

— MODULE *SCS* —

This specification expresses the actions/states that happens around cruise control system. Speed increase/decrease, car braking, etc are some behaviours that are somehow realated with a car with cruise control system.

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EXTENDS *Integers*

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VARIABLES *acousticWarn*, *brakePedal*, *cc*, *desiredLimit*, *desiredSpeed*, *engine*,
frontCarGap, *gasPedal*, *lever*, *sl*, *slWarn*, *speed*, *visualWarn*

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Macro variables are established below.

critical \triangleq 4
maxSpeed \triangleq 4
minSpeed \triangleq 2
none \triangleq 1
safe \triangleq 2
speedVariation \triangleq 1
stopped \triangleq 1
unsafe \triangleq 3

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Anyone who wants to see if something is working/happening must enter below a predicate (which will be an invariant) where model will certainly fail, in order to see the steps until the desired state.

This invariant will force *TLC* to show a sequence of states before speed equals *desiredLimit* when the speed limit function is available.

$$End \triangleq \neg(speed = desiredLimit \wedge sl = \text{"on"})$$

This invariant will force *TLC* to show a sequence of states before engine turns off. Note that engine's init state needs to be modified to "on" or *TLC* will always find this invariant to be false at the init state.

$$End \triangleq engine \neq \text{"off"}$$

This invariant will force *TLC* to show a sequence of states before engine turns off with speed limit function activated. Note that engine's init state needs to be modified to "on" or *TLC* will always find this invariant to be false at the init state.

$$End \triangleq \neg(engine = \text{"off"} \wedge sl = \text{"off"})$$

This invariant will force *TLC* to show a sequence of states before speed equals desired speed in order to check if, before that and after cruise control is activated, the lever turns, for example, position 3.

$$End \triangleq \neg(cc = \text{"on"} \wedge speed \neq desiredSpeed \wedge lever = 3)$$

This invariant will force *TLC* to show a sequence of states where *desiredLimit* is either 2, 3 or 4.

$$End \triangleq \neg(desiredLimit = 2) \wedge \neg(desiredLimit = 3) \wedge \neg(desiredLimit = 4)$$

This invariant will force *TLC* to show a sequence of states where lever turns to 5, which turns the speed limit function off (it also turns it on but that's not what we want to check here).

$$End \triangleq \neg(lever = 5 \wedge sl = \text{"off"})$$

This invariant will force *TLC* to show a sequence of states where speed limit LED lights up (that happens when speed limit function is activated).

$$End \triangleq \neg(slWarn = \text{"on"})$$

$$End \triangleq 1 = 1$$

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SCS1

$$SCS1 \triangleq (engine = \text{"off"}) \Rightarrow (desiredSpeed = none)$$

SCS2

$$SCS2 \triangleq (lever = 1) \Rightarrow \begin{aligned} &\vee desiredSpeed = none \\ &\vee speed < desiredSpeed \\ &\vee speed > desiredSpeed \\ &\vee speed = desiredSpeed \end{aligned}$$

SCS3 – Assuming that below 20km/h is equal to stopped.

$SCS3 \triangleq (speed = stopped \wedge desiredSpeed = none) \Rightarrow cc = \text{"off"}$

SCSA – *SCSA* gathers *SCS*s 4, 5, 7 and 8, assuming that the lever doesn't have resistance levels and that pushing the lever to 2 only increases the desired speed, under normal conditions (with speed limit function off).

$SCSA \triangleq (lever = 2 \wedge sl = \text{"off"}) \Rightarrow (desiredSpeed = desiredSpeed + speedVariation)$

SCSB – *SCSB* gathers *SCS*s 6, 9 and 10, assuming that the lever doesn't have resistance levels and that pushing the lever to 3 only decreases the desired speed, under normal conditions (with speed limit function off).

$SCSB \triangleq (lever = 3 \wedge sl = \text{"off"}) \Rightarrow (desiredSpeed = desiredSpeed - speedVariation)$

SCS11

$SCS11 \triangleq \begin{aligned} &\wedge lever = 2 \vee lever = 3 \\ &\wedge cc = \text{"off"} \\ &\wedge sl = \text{"off"} \\ &\Rightarrow (desiredSpeed = speed) \end{aligned}$

isto igual ao que est em cima certo ???

$SCS11 \triangleq ((lever = 2 \vee lever = 3) \wedge cc = \text{"off"} \wedge sl = \text{"off"}) \Rightarrow (desiredSpeed = speed)$

SCS12

$SCS12 \triangleq lever = 4 \Rightarrow cc = \text{"off"}$

SCS13

$SCS13 \triangleq lever = 1 \Rightarrow cc = \text{"on"}$

SCS14

SCS15

$SCS15 \triangleq (cc = \text{"on"} \wedge gasPedal = \text{"pressed"}) \Rightarrow speed > desiredSpeed$

SCS16

$SCS16 \triangleq brakePedal = \text{"pressed"} \Rightarrow cc = \text{"off"}$

SCS17

$SCS17 \triangleq lever = 4 \Rightarrow cc = \text{"off"}$

SCS18

SCS19

SCS25 – Assuming that visual warning is activated if the actual distance is either unsafe or critical.

$SCS25 \triangleq (frontCarGap = unsafe \vee frontCarGap = critical) \Rightarrow visualWarn = \text{"on"}$

SCS26 – Assuming that acoustic warning is activated if the actual distance is critical.

$SCS26 \triangleq \text{frontCarGap} = \text{critical} \Rightarrow \text{acousticWarn} = \text{"on"}$

$SCS29$

$SCS29 \triangleq (\text{lever} = 5 \wedge \text{sl} = \text{"on"}) \Rightarrow \text{sl} = \text{"on"}$

$SCS30$

$SCS30 \triangleq \begin{aligned} &\wedge \text{sl} = \text{"on"} \Rightarrow \text{slWarn} = \text{"on"} \\ &\wedge \text{sl} = \text{"off"} \Rightarrow \text{slWarn} = \text{"off"} \end{aligned}$

$SCS31$

$SCS31 \triangleq \begin{aligned} &\wedge ((\text{lever} = 2) \wedge (\text{sl} = \text{"on"})) \Rightarrow \text{speed} < \text{desiredLimit} \\ &\wedge ((\text{lever} = 3) \wedge (\text{sl} = \text{"on"})) \Rightarrow \text{speed} \leq \text{desiredLimit} \end{aligned}$

$SCS32$

$SCS32 \triangleq \text{sl} = \text{"on"} \Rightarrow \text{speed} \leq \text{desiredLimit}$

$SCS35$

$SCS35 \triangleq \begin{aligned} &\wedge \text{lever} = 4 \Rightarrow \text{sl} = \text{"off"} \\ &\wedge (\text{lever} = 5 \wedge \text{sl} = \text{"off"}) \Rightarrow \text{sl} = \text{"off"} \end{aligned}$

This predicate assures that the following specifications are true.

$SCSsOK \triangleq \begin{aligned} &\wedge SCS1 \\ &\wedge SCS2 \\ &\wedge SCS3 \\ &\wedge SCSA \\ &\wedge SCSB \\ &\wedge SCS11 \\ &\wedge SCS12 \\ &\wedge SCS13 \\ &\wedge scs14 \\ &\wedge SCS15 \\ &\wedge SCS16 \\ &\wedge SCS17 \\ &\wedge SCS19 \\ &\wedge SCS25 \\ &\wedge SCS26 \\ &\wedge SCS29 \\ &\wedge SCS30 \\ &\wedge SCS31 \\ &\wedge SCS32 \\ &\wedge SCS33 \\ &\wedge SCS34 \\ &\wedge SCS35 \end{aligned}$

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This predicate is an invariant and remains true across all of the states. It establishes the type of each variable.

$$\begin{aligned}
 TypeOK \triangleq & \quad \wedge \textit{acousticWarn} \in \{\text{"off"}, \text{"on"}\} \\
 & \quad \wedge \textit{brakePedal} \in \{\text{"pressed"}, \text{"unpressed"}\} \\
 & \quad \wedge \textit{cc} \in \{\text{"off"}, \text{"on"}\} \\
 & \quad \wedge \textit{desiredLimit} \in \textit{none} \dots \textit{maxSpeed} \quad \text{1-none 2-slow 3-medium 4-fast} \\
 & \quad \wedge \textit{desiredSpeed} \in \textit{none} \dots \textit{maxSpeed} \quad \text{1-none 2-slow 3-medium 4-fast} \\
 & \quad \wedge \textit{engine} \in \{\text{"off"}, \text{"on"}\} \\
 & \quad \wedge \textit{frontCarGap} \in \textit{none} \dots \textit{critical} \quad \text{1-none 2-safe 3-unsafe 4-critical} \\
 & \quad \wedge \textit{gasPedal} \in \{\text{"pressed"}, \text{"unpressed"}\} \\
 & \quad \wedge \textit{lever} \in 0 \dots 5 \\
 & \quad \wedge \textit{sl} \in \{\text{"off"}, \text{"on"}\} \\
 & \quad \wedge \textit{slWarn} \in \{\text{"off"}, \text{"on"}\} \\
 & \quad \wedge \textit{speed} \in \textit{stopped} \dots \textit{maxSpeed} \quad \text{1-stopped 2-slow 3-medium 4-fast} \\
 & \quad \wedge \textit{visualWarn} \in \{\text{"off"}, \text{"on"}\}
 \end{aligned}$$

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This predicate is another invariant and remains true across all of the states. It's different than the other above because it assures properties not related with variables types.

$$PropertiesOK \triangleq 1 = 1 \quad \text{Not necessary.}$$

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Defines initial state.

$$\begin{aligned}
 Init \triangleq & \quad \wedge \textit{acousticWarn} = \text{"off"} \\
 & \quad \wedge \textit{brakePedal} = \text{"unpressed"} \\
 & \quad \wedge \textit{cc} = \text{"off"} \\
 & \quad \wedge \textit{desiredLimit} = \textit{none} \\
 & \quad \wedge \textit{desiredSpeed} = \textit{none} \\
 & \quad \wedge \textit{engine} = \text{"off"} \\
 & \quad \wedge \textit{frontCarGap} = \textit{none}
 \end{aligned}$$

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The car brakes and reduces current speed (in one unit).

Decreases front car gap from safe to unsafe or from unsafe to critical, activating the corresponding warnings.

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$$\begin{aligned}
& \wedge \text{visualWarn}' = \text{"on"} \\
\text{ELSE IF } \text{frontCarGap} = 2 & \\
& \text{THEN } \wedge \text{acousticWarn}' = \text{"off"} \\
& \wedge \text{visualWarn}' = \text{"on"} \\
& \text{ELSE } \wedge \text{acousticWarn}' = \text{"off"} \\
& \wedge \text{visualWarn}' = \text{"off"} \\
& \wedge \text{brakePedal}' = \text{brakePedal} \\
& \wedge \text{cc}' = \text{cc} \\
& \wedge \text{desiredLimit}' = \text{desiredLimit} \\
& \wedge \text{desiredSpeed}' = \text{desiredSpeed} \\
& \wedge \text{engine}' = \text{engine} \\
& \wedge \text{frontCarGap}' = \text{frontCarGap} + 1 \\
& \wedge \text{gasPedal}' = \text{gasPedal} \\
& \wedge \text{lever}' = \text{lever} \\
& \wedge \text{sl}' = \text{sl} \\
& \wedge \text{slWarn}' = \text{slWarn} \\
& \wedge \text{speed}' = \text{speed}
\end{aligned}$$

Decreases current speed (in one unit).

$$\begin{aligned}
\text{DecreaseSpeed} \triangleq & \wedge \text{brakePedal} = \text{"unpressed"} \\
& \wedge \text{cc} = \text{"off"} \\
& \wedge \text{engine} = \text{"on"} \\
& \wedge \text{gasPedal} = \text{"unpressed"} \\
& \wedge \text{lever} = 0 \\
& \wedge \text{speed} > \text{stopped} \\
& \wedge \text{acousticWarn}' = \text{acousticWarn} \\
& \wedge \text{brakePedal}' = \text{brakePedal} \\
& \wedge \text{cc}' = \text{cc} \\
& \wedge \text{desiredLimit}' = \text{desiredLimit} \\
& \wedge \text{desiredSpeed}' = \text{desiredSpeed} \\
& \wedge \text{engine}' = \text{engine} \\
& \wedge \text{frontCarGap}' = \text{frontCarGap} \\
& \wedge \text{gasPedal}' = \text{gasPedal} \\
& \wedge \text{lever}' = \text{lever} \\
& \wedge \text{sl}' = \text{sl} \\
& \wedge \text{slWarn}' = \text{slWarn} \\
& \wedge \text{speed}' = \text{speed} - \text{speedVariation} \\
& \wedge \text{visualWarn}' = \text{visualWarn}
\end{aligned}$$

Predicate that is continuously called since when the lever is turned to 1 untill speed equals desired speed.

$$\begin{aligned}
\text{EqualsDesiredSpeed} \triangleq & \wedge \text{brakePedal} = \text{"unpressed"} \\
& \wedge \text{cc} = \text{"on"} \\
& \wedge \text{desiredSpeed} \neq \text{none} \\
& \wedge \text{engine} = \text{"on"}
\end{aligned}$$

$$\begin{aligned}
\wedge \text{gasPedal} &= \text{"unpressed"} \\
\wedge \text{lever} &= 0 \\
\wedge \text{speed} &\neq \text{desiredSpeed} \\
\wedge \text{acousticWarn}' &= \text{acousticWarn} \\
\wedge \text{brakePedal}' &= \text{brakePedal} \\
\wedge \text{cc}' &= \text{cc} \\
\wedge \text{desiredLimit}' &= \text{desiredLimit} \\
\wedge \text{desiredSpeed}' &= \text{desiredSpeed} \\
\wedge \text{engine}' &= \text{engine} \\
\wedge \text{frontCarGap}' &= \text{frontCarGap} \\
\wedge \text{gasPedal}' &= \text{gasPedal} \\
\wedge \text{lever}' &= \text{lever} \\
\wedge \text{sl}' &= \text{sl} \\
\wedge \text{slWarn}' &= \text{slWarn} \\
\wedge \text{visualWarn}' &= \text{visualWarn} \\
\wedge \text{ApproachesDesiredSpeed}
\end{aligned}$$

Increases front car gap from critical to unsafe or from unsafe to safe, deactivating the corresponding warnings.

$$\begin{aligned}
\text{IncreaseFrontCarGap} \triangleq & \wedge \text{cc} = \text{"on"} \\
& \wedge \text{engine} = \text{"on"} \\
& \wedge \text{frontCarGap} > \text{safe} \\
& \wedge \text{gasPedal} = \text{"unpressed"} \\
& \wedge \text{lever} = 0 \\
& \wedge \text{IF } \text{frontCarGap} = 3 \\
& \quad \text{THEN } \wedge \text{acousticWarn}' = \text{"off"} \\
& \quad \wedge \text{visualWarn}' = \text{"off"} \\
& \quad \text{ELSE } \wedge \text{acousticWarn}' = \text{"off"} \\
& \quad \wedge \text{visualWarn}' = \text{"on"} \\
& \wedge \text{brakePedal}' = \text{brakePedal} \\
& \wedge \text{cc}' = \text{cc} \\
& \wedge \text{desiredLimit}' = \text{desiredLimit} \\
& \wedge \text{desiredSpeed}' = \text{desiredSpeed} \\
& \wedge \text{engine}' = \text{engine} \\
& \wedge \text{frontCarGap}' = \text{frontCarGap} - 1 \\
& \wedge \text{gasPedal}' = \text{gasPedal} \\
& \wedge \text{lever}' = \text{lever} \\
& \wedge \text{sl}' = \text{sl} \\
& \wedge \text{slWarn}' = \text{slWarn} \\
& \wedge \text{speed}' = \text{speed}
\end{aligned}$$

Increases current speed (in one unit) until the maximum speed is achieved or until speed limit is reached as long as speed limit function is activated.

$$\begin{aligned}
\text{IncreaseSpeed} \triangleq & \wedge \text{brakePedal} = \text{"unpressed"} \mid \\
& \wedge \vee \wedge \text{cc} = \text{"off"}
\end{aligned}$$

$$\begin{aligned}
& \wedge sl &= \text{"off"} \\
& \wedge speed &< maxSpeed \\
\vee \wedge cc &= \text{"off"} \\
& \wedge sl &= \text{"on"} \\
& \wedge speed &< desiredLimit \\
\vee \wedge cc &= \text{"on"} \\
& \wedge sl &= \text{"off"} \\
& \wedge speed &\geq desiredSpeed \\
& \wedge speed &< maxSpeed \\
\wedge engine &= \text{"on"} \\
\wedge lever &= 0 \\
\wedge acousticWarn' &= acousticWarn \\
\wedge brakePedal' &= brakePedal \\
\wedge cc' &= cc \\
\wedge desiredLimit' &= desiredLimit \\
\wedge desiredSpeed' &= desiredSpeed \\
\wedge engine' &= engine \\
\wedge frontCarGap' &= frontCarGap \\
\wedge gasPedal' &= \text{"pressed"} \\
\wedge lever' &= lever \\
\wedge sl' &= sl \\
\wedge slWarn' &= slWarn \\
\wedge speed' &= speed + speedVariation \\
\wedge visualWarn' &= visualWarn
\end{aligned}$$

Nothing changes.

$$\begin{aligned}
NothingChanges \triangleq \wedge brakePedal &= \text{"unpressed"} \\
& \wedge gasPedal &= \text{"unpressed"} \\
& \wedge lever &= 0 \\
& \wedge acousticWarn' &= acousticWarn \\
& \wedge brakePedal' &= brakePedal \\
& \wedge cc' &= cc \\
& \wedge desiredLimit' &= desiredLimit \\
& \wedge desiredSpeed' &= desiredSpeed \\
& \wedge engine' &= engine \\
& \wedge frontCarGap' &= frontCarGap \\
& \wedge gasPedal' &= gasPedal \\
& \wedge lever' &= lever \\
& \wedge sl' &= sl \\
& \wedge slWarn' &= slWarn \\
& \wedge speed' &= speed \\
& \wedge visualWarn' &= visualWarn
\end{aligned}$$

Releases brake pedal right after being pressed unless it keeps breaking.

$$\begin{aligned}
ReleaseBrakePedal \triangleq & \wedge brakePedal = \text{"pressed"} \\
& \wedge engine = \text{"on"} \\
& \wedge gasPedal = \text{"unpressed"} \\
& \wedge lever = 0 \\
& \wedge acousticWarn' = acousticWarn \\
& \wedge brakePedal' = \text{"unpressed"} \\
& \wedge cc' = cc \\
& \wedge desiredLimit' = desiredLimit \\
& \wedge desiredSpeed' = desiredSpeed \\
& \wedge engine' = engine \\
& \wedge frontCarGap' = frontCarGap \\
& \wedge gasPedal' = gasPedal \\
& \wedge lever' = lever \\
& \wedge sl' = sl \\
& \wedge slWarn' = slWarn \\
& \wedge speed' = speed \\
& \wedge visualWarn' = visualWarn
\end{aligned}$$

Releases gas pedal right after speed increasement unless it keeps increasing speed.

$$\begin{aligned}
ReleaseGasPedal \triangleq & \wedge brakePedal = \text{"unpressed"} \\
& \wedge engine = \text{"on"} \\
& \wedge gasPedal = \text{"pressed"} \\
& \wedge lever = 0 \\
& \wedge acousticWarn' = acousticWarn \\
& \wedge brakePedal' = brakePedal \\
& \wedge cc' = cc \\
& \wedge desiredLimit' = desiredLimit \\
& \wedge desiredSpeed' = desiredSpeed \\
& \wedge engine' = engine \\
& \wedge frontCarGap' = frontCarGap \\
& \wedge gasPedal' = \text{"unpressed"} \\
& \wedge lever' = lever \\
& \wedge sl' = sl \\
& \wedge slWarn' = slWarn \\
& \wedge speed' = speed \\
& \wedge visualWarn' = visualWarn
\end{aligned}$$

Lever goes to it's neutral state after being manipulated.

$$\begin{aligned}
TurnLever0 \triangleq & \wedge engine = \text{"on"} \\
& \wedge gasPedal = \text{"unpressed"} \\
& \wedge lever \neq 0 \\
& \wedge acousticWarn' = acousticWarn \\
& \wedge brakePedal' = brakePedal \\
& \wedge cc' = cc \\
& \wedge desiredLimit' = desiredLimit
\end{aligned}$$

$$\begin{aligned}
\wedge \text{desiredSpeed}' &= \text{desiredSpeed} \\
\wedge \text{engine}' &= \text{engine} \\
\wedge \text{frontCarGap}' &= \text{frontCarGap} \\
\wedge \text{gasPedal}' &= \text{gasPedal} \\
\wedge \text{lever}' &= 0 \\
\wedge \text{sl}' &= \text{sl} \\
\wedge \text{slWarn}' &= \text{slWarn} \\
\wedge \text{speed}' &= \text{speed} \\
\wedge \text{visualWarn}' &= \text{visualWarn}
\end{aligned}$$

Activates cruise control.

$$\begin{aligned}
\text{TurnLever1} \triangleq & \wedge cc = \text{"off"} \\
& \wedge \text{brakePedal} = \text{"unpressed"} \\
& \wedge \text{engine} = \text{"on"} \\
& \wedge \text{gasPedal} = \text{"unpressed"} \\
& \wedge \text{lever} = 0 \\
& \wedge \text{sl} = \text{"off"} \\
& \wedge \vee \text{desiredSpeed} > \text{none} \\
& \quad \vee \text{speed} > \text{stopped} \\
& \wedge \text{acousticWarn}' = \text{"off"} \\
& \wedge \text{brakePedal}' = \text{brakePedal} \\
& \wedge cc' = \text{"on"} \\
& \wedge \text{desiredLimit}' = \text{desiredLimit} \\
& \wedge \text{engine}' = \text{engine} \\
& \wedge \text{frontCarGap}' = \text{safe} \\
& \wedge \text{gasPedal}' = \text{gasPedal} \\
& \wedge \text{lever}' = 1 \\
& \wedge \text{sl}' = \text{sl} \\
& \wedge \text{slWarn}' = \text{slWarn} \\
& \wedge \text{speed}' = \text{speed} \\
& \wedge \text{visualWarn}' = \text{"off"} \\
& \wedge \text{IF } \text{desiredSpeed} = \text{none} \\
& \quad \text{THEN } \text{desiredSpeed}' = \text{speed} \\
& \quad \text{ELSE } \wedge \text{desiredSpeed}' = \text{desiredSpeed} \\
& \quad \wedge \text{ApproachesDesiredSpeed}
\end{aligned}$$

Increases desired speed, desired limit or equals desired speed to current speed depending on the *cc*, *sl*, or *cc* and *sl* states.

$$\begin{aligned}
\text{TurnLever2} \triangleq & \wedge \text{brakePedal} = \text{"unpressed"} \\
& \wedge \text{engine} = \text{"on"} \\
& \wedge \text{gasPedal} = \text{"unpressed"} \\
& \wedge \text{lever} = 0 \\
& \wedge \text{acousticWarn}' = \text{acousticWarn} \\
& \wedge \text{brakePedal}' = \text{brakePedal} \\
& \wedge cc' = cc
\end{aligned}$$

$$\begin{aligned}
& \wedge engine' = engine \\
& \wedge frontCarGap' = frontCarGap \\
& \wedge gasPedal' = gasPedal \\
& \wedge lever' = 2 \\
& \wedge sl' = sl \\
& \wedge slWarn' = slWarn \\
& \wedge speed' = speed \\
& \wedge visualWarn' = visualWarn \\
& \wedge \vee \wedge cc = \text{"on"} \\
& \quad \wedge desiredSpeed < maxSpeed \\
& \quad \wedge sl = \text{"off"} \\
& \quad \wedge desiredLimit' = desiredLimit \\
& \quad \wedge desiredSpeed' = desiredSpeed + speedVariation \\
& \vee \wedge cc = \text{"off"} \\
& \quad \wedge desiredLimit < maxSpeed \\
& \quad \wedge sl = \text{"on"} \\
& \quad \wedge desiredLimit' = desiredLimit + speedVariation \\
& \quad \wedge desiredSpeed' = desiredSpeed \\
& \vee \wedge cc = \text{"off"} \\
& \quad \wedge speed > stopped \\
& \quad \wedge sl = \text{"off"} \\
& \quad \wedge desiredLimit' = desiredLimit \\
& \quad \wedge desiredSpeed' = speed
\end{aligned}$$

Decreases desired speed, desired limit or equals desired speed to current speed depending on the *cc*, *sl*, or *cc* and *sl* states.

$$\begin{aligned}
TurnLever3 \triangleq & \wedge brakePedal = \text{"unpressed"} \\
& \wedge engine = \text{"on"} \\
& \wedge gasPedal = \text{"unpressed"} \\
& \wedge lever = 0 \\
& \wedge acousticWarn' = acousticWarn \\
& \wedge brakePedal' = brakePedal \\
& \wedge cc' = cc \\
& \wedge engine' = engine \\
& \wedge frontCarGap' = frontCarGap \\
& \wedge gasPedal' = gasPedal \\
& \wedge lever' = 3 \\
& \wedge sl' = sl \\
& \wedge slWarn' = slWarn \\
& \wedge speed' = speed \\
& \wedge visualWarn' = visualWarn \\
& \wedge \vee \wedge cc = \text{"on"} \\
& \quad \wedge desiredSpeed > minSpeed \\
& \quad \wedge sl = \text{"off"}
\end{aligned}$$

$$\begin{aligned}
& \wedge \text{desiredLimit}' = \text{desiredLimit} \\
& \wedge \text{desiredSpeed}' = \text{desiredSpeed} - \text{speedVariation} \\
\vee \wedge \text{cc} &= \text{"off"} \\
& \wedge \text{desiredLimit} > \text{minSpeed} \\
& \wedge \text{sl} = \text{"on"} \\
& \wedge \text{desiredLimit} - \text{speedVariation} \geq \text{speed} \\
& \wedge \text{desiredLimit}' = \text{desiredLimit} - \text{speedVariation} \\
& \wedge \text{desiredSpeed}' = \text{desiredSpeed} \\
\vee \wedge \text{cc} &= \text{"off"} \\
& \wedge \text{speed} > \text{stopped} \\
& \wedge \text{sl} = \text{"off"} \\
& \wedge \text{desiredLimit}' = \text{desiredLimit} \\
& \wedge \text{desiredSpeed}' = \text{speed}
\end{aligned}$$

MAIS SIMPLES EM CIMA, NAO ?? CONFIRMAR

$$\begin{aligned}
\text{TurnLever3} &\triangleq \vee \wedge \text{brakePedal} = \text{"unpressed"} \\
& \wedge \text{desiredSpeed} > \text{minSpeed} \\
& \wedge \text{engine} = \text{"on"} \\
& \wedge \text{gasPedal} = \text{"unpressed"} \\
& \wedge \text{lever} = 0 \\
& \wedge \text{sl} = \text{"off"} \\
& \wedge \text{brakePedal}' = \text{brakePedal} \\
& \wedge \text{cc}' = \text{cc} \\
& \wedge \text{desiredLimit}' = \text{desiredLimit} \\
& \wedge \text{desiredSpeed}' = \text{desiredSpeed} - \text{speedVariation} \\
& \wedge \text{engine}' = \text{engine} \\
& \wedge \text{gasPedal}' = \text{gasPedal} \\
& \wedge \text{lever}' = 3 \\
& \wedge \text{sl}' = \text{sl} \\
& \wedge \text{speed}' = \text{speed} \\
\vee \wedge \text{brakePedal} &= \text{"unpressed"} \\
& \wedge \text{desiredLimit} > \text{minSpeed} \\
& \wedge \text{engine} = \text{"on"} \\
& \wedge \text{speed} < \text{desiredLimit} \\
& \wedge \text{lever} = 0 \\
& \wedge \text{sl} = \text{"on"} \\
& \wedge \text{brakePedal}' = \text{brakePedal} \\
& \wedge \text{cc}' = \text{cc} \\
& \wedge \text{desiredLimit}' = \text{desiredLimit} - \text{speedVariation} \\
& \wedge \text{desiredSpeed}' = \text{desiredSpeed} \\
& \wedge \text{engine}' = \text{engine} \\
& \wedge \text{gasPedal}' = \text{gasPedal} \\
& \wedge \text{lever}' = 3 \\
& \wedge \text{sl}' = \text{sl} \\
& \wedge \text{speed}' = \text{speed}
\end{aligned}$$

Deactivates cruise control or speed limit function.

$$\text{TurnLever4} \triangleq \wedge \text{brakePedal} = \text{"unpressed"}$$

$\wedge \vee cc$	= "on"
$\vee sl$	= "on"
$\wedge engine$	= "on"
$\wedge gasPedal$	= "unpressed"
$\wedge lever$	= 0
$\wedge brakePedal'$	= $brakePedal$
$\wedge acousticWarn'$	= "off"
$\wedge cc'$	= "off"
$\wedge desiredLimit'$	= $desiredLimit$
$\wedge desiredSpeed'$	= $desiredSpeed$
$\wedge engine'$	= $engine$
$\wedge frontCarGap'$	= $none$
$\wedge gasPedal'$	= $gasPedal$
$\wedge lever'$	= 4
$\wedge sl'$	= "off"
$\wedge slWarn'$	= "off"
$\wedge speed'$	= $speed$
$\wedge visualWarn'$	= "off"

Activates or deactivates speed limit depending on the actual state.

$TurnLever5 \triangleq$	$\wedge brakePedal$	= "unpressed"
	$\wedge cc$	= "off"
	$\wedge engine$	= "on"
	$\wedge gasPedal$	= "unpressed"
	$\wedge lever$	= 0
	$\wedge speed$	$\leq desiredLimit$
	$\wedge acousticWarn'$	= $acousticWarn$
	$\wedge brakePedal'$	= $brakePedal$
	$\wedge cc'$	= cc
	$\wedge desiredLimit'$	= $desiredLimit$
	$\wedge desiredSpeed'$	= $desiredSpeed$
	$\wedge engine'$	= $engine$
	$\wedge frontCarGap'$	= $frontCarGap$
	$\wedge gasPedal'$	= $gasPedal$
	$\wedge lever'$	= 5
	$\wedge \vee \wedge sl$	= "on"
	$\wedge sl'$	= "off"
	$\wedge slWarn'$	= "off"
	$\vee \wedge sl$	= "off"
	$\wedge sl'$	= "on"
	$\wedge slWarn'$	= "on"
	$\wedge speed'$	= $speed$
	$\wedge visualWarn'$	= $visualWarn$

Turn engine off.

$$\begin{aligned}
\text{TurnEngineOff} \triangleq & \wedge \text{brakePedal} = \text{"unpressed"} \\
& \wedge \text{engine} = \text{"on"} \\
& \wedge \text{gasPedal} = \text{"unpressed"} \\
& \wedge \text{speed} = \text{stopped} \\
& \wedge \text{acousticWarn}' = \text{"off"} \\
& \wedge \text{brakePedal}' = \text{brakePedal} \\
& \wedge \text{cc}' = \text{"off"} \\
& \wedge \text{desiredLimit}' = \text{none} \\
& \wedge \text{desiredSpeed}' = \text{none} \\
& \wedge \text{engine}' = \text{"off"} \\
& \wedge \text{frontCarGap}' = \text{none} \\
& \wedge \text{gasPedal}' = \text{gasPedal} \\
& \wedge \text{lever}' = 0 \\
& \wedge \text{sl}' = \text{"off"} \\
& \wedge \text{slWarn}' = \text{"off"} \\
& \wedge \text{speed}' = \text{stopped} \\
& \wedge \text{visualWarn}' = \text{visualWarn}
\end{aligned}$$

Turn engine on.

$$\begin{aligned}
\text{TurnEngineOn} \triangleq & \wedge \text{brakePedal} = \text{"unpressed"} \\
& \wedge \text{cc} = \text{"off"} \\
& \wedge \text{engine} = \text{"off"} \\
& \wedge \text{gasPedal} = \text{"unpressed"} \\
& \wedge \text{lever} = 0 \\
& \wedge \text{sl} = \text{"off"} \\
& \wedge \text{acousticWarn}' = \text{acousticWarn} \\
& \wedge \text{brakePedal}' = \text{brakePedal} \\
& \wedge \text{cc}' = \text{cc} \\
& \wedge \text{desiredLimit}' = \text{none} \\
& \wedge \text{desiredSpeed}' = \text{desiredSpeed} \\
& \wedge \text{engine}' = \text{"on"} \\
& \wedge \text{frontCarGap}' = \text{frontCarGap} \\
& \wedge \text{gasPedal}' = \text{gasPedal} \\
& \wedge \text{lever}' = 0 \\
& \wedge \text{sl}' = \text{sl} \\
& \wedge \text{slWarn}' = \text{slWarn} \\
& \wedge \text{speed}' = 1 \\
& \wedge \text{visualWarn}' = \text{visualWarn}
\end{aligned}$$

#####

#####

Defines the next state.

$Next \triangleq \vee Brake$
 $\vee DecreaseFrontCarGap$
 $\vee DecreaseSpeed$
 $\vee EqualsDesiredSpeed$
 $\vee IncreaseFrontCarGap$
 $\vee IncreaseSpeed$
 $\vee NothingChanges$
 $\vee ReleaseBrakePedal$
 $\vee ReleaseGasPedal$
 $\vee TurnLever0$
 $\vee TurnLever1$
 $\vee TurnLever2$
 $\vee TurnLever3$
 $\vee TurnLever4$
 $\vee TurnLever5$
 $\vee TurnEngineOff$
 $\vee TurnEngineOn$

#####

#####

DVIDAS SCS11, turn lever 3
perguntar se sai muito tla

SCS – 1 → check! *MAS PERGUNTAR AO PROF*
SCS – 2 → check! *MAS PERGUNTAR AO PROF*
SCS – 3 → check!
SCS – 4 → check *SCSA!*
SCS – 5 → check *SCSA!*
SCS – 6 → check *SCSB!*
SCS – 7 → check *SCSA!*
SCS – 8 → check *SCSA!*
SCS – 9 → check *SCSB!*
SCS – 10 → check *SCSB!*
SCS-A → check! *MAS PERGUNTAR AO PROF PQ NAO SE SABE FAZER ASSERT*
SCS-B → check! *MAS PERGUNTAR AO PROF PQ NAO SE SABE FAZER ASSERT*
SCS – 11 → check! *MAS PERGUNTAR AO PROF PQ NAO SE SABE FAZER ASSERT*
'BEM'
SCS – 12 → check!
SCS – 13 → check!
SCS – 14 → check! *MAS PERGUNTAR AO PROF PQ NAO SE SABE FAZER ASSERT*
SCS – 15 → not hap
SCS – 16 → check!


```

SCS – 17 → check!
SCS – 18 → check! MAS PERGUNTAR AO PROF PQ NAO SE SABE FAZER ASSERT
SCS – 19 → check! MAS PERGUNTAR AO PROF PQ NAO SE SABE FAZER ASSERT
SCS – 20 → won't be specified.
SCS – 21 → won't be specified.
SCS – 22 → won't be specified.
SCS – 23 → won't be specified.
SCS – 24 → won't be specified.
SCS – 25 → check!
SCS – 26 → check!
SCS – 27 → won't be specified.
SCS – 28 → won't be specified.
SCS – 29 → check! MAS PERGUNTAR AO PROF
SCS – 30 → check!
SCS – 31 → check! MAS PERGUNTAR AO PROF
SCS – 32 → check!
SCS – 33 → won't be specified.
SCS – 34 → won't be specified.
SCS – 35 → check! MAS PERGUNTAR AO PROF
SCS – 36 → won't be specified.
SCS – 37 → won't be specified.
SCS – 38 → won't be specified.
SCS – 39 → won't be specified.
SCS – 40 → won't be specified.
SCS – 41 → won't be specified.
SCS – 42 → won't be specified.
SCS – 43 → won't be specified.

```

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\ * Modification History
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\ * Last modified Wed Jan 08 15:14:13 WET 2020 by ricardo
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