CAN bus multiconverter DS480 / DS481

CAN-convenience, CAN-powertrain,
CAN-tacho, CAN-FMS (SAE J1939),
CAN-EOBD, CAN-ISO11992
SAE J1708/J1587

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FMS (SAE J1939)
(CAN, RS232-UART, RS232-3.3V)

ver. 0.04

The purpose of this document is to present the features, the installation procedure and configuration of the DS480/DS481 multiconverter.

1. Basic information

1.1. DS480 /DS481 multiconverter is the device intended for reading data from various in-vehicle CAN bus and J1708/J1587 networks, converting the acquired data and sending them in the FMS (SAE J1939) format via dedicated CAN-bus (noted CAN1) to any telemetric (logistical) GSM/GPS system with FMS CAN input. The device can simultaneously acquire data from 3 CAN bus networks, noted CAN2, CAN3, CAN4 on schematic diagram.
The optional method of access to the acquired data is the Digital Systems proprietary CAN2RS protocol. With this protocol, the data is read via RS232 interface with RS232 (UART) levels or with 3.3V logic levels.
Moreover, the DS481 can control the vehicle by sending CAN bus data to convenience CAN bus. In the DS480, for security reasons, the CAN bus command sending is disabled.

1.2. The device handles data from manufacturer-specific CAN bus networks of more than 450 vehicles (concerning the convenience CAN bus and powertrain CAN bus)

1.3. The device allows reading data from EOBD CAN bus (European On board Diagnosis) in the vehicle diagnostic socket. The OBD CAN bus is currently obligatory in the US / EU vehicles.

1.4. The device allows reading data from SAE J1939 / FMS (Fleet Management System) / tachograph CAN bus.

1.5. The device can read data from ISO 11992 CAN-bus, which is the protocol oriented for connecting truck and trailer or connecting bodybuilder applications with the Mercedes-Benz vehicles

1.6 The example of acquiring data simultaneously from 3 CAN buses is the Iveco Daily van:
  - CAN2 acquires from convenience CAN the information concerning RPM, fuel level, door switches status, locking/unlocking with OEM remote, ignition status.
  - CAN3 acquires from EOBD CAN: VIN (vehicle identification number), engine temperature and engine load.
  - CAN4 acquires from CAN-SAEJ1939 tachograph data.

1.7. The list of compatible vehicles and the information on the acquired data is presented on the dedicated web site of the manufacturer.

1.8. DS480/DS481 is intended for installation in the vehicles with 12V or 24V power supply.

1.9. The programming and configuration of the DS480/DS481 is done by the USB interface with the dedicated PC software. The software works on Windows 98, Windows XP, Windows 7, Windows Vista without need to install any drivers. The software allows visualizing of signals and data acquired by the device.

2. The data being sent on CAN1 in the FMS (SAE J1939) format.

2.1. The CAN1-FMS output data are being sent as long as the CAN bus data is received on any of vehicle CAN buses (CAN2/CAN3/CAN4). If the received CAN bus traffic stops (the vehicle goes into standby mode), the DS480/DS481 stops transmitting FMS data on CAN1-FMS after few hundred milliseconds.

Basic vehicle data - acquired from various CAN and J1708/J1587 buses.

Data name / physical quantity	FMS parameter and frame
Vehicle wheel speed	SPN1624/ TCO1
Engine speed	SPN190 / EEC1
Engine coolant temperature	SPN110 / ET1
Accelerator pedal position	SPN91 / EEC2
Engine Load	SPN92 / EEC2
Fuel Level	SPN96/DD
Total Vehicle Distance	SPN917 / VDHR
Ambient Air Temperature	SPN171/ AMB
VIN (vehicle identification number)	SPN237/ VI

Extended set of vehicle data - acquired from CAN SAE J1939 (FMS)

Data name	Physical quantity	Nazwa parametru i ramki FMS
TachoOverspeed	Vehicle overspeeds tacho limit	SPN1614/ TCO1
TachoDirection	Vehicle direction (forward/reverse)	SPN1619/ TCO1
TachoMotion	Vehicle is in motion	SPN1611/ TCO1
TachoDrv1WorkingState	Driver No1 status (drive/work/rest...)	SPN1612/ TCO1
TachoDrv2WorkingState	Driver No2 status (drive/work/rest...)	SPN1613/ TCO1
TachoDrv1Card	Driver No1 card is present	SPN1615/ TCO1
TachoDrv2Card	Driver No2 card is present	SPN1616/ TCO1
TachoDrv1Time	Driver No1 work time (number of hours left)	SPN1618/ TCO1
TachoDrv2Time	Driver No2 work time (number of hours left)	SPN1619/ TCO1
TachoPerformance	Tachograph performance analysis	SPN1620/ TCO1
TachoHandling	Tachograph - handling is required (e.g. no paper)	SPN1621/ TCO1
TachoSystemEvent	Tachograph - system event (e.g. failure)	SPN1622/ TCO1
PTOstate	Power Take-off status (engine powered devices)	SPN 976 / CCVS
PTOengaged	At least 1 PTO is enabled	SPN3948/ PTODE
ClutchSwitch	Clutch is pressed	SPN 598 / CCVS
BrakeSwitch	Brake is pressed	SPN 597 / CCVS
CruiseControlSwitch	Cruise Control is Enabled	SPN 595 / CCVS
TotalFuelUsed	Total amount of fuel used by the vehicle	SPN250 / LFC1
HR_TotalFuelUsed	High resolution of total fuel used.	SPN5054/ HRLFC
EngineTotalHrs	Total amount of hours of vehicle work	SPN247 / HOURS
ServiceDistance	Distance to next vehicle Inspection/service	SPN914 / SERV
AxleWeight [4]	The weight on vehicle axes.	SPN582 / VW
FMS_SWtruck[2]	FMS software version concerning trucks	SPN2806/ FDD1
FMS_SWbus[2]	FMS software version concerning buses	SPN2805/ FDD1
FMS_SWreqsupp	Does FMS gate support "requests"?	SPN2804/ FDD1
FMS_SWdiagsupp	Does FMS gate support diagnostic information?	SPN2803/ FDD1
FuelRate	Fuel consumption - litres / hours	SPN183/ LFE
InstanousFuelEconomy	Fuel consumption - km/liter	SPN184/ LFE

2.2 The format of CAN output data is SAE J1939 (CAN 2.0B, 29-bit message identifiers, 250kB/s). The data being sent is the subset of J1939, described in the FMS (Fleet Management Systems) document for trucks: "*FMS-Standard Interface description Vers. 02.00*", as of date 11.09.2010.

The following FMS 2.0 for trucks CAN frames are being sent:

CAN frame identificator	FMS frame name	FMS frame acronym
0x00F00400	Electronic Engine Controller #1	EEC1
0x00F00300	Electronic Engine Controller #2	EEC2
0x00FEEE00	Engine Temperature 1	ET1
0x00FEFC00	Dash Display	DD
0x00FEC100	High Resolution Vehicle Distance	VDHR
0x00ECFF00 0x00EBFF00	Vehicle Identification	VI
0x00FEF100	Cruise Control/Vehicle Speed	CCVS
0x00FEE900	Fuel Consumption	LFC
0x00FD0900	High Resolution Fuel Consumption	HRLFC
0x00FEEA00	Vehicle Weight	VW
0x00FEE500	Engine Hours, Revolutions	HOURS
0x00FEC000	Service Information	SERV
0x00FE6C00	Tachograph	TCO1
0x00FEF500	Ambient Conditions	AMB
0x00FEF200	fuel economy	LFE
0x00FDD100	FMS-standard Interface	FMS
0x00FDA400	PTODE frame	PTODE

2.3. As the FMS standard for trucks does not cover information on
- status of door switches
- status of vehicle central door locking / vehicle lock with OEM remote signals and status
- status of engine ECU MIL (Malfunction Indicator Lamp)
- hazard lights status,
the information presented above is being sent via 3 frames from FMS for buses standard.
according to "*Bus FMS-Standard Interface description Vers. 00.02*" as of date 07.07.2009.

CAN frame identificator	FMS frame name	FMS frame acronym
0x00FE4E00	Door Control 1	DC1
0x00FDA500	Door Control 2	DC2
0x00FD7D00	FMS Tell Tale Status	FMS1

Due to atypical approach, the details of these frames and mapping of specified vehicle data on bus FMS frames will be precisely described below.

Door Control 1: DC1

PGN Hex	00FE4E	
PGN	65,102	
Rep. Rate	100 ms	

	Data Byte 1	Data Byte 2	Data Byte 3	Data Byte 4	Data Byte 5	Data Byte 6	Data Byte 7	Data Byte 8
Bit No.	8 7 6 5 4 3 2 1							
Name / values	**SPN 1821** — Position of doors: 0000 = at least 1 door is open; 0001 = closing last door; 0010 = all doors closed; 0011-1101 not defined; 1110 = Error; 1111 = not available. **SPN 1820** — Ramp/Wheel chairlift: 00 = inside bus; 01 = outside bus; 10 = Error; 11 = not available. **SPN 3411** — Status 2 of doors: 00 = all bus doors disabled; 01 = at least 1 bus door enabled; 10 = error; 11 = not available	Not used in Bus-FMS-Standard	Not used in Bus-FMS-Standard	Not used in Bus-FMS-Standard	Not used in Bus-FMS-Standard	Not used in Bus-FMS-Standard	Not used in Bus-FMS-Standard	Not used in Bus-FMS-Standard

Description acc. SAE J1939:

Status 2 of doors: Composite indication of all bus door statuses. Enabled means the bus doors are able to be automatically opened or closed.

Ramp/Wheel Chair Lift Position: Signal which indicates the actual position of the ramp / wheel chair lift.

Position of Doors: Signal which indicates the actual position of the doors.

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the following assumptions of data mapping has been made:

1. Status2 = 00   the vehicle is locked with OEM remote control

   Status2 = 01   the vehicle is unlocked with OEM remote control

2. Position of Doors = 0000   at least 1 door, trunk or bonnet is opened

   Position of Doors = 0010   all door, trunk and bonnet is locked

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Door Control 2: DC2

PGN Header: **00FDA5** PGN: **64,933** Rep. Rate: **100 ms**

Data Byte	Field (SPN)	Name	Value mapping
Data Byte 1	SPN 3412	Lock Status Door 1	00 = Unlocked, 01 = Locked, 10 = Error, 11 = Not available
	SPN 3413	Open Status Door 1	00 = Closed, 01 = Open, 10 = Error, 11 = Not available
	SPN 3414	Enable Status Door 1	00 = Disabled, 01 = Enabled, 10 = Error, 11 = Not available
	SPN 3415	Lock Status Door 2	00 = Unlocked, 01 = Locked, 10 = Error, 11 = Not available
Data Byte 2	SPN 3416	Open Status Door 2	00 = Closed, 01 = Open, 10 = Error, 11 = Not available
	SPN 3417	Enable Status Door 2	00 = Disabled, 01 = Enabled, 10 = Error, 11 = Not available
	SPN 3418	Lock Status Door 3	00 = Unlocked, 01 = Locked, 10 = Error, 11 = Not available
	SPN 3419	Open Status Door 3	00 = Closed, 01 = Open, 10 = Error, 11 = Not available
Data Byte 3	SPN 3420	Enable Status Door 3	00 = Disabled, 01 = Enabled, 10 = Error, 11 = Not available
	SPN 3421	Lock Status Door 4	00 = Unlocked, 01 = Locked, 10 = Error, 11 = Not available
	SPN 3422	Open Status Door 4	00 = Closed, 01 = Open, 10 = Error, 11 = Not available
	SPN 3423	Enable Status Door 4	00 = Disabled, 01 = Enabled, 10 = Error, 11 = Not available
Data Byte 4	SPN 3424	Lock Status Door 5	00 = Unlocked, 01 = Locked, 10 = Error, 11 = Not available
	SPN 3425	Open Status Door 5	00 = Closed, 01 = Open, 10 = Error, 11 = Not available
	SPN 3426	Enable Status Door 5	00 = Disabled, 01 = Enabled, 10 = Error, 11 = Not available
	SPN 3427	Lock Status Door 6	00 = Unlocked, 01 = Locked, 10 = Error, 11 = Not available
Data Byte 5	SPN 3428	Open Status Door 6	00 = Closed, 01 = Open, 10 = Error, 11 = Not available
	SPN 3429	Enable Status Door 6	00 = Disabled, 01 = Enabled, 10 = Error, 11 = Not available
	SPN 3430	Lock Status Door 7	00 = Unlocked, 01 = Locked, 10 = Error, 11 = Not available
	SPN 3431	Open Status Door 7	00 = Closed, 01 = Open, 10 = Error, 11 = Not available
Data Byte 6	SPN 3432	Enable Status Door 7	00 = Disabled, 01 = Enabled, 10 = Error, 11 = Not available
	SPN 3433	Lock Status Door 8	00 = Unlocked, 01 = Locked, 10 = Error, 11 = Not available
	SPN 3434	Open Status Door 8	00 = Closed, 01 = Open, 10 = Error, 11 = Not available
	SPN 3435	Enable Status Door 8	00 = Disabled, 01 = Enabled, 10 = Error, 11 = Not available
Data Byte 7	SPN 3436	Lock Status Door 9	00 = Unlocked, 01 = Locked, 10 = Error, 11 = Not available
	SPN 3437	Open Status Door 9	00 = Closed, 01 = Open, 10 = Error, 11 = Not available
	SPN 3438	Enable Status Door 9	00 = Disabled, 01 = Enabled, 10 = Error, 11 = Not available
	SPN 3439	Lock Status Door 10	00 = Unlocked, 01 = Locked, 10 = Error, 11 = Not available
Data Byte 8	SPN 3440	Open Status Door 10	00 = Closed, 01 = Open, 10 = Error, 11 = Not available
	SPN 3441	Enable Status Door 10	00 = Disabled, 01 = Enabled, 10 = Error, 11 = Not available
		Not defined	
		Not defined	

Remark:

Lock Status:
- locked -> doors cannot be operated by the driver or a passenger
- unlocked -> door may be operated by the driver or a passenger

Enable Status:
- disabled -> door cannot be opened by a passenger
- enabled -> door can be opened by a passenger

Open Status:
- closed -> door is completely closed
- open -> door is not completely closed

the following assumptions of data mapping has been made:

1. Lock Status = 00 / Enable Status=01 — the vehicle is locked with OEM remote control
   Lock Status = 01 / Enable Status=00 — the vehicle is unlocked with OEM remote control
2. Open Status = 01 — the given door, trunk or bonnet is opened (the switch is opened)
   Open Status = 02 — the given door, trunk or bonnet is closed (the switch is closed)
3. Door1 - door FL, Door2 - door FR, Door3 - door RL, Door4 - door RR, Door5 - trunk, Door6 - bonnet.
4. The signal of Door7 is being sent as "opened" when OEM alarm triggering is detected by the DS480/DS481.
5. If the vehicle trunk is opened by 3rd button on OEM remote, the LockStatus and Enable Status of door No5 (trunk) is changed. Moreover, in VAN vehicles, the Lock Status and Enable status of left and right rear doors (3 and4) is changed.

FMS Tell Tale Status : FMS1

	PGN Hex	PGN	Rep. Rate
	00FD7D	64,893	1000 ms

Byte No.	Bit No. 8 7 6 5 4 3 2 1	Name / values
Data Byte 1	(bits 8–7)	Not defined (set to "1")
Data Byte 1		Telltale Block ID — see table for Block ID and Telltale ID; 1111 = don't care
Data Byte 1		Telltale Status 1: 000 = off, 001 = Cond. Red, 010 = Cond. Yellow, 011 = Cond. Info, 100–110 = Reserved, 111 = not available
Data Byte 2		Not defined (set to "1")
Data Byte 2		Telltale Status 3: 000 = off, 001 = Cond. Red, 010 = Cond. Yellow, 011 = Cond. Info, 100–110 = Reserved, 111 = not available
Data Byte 2		Telltale Status 2: 000 = off, 001 = Cond. Red, 010 = Cond. Yellow, 011 = Cond. Info, 100–110 = Reserved, 111 = not available
Data Byte 3		Not defined (set to "1")
Data Byte 3		Telltale Status 5: 000 = off, 001 = Cond. Red, 010 = Cond. Yellow, 011 = Cond. Info, 100–110 = Reserved, 111 = not available
Data Byte 3		Telltale Status 4: 000 = off, 001 = Cond. Red, 010 = Cond. Yellow, 011 = Cond. Info, 100–110 = Reserved, 111 = not available
Data Byte 4		Not defined (set to "1")
Data Byte 4		Telltale Status 7: 000 = off, 001 = Cond. Red, 010 = Cond. Yellow, 011 = Cond. Info, 100–110 = Reserved, 111 = not available
Data Byte 4		Telltale Status 6: 000 = off, 001 = Cond. Red, 010 = Cond. Yellow, 011 = Cond. Info, 100–110 = Reserved, 111 = not available
Data Byte 5		Not defined (set to "1")
Data Byte 5		Telltale Status 9: 000 = off, 001 = Cond. Red, 010 = Cond. Yellow, 011 = Cond. Info, 100–110 = Reserved, 111 = not available
Data Byte 5		Telltale Status 8: 000 = off, 001 = Cond. Red, 010 = Cond. Yellow, 011 = Cond. Info, 100–110 = Reserved, 111 = not available
Data Byte 6		Not defined (set to "1")
Data Byte 6		Telltale Status 11: 000 = off, 001 = Cond. Red, 010 = Cond. Yellow, 011 = Cond. Info, 100–110 = Reserved, 111 = not available
Data Byte 6		Telltale Status 10: 000 = off, 001 = Cond. Red, 010 = Cond. Yellow, 011 = Cond. Info, 100–110 = Reserved, 111 = not available
Data Byte 7		Not defined (set to "1")
Data Byte 7		Telltale Status 13: 000 = off, 001 = Cond. Red, 010 = Cond. Yellow, 011 = Cond. Info, 100–110 = Reserved, 111 = not available
Data Byte 7		Telltale Status 12: 000 = off, 001 = Cond. Red, 010 = Cond. Yellow, 011 = Cond. Info, 100–110 = Reserved, 111 = not available
Data Byte 8		Not defined (set to "1")
Data Byte 8		Telltale Status 15: 000 = off, 001 = Cond. Red, 010 = Cond. Yellow, 011 = Cond. Info, 100–110 = Reserved, 111 = not available
Data Byte 8		Telltale Status 14: 000 = off, 001 = Cond. Red, 010 = Cond. Yellow, 011 = Cond. Info, 100–110 = Reserved, 111 = not available

Annotations:

Tell Tale Status:

The Tell Tale Status information is derived from information displayed to the driver's dashboard.

The tell tale number is related to the description in the ISO 7000 document.

The not related to ISO 7000 is stated with "no" (Telltale ID 36-41).

TellTale ID 42-45 is reserved

There are three possible conditions stated: Red ("R"), Yellow ("Y"), Info ("I"). The interpretation of the status is manufacturer dependant and might be different.

For details please refer to the manufacturers' document.

The symbols used in the dash display of each manufacturer might vary from ISO symbols.

Additional comment:

see example in 2.3

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the following assumptions of data mapping has been made:

1. Check Engine / MIL   *as: Engine Emission System failure,*   Block ID = 2, Telltale Status 4, Condition 000/010 (Yellow)
2. Ignition ON   *as: Engine,*   Block ID = 1, Telltale Status 3, Condition 000/011   (Info)
3. *Direction indicators*   *as: Turn signals,*   Block ID = 0, Telltale Status 4, Condition 000/011 (Info)
4. Hazard lights   *as: Hazard warning,*   Block ID = 0, Telltale Status 5, Condition 000/011 (Info)

Telltale identificators:

Block ID	Telltale Status	Telltale ID	ISO No.	Name
0	1	1	27	Cooling air conditioning
0	2	2	82	High beam, main beam
0	3	3	83	Low beam, dipped beam
0	4	4	84	Turn signals
0	5	5	85	Hazard warning
0	6	6	100	Provision for the disabled or handicapped persons
0	7	7	238	Parking Brake
0	8	8	239	Brake failure/brake system malfunction
0	9	9	242	Hatch open
0	10	10	245	Fuel level
0	11	11	246	Engine coolant temperature
0	12	12	247	Battery charging condition
0	13	13	248	Engine oil
0	14	14	456	Position lights,side lights
0	15	15	633	Front fog light
1	1	16	634	Rear fog light
1	2	17	637	Park Heating
1	3	18	640	Engine
1	4	19	717	Service, call for maintenance
1	5	20	1168	Transmission fluid temperature
1	6	21	1396	Transmission failure/malfunction

Block ID	Telltale Status	Telltale ID	ISO No.	Name
1	7	22	1407	Anti-lock brake system failure
1	8	23	1408	Worn brake linings
1	9	24	1422	Windscreen washer fluid/windshield washer fluid
1	10	25	1434	Tire failure/malfunction
1	11	26	1603	Malfunction/general failure
1	12	27	2426	Engine oil temperature
1	13	28	2427	Engine oil level
1	14	29	2429	Engine coolant level
1	15	30	2440	Steering fluid level
2	1	31	2441	Steering failure
2	2	32	2461	Height Control (Levelling)
2	3	33	2574	Retarder
2	4	34	2596	Engine Emission system failure
2	5	35	2630	ESP indication
Non ISO Symbols				
2	6	36	no	Brake lights
2	7	37	no	Articulation
2	8	38	no	Stop Request
2	9	39	no	Pram request
2	10	40	no	Bus stop brake
2	11	41	no	Ad blue level

3. Connection of DS480/DS481 to the vehicle

3.1. The DS480/DS481 has 3 CAN buses for connecting with the vehicle networks : CAN2, CAN3, CAN4. Every of them can be connected to CAN-EOBD, CAN-tacho/FMS/J1939 or powertrain CAN.

3.2. For every of DS480/DS481 CAN bus, the so-called CAN-level must be configured. The selection of "CAN-level" chooses the method of acquiring data from the vehicle - bus speed, format of data, frame identifiers etc. Different Levels are dedicated for various vehicle models. The method of device configuration is described in further part of this document.

3.3. The DS480/DS481 CAN2-bus is dedicated for connecting vehicle convenience CAN bus integrating vehicle body ECUs, responsible for e.g. central door locking, OEM remote etc. Connection diagram of DS480/DS481 to convenience CAN of given vehicle is the same as connection of Vehicle Security System and is provided for certified installers by Digital Systems.

3.4. On some vehicles, despite CAN2-bus, there is a need to connect 1/2 analogue lines to distinguish between locking and unlocking vehicle with OEM remote and locking/unlocking with e.g. mechanical key. These vehicles (e.g. Renault Clio, Mazda 3, Nissan Quashquai) are noted by a mark sign in the column "*CAN+Analogue Lock status*" , on the vehicle list supported by Digital Systems. The wiring diagrams for such vehicles include connections to icons: *Status1* and *Status3*. The *Status1* wire is blue and *Status3* wire is white.

3.5. On some vehicles, the acquisition of vehicle data requires connecting of CAN bus other than convenience CAN - usually it is the high-speed powertrain CAN. These vehicles are described on the vehicle list by two CAN-bus levels: the first one of them is for DS480/DS481 CAN2, the second one is for DS480/DS481 CAN3. For such vehicles, the additional connection diagrams are provided.

3.6. The connection to EOBD CAN-bus should be done in EOBD socket, pin 6 and pin 14. The DS480/DS481 acquires data from the vehicle on the same polling principle as OEM vehicle EOBD tester: it polls the vehicle for necessary vehicle data. If the DS480/DS481 detects that real EOBD tester is connected to the vehicle, it stops polling, in order not to mess with the OEM tester communication. As a consequence - there can be a temporary lack of access to vehicle data acquired from EOBD e.g. when the vehicle is being diagnosed in the workshop service.
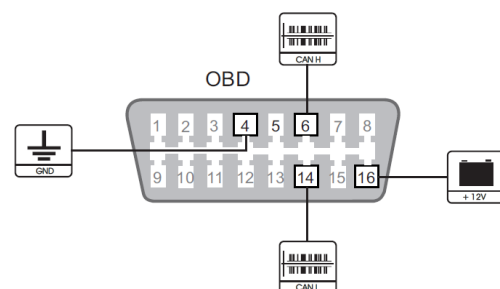
3.7 DS480/DS481 can be connected to any SAE J1939 compliant CAN-bus (usually a tachograph or FMS (Fleet Management System) CAN-bus. The device can also be connected to a few J1939 compliant CAN buses in case when every of the vehicle J1939 buses contains only a unique subset of data. In such case, the DS480/DS481 acquires data from 2-3 J1939 CAN buses and transmits the data via FMS protocol on CAN1-bus

WARNING!
   The convenience CAN should always be connected to CAN2
   If the convenience CAN is connected to CAN2, the other CAN-buses should be connected to CAN3 or CAN4.
   If the convenience CAN is not connected, other vehicle CAN buses can be connected to any CAN2/CAN3/CAN4 CAN-buses of DS480/DS481.

4. Configuration and testing of the DS480/DS481

4.1. In order to acquire the data properly, the DS480/DS481 has to be configured with a dedicated PC software. The software works on Windows 98, Windows XP, Windows 7, Windows Vista without the need to install any drivers. The device is connected to the PC with the miniUSB cable.

4.2. If the program is started and the DS480/DS481 is connected, the upper part of the software panel shows the 4 controls to set so-called "CAN-levels" - the methods of CAN-bus operation and data acquisition for all the CAN1/CAN2/CAN3/CAN4 interfaces of DS480/DS481. **The level 140 should be chosen for CAN1, in order to enable sending acquired data in FMS format data on CAN1.** The CAN2, CAN3 and CAN4 levels depend on the vehicle mark model, and required set of data. The CAN levels (for convenience or powertrain CAN) are presented on the vehicle list and on the vehicle specific CAN wiring diagrams.

Special CAN levels

CAN level	Description
111	selects the EOBD mode (connection the vehicle diagnostic socket)
88	selects the acquisition of data from any SAE J1939 bus (FMS, tachograph etc.)
137	selects the acquisition of data from SAE J1939, with calculation of *total fuel level used* as the sophisticated integration of momentary fuel consumption - the level is intended for SAE J1939 compliant technical objects without access to fuel level and fuel amount used data, but with momentary fuel consumption.
140	Enables transmission (sending) of the acquired data ("output data" dataset as SAE J1939 FMS CAN bus frames on CAN1 of the DS480/DS481.
146	selects the acquisition of data from SAE J1939 bus (FMS, tachograph etc.) in case the vehicle has the dedicated output (gateway) for telemetric system and the DS480/DS481 would be the only device connected to that CAN access point. In such case the DS480/DS481 must acknowledge its presence on the bus. On "normal" FMS levels, the DS480/DS481 is in "listen-only" stealth mode and does not acknowledge its presence on the bus.
148	selects the acquisition of data from ISO11992 CAN-bus connecting track and trailer or used as a CAN bus for connecting bodybuilder solutions to the Mercedes vehicles.

PC software operation panel:

4.3. The PC software has 2 tools to check if the DS480/DS481 acquires data correctly from the vehicle: the *Signal Monitor* and *Diagnostic Data Monitor*.

4.4. The *Signal Monitor* displays the signals, which are mostly read from the convenience CAN bus: Locking/unlocking the vehicle with OEM remote, detection of OEM alarm triggering, vehicle LockState, door open signals, trunk and bonnet open signals, ignition switch status read from CAN bus, ignition switch status considering both CAN signals and analogue ignition input, hazard lights status, additional analogue lines status, signals confirming cenvenience CAN2 bus vehicle control (*SEND_*...), detection of vehicle engine ECU MIL (Malfunction Indicator Lamp - check engine).

4.5. Vehicle Diagnostic Data Monitor shows the values of data currently read from the vehicle CAN buses and the output data - being the selection of data from different sources. The "*Choose data preview*" radiobuttons noted CAN2, CAN3,CAN4 and "Output data" allows selecting which data are presented on the panel (data from acquired from CAN2, from CAN3 or the Output data set). The output dataset is the set of data selected from various data sources - e.g. engine rpm from convenience CAN and the VIN from EOBD CAN. The output data can be transmitted in FMS format via CAN1 or accessed by Digital Systems proprietary CAN2RS protocol via RS232 interface.

In order to configure DS480/DS481, **every necessary output data** (transmitted data e.g. engine RPM) **must be tied to a given input data source**: CAN2/CAN3/CAN4. If the data is not tied - it will not be sent. Choosing of data source can be done if the "Output data" radiobutton is selected. In such case, the small listbox near every data allows choosing the source of data. Setting "-" in the listbox configures that the given data (e.g. engine RPM) will not be sent.

Choosing 2/3/4 configures, that the output value will be taken accordingly from CAN2/CAN3/CAN4.

Example: in the previously described Iveco Daily with tachograph, it must be configured, if the DS480/DS480 should send vehicle speed read from convenience CAN-bus, vehicle speed read by EOBD protocol from connection in diagnostic socket or vehicle speed read from the tachograph.

4.6. **Automatic scale of fuel level: conversion from litres to percentage of the fueltank.**

The FMS standard (SAE J1939) describes fuel level as percent scale of the fuel tank. The DS480/DS481 uses that unit in its output data. However, on some vehicles (e.g. VAG VW/Audi) the unit of fuel level on CAN is litres.

The DS480/DS481 automatically checks and saves, every 60 seconds, maximum value of fuel level in litres in non-volatile memory of the device

If in the period between these checks, the current fuel level read from CAN extends the maximum value, the highest non-error value specified in FMS is being sent (102%). After the new maximum is saved, the percent level of 100% is being sent.

To sum up: in the vehicles which sent fuel level in litres on CAN, even if we do not knop the fuel tank capacity, it is enough to top-up the fuel tank after installation to callibrate the litres-to-percent conversion correctly.

If there is a need to re-calibrate the fuel scale conversion, press the "fuel scale reset" button on the PC software panel
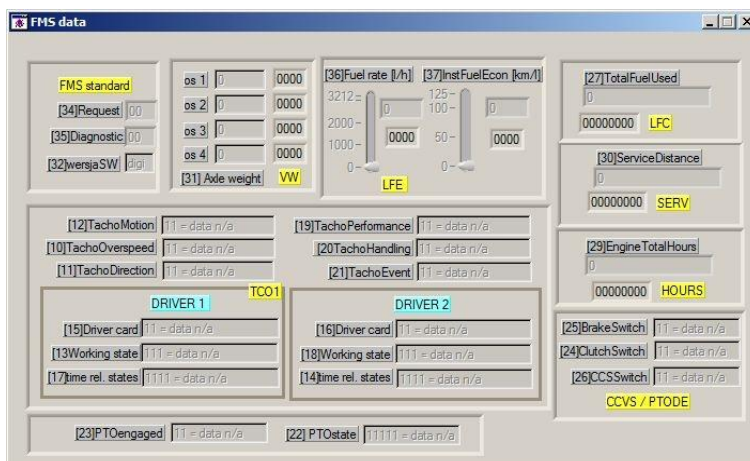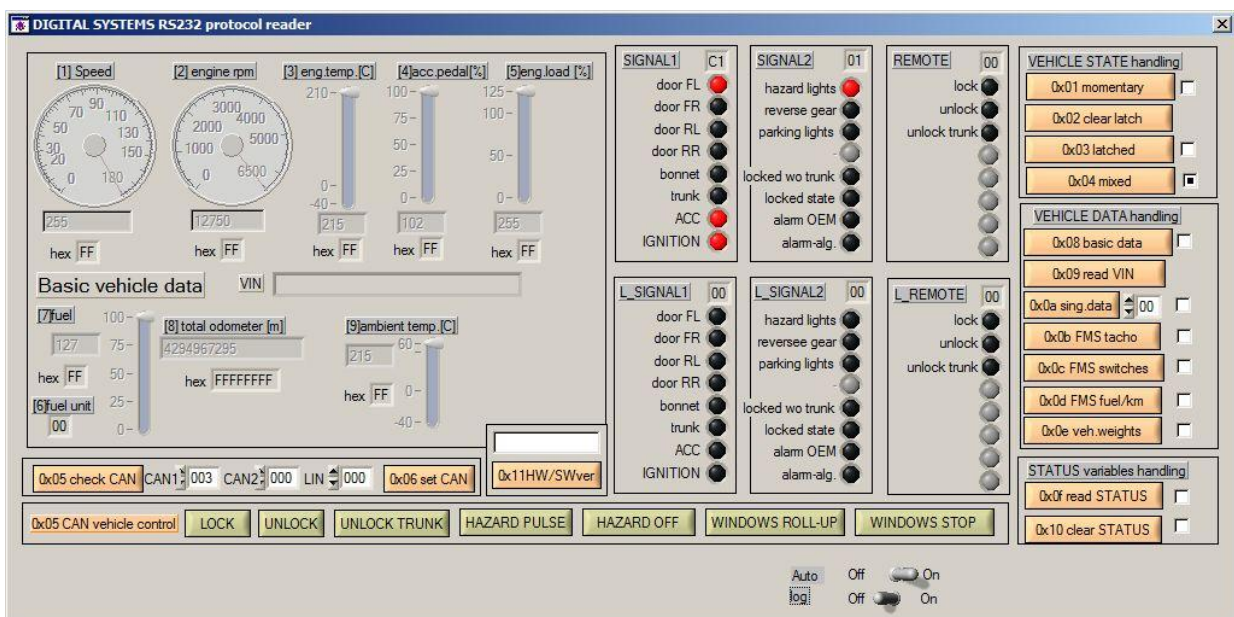
5. Output data reading with CAN2RS protocol

5.1. The device can sent the output data to the telemetric/logistic system via Digital Systems CAN2RS proprietary protocol on RS232 interface (115200baud). The DS480/481 is produced with RS232 interface with standard voltage levels +/-10V. However, on a demand, the device can be produced with the 3.3V logic RS232 interface.

5.2. The white-red wire No.12 in connector 2 (J2-12) is the RS232 Tx (output) line in the DS480/DS481 biało-czerwony nr 12 w złączu 2 (J2-12); The white-black wire No11 in connector 2 (J2-11) is the RS232 Rx (Input) line in the DS480/DS481.

5.3. The CAN2RS protocol is fully described in another document.

5.4 The Digital Systems provides a protocol and dedicated tool - the PC software to communicate with DS480/DS481 by CAN2RS protocol on RS323. It allows to analyse and test the CAN2RS protocol. The man panel of the software and the log with communication between PC and DS480/DS481 are presented below.

6. DS480/DS481 wiring diagram