Test Data Information

Sensor position

The three sensors used to log vehicle states and their respective position w.r.t drive axle have been shown in Figure 1.

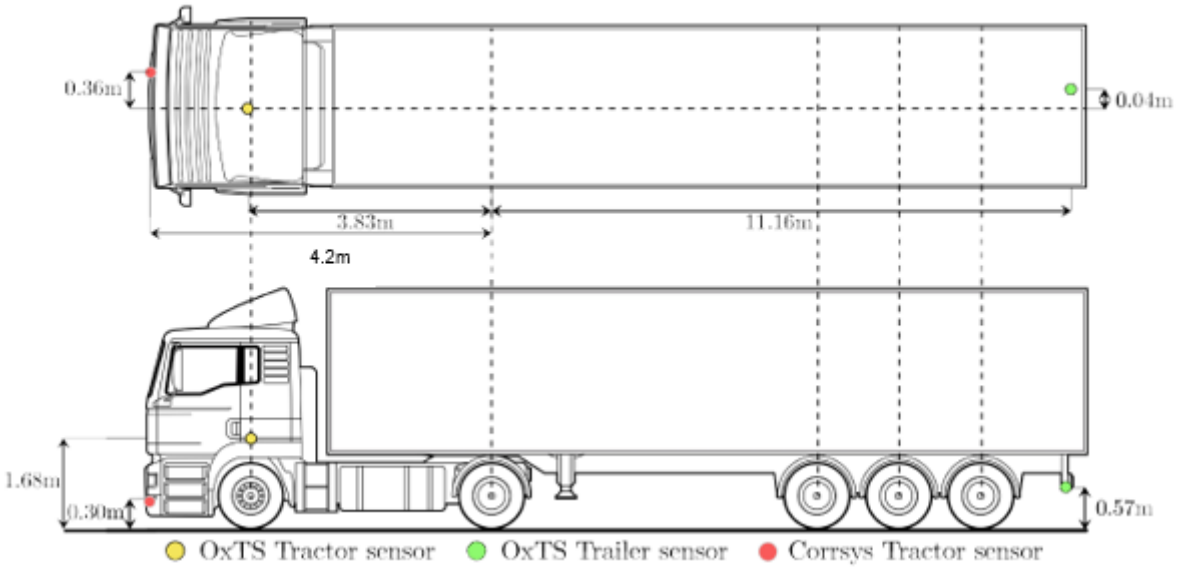


Figure 1: Sensor Position

Presentation of tests

Test names and their corresponding abbreviations have been shown in Figure 2

Test Type	Runs
Constant Steer [CS]	16
Transient Response [TR1 & TR2]	8
Step Steer - Reverse Driving [SSR]	18
Docking Manoeuvre style [D1, D2, D3 & D4]	23
Total	65

Figure 2: Test names and total runs

Processed data have been stored in the following format:

$< Test\ name > \_ < left\ or\ right\ turn > \_ < steering\ wheel\ amplitude > s\_ < vehicle\ velocity > v\_ < Loaded\ or\ Unloaded > \_ < run >$

for example: CS_L_500s_10v_UL_3

For docking manoeuvre, all the test will stored and presented in the following structure:

$< Test\ name > \_ < Velocity > v\_ < Loaded\ or\ Unloaded > \_ < run >$

for example: D1_7v_LO_2

Coordinate system

Variables logged from the OxTS and Corrsys sensor follow the reference frame listed in Table 1. They have all been converted to follow Adapted ISO axes system.

Table 1: Reference frames

Oxts Frame	Direction	Corresponding ISO axes
OxTS NED frame (Figure 3)	North	North
	East	west (-East)
	Down (in direction along gravity)	Up (-Down)
OxTs Horizontal frame (Figure 4)	Longitudinal	x
	Lateral (to the right of the body)	y (-Lateral)
OxTs Vehicle Frame (Figure 5)	X	x
	Y (to the right of the body)	y (-Y)
	Z (in direction along gravity)	z (-Z)
Corrsys	X	x
	Y (to the right of the body)	y
	Z (in the direction of gravity)	z

Processed data description

After running the 'Run_rawdata_processing.m'script file the following varables will be stored in a structured format 'm' (measurement data)

Tractor Variable Name	Description	Units
m.tractor.oxts.ax1_hf	Longitudinal acceleration -horizontal frame	m/s^2
m.tractor.oxts.ay1_hf	Lateral acceleration - horizontal frame	m/s^2
m.tractor.oxts.az1_hf	vertical acceleration - horizontal frame	m/s^2
m.tractor.oxts.sliprate1_hf	Slip acceleration - horizontal frame	m/s^2
m.tractor.oxts.ax1_vf	Longitudinal acceleration - vehicle frame	m/s^2
m.tractor.oxts.ay1_vf	Lateral acceleration - vehicle frame	m/s^2
m.tractor.oxts.az1_vf	vertical acceleration -vehicle frame	m/s^2
m.tractor.oxts.vx1_hf	Longitudinal velocity – horizontal frame (local)	m/s
m.tractor.oxts.vy1_hf	Lateral velocity – horizontal frame (local)	m/s
m.tractor.oxts.vel_north	Longitudinal velocity – NED frame (global)	m/s
m.tractor.oxts.vel_west	Lateral velocity – NED frame (global)	m/s
m.tractor.oxts.vel_up	Longitudinal velocity – NED frame (global)	m/s
m.tractor.oxts.speed2d	Lateral velocity – NED frame (global)	m/s
m.tractor.oxts.phi1dotdot_vf	Roll acceleration – vehicle frame	rad/s^2
m.tractor.oxts.theta1dotdot_vf	Pitch acceleration – vehicle frame	rad/s^2
m.tractor.oxts.psi1dotdot_vf	Yaw acceleration – vehicle frame	rad/s^2
m.tractor.oxts.phi1dot_hf	Roll velocity – horizontal frame	rad/s
m.tractor.oxts.theta1dot_hf	Pitch velocity – horizontal frame	rad/s
m.tractor.oxts.psi1dot_hf	Yaw velocity – horizontal frame	rad/s
m.tractor.oxts.phi1dot_vf	Roll velocity – vehicle frame	rad/s
m.tractor.oxts.theta1dot_vf	Pitch velocity – vehicle frame	rad/s
m.tractor.oxts.psi1dot_vf	Yaw velocity – vehicle frame	rad/s
m.tractor.oxts.phi1	Roll angle	rad

m.tractor.oxts.theta1	Pitch angle	rad
m.tractor.oxts.psi1	Yaw angle	rad
m.tractor.oxts.lat1	Latitude	deg
m.tractor.oxts.lon1	Longitude	deg
m.tractor.oxts.alt1	Altitude	m
m.tractor.oxts.x1	Global x-position	m
m.tractor.oxts.y1	Global y-position	m
m.tractor.oxts.z1	Global z-position	m
m.tractor.CANbus.engine_speed	Engine speed	rpm
m.tractor. CANbus.gear	Gear position	m
m.tractor. CANbus.delta	Steering wheel position	rad
m.tractor.CANbus.deltadot	Steering wheel velocity (no signal)	rad/s
m.tractor.CANbus.wheel_FL	Wheel speed -Front left	rad/s
m.tractor.CANbus.wheel_RL	Wheel speed -Rear left	rad/s
m.tractor.CANbus.wheel_FR	Wheel speed -Front right	rad/s
m.tractor.CANbus.wheel_RR	Wheel speed -Rear right	rad/s
m.tractor.rtRange.forward_pos	Longitudinal position between tractor and trailer oxts position	m
m.tractor.rtRange.lateral_pos	Lateral position between tractor and trailer oxts position	m
m.tractor.rtRange.forward_vel		m/s
m.tractor.rtRange.lateral_vel		m/s
m.tractor.rtRange.res_pos	Resultant position between tractor and trailer oxts position	m
m.tractor.rtRange.res_vel		m/s
m.tractor.rtRange.res_headingangle		
m.tractor.rtRange.phi2	Roll angle of oxts trailer	rad
m.tractor.rtRange.theta2	Pitch angle of oxts trailer	rad
m.tractor.rtRange.psi2	Heading angle of oxts trailer	rad
m.tractor.rtRange.lat2	Latitude of oxts trailer	deg
m.tractor.rtRange.lon2	Longitude of oxts trailer	deg
m.tractor.rtRange.vel_north	Longitudinal velocity – NED frame (global)	m/s
m.tractor.rtRange.vel_west	Lateral velocity – NED frame (global)	m/s
m.tractor.rtRange.vel_up	Longitudinal velocity – NED frame (global)	m/s
m.tractor.rtRange.speed2d	Lateral velocity – NED frame (global)	m/s
m.tractor.corrsys.psi1dot	Yaw velocity	rad/s
m.tractor.corrsys.vx*	longitudinal velocity	m/s
m.tractor.corrsys.vy**	Lateral velocity	m/s

*The Corrsys longitudinal velocity (m.tractor.corrsys.vx) remains positive while driving in reverse as well.

**The Corrsys lateral velocity (m.tractor.corrsys.vy) does not match the oxts lateral velocity when the vehicle is driving in reverse.

Trailer Variable Name	Description	Units
m.trailer.oxts.ax2_hf	Longitudinal acceleration - horizontal frame	m/s^2
m.trailer.oxts.ay2_hf	Lateral acceleration – horizontal frame	m/s^2
m.trailer.oxts.az2_hf	vertical acceleration – horizontal frame	m/s^2
m.trailer.oxts.sliprate2_hf	Slip acceleration – horizontal frame	m/s^2
m.trailer.oxts.ax2_vf	Longitudinal acceleration – vehicle frame	m/s^2
m.trailer.oxts.ay2_vf	Lateral acceleration – vehicle frame	m/s^2
m.trailer.oxts.az2_vf	vertical acceleration – vehicle frame	m/s^2
m.tractor.oxts.vx1_hf	Longitudinal velocity – horizontal frame	m/s
m.tractor.oxts.vy1_hf	Lateral velocity – horizontal frame	m/s
m.tractor.oxts.vel_north	Longitudinal velocity – NED frame	m/s
m.tractor.oxts.vel_west	Lateral velocity – NED frame	m/s
m.tractor.oxts.vel_up	Longitudinal velocity – NED frame	m/s
m.tractor.oxts.speed2d	Lateral velocity – NED frame	m/s
m.trailer.oxts.phi2dotdot_vf	Roll acceleration – vehicle frame	rad/s^2
m.trailer.oxts.theta2dotdot_vf	Pitch acceleration – vehicle frame	rad/s^2
m.trailer.oxts.psi2dotdot_vf	Yaw acceleration – vehicle frame	rad/s^2
m.trailer.oxts.phi2dot_hf	Roll velocity – horizontal frame	rad/s
m.trailer.oxts.theta2dot_hf	Pitch velocity – horizontal frame	rad/s
m.trailer.oxts.psi2dot_hf	Yaw velocity – horizontal frame	rad/s
m.trailer.oxts.phi2dot_vf	Roll velocity – vehicle frame	rad/s
m.trailer.oxts.theta2dot_vf	Pitch velocity – vehicle frame	rad/s
m.trailer.oxts.psi2dot_vf	Yaw velocity – vehicle frame	rad/s
m.trailer.oxts.phi2	Roll angle	rad/s
m.trailer.oxts.theta2	Pitch angle	rad/s
m.trailer.oxts.psi2	Yaw angle	rad/s
m.trailer.oxts.lat2	Latitude	deg
m.trailer.oxts.lon2	Longitude	deg
m.trailer.oxts.alt2	Altitude	m
m.trailer.oxts.x2	Global x-position	m
m.trailer.oxts.y2	Global y-position	m
m.trailer.oxts.z2	Global z-position	m

Appendix

Conversion to cartesian coordinates

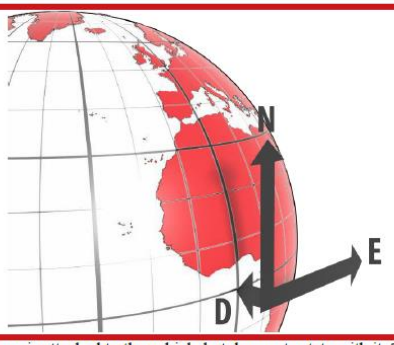
According to geographic coordinate system, longitude spans in East and West direction. Latitude spans in north and south. However, in MATLAB and specifically according to latlon2local function, latitude corresponds to xEast and longitude corresponds to yNorth. Hence the following conversion have been applied which can be directly used along with vehicle model global position (iff following adapted ISO standards).

```
origin1 = [m.tractor.oxts.lat1(1),m.tractor.oxts.lon1(1),m.tractor.oxts.alt1(1)];
[xEast1,yNorth1,zUp1] =
latlon2local(m.tractor.oxts.lat1,m.tractor.oxts.lon1,m.tractor.oxts.alt1(1),origin1);
m.tractor.oxts.x1=yNorth1;
m.tractor.oxts.y1=-xEast1;
m.tractor.oxts.z1=-zUp1;

[xEast2,yNorth2,zUp2] =
latlon2local(m.trailer.oxts.lat2,m.trailer.oxts.lon2,m.trailer.oxts.alt2(1),origin1);
m.trailer.oxts.x2=yNorth2;
m.trailer.oxts.y2=-xEast2;
m.trailer.oxts.z2=-zUp2;
```

Oxts Frames

Figure 5. OxTS NED navigation frame definition



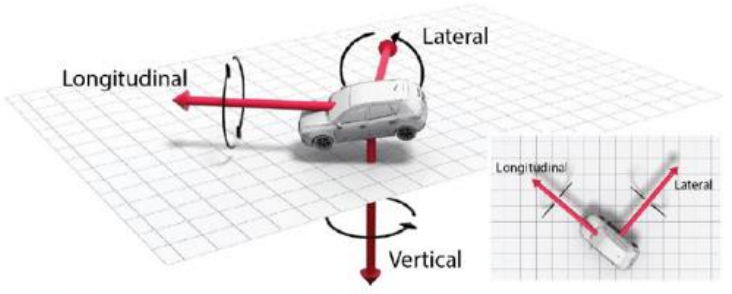
The OxTS navigation frame is attached to the vehicle but does not rotate with it. The down axis is always aligned to the gravity vector and north always points north.

Figure 3: OxTS NED frame definition

OxTS horizontal frame

The OxTS horizontal frame (sometimes called the level frame) is attached to the vehicle but does not rotate with the roll and pitch of the vehicle. It rotates by the heading of the vehicle. The definition of the OxTS Horizontal frame is listed in Table 14 and shown in Figure 7.

Figure 7. OxTS horizontal frame definition



The OxTS horizontal frame is attached to the vehicle. The longitudinal and lateral axes remain parallel to a horizontal plane. The longitudinal axis is also parallel to the vehicle's heading when viewed from above.

Figure 4: OxtS horizontal frame definition

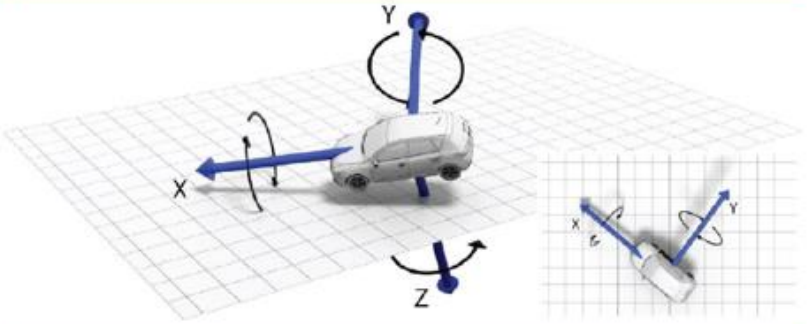
OxTS vehicle frame

The OxTS vehicle frame is attached to the body of the vehicle. It is related to the INS through the rotations in the Orientation page of NAVconfig. It can be changed while the INS is running using the Quick Config tool of NAVdisplay. The definitions of the vehicle frame are listed in Table 16 and shown in Figure 9.

Table 16. Vehicle frame definition

Axis	Description
X	This is the forward direction of the car.
Y	This is the right direction of the car.
Z	This is the down direction of the car.

Figure 9. Vehicle frame definition



The OxTS vehicle frame is attached to the vehicle and rotates with it in all three axes. The X-axis remains parallel to the vehicle's heading, while the Y-axis points to the right and is perpendicular to the vehicle's vertical plane of symmetry

Figure 5: OxTS Vehicle frame definition