System Specification

Automatic Door

AuDo

Release

Subject department	Name	Date	Signature
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Note:
In order to uniquely identify document contents, the database assigns identifiers (**SourceID**). The identifiers may appear at different locations in the document depending on how the document is formatted:

- ID left, text right (requirement)
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V09					
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V15					

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1 Introduction (STD-1)

STD-2: This Requirements Specification describe the requirements of SMURF AG (referred to as "client" in the following) for the product to be developed by the supplier (referred to as "contractor" in the following).

1.1 Disclaimer (STD-10)

STD-11: This Requirement Specification describes a Demo System. Although inspired by real-world systems, it does neither reflect a current nor a future system that is part of Mercedes-Benz Passenger Cars.

STD-12: This document is inspired by the way specification documents are written at Mercedes-Benz Passenger Car Development. However, it contains intentionally requirements defects and other flaws that may occur during writing specificaition documents in industry.

1.2 Document Creation with DOORS (STD-3)

STD-4: The present document was generated from a database (DOORS). Maintenance and updating of this document is performed in this database.

STD-5: In order to uniquely identify document contents, the database assigns identifiers (**SourceID**). The identifiers may appear at different locations in the document depending on how the document is formatted:

- ID left, text right (requirement)
- ID under the text (requirement)
- ID in brackets after a heading

STD-6: The requirements contained in this document may be acquired by the contractor as a DOORS export.

STD-7: Each requirements has some additional attributes providing additional information:

STD-8: **Attribute Object Type**. The values are as follows:

- Heading: The corresponding text object is a heading, meant to structure the requirements document
- Predefinition: The corresponding text object contains a legally binding fact that has to be taken into account by the client.
- Requirement: The corresponding text object contains a legally binding requirement that has to be fulfilled by the contractor. The fulfilling of the requirement may be verified by the client.
- Information: The corresponding text object contains additional information that either provide additional examples or explanations or are meant to structure the text.

STD-9: **Attribute Verification Method**. This attribute is relevant for objects with Object type = requirement only. It defines the type of verification method the client intends to verify the fulfillment of the requirement.

2 Scope (STD-13)

2.1 Project Specification (STD-14)

AD-15: The system described in this requirements specification is refered to as Automatic Door.

AD-16: AuDo is herewith established as the binding abbreviated designation for the Automatic Door.

AD-17: The use of the system described in this requirement specification is planned for the SMURF series X12 and X14.

AD-18: For the described system, no distinctions are made for the different target markets, namely USA/Canada, China, Japan, and Rest of the World.

2.2 Short Description (STD-15)

AD-20: The Automatic Door is a car door where opening and closing is supported by an electric engine. It is intended to make opening and closing of heavy doors (as in luxury vehicles) more comfortable.

AD-21: An ultrasonic collission detection shall prevent damaging obstacles (e.g. other cars, walls, pedestrians).

AD-23: After unlocking a door with the inside door handle, the Automatic Door opens until (1) it reaches maximum opening position, (2) it detects an obstacle, or (3) the car passenger stops doors opening by holding the door via the door grab handle.

AD-24: An Automatic Door closes if the passenger gently pulls at the door grab handle. Closing stops either if the door is completely closed or an obstacle is detected (e.g. a coat or leg).

AD-25: Pushing the Automatic door from outside invokes also a closing process. Closing is done in a fast manner if no passenger is inside the car and slowly if a passenger sits inside the car.

AD-22: An Automatic Door is equipped with a retractable door handle. The door handle is extended when a car key is detected in proximity of the car and a hand is near the position of the door handle.

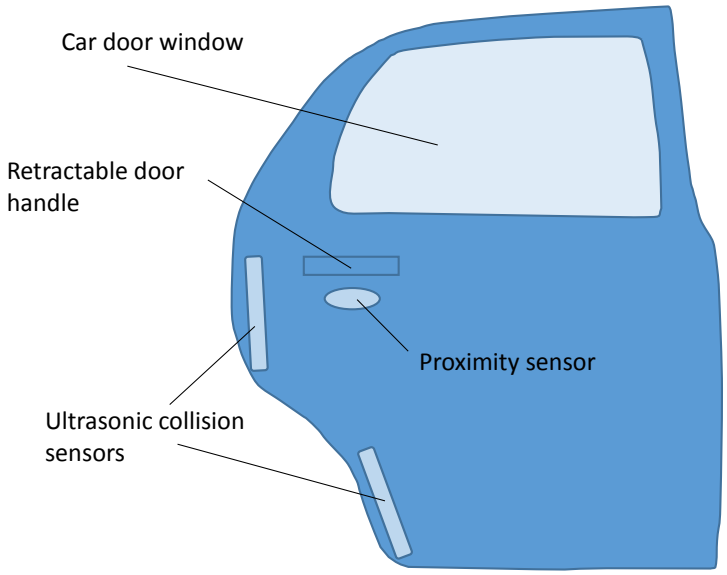
3 Product Specification (STD-16)

3.1 Product Scope and Interfaces (STD-20)

3.1.1 Elements of the Automatic Door (AD-53)

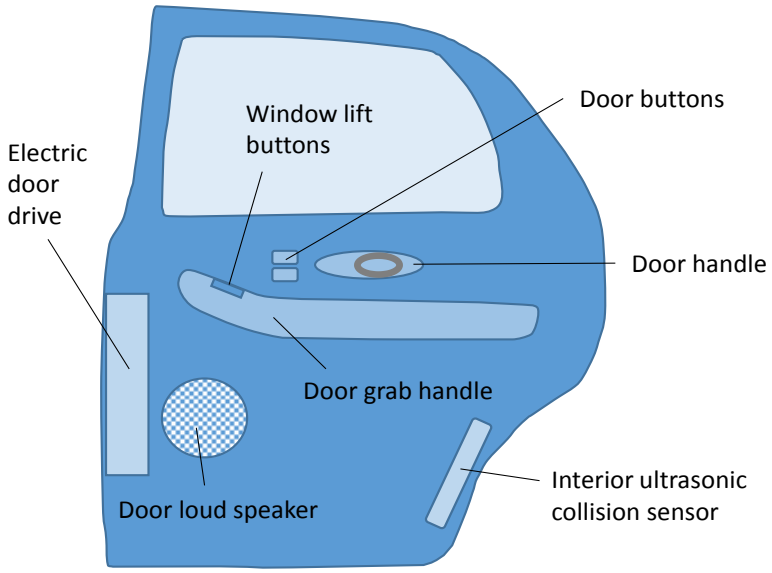
AD-31: **Figure:** Outside elements of an Automatic Door.

Outside view



AD-33: **Figure:** Inside elements of an Automatic Door.

Inside view



3.1.2 Interfacing Systems (AD-54)

AD-55: The following systems are interfacing the Automatic Door System:

AD-56: - KeyLessGo System: Provides information whether a valid car key is near the door.

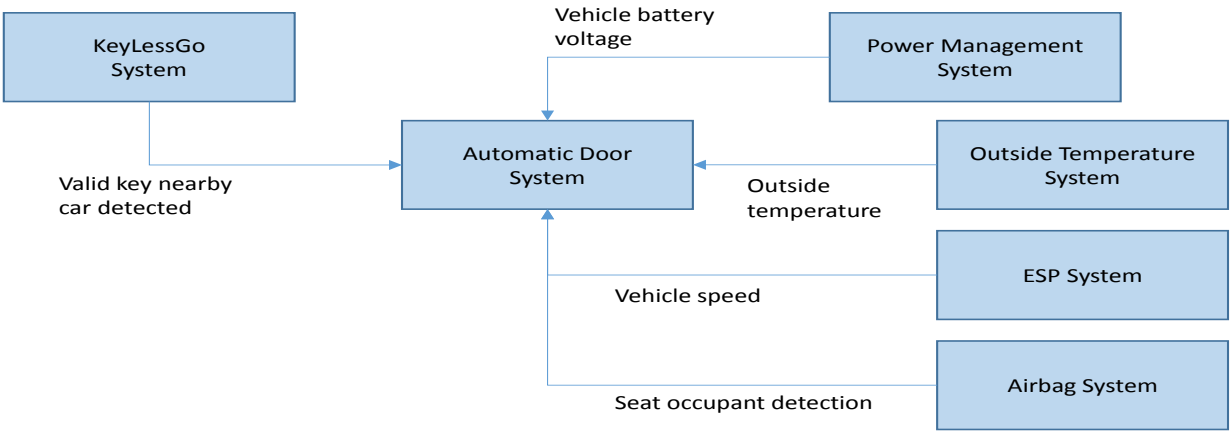
AD-57: - Power Management System: Provides information on the vehicle battery status.

AD-58: - Outside temperature system: Provides infomation on the outside temperature.

AD-60: - ESP system: Provides the current vehicle speed.

AD-90: - Airbag system: Provides information about occupied seats.

AD-59: **Figure:** Interfacing Systems



3.1.3 Components of the System (AD-107)

AD-108: The following components are part of the Automatic Door System:

AD-109: - Door Control Unit (DCU). Interfacing sensors and actors are: (1) door handle, (2) door grab handle (a capacity touch field), (3) door buttons, (4) interior ultrasonic collision sensor, (5) outside ultrasonic collision sensors, (6) proximity sensor, (7) motor for extending and retracting the outside door handle, (8) window lift buttons.

AD-110: - Electric door drive unit (EDDU).

3.2 Functions (STD-21)

3.2.1 Door Opening (AD-35)

AD-36: The overall preconditions for AuDo door opening are:

AD-37: • Battery voltage is in normal range, i.e. between 11.5V and 13.5V.

AD-38: • Outside temperatur is in normal range, i.e. it is between -10°C and +40°C.

AD-39: • There are no stored failure codes with respect to AuDo.

AD-48: • Vehicle speed is below 1 km/h.

AD-61: • Vehicle door is closed.

3.2.1.1 Opening from Inside (AD-40)

AD-41: Opening starts when the passenger lifts the door handle and the door mechanically unlocks.

AD-42: Opening continues until one or more of the following conditions are fulfilled:

AD-43: • One of the outside ultrasonic collision detection sensors detects an obstacle nearer than 5cm.

AD-44: • The passenger touches the door grab handle.

AD-45: • The door has reached its full opening position.

AD-46: • The passenger touches the door handle again.

AD-47: • The opening force is above the specified maximum force f_max.

AD-72: • The passenger uses a window lift button.

AD-111: • The passenger activates a door button.

AD-73: • One or more preconditions are violated.

AD-112: Opening also starts if the passenger activates the "door open button".

AD-114: If the door is locked, pressing the "door open button" first unlocks the doors mechanically, and then electic opening starts.

AD-115: If the doors has already been unlocked, pressing the "open doors button" starts electric opening until a stop opening condition (see AD-42) holds.

3.2.1.2 Opening from Outside (AD-51)

AD-52: When the KeyLessGo systems detects a valid key nearby the vehicle and the proximity detector detects a moving object within 10cm or less, the retractable door handle is extended.

AD-62: If the retractable door handle is not pulled within 10 seconds, it is moved back to the closed position.

AD-113: Another extension of the retractable door handle is only possible, if the proximity detector has not detected a moving object within 10cm or less for at least 2 seconds.

AD-63: If the retractable door handle has extended and moved back 5 times without any pulling, play protection is activated. This means, any further moving objects will not extend the retractable door handle any more.

AD-65: Play protection shall prevent unnecessarily door handle movements as this causes discharging of the vehicle battery and unnecessary mechanical load. Moving objects might be playing children or animals or moving plants.

AD-64: Play protection is deactivated by: (1) Locking and unlocking the vehicle via the radio key or (2) a time delay of 5 minutes.

AD-66: If the retractable door handle is pulled, the door unlocks. As long as the retractabe door handle is pulled, there is no automatic opening (as the passenger is directly nearby the door).

AD-67: If the retractable door handle is released and the proximity detector does not detect an object within 10cm or less and the ultrasonic collision sensors do not detect an obstacle within 10cm or less the automatic door opening is activated.

AD-68: The opening of the door is activated 'til at least a single conditions is fulfilled:

AD-69: - An object is detected by the ultrasonic sensors within 5cm

AD-70: - The door is stopped from inside the car (e.g. by touching the door grab handle or the door handle).

AD-71: - The electric door drive detects an increasing force request during movement (e.g. due to an object that slows the door).

3.2.2 Door Closing (AD-49)

AD-74: The overall preconditions for AuDo door closing are as follows:

AD-76: • The relevant vehicle door is open

AD-77: • The vehicle is standing.

AD-75: • Vehicle power supply is in good condition. This means the we see 11.0V to 14.0V.

AD-78: • Outside temperatur: -10°C <= Current temperature <= +40°C.

AD-79: • No DTCs stored with respect to AuDo and its sensors.

3.2.2.1 Closing from Inside (AD-50)

AD-80: A vehicle passenger initiates doors closing by gently pulling the door grab handle.

AD-81: Doors closing stops when the passenger releases the door closing handle, one of the preconditions is no longer fulfilled, the door has closed, or the interior ultrasonic collision sensors detect an obstacle.

AD-82: If the door is almost closed (i.e. door touches vehicle cassis), the passenger may release the door grab handle. In this case, the final closing is performed automatically.

AD-116: The passenger can initiate doors closing by activating the "door close button". After pressing the button may be released.

3.2.2.2 Closing from Outside (AD-83)

AD-84: The electric door drive can sense momentum to the door that is applied from extern sources, like pushing the door, or moving the door due to wind.

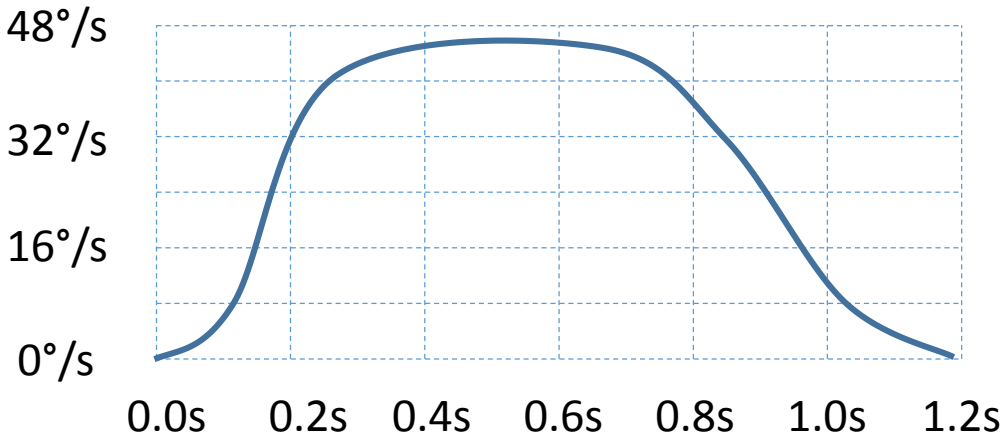
AD-85: If the door drive detects a moderate momentum that origins from a person outside the car pushing the door, the closing process shall start.

AD-86: A moderate momentum is defined as follows:
- Pushing force between 10N and 50N
- Acceleration beetween 5m/s² and 15m/s².

AD-87: Additionally, the ultrasonic collision sensors and/or the proximity sensor shall detect an object so that we can assume that a person is pushing the door and the movement it not initiated by wind.

AD-88: The closing speed shall depend on "Is there a passenger sitting on the related seat?". If there is a passenger, closing speed shall be 25°/second. If there is no passenger on the related seat, closing speed shall be 45°/second.

AD-89: Closing shall be accelerated and decelerated according to the following figure (for the 45°/second case).

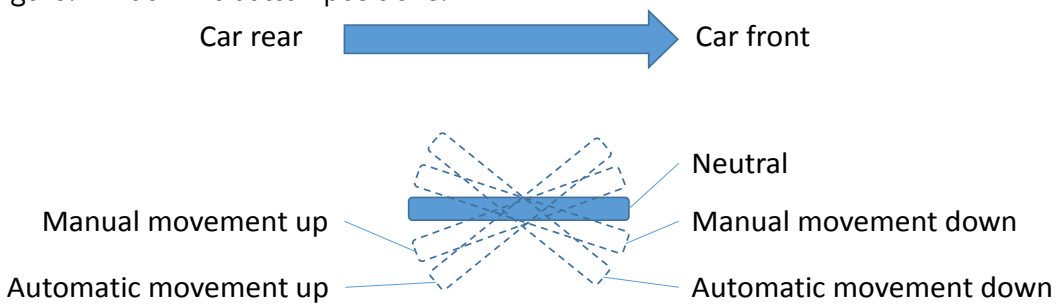


3.2.3 Window Lift (AD-91)

AD-92: A window lift button has the following positions:
- Neutral
- Manual movement up
- Automatic movement up

- Manual movement down
- Automatic movement down

AD-117: Figure: window lift button positions:



AD-93: Without passenger interaction, a window button is in neutral position. By pulling a window lift button, it moves from neutral to manual movement up to automatic movement up. By pushing a window lift button, it moves from neutral to manual movement down to automatic movement down. There is a haptic feedback when switching between the positions.

3.2.3.1 Window opening (AD-94)

AD-118: The follwing preconditions must hold in order to activate the electric window opener:

AD-119: - Vehicle power supply is in good condition. This means the we see 11.2V to 13.5V.

AD-120: - There are no stored DTCs with respect to electric window.

AD-121: - Ignition is on.

AD-122: While the button is in manual movement down position, the window is moved down.

AD-124: If the window lift button has been pushed to the automatic movement position, electric window opening shall continue even if the button is released.

AD-123: Electric window opening stops, if the force to open the window exceeds certain limits (e.g. due to blocking ice), the button is released, the window is completely opend, one of the preconditions is no longer fulfilled.

3.2.3.2 Window closing (AD-125)

AD-126: The follwing preconditions must hold in order to close the window:

AD-127: - Battery power between 11.2 and 13.5V.

AD-134: - No stored failure codes.

AD-128: - Ignition on.

AD-129: While window button = "manual movement up" the window moves up.

AD-130: If window button = "automatic movement up", the window shall move up until it is fully closed or anti-pinch protection is activated.

AD-131: Pressing the window button while moving the window up again stops the closing process.

3.3 Error Handling (STD-22)

AD-165: Generally, error handling and diagnosis shall be adhere to [SDD:01].

AD-167: The following errors shall be detected by the DCU and stored in the DTC (Diagnostic Trouble Code) mentioned in the brackets.

AD-168: [DTC-1202] Short circuit of door handle

AD-169: [DTC-1203] Too high capacity of door grab handle (i.e. higher than 1200µF)

AD-170: [DTC-1204] Too low capacity of door gran handle (i.e. lower than 200µF)

AD-171: [DTC-1205] Short circuit of outside ultrasonic collision sensors

AD-172: [DTC-1206] Open load of outside ultrasonic collision sensors

AD-173: [DTC-1207] Short circuit of proximity sensor

AD-174: [DTC-1208] Open load of proximity sensor

AD-175: [DTC-1209] No movement of motor for extending and retracting the outside door handle

AD-176: [DTC-1210] Short circuit of window lift buttons.

3.4 Operating Conditions (AD-136)

AD-138: The AuDo system must be operational between outside temperatures between -40°C and +50°C.

AD-99: The AuDo system must be operational also if there are bad wheather conditions or a visual range is shorter than 20 meters.

AD-100: If there are further operational constraints, the worst case scenario must be established by the contractor and approved by the client.

AD-140: The AuDo system shall fulfill the environmental constraints as described by [STD:4321].

AD-141: The contractor is responsible to run adequate tests (e.g. vibration) and provide the test result documentation to the client.

3.5 Implementation Constraints (AD-137)

AD-139: The implementation should be made according to [AUTOSAR 4.2].

AD-98: All timing aspects have to be handled appropriate to [AUTOSAR 4.2].

AD-142: Should it be the case that RAM consumtion exceeds 90% of available space at Start-of-Production, then the contractor shall propose means to lower memory consumption early in the project.

AD-103: This task configuration shall be closely discussed between the client and the contractor and should be agreed by the client.

4 Contacts and Responsibilities (STD-17)

4.1 Client's contracts (STD-23)

STD-24: The contact persons for the client are listed in the following section.

STD-25: System responsible:
Name: John Doe
Department: Electric Door Systems
Mail: john.doe@smurf.com

STD-26: Materials purchasing:
Name: Jane Money
Department: Int. Mat. Purchase 2.1
Mail: jane.money@smurf.com

STD-27: Functional safety:
Name: Monica McSafety

Department: Electric Door Systems
Mail: monica.mcsafety@smurf.com

4.2 Project Responsibilities (STD-28)

STD-29: The contractor shall maintain an "open points" list, to include a measure tracking system.

STD-30: On request, the contractor shall allow the client to inspect the open points list and the measure tracking system. On request, the contractor shall provide relevant documents to the client once or in a rhythm which is to be defined (e.g. weekly) to the client in electronic form.

STD-31: The contractor shall designate a project manager for the project; he coordinates and monitors the processes within the contractor's organization and acts as the interface to the client.

STD-32: Which project partner assumes which responsibilities in the project are defined in the following list.

STD-33: The following designations are used in the responsibilities list:
- R = Responsible for development
- E = Executes development
- C/A = Checks/approves development
- A = Performs acceptance procedures
- I = Receives information

STD-34: **Product FMEA**
Scope: AuDo System
Client: C/A, I
Contractor: R, E

STD-35: **Creation of technical specifications**
Scope: AuDo System
Client: A
Contractor: R, E

5 Documentation (STD-18)

STD-38: The contractor shall continuously document the development status of the product. Upon request, the contractor shall allow the client to inspect this documentation.

STD-37: The documentation must comply with all laws, rules and technical guidelines and standards that apply to the overall product or parts thereof.

STD-36: For this component, requirements with integrity levels exist. These shall be developed and documented as per provision in the [ISO 26262].

6 Other Applicable Documents (STD-19)

STD-39: The following list contains documents prepared by the client or by external entities. If a version or issue date is cited for a document, then this version shall apply. Otherwise, the newest version of the document shall be used.

STD-40: The contractor shall examine the standards referenced here for actuality. If these standards have changed in the course of the development, the contractor shall point out, what this means for time and costs.

AD-161: [ISO 26262] Road vehicles - Functional safety - All Parts

AD-163: [STD:1228] Design Guidelines for Connection Systems, issue 2015-10

AD-162: [STD:4321] Electric and Electronic Components in Motor Vehicles – Environmental Requirements and Tests

AD-166: [SDD:01] Smurf Diagnostic Definition, Issue 2018-02