



## **TiGR protocol**

# **Telediagnostic for intelligent Garage in Real-time**

## **Protocol Technical Specifications**

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## 1 DEFINITIONS

TiGR protocol	Telediagnostic for Intelligent Garage in Real-time protocol
FM	Fleet Management
OBU	On-board Unit
VehMan	Vehicle Manufacturer
ITS	Intelligent Transport System
Fault	Any vehicle or ITS status requesting maintenance
Failure	The break-down of a vehicle or ITS function (requiring an intervention not planned in the ordinary maintenance plans of the vehicle or ITS)
Third party	any supplier of FM systems connected to Telediagnostic system implementing TiGR protocol
FM Client	the protocol client implemented in FM back-office to provide connection with Telediagnostic server

## 2 SCOPE OF THIS DOCUMENT

This document describes the technical requirements for connecting a Fleet Management system implemented by a third party to a Telediagnostic back-office to provide vehicle operating and diagnostic data required for Telediagnostic service.

## 3 REFERENCE DOCUMENTS

[1] ITxPT<sup>1</sup> specifications:

S02 Onboard Architecture specifications

S03 Backoffice Architecture specifications

These specifications are available on ITxPT documentation centre<sup>2</sup>.

[2] FMS-Standard Description Version 04 13.10.2017

This specification is available on FMS website<sup>3</sup>.

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<sup>1</sup> <http://itxpt.org/>

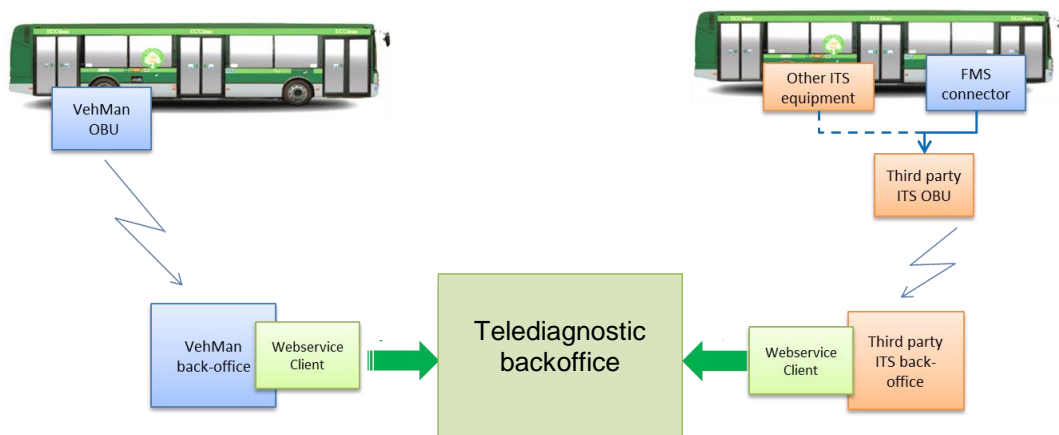
<sup>2</sup> <http://wiki.itxpt.org/>

<sup>3</sup> <http://www.fms-standard.com/>

## 4 SYSTEM ARCHITECTURE

Telediagnostic system architecture consists of

- An On-Board Unit (OBU) provided by a third party (VehMan or ITS supplier) for each vehicle monitored;
- Different FM back-offices collecting data from the OBUs (one for each OBU supplier);
- **A connector from each FM back-office to Telediagnostic back-office, consisting of a RESTful Web Service Client implemented in the FM back-office and a Server provided by Telediagnostic back-office**
- Telediagnostic back-office integrating data from different back-office interfaces.



***Telediagnostic system architecture***

Based on this architecture, each OBU provider (VehMan or ITS supplier) can offer proprietary back-offices for specific service (eco-driving, AVMS, ...).

## 5 EVENTS STRUCTURE

The transfer of data in the connector between FM back-offices and Telediagnostic server shall be event driven.

### 5.1 Event Header

Each event message (vehicle fault, ITS fault, system diagnostic and manual input) shall consist of a header with a standard format in accordance with structure class "HeaderEvt" as defined in 13.2.

Each event message may contain additional structure(s) with variable list of associated data depending on event type. These additional structures "EventON", "EventOFF", "EventTRK", "EventLT" and "EXTRA" are defined in 13.2.

The message header shall include the following parameters:

Code	Description	Availability
"ID"	Protocol release Id (assigned by Telediagnostic service supplier)	[mandatory]
"SERVERNAME"	Mnemonic identifier of connector client (to be agreed with telediagnostic service supplier)	[mandatory]
"VIN"	Vehicle Identification (VIN)	[mandatory]
"PROG"	Event serial No.	[mandatory]
"EVTDATE"	Event DateTime [UNIX format]	[mandatory]
"SRVDATE"	Event Server DateTime [UNIX format]	[mandatory]
"SENDDATE"	Event Send DateTime [UNIX format]	[mandatory]
"CODE"	TiGR Event Code as defined in 5.2	[mandatory]
"TYPE"	Structure of additional data to be sent with the event	[mandatory]
"TX"	Event Transition mode	[mandatory]
"DST"	Vehicle Mileage	[mandatory]
"GPSInfo"	Current GNSS position information	[mandatory]
"LAT"	Latitude of GNSS coordinate	[mandatory]
"LON"	Longitude of GNSS coordinate	[mandatory]
"ALT"	Altitude of GNSS coordinate	[mandatory]
"HEAD"	Heading of GNSS coordinate	[recommended]
"NUMSAT"	Number of satellites available	[recommended]
"DOP"	Dilution of precision	[recommended]
"GNSSType"	the information about the used GNSS System	[recommended]

Note1: All fields in the header must be filled

Note2: "LAT" and "LON" format is DD\*60000 (decimal degrees' format). To be filled with "0" if no information is available.

Where:

### “PROG” - Event Serial no.

Events shall be identified by a unique incremental counter for each individual vehicle (independently of the Event code). The “PROG” of first event issued by an OBU is set at “1”. Then the “PROG” of each new following events is set at [“PROG” number from previous event +1] even if the OBU is switched off or restarted.

### “TYPE” - Structure of additional data

The field “TYPE” shall be filled using the following string, it defines the structure of additional data to be sent with the event:

- “HEADER\_ONLY” (if no additional data are defined)
- “EVENT\_ON”
- “EVENT\_OFF”
- “JOURNEY”
- “TRACKING”

### “TX” - Transition Mode

The transition mode identifies activation (1 = ON) and termination (0 = OFF) of fault events having a persistence in time.

For “EVENT\_ON” type, transition Mode may be set = 1 (ON).

For “EVENT\_OFF” type, transition Mode may be set = 0 (OFF).

In case of Events having no persistence in time (such as “HEADER\_ONLY”, “TRACKING” and “JOURNEY” types), transition Mode may be set = 3 (“NA”).

### “EVTDATE” / “SRVDATE” / “SENDDATE” - DateTime

The “EVTDATE” / “SRVDATE” / “SENDDATE” timestamps are defined as a local time. Events shall be timestamped with a local time synchronization according to the local environment where vehicles are operated. The value shall be the UNIX format of the event date time (GNSS time is recommended) combined to the local time zone offset.

### “GPSInfo”

GNSS coordinates and related data provided by the internal GNSS receiver of the OBU. “GNSSType” is the information about the used GNSS System among following GPS, GALILEO, DEADRECKONING.

## 5.2 TiGR Events Coding System

The Event codes consists of 4 alphanumeric.

The 1<sup>st</sup> character identifies the type of the Event:

- E = ordinary exploitation event
- D = abnormal exploitation event
- F = Vehicle or ITS Failure
- M = Maintenance warning (fluid levels, filters clogged, etc.)

The 2<sup>nd</sup> and 3<sup>rd</sup> characters identify the vehicle or ITS Function interested.  
 The 4<sup>th</sup> character is used to differentiate events related to the same Function, normally to differentiate alerts (orange) and alarms (red). In some cases, additional codes are used if there are several alerts and alarms for a similar code.

The List is subject to extensions or modifications according to Telediagnostic service requirements and/or Third party new features implementations.

## 6 ORDINARY EXPLOITATION EVENTS

The following ordinary exploitation events are provided:

“CODE”	“TYPE”	Description	Availability
“EC10”	“HEADER ONLY”	Ignition ON	[mandatory]
“EC11”	“HEADER ONLY”	Ignition OFF	[mandatory]
“EM00”	“HEADER ONLY”	Engine Start <sup>4</sup>	[mandatory]
“EM01”	“HEADER ONLY”	Engine Stop <sup>5</sup>	[mandatory]
“EV00”	“TRACKING”	Localization event (Tracking)	[mandatory]
“EV10”	“HEADER ONLY”	Doors opening <sup>6</sup>	[optional]
“EV11”	“HEADER ONLY”	Doors closing <sup>7</sup>	[optional]
“EV20”	“HEADER ONLY”	Start-of-Journey	[mandatory]
“EV21”	“JOURNEY”	End-of-Journey	[mandatory]
“EB90”	“HEADER ONLY”	Parking Brake Activated <sup>8</sup>	[optional]
“EB91”	“HEADER ONLY”	Parking Brake Deactivated <sup>9</sup>	[optional]

Note: Such events are set with transmission mode TX = 3

<sup>4</sup> As provided in [2] - msg Electronic Engine Controller #1: EEC1 – PGN F004 / SPN 190

<sup>5</sup> As provided in [2] - msg Electronic Engine Controller #1: EEC1 – PGN F004 / SPN 190

<sup>6</sup> As provided in [2] - msg Door Control 1: DC1 – PGN FE4E / SPN 1821

<sup>7</sup> As provided in [2] - msg Door Control 1: DC1 – PGN FE4E / SPN 1821

<sup>8</sup> As provided in [2] - msg Cruise Control/Vehicle Speed: CCVS – PGN FEF1 / SPN 70 or msg FMS Tell Tale Status: FMS1 – PGN FD7D / TTS7

<sup>9</sup> As provided in [2] - msg Cruise Control/Vehicle Speed: CCVS – PGN FEF1 / SPN 70 or msg FMS Tell Tale Status: FMS1 – PGN FD7D / TTS7

## 6.1 Start-of-Journey event

A “start-of-journey” event - code EV20 - shall be issued as soon as the vehicle is leaving a Depot. If no other information is available, the Event may be issued once the vehicle runs 500 meters after the Ignition ON event - code EC10.

As HEADER\_ONLY type, the “start-of-journey” event shall comply with standard format of structure class "HeaderEvt" as defined in 13.2.

## 6.2 End-of-Journey event

If no other information is available, an “end-of-Journey” event - code EV21 - is issued not later than 30 minutes after the Ignition OFF event - code EC11, provided that the total distance driven from the last “end-of-journey” is greater than 1000 meters.

As JOURNEY type, the “end-of-journey” event shall comply with standard format of structure class "HeaderEvt" + "EventLT" as defined in 13.2.

For the End-of-Journey event the following context data are provided:

Code	Description	Availability
“ADBL”	AdBlue Level [%]	[recommended]
“VMCRx”	Brake Pads wear-out [%] [x=1-6]	[recommended]
Life-Time Data <sup>10</sup> :		
“TVD”	Total Vehicle Distance	[mandatory]
“TEO”	Total Engine Hours	[mandatory]
“TFU”	Total Fuel Used	[mandatory]
“TES”	Total Engine Starts counter	[recommended]
“TDFC”	Total Front Door openings counter	[recommended]
“TDRC”	Total Rear Door openings counter	[recommended]
“TD2C”	Total Middle Door#2 openings counter	[recommended]
“TD3C”	Total Middle Door#3 openings counter	[recommended]
Journey Report Data: <sup>11</sup>		
“MVDH”	Journey Vehicle Distance	[mandatory]
“MEO”	Journey Engine Hours	[mandatory]
“MFU”	Journey Fuel Used	[mandatory]
“MKO”	Journey Ignition ON Time	[recommended]
“MBT”	Journey Braking Time	[recommended]
“MBD”	Journey Braking Distance	[recommended]
“MDO”	Journey Service Stops (doors opening) counter	[recommended]

**Note:** A Journey is the vehicle travel between the first ignition ON (before the Start-of-Journey event) and the last ignition OFF (before the End-of-Journey event).

<sup>10</sup> Cumulated since the first power ON of the vehicle excepted for TES and TDxx (cumulated since the first power ON of the OBU)

<sup>11</sup> Cumulated since the previous « start-of-journey »



### 6.3 Tracking Event

A tracking event - code EV00 - shall be sent at regular intervals, when the vehicle is powered ON<sup>12</sup> and even if during the interval other events appeared.

The period is psecified by Telediagnostic service supplier.

The recommended period is 120 seconds.

As TRACKING type, the “tracking” event shall comply with standard format of structure class "HeaderEvt" + " EventTRK" as defined in 13.2.

For each Tracking event the following context data are provided:

Code	Description	Availability
“SMX”	Current vehicle speed	[recommended]
“VB”	Battery voltage	[recommended]
“TRM”	Engine coolant temperature	[recommended]
“RPM”	Engine speed [rpm]	[recommended]
“BRKPx”	Service Air Brake Pressure Circuit [x=1-4 <sup>13</sup> ]	[recommended]
“GEAR”	Current gear	[recommended]
“BRKSTS”	Brake pedal status	[recommended]
“PAC”	Accelerator pedal position	[recommended]
“STP”	Doors status	[recommended]
“LMC”	Fuel Level	[recommended]
“BEPx”	Bellows Pressures [x=1-6]	[recommended]
“TMX”	Transmission Oil Temperature	[recommended]

Note: “VB” format is volt\*10

<sup>12</sup> ie. between Ignition ON event - code EC10 and Ignition OFF event - code EC11

<sup>13</sup> #3 Middle axis, #4 Auxiliary circuits

## 7 VEHICLE FAULT EVENTS

### 7.1 Vehicles pre-equipped with VehMan “native solutions”

The minimum list of faults to be detected by the VehMan OBU and provided to Telediagnostic server shall be defined by the Fleet Owner in the Tender and/or Purchase Contract for new vehicles supply.

The transcodification of “native” FM fault codes into TiGR Event codes shall be based on “translation tables” implemented in the VehMan web service Client.

The translation tables for each vehicle model shall be agreed between the VehMan and Telediagnostic service supplier.

### 7.2 FMS retrofit applications

The following paragraphs are reserved for FMS retrofit applications

#### 7.2.1 TTS management<sup>14</sup>

Tell-tale Status (TTS) reproduces dashboard lights condition.

TTS are defined in [2] - msg FMS Tell Tale Status: FMS1 – PGN FD7D.

#### 7.2.2 TTS condition

For each Tell-tale, 4 valid binary condition values are defined according to [2]:

- 000 = Off
- 001 = Alert (yellow)
- 010 = Alarm (red)
- 011 = Info

Note: Condition “111 = not available” is not monitored.

Only TTS changes relevant for Telediagnostic service must generate events for Telediagnostic server.

The list of TTS ID and condition to be monitored by the Data Acquisition System shall be agreed with Telediagnostic service supplier.

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<sup>14</sup> For vehicles equipped with FMS v02 or superior

### 7.2.3 Implementation of FMS TTS

A “TTS0” Event is used for reporting TTS changes as defined in 7.2.2.

- A “TTS0” event with TYPE “EVENT\_ON” [transition mode TX = 1] shall be issued every time a TTS enters in a new monitored status.
- A corresponding “TTS0” Event with TYPE “EVENT\_OFF” [transition mode TX = 0] shall be issued when the pending monitored status is terminated.

“CODE”	“TYPE”	Description	Availability
“TTS0”	“EVENT_ON”	Fault ON event	[mandatory]
“TTS0”	“EVENT_OFF”	Fault OFF event	[mandatory]

Note: In case of transition from one monitored state to another monitored state, two TiGR events shall then be issued: one with Transition mode OFF and one with Transition mode ON

### 7.2.4 Alternators status monitoring

The error status of alternators is reported in FMS message “AS” - PGN 00FED5, Byte 3<sup>15</sup> as defined in [2].

An event ON / OFF - code FE01 - shall be issued for each alternator reported in fault in FMS message (value “10”). The field “ALTERNATORID” in the [EXTRA](#) structure shall be used to specify the alternator in fault (4 alternators are defined in FMS).

FE01 events triggered by FMS message “AS” shall be issued independently of Events eventually triggered by TTS ID 12<sup>16</sup>.

“CODE”	“TYPE”	Description	Availability
“FE01”	“EVENT_ON”	Fault ON event	[mandatory]
“FE01”	“EVENT_OFF”	Fault OFF event	[mandatory]

<sup>15</sup> Provided in all FMS versions

<sup>16</sup> Conditions yellow or red

### 7.3 Vehicle fault event specific context data

The following context data are associated to each Vehicle fault event.

This section applies to either vehicles pre-equipped with VehMan “native solutions” or FMS retrofit applications.

Additional context data may be provided on request.

#### 7.3.1 Fault ON event specific context data

For each vehicle fault event, a vehicle fault ON event is issued when the fault occurs.

As EVENT\_ON type, the vehicle fault ON event shall comply with standard format of structure class "HeaderEvt" + "EventON" + “EXTRA” (optional) as defined in 13.2.

The list of context data to be provided for each Fault ON event is the following:

Code	Description	Availability
“TCA”	Time elapsed from Ignition ON	[mandatory]
“TAM”	Time elapsed from Engine start	[mandatory]
“SMX”	Current vehicle speed	[mandatory]
“VB”	Battery voltage	[recommended]
“TRM”	Engine coolant temperature	[recommended]
“TMX”	Transmission oil temperature	[recommended]
“RPM”	Engine speed	[recommended]
“GEAR”	Current gear	[recommended]
“BRKSTS”	Brake pedal status	[recommended]
“PAC”	Accelerator pedal position	[recommended]
“STP”	Doors status	[recommended]
“TTID”	Tell-tale ID [1-60]	[mandatory for TTS0 event] <sup>17</sup>
“TTSTS”	Tell-tale condition	[mandatory for TTS0 event] <sup>18</sup>
	Extended “ <a href="#">EXTRA</a> ” fields (see 7.3.3)	[not applicable to TTS0 event]

Note: “VB” format is volt\*10

<sup>17</sup> Only for FMS retrofit applications

<sup>18</sup> Only for FMS retrofit applications

### 7.3.2 Fault OFF event specific context data

For each vehicle fault event, a vehicle fault OFF event is issued when the fault terminates.

If a vehicle fault is pending when an Ignition OFF event occurs - code EC11 (ie. vehicle fault ON occurred without fault OFF), then a vehicle fault OFF event is issued not later than 30 minutes after the Ignition OFF event - code EC11.

As EVENT\_OFF type, the vehicle fault OFF event shall comply with standard format of structure class "HeaderEvt" + "EventOFF" as defined in 13.2.

The list of context data to be provided for each Fault OFF event is the following:

Code	Description	Availability
"PROGON"	" <a href="#">PROG</a> " value of related Fault ON event	[mandatory]
"EVD"	Fault duration	[mandatory]
"FOD"	Distance driven while fault pending	[recommended]
"SMX"	Current vehicle speed	[recommended]
"VB"	Battery voltage	[recommended]
"TRM"	Engine coolant temperature	[recommended]
"TMX"	Transmission oil temperature	[recommended]
"RPM"	Engine speed	[recommended]
"GEAR"	Current gear	[recommended]
"BRKSTS"	Brake pedal status	[recommended]
"PAC"	Accelerator pedal position	[recommended]
"STP"	Doors status	[recommended]
"TTID"	Tell-tale ID [1-60]	[mandatory for TTS0 event]
"TTSTS"	Tell-tale condition	[mandatory for TTS0 event]

Note: "VB" format is volt\*10

### 7.3.3 Extended “EXTRA” data for vehicle fault event

Messages reporting Fault ON events may include additional EXTRA data to specify the faulty component where applicable.

EXTRA data shall comply with structure class "EXTRA" as defined in 13.2.

The list of context data to be provided for each EXTRA structure is the following:

Code	Description	Availability
“CodeVMC”	FM “native” fault code	[where applicable]
“DTC_SRC”	DTC Fields [SRC]	[where applicable]
“DTC_VRT”	DTC Fields [VRT]	[where applicable]
“DTC_SPN”	DTC Fields [SPN]	[where applicable]
“DTC_FMI”	DTC Fields [FMI]	[where applicable]
“INFOADD”	additional textual information	[where applicable]
“WHEELID”	Wheel id.	[where applicable]
“AIRCIRCID”	Air circuit id.	[where applicable]
“DOORID”	Door id.	[where applicable]
“ALTERNATORID”	Alternator id.	[where applicable]
“WORNPERC”	% worn pad	[where applicable]
“DEVTYP”	Device Type	[where applicable]
“DEVID”	Device id	[where applicable]

Note1: The “CodeVMC” data is related to the original event code issued by the third party FM OBU. The descriptions of CodeVMC will be defined in dedicated dictionaries to be provided by the FM supplier.

Note2: “DTC” fields shall contain the codes (HEX) exposed by the interested on-board ECU (where available).

Note3: “INFOADD” shall be used to provide additional detail regarding the fault. If the DTC is available, “INFOADD” shall report the textual description of the DTC.

“INFOADD” text shall be provided in the language agreed with Telediagnostic service supplier.

Note4: “DEVTYP” and “DEVID” are applicable only for [ITS Fault events](#).

## 8 ITS FAULT EVENTS

A ITS fault consists of failure “F” code or maintenance warning “M” code for ITS modules like AVMS, ticketing, passenger information, video surveillance, passenger counting...

The list of faults for ITS modules supported by Telediagnostic server is defined between the FM supplier and Telediagnostic service supplier.

The following context data are associated to each ITS fault event.

### 8.1 ITS Fault ON event specific context data

For each ITS fault event, a ITS fault ON event is issued when the fault occurs.

As EVENT\_ON type, the ITS fault ON event shall comply with standard format of structure class "HeaderEvt" + "EventON" + “EXTRA” (optional) as defined in 13.2.

For ITS fault ON event, only the following subset of context data shall be provided:

Code	Description	Availability
“TCA”	Time elapsed from Ignition ON	[recommended]
“VB”	Battery voltage	[recommended]
“RPM”	Current vehicle speed	[recommended]
“STP”	Doors status	[recommended]
	Extended “ <a href="#">EXTRA</a> ” fields (see 0)	[where applicable]

### 8.2 ITS Fault OFF event specific context data

For each ITS fault event, a ITS fault OFF event is issued when the fault terminates.

If a ITS fault is pending when an Ignition OFF event occurs - code EC11 (ie. vehicle fault ON occurred without fault OFF), then a ITS fault OFF event is issued not later than 30 minutes after the Ignition OFF event - code EC11.

As EVENT\_OFF type, the ITS fault OFF event shall comply with standard format of structure class "HeaderEvt" + "EventOFF" as defined in 13.2.

For ITS fault OFF event, only the following subset of context data shall be provided:

Code	Description	Availability
“PROGON”	” <a href="#">PROG</a> ” value of related Event ON	[mandatory]
“EVD”	Fault duration	[mandatory]
“FOD”	Distance driven while fault pending	[where applicable]

### 8.3 Extended “EXTRA” data for ITS fault event

Messages reporting ITS fault ON events may include additional EXTRA data to specify the faulty component where applicable.

EXTRA data shall comply with structure class "EXTRA" as defined in 13.2.

For ITS Fault ON event, only the following subset of EXTRA context data shall be provided:

Code	Description	Availability
“CodeVMC”	FM “native” fault code	[recommended]
“INFOADD”	additional textual information <sup>19</sup>	[recommended]
“DOORID”	Door id	[where applicable]
“DEVTYP”	Device Type	[where applicable]
“DEVID”	Device id	[where applicable]

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<sup>19</sup> may contain the “native” fault code of the ITS system



## 9 SYSTEM DIAGNOSTICS EVENTS

The FM gateway shall report to Telediagnostic server any loss of connection, OBU fault or abnormal condition which may have an impact on Telediagnostic service.

The following table summarize the fault codes applicable in the different situations:

Event Code	Description	Remarks
FIB0	Connectivity failure	This alarm must be generated by the FM gateway in case of abnormal interruption of communications with the OBU. The strategy for the detecting the failure is depending on FM implementation. Transition OFF Events shall be issued only when the connection with the OBU has been reactivated.
FIB1	Failure of CAN connections to the vehicle	Applicable to either connections to internal CAN in case of pre-equipment by the VehMan, or to FMS standard connector in case of retrofit applications.
FIB2	On-board RT Clock malfunctions	This alert is reserved for On-board RT Clock failures (normally detected by the OBU self-diagnostic system)
FIB3	GNSS module malfunctions	This alert is reserved for GNSS failures (normally detected by the OBU self-diagnostic system)
FIB4	GPRS malfunctions	This alert is reserved for GPRS failures (normally detected by the OBU self-diagnostic system)
FIB5	Gyrometer failure	Where applicable
FIB6	Wi-Fi module failure	Where applicable
DIB3	Insufficient GNSS signal	This alert shall be generated by the OBU to trace the cause of wrong or not accurate coordinates in the Events sent to Telediagnostic
DIB4	Insufficient GPRS signal	This alert shall be generated by the OBU to trace the cause of delayed transmission of Events to Telediagnostic

## 10 MANUAL INPUT EVENTS

These are events generated by manual input to report any types of events such as:

- Body damages
- Cleanness
- Dysfunctional equipment
- Unexpected vehicle behavior
- Vehicle faults (complementary to FMS or VehMan native solutions)

These events can be reported by the driver before or during operation, the mechanics, or any people in charge of vehicle maintenance or operation.

**To be completed**

## **11 REAL-TIME PERFORMANCE**

Under GPRS coverage Events should be delivered to Telediagnostic server within 30 seconds from physical event detection on-board.

## **12 TRAFFIC ON-THE-AIR**

In the event that the back-office connection with the vehicle third party OBU is managed via a public network (2G/3G/4G), the third-party system shall implement intelligent “traffic saving” strategies to minimize the service extra-costs determined by the monitoring of TTS status.

## 13 IMPLEMENTATION

A WCF Web Service shall be implemented by the FM third part.

The message shall be encapsulated in a Json stream, and sent to the Telediagnostic Web Service as a POST request.

### 13.1 Data Contract

The **Data Contract** exposed by the Telediagnostic web service is the following one<sup>20</sup>:

```
[DataContract]
[Newtonsoft.Json.JsonObject(MemberSerialization = Newtonsoft.Json.MemberSerialization.OptIn)]
public class EventOnMessage
{
    public HeaderEvt Header = new HeaderEvt();
    public EventON EvtON = new EventON();
    public EventOFF EvtOFF = new EventOFF();
    public EventTRK EvtTRK = new EventTRK();
    public EventLT EvtLT = new EventLT();
    public Extra Extra = new Extra();
}
```

Note: related Json structure class file is available on request.

### 13.2 Structure definition

Structure Class "HeaderEvt" (shall be provided for all kind of messages)

```
{
    public int ID;
    public string SERVERNAME;
    public string VIN;
    public int PROG;
    public long EVTDATE;
    public long SRVDATE;
    public long SENDDATE;
    public string CODE;
    public string TYPE;
    public int TX;
    public int DST;
    public GPSInfo GpsInfo = new GPSInfo();
        public long LAT;
        public long LON;
        public long ALT;
        public int HEAD;
        public int NUMSAT;
}
```

<sup>20</sup> If Visual Studio is used:

- the Framework utility placed in the namespace System.Runtime.Serialization.Json.DataContractJsonSerializer shouldn't be used, because it has got a serious issues with the datetime field type.
- The library released by Newton and available in NuGet is recommended (cf. <https://www.nuget.org/packages/Newtonsoft.Json/6.0.8>).

### Structure Class "EventON"

```
{  
    public int TCA;  
    public int TAM;  
    public int SMX;  
    public int VB;  
    public int TRM;  
    public int TMX;  
    public int RPM;  
    public int GEAR;  
    public int BRKSTS;  
    public int PAC;  
    public int STP;  
    public int TTID;  
    public int TTSTS;  
}
```

### Structure Class "EventOFF"

```
{  
    public int PROGON;  
    public int EVD;  
    public int FOD;  
    public int SMX;  
    public int VB;  
    public int TRM;  
    public int TMX;  
    public int RPM;  
    public int GEAR;  
    public int BRKSTS;  
    public int PAC;  
    public int STP;  
    public int TTID;  
    public int TTSTS;  
}
```

### Structure Class "EventTRK"

```
{  
    public int SMX;  
    public int VB;  
    public int TRM;  
    public int RPM;  
    public int BRKP1;  
    public int BRKP2;  
    public int BRKP3;  
    public int BRKP4;  
    public int GEAR;  
    public int BRKSTS;  
    public int PAC;  
    public int STP;  
    public int LMC;  
    public int BEP1;  
    public int BEP2;  
    public int BEP3;  
    public int BEP4;  
    public int BEP5;  
    public int BEP6;  
    public int TMX;  
}
```

Structure Class “EXTRA”

```
{  
    public string CodeVMC;  
    public string DTC_SRC;  
    public string DTC_VRT;  
    public string DTC_SPN;  
    public string DTC_FMI;  
    public string INFOADD;  
    public string DEVTYP;  
    public string DEVID;  
    public string WHEELID;  
    public string AIRCIRCID;  
    public string DOORID;  
    public string ALTERNATORID;  
    public string WORNERC;  
}
```

Structure Class “EventLT”

```
{  
    public int ADBL;  
    public int VMCR1;  
    public int VMCR2;  
    public int VMCR3;  
    public int VMCR4;  
    public int VMCR5;  
    public int VMCR6;  
    public int TVD;  
    public int TEO;  
    public int TFU;  
    public int TES;  
    public int TDFC;  
    public int TD2C;  
    public int TD3C;  
    public int MVDH;  
    public int MEO;  
    public int MFU;  
    public int MKO;  
    public int MBT;  
    public int MBD;  
    public int MDO;  
}
```

All fields of **Header structure** must be filled in order to send the message to the Telediagnostic server.

If the parameter “DST” is not available, it shall be set as integer max value (**2147483647**)

If the GNSS localization is not sufficiently accurate or not available, all the fields in the structure “GPSInfo” shall be sets as **0**.

For UNIX formatted parameters (“EVTDATE”, “SENDDATE” and “SRVDATE”): timestamps shall be provided including the time zone offset as defined in 5.1 Event Header.

For example:

*EVTDATE (Local time in UNIX format) = Event date time (UTC UNIX) +/- Time zone Offset*

For all other structures, if a parameter is not defined or not available on-board, the related field value has to be:

- set as integer max value (**2147483647**) if the field type is integer
- set as “**NULL**” if the field type is string

The Telediagnostic server will automatically translate them into “ND”.

### 13.3 Examples

Examples of the typical messages are the following.

Note: related Json examples files are available on request.

#### 13.3.1 EC10 - Ignition ON

- Format: Structure Class “HeaderEvt”
- Code:

```
"Header":
{
  "ID" : 4,
  "SERVERNAME" : "ABB"
  "VIN" : "VIN000000000000001",
  "PROG" : 1345,
  "EVTDATE" : 1492714346,
  "SRVDATE" : 1492714366,
  "SENDDATE" : 1492714386,
  "CODE" : "EC10",
  "TYPE" : "HEADER_ONLY",
  "TX" : 3,
  "DST" : 240636,
  "GPSInfo" : { "LAT" :2932530,"LON" :155604,"ALT" : 260,"HEAD" : 0,"NUMSAT" : 7 }
}
```

#### 13.3.2 EM00 – Engine start

- Format: Structure Class “HeaderEvt”
- Code:

```
"Header":
{
  "ID" : 4,
  "SERVERNAME" : "ABB"
  "VIN" : "VIN000000000000001",
  "PROG" : 1345,
  "EVTDATE" : 1492714346,
  "SRVDATE" : 1492714366,
  "SENDDATE" : 1492714386,
  "CODE" : "EM00",
  "TYPE" : "HEADER_ONLY",
  "TX" : 3,
  "DST" : 240636,
  "GPSInfo" : { "LAT" :2932530,"LON" :155604,"ALT" : 260,"HEAD" : 0,"NUMSAT" : 7 }
}
```

### 13.3.3 EV00 - Localization event (Tracking)

- Format: Structure Class "HeaderEvt" + Structure Class "EventTRK"
- Code:

```

"Header":
{
  "ID" : 4,
  "SERVERNAME" : "ABB"
  "VIN" : "VIN00000000000001",
  "PROG" : 1345,
  "EVTDATE" : 1492714346,
  "SRVDATE" : 1492714366,
  "SENDDATE" : 1492714386,
  "CODE" : "EV00",
  "TYPE" : "TRACKING",
  "TX" : 3,
  "DST" : 240636,
  "GPSInfo" : { "LAT" :2932530,"LON" :155604,"ALT" : 260,"HEAD" : 0,"NUMSAT" : 7 }
}
,
"EvtTRK":
{
  "SMX" : 34,
  "VB" : 264,
  "TRM" : 41,
  "RPM" : 742,
  "BRKP1" : 204,
  "BRKP2" : 210,
  "BRKP3" : 190,
  "BRKP4" : 184,
  "GEAR" : 1,
  "BRKSTS" : 0,
  "PAC" : 26,
  "STP" : 0,
  "LMC" : 84,
  "BEP1" : 201,
  "BEP2" : 198,
  "BEP3" : 212,
  "BEP4" : 194,
  "BEP5" : 196,
  "BEP6" : 189,
  "TMX" : 54,
}

```



### 13.3.4 EV21 – End-of-Journey

- Format: Structure Class "HeaderEvt" + Structure Class "EventLT"
- Code:

```

"Header":
{
  "ID" : 4,
  "SERVERNAME" : "ABB"
  "VIN" : "VIN00000000000001",
  "PROG" : 1345,
  "EVTDATE" : 1492714346,
  "SRVDATE" : 1492714366,
  "SENDDATE" : 1492714386,
  "CODE" : "EV21",
  "TYPE" : "JOURNEY",
  "TX" : 3,
  "DST" : 240636,
  "GPSInfo" : { "LAT" :2932530,"LON" :155604,"ALT" : 260,"HEAD" : 0,"NUMSAT" : 7 }
}
,
"EvtLT":
{
  "ADBL" : 85,
  "VMCR1" : 60,
  "VMCR2" : 59,
  "VMCR3" : 44,
  "VMCR4" : 42,
  "VMCR5" : 74,
  "VMCR6" : 79,
  "TVD" : 172135,
  "TEO" : 13693,
  "TFU" : 92674,
  "TES" : 4521,
  "TDFC" : 225264,
  "TDRC" : 154548,
  "TD2C" : 169542,
  "TD3C" : 187596,
  "MVDH" : 195488,
  "MEO" : 36215,
  "MFU" : 975,
  "MKO" : 29456,
  "MBT" : 14256,
  "MBD" : 24545,
  "MDO" : 310,
}

```

### 13.3.5 TTSS0 – Event ON

- Format: Structure Class “HeaderEvt” + Structure Class “EventON” + optional Structure Class “EXTRA”
- Code:

```

"Header":
{
  "ID" : 4,
  "SERVERNAME" : "ABB"
  "VIN" : "VIN00000000000001",
  "PROG" : 1345,
  "EVTDATE" : 1492714346,
  "SRVDATE" : 1492714366,
  "SENDDATE" : 1492714386,
  "CODE" : "TTSS0",
  "TYPE" : "EVENT_ON",
  "TX" : 1,
  "DST" : 240636,
  "GPSInfo" : { "LAT" :2932530,"LON" :155604,"ALT" : 260,"HEAD" : 0,"NUMSAT" : 7 }
}
,
"EvtON":
{
  "TCA" : 240,
  "TAM" : 220;
  "SMX" : 2;
  "VB" : 252,
  "TRM" : 65,
  "TMX" : 72,
  "RPM" : 750,
  "GEAR" : 4,
  "BRKSTS" : 0,
  "PAC" : 52,
  "STP" : 0,
  "TTID" : 29,
  "TTSTS" : 2,
}
,
"Extra":
{
  "CodeVMC" : "34569",
  "DTC_SRC" : "2",
  "DTC_VRT" : "2",
  "DTC_SPN" : "2",
  "DTC_FMI" : "2",
  "INFOADD" : "ITS ERROR"
  "DEVTYP" : "DISPLAY"
  "DEVID" : "1"
  "WHEELID" : "2",
  "AIRCIRCID" : "2",
  "DOORID" : "2",
  "ALTERNATORID" : "2",
  "WORNPERC" : "2",
}

```

### 13.3.6 TTS0 – Event OFF

- Format: Structure Class "HeaderEvt" + Structure Class "EventOFF"
- Code:

```

"Header":
{
  "ID" : 4,
  "SERVERNAME" : "ABB"
  "VIN" : "VIN00000000000001",
  "PROG" : 1374,
  "EVTDATE" : 1492714346,
  "SRVDATE" : 1492714366,
  "SENDDATE" : 1492714386,
  "CODE" : "TTS0",
  "TYPE" : "EVENT_OFF",
  "TX" : 0,
  "DST" : 240636,
  "GPSInfo" : { "LAT" :2932530,"LON" :155604,"ALT" : 260,"HEAD" : 0,"NUMSAT" : 7 }
}
,
"EvtOFF":
{
  "PROGON" : 1345,
  "EVD" : 65,
  "FOD" : 650,
  "SMX" : 25,
  "VB" : 276,
  "TRM" : 74,
  "TMX" : 77,
  "RPM" : 825,
  "GEAR" : 2,
  "BRKSTS" : 0,
  "PAC" : 26,
  "STP" : 0,
  "TTID" : 29,
  "TTSTS" : 2,
}

```

### 13.3.7 Alternator fault – Event ON

- Format: Structure Class “HeaderEvt” + Structure Class “EventON” + optional Structure Class “EXTRA”
- Code:

```

"Header":
{
  "ID" : 4,
  "SERVERNAME" : "ABB"
  "VIN" : "VIN00000000000001",
  "PROG" : 1345,
  "EVTDATE" : 1492714346,
  "SRVDATE" : 1492714366,
  "SENDDATE" : 1492714386,
  "CODE" : "FE01",
  "TYPE" : "EVENT_ON",
  "TX" : 1,
  "DST" : 240636,
  "GPSInfo" : { "LAT" :2932530,"LON" :155604,"ALT" : 260,"HEAD" : 0,"NUMSAT" : 7 }
}
,
"EvtON":
{
  "TCA" : 240,
  "TAM" : 220;
  "SMX" : 2;
  "VB" : 252,
  "TRM" : 65,
  "TMX" : 72,
  "RPM" : 750,
  "GEAR" : 4,
  "BRKSTS" : 0,
  "PAC" : 52,
  "STP" : 0,
  "TTID" : 2147483647,
  "TTSTS" : 2147483647,
}
,
"Extra":
{
  "CodeVMC" : "NULL",
  "DTC_SRC" : "NULL",
  "DTC_VRT" : "NULL",
  "DTC_SPN" : "NULL",
  "DTC_FMI" : "NULL",
  "INFOADD" : "NULL"
  "DEVTYP" : "NULL"
  "DEVID" : "NULL"
  "WHEELID" : "NULL",
  "AIRCIRCID" : "NULL",
  "DOORID" : "NULL",
  "ALTERNATORID" : "2",
  "WORNPERC" : "NULL",
}

```

### 13.3.8 Native fault – Event ON

- Format: Structure Class “HeaderEvt” + Structure Class “EventON” + optional Structure Class “EXTRA”
- Code:

```

"Header":
{
  "ID" : 4,
  "SERVERNAME" : "ABB"
  "VIN" : "VIN00000000000001",
  "PROG" : 1345,
  "EVTDATE" : 1492714346,
  "SRVDATE" : 1492714366,
  "SENDDATE" : 1492714386,
  "CODE" : "FM24",
  "TYPE" : "EVENT_ON",
  "TX" : 1,
  "DST" : 240636,
  "GPSInfo" : { "LAT" :2932530,"LON" :155604,"ALT" : 260,"HEAD" : 0,"NUMSAT" : 7 }
}
,
"EvtON":
{
  "TCA" : 240,
  "TAM" : 220;
  "SMX" : 2;
  "VB" : 252,
  "TRM" : 65,
  "TMX" : 72,
  "RPM" : 750,
  "GEAR" : 4,
  "BRKSTS" : 0,
  "PAC" : 52,
  "STP" : 0,
  "TTID" : 29,
  "TTSTS" : 2,
}
,
"Extra":
{
  "CodeVMC" : "34569",
  "DTC_SRC" : "2",
  "DTC_VRT" : "2",
  "DTC_SPN" : "2",
  "DTC_FMI" : "2",
  "INFOADD" : "ENGINE FAULT"
  "DEVTYP" : "ENGINE"
  "DEVID" : "1"
  "WHEELID" : "2",
  "AIRCIRCID" : "2",
  "DOORID" : "2",
  "ALTERNATORID" : "2",
  "WORNPERC" : "2",
}

```

## ANNEX - STRUCTURE DICTIONARY

Here is a general description of the fields contained in the structures:

"ADBL"	the AdBlue (Urea) Level [lsb = 1%] <sup>21</sup>
"AIRCIRCID"	the identifier of the air circuit [1-4]
"ALT"	the altitude of GNSS coordinate [lsb = 1m]
"ALTERNATORID"	the identifier of the alternator [1-4]
"BEPx"	the current pressure of bellow x [lsb = 1 kPa] <sup>22</sup>
"BRKPx"	the current pressure of air circuit x [lsb = 1 kPa] <sup>23</sup>
"BRKSTS"	the brake pedal status [0;1] <sup>24</sup>
"CODE"	the telediagnostic code of the event
"CodeVMC"	the native code of the event in the gateway
"DEVTYP"	the type of device <sup>25</sup>
"DEVID"	the identifier of the device <sup>26</sup>
"DOORID"	the identifier of the door [1-10] <sup>27</sup>
"DOP"	the dilution of precision from GNSS receiver [hdOP, vdOP or pdOP]
"DST"	the current mileage of the vehicle [lsb = 1 m] <sup>28</sup>
"DTC_FMI"	the DTC field [FMI]
"DTC_SPN"	the DTC field [SPN]
"DTC_SRC"	the DTC field [SRC]
"DTC_VRT"	the DTC field [VRT]
"EVD"	the time elapsed while the fault is ON [lsb = 1 sec]
"EVTDATE"	the data time when the event appeared on the vehicle [UNIX timestamp] <sup>29</sup>
"FOD"	the distance covered while the fault is ON [lsb = 1 m]
"GEAR"	the current gear [0 = Neutral; -1 = reverse; 1-n = drive gear] <sup>30</sup>
"GNSSType"	the information about the used GNSS System [GPS, GALILEO, DEADRECKONING]
"GPSInfo"	current GNSS position information <sup>31</sup>
"HEAD"	Heading of GNSS coordinate
"ID"	identifies the protocol release id (assigned by telediagnostic service supplier)
"INFOADD"	optional textual information [max 250 chr]

<sup>21</sup> As provided in [2] – Aftertreatment 1 Diesel Exhaust Fluid: AT1T1I – PGN FE56 / SPN 1761

<sup>22</sup> As provided in [2] - msg Air Suspension Control 4: ASC4 – PGN FE58 / SPN 1725 / 1726 / 1727 / 1728

<sup>23</sup> As provided in [2] - msg Air Supply Pressure: AIR1 – PGN FEAE / SPN 1087 / 1088 with: Circuit #3 = "Middle axis", Circuit #4 = "Auxiliary circuits"

<sup>24</sup> As provided in [2] - msg Cruise Control/Vehicle Speed: CCVS – PGN FEF1 / SPN 597

<sup>25</sup> Shall contain a text code to identify the type of the device (camera, TFT, LED, loudspeaker, mic, passenger counting sensor, etc.)

<sup>26</sup> Shall contain the id [1,2...] of the specific device affected by the fault

<sup>27</sup> Door id is related to device installation. Coding according to implementation.

<sup>28</sup> As defined [2] – msg High Resolution Vehicle Distance: VDHR – PGN FEC1 / SPN 917

<sup>29</sup> EVTDATE (Local time in UNIX format) = Event date time (UTC UNIX) +/- Time zone Offset

<sup>30</sup> As provided in [2] – Electronic Transmission Controller 2: ETC2 – PGN F005 / SPN 523

<sup>31</sup> This "sub structure" is mandatory, to be filled with "0" if no information is available.

"LAT"	the latitude of GNSS coordinate <sup>32</sup>
"LON"	the longitude of GNSS coordinate <sup>33</sup>
"LMC"	the Fuel Level [lsb = 1%] <sup>34</sup>
"MBD"	the Journey distance driven braking [lsb = 1 m]
"MBT"	the Journey time elapsed braking [lsb = 1 sec]
"MDO"	the Journey doors openings counter <sup>35</sup>
"MEI"	the Journey engine idle time [lsb = 1 sec]
"MEO"	the Journey engine hours [lsb = 1 sec]
"MFU"	the Journey fuel used [lsb = 1 dL] <sup>36</sup>
"MKO"	the Journey ignition ON time [lsb = 1 sec]
"MVDH"	the Journey vehicle distance [lsb = 1 m]
"NUMSAT"	the number of satellites available
"PAC"	the accelerator pedal position [lsb = 1%] <sup>37</sup>
"PROG"	an incremental number for each event received from a single vehicle
"PROGON"	the "PROG" of the EVENT_ON (only in case of the EVENT_OFF)
"RPM"	the engine speed [lsb = 1 rpm] <sup>38</sup>
"SENDDATE"	the date time when the event has been sent by the Client to telediagnostic backoffice [UNIX timestamp] <sup>39</sup>
"SERVERNAME"	Mnemonic identifier of connector client (to be agreed with telediagnostic service supplier)
"SMX"	the current vehicle speed [lsb = 1 km/h] <sup>40</sup>
"SRVDATE"	the date time when the event has been stored in the Gateway back-office [UNIX timestamp] <sup>41</sup>
"STP"	the status of the doors (1 = open if at least one is open; 0 = all doors closed) <sup>42</sup>
"TAM"	the time elapsed from engine start [lsb = 1 sec]
"TCA"	the time elapsed from ignition ON [lsb = 1 sec]
"TD2C"	the total (life time) Door#2 openings counter <sup>43</sup>
"TD3C"	the total (life time) Door#3 openings counter <sup>44</sup>
"TDFC"	the total (life time) Front door openings counter <sup>45</sup>

<sup>32</sup> Format is DD\*60000 (decimal degrees' format).

<sup>33</sup> Format is DD\*60000 (decimal degrees' format).

<sup>34</sup> As provided in [2] - msg Dash Display: DD – PGN FEFC / SPN 96

<sup>35</sup> As provided in [2] - msg Door Control 1: DC1 – PGN FE4E / SPN 1821

<sup>36</sup> As provided in [2] - msg Fuel Consumption: LFC – PGN FEE9 / SPN 250

note: msg High Resolution Total Fuel Used – PGN FD09 / SPN 5054 recommended for OEM pre-equipment or FMS v.03 or superior

<sup>37</sup> As provided in [2] - msg Accelerator Pedal Position: EEC2 – PGN F003 / SPN 91

<sup>38</sup> As provided in [2] – msg Electronic Engine Controller #1: EEC1 – PGN F004 / SPN 190

<sup>39</sup> SENDDATE (Local time in UNIX format) = Event date time (UTC UNIX) +/- Time zone Offset

<sup>40</sup> As provided in [2] - msg Cruise Control/Vehicle Speed: C CVS – PGN FEF1 / SPN 84

<sup>41</sup> SRVDATE (Local time in UNIX format) = Event date time (UTC UNIX) +/- Time zone Offset

<sup>42</sup> As provided in [2] - msg Door Control 1: DC1 – PGN FE4E / SPN 1821

note: Door Control 2: DC2 – PGN FDA5 / SPN 3413 / 3416 / 3419 / 3422 / 3425 / 3428 / 3431 / 3434 / 3437 / 3440 can be used if SPN 1821 is not available

<sup>43</sup> As provided in [2] - msg Door Control 2: DC2 – PGN FDA5 / SPN 3416

<sup>44</sup> As provided in [2] - msg Door Control 2: DC2 – PGN FDA5 / SPN 3419

<sup>45</sup> As provided in [2] - msg Door Control 2: DC2 – PGN FDA5 / SPN 3413

"TDRC"	the total (life time) Rear door openings counter <sup>46</sup>
"TEO"	the total (life time) engine hours [lsb = 1 h] <sup>47</sup>
"TES"	the total (life time) engine starts counter
"TFU"	the total (life time) fuel used [lsb = 1 L] <sup>48</sup>
"TMX"	the Transmission Oil Temperature [lsb = 1°C]
"TRM"	the engine coolant temperature [lsb = 1°C] <sup>49</sup>
"TTID"	the tell-tale ID [1-60] <sup>50</sup>
"TTSTS"	the tell-tale condition [1 - RED; 2 - YELLOW; 3 - INFO] <sup>51</sup>
"TVD"	the total (life time) vehicle distance [lsb = 1 km] <sup>52</sup>
"TX"	the transition mode of the event [0 - OFF; 1- ON; 3 - NA]
"VB"	the battery voltage [lsb = 0,1V] <sup>53</sup>
"VIN"	identifies the Vehicle identification number <sup>54</sup>
"VMCRx"	the Brake Pads wear-out for Brake pad x [1-6] [lsb = 1%] <sup>55</sup>
"WHEELID"	the identifier of the wheel [1-6] <sup>56</sup>
"WORNPERC"	the wear-out related to the Brake Pad in Fault [lsb = 1%]

<sup>46</sup> As provided in [2] - msg Door Control 2: DC2 – PGN FDA5 / SPN 3416 (if no Door#2 and no Door#3) or SPN 3419 (if Door#2 and Door#3) or SPN3422 (if Door#2 and Door#3)

<sup>47</sup> As provided in [2] - msg Engine Hours, Revolutions: HOURS – PGN FEE5 / SPN 247

<sup>48</sup> As provided in [2] - msg Fuel Consumption: LFC – PGN FEE9 / SPN 250

note: msg High Resolution Total Fuel Used – PGN FD09 / SPN 5054 recommended for OEM pre-equipment or FMS v.03 or superior

<sup>49</sup> As provided in [2] - msg Engine Temperature 1: ET1 – PGN FEEE / SPN 110

<sup>50</sup> As defined in [2] - msg FMS Tell Tale Status: FMS1 – PGN FD7D, Tell-tale ID is the combination of Block ID and Tell-tale Status.

<sup>51</sup> As provided in [2] - msg FMS Tell Tale Status: FMS1 – PGN FD7D, 001 = Cond. Red, 010 = Cond. Yellow, 011 = Cond. Info

<sup>52</sup> As provided in [2] - msg High Resolution Vehicle Distance: VDHR – PGN FEC1 / SPN 917

<sup>53</sup> Format is Voltage\*10

<sup>54</sup> As provided in [2] - PGN ECFF and PGN EBFF for Vehicle ID longer than 8 Bytes

<sup>55</sup> One data for each wheel starting from front left wheel

<sup>56</sup> starting from front left wheel