User's guide for DT-M010

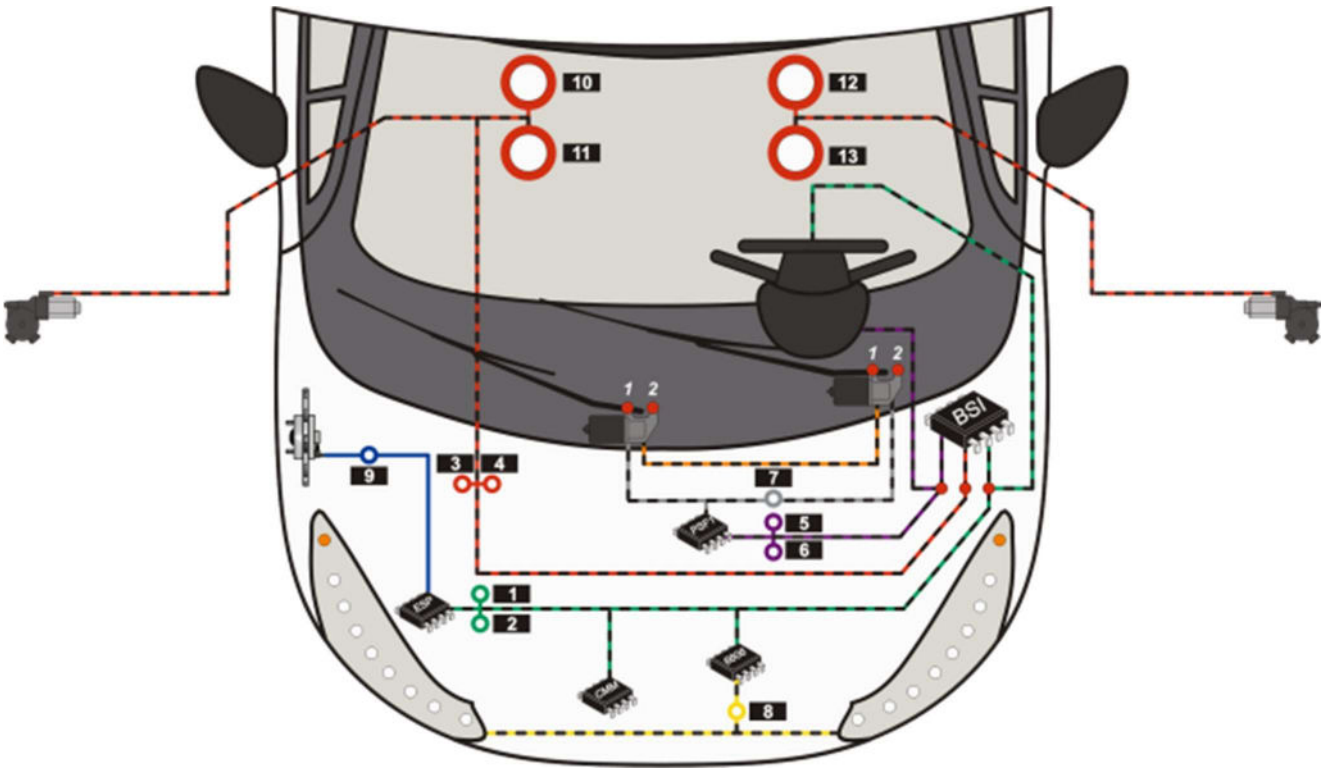
MULTIPLEXED NETWORK ANALYSIS MODULE

EXXOTEST® EDUCATION

DM N° 00297524-v1

1. DESCRIPTION OF MODULE

1.1. Description of multiplexed networks.



High Speed CAN 500 Kbit/s

Low Speed Passenger Comfort CAN 125 Kbit/s

Low Speed Bodywork CAN 125 kbit/s

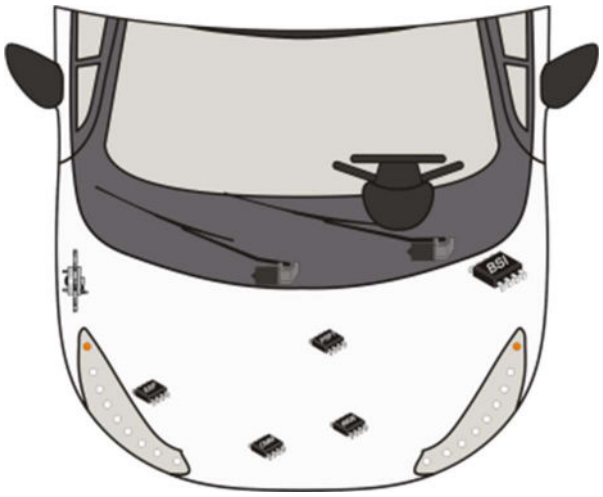
Wheel sensor signal

LIN 1 Windscreen wipers 19.2 Kbits/s

LIN 2 Headlights 19.2 Kbits/s

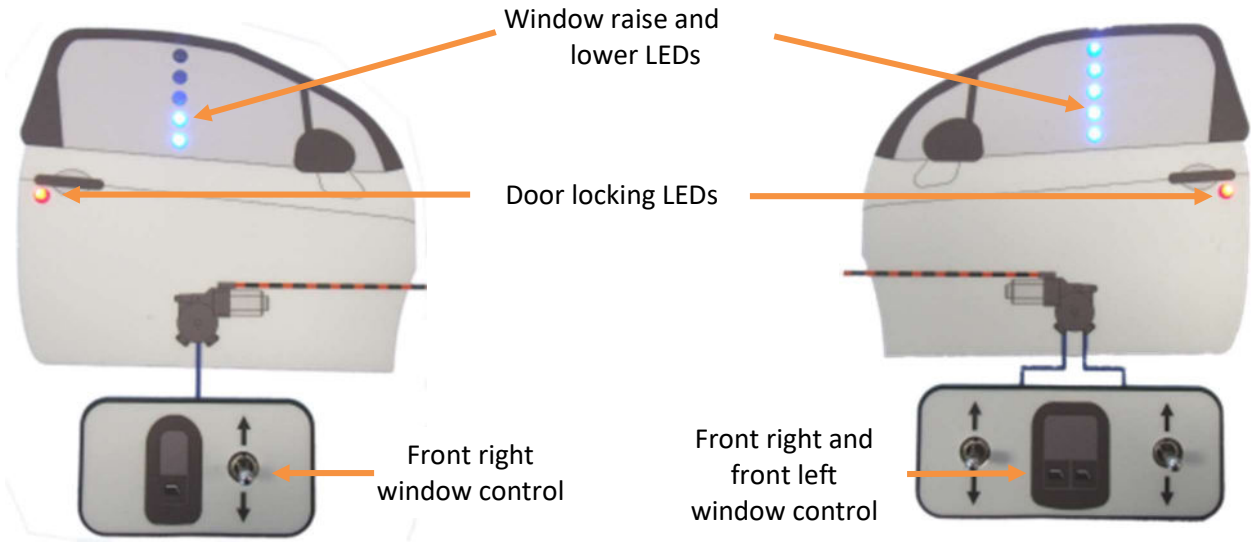
Private synch network

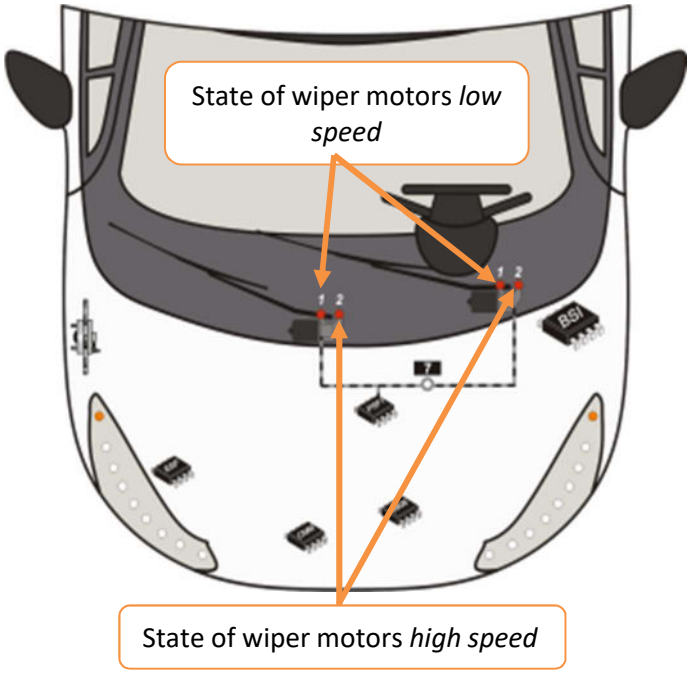
1.2. Description of calculators



Name of calculator	Description
BSI	Built-in Systems Interface: the most important calculator on the vehicle. All multiplexed CAN networks transit via this calculator.
PSF1	Motor Service Interface - manages power to the engine compartment, headlights, windscreen wiper motors, horn, etc.)
6606	Headlight dynamic aim correction unit
CMM	Engine Control Unit (manages fuel injection, etc.)
ESP	ESP calculator

1.3. Description of controls





Lighting controller

Steering wheel angle sensor regulator

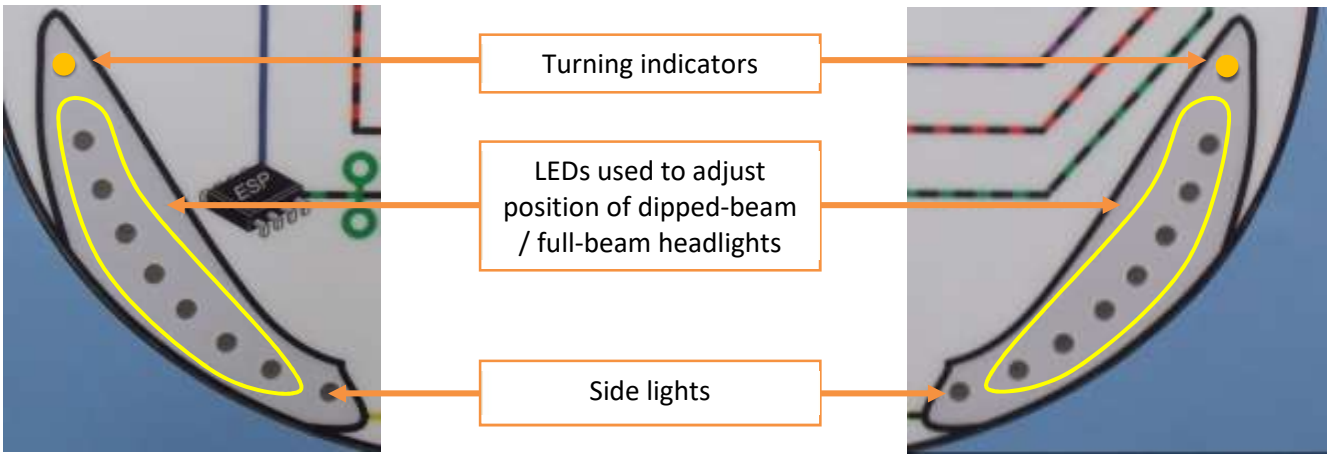
Wiper controller

Multi-function screen displays actual data, hexadecimal frames from all buses and serves to generate a synch trigger that analyses a frame.

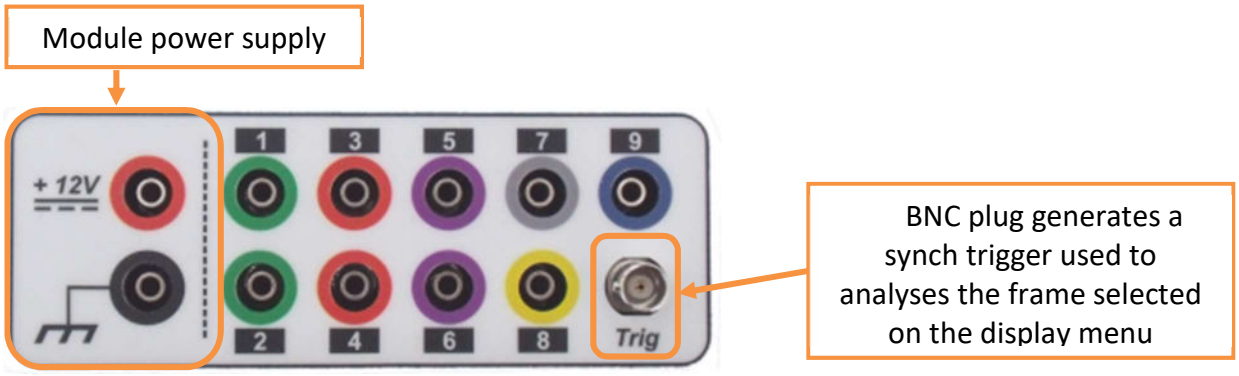
Bus data rate selector. Can be configured in real time mode or slow mode, to adapt to all oscilloscopes featuring a bandwidth higher than 10 MHz

In slow mode, the frames cannot be seen on Muxtrace (acquisition

Network	Real mode	Slow mode
Intersystem CAN	500 Kbits/s	12 Kbits/s
Low Speed CAN	125 Kbits/s	
LIN	19.2 Kbits/s	2.44 Kbits/s

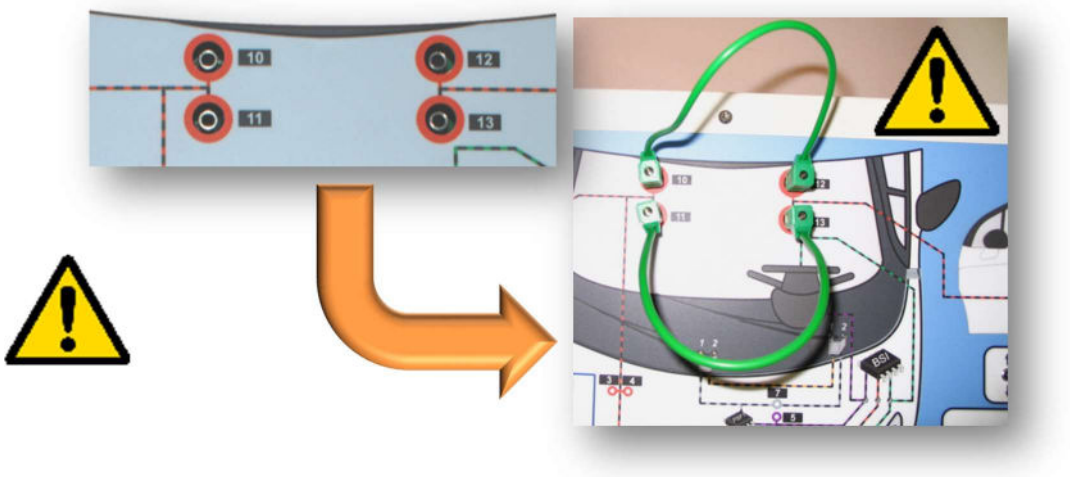


1.4. Measuring terminal:



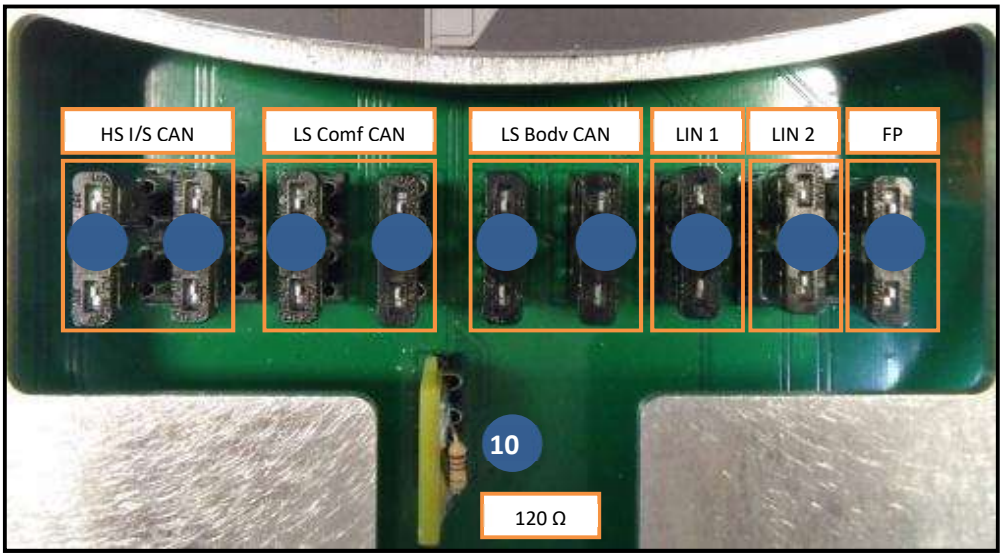
Terminal number	Signal description
1	High Speed CAN **H**
2	High Speed CAN **L**
3	Low Speed Comfort CAN **H**
4	Low Speed Comfort CAN **L**
5	Low Speed Bodywork CAN **H**
6	Low Speed Bodywork CAN **L**
7	LIN 1 Windscreen wipers
8	LIN 2 Headlights
9	Wheel sensor
10	Low Speed Comfort CAN **L**
11	Low Speed Comfort CAN **H**
12	Low Speed Comfort CAN **L**
13	Low Speed Comfort CAN **H**

1.5. Measuring module wiring



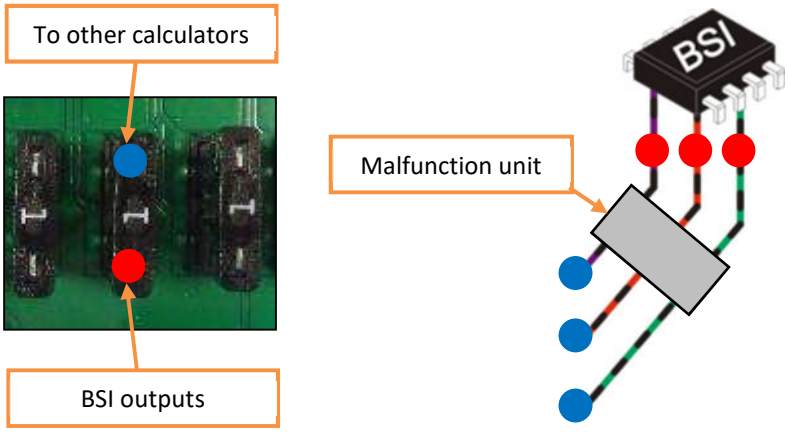
Two 25 cm cables supplied with the mock-up serve to connect terminal 10 to terminal 12 and terminal 11 to terminal 13 to extend the LS CAN network to the driver's door (without this connection the driver's door will not lock/unlock and the passenger side window control on the driver's side will not work).

1.6. Malfunction unit



Fuse number	Signal description
1	High Speed Inter-system CAN **H**
2	High Speed Inter-system CAN **L**
3	Low Speed Comfort CAN **H**
4	Low Speed Comfort CAN **L**
5	Low Speed Bodywork CAN **H**
6	Low Speed Bodywork CAN **L**
7	LIN 1 Windscreen wipers
8	LIN 2 Headlights
9	Malfunction fuse
10	120 Ω termination resistance of HS Inter-system CAN

1.7. Fuse pairing



2. MODULE OPERATION

2.1. On power-up

When powered up, the vehicle is closed; the locking/unlocking LEDs are lit.

Only the lighting, windscreen wiper and window controls are accessible.

Note: *Remember to connect the two 25 cm cables (terminal 10 to terminal 12 and terminal 11 to terminal 13) to extend the LS Comfort CAN network to the driver's door (see "wiring" section on page 8).*

2.2. Vehicle start-up

To start the vehicle engine, you must:

- Unlock the doors. The turning indicators flash.
- Start the engine (push Start). The status LED changes from **red** to flashing **green**. On the multi-function display in the "Vehicle status" section, the *vehicle speed*, *engine speed* and *gear* data change according to the variation on the speed potentiometer.
- Press the accelerator.

Note: *the doors automatically lock when the vehicle reaches a speed of 10 km/h.*

2.3. Vehicle stop

To stop the vehicle, you must:

- Slow the vehicle speed to 0 km/h.
- Stop the engine (push Stop). The status LED changes from flashing **green** to red. On the multi-function display in the "Vehicle status" section, the *vehicle speed*, *engine speed* and *gear* data display values of 0.
- Unlock the doors to exit the vehicle.
- Lock the doors.

Note: *the turning indicators light up for 3 seconds. Long press: the "Ambience lighting" function is activated.*

3. DESCRIPTION OF FUNCTIONS

3.1. Vehicle speed and engine speed

The engine speed is coded using two bytes, the minimum and maximum hexadecimal values (noted value (16)) are therefore:

- 0000 (16) corresponding to 0000 in decimal notation.
- FFFF (16) corresponding to 65535 in decimal notation. As the value FFFF(16) is in some cases considered to be invalid, the maximum value used will be FFFE(16), corresponding to 65534 in decimal

The engine speed values ranges from 0 rpm to approximately 8000 rpm.

The ratio between the maximum engine speed and its associated decimal value is: 65534 / 8000 = 8.19 rounded down to 8.

Example: To decode an engine speed, you therefore need to convert from hexadecimal to decimal then divide the decimal value by 8.

For an engine speed displayed on the panel of 3E20 (16):

3E20 (16) in decimal notation gives: 15904.
Divide 15904 by 8 = 1988 rpm

For the vehicle speed, the same method is used yet the ratio is not 8 but 100:

Example: For an engine speed displayed on the panel of 1BBC (16):

1BBC (16) in decimal notation gives: 7100.

Divide 7100 by 100 = 71 km/h

The relationship between the vehicle speed and the engine speed is calculated using this formula:

Engine speed = [vehicle speed] / [gear ratio x 60 x reduction coefficient x wheel coefficient].

The reduction coefficient is: 0.2787
The wheel coefficient is: 1793e-6 (based on a 165/70 R14 wheel).

3.1.1. Gear ratios

Gear	Ratio
N	0
1	0.2927
2	0.5526
3	0.8529
4	1.1714
5	1.4688

Example: for a vehicle speed stabilized at 130 km/h and with 4th gear engaged, the engine speed is:

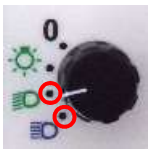
Engine speed = [130] / [1.1714 x 60 x 0.2787 x 0.001793] = 3701.43 ⍰ 3700 rpm.

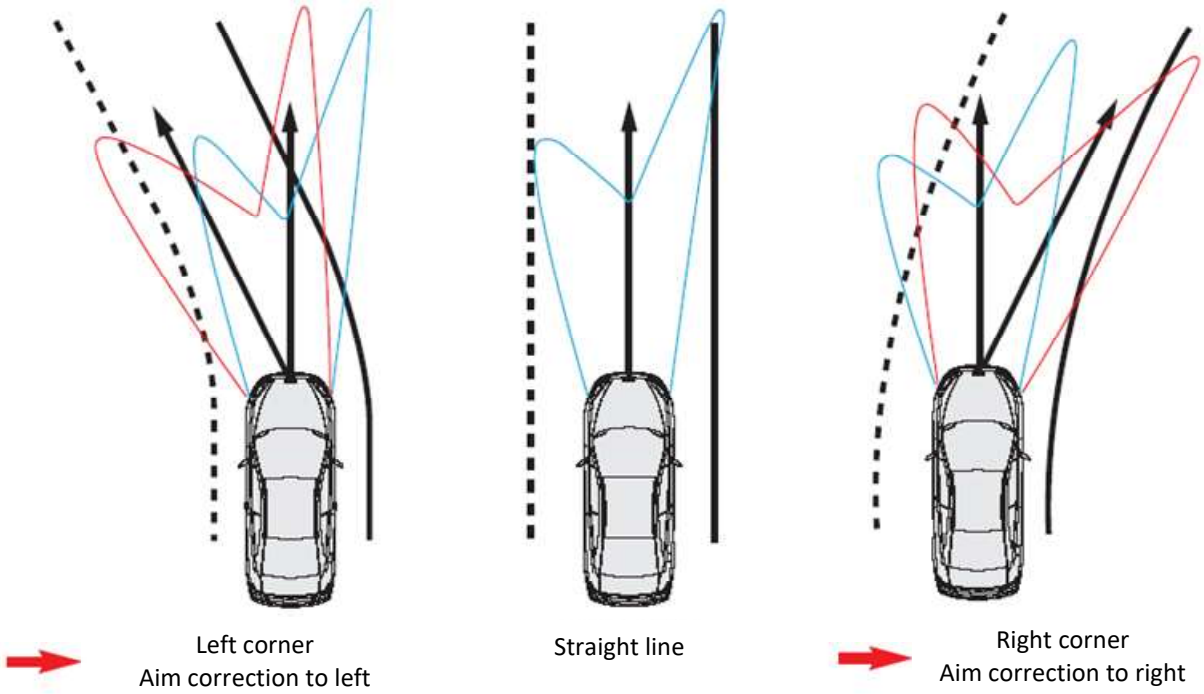
3.2. Headlights

The headlight aim function (or AFS "Adaptive Front lighting System) provides light to the driver in their line of sight in front and to the sides of the vehicle, taking into account the characteristics of the vehicle (ride height) and the corner approached (direction, curve, speed). It must also comply with regulations applicable to discharge lamp systems. Consequently, it uses an automatic site correction device.

The headlight aim adjustment function serves to modify the angle of the light beam in relation to the longitudinal axis of the vehicle, taking into account the corner approached.

Aim adjustment is possible for both dipped and full-beam headlights.





This system enhances driving comfort and safety by enabling the driver to better anticipate the vehicle trajectory.

Depending on the position of the steering wheel angle potentiometer (value in degrees), the headlight beams move (correction of aim). The aim correction angle varies from -78° (light internal angle) to +78° (light external angle).

3.1.2. Ambience lighting function

The ambience lighting function keeps the headlight on for 15 seconds if you:

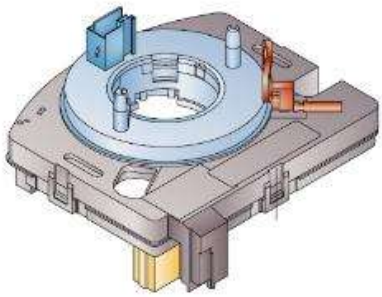
- push once on the "Engine stop" push button and push once on the "Lock/Unlock" button

3.3. Steering wheel angle sensor

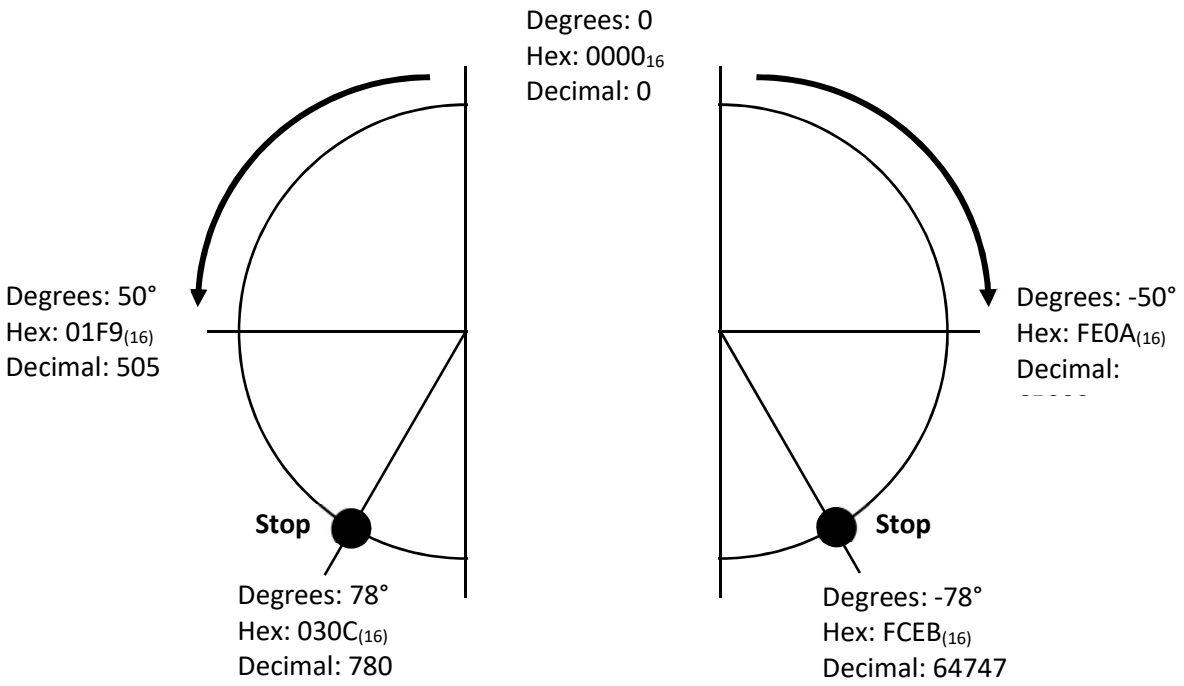
The steering wheel angle sensor, also called the turning angle transmitter, is mounted between the steering column controls and the steering wheel (integrated in COM2000 at PSA).

It transmits data concerning the front wheel turning angle and the turning direction (driver control) to the ESP calculator.

The ESP receives these data and determines the vehicle behaviour according to the yaw velocity and the lateral acceleration.



3.1.3. Calculation of steering wheel angle



Rotation of the steering wheel to the right generates a negative angle. As soon as the calculator detects a rotation to the right, it counts down starting at $FFFF_{(16)}$ (65535).

To calculate the steering wheel angle, do the following operation:

65535 – 65033 = 502 ➔ 502 / 10 = 50 ➔ -50° because the angle is negative.

Other example:

65535 – 64747 = 788 ➔ 788 / 10 = 78.8 ➔ -78.8°

3.4. Windscreen wipers

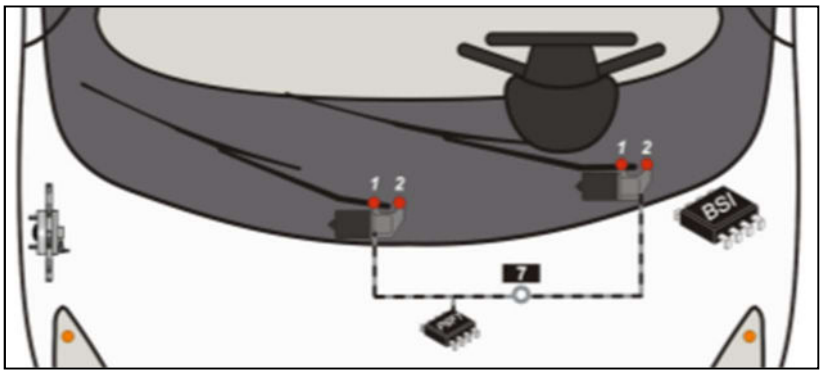
Windscreen or windshield wipers feature a rubber strip fixed to an articulated arm. The other end of the arm is fixed to the drive shaft of an electric motor controlled by a switch on the steering wheel column.

Using a spring, the arm presses the strip against the window with a certain force and wipes the windscreen as it is driven by the back and forth motion of the motor.

This accessory is variable in number depending on the size of the windscreen and the arm design. They are frequently found on the rear window, generally with one wiper. They must be installed on the front windscreen, and need to be associated with a screen wash system.

On a vehicle, there are five positions; Auto, off, intermittent, 1, 2. On the DT-M010, we only use 4 positions (Off, intermittent, 1 and 2) as the rain sensor is not included on the module (the Auto function is therefore redundant).

On the module, 2 LED lamps are featured for each motor, 1 LED for speed 1 and one LED for speed 2. Intermittent mode (I) causes the speed 1 LED lamps to flash.



When the control is on:

			
Nothing happens	The wiper speed varies according to the vehicle speed. The speed 1 LED lamps flash. When the vehicle speed drops below 5 km/h, the wiper speed is reduced (from high speed to low speed, or from low speed to intermittent). When the vehicle speed move above 10 km/h again, the initial speed becomes active.	Wiper speed = *low speed*	Wiper speed = *high speed*

3.5. Locking / unlocking doors

As soon as the ignition is turned on, the doors are closed. 

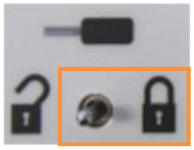
The doors automatically lock when the vehicle reaches a speed of 10 km/h.

If the driver presses the push button when the vehicle is above 10 km/h, the doors are unlocked.

Door lock front left

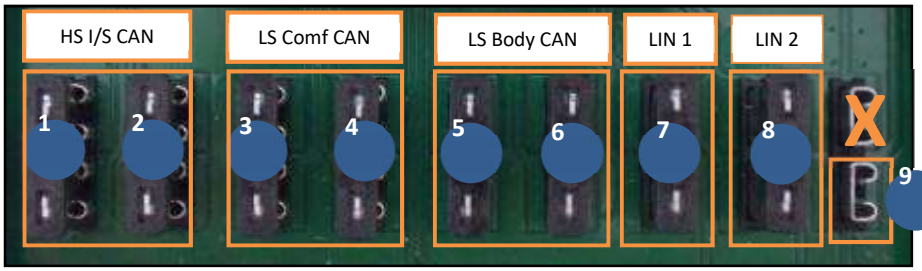
3.6. Window controls

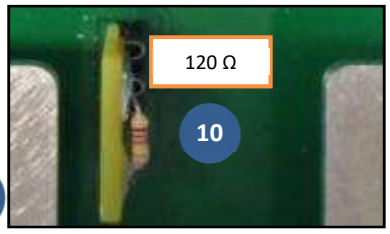
Automatic window closing function:



Interaction with push button to lock / unlock doors: long press for 2 seconds: the windows close automatically.

4. Description of malfunctions





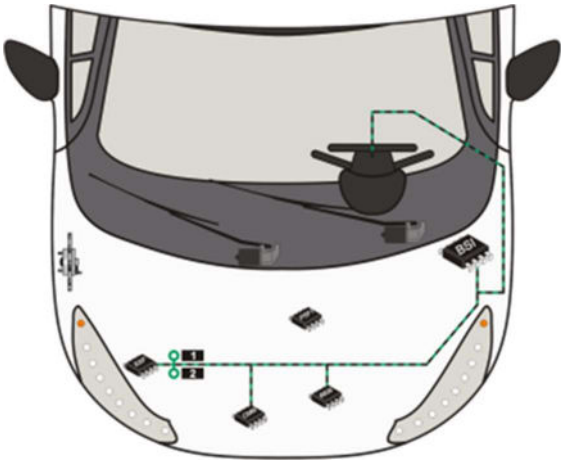
Fuse number	Disconnected	Connected to terminal 9 (short-circuit on +)	Connected to Earth (short-circuit on -)	Connected together (short-circuit on network)
1	***Bus OFF***	***Bus OFF***	***Bus OFF***	-
2	***Bus OFF***	***Bus OFF***	***Bus OFF***	-
1 & 2	***Bus OFF***	Problem not replicable	Problem not replicable	***Bus OFF***
3	***Degraded mode***	***Degraded mode***	***Degraded mode***	-
4	***Degraded mode***	***Degraded mode***	***Degraded mode***	-
3 & 4	***Bus OFF***	Problem not replicable	Problem not replicable	***Degraded mode***
5	***Degraded mode***	***Degraded mode***	***Degraded mode***	-
6	***Degraded mode***	***Degraded mode***	***Degraded mode***	-
5 & 6	***Bus OFF***	Problem not replicable	Problem not replicable	***Degraded mode***
7	***Bus OFF***	***Bus OFF***	***Bus OFF***	-
8	***Bus OFF***	***Bus OFF***	***Bus OFF***	-
120 Ω	***Bus OFF***	Problem not replicable	Problem not replicable	-

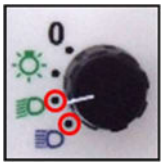
Problem not replicable
Bus OFF (nothing functions any more)
Degraded mode "fault tolerant"

5. DEGRADED MODES

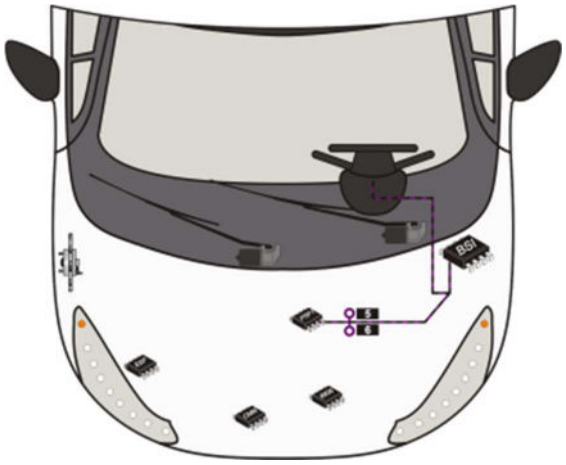
Degraded modes are reduced operating modes activated by calculators in the event of a malfunction in an electrical sector of the system (sensor malfunction and/or multiplexing problem).

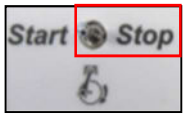
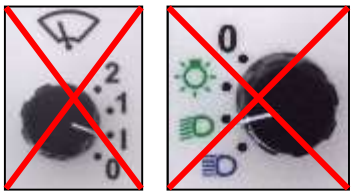
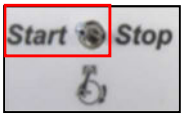
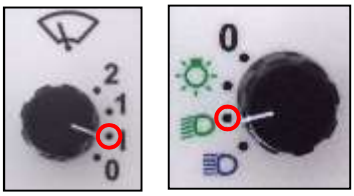
5.1. High Speed Inter-system CAN



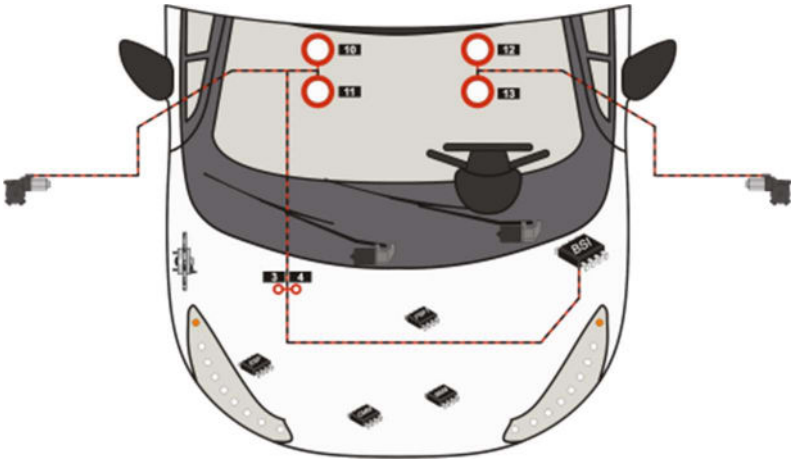
Engine status 	 If the engine is stopped when the malfunction occurs on the HS CAN, it is impossible to start the engine.	 If the engine is already running when the malfunction occurs on the HS CAN, it continues to run. However, if you stop the engine at this time, it will be impossible to start it again.
Status of steering wheel angle sensor 	 When a malfunction occurs (engine stopped or running), if the headlight control is in dipped-beam or full-beam position, the steering wheel angle sensor is not active on the headlights: they remain in their last known aim position.	

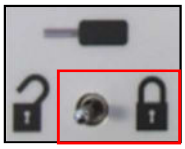
5.2. Low Speed Bodywork CAN



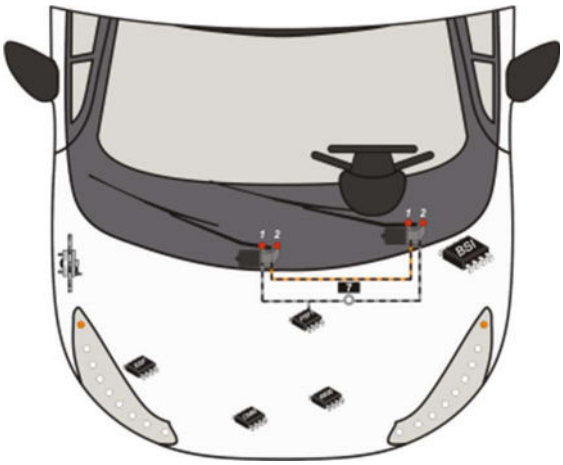
Engine status 	 If the engine is stopped when the malfunction occurs: • The side light, dipped-beam and full-beam instructions no longer work. • The windscreen wiper instructions no longer work. 	 If the engine is running when the malfunction occurs: • The dipped-beam headlights are turned on automatically. • The windscreen wipers change to intermittent mode. 
	The Ambience lighting function no longer works.	

5.3. Low Speed Comfort CAN



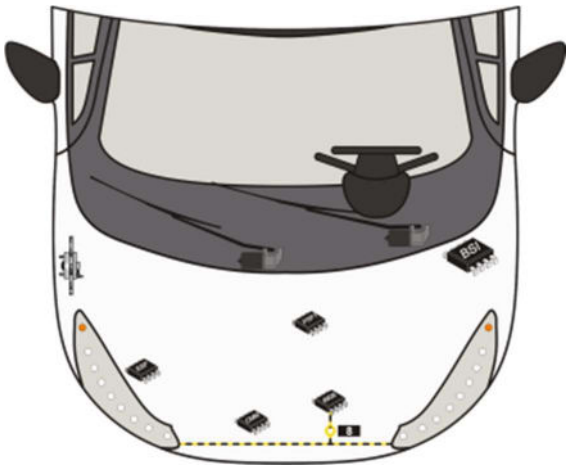
Controls windows 	Front right window control  The front right window control A is wired, it continues to operate if a malfunction occurs on the LS Comfort CAN.	Front left window control  The front left window control C is wired, it continues to operate if a malfunction occurs on the LS Comfort CAN. The front right window control B positioned on the left side control is multiplexed; if a malfunction occurs, the instruction no longer works.
	If a malfunction occurs, the automatic window close function no longer works.	

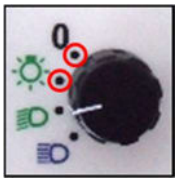
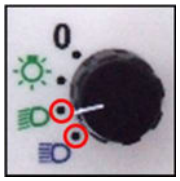
5.4. LIN 1 Windscreen wipers



Engine status 	 If the engine is stopped when the malfunction occurs: • The windscreen wiper instructions no longer work.	 If the engine is running when the malfunction occurs: • The windscreen wipers change to intermittent mode. 

5.5. LIN 2 Headlights



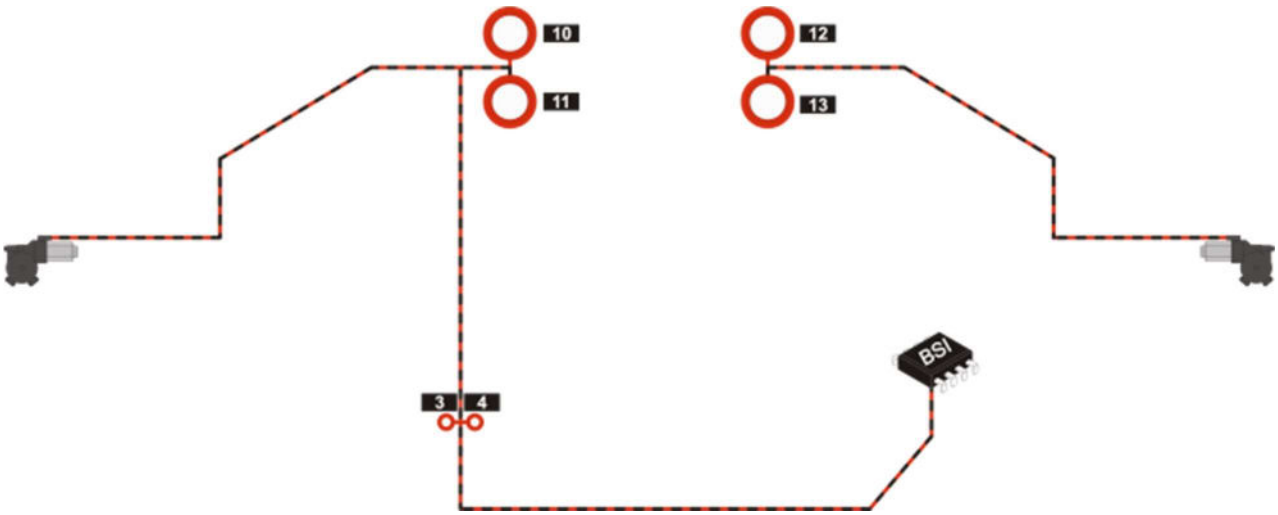
Headlight status	 If a malfunction occurs (whether the engine is stopped or running) and the headlights are off or in side lights mode, nothing happens.	 If a malfunction occurs (whether the engine is stopped or running) and the headlights are in dipped-beam or full-beam status, the headlights return to their default (central) position.

6. MESSAGES

The detailed message tables are in this form:

IDENT	Period	Description	1	2	3	4	5	6	7	8
Frame identifier	*Frame period in ms*	*Data on frame composition*	*Byte 1*	*Byte 2*	*Byte 3*	*Byte 4*	*Byte 5*	*Byte 6*	*Byte 7*	*Byte 8*

6.1. Low Speed Comfort CAN



IDENT	Period (ms)	Description	1
34C	100	Status of driver & passenger window controls	Driver manual opening = $80_{(16)}$ Driver automatic opening = $C0_{(16)}$ Driver manual closing = $10_{(16)}$ Driver automatic closing = $30_{(16)}$ Passenger manual opening = $08_{(16)}$ Passenger automatic opening = $0C_{(16)}$ Passenger manual closing = $01_{(16)}$ Passenger automatic closing = $03_{(16)}$

IDENT	Period (ms)	Description	1	2	3	4
3B6	100	Engine speed and vehicle speed	Engine speed		Vehicle speed	

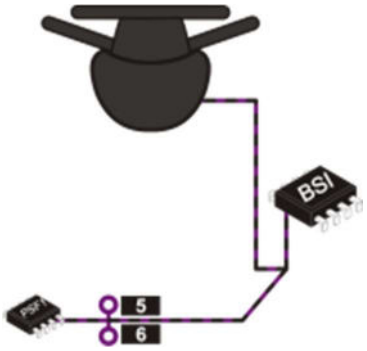
IDENT	Period (ms)	Description	1	2
38C	100	Central locking / unlocking	Locking = $22_{(16)}$ Unlocking = $11_{(16)}$	$00

IDENT	Period (ms)	Description	1	2	3
3E1	1000	Function status	Automatic door locking = 03(16	Door locking activated = $C0_{(16)}$ Door locking deactivated = $40_{(16)}$	00_{16}

IDENT	Period (ms)	Description	1
3D5	100	Driver window control	Stop = $00_{(16)}$ Close = $04_{(16)}$ Open = $0A_{(16)}$

IDENT	Period (ms)	Description	1	2
3D6	100	Passenger window control	Stop = $00_{(16)}$ Close = $04_{(16)}$ Open = $0A_{(16)}$	Automatic window close control = $01_{(16)}$ Standby = $00_{(16)}$

6.2. Low Speed Bodywork CAN



IDENT	Period (ms)	Description	1	2	3	4
3B6	100	Engine speed and vehicle speed	Engine speed		Vehicle speed	

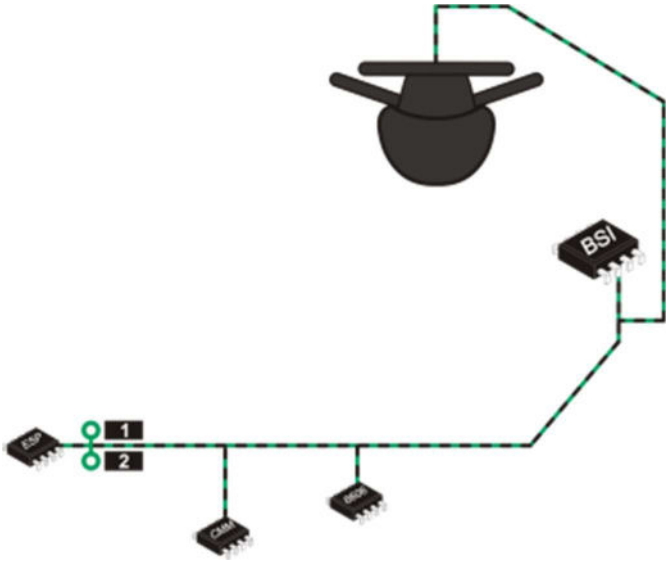
IDENT	Period (ms)	Description	1	2	3	4	5
236	100	Activation of steering wheel angle sensor	$00_{(16)}$	$00_{(16)}$	$00_{(16)}$	Active mode = $01_{(16)}$ Inactive mode = $00_{(16)}$	$00_{(16)}$

IDENT	Period (ms)	Description	1	2	3
294	100	Headlight and wiper control	Standby = $20_{(16)}$ Side lights = $40_{(16)}$ Dipped-beam lights = $80_{(16)}$ Full-beam lights = $08_{(16)}$	Standby = $00_{(16)}$ Intermittent wiper = $20_{(16)}$ Wiper speed 1 (high) = $40_{(16)}$ Wiper speed 2 (high) = $80_{(16)}$	Standby = $02_{(16)}$ Side lights = $08_{(16)}$ Dipped-beam lights = $10_{(16)}$ Full-beam lights = $30_{(16)}$

IDENT	Period (ms)	Description	1
2F6	500	Status of key + engine controls	Standby = $00_{(16)}$ +APC (+ After Ignition) = $08_{(16)}$ Engine running = $0A_{(16)}$

IDENT	Period (ms)	Description	1	2	3
282	1000	Automatic window closing control	Rotating code generated by an algorithm		

6.3. High Speed Inter-system CAN



IDENT	Period (ms)	Description	1	2	3	4
108	100	Engine speed and vehicle speed	Engine speed		Vehicle speed	

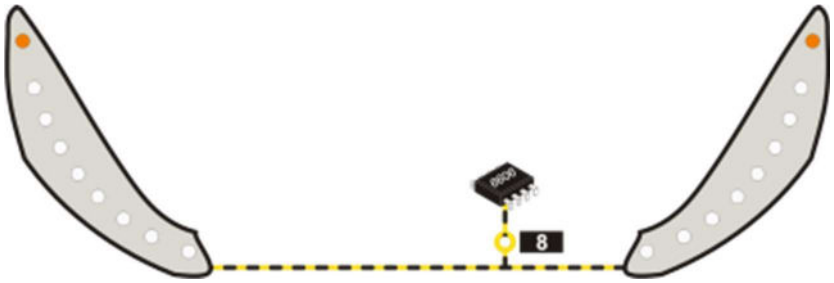
IDENT	Period (ms)	Description	1	2
105	10	Steering wheel angle data	Angle in degrees	

6.4. LIN 1 Windscreen wipers

IDENT	Period (ms)	Description	1	2	3	4
20	40	Wiper control	Standby = $00_{(16)}$ Intermittent = $01_{(16)}$ Speed 1 (low) = $04_{(16)}$ Speed 2 (high) = $04_{(16)}$	$00_{(16)}$	$00_{(16)}$	$00_{(16)}$

IDENT	Period (ms)	Description	1	2	3	4
21	40	Wiper status	Standby = $22_{(16)}$ Intermittent = $20_{(16)}$	$00_{(16)}$	$00_{(16)}$	$00_{(16)}$

6.5. LIN 2 Head lights



IDENT	Period (ms)	Description	1	2	3	4
01	80	Aim correction on left headlight	Phase 1 = $F1_{(16)}$ Phase 2 = $71_{(16)}$	Phase 1 = $00_{(16)}$ Phase 2 = $01_{(16)}$	Headlight angle (from 8 to 15°)	00_{16}

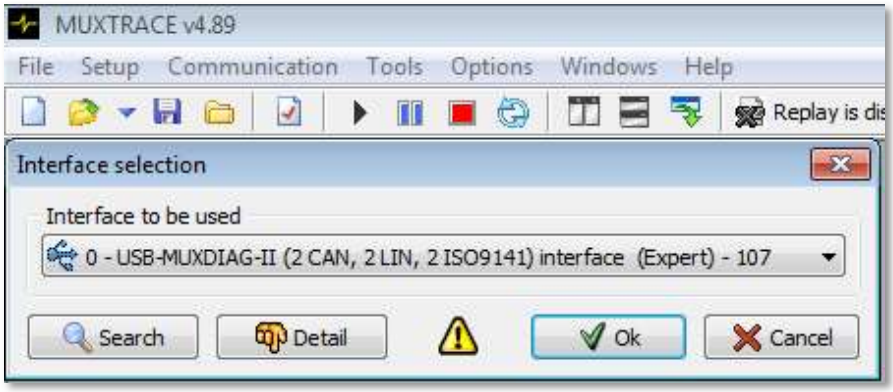
IDENT	Period (ms)	Description	1	2	3	4
02	80	Aim correction on right headlight	Phase 1 = $F9_{(16)}$ Phase 2 = $79_{(16)}$	Phase 1 = $00_{(16)}$ Phase 2 = $01_{(16)}$	Headlight angle (from 8 to 15°)	00_{16}

Note: the phases (1 and 2) are related to the angle indicator (negative or positive)

7. MUXTRACE TUTORIAL

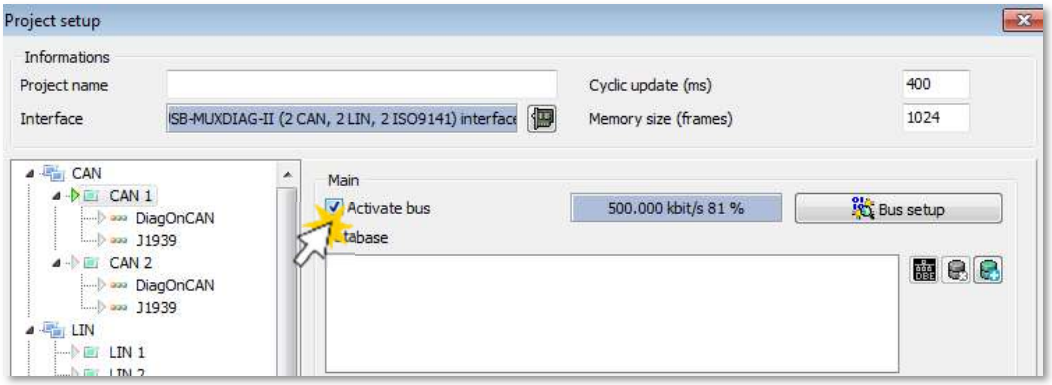
7.1. Configure the MUXTRACE software

On engine start, MUXTRACE® verifies the PLC or USB units present or connected to the computer:

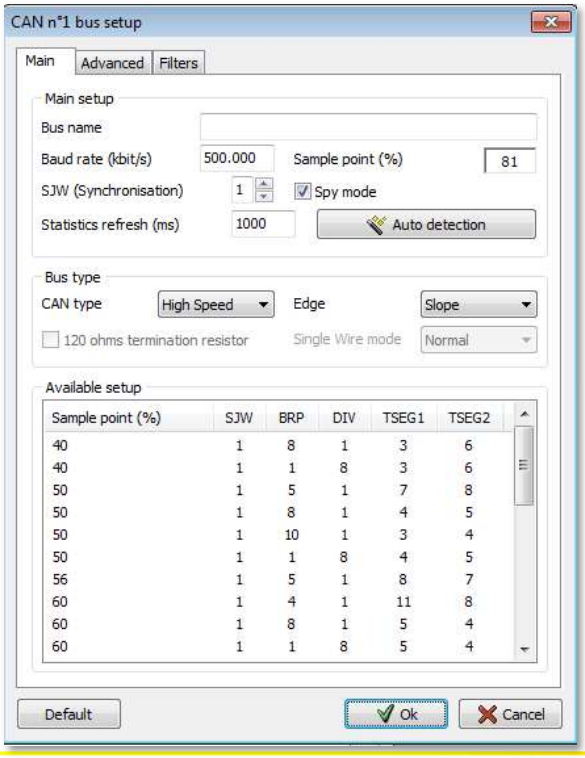


➢ **Click OK then New document**

➢ In the Project configuration window, assign a name to the project then select the BUS and enable the "Bus used" box:



➢ **Click Bus parameters**

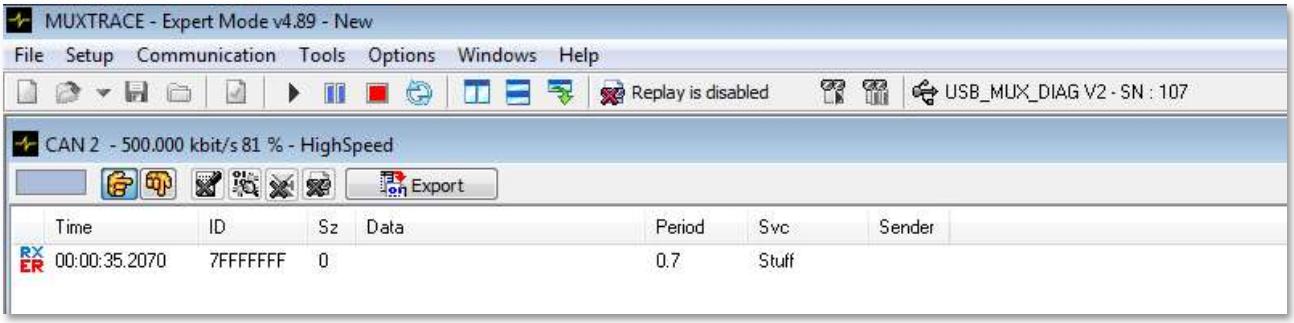


- Assign a name to the network
- Disable spy mode
- Enter the correct speed
- Confirm this window then validate the project configuration.

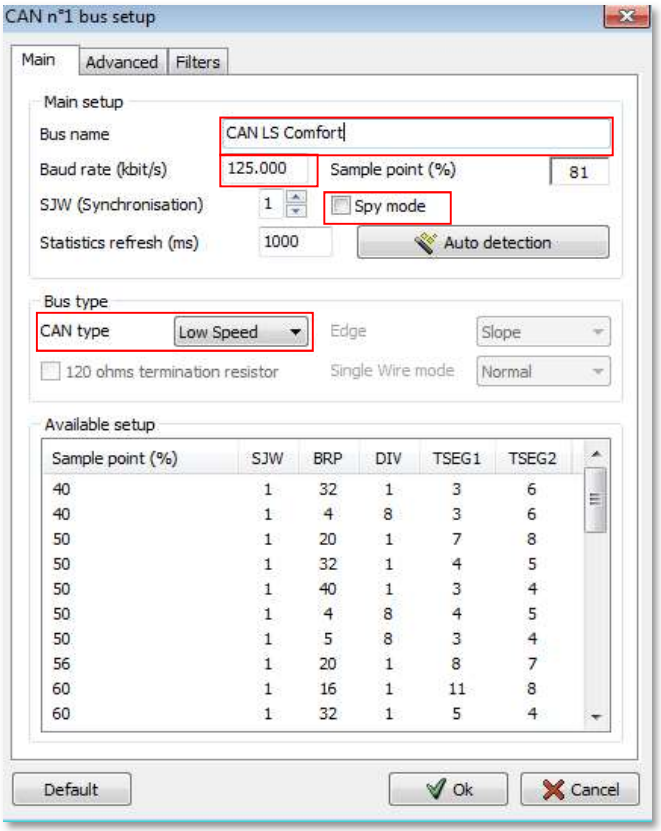
➢ The window for the CAN network you have just configured appears in MUXTRACE®:

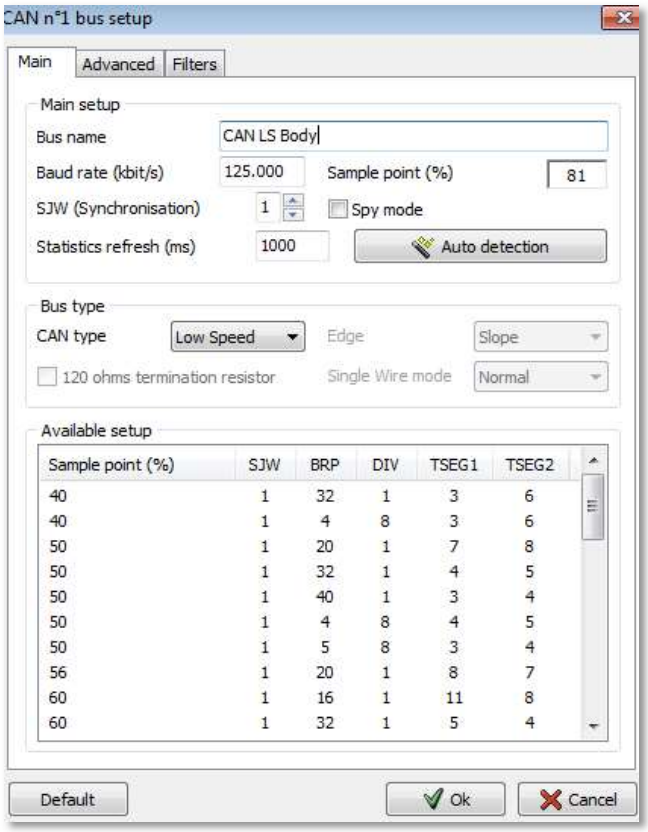
- Connect the USB unit to the DT-M010 module
- Start acquisition by clicking the green arrow.

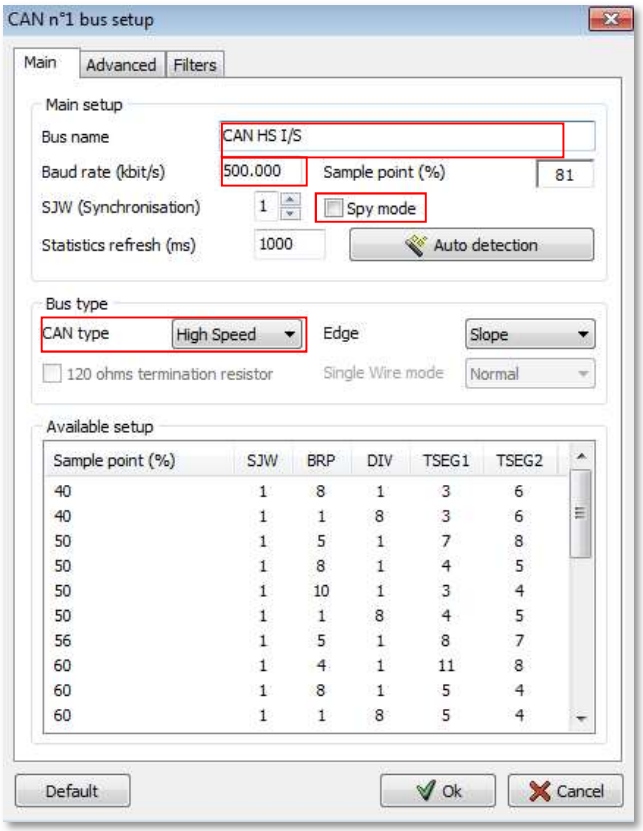
➢ The communication in progress on the CAN network appears on the screen:

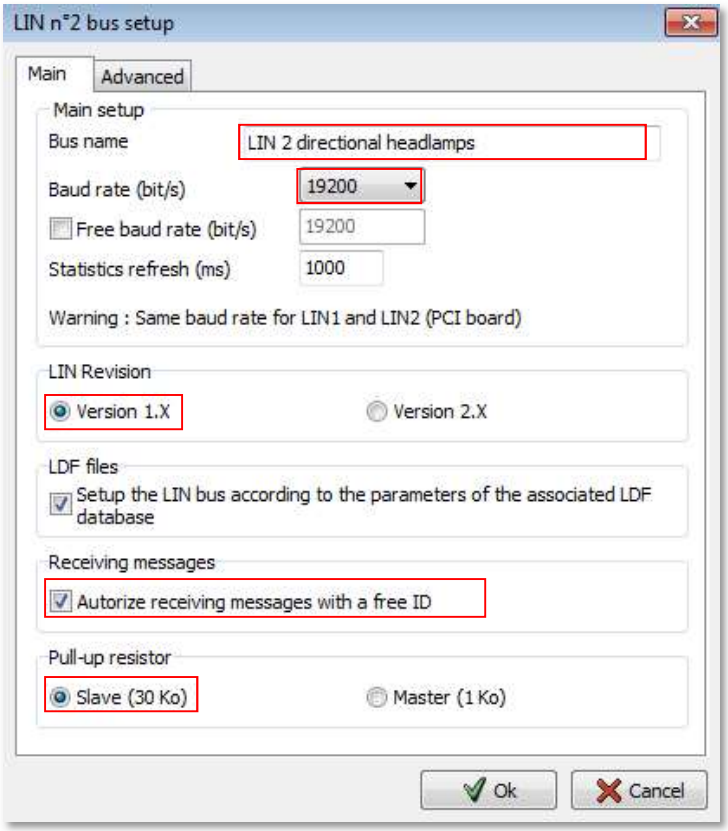


7.2. Configuration of bus on DT-M010:



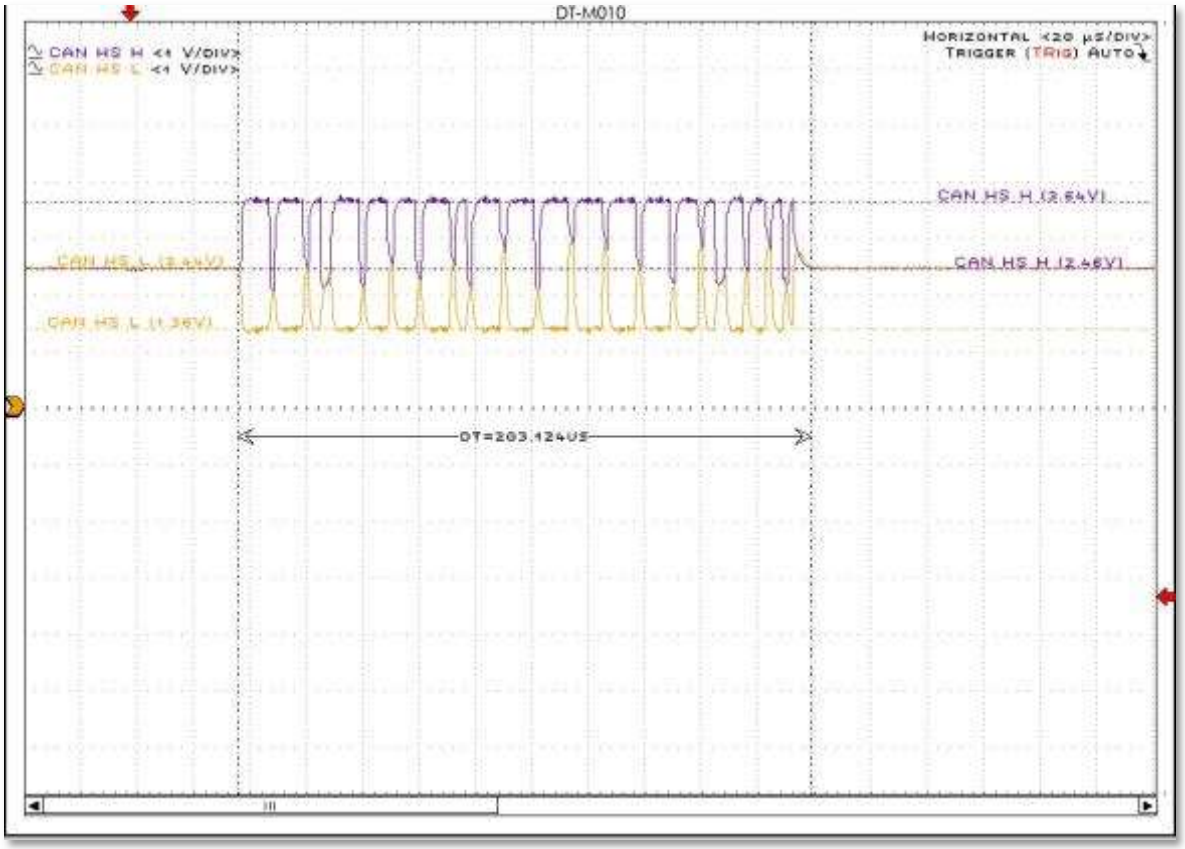




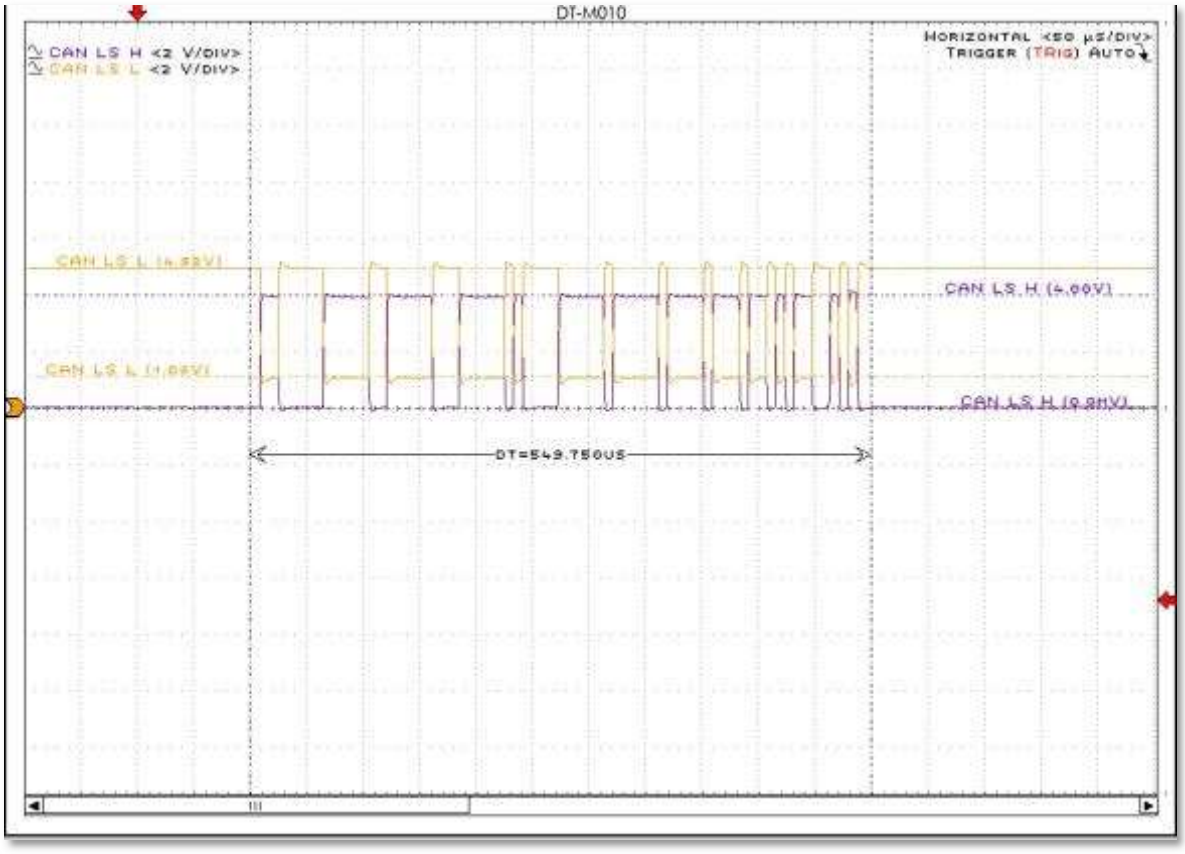


8. EXAMPLES OF MULTIPLEXED SIGNAL READINGS

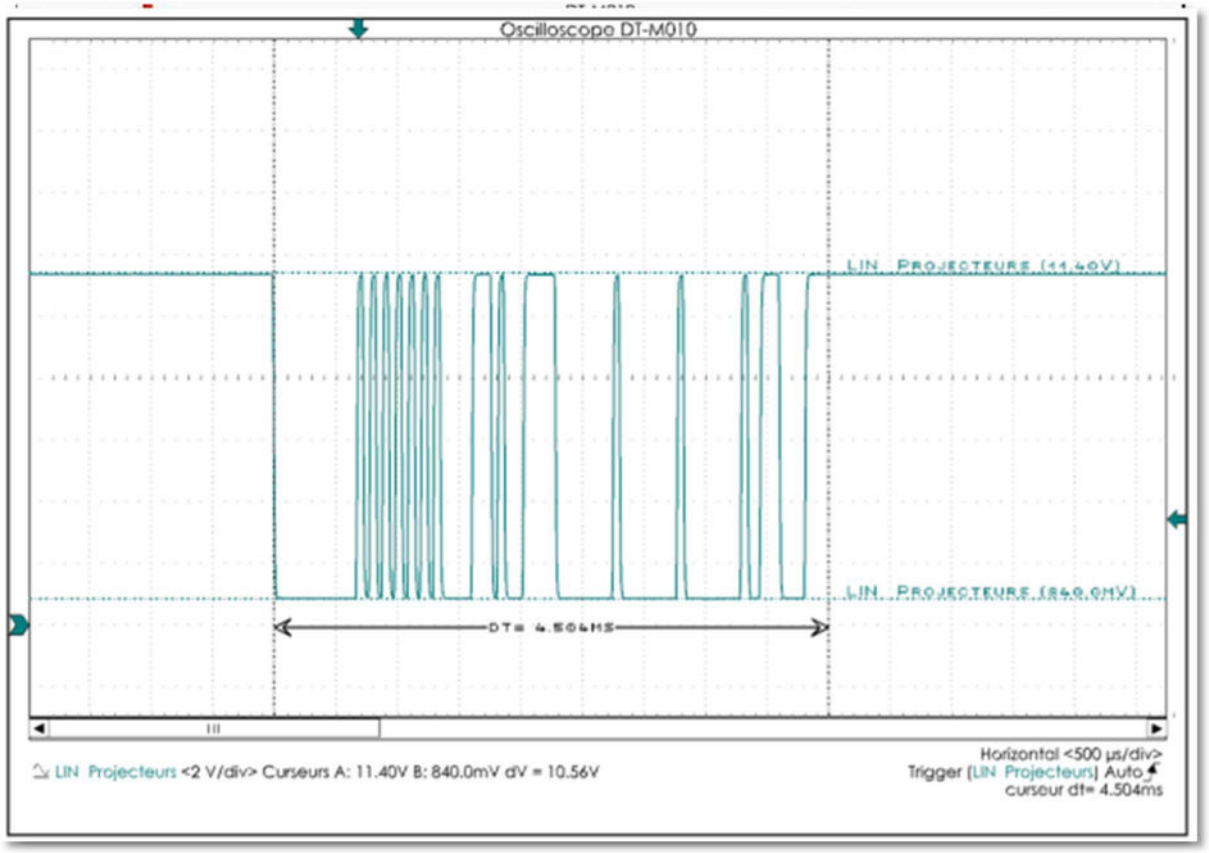
High Speed Inter-system CAN:



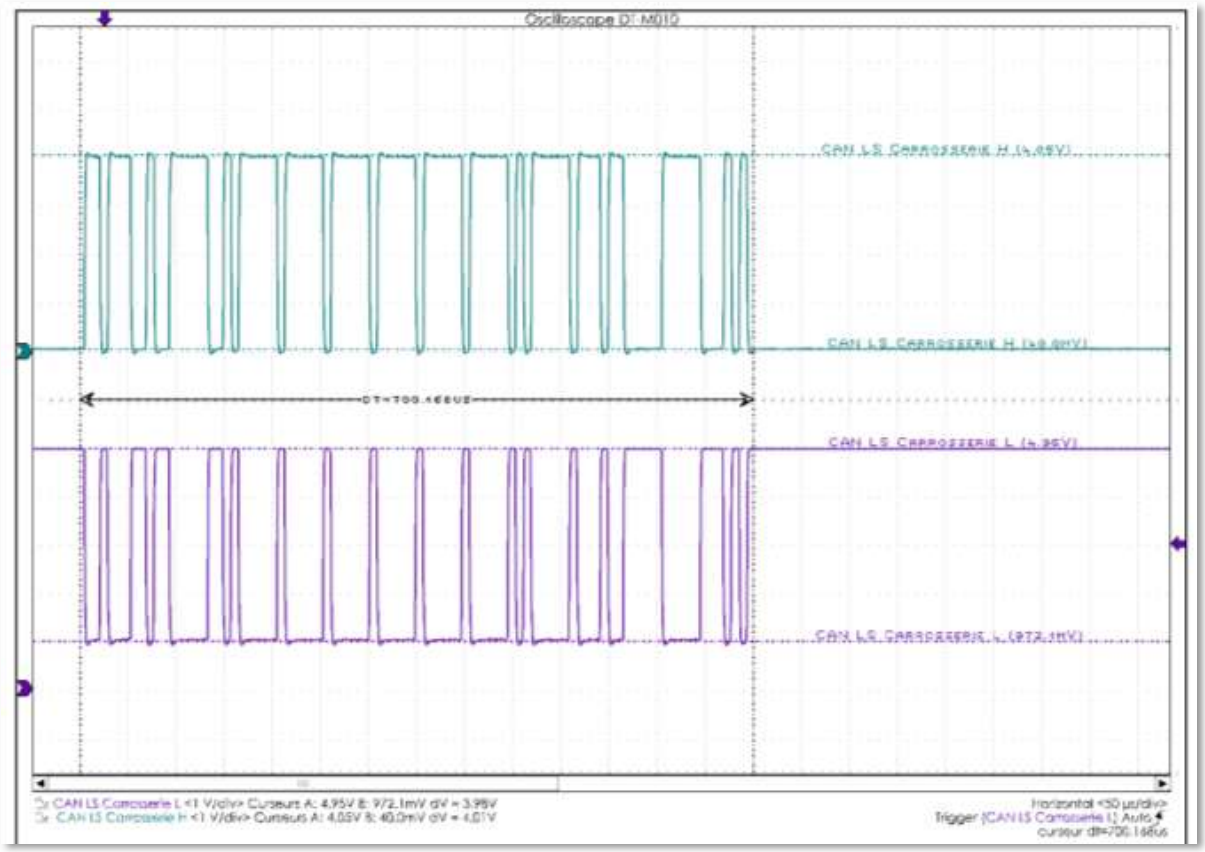
Low Speed Comfort CAN:

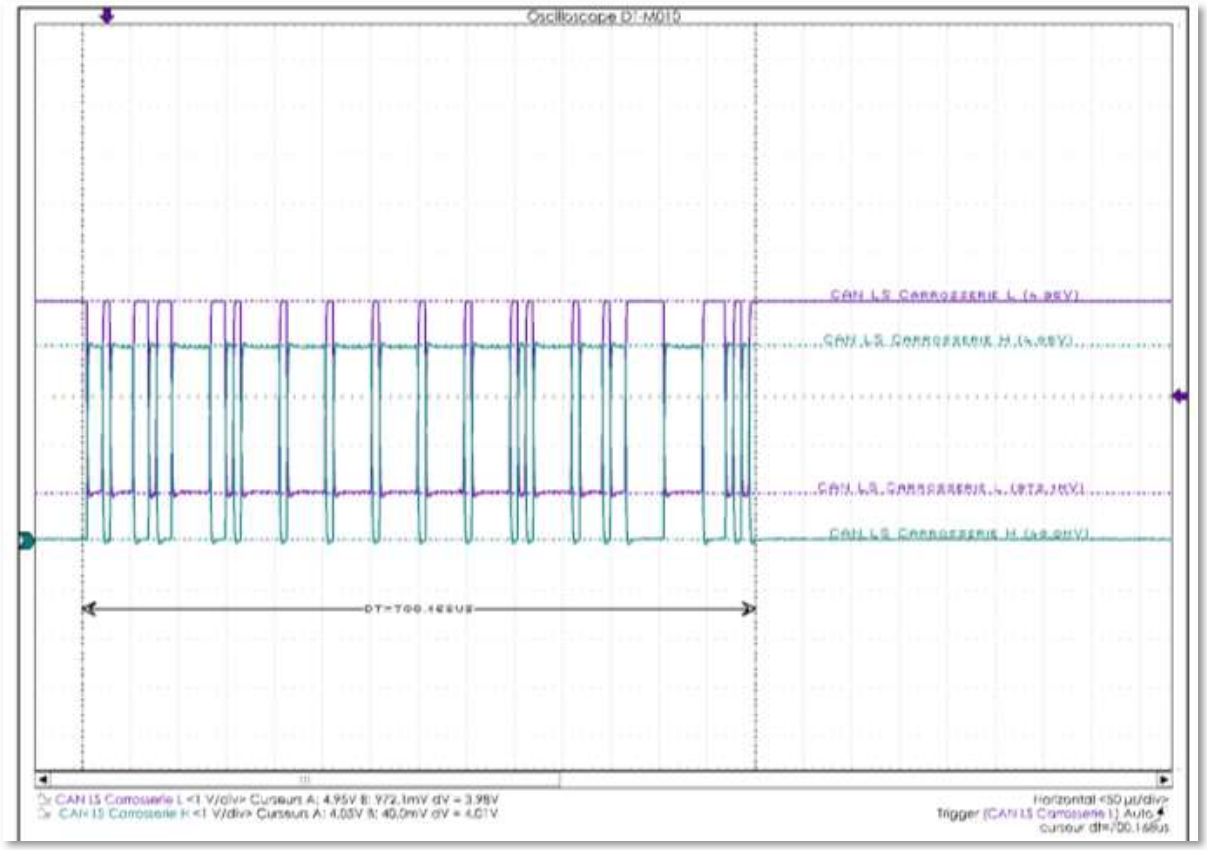


Low Speed Bodywork CAN:



LIN 2 Headlights




Oscilloscope DT-M010
CAN LS Carrosserie L (4.95V)
CAN LS Carrosserie H (4.05V)
CAN LS Carrosserie L (972.1mV)
CAN LS Carrosserie H (40.0mV)
DT=700.1666us
CAN LS Carrosserie L <1 V/div> Curseur A: 4.95V B: 972.1mV dV = 3.98V
CAN LS Carrosserie H <1 V/div> Curseur A: 4.05V B: 40.0mV dV = 4.01V
Horizontal <50 µs/div>
Trigger (CAN LS Carrosserie L) Auto
curseur dt=700.1666us

By means of this declaration of conformity, as defined by the European Directive on Electromagnetic Conformity 2004/108/EC, the company:

ANNECY ELECTRONIQUE S.A.S
Parc Altaïs
1, rue Callisto
74650 CHAVANOD

Declares that the following product:

Brand	Model	Description
EXXOTEST	**DT-M010**	**Teaching module for the study and understanding of multiplexed networks**

I. has been manufactured in accordance with the requirements of the European directive:

- EMC Directive 2004/108/EC - 15/12/2004
- Low Voltage Directive 2006/95/EC
- Machinery Directive 2006/42/EC

and satisfies the requirements of the following standard:

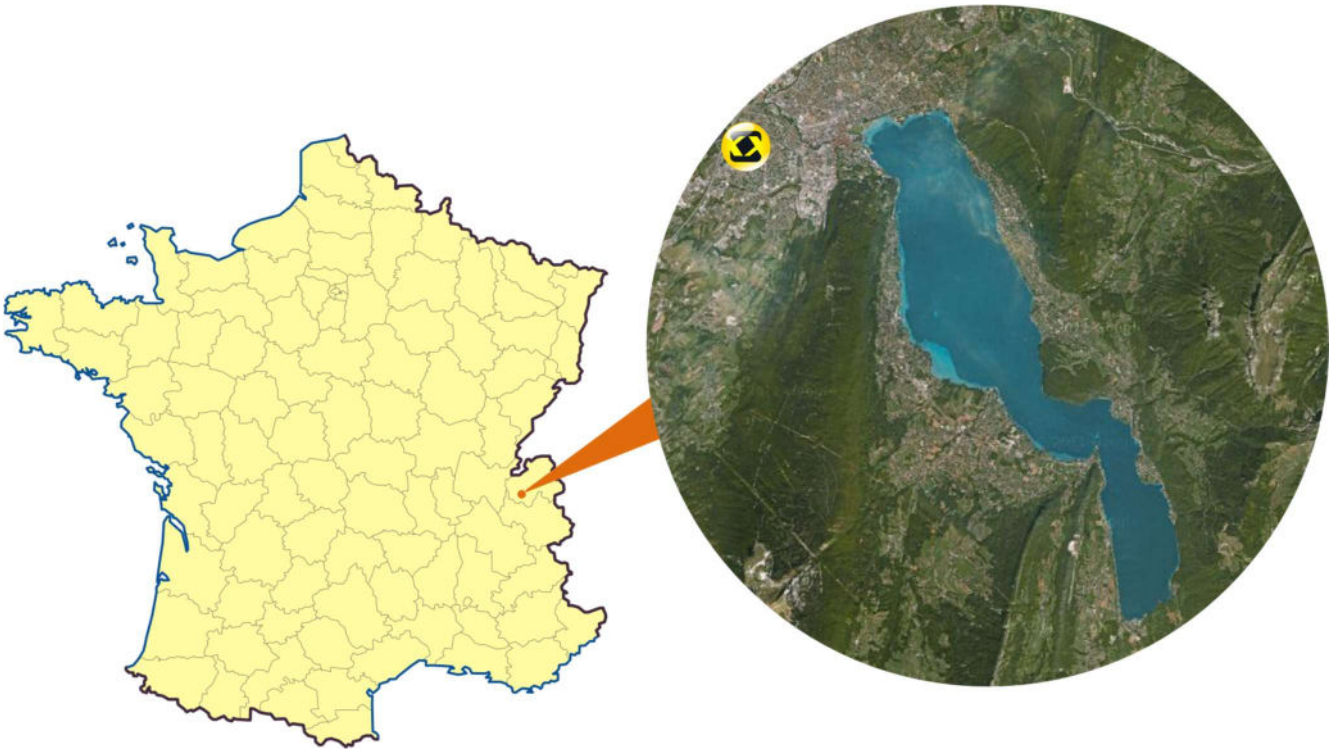
- NF EN 61326-1 dated 07/1997 +A1 of 10/1998 +A2 of 09/2001
  Electrical measurement, control and laboratory equipment, EMC-related requirements.

II. has been manufactured in accordance with the requirements of the European Directives relating to EEE design and WEEE management for the EU. :

- Directive 2002/96/EC dated 27 January 2003 on Waste Electronic and Electrical Equipment (WEEE)

- Directive 2002/95/EC dated 27 January 2003 on the limitations for the use of certain hazardous substances in the construction of Electronic and Electrical Equipment (EEE).

Drawn up in Saint-Jorioz on 20 July 2007.
CEO, Stéphane SORLIN



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ANNECY ELECTRONIQUE, Parc Altaïs – 1 rue Callisto – F74650 CHAVANOD
Tel : +33 (0)4 50 02 34 34 – Fax : +33 (0)4 50 68 58 93
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