1-Wire Temperature Sensor Overview

Cellocator Division
Pointer Telocation Ltd.

Proprietary and Confidential

Version 1.1

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POINTER

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1 Introduction

1.1 Scope and Purpose

The purpose of this document is to describe the features and capabilities of the 1-Wire Temperature Sensor, which connects to the 1-wire bus of the Cellocator unit and enables temperature-monitoring in Fleet Management applications.

The document is intended for TSP or IT integrators who want to use the information provided by the sensor within their Telematics applications. It is intended to provide all the required information for customers, customer support, and sales personnel.

The document provides information regarding the available solution, sensor description, the sensors and involved components technical specifications, installation instructions, integration with the Cellocator unit, notes for the Telematics application developer and EN18230 compliance declaration.

1.2 Abbreviations

Abbreviation	Description
TSP	Telematics Service Provider
IT	Information Technology

1.3 References

All the reference documents listed in the following table can be downloaded from the Knowledge Base section of the Pointer website (www.Cellocator.com).

#	Reference	Description
1.	Maxim DS18b20 Datasheet	
2.	1-Wire Network Design Guide	
3.	Cello Family Hardware Installation Guide	
4.	Harness Selection Wizard	
5.	Cellocator Cello Programming Manual	
6.	Cellocator Wireless Communication Protocol	

1.4 Revision History

Version	Date	Description
1.0	10/05/2015	Initial version
1.1	June 17, 2015	Update integration section

2 General Description

2.1 Overview

The 1-wire Temperature Sensor provides a low-cost, easy to install solution for the cold chain transportation markets.

Each Cello unit can support up to 4 temperature sensors installed in different places in the vehicle and communicate online the measured temperature values to a telematics application. The CR300 unit can support one temperature sensor.

Cellocator also provides several installation accessories to ensure professional, reliable and fast installation of several temperature sensors on the same 1-wire bus. The Cellocator unit and the 1-wire temperature sensor comply with EN 12830, allowing usage in applications which require compliance with this standard.

2.2 Product Components

The 1-wire temperature sensors and required installation components are listed in Table 1 below.

Name/Part Number	Description	Picture
Cellocator 1-Wire Temperature Sensor PN: AR0273	Temperature Sensor, 5m in length.	
Cellocator 1-Wire Temperature Sensor PN: AR0300	Temperature Sensor, 1m in length.	
CAT5 Cable with RJ45 Connectors PN: 711-00357	Standard CAT5 Cable, providing shielded and twisted pair wires, 5m in length, and terminated with RJ45 connectors. Used for temperature sensor extension.	
RJ45 Male to 2 RJ45 Female Adapter PN: MP0256	Adapter which allows the connection of an extension cable and temperature sensor to the Cello harness.	

RJ45 Female to 2 RJ45 Female Adapter PN: MP0257	Adapter which allows the connection of an additional extension cable and temperature sensor to the end of an extension cable.	
DFD to RJ45 Female Adapter PN: 711-00314	Adapter which provides RJ45 termination to the Dallas wire of the Cello harness.	

Table 1: Cellocator 1-Wire Temperature Sensor Components

2.3 1-wire Temperature Sensor Description

The 1-wire temperature sensor is based on the DS18B20 chip technology which provides a unique 64-bit serial code and accurate (0.0625°C resolution) temperature readings. The temperature is communicated via a 1-wire interface.

Power for reading, writing, and performing temperature conversions can be derived from the 1-wire data line itself with no need for an external power source.

Each 1-wire temperature sensor contains a unique silicon serial number, and thus multiple 1-wire temperature sensors can exist on the same 1-wire bus. The Cello GNSS family supports up to 4 temperature sensors on the 1-wire interface, in parallel to driver and trailer ID functionality.

The temperature sensor is housed in a stainless steel tube providing fast temperature transient measuring. It also utilizes chemical resistant cable sealed to the tube which provides a weather proof solution.

The sensor is terminated with a male RJ45 connector, allowing fast installation to the Cello harness and adapters.

Two temperature sensor models are supported:

- AR0273 - which supports a 5 meter cable
- AR0300 - which supports a 1 meter cable

The 1-wire temperature sensor is supported by the Cello GNSS family and by the CR300; please contact your sales manager or Customer Support in order to verify which product variants and FW versions are supported.

2.4 1-wire Temperature Sensor Highlights

- 1-wire interface
- Based on DS18B20 chip technology. Each DS18B20 has a unique 64-bit serial code.
- Digital information eliminates signal attenuation due to cable length

- Weather proof
- Supports multiple sensors on the same 1-wire bus
- Low current consumption
- No calibration is required
- Rapid thermal response to changing conditions
- Operating temperature range: -55°C to +125°C
- ±0.5°C accuracy from -10°C to +85°C

2.5 Solution Description and Narrative

The sensor is installed in the area that requires temperature monitoring; it measures the temperature level, performs an analog to digital conversion, and sends the 12 bit digital information to the Cellocator unit's 1-wire interface.

The Cellocator unit supports up to 4 temperature sensors on the 1-wire interface. It sends the received digital information with the sensor identification, encapsulated in message 9, periodically (according to a programmable time), to the telematics application server. The unit can also be programmed to send the temperature value on every location (type 0) update message.

The telematics application can save the temperature levels, generate online presentations and historic reports, alert the user of breached thresholds, plus perform other application layer activities

3 Installation Instructions

CAUTION: To avoid possible bodily injury, or damage to the vehicle, the installer must be a certified technician who has been qualified to install the system.

3.1 Pre-installation Preparation

- Plan the location of each temperature sensor.
- Using an evaluation setup in a lab and the Evaluation Suite, get the unique 1-wire serial number of the sensor (as explained in the *Integration Description* section).
- Label each temperature sensor with its unique 1-wire serial number and its planned location.

3.2 Key Installation Guidelines

Installation of several 1-wire components on the same 1-wire bus requires knowledge and experience. Please refer to the 1-wire network design guide (as listed in the *References* section) for further information.

The installation components and instructions are based on the following guidelines:

- Short stubbed topology for installation of several sensors, where the Cello unit serves as the bus master and the temperature sensors are the slaves. In the example below, slaves 1, 2 and 3 have short stubs to the main network bus. Note that only the one meter temperature sensor should be used as a stub.

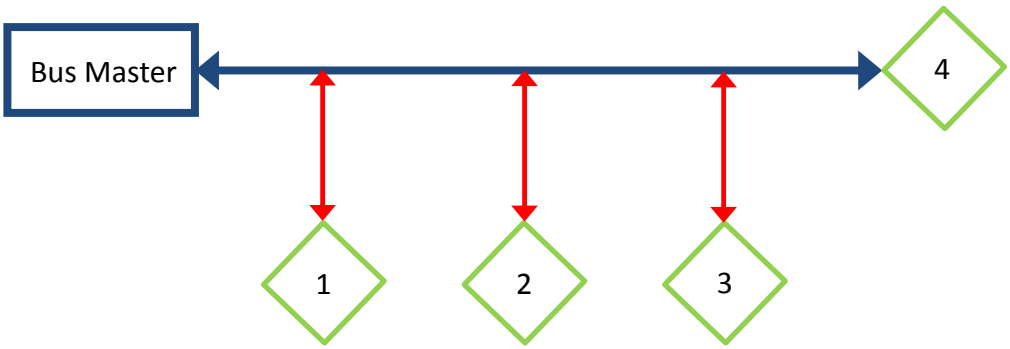

Figure 1: Short stub topology

- The cable for the main network bus should be shielded and utilise twisted pair wires.
- Low cost and off the shelf components.
- Easy to install.

3.3 Preparing the Cello harness

➤ **To prepare the Cello harness for the 1-wire temperature sensor:**

1. Cut the DFD connector from the DFD to RJ45 female adapter.

2. Connect the blue and black wires of the adapter to ground (the black wire of the Dallas thread of the full harness).
3. Connect the green wire of the adapter to the 1-wire interface (pin 20) of the Cello unit (the orange wire in the Dallas thread of the full harness).

   The prepared Cello Harness is shown in the picture below.

Figure 2: Cello Harness prepared for 1-wire Temperature Sensor installation

The Dallas thread of the Cello harness is now terminated with the female RJ45 connector and ready for temperature sensor installation.

3.4 Installing one 1-wire Temperature Sensor

➤ **To install one 1-wire temperature sensor:**

- Connect the sensor RJ45 male connector to the harness RJ45 female connector.

  If an extension is required:

  - Connect the male adapter to the harness RJ45 female connector.
  - Connect the extension cable to the male adapter.
  - Connect the female adapter to the extension cable.
  - Connect the sensor to the female adapter.

  If more than one extension is required add more sets of female adapter and extension cables as required.

The following illustration shows the installation of one temperature sensor with two extensions.

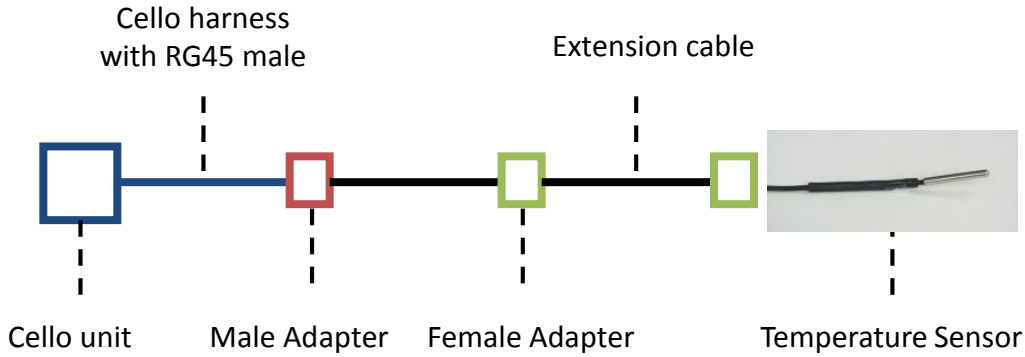

Figure 3: Installing one temperature sensor with two extensions

3.5 Installing several 1-wire Temperature Sensors

➤ **To install several 1-wire temperature sensors:**

1. Use extension cables and adapters as described in the previous section to extend the cable.
2. Make sure that an adapter is available next to each area that requires temperature monitoring.
3. Connect the 1 meter temperature sensor to the appropriate adapter, as shown below.

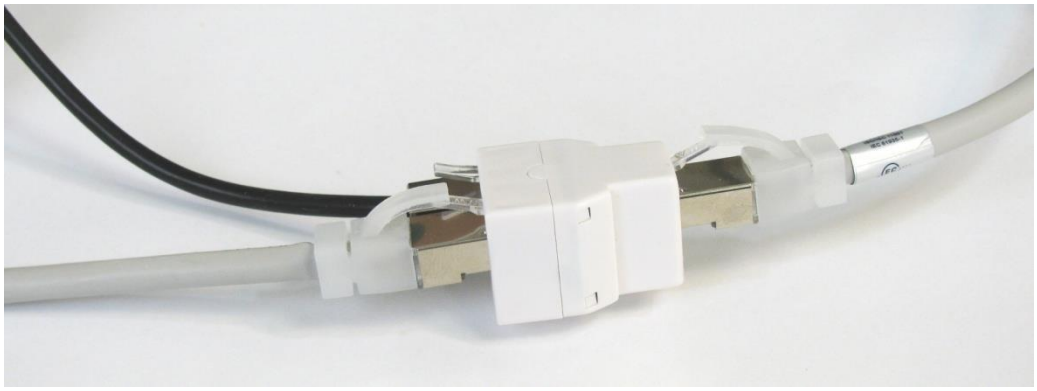

Figure 4: Connecting Temperature Sensor with extension cable to adapter

Notes:

- The Cello unit supports up to four 1-wire temperature sensors.
- CR300 supports one 1-wire temperature sensor.
- Only one meter temperature sensors can be used on multi-sensor installations.
- It is the installer's responsibility to ensure weather proof protection of the adapter connections.

Please review the CelloFamily Hardware Installation Guide for instructions regarding connecting the sensors to the Cello Harness.

Please review the Harness Selection Wizard to select the best harnesses for your specific application.

3.6 Post Installation Activities

Review the type 9 temperature measurement reports and verify that the temperature sensors are active and installed in the planned locations.

4 Integration Description

The 1-wire temperature sensor is supported by the Cello GNSS family and the CR300.

Please contact your sales manager or Customer Support in order to verify which product variants and FW versions support the 1-wire temperature sensor bus.

4.1 Cellocator Unit Programming

The Cellocator unit should be programmed as follows:

- **Enable Dallas bus mode:** In the Programmer address *03 Time & Trip events \ Driver Authentication* set the *Enable Dallas Bus mode* parameter to enable.
- **Enable periodic temperature type 9 messages for home network:** In programmer address *09 SingleWire Temperature Sensors\Home Network* set the Enable SingleWire Temperature Sensors Inputs update Logged message to enable and set the singleWire Temperature Sensors updates Period Value in Home Mode to the required time interval (e.g. 5 minutes).
- **Enable periodic temperature type 9 messages for roam network (if required):** Repeat the programming for Roam Network in the address *09 SingleWire Temperature Sensors\Roam Network*.
- **Enable temperature report in byte 26-29 of message 0:** In programmer address *01 Communication and Configuration\Inputs&Outputs\Analog&Frequency in OTA message* program the required temperature sensor per byte. In the image below temperature sensor #1 measurements will be reported in byte 26.

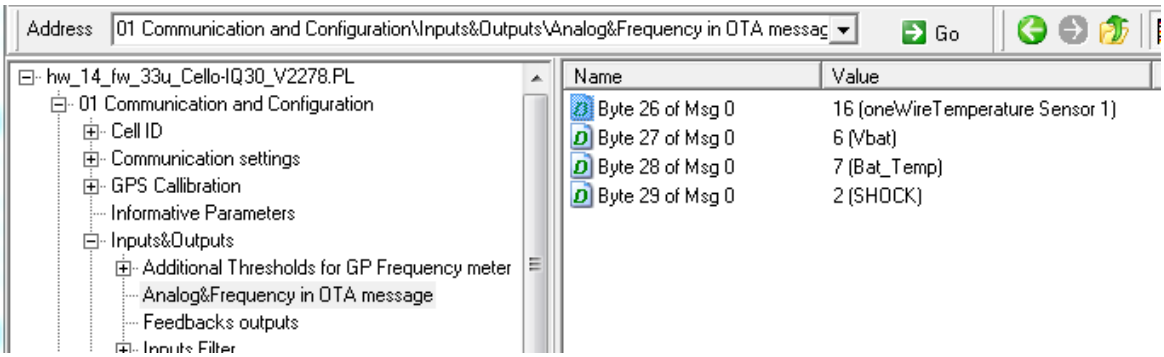

Figure 5: Temperature Sensor measurements in message 0

NOTE: The temperature sensor # is automatically assigned to a specific physical temperature sensor by the unit and may be changed if another temperature sensor is removed or disconnected. The alignment of temperature # to the unique 1-wire serial number is specified in the type 9 message as explained in the next section. ----------

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Please review the *oneWire Temperature Sensors* and *Bytes 26-29 of OTA Message 0* section in the Cellocator Cello Programming Manual for further information.

4.2 Cellocator Unit Messages

The Cellocator unit provides the following messages for the 1-wire temperature sensor.

- Type 9, Sub-data type 0x19, *oneWire Temperature Sensor Measurement* Request – InBound can be used by the application for requesting the current value of the four 1-wire temperature sensors.
- Type 9, Sub-data type 0x19, *oneWire Temperature Sensor Measurement* is sent by the Cellocator unit and reports the current value of the of the four 1-wire temperature sensors as a response to the *oneWire Temperature Sensor Measurement* Request – InBound or periodically per the programmable periodic time transmission parameter. The message includes each sensor's unique 1-wire serial code and the measured temperature in a signed 16 bit number with 0.0625°C (2^{-4}) resolution.
- Type 0 message bytes 26-29 can be configured to report the measured temperature in a signed 8 bit number with 1°C (2^{0}) resolution for each of the four temperature sensors.

Please note that in type 0 messages, the sensors are identified as sensor 1, sensor 2, etc., while in type 9 messages the sensors are identified as first sensor, second sensor, etc

For further information regarding the messages description and format, refer to the Cellocator Wireless Communication Protocol.

4.3 Evaluation

Type 9 temperature reports can be viewed and parsed using the Communication Center, as shown in the picture below.

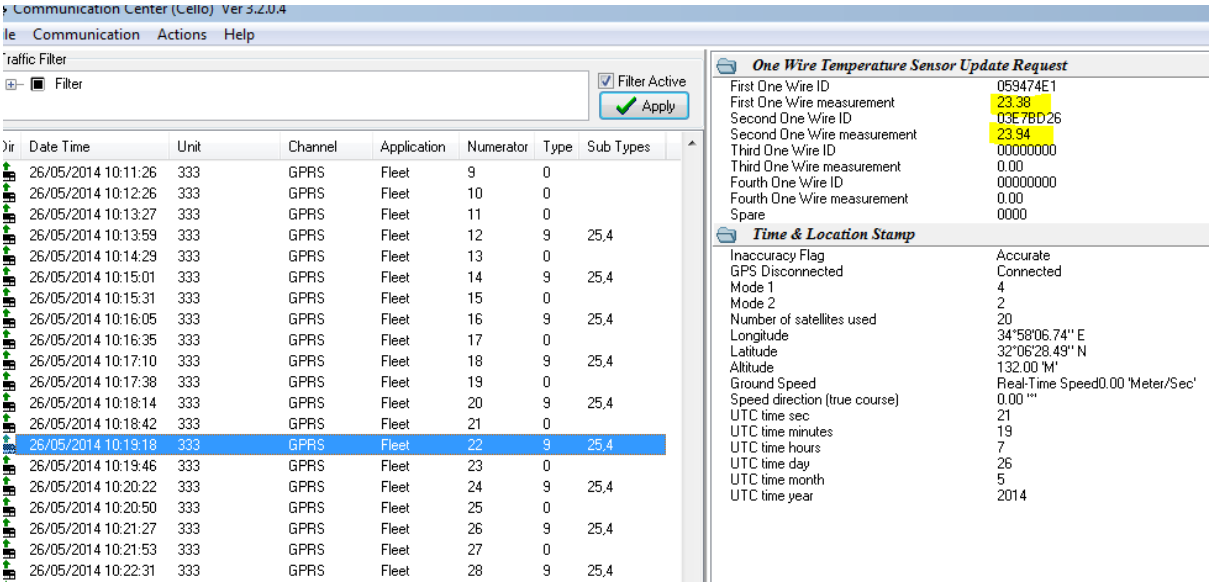

Figure 6: Type 9 temperature reports

5 SW Application Integration Guide

5.1 Application Notes

It is recommended that each sensor descriptor should include its unique 1-wire serial number and location in the vehicle for validating a proper installation, when more than one temperature sensor is installed.

The Cellocator unit does not support thresholds and alerts. Consequently, if needed, they should be implemented in the application.

5.2 Usage of Temperature Data in Message 0

The temperature data in message 0 can be monitored for threshold and alerts and also to eliminate or minimize the frequency of the periodic type 9 temperature reports. Please note that type 9 message is required in order to relate the sensor number to its unique 1-wire serial number. In order to verify the relevant sensor identity and its location, a type 9 temperature query request has to be generated when an alert is detected.

6 EN12830 Compliance

This section describes guidelines for the use of the Cellocator unit with the 1-wire temperature sensor in order for them to be compliant with EN12830.

6.1 Compliance Table

The EN12830 standard defines the requirements for a measuring instrument comprised from a recording instrument, which provides the temperature measurement and the displaying device, which present the measurement to the user. The Cellocator unit with the 1-wire temperature sensor is categorized as a recording instrument with an external sensor, where the displaying device's role is the responsibility of the telematics SW application. Therefore full EN12830 compliancy can be met only if the telematics SW application can comply with the displaying device requirements.

The table below explains the status of compliancy required from the Cellocator solution for the recording instrument, and states the requirements which should be met by the SW application.

The table form is defined by the EN12830 standard and all references in the table refer to the EN12830 standard.

Requirement	Description
General requirements	
Suitable for storage	Not Applicable. *See Note 1*
Suitable for transport	Comply
Measuring range (see 4.2)	Comply
Chart (disk, tape) (see 4.4.3)	SW application responsibility.
Autonomous power supply (see 4.5)	Comply. *See Note 2*
Degree of protection provided by enclosure (see 4.6, 5.6.7)	Comply. *See Note 3*
Supply voltage (see 4.8.1 or 4.8.2 and 5.6.2)	Comply. *See Note 4*
Frequency (see 4.8.3)	Not Applicable.
Power cut-offs (see 4.8.4)	Comply. *See Note 5*
Requirements for metrological characteristics	
Maximum permissible error and resolution (see 4.9.2.1) and temperature measurement error (see 5.3)	Comply. Accuracy class 1 @ -10°C to +85°C Accuracy class 2 @ <-10°C, > +85°C
Recording interval (see 4.9.2.2)	Comply. *See Note 6*
Recording duration (see 4.9.2.3)	Comply. *See Note 7*
Maximum relative timing error (see 4.9.2.4)	Comply. *See Note 8*

Requirement	Description
and time recording error (see 5.5)	
Response time (see 4.9.2.5 and 5.4)	Comply.
Climatic environment (see 4.9.3.1) and influence of ambient temperature (see 5.6.3)	Cellocator unit without protector supports climatic environment B. Cellocator unit with protector supports climatic environment D.
Mechanical vibrations (see 4.9.3.2 and 5.6.6)	Comply.
Shock resistance (see 4.9.3.3 and 5.6.5)	Comply.
Climatic environment (see 4.9.3.1) and temperature testing under storage and transport conditions for the recorder (see 5.6.4)	Comply.
Electrical power disturbances and susceptibility to radiated electromagnetic field (see 4.8.5) and dielectric strength (see 5.6.9)	Comply.

Table 2: EN12830 Compliance

Notes:

- *Note 1:* The Cellocator unit with the 1-wire temperature sensor can also be used for online reporting for a storage application and a compliance table can be generated for that scenario if required.
- *Note 2:* The backup battery can be considered as an autonomous power supply. The unit documents provide the information regarding the usage temperature of the battery. The unit reports to the application on low battery (when there is a need for replacement or charging).
- *Note 3:* The unit support IP20 for installation in the driver cabin; the unit with protector supports IP65 for installations inside cold enclosures or outside the vehicle.
- *Note 4:* When connected to the vehicle battery, the unit conforms to the rated operating and limiting conditions for 12V and 24V external supply voltage. The operating time of the unit when disconnected from the vehicle battery depends on the specific programmed operation policy of the unit.
- *Note 5:* All records are stored in the unit, even in cases when power is not available, until they are sent to the server.
- *Note 6:* The recording interval is programmable and should be programmed to comply with the standard.
- *Note 7:* The unit can store up to 9000 temperature records.
- *Note 8:* The time is aligned with the GPS time every one second to ensure its accuracy.

6.2 Compliance Marking

The EN12830 standard requires that the Cellocator unit will be clearly and permanently marked regarding EN18230 compliance. An adhesive label with the required EN18230 information is provided by Cellocator and should be attached to the Cellocator unit by the installer.

6.3 Periodic Verification

The EN12830 standard requires that the temperature recorder, when in service, shall be verified periodically in accordance with prEN 13486. This task should be conducted by the service provider.

7 Temperature Sensor Technical Specifications

Parameter	Value
Supply voltage	3.0V to 5.5V
Max supply current	1.5 mA
Operating temperature range	-55°C to +125°C (-67F to +257F),
Accuracy (Measurement error)	±0.5°C from -10°C to +85°C ±2°C below -10°C and above +85°C
Measurement resolution	0.0625 (2^{-4}) °C
Response time @ EN12830 test conditions	5:30 minutes
EN12830 compliancy	Yes
Standards compliancy	ISO, SGS, ROHS, CE
Enclosure standard	Waterproof
Probe material	Stainless steel
Probe dimensions	Φ6*30mm
Wire material	PVC
Wire length	5m - 5000mm±100mm 1m - 1000mm±100mm

Table 3: 1-Wire Temperature Sensor Specifications