Comfort Control Unit in SysML

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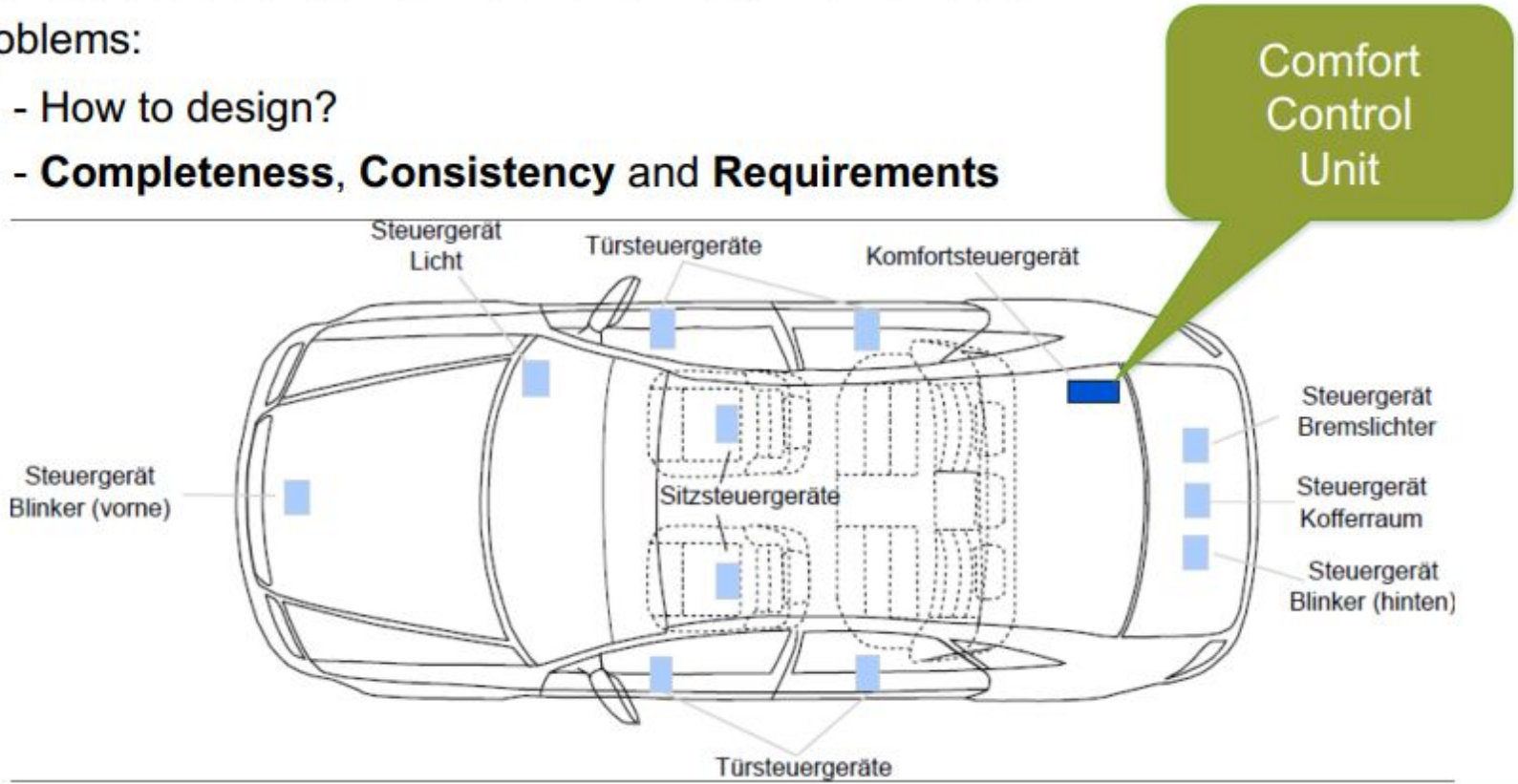
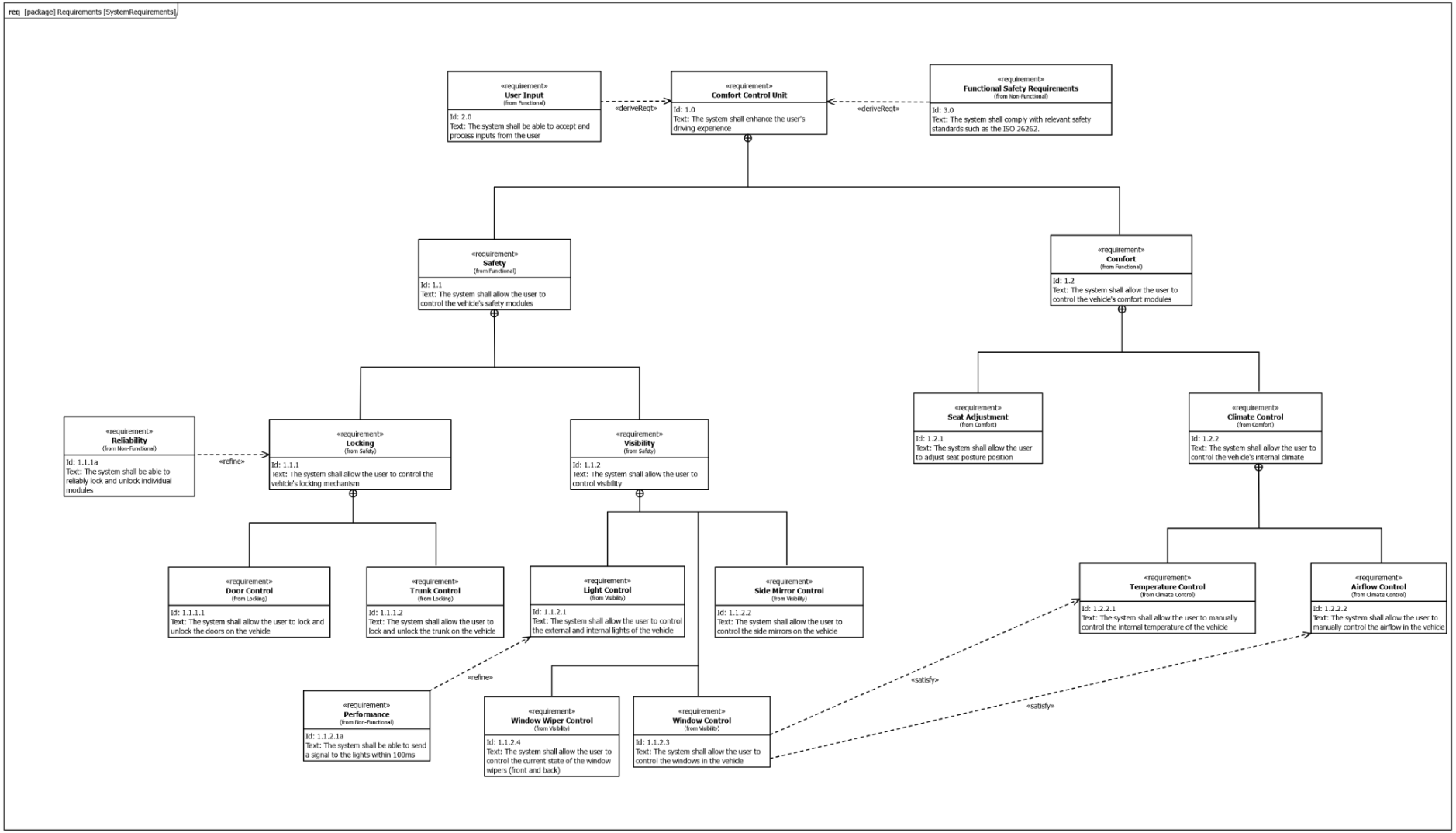
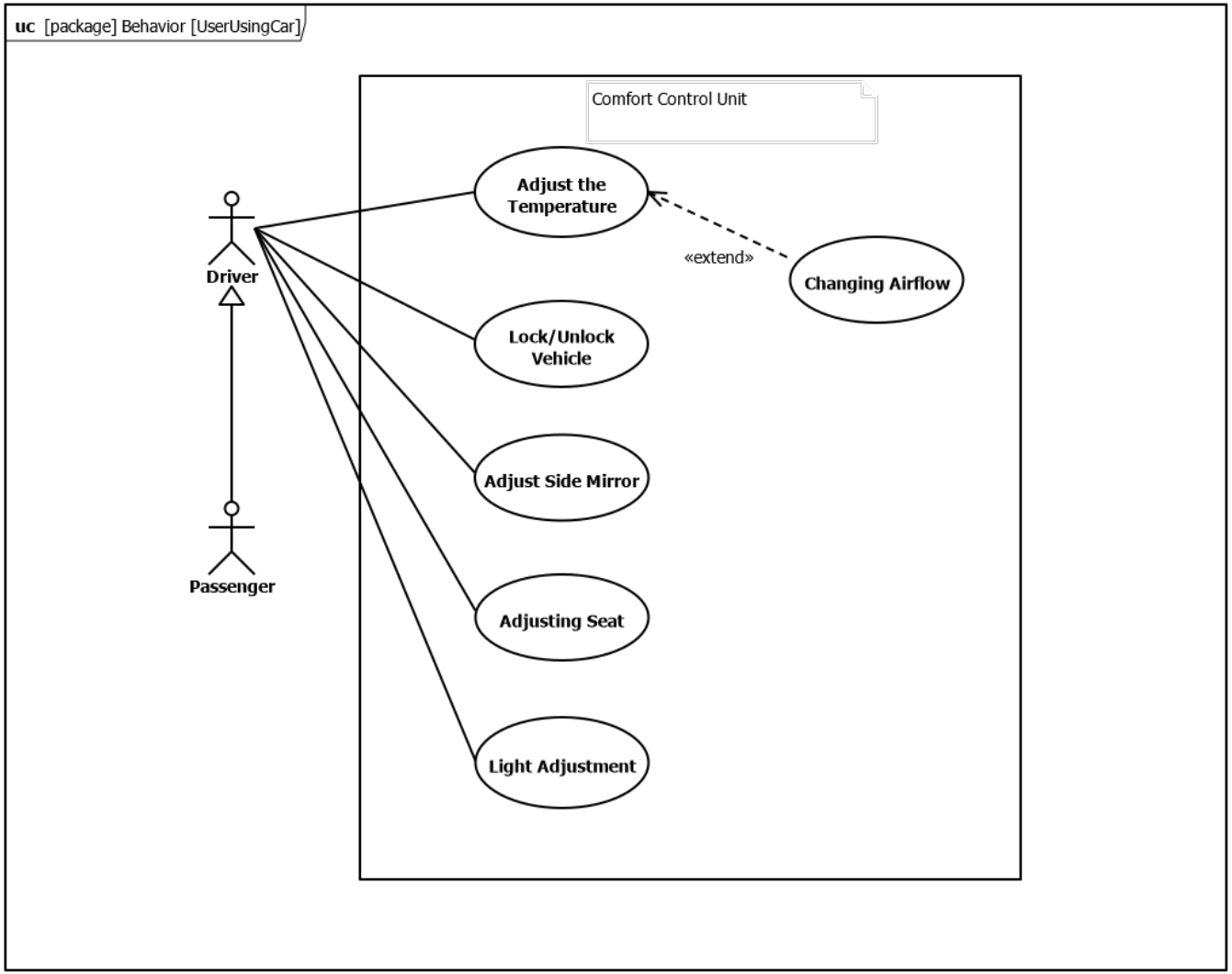
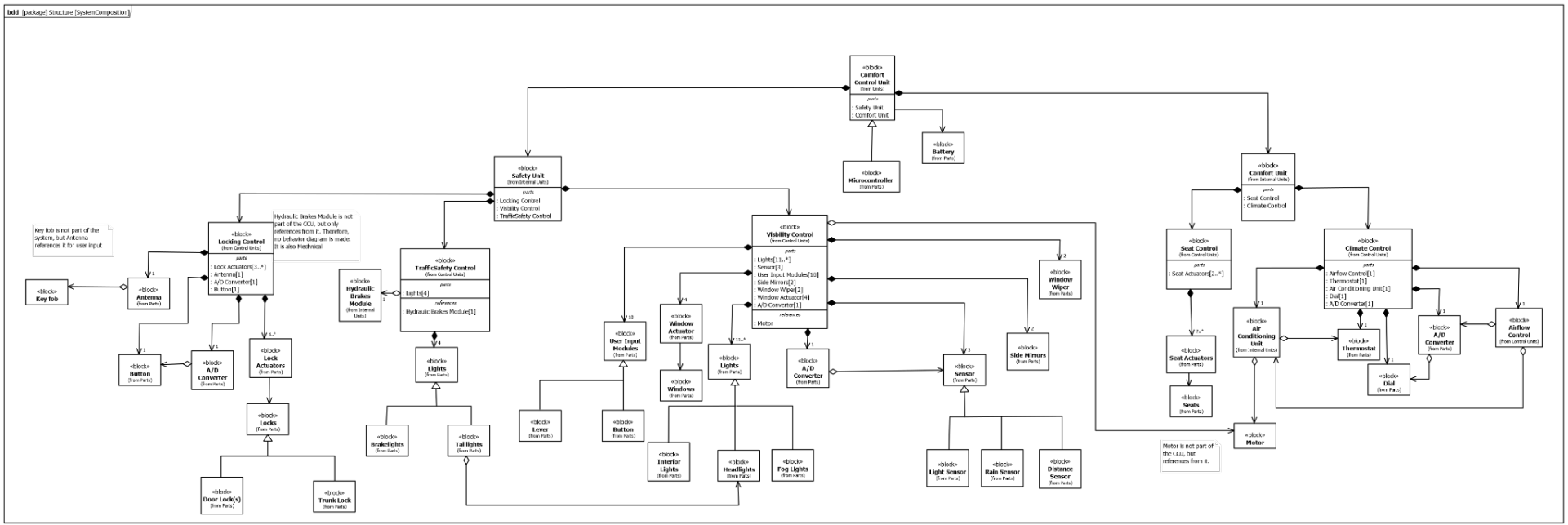
Comfort Control Unit

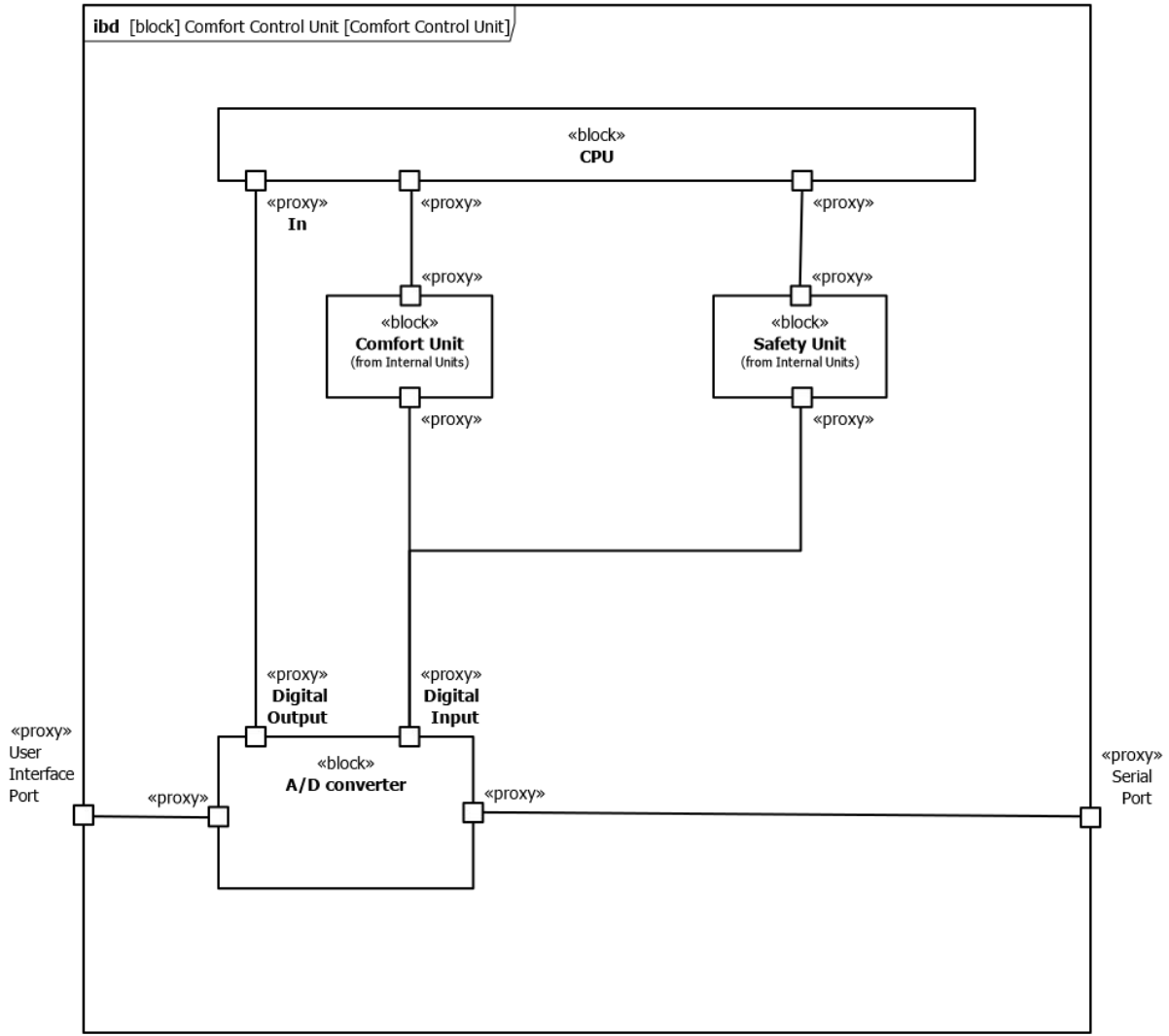
- System control lights, signals and doors of car
- Interfaces to other domain networks in car, like Powertrain
- Problems:
  - How to design?
  - **Completeness**, **Consistency** and **Requirements**

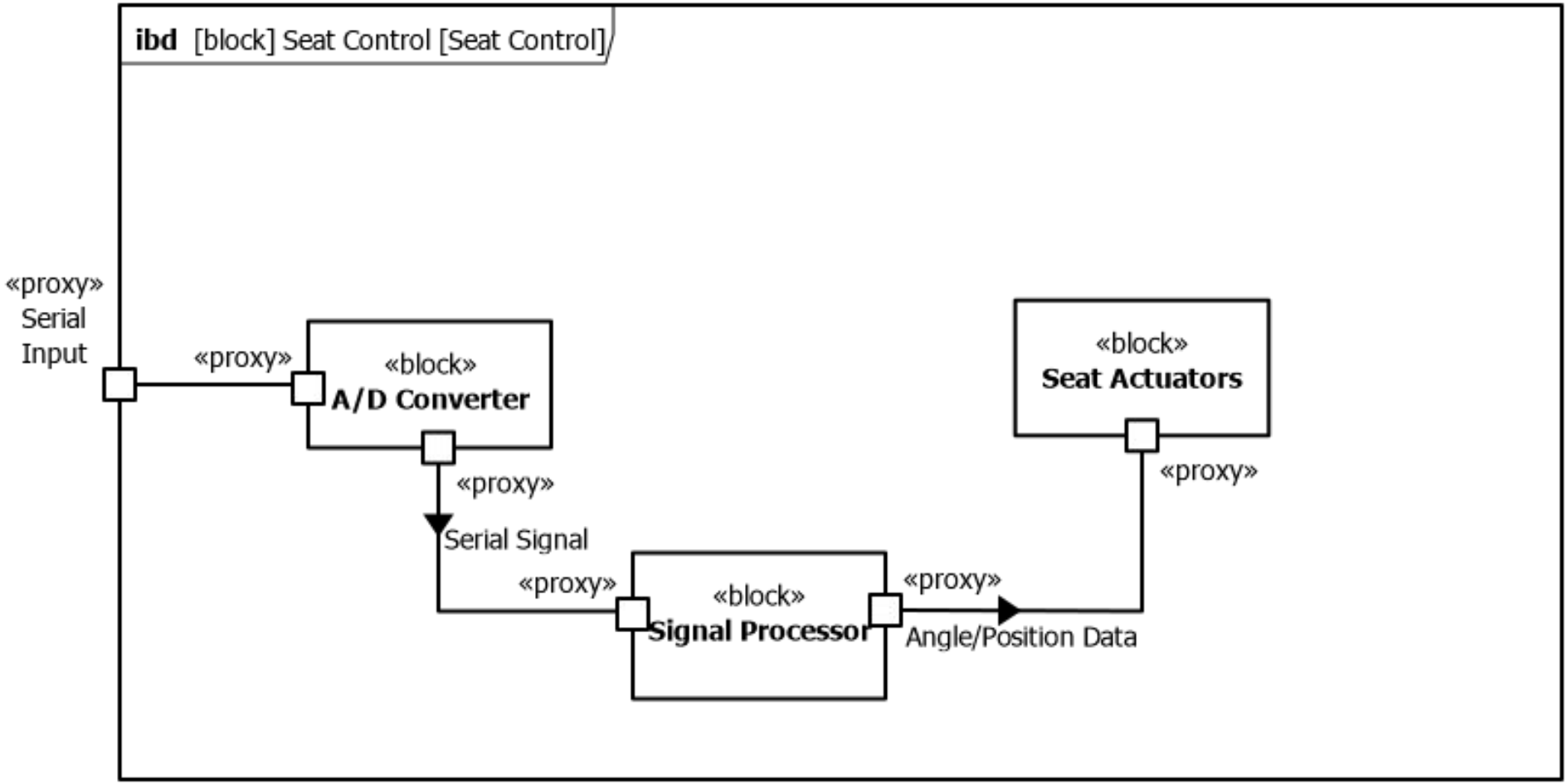


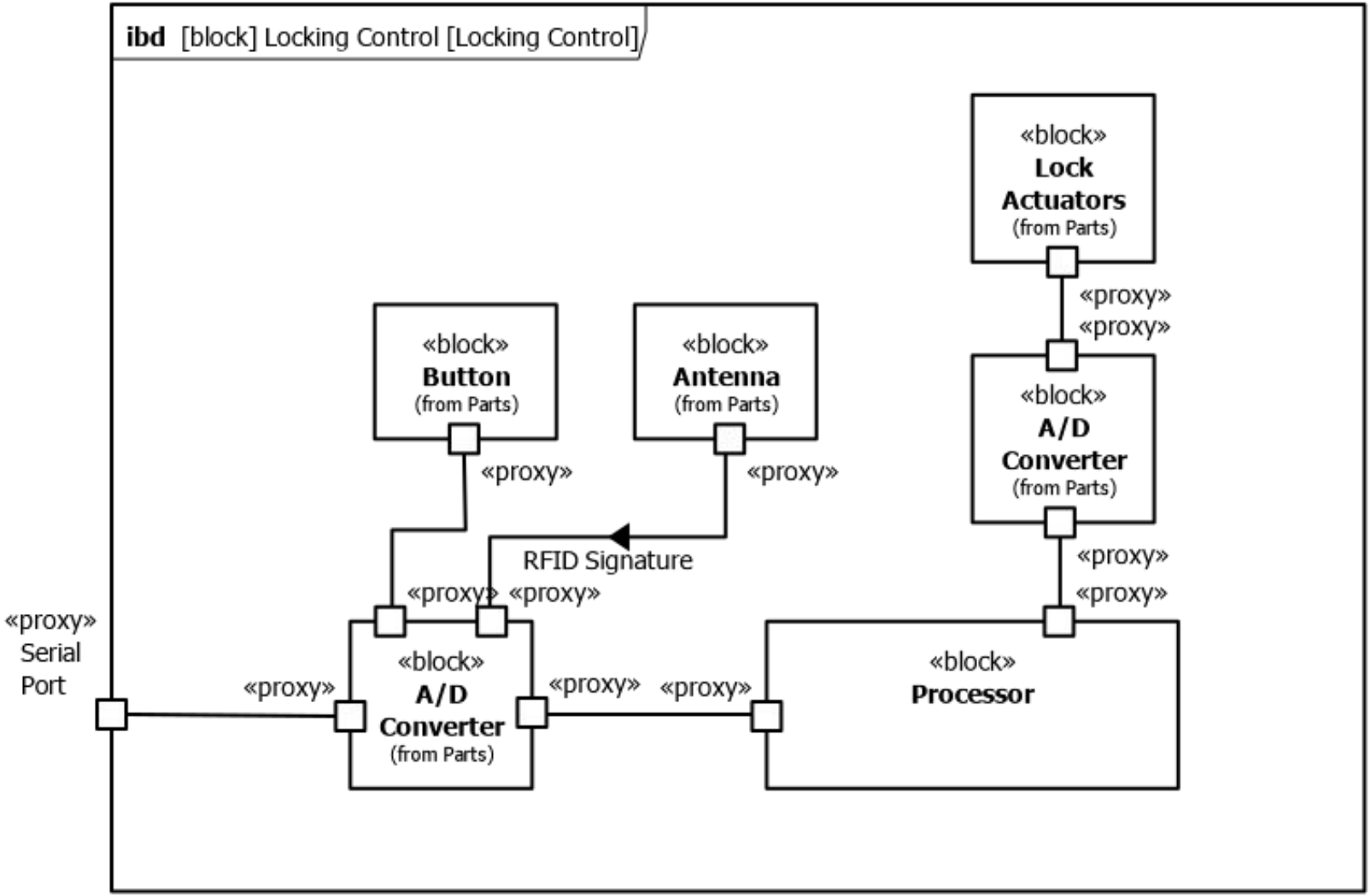

«requirement»
User Input
(from Functional)
Id: 2.0
Text: The system shall be able to accept and process inputs from the user
«deriveReqt»
«requirement»
Comfort Control Unit
Id: 1.0
Text: The system shall enhance the user's driving experience
«deriveReqt»
«requirement»
Functional Safety Requirements
(from Non-Functional)
Id: 3.0
Text: The system shall comply with relevant safety standards such as the ISO 26262.
«requirement»
Safety
(from Functional)
Id: 1.1
Text: The system shall allow the user to control the vehicle's safety modules
«requirement»
Comfort
(from Functional)
Id: 1.2
Text: The system shall allow the user to control the vehicle's comfort modules
«requirement»
Reliability
(from Non-Functional)
Id: 1.1.1a
Text: The system shall be able to reliably lock and unlock individual modules
«refine»
«requirement»
Locking
(from Safety)
Id: 1.1.1
Text: The system shall allow the user to control the vehicle's locking mechanism
«requirement»
Visibility
(from Safety)
Id: 1.1.2
Text: The system shall allow the user to control visibility
«requirement»
Seat Adjustment
(from Comfort)
Id: 1.2.1
Text: The system shall allow the user to adjust seat posture position
«requirement»
Climate Control
(from Comfort)
Id: 1.2.2
Text: The system shall allow the user to control the vehicle's internal climate
«requirement»
Door Control
(from Locking)
Id: 1.1.1.1
Text: The system shall allow the user to lock and unlock the doors on the vehicle
«requirement»
Trunk Control
(from Locking)
Id: 1.1.1.2
Text: The system shall allow the user to lock and unlock the trunk on the vehicle
«requirement»
Light Control
(from Visibility)
Id: 1.1.2.1
Text: The system shall allow the user to control the external and internal lights of the vehicle
«requirement»
Side Mirror Control
(from Visibility)
Id: 1.1.2.2
Text: The system shall allow the user to control the side mirrors on the vehicle
«requirement»
Temperature Control
(from Climate Control)
Id: 1.2.2.1
Text: The system shall allow the user to manually control the internal temperature of the vehicle
«requirement»
Airflow Control
(from Climate Control)
Id: 1.2.2.2
Text: The system shall allow the user to manually control the airflow in the vehicle
«refine»
«requirement»
Performance
(from Non-Functional)
Id: 1.1.2.1a
Text: The system shall be able to send a signal to the lights within 100ms
«requirement»
Window Wiper Control
(from Visibility)
Id: 1.1.2.4
Text: The system shall allow the user to control the current state of the window wipers (front and back)
«requirement»
Window Control
(from Visibility)
Id: 1.1.2.3
Text: The system shall allow the user to control the windows in the vehicle
«satisfy»
«satisfy»

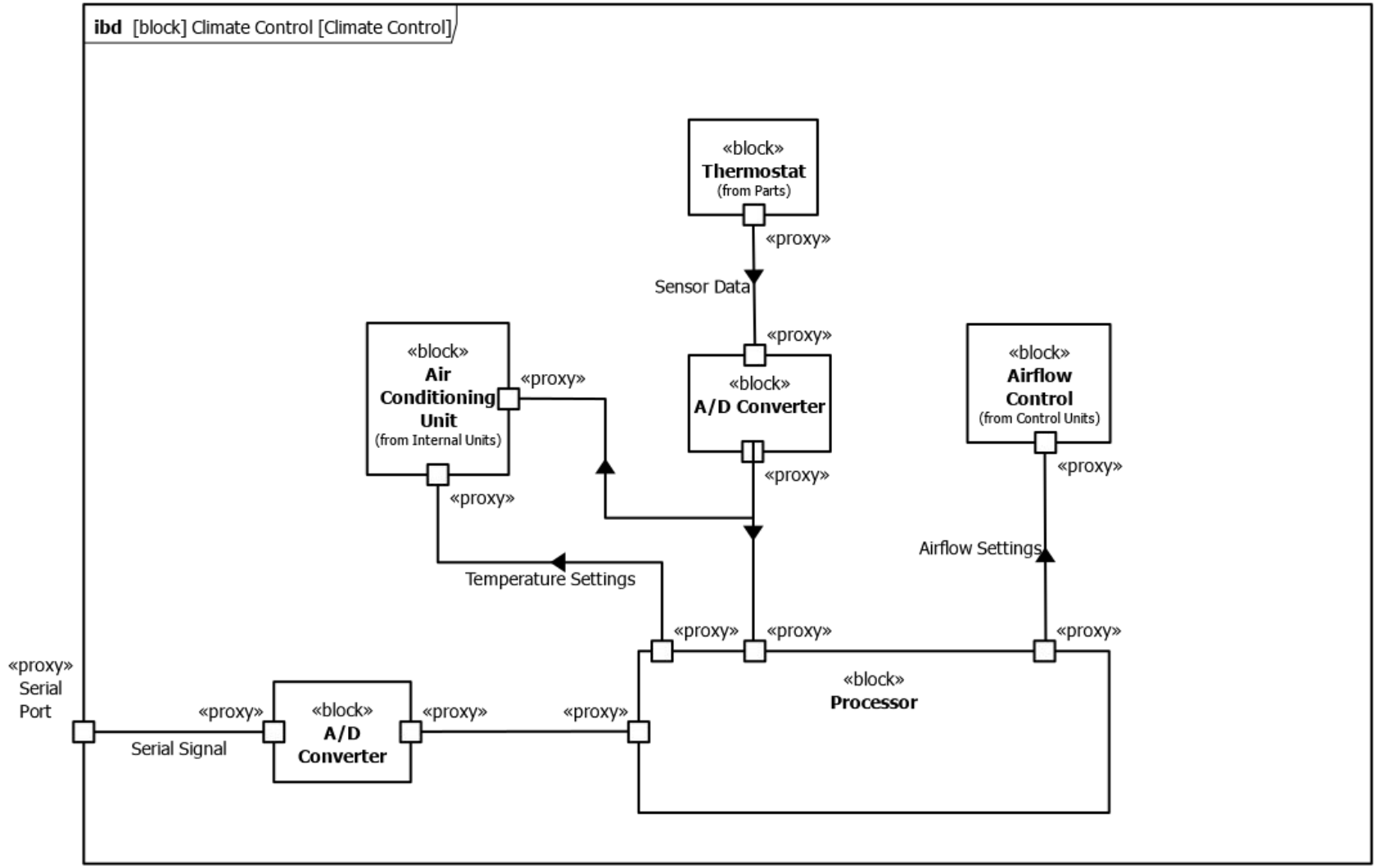

uc [package] Behavior [UserUsingCar]
Comfort Control Unit
Adjust the Temperature
«extend»
Changing Airflow
Driver
Lock/Unlock Vehicle
Adjust Side Mirror
Passenger
Adjusting Seat
Light Adjustment

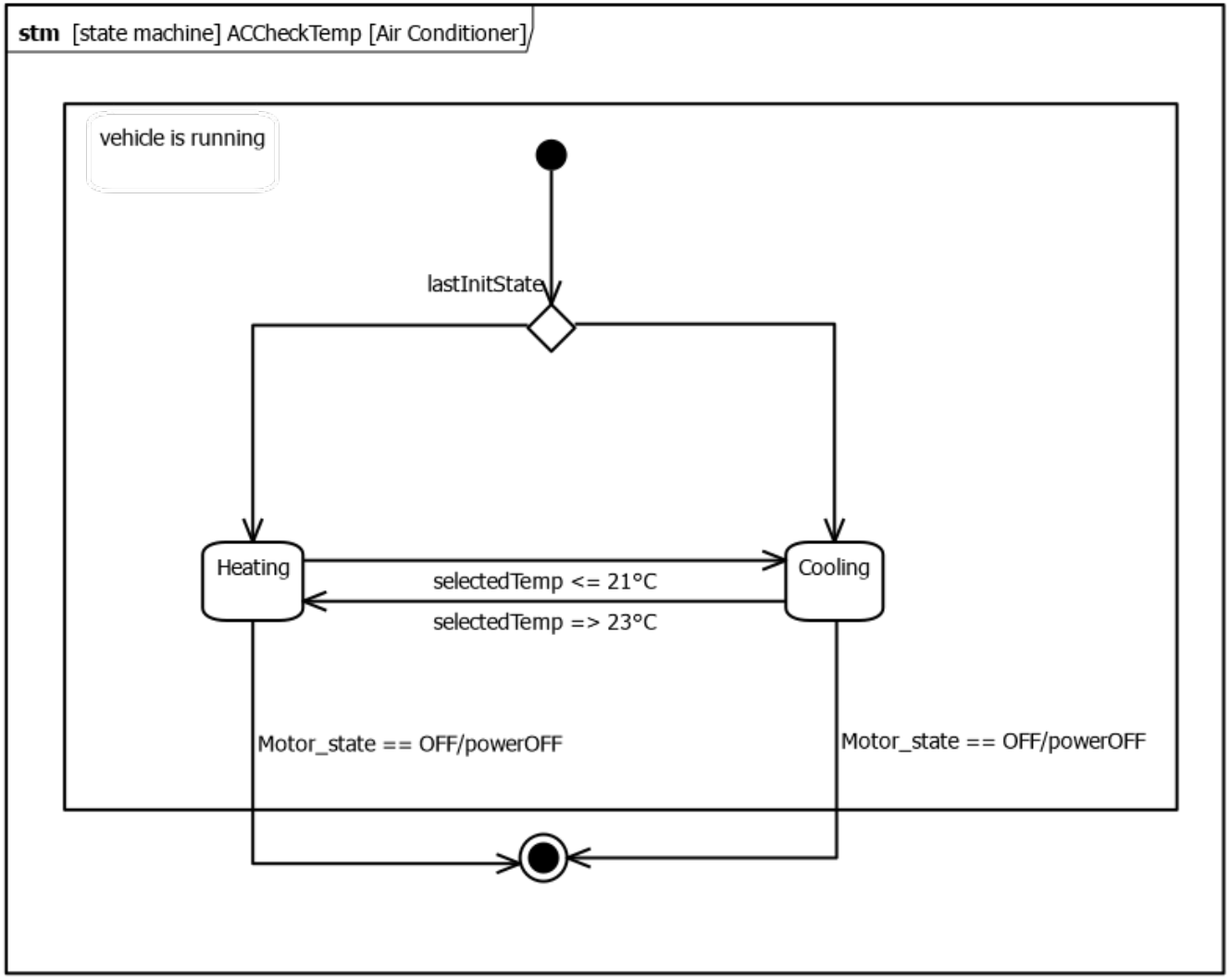

bdd [package] Structure [SystemComposition]
«block» Comfort Control Unit (from Units)
parts
: Safety Unit
: Comfort Unit
«block» Battery (from Parts)
«block» Microcontroller (from Parts)
«block» Safety Unit (from Internal Units)
parts
: Locking Control
: Visibility Control
: TrafficSafety Control
«block» Comfort Unit (from Internal Units)
parts
: Seat Control
: Climate Control
Key fob is not part of the system, but Antenna references it for user input
«block» Locking Control (from Control Units)
parts
: Lock Actuators[3..*]
: Antenna[1]
: A/D Converter[1]
: Button[1]
Hydraulic Brakes Module is not part of the CCU, but only references from it. Therefore, no behavior diagram is made. It is also Mechnical
«block» TrafficSafety Control (from Control Units)
parts
: Lights[4]
references
: Hydraulic Brakes Module[1]
«block» Visibility Control (from Control Units)
parts
: Lights[1..*]
: Sensor[1]
: User Input Modules[10]
: Side Mirors[2]
: Window Wiper[2]
: Window Actuator[4]
: A/D Converter[1]
references
: Motor
«block» Seat Control (from Control Units)
parts
: Seat Actuators[2..*]
«block» Climate Control (from Control Units)
parts
: Airflow Control[1]
: Thermostat[1]
: Air Conditioning Unit[1]
: Dial[1]
: A/D Converter[1]
«block» Key fob
«block» Antenna (from Parts)
«block» Hydraulic Brakes Module (from Internal Units)
«block» Button (from Parts)
«block» A/D Converter (from Parts)
«block» Lock Actuators (from Parts)
«block» Locks (from Parts)
«block» Door Lock(s) (from Parts)
«block» Trunk Lock (from Parts)
«block» Lights (from Parts)
«block» Brakelights (from Parts)
«block» Taillights (from Parts)
«block» User Input Modules (from Parts)
«block» Lever (from Parts)
«block» Button (from Parts)
«block» Window Actuator (from Parts)
«block» Windows (from Parts)
«block» Lights (from Parts)
«block» Interior Lights (from Parts)
«block» Headlights (from Parts)
«block» Fog Lights (from Parts)
«block» A/D Converter (from Parts)
«block» Sensor (from Parts)
«block» Light Sensor (from Parts)
«block» Rain Sensor (from Parts)
«block» Distance Sensor (from Parts)
«block» Window Wiper (from Parts)
«block» Side Mirors (from Parts)
«block» Seat Actuators (from Parts)
«block» Seats (from Parts)
«block» Air Conditioning Unit (from Internal Units)
«block» Thermostat (from Parts)
«block» Dial (from Parts)
«block» A/D Converter (from Parts)
«block» Airflow Control (from Control Units)
«block» Motor
Motor is not part of the CCU, but references from it.

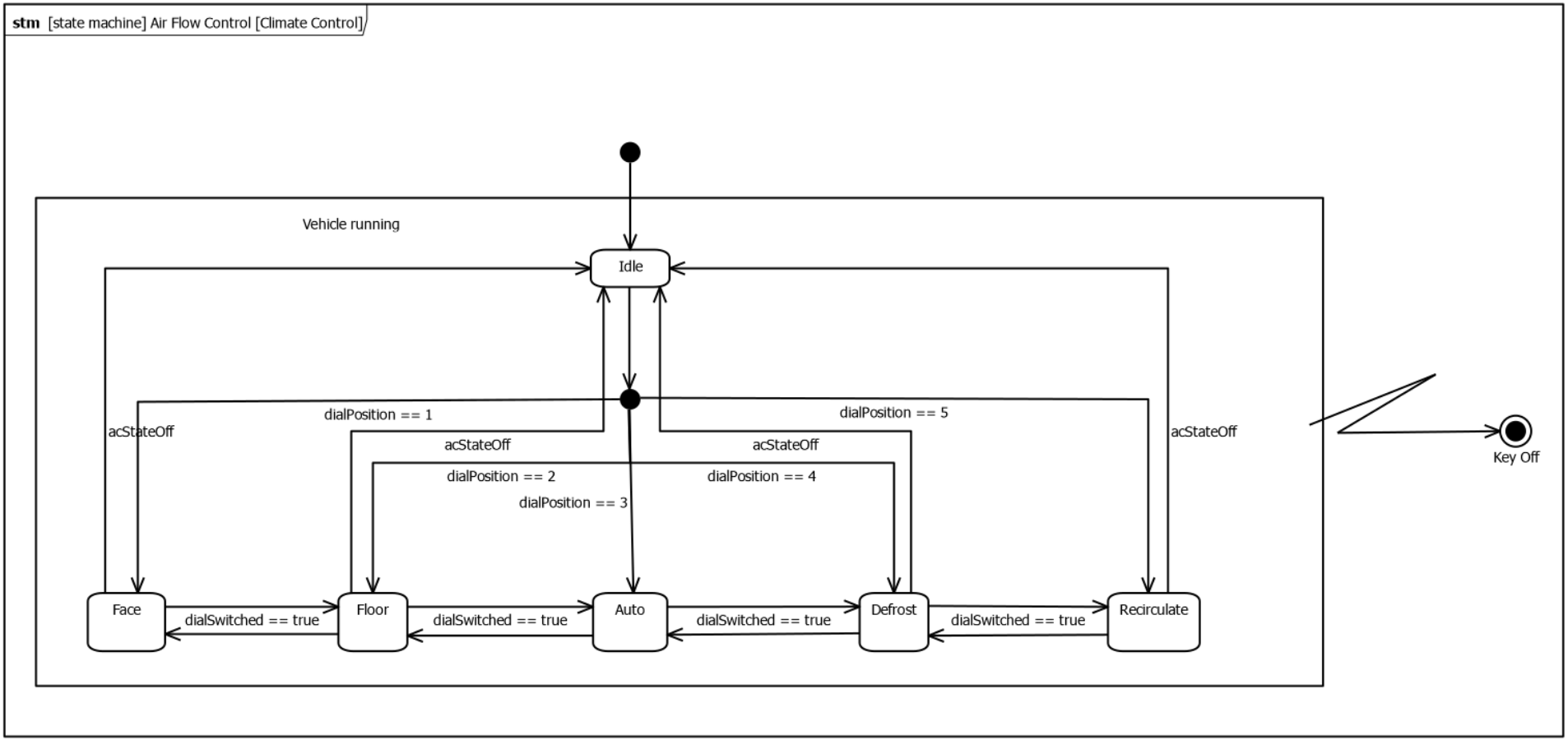

ibd [block] Comfort Control Unit [Comfort Control Unit]
«block»
CPU
«proxy»
In
«proxy»
«proxy»
«proxy»
«proxy»
«block»
Comfort Unit
(from Internal Units)
«proxy»
«block»
Safety Unit
(from Internal Units)
«proxy»
«proxy»
«proxy»
Digital
Output
«proxy»
Digital
Input
«proxy»
User
Interface
Port
«block»
A/D converter
«proxy»
«proxy»
«proxy»
Serial
Port

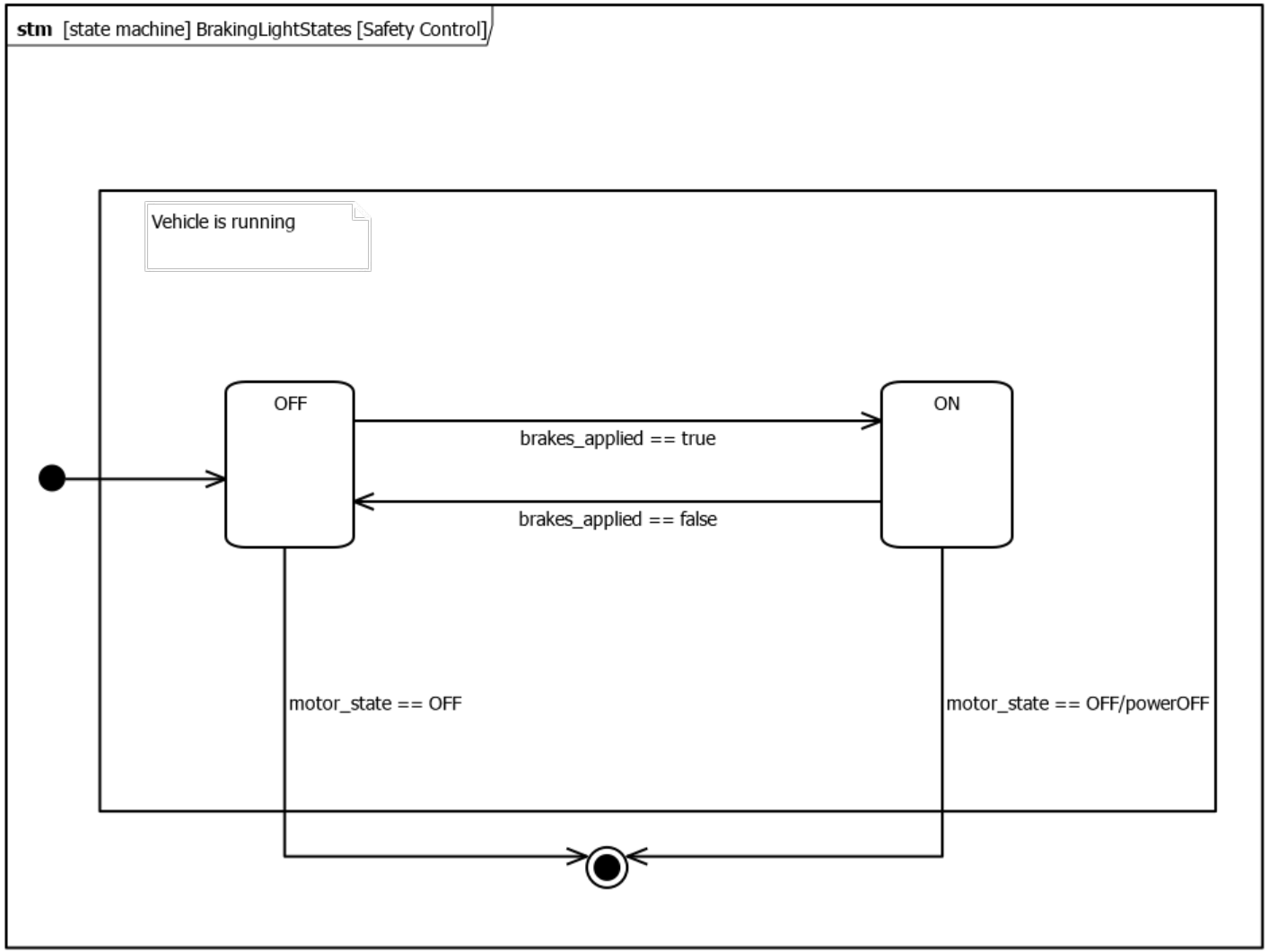

ibd [block] Seat Control [Seat Control]
«proxy»
Serial
Input
«proxy»
«block»
A/D Converter
«proxy»
Serial Signal
«proxy»
«block»
Signal Processor
«proxy»
Angle/Position Data
«block»
Seat Actuators
«proxy»

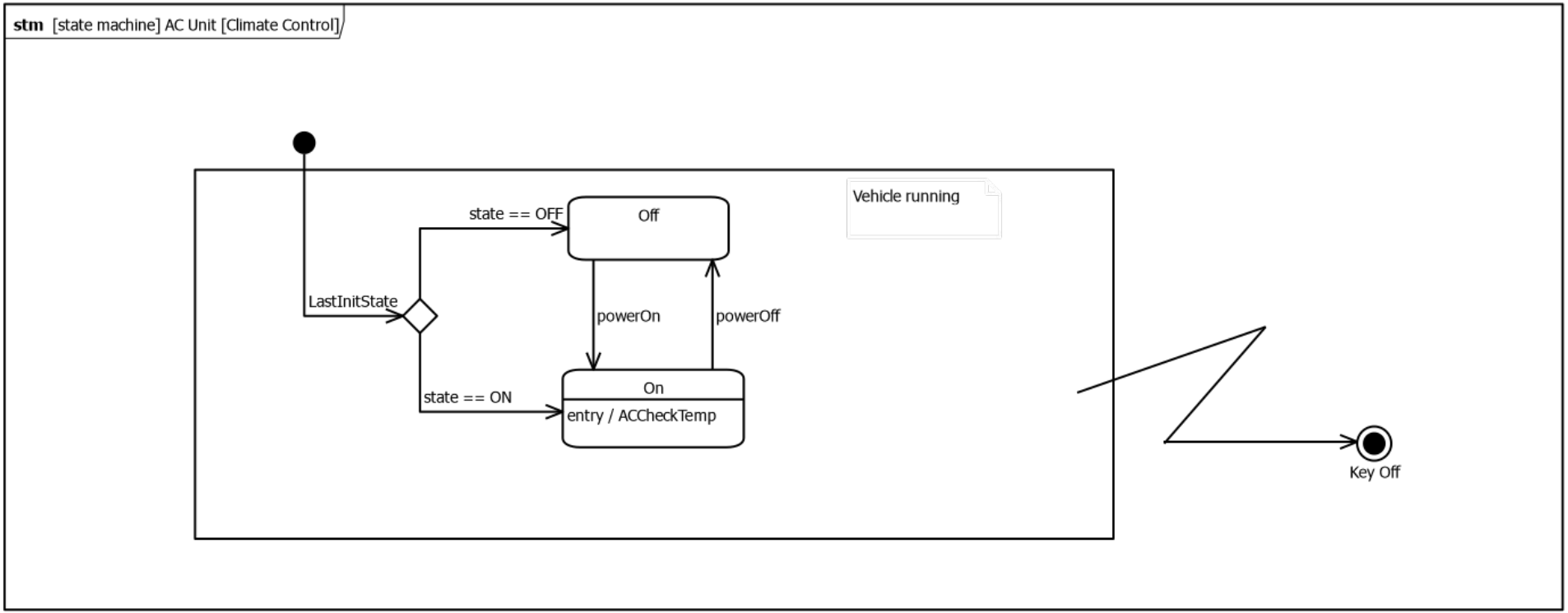

ibd [block] Locking Control [Locking Control]
«block»
Lock
Actuators
(from Parts)
«proxy»
«proxy»
«block»
Button
(from Parts)
«block»
Antenna
(from Parts)
«block»
A/D
Converter
(from Parts)
«proxy»
«proxy»
«proxy»
RFID Signature
«proxy»
«proxy»
«proxy»
«proxy»
«proxy»
Serial
Port
«block»
A/D
Converter
(from Parts)
«proxy»
«proxy»
«block»
Processor

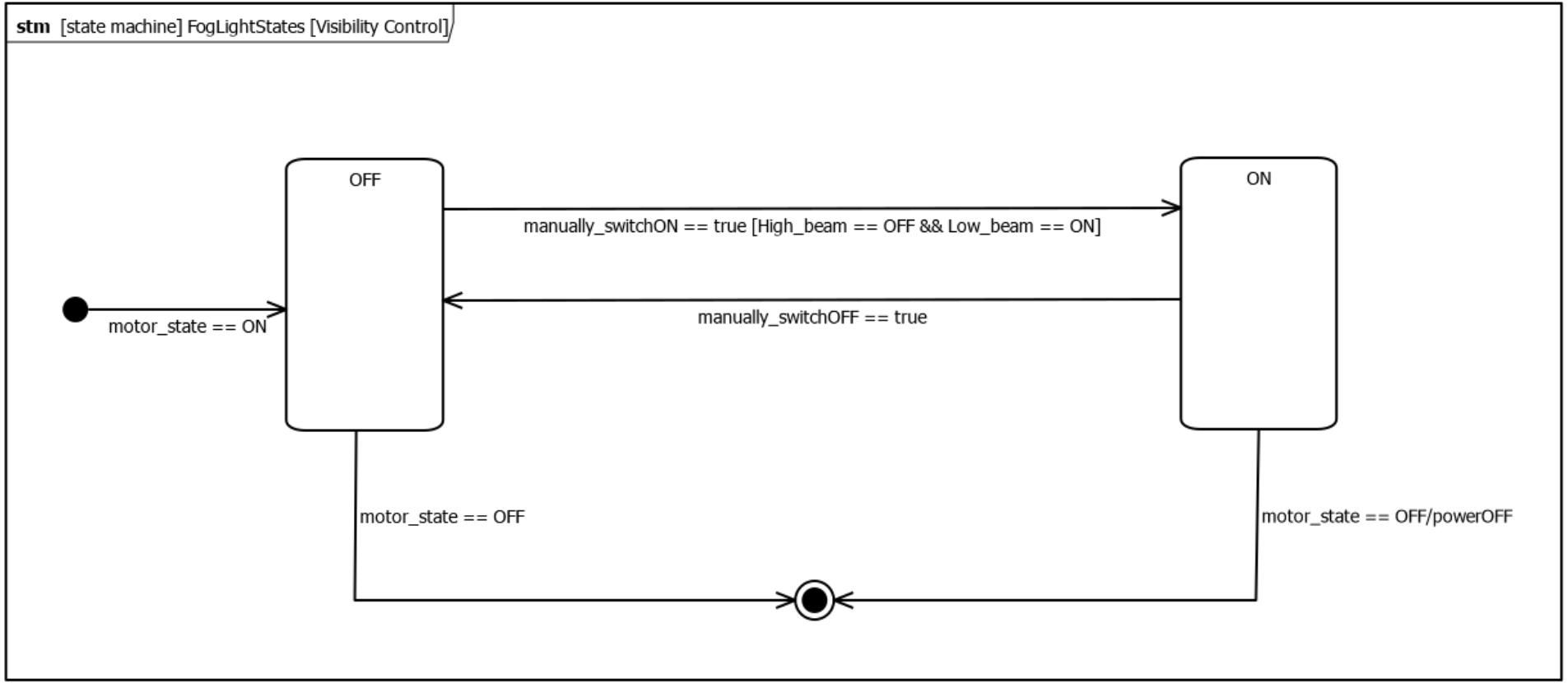

ibd [block] Climate Control [Climate Control]
«block»
Thermostat
(from Parts)
«proxy»
Sensor Data
«proxy»
«block»
A/D Converter
«proxy»
«block»
Air
Conditioning
Unit
(from Internal Units)
«proxy»
«proxy»
Temperature Settings
«block»
Airflow
Control
(from Control Units)
«proxy»
Airflow Settings
«proxy»
«proxy»
«proxy»
«proxy»
Serial
Port
«proxy»
Serial Signal
«block»
A/D
Converter
«proxy»
«proxy»
«block»
Processor

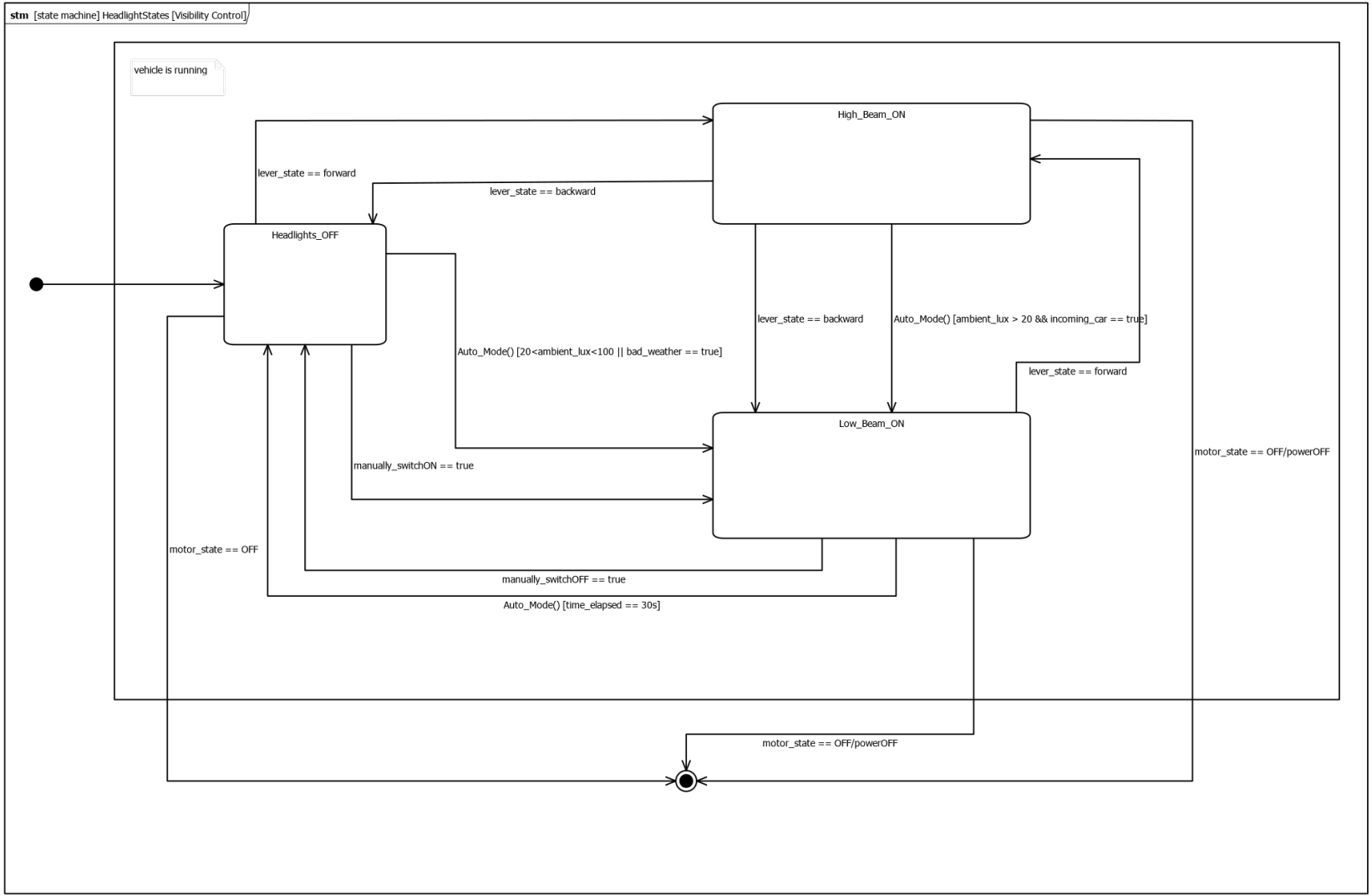

stm [state machine] ACCheckTemp [Air Conditioner]
vehicle is running
lastInitState
Heating
Cooling
selectedTemp <= 21°C
selectedTemp => 23°C
Motor_state == OFF/powerOFF
Motor_state == OFF/powerOFF

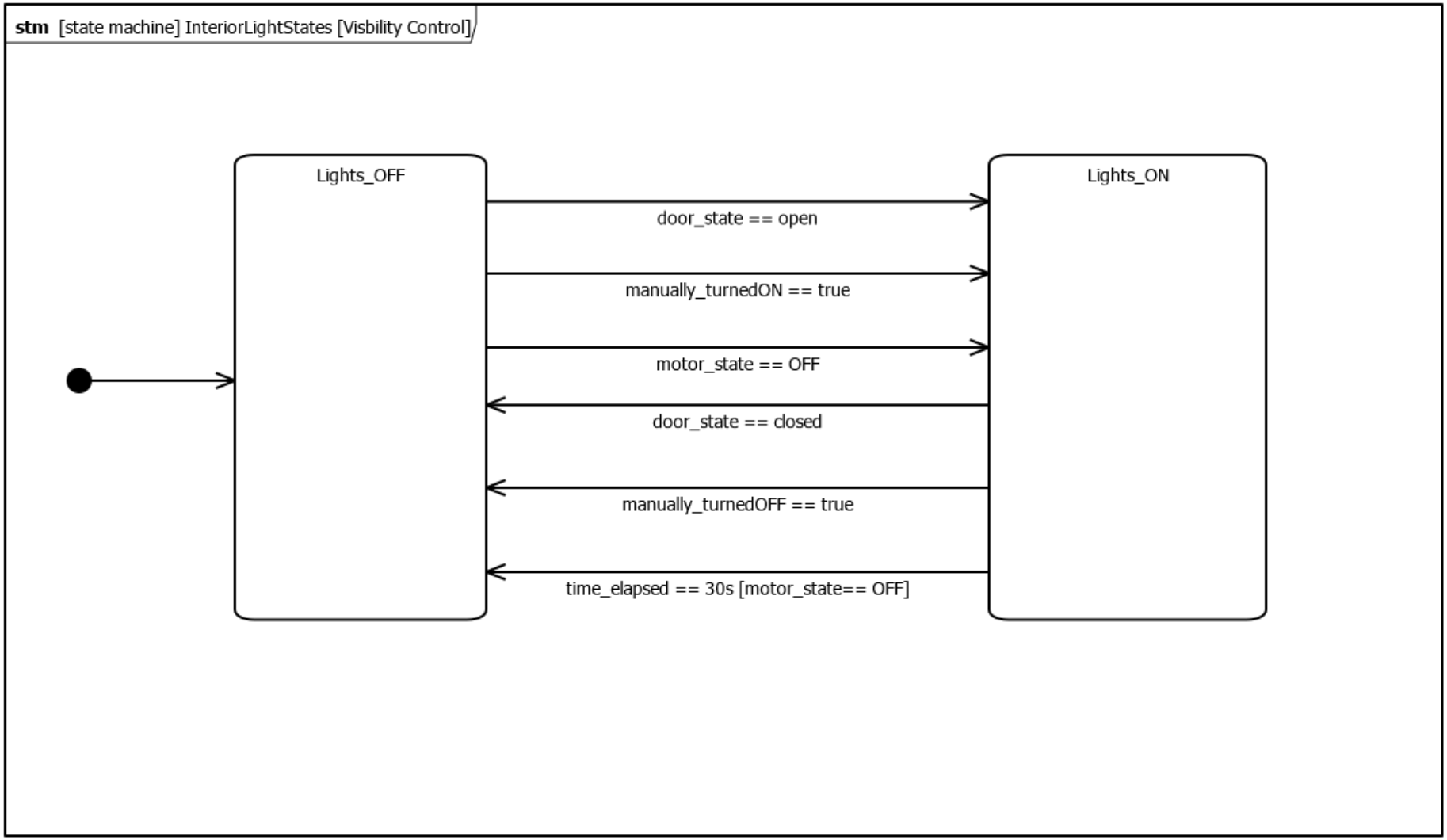

stm [state machine] Air Flow Control [Climate Control]
Vehicle running
Idle
acStateOff
dialPosition == 1
acStateOff
dialPosition == 2
dialPosition == 3
dialPosition == 4
acStateOff
dialPosition == 5
acStateOff
Key Off
Face
dialSwitched == true
Floor
dialSwitched == true
Auto
dialSwitched == true
Defrost
dialSwitched == true
Recirculate

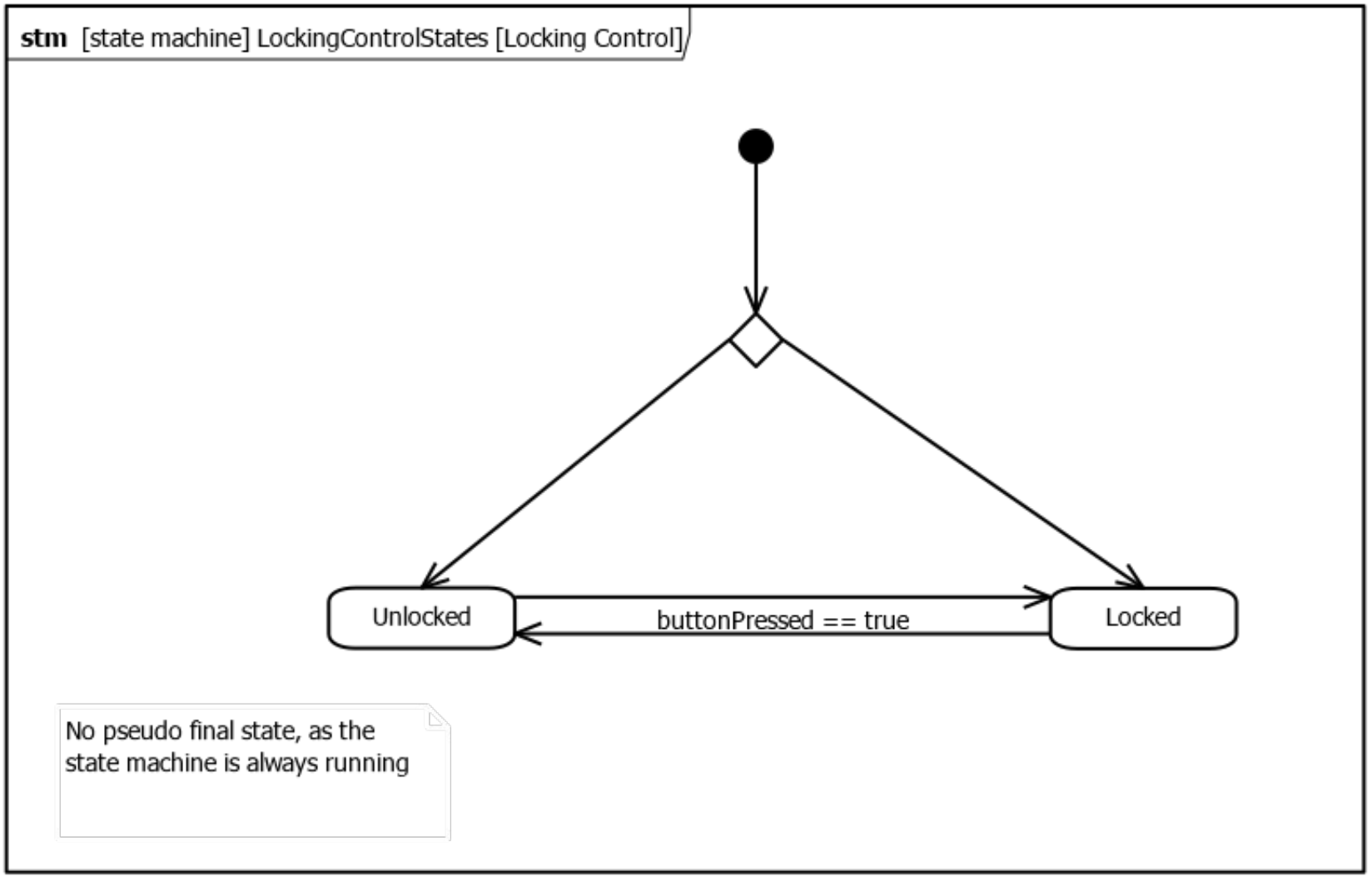

stm [state machine] BrakingLightStates [Safety Control]
Vehicle is running
OFF
ON
brakes_applied == true
brakes_applied == false
motor_state == OFF
motor_state == OFF/powerOFF

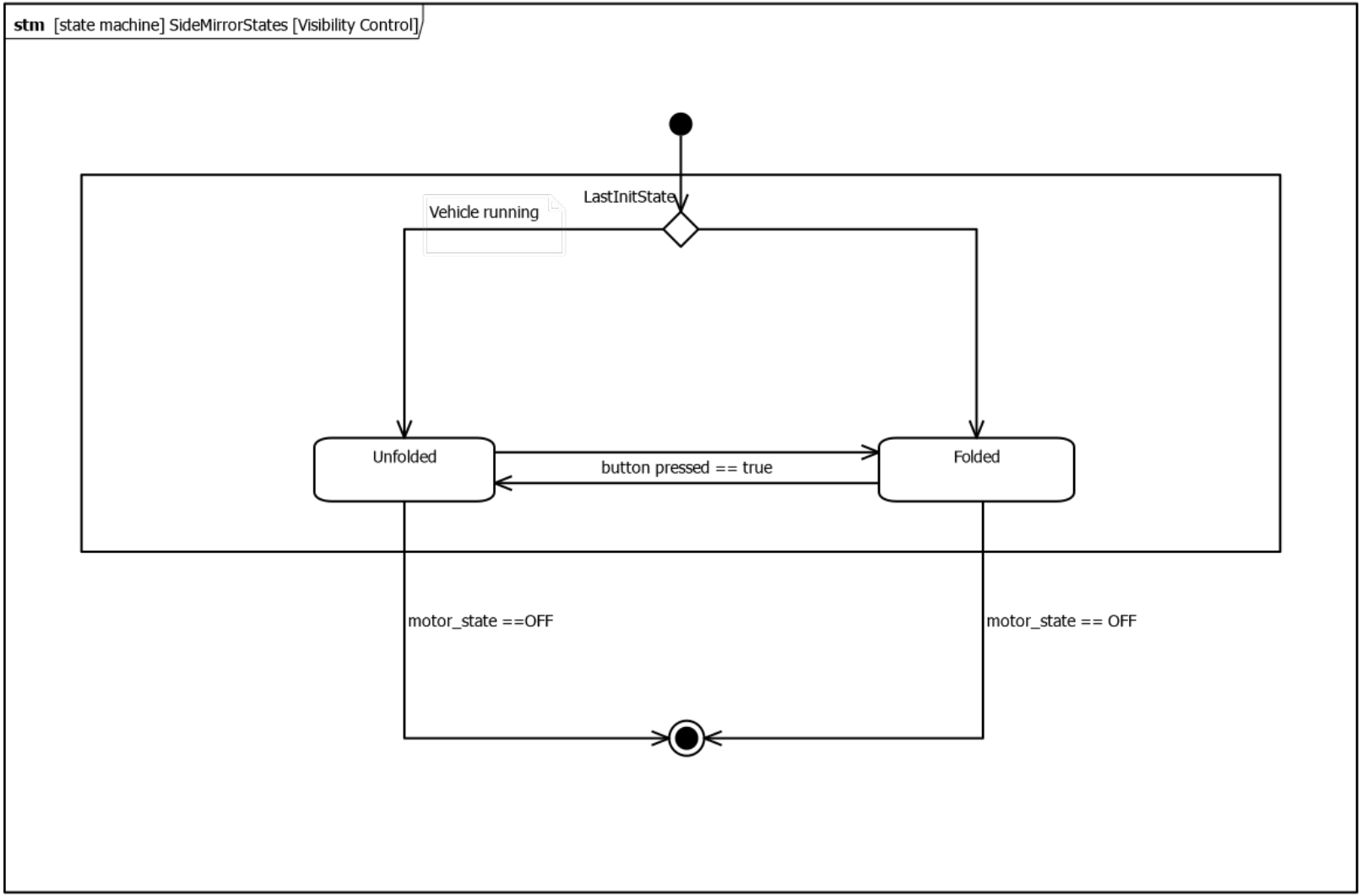

stm [state machine] AC Unit [Climate Control]
Vehicle running
state == OFF
Off
LastInitState
powerOn
powerOff
state == ON
On
entry / ACCheckTemp
Key Off

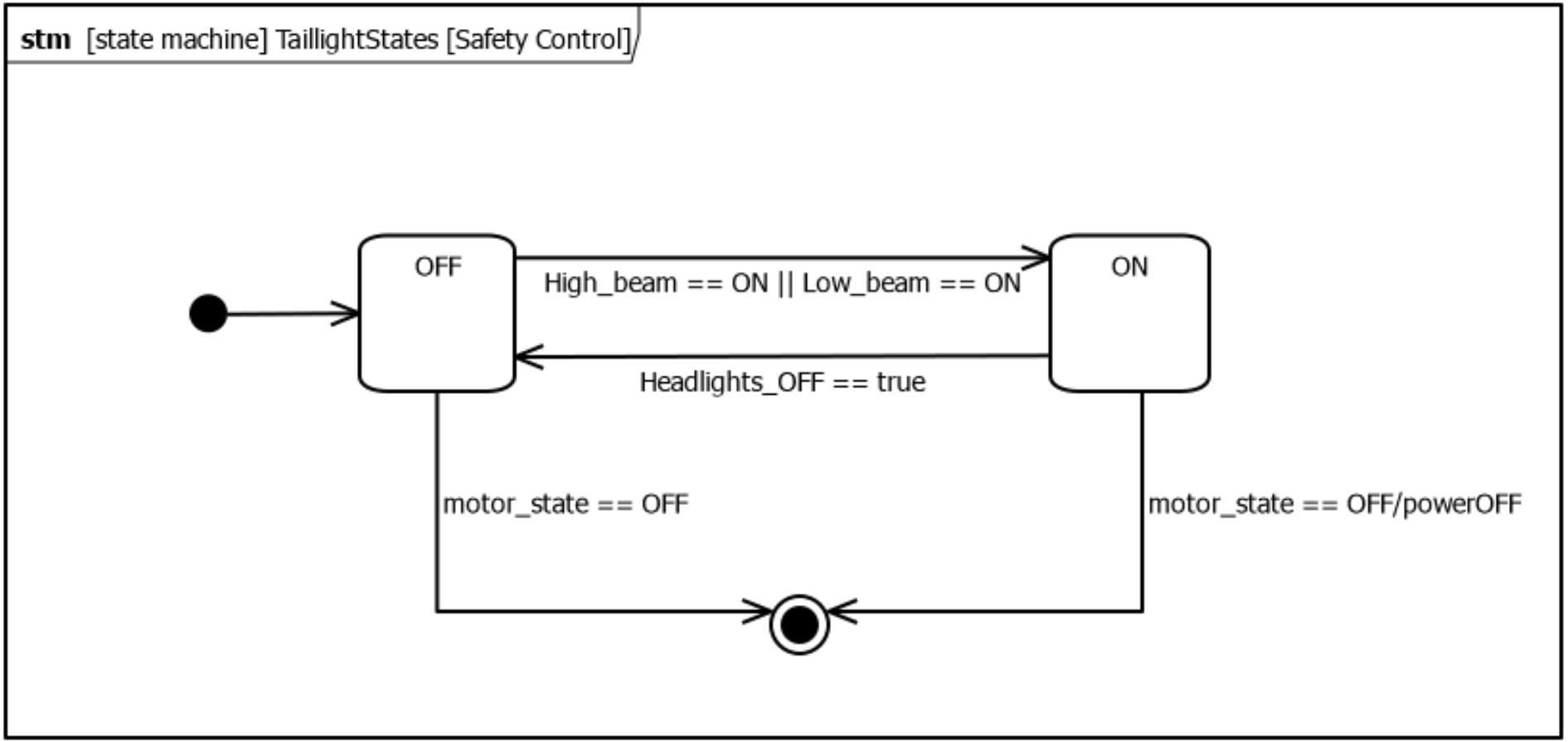

stm [state machine] FogLightStates [Visibility Control]
OFF
ON
manually_switchON == true [High_beam == OFF && Low_beam == ON]
manually_switchOFF == true
motor_state == ON
motor_state == OFF
motor_state == OFF/powerOFF

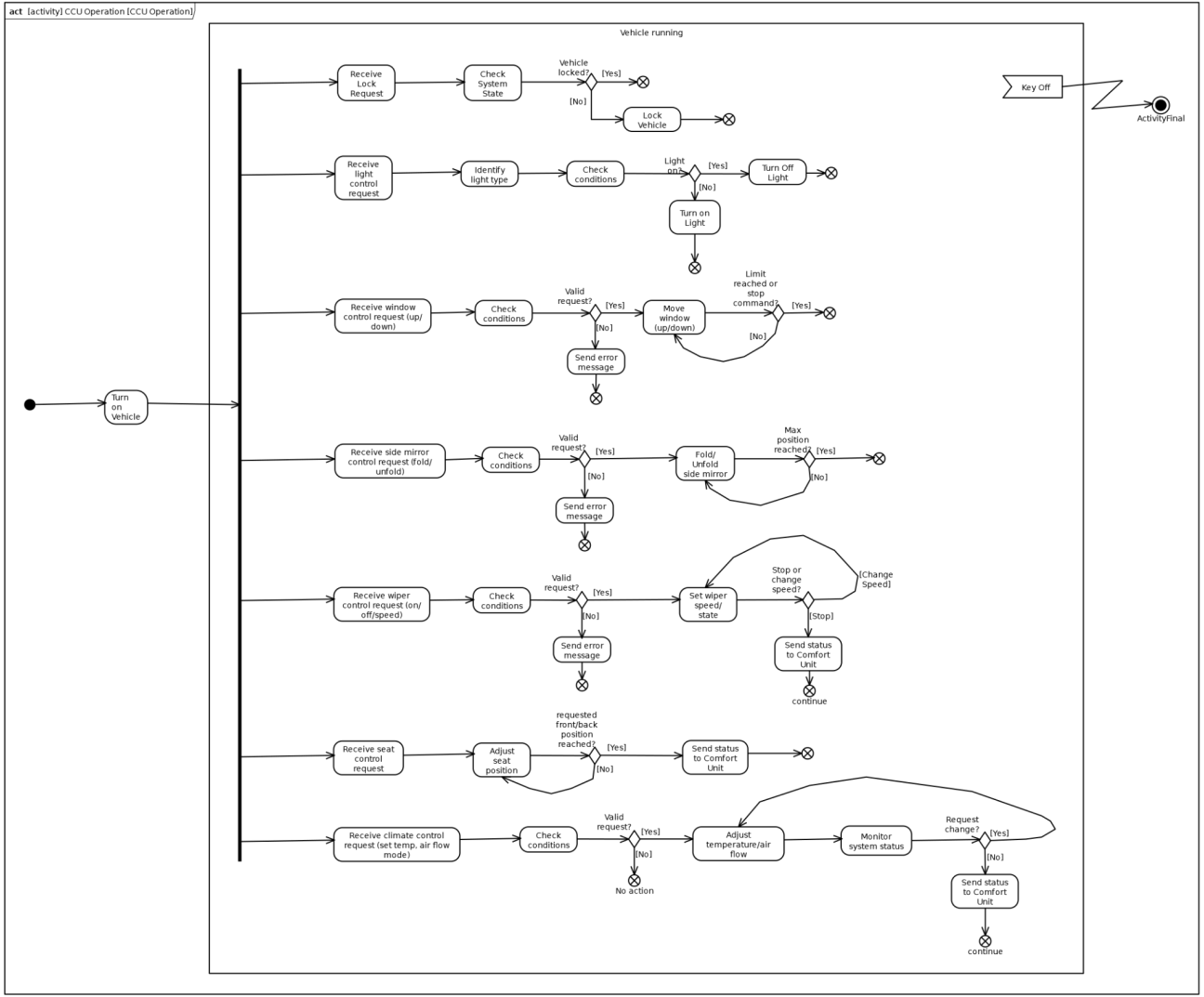

stm [state machine] HeadlightStates [Visibility Control]
vehicle is running
High_Beam_ON
lever_state == forward
lever_state == backward
Headlights_OFF
lever_state == backward
Auto_Mode() [ambient_lux > 20 && incoming_car == true]
Auto_Mode() [20<ambient_lux<100 || bad_weather == true]
lever_state == forward
Low_Beam_ON
motor_state == OFF/powerOFF
manually_switchON == true
motor_state == OFF
manually_switchOFF == true
Auto_Mode() [time_elapsed == 30s]
motor_state == OFF/powerOFF

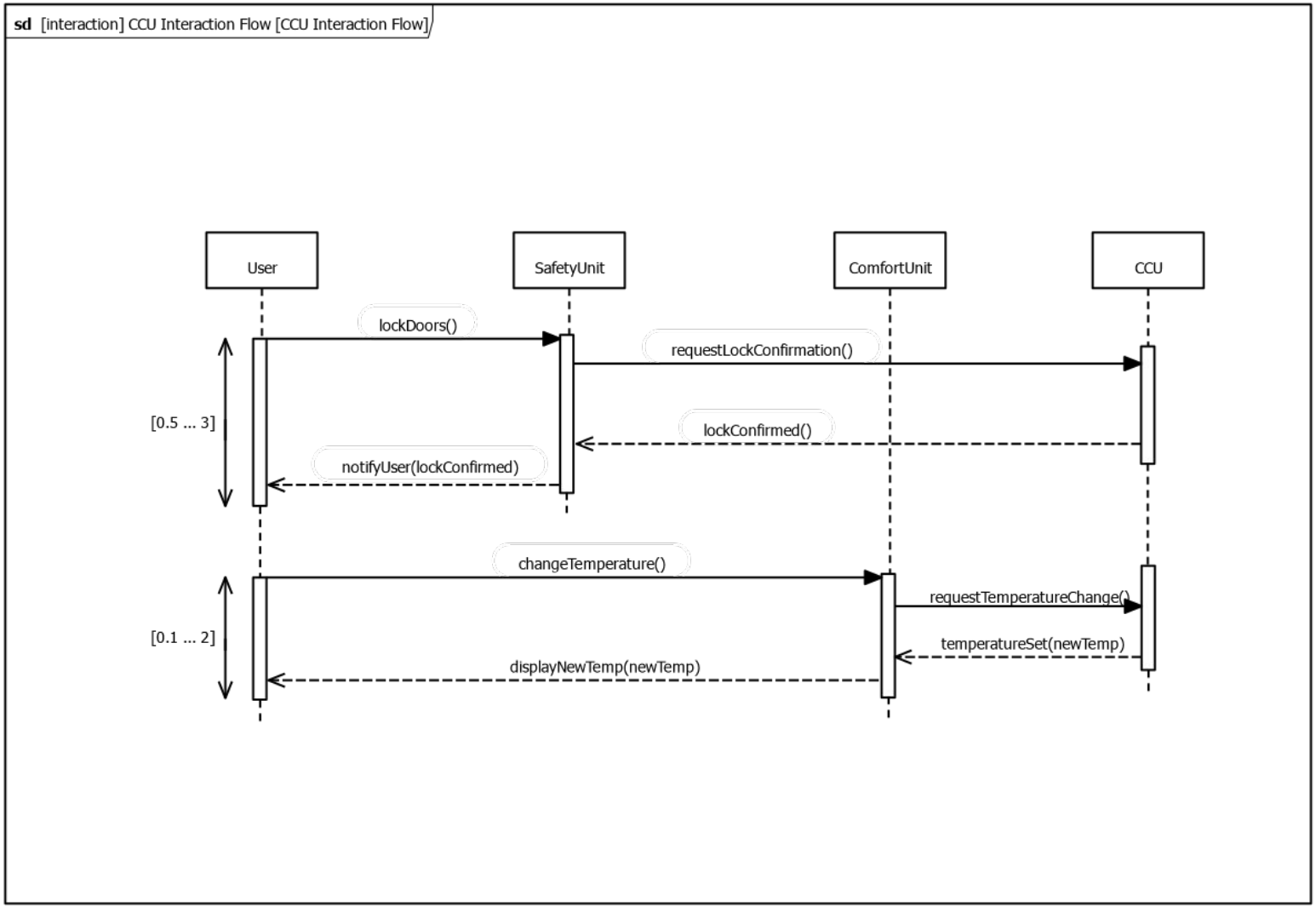

stm [state machine] InteriorLightStates [Visbility Control]
Lights_OFF
Lights_ON
door_state == open
manually_turnedON == true
motor_state == OFF
door_state == closed
manually_turnedOFF == true
time_elapsed == 30s [motor_state== OFF]


stm [state machine] LockingControlStates [Locking Control]
Unlocked
buttonPressed == true
Locked
No pseudo final state, as the
state machine is always running


stm [state machine] SideMirrorStates [Visibility Control]
LastInitState
Vehicle running
Unfolded
button pressed == true
Folded
motor_state ==OFF
motor_state == OFF


stm [state machine] TaillightStates [Safety Control]
OFF
ON
High_beam == ON || Low_beam == ON
Headlights_OFF == true
motor_state == OFF
motor_state == OFF/powerOFF


act [activity] CCU Operation [CCU Operation]
Vehicle running
Turn on Vehicle
Receive Lock Request
Check System State
Vehicle locked?
[Yes]
[No]
Lock Vehicle
Key Off
ActivityFinal
Receive light control request
Identify light type
Check conditions
Light on?
[Yes]
Turn Off Light
[No]
Turn on Light
Receive window control request (up/down)
Check conditions
Valid request?
[Yes]
[No]
Send error message
Move window (up/down)
Limit reached or stop command?
[Yes]
[No]
Receive side mirror control request (fold/unfold)
Check conditions
Valid request?
[Yes]
[No]
Send error message
Fold/Unfold side mirror
Max position reached?
[Yes]
[No]
Receive wiper control request (on/off/speed)
Check conditions
Valid request?
[Yes]
[No]
Send error message
Set wiper speed/state
Stop or change speed?
[Change Speed]
[Stop]
Send status to Comfort Unit
continue
Receive seat control request
Adjust seat position
requested front/back position reached?
[Yes]
[No]
Send status to Comfort Unit
Receive climate control request (set temp, air flow mode)
Check conditions
Valid request?
[Yes]
[No]
No action
Adjust temperature/air flow
Monitor system status
Request change?
[Yes]
[No]
Send status to Comfort Unit
continue


sd [interaction] CCU Interaction Flow [CCU Interaction Flow]
User
SafetyUnit
ComfortUnit
CCU
lockDoors()
requestLockConfirmation()
[0.5 ... 3]
lockConfirmed()
notifyUser(lockConfirmed)
changeTemperature()
requestTemperatureChange()
[0.1 ... 2]
temperatureSet(newTemp)
displayNewTemp(newTemp)


Thank You!