

CelloSense

Product Overview



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1 Introduction

The purpose of this document is to provide high-level information required by service providers and enterprises wishing to utilize the CelloSense device as part of a wireless sensor network (WSN) solution. The solution offers a rugged and long-life battery for real-time visibility, security and awareness of cargo and asset location, in addition to the monitoring of condition, problems and delays throughout the supply chain.

1.1 Document Scope

This document describes the high-level system features and capabilities of the CelloSense device.

This document does not deal with the protocols and interfaces between the CelloSense and the backend, nor with the algorithms and logic engine implemented in order to deliver a complete remote monitoring and tracking system. These protocols, APIs, and algorithms are described in separate documentation, as listed in the following sections.

1.2 Definitions, Acronyms and Abbreviations

Name	Description
WSN	Wireless Sensor Network
Hub (CelloTrack Nano 20 – from FW version 34n)	Asset & Cargo Management IoT solution using internal sensors and also functioning as a hub for a Wireless Sensor Network (WSN)
CelloSense	Cellocator’s long-life, low maintenance sensor, industrial device
BLE	Bluetooth Low Energy (BT Smart)
PCB	Printed Circuit Board
OTA	Over The Air
FOTA	Firmware Update Over The Air

Table 1: Definitions, Acronyms and Abbreviations



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1.3 References and Bibliography

No.	Document Name
1	CelloSense Release Notes
2	CelloSense Installation Guide

Table 2: References and Bibliography

1.4 List of Changes

Version	Change	Remarks	Date Approved
1.0	1 st version		November 6, 2019

Table 3: List of Changes

2 CelloSense at a Glance

2.1 General

With the ever-increasing growth in global supply chains, maintaining an accurate picture of what is happening across your business at any given time is practically impossible. CelloSense, as part of a sensor network, can greatly enhance your supply chain management and costs, especially within high impact environments.

Based on IoT technology that incorporates a WSN, CelloSense with its BLE communication is an innovative, rugged, and smart monitoring system that requires low maintenance while ensuring a wide range of businesses in an ever-increasing array of industries can monitor their global cargos and assets.

Using renowned Cellocator firmware and technology, the CelloSense utilizes additional BLE cutting edge technology and extensive sensing capabilities to provide a solution that not only tracks assets but also monitors the environment and conditions in which the asset is currently located or handled, via temperature, accelerometer, and magnetic (doors closing/opening) internal sensors.



Figure 1: CelloSense Sensors

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The CelloSense device provides a robust Multi-Sensor for Real-Time Monitoring & Event Triggering in various IoT applications:

- ◆ Enables **real-time** awareness of a variety of objects using the CelloSense as a short range of Wireless Sensor Network (WSN).
- ◆ Providing on-the-fly alert notifications enabling you to take **proactive actions whenever required**.
- ◆ **Many** different environment sensing capabilities.
- ◆ **Easy integration** with hub.
- ◆ High **ROI** (competitive pricing).
- ◆ **BLE** based – the common protocol used in the IoT industry.
- ◆ **Robust** and **rugged** design for high impact environments and IP69K compliance.
- ◆ **Long-life**, seven years of battery operation (defined scenario).

2.2 Main Features and Benefits

This section lists the main features of the CelloSense system and the benefits they provide. For a full list of the available features and further explanations on each feature, refer to the *Feature List* section.

- ◆ A range of **internal embedded sensors** that can sense temperature, movement, and door status. These sensors play a big role in reducing risk and exposure to losses, in turn bringing peace of mind to customers.
- ◆ Can be used as a **Wireless Sensor Network** via BLE communication to the hub (CelloTrack Nano 20).
- ◆ Keep alive messages ensure parts can be tracked within large warehouses.
- ◆ Install and forget, no maintenance, no battery replacement.
- ◆ Long-life batteries (about seven-year lifespan) do not need replacing or recharging.
- ◆ Inherent **Data Logger** with the ability to store around 3,000 logged data samples and events.
- ◆ **Rugged plastic enclosure**, protecting against sunlight and chemicals.
- ◆ Easy to install within harsh environments via two metal tie-wraps or two supplied screws.
- ◆ **IP69K** Certified (protected against close-range high pressure, high temperature spray downs).
- ◆ Designed to meet **ISO 16750** standard (environmental conditions).
- ◆ Compliance with **GDP – Good Distribution Practice** (Europe, US).

2.3 Intended Markets

The CelloSense is intended for a wide-range of vertical markets within the MRM industry, many of which can greatly benefit from Cellocator's long-standing expertise in logistics and tracking.

The example vertical markets in the following sections are just a sample of the capabilities of the CelloSense.

2.3.1 Cold Chain Compliance

With CelloSense devices installed inside a temperature-controlled container / trailer (together with a hub), or attached to a pallet, box or other type of package loaded with pharmaceutical or perishables, stakeholders in the cold chain process can easily and reliably monitor in real-time the microclimate of the pallet / box, rather than the container environment only.

This helps to ensure adequate shelf-life time, guarantee compliance with shipment regulations, and even enables a real-time response in exceptional cases.



Figure 2: Cold Chain Solution

2.3.2 Real-Time Tracing & Inventory Management

The CelloSense can also provide a real-time tracking and field logistics solution for both warehouse management and the tracking of inventory.

For warehouse management, the once a day (keep alive) alert enables the warehouse to remain aware of each and every part, especially in large warehouses, while the tracking of inventory can be particularly useful for monitoring the moving of parts from a logistics center/warehouse to a customer site.



Figure 3: Real-Time Tracing & Inventory Management

2.3.3 Cargo Monitoring Logistics / Scheduling / Proof of Delivery

High-value cargo being sent from distribution centers or manufacturer sites must reach their destination according to shipment order specifications.

With CelloSense devices that communicate with a hub (i.e., the CelloTrack Nano 20 hub), stakeholders can ensure each cargo item, asset or pallet reaches its planned destination on time and according to a predefined route.



Figure 4: Cargo Monitoring Logistics Solution

2.4 BLE (CelloSense) vs. Active/Passive RFID

The following table presents a matrix of parameters comparing the BLE communication adopted by the CelloSense and commonly used in IoT devices, versus old RFID technology in use in various existing logistic and warehouse solutions.

Feature / Technology	BLE	Passive RFID	Active RFID
Power source	Internal (<15mA)	Energy transferred using RF from reader	Internal to tag
Battery	Yes	No	Yes
Required signal strength to unit	Medium	Very low	Very high
Range	Up to 100m	Up to 3-5 meters	Up to 100m

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Feature / Technology	BLE	Passive RFID	Active RFID
Cost	Expensive (~10\$)	Cheap (<1\$)	Expensive (~10\$)
Support internal sensors	Yes	No	Yes
Security	Strong	Weak	Strong
Smartphone/Tablet communications	Yes	No	No
Applications	App, logistic, inventory, asset tracking (WSN)	Inventory, logistic, security (restricted area), user identification, vending machine	Tracking person/asset
Frequency	2.4G	Various: LF, HF, UHF, SHF	
Bit rate	~200 kbit/s		

Table 4: BLE (CelloSense) vs. Active/Passive RFID

3 CelloSense Features and Capabilities

3.1 Feature List and capabilities of CelloSense vs. MultiSense

Feature	CelloSense	MultiSense
Orientation and Absolute Orientation	√	√
Impact	√ (or free-fall)	√ (or free-fall)
Free-fall	√ (or impact)	√ (or impact)
Temperature Sensor	√	√
Door Open/Close	√	√
Light Sensor	-	√
Humidity Sensor	-	MS-TH
Short Range Low Energy Wireless Communication	√	√
Long life battery	~7 years	>1 year
Maintenance (battery replacement)	-	√
Power on/off button	Always on	√
IP	IP69K	IP67

Table 5: Applicability Table

3.1.1 Internal Sensors

The internal sensors are the main elements of the CelloSense, and provide the monitoring abilities that ensure your assets stay secure. The following sections describe each of the sensors and their capabilities.

3.1.1.1 Accelerometer

The legacy CelloTrack accelerometer is used to detect movement, vibrations or impact of assets and enables different transmission rates for a moving asset and a standing asset. It is based on the interrupt mechanism (of the accelerometer chip) for acceleration incidents that pass a certain (configurable) threshold. When the acceleration reading crosses the configured threshold for longer than the configured time, an Impact event is generated.

Orientation Change and Absolute Orientation

When the Earth-gravity vector of the CelloSense exceeds the configured threshold (degrees measured), an Orientation event can also be generated and logged. This feature can be used to detect rollover situations, where the tracked asset is rolled on one of its sides or is placed upside down. The Absolute Orientation (x,y,z vectors) is reported via all transmissions of data regarding the asset(s) orientation.

Movement/Freefall/Impact

The legacy accelerometer user can configure it to work with one of three modes, impact, freefall and ordinary movement events. Impact events detect harsh and dangerous incidents such as a crash, and are easily distinguished from freefall, load/unloading movements and breaching attempts.

3.1.1.2 Temperature Sensor

The readings collected by the sensor ensure *data logging capabilities* that are smart and adaptive in that they help reserve battery life and save energy.

Getting real time temperature measurements dramatically improves the control of the shipment and gives the ability to react accordingly.

In order to be compatible with GDP (Good Distribution Practice), the internal temperature sensor guarantees an accuracy of $\pm 1^{\circ}\text{C}$ and a minimum resolution of 0.1°C .

3.1.1.3 Door Open/Close

The Door Open / Close sensor enables the placement of CelloSense devices on doors/windows together with a magnet device on door/window frames, so that if the door or window is opened/closed, events will be generated.

3.1.1.4 Proximity Alert

WSN-enabled to identify a "missing object" from the entire solution of the logistic supply chain.

For example, if a pallet embedded with a CelloSense device is being removed, is not in the right place, or appears to have been stolen, the Nano hub (or any other hub) can send an alert reporting the missing package/box.

For this feature, the RSSI signal strength can be configured according to your specific needs.

3.1.2 BLE Wireless Communication with CelloTrack Nano 20

The method of communication between the CelloSense devices and CelloTrack Nano 20 is *BLE (Bluetooth Low Energy) 2.4 GHz short range low energy wireless communication*. This method of communication is intended to provide considerably reduced power consumption, footprint and cost, with these three parameters the most important values within the IoT world.

Using *BLE*, the Nano 20 can communicate with up to 16 CelloSense devices in a *Master* and *Slave* type setup. However, in order to function correctly as a WSN, the Nano unit and CelloSense devices must be paired.

Using Nano 20 and paired CelloSense devices as a local WSN enables you to leverage an environment, within which you can sense where different measurements are expected

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such as inside cooled cargo boxes, or in a long trailer where the environmental conditions inside the trailer may be different for objects closer to the door.

Another form of communication between the CelloTrack Nano 20 hub and CelloSense devices is via *transparent* (guest) mode. In this mode, no pairing process is required and thus the CelloTrack Nano 20 does not manage or save CelloSense device data or thresholds. As a result, in transparent mode the CelloTrack Nano 20 can be used as a gateway to unlimited CelloSense devices. In situations where only CelloSense MAC addresses are required, Tag mode (similar to iBeacon mode) can be activated.

3.1.3 Data Logger

The CelloSense can store around 3,000 logged data samples and events with enable/disable capability.

A combination of data logger with the “Tx-on-Violation-only” mode will store samples and events in the logger, while transmitting events and violations in real-time.

3.1.4 Long Life Battery

The long-life AA ER14505 Li-SOCI 2600mAh non-rechargeable battery should last for seven years in typical scenarios. The CelloSense is a disposable device with no maintenance required.

3.1.4.1 Battery Lifetime

The CelloSense battery is designed to last ~7 years under the following settings and conditions:

- ◆ +8dbM Tx power
- ◆ Magnetic sensor is active
- ◆ Temperature sensor is active
- ◆ Sampling rate: St Stationary - once every 360 minutes; At movement - once every 0.5 minute
- ◆ Transmission rate: St Stationary - once every 360 minutes; At movement - once every 0.5 minute
- ◆ Room temperature (25°C)

Note that where temperature is not mentioned, battery performance is valid at +20°C.

3.1.5 Support for iOS background scanning

The “Services” field and the added half of the MAC address to the “Complete local name” string ensures full functionality in an iOS environment, also when the app is running in the background.

3.1.6 Configurable parameters

The following transmission and connection parameters can be configured:

- ◆ CelloSense Tx power (+8 to -18 dBm)
- ◆ Tx duration (20-5100 ms)

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- ◆ Timers multiplier: multiplier of 60 (seconds→minutes) allows Relaxed / Violation / Proximity timers to go beyond the 24h limit (up to 60 days)
- ◆ Connection timeout: maximum allowed time a CelloSense connection session can last (1-2147 seconds)

3.2 Mounting

The CelloSense devices can be attached to a tracked object via two methods: using two screws, or with plastic/metal ties that can be weaved through the two holes on the side of the device.

3.3 CelloSense Hardware Components

The CelloSense hardware components are listed in the table below:




Name/Part Number	Description	Picture
CelloSense device PN: 715-50100	The CelloSense device.	
CelloSense Accessories PN: 712-00020	Includes Two metal tie wraps , One sided adhesive , Two screws	
CelloSense – Magnet device PN: 712-00010	Installed in locations to work opposite the CelloSense (such as on a door).	

Table 6: HW Components

4 CelloSense Devices

This section describes the CelloSense devices and their technical attributes. Note that the CelloSense device is sealed to conform to standard **IP69K** (protection against close-range high pressure, high temperature spray downs).

4.1 Communication with the CelloTrack Nano 20 Hub

Communication between the CelloSense device and Nano 20 is via *short range low energy wireless communication*. The actual rate of communication between the two can be configured.

There is also a special communication feature called CelloSense Provisioning: if five *keep alive* messages are not received (according to a configurable parameter) by the device, an event is created and the relevant device is considered "lost". If the device is subsequently communicative, a communication-restore event is sent.

4.2 Pairing CelloSense Devices with the Nano 20 Hub

In order to create the WSN, the CelloTrack Nano 20 and each CelloSense device must be paired.

The Nano 20 can pair with up to 16 devices, though it is also possible to report on "Guest" or "Tag" CelloSense devices, which are not actually paired with the Nano 20 hub (but part of a VLR (Visitor Location Register) database, meaning the Nano 20 can transparently transfer the CelloSense device data to the backend but the Nano 20 does not manage CelloSense devices, i.e. logs/thresholds).

The Nano 20 can work in parallel with paired CelloSense devices and "Guest" or "Tag" CelloSense devices. "Guest" or "Tag" CelloSense devices can be especially useful when many mobile cargo loads / assets need to be monitored.

The difference between "Guest" and "Tag" modes is that the CelloTrack Nano only reports on the existence (advertisements) of unpaired CelloSense units in Tag mode, while in Guest mode the sensor data is sent to the backend.

Pairing is performed via the Cellocator Programmer tool (shown in the following image) by entering the CelloSense MAC address.

For further information, download the *CelloTrack Nano Installation Guide* from the Cellocator Knowledge Base.

5 Technical Specifications

Communication	
Short Range RF	BLE 4.1 - 2.4GHz wireless communication
Power Output	8mW
Interfaces	
Accelerometer	3D, $\pm 2g/\pm 8g$ range, 12 Bit representation, 1mg / 4mg resolution <ul style="list-style-type: none"> Vibration sensing with programmable threshold Free-fall sensing with programmable threshold Impact sensing with threshold up to 8g
Power	
Current Consumption	Transmission pulse: 23mA Active connection with hub (Avg): <250uA All sensors active and logging: <60uA Hibernation: <10uA
Internal Battery	ER14505 primary battery, 3.6V Lithium-Thionyl Chloride, AA size, 2500mAh
Sensors	
Temperature	Typical accuracy: 0°C to 85°C: $\pm 0.5^\circ\text{C}$ -25°C to 0°C: $\pm 1.0^\circ\text{C}$ -30°C to -25°C: $\pm 2.0^\circ\text{C}$ Resolution: 0.1°C
Open/Close door	10-20mm range from the defined permanent magnet
Free fall / Impact / Motion	Free fall detection with programmable threshold Impact with threshold up to 8g Motion detection with programmable threshold
Environment	
Temp, operation	-30°C to +85°C
Temp, storage	-40°C to +85°C
Ingress Protection	IP69K
Vibration, Impact	Shock resistance according to EN 60068-2-27, Vibration according to EN 12830



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Mounting	Nylon/metal tie-wraps, 2 screws and/or double-sided adhesive.
Certifications	
CE	CE (EMC, Safety, R&TTE)
FCC	Upon commercial need
IEC 60529 – IP69K	Unit passes all relevant IEC 60529 – IP69K regulation tests
Environmental	Unit passes all relevant environmental regulation tests
Dimensions & Weight	
Dimensions	111 x 46.3 x 28.6 mm
Weight	90 gr

Table 7: CelloSense Specifications