RE Wiki**

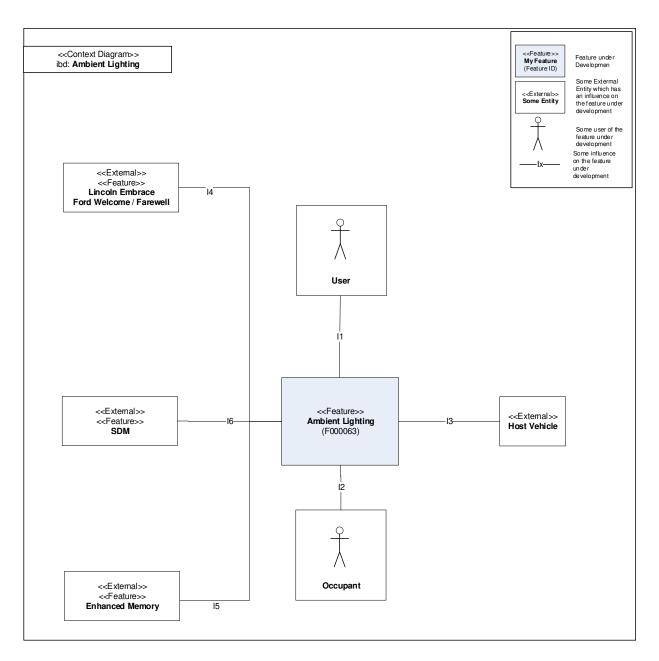


Figure 1: Ambient Lighting Context Diagram

3.2 List of Influences

ID	External Entity	Influence Description	
11/12	Users/ Occupants	User can toggle ambient mode between enabled and disabled	
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		User can manually choose color of ambient lights User can manually choose intensity of ambient lights User can interact with door ambient lights by opening/closing door User can deactivate/activate Welcome/Farewell mode Receives output (Illumination)
13	Host Vehicle	Provides influence through physical interface for user inputs and lighting hardware for output Provides pre/post conditions e.g. Ignition States, door opening and locking states, battery power conditions, headlamp switch state Receives output (Illumination)
14	Lincoln Embrace / Ford Welcome & Farewell	Can (de)activate ambient lighting under certain conditions (See Welcome Farewell Feature Specification – F001002)
15	Enhanced Memory	Provides personalization profile numbers to recall stored ambient lighting settings or perform an operation. Operations: Copy of Ambient Lighting settings from the active profile to a selected profile
16	SDM	Provides active drive mode to Ambient Lighting Feature

Table 6: List of Influences

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4 FEATURE MODELING

4.1 Operation Modes and States

#Hint: (Optional) State Charts are a popular means to express feature behavior in terms of states and modes. An advantage of this state machine like approach is, that consistency can be easily verified. Refer for details of this method to the RE Wiki

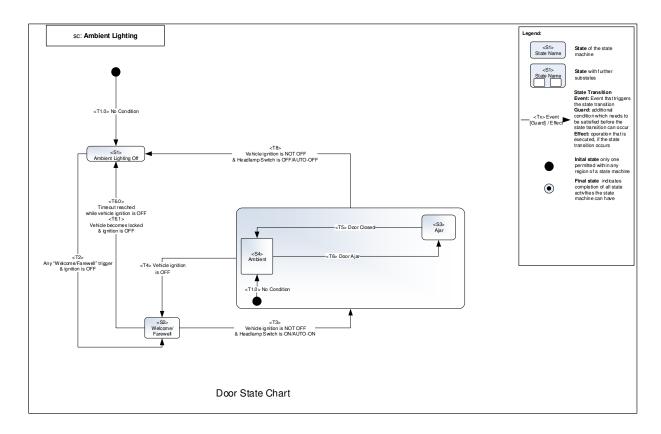


Figure 2a: Feature Operation States and Modes - Door

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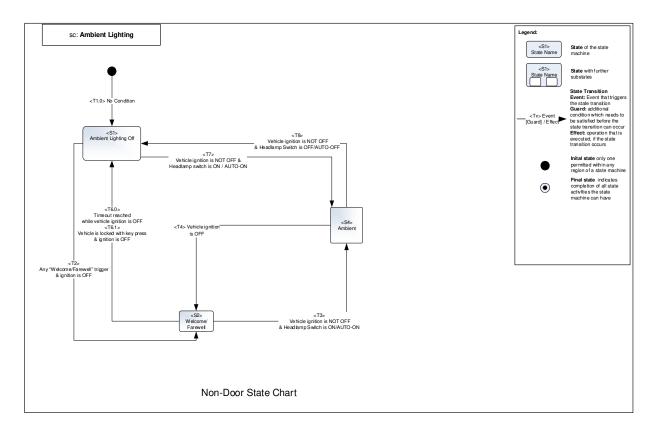


Figure 3b: Feature Operation States and Modes - Non-Door

State	Description	Requirements Reference (optional)
S1	Off	
S2	Welcome/Farewell	
S3	Ajar	
S4	Ambient	
S5		

Table 7: Operation States and Modes

Transition ID	Description	Requirements Reference (optional)
T1	25 second inactivity timeout reached while in Welcome Farewell state	
T2	Any of the following actions while the vehicle ignition is OFF	
	Welcome Triggers: Approach detected, vehicle unlocked, any	
	door opened, any door closed	
T3	Vehicle ignition transitions from OFF/ACC to RUN/START	
T4	Vehicle ignition transitions from RUN/START to OFF/ACC	
T5	The door is CLOSED	
T6	The door is AJAR	
T7	Vehicle ignition is NOT OFF & Headlamp switch is ON / AUTO-ON	
T8	Vehicle ignition is NOT OFF & Headlamp switch is OFF / AUTO-OFF	

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Table 8: Transition between Operational States

4.2 Use Cases

#Hint: (Optional) For details of the "Use Case" method refer to the RE Wiki

4.2.1 USE CASE DIAGRAM

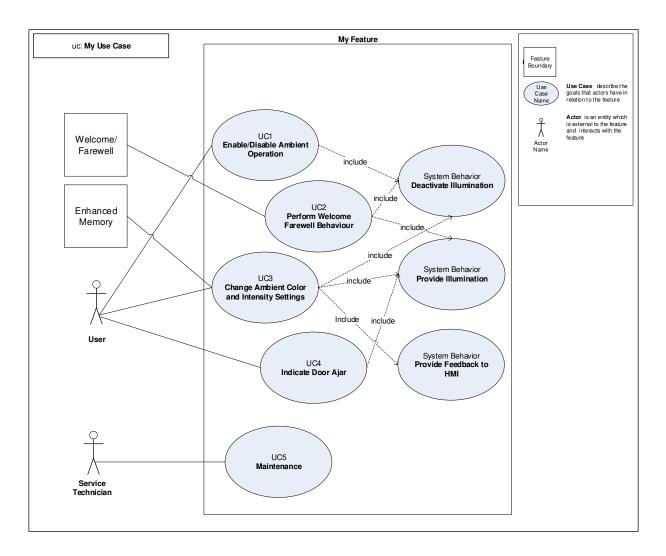


Figure 4: Use Case Diagram

4.2.2 ACTORS



Actor	Description
Enhanced Memory	Feature that maintains personalization profiles and their associated vehicle settings
Occupant	Any person seated within the vehicle
User	Any individual who may interact with the vehicle
Welcome / Farewell	Feature that coordinates response(s) from vehicle lights during customers entry and exit, has ability to activate/deactivate ambient lighting

Table 9: List of Actors

4.2.3 USE CASE DESCRIPTIONS

#Hint: (Optional) Please use the Add Ins -> Add Requirement macro (select "Use Case" as type) to add a new Use Case Description.

Use Case 1: Enable/Disable Ambient Operation

###UC_F_AMBL_00001### Enable Ambient Operation

Purpose		To describe the scenario of enabling "Ambient" operation mode of the feature	
Actors		User	
Precondition		Vehicle Ignition is in RUN/START	
Main Flow	M1	The User turns the headlamp switch to ON	
Alternative Flow 1		The user turns the headlamp switch to AUTO	
		Nighttime visibility conditions have been detected	
Alternative Flow 2			
Post-condition		The Ambient lighting turns ON in Ambient Mode	

###UC_F_AMBL_00002### Disable Ambient Operation

Purpose		To describe the scenario of disabling "Ambient" operation mode of the feature	
Actors		User	
Precondition		Vehicle Ignition is in RUN/START	
Main Flow	M1	The User turns the headlamp switch to OFF	
Alternative Flow 1		The user turns the headlamp switch to AUTO	
		Daytime visibility conditions have been detected	
Alternative Flow 2			
Post-condition		The Ambient lighting turns OFF	

Use Case 2: Perform Welcome Farewell Behavior

###UC_F_AMBL_00003### Perform Welcome Farewell Behaviour (F001002)

Purpose	To describe a scenario of the feature responding to a Welcome Farewell Trigger. For a full list of triggers and behaviors refer to the Welcome Farewell /
	Lincoln Embrace Strategy RQT-002004-704098.

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Actors		User
		Welcome Farewell
Precondition		Vehicle Ignition is OFF
Main Flow	M1	The User interacts with the Welcome Farewell feature
	M2	Welcome Farewell instructs ambient lighting to turn on/off in a specific color and intensity
Post-condition		Based on instructions received the Ambient Lights are ON in a specific color and intensity or OFF

Use Case 3: Change Ambient Color and Intensity Settings

###UC_F_AMBL_00004### Changing Ambient Lighting Colour

Purpose		To describe the scenario of a user changing the ambient lighting color setting
Actors		User
Precondition		Vehicle ignition is in RUN/START
Main Flow	M1	The user selects a new color through the feature HMI
Post-condition		The ambient lighting is on in a new color and intensity
		The HMI screen displays updated settings

###UC_F_AMBL_00005### Changing Ambient Lighting Intensity

Purpose		To describe the scenario of a user changing the ambient lighting intensity
		setting
Actors		User
Precondition		Vehicle ignition is in RUN/START
Main Flow	M1	The user selects a new intensity through the feature HMI
	M2	
Post-condition		The ambient lighting is on in a new color and intensity
		The HMI screen displays updated settings

###UC_F_AMBL_00006### Turning OFF Ambient Lighting via HMI

Purpose		To describe the scenario of a user turning OFF ambient lighting via the HMI
Actors		User
Precondition		Vehicle is configured for Single Color Ambient Lighting Ambient Lighting is ON in the vehicle Ambient Lighting HMI is active
Main Flow	M1	The user selects Ambient Lighting OFF via the HMI
	M2	
Post-condition		The Ambient Lighting is turned OFF in the vehicle The HMI shows Ambient Lighting turned OFF

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###UC_F_AMBL_00007### Changing Ambient Lighting Settings via Enhanced Memory

Purpose		Describes the scenario of changing ambient lighting settings through interaction with the Enhanced Memory Feature. Reference the Enhanced Memory feature specification (F000172) for more details on methods by which a driver profile can be changed.
Actors		User Enhanced Memory
Precondition		Vehicle equipped with Enhanced Memory Profile X exists with associated ambient lighting settings but is not active
Main Flow	M1	The user changes to driver profile X via Enhanced Memory
	M2	Enhanced Memory provides new profile to ambient lighting
Post-condition		The ambient lights transition to the color and intensity associated with profile X The HMI screen displays updated settings

###UC_F_AMBL_00008### Ambient Door Ajar Indication (Lincoln/Ford Multicolour ONLY)

Purpose		To describe the scenario of a user opening a door or leaving it ajar in ambient operation mode
Actors		User
Precondition	Vehicle ignition is in RUN/START All doors are closed Lincoln/Ford Multicolor variant ONLY Ambient Lighting is enabled	
Main Flow	M1	A user opens any vehicle door
Alternative Flow 1		
Post-condition		The door ambient lighting LEDs for any open door are on in the Ajar color (Red) at 100% intensity

4.3 Driving Scenarios

#Hint: (**Optional**) For details of the "Driving Scenario" method refer to the <u>RE Wiki</u>. Please use the Add Ins -> Add Requirement macro (select "Scenario" as type) to add a new Driving Scenario Description.

4.4 Decision Tables

#Hint: (**Optional**) For details of this method refer to the <u>RE Wiki</u>. Use decision table, if state / transition table in 4.1 does not sufficiently describe behavior of feature.

Input Signal 1	Input Signal 2	Input Signal 3	Input Signal 4	Output Signal
Value I1	Value I2			Value O1



FEATURE REQUIREMENTS

#Hint: (Mandatory) Please use the Add Ins -> Add Requirement macro (select "Requirement" as type) to add a new requirements in this section. Refer to the RE Wiki for how to write good requirements.

Functional Requirements

###R_F_AMBL_00001### Host Vehicle State (Power Mode) for Feature Operation

Ambient Lighting shall have functionality across all vehicle Power Modes and Vehicle Modes that would qualify under "normal" operation of vehicle

> Vehicle isn't in an error, error recovery, diagnostic, or any related state which would inhibit normal function of the vehicle

###R_F_AMBL_00002### Conformance to Welcome Farewell Feature Specification

While in Welcome Farewell Mode Ambient Lighting shall conform to behavioral requirements cascaded to it by Welcome Farewell

> The feature abides by commands given to it by Welcome Farewell while in Welcome Farewell Mode

> > End of Requirement

###R_F_AMBL_00003### Manually Selectable Intensity

While in Ambient operation mode Ambient Lighting shall allow a user to manually select the ambient lighting intensity between 0 and 100%

###R_F_AMBL_00004### Light Output Color

Depending on the Ambient Lighting variant, Ambient Lighting shall provide the light color options listed in table below:

Variant	Color	
Ford Single Color	Ice Blue	
Ford Multicolor (including	Ice Blue	
CAL)	Orange	
	Soft Blue	
	Red	
	Green	
	Blue	
	Purple	
Lincoln	Lincoln White	
	Amber	
	Teal	
	Burnt Orange	
	Lincoln Blue	
	Lincoln Green	
	Lilac	

End of Requirement

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###R_F_AMBL_00005### Ambient Lighting User Feedback

Ambient Lighting shall provide feedback of active settings to the user through the HMI

End of Requirement

###R_F_AMBL_00006### Data Analytics

Ambient Lighting shall record:

- How frequently users change the color of Ambient Lighting (Multi Color Variants)
- o How often users manually change the intensity of Ambient Lighting
- How often NJOD color is overridden by customer (Contextual Ambient Lighting)

End of Requirement

###R_F_AMBL_00007### Lighting Transition Interruption

Ambient lighting shall begin ramp ON or ramp OFF illumination behavior instantaneously at the time a new request is received without having to complete the previous ramp request

End of Requirement

###R_F_AMBL_00008### Ramp ON (Ambient Mode)

When transitioning to ON while in Ambient Mode, Ambient Lighting shall ramp ON to the desired intensity at a configurable rate.

End of Requirement

###R_F_AMBL_00009### Ramp OFF (Ambient Mode)

When transitioning to OFF from Ambient Mode Ambient Lighting shall ramp OFF at a configurable rate.

End of Requirement

###R_F_AMBL_00010### Ramp ON (To Welcome/Farewell Mode)

When transitioning to ON in Welcome/Farewell Mode, Ambient Lighting shall ramp ON at a configured rate of 3 seconds

End of Requirement

###R_F_AMBL_00011### Ramp OFF (From Welcome/Farewell Mode)

When transitioning to OFF in Welcome/Farewell Mode, Ambient Lighting shall ramp OFF at a configured rate of 4 seconds

End of Requirement

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###R_F_AMBL_00012### Enhanced Memory – Store Profile Settings

Ambient Lighting shall support Enhanced Memory by storing settings for each Personalization Profile as they are updated

End of Requirement

###R_F_AMBL_00013### Enhanced Memory - Operations - Copy

When requested Ambient Lighting shall support Enhanced Memory by performing a copy of the Ambient Lighting settings from the active Personalization profile onto the selected Personalization profile

End of Requirement

###R_F_AMBL_00014### Ambient Lighting Strategy (UX/CIED)

Ambient Lighting shall comply with to RQT-002004-022593 the Ambient Lighting Strategy

End of Requirement

- 5.1
- 5.1.1 ERROR HANDLING
- 5.2 Nonfunctional Requirements
- 5.2.1 PERFORMANCE
 - The Ambient Lighting shall not flicker while in Welcome/Farewell mode
- 5.2.2 SECURITY
- 5.2.3 **RELIABILITY**

5.3 Safety

Feature is not Functional Safety Relevant

5.4 HMI Requirements

- _
- o Each Feature Variant Shall have a distinct HMI display
- o The HMI shall have an individual intensity slider for each ambient lighting color
- The HMI shall log:
 - How frequently users change the color of Ambient Lighting (multi-color variants)
 - · How often intensities of Ambient Lighting are changed
 - How often NJOD color is overridden by customer (Contextual Ambient Lighting ONLY)

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5.5 Other Requirements

5.5.1 MANUFACTURING REQUIREMENTS

5.5.2 SERVICE REQUIREMENTS

#Hint: Requirements in this section could specify, e.g. what needs to be considered, if individual ECUs are replaced or new SW is flashed to ECUs (parameter set in non-volatile memory might get inconsistent and needs also to be updated).

5.5.3 AFTER SALES REQUIREMENTS

#Hint: Requirements in this section could specify, e.g. input for the Owner's Manual could be gathered.

5.5.4 PROCESS REQUIREMENTS

#Hint: Requirements in this section are relevant for the development process of the feature, e.g. ISO26262 compliance.

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6 ARCHITECTURE

6.1 Functional Architecture

#Hint: (Optional – could be depicted in the Function Spec instead) This section depicts the coarse Functional Architecture. This architectural step is needed to find the right functional partitioning for the function level. The function shown here are those, which are specified on function level. Either SysML activity diagrams or Data Flow Diagrams could be used to depict such a Functional Architecture. Only object flows (=signals) should be used, if a SysML Activity Diagram is used.

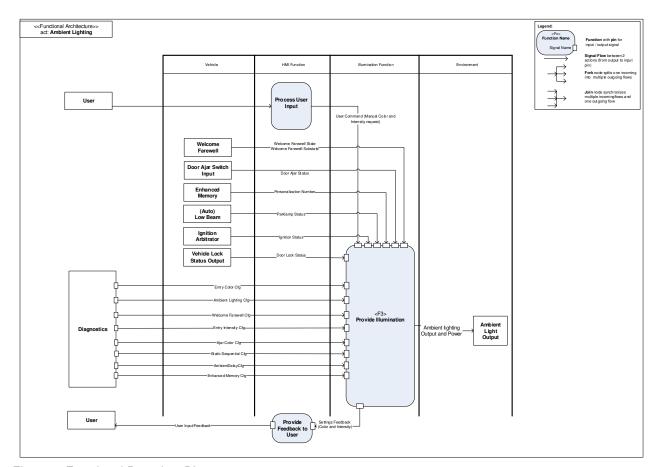


Figure 5: Functional Boundary Diagram

6.1.1 LIST OF FUNCTIONS

#Hint: The functions shown in the Functional Architecture should be listed and described in the table below

Function Name	Description	Link to Function Spec	Comments
Process User Input & Feedback (HMI Function)	Receive/Translate/Transmit User Input to change ambient lighting settings and the feedback sent to the HMI		
Provide Illumination	System function that contains all feature functions that are related to provide the actual light		

Table 10: List of Functions

EESE

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6.2 Logical Architecture

#Hint: (This section is required for Functional SafetyAnalysis only – remove otherwise) FS Analysis requires a description of the boundary of the feature and its elements, the behavior achieved by similar functions, features or elements as well as the allocation and distribution of functions among the involved systems and elements. A simple block diagram or a SysML Internal Block Diagram could be used to depict the Logical Architecture

Figure 6: Logical Boundary Diagram

6.2.1 LOGICAL INTERFACES

#Hint: (Only required for Functional SafetyAnalysis) The FS analysis requires a description on interactions of the feature with other features or elements.

Table 11: Feature Interactions

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7 OPEN ISSUES

ID	Issue Description	e-Tracker / Reference	Responsi ble	Status	Solution
1	Current factory default state of Ambient Lighting is OFF. Should this be changed to ON?				
2	Single Color Ambient Lighting HMI intensity steps do not match BCM capability. Requirement captured in ALS RQT.				Capture requirement ensuring HMI intensity resolution matches the logical functions' intensity resolution.
3					
4					
5					
6					
7					
8					
9					

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8 REQUIREMENTS TRACEABILITY

Note: The requirements traceability matrix will be generated in the future by VSEM. For the time being this just lists all use cases / requirements specified in this document.

8.1 Use Cases

No table of contents entries found.

8.2 Requirements

No table of contents entries found.

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9 REVISION HISTORY

Rev.	Vers.	Date	Description	Approved by	Responsible
001			Initial version		Jbaden1

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