EURO NCAP

#FORSAFERCARS

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Data Acquisition And Assessment Criteria Calculation

Safe Driving & Crash Avoidance

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PREFACE

DISCLAIMER: Euro NCAP has taken all reasonable care to ensure that the information published in this protocol is accurate and reflects the technical decisions taken by the organisation. In the unlikely event that this protocol contains a typographical error or any other inaccuracy, Euro NCAP reserves the right to make corrections and determine the assessment and subsequent result of the affected requirement(s).

CONTENTS

1 TEST DATA

To ensure consistency in the general folder structure, this chapter details the required folder structure. For each (sub)test where measurements are performed with vehicles and/or other test equipment, all test data shall be provided in ISO-MME 1.6 format and shall be fully compliant with the ISO/TS 13499 standard. It should be noted that some file names are also prescribed in this document. All data shall be provided using SI units unless specified otherwise.

1.1 Crash Avoidance

The following folder structure, generated automatically in the Euro NCAP sharing platform, is to be used for all test series where the name of the main folder containing all tests consists of:

- The year of test
- OEM abbreviation
- Euro NCAP internal number (4 digits)
- Make and Model

Where Euro NCAP tests contain a number of sub-tests, the next paragraph details the folder structure, names of the sub-system test folders and where applicable the file names.

On the highest level, the folder structure is as follows with on the right an example using the Volvo ES90 that is assumed to be tested in 2026 with a Euro NCAP internal number of 9999.

• **MAIN FOLDER NAME**	• **26-VOL-9999-Volvo ES90**	**Uploaded by:**
AEB Pedestrian test folder	26-VOL-9999-AEBP	Laboratory
AEB Bicyclist test folder	26-VOL-9999-AEBB	Laboratory
AEB Motorcyclist test folder	26-VOL-9999-AEBM	Laboratory
AEB Car-to-Car tests folder	26-VOL-9999-AEBC	Laboratory
SAS tests folder	26-VOL-9999-SAS	Laboratory
LSS tests folder	26-VOL-9999-LSS	Laboratory
OSM information	26-VOL-9999-OSM	Laboratory

1.1.1 Sub-test folders

The number of sub-test folders in each of the following main folders depends on the performance of the vehicle under test. For each of the test combinations, there shall be a separate sub-test folder.

The following chapters illustrate the sub-test folder structure. It should be noted that the test laboratory may use the naming convention of their choice for each of the sub-test folders.

1.1.1.1 AEB Car-to-Car

- **MAIN FOLDER NAME**
- …
- AEB Car-to-Car tests folder
  - <AEB-C CCRs 30km/h AEB test number>
  - …
  - <AEB-C CCRm 50km/h FCW test number>
  - …
  - < AEB-C CCRb 40km/h AEB test number >
  - …
  - <AEB-C CCFt 10km/h 20km/h test number>
  - …
- …

- **26-VOL-9999-Volvo ES90**
- …
- 26-VOL-9999-AEBC
  - 9999-CCRs_AEB_30VUT_075-01
  - …
  - 9999-CCRm_FCW_50VUT_125-01
  - …
  - 9999-CCRb_AEB_40_6-01
  - …
  - 9999-CCFt_10VUT_20GVT-01
  - …
- …

1.1.1.2 AEB Motorcycle

- **MAIN FOLDER NAME**
- …
- AEB Motorcycle tests folder
  - <AEB-M CMRs50 30km/h test number>
  - …
  - <AEB-M CMRb25 12m. -4m/s² test number>
  - …
  - <AEB-M ELK oncoming0.6m/s 72km/h test number>
  - …
  - <AEB-M CMFt 20km/h 55km/h test number>
  - …

- **26-VOL-9999-Volvo ES90**
- …
- 26-VOL-9999-AEBM
  - 9999-CMRs50_AEB_30VUT-01
  - …
  - 9999-CMRb25_FCW_12_4-01
  - …
  - 9999-ELK_ONC_06D_72EMT-01
  - …
  - 9999-CMFt_20VUT_55EMT-01
  - …
- …

1.1.1.3 AEB Pedestrian

- **MAIN FOLDER NAME**
- …
- AEB Pedestrian tests folder
  - <CPLAday test1>
  - <CPLAday validation-2 test number>
  - <CPLAday validation-3 test number>
  - …
  - <CPTAs validation-1 test number>
  - …
  - …
- …

- **26-VOL-9999-Volvo ES90**
- …
- 26-VOL-9999-AEBP
  - CPLAday-01
  - CPLAday-02
  - CPLAday_V3-01
  - …
  - CPTAs_VUT-01
  - …
  - …
- …

1.1.1.4 AEB Bicyclist

- **MAIN FOLDER NAME**
- …
- AEB Bicyclist tests folder
  - <AEB-B CBNa50 30km/h test number>
  - …
  - <AEB-B CBNaO50 40km/h test number>
  - …
  - <AEB-B CBDaO INFO test number>
  - …
  - …
- …

- **26-VOL-9999-Volvo ES90**
- …
- 26-VOL-9999-AEBB
  - 9999-CBNa50_30VUT-01
  - …
  - 9999-CBNaO50_40VUT-01
  - …
  - 9999-CBDaO_INFO-01
  - …
  - …
- …

1.1.1.5 Lane Support Systems

The test numbers for each sub-test consists of the Lane Support Systems scenarios (ELK-REN, ELK-ON, ELK-OV), the lateral velocity and finally followed by the letter indicating left or right.

- **MAIN FOLDER NAME**
- …
- Lane Support Systems tests folder
  - < LSS ELK-REN 0.3 right test number >
  - …
  - < LSS ELK-OV 0.3 left test number >
  - …
- …

- **26-VOL-9999-Volvo ES90**
- …
- 26-VOL-9999-LSS
  - 9999-ELK-REN-03R
  - …
  - 9999-ELK-OV-03L
  - …
- …

1.1.1.6 Occupant Status Monitoring

The number of sub-test folders in the Occupant Status Monitoring folder is depending on the equipment available and the Driver Status Monitoring performance of the vehicle under test. For DSM, each of the driver status types (long distraction, short distraction, phone use, fatigue) there will be a separate sub-test folder.

- **MAIN FOLDER NAME**
- …
- Occupant Status Monitoring tests folder
  - 26-VOL-9999-SBR
    - Seatbelt reminder test report.pdf
  - 26-VOL-9999-DSM
    - < OSM Long distraction test number >
    - …
    - < OSM Short distraction test number >
    - …
    - < OSM Phone use test number >
    - …
    - < OSM Fatigue test number >
    - …
      - Driver Status Monitoring test report.pdf
- …

- **26-VOL-9999-Volvo ES90**
- …
- 26-VOL-9999-OSM
  - 26-VOL-9999-SBR
    - 9999-SBR Test Report.pdf
  - 26-VOL-9999-DSM
    - 9999- LD_01
    - …
    - 9999- SD_01
    - …
    - 9999- PU_01
    - …
    - 9999- FAT_ 01
    - ...
      - 26-VOL-9999-DSM Test Report.pdf
- …

1.2 Assisted Driving

The following folder structure, generated automatically in the Euro NCAP sharing platform, is to be used for all test series where the name of the main folder containing all tests consists of:

- The year of test
- OEM abbreviation
- Euro NCAP internal AD number (4 digits) beginning with A
- Make and Model

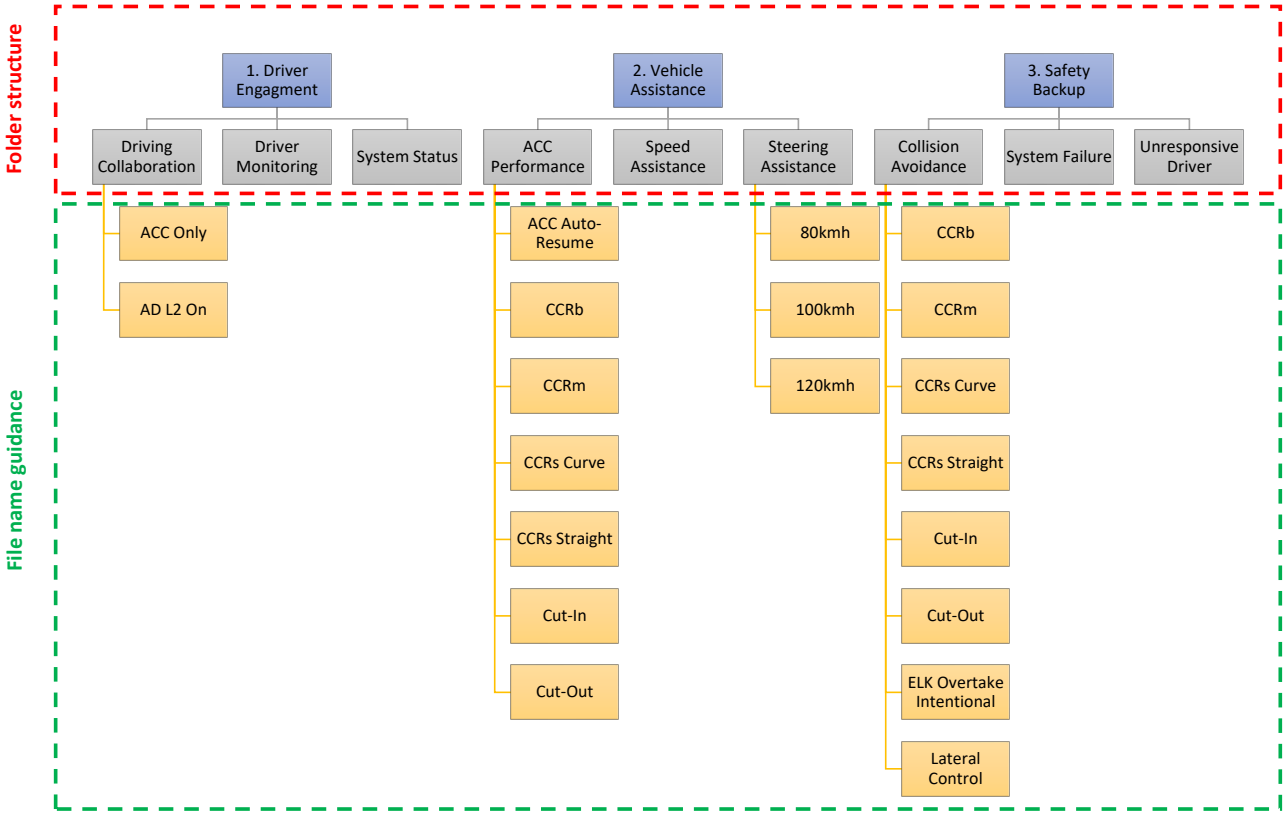
Where Euro NCAP tests contain a number of sub-tests, the next paragraph details the folder structure, names of the sub-system test folders and where applicable the filenames.

On the highest level, the folder structure is as follows with on the right an example using the Volvo ES90 that is assumed to be tested in 2022 with a Euro NCAP internal number of 9999.

- **MAIN FOLDER NAME**
  - <ACC test number>
  - <Driver collaboration test number>
  - < Driver monitoring test number >
  - <Lane support test number>
  - <Speed assist test number>
  - <Steering assistance test number>
  - Media files
  -
  - Euro NCAP Spreadsheet.xlsm

- **26-VOL-A999-Volvo ES90**
  - 26-VOL-A999-ACC
  - 26-VOL-A999-DRV_COL
  - 26-VOL-A999-DRV_MON
  - 26-VOL-A999-LSS
  - 26-VOL-A999-SA
  - 26-VOL-A999-STR_ASSIST
  - 26-VOL-A999-MEDIA
  -
  - 26-VOL-9999-Volvo ES90 Spreadsheet.xlsm

The Assisted Driving test folder contains 3 folders with 3 sub-folders each, according to the structure in below diagram:



1.2.1.1 ACC

The ACC test folder contains 3 sub-test folders.

- **MAIN FOLDER NAME**
  - …
  - ACC tests folder
    - …
    - ACC test report .pdf
  - …

- **26-VOL-A999-Volvo ES90**
  - …
  - 26-VOL-A999-ACC
    - …
    - 26-VOL-A999-ACC .pdf
  - …

1.3 ISO MME folder structure

The ISO MME folder structure is to be applied to all applicable tests and the files contained in these folders follow the ISO/TS 13499 standard. The main directory contains two folders and two files. The following folders and files (comment files when needed) need to be provided for every test performed, where the test number is the one as specified in the previous section.

For each file and folder (where necessary) the required contents are specified in detail in the paragraphs below.

- **TEST NUMBER**
  - Channel
  - Movie
  - <test number>.mme
  - <test number>.txt

1.3.1 Channel folder

The channel folder contains all channels from the vehicle and targets used in the test as defined in Section 2.

- **TEST NUMBER**
  - Channel
    - <test number>.xxx
    - <test number>.chn
  - …

1.3.2 Movie folder

The movie folder contains the inspection quality films, using the exact names as specified in the Euro NCAP Film and Photo protocol.

- **TEST NUMBER**
  - …
  - Movie
    - < test number _ name of movie file 1>
    - < test number _ name of movie file m>
  - …

1.3.3 MME-file

The mme-file contains the information of the test where the type of test and subtype of test shall be selected from the table below.

- **TEST NUMBER**
  - …
  - <test number>.mme

The mme-file shall contain the following header:

Item	Header	Remarks
Data format edition number	:1.6	
Laboratory name	:<lab name>	
Customer name	:Euro NCAP	
Customer project ref. number	:<test series number>	4 digits number, e.g. 9999
Title	:Euro NCAP <year of test>	
Timestamp	:<date> <time>	YYYY/MM/DD, HH:MM
Scenario	:<see table>	
Type of the test	:<see table>	
Condition of test	:<see table>	
Region	:<EU/UK>	
Robustness Layer	:<Type;Robustness layer; Parameter><see table>	Example: Target;Speed
Name of test object 1	:<make, model>	
Driver position object 1	:<1/3>	LHD=1, RHD=3
Ref. number of test object 1	:<VIN >	
S/W version of TOB 1		As given by OEM
Dimensions test object 1	:<length>, <width>	Dimensions as defined in protocol
Shape Front TOB 1	:(x1;y1), (x2;y2), (x3;y3), (x4;y4), (x5;y5) (x6;y6), (x7;y7)	Origin (x4,y4) at the most forward point on the centreline of test object 1
Shape Rear TOB 1	:(x1;y1), (x2;y2), (x3;y3), (x4;y4), (x5;y5) (x6;y6), (x7;y7)	All coordinates relative to the most forward point on the centreline of test object 1
Shape Right Side TOB 1	:(x1;y1), (x2;y2), (x3;y3), (x4;y4), (x5;y5) (x6;y6), (x7;y7)	
Shape Left Side TOB 1	:(x1;y1), (x2;y2), (x3;y3), (x4;y4), (x5;y5) (x6;y6), (x7;y7)	
Velocity longitudinal TOB 1	:<VUT longitudinal velocity>	Desired (scenario) velocity

Velocity lateral TOB 1	:<VUT lateral velocity>	Desired (scenario) velocity
Impact side TOB 1	:<FR,LE,RI,RE>	
Impact location test object 1	:<%>	Desired (scenario) impact location in %
Name of test object 2	:<PTa/PTc/…>	Target Type
Velocity test object 2	:<target velocity>	Desired (scenario) velocity
Acceleration test object 2	:<target acceleration>	Desired (scenario) acceleration
Heading test object 2	:<target heading>	Desired (scenario) heading
Type of data source	:<type>	VTA or Physical Tests

Note: the non-standard attributes need to be preceded by a point ".xxx"

1.3.3.1 Scenario, type of test and condition of test

Scenario	Type of the test	Condition of test
CCRs	:<AEB/AES/ESS>	
CCRm	:<AEB/AES >	
CCRb	:<AEB/AES >	
CCFhos	:<AEB/AES >	
CCFhol	:<AEB/AES >	
CMRs	:<AEB/AES/ESS>	
CMRb	:<AEB/AES >	
CPLA	:<AEB/FCW/ESS>	:<D/N>
CBLA	:<AEB/FCW/ESS>	
CCFtap	:<AEB>	
CMFtap	:<AEB>	
CPTA	:<AEB>	:<fs/ns/fo/no>
CBTA	:<AEB>	:<fs/ns/fo/no>
CCCscp	:<AEB>	
CMCscp	:<AEB>	
CPNA	:<AEB >	:<D/N>
CPFA	:<AEB>	:<D/N>
CPNCO	:<AEB/AES>	:<D/N>
CBNA	:<AEB>	
CBFA	:<AEB>	
CBNAO	:<AEB>	
ELK-RE		:<D/P>
ELK-ON		
ELK-OV		:<U/I>
CPMRC		

CPMFC		:<D1/D2>
CBDA	:<i/w/r>	

1.3.3.2 Robustness layers

Type	Robustness Layer		Parameter 1
	Name	Code	
[None]	Not applicable	N/A	No robustness layer applied
VUT	Driver input pre-crash	DI	-
Target	Speed	S	<adjusted target velocity in km/h>
	Acceleration	A	<adjusted target acceleration in m/s^2>
	Initial position offset	IP	<adjusted target position offset in m>
	Trajectory/Heading	H	<adjusted target heading in degrees>
Environment	Illumination (Nighttime)	N	
	Illumination (Headlamp Glare)	HG	TBD (from CA 002)
	Infrastructure/Clutter	I	TBD (from CA 002)
	Obscuration/Obstruction	O	TBD (from CA 002)

2 CHANNEL NAMES AND FILTERS

For test objects used in the different Euro NCAP tests, both physical and virtual, the following channel names shall be used. All channels shall be supplied either unfiltered or prefiltered. The appropriate filters of these channels will be performed by the analysis software used.

2.1 Vehicle for Active Safety tests

Location	Parameter	ISO code	Unit	R_{efSys}	Filter	Assessment Calculation
Time (AEB)	FCW activation time	10TFCW000000EV00	1	-		FCW Time-to-Collision
	Time where VUT enters in curve segment	10TECS000000EV00	1	-		T_{steer}
Time (LSS)	LDW activation time	10TLDW000000EV00	1	-		Distance to Line Crossing for LDW
Time (Dooring)	Time where VUT driver door opening interface	T_door_operation 10TDOP000000EV00	1	-		Contact sensor / door operation channel / video [optional]
	Time of Visual Information signal	10TINF000000EV00	1	-		
	Time of Warning signal	10TWRN000000EV00	1	-		
	Time when the door opens	T_open 10TDOP010000EV00	1	-		Contact sensor / door operation channel / video [optional]
Vehicle Front	Position X_{VUT}, Y_{VUT}	10VEHC000000DS[X,Y]P	m	TST		

	Speed V_{VUT_x}, V_{VUT_y}	10VEHC000000VE[X,Y]P	m/s	1DY		Relative impact speed, Speed reduction
	Acceleration A_{VUT_X} A_{VUT_Y}	10VEHC000000AC[X,Y]S	m/s^2	1DY	*	
	Yaw velocity Ψ_{VUT}	10VEHC000000AVZP	rad/s	1DY	*	
	Yaw angle	10VEHC000000ANZP	rad	TST		
Vehicle front wheel (outer edge)	Position $X_{VUT,wheel}$, $Y_{VUT,wheel}$	1[1,3]WHEL000000DS[X, Y]P	m	TST**		DTLE for LKA DTLE for LDW
Steering wheel	Steering wheel angle velocity	10STWL000000AV1P	rad/s	LOC		
	Steering wheel angle	10STWL000000AN1P	rad	LOC		
	Steering wheel torque	10STWL000000MO1P	Nm	LOC	*	Estimated torque from steering wheel
Accelerator pedal	Pedal position (robot output)	10PEAC000000DS0P	m	LOC		
Brake pedal	Pedal position (robot output)	10PEBR000000DS0P	m	LOC		
	Pedal Force	10PEBR000000FO0P	N	LOC		

**Driving dynamics filter, 10Hz, 12 pole butterworth, phase compensated*

***Origin on the lane marking (before the bend)*

2.2 Euro NCAP Global Vehicle Target

Location	Parameter	ISO code	Unit	Ref Sys	Filter	Assessment Calculation
GVT	Position X_{GVT}, Y_{GVT}	20VEHC000000DS[X,Y]P	m	TST		
	Speed V_{GVT_x}, V_{GVT_y}	20VEHC000000VE[X,Y]P	m/s	2DY		Relative impact speed
	Acceleration A_x	20VEHC000000ACXS	m/s^2	2DY	*	
	Yaw velocity $\boldsymbol{\Psi}_{GVT}$	20VEHC000000AVZS	rad/s	2DY	*	
	Yaw angle	20VEHC000000ANZP	rad	TST		

**Driving dynamics filter, 10Hz, 12 pole butterworth, phase compensated*

2.3Euro NCAP Pedestrian Target

Location	Parameter	ISO code	Unit	RefSys	Filter	Assessment Calculation
EPT adult & child	Position X_{EPT} , Y_{EPT}	20PED[A,C]000000DS[X,Y]P	m	TST		
	Speed V_{EPT_x} ,V_{EPT_y}	20PED[A,C]000000VE[X,Y]P	m/s	2DY		
	Acceleration A_x	20PED[A,C]000000ACXS	m/s^2	2DY	*	
	Yaw angle	20PED[A,C]000000ANZS	rad/s	TST		
	Yaw velocity $\boldsymbol{\Psi}_{EPT}$	20PED[A,C]000000AVZP	rad	2DY	*	

**Driving dynamics filter, 10Hz, 12 pole butterworth, phase compensated*

2.4 Euro NCAP Bicyclist Target

Location	Parameter	ISO code	Unit	RefSys	CFC	Assessment Calculation
EBT adult	Position X_{EBT} , Y_{EBT}	20CYCL000000DS[X,Y]P	m	TST		
	Speed V_{EBT_x} ,V_{EBT_y}	20CYCL000000VE[X,Y]P	m/s	2DY		
	Acceleration A_x	20CYCL000000ACXS	m/s^2	2DY	*	
	Yaw angle	20CYCL000000ANZS	rad/s	TST		
	Yaw velocity Ψ_{EBT}	20CYCL000000AVZP	rad	2DY	*	

**Driving dynamics filter, 10Hz, 12 pole butterworth, phase compensated*

2.5 Euro NCAP Motorcycle Target

Location	Parameter	ISO code	Unit	RefSys	CFC	Assessment Calculation
EMT	Position X_{EMT} , Y_{EMT}	20TWMB000000DS[X,Y]P	m	TST		
	Speed V_{EMT_x} ,V_{EMT_y}	20TWMB000000VE[X,Y]P	m/s	2DY		
	Acceleration A_x	20TWMB000000ACXS	rad/s	2DY	*	
	Yaw angle	20TWMB000000ANZS	rad	TST		
	Yaw velocity Ψ_{EMT}	20TWMB000000AVZP	m/s^2	2DY	*	

3 ASSESSMENT CRITERIA CALCULATION

This chapter describes the calculation for the parameters used for the assessment criteria used within Euro NCAP active safety tests, including the filters that are applied to each channel used in these calculations. The test laboratory shall supply Euro NCAP with the filtered channels outlined in chapter 2, and the calculation of parameters will be done by Euro NCAP as described in this chapter.

3.1 Autonomous Emergency Braking

3.1.1 Relative impact speed

The (relative) impact speed is calculated with the following formula

$$v_{rel,impact} = v_{VUT}(t_{impact}) - v_{target}(t_{impact})$$

With:

V_{VUT}	Speed of VUT
V_{Target}	Speed of target
t_{impact}	Time of impact

For V_{rel_impact} calculation in CPNA, CPFA, CPNCO, CBNA, CBFA and CBNAO scenarios, the Target's velocity component to be used shall be the one aligned with VUT direction of travel.

3.1.2 Speed reduction

The speed reduction is calculated with the following formula:

$$v_{reduction} = v_{VUT}(t_0) - v_{VUT}(t_{impact})$$

With:

V_{VUT}	Speed of VUT
t_0	Time of start of test
t_{impact}	Time of impact

3.1.3 Time-to-Collision

Time-to-collision (TTC) is defined as the time remaining before a collision would occur if the relative speed between the VUT and the Target remains constant:

$$TTC = \frac{D_{VUT\_Target}}{v_{VUT} - v_{target}}$$

With:

D_{VUT_Target}	Closest distance between the Target bounding box and the VUT profiled line (i.e., closest polygon-to-polygon distance).
V_{VUT}	Speed of VUT
V_{GVT}	Speed of target

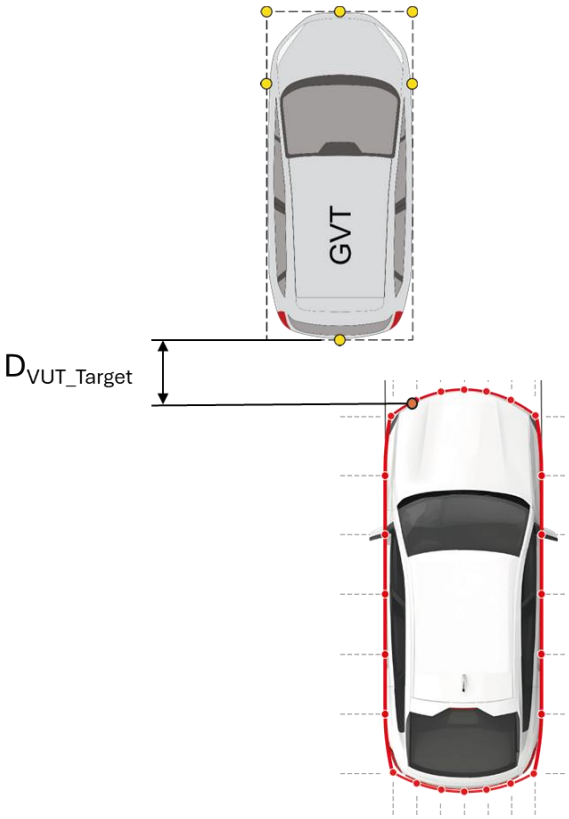


Figure 3-1 TTC in a CCRs scenario

3.1.4 Time Headway

Time Headway (THW) is defined as the time it takes the VUT to travel the closest distance between the front of the VUT and the rear of the preceding Target.

$$TTC = \frac{D_{VUT\_Target}}{v_{VUT}}$$

With:

D_{VUT_Target}	closest distance between the Target bounding box and the VUT profiled line (i.e., closest polygon-to-polygon distance).

3.1.5 FCW Time-to-Collision

The Time-to-Collision of FCW is calculated with the following formula:

$$TTC_{FCW} = TTC(t_{FCW})$$

With:

TTC	Time-to-Collision	
t_{FCW}	Time of FCW initiation	10TFCW000000EV00

3.2 Lane Support Systems

3.2.1 Distance to Line Crossing for LKA

The Distance-to-Line Crossing for LKA is calculated with the following formula:

$$DTLC_{LKA} = max(y_{VUT,wheel}) - y_{line}$$

With:

$y_{VUT,wheel}$	Lateral position of the outer edge of wheel
y_{line}	Lateral position coordinate of inner edge of line/road edge

3.2.2 Distance to Line Crossing for LDW

The Distance-to-Line Crossing for LDW is calculated with the following formula:

$$DTLC_{LDW} = y_{VUT,wheel}(t_{LDW}) - y_{line}$$

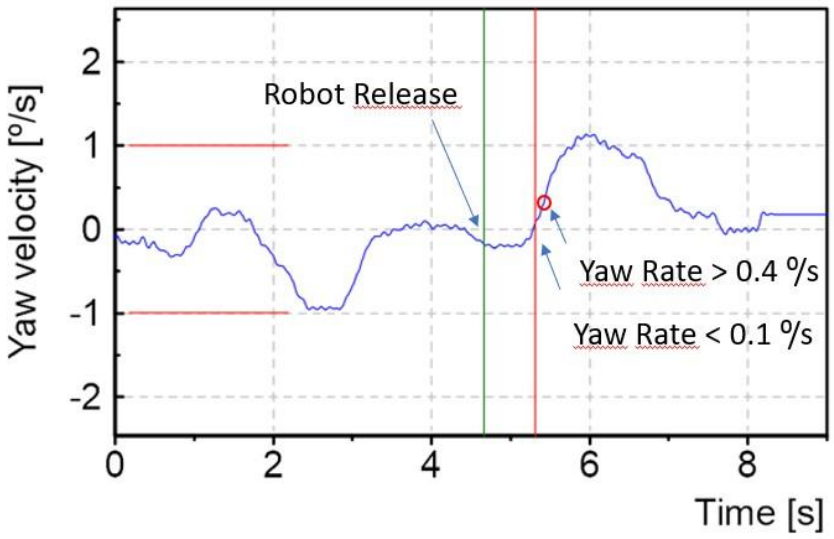
With:

$y_{VUT,wheel}$	Lateral position of the outer edge of wheel	
t_{LDW}	Time of LDW initiation	10TLDW000000EV00
y_{line}	Lateral position coordinate of inner edge of line/road edge	

3.2.3 T_{LKA}

T_{LKA} means the time where the LKA system of the vehicle intervenes. Activation time is determined by the following sequence, based on Yaw velocity $\boldsymbol{\Psi}_{VUT}$ (10VEHC000000AVZP) during the LSS manoeuvre:

1. Steering robot release is triggered by X position of VUT (green vertical line)
2. Identify when $\boldsymbol{\Psi}_{VUT}$ > 0,4°/s
3. From point 2., start searching backwards until $\boldsymbol{\Psi}_{VUT}$ < 0,1°/s → T_{LKA} (red vertical line)



3.3 Acceleration application

3.3.1 T_{ACCEL}

T_{ACC} means the time where the accelerator pedal input is applied in CPMFC scenario (Low Speed Collisions protocol), which is as soon as the accelerator pedal position (10PEAC000000DS0P) has reached 90% of the total position.