Cello-CANiQ Overview

Cellocator Division
Pointer Telocation Ltd.

Proprietary and Confidential

Version 1.4

Revised and Updated: October 13, 2015

POINTER

POINTER TELOCATION LTD. 14 HAMELACHA ST., ROSH HA'AYIN 48091, ISRAEL • TEL: 972-3-5723111 • FAX: 972-3-5723100 • www.pointer.com

Legal Notices

IMPORTANT

1. All legal terms and safety and operating instructions should be read thoroughly before the product accompanying this document is installed and operated.
2. This document should be retained for future reference.
3. Attachments, accessories or peripheral devices not supplied or recommended in writing by Pointer Telocation Ltd. May be hazardous and/or may cause damage to the product and should not, in any circumstances, be used or combined with the product.

General

The product accompanying this document is not designated for and should not be used in life support appliances, devices, machines or other systems of any sort where any malfunction of the product can reasonably be expected to result in injury or death. Customers of Pointer Telocation Ltd. Using, integrating, and/or selling the product for use in such applications do so at their own risk and agree to fully indemnify Pointer Telocation Ltd. For any resulting loss or damages.

Warranty Exceptions and Disclaimers

Pointer Telocation Ltd. Shall bear no responsibility and shall have no obligation under the foregoing limited warranty for any damages resulting from normal wear and tear, the cost of obtaining substitute products, or any defect that is (i) discovered by purchaser during the warranty period but purchaser does not notify Pointer Telocation Ltd. Until after the end of the warranty period, (ii) caused by any accident, force majeure, misuse, abuse, handling or testing, improper installation or unauthorized repair or modification of the product, (iii) caused by use of any software not supplied by Pointer Telocation Ltd., or by use of the product other than in accordance with its documentation, or (iv) the result of electrostatic discharge, electrical surge, fire, flood or similar causes. Unless otherwise provided in a written agreement between the purchaser and Pointer Telocation Ltd., the purchaser shall be solely responsible for the proper configuration, testing and verification of the product prior to deployment in the field.

POINTER TELOCATION LTD.'S SOLE RESPONSIBILITY AND PURCHASER'S SOLE REMEDY UNDER THIS LIMITED WARRANTY SHALL BE TO REPAIR OR REPLACE THE PRODUCT HARDWARE, SOFTWARE OR SOFTWARE MEDIA (OR IF REPAIR OR REPLACEMENT IS NOT POSSIBLE, OBTAIN A REFUND OF THE PURCHASE PRICE) AS PROVIDED ABOVE. POINTER TELOCATION LTD. EXPRESSLY DISCLAIMS ALL OTHER WARRANTIES OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF NON-INFRINGEMENT, MERCHANTABILITY, SATISFACTORY PERFORMANCE AND FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL POINTER TELOCATION LTD. BE LIABLE FOR ANY INDIRECT, SPECIAL, EXEMPLARY, INCIDENTAL OR CONSEQUENTIAL DAMAGES (INCLUDING WITHOUT LIMITATION LOSS OR INTERRUPTION OF USE, DATA, REVENUES OR PROFITS) RESULTING FROM A BREACH OF THIS WARRANTY OR BASED ON ANY OTHER LEGAL THEORY, EVEN IF POINTER TELOCATION LTD. HAS BEEN ADVISED OF THE POSSIBILITY OR LIKELIHOOD OF SUCH DAMAGES.

Intellectual Property

Disclaimer

Cello-CANiQ is an open platform that allows the user to implement various CANBUS connectivity configurations in regards to ECU parameters being captured or queried, as well as the querying rate. While using the vehicle's OBDII port, the Cello-CANiQ sends queries to the diagnostics ECU. In such installations, if an unqualified user defines a faulty configuration, it may result in errors on the OBD port. In other cases, the installer may choose to connect the device directly to the vehicle bus, via a wired connection and not a dedicated connector – an installation type which can be viewed by a vehicle manufacturer as a cause for warranty remit. As a result, the user should use only the validated installation and device configuration officially recommended by Cellocator.

In no event shall Pointer be liable for any direct, indirect, incidental, special, punitive or consequential damage, losses or expenses relating to or arising from the Cello-CANiQ, including without limitation, its installation, programming, configuration and use thereto; provided however, that Pointer warrants to the buyer that during the period of one year commencing on the date the Cello-CANiQ is purchased the Cello-CANiQ shall conform in all material respects with the performance specifications, attached to the unit purchased.

Table of Contents

List of Tables

List of Figures

1 Introduction

The purpose of this document is to describe the features and capabilities of the Cello-CANiQ product, and 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 product. This document does not deal with the protocols and interfaces between the Cello-CANiQ device and the SW backend, nor with the low level algorithms, state machines and logic engine implemented in order 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	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.
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).

Name	Description
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)
7	Evaluation Manual
8	Cello Family Hardware Installation Guide

Table 2 – References

1.4 List of Changes

Version	Change	Remarks	Date Approved
1.0	First Draft		
1.1	Second Draft		
1.2	Add CE number to specifications Add EN12830 compliance		
1.3	Addition CAN functionalities and CAN editor improvements		October 11, 2015
1.4	Minor update		October 13, 2015

Table 3 - List of Changes

2 System Overview

2.1 General

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

The Cello-CANiQ allows connectivity with various vehicle environment interfaces, including standard CANBUS and OBD interfaces, driver identification, and serial communication with third party devices, discrete, analog and frequency measurement ports, voice channel, DTCO, 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, a member of the new Cello platform, provides modular and scalable HW options ("peripheral ready", such as SD card, DTCO D8 connectivity and multiple communication technology support) as well as a highly flexible and configurable infrastructure for easy programming of the requested triggering, reaction and messaging scheme as a function of the complex array of inputs received from the vehicle BUS.

The Cello-CANiQ supports DIRECT connectivity to vehicle data buses supporting ISO-11898, J1939 and/or ISO-15765 via an OBDII connector. HW form and fit are not changed and the enclosure and connectors look similar to other Cello family devices. Nevertheless, as part of the new Cello Platform, this product features a number of important enhancements, including 3G support, a multi-GNSS (GPS and Glonass Hybrid positioning) 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. Subsequent sections in this document provide further details on these features and capabilities.

Module / Issue	Feature / Functionality
CAN bus	Supporting Variable BUS rates with automatic detection mechanism (125/250/500Kbps, 1Mbps).
	CAN Editor: New graphical programming tool for CAN filters/operators/triggers configuration.
	Improved CSA using parameters obtained from CANBUS 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 up to 25 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).
	DTC request / report over supported CANBUS protocols.
	Optional write-protected connection to the CANBUS through capacitance adapter.
Enhanced DBM	Using parameters received from CANBUS 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	SDIO infrastructure - Future Applications enabler.
	1-WIRE bus with current driving capabilities.
	DTCO D8 port interface – HW infrastructure.
OTA communication	Scalable cellular communication platform - Telit UE-910 (2G, 3G).
GPS	Multi-GNSS: GPS & Glonass hybrid support.
	AGPS Ready
	External antenna short / open circuit detection and alert with automatic switching.
Mechanical Aspects	Cello enclosure.
	Internal / external GPS antenna.
	OBD harness with DFD support.
	Generic harness with CANBUS connectivity and DFD support.
	Y-shape harness for OBD installations – Soon To Be Implemented

Table 4 - Cello-CANiQ Phased Release Content

2.2 System Narrative

The Cello-CANiQ 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 privates and LCVs) such as Usage Based Insurance (UBI).
- It further improves Cello-IQ features and capabilities by enabling 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 keeps pace with industry standards of communication technologies, location finding sensitivity and accuracy, and jamming immunity via advanced Cellular and GNSS engines.

The Cello-CANiQ allows interfacing with an OBDII port, in addition to the backward compatible connectivity to ISO-11898 / J1939 networks. The supported OBDII ECU interrogation, along with the advanced logic engine for vehicle bus filtering and triggering, allows the user to configure the device to report vehicle performance exceptions upon detection, to monitor the ongoing usage profile of the vehicle, to indicate required preventive measures or maintenance, to detect driver misbehavior, and so on.

These capabilities should contribute dramatically to a further reduction of 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.

2.2.1 *Cello-CANiQ Product Variants*

There are three HW variants of the Cello-CANiQ:

- Cello-CANiQ 2G
- Cello-CANiQ 3G NA
- Cello-CANiQ 3G EU

For each HW variant, two Feature Package (FP) FW variants exist: 30 and 50.

FP30 includes fleet and CAN functionalities, and FP50 includes fleet, CAN and advanced DBM functionalities.

In addition, FP upgrade procedures will be available for each unit.

Unit / Feature Package	Cello IQ (GNSS) 2G (HW[1])		Cello-CANiQ 2G (HW[2])		Cello-CANiQ 3G (NA (HW[3]) ,EU (HW[4]))	
	valid version	upgrade	valid version	upgrade	valid version	upgrade
30 (Fleet)	V (FW[1])		+CAN (FW[6])		+CAN (FW[4])	
40 (DBM)	V (FW[2])		NA		NA	
50 (Advanced DBM)	V (FW[3])		+CAN (FW[7])		+CAN (FW[5])	

4 HW variants
7 FW variants
5 upgrades procedures

Figure 1 – Single Platform Product Matrix

3 Cello-CANiQ Technical Overview

3.1 System Architecture

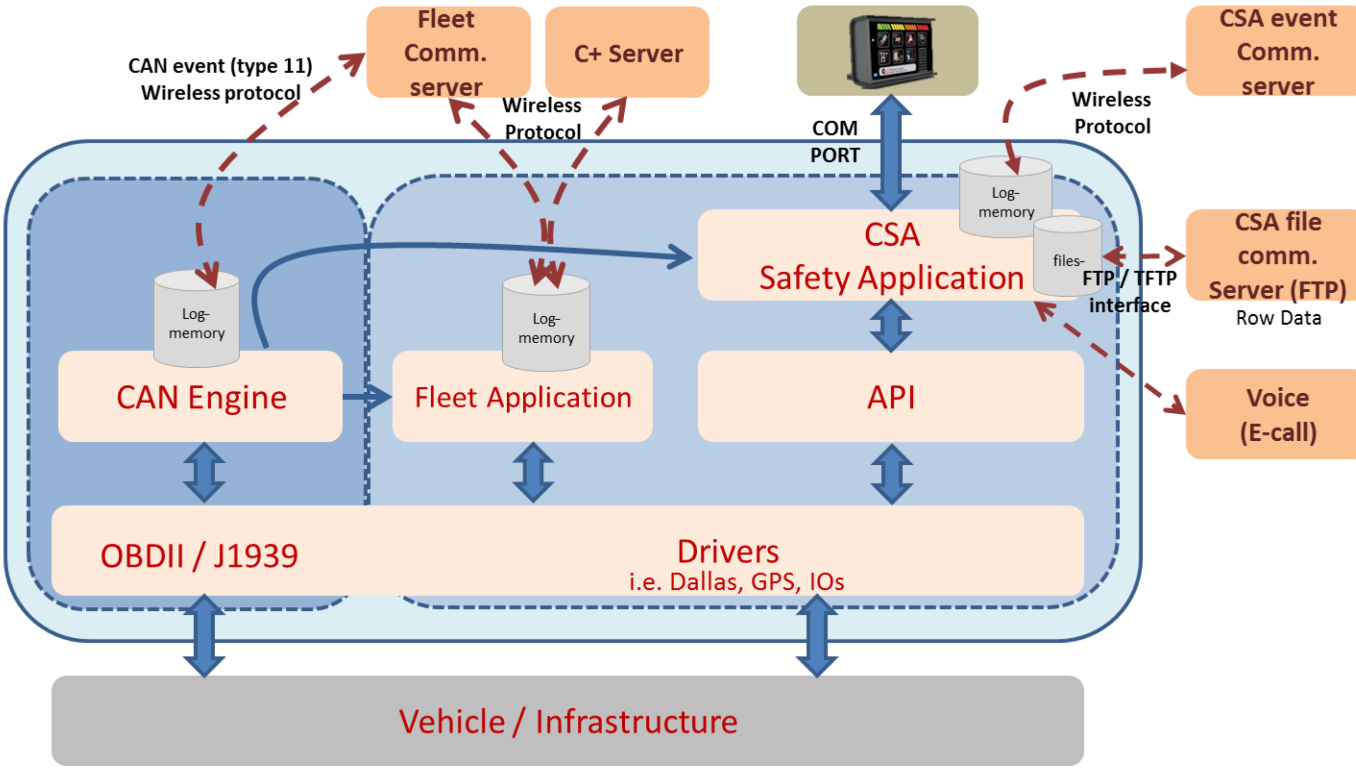


Figure 2 - Cello-CANiQ System Architecture

The Cello-CANiQ HW design and architecture is based on the Cello-IQ in order to allow the optional operation (see the available variants in the following sections) of the existing Cello-IQ logic and algorithms (CSA). In addition, all existing fleet management and security features and capabilities, at the time of the Cello-CANiQ version release, are supported by default.

Vehicle parameter and sensors are monitored constantly by the CANBUS 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.

An additional module added to the Cello-CANiQ is the CAN engine. This 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 new modular protocol (message type 11), enhancing the legacy type 9 messages in order to improve message structuring and parsing flexibility.

The Cello-CANiQ 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 CANBUS Triggering Logic Engine

3.2.1 *Supported # of Monitored Sensors*

The Cello-CANiQ can filter and monitor:

- 14 Parameters sets (PGNs) concurrently on the ISO-11898 / J1939 bus can be filtering.
- By applying 'bits selection mask' one can filter more than one Arbitration ID using the same filter and by that to increase dramatically the number of concurrently filtered parameters.
- OBDII PIDs – Maximum of 25 concurrently monitored PIDs (either standard or non-standard).

The Cello-CANiQ can operate in one of the above mentioned modes.

3.2.2 *CAN Parameters Evaluation for Triggering*

Using the CAN editor SW tool, the user can define the following logic operators as **triggers** for CAN-based event generation. The triggering logic engine in the Cello-CANiQ evaluates the status of the filtered sensors at least 10 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 existing value and the previous value of a certain sensor is above or below a certain threshold.
6.	Difference inside/outside range	Difference between 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 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	Compares between two different parameters and

	Condition	Description
	variables	checks whether 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.
11.	Boolean logic operator with Timer (two conditions fulfilled within Tb)	Any Boolean combination of the above listed conditions (AND/OR/NOT) for two sensors which their specified condition fulfills within a predefined time since the first occurrence.
12.	Is in set(or not set)	The operator detects if missing/exist 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 a number of conditions:

- Normally the fuel level is sampled too fast to detect theft. The sample rate is reduced dramatically to detect theft.
- During driving, the fuel sloshes from side to side in the tank, and the sampled fuel level is typically unstable. In addition, the 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 unit compare the first stable fuel reading with the one recorded before the ignition was switched off.
- The 'Selected Arbitration IDs' field at the Filters tab is showing the filtered Arbitration ID after the mask function is activated

3.2.3 *Event Generation Methods*

3.2.3.1 General

There are three schemes in which the Cello-CANiQ 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:** CAN message is logged every 'T' seconds as long as the ignition switch is turned on or the engine is running.

3.2.3.2 DTC Capture Logic

Diagnostics Trouble Code reporting is supported by both J1979 and J1939/71 and can be captured by the Cello-CANiQ. The capturing and reporting logic is able to detect any changes in the trouble codes state as reported by the ECU or the various sensors in the CANBUS network. This means that any addition / deletion / change in trouble code data leads to event logging and reporting to the backend.

3.2.3.3 Back Off Mechanism

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

3.2.4 *CAN Reporting Features*

3.2.4.1 CAN Status Events Type

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

3.2.4.2 CAN Status Event Attributes

CAN events (Type 11) generated by the Cello-CANiQ 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 Sensors values upon activation – (**M**)
- Attached Sensors – up to 20 sensors can be attached to a CAN message, representing the values upon trigger activation as additional information – (**O**)
- Timer Value which caused 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**)

3.2.4.3 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 CANBUS 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 also sensor ID 459 which means that the *vehicle speed* was 80Km/h.

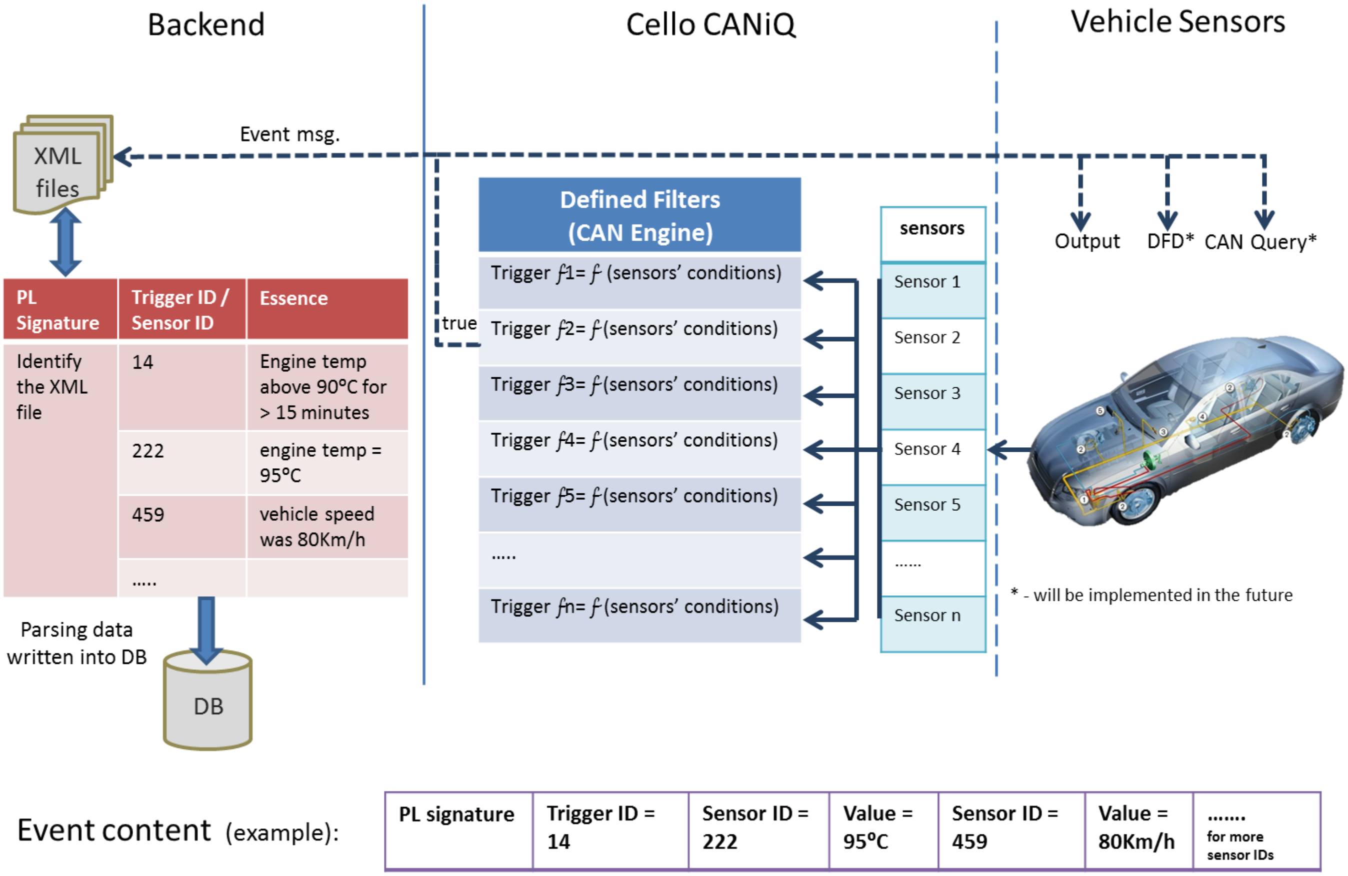


Figure 3 – Triggering Procedure

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 may also be linked with one or more triggers, which allow 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 Integration Manual*.

3.2.4.4 In-vehicle Local Intervention

Upon fulfilment of a trigger, the Cello-CANiQ 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 in 0.1 second resolution)
  - Pattern – once / repeating
- **Message to the DFD (To Be Implemented)**
  - Message identifier
  - Type: Visual (LED array only)/beeps/voice/all
  - Severity – 1 to 4
  - Pattern: once / repeating (with interval) / duration

3.2.4.5 Tampering / Fault Detection

If the Cello-CANiQ 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.

3.2.4.6 Analysis Exceptions

- **RPM**

  Whenever the RPM parameter is available (from CANBUS or from 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 with 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 unit's applications (over speeding, idling and driver behaviour) need to use this manipulated speed in order to synchronize between the driver experience and the unit's reporting. But, for getting 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 a standardized PID but it can be obtained via:

- Fuel Consumption parameter from the CAN bus (OBDII and J1939) – if it exists.
- Integral calculations on the Momentary Engine Fuel Rate are translated at the end of the trip to the total fuel consumption per trip.

3.3 Special Applications

3.3.1 *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 and make it more credible, accurate and informative.

The following variables (sensors), either from OBD or J1939 interfaces, are used whenever available by the CSA (inputs to the CSA) as explained (the Cello-CANiQ 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 maneuver statistics (Max RPM) and trip statistic files. • Used as another measure to reliably monitor real vehicle idling together with the vehicle speed: Engine running and vehicle speed < TH, means idling vs. engine is not running and the ignition switch is open – this is not idling. • Used in order 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 in order to calculate odometer accurately (<1% error) as the primary source of information. It can be correlated with the GPS-based odometer calculations in order to get highly accurate results.

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

4.	Fuel level	• Fuel level in vehicle's tank (upon trip start/end)

#	Vehicle BUS Variable / Parameter	Integration into CSA Functions
		is reported at the end of each trip in the trip statistics file. • The Cello-CANiQ accepts the fuel tank size in order to convert % values into actual fuel amount in liters. • Fuel level can be obtained either from the CANBUS (higher priority) or from external sensor.
5.	VIN	• The Cello-CANiQ can retrieve VIN and use it as a unique vehicle identifier upon report of crash / accident in the crash attributes file. • The Cello-CANiQ can accept 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. • Whenever the driver has not fastened their seatbelt and the vehicle speed is >20Km/h for more than X seconds (configurable parameters), 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 maneuver concerned with braking (including combo event). • Braking events in which ABS was activated will always get a zero score ('0').
9.	ESP / ESC*	• Whenever available, it is reported in every maneuver concerned with Acceleration and/or Turn. • Maneuvers in which EPS/ESC system was activated will get a zero score ('0').

Table 6 – DBM-related CAN Parameters

* Future enhancements

3.4 CANBUS Interfaces

3.4.1 *Physical Connection*

Cello-CANiQ 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).
- 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.

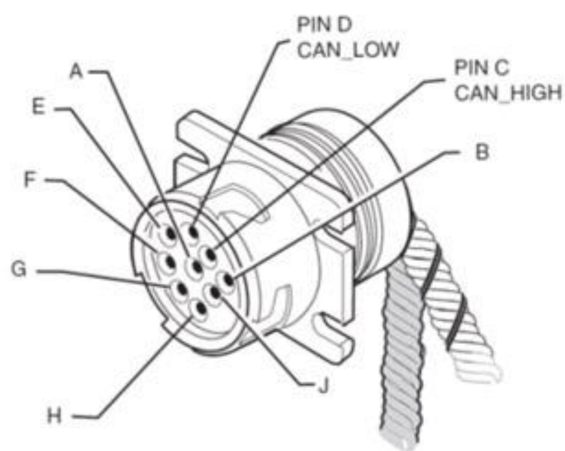


Figure 4 – SAE J1939 Connector

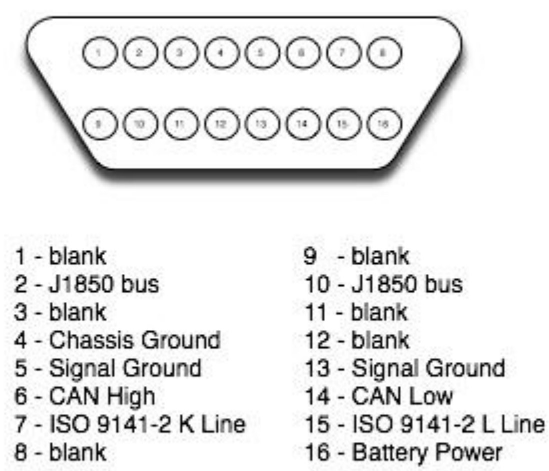


Figure 5 – OBDII Connector

3.4.2 *Cello-CANiQ Pinout*

Pin Number	Function
1	Backup Battery/ CELLO Debug
2	Main Power (VCC)
3	GND for Debug
4	Ignition Switch
5	CAN-L
6	Global output, LED, or Geo-Fence notification
7	Global output, Engine Immobilizer, or Geo-Fence notification
8	Input from DTCO D8 port
9	Handsfree – Audio Out
10	Handsfree - Audio In
11	CAN-H
12	RS232 TXD
13	RS232 RXD
14	Global inputs, Door
15	Global input, standard voice call control, privacy mode control, usage counter input, or frequency counter
16	Global input, emergency button, usage counter, or emergency voice call initiation
17	Gradual immobilizing, or global output, or Geo-Fence notification
18	Global output, system feedback, or Geo-Fence notification
19	Handsfree – Audio GND
20	Dallas

Table 7 – Cello-CANiQ Pinout

3.4.3 *Supported BUS Rate*

The Cello-CANiQ can automatically detect the available CANBUS baud rate and set the self-baud rate automatically from the following options:

- 125 Kbps (typically used in comfort buses)
- 250 Kbps (typically used by J1939)
- 500 Kbps (typically used by OBDII)

3.4.4 *Supported Protocols*

- J1979 / J2284/ ISO15765-4
- J1939 / ISO 11898

3.4.4.1 J1979 PID Interrogation

Unlike the J1939, in which the Cello-CANiQ does not place queries onto the vehicle bus, requests are sent through the OBDII socket in order 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 of these PIDs are supported by all vehicle types and models.

The majority of all OBD-II PIDs in use are actually non-standard. For most modern vehicles, there are many more functions supported on the OBD-II interface than are covered by the 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 has the infrastructure to deal with both standard and non-standard PIDs, as described in the following sections.

3.4.4.2 Common standard PIDs

The PIDs in the table below are likely to be supported by > 80% of the vehicles manufactured after 2004. The Cello-CANiQ Editor provides predefined building blocks of these parameters to be easily used while 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
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 8 – Common OBDII PIDs

3.4.4.3 Non-existing standard PIDs

Whenever a standard PID does not respond as expected or is not available at all 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.

3.4.4.4 Other Standard PIDs

The following PIDs are likely to be supported by > 20% of the vehicles manufactured after 2004. Cello-CANiQ 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) like in the case of the PIDs described in Table 8.

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	# of warm-ups since codes cleared
1	31	2	Distance traveled since codes cleared
1	33	1	Barometric pressure
1	3C	2	Bank 1, Sensor 1
1	40	4	PIDs supported [41 - 60]
1	41	4	Monitor status 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

Mode	PID (HEX)	Data bytes returned	Description
1	7F	13	Engine run time
2	2	2	Freeze frame trouble code
9	1	1x5	VIN Message Count in command 09 02

Table 9 - Additional Standard PIDs

3.4.4.5 Non-standard PID

On top of the above listed PIDs which the Cello-CANiQ recognizes and parses if available and if configured to, it 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.), usually following a reverse engineering process or information received from the OEM.

3.5 Harnesses

3.5.1 *OBDII Basic Harness*

In the proposed basic OBDII harnesses, the OBDII connector is an ultra-low-profile connector intended to minimize interference by the driver, surrounding plastic covers, or adjacent components. The basic OBDII harness supports DFD connection. The following list describes the functionality of the harness:

- Main Cello-CANiQ connector branch - 1.2m
- Sleeved 4-wire harness: CAN H, CAN L, GND, VCC
- 1st end – Standard 20 pin Molex
- 2nd end – standard OBDII connector, ultra-low profile
- DFD branch with DFD connector at the end, 0.9m length

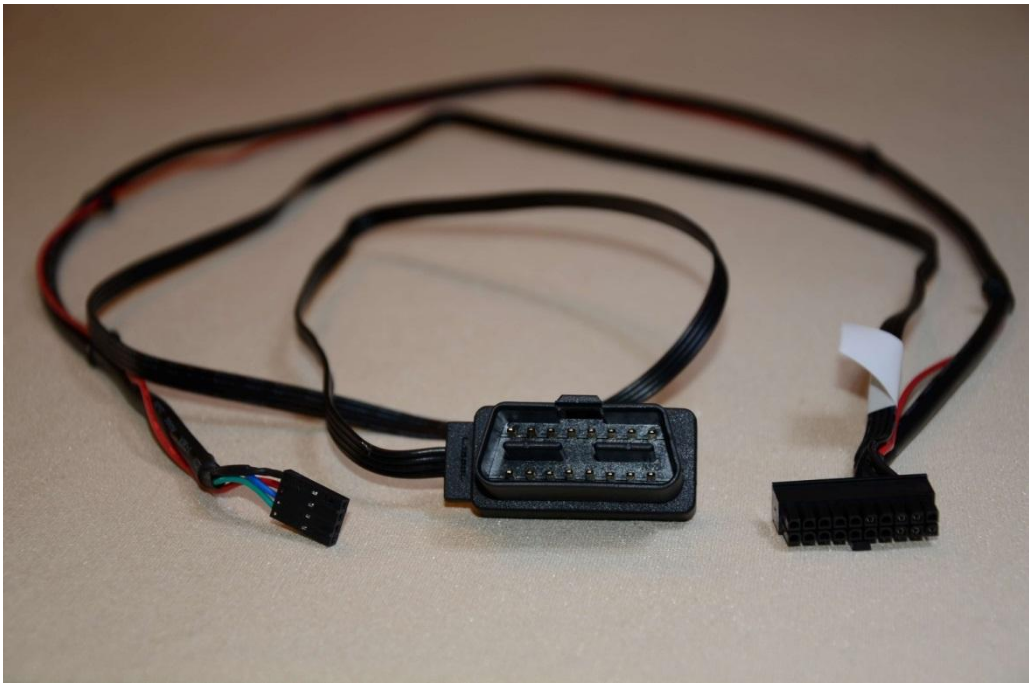


Figure 6 –Cello-CANiQ Basic OBDII Harness

3.5.2 *Cello-CANiQ Generic Harness*

- Mold-free connector
- Lines length: VCC,GND,IGN – 1.8m, other I/O's - 1.2m
- I/Os: Dallas 1-wire (sleeved with GND), GND+VCC+IGN (sleeved with exposed colored edges), DFD interface (VCC as power source instead of IGN), 2 inputs (Pin14 – shielded, Pin15 – single wire), 3 output (PWM immobilizer, Std Immobilizer, Blinkers), LED (connector), CAN H&CAN L (Twisted pair)
- 1st end – Standard 20 pin Molex
- 2nd end – DFD connector (1m), LED (1m), Open wires – full length

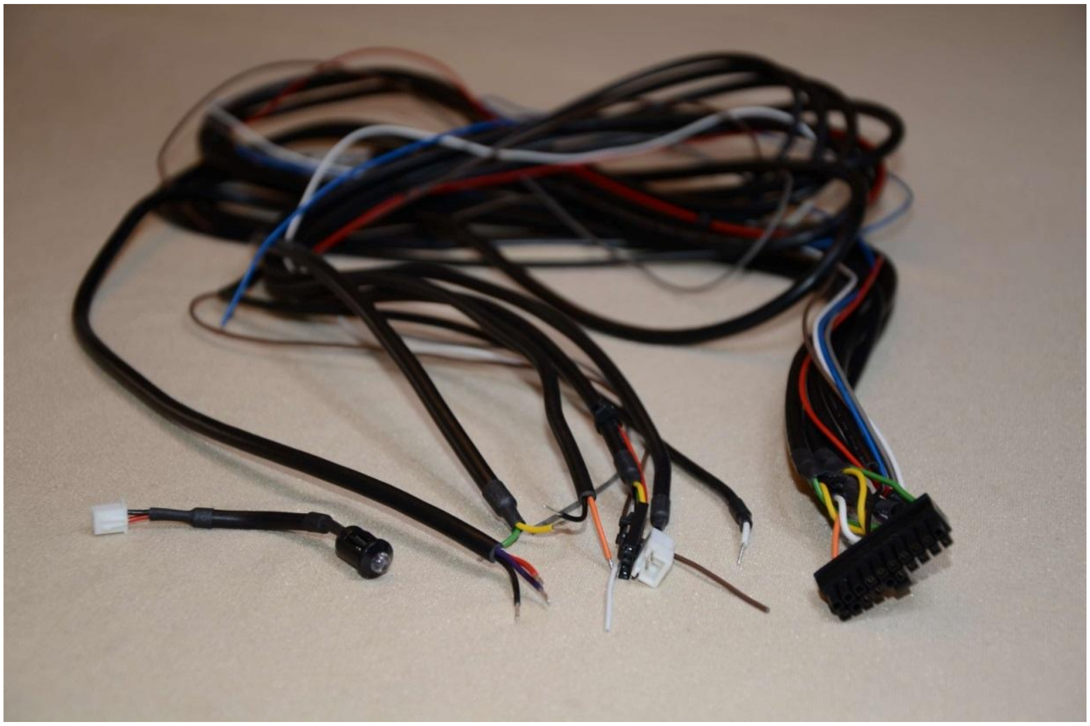


Figure 7 - Cello-CANiQ Generic Harness

3.5.3 *The OBDII Y Cable*

The OBDII Y Cable is an adapter connecting the vehicle OBDII connector to the Cello harness, allowing covert installation and connection of diagnostics tools in a workshop.

Figure 8 - 711-00335 OBDII Y Cable

4 Professional Services

The Cello-CANiQ 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.

Due to the fact that only part 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 vehicles models and parameters sampled by the field engineering team. You can find it in the Cellocator Knowledge Base web page, under the Cello CANiQ 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, 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 or opportunity requiring CAN bus integration. The Cellocator team will evaluate the opportunity, 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.

5 Release Package Content

The existing CAN management SW tools, used with the Compact family, were completely redesigned in order to provide a convenient, flexible and intuitive user interface.

5.1 Evaluation Suite

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.

The Cellocator Evaluation Suite contains a complete set of components that simplify bench testing of the system and serve as a demonstration platform for people 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.

5.1.1 *Cellocator Programmer*

The CAN Editor is a new 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 module fulfils the following objectives:

- 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.

Please refer to the *Cello-CANiQ Integration Introduction* presentation for further information.

5.1.2 *Communication Center*

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

5.1.3 *FMS Transmitter*

The CANiQ FMS (Fleet Management System) Transmitter application simulates the CAN bus activity to the CANiQ unit by sending CAN messages from the PC, using the CAN USB device connection.

5.1.4 *CAN Recorder*

The CAN USB Logger application logs CAN data from a vehicle's CAN bus and stores it into a file for further usage. The CAN Logger screen has several tabs used to view and manipulate the data. For example, the data displayed in the **FMS** tab can be utilized by the FMS transmitter application. Items in the **Existence** column, marked with green checkmarks (√) are available on the vehicle CAN Bus and items marked with red X signs are not available.

5.1.5 *CAN Emulator*

The CAN Bus Emulator is an integration / evaluation tool, provided in addition to the Evaluation Suite, which allows the sending of CAN bus information to the Cello-CANiQ CAN interface, simulating a vehicle CAN bus operation.

Please refer to the *Cello-CANiQ Integration Introduction* presentation for further information.

5.2 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. The user 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 a number of important features and benefits, including:

- Provides Cellocator customers with all major provisioning tools at the click of a mouse.
- Eliminates the need of 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).
- Cellocator+ manages the whole device management process.
- Customers can view update statuses in real time through the Web.

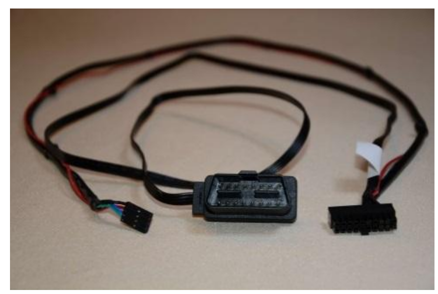
5.3 Integration Package

The Cellocator Gateway is a set of SW components offered to Cellocator customers wishing to integrate the Cellocator OTA protocol into their production environment. Customers using Cellocator Gateway benefit from a quicker and easier integration process, and 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 investing a large amount of time and resources.

Since the Cello-CANiQ 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.

6 Cello CAN-IQ Hardware Components

The Cello-IQ hardware components are listed in the table below.

Name/Part Number	Description	Picture
Cello-CANiQ	3 HW variants: ◆ Cello-CANiQ 2G ◆ Cello-CANiQ 3G NA ◆ Cello-CANiQ 3G EU	
Cello-CANiQ Basic OBDII Harness **PN** 711- 00321	This harness can be used to connect the Cello-CANiQ to a vehicle OBDII interface. The OBDII connector is an ultra-low profile connector intended to minimize interface with the driver, surrounding plastic covers, or adjacent components. Besides CAN connectivity it includes also connection to main power and ground and communication to the DFD.	
Cello-CANiQ Generic Harness **PN** 711- 00318	14 wires harness dedicated to Cello-CANiQ with DFD connector. 1.2 meter length (1.8 meter power wires) with frequency counting support main power and ignition, CAN high and CAN low, LED with connector interface, Ext. immobilizer output, Ext. data (serial port), Door, Shock sensor (unlock 2), Gradual output, Global output, Dallas including distress button. Suitable for complementary adaptors (not included).	

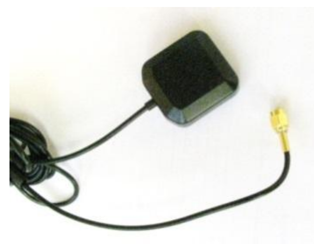
Name/Part Number	Description	Picture
OBDII Y Cable **PN** 711-00335	OBDII Y Cable is an adapter connecting the vehicle OBDII connector to the Cello harness, allowing covert installation and connection of diagnostics tools in a workshop.	
DFD Unit **PN** 715-50000	Driver Feedback Display provides visual and audible notifications intended for friendly Eco-driving coaching and real-time assistance to help improve the driver's safety level.	
External GNSS Antenna **PN:** AN0048	Optional external active antenna for the hybrid GNSS (GPS and Glonass) receiver of the Cello-IQ.	
Cello-CANIQ Evaluation kit	The Cello-CANIQ Evaluation Kit includes all the components required for the evaluation of the Cello-IQ.	

Table 10 - Cello-IQ Components

7 Documentation

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

8 Technical Specifications

Communication	
GSM Modes:	**3G:** NA: UMTS/HSPA/GSM/GPRS/EDGS: 5.76[UL]/7.2[DL] Mbps, 850/1900 EU: UMTS|HSPA: 5.7[UL]/7.2[DL] Mbps, 900/2100 GSM/GPRS/EDGE: 850/900/1800/1900 MHz **2G:** GSM/GPRS: 24[UL]/48[DL] Kbps, 850/900/1800/1900 MHz
Power Output	2W, 1W
SIM	Internal, replaceable, remote PIN code management
Antenna	Internal, multi band GSM antenna
Packet Data	TCP/IP, UDP/IP
SMS	PDU, text SMS for data forwarding
GPS	
Technology	STM STA8088 Chipset
Sensitivity (tracking)	-162dBm
Acquisition (normal)	Cold <35Sec, Warm<35Sec, Hot<1Sec
Internal Antenna	On board, internal patch antenna
External Antenna	External Active antenna (2.85V ± 0.5%), SMA connector. External Antenna short/Disconnect detection circuitry. Firmware controlled receiver antenna source selection.
Inputs and Outputs	
Inputs	1 internally pulled down input dedicated for ignition switch 1 internally pulled up Discrete Dry inputs with assignable functionality and configurable threshold for logical high and low states. 2 configurable inputs capable to serve 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, accuracy ±20mV; 8bits, adapted to 0-30V

	signal, resolution 100mV, accuracy ±100mV **Discrete Dry** – configurable threshold for logical high and low states. **Discrete Wet** - configurable threshold for logical high and low states.
Outputs	4 general purpose open drain outputs (250mA max) with assignable functionality.
Interfaces	
Voice Interface	Cellocator HF compliant Full duplex Echo cancelation Noise suppression Spy listening option Auto-answer option Volume control by single button or two buttons Distress voice call and plain call generation
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 (RS232 out)	External Monitoring of Modem-CPU dialog 115000bps True RS232 levels; 8 bit, 1 Stop Bit, No Parity
CAN interface	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
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 Car Alarm Authorization
Accelerometer	3D, ±2g/8g range, 12 Bit representation, 1mg resolution, I2C interface
Connectors	20pin Molex, Automotive SMA switch for optional external GPS Antenna
Power	
Input Voltage	7-32VDC
Average Current consumption	**Normal:** 40mA **Economic:** 23mA **Hibernation:** <2mA **Shipment (Off):** <20uA (Internal Battery)
Internal Battery	Li-Ion Polymer, 3.7V, 900mAh, 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 two 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: w/o 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	91x73x23mm
Weight	110gr

Table 11 - Technical Specifications