INSTRUCTIONS:

Fill out the hazard analysis and risk assessment below

HA-001 should be for the lane departure warning function as dis

HA-002 should be for the lane keeping assistance function as di

Then come up with your own situations and hazards f

When finished, export your spreadsheet as a pdf file s

Hazard ID	Sit		
	Operational Mode	**Operational Scenario**	**Environmental Details**
HA-001	OM03 - Normal Driving	OS04 - Highway	EN06- Rain(Slippery Road)
HA-002	OM03 - Normal Driving	OS03 – Country Road	EN01- Normal Conditions
HA-003	OM03 - Normal Driving	OS04 - Highway	EN01- Normal Conditions
HA-004	OM03 - Normal Driving	OS04 - Highway	EN04- Snowfall (Degraded Mode)

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or the lane assistance system. Fill in the HA-003 and HA-004 rows.

so that a reviewer can easily see your work.

tuational Analysis

Situation Details	Other Details (optional)	Item Usage (function)	Situation Description
SD02 - High Speed		IU01 - Correctly used	Normal situation of driving in the rain over 40mph (high speed situation). This is considered dangerous as the slippery road can increase the probability of a hazardous event.
SD02 - High Speed		IU02 – Incorrectly used	Normal driving on a country road during normal conditions with high speed and incorrectly used the system.
SD02 - High Speed		IU01 - Correctly used	Normal situation of driving in the rain over 40mph (high speed situation).
SD01 – Low Speed		IU01 - Correctly used	Normal situation of driving on a highway road 40mph (high speed situation). The driver is incorrectly using the Lane Assistance Feature by either not paying attention or not following the warnings. This is considered dangerous and can increase the probability of a hazardous event.

Hazard Identificati			
Function	**Deviation**	**Deviation Details**	**Hazardous Event (resulting effect)**
Lane Departure Warning (LDW) function shall apply an oscillating steering torque to provide the driver	DV04 – Actor effect is too much	The LDW applies an oscillating torque above limit.	EV00 – Collision with other vehicle
Lane Keeping Assistance (LKA) function shall apply the steering torque when active in order to stay in ego lane	DV03 – Function is always activated.	The Lane Keeping function is always activated.	EV00 – Collision with other vehicle
Lane Departure Warning (LDW) function shall apply an oscillating steering torque to provide the driver with haptic feedback	DV07 – Actor action is too late	The LDW torque is applied after a big delay.	EV00 – Collision with other vehicle
Lane Keeping Assistance (LKA) function shall apply the steering torque when active in order to stay in ego lane	DV19- Sensor detection is wrong	The camera sensors may blocked by heavy snow fall	EV00 – Collision with other vehicle

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Event Details	Hazardous Event Description	Exposure (of situation)	Rationale (for exposure)
The haptic feedback is too high for the driver to control. The result may result in a collision with another vehicle	If the LDW applies an oscillating torque above limit, it could potentially cause a collision	E3 – Medium Probability	Highways have many surrounding cars.
The driver may perceive the system as self-driving feature instead of drive-assist feature.	The driver does not use the function properly	E2 – Low Probability	The duration and frequency of exposure can easily fall into the range for E2 – Low Probability
The loss of vehicle control can potentially result in a collision	If the LDW applies an oscillating torque above limit, it could potentially cause a collision	E3 – Medium Probability	Highways have many surrounding cars.
The camera images may not detect lane lines correctly which can potentially result in a collision	The lane departure system is properly used but undetected error occurs.	E2 – Low Probability	The duration and frequency of exposure can easily fall into the range for E2 – Low Probability

Hazardous Event Classification		
Severity (of potential harm)	**Rationale (for severity)**	**Controllability (of hazardous event)**
S3 _Life Threatening or Fatal Injuries	Collisions with other vehicles can be potentially life threatening or fatal	C3 – Difficult to control
S3 _Life Threatening or Fatal Injuries	Collisions with other vehicles can be potentially life threatening or fatal	C3 – Difficult to control
S3 _Life Threatening or Fatal Injuries	Collisions with other vehicles can be potentially life threatening or fatal	C2 – Normally Controllable
S3 _Life Threatening or Fatal Injuries	Collisions with other vehicles can be potentially life threatening or fatal	C2 – Normally Controllable

	Determination of ASIL and Safety Goals	
Rationale (for controllability)	**ASIL Determination**	**Safety Goal**
The high haptic feedback does not provide a positive feedback to the driver that the vehicle is in control which could result in lack of control and cause a collision	ASIL-C	The oscillating steering torque from the LDW function shall be limited.
A panic situation by a driver in potential collision event may result in a fatal accident	ASIL-B	The LKA function shall be time limited. The steering oscillations will cease after a short time interval to allow the driver to take over control of the vehicle
Normally vehicles ride in the center of the lane and the LKA should have enough room to adjust.	ASIL-B	The LDW will look to minimize the latency of sending the steering torque.
If there is snow on the road it is likely the vehicle is moving at low speed and the driver is probably attentive to adjustments.	QM	The LKA shall accurately determine vehicles position in the lane and apply steering torque when needed.

EXAMPLE DISCUSSED IN THE PROJECT INSTRUCTION

Hazard ID	
	Operational Mode
HA-001	Normal Driving

MORE EXAMPLES - Headlamp System

Hazard ID	
	Operational Mode
HA-001	OM03 - Normal Driving
HA-002	OM03 - Normal Driving
HA-003	OM03 - Normal Driving
HA-004	OM03 - Normal Driving
HA-005	OM03 - Normal Driving

IS - Headlamp System

Situ	
Operational Scenario	**Environmental Details**
City Road	Normal Conditions

Situ	
Operational Scenario	**Environmental Details**
OS01 - City Road	EN01 - Normal conditions
OS01 - City Road	EN04 - Snowfall (degraded view)
OS03 - Highway	EN04 - Snowfall (degraded view)
OS02 - Country Road	EN01 - Normal conditions
OS02 - Country Road	EN04 - Snowfall (degraded view)

ational Analysis

Situation Details (optional)	Other Details (optional)	Item Usage (function)
Low Speed	Night time + Obstacle on the road	Correctly Used

uation Analysis

Situation Details (optional)	Other Details (optional)	Item Usage (function)
SD03 - Low speed	Night time + Obstacle on the road	IU01 - Correctly used
SD03 - Low speed	the road and no other	IU01 - Correctly used
SD03 - High speed	the road or upcoming	IU01 - Correctly used
SD02 - High speed	Night time + Oncoming vehicle	IU01 - Correctly used
SD04 - High speed	the road and no other	IU01 - Correctly used

Situation Description	Function	Deviation
Conditions at Low Speed at Night with an	Low beam illuminates the roadway in the dark	Function not activated

Situation Description	Function	Deviation
conditions with Low speed (Night time +	Low beam illuminates the roadway in the dark	DV01 - Function not activated
(degraded view) with Low speed (Night time + Obstacle on the road and no other	Low beam illuminates the roadway in the dark	DV01 - Function not activated
(degraded view) with High speed (Night time	Low beam illuminates the roadway in the dark	DV01 - Function not activated
Normal conditions with High speed (Night	Low beam illuminates the roadway in the dark	DV01 - Function not activated
Snowfall (degraded view) with High speed (Night time + Obstacle on the road and no	Low beam illuminates the roadway in the dark	DV01 - Function not activated

Hazard Identification		
Deviation Details	**Hazardous Event (resulting effect)**	**Event Details**
Both headlights stop working	Front collision with obstacle	the obstacle with

Hazard Identification		
Deviation Details	**Hazardous Event (resulting effect)**	**Event Details**
Both headlights stop working	EV04 - Front collision with obstacle	the obstacle with
Both headlights stop working	EV04 - Front collision with obstacle	the obstacle with
Both headlights stop working	EV04 - Front collision with obstacle	infrastructure with
Both headlights stop working	EV08 - Collision with other vehicle	the oncoming vechile
Both headlights stop working	EV04 - Front collision with obstacle	infrastructure with

Hazardous Event Description	Exposure (of situation)	Rationale (for exposure)
total loss of low beam	E4 - High probability	night driving in the city is a regular activity

Hazardous Event Description	Exposure (of situation)	Rationale (for exposure)
total loss of low beam	E4 - High probability	night driving in the city is a regular activity
total loss of low beam	E1 - Very low probability	completely unilluminated roads
total loss of low beam	E2 - Low probability	driving, however, heavy snow
total loss of low beam	E4 - High probability	country driving is part of regular driving
total loss of low beam	E2 - Low probability	regular driving, however, heavy snow occurs a few times a

Hazardous Event Classification	
Severity (of potential harm)	**Rationale (for severity)**
S1 - Light and moderate injuries	In city traffic, speed of vehicle is expected to be low

Hazardous Event Classification	
Severity (of potential harm)	**Rationale (for severity)**
S1 - Light and moderate injuries	In city traffic, speed of vehicle is expected to be low
S1 - Light and moderate injuries	In city traffic, speed of vehicle is expected to be low
S3 - Life-threatening or fatal injuries	On highway speed of vehicle is expected to be high
S3 - Life-threatening or fatal injuries	On country roads speed of vehicle is expected to be high
S3 - Life-threatening or fatal injuries	On country roads speed of vehicle is expected to be high

Controllability (of hazardous event)	Rationale (for controllability)
C0 - Controllable in general	to control the situation by applying brakes and there is additional

Controllability (of hazardous event)	Rationale (for controllability)
C0 - Controllable in general	to control the situation by applying brakes and there is additional
C1 - Simply controllable	drivers usually drive at lower end of city speeds and hence are expected to be
C2 - Normally controllable	of illumination on road and hence >90% drivers are able to brake and
C1 - Simply controllable	road, it will be difficult for the average
C3 - Difficult to control or uncontrollable	road, it will be difficult for the average

Determination of ASIL and Safety Goals	
ASIL Determination	**Safety Goal**
QM	Total Loss of Beam Shall Be Prevented

Determination of ASIL and Safety Goals	
ASIL Determination	**Safety Goal**
QM	Total loss of low beam shall be prevented
QM	Total loss of low beam shall be prevented
A	Total loss of low beam shall be prevented
B	Total loss of low beam shall be prevented
B	Total loss of low beam shall be prevented

Hazard & Risk Analysis De

Operational Mode

ID	Mode
OM01	Parked
OM02	Ignition on
OM03	Normal driving
OM04	Backward driving
OM05	Degraded driving
OM06	Towing (active)
OM07	Towing (passive)
OM08	Service
OM09	N/A

Operational Scenario

ID	Scenario
OS01	Any Road
OS02	City Road
OS03	Country Road
OS04	Highway
OS05	Mountain Pass
OS06	Off Road
OS07	Road with gradient
OS08	Road with bump
OS09	Road tunnel
OS10	Road with construction site
OS11	N/A

Situation Details

ID	Scenario
SD01	Low speed
SD02	High speed
SD03	Normal acceleration
SD04	High acceleration
SD05	Normal braking
SD06	High braking
SD07	N/A

Item Usage

ID	Mode
IU01	Correctly used
IU02	Incorrectly used
IU03	N/A

Environmental Details

ID	Scenario

EN01	Normal conditions
EN02	Sun blares (degraded view)
EN03	Fog (degraded view)
EN04	Snowfall (degraded view)
EN05	Cross-wind (lateral force)
EN06	Rain (slippery road)
EN07	Snow (slippery road)
EN08	Glace (slippery road)
EN09	N/A

finitions

Remarks
Car is parked, ignition is off
Car is parked, ignition is on
Car is driving
Car is driving
Limp home mode
Towing another car
Beeing towed by another car
Vehicle is in repair garage
not applicable or not relevant

Remarks
road type
road type
road type
road type
road type
road type
road attribute
road attribute
road attribute
road attribute
not applicable or not relevant

Remarks
driving attribute
driving attribute
driving attribute
driving attribute
driving attribute
driving attribute
not applicable or not relevant

Remarks
Intended usage
Unintended usage (foreseeable)
not applicable or not relevant

Remarks

weather attribute
weather attribute
weather attribute
weather attribute
weather attribute
road attribute
road attribute
road attribute
not applicable or not relevant

Reference
OM01 - Parked
OM02 - Ignition on
OM03 - Normal driving
OM04 - Backward driving
OM05 - Degraded driving
OM06 - Towing (active)
OM07 - Towing (passive)
OM08 - Service
OM09 - N/A

Reference
OS01 - Any Road
OS02 - City Road
OS03 - Country Road
OS04 - Highway
OS05 - Mountain Pass
OS06 - Off Road
OS07 - Road with gradient
OS08 - Road with bump
OS09 - Road tunnel
OS10 - Road with construction site
OS11 - N/A

Reference
SD01 - Low speed
SD02 - High speed
SD03 - Normal acceleration
SD04 - High acceleration
SD05 - Normal braking
SD06 - High braking
SD07 - N/A

Reference
IU01 - Correctly used
IU02 - Incorrectly used
IU03 - N/A

Reference

EN01 - Normal conditions
EN02 - Sun blares (degraded view)
EN03 - Fog (degraded view)
EN04 - Snowfall (degraded view)
EN05 - Cross-wind (lateral force)
EN06 - Rain (slippery road)
EN07 - Snow (slippery road)
EN08 - Glace (slippery road)
EN09 - N/A

Deviation

ID	Deviation (Guideword)	Remarks
DV01	Function not activated	Activation error
DV02	Function unexpectedly activated	Activation error
DV03	Function always activated	Activation error
DV04	Actor effect is too much	Quantitative error
DV05	Actor effect is too less	Quantitative error
DV06	Actor action too early	Timing error
DV07	Actor action too late	Timing error
DV08	Actor action before	Sequence error
DV09	Actor action after	Sequence error
DV10	Actor effect is reverse	Logical error
DV11	Actor effect is wrong	Logical error
DV12	Sensor sensitivity is too high	Quantitative error
DV13	Sensor sensitivity is too low	Quantitative error
DV14	Sensor detection too early	Timing error
DV15	Sensor detection too late	Timing error
DV16	Sensor detection before	Sequence error
DV17	Sensor detection after	Sequence error
DV18	Sensor detection is reverse	Logical error
DV19	Sensor detection is wrong	Logical error
DV20	N/A	not applicable or not relevant

Hazardous Events (possibe effects)

ID	Hazardous Event	Remarks
EV-07	None	
EV-06	Front collision with oncoming traffic	
EV-05	Front collision with ahead traffic	
EV-04	Front collision with obstacle	
EV-03	Rear collision with trailing traffic	
EV-02	Side collision with other traffic	
EV-01	Side collision with obstacle	
EV00	Collision with other vehicle	
EV01	Collision with train	
EV02	Collision with pedestrian	
EV03	Car spins out of control	
EV04	Car comes off the road	
EV05	Car catches file	
EV06	N/A	

Reference
DV01 - Function not activated
DV02 - Function unexpectedly activated
DV03 - Function always activated
DV04 - Actor effect is too much
DV05 - Actor effect is too less
DV06 - Actor action too early
DV07 - Actor action too late
DV08 - Actor action before
DV09 - Actor action after
DV10 - Actor effect is reverse
DV11 - Actor effect is wrong
DV12 - Sensor sensitivity is too high
DV13 - Sensor sensitivity is too low
DV14 - Sensor detection too early
DV15 - Sensor detection too late
DV16 - Sensor detection before
DV17 - Sensor detection after
DV18 - Sensor detection is reverse
DV19 - Sensor detection is wrong
DV20 - N/A

Reference
EV-07 - None
EV-06 - Front collision with oncoming traffic
EV-05 - Front collision with ahead traffic
EV-04 - Front collision with obstacle
EV-03 - Rear collision with trailing traffic
EV-02 - Side collision with other traffic
EV-01 - Side collision with obstacle
EV00 - Collision with other vehicle
EV01 - Collision with train
EV02 - Collision with pedestrian
EV03 - Car spins out of control
EV04 - Car comes off the road
EV05 - Car catches file
EV06 - N/A

Exposure

ID	Description	Duration (of situation)
E0	Incredible	
E1	Very low probability	Not specified
E2	Low probability	<1 % of average operating time
E3	Medium probability	1 % to 10 % of average operating time
E4	High probability	>10 % of average operating time

Severity

ID	Description	Remarks
S0	No injuries	No injuries
S1	Light and moderate injuries	Light and moderate injuries
S2	Severe and life-threatening injuries	Severe and life-threatening injuries (survival probable)
S3	Life-threatening or fatal injuries	Life-threatening injuries (survival uncertain), fatal injuries

Controllability

ID	Description	Remarks
C0	Controllable in general	Controllable in general
C1	Simply controllable	99 % or more of all drivers or other traffic participants are usu
C2	Normally controllable	90 % or more of all drivers or other traffic participants are usu
C3	Difficult to control or uncontrollable	Less than 90 % of all drivers or other traffic participants are u

Frequency (of situation)	Reference
	E0 - Incredible
Occurs less often than once a year for the great majority of d	E1 - Very low probability
Occurs a few times a year for the great majority of drivers	E2 - Low probability
Occurs once a month or more often for an average driver	E3 - Medium probability
Occurs during almost every drive on average	E4 - High probability

Probability of Injuries	Reference
AIS 0 and less than 10 % probability of AIS 1-6	S0 - No injuries
More than 10 % probability of AIS 1-6 (and not S2 or S3)	S1 - Light and moderate injuries
More than 10 % probability of AIS 3-6 (and not S3)	S2 - Severe and life-threatening injuries
More than 10 % probability of AIS 5-6	S3 - Life-threatening or fatal injuries

	Reference
	C0 - Controllable in general
ually able to avoid harm	C1 - Simply controllable
ually able to avoid harm	C2 - Normally controllable
sually able, or barely able, to avoid harm	C3 - Difficult to control or uncontrollable

Controllability	Exposure	Severity		
		S0	S1	S2
C1	E1	QM	QM	QM
	E2	QM	QM	QM
	E3	QM	QM	QM
	E4	QM	QM	A
C2	E1	QM	QM	QM
	E2	QM	QM	QM
	E3	QM	QM	A
	E4	QM	A	B
C3	E1	QM	QM	QM
	E2	QM	QM	A
	E3	QM	A	B
	E4	QM	B	C

S3
QM
QM
A
B
QM
A
B
C
A
B
C
D