Cello-CANiQ-M™
Product Overview

Proprietary and Confidential

Version 1.0

Revised and Updated: 23 February 2022

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1 Introduction

The purpose of this document is to describe the features and capabilities of the Cello-CANiQ-M product. It is intended for product, marketing, support and sales teams of Cellocator partners, integrators and service provider customers.

1.1 Document Scope

The document describes the high-level system features and capabilities of the Cello-CANiQ-M product. This document does not deal with the protocols and interfaces between the Cello-CANiQ-M device and the SW backend, nor with the low-level algorithms, state machines and logic engine implemented to deliver a complete remote diagnostics and enhanced driver behavior system. These protocols, APIs, algorithms, and state machines are described in separate documentation, as listed in the following sections.

1.2 Definitions, Acronyms and Abbreviations

Name	Description
Cello-CANiQ-M	Cellocator's high end fleet management solution.
OBDII	On board diagnostics standard.
CAN	Controller Area Network.
PID	Parameter ID.
ISO 11898 -1/2	The basic CAN standard. Specifies the data link layer and the physical layer of the CAN in passenger cars and light duty vehicles.
SAE J1939	An SAE standard for a vehicle bus in medium and heavy-duty vehicles.
SAE J1979	An SAE standard which defines the communication between the vehicle diagnostics socket and test equipment.
SAE J1708	An SAE standard used for serial communications between ECUs on a heavy-duty vehicle and between a computer and the vehicle
ISO 15765	A standard that defines CAN for diagnostics in passenger cars and legislate OBD in light duty vehicles.
SAE J2284	SAE recommended practices for high-speed CAN (500Kbps), physical layer and portions of the data link layer for passenger cars and light duty vehicles.
PGN	Parameter Group Number.
SPN	Suspect Parameter Number (encapsulated by PGN).
ECU	Electronic control unit – a vehicle computer managing variable sets of data, mainly for emission and fuel consumption attributes.
FMS	A subset of J1939 defined for European manufacturers' Bus and Truck/Trailer market (Volvo, Scania, DAF, Daimler, Renault, Iveco, etc.).
DTCO D8	Digital Tachograph D8 – Serial data output channel continuously transmitting (in key on) speed, distance, time, date, engine revs, driver and co-driver activity information in a proprietary format.

Table 1 – Definitions, Acronyms and Abbreviations

1.3 References and Bibliography

No.	Document Name
1	Cellocator Cello Programming Manual
2	Cellocator Wireless Communication Protocol
3	Cellocator Serial Communication Protocol
4	Cellocator CSA Programming Manual
5	Cellocator Programmer Manual (including the CAN Editor)
6	Evaluation Manual
7	Cello Family Hardware Installation Guide

Table 2 – References

1.4 List of Changes

Version	Change	Remarks	Date Approved
1.0	First Draft		November 9, 2021

Table 3 - List of Changes

2 System Overview

2.1 General

The Cello-CANiQ-M addresses the mid and high-end segments of fleet management products for various advanced applications in vehicle, driver and logistics management.

The Cello-CANiQ-M enables connectivity with various vehicle environment interfaces, including standard CAN bus, OBD and K-Line interfaces, driver identification, as well as serial communication with third party devices, discrete, analog and frequency measurement ports, and others. All these interfaces are designed and configured for maximum flexibility in data aggregation, filtering, processing and reporting in a way which enables the development of future applicative add-ons.

The Cello-CANiQ-M, part of the Cello platform, provides modular and scalable HW options. It also provides a highly flexible and configurable infrastructure for easy programming of triggers, reaction and messaging schemes as a function of the complex array of inputs received from the vehicle bus.

The Cello-CANiQ-M supports direct connectivity to vehicle data buses supporting OBDII (ISO 15765, ISO 14229), CAN2.0 (ISO 11898, J1939, FMS), K-Line (ISO 14230 parts 1&2, ISO 9141-2) and J1708 (SAE J1587).

As part of the new Cello Platform, this product features several important enhancements, including 4G support, a multi-GNSS (GPS + GLONASS DGPS SBAS) engine, 1-wire bus support, and other infrastructure improvements, as described in the following sections.

The following table describes some of the main features and capabilities introduced with the Cello-CANiQ-M. Subsequent sections in this document provide further details on these features and capabilities.

Module / Issue	Feature / Functionality
CAN Bus	Support for variable bus rates (125/250/500Kbps, 1Mbps).
	CAN Editor: a graphical programming tool for configuration of CAN filters / operators / triggers.
	Improved CSA using parameters obtained from CAN bus connectivity (Speed, RPM, etc.).
Event-based complex triggering logic	Flexible CAN parameters evaluation for triggering via operators, timers and conditions.
	Type 11 messages: Generic CAN message templates for optimized data collection.
	Flexible event reaction scheme (output activation / messaging).

Module / Issue	Feature / Functionality
Support CAN & OBDII Protocols	Monitoring more than 80 concurrent parameters via OBDII querying.
	Filtering and monitoring up to 14 concurrent parameters via J-line.
	Full compatibility with J1939 for medium and heavy trucks including FMS.
	OBDII common standard PIDs support (see PIDs sheet).
	Full compatibility with K-Line (slow, fast) interface.
	DTC request / report over supported CAN bus protocols.
	Optional write-protected connection to the CAN bus through capacitance adapter.
Enhanced DBM	Using parameters received from CAN bus in maneuver / trip scoring calculations.
	Option for vehicle-based parameters in crash detection and E-call applications (Airbag, seat belt, etc.).
	Optional onboard road attributes layer for real- time over speed monitoring.
Extended IO	1-WIRE bus with current driving capabilities.
OTA Communication	Scalable cellular communication platform.
GPS	Multi-GNSS: GPS + GLONASS SBAS.
Mechanical Aspects	Cello enclosure.
	OBD harness with DFD support.
	OBD splitter (supports K-Line).
	Y-shape harness for OBD installations.

Table 4 - Cello-CANiQ-M Features

The Cello-CANiQ-M also fulfills the following objectives:

- It addresses the evolving fleet management market, which is trending towards advanced remote diagnostics, vehicle management and driver safety applications. It also enables market penetration in verticals which require OBDII connectivity (mainly private vehicles and LCVs) such as Usage Based Insurance (UBI), EV charging stations, and more.
- It enables direct connection to the vehicle bus and extraction of essential vehicle performance parameters (such as RPM, Speed, and VIN) required for more accurate and reliable driver behavior and ECO driving applications.
- It complies with the latest industry standards of communication technologies, location finding sensitivity and accuracy, and jamming immunity via advanced cellular and GNSS engines.

The Cello-CANiQ-M also enables interfacing with an OBDII port, in addition to the backward compatible connectivity to ISO-11898 / J1939 / J1708 networks. The supported OBDII ECU interrogation, along with the advanced logic engine for vehicle bus filtering and triggering, enables you to perform several actions, including:

- Configure the device to report vehicle performance exceptions upon detection.
- Monitor the ongoing usage profile of the vehicle.
- Indicate required preventive measures or maintenance.
- Detect driver misbehavior.

These capabilities help to dramatically reduce fleet operation costs through reduced wear and tear, shortened vehicle down time, lower warranty expenses, improved driving habits, optimized maintenance length, cost and scheduling, and so on.

3 Cello-CANiQ-M Technical Overview

3.1 System Architecture

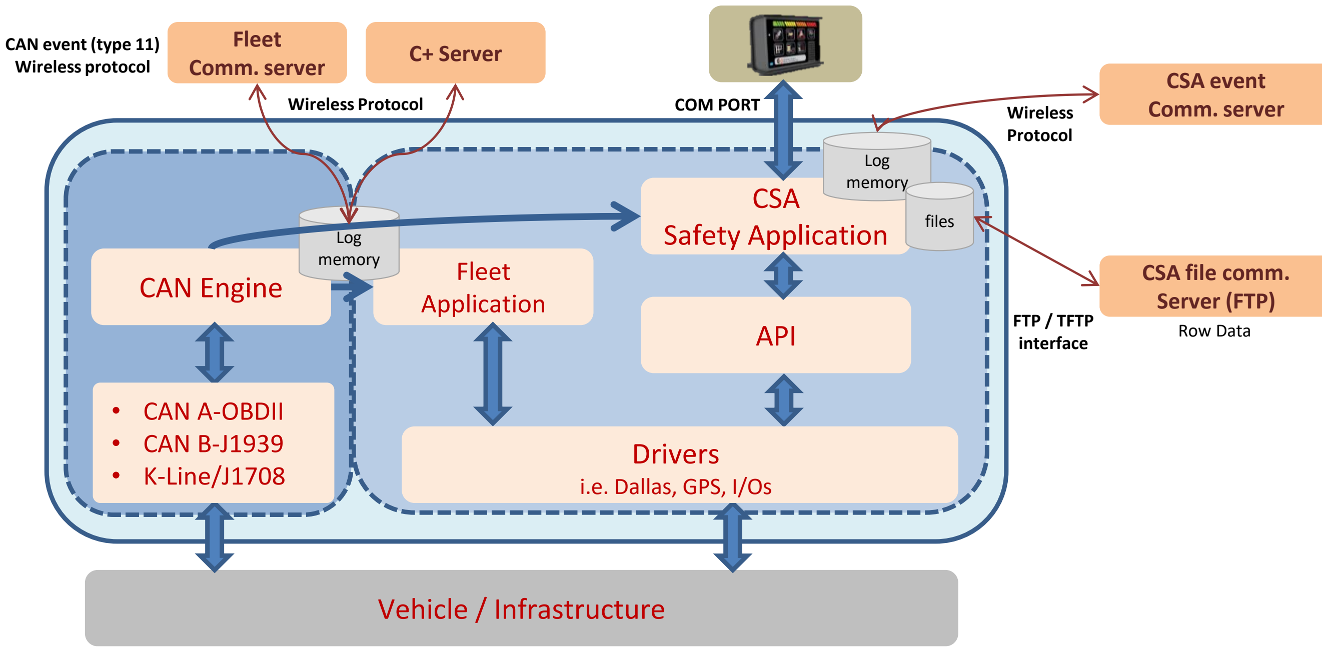

Figure 1 - Cello-CANiQ-M System Architecture

Vehicle parameters and sensors are monitored constantly by the CAN bus controller, which does not include any computing footprint on the device's MCU, as opposed to the design of the legacy Compact CAN which performed data filtering and analysis inside the CPU.

The CAN engine module obtains the PIDs / PGNs / SPNs from the drivers' layer, analyzes variables, and transfers them to the Fleet application module, CSA module, and to the backend via the OTA type 11 protocol.

CAN and OBD events are based on a modular protocol (message type 11), enhancing the message structuring and parsing flexibility.

The Cello-CANiQ-M HW design supports the optional internal interface of the MCU with extended NVM with a minimum capacity of 256Mbytes. This memory space will be used in the future for GIS based applications, such as real onboard over speeding monitoring, route usage violation, road sign compliance, and so on.

3.2 CAN Bus Triggering Logic Engine

3.2.1 *Supported # of Monitored Sensors*

The Cello-CANiQ-M can filter and monitor:

- 14 parameter sets (PGNs) concurrently on the ISO-11898 / J1939 / K-Line bus.

- More than one Arbitration ID using the same filter (by applying a “bits selection mask”); and subsequently a large increase in the number of concurrently filtered parameters.
- A maximum of 80 concurrently monitored OBDII PIDs (either standard or non-standard).

3.2.2 *CAN Parameters Evaluation for Triggering*

Using the CAN Editor SW tool, you can define the following logic operators as **triggers** for CAN-based event generation. The triggering logic engine in the Cello-CANiQ-M evaluates the status of the filtered sensors at least ten times a second, or at the maximal refresh rate available per sensor, whichever is lower.

	Condition	Description
1.	IN&OUT range	Sensor value goes in and/or out of a predefined range. All combinations are possible: in only/out only/both in and out.
2.	State equals to	A binary or a finite state parameter equal to a certain value.
3.	Above or below threshold	Sensor value goes above or below a predefined value. All combinations are possible: up only, down only, up and down (with or without hysteresis).
4.	State change	A binary or a finite state parameter changed its value.
5.	Difference below or above threshold	Difference between an existing value and the previous value of a certain sensor is above or below a certain threshold.
6.	Difference inside/outside range	Difference between an existing value and the previous value of a certain sensor is inside or outside a predefined range.
7.	Difference from last generated event	As per 5 & 6 above, but comparing to the value registered upon generation of the last event rather that the value in the last sensor reading (used, for example, for maintenance scheduling based on the odometer).
8.	Delta between two variables	Compares between two different parameters and checks whether the delta is above or below a certain threshold.
9.	Boolean logic operator of two evaluations mentioned above	Any Boolean combination of the above listed conditions (AND/OR/NOT) for one or two sensors.
10.	Boolean logic operator with Timer (two conditions exist for longer than Ta)	Any Boolean combination of the above listed conditions (AND/OR/NOT) for one or two sensors which is fulfilled for at least a predefined time.

	Condition	Description
11.	Boolean logic operator with Timer (two conditions fulfilled within a 'Tp')	Any Boolean combination of the above listed conditions (AND/OR/NOT) for two sensors whose specified condition is fulfilled within a predefined time after the first occurrence.
12.	Is in set (or not set)	The operator detects if missing/existing variable value from configured by PL list.
13.	Fuel theft detection operator	Dedicated operator for fuel theft detection.

Table 5 - CAN Sensor Evaluation for Triggering

3.2.2.1 Fuel theft detection operation

An operator for fuel theft is determined by several conditions:

- Normally, the fuel level is sampled too fast to detect theft. The sample rate is therefore reduced dramatically to detect theft.
- When driving, the fuel sloshes from side to side in the tank, and the sampled fuel level is typically unstable. In addition, fuel is normally stolen when the vehicle is not moving. Therefore, the fuel sampling for theft detection only occurs when the velocity is zero.
- Even after the vehicle stops, the fuel sloshes about in the tank for a few seconds. Therefore, the sampling for theft detection is postponed for a few seconds after the vehicle stops.
- In most cases, fuel theft occurs during the engine off state, when the CAN bus is not operational. Therefore, upon Ignition On, the Cello-CANiQ-M unit compares the first stable fuel reading with the reading recorded before the ignition was switched off.
- The 'Selected Arbitration IDs' field in the Filters tab shows the filtered Arbitration ID after the mask function is activated.

3.2.3 *MIL Parameter over OBD*

A bit parameter configuration in the PL enables the sending of the MIL (Malfunction Indicator Lamp) value when modified. The Cello-CANiQ-M compares the value of the MIL received from the OBD with the current stored value, and, if different, will send the new value to the backend via serial or OTA.

3.2.4 *Event Generation Methods*

3.2.4.1 General

There are three schemes in which the Cello-CANiQ-M generates a CAN-based event:

- **Once:** If one of the conditions listed in the previous section is fulfilled.
- **Periodic & Time limited**: If one of the conditions listed in the previous section is fulfilled and the user sets the system to log *x* CAN status updates with period 'Tp' between each two consecutive updates, or until the condition terminates, whichever comes first.

- **Periodic:** A CAN message is logged every ‘T’ second, as long as the ignition switch is turned on or the engine is running.

3.2.4.2 DTC Capture Logic

Diagnostics Trouble Code (DTC) reporting is supported by J1979, J1939/71 and K-Line, and can be captured by the Cello-CANiQ-M. The capturing and reporting logic can detect any changes in the trouble code state, as reported by the ECU or the various sensors in the CAN bus network. This means that any addition / deletion / change in trouble code data leads to event logging and reporting to the backend.

3.2.4.3 Back Off Mechanism

The logic engine can detect abnormal event generation rates caused by malfunctions of the bus / vehicle / device, and limit the number of generated events, along with reporting the attributes of the detected problem.

3.2.5 *CAN Reporting Features*

3.2.5.1 CAN Status Events Type

CAN events (Type 11) **are always memory logged events** to ensure zero loss of vehicle data.

3.2.5.2 CAN Status Event Attributes

CAN events (Type 11) generated by the Cello-CANiQ-M are modular and composed of the following Mandatory (**M**) and/or Optional (**O**) parts. Optional parts can be added (or removed) in the configuration:

- Header (**M**)
- Activated Trigger(s) ID(s) (**M**)
- Triggered Sensor values upon activation (**M**)
- Attached Sensors – up to 35 sensors can be attached to a CAN message, representing the values upon trigger activation as additional information (**O**)
- Timer Value which caused the trigger activation – if it exists (**O**)
- Trigger Activation time (**M**)
- Trigger Activation location (**O**)
- Other information modules representing status upon trigger activation, such as: I/O status, Driver ID, etc. (**O**)

3.2.5.3 Server-Side CAN Event Interpretation

The structure of the CAN event allows the backend to understand clearly, uniquely and unambiguously, why the event was generated and what are the CAN bus data elements in the message content.

For example, the explicit meaning of the trigger(s) ID(s) and explicit meaning of the various sensor IDs sent in the message can be automatically deduced on the server side using an XML file, which is generated by the CAN Editor for each unique PL and saved on the backend. This XML is associated with a PL signature sent in every uplink message and can be used upon message reception for easy parsing and presentation layer update.

For example, using the XML file, back-office personnel can understand that:

- Trigger ID 14 stands for "Engine temp higher than 90^{0}C for more than 15 minutes".
- An event holds sensor ID 222, which means *engine temp* = 95^{0}C, and sensor ID 459, which means that the *vehicle speed* was 80Km/h.

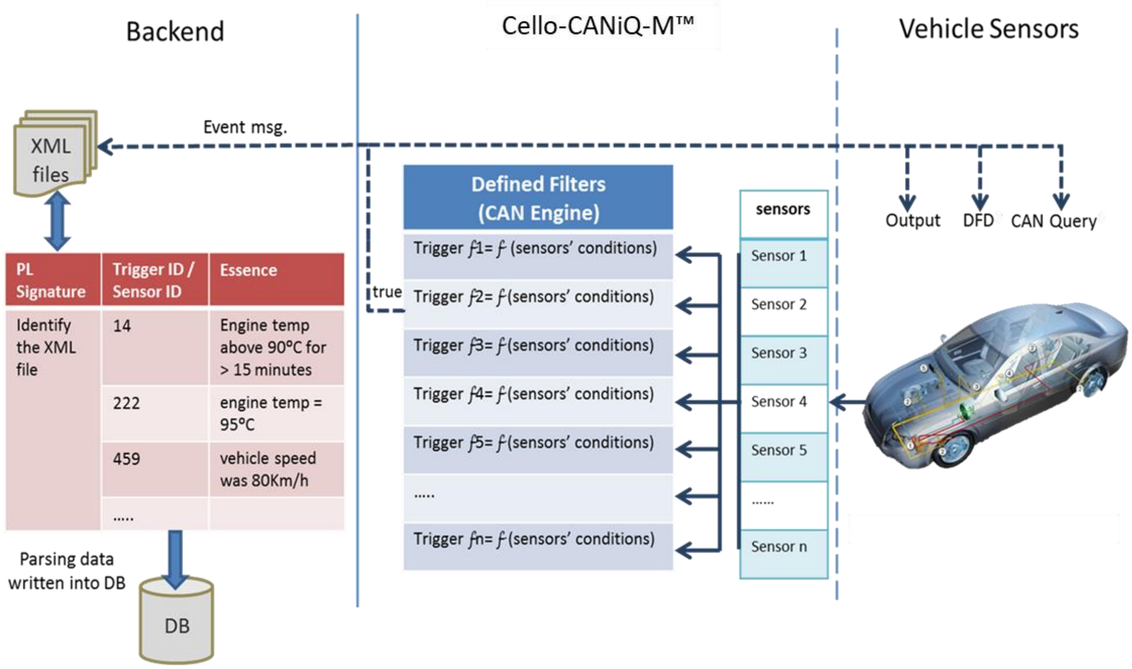

Figure 2 – Triggering Procedure

Sensors Array

- The sensors array is a storage space for information extracted by sensor type filters. Each sensor filter is linked with one of the sensor variables in the array. More than one filter may be linked with the same sensor variable, enabling the extraction of certain data using different filters.
- Each sensor can also be linked with one or more triggers, which allows certain actions to be performed when sensor values fulfill certain conditions.

Triggers

- The sensor triggers permit the unit to react to certain conditions of the information extracted to sensors.
- Triggers are defined by the CAN Editor and downloaded to the unit.

XML Files

- Contains the interpretation for each Trigger ID or Sensor ID, where the key is the PL signature.

For more information about the XML files generated with a PL and its use in the back end, please refer to the *Cello-CANiQ-M Programming Manual*.

3.2.5.4 In-vehicle Local Intervention

Upon fulfilment of a trigger, the Cello-CANiQ-M can perform additional local actions, on top of event transmission, such as:

- **Output activation** – it is possible to define the activated output and its pattern:
  - Permanent activation (either 'nested' or 'ad-hoc')
  - Pulse (with length definition based on a 0.1 second resolution)

- Pattern – once / repeating

- **Message to the DFD**
  - Message identifier
  - Type: Visual (LED array only)/beeps/voice/all
  - Severity – 1 to 4
  - Pattern: once / repeating (with interval) / duration

3.2.5.5 Tampering / Fault Detection

If the Cello-CANiQ-M is configured to monitor a vehicle bus but a valid bus connection cannot be detected by the device, an appropriate event is generated according to a predefined timeout threshold.

3.2.5.6 Analysis Exceptions

- **RPM**

  Whenever the RPM parameter is available (from the CAN bus or pulse counter), it's applied to the FM / CSA logic engine.

- **Odometer**

  Since the vehicle’s real odometer is not supported by the standard set of PIDs, and cannot be always extracted explicitly, the odometer value of the vehicle can be calculated by the Cello-CANiQ-M with an error level of not more than 1%.

- **Speed Calculation**

  The speed value reported by the CAN bus is typically inaccurate; it reflects the speed shown to the driver on the speedometer, but is manipulated by vehicle vendors (which, in most cases, increases the real speed for driver safety reasons).

  - Most of a Cello-CANiQ-M unit's applications (over speeding, idling and driver behaviour) need to use this manipulated speed to synchronize between the driver experience and the unit's reporting. But, to get real odometer values calculated from the speed, it is required to use the real speed values and not the manipulated speed values. For this reason, legacy systems used the "CAN Speed Correction Delta" parameter, which multiplies an existing System Speed by a pre-programmed signed value.
  - The inaccuracy of the CAN speed (as per the speedometer reading) is typically non-linear and should be calibrated with the GPS speed (as described in the *Cellocator Programmer Manual*).

- **Trip Fuel Consumption**

  Trip fuel consumption is one of the most important pieces of information for the Fleet Manager, after fleet daily expenses and fuel vandalism suspicion. Fuel consumed per trip is not always a standardized PID but it can be calculated / reported by the Cello-CANiQ-M according to the techniques below.

  Whenever calculated and reported in a trip report, the fuel consumption data is separated into two fields:

  - Total fuel consumed during movement
  - Total fuel consumed during idling

  Note: Idle/movement separation is available on CSA only.

One of the following five methods is used to determine the total fuel consumed in a trip:

- Subtract the last known "Total fuel consumed" parameter from the Total fuel consumed reported in the CAN bus (OBDII / J1939), upon end of the current trip.
- Calculating total fuel consumption from the fuel level, either from the fuel level from the CAN bus or physical fuel probe (by calculating the tank percentage level before and after a trip and translating it to total fuel consumed).
- Calculated by integral over momentary fuel rate parameter reported in the bus.
- Valid Pointer formula for gasoline engines (calculated on MAF air flow rate) and diesel engines (calculated on RPM and Injected Fuel Quantity).
- A formula (for gasoline) based on MAP (Manifold Air Pressure).

Diesel	**Trip Fuel Consumption**		Gasoline
	Fuel Consumed parameter		
	Calculated from Fuel Level (CANBUS/fuel probe)		
	Calculated by integral momentary on Fuel Rate (CANBUS)		
	Calculated on RPM and Injected Fuel Quantity	Calculated on MAF air flow rate	
		Calculated on MAP (Manifold Air Pressure) and Absolute Temperature	

The MAF sensor measures the volume of air going into the engine [grams/sec]

Figure 3 – Trip Fuel Consumption

Note: For each Trip End event, if enabled, it is automatically assigned with Trip Statistics (CSA module 32), and the trip fuel report data (idling, movement) is added.

3.3 Support for DTCO D8

Cello-CANiQ-M supports communication with a Digital Tachograph via the D8 port or via CAN (FMS standard) for HoS event triggering. This feature has been tested with VDO DTCO devices.

3.4 Real Idling

The Real Idling feature is based on RPM and Speed parameters.

If enabled by the user in the PL, the device refers to the RPM and Speed parameters received from the CAN/K-Line/GPS/Vss and determines idling only when the engine is running (RPM > defined value), and speed is lower than a defined threshold for a predefined time. As a result, idling will not be triggered if the switch is turned on, but the engine is not running. The Real Idling feature is applicable to both CSA and Fleet applications.

3.5 Usage Counter Based on Vehicle Voltage

The Usage Counter message takes into account the following conditions (and not only ignition state): Ignition is ON and Voltage has to be over 13v / or over 26v (for 24v vehicle batteries), as defined in the PL parameter.

The Usage Counter is stopped in the Ignition Off state.

3.6 Crash Detection in All Ignition States

The unit can also detect light/heavy crashes during Ignition Off, when configured with "average hibernation" (crash detection in "Full hibernation" is not available due to the low sampling rate of the accelerometer).

3.7 Thresholds for 1-wire Temperature Sensors

One of the main usages for temperature sensors is to get alerts only when the temperature exceeds the set temperature range, primarily to prevent shipment damage.

As a result, two thresholds (upper and lower) can be set for each 1-wire temperature sensor (for up to four temperature sensors). You can define the temperature range for all four temperature sensors as one definition in the PL, or apply different thresholds for each of them.

The thresholds are not mandatory (you can define both, only the upper or lower threshold, or none). If no thresholds are defined, no alerts are generated for temperature anomalies, and only periodic temperature measurements are sent.

3.8 PointerCept Logic

PointerCept logic implemented through a special activation code mechanism via the Programmer.

3.9 Special Applications

3.9.1 *Enhanced Driver Behavior Management (DBM)*

In-vehicle data connectivity opens a window to a wide range of information which can improve and enhance CSA functions and features. As a result, these features become more credible, accurate and informative.

The following variables (sensors), either from OBD, J1939 or K-Line interfaces, are used whenever available by the CSA (inputs to the CSA) as indicated. Note that the Cello-CANiQ-M configuration provides an indication of the existence of the relevant parameters as information sources for the CSA.

#	Vehicle BUS Variable / Parameter	Integration into CSA Functions
1.	RPM	• Used for all RPM based eco-driving functions of the CSA and is reported in manoeuvre statistics (Max RPM) and trip statistic files. • Used to reliably monitor real vehicle idling, together with the vehicle speed: Engine running and vehicle speed < TH (which is idling) vs. engine is not running and the ignition switch is open (which is not idling). • Used to reliably determine the engine state and to affect all other system functionalities derived from the engine status (Standby – Engine On/Off, hibernation, reporting logic, etc).
2.	Vehicle Speed	• Replaces GPS speed data whenever GPS is unavailable (underground parking / tunnels, etc.) or inaccurate (bad quality, during idling). • A non-linear conversion array is utilized to calibrate with GPS speed. • Whenever vehicle speed is available and "odometer" PID/PGN is unavailable, speed is used to calculate the odometer accurately (<1% error) as the primary source of information. It can be correlated with the GPS-based odometer calculations to get highly accurate results.

3.	Fuel flow rate	• Used to report MAX fuel flow rate during a manoeuvre in the manoeuvre statistics.
		• Used to calculate total fuel consumed during a trip in two distinct conditions:
		   ○ Idling
		   ○ Movement

#	Vehicle BUS Variable / Parameter	Integration into CSA Functions
4.	Fuel level	• Fuel level in a vehicle's tank (upon trip start/end) is reported at the end of each trip in the trip statistics file. • The Cello-CANiQ-M accepts the fuel tank size to convert % values into an actual fuel amount in liters. • Fuel level can be obtained either from the CAN bus (higher priority) or from an external sensor.
5.	VIN	• The Cello-CANiQ-M can retrieve the VIN and use it as a unique vehicle identifier when reporting a crash / accident in the crash attributes file. • The Cello-CANiQ-M can accept the VIN from the OBDII/CANBUS or via an API (OTA or serial command).
6.	# Of fastened seatbelts*	• Whenever this parameter is available from the vehicle data bus it is reported in the crash attributes file upon accident/crash detection. • If the driver has not fastened their seatbelt and the vehicle speed is >20Km/h for more than X seconds (configurable), an event is registered and sent to the backend.
7.	Airbag status*	• Whenever this parameter is available from the vehicle data bus, it is reported in the crash attributes file upon accident/crash detection (airbag activated / not activated).
8.	ABS*	• Whenever available, it is reported in every braking manoeuvre (including combination of events). • Braking events in which the ABS was activated will always get a zero score ('0').
9.	ESP / ESC*	• Whenever available, it is reported in every acceleration and/or turn manoeuvre. • Manoeuvres in which the EPS/ESC system was activated will get a zero score ('0').

Table 6 – DBM-related CAN Parameters

* Future enhancements

3.10 CAN Bus Interfaces

3.10.1 *Physical Connection*

Cello-CANiQ-M can be connected to a vehicle bus through the following distinct interfaces:

- OBDII socket via ports 6 (CAN-High) and 14 (CAN-Low). Sometimes CAN2.0 protocols exist in other ports of the OBD socket (for example: Pin 3 and Pin 11 in Ford vehicles).
- K-Line interface (ISO 9141-2) via port 7. The system automatically detects and applies the proper K-Line protocol (Slow/Fast) to communicate with the OBDII K-Line port.
- Directly to an ISO-11898 network, either through a dedicated J1939 connector or simple wire connection of a CAN high/low twisted pair harness.
- Using a decoupling capacitance device (such as CanGoclick), which ensures protected connectivity against writing to the bus. Such a device provides a CAN H/L equivalent interface.

The following images show typical CAN/OBD interfaces in heavy trucks and light vehicles.

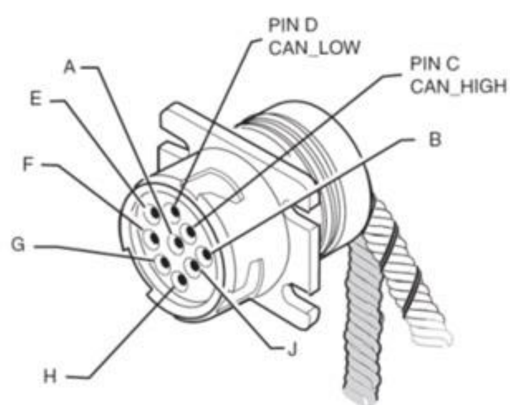

Figure 4 – SAE J1939 Connector

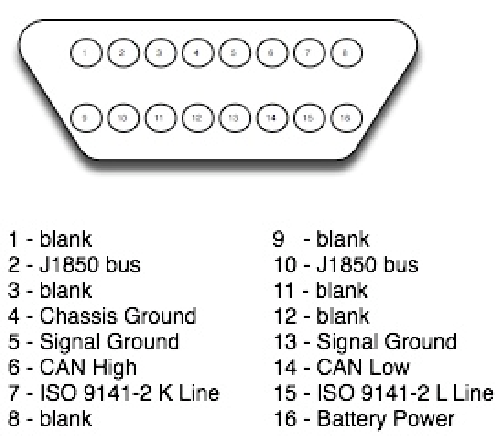

Figure 5 – OBDII Connector

3.10.2 *Cello-CANiQ-M Harnesses*

The Cello-CANiQ-M includes two harnesses, as described below.

+Vout	1	10	+Vin
GND	2	11	GND
Ignition	3	12	Input-3 (Panic)
Input-1 (Door)	4	13	1-Wire
RS232_EXT_TX	5	14	RS232_EXT_RX
GPIO-2	6	15	GPIO-1
Output-1 (Blinkers)	7	16	DTCO_D8
Output-2 (LED alert)	8	17	Input-2 (Shock)
Output-3 (PWM)	9	18	Output-4 (STD immob.)

Figure 6 – 18 Pins Connector

J1708_P	1	8	CANH1
J1708_N	2	9	CANL1
CANH2	3	10	K-Line
CANL2	4	11	SWCAN
Ignition	5	12	GND
OBD_Vin	6	13	+Vin
DBG_UART_RX	7	14	DBG_UART_TX

Figure 7 – 14 Pins Connector

3.10.3 *Supported Protocols*

- J1979 / J2284/ ISO15765-4
- J1939 / ISO 11898
- K-Line / ISO 14230 - parts 1 & 2 and 9141-2
- J1708 / SAE J1587

3.10.3.1 J1979 PID Interrogation

Unlike the J1939, in which the Cello-CANiQ-M does not place queries onto the vehicle bus, requests are sent through the OBDII socket to retrieve parameters which are needed by the application layer. The standard J1979 protocol defines a list of PIDs which can be queried. Unfortunately, not all these PIDs are supported by all vehicle types and models.

Most of the OBD-II PIDs in use are non-standard. For most modern vehicles, there are many more functions supported on the OBD-II interface than are covered by standard PIDs, and there is relatively minor overlap between vehicle manufacturers for these non-standard PIDs.

There is very limited information available in the public domain for non-standard PIDs. However, the Cello-CANiQ-M has the infrastructure to deal with both standard and non-standard PIDs, as described in the following sections.

3.10.4 *K-Line Interoperability*

The K-Line vehicle interface and CAN interface work in parallel and individually, where each line is connected to the other vehicle's ECUs, if both protocols are active in the OBDII port. The Cello unit can perform onboard analysis and trigger events logic from all connected interfaces (K-Line / CAN).

DTC can be retrieved from any valid connected interface (CAN/K-Line).

3.10.4.1 Common standard PIDs

The PIDs in the table below are likely to be supported by more than 80% of the vehicles manufactured after 2004. The Cello-CANiQ-M Editor provides predefined building blocks of these parameters which can be used when configuring the monitoring attributes of the device.

Mode	PID (HEX)	Data Bytes Returned	Description
1	1	4	Monitor status since DTCs cleared (includes malfunction indicator lamp (MIL) status and number of DTCs)
1	4	1	Calculated engine load value
1	5	1	Engine coolant temperature
1	0C	2	Engine RPM
1	0D	1	Vehicle speed
1	0F	1	Intake air temperature
1	11	1	Throttle position

Mode	PID (HEX)	Data Bytes Returned	Description
1	1C	1	OBD standards this vehicle conforms to
1	20	4	PIDs supported [21 - 40]
1	21	2	Distance traveled with malfunction indicator lamp (MIL) on
3	N/A	n*6	Request trouble codes (no PID required)
9	0	4	Mode 9 supported PIDs 01 to 20
9	2	5x5	Vehicle identification number (VIN)

Table 7 – Common OBDII PIDs

3.10.4.2 Extracting standard PIDs

The Cello-CANiQ-M unit extracts the supported (standard) PIDs from the currently connected vehicle through the Cello device to the Programmer via OTA or serial (if enabled via the PL parameter). This functionality enables you to define trigger logics via the CAN Editor, using proven existing parameters.

Note: For this capability, the standard PID attributes are removed from the Cello unit program memory and saved at the level of the SW (Programmer / Communication Centre).

3.10.4.3 Non-existing standard PIDs

Whenever a standard PID does not respond as expected or is not available in a specific vehicle, this information is reported to the server side in a dedicated message type or a dedicated field within an existing message.

3.10.4.4 Other Standard PIDs

The following PIDs are likely to be supported by more than 20% of the vehicles manufactured after 2004. Cello-CANiQ-M support (request and analysis) of these PIDs is optional. These PIDs will only be queried if defined in the PL configuration of the device and not automatically (by default) as for the PIDs described in Table 7.

Mode	PID (HEX)	Data bytes returned	Description
1	0	4	PIDs supported [01 - 20]
1	6	1	Short term fuel % trim - Bank 1
1	7	1	Long term fuel % trim - Bank 1
1	10	2	MAF air flow rate
1	1F	2	Run time since engine start
1	2F	1	Fuel level input
1	30	1	Number of warm-ups since codes cleared
1	31	2	Distance traveled since codes cleared

Mode	PID (HEX)	Data bytes returned	Description
1	33	1	Barometric pressure
1	3C	2	Bank 1, Sensor 1
1	40	4	PIDs supported [41 - 60]
1	41	4	Monitor status in this drive cycle
1	42	2	Control module voltage
1	43	2	Absolute load value
1	44	2	Command equivalence ratio
1	45	1	Relative throttle position
1	46	1	Ambient air temperature
1	47	1	Absolute throttle position B
1	48	1	Absolute throttle position C
1	49	1	Accelerator pedal position D
1	4A	1	Accelerator pedal position E
1	4B	1	Accelerator pedal position F
1	4D	2	Time run with MIL on
1	51	1	Fuel type
1	5E	2	Engine fuel rate
1	7F	13	Engine run time
2	2	2	Freeze frame trouble code
9	1	1x5	VIN Message Count in command 09 02

Table 8 - Additional Standard PIDs

3.10.4.5 Non-standard PID

In addition to the above listed PIDs which the Cello-CANiQ-M recognizes and parses if available and if configured to, the Cello-CANiQ-M also supports the querying and analysing of nonstandard PIDs according to attributes provided by the user through the configuration interface (such as the polling interval, PID, mode, data structure, units, multipliers, etc.). This usually follows a reverse engineering process or information received from the OEM.

4 Related Parts

The main Cello-CANiQ-M associated parts are listed in the table below.

Name/Part Number	Description
Cello-CANiQ-M (Assembly) **PN:** CT8000267-000 (Basic)	
DFD Unit (optional) **PN:** 715-50000	The Driver Feedback Display provides visual and audible notifications intended for friendly Eco-driving coaching and real-time assistance to help improve the driver's safety level.
Cello-CANiQ-M Evaluation kit (optional) **PN:** k090-067	The Cello-CANiQ-M Evaluation Kit includes all the components required for the product's evaluation.

Table 9 - Cello-CANiQ-M Associated Parts

4.1 Harnesses

The available Cello-CANiQ-M harnesses are listed below.

Part Number	Description
PN: 711-00444	Full 18 pin without mold
PN: 711-00445	Full 14 pin without mold
PN: 711-00446	Single CAN 14-pin
PN: 711-00385	OBDII splitter (supports K-Line)
PN: 715-50500	Contactless CAN Bus adapter

Table 10 - Cello-CANiQ-M Harnesses

4.1.1 *The CAN Contactless Adapter*

Some OBDII installations require a non-intrusive, non-galvanic interface with the vehicle. The 715-50500 CAN Contactless Adapter provides such a solution; it is mounted around the vehicle's CANH and CANL wires and senses the electromagnetic field generated when data is sent over CAN wires and translates these fields into standard CAN High and CAN Low signals. The CAN High, CAN Low signals are connected to the Cello-CANiQ-M CAN interface as if it was directly connected to the original bus.

Figure 8 - CAN Contactless Adapter

5 Professional Services

The Cello-CANiQ-M gives access to the vehicle CAN bus. This capability gives the unit the ability to read vehicle sensors and codes directly from the vehicle ECU's and process them according to the customer's applicative needs.

Since only some of the PIDs and PGNs in today's CAN networks are in the public knowledge domain, the identifiers and sensor attributes of many OEM custom or nonstandard sensors need to be extracted by reverse engineering processes or through direct relationships with vehicle manufacturers and dealers.

Cellocator publishes a monthly list of vehicles which are divided into three categories: *trucks*, *commercial* and *private.* This list includes all vehicle models and parameters sampled by the field engineering team. You can find it in the Cellocator Knowledge Base, under the Cello-CANiQ-M family, with the file name Supported Vehicles Database.

Legend	
!	Comment
V	Supported (Query)
V	Supported (Listen)
X	Not Supported

Vehicle Attributes / **Parameter Name**

Brand	Model	Year	Type	Standard	Vehicle identification number	Engine speed (RPM)	Wheel-Based Vehicle Speed	High Resolution Total Vehicle Distance	Engine Coolant Temperature	Engine total fuel used	Fuel level	Engine Intake Manifold 1 Temperature	PTO (Power Take Off)	Accelerator pedal position
DAF	XF	2004	Truck	J1939		V	V	V	V	V	V		V	V
	XF	2005	Truck	J1939		V	V	V	V	V	V		V	V
	XF	2006	Truck	J1939		V	V	V	V	V	V		V	V
	XF	2007	Truck	J1939		V	V	V	V	V	V		V	V
	XF	2008	Truck	J1939		V	V	V	V	V	V		V	V
	XF	2009	Truck	J1939		V	V	V	V	V	V		V	V
	XF	2010	Truck	J1939		V	V	V	V	V	V		V	V
	XF	2011	Truck	J1939		V	V	V	V	V	V		V	V
	XF	2012	Truck	J1939		V	V	V	V	V	V		V	V
	XF	2013	Truck	J1939		V	V	V	V	V	V		V	V
	XF	2014	Truck	J1939		V	V	V	V	V	V		V	V
	CF	2004	Truck	J1939		V	V	V	V	V	V		V	V
	CF	2005	Truck	J1939		V	V	V	V	V	V		V	V
	CF	2006	Truck	J1939		V	V	V	V	V	V		V	V
	CF	2007	Truck	J1939		V	V	V	V	V	V		V	V
	CF	2008	Truck	J1939		V	V	V	V	V	V		V	V
	CF	2009	Truck	J1939		V	V	V	V	V	V		V	V
	CF	2010	Truck	J1939		V	V	V	V	V	V		V	V
	CF	2011	Truck	J1939		V	V	V	V	V	V		V	V

INFO | TRUCKS DATABASE | COMMERCIAL DATABASE | PRIVATE DATABASE

Figure 9 - Supported Vehicles Database (Snapshot)

With the introduction of Cello-CANiQ-M, Cellocator established a Professional Services team consisting of CAN field application and support engineers, who will support reverse engineering, PL configuration and field test processes according to each customer's unique requirements.

As a Cellocator partner, you are encouraged to apply to your account manager with a project requiring CAN bus integration. The Cellocator team will evaluate the project, the existing knowledge and the project complexity, and will advise upon the best configuration solution, which may require vehicle bus inspection and data extraction. If approved commercially, Cellocator's Professional Services team will support the process, starting with project analysis, commercial evaluation, reverse engineering (or other scheme of data extraction), PL configuration definition, and lab tests. Note that the proposed service may involve additional NRE costs on top of the delivered HW costs.

6 Release Package Content

The legacy CAN management SW tools have been completely redesigned in order to provide a convenient, flexible and intuitive user interface.

6.1 Evaluation Suite

The Cellocator Evaluation Suite contains a complete set of components that simplifies bench testing of the system and serves as a demonstration platform for customers wishing to understand the operational aspects of the system. The Suite is also intended to facilitate the development of interfaces to the Cellocator system by integrators or service providers.

The *Cellocator Evaluation Suite Manual* is a comprehensive guide that provides information required to run an initial appraisal and testing process of Cellocator units, without requiring connection to an actual vehicle during testing.

6.1.1 *Cellocator Programmer*

6.1.1.1 Feature Authentication Codes

For dedicated customer projects, a *Feature Authentication Codes* option is accessible via the Programmer, enabling you to activate those special development projects into one source code without a "dirty" PL with non-relevant parameters.

In the Programmer, the code activation is entered in a dialog box (accessed via a toolbar button, as indicated below).

When connecting the Cello unit to the Programmer serial port for the first activation, you should click the **Feature Authentication codes** toolbar icon and enter the code that was sent from Cellocator CS. By entering this code, the relevant feature will be automatically activated, and the relevant PL folders displayed, which will be activated for any connected device.

This feature is also supported OTA, so devices already in the field which are upgraded to the latest version will also get this activation feature; a secured API/protocol was developed which sends the activation code to the device via the customer's backend.

6.1.1.2 CAN Editor

The CAN Editor is a Cellocator Programmer module that enables the user to select CAN variables, define trigger schemes, and define CAN actions.

The CAN Editor is a graphical tool designed to configure CAN related information sources with user defined behavior. It enables the user to select CAN variables and associate them with operators. Operators (which are logical data manipulation functions) manipulate the CAN data and generate events.

Variables and operators are associated by a simple graphical "Click & Drag" action designed to connect the vehicle to the operator.

The CAN Editor enables the following:

- Definition of the set of monitored sensors
- Definition of triggering and reporting rules and conditions
- Creation and selection of vehicle and/or monitoring configuration templates
- Parsing and analysis of incoming CAN-related data, etc.

6.1.2 *Communication Center*

Supports CAN messages (Type 11 protocol), with the OTA programmer also supporting CAN messages.

6.2 Cellocator+

The Cellocator+ System is a web-based application that enables Cellocator customers to perform configuration and firmware updates to Cellocator devices, and view the status of these updates in real-time and through reports via an intuitive interface.

The Cellocator+ System supports customers wishing to directly view and modify their device information. Users can request displays of device data and status and configuration management, and can perform configuration updates by attaching PL (Programming Library) files or firmware versions to a device or set of devices while the system manages the programming session.

The Cellocator+ System has several important features and benefits, including:

- Provides Cellocator customers with all major provisioning tools at the click of a mouse.
- Eliminates the need for all customers to maintain provisioning tools in their systems.
- Reduces time-to-market for new customers.
- Provides reports on update history (to be implemented in future versions).
- Manages the whole device management process.
- Enables customers to view update statuses online in real-time.

6.3 Integration Package

The Integration Package includes the Cellocator Gateway, a set of SW components offered to Cellocator customers wishing to integrate the Cellocator OTA protocol into their production environment. Cellocator Gateway provides customers with a quicker and easier integration process; customers are also entitled to software upgrades, technical support and more. Cellocator Gateway is a multi-platform solution and can run over Windows or selected Linux OS. The Integration Package provides high availability and load balancing options, as well as enabling clients the opportunity to integrate and start working with Cellocator units without the need to invest a large amount of time and resources.

As the Cello-CANiQ-M is a remote diagnostics device, intended to be integrated by fleet management SW development and integration companies, it supports its new protocols and Cellocator integration tools including all message and command types, as defined in the *Protocols Specification* document.

7 Documentation

The product is supported by set of documents including Evaluation, Integration and Installation manuals, Protocols description, programming reference etc. For more information, refer to the documents listed in section 1.3.

8 Technical Specifications

Communication	
Cellular Communication	LTE CAT M1 WW with 2G Fallback CAT M1: B1, B2, B3, B4, B5, B8, B12, B13, B18, B19, B20, B26, B28 2G: GSM850, GSM900, DCS1800, PCS1900
Data Rates	CAT M1: uplink up to 375kbps, downlink up to 300kbps 2G (EGPRS): uplink up to 236kbps, downlink up to 296kbps
Power Output	2W 33db GSM, 0.5W 27db EDGE, 0.2W 23db LTE, ALL with ± 2db (1.5mW)
SIM	Internal, replaceable, remote PIN code management
Antenna	Internal, multi bands, LTE bands + GSM bands
Packet Data	TCP/IP or UDP/IP for commands and events, FTP and TFTP for crash files upload
SMS	PDU, text SMS for data forwarding
BLE 5.2	• Serial over BLE • Wireless Maintenance / MDT • Built-in chip antenna
GNSS	
Technology	Quectel L76-NB
Sensitivity (tracking)	High sensitivity: -165dBm during tracking, -148dBm during acquisition
Channels	99 acquisition/ 33 tracking channels and 210 PRN channels
GPS	DGPS, SBAS (WAAS/ EGNOS/ MSAS/ GAGAN)
TTFF @-130dBm	Cold Start<30s, Warm Start<2s, Hot Start<2s
Internal Antenna	On board, internal patch antenna
External Antenna	Optional external active antenna (2.85V ± 0.5%), SMA connector (not in every model) External antenna short/disconnect detection circuitry, firmware-controlled receiver antenna source selection

Inputs and Outputs	

Inputs	• One (1) input dedicated for ignition switch
	• One (1) internally pulled up discrete dry or wet input with assignable functionality and configurable threshold for logical high and low states
	• Two (2) configurable inputs capable of serving as:
	  ○ Frequency counters - configurable resolution; up to 5kHz input signal; signal level (3V < Vin ≤ 30V), accuracy ±2%
	  ○ Analog inputs with variable resolution - 8bit, adapted to 0-2.5V signal, resolution 20mV, and accuracy ±20mV; 8bits, adapted to 0-30V Signal, resolution 100mV, accuracy ±100mV
	  ○ Discrete Dry and Wet – both, configurable threshold for logical high and low states

Outputs	4 general purpose open drain outputs (250mA max) with assignable functionality
Configurable I/Os	2 pins either digital inputs (internally pulled up or wet) or outputs
Interfaces	
COM port (RS232)	Selectable baud rate (9600 or 115000bps) True RS232 levels; 8 bit, 1 Stop Bit, No Parity MDT Interface Garmin™ Interface PSP™ (Car Alarm) Interface Cellocator Serial Protocol Transparent data mode Configuration update Firmware upgrade
Debug port (UART)	External Monitoring of Modem-CPU dialog True RS232 levels; 115000bps, 8 bit, 1 Stop Bit, No Parity
J-1708 / RS485 (optional)	SAE J1587 and SAE J1922
USB 2.1	Micro USB (Type B) UART access for debug and maintanance OTG hardware ready
Two (2) CAN HS interface	CAN FD HW readiness CAN-H, CAN-L Signals Bus-Pin Fault Protection up to ±36 V Bus-Pin ESD Protection Exceeds 16-kV HBM ISO 11898; Signaling Rate up to 1 Mbps

	Extended –7V to 12V Common-Mode Range SAE J1939 Standard Data Bus Interface ISO 15765 for OBDII connectivity ISO 11783 Standard Data Bus Interface ISO 9141-2 and 14230-2 for K-Line Connectivity
Single Wire CAN	SAE J2411 single wire
K-Line interface	A bi-directional one-wire-bus interface compliant with ISO 9141-2 and ISO 14230 1&2
D8 interface	D8 serial protocol Rx line for interfacing Digital Tachograph (DTCO), infrastructure preparation
1-Wire™ (Dallas port)	DS1990A, DS1971 compliant Extended bus current source with 7 mA driving capability Driver management (supports up to 100 DriverIDs) Car Alarm Authorization
Accelerometer	3D, ±2g/8g range, 12 Bit representation, 1mg resolution, I2C interface
Connectors	18pin Molex for IO applications 14pin Molex for CAN applications SMA switch for optional external GPS Antenna
Power	
Input Voltage	8-32VDC
Average Current consumption	**Normal:** 40mA **Economic:** 23mA **Hibernation:** <2.5mA **Shipment (Off):** <20uA (Internal Battery)
Internal Battery	Li-Ion Polymer, 3.7V, 1000mAh, rechargeable Up to 200 Tx @ 1Msg/min @ 25°C Embedded NTC for temperature-controlled charging Operating Temperature: -20 (65% charge) to 60°C **Protections:** over current, overcharge and over discharge
Vehicle Environment Immunity	
Immunity	Compliant with ISO 7637 test level #4 (in accordance with e-mark directive)
Environment	
Temp, operation	-30°C to +70°C full performance
Temp, storage	-40°C to +85°C

Humidity	95% non-condensing
Ingress Protection	IP40
Vibration, Impact	ISO 16750
Power transients	ISO 7637 Test level 4 (e-mark directives compliant)
Mounting	Tie-wraps and/or double-sided adhesive
Certifications	
FCC	Part 15 Subpart B, part 22/24 compliant
CE	CE EMC & R&TTE according to 89/336/EEC or 1999/5/EC CE Safety EN60950-1:2001+A11:2004 CE number - CE 1177,1909 Automotive Directive 2004/104/EC (E-Mark)
IC	Industrial Canada
PTCRB	TRP, TIS, Spurious and harmonics emission
EN12830 compliance With 1-wire temperature sensor	Suitability: T Climatic environment: without Cello Protector – B with Cello Protector – D Accuracy class: -10°C to +85°C - 1 <-10°C, > +85°C - 2 Range: -55°C to +125°C
Dimensions and Weight	
Dimensions	104 x 86 x 26.9mm
Weight	140gr

Table 11 - Technical Specifications