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Report No. LM2010015B-04
Project No. LM2010015B

Emissions Tampering, Urea emulator installed in an Euro VI A heavy truck.

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Test period: 01/04/2021 – 23/04/2021
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This report contains 47 pages including this cover and 4 annexes.

CONTENTS

1. OBJECT

Evaluation of one emissions tampering device available on the market to check how the device can modify the proper operation of the vehicle's emissions control systems.

2. MEASUREMENT EQUIPMENT

Three different data sources were used in order to analyse the emissions, fuel consumption and CAN messages:

- Instrumented Signals acquired with INCA software:
  - Mini Cori-flow: for measuring **Urea mass flow [g/s]**
  - Pressure Transducer: for measuring **Urea line pressure [kPa]**
  - Current Ring: for measuring **Urea Injector Current [A]**
  - V_Box: for measuring **Vehicle Speed [km/h]**

- OBD_Silver_Scan_Tool: Diagnostics tool for measuring signals according to standard ISO 27145.

- Canalyzer: for measuring CAN messages.
  - CAN 1: OBD CAN messages
  - CAN 2: SCR (Selective catalytic reduction) – ECM (Engine Control Module) CAN line messages

2.1 OBD Silver Scan Tool

Silver Scan Tool is a diagnosis software application based on On Board Diagnosis (OBD) standard protocol. This software allows us to log the emissions related available signals included in the ISO 27145 standard.

2.2 Instrumented signals

2.2.1 Mini Cori-Flow

The Bronkhorst Mini cori-flow flowmeter is a mass flow meter for liquids or gases.

	Urea flow meter
Internal identification number	141687
Date of calibration	January 06th, 2021
Serial number	B14202070A
Model number	M14-ABD22-0-S

Table 1 Flowmeter Specifications

2.2.2 Pressure transducer

	Pressure sensor
Internal identification number	130727
Date of calibration	December 23rd, 2020
Serial number	01527/16
Model number	PTX 1400

Table 2 Pressure Transducer Specifications

2.2.3 Current clamp

	Current clamp
Internal identification number	200141
Date of calibration	February 17th, 2021
Serial number	719178
Model number	HTR 50-SB

Table 3 Current Clamp Specifications

2.3 Canalyzer

Datalogger from VECTOR to record the CAN messages (Raw signal).

2.4 INCA Software

INCA together analogue input module for recording the instrumented signals.

	Analogue input
Internal identification number	161308
Date of calibration	November 17th, 2020
Serial number	2501559
Model number	ES410.1

Table 4 INCA Software Specifications

2.5 Instrumentation Layouts

Original Exhaust aftertreatment

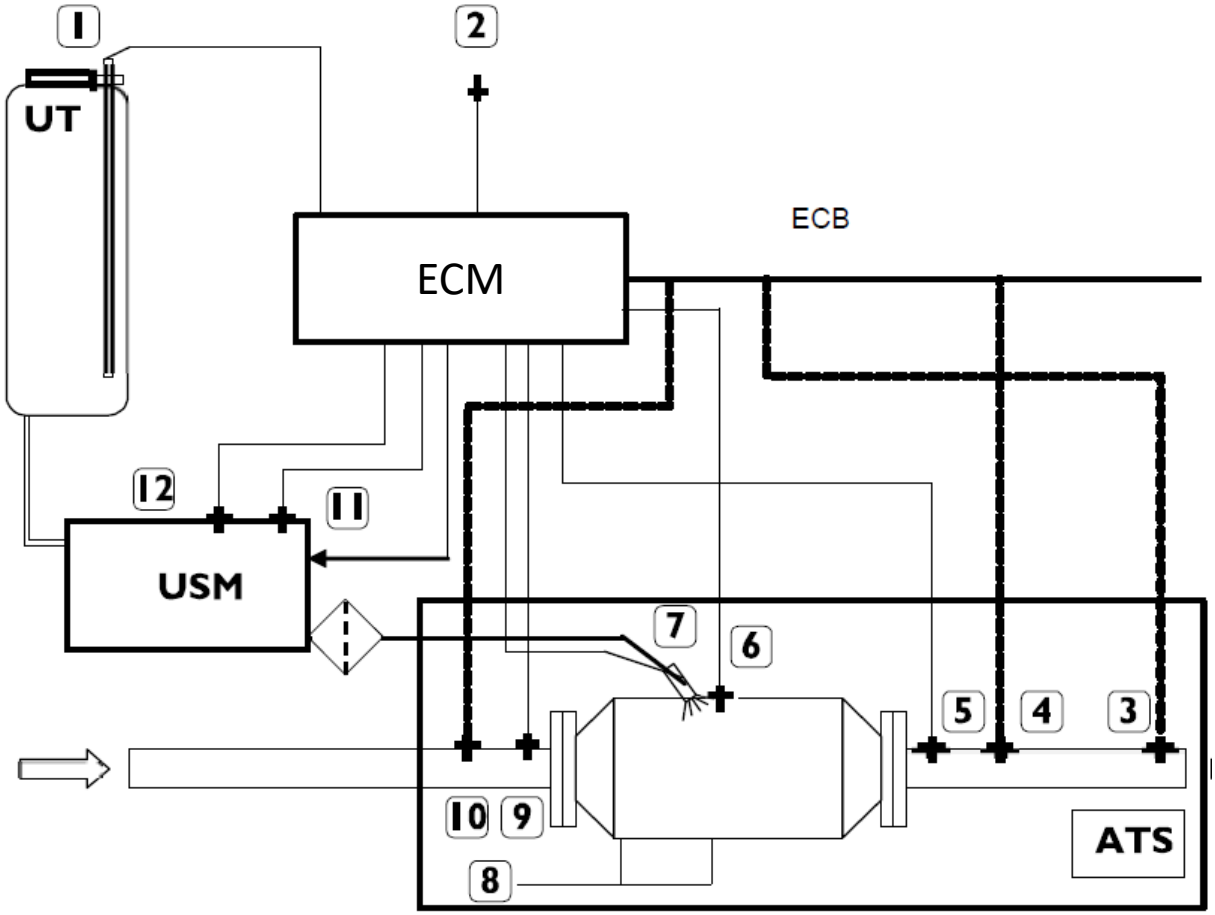

Figure 1 Exhaust aftertreatment layout

1 Level and temperature Adblue sensor
2 Humidity sensor
3 NH3 Sensor
4 After catalyst NOx sensor
5 After catalyst temperature sensor
6 Before SCR temperature sensor
7 Urea injector
8 DPF deltaP sensor
9 Before catalyst temperature sensor
10 Before catalyst NOx sensor
11 Adblue temperature sensor
12 Adblue pressure sensor

USM: Urea Supply Module
ECM: Engine Control Module

Instrumented signals

The following instrumentation has been installed in all tests.

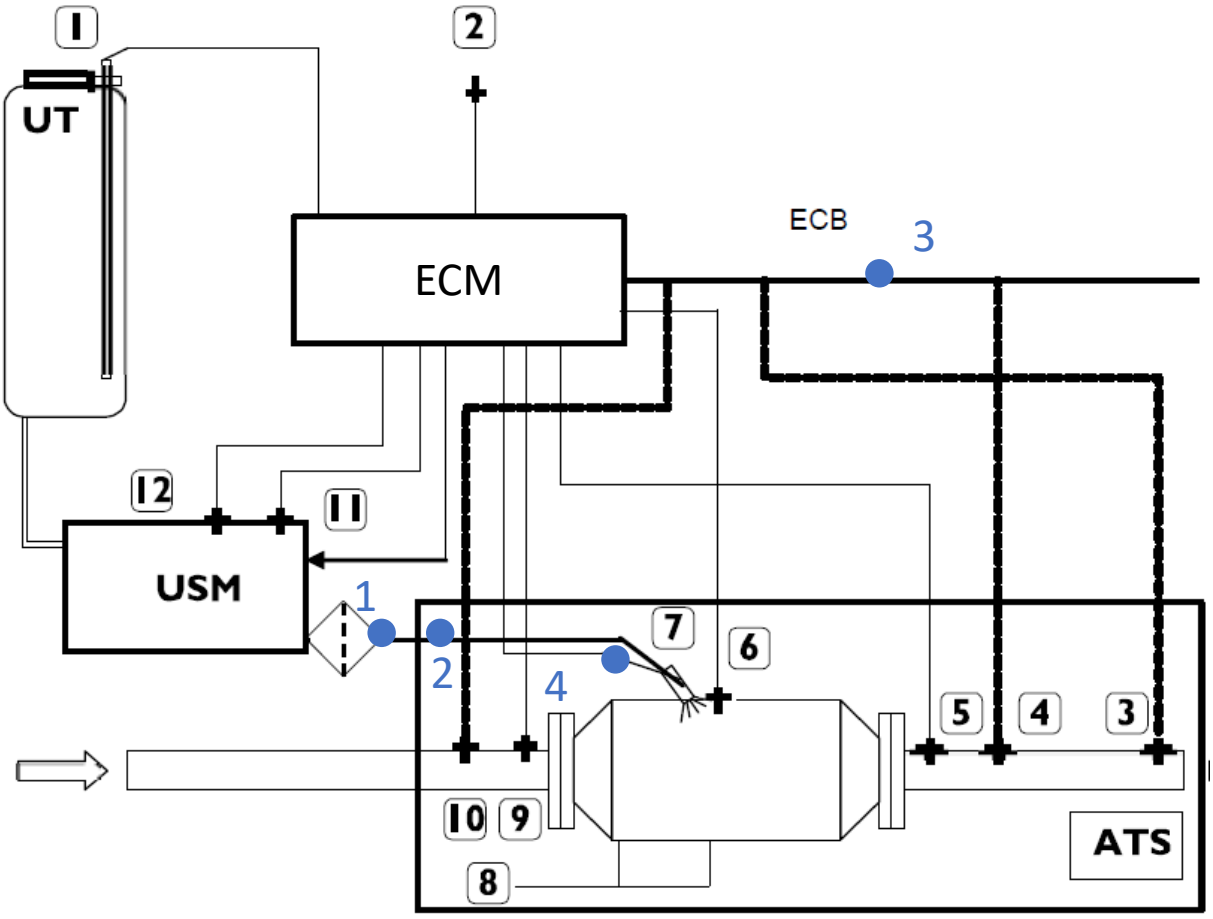

Figure 2 Exhaust aftertreatment, instrumented signals.

Signals instrumented (blue):

1 Urea mass flow (g/s).
2 Urea pressure sensor (kPa).
3 CAN_H and CAN_L.
4 Urea injector current (A).

2.5.1 USM isolated for OBD validation

As shown in figure 3 with red crosses, the urea pressure wires and the pump control wires were physically cut, opening the circuit and isolating the communication between the USM and the ECM.

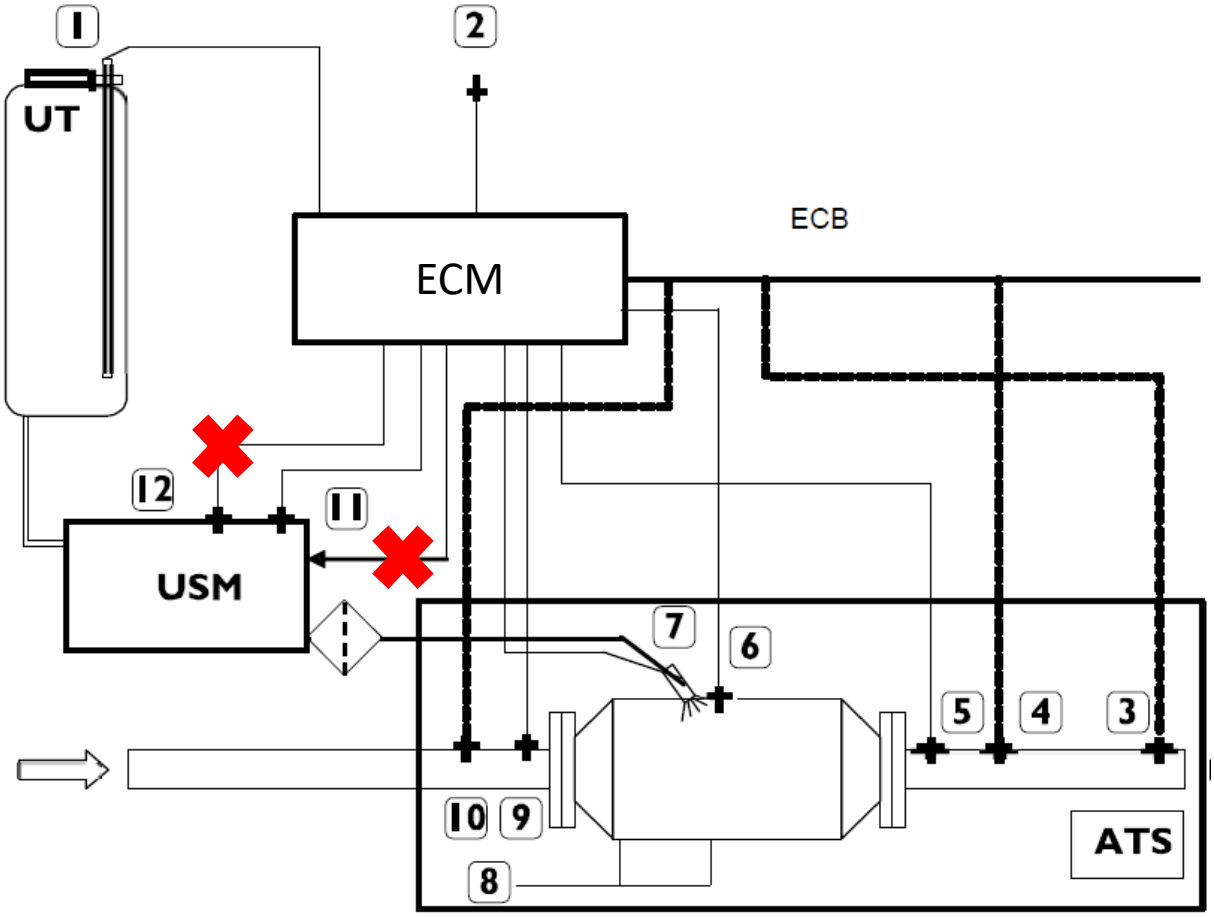

Figure 3 Exhaust aftertreatment layout, USM isolated for OBD validation

Figure 4 USM isolated after urea pump and pressure signal wiring cut

2.5.2 Urea emulator device installation

As shown in figure 5 with red crosses, the urea pressure wires and the pump control wires were physically cut. The red points show the emulator instrumentation points.

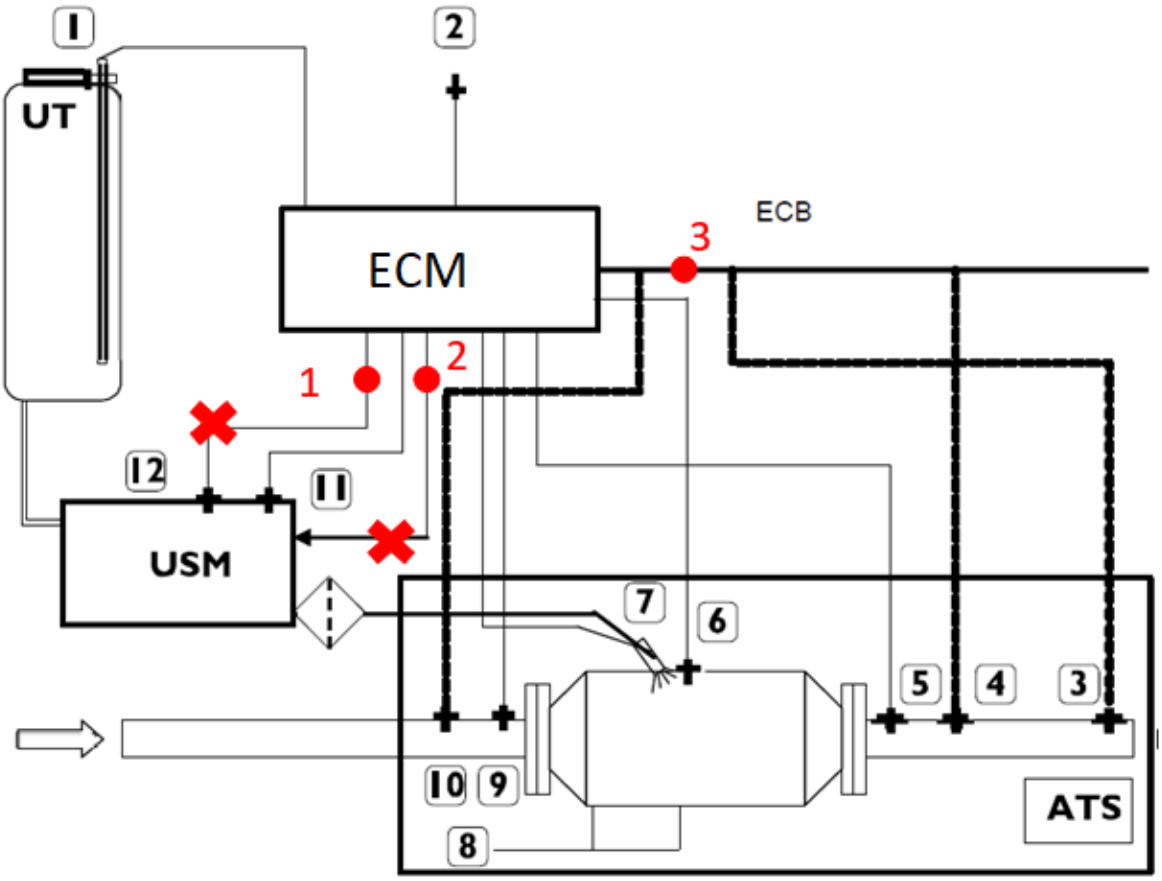

Figure 5 Exhaust aftertreatment, emulator installation

Urea emulator installation connection points:

1 Urea pressure sensor signal,

2 Urea pump control signal.

3 CAN_H and CAN_L and

Vehicle 24V Fuse

Vehicle GND

Figure 6 Adblue (SCR) emulator pinout

2.5.3 Original conditions with urea emulator installed in parallel

In this configuration the emulator channels Power, GND, CAN_H and CAN_L had been connected to the vehicle and we logged with INCA the urea pressure and the urea pump signals. This test is in original conditions and the emulator does not affect the vehicle.

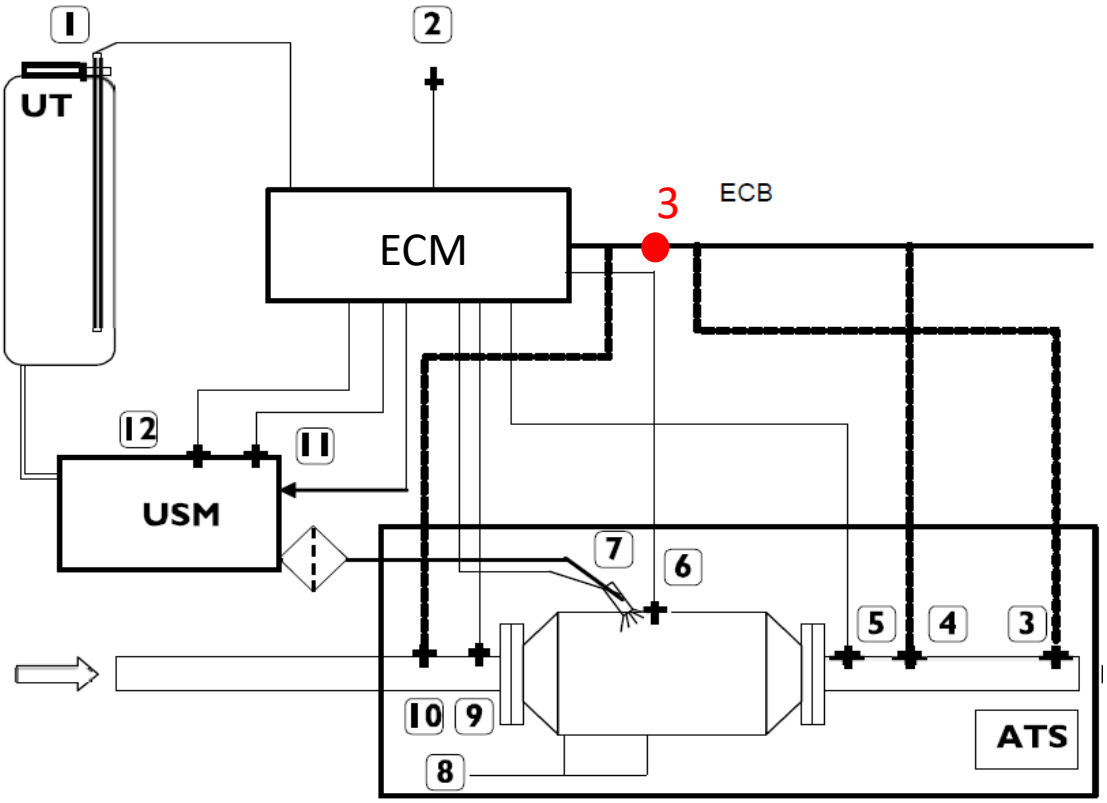

Figure 7 Exhaust aftertreatment, emulator connected in parallel

Urea emulator installation connection points:

INCA - Urea pressure sensor signal, ○

INCA – Urea pump control signal. ●

3 CAN_H and CAN_L ● and ●

Vehicle 24V Fuse ●

Vehicle GND ●

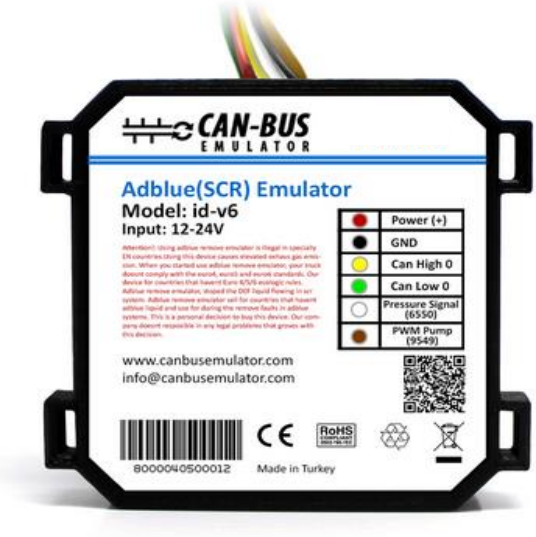

Figure 8 Adblue (SCR) emulator pinout

3. ROUTES AND TEST PROCEDURE SPECIFICATIONS

3.1. Test for OBD validation

Test performed with the Urea Supply Monitoring isolated (as explained in Instrumentation layout 3.5.1) to validate the OBD standard, the table below shows the characteristics of the tested routes:

Route	Date	Time	Emulator installed? (Y/N)	Driven mileage (km)	Driven hours (h)	Comments
Route 1	08/04/2021	13:52	No	239.12	3.52	USM Isolated
Route 2	08/04/2021	18:19	No	271.58	4.56	USM Isolated
Route 3	09/04/2021	13:03	No	134.61	2.28	USM Isolated - Torque reduction
Route 4	09/04/2021	17:26	No	101.2	1.71	USM Isolated - Torque reduction

Table 5 Characteristics of the routes performed for OBD validation.

3.2. Test with emulator installed

Test performed with the Adblue urea emulator installed (as explained in Instrumentation layout 3.5.2), the table below shows the characteristics of the tested routes:

Route	Date	Time	Emulator installed? (Y/N)	Driven mileage (km)	Driven hours (h)	Comments
Route 5	13/04/2021	16:49	Yes	239.6	3.65	No MILs present and no counters increased.
Route 6	14/04/2021	18:26	Yes	237.75	3.46	No MILs present and no counters increased.

Table 6 Characteristics of the routes performed with emulator.

3.3. Test in original conditions with urea emulator installed in parallel

Test performed in original conditions with the emulator installed in parallel (as explained in Instrumentation layout 3.5.3), the table below shows the characteristics of the tested route:

Route	Date	Time	Emulator installed? (Y/N)	Driven mileage (km)	Driven hours (h)	Comments
Route 7	16/04/2021	16:32	No	190.32	3.32	Original conditions

Table 7 Characteristics of the route performed in original conditions.

4. TEST RESULTS

The results were separated in three tests following the test description in point 3.

The following parameters have been selected for the test monitoring, as an example the parameters in original conditions are shown in the table below:

Route	Dosing counter (h)	NOx Warning System	Level One Inducement	Ad Blue ON?	Torque reduction? (Y/N)	MIL ON?
Original Conditions	0h	Inactive	Inactive	YES	NO	NO

Table 8 Parameters selected for route comparison.

The figure below shows a picture taken in the vehicle's cluster during the testing activities. There were two light indicators present: the NOx warning system and the malfunction indicator lamp (MIL) related to Level one inducement.

Figure 9 Vehicle's cluster with MILs and warnings.

4.1 Test for OBD validation

Tests performed with the Urea Supply Monitoring isolated (as explained in Instrumentation layout 3.5.2) to validate the OBD standard. These tests were separated in the routes below with the following results:

Route	Dosing counter (h)	NOx Warning System	Level One Inducement	Ad Blue ON?	Torque reduction? (Y/N)	MIL ON?
Route 1	0-3h	Active	Inactive	NO	NO	NO
Route 2	3-7h	Active	Inactive	NO	NO	NO
Route 3	7-10h	Active	Active	NO	YES	YES
Route 4	10-12h	Active	Active	NO	YES	YES

Table 9 Parameters measured for OBD validation test

4.1.1. Route 1

The table below shows the Route 1 conditions:

Test date		08/04/2021
Test start (UTC)		13:52
Total test duration	s	12688
Distance	km	239.12
Average speed	km/h	67.94
Average fuel rate	l/h	23.23
Diesel consumption	l	81.77
Average urea rate	g/s	0.0
Urea consumption	g	0
Urea consumption	l	0

Table 10 Test characteristics on Route 1

Urea - Adblue density:1.090g/cm^3

There were 2 DTCs present during the routes:

- DTC2012 = P208B Reductant Pump "A" Control Performance/Stuck Off
- DTC2012 = P208A Reductant Pump "A" Control Circuit/Open

The following figure shows the Route 1 OBD parameters:

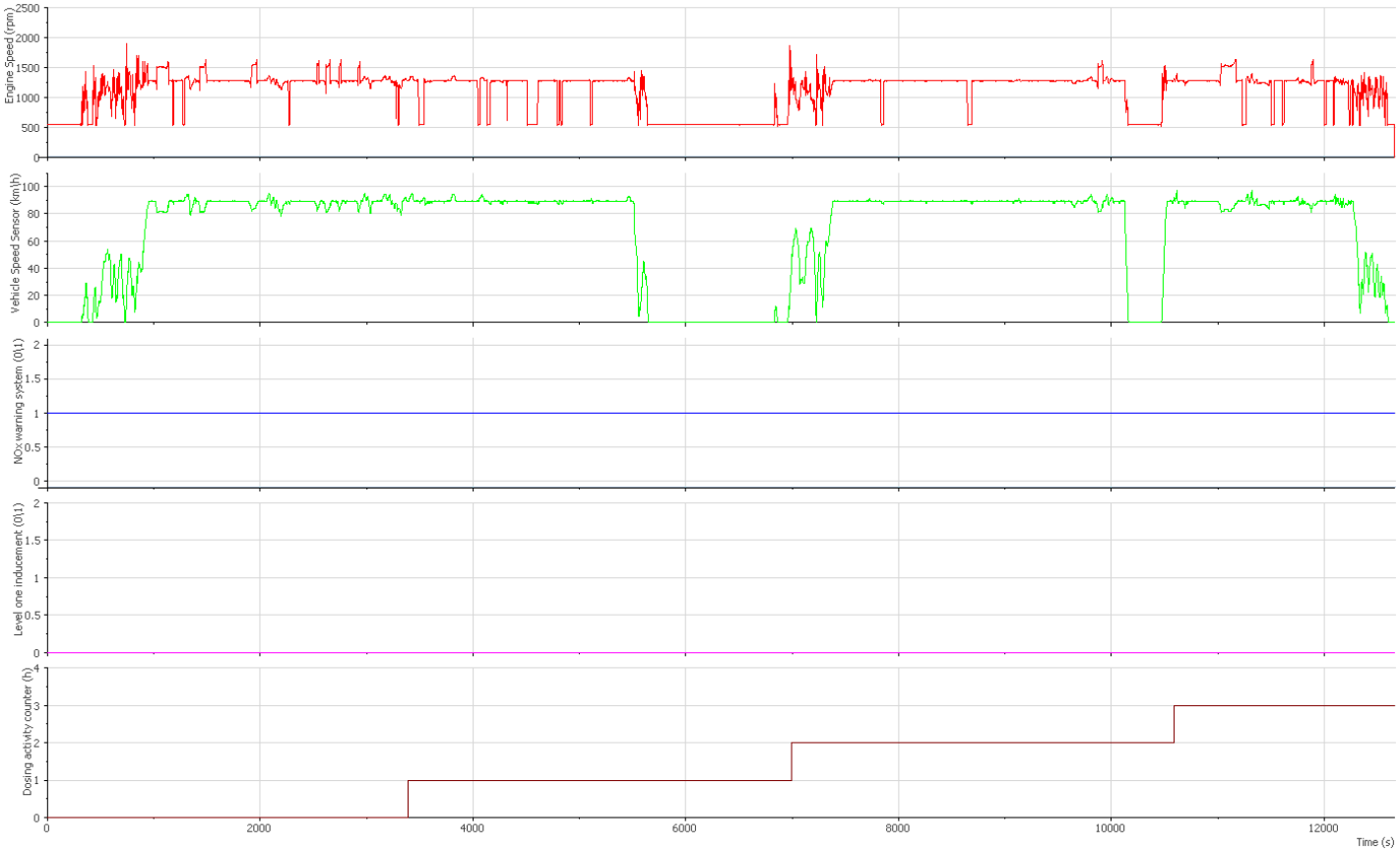

Figure 10 Route 1 OBD parameters

- Engine speed (rpm) -----
- Vehicle speed sensor (km/h) -----
- NOx warning system status(0/1) ----- 0 = OFF | 1 = ON 
- Level one inducement status(0/1) ----- 0 = OFF | 1 = ON 
- Dosing activity counter (h) -----

During this route the NOx warning system status (-----) was active and the dosing activity counter (-----) was increasing.

4.1.2. Route 2

The table below shows the Route 2 conditions:

Test date		08/04/2021
Test start (UTC)		18:19
Total test duration	s	16444
Distance	km	271.58
Average speed	km/h	59.45
Average fuel rate	l/h	20.99
Diesel consumption	l	95.97
Average urea rate	g/s	0
Urea consumption	g	0
Urea consumption	l	0

Table 11 Test characteristics on Route 2

Urea - Adblue density:1.090g/cm^3

There were 2 DTCs present during the routes:

- DTC2012 = P208B Reductant Pump "A" Control Performance/Stuck Off
- DTC2012 = P208A Reductant Pump "A" Control Circuit/Open

The following figure shows the Route 2 OBD parameters:

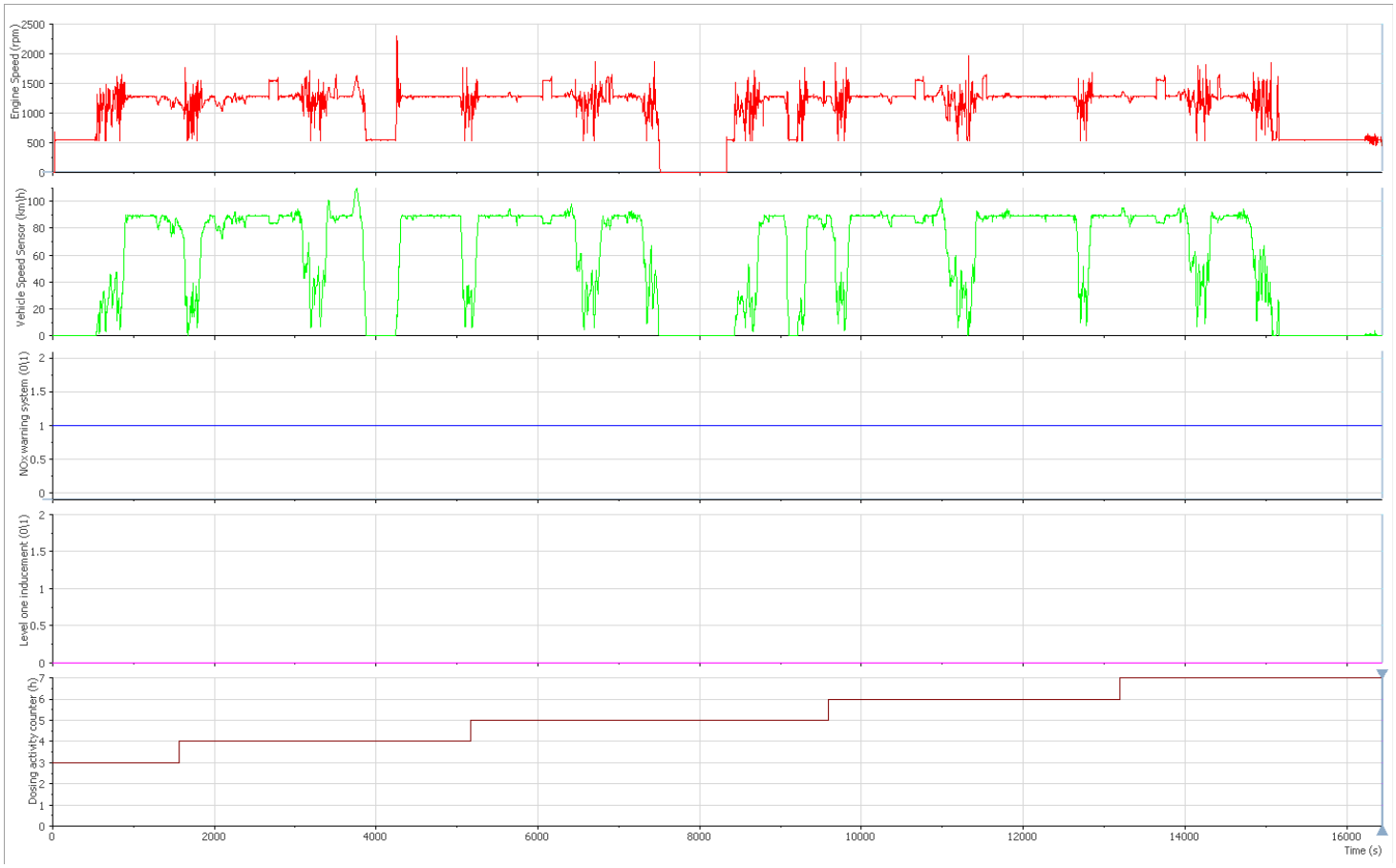

Figure 11 Route 2 OBD parameters

- Engine speed (rpm) -----
- Vehicle speed sensor (km/h) -----
- NOx warning system status(0/1) ----- 0 = OFF | 1 = ON 
- Level one inducement status(0/1) ----- 0 = OFF | 1 = ON 
- Dosing activity counter (h) -----

During this route the NOx warning system status (-----) was active and the dosing activity counter (-----) was increasing.

4.1.3. Route 3

The table below shows the Route 3 conditions:

Test date		09/04/2021
Test start (UTC)		13:03
Total test duration	s	8216
Distance	km	134.61
Average speed	km/h	58.97
Average fuel rate	l/h	31.24
Diesel consumption	l	47.89
Average urea rate	g/s	0
Urea consumption	g	0
Urea consumption	l	0

Table 12 Test characteristics on Route 3

Urea - Adblue density:1.090g/cm^3

There were 3 DTCs present at the end of the route:

- DTC2012= P1000 Manufacturer Controlled DTC
- DTC2012 = P208B Reductant Pump "A" Control Performance/Stuck Off
- DTC2012 = P208A Reductant Pump "A" Control Circuit/Open

The following figure shows the Route 3 OBD parameters:

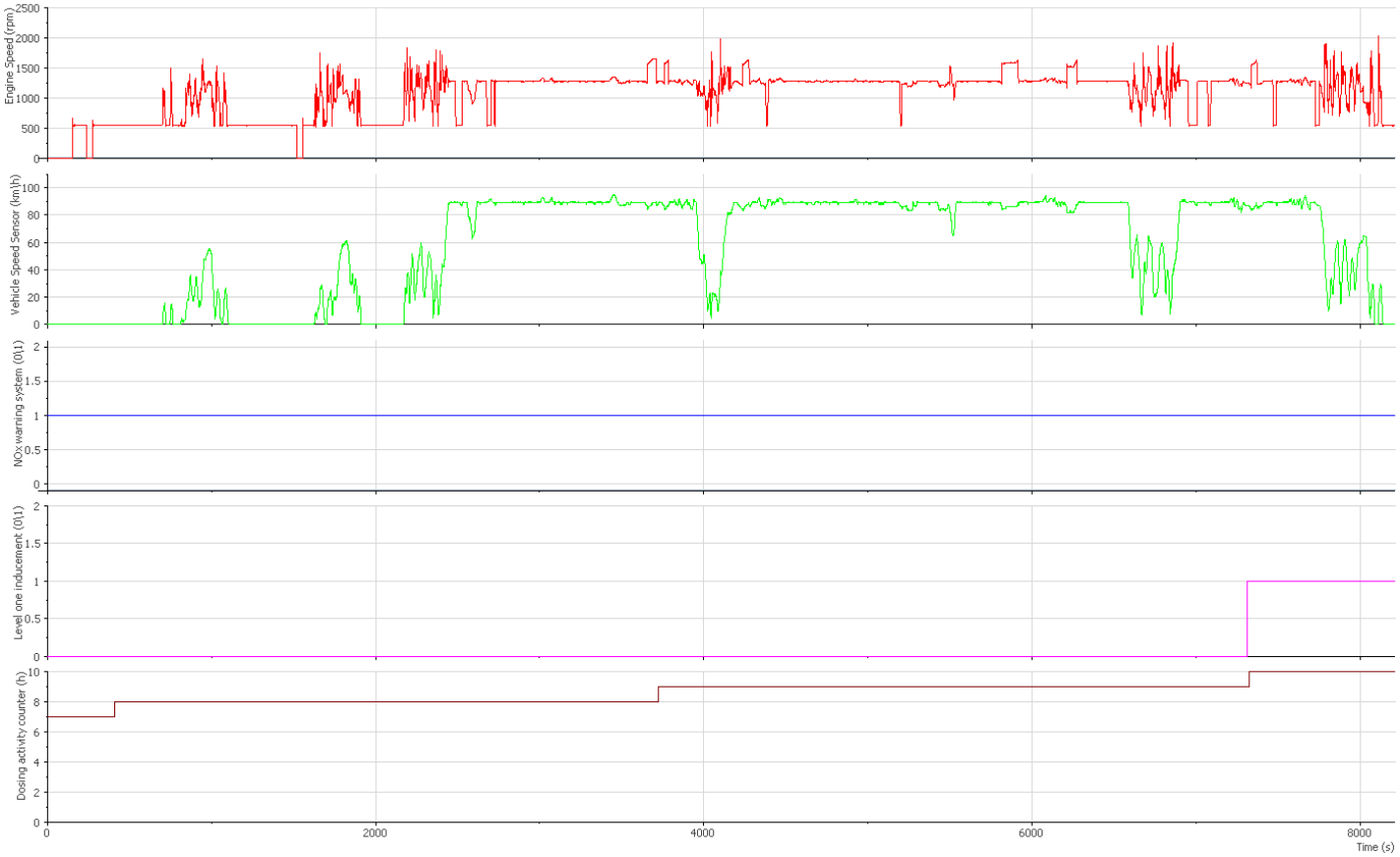

Figure 12 Route 3 OBD parameters

- Engine speed (rpm) -----
- Vehicle speed sensor (km/h) -----
- NOx warning system status(0/1) ----- 0 = OFF | 1 = ON 
- Level one inducement status(0/1) ----- 0 = OFF | 1 = ON 
- Dosing activity counter (h) -----

During this route the NOx warning system status (-----) was active and the dosing activity counter (-----) was increasing.

When the dosing activity counter (-----) reaches 10h the Level one inducement status (-----) changes the status from inactive to active and a torque reduction starts.

4.1.4. Route 4

The table below shows the Route 4 conditions:

Test date		09/04/2021
Test start (UTC)		17:26h
Total test duration	s	6185
Distance	km	101.2
Average speed	km/h	58.90
Average fuel rate	l/h	31.24
Diesel consumption	l	37.56
Average urea rate	g/s	0
Urea consumption	g	0
Urea consumption	l	0

Table 13 Test characteristics on Route 4

Urea - Adblue density:1.090g/cm^3

There were 3 DTCs present at the end of the route:

- DTC2012= P1000 Manufacturer Controlled DTC
- DTC2012 = P208B Reductant Pump "A" Control Performance/Stuck Off
- DTC2012 = P208A Reductant Pump "A" Control Circuit/Open

The following figure shows the Route 4 OBD parameters:

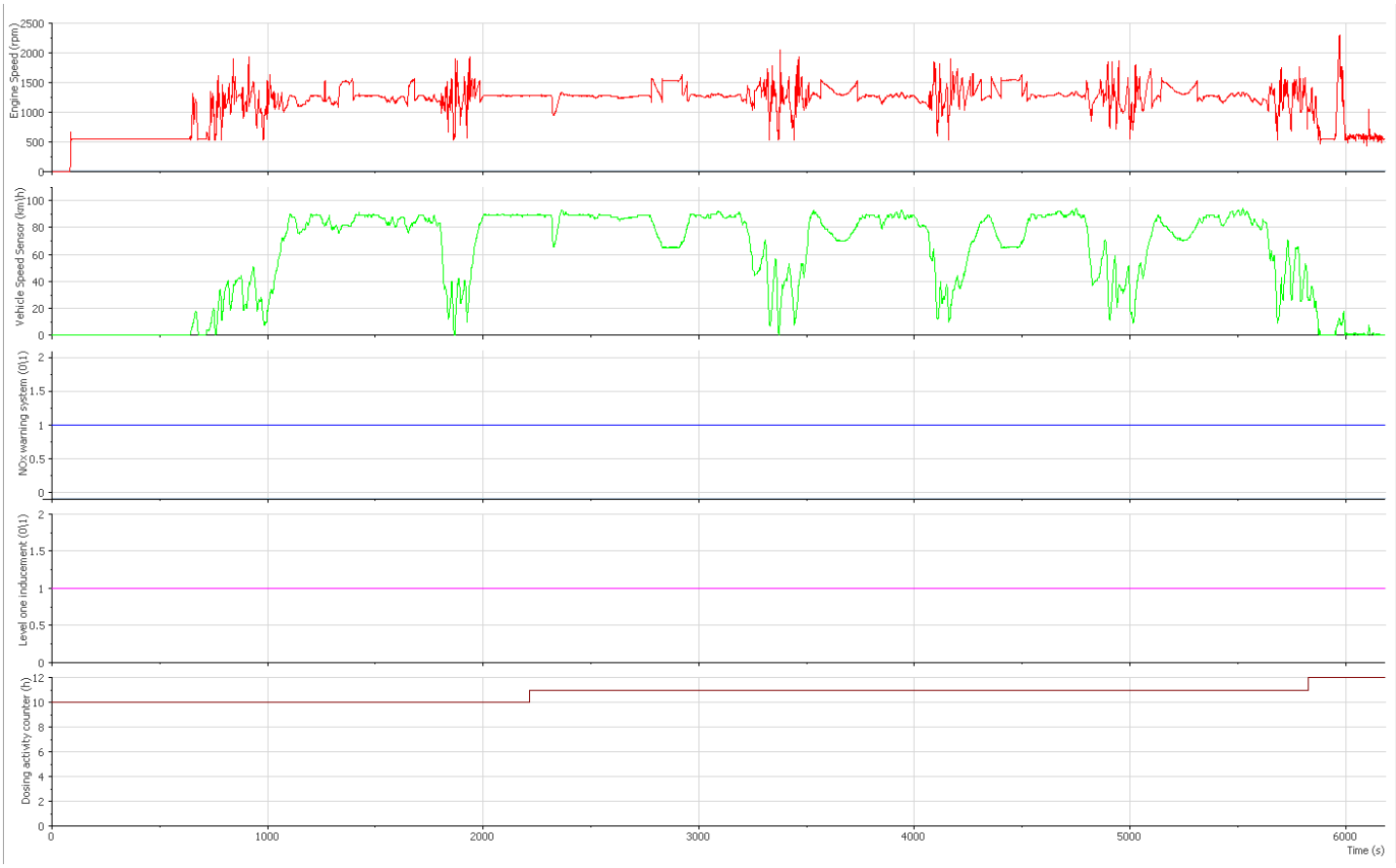

Figure 13 Route 4 OBD parameters

- Engine speed (rpm) -----
- Vehicle speed sensor (km/h) -----
- NOx warning system status(0/1) ----- 0 = OFF | 1 = ON 
- Level one inducement status(0/1) ----- 0 = OFF | 1 = ON 
- Dosing activity counter (h) -----

During this route the NOx warning system status (-----) was active, the Level one inducement status (-----) was active and the dosing activity counter (-----) was increasing.

There was a torque reduction during the route.

4.2 Test with emulator installed

Test performed with the AdBlue urea emulator installed (as explained in Instrumentation layout 3.5.2), these tests were separated in the routes below with the following results:

Route	Dosing counter (h)	NOx Warning System	Level One Inducement	Ad Blue ON?	Torque reduction? (Y/N)	MIL ON?
Route 1	0h - 9h after engine off	Inactive	Inactive	NO	NO	NO
Route 2	0h - 10h after engine off	Inactive	Inactive	NO	NO	NO

Table 14 Parameters measured with emulator installed.

4.2.1. Route 5

The table below shows the Route 5 conditions:

Test date		13/04/2021
Test start (UTC)		16:49h
Total test duration	s	13167
Distance	km	239.06
Average speed	km/h	65.85
Average fuel rate	l/h	22.43
Diesel consumption	l	81.63
Average urea rate	g/s	0
Urea consumption	g	0
Urea consumption	l	0

Table 15 Test characteristics on Route 5

Urea - Adblue density:1.090g/cm^3

Route 5 was started with the urea emulator installed and after clearing DTCs with the OBD Silver Scan Tool diagnosis (as shown in Annex II in the installation disclaimers provided by the supplier).

There were no DTCs present during the route.

There were 2 DTCs present when the engine was switched off:

- DTC2012 = P208C Reductant Pump "A" Control Circuit Low
- DTC2012 = P20AD Reductant Metering Unit Temperature Sensor Circuit Range/Performance

The following figure shows the Route 5 OBD parameters:

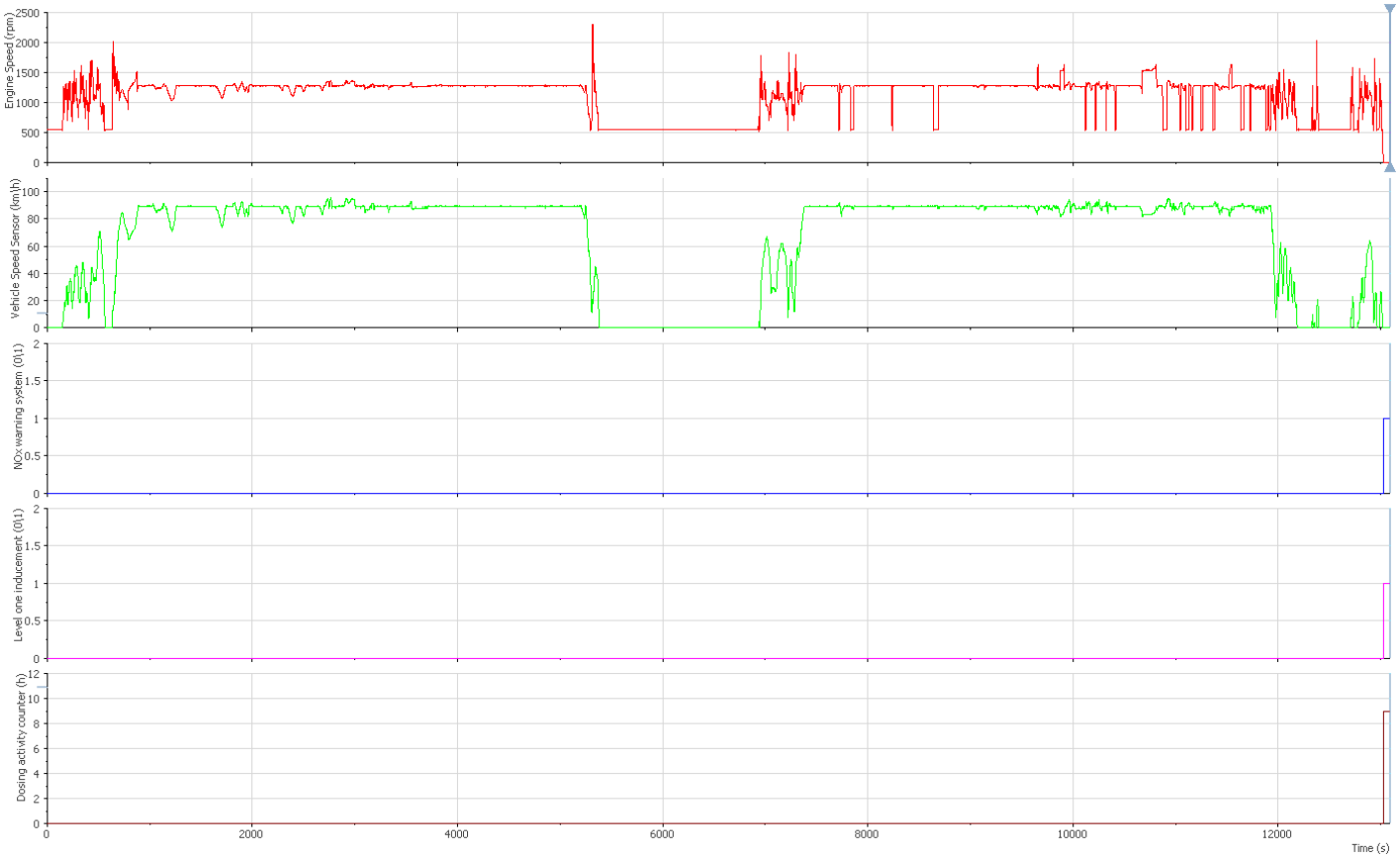

Figure 14 Route 5 OBD parameters

- Engine speed (rpm) -----
- Vehicle speed sensor (km/h) -----
- NOx warning system status(0/1) ----- 0 = OFF | 1 = ON 
- Level one inducement status(0/1) ----- 0 = OFF | 1 = ON 
- Dosing activity counter (h) -----

The truck with the urea emulator installed was working properly with no counters increased, no warnings and no MIL present during the route.

When the engine was switched off these parameters change status.

The following figure shows the Route 5 OBD parameters when the engine was switched off:

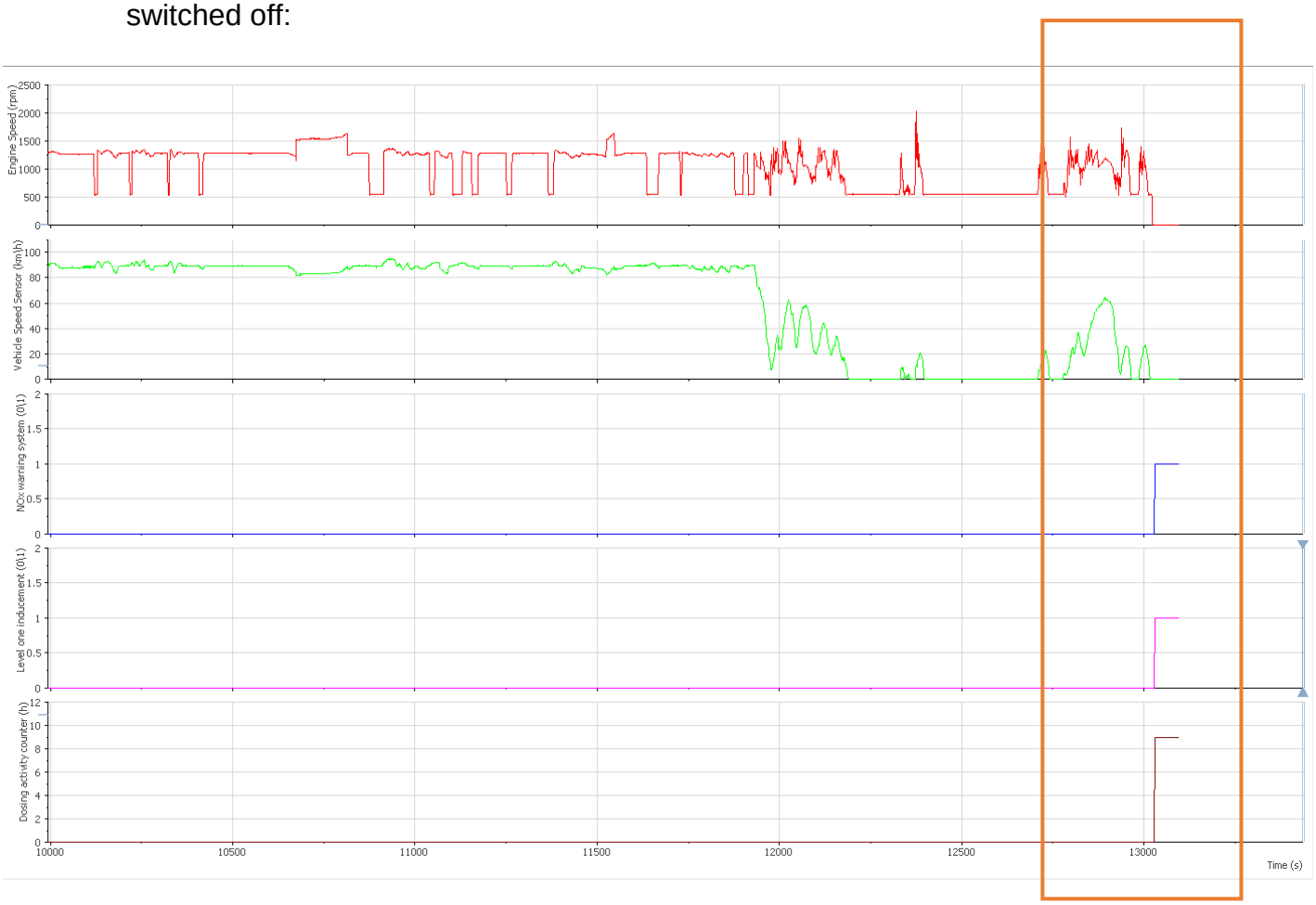

Figure 15 Route 5 OBD parameters when engine was switched off

- Engine speed (rpm) -----
- Vehicle speed sensor (km/h) -----
- NOx warning system status(0/1) ----- 0 = OFF | 1 = ON 
- Level one inducement status(0/1) ----- 0 = OFF | 1 = ON 
- Dosing activity counter (h) -----

When the engine was switched off NOx warning system status (-----) and Level one inducement status (-----) changes to active and the dosing activity counter (-----) increases.

As shown in OBD Regulation (Annex I), the dosing activity counter (-----) was not resetting and reactivates again.

4.2.2. Route 6

The table below shows the Route 6 conditions:

Test date		14/04/2021
Test start (UTC)		18:26h
Total test duration	s	12484
Distance	km	237.75
Average speed	km/h	69.06
Average fuel rate	l/h	23.67
Diesel consumption	l	81.48
Average urea rate	g/s	0
Urea consumption	g	0
Urea consumption	l	0

Table 16 Test characteristics on Route 6

Urea - Adblue density:1.090g/cm^3

Route 6 was started with the urea emulator installed and after clearing DTCs with the OBD Silver Scan Tool diagnosis (as shown in Annex II in the installation disclaimers provided by the supplier).

There were no DTCs present during the route.

There were 2 DTCs present when the engine was switched off:

- DTC2012 = P208C Reductant Pump "A" Control Circuit Low
- DTC2012 = P20AD Reductant Metering Unit Temperature Sensor Circuit Range/Performance

The following figure shows the Route 6 OBD parameters:

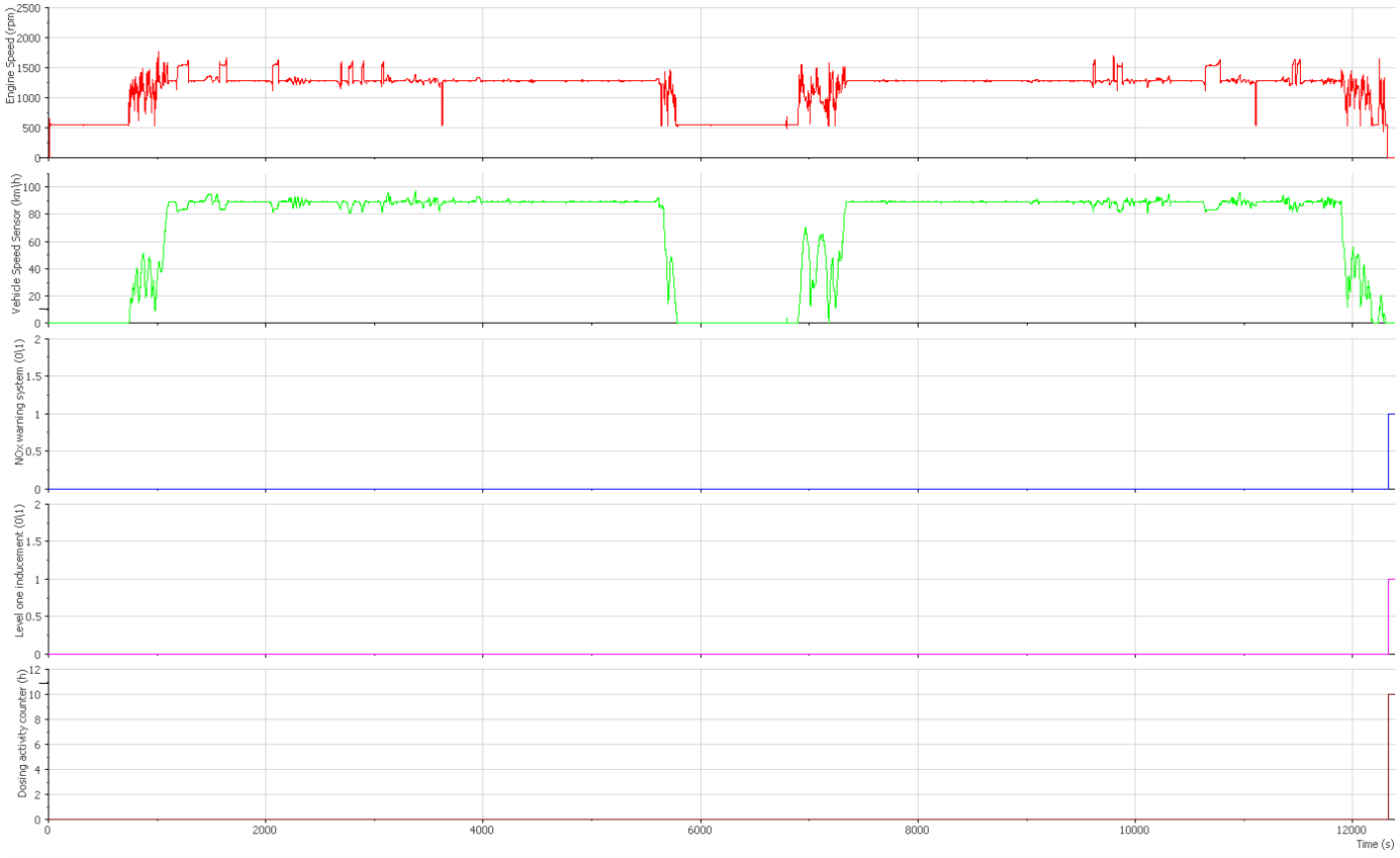

Figure 16 Route 6 OBD parameters

- Engine speed (rpm) -----
- Vehicle speed sensor (km/h) -----
- NOx warning system status(0/1) ----- 0 = OFF | 1 = ON 
- Level one inducement status(0/1) ----- 0 = OFF | 1 = ON 
- Dosing activity counter (h) -----

The truck with the urea emulator installed was working properly with no counters increased, no warnings and no MIL present during the route.

When the engine was switched off, these parameters change status.

The following figure shows the Route 6 OBD parameters when the engine was switched off:

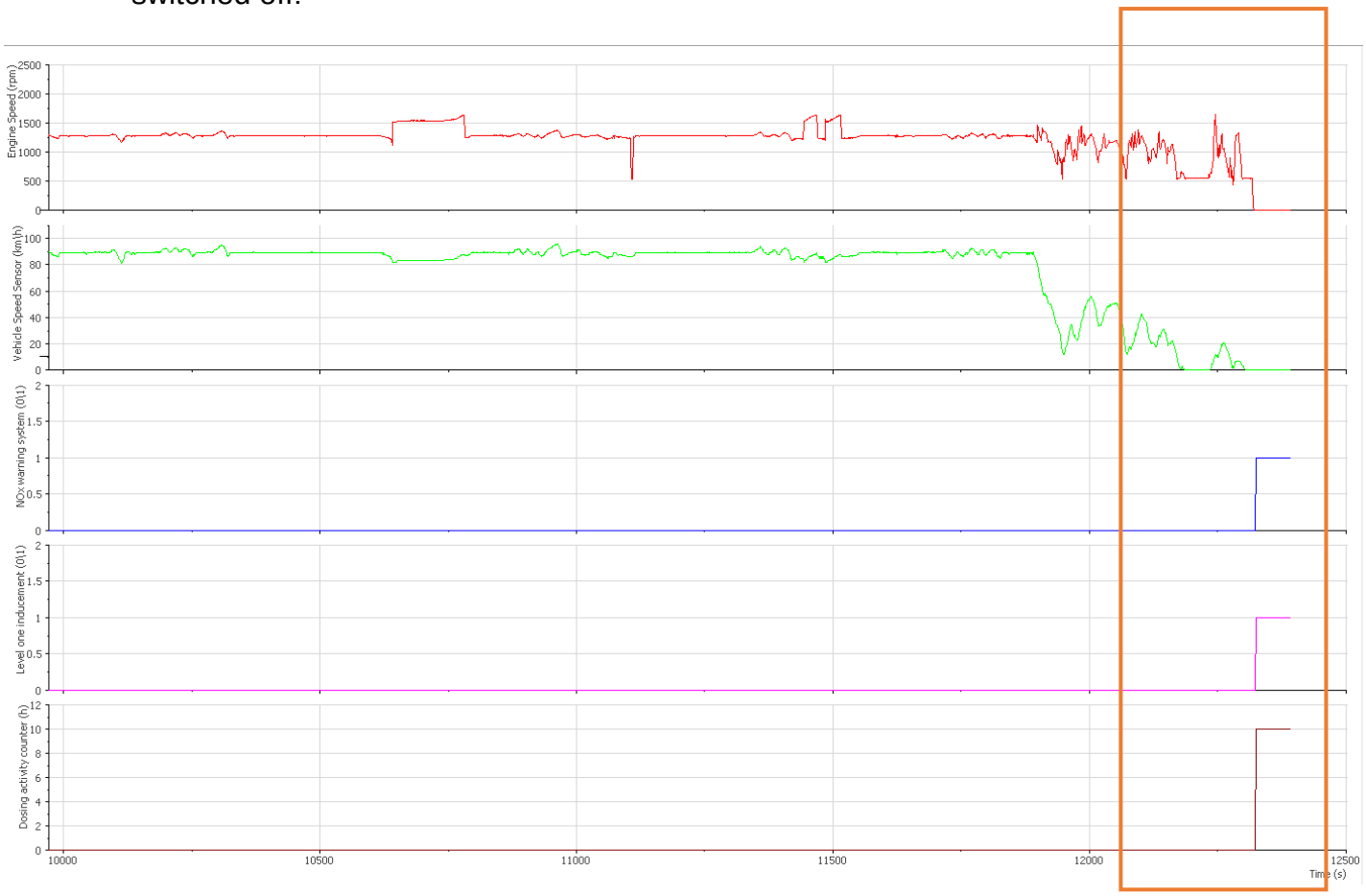

Figure 17 Route 6 OBD parameters when engine was switched off

- Engine speed (rpm) -----
- Vehicle speed sensor (km/h) -----
- NOx warning system status(0/1) ----- 0 = OFF | 1 = ON 
- Level one inducement status(0/1) ----- 0 = OFF | 1 = ON 
- Dosing activity counter (h) -----

When the engine was switched off NOx warning system status (-----) and Level one inducement status (-----) changes to active and the dosing activity counter (-----) increases.

As shown in OBD Regulation (Annex I), the dosing activity counter (-----) was not resetting and reactivates again.

4.3 Test in original conditions with urea emulator installed in parallel

Test performed in original conditions with the emulator installed in parallel (as explained in Instrumentation layout 3.5.3), this test was performed on Route 7 with the following results.

Route	Dosing counter (h)	NOx Warning System	Level One Inducement	Ad Blue ON?	Torque reduction? (Y/N)	MIL ON?
Route 7	0h	Inactive	Inactive	YES	NO	NO

Table 17 Parameters measured in original conditions with emulator installed in parallel.

4.3.1. Route 7

The table below shows the Route 7 conditions:

Test date		16/04/2021
Test start (UTC)		14:32h
Total test duration	s	11977
Distance	km	190.32
Average speed	km/h	57.19
Average fuel rate	l/h	21.18
Diesel consumption	l	70.46
Average urea rate	g/s	0.44354
Urea consumption	g	5288.28
Urea consumption	l	4851.63

Table 18 Test characteristics on Route 7

Urea - Adblue density:1.090g/cm^3

There were no DTCs present during and after the route.

The following figure shows the Route 7 OBD parameters:

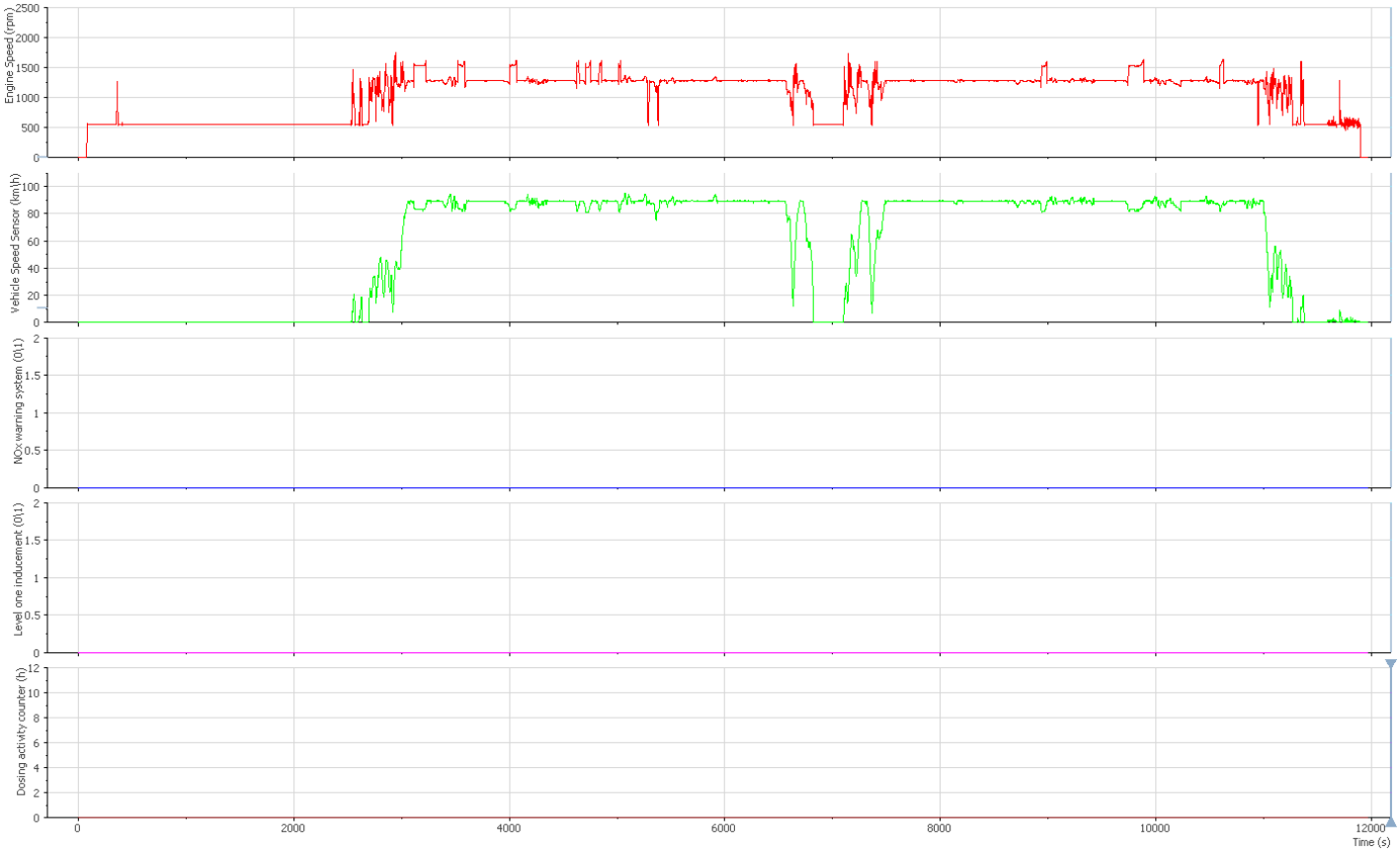

Figure 18 Route 7 OBD parameters

- Engine speed (rpm) -----
- Vehicle speed sensor (km/h) -----
- NOx warning system status(0/1) ----- 0 = OFF | 1 = ON 
- Level one inducement status(0/1) ----- 0 = OFF | 1 = ON 
- Dosing activity counter (h) -----

During this route the NOx warning system status (-----), the Level one inducement status (-----) and the dosing activity counter (-----) were inactive. The vehicle was working in original conditions with urea injection.

The following figure shows the Route 7 auxiliary instrumented parameters logged with INCA:

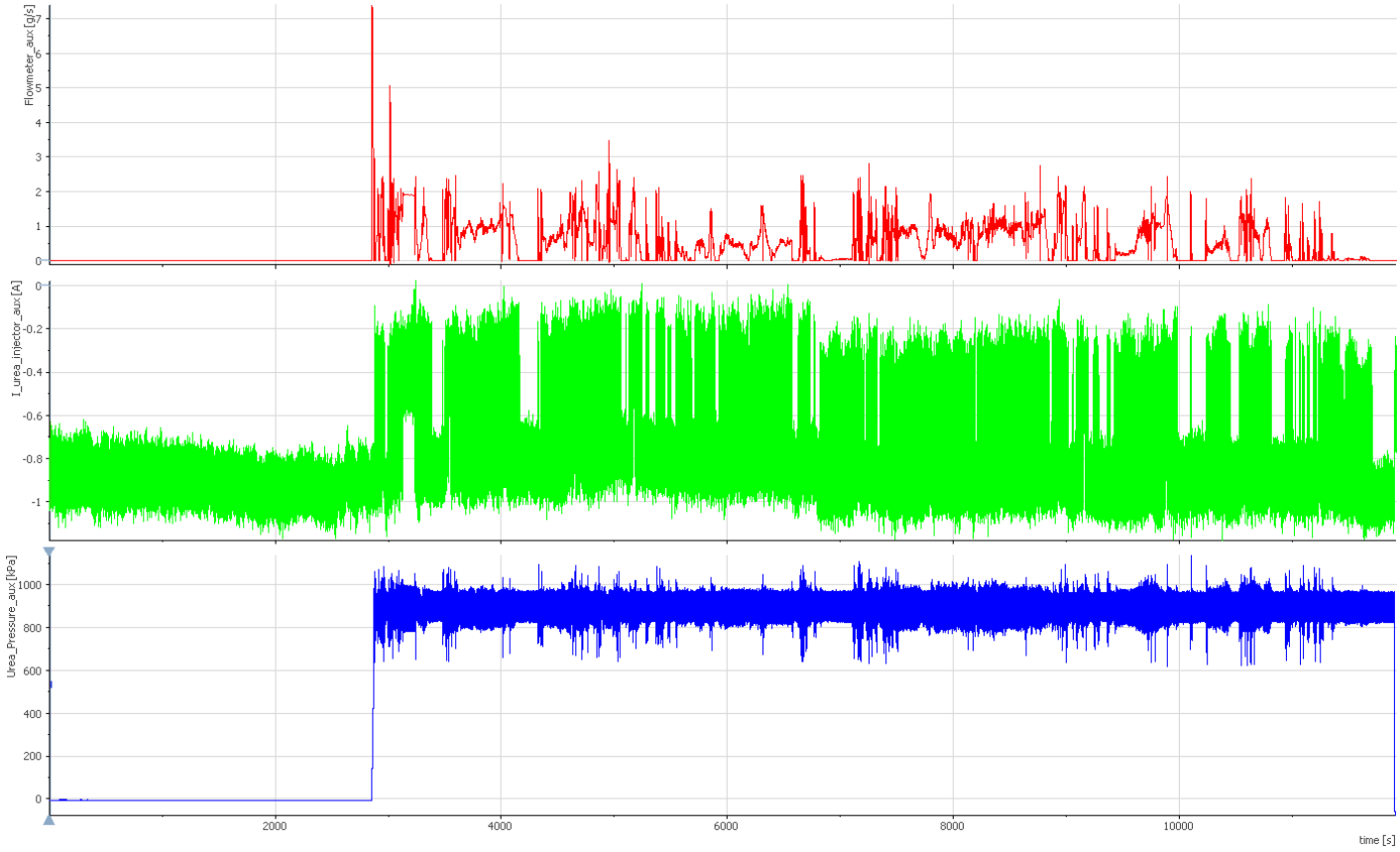

Figure 19 Route 7 auxiliary instrumented parameters logged with INCA.

- Urea flowmeter (g/s) -----
- Urea injector current (A) -----
- Urea pressure signal (kPa) -----

As shown in the graphics, the vehicle starts injecting urea to the exhaust aftertreatment system near the route's second 300.

The following figure shows the Route 7 parameters logged from the vehicle compared to the parameters logged from the emulator installed in parallel:

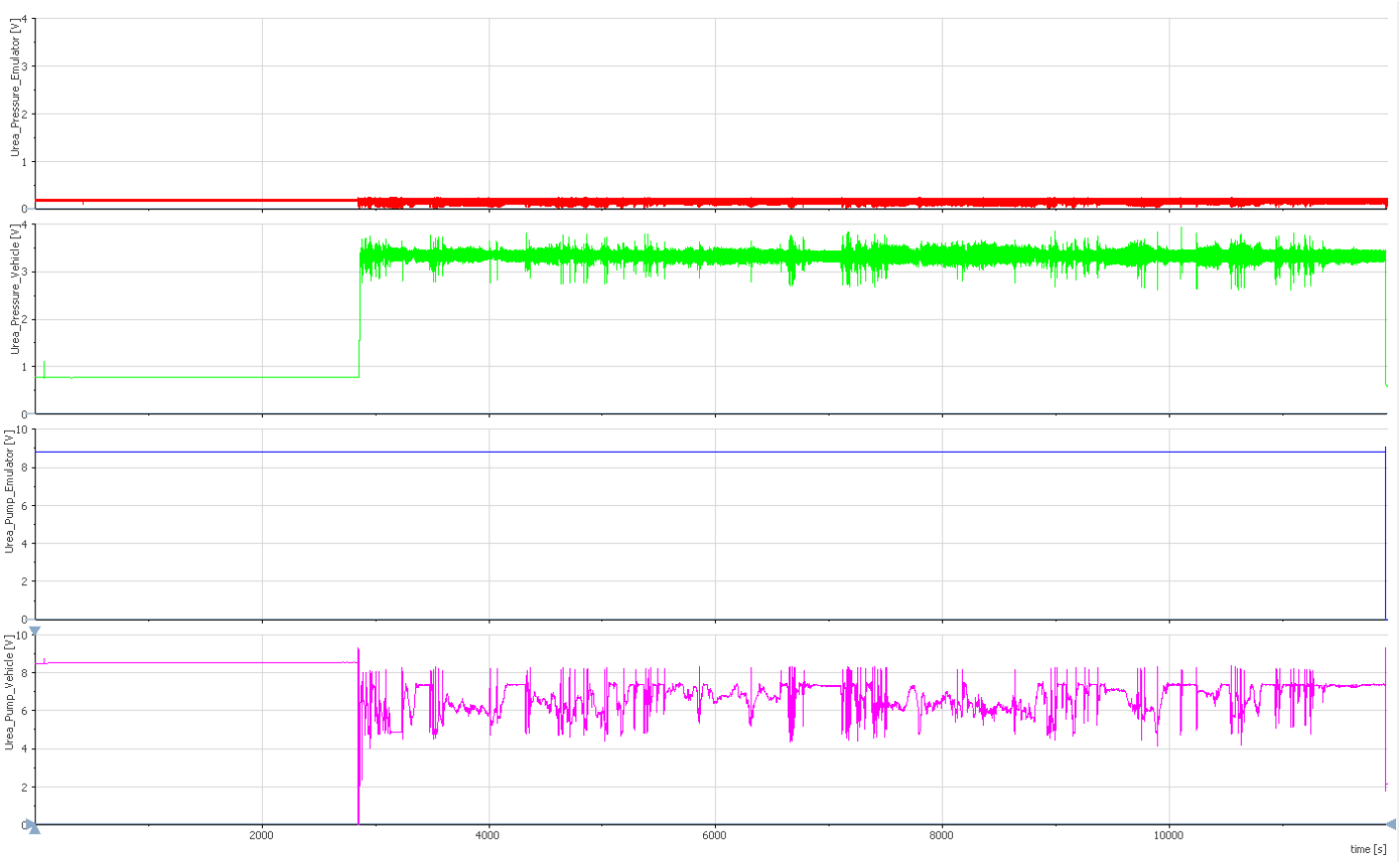

Figure 20 Route 7 vehicle and emulator pressure and pump signals

- Urea pressure emulator (V) -----
- Urea pressure vehicle (V) -----
- Urea pump emulator (V) -----
- Urea pump vehicle (V) -----

Near the route's second 300 (when the vehicle starts injecting urea) the urea pump vehicle signal (-----) changes the voltage to activate the USM and then the urea pressure vehicle signal (-----) was increased.

When we install the emulator, we cut the urea pump vehicle signal (-----) and the urea pressure vehicle signal (-----). The emulator was replacing these signals by the urea pump emulator signal (-----) and the urea pressure emulator signal (-----) respectively.

The emulator with the urea pump emulator signal (-----) was emulating a status where no urea injection was needed.

5. CONCLUSIONS

After the tests performed on the 7 routes we can draw the following conclusions:

1. We can assure that the OBD urea system monitoring is working as described in the United Nations Regulation No.49. With the USM isolated, it first starts with the NOx warning system light flashing, after 10h the Level one inducement MIL is enabled with a torque reduction.

2. The truck works properly without any warning system lights nor torque loss or restriction after the urea emulator installation.

3. There was no urea consumption during Routes 1-4 (with USM isolated) and Routes 5-6 (with emulator installed). We can assure that by monitoring the SCR system with the auxiliary instrumentation: Urea line pressure, Urea mass flow and Urea injector signal.

4. The urea emulator device was connected to the vehicle CAN network. The device emulates the urea pump control and urea pressure signals similar to an idle status where no urea injection was needed in original conditions.

6. HOW TO DETECT IT?

One of the questions after the conclusions is how to detect the AdBlue urea emulators in the vehicle technical inspection station.

These devices are easy to install and remove from the vehicle, so the most probable scenario is that users remove it before going to a vehicle technical inspection station. Otherwise, if the emulator is installed on the vehicle, we can detect it following the next steps.

6.1. Visual Inspection

These devices are small and could be hidden in different parts of the vehicle, but there are some key components to be checked:

OBD Port: check that there are no connected devices.

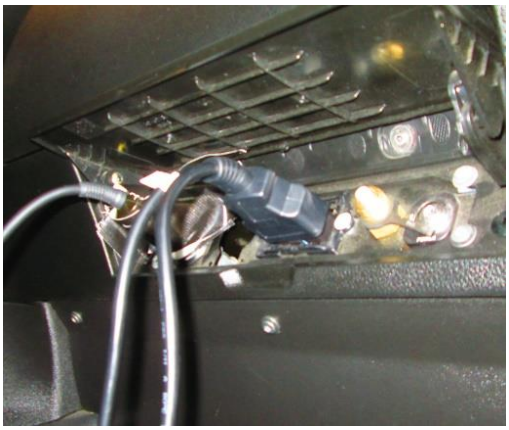

Figure 21 Visual inspection: OBD Port

SCR Socket: check that there is no manipulated wiring.

Figure 22 Visual inspection: SCR Socket

Urea fuel tank: check that there is no manipulated wiring nor urea lines.

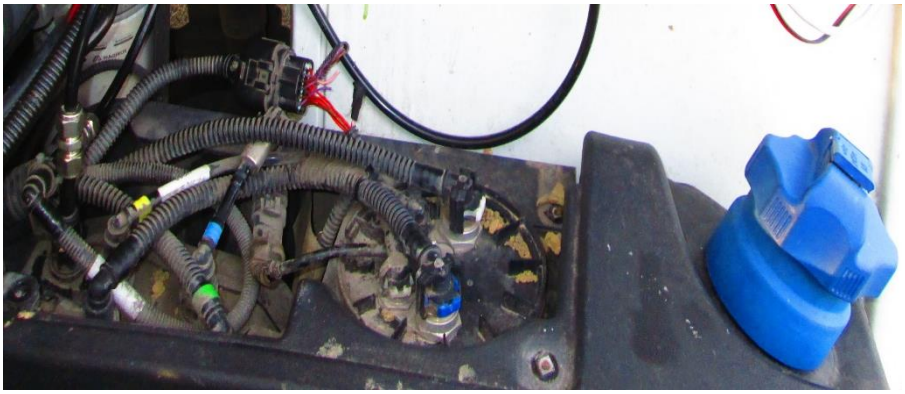

Figure 23 Visual inspection: Urea Fuel Tank

Fuse Box: check that there are no emulators or additional wires connected to the supply fuses.

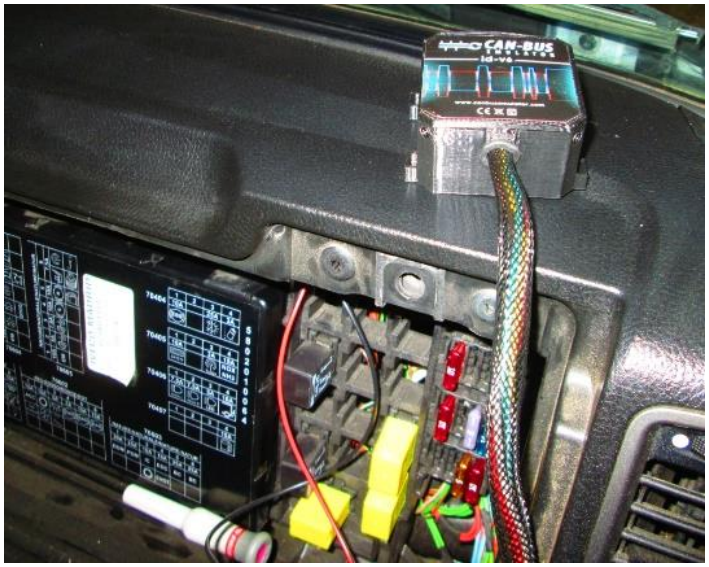

Figure 24 Visual inspection: Fuse Box

6.2. Actuator testing with diagnosis dedicated software

Actuator testing: If the diagnosis software has the original equipment manufacturer (OEM) licenses or specific vehicle model updated in the database, some actuator test functions are allowed as shown in the example below.

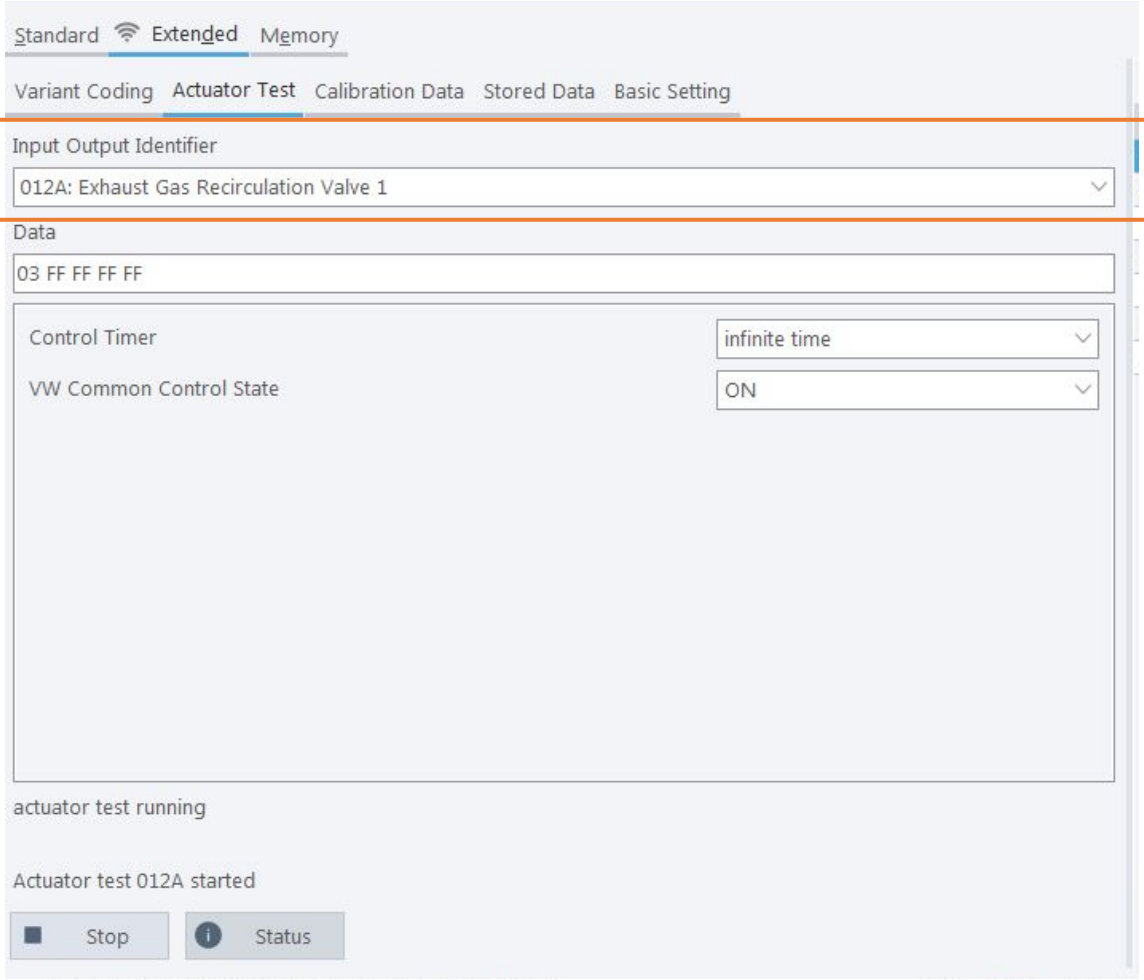

Figure 25 Actuator test example

With these actuator test functions it is possible to enable the SCR components actuation and measure the pollutants with external sensors.

6.3. Increase the complexity of OBD standard

Making the vehicle OBD diagnostics system more accurate or complex monitoring more urea system parameters then it would make more difficult to create a device capable to emulate the SCR operation.

Annex I: OBD Regulation

This annex contains 3 pages.

ANNEX I: OBD Regulation

The OBD Regulation was obtained in the United Nations Regulation No.49:

https://unece.org/fileadmin/DAM/trans/main/wp29/wp29regs/2013/R049r6e.pdf

Eur-Lex, access to European Union law:

https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02011R0582-20210101

The figures below show extracts of the driver warning and inducement activation and deactivation mechanisms that apply to this Regulation:

Annex 11 – Appendix 2

A.2.2.1. The driver warning system shall be activated when the diagnostic trouble code (DTC) associated with a malfunction justifying its activation has the status defined in Table 1.

Table 1
Activation of the driver warning system

Failure type	*DTC status for activation of the warning system*
Poor reagent quality	Confirmed and active
Low reagent consumption	Potential (if detected after 10 hours), potential or confirmed and active otherwise
Absence of dosing	Confirmed and active
Impeded EGR valve	Confirmed and active
Malfunction of the monitoring system	Confirmed and active

Figure 26 Activation of driver warning system from Regulation No.49

Table 2
Counters and inducement

	DTC status for first activation of the counter	*Counter value for low-level inducement*	*Counter value for severe inducement*	*Frozen value held by the counter during the period just after severe inducement*
Reagent quality counter	Confirmed and active	10 hours	20 hours	18 hours
Reagent consumption counter	Potential or confirmed and active (see Table 1)	10 hours	20 hours	18 hours
Dosing counter	Confirmed and active	10 hours	20 hours	18 hours
EGR valve counter	Confirmed and active	36 hours	100 hours	95 hours
Monitoring system counter	Confirmed and active	36 hours	100 hours	95 hours

Figure 27 Counters and inducement from the Regulation No.49

E/ECE/324/Rev.1/Add.48/Rev.6
E/ECE/TRANS/505/Rev.1/Add.48/Rev.6
Annex 11 – Appendix 2

Figure 1
Reactivation and resetting to zero of a counter after a period when its value has been frozen

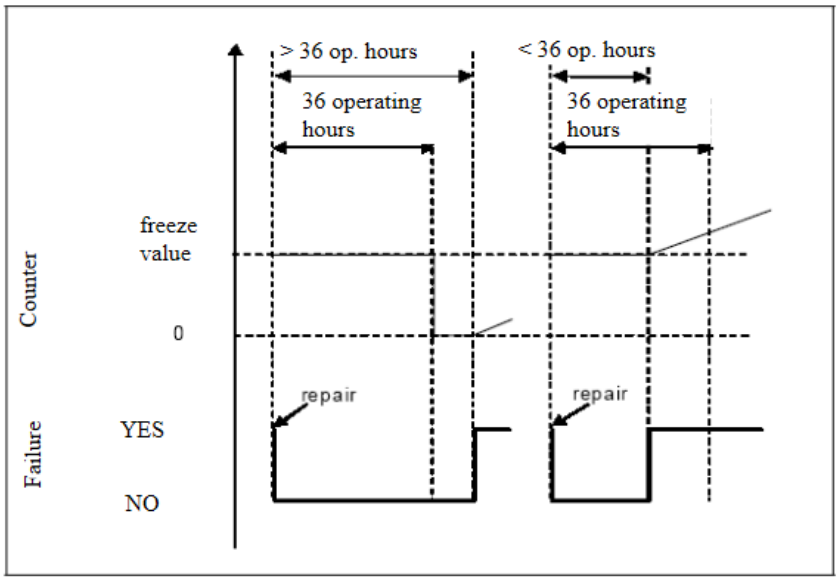

Figure 28 Counter reactivation and resetting from the Regulation No.49

A.2.5.4. Figure 4 illustrates three cases of failure of the urea dosing system. This figure also illustrates the process that applies in the case of the monitoring failures described in paragraph 9. of this annex:

(a) Use case 1: the driver continues operating the vehicle in spite of the warning until vehicle operation is disabled;

(b) Repair case 1 ("good" repair): after disablement of the vehicle, the driver repairs the dosing system. However, some time afterwards, the dosing system fails again. The warning, inducement, and counting processes restart from zero;

(c) Repair case 2 ("bad" repair): during the low-level inducement time (torque reduction), the driver repairs the dosing system. Soon after, however, the dosing system fails again. The low-level inducement system is immediately reactivated and the counter restarts from the value it had at the time of repair.

Figure 29 Dosing system failure from the Regulation No.49

Figure 4
Failure of the reagent dosing system

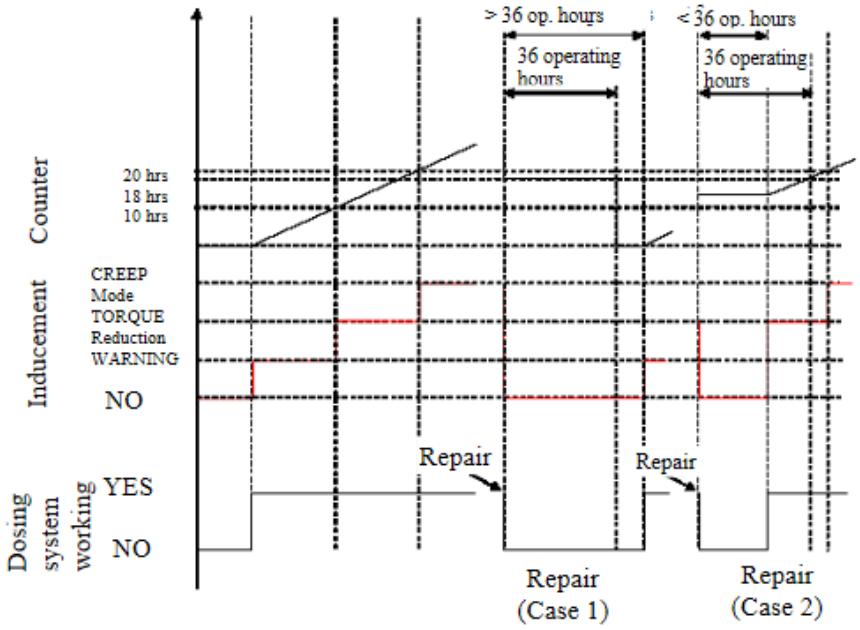

Figure 30 Dosing system failure diagram from the Regulation No.49

Annex II: Urea Emulator

This annex contains 2 pages.

ANNEX II: Urea emulator

The following information about the urea emulator device used in the project was obtained on the urea emulator supplier website:

https://www.canbusemulator.com/en/euro-6-adblue-scr-emulator/

Figure 31 Urea emulator device picture used in the project

Attention!: using adblue remove emulator is illegal in specially EN countries.Using this device causes elevated exhaus gas emission. When you started use adblue remove emulator, your truck doesnt comply with the euro4, euro5 and euro6 standards. Our device for countries that havent euro 4/5/6 ecologic rules. Adblue remove emulator, stoped the DEF liquid flowing in scr system. Adblue remove emulator sell for countries that havent adblue liquid and use for during the remove faults in adblue systems. This is a personal decision to buy this device. Our company doesnt resposible in any legal problems that groves with this decision.

Figure 32 Urea emulator usage disclaimer

What is the AdBlue?

Diesel exhaust fluid (DEF) is an aqueous urea solution made with 32.5% urea and 67.5% deionized water. It is standardised as AUS 32 (aqueous urea solution) in ISO 22241.[3] DEF is used as a consumable in selective catalytic reduction (SCR) in order to lower NOx concentration in the diesel exhaust emissions from diesel engines.

Euro 6 AdBlue Remover Advantages;

-Prevent all AdBlue system faults

-You don’t need AdBlue fuel

-You don’t get and AdBlue or NOx fault

-Prevent torque loss

Importance of Euro6 AdBlue Emulator

Trucks generally give AdBlue or NOx system faults so working hard. Your truck may loss torque so some AdBlue faults or fault lamps.

These problems cause you to lose money and time. After the installation AdBlue remove emulator, you don’t get another AdBlue faults

and you don’t need add AdBlue fuel. After the installation, your AdBlue fuel level will up automatically.

AdBlue Remove emulator disable these systems

- AdBlue system (All)

- AdBlue Pump

- AdBlue NOX sensor

- DPF system

- DPF temperature sensor

- DPF regeneration

The urea emulator used in this project has the following pinout:

- Power
- GND
- Can High 0
- Can Low 0
- Pressure signal
- Pump control signal

Figure 33 Adblue (SCR) emulator pinout

Attention!: When you connect an adblue emulator to the truck, in some situations the truck may give an error code. Thus, you have to delete an error code by using diagnostic tools after that you connect an adblue emulator to the truck.

You should definitely cancel the DPF after installing the Adblue removal emulator.(?)

Figure 34 Urea emulator installation disclaimers

On the urea emulator supplier website, there are different urea emulators which works with different procedures depending on model or vehicle manufacturer:

https://www.canbusemulator.com/en/euro-6-adblue-scr-emulator

Annex III: Instrumentation Pictures

This Annex contains 2 pages.

ANNEX III: Pictures of the instrumentation

1. The following picture shows the urea emulator installed in the vehicle:

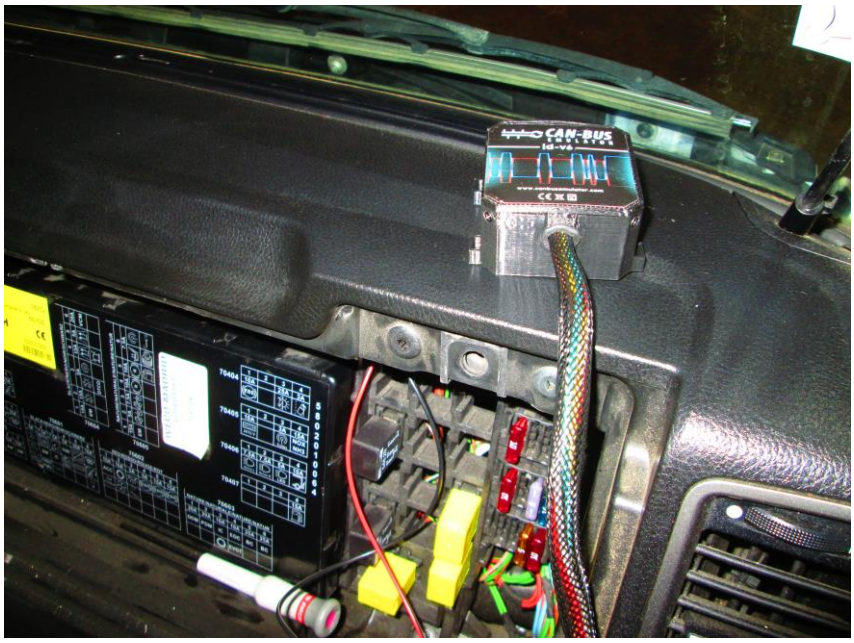

Figure 35 Urea emulator installed in the vehicle

2. The following picture shows the current ring installed for measuring the Urea Injector Current:

Figure 36 Current ring installed

3. The following picture shows INCA devices, OBD connectors, the canalyzer and laptops used for the measurements.

Figure 37 INCA devices, OBD connectors, canalyzer and laptops used

4.The following picture shows the flowmeter and the pressure transducer for measuring Urea mass flow and Urea line pressure respectively:

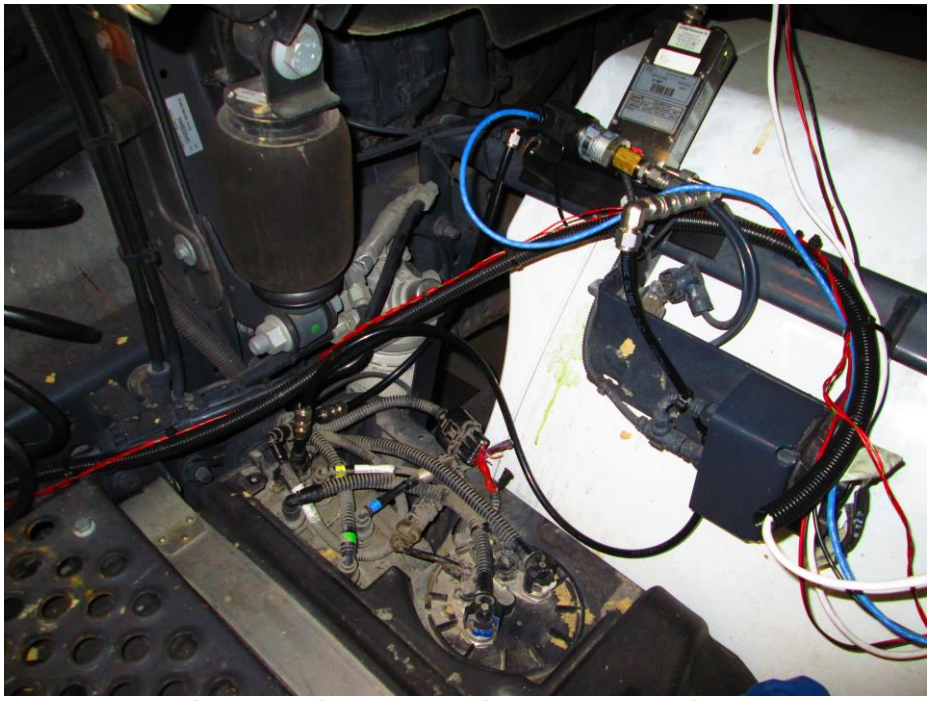

Figure 38 Flowmeter and pressure transducer

Annex IV: Index of tables and figures

This annex contains 2 pages.

ANNEX IV: Index of tables and figures

Tables:

Figures: