Interface CAR2FMS v3

Content:

Ing. David Španěl

Mgr. Vítězslav Rejda

CAR2FMS is a device designed for conversion of data from various cars into FMS or concentrated CANLAB format. As input data, you can use 2x input CAN, J1708, digital tachograph info-interface, and two analog inputs. Besides FMS gate function, CAR2FMS serves for DM1 car errors reading, calculation of histograms, and ride statistics for assessment of driving style of a driver.

CAR2FMS can be used for example in following situations:

- Older trucks Volvo and Renault, fuel information is not available at CAN, but at J1708 bus.

- Cars, where it is necessary to read data from two CAN buses, but car GPS unit contains just one CAN bus.

- In cars, where user doesn't know CAN protocol in car and CAR2FMS can convert it into FMS or CANLAB concentrated format.

- In situations, when car CAN unit allows to transmit only limited amount of CAN messages (identificators) or when it doesn't allow to transmit multipacket messages according to SAE J1939.

- In the car, there is no value of fuel level at CAN available, fuel probe is analogue and it leads directly to dashboard.

- Car has additional tank that can be equipped with analog/CAN or RS485 float. CAR2SMS allows sending of data as primary and secondary tank or as one tank with placed volume ratio of both tanks.

- On the tank of the car, there is more accurate CAN fuel probe – its data shall substitute CAN data leading to GPS unit.

- Car contains digital tachograph that is not connected to CAN or doesn't send data about driver´s ID or his set activity to CAN.

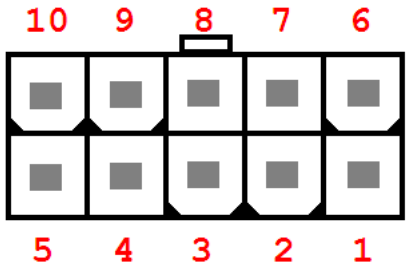
- On the CAN, there is not information about total fuel consumption and consumption per ride, there is only information about fuel flow rate. CAR2FMS allows to count total consumption of fuel per ride.

- When it is necessary to calculate statistics and histograms of a ride.

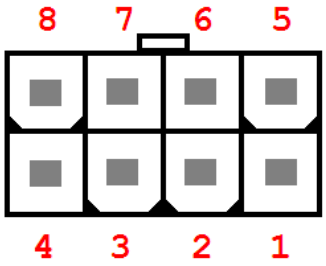
- GPS car units of third parties are used, where it is not possible to add another functionality. We can try to provide required custom-made function using CAR2FMS transducer.

Connector wiring

Pinout is the same as in case of CAR2FMS / CAR2FMS V2.



Pin	Description
1	Power 8..32 V
2	Output – signal switched on (power supply) during tachograph information segment generating at CAN.Signal used for example for preferred data sending from car unit to the server.
3	CAN OUT, high.
4	CAN IN, high.
5	Tachograph GND (pin 6 at tachograph A-connector)
6	Signal 15 (key, ignition). If continuous run required, connect with power.
7	GND
8	CAN OUT, low.
9	CAN IN, low.
10	Tachograph (pin 8, tachograph D-connector).

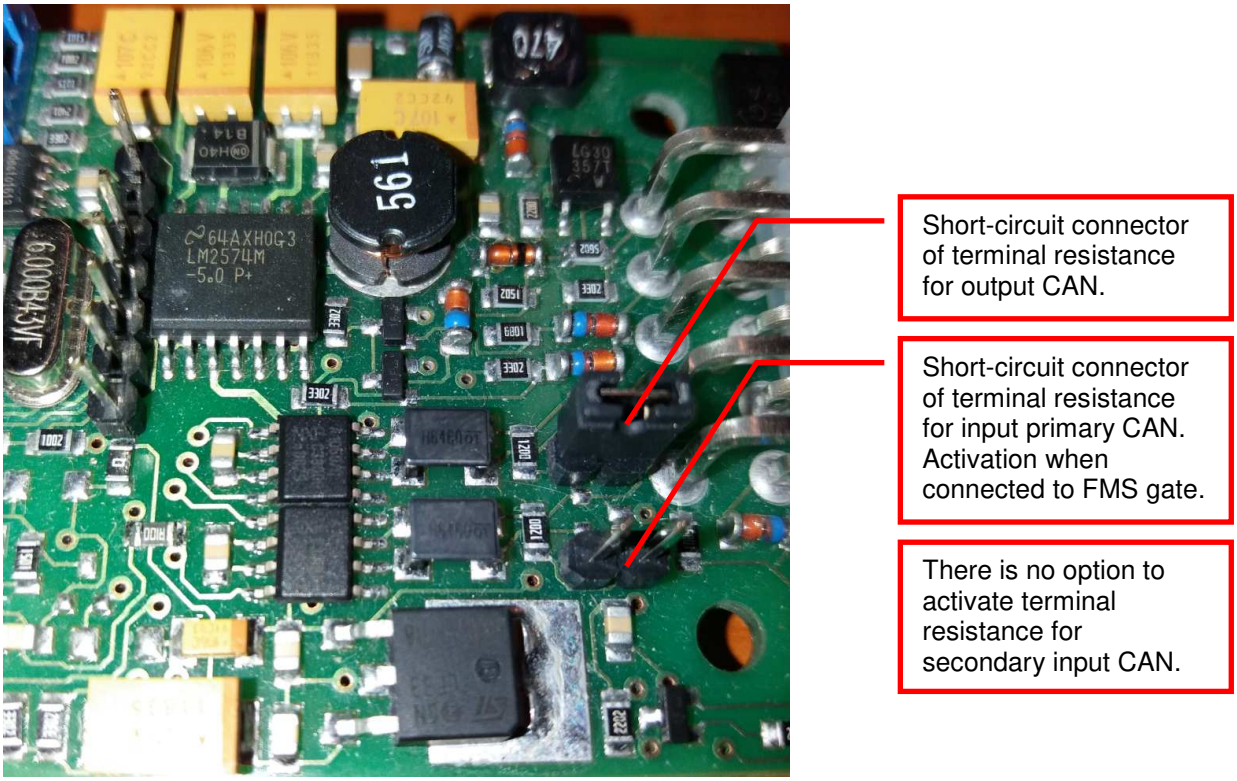


Pin	Description
1	AN 2
2	AN GND
3	CAN IN 2, high
4	J1708 A
5	AN 1
6	AN GND
7	CAN IN 2, low
8	J1708 B

Signal LED

LED	Description
1	Power signalizing.
2	Signalizing incoming data from input CAN 2.
3	Yellow: Signalizing incoming data from input CAN 1. Red: Input CAN 1 error.
4	Yellow: N/A Red: Output CAN error.
5	Yellow: Signalizing incoming data from digital tachograph, pin D8. Red: Incoming data from J1708.
3+4	Simultaneous red flashing of both LED signalizes sending of tachograph information segment to CAN.
3+4	Simultaneous yellow flashing of both LED signalizes reception of configuring parameter from setting plug-in at output CAN.

Terminal resistance



Change of CAR table without configuration plug-in

It is possible to change table for setting type of a car without using configuration plug-in. To set the table it is necessary to set positions 1..5 to OFF (output TCO1 and Driver ID), however it is necessary to activate listen only mode that has no meaning when CAN input is not active. In such situation, value according to 7 and 8 DIP position is set as CAR table. Position 7 and 8 set to OFF sets the first table; when 7 is ON and 8 is OFF, second table is set.
When 7 is OFF and 8 is ON, third table is set. When 7 and 8 are ON, fourth table is set.

DIP setting has to be made before connecting of power / signal 15. After activation of CAR2FMS V3 new table value is set. CAR2FMS function is not activated, only LED 2 periodically flashes, number of flahes corresponds to number of table. Interval is approximately 3 seconds.

Then, it is necessary to disconnect CAR2FMS from power and set DIP according to selected car.

DIP setting

DIP	Description
1	Car type setting
	Table 1
3	***Reverse order to DIP – binary code***
4	**POS 54321**
5	00000 = Only TCO1 and Driver ID outputs (Listen only cannot be set*) 00001 = VW/Škoda before MQB 00010 = VW/Škoda MQB platform 00011 = VW/Škoda MQB CNG platform 00100 = VW/Škoda MQB Audi 00101 = Škoda MQB (secondary CAN for comfort – maintenance interval reading) 00111 = Volvo truck from 2013, secondary CAN 500k also connected 01001 = Citroen Jumper V1 01010 = Citroen Jumper V2 01011 = Ford Transit 2017 01100 = Ford Mondeo 01101 = Ford Transit 2015 01110 = Ford Transit before 2015 01111 = Ford Turneo 10000 = Ford C-Max 10001 = Ford S-Max 10010 = Ford Fusion 10011 = Fiat Ducato/Doblo with Ext ID, also connection of secondary CAN 10100 = Ford Ranger 10101 = Ford Turneo Connect 10110 = Citroen Berlingo 10111 = Peugeot 207 V1 11000 = Peugeot 207 V2 11001= Peugeot 308 V1 11010= Peugeot 308 V2 11011 = Mercedes truck before 2015 11100 = Only Fuel Level (FEFC) output, from CAN/J1708/AN output according to settings 11101 = SAE 1939, 500k 11110 = SAE1939/FMS 250k 11111 = boot mode **Table 2** **POS 54321** 00001 = Hyundai I20 2016 00010 = Hyundai IX35 01000 = Honda Civic 10000 = Nissan 1 – Micra, Note 10001 = Nissan 2 – Primastar, Kubistar 10010 = Nissan 3 – Navara 10011 = Nissan 4 10100 = Nissan 5 – X-Trail

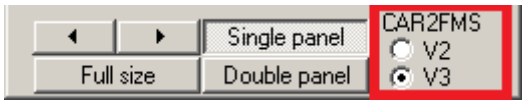
	10101 = Ford Transit 2017 V2 10110 = Renault Megane 2014, Trafic 2015, Scenic 2012 10111 = Renault Escape 2017, Talisman 2016, Megane 2018 11000 = Renault Megane 11001 = Renault Master from 2011 11010 = Renault Master till 2010 V1 11011 = Renault Master till 2010 V2 11100 = Fiat Ducato, Peugeot Boxer 2017, secondary CAN 50k 11101 = Fiat Doblo LS 50 k **Table 3** **POS 54321** 00001 = Chrysler Voyager 00100 = Mazda 01000 = Mercedes Sprinter/VW Crafter 01001 = Mercedes Vito 01010 = Mercedes Sprinter, also secondary CAN 83.3k connected 01011 = Mercedes C180 01100 = Mercedes Sprinter, also secondary CAN 83.3k V2 connected 01101 = Mercedes Vito 2018 / V220 2018 01110 = Mercedes Sprinter 2018 10000 = Opel Movano/Vitaro 250k 10001 = Opel Movano/Vitaro 500k 10010 = Opel Astra J 11000 = Suzuki SX4 11100 = Toyota 11101 = Toyota Auris **Table 4** **POS 54321** 00001 = BMW 500k 00010 = BMW 100k 00011 = IVECO 250k 00100 = IVECO 500k 00011 = Iveco 250k 00100 = Iveco 500k 10000 = SAE 1939, primary 250, secondary 250, both CANs are processed the same way** 10001 = SAE 1939, primary 250, secondary 250, both CANs are processed the same way** 10010 = FENDT 936 Vario, primary 250 engine, secondary 250 comfort (ISO bus) 10011 = Takeuchi 250k 10100 = Kutoba M7171 11000 = Volvo XC90 2013 11001 = Jeep Grand Cherokee 2017 11010 = Volvo XC90 2015 11100 = SAE 1939, 250k, trip fuel from fuel rate***

	11101 = SAE 1939, 500k, trip fuel from fuel rate*** * CAR table change mode ** This mode is utilizable, when there are 2 CAN buses in the car according to J1939 and each of them contains just part of information. In this mode, data is read from both CAN and information is united at output CAN. *** Fuel consumption is counted from fuel rate. Fuel consumption per ride is counted. This information is sent in Fuel Consumption report and High Resolution Fuel Consumption within first 4 bytes that are not used in case of FMS. “Send as total fuel” setting can be used for sending of counted fuel per ride as a whole.
6	Setting of input CAN into Listen only mode.
7	Tachograph type setting. **POS 87** 00-VDO 01-Stoneridge 11- Not connected / configuration via 485

Configuration plug-in

Configuration of parameters and setting of CAR2FMS version 3 transducer is made via new configuration plug-in for CAR2FMS. New version of plug-in 3.XX is compatible with older plug-in version, however, it allows setting of new parameters that are not available in case of older transducer.

In lower part of plug-in you can switch setting of plug-in for V2 version and older and new V3 version.



Switching of CAR2FMS version leads to change of layout and function of some control elements.

There is significant change only in case of calibration of analog inputs that are configured differently. Other functions can be configured also using older version of plug-in, however, it is recommended to always use the most recent version.

In case of J1708 bus significant change has been done. Primary source of information for CAR2FMS is CAN. J1708 interface is always functional within SAE J1939 setting. If an information is accessible at input CAN, this information (*) is sent to output CAN, if this information is not accessible at CAN, but it is accessible at J1708, input J1708 is used as source of information.

Therefore page J1708 in configuration plug-in serves only for verification, which data is accessible at J1708. Change of calculation of statistics is related to that – it is possible to set fuel flow rate at J1708 as source of information about fuel.

* Except for fuel state, when it is possible to set also another source.

Structure of generated multiplexed messages

Besides data in FMS format (or concentrated data), multiplexed data carrying additional information are generated at output CAN.

Within one firmware, CAR2FMS V3 version contains both functions of data output at output CAN, it means FMS mode and concentrator mode. This mode can be set via configuration plug-in. Unlike CAR2FMS V2, it is not necessary to update firmware for change of FMS / concentrator.

At CAN bus, the device generates information from tachograph, statistics, car error codes and other data in the moment of change of this information. For generating, message with PGN FE6B is used. Information is generated in sequence of several of these messages. After generating of fragment of sequence, digital output is activated for short period of time. By connection to digital input, e.g. in case of TELTONIKA device, it is possible to request sending of fragments to server. By this forced sending it is possible to secure transmission of all multiplexed data at devices, where it is possible to set only limited amount of data read from CAN.

Where the device supports reading of driver ID in classic multipacket transmission, this variant of transmission can be also set.

FE6B h							
65131							
Data Byte 1	**Data Byte 2**	**Data Byte 3**	**Data Byte 4**	**Data Byte 5**	**Data Byte 6**	**Data Byte 7**	**Data Byte 8**
Data Marker - Data type - index	Data	Data	Data	Data	Data	Data	Data

Data marker:
It marks type of transmitted data, this type also determines their length (number of CAN segments of messages that shall be connected). It also marks segment index.

Bit 7..5 data type
Bit 4 odd/even sequence, bit changes state in each sequence
Bit 3..0 segment index

Data type:
0: Driver ID
1: Extinfo 1
2: Extinfo 2
3: Extinfo 3
4: DM1

CAR2FMS allows setting of mode, when sequence bit at Driver ID message is extended from one bit to 2. It is suitable e.g. for better connecting of fragments at server. In this mode, Extinfo 1 and Extinfo 2 packets are not supported. For Driver ID, segment index is limited to 3 bits. Extinfo 3 and DM1 packets are not changed.

Data type:
5: Driver ID

Bit 7..5 data type
Bit 4..3 sequence counter
Bit 2..0 segment index

The function is activated by option “Extended sequence number” on the first screen in the setting plug-in.

	Sequence 1 bit	**Sequence number 2 bits**
Driver ID	000A BBBB	101A ABBB
Extinfo 1	001A BBBB	
Extinfo 2	010A BBBB	
Extinfo 3	0110 0000	0110 0000
DM1	100A BBBB	100A BBBB
Stat	11CC CBBB	11CC CBBB

A-sequence number
B-number of fragment/segment
C-histogram/statistics identifier

Data type 0 – Driver ID – CANLAB format

This data type is made of 7 segments

Data Byte 1	**Data Byte 2**	**Data Byte 3**	**Data Byte 4**	**Data Byte 5**	**Data Byte 6**	**Data Byte 7**	**Data Byte 8**
Data Marker - Data type 0 - Index 0	Work states	Driver 1 states	Driver 2 states	Tachograph status	Driver 1 ID length	Driver 1 ID length	Not used (255)
Data Marker - Data type 0 - Index 1	Driver 1 ID, character #1	Driver 1 ID, character #2	Driver 1 ID, character #3	Driver 1 ID, character #4	Driver 1 ID, character #5	Driver 1 ID, character #6	Driver 1 ID, character #7
Data Marker - Data type 0 - Index 2	Driver 1 ID, character #8	Driver 1 ID, character #9	Driver 1 ID, character #10	Driver 1 ID, character #11	Driver 1 ID, character #12	Driver 1 ID, character #13	Driver 1 ID, character #14
Data Marker - Data type 0 - Index 3	Driver 1 ID, character #15	Driver 1 ID, character #16	Driver 1 ID, character #17	Driver 1 ID, character #18	Driver 1 ID, character #19	Driver 1 ID, character #20	Not used (255)
Data Marker - Data type 0 - Index 4	Driver 2 ID, character #1	Driver 2 ID, character #2	Driver 2 ID, character #3	Driver 2 ID, character #4	Driver 2 ID, character #5	Driver 2 ID, character #6	Driver 2 ID, character #7
Data Marker	Driver 2 ID,	Driver 2 ID,	Driver 2 ID,	Driver 2 ID,	Driver 2 ID,	Driver 2 ID,	Driver 2 ID,

- Data type 0 - Index 5	character #8	character #9	character #10	character #11	character #12	character #13	character #14
Data Marker - Data type 0 - Index 6	Driver 2 ID, character #15	Driver 2 ID, character #16	Driver 2 ID, character #17	Driver 2 ID, character #18	Driver 2 ID, character #19	Driver 2 ID, character #20	Not used (255)

Driver 1 ID, character #1 and Driver 2 ID, character #1 can be ignored, character #2 contains country code. For nationality please follow table below. Card code begins from character #3. In some cases, text country code is transmitted on the first three positions. In this case, the character 1 is printable digit.

Austria A (01)H	Iceland IS (1C)H
Albania AL (02)H	Kazakhstan KZ (1D)H
Andorra AND (03)H	Luxembourg L (1E)H
Armenia ARM (04)H	Lithuania LT (1F)H
Azerbaijan AZ (05)H	Latvia LV (20)H
Belgium B (06)H	Malta M (21)H
Bulgaria BG (07)H	Monaco MC (22)H
Bosnia Herzegovina BIH (08)H	Moldova MD (23)H
Belarus BY (09)H	FYROM (Macedonia) MK (24)H
Switzerland CH (0A)H	Montenegro MNE (34)H
Cyprus CY (0B)H	Norway N (25)H
Czech Republic CZ (0C)H	Netherlands NL (26)H
Germany D (0D)H	Portugal P (27)H
Denmark DK (0E)H	Poland PL (28)H
Spain E (0F)H	Romania RO (29)H
Estonia EST (10)H	San Marino RSM (2A)H
France F (11)H	Russia RUS (2B)H
Finland FIN (12)H	Sweden S (2C)H
Liechtenstein FL (13)H	Slovakia SK (2D)H
Faroe Islands FR (14)H	Slovenia SLO (2E)H
United Kingdom UK (15)H	Serbia SRB (35)H
Georgia GE (16)H	Turkmenistan TM (2F)H
Greece GR (17)H	Turkey TR (30)H
Hungary H (18)H	Ukraine UA (31)H
Croatia HR (19)H	Uzbekistan UZ (36)H
Italy I (1A)H	Vatican City V (32)H
Ireland IRL (1B)H	Yugoslavia YU (33)H

Tachograph information structure

Work states

Bit 2..0 :Driver 1 working state

000 = Break/Rest
001 = Driver available
010 = Work
011 = Drive
110 = Error
111 = Not available

Bit 5..3 :Driver 2 working state

000 = Rest
001 = Driver available
010 = Work
011 = Drive
110 = Error
111 = Not available

Bit 7..6 :Driver recognize

00 = Vehicle motion not detected
01 = vehicle motion
10 = Error
11 = Not available

Driver 1 states

Bit 3..0 : Driver 1 time rel states
- 0000 = Normal
- 0001 = 15 min bef. 4 ½ h
- 0010 = 4 ½ h reached
- 0011 = 15 min before warning 1 (9h)
- 0100 = Warning 1 reached
- 0101 = 15 min before warning 2 (16h)
- 0110 = Warning 2 reached
- 1101 = Other
- 1110 = Error
- 1111 = Not available

Bit 5..4 : Driver 1 card
- 00 = Card not present
- 01= Card present
- 10 = Error
- 11 = Not available

Bit 7..6 : Overspeed
- 00 = No overspeed
- 01 = Overspeed
- 10 = Error
- 11 = Not available

Driver 2 states

Bit 3..0 : Driver 1 time rel states
- 0000 = Normal
- 0001 = 15 min bef. 4 ½ h
- 0010 = 4 ½ h reached
- 0011 = 15 min before warning 1 (9h)
- 0100 = Warning 1 reached
- 0101 = 15 min before warning 2 (16h)
- 0110 = Warning 2 reached
- 1101 = Other
- 1110 = Error
- 1111 = Not available

Bit 5..4 : Driver 1 card
- 00 = Card not present
- 01= Card present
- 10 = Error
- 11 = Not available

Bit 7..6 : Overspeed
- 00 = No overspeed
- 01 = Overspeed
- 10 = Error
- 11 = Not available

Tachograph

Bit 0..1 : System event

00 = No tachograph event
01 = Tachograph event
10 = Error
11 = Not available

Bit 2..3 : Handling information

00 = No handling information
01 = Handling information
10 = Error
11 = Not available

Bit 5..4 : Tachograph performance

00 = Normal performance
01 = Performance
10 = Error
11 = Not available

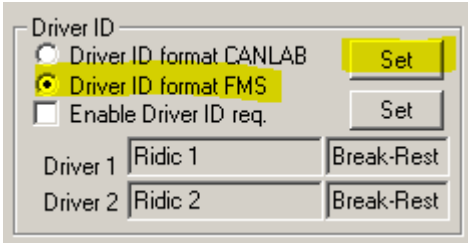
Bit 7..6 : Direction indicator

00 = Forward
01 = Reverse
10 = Error
11 = Not available

Data type 0 – Driver ID – FMS format

This transmission follows the FMS standard documentation. Therefore, single message, if no card is inserted. Multipacket transmission is available, if at least one card is inserted. Each card identification has 17 bytes (numerical one-byte country code + 16 identification bytes). Digit '*' used as separator.

In this mode, Extinfo packets transmission mode is not supported.



Data type 1 – Extinfo 1

Data is generated with 10 seconds period consisted of 3 segments.

Data Byte 1	Data Byte 2	Data Byte 3	Data Byte 4	Data Byte 5	Data Byte 6	Data Byte 7	Data Byte 8
Data Marker	Hours	Minutes	Seconds	Day	Month	Year	Not

- Data type 1 - Index 0							used (255)
Data Marker - Data type 1 - Index 1	RPM 0.125 rpm/bit	RPM	Total vehicle distance 5m/bit	Total vehicle distance	Total vehicle distance	Total vehicle distance	Not used (255)
Data Marker - Data type 2 - Index 2	Tachograph vehicle speed 1/256 km/h / bit	Tachograph vehicle speed	Trip vehicle distance 5m/bit	Trip vehicle distance	Trip vehicle distance	Trip vehicle distance	Not used (255)

Data type 2 – Extinfo 2

Data is generated only after the start of device.

Data Byte 1	**Data Byte 2**	**Data Byte 3**	**Data Byte 4**	**Data Byte 5**	**Data Byte 6**	**Data Byte 7**	**Data Byte 8**
Data Marker - Data type 2 - Index 0	Vehicle REG length	Vehicle REG, character #1	Vehicle REG, character #2	Vehicle REG, character #3	Vehicle REG, character #4	Vehicle REG, character #5	Vehicle REG, character #6
Data Marker - Data type 2 - Index 1	Vehicle REG, character #7	Vehicle REG, character #8	Vehicle REG, character #9	Vehicle REG, character #10	Vehicle REG, character #11	Vehicle REG, character #12	Vehicle REG, character #13
Data Marker - Data type 2 - Index 2	Vehicle REG, character #14	Vehicle REG, character #15	Vehicle REG, character #16	Vehicle REG, character #17	Vehicle REG, character #18	Vehicle REG, character #19	Vehicle REG, character #20
Data Marker - Data type 2 - Index 3	Vehicle ID length	Vehicle ID, character #1	Vehicle ID, character #2	Vehicle ID, character #3	Vehicle ID, character #4	Vehicle ID, character #5	Vehicle ID, character #6
Data Marker - Data type 2 - Index 4	Vehicle ID, character #7	Vehicle ID, character #8	Vehicle ID, character #9	Vehicle ID, character #10	Vehicle ID, character #11	Vehicle ID, character #12	Vehicle ID, character #13
Data Marker - Data type 2 - Index 5	Vehicle ID, character #14	Vehicle ID, character #15	Vehicle ID, character #16	Vehicle ID, character #17	Vehicle ID, character #18	Vehicle ID, character #19	Vehicle ID, character #20
Data Marker - Data type 2 - Index 6	CAR2FMS FW, character #2	CAR2FMS FW, character #3	CAR2FMS FW, character #4	CAR2FMS FW, character #5	CAR2FMS FW, character #6	CAR2FMS FW, character #7	CAR2FMS FW, character #8
Data Marker - Data type 2 - Index 7	Segment period low byte	Segment period high byte	Startup delay	Shutdown delay	DIP	Remove fuel level	Not used (255)
Data Marker - Data type 2 - Index 8	J1708 bit flags	J1708 bit flags	J1708 bit flags	J1708 enabled	Not used (255)	Not used (255)	Not used (255)

Data type 3 – Extinfo 3

This packet can be generated instead of Driver ID if driver's ID is not changed and only mode of his action is changed. Setting of packet generating is made by means of CAN message sent to output CAN.

Data Byte 1	Data Byte 2	Data Byte 3	Data Byte 4	Data Byte 5	Data Byte 6	Data Byte 7	Data Byte 8
Data Marker - Data type 3 - Index 0	Work states	Driver 1 states	Driver 2 states	Tachograph status	Total vehicle distance	Total vehicle distance	Total vehicle distance

Resolution of Total vehicle distance in this packet is not 5 m as in case of Extinfo 1, but is lowered to 250 m.

Data type 4 – DM1

Bit 4..0 segment index (extended of parity bit that is not used). Sending up to 32 error codes is supported. Error codes are saved into internal memory during the ride (CAR2FMS on) and they are transmitted during shut-off after disconnection of signal 15. Each segment contains one error code that consists of several parts.

DM1 message generating must be enabled by configuration plug-in (option Enable DM1).

Data Byte 1	Data Byte 2	Data Byte 3	Data Byte 4	Data Byte 5	Data Byte 6	Data Byte 7	Data Byte 8
Data Marker - Data type 4 - Index n	ECU address	Lamp status	SPN LB	SPN MB	SPN HB	FMI	Bit 0-6 OC Bit 7 Data flag

ECU address:

0 Engine #1	34 Auxiliary Valve Control	66 Ramp Control
1 Engine #2	35 Hitch Control	67 Clutch/Converter Unit
3 Transmission #1	36 Power TakeOff (Front or Secondary)	68 Auxiliary Heater #1
4 Transmission #2	37 Off Vehicle Gateway	69 Auxiliary Heater #2
5 Shift Console - Primary	38 Virtual Terminal (in cab)	70 Engine Valve Controller
6 Shift Console – Secondary	39 Management Computer #1	71 Chassis Controller #1
7 Power TakeOff - (Main or Rear)	40 Cab Display #1	72 Chassis Controller #2
8 Axle - Steering	41 Retarder, Exhaust, Engine #1	73 Propulsion Battery Charger
9 Axle - Drive #1	42 Headway Controller	74 Communications Unit, Cellular
10 Axle - Drive #2	43 On-Board Diagnostic Unit	75 Communications Unit, Satellite
11 Brakes - System Controller	44 Retarder, Exhaust, Engine #2	76 Communications Unit, Radio
12 Brakes - Steer Axle	45 Endurance Braking System	77 Steering Column Unit
13 Brakes - Drive axle #1	46 Hydraulic Pump Controller	78 Fan Drive Controller
14 Brakes - Drive Axle #2	47 Suspension - System Controller #1	79 Seat Control #2
15 Retarder - Engine	48 Pneumatic - System Controller	80 Parking brake controller
16 Retarder - Driveline	49 Cab Controller - Primary	81 thru 127 are reserved for future
17 Cruise Control	50 Cab Controller - Secondary	assignment by SAE
18 Fuel System	51 Tire Pressure Controller	248 File Server / Printer
19 Steering Controller	52 Ignition Control Module #1	249 Off Board Diagnostic-Service Tool #1
20 Suspension - Steer Axle	53 Ignition Control Module #2	250 Off Board Diagnostic-Service Tool #2
21 Suspension - Drive Axle #1	54 Seat Control #1	251 On-Board Data Logger
22 Suspension - Drive Axle #2	55 Lighting - Operator Controls	252 Reserved for Experimental Use
23 Instrument Cluster #1	56 Rear Axle Steering Controller #1	253 Reserved for OEM
24 Trip Recorder	57 Water Pump Controller	254 Null Address
25 Passenger-Operator Climate Control #1	58 Passenger-Operator Climate Control	
26 Alternator/Electrical Charging System	#2	
27 Aerodynamic Control	59 Transmission Display - Primary	255 GLOBAL (All-Any Node)

28 Vehicle Navigation 29 Vehicle Security 30 Electrical System 31 Starter System 32 Tractor-Trailer Bridge #1 33 Body Controller	60 Transmission Display - Secondary 61 Exhaust Emission Controller 62 Vehicle Dynamic Stability Controller 63 Oil Sensor 64 Suspension - System Controller #2 65 Information System Controller #1	

Lamp status:

- bit 2-3 Amber warning lamp status
- bit 4-5 Red stop lamp status
- bit 6-7 Malfunction lamp status

00 – Lamp off, 01 – Lamp on

SPN:

Suspect Parameter Number: number that identifies error. First 511 digits correspond to PIDs that are defined in SAE 1587. From 512, SPN are defined by J1939 standard. SPN 520192 (0x7F000) to 524287 (0x7FFFF) are designed to be defined by manufacturer.

FMI:

Failure Mode Indicator

0: Data Valid but above Normal Operating Range
1: Data Valid but below Normal Operating Range
2: Data Erratic, Intermittent or Incorrect
3: Voltage above Normal or Shorted to High Source
4: Voltage below Normal or Shorted to Low Source
5: Current below Normal or Open Circuit
6: Current above Normal or Grounded Circuit
7: Mechanical System Not Responding or out of adjustment
8: Abnormal frequency or pulse width or period
9: Abnormal Update Rate
10: Abnormal Rate of Change
11: Root Cause Not Known
12: Bad Intelligent Device or Component
13: Out of Calibration
14: Special Instructions
15: Data Valid But Above Normal Operating Range (Least Severe Level)
16: Data Valid But Above Normal Operating Range (Moderate Severe Level)
17: Data Valid But Below Normal Operating Range (Least Severe Level)
18: Data Valid But Below Normal Operating Range (Moderate Severe Level)
19: Received Network Data in Error: (Multiplexed Data)
20: Data Drifted High (rationality high)
21: Data Drifted Low (rationality low)
31: Condition Exists
21..30 Reserved for SAE Assignment.

OC:

Occurrence counter

Counter of number of errors occurrence (0..126). Value 127 – not applicable.

Bit 7 (the highest) has a special significance. In case of setting on 1 it is necessary to reposition SPN bits. It can differ for each manufacturer of the car or ECU. Please contact us for more information.

Data concentration

Dash Display message is an example of suitability of data concentration. Within FMS format, this message contains only one byte with information about state of tank. Function of data concentration creates CAN messages set with its own definition of structure of individual CAN messages. Format of individual data, thus meaning of bits, significance of bits, offset and so on is kept – so it is the same as in case of FMS standard definition.

This function solves situation, when it is possible to use only limited amount of identifiers of CAN messages for transmission to server.

In case of connection directly to motor CAN of a car, some other data can be provided. This data is marked with asterisk in following table.

For display of this concentrated data in PP2CAN it is possible to use *Signal receiver* tool, where you can read configuration file FMS_koncentrator.eye.

PGN	Data byte							
	0	1	2	3	4	5	6	7
B100	Engine speed - RPM		Wheel based speed		High resolution total vehicle distance			
B200	Fuel level	Fuel level 2	Instantaneous Fuel Economy		Engine hires total fuel used			
B300	Actual Engine – Percent Torque	Clutch switch/Brake switch/Cruise control active (*1)	Actual Retarder - Percent Torque	Retarder Selection, non-engine	Selected Gear	Retarder Torque Mode	Engine Percent Load At Current Speed	PTO state + At least one PTO engaged (*2)
B400	Tachograph				Tachograph speed		Service distance	
B500	Door Control 1:	After treatment 1 Diesel Exhaust Fluid	Engine coolant temperature	Accelerator pedal position 1	Engine total hours of Operation			
B600	Gross Combination Vehicle Weight		Ambient Air Temperature		Fuel Rate		Service Brake Air Pressure Circuit #1	Service Brake Air Pressure Circuit #2
B700	FMS Tell Tale Status							
B800	Axle/tire location – axle weight (*3)	Axle weight		Axle/tire location – tire pressure (*3) *	Tire pressure *	NOT USED	NOT USED	NOT USED
BA00	High resolution trip vehicle distance *				Engine trip fuel used *			
BB00	Total idle fuel used *				Total idle hours *			

(*1) Clutch switch: bit 6-7, Brake switch: bit 4-5, Cruise control active: bit 0-1
(*2) PTO state: bit 0-4, At least one PTO engaged: bit 6-7
(*3) Tire location: bit 0-3, Axle location: bit 4-7

Configuration of analog inputs and fuel calibration

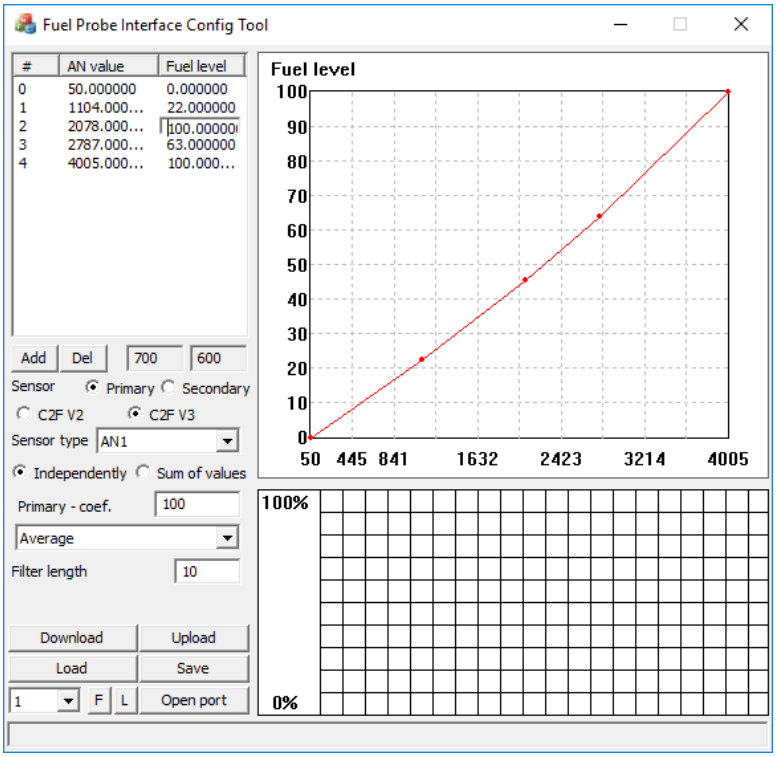
CAR2FMS version can be set with 2 analog voltage inputs with 12 bits resolution. These inputs are used as information about fuel state. It is possible to send data as primary and secondary tank or to combine this data. It is possible to set calibration table for each input.

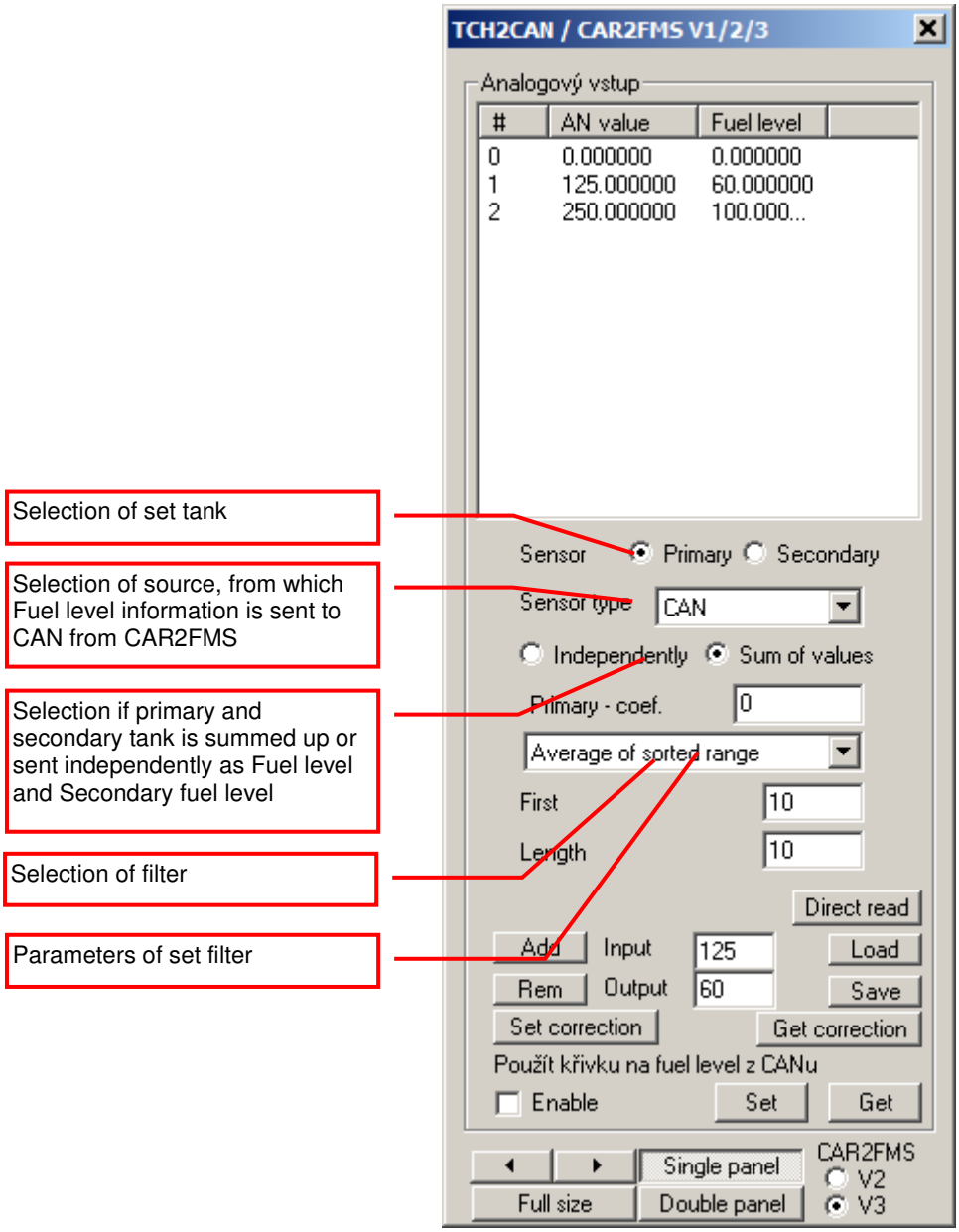
Besides usage of analog inputs as information about fuel, CAR2FMS V3 allows to exactly specify source of information about fuel. So it is possible to combine e.g. data from CAN from original tank with analog signal from secondary additionally added tank. Or you can refuse data about tank. For each source of information, it is possible to set calibration table. So it is possible to subsequently calibrate data from CAN, e.g. data about fuel in case of cars where litres can be converted to percentage.

If two tanks are used, thanks to provided ratio it is possible to combine data of primary and secondary tank into primary one, or to send data as primary or secondary tank.

You can also apply selected filter of values for data about tank state, so you reduce fluctuation of fuel state during the ride.

For work in field, if there is not USB2CAN transducer at disposal for configuration, it is possible to do calibration using special program via transducer to RS485 that is connected to J1708 input. Please contact us for more information. User friendly Fuel Probe Interface Config Tool is designed for setting via RS485.

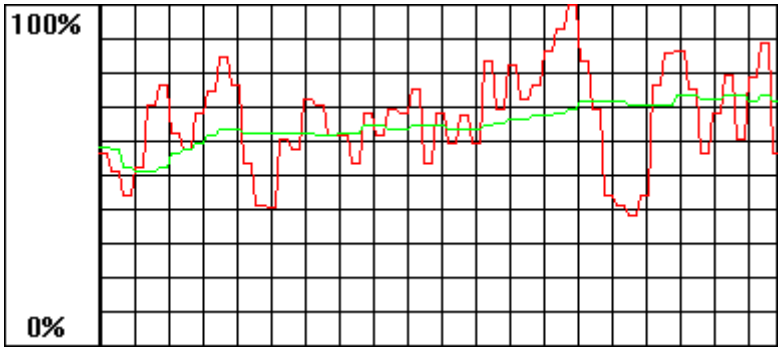




Filter	Description
0 – Arithmetic mean.	Arithmetic mean is counted from given number of samples.
1 – Arithmetic mean with difference	Arithmetic mean is counted from given number of samples; samples with higher than set difference from mean are subsequently eliminated. Arithmetic mean is counted again our of the rest of samples.
2 – Median	Samples are arranged and middle sample is used.
3 – Average from arranging (recommended)	All 29 samples are arranged. Average is counted from given area of arranged range. Area is given by index of the first sample and its length.
4 – Harmonic mean	Harmonic mean is counted from entered number of samples. Description of harmonic mean: https://en.wikipedia.org/wiki/Harmonic_mean
5 – Geometric mean	Geometric mean is counted from entered number of samples. Description of geometric mean: https://en.wikipedia.org/wiki/Geometric_mean

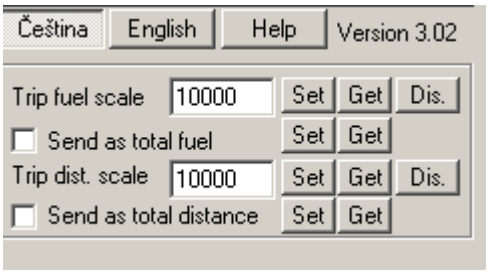
Maximum length of filter – number of samples for filtration is 29. Period of samples is 333 ms.

On the following picture you can see, how extreme deviations of fuel level are filtered while using filter 3.



Trip distance and Trip fuel calibration

In case of some cars it is possible to read information about number of wheels revolutions, or about amount of injected fuel. However, this information doesn't have scale and driven distance depends on dimension of wheels of a car. As well as amount of fuel depends on engine. Scaling of information is possible on the side of server as well as CAR2FMS V3. Scale is set via parameters – see picture:



Value 10000 corresponds to scale 1. Thus, value 1000 corresponds to scale 0.1.
Click "Dis." to disable function of scale.
Trip Distance/Fuel data can be sent also as Total. After each switch on C2F Distance and Fuel are counted from zero, however, data is sent in bytes for Total. Relevant selections are available.

This function is designed for making calibration simple, then, it is not necessary to use calibration table.

Transmission of statistics / histograms

Transmission is made the same way as in case of transmission of Driver ID at standard firmware for CAR2FMS. The first data byte – data marker has following structure of bits:

Data of distance, time, total fuel consumption is transmitted as percentage whack of total distance per ride, total time of a ride, total fuel consumption per ride. Bit resolution is 0.4 percent.

Meaning of bits of data marker:

11CC CBBB

- 11 – identification of statistics packet
- CCC – identification of data (ID) – statistics or any histogram
- BBB – index of segment

Data type	Data ID	Number of segment
Statistics	0	6
Speed histogram	1	2
RPM histogram according to time	2	3
RPM Histogram according to fuel	3	3
Histogram of acceleration pedal	4	2
Histogram of engine load	5	2

Version 2

From firmware 3.33 version, for CAR2FMS v3 there is added option of generating statistics with different format of data marker, when data marker contains parity bit.
However, it is not possible to distinguish if it is version 1 or 2 according to the first segment. It can be done based on data in Extinfo 2 – there is added information about set version of statistics, or according to number of segments at histogram transmission.

11AC CBBB

- 11 – identification of statistics packet
- A - parity
- CC – identification of data (ID) – statistics or any histogram
- BBB – index of segment

Data type	**Data ID**	**Number of segment**
Statistics	0	6
Histogram of speed, acceleration pedal and engine load	1	2 (2+2+2)
RPM histogram according to time and fuel	2	6 (3+3)

Transmission of statistics

Data Byte 1	**Data Byte 2**	**Data Byte 3**	**Data Byte 4**	**Data Byte 5**	**Data Byte 6**	**Data Byte 7**	**Data Byte 8**
Data Marker - Data ID 0 - Index 0 - xC0	Active brake	Active retarder	In tension	Zero consumption	*Above max RPM*	Time with cruise control	Constant accelerator
Data Marker - Data ID 0 - Index 1 - xC1	Above speed limit	Fuel at standing	Distance with cruise control	Fuel with cruise control	In EKO revolutions	Fuel in EKO revolutions	Distance above EKO revolutions

Data Marker - Data ID 0 - Index 2 - xC2	Distance above EKO revolutions at consumption	Above speed limit 2	Time in movement	Maximum reached revolutions. 1bit=0,125 RPM	Maximum reached speed. 1bit=1/256 km/h
Data Marker - Data ID 0 - Index 3 - xC3	Time in seconds, when engine was in operation			Counter of parking brake activity	Automatic gearbox
Data Marker - Data ID 0 - Index 4 - xC4	Total passed distance per ride, resolution 1 b=5 m			Counter of brake activity	255
Data Marker - Data ID 0 - Index 5 - xC5	Consumed fuel per ride, resolution 1 b=10 ml			Usage of the highest gearing grade	Highest used gearing grade	Setting, see note
Note: bit 0: 0 = time, 1= distance, bit 1..2: 0 = calculation from hires total fuel used, 1 = calculation from trip fuel/fuel rate, 2 = calculation from fuel rate at J1708					

Active brake

Time or passed distance in percentage of total time of ride or length of ride, when switch of brake was active. There is a condition that speed of the car is higher than minimum.

Active retarder

Time or passed distance in percentage of total time of a ride or length of ride, when retarder was active. There is a condition that speed of a car is higher than minimum.

In tension

Time of passed distance in percentage of total time of a ride or length of ride, when value of accelerator was higher than minimum set value or when cruise control was active.

Zero consumption

Time or passed distance in percentage of total time of a ride or length of ride. There is a condition that set data is available and fuel consumption is counted out of it (high resolution total fuel used or fuel rate at CAN or J1708). Data is counted, if speed is higher than minimum and accelerator has lower value than set minimum value.

Above max RPM

Time or passed distance in percentage of total time of a ride or length of ride. This data is counted, if revolutions are higher than set maximum and value of accelerator is higher than set minimum value (no motor braking).

Time with cruise control

Time in percentage of total time of a ride, when cruise control was active.

Constant accelerator

Time of passed distance in percentage of total time of a ride or length of ride, when accelerator was constant (deviation below 1.2 percent). There is a condition that deviation didn't change within 5 seconds, value of accelerator is higher than minimum and speed is higher than minimum.

Above speed limit

Time or passed distance in percentage of total period of a ride or length of ride, when speed was higher than maximum set value.

Fuel at standing

Consumed fuel at standing in percentage of consumed fuel per ride. There is a condition of non-zero revolutions, speed lower than minimum set value and PTO is not active.

Distance with cruise control

Distance in percentage of length of a ride, when cruise control was active.

Fuel with cruise control

Consumed fuel in percentage of total consumed fuel per ride per time, when cruise control was active. There is a condition of non-zero revolutions and correct setting of source used for counting of consumed fuel.

In EKO revolutions

Time or passed distance in percentage of total time of a ride or length of a ride. There is a condition that revolutions are within set range of economic revolutions.

Fuel in EKO revolutions

Consumed fuel in percentage of total consumed fuel per ride. There is a condition that revolutions are within set range of economic revolutions and PTO is not active.

Distance above EKO revolutions

Passed distance in percentage of length, when revolutions are above economic limit.

Distance above EKO revolutions at consumption

Passed distance in percentage of length of ride, when revolutions are above economic limit and consumption is above zero.

Above speed limit 2

Time in percentage of total time of a ride, when speed was above second set speed limit.

Time in operation

Time in percentage of total time of a ride, when speed was higher than set limit of minimum speed.

Maximum reached revolutions

Maximum reached revolutions per ride, if value of accelerator was higher than set minimum value.

Maximum reached speed

Maximum reached speed per ride.

Time in seconds, when engine was in operation

Data is used for conversion of percentage to approximate data in seconds.

Counter of parking brake activity

Each activation of parking brake is counted once.

Automatic gearbox

Time or passed distance in percentage of total time of a ride or length of ride, when automatic gearbox was active. There is a condition of speed higher than set minimum speed.

Total passed distance per ride

Data is used for conversion of percentage to approximate data about distance.

Counter of brake activity

Each activation of a brake is counted once.

Consumed fuel per ride

Data is used for conversion of percentage to approximate data about amount of fuel.

Usage of the highest gear grade

Time or passed distance in percentage of total time of a ride or length of a ride, when the higher gear grade was used. There is a condition of speed higher than set minimum speed. Data about highest used gear grade per ride are added to the value in following byte.

Highest used gear grade

See above.

Setting

It allows determine if the car is set to calculation according to time or distance and the source used for counting of consumed fuel.

Transmission of speed histogram

Data Byte 1	Data Byte 2	Data Byte 3	Data Byte 4	Data Byte 5	Data Byte 6	Data Byte 7	Data Byte 8
Data Marker - Data ID 1 - Index 0 - C8	Speed <1km/h	1-40 km/h	40-60 km/h	60-70 km/h	70-80 km/h	80-85 km/h	85-90 km/h
Data Marker - Data ID 1 - Index 1 - C9	90-110 km/h	110-130 km/h	>130km/h	255	255	255	255

Transmission of revolution histogram according to time and fuel

Data ID for time 2, for fuel 3

Data Byte 1	Data Byte 2	Data Byte 3	Data Byte 4	Data Byte 5	Data Byte 6	Data Byte 7	Data Byte 8
Data Marker - Data ID 2/3 - Index 0 - xD0/xD8	Revolutions < 1000rpm	1,000-1,200	1,200-1300	1,300-1,400	1,400-1,500	1,500-1,600	1,600-1,700
Data Marker - Data ID 2/3 - Index 0 - xD1/xD9	1,700-1,800	1,800-2,000	2,000-2,200	2,200-2,500	2,500-3,000	3,000-3,500	3,500-4,000
Data Marker - Data ID 2/3 - Index 0 - xD2/xDA	4,000-4,500	4,500-5,000	>5,000	255	255	255	255

Transmission of acceleration pedal histogram

Data Byte 1	Data Byte 2	Data Byte 3	Data Byte 4	Data Byte 5	Data Byte 6	Data Byte 7	Data Byte 8
Data Marker - Data ID 4 - Index 0 - xE0	0%	>0% - 10%	10%-20%	20%-30%	30%-40%	40%-50%	50%-60%
Data Marker - Data ID 4 - Index 1 - xE1	60%-70%	70%-80%	80%-90%	>90%	255	255	255

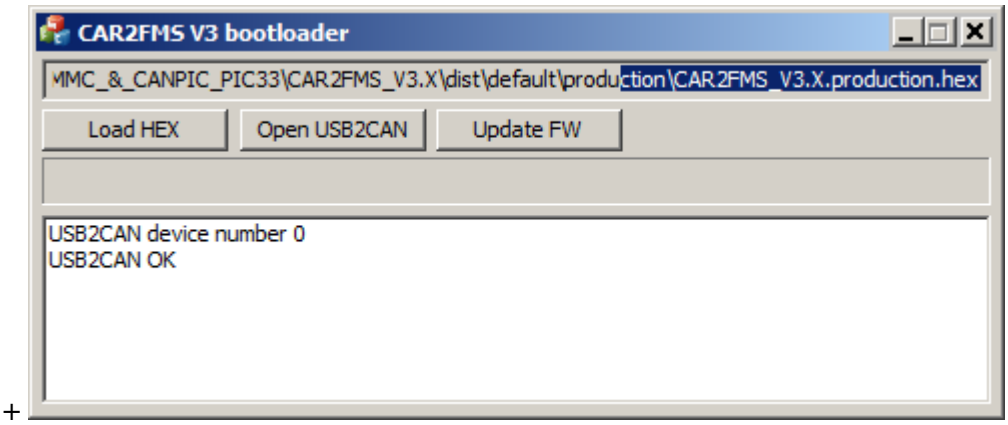
Engine load histogram transmission

Data Byte 1	Data Byte 2	Data Byte 3	Data Byte 4	Data Byte 5	Data Byte 6	Data Byte 7	Data Byte 8
Data Marker - Data ID 5 - Index 0 - xE8	0%	>0% - 10%	10%-20%	20%-30%	30%-40%	40%-50%	50%-60%
Data Marker - Data ID 5 - Index 1 - xE9	60%-70%	70%-80%	80%-90%	90%-100%	100%-110%	>110%	255

Firmware Update

For FW update, DIFFERENT program is used than in case of CAR2FMS V2.

Firmware update is made by CAN bus. It is necessary to use USB2CAN transducer with CAR2CAN_V3_Bootloader.exe specialized application.



Installation step by step:

1) On CAR2FMS switch DIP 1 to 5 to ON position.
2) Connect USB2CAN to output CAN and activate CAR2CAN_V3_Bootloader.
3) Press Load and read firmware.
4) Press Update FW and activate process of firmware loading.
5) CAR2FMS signalize individual phases of FW loading by LED flashing. Primarily, FW is deleted from FLASH memory, which is signalized by alternating flashing of yellow LEDs. After that, FW is loaded into this memory, which is signalized by alternating flashing of red LEDs and simultaneously by progress-bar in application in PC. Then, it is loaded from FLASH to microcontroller memory, where flashing of red and yellow LEDs alternates. Finally, FLASH memory is deleted, which is again signalized by alternating flashing of yellow LEDs.

6) After reading of firmware disconnect power from CAR2FMS.
7) Select given car at DIP 1 to 5.
8) When power connected, new firmware is launched.

Customer functions

Thanks to flexible modular structure of source code of firmware we offer ability to implement other functions according to customer requirements.

LOKSYS Customer function

Customer function LOKSYS is designed for transmission of additional information via unit that doesn't allow add option of transmission of additional data. In this case, it is related to data about OBD error codes in car and information about kilometers and days to service control.
Data from the car are converted into FMS format. For example, if VW MQB car is set on C2F, connection to FMS gate is set on the unit.
Information is coded into data about total amount of kilometers. Car unit shall transmit information about state of total amount of kilometers in the moment, when their change occurs.

Data about total amount of kilometers in FMS/SAE J1939 format has 32 bits with resolution 5 m/bit. The range is more than 21 million kilometers. If two highest bits of 32bit word are used for definition of transmitted data, number of kilometers is limited to approximately 5 million, which is not significant limitation. If necessary, CAR2FMS codes data instead of total amount of kilometers. One of 2 upper bits is simultaneously set, so significant change of total amount of kilometers always occurs and unit sends them and at server, within data processing, it is possible to distinguish the type of data.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
A		B			DATA																										

A – data class
- 00 total amount of kilometers in B+DATA
- 01 LOKYS DATA
- 10 and 11 not used

B – data type if LOKSYS DATA is set
- 000 error codes OBD
- 001 distance to service control
- 010 distance to oil change
- 011 days to service control
- 100 days to oil change

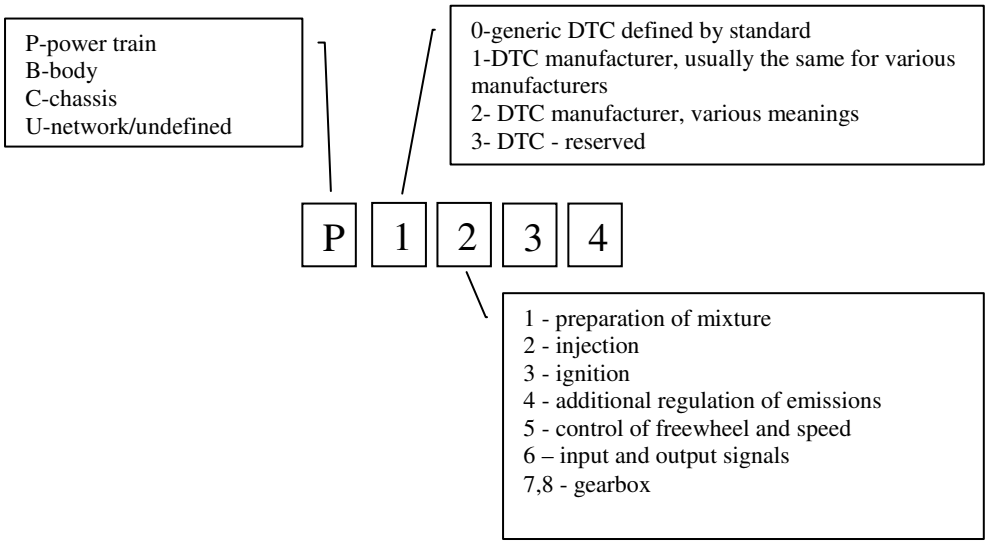
OBD DTC

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	1	0	0	0	A				B	C				D		E				F				G				H			

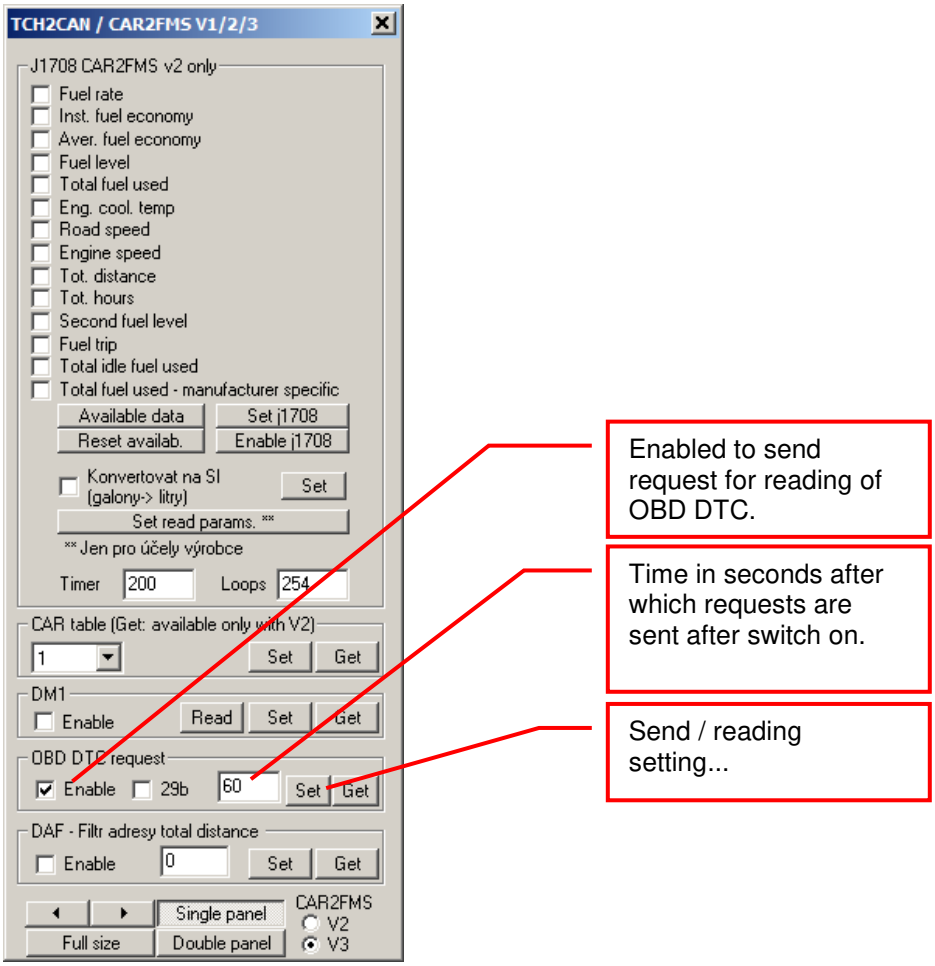
A - index of DTC message
B – 0 – permanent error codes (mode 3), 1 – sporadic error codes (mode 7)

C – source address
DEFGH – error code

D error code is decoded like this: 0-P, 1-C, 2-B, 3-U.
EFGH error codes are values 0..9.



For reading of OBD it is suitable to activate function of reading of error codes by CAR2FMS. However, we need to realize that for transmission of this request it is not possible to set regime Listen Only at CAR2FMS. CAR2FMS sends request about error codes to CAN after passage of set period of time after switch on.



Example:

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	1	0	0	0	0	0	1	1	1	0	0	0	1	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	1	1	1
0	1	0	0	0	A				B	C				D		E				F				G				H			

Error code index 3, OBD error mode 7, source address ECU 1, code B2407.

Number of days and km till service control

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	1	0	0	1	Not used			Distance to service control																							
		0	1	0	Not used			Distance to change of oil																							
		0	1	1	Not used			Days till service control																							
		1	0	0	Not used			Days till change of oil																							

Example

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	1	0	1	0	Not used			0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	1	1	1	0	1	1	0	0	0

0b0000 0000 0010 0111 1101 1000 = 10200 km

PROTANK Customer function

For activation of this function it is necessary to use special build firmware. Build has the same functions as standard firmware, however, it contains also this function.
Data is send in segments with forced sending by switching of digital input as in case of driver identification, statistics and so on. It is also possible to use different indentifier of CAN message: ID 216h in 11 bit (standard) format.

Data Byte 1	Data Byte 2	Data Byte 3	Data Byte 4	Data Byte 5	Data Byte 6	Data Byte 7	Data Byte 8
0	Side brush down, car runs	Brush on the left side, down, car runs	Brush on the right side, down, car runs	Total hours of sweeping			
1	Front brush on	Level of water		Total distance of sweeping			
2	Pre-spraying ON	High-pressure pump ON	Revolutions of suction fans		Medium-pressure pump ON	Rear power hydraulics ON	Gritter ON