Cellocator Cello Programming Manual - CelloTrack Nano

Proprietary and Confidential

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POINTER TELOCATION LTD. 14 HAMELACHA ST. ROSH HA'AYIN 4809133, ISRAEL • TEL: 972-3-5723111 • FAX: 972-3-5723100 • WWW.POINTER.COM

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1 Introduction

1.1 About this Document

This document defines the contents of the Cellocator Unit's Configuration Memory (CM). The CM is a non-volatile memory, which is used to store different parameters that affect the behavior of the unit, as well as communication parameters, which are necessary for the Cellocator unit's correct operation.

The CM can be read and written both from the wireless channel as well as from the direct wire interface. Refer to the Wire and Wireless Protocols in order to learn how to read and write to the CM. Note that if the stored communication parameters are not correct, the wireless channel might not work, so the only way to program the CM might be via the direct wire interface.

1.2 Applicability Table

Device	Comments
CelloTrack Family	All information related to CelloTrack in this document refers to CelloTrack-T units based on the Cello platform. CelloTrack-T family includes the standard CelloTrack and CelloTrack Power. The CelloTrack Power has built-in charger and charging control logic. CelloTrack-T members are distributed with 2G or 3G modems according to the specific hardware part number. Unsupported features include the following: Towing detection, Driver Authentication, Audio call, CFE, Pulse Counter, APS mode in 2G variant, and GSM Jamming in 3G variant. Most of the functionality is also inherited to CelloTrack-Nano units.

1.3 References

All the reference documents listed in the following table can be downloaded from the support section of the Pointer Website (www.pointer.com).

#	Reference	Description

1.4 Document Conventions

Unless otherwise specified:

- All multiple bytes values are stored and treated Intel-style (meaning, "little endian", least significant bytes first).
- All the parameters are loaded from CM upon reset. **In other words, changing the programming parameters will take effect only after unit reset.**

This document defines the common programmable features, supported by all the modifications of Cellocator units, as well as the specific programmable options, supported by specific modifications only. The non-common options are highlighted.

2 Accessing the Configuration Memory via Wireless Channel (OTA)

When done over the air (OTA), CM access is performed in blocks. The 4096 bytes are partitioned to aligned, non-overlapping blocks of 16 bytes. This means the whole CM space contains 256 different blocks, assigned with block codes of 0 (zero) to 255 (decimal).

The first block (which represents CM locations 0 to 15 decimal) is assigned with block code 0 (zero). The following blocks are assigned with successive numbers (block 1 for locations 16 to 31 and so on).

Refer to the *Cellocator Wireless Communication Protocol* document for more information about accessing the CM via the wireless channel.

3 Accessing the Configuration Memory via Direct Wire Interface

The CM cells are accessed via the direct wire interface in a linear manner. This means that cells are identified by their actual addresses – there are no blocks or pages.

Refer to the *Cellocator Serial Communication Protocol* for more information about accessing the CM via the direct wire interface.

4 Event Types generated by Cellocator devices

Every event (like trigger on input, violation of speed any other), generated by the Cellocator unit can be threaded in 4 ways, as per the descriptions below. Every enabled event causes the unit to generate a location message type 0 (see description in *Cellocator Wireless Communication Protocol*) with the appropriate transmission reason. The various event types are described in the following sections.

4.1 Logged (Plain) Event

If the condition for the specific event is met, the unit will create an event and store it into its non-volatile memory. The event will be uploaded to the Control Center only during the GPRS session and will be deleted from the memory of the unit only after reception of an Acknowledge. Note: Plain events will never be delivered by SMS.

4.2 Distress Event

If the condition for the specific event is met, the unit will create a series of messages (session) with the same transmission reason. The messages will be uploaded to the Control Center immediately with the first available communication transport (during IP session – over IP, otherwise by SMS). The messages are not stored in the memory and if there is no cellular coverage at the moment of sending the message will be lost. Distress events do not require ACK from the control center.

The number and time between messages in a Distress transmission session is defined in a Time between Transmissions section of that document.

Distress sessions caused by the same trigger, which occurred while the first session is not over, restarts the session from the beginning.

Distress sessions caused by a different trigger, which occurred while the first session is not over, causes a new distress session (up to 5 distress sessions can be maintained concurrently).

A 6th distress session, while the previous 5 are still active, will be lost.

It is also possible to initiate an endless (or specified duration) distress session by command from the CCC. Upon starting, this session cancels all active distress sessions. The session will be stopped by any other distress session or by a command from the OTA.

Distress sessions may be prolonged by up to 20 seconds after the transmission of the last distress message.

4.3 Security Event

As per the Distress Event, but in this instance the condition for event generation is only checked when the alarm of the unit is armed (only applicable for security modification of the Cellocator unit). If the condition for the specific event is met, the unit will create a series of messages with the same transmission reason.

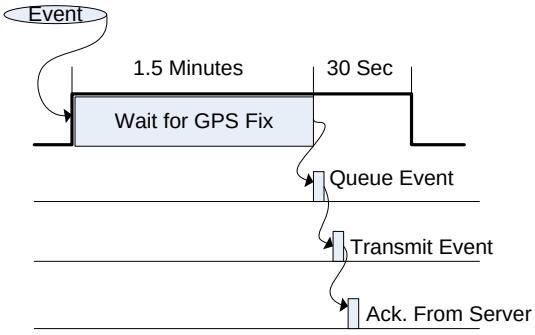
The number and time between messages in a Security transmission session is defined in a Security Section of that document.

IMPORTANT: Any event can be created in multiple ways simultaneously.

4.4 Active Logged (Plain) Event

The "Active Logged Event" is a new configurable feature designed to enhance the functionality of legacy logged events. The feature affects all events configured as logged (or plain). Enabling the "Active Logged Event" feature changes the behavior of the system in the following way:

- **During Hibernation**
  When a new event is generated, the unit will turn its modem and GPS on, wait for a GPS fix and then queue the event into the event queue. The event will be transmitted to the server, acknowledged by the server and removed from the queue. "Active Logged Event" turns the unit on from hibernation for up to 2 minutes. If a GPS fix is not detected within 1.5 minutes from the beginning of the session, the event will be queued into the events queue and sent towards the server while giving an extra 30 seconds for the server to acknowledge the event. If a Cellular link is not available the unit will be turned off and the message will wait in the queue for later delivery.



- **During Live Tracking**
  When a new event is generated, and the GPS is off (in CelloTrack units), the unit will turn the GPS on, wait for a fix and then insert the event into the event queue.

The "Active Logged Event" feature is important for units, such as CelloTrack, which are battery operated and mostly hibernating while periodically communicating with the server. Prior to this feature, users had to configure both "Event" and "Distress" bits to achieve this functionality.

5 Address and Bitmask Field Allocation Tables

This section describes the addresses and bit mask field allocations. Where relevant, there are references to corresponding sections, where you can find further information.

- **Address allocation table**, see below
- **Bitmask Field allocation tables**, page 26

5.1 Address Allocation Table

Address	Purpose
0	Application Configuration byte 1
1	Application Configuration byte 2
2	CelloTrack: Configuration
3 - 4	Hibernation mode communication settings
6	Application Configuration byte 3
7	Application Configuration byte 4
8 - 31	Operational Sever - PPP Username
32-34	Trip for a Distance event in Roaming mode
35	Time/Distance alert multipliers for High Speed in Roaming GSM
36 - 65	Operational Sever - APN
66 - 69	Default Target IP Address (for GPRS)
70 - 71	Time between Idle Transmissions
72 - 73	Time between Distress Transmissions
74	Operational Server - Modem type code
75	Number of Distress transmissions
76 - 79	GPS odometer's current value
80 - 83	Base unit (measurement factor of GPS odometer)
84	Max Time between GPS readings for SxT calculation
85 - 88	GPS odometer - Last Distance Event (in base units)

Address	Purpose
89 - 91	Trip for a Distance event (in base units)
92	Time/Distance alert multipliers for High Speed in Home GSM
93	Over Speed velocity threshold for GPS Over Speed Start event
94	Over Speed velocity threshold for GPS Over Speed End event
95	Over Speed time event filter
96	Idle Speed Velocity threshold for GPS Idle End event
97	Idle Speed Velocity threshold for GPS Idle Speed Start event
98	Idle Speed event time filter
99	GPS Events Mask Bitmap
100 - 101	Inputs Logic Invert Mask
102	GPS Distress Triggers Bitmapped mask
104	Journey Start Event time filter
105	Journey Stop Event time filter
106	Time Report Period Value
107 - 108	Listening UDP Port (while connected to both operational server or maintenance server)
109 - 110	Operational server TCP/UDP Target Port
115	Main Power Low threshold - high level (Doesn’t exist in Solar)
116	Main Power Low threshold - low level
121	Mask of Analog Inputs Events
122	Mask of Analog Inputs Distress
124 - 125	Inputs Events mask – on Falling
126 - 127	Inputs Events mask – on Rising
128 - 129	Inputs Distress mode mask - on Falling
130 - 131	Inputs Distress mode mask - on Rising
132 - 133	Towing detection – Speed threshold

Address	Purpose
134 - 135	Towing detection – Geo-Fence perimeter
136	Common Discrete Inputs change Time filter
137	Towing Detection and Towed Mode Time Filter
138	Maximum Backup Battery extra charge time
139	Message Transit Acknowledge timeout
140	Outputs pulse width period
141 - 164	Operational Sever - PPP Password
165 - 166	Modem Reset Period
167 - 176	BCALL (Brake down) Destination number
177 - 186	SMS Center Address
187 - 196	SMS Default Destination Address
197 - 200	SIM PIN code
201 - 202	Communication settings in Home GSM Network Mode
203 - 204	Communication settings in Roam GSM Network Mode
205	Advanced GSM Jamming Detection – Ignition Off - 1st activated output (Infrastructure)
206	Advanced GSM Jamming Detection – Ignition Off - Template of 1st activated output (1st byte) (Infrastructure)
207	Advanced GSM Jamming Detection – Ignition Off - Template of 1st activated output (2nd byte) (Infrastructure)
208	Advanced GSM Jamming Detection – Ignition Off – 2nd activated output
209	Advanced GSM Jamming Detection – Ignition Off - Template of 2nd activated output (1st byte) (Infrastructure)
210	Advanced GSM Jamming Detection – Ignition Off - Template of 2nd activated output (2nd byte)
211	Advanced GSM Jamming Detection – Ignition Off - Delay for output activation for the 1st output (Infrastructure)
212	Advanced GSM Jamming Detection – Ignition Off - Delay for output activation for the 2nd output (Infrastructure)

Address	Purpose
213	Advanced GSM Jamming Detection – Jamming Detection Time Filter: Jamming detection time in resolution of 3 Seconds. Ranges between 3 Seconds to 765 Seconds. Default 10 Seconds (Infrastructure)
214	Advanced GSM Jamming detection – Ignition On and Ignition Off Jamming End Time Filter (15 Sec resolution) (Infrastructure)
215	Logged Events Amount for Upload Offline Events
216-217	Unused
218-219	Logged Events Upload Periodic Timer
220	Timeout before switching off the modem
221	Number of Logged Events Upload Retries
222	Time Between Logged Events Upload Retries
223-224	Local Timer to Upload Logged Events
225-226	Movement Timer Before Local Timer Activation
227-228	Unused
230[1]	Modem On Delay Timer
231	Unused
255	Offline Tracking - Auto Upload configuration
259-260	Offline Tracking - Time to Auto Upload after Trip Stop
263	GPS Peeking – Max. On Time
264 - 265	GPS Peeking – Off Time
266	Power Management mode
267	GSM Peeking – Maximum Modem On Time
268 - 269	GSM Peeking – Off Time
270	GSM Peeking – Maximum Network Registration Time

[1] Available only for CR300B (New Platform) from FW version 43m and later, and for CR300B (Legacy) from FW version 43h and later.

Address	Purpose
271 - 272	Hibernation Mode Delay
283	Number of retries to forward data over UDP
284	Anti-Flooding timer
285	Garmin Configuration CelloTrack Configuration 1
295-299	Unused
350	Unused
402-411	Unused
412	Security - Max. Amount of failure samples
413	Security – Pre-arming Time
414	Security - Time to Passive Arming
415	Security - Time to Pre-Arming
416	Security - Silent delay time
417	Security - Maximum time in Garage mode
418-420	Reserved, ex. Security - Security inputs invert bitmap
421	Security - Trigger an Alarm upon Towing Detection during Alarm Armed
422 - 425	Security - Security inputs mask bitmap
426	Security - Number of Security transmissions
427	Security - Time between Security transmissions
428	Security - Logic configuration
454	Max Extra GPS On Time for Distress Mode
455	Velocity threshold for HIGH SPEED mode
465	Additional inputs functionality control bitmask
466	Analog Measurement Averaging Time
467	Accelerometer Configuration

Address	Purpose
468	Voltage Level Threshold IgnitionOn Detection
469	Internal variable: AHR counter
471-472	UART configuration
473	Speed Range Threshold V0
474	Speed Range Threshold V1
475	Speed Range Threshold V2
476	Harsh Braking Threshold for Speed range 0
477	Harsh Braking Threshold for Speed range 1
478	Harsh Braking Threshold for Speed range 2
479	Harsh Braking Threshold for Speed range 3
480	Course Delta Threshold for Speed range 0
481	Course Delta Threshold for Speed range 1
482	Course Delta Threshold for Speed range 2
483	Course Delta Threshold for Speed range 3
485	Time Based Alert Period Multiplier for NOIP mode
492	Idle Speed Alerts Control Bitmask
493	Time Based Events Mask Bitmap
494	Time Based Distress Mask Bitmap
496	GPS Events Mask (second byte, the first is on 99)
497	Active GPS Distress Triggers Bitmapped mask (second byte, the first is on 102)
499	Time event period in Roaming
500	GPS Navigation Start/Stop Filter
504	Maximum number of AHR retries
509	GPS management bitmap
511	Acceleration Threshold for Speed range 0

Address	Purpose
512	Acceleration Threshold for Speed range 1
513	Acceleration Threshold for Speed range 2
514	Acceleration Threshold for Speed range 3
515	Registration Lack Timeout (for Modem's AHR)
540 -603	Extended Events Control Bits array: 256 entries of 2 Bits representing the extended configurable option for each of the fleet events.
800-999	White list phone numbers for dial-in
1004	Geo-Fence Alert Mask for events
1005	Geo-Fence Alert Mask for distress
1006	Geo-Fence violation filter
1008	Roaming Operator's Management - Timer of Auto-Search
1009	Roaming Operator's Management - Number of PLMNs programmed
1010-1012	Roaming Operator's Management - PLMN 1
1013-1015	Roaming Operator's Management - PLMN 2
….	….
1307-1309	Roaming Operator's Management - PLMN 100
1310	V-Trek - V1
1311	V-Trek - T1
1312	V-Trek - V2
1313	V-Trek - T2
1314 - 1317	Reserved for Customer's Use designed to store customer's proprietary data (like specific EEPROM content identifier)
1318	Configuration 1 (legacy 285)
1319	GPS based movement timeOut
1322-1325	Geofence Outputs activation 0-3

Address	Purpose
1326-1329	New SIM PIN
1330	First Usage Counter input
1331	Second Usage Counter input
1332	Usage Counter Reporting interval
1337-1338	Advanced Glancing (peeking): Glancing time for movement and not charging state.
1339-1340	Advanced Glancing (peeking): Glancing time for No movement and charging state.
1341-1342	Advanced Glancing (peeking): Glancing time for movement and charging state.
1344	Wake Up message configuration
1346	Period between the alerts, triggered by detection of power disconnection
1347	Application Configuration byte 5
1348	Application Configuration byte 6
1349	Application Configuration byte 7
1352	Periodical Modem Reset Randomization threshold
1353	Anti-flooding randomization threshold
1387-1388	Go / Halt Speed Detection threshold
1389	Go / Halt Time threshold filter
1390	Go / Halt – Session Control Bitmask
1391	Modem type code for Maintenance Server
1392-1395	Maintenance Server IP address
1396-1397	Maintenance Server Target Port
1398	Maintenance Server configuration bitmask
1399	Maintenance Server connection period
1400	Maintenance Server Session Time Update

Address	Purpose
1403-1432	Maintenance Server APN
1433	Vector Change Detection Bitmask
1434	Compressed Vector Change Report Timeout
1435	Vector Change Detection angle
1444	Cellular Network Selection
1446	Power configuration settings
1447	Activation/Deactivation Procedure options
1614-1615	Glancing at Specific Time
1616	GPS peeking On time during Live Tracking
1619	Time event resolution multiplier for "external power" mode
1620	Select Measurement source reported in Byte 26 of OTA Msg type 0
1621	Select Measurement source reported in Byte 27 of OTA Msg type 0
1622	Select Measurement source reported in Byte 28 of OTA Msg type 0
1623	Select Measurement source reported in Byte 29 of OTA Msg type 0
1625	GPS DOP Threshold
1626-1649	Maintenance Server APN Username
1650-1673	Maintenance Server APN Password
1711	Reserved for manufacturer usage (Timer of retry of SIM operation upon failure)
1847-1913	Nano Phase-2 parameters
1914	Lock to Certain IMSI
2044	Tilt Tamper Messaging
2045	Tilt Tamper Angle Change Threshold
2046	Tilt Tamper Time Filter

Address	Purpose
2050	Orientation Change Messaging
2051	Orientation Change Angle Change Threshold
2052	Orientation Change Time Filter
2039-2091	CelloTrack Nano and BT Extender area
2092-2347	MultiSense parameters
2348-2367	CelloTrack Nano area and BT Extender area
2394 -2425	Default target DNS Address (for Maintenance Server)
2464-2495	Operational Server DNS Address
2496-2516	Geo-Fence 1 Configuration
….	….
4080-4095	Geo-Fence 100 Configuration
4096	Unused
4098-4099	Unused

5.2 Bitmask Field Allocations

This field describes the allocation of configuration bits in the bitmap configuration bytes. The description of each bit is provided in other sections in this document.

5.2.1 Application Configuration

Address: 0, Application Configuration byte 1

Enable Transparent Mode	Long Transmission Ack. Timeout	Enable warning output activation during Gradual immobilization	Ignition filter source for starting Driver Authentication time calculations	Presentation of inputs in wireless Cellocator protocol	Enable conditional activation of immobilizer	Enable infinite driver notification when Driver is not identified	Active Logged (Plain) Events Enable

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Address: 1, Application Configuration byte 2

Wake up from hibernation upon periodical Usage counter update timer expiration	Enable Command Authentication	Enable Immobilizer activation while there is no Authentication code	Enable modem's power control by Door input	Generate an event per AHR	Ignore Geo-Violations on Boot	Shorten cellular registration timeout	
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Address: 3, Hibernation mode communication settings

Reserved		Reserved			Renew GPRS upon drop in (in semi-hibernation)		
Bits 7	Bits 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Address: 4, Hibernation mode communication settings

Enable Pre-Hibernation distress	Enable Pre-Hibernation event				Reserved	Enable Intermediate state of Anti-flooding in semi-hibernation	
Bits 7	Bits 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Address: 6, Application Configuration byte 3

		Overlapping Geo-Fence logic: Global/ Discrete		GPS Reset on ignition off When not in navigation	GPS Reset on ignition off When in Navigation	Disable Active Transmissions	
Bits 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Address: 7, Application Configuration byte 4

				Synchronize unit's time with GPS time only when GPS is navigating	Enable Usage Counters		
Bit 7	Bit 6	Bit 5	Bit 4	Bit3	Bit 2	Bit 1	Bit 0

Address: 1347, Application Configuration byte 5

							Enable Max Speed Report
Bits 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Address: 1348, Application Configuration byte 6

	Enable Offline tracking	Consider Unknown Operators As Forbidden		Disable GSM Jamming Event (Legacy + Ignition On)		Enable Auto SIM PIN locking	
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Address: 1349, Application Configuration byte 7

							Enable Monitoring logical status of Ignition in OTA packets
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Address: 526, Application Configuration byte 10

	Periodic Transmission (in battery saving mode) - Type-0 0-Disable 1-Enable						
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

5.2.2 Communication Events Mask

Address: 604

Unused	Unused	Unused	Unused	Unused		Enable Voice Call Events	
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

5.2.3 Communication Settings in Home/Roam GSM Network Mode

Address: Home GSM: 201; Roam GSM: 203; Hibernation: 3

Enable SMS		Enforce SMS Destination	Generate Cell ID packet (RT) with any distress while there is no valid GPS	Generate Cell ID packet (logged) with any event while there is no valid GPS	GPRS Enable		
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0[2]

Address: Home GSM: 202; Roam GSM: 204; Hibernation: 4

Unused		Disable forward from serial port to SMS	Disable active transmissions via SMS	Enable incoming Voice Call	Enable IP up event	Enable Intermediate state of Anti-flooding	Auto Answer Voice call (if incoming voice enabled)
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

5.2.4 WAKE UP Message Configuration

Address: 1344

Enable GPRS Wake up message	Enable SMS Wake up message	Number of repetitions, Value of zero set number of retries to 64					
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

[2] Available only for CR300B (New Platform) from FW version 43m and later, and for CR300B (Legacy) from FW version 43l and later.

5.2.5 GPS Management Bitmap

Address: 509

Enable Tight GPS PMODE Filter	Enable A-GPS	Not used	Enable WAAS (for USA and Hawaii)		Reset last known location on Ignition off	Enable Pythagoras Calculation	Enable Speed x Time Calculation (SxT)
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

5.2.6 Maintenance Server Configuration Bitmap

Address: 1398

Reserved		Enable Modem FW Upgrade from the Maintenance Server	Enable auto connection to maintenance server	Reconnect to the maintenance server after firmware upgrade	Enable connection to the maintenance server on each power up.	Enable firmware upgrade from the maintenance server	Enable programming updates from the maintenance server
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

5.2.7 UART Configuration

Address: 471

Reserved				Baud rate			
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Address: 472

Reserved	Flow Control		Stop Bits		Parity		
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

5.2.8 Alternative Inputs Usage Bitmap

Address: 465

Bits 5-7	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

5.2.9 Time Based Mask Bitmap

Address: 493 for events
494 for distress

Only in 494 Do not wake up from hibernation upon comm.idle distress		Reserved				Enable Time events	Enable event for Communication Idle
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

5.2.10 Over (and Idle) Speed Session Control Bitmap

Address: 492

Create Idle/Over Speed End event for open session per ignition Off	Start Idle speed timer with ignition On	Don't use time filter to close Idle speed session	Don't use time filter to close Over speed session	Multiplier for filter of Idle Speed Start Session			
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

5.2.11 Go/Halt Session Control Bitmap

Address: 1390

Spare			Don't use time threshold filter for "Go" detection	Multiplier for Go/Halt Time Threshold filter For "Halt" detection			
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

5.2.12 GPS Alerts Mask Bitmap

Address: 99 For events
102 For distress

Enable event upon location change detection when Ignition Off	Enable event upon speed detection when Ignition Off	Enable Sudden Course Change Sensor	Enable Sudden Speed Change sensor	Enable Idle Speed Events	Enable Over Speed Events	Enable Distance Events	Enable GPS Navigation Start/Stop Events
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Address: 496 For events

497 For Distress

Not used					Enable Go/Halt Events 0 – Disable 1 - Enable	Enable Event per GPS Auto Factory reset	Enable GPS Disconnection
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

5.2.13 Time Report Period Value (Home, Roam, High Speed)

Address: For Home GSM: 106

For Roam GSM: 499

Resolution Definer	Basic Period Value (BPV)						
Bits 7	Bits 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

5.2.14 Time/Distance Alert Multipliers for High Speed Mode

Address: For Home GSM: 92

For Roam GSM: 35

Time Event Multiplier for HIGH SPEED mode				Distance Event Multiplier for HIGH SPEED mode			
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

5.2.15 Discrete Inputs Masks

Address: For Inversion 100-101

Inputs Events on Falling 124-125

Inputs Events on Rising 126-127

Inputs Distress on Falling 128-129

Inputs Distress on Rising 130-131

Security inputs mask bitmap 422-425

Lower byte

	Panic	Driving Status (Ignition or accelerometer based)			GP1 (dry contact input in power harness)		

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Important notes:

- The GP1 (dry contact input in power harness of the Nano), is active only while the power harness is actively supplying power to the unit.
- The distress and the events are applicable when the input mode is set to either "Normal" or "Dry contact input mode selection" (per address 2046 bits 4-5).
- The invert bit doesn't affect the raw value shown on IO bytes in type-0 (byte 21 bit 2) or in its encapsulated form as Type-11 module 41.

5.2.16 Mask of Analog Inputs Alerts

Address: 121 for events, 122 for distress

Ignition Switch On				Ignition Switch Off			
		Battery low level	Battery Restored from Low level	Charging voltage power Event (also in Ignition On)		Battery low level	Battery Restored from Low level
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

5.2.17 Geo-Fence Alert Mask

Address: 1004 - For events

1005 - For distress

Unused			No Modem Zone Entry	Geo Hot Spot Traversal	Way Point violation	Keep Out Fence violation	Keep In Fence violation
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

5.2.18 Offline Tracking - Auto Upload Configuration

Address: 255

Unused						Memory Full	Ignition Off Event
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

5.2.19 Security Settings Bitmask 1

Address: 421

Unused							Trigger an Alarm Upon Towing Detection During Alarm Armed
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

5.2.20 Security Settings Bitmask 2

Address: 424

`Unused							Trigger an Alarm Upon Main Power Disconnection Detection
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

5.2.21 Security Logic Configuration

Address: 428

Unused	Auto-gradual stop Enable	Unused		Auto Arming Independent from door	Disable Auto Arming	Does Not Trigger Silent delay upon Unlock detection	Unused
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

5.2.22 Active Correlation Lines

Address: 287

Unused					Shock (pin 15)	Unlock (pin 11)	Lock (pin 5)
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

5.2.23 Vector Change Detection Bitmask

Address: 1433

Reserved	Prevent Curve Smoothing Message generation	*Enable* Compress Vector change	Enable Vector change Detection Distress	Enable Vector change Detection Events

				during "Halt" mode	Detection		
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

5.2.24 Accelerometer Configuration

Address: 467

			Detection Sensitivity 0 - Very insensitive 1 - Normal 2 - Very sensitive 3 - spare			
Bit 7	Bit 6	Bit 5	Bits 3-4	Bit 2	Bit 1	Bit 0

6 Communication and Configuration

6.1 Communication Events

6.1.1 Enable Voice Call Events

Address: 604, bit 1

Description: This parameter enables to send logged events upon start/stop of incoming/outgoing voice calls.

Whenever a voice session is started and ended, the unit will create a type-0 event with **TR=18**:

- Upon start of incoming voice call, the unit will transmit a "Start Incoming Voice Call" event (**Type 0, TR 18, STR 1**).
- Upon stop of incoming voice call, the unit will transmit a "Stop Incoming Voice Call" event (**Type 0, TR 18, STR 0**).

Data Range: 1 - Enable, 0 - Disable

Default value: 0 - Disable

6.2 Communication Settings

6.2.1 GPRS Settings

6.2.1.1 Acknowledge OTA

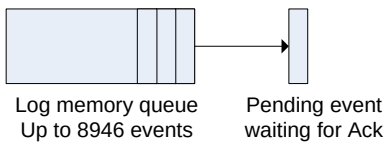
6.2.1.1.1 Message Transit Acknowledge Timeout

Address: 139

This parameter defines the maximum time the unit will wait for server to acknowledge a plain event (plain events are one of the four available event generation patterns proposed by Cellocator unit; refer to the Event Types section in this document). If no ACK is received by this time, the event will be retransmitted.

Event Delivery Algorithm

Once generated, a plain event is stored in the unit's Log memory. This Log memory can store up to 8946 **plain** events. When the Log memory is full, newer events will push out the older ones (FIFO). Events will be uploaded to the Control Center only when GPRS is available and will be deleted from the unit's Log memory only when acknowledgment is received from Central Control. ***NOTE: Plain events will never be***



delivered by SMS!

The unit supports one pending event waiting for server acknowledgment. When server acknowledgment is received, the pending event is deleted from the Log memory head, and the next event is moved to the pending event data structure in order to be sent to the server.

NOTE: Legacy units used to have 16 concurrent pending events.

If the Acknowledge is not received during the time defined in Message Transit Acknowledge Timeout, the event is resent.

Data format: 8-bit unsigned. Resolution is 20msec or 160mseconds, according to the value of Acknowledge Timeout Extension Multiplier bit, see below.

Note that there is a separate control of ACK to forward data message from server to 3rd party device connected to the serial port of the unit (application configuration byte 5).

Value span: 00h to FFh (=5.1sec or ~40 seconds)

Default value: 200 (4sec)

6.2.1.1.2 Acknowledge Timeout Extension Multiplier

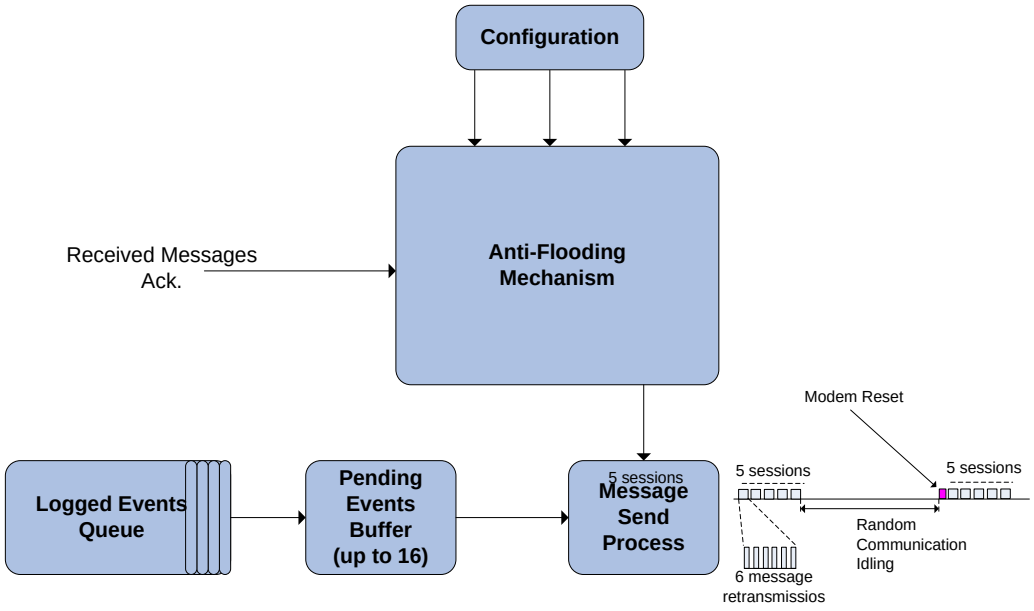
Address: 0 bit 6

If this bit is enabled (1) the resolution of Message Transit Acknowledge Timeout parameter will be 160mseconds/bit, otherwise 20msec/bit

Default value: 1 (160mseconds/bit)

6.2.1.2 Anti-flooding

The Anti-Flooding mechanism is designed to minimize the unit's message Retransmissions in situations where GPRS connection is available but the server is unreachable.
The Anti-flooding will randomize the idle communication time between message retransmission sessions to avoid server overloading in situations where the server becomes available after period of server unavailability and to avoid network overloading.



The block diagram above describes the Anti-Flooding mechanism. The Anti-Flooding mechanism's most important input is the received server acknowledgment; in case there are no acknowledge messages returned from the server, the Anti-Flooding mechanism will implement the following retry patterns:

Send each pending message 6 times while waiting for ack. between each transmission.

Repeat the above sessions 5 times.

Stop transmissions for a random time based on "Anti-Flooding timer" and "Anti-Flooding randomization threshold" configurable parameters (see Anti-Flooding timer, Anti-Flooding randomization threshold). This random period is defined in the diagram as "Random Communication Idling".

Reset the modem.

Go to step 1.

The Anti-Flooding has another sub operational mode called "Intermediate state of Anti-Flooding" which when enabled blocks message transmission till only after IPUP is acknowledged by the server. This operational mode will start logged events transmission only after the server is guaranteed to be responsive. Enabling this mode will implement the above Anti Flooding behavior only for IPUP messages while not saving IPUP events into the log memory. Refer to Intermediate state of Anti-Flooding Activation Control. The Intermediate Anti Flooding mode can be selected to work in Home network, Roam network and in hibernation.

6.2.1.2.1 Anti-Flooding Timer

Address: 284

Description: This parameter defines a "communication idling" timeout, used by the unit to decrease a communication costs during the server (CCC) failure.

Data format: 1 byte with a resolution of 1 minute

Value span: 0-255minutes, a value of zero means no delay between the sets

Default value: 0

6.2.1.2.2 Anti-Flooding Randomization Threshold

Address: 1353

Description: In case of server failure all the units are entering Anti-Flooding simultaneously and, as a result, reconnecting to CC simultaneously after the Anti-Flooding delay expires. This causes a heavy load of communication on the CC server and might cause a new crash. In order to prevent this issue it is possible to randomize the Anti-Flooding timer.

The timer is restarted every time with a different value, limited by a programmable threshold.

(A – Ta)≤ Anti-flooding interval≤(A+ Ta)

A - Anti-flooding timer parameter

Ta - Anti-flooding threshold, programmed in EEPROM

Wrong programming protection:

if A≤Ta the unit will NOT use the low limit of randomization.

Data format: Resolution of programmable threshold is 30 seconds, 1 byte

Value span: 0-127 minutes, a value of zero means no randomization

Default value: 0

6.2.1.2.3 Enable IP Up Alert (Event)

Address: 202, bit 2 for home network

204, bit 2 for roam network

Description: The "IP up" alert is generated with every dial-up to GPRS in order to update the Central Control with the resent IP address of the unit. In cases when SIM card is associated with static IP, it is possible to cancel IP up events.

Note that "IP Up event" CANNOT be disabled if Intermediate state of Anti-flooding is enabled.

Default value: 1 – both enabled

6.2.1.2.4 Intermediate state of Anti-Flooding Activation Control

Address: 202, bit 1 for home network

204, bit 1 for roam network

4, bit 1 for hibernation, if enabled for active GSM network

Description: If Intermediate state is enabled, the unit will not store IP Up events into log memory. When dialing to GPRS, only IP Up messages will be sent to the server. The unit will not try to download accumulated event before reception ACK to the IP Up message (see Anti-flooding description above).

Default value: all three enabled (1). In CelloTrack family to save energy all three are disabled.

6.2.1.2.5 Enable Active Logged (Plain) Events

Address: 0, Bit 0

Description: "Active Logged Events" is a new configurable feature designed to enhance the functionality of legacy logged events. The feature affects all events configured as logged (or plain). For more details refer to Active Logged (plain) Event.

Default value: Disable

6.2.1.3 Operational Server Support

The operational communication server is used for uploading positions and other events from the end unit. Normally this will be a communication gateway of the Central Control application.

6.2.1.3.1 Operational Server APN

Address: 36-65

Name in Programmer: APN

Description: This parameter contains an APN used upon dialing to an operational communication server.

Data format: 30 bytes string, first byte is length

Value span: First byte 0 to 0x1D, second to 30th - ASCII characters

Default value: ASCII "internet"

6.2.1.3.2 Operational Server APN Username

Address: 8-31

Name in Programmer: GPRS PPP Username

Description: This parameter contains a PPP username used upon dialing to an APN defined for operational server.

Data format: 24 bytes string, first byte is length

Value span: First byte 0 to 0x17, second to 24th - ASCII characters

Default value: ASCII "test"

6.2.1.3.3 Operational Server APN Password

Address: 141-164

Name in Programmer: GPRS PPP Password

Description: This parameter contains a PPP password, used upon dialing to an APN defined for operational server.

Data format: 24 bytes string, first byte is length

Value span: First byte 0 to 0x17, second to 24th ASCII characters

Default value: zeroes

6.2.1.3.4 Operational Server IP Address

Address: 66 to 69

Name in Programmer: Default Target IP Address (for GPRS)

Description: Stores an IP address of the operational server. All the messages (both active and passive, irrespectively to the source of the incoming command) during normal operation will be sent to this IP address.

If this parameter contains zeros, the unit will use an operational DNS instead.

Data format: 4 bytes IP address, Intel order (low significant bytes first)

Default value: 0.0.0.0 (change to the IP address of central command)

6.2.1.3.5 Operational Server DNS Address

Address: 2464-2495

Name in Programmer: Default target DNS Address (operational server)

Description: The Domain Name System (DNS) is a hierarchical naming system for computers, services, or any resource connected to the Internet or a private network. It translates domain names meaningful to humans into the numerical (binary) identifiers associated with networking equipment for the purpose of locating and addressing these devices worldwide.

In our case the DNS support is required in order to prevent a necessity to assign a static IP to each of the servers (operational and maintenance).

A domain name usually consists of two or more parts (technically labels), which are conventionally written separated by dots, such as example.com.

- Cello supports down to 2 levels subdomains (e.g. XXX.XXX.XXX.XXX), maximum length is 32 chars.
- Labels are restricted to a small subset of the ASCII character set known as LDH, the Letters A–Z in upper and lower case, Digits 0–9, Hyphen, and the dot to separate LDH-labels; see RFC 3696 section 2 for details.

The DNS will be used for dial up only if the IP address field of the corresponding server (in programming memory) is set to zero (e.g., 0.0.0.0).

If the IP address field of the corresponding server is not set to zero – the unit shall use this IP address for dial up.

Data format: 32 bytes string, first byte is length.

6.2.1.3.6 Listening UDP Port (while connected to both Operational Server or Maintenance Server)

Address: 107-108

Name in Programmer: GPRS Self Port

Description: This parameter stores the listening UDP port. This should be the "destination port" of incoming UDP messages, it will also be sent as a "source port" of an outgoing transmissions.

Value resolution & span: 0- 65535’

Default value: 231

6.2.1.3.7 Operational Server Target Port

Address: 109 -110

Description: This parameter stores the "destination port" of outgoing UDP or TCP (depends on Modem Type code) messages while connected to the operational server. This will be the also listening UDP or TCP port of target host.

Value resolution & span: 0- 65535’

Default value: 231

6.2.1.3.8 Modem Type Code for Operational Server

Address: 74

Description: This parameter defines dial up type, which is differs according to the communication platform and modem connected.

Valid values: According to the table below:

Value	Network
0	UDP/IP over GPRS
1-3	Not supported
4	TCP/IP over GPRS

Default value: 4 - TCP/IP over GPRS

6.2.1.4 Maintenance Server Support

The Cellocator unit supports a periodic connection to the maintenance server, which is used as a Service & Support Server.

It is possible to set an additional APN, IP address, ports and dial up type for the Maintenance Server; this server will be used for a periodical service communication sessions.

It is also possible to force the unit to connect to the specific server manually, using the OTA command (SMS or GPRS). If the command to connect to maintenance server is received during the communication peak of full hibernation – the unit will connect to maintenance server upon the end of the peeking.

The unit periodically connects (completely drop an existing connection and redial using the dedicated APN) to this server in order to check for the latest firmware and/or programming update. It is possible to enable auto connection to the maintenance server upon power up and upon firmware upgrade.

The connection to the maintenance server:

- In TCP mode - TCP socket establishment and a Maintenance Platform Manifest* packet paste into this socket.
- In UDP mode - it will be just a Maintenance Platform Manifest* UDP packet delivery to the Maintenance server and use listening port according to the configuration of the maintenance server.

An acknowledge (OTA message type 4) should be received in with a defined timeout; otherwise the platform manifest will be resent.

In case the unit cannot establish a connection to the maintenance server while the GPRS is available, it will use a dial up retry algorithm defined in Anti-Flooding section of this document.

If all the retries fail, the unit will stop trying and connect back to an operational server (instead of entering Anti-Flooding, as it would do while connected to an operational server).

If the timeout of periodical connection to the maintenance server expires while the unit is hibernating, it will not wake up; instead it will dial the maintenance server immediately after the next COM glancing.

It is possible to disable firmware upgrades or programming from the maintenance server.

The unit automatically disconnects from the maintenance server and connects back to its operational communication server after 3 minutes after the last communication transaction.

The unit does NOT send logged or distress events to the maintenance server. It keeps logging events as usual during the maintenance session (except during firmware upgrades) but does not upload them. The unit will reply to commands sent from a maintenance server.

Distress alerts and real time based alerts that occurred during the maintenance session **will be lost**.

The unit will ignore the incoming voice calls and the incoming SMS notification during the maintenance session (the SMS will be processed after the maintenance session end). Outgoing voice call initiation attempts (both plain and emergency) are ignored during the maintenance session.

After any reset occurred during the maintenance session (except the final reset of firmware upgrade procedure, see bitmap below) the unit will connect back to the primary server.

6.2.1.4.1 Enable Programming Updates from the Maintenance Server

Address: 1398, Bit 0

Description: If this bit is enabled the unit will accept updates of programming parameters from maintenance server.

Default value: 0 - Disable

6.2.1.4.2 Enable Firmware Upgrade from the Maintenance Server

Address: 1398, Bit 1

Description: If this bit is enabled the unit will perform firmware upgrade if the process will be initiated from maintenance server.

Default value: 0 – Disable

6.2.1.4.3 Enable Connection to the Maintenance Server on each Power-Up.

Address: 1398, Bit 2

Description: If this bit is enabled the unit will automatically connect to the maintenance server upon each power up.

Default value: 0 - Disable

6.2.1.4.4 Reconnect to the Maintenance Server after Firmware Upgrade

Address: 1398, Bit 3

Description: If this bit is enabled the unit will automatically reconnect to the maintenance server after firmware upgrade (irrespectively from what server, main or backup, the upgrade was performed).

If this bit is disabled the unit will connect back to an operational server immediately upon the end of the upgrade, without even validation of the upgrade process success.

Reconnection to the maintenance server after firmware upgrade is normally required in order to validate successful firmware upgrade and to set up new added configuration parameters.

Default value: 0 - Disable

6.2.1.4.5 Enable Auto Connection to Maintenance Server

Address: 1398, Bit 4

Description: If this bit is disabled the unit will never try connecting to the maintenance server automatically (even if enabled in previous bits), but it will still be possible to force the unit to connect to the maintenance server by a command from OTA.

Default value: 0 - Disable

6.2.1.4.6 Maintenance Server Connection Period

Address: 1399

Description: This parameter defines a time between automatic maintenance sessions. Maintenance server connection period will automatically randomize, in order to prevent a load on the maintenance server, caused by simultaneous connection of multiple units.

The randomization is affected by a unit's ID in the following way:

Real period = Programmed Period + {last 2 digits of decimal representing of unit's ID} [min]

Data format: 1 byte with a resolution of 90 minutes (1.5 hours).

In case of zero, the real period will be only {last 2 digits of decimal representing of unit's ID} [min]

Value span: 0-15.9 days

Default value: 16 dec (1 day)

6.2.1.4.7 Maintenance Server APN

Address: 1403-1432

Description: This parameter define a dedicated APN, used by the unit during GPRS dial up only during a connection to the maintenance server.

Data format: 30 bytes string, first byte is length

Value span: 1st byte – 0 to 0x1D, 2nd to 30th - ASCII characters

Default value (Hex): 08 69 6E 74 65 72 65 61 6C 00 …

6.2.1.4.8 Maintenance Server APN Username

Address: 1626-1649

Description: This parameter contains a PPP username used upon dialing to an APN defined for the maintenance server.

Data format: 24 bytes string, first byte is length

Value span: First byte 0 to 0x17, second to 24th - ASCII characters

Default value (Hex): 04 74 65 73 74 00 00 00 00 00 00 00 …. 00

6.2.1.4.9 Maintenance Server APN Password

Address: 1650-1673

Description: This parameter contains a PPP password, used upon dialing to an APN defined for the maintenance server.

Data format: 24 bytes string, first byte is length

Value span: First byte 0 to 0x17, second to 24th ASCII characters

Default value (Hex): 00 00 00 00 00 00 00 00 00 00 00 00

6.2.1.4.10 IP Address (for GPRS) for Maintenance Server

Address: 1392 to 1395

Description: Stores the target IP address used by the unit during a maintenance session.

Data format: 4 bytes IP address, Intel order (low significant bytes first)

Default value: 62.90.141.201 (current main maintenance server)

6.2.1.4.11 Default Target DNS Address (Maintenance Server)

Address: 2394-2425

Description: As per the DNS for the operational server, described earlier in this document.

The DNS will be used for dial up only if the Maintenance Server IP Address field is set to zero (e.g., 0.0.0.0). If the IP address field is not set to zero, the unit will use this IP address for dial up.

Data format: 32 bytes string, first byte is length

6.2.1.4.12 GPRS Target Port for Maintenance Server

Address: 1396-1397

Description: Those EEPROM cells store the "destination port" of outgoing UDP or TCP messages (during the maintenance session). This will also be the listening UDP or TCP port of target host.

Value resolution & span: 0 - 65535

Default value: 7435

6.2.1.4.13 Listening UDP Port for Maintenance Server

Address: 107 -108

Name in Programmer: Listening UDP Port

Description: As per for the operational server.

6.2.1.4.14 Modem Type Code for Maintenance Server

Address: 1391

Description: This parameter defines the connection type of the maintenance server.

Valid values: According to the table below:

Value	Network
0	UDP/IP over GPRS
1-3	Not supported
4	TCP/IP over GPRS

Default value: 0

6.2.1.4.15 Maintenance Server Session Time Update

Address: 1400

Description: The maintenance server will use default 3 Min session timeout when first connecting to the C+ server. After the first message arrives from the maintenance server to the unit, the FW will cancel the 3 Min time out, or what is left of it, and replace it with a new session timeout value defined by this parameter.

Valid values: Min time 30 Sec: 3

Resolution: 10 Sec

Default value: 90 Seconds

6.2.2 SMS Settings

6.2.2.1 SMS Destination Address

Addresses: 187-196

Description: Stores the default target address used by the unit. Under normal circumstances, this will be the SMS number of the SMS server of central control.

Note that this parameter defines only the default target address, which will be used only for active transmissions (i.e. transmissions that are automatically generated by the unit). Passive transmissions (i.e. replies for commands and queries) will be sent to the address that generated the command/query.

Data format (GSM-SMS): First byte should contain the total amount of digits that make up the actual address (not including address type byte). Second byte is the address type byte, which should be 91h for international address (recommended type to use, to allow roaming) or 81h for local address. The rest of the bytes contain the actual address, encoded in BCD. The order of the transmission is bytes with lower address first, lower nibbles (nibble = 4 bit) first. If only the lower nibble of a byte is used (this is legal only in the last byte – in case this is the last digit of the address), the higher nibble should have all of its bits set (the nibble should contain 15 dec). The rest of the bytes that are not used should contain FFh.

Default value: NULL.

6.2.2.2 SMS Center Address

Addresses: 177 – 186

Name in Programmer: SMSC Address

Description: This parameter stores the address of the cellular operator's SMS center. This parameter is applicable only for units that make use of SMS.

Data format (GSM-SMS): First byte should contain the total amount of bytes that actually contain the address (including address type byte). Second byte is the address type byte, which should be 91h for international address (recommended type to use, to allow roaming) or 81h for local address. The rest of the bytes contain the actual address, encoded in BCD. The order of the transmission is bytes with lower address first, lower nibbles (nibble = 4 bit) first. If only the lower nibble of a byte is used (this is legal only in the last byte – in case this is the last digit of the address), the higher nibble should have all of its bits set (the nibble should contain dec 15). The rest of the bytes that are not used should contain FFh.

This number has to be either left blank or set to the correct value; otherwise the unit will not be able to send any SMS message.

Example: If the parameter contains 07h 91h 79h 52h 14h 32h 54h F6h FFh, the address that will be used is the international address +972-54-123456, from left to right.

Default value: NULL (blank).

6.2.3 Comm. Permissions in Home/Roam Network

6.2.3.1 Enable GPRS

Address: In home network 201 bit 2, in Roam network 203 bit 2, in hibernation 3, bit 2 (see the following parameter).

Description: If this parameter is enabled the unit will utilize GPRS whenever possible as a default communication channel.

Default value: Enabled (1) In Home network, Disabled (0) in Roaming

6.2.3.2 Renew GPRS upon Drop (in Hibernation, GPS Peeking)

Address: 3, bit 2

Description: If GPRS is enabled, the unit will try maintaining GPRS session active all the time, even if there is no data to transfer (for example on parking, during one of the hibernation modes).

Due to resource reasons the GPRS network is searching for an idling connections and actively shutting them down. Once the connection is down - the unit will try redialing the network and generate an additional useless traffic and charge.

If this bit is disabled, the unit will not renew the GPRS session during hibernation upon drop. The session will be restored only in case the unit is leaving hibernation due to an Ignition On or Distress Session.

This bit can also be disabled when it is required to prevent GPRS dial up during GSM peeks (in full hibernation only).

Default: 1 (renew session)

6.2.3.3 Enable SMS

Address: In home network 201 bit 7, in Roam network 203 bit 7

Description: If this parameter is enabled the unit will respond to a valid incoming SMS commands and generate an active distress and real-time messages (if enabled in the next parameter) when GPRS is not available.

Default value: Enabled in both Home and Roaming (1)

6.2.3.4 Enable Active Transmissions via SMS

Address: In home network 202 bit 4, in Roam network 204 bit 4

Description: If this parameter is disabled, the unit will not generate any active SMS traffic (distress or real-time, except the "Wake Up" SMS messages, see description below), even if SMS communication is enabled in previous parameter.

Default value: Disable (1)

6.2.4 COM port settings

Note that not all the available options are currently supported.

6.2.4.1 Baud rate

Address: 471, bits 0-3

Description: Defines the baud rate of unit's COM, as per the table below:

Value (dec)	Baud rate (bps)	Currently supported
0	110	
1	300	
2	600	
3	1200	
4	2400	
5	4800	
6	9600	√
7	14400	
8	19200	√
9	38400	
10	56000	
11	57600	
12	115200	√ (default)
13	128000	
14	256000	
15	460800	√

Default: 12

6.2.4.2 Parity

Address: 472, bits 0-2

Description: Defines the parity of unit's COM as per the table below:

Value (dec)	Parity	Currently supported
0	No Parity	√ (default)

1	Odd Parity	
2	Even Parity	
3	Mark Parity	
4	Space Parity	
5-7	Unused	

Default: 0

6.2.4.3 Stop Bits

Address: 472, bits 3-4

Description: Defines the stop bits of unit's COM, as per the table below:

Value (dec)	Stop Bits	Currently supported
0	One Stop Bit	√ (default)
1	1.5 Stop Bits	
2	Two stop bits	
3	Unused	

Default values: 0

6.2.4.4 Flow Control

Address: 472, bits 5-6

Description: Defines the flow control of unit's COM, as per the table below:

Value (dec)	Flow Control	Currently supported
0	No Flow Control	√ (default)
1	Software flow control	
2	Hardware flow control	
3	Unused	

Default values: 0

6.2.5 Distress Session Configuration

A Distress Session is one of four possible ways to deliver data to a Central Control (refer to the *Event Types generated by Cellocator devices* section).

If the condition for the specific event is met, the unit will create a series of messages with the same transmission reason. The messages will be uploaded to the Control Center immediately with the first available communication transport (during IP session – over IP, otherwise by SMS). The messages are not stored in the memory and if there is no cellular coverage at the moment of sending – the message will be lost. Distress events do not require any kind of acknowledge.

The number and time between messages in Distress Session is defined in parameters below, but can be temporary overwritten by Distress Session initiation OTA command.

Distress session caused by the same trigger, occurred while the first session is not over yet restarts the session from the beginning.

Distress session caused by different trigger, occurred while the first session is not over yet causes new distress session (up to 5 distress sessions might be maintained concurrently). The 6th distress session, while previous 5 are still active, will be lost.

It is also possible to initiate an endless (or specified duration) distress session by command from CCC. Upon start, this session cancels all active distress sessions. The session will be stopped by any other distress session or by a command from OTA.

6.2.5.1 Time between Distress Transmissions

Address: 72-73

Description: This parameter defines the amount of time between two consecutive Distress Transmissions in distress session initiated by trigger of distress event.

The amount and the period of distress events generated during session initiated by OTA command is defined by the command itself.

Data Format: 16-bit unsigned integer, 0.01 seconds resolution

Legal values span: 01h to FFFFh – 65535 (~11minutes)

Default value: 1000 (10 seconds)

6.2.5.2 Number of Distress Transmissions

Address: 75

Description: This parameter defines the amount of transmissions that will be generated in a single distress session triggered by internal logic, if no more sensors are triggered.

The maximum time of single distress session is [this parameter]*[time between transmissions]. Take into account up to another second per transmission (this is the time that it takes the unit to prepare and arrange a transmission).

NOTE: A Distress session initiated by OTA command will contain the number of messages specified in a command.

Legal values span: 01h (one transmission) through 00FFh (255 transmissions). 0 is illegal.

Default value: 1

6.2.6 Wake Up Messages

In most of the cases the unit is sent to the installation site programmed with operational PL file, but without a SIM card. The SIM card is being inserted on installation site.

In order to create an automatic association of the unit with the SIM number in CCC application, the unit initiates a real-time message using SMS or GPRS, according to the bitmap below.

In case Wake Up message has not been sent due to server side issue triggering Anti flooding condition, The Wake Up message counter will be reset and the Number Of Repetition counting will start again from 0.

6.2.6.1 Enable SMS Wake Up

Address: 1344, bit 6

Description: An SMS message/s (number is set in repetitions field of the same byte) will be sent to the Default Destination SMS address upon power up, after successful registration into Home or Roam GSM network, respectively to SMS rules (like pre-programmed GSM operator's selection, active transmissions block etc).

The "SMS Wake up" event does not require any type of ACK. The message shall be retransmitted in case error.

NOTE: The "wake up" message will be transmitted even if active transmissions are disabled. In addition, the time between Wake up SMS repeated messages will be 40 seconds (except for the CelloTrack Nano, in which the time between emergency transmissions will be shorter but still dependent on network responses).

NOTE: In CelloTrack and CelloTrack-T, Wake up SMS will be sent every time the unit is moved between Inactive to Active states.

Default value: 0 - disabled

6.2.6.2 Enable GPRS Wake Up

Address: 1344, bit 7

Description: The message will be sent to the Default Destination IP address upon power up, after successful registration into Home or Roam GSM network, and dial up to GPRS, respectively to GPRS rules (like pre-programmed GSM operator's selection etc). The message requires ACK (standard type 4 message). If ACK is not received, it will be resent limited number of times, as configured in "Number of Repetitions" parameter (address 1344, bits 0-5).

Default value: 0 - disabled

6.2.6.3 Number of Repetitions

Address: 1344, bits 0-5

Description: This parameter defines the amount of SMS/GPRS Wake Up messages. In case of failure during sending Wake Up event via GPRS (ACK is not received), the unit will try to resend the message with a period configured in "Time between Distress Transmissions" parameter (address 72). Every power cycle, the repetition counter is reset to 0 and the count is restarted.

Default: 5

6.2.7 Offline Tracking

This mode is designed to enable offline data logging. During this mode the modem of the unit remains off, although the GPS, processor and all the peripherals are managed by unit's logic as usual. The unit is generating and storing logged events in its non-volatile memory and once a day (for example, or as configured) establishes a connection to upload all of them during a single communication session.

The modem is also temporarily switches on upon trigger of distress session (in this session only the distress event itself is sent).

The communication session for accumulated data upload will be initiated in the following cases:

- At the end of trip (upon expiration of the dedicated timeout after the Stop alert)
- Upon filling of 90% of memory capacity
- Upon expiration of Logged Events Upload Periodic Timer
- Upon reaching a certain amount of logged events
- Upon activation of Input
- Upon movement in a certain time
- Due to FOTA process

In case of failure of upload process when the unit tries to upload the logged events (i.e. if not all the events were uploaded for any reason), the will perform a configurable number of retries, with a configurable time between the retries.

If during a retry session one of the 5 upload modes is triggered again, the retry mechanism will be "restarted" (e.g. if the number of upload retries was configured to 5, and in the current retry session 3 retries were done, and an upload mode is triggered again, the unit will perform the upload sequence again, i.e. first upload try + 5 retries).

If a retry session was "expired" (i.e. the unit performed all the retries as configured, and still failed to upload all of the logged events), the unit will return to silent offline tracking, until the next upload mode is triggered.

If "Enable Live tracking"= Disabled, then offline tracking become not applicable.

6.2.7.1 Enable Offline Tracking

Address: 1348, bit 6

If this bit is enabled (1) the unit switches the modem on and initiate the GPRS session only when data download is required (see below). The rest of the time the modem remains off.

Upon the end of data upload process the session and the modem is shut down.

The modem will also be switched on during distress sessions and real time alerts (Wake up etc.).

In case of wake up due to distress session (or real time alert) the modem will be switched off after transmission of the last message (any valid Cellocator message will extend this timeout by an additional 10 seconds).

Provided the parameter "Enable Live tracking"= (0) Enabled (it's a primary condition), Switching the modem on followed by GPRS dial up is initiated by the unit upon:

- At the end of trip (upon expiration of the dedicated timeout after the Stop alert)
- Upon filling of 90% of memory capacity
- Upon expiration of Logged Events Upload Periodic Timer
- Upon reaching a certain amount of logged events
- Upon activation of input
- Upon movement in a certain time
- Due to FOTA process

After modem's wake up it will try to register into a GSM network. If the registration is not accomplished during timeout, defined in "Maximum Network Registration Time" (address 270), the modem will be switched off until next wake up.

Any modem reset, occurred during the upload session, will be followed by modem wake up and registration attempt as per "Maximum Network Registration Time" (address 270).

If the GSM registration is successful, the unit will get more time to dial up GPRS and deliver the first message from the log (the total time from modem wake up is "Maximum Network Registration Time" + 90 seconds, independently from the exact moment of GSM registration). If during this timeout the unit failed to establish GPRS session and deliver the first message - the modem shall be switched off until next wake up.

The unit will not switch off the modem while data transfer is in process;

The modem will be switched off:

- While log is not empty: 90 seconds after last message reception (in case of session drop or server failure).
- While log is empty: 10 seconds after last valid message reception (including ACK)
- This timeout is configurable via "Timeout before switching off the modem" parameter.

Once the dial up attempts stop for one of the reasons described above, no more GPRS dialup attempts (or modem wakes up followed by GPRS dial up attempts) will be made

until Stop Journey is detected. After such an event, dial up attempts will start again as described above.

Maintenance Session, if enabled, will start immediately after ANY data session occurred after periodical maintenance timeout expiration. In such a case the modem will be switched off after the end of the maintenance session. There is no dedicated modem wake up for maintenance session.

Serial data Forward mechanism (MDT, Garmin, transparent data ...) will behave in following manner during offline mode:

- During modem wake up due to Emergency session, then the data forwarded from COM port will be forwarded to the server.
- During modem wake up due to Ignition OFF or memory overfilling, then the data will be lost.

Default: 0 (Disable)

6.2.7.2 Timeout before switching off the modem

Address: 220

This timer is restarted every time a data packet is received (to allow the server time to send necessary commands to the unit, if needed), when the log is not empty (i.e. not all logged events were uploaded to the server). Note that the FW limits this parameter to be minimum 30 seconds, so any programmed value under 30 seconds would be treated as 30 seconds.

After completion of uploading all of the logged events (i.e. the log is empty), the unit is switching off the modem after 10 seconds (hardcoded).

Resolution: 2 seconds/bit

Default value: 90 seconds

6.2.7.3 Auto Upload after Ignition Off Event

Address: 255, bit 0

Description: If this bit is enabled (1), the unit will wake up the modem and establish GPRS session upon expiration of a timeout (Time to Auto-Upload) after a Stop alert.

Data Range: 1 - Enable, 0 - Disable

Default Value: 0 - Disable

6.2.7.4 Auto Upload upon Memory Overflow

Address: 255, bit 1

Description: If this bit is enabled (1), the unit will wake up the modem and establish GPRS session upon detection of memory overflow (90% full).

Data Range: 1 - Enable, 0 - Disable

Default Value: 0 - Disable

6.2.7.5 Time to Auto Upload after Trip Stop

Address: 259 – 260

Description: This parameter defines time interval between Trip Stop and GPRS dial up for data upload. Disabling the automatic upload at trip stop is done by "Auto Upload after Ignition Off Event" parameter (address 255, bit 0).

Value resolution & span: Resolution is 4 Seconds. Span from: 4 seconds (0x0001), to 18:12 Hours (0xFFFF).

Default value: 5400, (0x1518h), 1.5 Hours

6.2.7.6 Logged Events Auto Upload Timer

Address: 218 – 219

Description: This parameter defines the period for periodical auto-upload of events accumulated during Offline mode. 0 – cancels periodical auto upload.

Value resolution & span: Resolution is 1 minutes. Span from: 1 minute to 65535 minutes. 0 disables the periodic upload.

Default value: 0

6.2.7.7 Logged Events Amount for Upload Offline Events

Address: 215

Description: This parameter defines the amount of logged events for upload of events accumulated during Offline mode. 0 – cancels the amount dependent upload.

Value resolution & span: Resolution is 1 event. Span from: 1 to 255 events.

Default value: 0

6.2.7.8 Number of Logged Events Upload Retries

Address: 221

Description: This parameter defines the number of logged events upload retries (in case of no GSM connection when attempting to upload logged events). 0 – cancels the retry mechanism.

Value resolution & span: Resolution is 1 retry. Span from: 1 to 255 retries.

Default value: 0

6.2.7.9 Time Between Logged Events Upload Retries

Address: 222

Description: This parameter defines the time between logged events upload retries (in case of no GSM connection when attempting to upload logged events).

Value resolution & span: Resolution is 10 seconds. Span from: 10 to 250 seconds.

Default value: 0

6.2.7.10 Local Timer to Upload Logged Events

Address: 223-224

Description: This parameter, together with "Movement Timer Before Local Timer Activation" (address 225-226) define a time range for a local upload mode for logged events. The "Local Timer to Upload Logged Events" starts after previous upload session ends. After it expires, the "Movement Timer Before Local Timer Activation" starts. If during this time the unit moves, the logged events are uploaded, and the "Local Timer to Upload Logged Events" starts again.

Value resolution & span: Resolution is 1 minute. Span from: 0 to 65535 minutes.

Default value: 30 minutes

6.2.7.11 Movement Timer Before Local Timer Activation

Address: 225-226

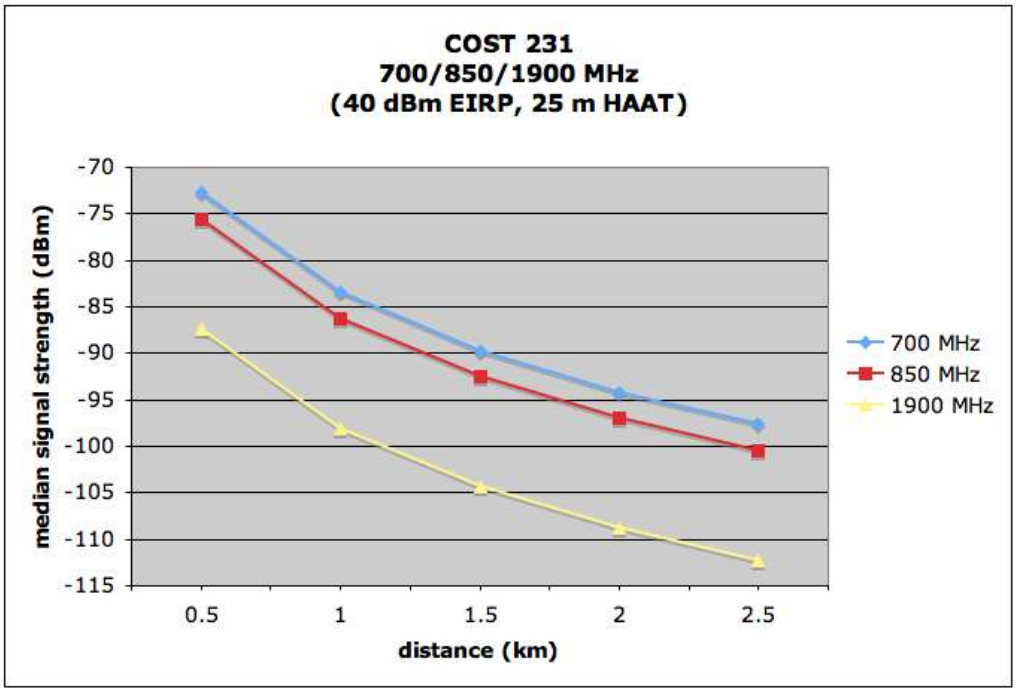
Description: This parameter, together with "Local Timer to Upload Logged Events" (address 223-224) define a time range for a local upload mode for logged events. The "Local Timer to Upload Logged Events" starts after previous upload session ends. After it expires, the "Movement Timer Before Local Timer Activation" starts. If during this time the unit moves, the logged events are uploaded, and the "Local Timer to Upload Logged Events" starts again.

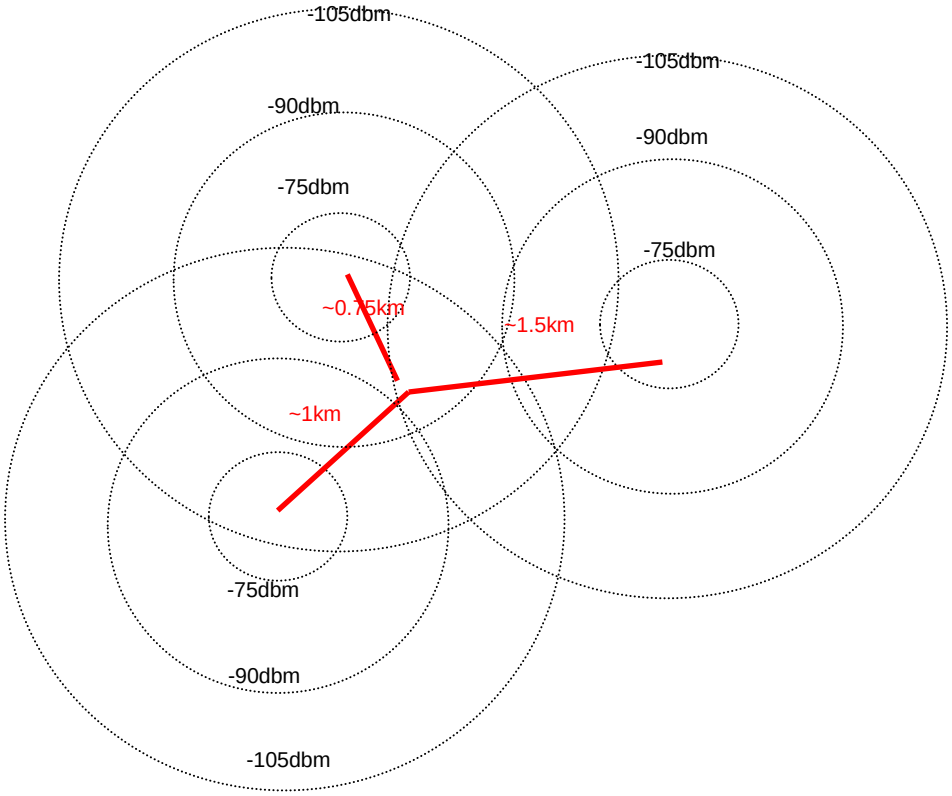
Value resolution & span: Resolution is 1 minute. Span from: 0 to 65535 minutes.

Default value: 10 minutes

6.2.8 Cell ID Based Location (Neighborhood list of the serving GSM cell)

The Cell ID triangulation is an alternative location method. In cases when the GPS is not available information regarding in-range cellular towers (Cells) with known location, along with signal power or SNR (Signal to Noise Ratio) indication, might be used for location approximation of the transmitting device.





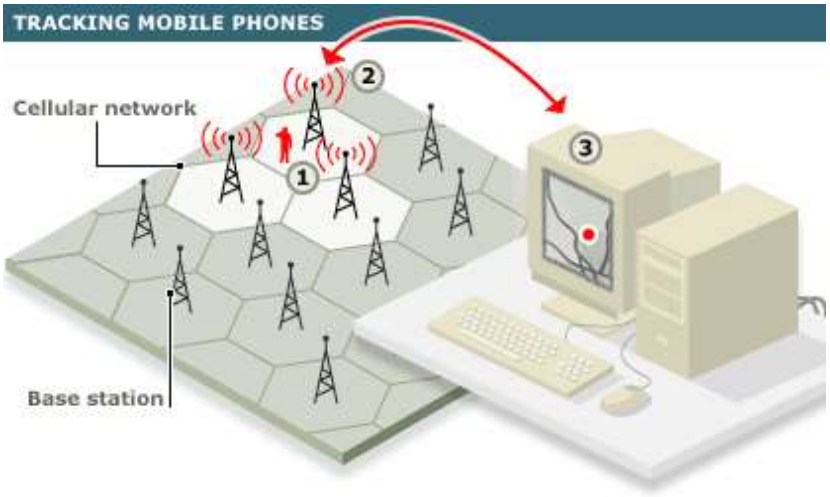
The location of the transmitting vehicle in respect with the "in-range" cells and the RF signal propagation attributes which can be significantly affected by reflectors, black spots, interference, etc. all of this may influence the relative "reliability" of the SNR indication as an estimator for the distance of the vehicle from the receiving Cell.

How does it work with Cellocator unit?

When the unit loses a GPS signal for longer than 2 minutes, it will poll modem for Cell ID information. The modem will update with the following parameters of up to 7 cells (the serving cells and up to 6 neighbor cells):

- Base station identification code
- Cell ID
- Location Area Code
- Received signal strength in dBm

The message, containing this information and CellID retrieval timestamp, will accompany any log or distress message (as per configuration) generated by Cellocator unit during GPS coverage loss.



Positioning software performs a triangulation calculation on the information and the data is converted into a geographical location: strongest reception signal theoretically defines closest cells.

Conditions to consider GPS coverage loss and restore

The GPS coverage loss in is considered when:

- The GPS is communicating (connected)
- The location appears as invalid for longer than 2 minutes in Standby mode or timeout, programmed in "GPS Max On time" parameter in hibernation mode.

The recovery from Cell ID state is to GPS coverage state, in standby (i.e. not Hibernation) mode, happens when the GPS location is considered valid continuously for more than 1 minute or as in PL parameter 500/1 "GPS Navigation Start_Stop filter" in hibernation mode.

Behavior during No GPS Mode

Once the "NO GPS" mode is started, the unit is polling Cell ID neighborhood information from modem periodically, every 1 minute.

The data session (to operational server only) is suspended during polling, the connection does not drop. Messages generated during Cell ID polling are delivered after data mode is restored.

The Cell ID neighborhood data is stored in a unit and delivered as an additional message to a central control after any event or distress message. The additional message contains the next sequential message numerator for easy correlation.

In 3G networks, information of the neighbor cells is not available. Thus, the modem is polled for current serving cell extended data, which may include sector data, which in turn may improve determining the unit location.

6.2.8.1 Enable Generation of Logged Cell ID Escorting Packet

Address: 201, bit 3 in Home Network

203, bit 3 in Roam Network

Description: If this flag is enabled, the unit will generate logged message, following any logged message Type-0 or Type-11 while the GPS location is considered as invalid.

The logged messages will be stored in the same buffer as corresponding messages Type-0 and use the same sequence of numerator for easy correlation.

The message will not be generated if the unit is not logged into GSM.

Default: 0 - Disabled

6.2.8.2 Enable Generation of Real Time Cell ID Escorting Packet

Address: 201, bit 4 in Home Network

203, bit 4 in Roam Network

Description: If this flag is enabled, the unit will generate real time message following any distress message Type-0 or "Active log event" of Type-11 while the GPS reading is considered as invalid.

The real time messages will be delivered using the same rules as the corresponding distress messages Type-0 and use the same sequence of numerator for easy correlation.

Default: 0 – Disabled

6.2.8.3 Enforce SMS Destination

Address: 201, bit 5 in Home Network

203, bit 5 in Roam Network

Description: Usually units have a predefined SMS destination ("SMS Destination Address" parameter) to which it sends it's initiated SMSs. As for SMS replies to transmissions from other addresses, the legacy logic dictates that they would be sent only to the originating address.

This parameter enable enforcing to send the ACK always (regardless of the origin of the command) to the same SMS destination number.

Default: 0 – Disabled

6.2.9 Internal Accelerometer Configuration

6.2.9.1 Accelerometer Sensitivity

Address 467, bits 3-4

Description: It is possible to calibrate the sensitivity of the internal accelerometer (3 levels) and to adapt it to any vehicle. The default value of 1 is adapted to detect movement start/end in standard private vehicle. In case of truck it is recommended to decrease the sensitivity level, in case of very silent vehicle – to increase it.

Values span: 0 - Very insensitive, 1 – Normal, 2 - Very sensitive, 3 - Spare

Default value: 1 – Normal

Note: The Accelerometer Sensitivity feature is applicable also in CelloTrack T units from FW version 61c.

6.2.9.2 Voltage Level Threshold for Ignition On Detection

Address 468

Description: This parameter allows to configure the main battery voltage for assisting accelerometer or Ignition input with Start/Stop detection, or for waking up the unit from hibernation upon connecting electrical vehicle to charging source. It only affects if bits 5 and/or 7 of address 467 and/or bit 0 of address 3 are set.

The Start Event shall be registered if movement by accelerometer is detected or Ignition input state is On, and the voltage of the main battery is higher than this parameter during the entire Start Event registration timeout.

The Stop Event shall be registered if NO movement by accelerometer is detected or Ignition input state is Off, and the voltage of the main battery is lower than this threshold during the entire Stop Event registration timeout.

Data format: 8-bit unsigned, 0.1176470588235V/bit

Default value: 12.81V

6.2.10 Roaming List, GSM Operator Management

The non-volatile configuration is storing a list of 100 Public Land Mobile Networks (GSM operators) with their priorities.

The end unit continuously* monitors a GSM operators (PLMNs) available on the air and dynamically selects the best cost effective operator according to the pre-programmed priority assigned to each one.

*The GSM operator selection mechanism is activated in 2 cases:

Periodically, according to pre-programmed timer

Upon new GSM registration, caused by reset or leaving the area covered by previously selected network.

After one of the conditions listed above becomes true the state machine takes control over the process and selects the best operator based on the list in the configuration memory.

6.2.10.1 Timer of Auto Search

Address: 1008

Description: This parameter defines a timer, used by the system to repeat search of available GSM networks in the air. The timer restarts each time when the unit is "taking decision" to register in a specific PLMN, irrespectively to the result of registration attempt.

Data format: The parameter is an 8-bit integer, resolution of 10 minutes.

Value span: 1 to 255 (10 minutes to 2550 minutes, zero is automatically translated into 30 minutes)

Default value: 6

6.2.10.2 Consider Unknown Operators as Forbidden

Address: 1348, bit 5

Description: If this flag is set, any PLMN not listed in the programming will be considered as forbidden.

Otherwise, if this bit is 0, any PLMN not listed in the programming will be considered as enabled with lowest priority.

Default value: zero (not forbidden)

6.2.10.3 Number of PLMNs Programmed

Address: 1009

Description: This parameter defines a number of active records in PLMN table.

Zero value cancel Roaming List Management feature.

Value span: 0 to 100

Default value: zero

6.2.10.4 Public Land Mobile Networks (PLMN)

Addresses:

Address	Value
1010-1012	PLMN 1
1013-1015	PLMN 2
….	….
1307-1309	PLMN 100

Description & Data Format:

Each PLMN number is composed of two fields:

MMC-Mobile Country Code

MNC-Mobile Network Code

It will be stored in the configuration memory together with its priority as a single parameter in the following way:

Priority			PLMN (MCC-MNC)			
Bit 23		Bit 20	Bit 19		Bit 1	Bit 0

The highest number in Priority field (15) is representing the most preferred network.

The value of 1 is the lowest priority, 2 - higher priority and so on.

The value of zero – is representing Forbidden PLMN.

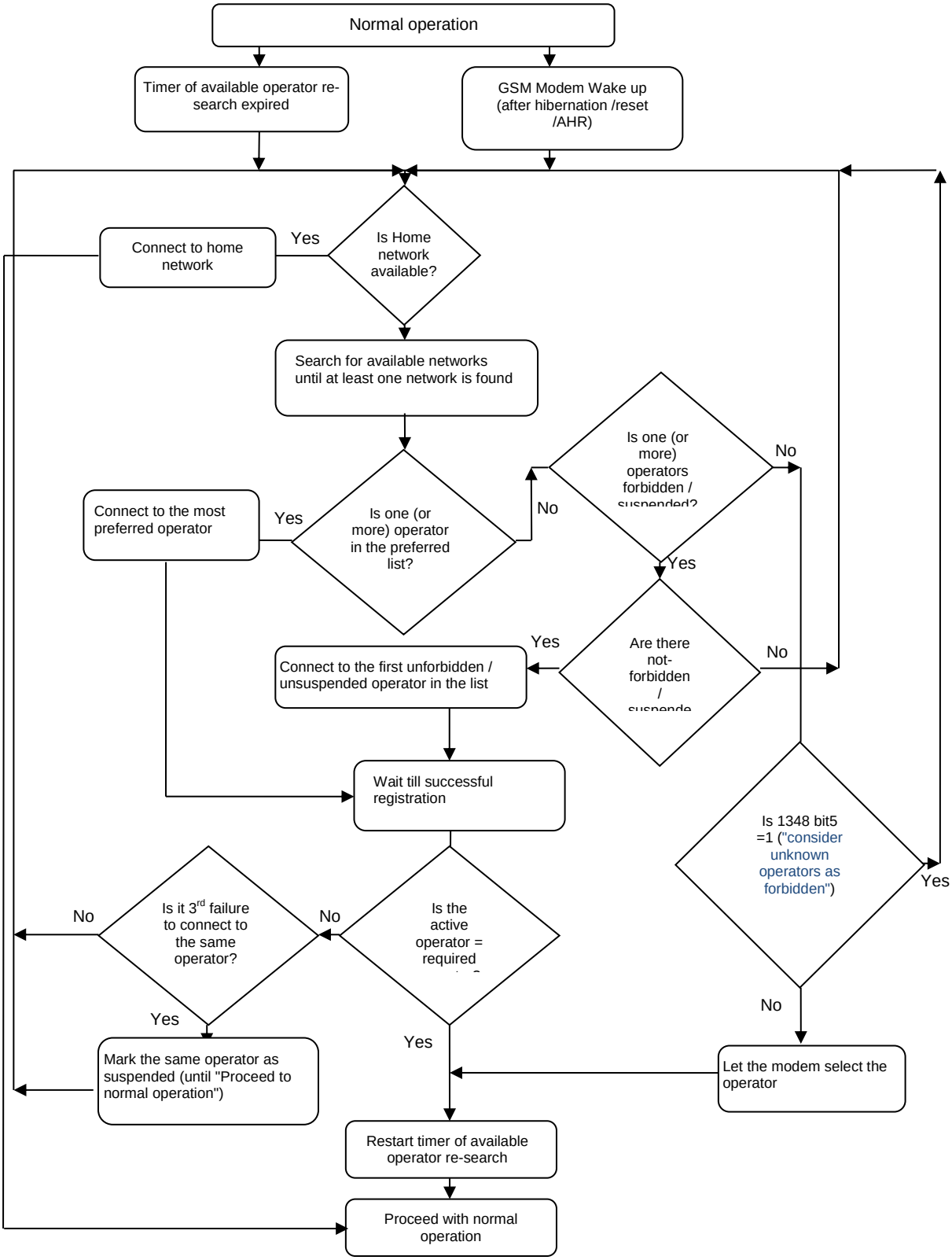
NOTE: The network available in the air, but not listed in the pre-programmed PLMN list will be treated as per configuration in "Consider Unknown Operators As Forbidden" above.

During searching of available networks (processing AT+COPS command) the modem is busy and not available for any type of communication. This process might take up to 3 minutes, but in majority of the cases will be accomplished in less than 20 seconds.

In case no available network found during search, or all the available networks are "forbidden" – the unit will hold and proceed with searching after expiration of Timer of Auto Search.

Default value: zeroes

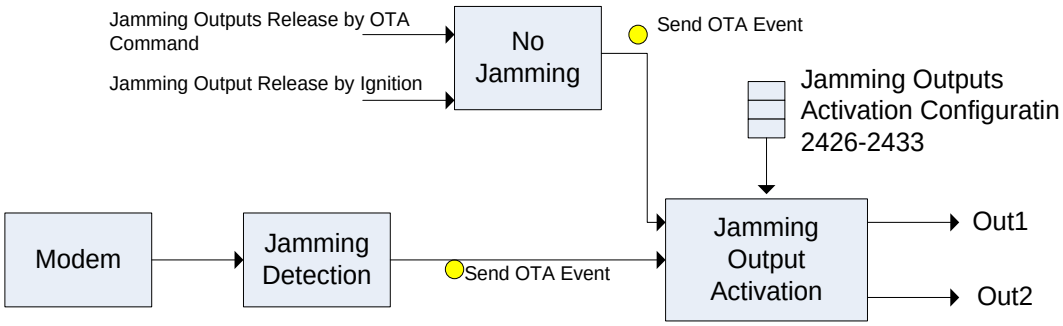
6.2.10.5 Operator Selection Flow Chart



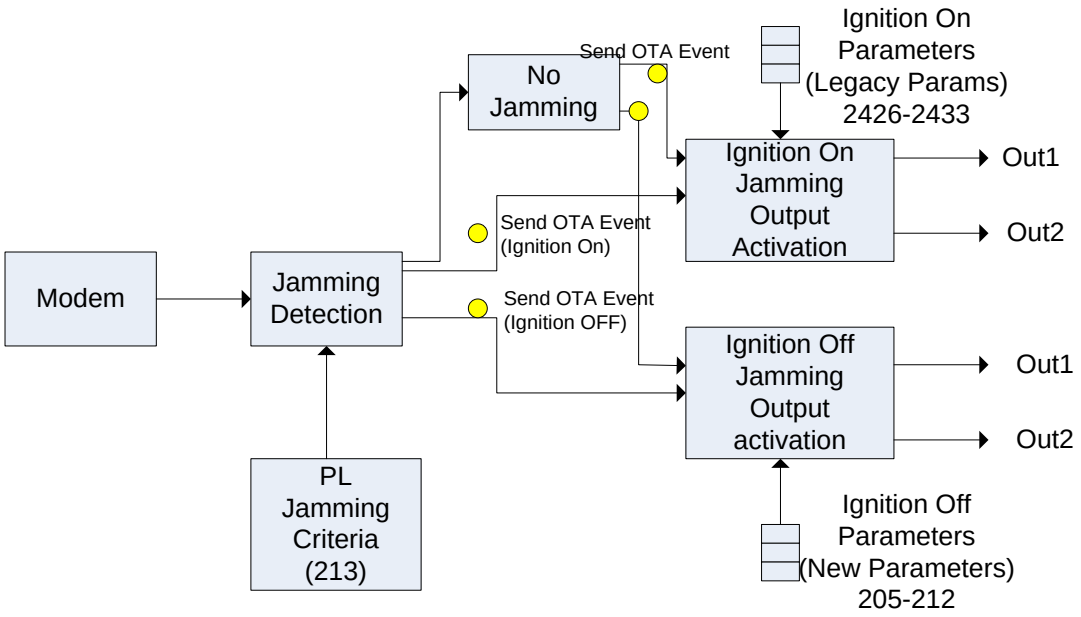
6.2.11 GSM Jamming Detection & Reaction

The GSM Jamming detection supports two modes of operation:

- **Legacy Jamming Detection mode**: Jamming is detected without any relation to the Ignition state of the vehicle. In this operational mode, jamming detection can activate up to two outputs for jamming driver feedback. The Jamming feedback is released by OTA command or Ignition Sequence.



- **Advanced Jamming Detection mode**: The jamming detection is depended on the vehicle's ignition state. Different outputs activations are allocated for Ignition On and Ignition Off states. Each Ignition state can drive up to two driver feedback outputs. Jamming Driver feedback outputs are released when jamming condition ends. The user can terminate the jamming state by the legacy sources (OTA commands and Ignition sequence). In the advanced mode, the user can configure the jamming detection time filter and the Jamming End condition time filter. Jamming events will be sent when jamming is detected or when jamming ends. The Jamming events will also reflect the vehicle's ignition state. The Ignition on jamming output activation configuration is the same configuration array used by the legacy jamming outputs activation.



The following responses to jamming detection are available and switchable by unit's programming:

- The unit allows activating a vehicle horn and / or blinkers in pre-programmed frequency and cadence.
- Each of the outputs (horn and blinkers) is equipped by independent activation time filter.
- The unit allows activating nested immobilization (after vehicle's stop) and / or immediate immobilization.
- Unconditionally the unit stores dedicated event for jamming detection into its non-volatile memory.
- The unit enables releasing activated outputs by valid Dallas or by certain activity of Ignition input.

6.2.11.1 GSM Jamming Detection

6.2.11.1.1 Telit

The cellular modem detects jamming and, if not during an active GPRS session, initiates periodical reports to a microcontroller while jammed (every 3 seconds).

The jamming status is considered as GSM JAMMED upon reception of 3 consecutive jamming detection notifications from the modem in 10 seconds. The unit stores a GSM JAMMED event (TR206, TR Specific data 0) upon jamming status changing to Jammed.

The jamming status is considered as GSM NOT JAMMED upon reception of a dedicated unsolicited message from the modem - "Operative". The unit stores a GSM JAMMED event (TR206, TR Specific data 1) upon jamming status change to Not Jammed.

Since during an active GPRS session unsolicited Jamming detection indications are not received, the microcontroller is temporary suspending GPRS session upon traffic jam (missing ACKs for at least 30 seconds and 3 lost ACKs minimum).

NOTE: In this case (GSM Jamming during GPRS Session) the Acknowledge Timeout directly affects time to Jamming Detection.

The unit will not suspend the GPRS session more than once; next session suspend can only happen in a subsequent GPRS session.

6.2.11.1.2 Cinterion

The Cinterion modem, unlike Telit, is not limited by active GPRS sessions – the jamming indications are issued in any state. The modem is not initiating any periodical report; it is reporting GSM jamming state change upon jamming start and end. The unit is immediately entering or leaving "Jamming" mode upon reception of the appropriate notification from the modem.

6.2.11.2 Advanced GSM Jamming Detection Mode

Address: 525, bit 6

Description: The Advanced Jamming detection mode differentiates between Ignition-On and Ignition-Off jamming detection criteria. Each mode (Ignition On or Ignition Off) has its dedicated outputs activation configuration parameters. The Advanced Jamming also enables the configuration of the jamming detection threshold and the "Jamming End" filter delay. OTA events reflecting the beginning and End of jamming sessions will be sent whenever jamming is detected or jamming stops. 0-Legacy Jamming support (not depended on Ignition state), 1-Advanced Jamming support, Ignition state depended.

Default value: zero (Disabled)

6.2.11.3 Disable GSM Jamming Event or Disable GSM Jamming Event during Ignition On

Address: 1348, bit 3

Description: This configuration parameter disables jamming OTA events. The functionality of this configuration bit depends on the state of the Jamming detection mode (See: Advanced GSM Jamming Detection Mode): If the advanced mode is configured, This configuration bit will only disable jamming events started during Ignition On, If the Advanced mode is not configured, this pin will disable all jamming events.

Note that Jamming detection started during Ignition On and ended while in Ignition Off will be reported even if "Disable GSM Jamming Event during Ignition off" is enabled.

In addition, output activation as a reaction to jamming is independent from registration of GSM JAMMED event.

Default value: zero (Jamming is NOT disabled)

6.2.11.4 GSM Jamming-End Time Filter

Address: 214

Description: The GSM Jamming-End Time Filter is only applicable if advanced jamming mode is enabled (See: Advanced GSM Jamming Detection Mode). The Jamming-End Time Filter defines the time required for declaring "End of Jamming" event. End of jamming will send a jamming end event and deactivate the associated outputs if configured by "Release by Jamming End" flag. Setting the Jamming End Time Filter to 0 will result in immediate outputs deactivation. The filter is common for both Ignition-on and Ignition-off jamming states. The timer resolution is 15 seconds.

Default value: 10 Minutes

Resolution: 15 second

6.2.11.5 GSM Jamming Detection Time Filter

Address: 213

Description: The GSM Jamming-End Time Filter is only applicable if advanced jamming mode is enabled (See: Advanced GSM Jamming Detection Mode). The Jamming detection Time Filter defines the basic criteria for declaring jamming condition. The time filter defines the minimal number of consecutive 3 seconds samples needed before jamming condition is detected. Each bit represents time delay of 3 seconds. The minimal value is 1 (0 will be translated to 1 by the Firmware). Typically this parameter will be set to 10, representing 30 Seconds time filter.

Default value: 30 Seconds (10)

Resolution: 3 second

6.2.11.6 Output Activation as a reaction to GSM Jamming Detection

Upon GSM jamming detection and expiration of activation timeouts, the unit can concurrently activate two outputs. Once activated by Jamming Detection logic, the output can only be deactivated by:

- A command (OTA or serial)
- Authorized Dallas
- Ignition activity pattern

Once deactivated by user or by command the output will be activated again only upon the next jamming detection. In other words: after the end of the active jamming session and beginning of the next one.

NOTE: Reset does not deactivate an output activated upon jamming detection.

6.2.11.6.1 Output, Auto-Activated upon Jamming Detection

Address: 2426 for first output and 2429 for second output, bits 0-2

Address: 205 for first output and 208 for second output, bits 0-2

Description: This pair of parameters defines a numbers of outputs that will be activated upon jamming detection.

Output name	Output number
Feature Disabled	0
Siren	1
Gradual Stop	2
St. Immobilizer	3
LED	4
Blinkers	5
Reserved	6
Reserved	7

Value span: 1 to 5

Default value: zero

6.2.11.6.2 Delay for Output Activation

Address: 2432 for first output and 2433 for second output

Address: 211 for first output and 212 for second output

Description: This pair of parameters contain a time filters for output activation upon GSM Jamming.

The event of Jamming detection will still be generated w/o any timeout.

If this parameter contains any number, different from zero, the output will not be activated immediately upon Jamming detection, but after a pre-programmed timer. An activation of the output will only occur if upon expiration of this timer a jamming session is still active.

The timer for output activation will start upon detection of GSM Jamming and reset upon detection of GSM Jamming end.

Resolution: 15 seconds / bit, maximum 63.75 minutes

Default value: zero (immediate activation upon Jamming detection)

6.2.11.6.3 Output Activation Pattern (Upon Jamming Detection)

Address: 2426 for first output and 2429 for second output, bits 3-5

Address: 205 for first output and 208 for second output, bits 3-5 (Advanced Mode during Ignition-Off)

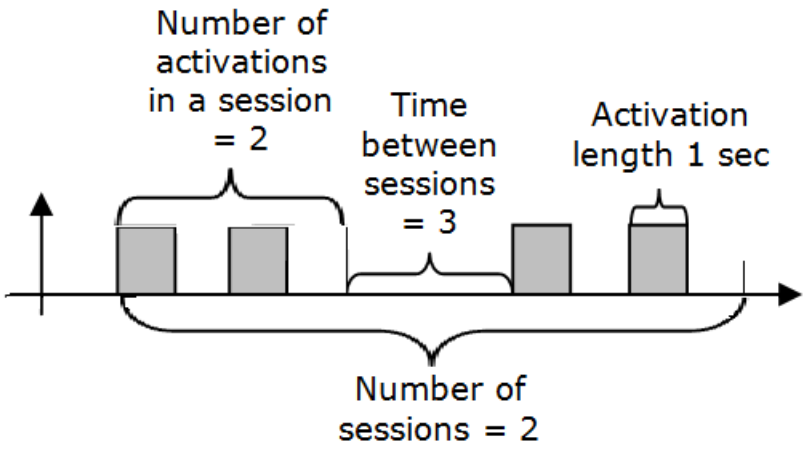
Description: This pair of parameters defines a activation pattern of outputs upon jamming detection.

Setting	Action
0	Pulse Activation (The output shall be activated for the time, defined in "Pulse Outputs Width Period", addr. 140 dec
1	Change state to "active" upon jamming detection, change to inactive upon release (by command, Dallas or Ignition Activity)
2	Activate Gradually (only compatible with Gradual Stop output)
3	Activate Nested (executed upon jamming detection only after vehicle stops, e.g. Ignition off or 10 valid GPS packets showing speed lower than 1 km/h)
4	Template Activation (according to the settings described below)
5-7	Reserved

6.2.11.7 Template of Output Activation upon Jamming Detection

Example of template:

Two activations in a session, 1 second per activation, 2 sessions, 3 seconds between sessions:



6.2.11.7.1 GSM Jamming - Output Activation Template - Activation Length

Address: 2427 for first output and 2430 for second output, bits 0-3

Address: 206 for first output and 209 for second output, bits 0-3 (Advanced Mode, During Ignition-Off)

Description: This pair of parameters defines a length of activation of the selected output upon GSM Jamming detection.

0 for the time, defined in "Pulse Outputs Width Period", addr. 140 dec

Value resolution: 0.5 second

Default value: zero

6.2.11.7.2 GSM Jamming - Output Activation Template - Number of Activations in a Session

Address: 2427 for first output and 2430 for second output, bits 4-7

Address: 206 for first output and 209 for second output, bits 0-3 (Advanced Mode, During Ignition-Off)

Description: This pair of parameters defines a number of activations of the selected output upon GSM Jamming detection.

0 – cancels outputs activation upon jamming detection

Default value: zero

6.2.11.7.3 GSM Jamming - Output Activation Template - Number of Activation Sessions

Address: 2428 for first output and 2431 for second output, bits 0-3

Address: 207 for first output and 210 for second output, bits 0-3 (Advanced Mode, During Ignition-Off)

Description: This pair of parameters defines a number of sessions of output activations upon GSM Jamming detection.

0 – for cyclic activation all the time of jamming

Default value: zero

6.2.11.7.4 GSM Jamming - Output Activation Template - Time between the Activation Sessions

Address: 2428 for first output and 2431 for second output, bits 4-7

Address: 207 for first output and 210 for second output, bits 4-7 (Advanced Mode, During Ignition-Off)

Description: This pair of parameters defines a time between activation sessions of output activations upon GSM Jamming detection.

Zero value: If zero is programmed the unit will only perform one session of activation irrespectively to the programmed number of sessions.

Value resolution: 0.5 second

Default value: zero

6.2.11.8 GSM Jamming Outputs Release

GSM jamming outputs can be released by Dallas key authentication or by Ignition sequence. When advanced jamming mode is enabled (See: Advanced GSM Jamming Detection Mode), It is possible also to release the outputs when GSM jamming condition ends.

6.2.11.8.1 Enable Output Release by GSM Jamming End condition while in Ignition-On

Address: 522, bit 5

Description: GSM Jamming-end detection will deactivate the outputs if this parameter is enabled. The "Jamming-End" state is declared after no jamming detection is detected for the time defined in "GSM Jamming End Filter":

0 - Jamming-End doesn't affect the activation outputs.

1 - Jamming-End will deactivate the GSM Jamming activation outputs.

This bit is applicable for jamming end condition detected while the unit was in Ignition-On.

Values span: 0- Disable, 1 - Enable

Default value: Enable

6.2.11.8.2 Enable Output Release by GSM Jamming End condition while in Ignition-Off

Address: 522, bit 4

Description: GSM Jamming-end detection will deactivate the outputs if this parameter is enabled. The "Jamming-End" state is declared after no jamming detection is detected for the time defined in "GSM Jamming End Filter":

0 - Jamming-End doesn't affect the activation outputs.

1 - Jamming-End will deactivate the GSM Jamming activation outputs.

This bit is applicable for jamming end condition detected while the unit was in Ignition-Off.

Values span: 0- Disable, 1 - Enable

Default value: Enable

6.2.11.8.3 Enable Output Release by Authorized Dallas

Address: 522, bit 7

Description: This bit enables deactivation of an output, activated by Jamming Detection Logic, by an authorized Dallas key

Values span: 0 - Disable, 1 - Enable

Default value: zero

6.2.11.8.4 Enable Output Release by Ignition Activity

Address: 522, bit 6

Description: This bit enables deactivation of an output, activated by Jamming Detection Logic, by the below specified sequence on Ignition line:

1. From ignition off state Switch Ignition on for a period between 0.5 to 2 seconds (Ignore input change time filter)

Switch it back off for a period between 0.5 to 2 seconds (Ignore input change time filter)

Repeat 1 and 2 four times.

Upon detection of deactivation activity on Ignition the unit will:

- Activate feedback "beep" (using feedback output/s)
- Release an output

Values span: 0 - Disable, 1 - Enable

Default value: zero

6.2.12 Other Configuration Parameters related to Communication Settings

6.2.12.1 Disable Active Transmissions

Address: 6 bit 1

Description: If set to `1 the unit will not actively initiate any kind of connection - SMS, GPRS or voice. It will reply to incoming SMS commands, if the relevant flags for the current roaming/homing state are enabled.

Default: 0 **–** Enable Active Transmissions

6.2.12.2 Enable Command Authentication

Address: 1 bit 6

Description: If this feature is enabled authentication of every incoming message to the unit (like command or acknowledge) will be verified. Each incoming message should include a unique code, generated as a function of two variables:

- Unit's ID

- 8 bytes Auth Table, stored in non-volatile memory of the unit and concurrently in the Communication Center application.

If the code will not be verified as authentic – the unit will not perform / acknowledge the command and will erase it.

The unit supports dedicated Auth Table read/write commands over its wire protocol. See description of the commands in a corresponding documentation.

The OTA Auth. table modification will be only be accepted by the unit if the Command Authentication feature is DISABLED.

Default: 0 **–** Disabled

6.2.12.3 Number of Retries to Forward Data over UDP GPRS

Address: 283

Description: This parameter defines number of retries to forward data from the COM port (for example from MDT) to the Central Control over UDP/IP. Such a message requires acknowledge (msg type 4) from the Central Control. If the acknowledge will not be received during the timeout defined by "Message Transit Acknowledge Timeout", the unit will resend it number of times, defined in this parameter.

If all the reties forwarding data through UDP will fail, the same message will be sent by SMS (if enabled in bytes 202, 204, bit 5).

Default value: 5

6.3 GPS Calibration

6.3.1 Base Unit (Measurement Factor of GPS Odometer)

Address: 80 to 83

Description: The value defines unit used for distance and odometer measurements. The selected value (for example 100m, 1km or 1 mile) will be used by the unit as a lowest distance unit to be reported and as a distance resolution.

The parameter is a 32-bit unsigned integer. Value is represented in centimeters. (100000 for 1 Km).

Valid values: Any non-zero value

Default Value: 100000

6.3.2 GPS Odometer Current Value

Address: 76 to 79

Description: This parameter stores the current "reading" of the vehicle odometer, in "base units" (see previous parameter). Normally this value is programmed upon installation (synchronization with vehicle odometer) and then maintained by the unit itself.

***NOTES**:*

- This parameter does not require reset to be implemented.
- Upon 'Ignition OFF' ('Stop Event time filter' elapsed), the unit will update the PL ('GPS odometer's current value') with the odometer value reported OTA (same as the value serially found in 'Master Unit Status Request'), regardless of the 'GPS odometer's current value' in PL.
- Having the 'GPS odometer's current value' serially programmed requires Power recycle in order to take effect.
- OTA update of 'GPS odometer's current value' will take effect immediately.
- Upon new FW boot due to any type of FW upgrade (serial, OTA, 'Cellocator+' etc.), the unit will take the odometer value stored in PL, which is true for the last 'Stop Report'.

  This note is more relevant for those users, upgrading while vehicle is traveling (after FW upgrade, odometer skip back to the last 'Stop Report' value can be observed).

Data format: The parameter is a 32-bit integer

Value span: 00000000h to FFFFFFFFh

Default value: 00000000h

6.3.3 Report Max. Speed instead of Real Time Speed

Address: 1347 bit 0

Description: If this bit is enabled (0) the unit will report in each logged event (message type 0 and 9) the maximum speed recorded from the previous logged event. This is useful for comparison with police ticket report.

Even if this bit is enabled, any real time and distress events will still contain a snapshot of the speed at the moment of message generation.

There is a bit in every OTA messages, clarifying the type of the reported speed (real-time or maximum).

Default: Disable (1)

6.3.4 Enable GPS Navigation Start-Stop updates

Address: 99, bit 0 for plain event

102, bit 0 for distress

Description: If this bit is set (1) the unit will generate an event/distress upon every GPS reading validity status change.

Default: Both Disable (0)

6.3.5 GPS Navigation Start/Stop filter

Address: 500

Description: This parameter defines number of invalid GPS packets, required for declaring a "GPS Navigation End"; it is also defines number of valid GPS packets required to declare "GPS Navigation Start".

Note that the GPS validity is automatically declared as "invalid" upon wake up or after reset.

Data format: The parameter is an 8-bits integer

Value span: 0-255 (value of zero cancels the filter)

Default value: 0x0A (10 seconds)

6.3.6 Enable Tight GPS PMODE Filter

Address: 509, bit 7

Description: If this flag is enabled, the unit will consider GPS data as valid only when PMODE1=3 (in GPS Data, refer to the Cellocator Wireless protocol) or 4 and PMODE2=2. Otherwise any of the following values of PMODE1:2,3,4,5 or 6 will be accepted as a valid fix.

Values:

0	Requires 2≤PMODE1≤6 values to deem position as "Correct".
1	Requires PMODE1 equal to 3-4 values and PMODE2=2 to deem position as "Correct".

First acquisition:

In order to speed up the GPS acquisition:

1. Upon initial boot (power up, excluding AHR) the GPS validity test will start according to "Normal GPS PMODE Filter", irrespective of the setting in this parameter AND w/o DOP validation.

   This simplified validation routine will work until the first acquisition compatible with "Tide GPS PMODE Filter" setting AND with DOP setting.

2. Upon achieving acquisition compatible with "Tide GPS PMODE Filter" the unit will start behaving according to the setting in this parameter AND with DOP setting as usual.

Data format: The parameter is a flags bitmap, "1" - Enable, "0" – Disable

Value span: any 8-bit value, four upper bits are currently a don't-care bits

Default value: 1

6.3.7 GPS DOP Threshold

Address: 1625

Description: Dilution of Precision (DOP) is a measure of how the geometry of the satellites affects the current solution's accuracy. This message provides a method to restrict use of GPS solutions when the DOP is too high.

This is actually an additional GPS solution validation tool: the GPS packets with an HDOP higher than the value in this parameter are marked as invalid.

Data format: unsigned 8 bits integer

Default value: 9

6.3.8 GPS accepted accuracy threshold

Address: 1853

Description: Additional filter that can be activated on location fixes. Accuracy below that TH will not considered to be valid fixes.

Data format: unsigned 8 bits integer

Valid Range: 2-510 meters. 0=Disable (pass everything)

Resolution: 2 meters.

Default value: 100 meters

6.3.9 Synchronize Unit's Time with GPS Time only when GPS is Navigating

Address: 7, bit 3

Description: This flag defines the condition for time synchronization with GPS time:

0 - Anyway, even when GPS is not navigating

1 - Only when the GPS is navigating

Default value: 1

6.3.10 Velocity Threshold for HIGH SPEED Mode

Address: 455

Description: The unit can be configured to decrease frequency of Time and Distance events on high speeds automatically. The speed threshold considered as "high speed" is programmed into this parameter.

This parameter is used by Time based alert Period Multiplier for HIGH SPEED mode (Address 92 and 35, bits 4 to 7) and by Distance Event Period Multiplier for HIGH SPEED mode (Address 92 and 35, bits 0 to 3) parameters to define from what speed the number of the events should be decreased.

Note, that the in order to switch the operational mode of the unit from "Low Speed Mode" to "High Speed Mode" the system speed must raise 3km/h above the programmed speed. Same way, in order to switch the operational mode of the unit from "High Speed Mode" to "Low Speed Mode" the system speed must fall 3km/h below the programmed speed.

Data format: 8-bit unsigned, unit's [cm/sec]

Default value: 60 km/h

6.3.11 GPS Maintenance Updates

6.3.11.1 Enable GPS Navigation Start-Stop Updates

Address: 99, bit 0 for plain event

102, bit 0 for distress

Description: If this bit is set (1) the unit will generate an event/distress upon every GPS reading validity status change. (Refer to wireless protocol for GPS signal validity definition)

The validity status changes after 10 consecutive GPS frames with the same validity status, different from the current one.

Default: Both Disable (0)

6.3.11.2 Enable Update per GPS Auto Factory Reset Updates

Address: 496, bit 1 for plain event

497, bit 1 for distress

Description: If enabled, the unit will create an event or/and distress per GPS Factory reset. Obviously the GPS Factory reset has to be enabled. See below description of GPS Factory reset.

Default value: Both 0 (Disable)

6.3.11.3 Enable GPS Disconnection Updates

Address: 496, bit 0 for plain event

497, bit 0 for distress

Description: If enabled, the unit will generate an event or/and distress of GPS Disconnection upon detection of 10 sequential missing packets from GPS.

The first received packet from GPS will cause the unit to generate GPS connection alert.

Default value: Both 0 (Disable)

6.3.12 GPS Odometer Management

6.3.12.1 Enable Speed x Time Calculation (SxT)

Address: 509, bit 0

Description: As a default, the unit queries the GPS every second. If that flag is enabled, the unit multiplies the speed at a specific location by 1 second, the result being the distance traveled during this second.

Speed (m/s) x 1 sec = elapsed distance (m)

Whenever the unit does not receive new GPS data for time, defined in Max Time between GPS readings for SxT calculation it will not use the regular calculating algorithm. Instead, it will ignore the time during which no reception was available and will restart calculating the elapsed distance immediately when satellite reception reappears.

If both Pythagoras and SxT calculation are enabled, the unit will use SxT when there is a valid GPS fix and Pythagoras when there is no GPS coverage.

Default: 1 - Enable

6.3.12.2 Enable Pythagoras Calculation

Address: 509, bit 1

Description: If this flag is enabled the unit will calculate the distance between 2 consistent GPS queries according to the Pythagoras theorem:

$$\text{Distance} = \sqrt{(\Delta Altitude)^2 + (\Delta Longtitude)^2 + (\Delta Latitude)^2}$$

If both Pythagoras and SxT calculation are enabled, the unit will use SxT when there is a valid GPS fix and Pythagoras when there is no GPS coverage (from last GPS fix to the next GPS fix).

Default: 1 - Enable

6.3.12.3 Reset Last Known Location on Ignition Off

Address: 509, bit 2

Description: Relevant for Pythagoras and combined Pythagoras + SxT calculation. If that flag is set (logical '1') the unit will dismiss the last detected location per detection of Ignition off. For future calculation will be used the first GPS fix obtained after Ignition On.

In other words the unit will ignore the distance, passed by the vehicle during Ignition Off mode. The feature is useful in case when the vehicle is being towed from one place to another.

Note that in this case the vehicle will also ignore the distance, passed from Ignition On to first GPS fix obtained.

Default: 0 - Disable

6.3.12.4 Max Time between GPS Readings for SxT Calculation

Address: 84

Description: This parameter stores the maximal time between two valid readings from GPS (in seconds) to be qualified for SxT odometer accumulation.

When you make a configuration take into a consideration the following rule:

where:

max speed in km/h – maximum speed that the vehicle get during the normal usage. Recommended 160km/h.

max time apart is a value programmed in this parameter.

base unit is "Base unit (measurement factor of GPS odometer)", address 80-83.

Data format: The parameter is an 8-bit integer.

Value span: 1 to 255

Default value: 7

6.3.13 GPS Reset Settings

6.3.13.1 Enable GPS Auto Factory Reset

Address: 497, bit 7

Description: If this bit is set, the unit will trigger a Factory Reset of the GPS in the following cases:

- The GPS communicates, but service fields MODE1 and MODE2 are equal to 0 and 16 respectively for 10 minutes**.**
- The GPS is communicating, but the data is considered as "not navigating" and the service fields MODE1 and MODE2 are not equal to 0 and 16 respectively for 15 minutes. In this case the unit is resetting GPS using On/Off line. If the condition is true for another 15 minutes – the unit will send factory reset command to GPS (effectively the factory reset is sent once in 30 minutes).

Default value: 0

6.3.13.2 GPS Reset Upon Ignition Off

Address: 6, bit 2 when GPS is navigating
6, bit 3 when GPS is NOT navigating

Description: As with any ARM based module, the GPS has to be reset from time to time. If one of hibernation modes is used, the GPS is reset upon entrance to hibernation.

But if the hibernation in not used the safest way to reset the GPS periodically is upon Ignition change to Off state. There is an advantage of doing such a maintenance reset when the GPS is navigating, because such a worm reset enables the shortest recovery time. It is also possible to do it only when the GPS is not navigating anyway, but in this case (for example on underground parking) the recovery might be longer.

Default values: bit 2 – 0 (disabled), bit 3 – 1 (enabled GPS reset upon ignition off when the GPS is not navigating)

6.3.13.3 GPS AHR (Auto Hardware Reset) – except in CelloTrack Nano

When the unit identifies 3 consecutive GPS communication errors, the unit will attempt to Auto Hardware Reset (AHR) its GPS up to programmable number of retries (according to Maximum Number of AHR parameter used also for Modem AHR, 5 by default).

The unit will create a dedicated event per each GPS AHR – TR 200, STR 2 (if enabled by Enable AHR Reporting parameter).

6.3.14 Enable WAAS (For USA and Hawaii)

Address: 509 bit 4

Description: The DGPS is enabled by default and the Cellocator unit will automatically use a satellite-based augmentation system (SBAS): the Indian (GAGAN), the European EGNOS and the Japanese MSAS, respectively. No need to enable anything else to work in those systems.

This bit should be enabled only for the Wide Area Augmentation System (WAAS) , which is using a network of ground-based reference stations, in North America and Hawaii, to measure small variations in the GPS satellites' signals in the western hemisphere.

0 - Disable

1 - Enable

Default value: 0 - Disable (only for LVx00 variants the default is: 1 – Enable)

6.3.15 Enable A-GPS

Address: 509 bit 6

Description: Assisted GPS is providing a faster TTFF and can also saves energy. If this bit is enabled, the unit will try retrieving new weekly A-GPS file from a dedicated server upon Ignition Off, 24 hours or less before expiration of the existing file.

This will typically shorten the TTFF by ~3 times if cold start mode is selected.

0 – Disable

1 – Enable

Default value: 0 – Disable

6.4 Inputs & Outputs

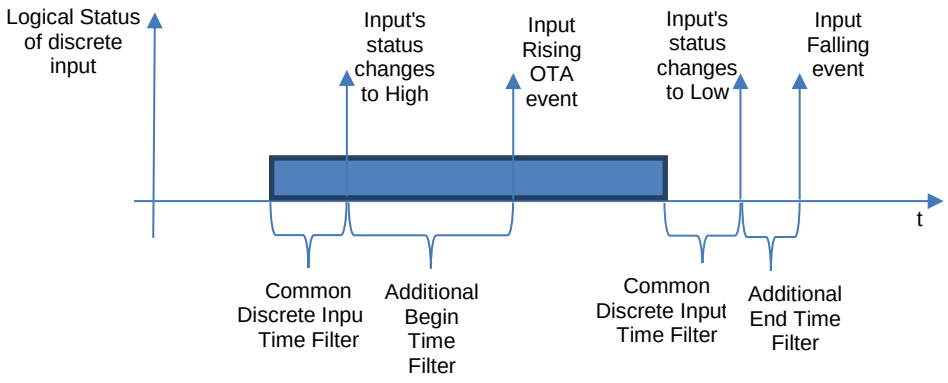
6.4.1 Discrete Inputs Triggering Time Filters

These two bytes defines the input's Additional Time Filters. The Additional Time Filter will extend the input's filtering capabilities separately for logical Rising and logical Falling.

The total filter is constructed from Common Discrete Inputs Time Filter (same for all inputs and all states) and dedicated filter for each state change (Rising/Falling) of each input.

It is possible to define asymmetric triggering delays for logical Rising and logical Falling for each one of system's discrete inputs.

The Additional Time Filter supports multiple resolutions from seconds to hours.



6.4.1.1 Common Discrete Inputs Time Filter

Address: 136

Description: This parameter is aimed to protect unit's discrete input from noise influence and defines time, from input's level change to change detection.

Data format: 8-bit unsigned, Resolution 10 msec.

Value span: 0x00 to 0xFF

Default value: d10

6.4.2 Analog Measurement Averaging Time

Address: 466

Name in Programmer: Power Sources Measurement Time filter

Description: This parameter is aimed to protect analog measurement from noise influence and defines averaging time. The reported value will be therefore an average voltage for the period defined in this parameter. (The sampling rate is every 10msec).

Data format: 8-bit unsigned, resolution 0.1 second

Value span: 0-25.5 seconds

Default value: 1 second

6.4.3 Analog (& Frequency) Inputs in OTA Message

Note that frequency counters are supported from FW30a.

6.4.3.1 Bytes 26-29 of OTA Message 0

Address:	1620	1621	1622	1623
Byte of OTA Message 0	26	27	28	29

Description: The OTA protocol provides 4 bytes dedicated for monitoring of analog inputs in few different message types. Those bytes can contain measurement from the different fields as per the configuration below.

Obviously if the selected source of Data is an Analog input, the corresponding input shall be programmed as an analog input in Input's Configuration.

Pin Number/Field Name	Number to be programmed	Remarks
USB input voltage	0	Default for byte 27 of OTA Message 0
Battery voltage (V bat)	1	Default for byte 26 of OTA Message 0
NTC	2	Default for byte 28 of OTA Message 0
Audio in	3	Not active (Infrastructure)
Reserved	4	
Reserved	5	
Reserved	6	
Reserved	7	
Nano source	8	As selected by parameters in addresses 2064 and 2065. Default for byte 29 of OTA Message 0

6.4.4 Usage Counter Configuration

6.4.4.1 General Description

This feature is designed for continuous counting of the "Working time" of a device, monitored by one or two unit's inputs. Example of possible usage is – monitoring of an engine's working hours.

The inputs who's "High State" time is counted are selectable by programming.

It is possible to assign each of two timers to a specific input, including the option to assign both timers into the same input. Every input, including ignition, supports "High State" or "usage" time calculation.

The value of the measured time from each input is located in the unit's RAM (protected, not erased on software reset). The unit makes mathematical rounding on partial minutes: (1:29 will be counted as 1 minute and 1:30 and above as 2 minutes).

Once a day the values of both Usage Counters are backed up to the especial address in non-volatile memory. The timer keeps time counting (from the value stored in RAM) each time when the logical level of the appropriate input changes from low to high.

The time counting stops each time the logical level of the input changes from high to low.

Dedicated Read/Write commands over RS232 and OTA are provided for Usage Counters, including a periodical Usage Counters update OTA packet.

6.4.4.2 Enable Usage Counters

Address: 7, bit 2

Description: In order to start Usage Counters time counting this bit shall be enabled (set to 1).

Status of this parameter can be changed without reset.

Default: 0 - Disable

6.4.4.3 Wake up from Hibernation upon Periodical Usage Counter Update Timer Expiration

Address: 1, bit 7

Description: This bit enables waking up the unit from full hibernation for periodic Usage Counter update.

Default: 0 - Disable

6.4.4.4 1st Usage Counter Input

Address: 1330

Description: The byte contains number of the input, utilized by the first Usage Counter. The unit will use this parameter to backup the value of the 1st Usage Counter from RAM once a day.

Input's numbers definition:

Input's name	Input's number
Door	0
Shock/Unlock2	1
Ignition	5
Panic	6
Unlock	7
Lock	10

In order to set the use of only one Usage Counter input, select inexistent input for the second counter (for example 4).

Default: 0

6.4.4.5 2nd Usage Counter Input

Address: 1331

Description: The byte contains number of the input, utilized by a second Usage Counter. The unit will use this parameter to backup the value of the 2nd Usage Counter from RAM once a day. In order to set use only one Usage Counter input – select inexistent input number in this parameter (for example 4).

Default: 0

6.4.4.6 Reporting Interval of Usage Counters

Address: 1332

Description: This parameter defines Usage Counters reporting period. Setting this value by standard programming access is not recommended, as it will require reset to be implemented. Refer to OTA and serial protocol document for a dedicated update command description.

Data format and resolution: 1 byte, 1 minute resolution (from 1 minute to 255 minutes). Zero value cancels timers reporting).

Default: 0 – Reporting canceled

6.4.5 Modem & SIM

6.4.5.1 Shorten Cellular Registration Timeout

Address: 1 bit 1

Description: This programmable bit enables/disables a longer GSM registration to (5 minutes). In case of lack of GSM registration after an expiration of this timeout the modem will be reset.

0 –5 minutes GSM registration timeout

1 - 30 seconds timeout

Default: 0 - 5 minutes GSM registration timeout

6.4.5.2 AHR (Auto Hardware Reset for Modem)

AHR (Auto Hardware Reset) is a process in which the unit performs power recycle to the Modem (i.e. power down to the Modem for at least 500ms) and to the Micro-processor.

The unit will perform AHR upon occurrence of one of the following scenarios:

- Responsive Modem: The Modem responds to AT commands, but No GSM registration in Ignition On mode for programmable time (configurable by "Registration Lack Timeout (for AHR)" parameter, address 515). In that case, the unit will perform AHR. If there is still no GSM registration according to the above conditions, additional AHRs will be performed, up to a programmable number of retries (configurable by "Maximum Number of AHR" parameter, address 504, bits 0-3).
- Non-Responsive Modem: The modem does not respond to AT commands for 5 consecutive queries. In that case, the unit will reset the Modem (SW reset). If there is still no response for the Modem after 4 resets, a power recycle to the Modem only (Pre-AHR) will be performed, after which the unit will wait for 1 second, and open a 30 seconds window in which the queries and resets process will be done again. If there is still no response from the Modem (i.e. the Pre-AHR mechanism didn't work), AHR will be performed. The process will repeat up to a programmable number of retries (configurable by "Maximum Number of AHR" parameter, address 504, bits 0-3).

The unit will create a dedicated event per each AHR (if enabled in Second Configuration Byte).

6.4.5.2.1 Registration Lack Timeout (for AHR)

Address: 515

Description: stores the timeout value (in minutes), before AHR trigger if the following conditions are true:

- No GSM coverage
- Ignition On mode

Data format: 1 byte, unsigned integer, resolution of minute. Zero value cancels the AHR upon lack of GSM registration.

Default value: 30 minutes

6.4.5.2.2 Maximum Number of AHR

Address: 504, bits 0-4

Description: The low nibble of this parameter stores the maximal allowed number of AHR retires in one session and the high nibble is currently reserved.

After the last AHR attempt, no more attempts will be made, even if the modem continues to be non-responsive or not registered.

If the AHR mechanism is disabled due to sustained non-responsiveness / non-registration (as explained above), it will only be re-enabled when achieving a full data connection, or reaching the idle modem management loop, if data connection is prohibited.

Zero retry number will cancel AHR process. Please note that setting this parameter to 0 is not recommended.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Reserved				Maximum number of AHR retries that will be made			

Data format: 1 byte = 2 nibbles.

Default value: bits 4-7 = 0, bits 0-3 = 5.

6.4.5.2.3 Enable AHR Reporting

Address: 1, bit 3

Description: If this bit is enabled the unit will store a plain event with dedicated transmission reason (address 200) upon each performed AHR.

Default: 0 - Disable

6.4.6 Modem Reset Settings

6.4.6.1 Modem Reset Period

Address: 165-166

Description: This parameter defines the time for periodical modem software reset. This period is restarted upon each manual and automatic modem reset as well as upon entering full hibernation.

Data format: 2 bytes value, resolution of 1 minutes

Value span: 0 to 65535 (* Zero value in P disables periodical Modem Reset)

Default value: 1440 (24 hours)

6.4.6.2 Periodical Modem Reset Randomization

Address: 1352

Description: In case of GPRS network failure all the units are reconnecting to CC simultaneously after the problem is rectified and it causes heavy communication load on the CC server.

The Periodical Modem Reset timer is also restarted in all the units at the same time, after concurrent reconnection to GPRS. It causes all the units to repeat simultaneous modem resets and this way keeps creating peaks of load on customer's communication server.

Randomization feature allows the unit to use pseudo random time for Periodical Modem Reset timer.

The timer is restarted each time to a different value, limited by a programmable threshold.

(P – Tr)≤ Modem Reset interval ≤(P+ Tr)

P - Periodical Modem Reset parameter

Tr - Periodical Modem Reset Threshold

Wrong programming protection: If P≥Tr the unit will NOT use the low limit of randomization.

Example:

P=30minutes (res=1min) and Tr=45minutes (res=15min) =>-15< modem reset <75

In this case the lower limit of randomization will not be used:

P≤ modem reset interval ≤75

Data format: Resolution of programmable threshold is 15 minutes, 1 byte

Default value: 0 (no randomization)

6.4.7 GSM Band & GPRS Auth Type

Setting proper values of network selection and PPP GPRS Connection Authentication type enables accelerating the GSM and GPRS registration process.

On each modem's initialization the unit will check network setting and modify it if the actual setting of the modem differs from the one, programmed in this section.

Same way on each modem's initialization the unit will check the PPP GPRS Connection Authentication type and modify it if the actual Authentication type of the modem differs from programmed in this section.

6.4.7.1 Cellular Network Selection

Address: 1444, bits 0-2

Description: This parameter enables to allow the modem free switching between networks, or to fix it to a certain network (for example in cases which fallback from 3G to 2G is not allowed).

Where the fallback is not applicable by the modem, the value is considered as "Reserved".

Range:

Enum	Description
0	Automatic
1	Reserved
2	2G Only
3	3G Only
4	4G Only

Default value: 0 – Automatic

6.4.8 SIM PIN

6.4.8.1 Enable Auto SIM PIN Locking

Address: 1348, bit 1

Description: If this bit is enabled ('1') the unit will auto-lock the SIM card with the PIN code programmed on addresses 1326 – 1329.

NOTES:

- Once enabled, the SIM PIN locking is irreversible; there is no way to cancel SIM PIN locking by command.
- The user has to upload the content of the programming after activation of this flag and programming in order to re-synchronize between the configuration file and the actual content of the programming.

IMPORTANT: Incorrect usage of this feature might cause SIM card blocking!

Refer to the description in the New SIM PIN section below for further details.

Default: 0 (Disable)

6.4.8.2 Active SIM PIN

Addresses: 197-200

Name in Programmer: SIM PIN

Description: This parameter stores the PIN code that will be entered to unlock the GSM SIM card when required.

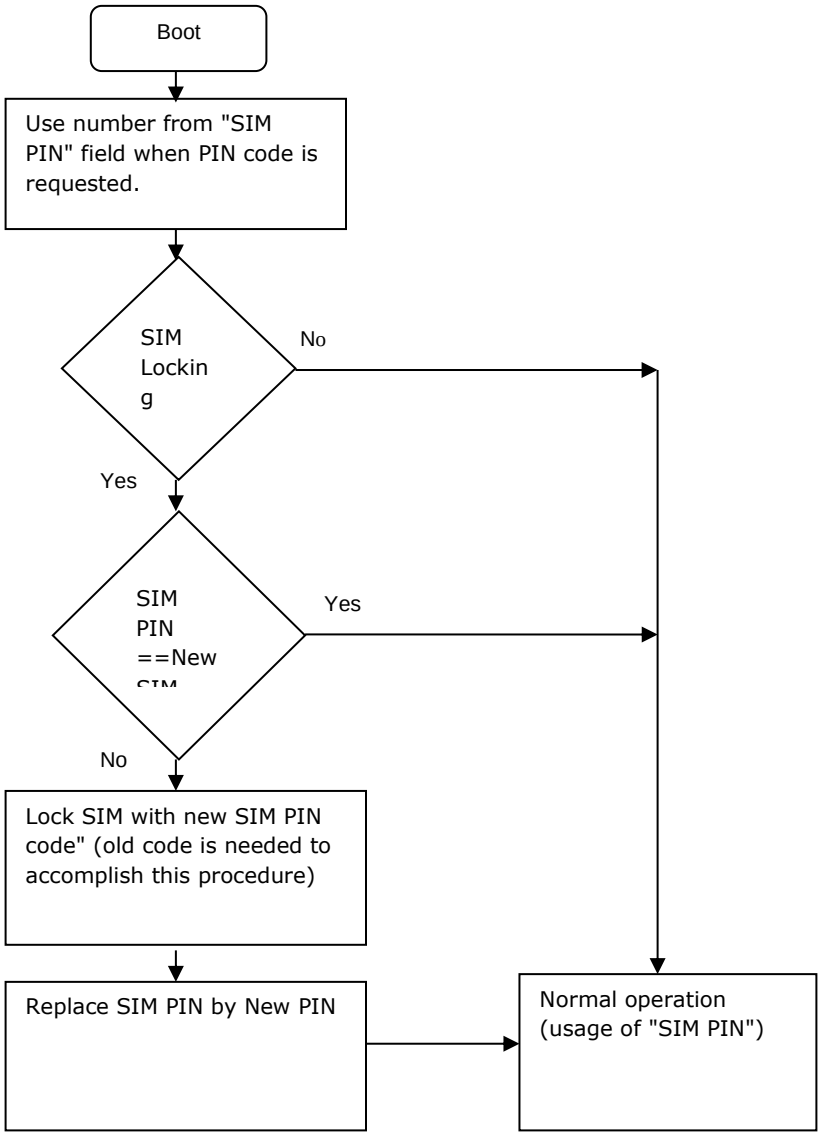
Data format (GSM): The bytes contain the digits of the PIN, encoded in BCD. The order of the transmission is bytes with lower address first, lower nibbles first. If only the lower nibble of a byte is used (this is legal only in the last byte – in case this is the last digit of the PIN), the higher nibble should have all of its bits set (the nibble should contain 15 dec). The rest of the bytes that are not used should contain 0xFF.

Default value: 1234

6.4.8.3 New SIM PIN

Addresses: 1326-1329

This parameter stores the new PIN code that should be used for locking the SIM Card during the SIM Lock procedure. This code will replace the Active SIM PIN on address 197-200 upon successful completion of the SIM Lock procedure:



NOTE: Since the unit is actively modifying content of its programming cells (replacing the old Pin code by the new one) the configuration file and the actual content of programming will lose synchronization. It is very important to synchronize them by uploading the actual content of the configuration memory from the unit before next configuration cycle.

WARNING: Programming the same configuration file twice, without uploading an actual content of programmable cells after the first programming, will cause immediate blocking of the SIM card.

Data format (GSM): The bytes contain the digits of the PIN, encoded in BCD. The order of the transmission is bytes with lower address first, lower nibbles first. If only the lower nibble of a byte is used (this is legal only in the last byte – in case this is the last digit of the PIN), the higher nibble should have all of its bits set (the nibble should contain 15 dec). The rest of the bytes that are not used should contain FFh.

Default value: 1234

6.4.8.4 Lock to Certain IMSI

Address: 1914

Description: If this parameter contains a value of 5 or 6 BCD numbers, the unit will validate an international mobile subscriber identity (MCC + MNC) of its SIM card ~15 seconds after any wake up. If the value of the SIM is different from the value predefined in this parameter – the unit will switch off the modem. If this parameter contains a value smaller than 5 digits the feature is disabled.

6.5 Power Management

6.5.1 Power Management Mode

Address: 266

Description: This parameter defines power consumption of the unit during Ignition Off mode.

Power consumption reduction is achieved as a trade off with availability: as the availability is lower, the power consumption is lower. The main power consumers of the unit are GPS and GSM modules; the unit switches them off periodically during parking.

Programmed Value	Mode Description	Description	Current Consumption
0	No hibernation	Both GSM and GPS modules are fully active during parking, GPRS session active	
2	Full Hibernation	Both GSM and GPS modules are in asynchronous peeking as per programming below. The unit does not respond to RS232 queries as well *Note: In this mode Security Modification will not be able to detect Signal Correlation*	(while both GPS & GSM off)

Default value: 2

6.5.2 Hibernation Mode Delay

Address: 271-272

Description: This parameter defines time interval between Stop Event and entering any programmed Hibernation Mode.

Note: a reception of message from server side (except ACK responses) in the delay period will reset the delay (i.e. the unit will count again the configured delay from last message reception before going to hibernation).

Data format: 16-bit unsigned integer, 16 seconds resolution

Value span: 0x01 (16 seconds) through 0xFFFF (291 hours)

Default value: 60', (16 minutes)

6.5.3 Enable Pre-Hibernation Update

Address: 4, bit 6 for event

4, bit 7 for distress

Description: This parameter enables and disables an update, before entering the full hibernation mode.

The update is not generated during GSM or GPS communication peeks, only between the Stop Event and entering the full hibernation; 15 seconds before an expiration of Hibernation Mode Delay timeout (Address 271).

In case of Hibernation Mode Delay timeout = 0, the event will be generated just after the Stop event.

Default: Both disable (zeroes)

6.5.4 Enable Data Forwarding from Serial Port by SMS (in Hibernation)

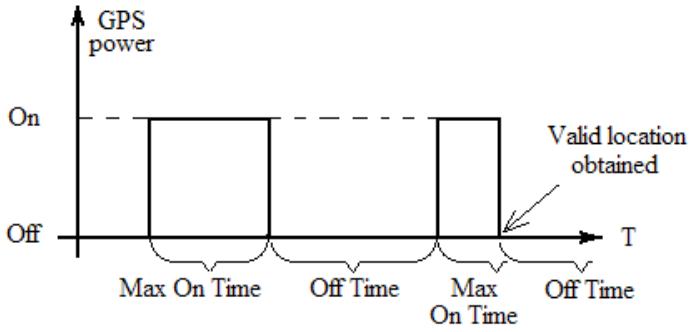
Address: 4 bit 5

Description: If this parameter is disabled, the unit will not try forwarding data from 3rd party device connected to unit's COM port (over CSP or Transparent Data protocols) through SMS in hibernation. (in case GPRS is not available or disabled, the forwarded data will be accumulated in unit's buffer).

Default value: Disabled (1)

6.5.5 GPS Peeking

6.5.5.1 GPS Peeking – Max On Time



Address: 263

Description: GPS peeking is a power management of GPS receiver, which enables to reduce its power consumption.

GPS peeking is activated in Ignition Off mode only, when Power Management mode is defined as 1or 2. Except for CelloTrack family, which is explained in section 12.1 below.

This parameter defines the maximum amount of time the GPS is kept turned on while peeking. The GPS will be turned off once a fix is achieved, or if the Max. On Time expires.

Data format: 8-bit unsigned integer, 16 seconds resolution

Value span: 01h (16 seconds) through 255 (68 minutes); zero value is illegal and shouldn't be used

Default value: 5’ (1 minute 20 seconds)

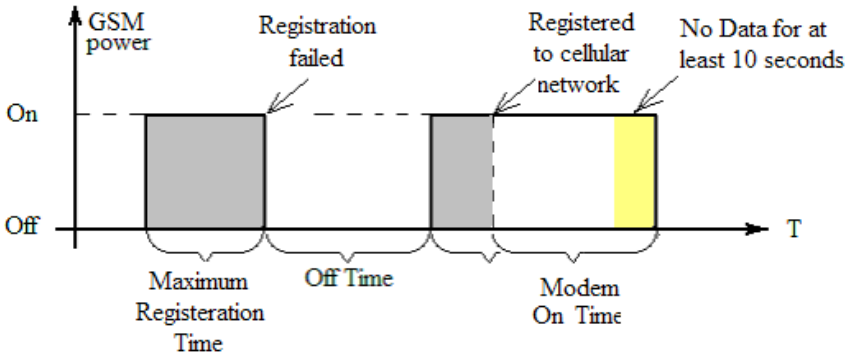
6.5.6 GSM Peeking

6.5.6.1 GSM Peeking – Maximum Network Registration Time

Address: 270

Description: GSM Peeking is a power management of GSM Modem, which allow to reduce its power consumption.

GSM peeking is activated in Ignition Off mode only, when Power management mode is defined as 2.



Maximum Network Registration Time: This parameter defines time interval, given to GSM modem for registration into cellular network. If registration wasn't accomplished during that time – the modem is being turned off for Off Time.

Maximum Network Registration Time overlaps with the "stronger" Maximum Modem On Time (defined in address 267). The modem is switched back off when Maximum Modem On Time expires and there is no data transfer for at least 10 seconds (even if Maximum Network Registration Time was configured to a higher value which hasn't expired yet).

Data format: 8-bit unsigned integer, 16 seconds resolution

Value span: 01h (16 seconds) through 255 (72.8 hours)

Default value: 4 (1 minute and 4 seconds)

6.5.6.2 GSM Peeking – Modem Off time

Address: 268-269

Description: This parameter defines the amount of time between GSM peeks. (Refer to the chart in GSM Peeking – Maximum Network Registration Time). During this time the GSM Modem is turned off, to conserve energy).

Data format: 16-bit unsigned integer, 16 seconds resolution.

Value span: 02h (32 seconds between two consecutive peeks) through FFFFh (~12 days between two consecutive peeks). Values below 32 seconds (<02h) are illegal and shouldn't be used.

Default value: 225 (1 hour from the end of one peek to the start of the next one)

6.5.6.3 GSM Peeking – Maximum Modem On time

Address: 267

Description: This parameter defines time the modem is kept turned on after waking up. Note that Maximum Modem On Time overlaps with the "weaker" Maximum Network Registration Time (defined in address 270), i.e. the Modem will be turned Off after Maximum Modem On Time, even if Maximum Network Registration Time was configured to a higher value which hasn't expired yet. If GPRS is enabled, the unit will dial GPRS and connect to the communication server during this time.

Data format: 8-bit unsigned integer, 16 seconds resolution

Value span: 1-255 (16 Sec – 68 min); value of 0 is illegal and shouldn't be used

Default value: 4 (1 minute and 4 seconds)

6.6 Voice Call Settings

6.6.1 Voice Call Destination Number

Addresses: 273-282

Description: Stores the default target address used by the unit to establish Voice call, initiated by the driver. Under normal circumstances, this will be a voice line phone number of Central Control room.

Data format: First byte should contain the total amount of digits that make up the actual address (not including address type byte). Second byte is the address type byte, which should be 91h for international address (recommended type to use, to allow roaming) or 81h for local address. The rest of the bytes contain the actual address, encoded in BCD. The order of the transmission is bytes with lower address first, lower nibbles (nibble = 4 bit) first. If only the lower nibble of a byte is used (this is legal only in the last byte – in case this is the last digit of the address), the higher nibble should have all of its bits set (the nibble should contain 15 dec). The rest of the bytes that are not used should contain FFh.

Default value: Null

6.7 Informative Parameters

6.7.1 Last Distance Event

Address: 85-88

Description: This parameter stores odometer value (in base units) recorded upon last Distance event generation. This parameter is not recommended for user modification, it is managed by the unit for recovery situations.

If upon programming the value programmed in this parameter will be higher than the value of odometer, the unit will overwrite it with the value of odometer.

Data format: The parameter is a 32-bit integer

Value span: 32bits range

Default value: 0

6.7.2 Field for Customer Use

Address: 1314 – 1317

Description: This field is designed to store customer's proprietary data (like specific EEPROM content identifier).

Data format: Customer defined

Default value: zeros

7 Distance and Speed Events

7.1 Distance Events

7.1.1 Enable Distance Updates

Address: 99 bit 1 for Plain Events

102 bit 1 for Distress Events

Description: This parameter enables generation of the Events and/or Distresses upon the passage of a certain distance.

The distance updates are generated with respect to Home or Roam GSM network and the speed of the vehicle. Normally the customer would expect reported distance to be longer in Roam networks (to save on a communication in roaming GSM) and on high speeds, where the rear events can still provide a good picture of the root.

Default value: Both zeros (disabled)

7.1.2 Trip for a Distance Event

Address: 89 – 91 for Home Network

32 – 34 for Roam Network

Description: This parameter defines a distance between two consequences Distance updates (events or distresses). The distance is in basic distance units.

Data format: The parameter is an unsigned a 24-bit integer

Default value: 5

7.1.3 Distance Event Multiplier for HIGH SPEED Mode

Address: 92, bits 0-3 for Home Network

35, bits 0-3 for Roam Network

Description: This parameter defines a multiplying factor of distance update for normal and high speeds. The speed is considered "high" when higher then programmed in Velocity threshold for HIGH SPEED mode on address 455.

For example: if Trip for a Distance event is set to 100 meters, and Distance Event Multiplier for roaming is set to 4, the unit will set distance updates in roaming mode to every 400 meters.

Default value: Both 1

7.2 Over and Idle Speed

7.2.1 Velocity Threshold for Over Speed Start Event

Address: 93

Description: This parameter stores velocity threshold used for Over Speeding session start. If velocity of the vehicle is higher than this threshold, for longer than programmed in the Over Speed Duration filter parameter, the unit will consider over-speeding. If corresponding updates are enabled, the unit will generate event or/and distress.

Note that the Overspeed start will be registered on a velocity of ~2km/h higher than programmed. In addition, this threshold is only used when not in "Trailer mode" and not in "Input dependent Over Speed" mode

Value resolution: Units in 32 cm/sec

Default value: 91 (105km/h)

7.2.2 Velocity Threshold for Over Speed End Event

Address: 94

Description: This parameter stores velocity threshold used for Over Speeding session end (only if the Over Speeding session is already open). If velocity of the vehicle gets lower than this threshold, for longer than programmed in Over Speed Duration filter parameter (or immediately as per the configuration flag described below), the unit will consider end of over-speeding.

If corresponding updates are enabled, the unit will generate event or/and distress.

Note that this threshold is only used when not in "Trailer mode" and not in "Input dependent Over Speed" mode

Value resolution: Units in 32 cm/sec

Default value: 87 (100km/h)

7.2.3 Filter of Over Speed Duration

Address: 95

Description: This parameter stores timeout value, used to consider the speed violation start/stop. It actually defines the over speed duration which will cause a corresponding update (if enabled).

Value resolution & span: Duration resolution is 2.5 Seconds. Duration Span from: 0 seconds (0x00h), to 10min 30 sec (0xFEh).

Default value: 4 (10 seconds)

7.2.4 Do not use Time Filter to Close Over Speed Session

Address: 492, bit 4

Description: If this bit is set, any open over speed sessions will be closed when the speed of the vehicle will get lower then "Velocity threshold for GPS over Speed End" threshold.

Default value: 0 (disabled)

7.2.5 Alternative Over Speed Threshold for Input Dependent Mode

Address: 2391

Description: The unit supports automatic change of over-speed thresholds while certain input is triggered.

This is useful to change over-speed threshold while raining (in this case the input will be connected to the wipers wire) or at night (in this case the input will be connected to the vehicle lights).

Function 12 is available in a list of options available for "Function assigned" byte in input's configuration. When it is selected for any input (except ignition), and this input is triggered, the unit will automatically use speed threshold programmed on address 2391 as both Over-speed start and Over-speed end thresholds.

NOTES:

- Over-speed threshold may change only while over-speed session is NOT active.
- If the input changes its state while the over-speed session is active – the unit will keep using over-speed thresholds selected upon over-speed session start.
- If both the "Trailer mode" and "Input dependent Over Speed" modes are active concurrently the unit will select the lowest speed threshold out of two.

Specific Transmission Reason byte of Over-Speed alert

Upon detection of over-speed violation the unit is sensing event or/and distress with transmission reason 34(start)/42 (stop). The "Specific Transmission Reason" byte of those messages will contain value "1" if the unit is utilizing alternative Over-speed thresholds while generating them.

This parameter contains an alternative value of Over-speed threshold, used when an input, programmed as "Over-speed threshold control" is triggered.

The same value is used for both Over-speed start and Over-speed end thresholds.

The over-speed time filter (programmed on address 95) shall expire prior to alert generation irrespectively to the selected speed thresholds.

Resolution: 32 cm/sec

Default value: 70km/h

7.2.6 Velocity Threshold for Idle Speed Start Event

Address: 97

Description: This parameter stores velocity threshold used for Idle Speeding session start (Idle Speeding refers to when the vehicle is parking with a working engine). If velocity of the vehicle gets lower than this threshold, for longer than programmed in Idle Speed Duration filter parameter (from ignition on or from higher speed), the unit will consider Idle Speeding start.

If corresponding updates are enabled, the unit will generate event or/and distress.

Value resolution: Units in 32 cm/sec

Default value: 14 (16 km/h)

7.2.7 Velocity Threshold for Idle End Event

Address: 96

Description: This parameter stores velocity threshold used for Idle Speeding end (only if the Idle Speeding session is already open). If velocity of the vehicle gets higher than this threshold, for longer than programmed in Over Speed Duration filter parameter (or immediately as per the configuration flag described below), the unit will consider end of idle-speeding.

If corresponding updates are enabled, the unit will generate event or/and distress.

Value resolution: Units in 32 cm/sec

Default value: 16 (19 km/h)

7.2.8 Filter of Idle Speed Duration

Address: 98

Description: Timeout value, used to consider the idle speed violation start /end.

Value resolution & span: Duration resolution is 2.5 seconds.

Duration Span from: 0 seconds (0x00), to 10 min 50 sec (0xFE)

Default value: 4 (10 seconds)

7.2.9 Multiplier for Idle Speed Start Detection Time Filter

Address: 492, bits 0-3

Description: This parameter contains a value of multiplier, used to increase dramatically Idle Speed Start detection time.

Time for generation Idle Speed Start	=	Idle Speed Duration Filter	*	(Multiplier +1)

Value of 0 disables multiplier.

Default: zero

7.2.10 Do not use Time Filter to Close Idle Speed Session

Address: 492, bit 5

Description: If this bit is set, any open idle speed sessions will be closed when the speed of the vehicle will get higher than "Velocity threshold for GPS Idle Speed End" for longer than 10 seconds.

Default value: 0 (disabled)

7.2.11 Start Idle Speed Timer with Ignition On

Address: 492, bit 6

Description: When this bit is set, the unit will start counting time to Idle Speed Start from the Ignition On detection. Otherwise (if this bit is zero) the timer activated from the first time the speed is getting lower than *Velocity threshold for GPS Idle Speed Start*

Default value: 0 (disabled)

7.2.12 Create Idle/Over Speed End Update for an Open Session per Ignition Off

Address: 492, bit 7

Description: When this bit is set, the unit will close opened Idle/Over Speed sessions upon ignition off and generate an appropriate updates.

Otherwise (this bit is zero) the unit will not generate an appropriate updates and simply close any open speed session upon Ignition off.

Default value: 0 (disabled)

7.2.13 Events and Distress Control

7.2.13.1 Enable Distress for Idle Speed Start/End

Address: 102, bit 3

Description: If this bit is set the unit will generate distress session upon every Idle Speed start /end.

Default value: 0 (disabled)

7.2.13.2 Enable Events for Idle Speed Start/End

Address: 99, bit 3

Description: If this bit is set the unit will generate an event upon every Idle Speed start /end.

Default value: 0 (disabled)

7.2.13.3 Enable Events for Over Speed Start/End

Address: 99, bit 2

Description: If this bit is set the unit will generate an event upon every Over Speed start /end.

Default value: 0 (disabled)

7.2.13.4 Enter Distress for Over Speed Start/End

Address: 102, bit 2

Description: If this bit is set the unit will generate distress session upon every Over Speed start /end.

Default value: 0 (disabled)

7.3 Sudden Course Changed and Sudden Speed Change Sensors

Sudden Course Change and **Sudden Speed Change** sensors are derived from the GPS output; they analyze the delta speed and course between GPS fixes.

The speed and course thresholds are provided separately for each of 4 ranges of speed.

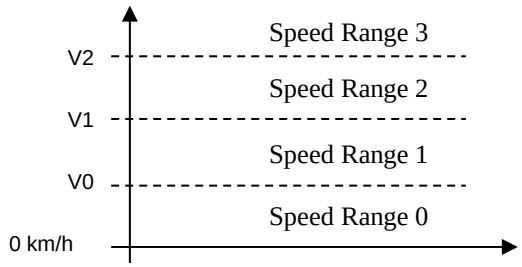
7.3.1 Speed Thresholds V0, V1 and V2

Address: V0-473

V1-474

V2-475

Description: The 4 speed ranges are defined by 3 speed thresholds: V0, V1 and V2



The speed ranges threshold (V0, V1, V2) must meet the condition: V0<V1<V2

Data format: 8 bits parameters with resolution of 16 cm/sec

7.3.2 Delta Speed and Delta Course for Speed Range X

Description: The sensors will trigger if the delta speed or/and course between two adjacent valid fixes (the unit is getting an updated GPS data fix every 1 second) exceeds a predefined speed or/and course thresholds for the specific speed range (if the current or last fix is invalid, the sensors won't trigger).

The following table contains address of speed and course thresholds for each speed range:

Speed Range	Harsh Braking Threshold 8 bits parameters with resolution of 16 cm/sec	Acceleration Threshold 8 bits parameters with resolution of 16 cm/sec	Course Delta Threshold 8 bits parameters with resolution of 0.016 rad
Speed Range 0	476	511	480
Speed Range 1	477	512	481
Speed Range 2	478	513	482
Speed Range 3	479	514	483

Zero value in any of the parameters above will cancel the corresponding sensor for the specific speed range.

Default Values:

Address (Dec)	Value (Dec)	Value
473	34	19.6 km/h
474	104	60 km/h
475	173	99.6 km/h
476	17	9.8 km/h

Address (Dec)	Value (Dec)	Value
477	17	9.8 km/h
478	17	9.8 km/h
479	17	9.8 km/h
480	49	45°
481	49	45°
482	49	45°
483	49	45°
511	17	9.8 km/h
512	17	9.8 km/h
513	17	9.8 km/h
514	17	9.8 km/h

Note: Sudden Course Change events will be masked when the speed is under 5 km/h.

7.3.3 Events, Distress Updates Control

7.3.3.1 Sudden Speed Change (Acceleration and Harsh Braking)

Address: 99, bit 4 for Events

102, bit 4 for Distress

Description: If this bit is set, the unit will generate a corresponding update for any detected harsh acceleration and harsh braking.

Default Values: zeros (disabled)

7.3.3.2 Sudden Course Change

Address: 99, bit 5 for Events

102, bit 5 for Distress

Description: If this bit is set, the unit will generate a corresponding update for any detected harsh course change. Note: sudden course change events which occurred when the speed is under 5 km/h will be filtered.

Default Values: zeros (disabled)

8 Time and Trip Events

8.1 Start and Stop Alerts

8.1.1 Start Alert Generation Time Filter

Address: 104

Name in Programmer: Start Event Time Filter

Description: This parameter stores time filter, defining a required duration of stable Ignition On state (after ignition state change) for triggering Start (driving session) alert.

Note that in CelloTrack-Nano, this time may be prolonged by up to 10 seconds (it's a system limitation).

The control of alert type (plain event / distress event) is made from Ignition Input Settings folder.

Value resolution & span: Duration resolution is 2.56 seconds.

Default value: 10.32 sec.

8.1.2 Stop Alert Generation Time Filter

Address: 105

Name in Programmer: Stop Event Time Filter

Description: This parameter stores time filter, defining a required duration of stable Ignition Off state (after ignition state change) for triggering Stop (driving session) alert.

Note that in CelloTrack-Nano, this time may be prolonged by up to 10 seconds (it's a system limitation).

The control of alert type (plain event / distress event) is made from Ignition Input Settings folder.

Value resolution & span: Duration resolution is 2.56 seconds

Default value: 10.32 sec.

8.2 Time-based Alert

This group of parameter controls time period of the updates, generated by the unit periodically between "Start" and "Stop" (when ignition switch is on). "Time alerts" or periodical updates are not generated after "Stop" (when ignition switch is off).

This period is controlled also by the OTA Tracking Command and applied on the fly with no reset.

Time-based alert period might be automatically modified by the unit in real time as a function of the following conditions:

- GSM condition: Home, Roam GSM network or No GSM coverage mode
- Speed: High Speed mode or Normal Speed mode.

There is also a possibility of dynamic Time-based alert period modification as a function of speed, refer to V-Trek feature below.

8.2.1 Time Alerts Resolution Definer

Address: 106, bit 7 for Home network

499, bit 7 for Roam network

Description: This bit defines resolution of the Timed Event Period. This resolution can be either 4 (when this bit is 0) or 90 seconds (when this bit is 1).

Resolution of 4 seconds enables setting Time-based alert period up to every ~8.4 minutes, resolution of 90seconds, up to ~3:10 hours

Note: *In case 3 parameters: " Force one second resolution Rome Mode ", "Resolution Definer in Roaming Mode" and "Time Report Period value in Roaming Mode" parameters are zero (value on address 499 and 526 bit 1 are 0), the unit will use Home parameters (programmed on address 106 and 526 bit 0) during Roaming.*

Default value: 0 – resolution of time-based alert period is 4 seconds

8.2.2 Time Alerts Period Value

Address: 106, bits 0-6 for Home network (**TEPH)**

499, bits 0-6 for Roam network (**TEPR)**

Description: This parameter stores a Time-based alert Period value with resolution configured in previous parameter (4 or 90 seconds). Value 0 disables the time-based alerts.

Note: *In case 3 parameters: " Force one second resolution Rome Mode ", "Resolution Definer in Roaming Mode" and "Time Report Period value in Roaming Mode" parameters are zero (value on address 499 and 526 bit 1 are 0), the unit will use Home parameters (programmed on address 106 and 526 bit 0) during Roaming.*

Default value: 75 (300 seconds when resolution is set to 4 seconds)

8.2.3 Force one second resolution Roaming Mode

Address: 526, bit 0 for Home GSM network

526, bit 1 for Roam GSM network

Description: This parameter forces the resolution of Time-based alert to one second, irrespectively to the values, programmed on addresses 106 and 499.

Default value: both 0 (disabled)

8.2.4 Time Alert Period Multiplier for High Speed Mode

Address: 92, bits 4-7 for Home GSM network

35, bits 4-7 for Roam GSM network

Description: This parameter stores the Multiplier of time-based alert Period during High Speed mode. For example if the programmed value is 2, on speed higher then Velocity Threshold for High Speed mode, the unit will generate two times less time-based alerts in a given period (i.e. if when not in High Speed mode the unit generates a time-based alert every x seconds, in High Speed mode the unit will generate a time-based alert every 2x seconds). Value of zero disables the time-based alerts in High Speed mode.

Default value: 1

8.2.5 Time Report Period Multiplier for NOIP Mode

Address: 485

Description: This parameter enables automatic change of time events period during NO IP mode (while GPRS is unavailable):

The basic time event period is multiplied by the factor programmed in this parameter.

Note: value of Zero is legal and considered by the unit as "1".

Default value: 1

8.2.6 Table of Time-based Alert Period Calculation

	Home Network		Roam Network	
	Time-based alerts Resolution Definer= 0	Time-based alerts Resolution Definer= 1	Time-based alerts Resolution Definer= 0	Time-based alerts Resolution Definer= 1
Low Speed	**TEPH** * 4 seconds	(**TEPH** +1) * 90 seconds	**TEPR** * 4 seconds	(**TEPR** +1) * 90 seconds
High Speed	HSpeedHm * (**TEPH** * 4 seconds)	HSpeedHm * (**TEPH** +1)* 90 seconds	HSpeedRm * (**BPVR** * 4 seconds)	HSpeedRm * (**BPVR** +1)* 90 seconds

- **TEPH** – Time-based alert Period in home network, bits 0:6 of address 106'
- **TEPR** – Basic period value in roam network, bits 0:6 of address 499 (value of zero will cause the unit to use Home settings during roaming)
- **HSpeedHm** – Time-based alert period multiplier for high speed mode in Home network, (bits 4:7 of address 92)
- **HSpeedRm** – Time-based alert period multiplier for high speed mode in Roam network, (bits 4:7 of address 35)

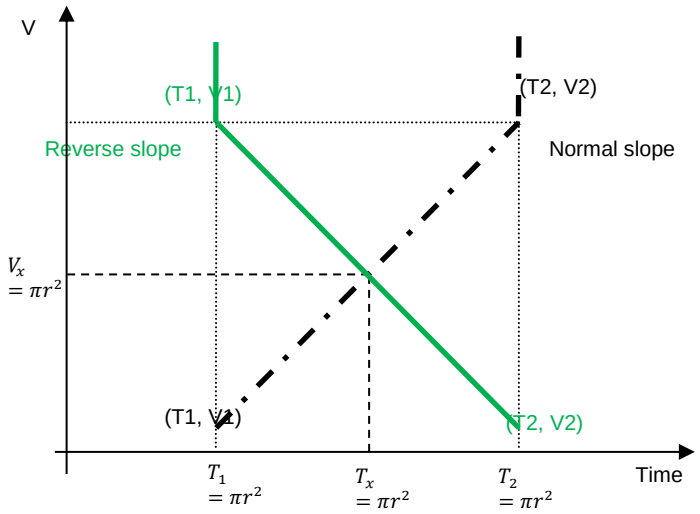
8.2.7 V-Trek: Dynamic Time-based Alerts Period Control as a Function of Speed

V-Trek algorithm proposes an advanced automatic control of Time-based alert period (Plain Events Only), intended to reduce communication costs by reduction of transmission number without decrease in alert quality.

The V-Trek algorithm controls Time-based alerts period as a function of speed. Obviously the time-based events shall be enabled in order to use V-Trek.

The V-Trek configuration relays on 4 parameters – minimum and maximum speed as well as transmission interval for each speed (min and max). A lower time interval causes more frequent transmissions.

NOTE: If all 4 parameters are set to zero, the V-Trek feature is not used. If the parameters are set, normal Time-based alert management is canceled and replaced by V-Trek.



8.2.7.1 Normal Slope of V-Trek

Normal slope is used when it is required to reduce number of transmissions on high speeds. The logic behind this is that number of turns on highways is lower than in city; reducing location updates 5 times on a highway will not harm the quality of the route traced on a map.

- on speed lower than V_1 the unit will not generate an events.
- on speed higher than V_2 the unit will constantly transmit with resolution of T_2.

On speed in range between V_1 and V_2 the transmission rate is dynamically changing: the update rate becomes slower as speed raises.

Normal Slope is considered when the $V_2 > V_1$.

8.2.7.2 Reverse Slope of V-Trek

Reverse slope is used when it is required to reduce number of transmissions on low speeds. The logic behind this is to reduce number of transmissions sent while driving in traffic jams.

- on speed lower than V_2 the unit will constantly transmit with resolution of T_2
- on speed higher than V_1 the unit will constantly transmit with resolution of T_1

On speed in range between V_1 and V_2 the transmission rate is dynamically changing: the update rate becomes faster as speed raises.

Reverse Slope is considered when the $V_2 < V_1$.

8.2.7.3 V-Trek Time Period Calculation

The unit compares the time passed from the last Time-based alert generation with the new calculated Time Period value (according to the current speed).

If the time passed from last Time-based alert is greater than the new calculated value of Time Period then the "timed event" will be triggered immediately; otherwise it will be triggered when the new calculated period will exceed.

8.2.7.3.1 V-Trek – V1 Speed

Address: 1310

Description: This parameter contains the value of V1 speed in km/h; see V-Trek feature description above.

Data format: unsigned integer, km/h

Default value: 0

8.2.7.3.2 V-Trek – T1 Time

Address: 1311

Description This parameter contains the value of T1 time period in minutes; see V-Trek feature description above.

Data format: unsigned integer, minutes

Default value: 0

8.2.7.3.3 V-Trek – V2 Speed

Address: 1312

Description: This parameter contains the value of V2 speed in km/h; see V-Trek feature description above.

Data format: unsigned integer, km/h

Default value: 0

8.2.7.3.4 V-Trek – T2 Time

Address: 1313

Description: This parameter contains the value of T2 time period in minutes; see V-Trek feature description above.

Data format: unsigned integer, minutes

Default value: 0

8.2.7.3.5 Event and Distress Control of Time Alert

Address: 493, bit 1 for Events

494, bit 1 for Distress

Description: This parameter enables generation of Event or Distress alerts for Time-based events, generated according to normal logic or V-Trek.

If both flags are disabled (0) the unit will still generate time-based plain events (due to backward compatibility issue with an older system)

In order to cancel Time-based events the Time-based Period shall be reset (zero).

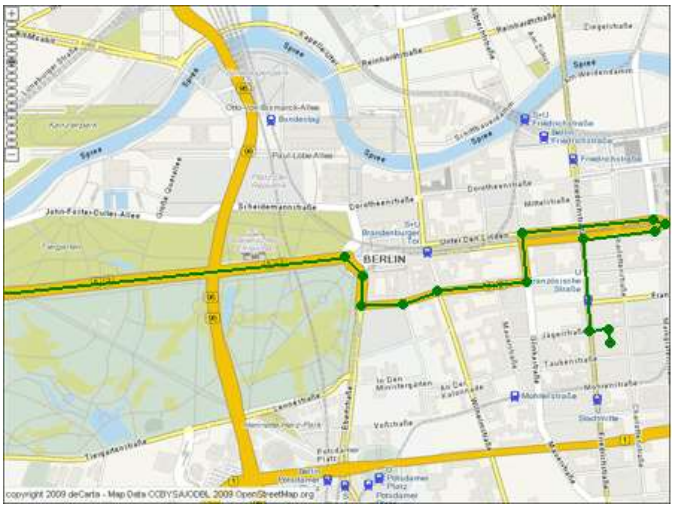
Default value: Both zeros, disabled

8.3 Curve Smoothing

The idea behind this feature is to provide a good correlation between the reported locations to the roads on a map without significant increase of communication cost.

Neither time nor distance events enable tracking as a function of road curves (note that it is possible to utilize sudden course change detection for "curve smoothing" with significant traffic increase), and the path on the map doesn't appear accurate enough, as shown below.

Detecting movement vector change dramatically improves the stickiness to the road and readability of the reports, but will also dramatically increase the traffic:



The vector change detection has to be supported by data compression in order to ensure good stickiness to a road curve for a reasonable price.

The vector change detection occurrence may be reported as a plain/distress events with TR204 (**vector change Report)**, or as a bulk of up to 6 **vector change detection** occurrences, compressed into a single message type 9 , sub-data D (refer to a wireless protocol for more details).

8.3.1 Enable Vector Change Detection Events /Distress

Address: 1433, bit 0 for Events

1433, bit 1 for Distress

Description: If this bit is enabled, upon generation of Start (or the first GPS Nav. Start after Start if there is no valid GPS upon Start) the unit stores reference vector of course.

The unit stores reference GPS stamp value (time, date, latitude, longitude, speed and course) every time it is detecting change of course's vector.

The stored reference course value is compared with the value of course received with every new valid GPS frame. If the received value of course differs from stored one more then the value of **vector change programmable parameter** (5° by default), the unit will log **vector change detection** occurrence (not event in the logged memory yet but in a volatile memory) and replaces reference course value by the new one.

Note that if compressed vector change report is enabled, the value of this parameter will be ignored.

If **compressed vector change report** (next parameter) is disabled the unit will generate a dedicated event/distress type 0 with TR204 (**Vector Change Report**).

Default: Both disable

8.3.2 Enable Compressed Vector Change Report

Address: 1433, bit 2

Description: If this bit is enabled, settings of bit's 0 and 1 of this byte (previous parameter) will be ignored. In this case the compressed vector change data will be sent by the unit in the following cases:

- Upon detection of 6th **vector change detection** occurrence. In this case the system will generate an Msg type 9 containing all 6 **vector change detection** occurrences.
- Timeout. If at least one vector change event is stored in unit's memory and no other vector changes were generated by the unit during the pre-programmed period, the system will generate Msg type 9 containing all previous **vector change detection** occurrences.
- Upon Stop. Msg type 9 containing all previous **vector change detection** occurrences (if any) will be generated immediately upon stop report.
- Upon reset command the Msg type 9 containing all previous **vector change detection** occurrences (if any) will be generated.

The Compressed **Vector change Report** Msg type 9 will be logged in the same message stack as plain event type 0, will utilize the same sequence of numerator and acknowledge rules.

The Compressed Vector change Report Msg type 9 will NEVER be generated as real-time or distress event, only as logged event.

Upon power up/reset the unit will record reference course/coordinates upon reception of the first valid GPS packet.

Note: When no significant course changes are detected by the unit (for example when driving long straight roads), the unit will send periodic "Compressed Vector Change Reports" to avoid compressed data overflow.

8.3.3 Compressed Vector Change Report Timeout

Address: 1434

Description: This parameter contains a timeout to generate Msg type 9 containing all logged **vector change detection** occurrences before six occurrences were accumulated.

This parameter will take affect when:

- Compress Vector change Detection is enabled,
- At least one vector change detection logged
- No vector change detection occurrence is logged by the unit during the period defined in this parameter

Range and resolution: Unsigned integer 8 bits, resolution of minutes

Default: 10 minutes

8.3.4 Vector Change Detection Angle

Address: 1435

This parameter defines the minimum course change from last logged event, considered as Vector change Detection occurrence. Possible values are 0 to 180°.

Range and resolution: 8 bits, unsigned integer, resolution of degrees

Default: 5°

8.4 Communication Idle Alerts

8.4.1 Time between Communication Idle Alerts

Address: 70-71

Name in Programmer: Time between Comm.Idle Transmissions

Description: This parameter defines the maximum time without any communication. If a message is not received within this timeout, an idle communication alert is registered.

It is possible (configuration bit described below) to wake up the unit from the full hibernation in order to try delivering this type of alert in real time.

This algorithm is frequently used as a "Heart Bit" of the unit, the "Keep Alive" messaging.

Data format: 16-bit unsigned integer, 1 minute resolution.

Default value: 30 (minutes)

8.4.2 Event and Distress Controls for Communication Idle Alert

Address: 493, bit 0 for plain event

494, bit 0 for distress

Description: This bit enables alerting Idling of Communication with period programmed in Time.

Default value: Event enabled (1), distress disabled (0)

8.4.3 Do not Wake Up from Hibernation upon Comm. Idle Distress

Address: 494, bit 7

Description: If this bit is set (1), the unit will not generate a distress Communication Idle alert in full hibernation, and therefore will not wake up from full hibernation upon expiration of Time between Communication Idle Alerts timeout.

Default value: 0 - wake up from full hibernation to alert Comm. Idle

9 Inputs Events

9.1 4 – Ignition

Ignition input can be used for detection of journey Start and Stop, which are key events in unit logic and require an especial treatment, or as a general purpose input (when journey Start/Stop is detected using an accelerometer).

Journey Start and Stop:

The system will enter hibernation mode between Journey Stop and Journey Start, and will start generating periodical events between Journey Start and Journey Stop

In case it is used for detection of journey Start and Stop, except "Common Discrete Inputs Time Filter" applied to every input, the Start/Stop Alert Generation Time Filters are applied as well.

A general purpose input:

If ignition input is used as a general purpose it is internally pulled down and can recognize the following signals:

- Low (logical zero) 0V<Vin<3.5V
- High: Vin>9V

Voltages between 3.5V to 9V are undefined.

9.1.1 Reporting Journey Start

Address: 126, bit 5 for event

130, bit 5 for distress

Description: if this bit is set the unit will generate a corresponding alert upon Journey Start detection (by ignition or by accelerometer).

Default Value: Event enabled (1), Distress – disabled (0)

9.1.2 Reporting Journey Stop

Address: 124, bit 5 for event

128, bit 5 for distress

Description: if this bit is set the unit will generate a corresponding alert upon Journey Stop detection (by ignition or by accelerometer).

Default Value: Event enabled (1), Distress – disabled (0)

9.1.3 Inverting Journey Start/Stop

Address: 100, bit 5

Description:

Once inverted:

The system will report "Journey Start" when low level (by ignition or by accelerometer) is recognized and vice versa.

Default Value: (0) not inverted

9.1.4 Reporting Signal Falling on Ignition

Address: 125, bit 7 for event

129, bit 7 for distress

Description: if this bit is set the unit will generate a corresponding alert upon detection of logical level falling from 1 to 0. In case this input is inverted, it will mean generation of the alert upon disconnection of this input from (-).

Note: This feature will not work when CFE configuration is used.

Default Value: zeros – disabled (0)

9.1.5 Reporting Signal Rising on Ignition

Address: 127, bit 7 for event

131, bit 7 for distress

Description: if this bit is set the unit will generate a corresponding alert upon detection of logical level rising from 0 to 1. In case this input is inverted, it will mean generation of the alert upon connection of this input to (-).

Note: This feature will not work when CFE configuration is used.

Default Value: zero – disabled (0)

9.1.6 Inverting Ignition Input

Address: 101, bit 6

Description: Ignition input is internally pulled down and therefore does not require an inversion in most of the cases.

In case it is serving as a GP and logical levels are opposite to physical levels – the input shall be inverted.

Default Value: (0) not inverted

9.2 16 – Panic

This input is equipped by an internal pull up resistor and therefore can only serve as discrete dry contact.

9.2.1 Function Assigned to Panic Input

Address 1700, bits 0-6

Name in Programmer: Assigned Function

Description: This field enables assignation of certain functionality to a Panic input.

Function number	Description	Comment
0	Use as a GP input (default)	
1-8	Reserved	
9	Volume Up (refer to Volume Control section in this document)	
10	Volume Down (refer to Volume Control section in this document)	
11	Reserved	
12	Over-speed threshold control If this function is selected, the unit will automatically use speed threshold programmed on address 2391 as both Over-speed start and Over-speed end thresholds while this input is triggered.	
13-31	Reserved	

Default Value: zero – GP input

9.2.2 Inverting Panic Input

Address: 100, bit 6

Description: Panic input is pulled up (internally); therefore it does require an inversion when it is required to detect activation by low level (-).

Once inverted: the "low" level of signal (below threshold programmed in parameter above) on this input will be treated as logical "1" (active). The "high" level of signal, as well as floating state, on this input will be treated as logical "0" (not active).

Default Value: (1) inverted

9.2.3 Threshold for Panic Input

Address: 1701

Description: This threshold defines the highest voltage on this input, which will still be considered as logical zero. Any voltage above the value programmed in this parameter (as well as open contact) will be considered as logical "one".

The unit is continually sampling voltage on this input and comparing the average measurement (refer to parameter below) with the threshold programmed in this parameter.

Value span: 57 (0.6V) to 240 (2.7V). Any measured value below 57 or above 240 causes the unit to convert this value to default (200).

Default Value: 200

9.2.4 Averaging Factor for Panic Input

Address: 1702

Description: The unit is continually sampling voltage on this input every 10 msec. The moving average of sample's number (preprogrammed in this parameter) is compared with the threshold (previous parameter) in order to decide concerning the logical level of the input.

NOTE: In the operational modes listed below the unit is ignoring averaging factor and processing each measurement sample separately:

- In Full Hibernation mode, including the Modem / GPS On Time
- In Signal Correlation Mode (applicable in security builds only)

Default Value: 10 samples

9.2.5 Reporting Signal Falling on Panic

Address: 124, bit 6 for event

128, bit 6 for distress

Description: If this bit is set the unit will generate a corresponding alert upon detection of logical level falling from 1 to 0. In case this input is inverted, it will mean generation of the alert upon disconnection of this input from (-).

Default Value: zeros – disabled (0)

9.2.6 Reporting Signal Rising On Panic

Address: 126, bit 6 for event

130, bit 6 for distress

Description: If this bit is set the unit will generate a corresponding alert upon detection of logical level rising from 0 to 1. In case this input is inverted, it will mean generation of the alert upon connection of this input to (-).

Default Value: zero – disabled (0)

10 Power Events

10.1 Power Threshold Settings

The thresholds listed below are used to determine if the main and backup power sources are low.

Each of these conditions for each of the power sources (main and backup) is equipped by pair of thresholds enabling to alerts in sessions.

10.1.1 Main Power Low Threshold – High/Low levels

Address: **115** – High level (Doesn't exist on CelloTrack-Solar)

116 – Low level (for CelloTrack-Solar see section _d2h_bmk__Ref535335408_22)

Description: The unit will trigger "Main Battery low" alert if the measured level of the main power will be lower than the value programmed in Main Power Low Threshold Low Level parameter.

The unit will trigger "Main Battery OK" alert if the measured level of the main power will be higher than the value programmed in Main Power Low Threshold High Level.

Data format: 8-bit unsigned,

0.0189V/bit

Default values:

Address 115: 3.591V

Address 116: 3.4965V

10.2 Power Events/Distress Control

10.2.1 Enabled Main Power Disconnected in Ignition Off Mode alert

Address: 121, bit 0 for events

122, bit 0 for distress

Description: If this bit is set the unit will generate appropriate alerts upon detection Main Power disconnected session start and end.

Default value: 0 – disabled

10.2.2 Enabled Main Power Low in Ignition Off Mode Alert

Address: 121, bit 1 for events

122, bit 1 for distress

Description: If this bit is set the unit will generate appropriate alerts upon detection Main Power Low session start and end.

Default value: 0 – disabled

10.2.3 Enabled Backup Battery Disconnected in Ignition Off Mode Alert

Address: 121, bit 2 for events

122, bit 2 for distress

Description: If this bit is set the unit will generate appropriate alerts upon detection Backup Battery Disconnect session start and end.

NOTE: The backup battery disconnection is sensed by voltage on NTC channel.

Default value: 0 – disabled

10.2.4 Enabled Backup Battery Low in Ignition Off Mode Alert

Address: 121, bit 3 for events

122, bit 3 for distress

Description: If this bit is set the unit will generate appropriate alerts upon detection Backup Battery Low session start and end.

Default value: 0 - disabled

10.2.5 Enabled Main Power Disconnected in Ignition On Mode Alert

Address: 121, bit 4 for events

122, bit 4 for distress

Description: If this bit is set the unit will generate appropriate alerts upon detection Main Power disconnected session start and end.

Default value: 0 – disabled

10.2.6 Enabled Main Power Low in Ignition On Mode Alert

Address: 121, bit 5 for events

122, bit 5 for distress

Description: If this bit is set the unit will generate appropriate alerts upon detection Main Power Low session start and end.

Default value: 0 – disabled

10.2.7 Enabled Backup Battery Disconnected in Ignition On Mode Alert

Address: 121, bit 6 for events

122, bit 6 for distress

Description: If this bit is set the unit will generate appropriate alerts upon detection Backup Battery Disconnect session start and end.

NOTES:

- If backup battery is not installed the unit will not generate the "backup battery disconnected" alert.
- The backup battery disconnection is sensed by voltage on NTC channel.

Default value: 0 – disabled

10.2.8 Enabled Backup Battery Low in Ignition On Mode Alert

Address: 121, bit 7 for events

122, bit 7 for distress

Description: If this bit is set the unit will generate appropriate alerts upon detection Backup Battery Low session start and end.

Default value: 0 - disabled

10.2.9 Period between the Alerts, Triggered by Detection of Power Disconnection

Address: 1346

Description: Normally the trigger configured as a "plain event" is only generated once, and the one configured as "distress" is generating single distress session upon trigger detection (as described above in this document).

The "Main Power disconnected" is an exception from this rule. This alert can be generated many times.

Note that if Main Power Disconnected alert is configured as "Distress" – it will cause a number of Distress *sessions*, according to the number, programmed in this parameters.

Resolution and data format: Minutes, from 1 to 255. 0 – backward compatible mode, cancels the repetitions (event or session will only be generated once)

Default value: 0 – repetitions canceled

11 Geo-Fences

11.1 Geo-Fence

The group of parameters below contains configuration structures of 100 internal Geo-Fences of Cellocator unit. Each geo-fence is a rectangular perimeter, activated in a selected time of the day. It is equipped by violation condition, capable to trigger an alert or output activity upon occurrence.

During Ignition On mode the unit is continually examining its location and checking if it is violating a condition of one of the fields.

Each of a 100 geo-fences is a structure of 16 bytes in the following order:

	Byte 15	Byte 14	Byte 13	Byte 12	Byte 11	Byte 10	Byte 9	Byte 8	Byte 7	Byte 6	Byte 5	Byte 4	Byte 3	Byte 2	Byte 1	Byte 0
Field description / Address	Config. byte 4	Maximal Latitude Displace-ment		Latitude of Fence's Centrum				Maximal Longitude Displace-ment		Longitude of Fence's Centrum				Configuration bytes 1,2 and 3		
Fence 0 2496-2512	2512															2496
Fence 1 2513-2528	2528															2512
Fence 99 4080-4095	4095															4080

11.1.1 Format of Geographical Perimeter

Address: 2496-4095

Name in Programmer: EdgePoint 0001 – 0100

Description: The perimeter is defined by center coordinates and maximal displacement for each coordinate (the same structure for longitude and latitude). The coordinates are the usual 10^{-8} radians format. The displacement is $10^{-8}/256$ radians (the same format like the coordinates but without the least significant byte and the most significant byte, keeping only the middle bytes).

Maximal Longitude Displacement		Longitude of Fence's Centrum			
Segment Byte 8	Segment Byte 7	Segment Byte 6	Segment Byte 5	Segment Byte 4	Segment Byte 3

Maximal Latitude Displacement		Latitude of Fence's Centrum			
Segment Byte 14	Segment Byte 13	Segment Byte 12	Segment Byte 11	Segment Byte 10	Segment Byte 9

Default value: all bytes are zeroes (all waypoints disabled).

11.1.2 Four Configuration Bytes of the Fence

Address: Bytes 0, 1, 2 and 15 of each fence:

Speed Limiting Geo-Fence Thresholds Select	Output Control			End time hours[3]	End time minutes	Start time hours	Start time minutes	
	Activation pattern	Output Number	TOE MSB					TOE (LSB)
31 30	29 28	27 26 25	24	23 22 21 20 19	18 17 16	15 14 13	12 11 10 9 8	7 6 5 4 3 2 1 0
Config. Byte 3				Config. Byte 2		Config. Byte 1		Config. Byte 0
Segment Byte 15				Segment Byte 2		Segment Byte 1		Segment Byte 0

[3] In order to set certain fence to be permanently active the start time shall be set to 0:00 and the end time to 24:00

11.1.3 TOE - Type of Entry

This field defines the usage of an appropriate Fence entry.

Bit 24	Bit 1	Bit 0	Entry type	Geo Fence Heading Angle Support (Not supported in CelloTrack family)
0	0	0	Entry is inactive (the whole 16 bytes are ignored by the unit)	No
0	0	1	Entry is active and treated as waypoint data	Yes
0	1	0	Entry is "keep out" fence data (unit must be outside location window)	Yes
0	1	1	Entry is "keep in" fence data (unit must be inside location window)	Yes
1	0	0	Entry is treated as Geo-hotspot (both entering and leaving cause a trigger)	Yes
1	0	1	Entry is treated as Modem Off zone. The unit generates an event and switches off the Cellular modem 10 seconds after entering the zone. The modem is turned on immediately upon exiting from the "no modem zone".	Yes
1	1	0	Speed limiting zone	Yes

11.1.4 Waypoint

Waypoints are perimeters, which the unit has to be found at defined time intervals. The unit must be found in the perimeter for at least one sample in the whole time window. Once it happens, the waypoint is "checked" (i.e. no additional checks will be done for this waypoint). If this does not happen, the unit will trigger a dedicated alert.

11.1.5 Geo Hot Spot

Generates trigger on entry and exit to a fenced zone. Transmission reason 191, Trigger's transmission-reason-specific data: Bits 0-6 is the index of the slot. Most significant bit (bit 7) indicates direction: entry to hot spot ("1") or exit from hot spot ("0"). Behavior is not affected by fence logic bit. Please note, Hot-Spot does not trigger outputs.

11.1.6 No Modem Zone

Generates trigger when shutting down modem as a result of entry to "no modem zone".

Trigger is generated only for the first fence that causes the modem's shutdown. Upon entry to another overlapping (or common boundary) "no modem" zones, while modem is already turned off, no more triggers are generated. Modem is shut down 10 seconds after entering "no modem zone", regardless of trigger settings.

The modem is turned on immediately upon exiting from the "no modem zone".

11.2 Fences Configuration

11.2.1 Geo-Fence Logic

Address: 6, bit 5

Description: This parameter defines the reference of the unit to the geo-fences (Applicable only for Keep In and Keep Out types).

Global context mode (fence logic = 0)

Keep in fences logic:

When position changes, trigger is generated if both terms below are true:

- In the new position *ALL* keep-in fences are in violation state (meaning - position is outside all keep-in fences).
- Previously at least one of the fences wasn't in violation state (position was in the area of at least one of the fences).

Trigger's transmission-reason-specific data is the index of latest slot that changed its status to violation state.

Keep out fences logic:

When position changes, trigger is generated if both the terms below are true:

- In the new position at least one of the fences is in violation state (meaning - position is inside one of the keep-out fences).
- Previously *ALL* keep-out fences weren't in violation state (position was outside the area of all keep-out fences).

Trigger's transmission-reason-specific data is the index of latest slot that changed its status to violation state.

Discrete context mode (fence logic = 1):

Triggers are generated discretely for violation of each keep-in/out fence, regardless of other fences status. Trigger's transmission-reason-specific data is the index of the slot that changed its status to violation state.

Default: 0 - Global context mode

11.2.2 Geo-Fence Violation Filter

Address: 1006

Description: This parameter designed to reduce number of fault Geo-Fence violation events. It defines required amount of sequential valid GPS packets (GPS packets are received every second) introducing Geo-Fence violation in order to generate an alert.

Default value: 1

Note: the violation filter is not applicable with waypoint type Geo-Fences (since by definition, in a waypoint type Geo-Fence one GPS sample in which the unit is inside the Geo-Fence perimeter is enough to "check" positively this Geo-Fence).

11.2.3 Ignore Geo-Fence Violation on Boot (after Reset)

Address: 1, bit 2

Description: If this bit is set, the "first geo-violation changes ignore" mode is activated.

This mode allows avoiding generation violation repetitions upon any kind of reset. In this mode, the unit will use the first stable violation state as the baseline for subsequent processing of geo-fences.

This means that any geo-fences in violation state on the first stable status are not reported, and only subsequent changes are reported.

Once started, "first geo-violation changes ignore" mode terminates when:

- A valid, stable GPS fix and geo-fence state is achieved. Any geo-violations at this point are not reported, and used as baseline.
- 120 seconds timeout expires. The rationale for this is not ignore important changes occurring at a later time, if this state started when there is no GPS coverage.
- After "first geo-violation changes ignore mode" ends, subsequent geo-violation changes are reported as usual.

Note that due to this mode's timeout, if GPS takes longer than 120 seconds to achieve a fix after boot, any active geo-violation will be reported as usual when GPS fix is finally achieved

Default value: 0 – Do not ignore violations on boot

11.2.4 Control of Geo-Fence Alters (Events and Distress)

11.2.4.1 Keep In Geo-Fence Zone Violation

Address: 1004, bit 0
1005, bit 0

Description: If this bit is enabled the unit will generate an alerts upon violation of Keep In Type of Geo-Zones.

Default: 0 – both Disable

11.2.4.2 Keep Out Geo-Fence Zone Violation

Address: 1004, bit 1

1005, bit 1

Description: If this bit is enabled the unit will generate an alerts upon violation of Keep Out Type of Geo-Zones.

Default: 0 – both Disable

11.2.4.3 Way Point Violation

Address: 1004, bit 2

1005, bit 2

Description: If this bit is enabled the unit will generate an alerts upon violation of Way Point Type of Geo-Zones.

Default: 0 – both Disable

11.2.4.4 Geo Hot Spot Violation

Address: 1004, bit 3

1005, bit 3

Description: If this bit is enabled the unit will generate an alerts upon violation of Geo Hot Spot Type of Geo-Zones.

Default: 0 – both Disable

11.2.4.5 No Modem Zone Entry

Address: 1004, bit 4

1005, bit 4

Description: If this bit is enabled the unit will generate an alerts upon violation of No Modem Type of Geo-Zones.

Default: 0 – both Disable

11.2.5 Geo-Fence Priority

Address: 6550-6574

Description: Geo-Fences are defined by a center coordinate, and latitude + longitude displacements from center (i.e. only rectangular zones can be defined).

Thus, when trying to cover a road (which obviously has turns and curves) with the rectangular Geo-Fences, some overlapping between Geo-Fences is necessary.

In some cases, this causes the unit to produce too many speed violation events, which may cause excess workload and confusion to the operator.

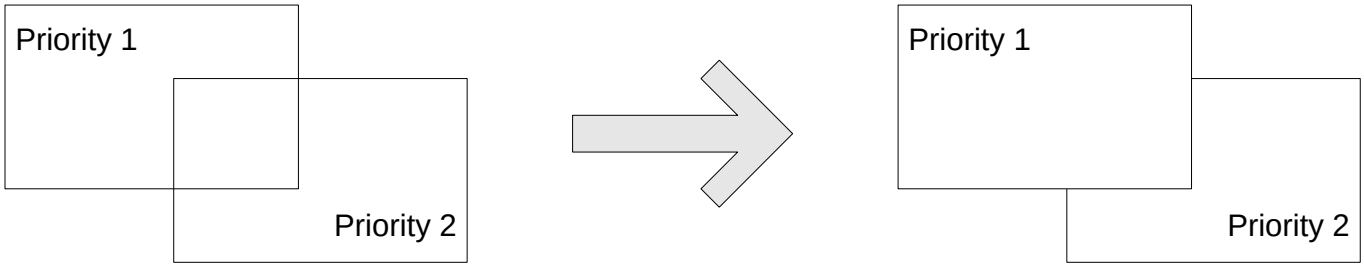
To solve this and create zone "continuity", a configurable priority is assigned for each Geo-Fence.

The priorities are:

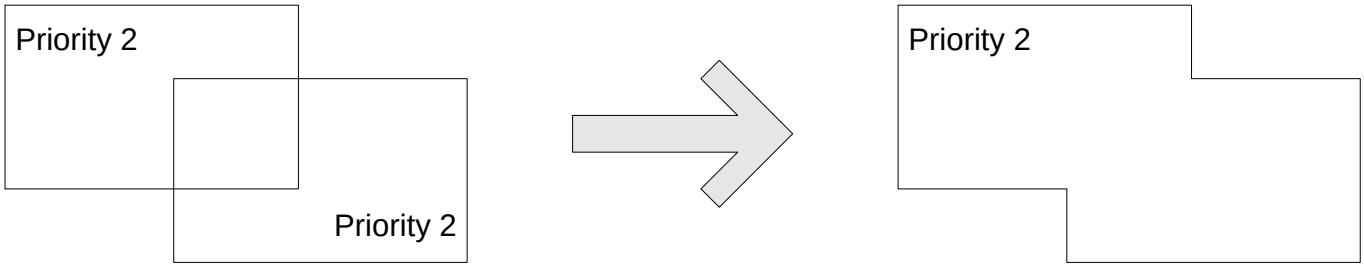
Priority	Value
1 (highest)	00
2	01
3	10
4 (lowest) - default	11

Address 6574								**…**	**Address 6550**							
GeoFence 100		GeoFence 99		GeoFence 98		GeoFence 97		…	GeoFence 4		GeoFence 3		GeoFence 2		GeoFence 1	
1	1	1	1	1	1	1	1	…	1	1	1	1	1	1	1	1
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	…	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

When the priorities of overlapping Geo-Fences are different, the unit considers only the boundary of the highest priority Geo-Fence:



When the priorities of overlapping Geo-Fences are equal, the unit considers them as one Geo-Fence with common boundaries:



12 CelloTrack

This section describes parameters associated with CelloTrack devices (both CelloTrack and CelloTrack Power). The CelloTrack Power device has more programming features associated with charging logic. Please refer to here for more CelloTrack Power configuration options.

12.1 CelloTrack Configuration 1

Address: 1318

Description: This parameter contains a bitmap, allowing controlling different activities of the CelloTrack unit.

Enable GPS peeking in Live Tracking	Enable Event on Peeking (COM-Location glancing)	Enable Distress on Peeking	Enable Live Tracking	Disable LED 2 in operation mode	Disable LED 1 in operation mode	Disable LED 2(System LED)	Disable LED 1(GSM LED)
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Disable LED 1 (GSM LED) - If this flag is enabled ('1'), the LED1 (GSM LED) of CelloTrack unit will be disabled.

The bit is for Infrastructure only and is currently not operational

Disable LED 2 (System LED) - If this flag is enabled ('1'), the LED2 (System LED) of CelloTrack unit will be disabled.

The bit is for Infrastructure only and is currently not operational

Disable LED 1 in operation mode - If this bit is enabled ('1'), the LED1 (GSM LED) of CelloTrack unit will be disabled in Activated mode, but will still respond in Non-activated mode during system activities like "Activation/Deactivation" procedures.

Disable LED 2 in operation mode - If this bit is enabled ('1'), the LED1 (GSM LED) of CelloTrack unit will be disabled in Activated mode, but will still respond in Non-activated mode during system activities like "Activation/Deactivation" procedures.

Enable Live Tracking - If this mode is enabled ('0') the unit will remain fully active while movement is detected. This way the unit will not switch off GSM and GPS during the entire trip. During this mode the unit is capable to generate periodical events (Time and Distance) according to pre-programmed rules. If this mode is disabled ('1'), the unit will be in hibernation during the entire trip. Only Start and Stop reports will be registered. Note: If Enable Live Tracking is enabled, the "Stop Event Time Filter" (address 105) minimal value will be limited by FW to 40 seconds.

See also "GPS Peeking in Live Tracking" parameter.

Enable Distress on Peeking - If this bit is enabled ('1'), then 20 to 30 seconds before the end of the COM-Location glancing the unit will trigger a distress session, in form of

standard position message including latest GPS data and an appropriate transmission reason (252)

Enable Event on Peeking - If this bit is enabled ('1'), then 20 to 30 seconds before the end of the COM-Location glancing the unit will trigger an event, in form of standard position message including latest GPS data and an appropriate transmission reason (252)

GPS peeking during Live tracking - This bit is only applicable if bit 4 of the same bitmask byte is enabled.

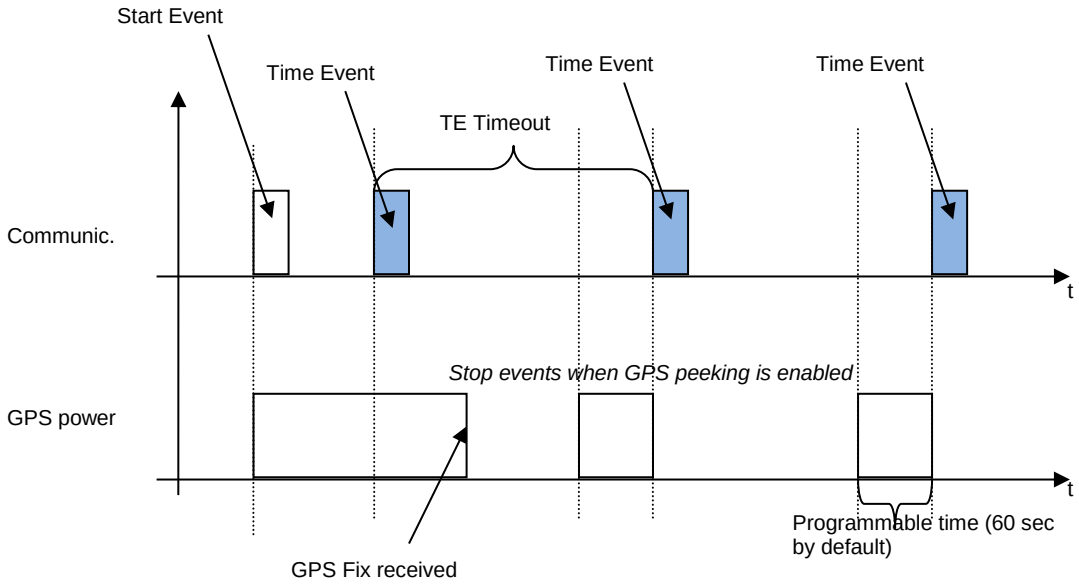
If this bit is enabled ("1"), the GPS will be operated in Live Tracking mode in a way, enabling an additional power saving as described below.

In the normal Live Tracking mode (see above) all the modules of the unit are activated and fully operational. When GPS Peeking during Live tracking is enabled the unit operates a GPS by peeks with preprogrammed length (instead of permanent activation) during the entire Live Tracking mode.

The GPS Peeks management is activated in the following conditions only:

- GPS peaks in Live Tracking is enabled in EEPROM
- Time Event interval is longer than 90 seconds
- Between the Start event and Stop Event
- Only after the first valid fix is obtained after the Start event

If the feature is enabled, the GPS will be switched off immediately after the Time Event message generation, and will be activated back programmable time before the next Time Event message generation.



When the "Stop events" are set as distress, the unit will process them as any other distress event, i.e. upon occurrence the GPS will be switched on for Distress session period plus Extra GPS Time for distress timeout.

While the "Stop" is set as a plain event, the unit will behave as follows:

- If the event occurs after the time event peek – the unit will not switch GPS on and will generate the event with the GPS stamp of the last time event. Then, after the Hibernation Timeout expires, the unit will enter the full hibernation mode.
- If the "Stop" event occurs during the pre-time event GPS peek – the unit will generate the event with the existing GPS stamp (even if valid location not received yet); then, after the Hibernation Timeout expires the unit will enter the full hibernation mode.

Default Value: 0x5F

12.2 CelloTrack Configuration 2

Address: 2

Description: This parameter contains a bitmap, allowing controlling different activities of CelloTrack unit.

Cradle mount Power save	GPIO control 2	GPIO control 1	Enable extended charging temperature range	Enable FixTime algorithm (Non CelloTrack-T)	Disable Cell ID packets on peeking)
Bit 7	Bit 5-6	Bit 3-4	Bit 2	Bit 1	Bit 0

12.2.1 Disable Cell ID Packets on Peeking

If this bit is enabled (1), the unit will NOT generate a CellID message during glancing (normal and ST), even if enabled in configuration (bits 6 and 7 of addresses 202, 204) and there is no valid GPS reading upon glancing event/distress generation.

12.2.2 Enable FixTime Algorithm (Non CelloTrack T Variants only)

During the Sleep mode the GPS, which is a primary source of real time clock is off and the microcontroller with its crystal is hibernating. The clock of the unit during this time is based on the RC oscillator, which is very inaccurate due to an inaccuracy of component's values and ambient affect.

Long Sleep cycles therefore might cause significant time inaccuracy. The FixTime algorithm switches off the crystal periodically and allows the microcontroller to calculate the real time correction of the clock based on RC.

Such a management is significantly improving an accuracy of the self clock, although increases current consumption by 3%-5% percent. It is recommended to activate FixTime algorithm only when Specific Time Glancing is used or the sleep periods are longer than 6 hours.

The FixTime feature is normally needed only for ST (Specific Time) Glancing; the customers who do not use ST Glancing might save power by switching the FixTime feature off.

"1" – default value means use FixTime, "0" – do not use FixTime

This feature is automatically enabled in CelloTrack T variants, no Configuration pin assigned for it.

12.2.3 Enable Extended Charging Temperature Range

This bit is applicable only for CelloTrack Power.

It is setting an ambient temperature range allowed for battery charging.

- 0 - for 'Normal' range, shall be selected for Li-Poly battery with temperature range of 0-45 °C
- 1 - for 'Extended' range, shall be selected for Sonata® battery with temperature range of -10-60 °C

Default Value: 0 – (for range of 0-45 °C)

12.2.4 GPIO Control 1/2 (CelloTrack only)

CelloTrack was built with true GPIO hardware support enabling the user to control the functionality of the 2 GPIO lines connected via the harness. The configuration bits were added to select between input functionality, output functionality and output with feedback. The GPIO inputs 1 and 2 are called "Door" and "Shock" in the inputs description above.

The user should note that if both GPIOs are disabled the unit will consume less energy and thus increase the battery operational time.

GPIO control 1	Description
0	GPIO disabled
1	GPIO functions as input only (Door)
2	GPIO functions as Output only (STD IMMOBILIZER)
3	GPIO functions as Output. The output actual state will be mirrored via the input.

GPIO control 2	Description
0	GPIO disabled
1	GPIO functions as input only (Shock)
2	GPIO functions as Output only (LED)

3	GPIO functions as Output. The output actual state will be mirrored via the input.

Default Value: 1 – GPIO functions as input only

12.2.5 Cradle Mount Power Save (CelloTrack only)

This feature enables the user to optimize the unit's power consumption if the unit's mounting policy is known in advance. If the unit will be mounted in the original supplied cradle and the configuration bit will be set to 0 the unit static current consumption will be decreased by 40uA. The same is true if the unit will not be mounted in Cradle this configuration bit will be set to 1.

Cradle mount power save	Description
0	Tamper switch will consume minimal energy during hibernation when not inserted to cradle
1	Tamper switch will consume minimal energy during hibernation when inserted into the cradle

Default Value: 1 – Cradle mount

12.3 GPS Peeking On Time during Live Tracking

Address: 1616

This parameter only applicable when "GPS peeking during live tracking" bit of the bitmask above is enabled.

The parameter contains a value of time used to power on the GPS before the Time Event generation.

Resolution: seconds

Data range: 40-80seconds (any value lower than 40 will be mean 40, any value higher than 80 will mean 80)

Default Value: 40 seconds

12.4 Activation/Deactivation Procedure Options

Address: 1447

The Bitmask:

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

12.4.1 Activation/Deactivation Procedure

It is possible to select programmatically between a standard Activation/Deactivation procedure, using two buttons: Tamper switch and Front Button (FB) and alternative Activation/Deactivation procedure using single button (the FB) only.

Activation/Deactivation Procedures using two buttons (Standard)	**Activation/Deactivation Procedures using one button (Alternative)**
Deactivation (from activated mode): **1) Deactivation by Button combination:** The Front Button (FB) is pressed for 3 seconds Tamper switch should not be pressed (the device is out of the cradle) **2) Deactivation by OTA Command** Type 0 command to force the CelloTrack unit to "Not Active" mode, see in "Cellocator Wireless Communication Manual" in section "Command Specific Data Field", command code 0x1d. **Deactivation process Indication:** The following LED sequence will be activated to reflect deactivation request was granted and the unit has started its deactivation procedures. Please note that deactivation procedures include also sending OTA event to reflect the fact the unit is about to be Deactivated (TR 102). **Unit Deactivated indication** The SYS LED blinks on/off in 200msec period to acknowledge deactivation request. The device enters a Non-Activated state until the next operation starts. Pressing FB while the device is in a cradle	**Deactivation (from activated mode):** **1) Deactivation by Button:** Deactivation (from activated mode): The Front Button (FB) is pressed for 6 seconds. **2) Deactivation by OTA Command** Type 0 command to force the CelloTrack unit to "Not Active" mode, see "Cellocator Wireless Communication Manual" in section "Command Specific Data Field", command code 0x1d. **Deactivation process Indication:** The following LED sequence will be activated to reflect deactivation request was granted and the unit has started its deactivation procedures. Please note that deactivation procedures include also sending OTA event to reflect the fact the unit is about to be Deactivated (TR 102). **Unit Deactivated indication** The SYS LED blinks on/off in a 200msec period to acknowledge deactivation request. The device enters a Non-Activated state until the next operation starts. Pressing FB while the device is in a cradle and activated will cause the unit to trigger

and activated will cause the unit to trigger the "Panic button triggered" procedure only. Note: Deactivation using two buttons can be Disabled if the "Disable Power Off by On/Off Front Button" parameter (address 1614, bit 7) is set to Disable	the "Panic button triggered" procedure only.
Activation (from not-activated mode): The Tamper switch is pressed (the device is in a cradle) The Front Button (FB) is pressed for 3 seconds **Indication of Successful Activation:** SYS LED glows while the FB is pressed. After 3 seconds of FB triggering the LED is switching off – here the FB can be released. If the FB is pressed while the Tamper switch is not pressed (the unit is out of the cradle) - the SYS LED begins to blink (1sec on/1 sec off) in order to confirm a Non-Activated state. When the GPS enters, navigation SYS LED starts to blink twice (short blink (1/4 sec blink once in 2 seconds) OTA event can be sent to reflect activation mode change (TR 102).	**Activation (from not-activated mode):** The Front Button (FB) is pressed for 3 seconds **Indication of Successful Activation:** SYS LED blinks (second on/second off) while the FB is pressed in deactivated mode. After 4 seconds of FB triggering the LED is switching off – here the FB can be released. When the GPS enters navigation SYS LED start blinking twice (short blink (1/4 sec blink once in 2 seconds) OTA event can be sent to reflect activation mode change (TR 102).

12.4.2 GPS-based Start Event Enable (Non CelloTrack T Variants only)

Address: 1447 bit 1

If this bit is set then start report (logged or distress) will not be sent unless GPS has detected a deflection from the original location.

If this bit is cleared then legacy functionality will be maintained: the start report will be sent only based on the accelerometer.

Default value: 0 – normal procedure (accelerometer based)

12.5 GPS-based Movement Timeout (Non CelloTrack T Variants only)

Address: 1319

This value will determine the GpsFix and Deflection timeout. After this time elapses a start event will be sent towards the Center if enabled by bit "GPS based Ignition Send events on timeout".

Resolution: 1 min

Data range: 0-255

Default Value: 60 min

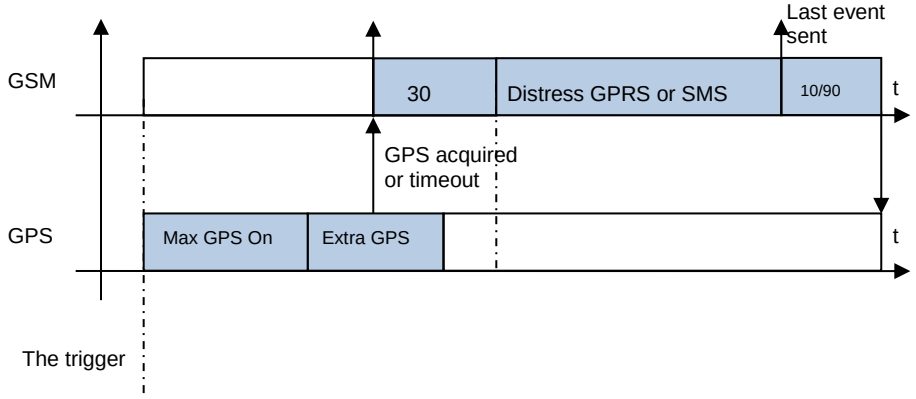
12.6 Max Extra GPS On Time for Distress Mode

Address: 1618

12.6.1 Distress Mode during COM-Location Glancing State

In most of the operational scenarios, except of periodical events (COM-Location Glancing) the customer will need to report additional events. For example – movement Start and Stop, tampering detection or trigger of front button.

The correct way of reporting of such alerts is to generate a Distress session upon detection of one of them (refer to a Distress Session definition in Programming manual).



The Distress session, triggered during sleep mode, is managed according to the following scenario:

Upon trigger of the distress session the unit immediately switches on both GPS and GSM waits for GPS acquisition or for expiration of Max GPS On time + GPS Extra Time (this parameter) programmable timeouts. During this time the modem has a chance to registries into GSM and GPRS.

Once the GPS is acquired or both timeouts expired, the unit initiates another timeout of 30 seconds and then initiates the Distress session.

The unit tries to send each of the distress messages by GPRS; if GPRS is not enabled or not available the message is sent by SMS. In case of SMS the time to next message of the same distress session is automatically set to 90 seconds.

10 (or 90 in case of SMS) seconds after the last distress message both GSM and GPS are switched off if no other Distress traffic is detected.

Data format: 1 byte, decimal value, one second resolution

Default Value: 60 seconds

12.7 Glancing at Specific Time (ST Glancing)

Address: 1614-1615

Description: This feature enables reception of a repository update from all the units of the fleet at the same time by wake up for a Com-Location glancing at the specified time of the day.

In order to decrease the load on the communication server upon simultaneous update of many units, the update time might not be absolutely accurate but may vary a bit as per pre-programmed randomization rule.

Similar to a normal Com-Glancing, the ST Glancing message is generated 20 to 30 seconds before the end of the glancing (the programmed time is the time of the glancing start, the wake up time) and follows the same rules, except the following items:

- The unit only will generate ST (Specific Time) event if the Day field of Last Valid GPS timestamp is not zero, which means that the GPS was navigating in the past and the time is synchronized. Otherwise the message should not be generated
- If randomization enabled, the actual time of the transmission will vary for every unit's ID according to the rule below:

A= P+ (ID)Mod10*(6min)

A= Actual Transmission Time

P = Programmed time

ID= Unit's unique ID

The ST transmission is generated with the transmission reason of Glancing (252, Transmission Reason Specific Data 1).

If both regular, interval-based glancing and ST glancing are enabled they both will be maintained simultaneously and independently.

If the at the time, specified in the ST Time parameter the unit is in a non-hibernation mode (like, for example, the Live Tracking), except the Normal Glancing, the unit will not generate an ST Glancing message.

NOTE: If the ST Glancing events are enabled, certain increase in current consumption is expected.

The CPU periodically wakes up the GPS module in order to synchronize an internal clock with the RTC of GPS and in order to be able to send the life signal within a resolution of no worse than 6 minutes.

The wake up mechanism is adaptive and determines the number of time that the GPS has to be turned on by measuring the clock deviation size. In most of the cases, only one synchronization wake up is required prior to the life signal event. From time to time, two synchronization wake ups may be observed.

In order to make current consumption calculation easier, use "Specific time" event as equal to (up to) 3 normal glancing events in 24 hours period (this is the worst case but usually no more than 2).

First byte (1614)

Disable Power Off by On/Off Front Button 0 – Enable 1 – Disable	Reserved	Disable ST randomization 0 – enable time randomization 1 – disable time randomization (default value)	ST Hour (0-23)[4] (beginning of the glancing and not the event) Default value - 12				
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Second byte (1615)

Enable ST Glancing Distress (disabled by default)	Enable ST Glancing Event (disabled by default)	ST Minutes (0-59)[5] (beginning of the glancing and not the event) Default value - 00					
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Default Value: 0 on both addresses (including "Disable Power Off by On/Off Front Button" parameter)

[4] Setting the "ST Hour" to a value bigger than 23, will cancel the ST Glancing.

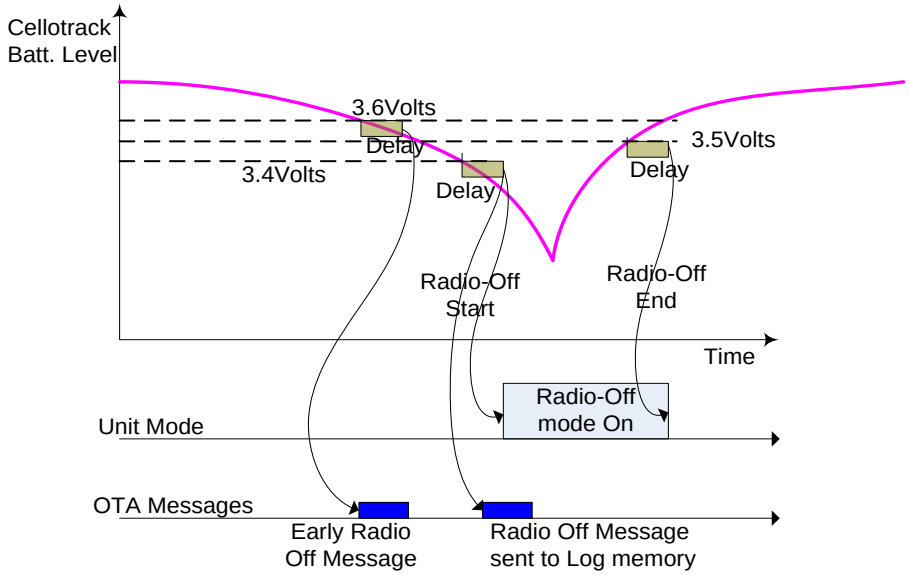
[5] Setting the "ST Minutes" to a value bigger than 59, will cancel the ST Glancing.

12.8 Radio-Off (CelloTrack and CelloTrack Power)

The Radio-Off feature was redesigned and adapted for battery powered CelloTrack devices. Radio-Off mode starts when CelloTrack battery voltage decreases bellow 3.4 Volts for 30 consecutive seconds and initiates the following set of actions is performed:

1. A Radio-Off event is generated and logged.
2. All log history is saved into nonvolatile memory.
3. Cellular modem and GPS are turned off.
4. The Firmware enters idle state.

The Radio-Off preventive actions taken when battery reaches critical level will insure the integrity of the logged history and facilitate smooth restart when power reapplied to the device.



Early radio off message will be generated by the unit when the battery voltage reaches 3.6 Volts or below for 30 consecutive seconds. The early Radio off message will inform the server side that the unit's battery voltage is very low and that Radio off mode is about to start soon.

12.9 Advanced Glancing (peeking): CelloTrack and CelloTrack Power

Addresses:

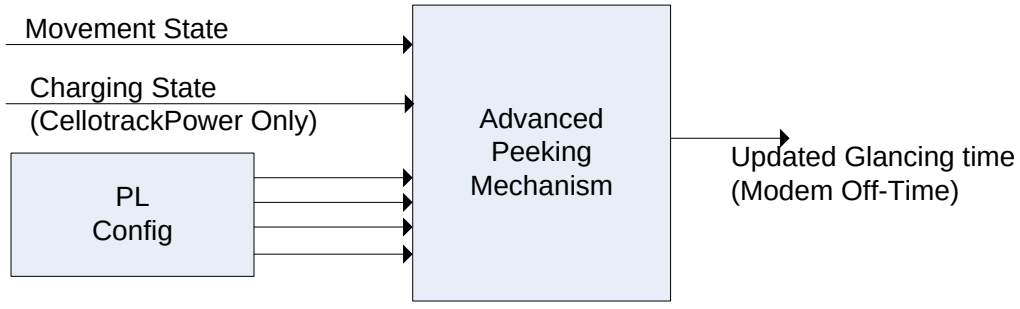
1337-1338: For Glancing time for movement and not charging state.

1339-1340: For Glancing time for No movement and charging state.

1341-1342: For Glancing time for movement and charging state.

Description: This feature enables the unit's glancing (Peeking) period to be adapted to various operational states.

Glancing, or peeking, in CelloTrack units is a self initiated event designed to wake the unit from hibernation and send a scheduled event. In CelloTrack, unlike other units, we do not support separate GPS and GSM peeking, both GPS and GSM peeking in CelloTrack are governed by GSM peeking parameters. The most dominant peeking parameter is the GSM Peeking – Modem Off time which sets the time between peeks. The Advanced Glancing (Peeking) feature enables the user to configure the GSM Peeking – Modem Off time according to the unit's charging state and its movement state. The motivation would be to increase peeking frequency if we have reliable charging energy source or if we have both charging energy source and we are moving (We have the energy, and we want to get more information about the unit's location while traveling) etc. The user can configure new values, overriding the legacy GSM Peeking – Modem Off time when movement or charging source are detected. The block diagram bellow describes the functionality of the "Advanced Glancing Mechanism". The new mechanism selects from the PL configuration the appropriate Glancing time as function of the system state (Charging or moving). Please note that when one of the above parameters (1337-1338, 1339-1340, 1341-1342) is set to 0, The legacy GSM Peeking – Modem Off time will be used as glancing time.



The following table describes the relations between the system state (Charging or moving) and the glancing time. Each system state glancing-time is represented by a dedicated configuration parameter. The unit's firmware will select the relevant configuration parameter when the system will change its state. The new glancing-time will be used in the next glancing period or if distress or Active Logged event will be triggered.

Glancing Time	No Movement	Movement
Not Charging	Glancing time = Define by parameter located at address 268. See GSM Peeking – Modem Off time Legacy time.	Glancing time = defined by parameter located at address 1337-1338. See CelloTrackGlangingTimeMovementNoCharge If the parameter is set to 0, The glancing time will be taken from GSM Peeking – Modem Off time If time is greater than 0 and less than 5 min it will be considered 5 minutes. Glancing time shall always be less than or equal to GSM Peeking – Modem Off time. Higher configurable values will be truncated to GSM Peeking – Modem Off time.
Charging (CelloTrack Power Only)	Glancing Time = defined by parameter located at address 1339-1340. See: CelloTrackGlangingTimeNoMovementCharge If the parameter is set to 0, The glancing time will be taken from GSM Peeking – Modem Off time If time is greater than 0 and less than 5 min it will be considered 5 minutes. Glancing time shall always be less than or equal to GSM Peeking – Modem Off time. Higher configurable values will be truncated to GSM Peeking – Modem Off time.	Glancing time = defined by parameter located at address 1341-1342. See: CelloTrackGlangingTimeMovementCharge If the parameter is set to 0, The glancing time will be taken from GSM Peeking – Modem Off time If time is greater than 0 and less than 5 min it will be considered 5 minutes. Glancing time shall always be less than or equal to GSM Peeking – Modem Off time. Higher configurable values will be truncated to GSM Peeking – Modem Off time.

The table below was added to reflect the fact that Charger power connected to CelloTrack Power is not a sufficient condition for considering unit's battery is actually being charged. For example, when charging power is connected and the temperature is out of charging range the battery will not be charged, in this case we are in NotCharging state.

Charger Power source State	Charging Logic Status	Charging Mode

Connected	Charging	Charging
	Not Charging due to extreme temperature	NotCharging
	Not Charging due to "Batt high" condition	Charging
Disconnected		NotCharging

Data format: 16-bit unsigned integer, 16 seconds resolution

Value span: 01h (16 seconds between two consecutive peeks) through FFFFh (~12 days between two consecutive peeksInputs Events)

Default: Disable (zeroes)

12.10 Cradle tamper events definitions

Address: 124, bit 0 for falling event

126, bit 0 for rising event

128, bit 0 for falling distress

130, bit 0 for rising distress

Description: In CelloTrack family, the "door" input signal (mentioned in _d2h_bmk__Ref450553304_22 _d2h_bmk__Ref26195540_22 and _d2h_bmk__Ref450553311_22 _d2h_bmk__Ref26195556_22) is used as the tamper signal which is an "Active low" signal.

This means that **High** = **TR #159 (Inactive)** = **inside the cradle**, and **Low** = **TR#158 (Active)** = **outside the cradle**.

But the terminology of "Rising" is removal from cradle and the term "Falling" is insertion to the cradle.

Default Value: zeros – Disable (0)

13 CelloTrack Power

This section describes dedicated CelloTrack Power configuration parameters. The CelloTrack Power configuration parameters are an addendum to the standard CelloTrack programming parameters as described in section 15.

The CelloTrack Power supports the following unique items:

- CelloTrack Power indicates the charger status in its outputs vector (4th outputs byte, bit 7; 1- charging, 0 – not charging) in both wireless and wire protocols.
- The unit reports the battery temperature measurement (sampled every second) in 4th byte of analog inputs in both wire and wireless protocols.
- The unit activates an external charger when all of the conditions below become true concurrently:
  1. The temperature is in the correct normal/extended (configurable) range (upon charging the temperature might increase by 5-6°C due to self heating).
  2. An external power supply is detected.
  3. The battery measurement is lower than 4.1V.
  4. The unit is not in hibernation (configurable).
- The unit shall stop battery charging when:
  1. The temperature out of threshold (after the first exceeding measurement).
  2. An external power supply is disconnected.
  3. The battery measurement is higher than 4.1V.
  4. The unit enters hibernation.

NOTE: It is mandatory to select NTC in one of the OTA bytes (26-28) in order to enable the charging function. See: **Bytes 26-29 of OTA Message 0**.

13.1 CelloTrack Power and Nano Configuration Settings

Address: 1446

Description: This parameter contains a bitmap controlling charging of CelloTrack power.

Not used	Enable Additional Extended Charging Temperature Range 0 – Act according to "Enable extended charging temperature range" parameter 1 – Allow battery charging in a (-20) - (+60) deg temperature range	Charging Stop upon "Battery Full" detection 0 – Keep charging 1 – Stop charging	

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Charging Stop upon "Battery Full" detection - By default the unit will stop charging when the battery voltage will reach 4.24V (for 2 consecutive measurements or 1 minute). It is possible to disable this auto charger deactivation in order to let the CCCV controller to do the job.

Enabling Charging in Hibernation: it is possible to enable charging in hibernation mode when:

- The temperature is in the correct normal/extended (configurable) range (upon charging the temperature might increase by 5-6°C due to self heating)
- An external power supply is detected
- The battery measurement is lower than 3.85V

The unit will stop battery charging when:

- The temperature out of threshold (after the first exceeding measurement)
- An external power supply is disconnected
- The battery measurement is higher than 4.1V

Default values:

For "Enabling Charging in Hibernation": 1 – Enable

For "Charging Stop upon Battery Full Detection" in CelloTrack Nano: 1 – Stop Charging

For "Charging Stop upon Battery Full Detection" in CelloTrack T Power: 0 – Keep Charging

For "Enable Additional Extended Charging Temperature Range" in CelloTrack T Power: 0 – Act according to "Enable extended charging temperature range" parameter

13.2 Slow charging in extreme temperatures

Address: 1859 bit 6

Description: This parameter enables the option to slow charge the normal internal battery in extreme temperatures, between -20 to 0C and also from 45 to 60C.

0=Disable, 1=Enable.

Default value: 1 = Enable

A summarizing table for all the possible combinations:

Slow charge in extreme temperatures enable	Charging Stop upon Battery Full detection	Enable extended charging temperature range	Enable Additional Extended Charging Temperature Range	

Address 1859.6	Address 1446.1	Address 2.2	Address 1446.2	Behavior
0	X	0	X	T < 0C : Stop charging 0C <= T < 45C : Fast charging (330mA) T >= 45C : Stop charging
0	X	1	0	T < -7C : Stop charging -7C <= T < 60C : Fast charging (330mA) T >= 60C : Stop charging
0	X	1	1	T < -19C : Stop charging -19C <= T < 60C : Fast charging (330mA) T >= 60C : Stop charging
1	Keep charging	X	X	T < 0C : Stop charging 0C <= T < 45C : Fast charging (330mA) T >= 45C : Stop charging
1	Stop charging	X	0	T < -7C : Stop charging -7C <= T < 0C : Slow charging (100mA) 0C <= T < 45C : Fast charging (330mA) 45C <= T < 60C : Slow charging (100mA) T >= 60C : Stop charging
1	Stop charging	X	1	T < -19C : Stop charging -19C <= T < 0C : Slow charging (100mA) 0C <= T < 45C : Fast charging (330mA) 45C <= T < 60C : Slow charging (100mA) T >= 60C : Stop charging

14 CelloTrack Nano

14.1 Overview

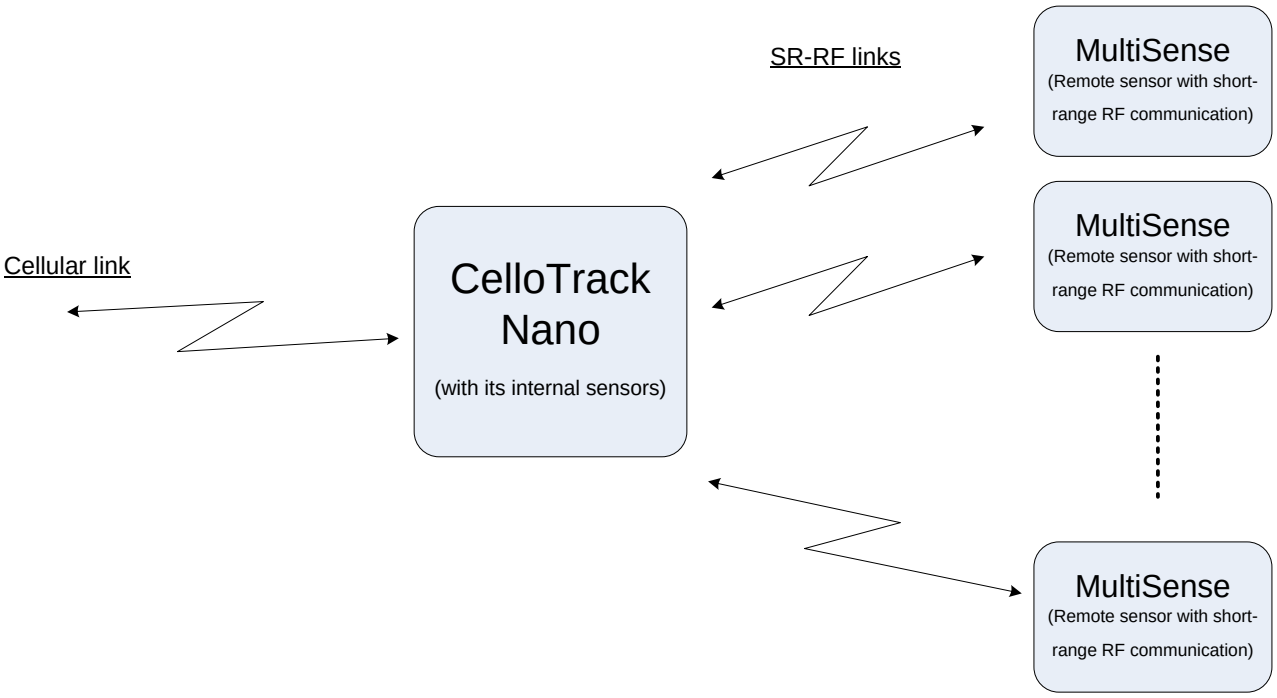
The CelloTrack Nano is an asset tracking solution, aimed at addressing the growing market of small assets management and cargo delivery and expanding the target markets to which the CelloTrack family applies: cargo tracking applications, smaller assets and high value mobile equipment, shorter tracking periods, as well as lone worker and lost child scenarios.

The target asset types are cargo boxes, airborne containers (temperature controlled or regular), cargo pallets, small size high-value assets (such as machines and small generators), high value suitcases and equipment (such as art, medical), and so on.

Target applications may include inventory management throughout short/mid-term Track & Trace, shipment and distribution management, security (anti-theft), protection (anti-vandal, break-in detection) and more.

The CelloTrack Nano can interface via a short-range RF link to multiple peripherals called "MultiSense" devices, which acts as Wireless Sensors Network (WSN). Read more about MultiSense devices in section 14.10.

The CelloTrack Nano inherited all CelloTrack-T functionality and added new functionality described in this section. For further information about the product, please refer to the *CelloTrack Nano Product Overview* document.



14.2 User Interface – Buttons, LEDs and Buzzer

14.2.1 Buttons

14.2.1.1 General

Each press on a Nano button when the unit is active activates a short audible beep by the buzzer (if enabled accordingly; read more about this setting here).

14.2.1.2 Right Button

The right button, marked "!", when pressed for 2 seconds or more (even if not released), followed by engagement feedback (buzzer and/or LED - configurable here and here), generates a panic event which will be sent to the server. An ACK sent by the server will generate another reception feedback – which is configurable here.

14.2.1.3 Left Button

This button has no related configuration parameters but is mentioned here anyway, just to give the full scope of the buttons in the CelloTrack Nano.

The left button, marked "⏻", when pressed for less than 3 seconds, will open the configurable size indication time window.

In addition, this button is turning the unit ON and OFF:

- Turn ON: Press 3 seconds while turned OFF. After that the system will self-test, as described here.
- Turn OFF: Press for 5 seconds while turned ON. At the end of that period, the turning ON/OFF occurs even if the button is not released.

14.2.1.4 Check-in and Check-out Functions

Pressing simultaneously (with ~200mS tolerance) on both buttons for at least 1 second (and less than 5 seconds), followed by a 0.5 second buzzer beep for every elapsed second (if enabled, as described here) and/or LEDs feedback (as configured here), transmits the current location once.

It is also related to set the baseline reference accelerometer position of the man down feature detailed here.

From FW release of 34j, there is also a Check-out feature:

If enabled in the PL, (Address 1857 =1) the unit will toggle from check-in state to check-out state by the short press on the 2 buttons simultaneously.

The initial state (after reset or power up) will be check-out.

There are 3 ways to end check-in state and go back to check-out state:

1. Timeout expiration of the check-in state will be according to PL parameter of "Check-in timeout" address 1857 (Default=24 Hours). At this case (assuming the event enable bits in address 2352 bits 4-7 are enabled) a check-out event will be generated with Type-0, TR=164, STR=17 and/or Type-11, Module-28, Event code-19.
2. User has terminated the state by pressing check-out buttons. At this case (assuming the event enable bits in address 2352 bits 4-7 are enabled) a check-out event will be generated with Type-0, TR=164, STR=18 and/or Type-11, Module-28, Event code-12.
3. System power-up.

System reset (all kinds of soft-resets) will **NOT** change the state.

User will be able to check if the Nano is at check-in or check-out state by shortly pressing the Power button (0.2-5 sec):

- If the Nano is in check-in state - the right LED will blink rapidly (200mS ON, 200mS OFF) Red for 3 sec, postponing the regular GPS/GSM indications.
- If the Nano is in check-out state - the right LED will blink slowly (500mS ON, 500mS OFF) Red for 3 sec, postponing the regular GPS/GSM indications.

14.2.1.5 MultiSense Pairing Feature

Pressing simultaneously (with ~200mS tolerance) on both buttons for more than 5 seconds will initiate the MultiSense in-field pairing process. See more details in section 15.2.4.

14.2.2 LEDs

14.2.2.1 Left LED

The left LED, marked "  " and "  ", gives indication of the power/battery and deviations (as described here).

When the unit is turned ON, or a short press is made on the left button (shorter than 5 seconds), or following reset command, (also see section 14.2.1.1), all the following LED indications are restarted according to the "Indications time window" parameter described here.

Battery status: When the unit is turned ON, short blinks of 100mS every X seconds show the battery status, according to the following legend:

Battery is 50-100% - Green:

Battery is 20-49% - Orange:

Battery is 0-19% - Red:

Out of range (deviations alert) indications:

When the unit is turned ON, or a short press made (shorter than 5 seconds) on the left button, only the most severe indication from the following list is displayed once, if that violation/deviation still exists.

When any sensor creates an out-of-range (alert) event, and if enabled by the bit in this configuration area, the left LED will signal a 3 second long continuous (once) or non-continuous pulse according to the following color scheme:

Light sensor out of range: 

Accelerometer out of range: 

Temperature out of range: [redacted]

Geo-fence violation: [redacted]

"Light sensor out of range" means the light level of the local sensor crossed the "open/close package threshold" event.

"Accelerometer out of range" means an orientation change event only.

"Temperature out of range" means the local temperature sensor is either above the upper TH or below the lower TH.

"Geo-fence violation" means all the possible kinds of violation supported and defined in the legacy version.

The priority in case more than a single sensor is out of range or deviated: from bottom to top (geo-fence is the highest priority, going down to light sensor which has the lowest priority). After that the lowest priority is for the battery status indication mentioned at the beginning of this section.

In general, switching between different indications is done without any gaps/delays so they look continuous (overlap).

The non-continuous pulse is: 800mS ON, 300mS OFF, 800mS ON, 300mS OFF, 800mS ON (once and every time a button is pressed).

All these out-of-range indications are displayed only for the "Indications time window". This time window also restarts after the left button is pressed again (as described here). After that they are cleared (turned OFF).

See also the configuration bits described here that enable each sensor out-of-range indication on the LED.

Charging indications:

When the micro-USB connector is plugged-in and charging is in progress, whether from the charger (AC wall adaptor) or PC, the left LED will act as described in the following table.

<table>
<tr><th colspan="2">Unit mode:</th><th>OFF (inactive)</th><th>ON (active)</th></tr>
<tr><td colspan="2">During actual charging</td><td>Constantly orange</td><td>Constantly orange</td></tr>
<tr><td rowspan="2">After charge completion</td><td>Inside the "Indications time window"</td><td rowspan="2">Constantly green</td><td>Regular LEDs indications</td></tr>
<tr><td>After (outside) the "Indications time window"</td><td>Constantly green</td></tr>
<tr><td colspan="2">Battery Fault</td><td>Constantly red</td><td>Constantly red</td></tr>
</table>

These indications have the highest priority and they override all other indications on this LED.

14.2.2.2 Right LED

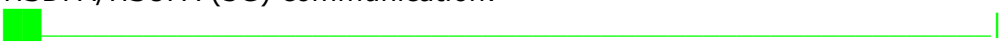
The right LED is marked "**GPS**" and "".

This LED has two time slots of 5 seconds long each; the first one is for indications from cellular modems (in green) and the second one is for GNSS module indications (in orange).

Each pulse is 500mS ON and 500mS OFF.

Cellular modem indications:

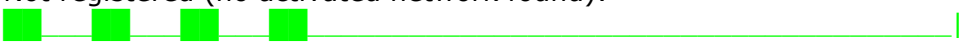
HSDPA/HSUPA (3G) communication:



GPRS/EDGE communication:

Registered (GSM-2G):

Not registered (no activated network found):



When the user shut down the unit by pressing the power button, and one of the bits are enabled here, the unit will push to the log the "Transmission before shutdown" event message.

Address: 2042 bits 0-1

Description: Transmission before shutdown event is created in Type-0 or as encapsulated inside a type-11 message.

Transmission before Shutdown messaging	
Type-0	
Logged	Distress
Bit 1	Bit 0

Default value: 0x00 = All disabled

If any form of immediate transmission method is selected by the user ("Active log event" and/or "Distress"), the unit will also initiate communication with the server and transmit

its entire log too, while blinking this LED (higher priority than all other indications) green at 200mS ON and 200mS OFF pace until completion and full shutdown.

Buzzer will beep in 200mS ON and 800mS OFF along the transmission.

Anyway (even if not transmitting), a "Dual short beeps" will be sound before actually going to inactive mode.

GNSS module indications:

Tracking good (Fix "Tight"):

Tracking poor (Fix "Plain"):

Acquisition (from power-up to "Plain" or "Tight"):

No satellites at all ("no fix" after fix), only at the first operation and cannot be reached if using A-GPS:

For example the light for a GPRS communication and good tracking will look like the following:

←--------5Sec--------→

All these indications are only displayed for the time set in the "Indications time window". After that they are cleared and not displayed.

14.2.3 Buzzer

14.2.3.1 Definitions

Buttons feedback beep = 20mS ON

Short beep = 200mS ON

Dual short beeps = 200mS ON, 200mS OFF, 200mS ON 

Dual long beeps = 1 Sec ON, 200mS OFF, 1 Sec ON 

Long beep = 2 Sec 

14.2.3.2 Buzzer Logic

- Upon power-up (turning ON) or system reset from any reason: short beep.
- After a successful BIST process: dual short beeps.
- If enabled here, every valid pressing on the buttons will sound the "Buttons feedback beep" (20mS).
- If enabled here, Panic /Check-in event activation operates the beeps, as explained in section 14.2.1.5.
- If enabled here, after a Panic (special distress) event is acknowledged by the server: long beep.
- Dial-in feature: In lone worker scenarios, some ringing from the unit buzzer may be needed, to catch the worker's attention. If enabled here, when the modem receives a ring/s for a voice call, it rings with its buzzer for 4 seconds and then stops, according to the ring beeps pattern described above.
- If enabled here, when any active sensors go out of the defined limits (all meanings of the "out-of-range" are explained here), plus geo-fences (all legacy violations related to geo-fences are relevant here too), the unit shall sound short beeps every configurable time **if** the "Indications time window" defined here is open/active.
- If enabled here (bit 5), a short beep is sounded upon any power-up packet received from a paired/preregistered MultiSense.
- See BLE pairing (and un-pairing) process related beeps in section 14.2.1.5.
- Upon shutdown sequence completion the buzzer shall sound "Dual short beeps" pattern. If enabled here, the buzzer shall also act according to shutdown sequence as described here.
- If any overlap of beeps should occur, the buzzer shall be activated on an OR basis, meaning the actual sound should be a superposition of all signals together.

14.2.4 Indications after Power Up (Built-In Self-Test)

The unit shall perform a Built-In Self-Test (BIST) upon any of the following cases:

- When battery is connected, while the system was active before disconnection.
- After turning ON (moving unit from inactive to active mode, at the end of the 3 second press duration).
- Upon receiving a reset command.

The Built-In Self-Test (BIST) includes GNSS module, Cellular modem basic (local) communication and confirmation a SIM and battery exists.

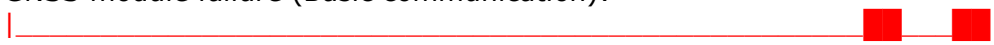
The indications look like the example below for the first 5÷10 seconds only, on the right LED:

Turning ON press feedback from the buzzer:

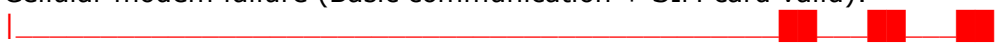
If all tested component are OK:

and on the buzzer:

GNSS module failure (Basic communication):



Cellular modem failure (Basic communication + SIM card valid):



Battery failure:

←----------first 5÷10 Sec after turn ON----------→

Short beep and dual-short beeps are defined in section 14.2.3.1.

The priority of failures is in descending order, battery being the highest. And only the highest priority is displayed.

Timing is 500mS ON and 500mS OFF.

All buttons are blocked/ignored during the entire BIST period.

14.3 System Modes

14.3.1 Improved Tracking Mode

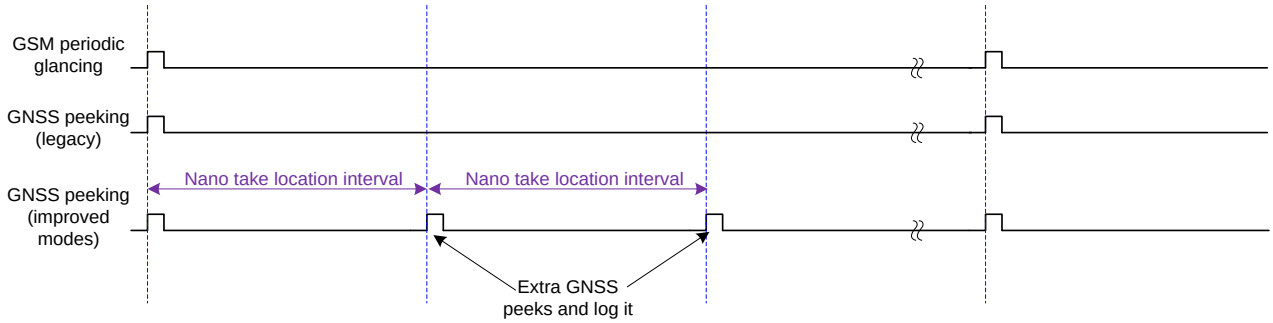
In this mode, the Nano adds the extra take locations between transmissions.

Since the entire system is hibernating most of the time, the battery life is prolonged.

In this mode, the unit uses an improved glancing of not-live-tracking related to the legacy mechanism:

- Samples its sensors according to the table below and logs them efficiently. Look for distress (critical) events (such as tamper, sensor reading crossed some predefined critical threshold) to report them immediately.
- Takes GNSS locations extra configurable times a day and logs them internally as Type-0 and/or type-11 with the same message but encapsulated, as mentioned in the *Wireless Protocol* document, depending on the configuration bits in PL address 603, bits 0-1, as defined here.

- GNSS and cellular modems are also activated upon distress event occurrences to immediately report the position of the event. A transmission is sent even if the GNSS has not got a fix after the timeout. As with the legacy version, if no fix is reached the Cell-ID transmission logic is used.
- The GNSS module is shut down, disregarding any applicative constraints to preserve energy.
- Turns on the cellular modem and transmits to the server, which is configurable in the GSM Peeking – Modem Off time parameter, including the logged positions, measurements and events.
- For all cellular transmissions, the entire log memory is transferred/uploaded, and then cleared upon an ACK from the server. In case there is no ACK or no link, it acts as per the legacy behavior.
- At all other times, the main MCU is sleeping (hibernating). During these times, the "Hibernation Mode Delay" parameter is maintained (the default is 2:40 minutes).



Sensor name	Sampling rate	Comment
All power sources, light sensor, battery NTC and other analog inputs	1 Second	
Accelerometer	1 Second	
Accurate temperature	Defined according to this and this parameters	In Nano 20 only
Barometer/Pressure	1 minute	In Nano 20 only

14.3.2 Improved Tracking with POD Mode (Infrastructure)

This mode, which will be supported in the 2nd phase of the project only, is the same as the regular improved mode, except the Nano is also addressable and available for communication at all times.

The battery life is much shorter in this mode. Refer to the external battery life calculator for more details.

14.4 The Layers Concept

Layer-0: The HW and FW layer

The FW activates the HW to sample the various sensors of the system every predefined time.

Some of the sensors' sample rates are configurable and some are constant (i.e. hardcoded).

The samples always occur and are not conditional.

Layer-1: The periodic glancing layer

Only when the unit is not moving (aka stationary state, "hibernating"), or ST glancing:

- Periodic glancing as defined in legacy (refer to the CelloTrack-T).
- According to a specific time of day (aka "ST glancing", see legacy).
- In every transmission the unit will transmit its location and the last sample of all sensors in the system.
- There is some ratio between location and full sensors glancing, as described in section 14.3.1.

Layer-2: Movement related events

When the unit is moving (in motion state, i.e. ignition-ON state):

- Legacy capabilities of offline and online tracking (in future powered variants) including:
  - Time events
  - Distance events
  - Speed events
  - Geo fencing
  - Curve smoothing

Layer-3: Sensors layer (data logging)

For each supported sensor, the user is able to determine:

- The applicative sampling/logging rate (if applicable)
- Monitoring rules (what triggers an event)
- Feedback rules (buzzer and LEDs activation patterns)
- Data upload rules

14.5 USB

14.5.1 Usage

Micro-B female USB connector, through which the unit can perform the following functions:

- Charge the internal battery from the supplied AC-adaptor or PC USB port.
- Interface via PC USB port for configuration.
- Interface via PC USB port for firmware updating.

14.5.2 Charging Speed

The internal charger supports 2 charging speeds:

- The slow speed is used when the unit recognizes the source as "weak", such as a USB 1.0 PC port, weak AC-adaptors or weak car-adaptors. The charging current in this case is ~100mA so a complete charge can sometimes take more than 10 hours.
- The faster speed is automatically chosen when the source is recognized to be able to supply enough current. The charging current in this case is ~330mA, so a complete charge will take less than 5 hours.

14.5.3 Charging Modes

The unit has 2 modes of charging:

- **FW controlled**: The Nano FW decides when to start and stop charging. It charges the battery to a certain hardcoded high-level charge point (e.g. 90%) and then lets the battery be consumed to the level of a hardcoded low-level charge point (e.g. 75%) before another charge cycle is started. In this way, the battery oscillates between 90% and 75% forever and the left LED toggles between green and yellow forever.
  To set this mode, set the parameter of "Charging Stop upon Battery Full detection" to "Stop charging".
  This mode of operation is more suitable for constantly powered systems and it keeps the battery healthier in the long run.
- **HW controlled:** The charger chip decides when the battery has reached full charge (100%) and then stops charging it. Indication on the left LED turns from orange to green. This operation is restarted every 5 hours.
  To set this mode, set the parameter of "Charging Stop upon Battery Full detection" to "Keep charging".
  This mode is more suitable for systems that get charged from time to time, but the system is not powered constantly.

If the "Dry contact input selection mode" is set to "Extended battery existence" mode (=1), then the unit shall ignore the regular mode bit and the actual mode shall be changed automatically according to the dry contact input value in the following way: Grounded → "Keep charging" and Floating/high-voltage → "Stop charging".

In this way we create the most power efficient system, where the Nano internal battery is charged to 100% as long as the external battery is in charging state (connected to power supply), but moves to a better efficient way of the "Stop charging" when transferring energy from a not-being-charged external battery to Nano internal battery.

14.5.4 Power-bank keep alive pulsing

Since many power-banks has some power conservation feature that shut them down if no load is detected for more than X seconds, if the Nano is about to use it as a secondary source of power, it has to present a certain load every period that is smaller than X.

The user may control the pulses width, rate and amplitude.

The chosen configuration has to be **optimized per battery model** and all the above parameters should be minimized to save energy but keep the power-bank awake on the other hand.

If one of these parameters is 0, the entire mechanism is disabled.

Important note: While the unit is connected to an active (switched ON) power bank, its battery percentage will be varying back and forth between 75% and 90%, due to "FW controlled" mentioned above, until the power-bank is drained out or disconnected. This is not reflecting the power bank level which is usually only displayed on its own LEDs.

14.5.4.1 Power bank keep alive pulse rate

Address: 1858

Description: Some power banks shut down their output if the load is not drawing any current for more than X seconds timeout.

This timer (if >0) create a pulse to keep the power bank awake.

Resolution: 1 seconds

Valid Range: 3-255 seconds, 0-2=Disable

Default value: 0= Disable

14.5.4.2 Power bank keep alive pulse width

Address: 1859 bits 0-4

Description: Some power banks shut down their output if the load is not drawing any current for more than X seconds timeout.

This parameter determines the pulse width to keep the power bank awake.

Resolution: 50mS

Valid Range: 50-1550 mS, 0=Disable

Default value: 20= 1 Second

14.5.4.3 Power bank keep alive pulse amplitude

Address: 1859 bit 7

Description: Some power banks shut down their output if the load is not drawing any current for more than X seconds timeout.

Note that temperature (configurable) limits for recharging are stronger than this selection, so if the unit is programmed to lower the recharge current to 100mA under 0°C, then it will pulse at no more than 100mA when in sub-zero temperatures, regardless of this parameter selection.

This parameter select the pulses amplitude, 0=100mA, 1=330mA

Default value: 0 = 100mA

14.5.4.4 External battery mode

Address: 1863 bit 0

Description: If this bit is set to '1' (enabled), the unit shall save as much power as possible even when connected to power. For example, the LEDs for charging indication will canceled when unit is in active state.

In inactive state of the system, the LEDs shall function as before.

This is to improve current consumption when working with external batteries and power-banks.

0 = Disable

1 = Enable

Default value: 0 = Disable

14.6 Sensors

HW Block / Function /Feature	Accelerometer	Ambient Light Sensor	Pressure Sensor	Accurate Temperature Sensor	Humidity Sensor (of the MultiSense)
Tilt tamper	X				
Orientation change	X				
Man-down	X				
Motion vs. stationary	X				
Report on absolute orientation	X				
Open/Close package		X			
Altimeter			X		
Temperature				X	X

/Humidity measuring and logging					

14.6.1 Use of IIR Filters

The IIR (infinite impulse response) filter used in many points in the design acts according to the following formula:

Upon power-up/reset/init the Sum gets an initial value of: **$Sum_0 \leftarrow Sample_0 * Factor$**

The Avg, which is actually the filtered value, is always: **Avg = Sum/Factor**

After the initiation point on each sample: **$Sum_n = Sum_{n-1} - Avg_{n-1} + sample_n$**

In this way, the actual time that will take the filtered value (Avg) to get from a certain steady-state value to some TH level is a function of start-point, end-point and the programmed factor.

Just to demonstrate it, for typical small values of "Factor", and as the response to a "Step function" this filter will evolve according to the following approximated table:

After X samples	Approximate percentage
1 x "Factor" samples	66%
2 x "Factor" samples	88%
3 x "Factor" samples	96%
4 x "Factor" samples	99%
5 x "Factor" samples	100%

For example, if IIR7 is configured (Factor=7), after 7 samples the filtered value will accumulate 66% of the 100% change in value. After 14 samples 88% and after 21 samples 96% etc.

14.6.2 Accelerometer

The accelerometer sensor is sampled once every second, and in addition it gives interrupts to the Nano when it has an impact larger than the following preconfigured threshold.

The reported impacts create impact events if enabled in the following mask here.

The sampled X,Y,Z value of the current acceleration are filtered (by IIR filter) and taken to calculate the RMS value, and roll and pitch angles. From these values it can derive a variety of features and links to their programming parameters:

- Tilt tamper

- Orientation change
- Man-down
- Detection when the unit is in motion and when it is stationary. As this is legacy behaviour, see more details in section 6.2.9 above.
- Reports on the absolute orientation at every transmission in both type-0 and type-11.

14.6.3 Ambient Light Sensor (ALS)

This sensor is used mainly to know if the package that holds the unit inside is closed (dark) or open (with some light).

The light sensor is sampled once every second and filtered by a configurable IIR filter.

The filtered level is compared against the configured threshold and if events are enabled here or here the unit creates open package or closed package events respectively.

14.6.4 Pressure Sensor (Altimeter)

The air pressure is measured every 1 minute, and is filtered and converted (by the chip) to meters.

The unit reports this value on every type-0 (at 32m resolution) and type-11 (at 0.1m resolution) transmission.

14.6.5 Accurate Temperature Sensor

This ±1°C accuracy sensor is sampled according to a configurable rate when it is within the configured limits and according to other configurable rate when out those limits for more than this time.

See more details under section 14.9.11.

14.7 BLE functionality

BLE (Bluetooth[6] Low Energy) is described in details in section 14.10.

14.8 Communication Protocols

Communication protocols and concept are all described in the *Cellocator Wireless Communication Protocol* document.

[6] BT SIG certification is currently in the product evolution process

14.9 Parameters Descriptions and Notes

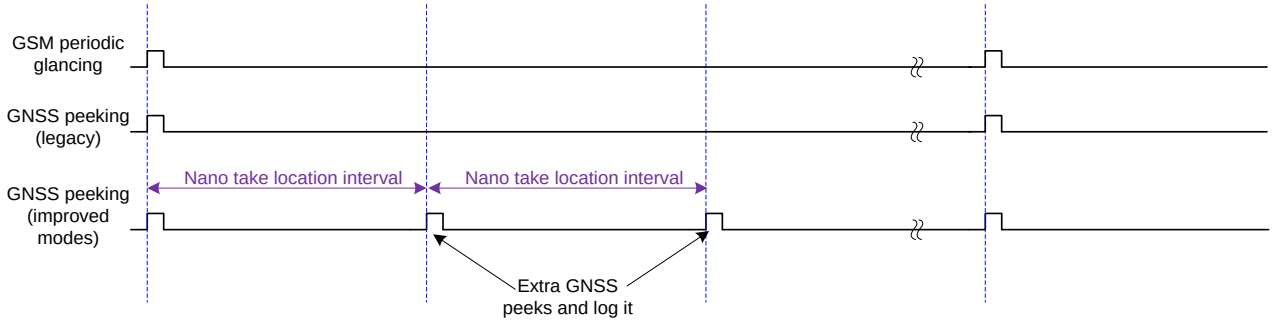
14.9.1 Nano Take Location Interval

Address: 2039 – (LSB)

2040, bits 0-5 (MSB)

Description: The unit performs an extra "take location" between 2 consecutive cellular transmissions and logs them.

This interval is from the last fix or timeout of "Max GPS on time", and it is parallel to the legacy "GPS off time" parameter.



Resolution: 1 minute

Data format: 14 bits

Data range: 1÷16383 (0=Disable extra peeking = same as legacy)

Default value: 0x168 = 360 = 6 hours

14.9.2 System Tracking Mode

Address: 2040 bits 6-7

Description: This sets the Nano's main tracking mode.

Important note: This system mode configuration is stronger than the configuration in the legacy "Enable live Tracking" bit.

Value	Unit mode
00	Tracking legacy
01	Tracking improved
10	Reserved
11	Reserved

Default value: 00 = 0 = Tracking legacy. See more details about this mode in 14.3.1.

14.9.3 GPS warm start

Address: 2052, bit 7

Description: When "Warm starts" is selected ('1', default), the GPS will never be shut down when unit hibernates so every GPS peeking will begin with a warm start (faster time-to-first-fix with optimal energy consumption). When "Cold starts" is selected, the GPS will be completely shut down when unit hibernates so every GPS peeking will begin with a cold start.

Default value: 1 = Warm starts.

14.9.4 Legacy Events Type-11 Configuration

First refer to the messaging concept described in section 5.1 of the *Cellocator Wireless Communication Protocol* document.

Addresses 540÷603 are allocated to contain a total of 512 bits, 2 bits for each one of the 256 possible transmission reasons of type-0 legacy events.

This enables the configuration of each transmission reason to be also sent over type-11 messages (if enabled, and regardless of type-0 legacy event configuration) as a Logged Event, as an "Active Log event" or as both, in the following way:

Address 540:

7	6	5	4	3	2	1	0
TR=3		TR=2		TR=1		TR=0	
Logged	"Active log event"	Logged	"Active log event"	Logged	"Active log event"	Logged	"Active log event"

…

And so on….till:

Address 603:

7	6	5	4	3	2	1	0
TR=255		TR=254		TR=253		TR=252	
Logged	"Active log	Logged	"Active log	Logged	"Active log	Logged	"Active log

	event"		event"		event"		event"

Default value: all zeroes (Disabled)

These fields can only be edited in the specialized table in the Cellocator Programmer tool.

Only relevant transmission reasons will appear in the table, all according to the table in section 2.2.3.11 of the *Cellocator Wireless Communication Protocol* document.

14.9.5 Tilt Tamper

In order to detect detachment of the Nano unit from the installation surface (along with its cradle or when installed without a cradle), a tilt-tamper mechanism can be used.

When orientation (by earth gravity) on each axis changes more than the configured angle threshold when compared to the steady state for a longer time than the configured timer threshold, the unit will report it.

This feature utilizes 2 IIR filters: slow (factor is hardcoded = 2) and very slow (factor is hardcoded = 30). Each IIR filter is implemented as following:

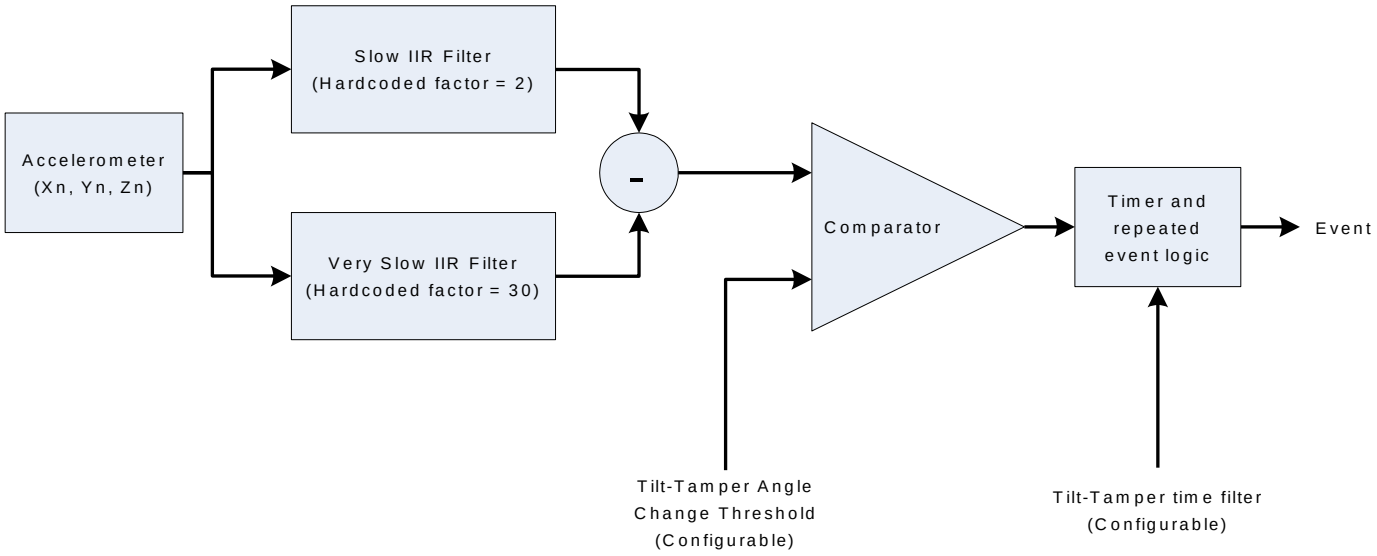
$$Sum_0 = Sample_0 * Factor$$

$$Avg = \frac{Sum}{Factor}$$

$$Sum_n = Sum_{n-1} - Avg_{n-1} + Sample_n$$

When Avg is the filtered value (filter output).

The subtraction of these 2 filters outputs is compared with the configurable threshold.



When a tilt tamper event is created, there is no other such event until the system has stabilized.

14.9.5.1 Tilt Tamper Messaging

Address: 2044 bits 4-7

Description: These bits enable (=1) or disable (=0) the messaging for the tilt-tamper feature.

Tilt-tamper messaging				Reserved
Type-11		Type-0		
Logged	"Active log event"	Logged	Distress	
Bit 7	Bit 6	Bit 5	Bit 4	Bits 0-3

Default value: 0x00 = All disabled

Note: The Tilt Tamper feature is applicable also in Cello-(CAN)IQ units from FW version 33x, and in CelloTrack T units from FW version 61c.

Type 11 messaging is not applicable for Cello-(CAN)IQ and CelloTrack T.

14.9.5.2 Tilt-Tamper Angle Change Threshold

Address: 2045

Description: Tilt threshold in degrees.

Resolution: 0.588º

Data format: 1 byte

Data range: 0÷255 = 0.588º÷150º, (0=Disable the entire feature; the recommended range is 30º÷100º)

Default value: 0x4D= 77 = 45.276º

14.9.5.3 Tilt-Tamper Time Filter

Address: 2046 bits 0-3

Description: Tilt time filter.

Resolution: 1 second

Data format: 4 bits

Data range: 0÷15 Seconds (0=Disable the entire feature)

Default value: 0 = Disabled

14.9.6 Accelerometer Based Impact / Free-fall Detection

Used in order to detect harsh and dangerous incidents such as crashes, haphazard loading/unloading, and breaching attempts.

It is based on the inherent interrupt mechanism (of the accelerometer chip) for acceleration passing a certain threshold. Either upwards (usually >1.5g), which is considered an impact, or downwards (usually < 0.5g), which was probably caused by a free-fall incident.

This impact or free-fall is configurable by a PL bit in the MultiSense, and fixed to impact only in the Nano itself. In phase 2, the Nano will also support the same configuration bit and free-fall feature (Infrastructure).

When the acceleration reading is higher than the configurable threshold, at any axis, for more than the configurable time, it is considered an impact event and the chip will generate an interrupt.

If enabled (see below), it is reported via the cellular link along with the peak RMS acceleration magnitude of that incident.

14.9.6.1 Accelerometer Impact/Free-fall Messaging

Address: 2047 bits 4-7

Description: These bits enable (=1) or disable (=0) the messaging for the Accelerometer impact/free-fall feature.

Accelerometer impact/free-fall messaging				Reserved
Type-11		Type-0		
Logged	"Active log event"	Logged	Distress	
Bit 7	Bit 6	Bit 5	Bit 4	Bits 0-3

Default value: 0x00 = All disabled

NOTE: If none of these bits are enabled, then the entire feature is disabled.

14.9.6.2 Accelerometer Impact Threshold

Address: 2048 bits 0-6

Description: Nano impact threshold.

Resolution: 63mg [g = Earth gravity units]

Data format: 7 bits, decimal value

Data range: 0÷127 = 0÷8g, valid range for impact is 1÷8g, valid range for free-fall is 0÷1g

Default value: 0x20 = 32 = 2.016g

14.9.6.3 Accelerometer Impact Time Filter

Address: 2049 bits 0-5

Description: Nano impact/free-fall time filter.

Resolution: 1 ODR cycle (=20mS)

Data format: 6 bits, decimal value

Data range: 0÷63 ODR cycles = 0÷1260mS, Valid range for impact= 20mS-1260mS, Valid range for Free-fall = 60mS-1260mS

Default value: 0x04 = 4 ODR cycles = 80mS

14.9.6.4 Accelerometer Impact / Free-fall mode selection

Address: 2048 bit 7

Description: Selecting the mode of the accelerometer in the Nano.

Data range: 0=Impact, 1=Free fall

Default value: 0 = Impact

14.9.6.5 Impact_Free-fall repetitions timer

Address: 1860

Description: After an impact or free-fall event was created, this timer is reset and no repetitions of this event will be created until the timer expires (per source). This is to prevent multiple events in a short time.

Resolution: 0.5 minute

Valid Range: 0.5-127.5 minutes, 0=Disable

Default value: 0x01 = 0.5 minute

14.9.7 Orientation Change

This feature can be used to detect rollover situations, where the tracked asset is rolled on one of its sides or upside down.

When the earth-gravity is moving more than the configured angle threshold, it shall be considered as an "Orientation change" event.

14.9.7.1 Orientation Change Messaging

Address: 2050 bits 4-7

Description: These bits enable (=1) or disable (=0) the messaging for the Orientation change feature.

Orientation change messaging				Reserved
Type-11		Type-0		
Logged	"Active log event"	Logged	Distress	
Bit 7	Bit 6	Bit 5	Bit 4	Bits 0-3

Default value: 0x00 = All disabled

14.9.7.2 Orientation Change Threshold

Address: 2051

Description: When the earth-gravity is moving more than this angle threshold, it shall be considered as an "Orientation change" event.

Resolution: 0.588º

Data format: 1 byte, decimal value

Data range: 0÷255 = 0.588º÷150º (0 = Disable the entire feature)

Default value: 0x4D = 77 = 45.276º

14.9.8 Man-down alarm and voice call

The "Check-in" operation fixates the 3 axis accelerometer values as a baseline reference.

Changing the unit orientation value above the threshold (in each axis, separately) related to the fixated baseline orientation will initiate a "Man down" event.

From FW version 34j and on, man-down events will be detected only within the "Check-in" window. So it will stop functioning when "Check-out timer" expired or check-out operation by the user is performed.

If all check-in/out events are disabled (Address 2352 bits 4-7 = 0), then man-down feature will not work either.

If enabled in the PL parameter of "Man-down delay and beeps enable" (address 2055.7), when a man-down situation occurs, a buzzer indication will be sound with long beeps (1 Sec on, 1 Sec off, and repeat) for 20 seconds (hardcoded).

The creation of the event will be delayed by that period.

During that period, the user can press the power button shortly (for 0.2-5 Sec) and cancel the buzzer and event creation (the man-down mechanism, will remain armed though).

If the event was not canceled by the user, the event will be sent to the server, re-arming this mechanism will be done when the orientation is back to the non-violation range of degrees (filtered in the same manner of detecting man-down).

If enabled in the PL parameter of "Man down event initiate outgoing voice call enable" (address 2055.6) the unit shall initiate a voice call (once) to the predefined phone number in PL parameter of "Voice call Destination number" (address 273), after getting all OTA ACKs, or 2 minutes hardcoded timeout, from the event transmission. The same timeout as the incoming calls ("Listen-in timeout", in address 1847) will be applied for the outgoing voice call as well.

If unit has no cellular link (not registered) or the unit is in hibernation and only logged event was enabled, the voice call will not be performed.

14.9.8.1 Man-down Messaging

Address: 2053 bits 4-7

Description: These bits enable (=1) or disable (=0) the messaging for the Man-down feature.

Man-down messaging				Reserved
Type-11		Type-0		
Logged	"Active log event"	Logged	Distress	
Bit 7	Bit 6	Bit 5	Bit 4	Bits 0-3

Default value: 0x00 = All disabled

14.9.8.2 Man-down Threshold

Address: 2054

Description: When the earth gravity is moving more than the defined angle threshold, it is considered a "Man down" event.

Resolution: 0.667º

Data format: 1 byte, decimal value

Data range: 0÷255 = 0.667º÷170.085º (0= Disable the entire feature)

Default value: 0x43 = 67 = Tilt angle of 44.689º

14.9.8.3 Man-down delay and beeps enable

Address: 2055.7

Description: When this parameter is set to '1', the man-down event shall be delayed by 20 seconds, accompanied with beeps, letting the user cancel the event (and the beeps) by pressing the power button shortly.

Default value: 0 = Disable

14.9.8.4 Man-down event initiate outgoing voice call enable

Address: 2055.6

Description: If this bit is set to '1' (enabled), upon creation of a Man-down event, the unit shall initiate a voice call (once) to the predefined phone number (configured in PL parameter of "Voice call Destination number" at address 273).

Default value: 0 = Disable

14.9.9 Package Open/Close Events

This feature is based on a light sensor, a configurable IIR filter and some small hysteresis.

The events shall be generated upon crossing the threshold (plus the hysteresis) of the filtered value. Meaning when unit is switched-on in stable environment, no event will be generated.

Any crossing of the threshold (plus the hysteresis) upwards will generate a "Package opened" event. Any crossing of the threshold (minus the hysteresis) downwards will generate a "Package closed" event.

14.9.9.1 Open Package Messaging

Address: 2056 bits 4-7

Description: These bits enable (=1) or disable (=0) the messaging for the open package feature (for both Nano and MultiSense).

<table>
<tr><td colspan="4">Open package messaging
(for both Nano and MultiSense)</td><td rowspan="3">Reserved</td></tr>
<tr><td colspan="2">Type-11</td><td colspan="2">Type-0</td></tr>
<tr><td>Logged</td><td>"Active log event"</td><td>Logged</td><td>Distress</td></tr>
</table>

Bit 7	Bit 6	Bit 5	Bit 4	Bits 0-3

Default value: 0x00 = All disabled

14.9.9.2 Close Package Messaging

Address: 2057 bits 4-7

Description: These bits enable (=1) or disable (=0) the messaging for the close package feature (for both Nano and MultiSense).

Close package messaging (for both Nano and MultiSense)				Reserved
Type-11		Type-0		
Logged	"Active log event"	Logged	Distress	
Bit 7	Bit 6	Bit 5	Bit 4	Bits 0-3

Default value: 0x00 = All disabled

14.9.9.3 Package Open/Closed Light Threshold

Address: 2058

Description: When the filtered light level crosses this threshold upwards, it will be considered a "Package open" event. When the filtered light level crosses this threshold downwards, it will be considered a "Package close" event.

Resolution: 2.5 lux

Data format: 1 byte, decimal value

Data range: 0÷255 = 0÷637.5 lux, **Valid range is 12.5÷637.5 lux** (values below 12.5 lux will be considered internally as value of 12.5).

Default value: 0x0C = 30 lux

14.9.9.4 Package Open/Closed Filter Factor

Address: 2059 bits 0-5

Description: This is the IIR filter convergence coefficient. Low values will give a faster response than higher ones.

Data format: 6 bits, decimal value

Data range: 2÷63 Second (value of 0 will disable the entire feature in the Nano only. Value of 1 is illegal and should not be set)

Default value: 0x02 = Fastest response

14.9.9.5 MultiSense button press event Messaging

Address: 2056 bits 2-3

Description: These bits enable (=1) or disable (=0) the messaging for the MultiSense button press event feature.

When the Nano unit receives an advertisement from a paired MultiSense with indication for button press it will create an event over **Type-11, module-28, Event-code-23** as described in the Cellocator wireless protocol document.

This can be used to turn the MultiSense button to a panic button, or any other desired operation trigger.

MultiSense button press event messaging	
Type-11	
Logged	"Active log event"
Bit 3	Bit 2

Default value: 00 = All disabled

14.9.10 Analog Source Selection

One of the measured sensors can be selected and routed to one of the type-0 legacy analog channels.

Note that only a single Nano source and type can be selected.

The selection is done by the following 2 selector parameters, the *Source of measurement* and *Sensor type*, see below.

14.9.10.1 Source of Measurement

Address: 2064

Description: This is the ENUM of this field:

0x00÷0x0F – MultiSense unit (according to its location in the PL, whether occupied/enabled or not)

0xFC – Guest/Tag MultiSense (not in the list)

0xFD – High accuracy or specialized sensors of the Nano 20 (for example: Accurate temperature sensor, pressure sensor, etc)

0xFE – MCU internal (temperature only)

0xFF – Reserved

Default value: 0xFD = High accuracy or specialized sensors of the Nano 20

14.9.10.2 Sensor Type

Address: 2065

Description: This in the ENUM of this field:

0 = Reserved

1 = Temperature

2 = Humidity (MultiSense only)

3 = Pressure (Nano only)

4 = Ambient Light Sensor (4 lux resolution)

NOTE: All units and resolutions are the thin (8-bit) versions as used in type-0.

Default value: 0x01 = Temperature

14.9.11 Temperature and Humidity Measurements

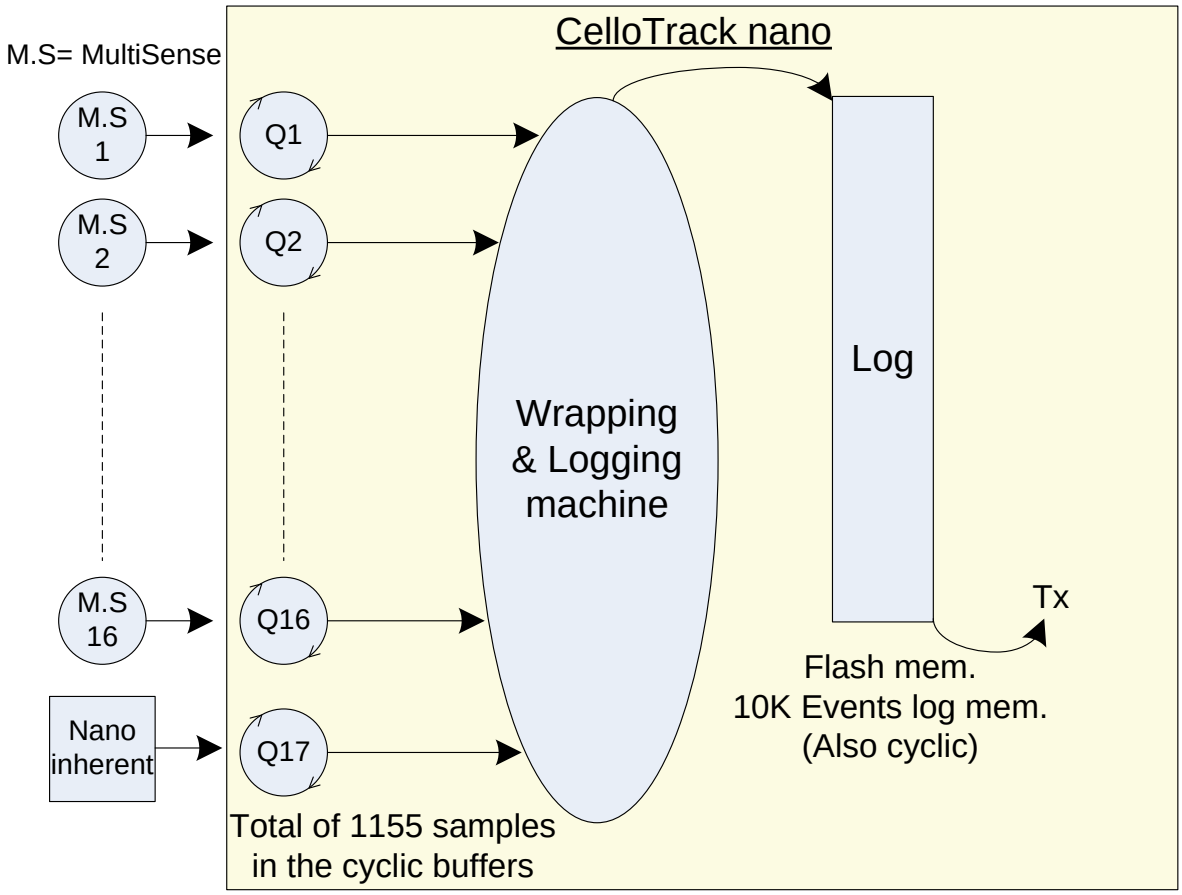
The unit has a buffer, which is divided equally between the existing (defined in the PL) channels.

There are up to 33 queues in a system; each queue shall contain up to 48 samples.

The multiplication of number of samples and number of queues shall not exceed **1155**.

Examples:

- Full system (16 humidity sources + 17 temperature sources), each queue will be 35 samples.
- 10 temperature sources, each queue will be 48 samples.
- 13 humidity sources + 14 temperature sources, each queue will be 42 samples.



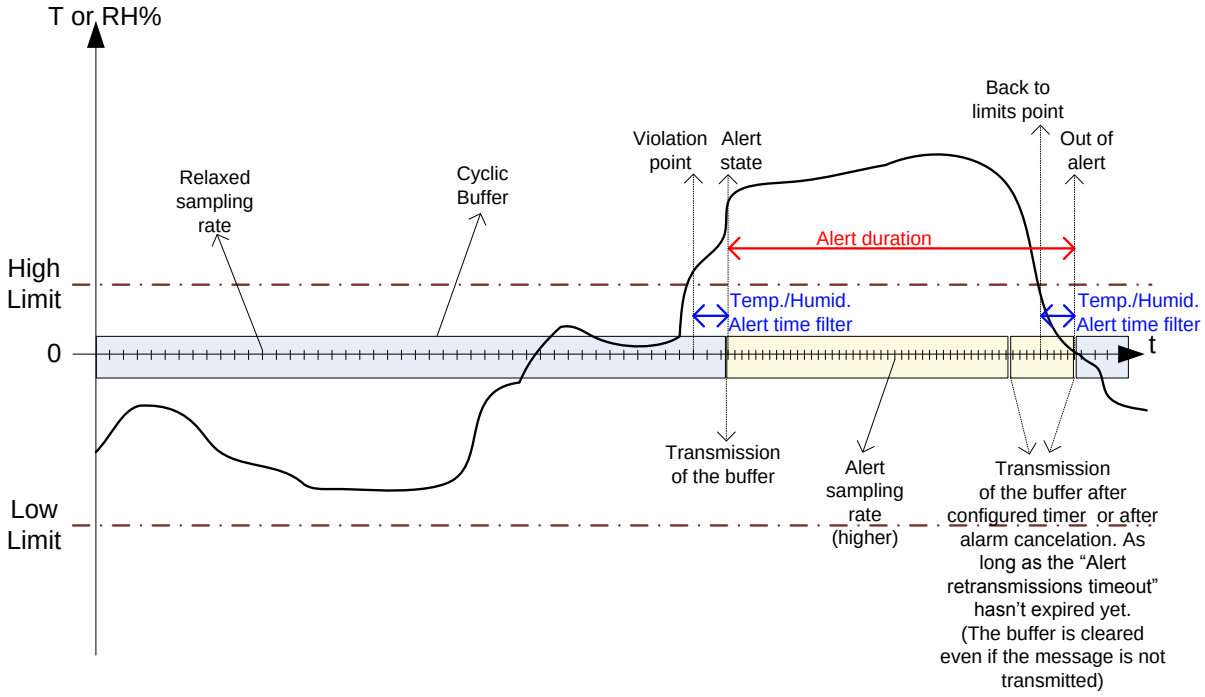
Each source has its separated state machine, and each buffer includes records and header.

IMPORTANT: If a specific channel is not configured correctly and/or has illegal values, for example:

- The lower-TH is higher than the upper-TH
- Out of range values
- Sampling rate or sampling during violation zeroed
- Alert time is less than one sampling time

In such cases, the system will ignore this channel completely: no events, no logging and no transmissions will be sent.

- If the Alert time is more than one sampling time and less than 2 sampling times it will wait 2 sampling time periods.
- If the Alert time is more than 2 sampling times the unit will wait the defined sampling time.



NOTES:

- Both "Low limit" and "High limit" thresholds are concurrently active. The unit always takes both of them into account.
- There are two sampling rates; one when not in alarm mode called "Relaxed sampling rate" and one in alert mode called "Alert sampling rate".
- If logging sampling rate (hours +minutes) or relaxed/alert sampling rates are zeroed or none of the related events are enabled – the entire feature is disabled.

IMPORTANT: All the parameters in the following sections (from sections 14.9.11.1 to 14.9.11.13) are related to the **Nano only**. The parallel parameters for MultiSense units are described in section 15.4.

14.9.11.1 Relaxed Temperature Sampling Rate

Address: 2066

Description: This is the sampling rate when the channel is not in alert state.

Resolution: 2 seconds

Data format: 1 byte, decimal value

Data range: 0÷255 = 0÷510. Valid range is 2÷510 seconds and must be < than "Temperature alert time", otherwise the entire logger is disabled.

Default value: 0x1E = 60 seconds

14.9.11.2 Temperature Alert High Limit Threshold

Address: 2067

Description: Temperature high limit threshold; above this is a violation.

Resolution: 1ºC

Data format: 1 byte, Signed (2's complementary) value.

Data range: -127÷128, Valid range is -50÷100 ºC

Default value: 0x00 = 0ºC

14.9.11.3 Temperature Alert Low Limit Threshold

Address: 2068

Description: Temperature low limit threshold; below this is a violation.

Resolution: 1ºC

Data format: 1 byte, Signed (2's complementary) value.

Data range: -127÷128, Valid range is -50÷100 ºC

Default value: 0xEC = -20ºC

14.9.11.4 Temperature Alert Time

Address: 2069

Description: Timeout before alert generation, after a TH is crossed; also used to exit an alert state after reverting to filter limits.

NOTE: This parameter will be rounded to the closest sampling time units.

Resolution: 1 minute

Data format: 1 byte, decimal value.

Data range: 0÷255, Valid range is 1÷255 minutes and must be > "Relaxed temperature sampling rate" and also > "Alert temperature sampling rate", otherwise the entire logger is disabled.

Default value: 0x02 = 2 minutes

14.9.11.5 Alert Temperature Sampling Rate

Address: 2070

Description: Time for a violation to become an alert, and also reverting from non-violation to non-alert.

Resolution: 2 seconds

Data format: 1 byte, decimal value

Data range: 0÷255, Valid range is 1÷255 = 2÷510 seconds and must be < than "Temperature alert time", otherwise the entire logger is disabled

Default value: 0x1E = 60 seconds

14.9.11.6 Sampling rate multiplier

Address: 2075.5

Description: When this bit is set to '1' the units of the Relaxed and Alert sampling rates above (Addresses 2066 and 2070) are turned from seconds to minutes (multiplied by 60).

0 = Seconds

1 = Minutes

Note: if the "minutes" multiplier is selected and one of the sampling rates is larger than few minutes, there might be a case that the "30 min after charging bit" will not cover all samples in the module 40. For example, relax or alert sampling rate is set to 60 min and the module 40 contains 10 samples (sent every 10 hours). In this case, the indication bit of "30 min after charging bit" may not cover and report on a charging periods that occurred in this 10 hours timeframe.

Default value: 0 = Seconds

14.9.11.7 High Limit Violation Event

Address: 2071 bits 4-7

Description: These bits enable (=1) or disable (=0) the messaging for the High limit violation event (both temperature and humidity. Not operational when MS data-logger is enabled).

High limit violation event (both temperature and humidity)				Reserved
Type-11		Type-0		
Logged	"Active log event"	Logged	Distress	
Bit 7	Bit 6	Bit 5	Bit 4	Bits 0-3

Note: When the bits of type-11 are enabled, the message used to convey the event is module 40 (and not module 28).

Default value: 0x00 = All disabled

14.9.11.8 Low Limit Violation Event

Address: 2072 bits 4-7

Description: These bits enable (=1) or disable (=0) the messaging for the Low limit violation event (both temperature and humidity. Not operational when MS data-logger is enabled).

Low limit violation event (both temperature and humidity)				Reserved
Type-11		Type-0		
Logged	"Active log event"	Logged	Distress	
Bit 7	Bit 6	Bit 5	Bit 4	Bits 0-3

Note: When the bits of type-11 are enabled, the message used to convey the event is module 40 (and not module 28).

Default value: 0x00 = All disabled

14.9.11.9 Nano Alert Retransmit Time

Address: 2073

Description: If an alert is not canceled by a special command (see the OTA protocol), the unit will keep retransmitting the buffer over and over again every this defined period, until the timeout expires.

NOTES:

- The value will be rounded to the closest whole "Alert temperature/humidity sampling rate" units.
- From this parameter the number of samples to send in a single transmission is calculated and then this number of samples is kept (and not the time).
  For example: If sampling rate is 5 minutes and this parameter is 1 hour, the unit will transmit every 12 samples (and not 1 hour), even if some samples are missing from a MultiSense for instance.
- If less than one unit of "Alert temperature/humidity sampling rate" is transmitted, the feature is disabled.
- If it has a larger value than the queue size, it will retransmit every full queue.
- A buffer can only be transmitted via type-11 messages. The retransmissions are also sent (if enabled) over type-0 messages with current single measurements only.

Resolution: 1 minute

Data format: 1 byte, decimal value

Data range: 0÷255 minutes

Default value: 0x0F = 15 minutes

14.9.11.10 Nano Alert Retransmissions Timeout

Address: 2074

Description: If alert is not cleared, the buffer keeps being retransmitted until this timeout expires.

Resolution: 10 minutes

Data format: 1 byte, decimal value

Data range: 0÷255, Valid range is 1÷255 = 10÷2550 Minutes, 0=Disable

Default value: 0x00 = Disable

14.9.11.11 Temp. & Humidity Idle Transmission Event Configuration

Address: 2075 bits 6-7

Description: The Temp. & humidity idle transmission event in context of data logging transmission when this time elapses since the last transmission.

If no alerts or special events occur for a long time, the system may not transmit anything for a long time. On the other hand, the user may want to be able to still get the data-logger functionality more frequently. When the "Temp. & humidity idle transmission event" bit is set, the data-logger will send its buffers anyway after this time has elapsed.

If "Time base transmissions" parameter is set to "Disable (according to number of samples)", then the transmissions will occur after sufficient number of samples have been logged.

These bits enable (=1) or disable (=0) the messaging for the temp. & humidity idle transmission event configuration.

Temp. & humidity idle transmission event configuration	
Type-11	
Logged	"Active log event"
Bit 7	Bit 6

Default value: 0x00 = All disabled

14.9.11.12 Transmit After This Time Elapsed Since Last Transmission (Hours)

Address: 2075 bits 0-4

Description: If no alert occurred, the unit will transmit the buffer anyway after the defined time (hours + minutes; minutes is defined in the next parameter).

If "Time base transmissions" parameter is set to "Disable (according to number of samples)", then the transmissions will occur after sufficient number of samples have been logged.

Data format: 5 bits, decimal value

Data range: 0÷31, Valid range is 0÷23 hours

Default value: 0x00 = 0 hours

14.9.11.13 Transmit After This Time Elapsed Since Last Transmission (Minutes)

Address: 2076 bits 0-5

Description: If no alert occurred, the unit will transmit the buffer anyway after the defined time (hours + minutes).

Data format: 6 bits, decimal value

Data range: 0÷63, Valid range is 0÷59 minutes

Default value: 0x00 = 0 Minutes

14.9.11.14 Time base transmissions

Address: 2076 bit 6

Description: If this bit is set to '1' (enabled), the unit shall transmit according to time base strictly and not number of samples (as done before release 34j), even if the module 40 array is empty (Number of samples in the payload = 0).

0 = Disable (according to number of samples)

1= Enable (according to time only)

Default: 1 = Enable (according to time only)

14.9.12 Indications Time Window

Address: 2080

Description: After power-up or reset, the units indication (Buzzer and LEDs) are shut down after the defined "Indications time window" value, in order to conserve energy.

When the unit is in ON state, every button press longer than 200mS but shorter than 5 seconds will prolong or open the indications window by restarting this "Indications time window".

Note that a zero value can result in an unstable system and therefore should not be used.

Resolution: 4 seconds

Data format: 1 byte, decimal value

Data range: 0÷255, valid range 1÷255 (4÷1020 seconds)

Default value: 0x08= 32 seconds

14.9.13 Buzzer Configuration

14.9.13.1 Buzzer Enable Bits

Address: 2077 bits 1-7

Description: These bits enable (=1) or disable (=0) the various buzzer indications.

Panic was ACKed by server Buzzer feedback	Ring beeps on dial in	Beep on registered MultiSense power-up	Panic Buzzer feedback	Check-in Buzzer feedback	Button press Buzzer feedback	User indication beeps	Reserved = 0
Bits 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Default value: 0xFC = All enabled except "User indication beeps"

14.9.13.2 Buzzer Beeps Interval On Out Of Limits Alert

Address: 2078

Description: When the configured sensors go out of their limits, repeating beeps are sounded at the defined interval.

Resolution: 1 second

Data format: 1 byte, decimal value

Data range: 0÷255, valid range is 1÷255 seconds

Default value: 0x0A = 10 seconds

14.9.13.3 User indication beeps timeout

Address: 1855

Description: If user doesn't acknowledge the "user indication beeps" by pressing the check-in buttons (both buttons for 1>t>5 Sec), the beeps will stop after this timeout.

Resolution: 1 second

Data format: 1 byte, decimal value

Data range: 0÷255, valid range is 1÷255 seconds

Default value: 0x0A = 10 seconds

14.9.14 LEDs Configuration

Address: 2079

Description: These bits enable (=1) or disable (=0) the various LED indications.

Panic LED feedback	Check-in LED feedback
Bits 7	Bit 6

Note that all these indications are displayed only for the "Indications time window" time. After that they are cleared (turned OFF).

Default value: 0x3 = both enabled

14.9.14.1 Battery State LED Interval

Address: 2079 bits 0-4

Battery state LED interval				
Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Description: This is the time between consecutive LED blinks of battery level. See 14.2.2 for more details.

All these battery indications are displayed only for the "Indications time window" time. After that they are cleared (turned OFF).

Resolution: 1 second

Data format: 5 bits, decimal value

Data range: 0÷31 seconds (0=Disable blinks entirely)

Default value: 0x05= 5 seconds

14.9.15 Check-in_out configuration

14.9.15.1 Check-in_out Messaging

Address: 2352 bits 4-7

Description: These bits enable (=1) or disable (=0) the messaging for the Check-in and Check-out events.

Check-in_out messaging				Reserved
Type-11		Type-0		
Logged	"Active log event"	Logged	Distress	
Bit 7	Bit 6	Bit 5	Bit 4	Bits 0-3

Default value: 0x00 = All disabled

14.9.15.2 Check-in timeout

Address: 1857

Description: After this timeout expires, the Check-in state shall be over, and back to Check-out state.

Resolution: 0.5 hours

Valid Range: 0.5-127.5 hours, 0 =No timeout - infinite time (until power up)

Default value: 0x30 = 24 hours

14.9.16 Work-ID (Activation) Messaging

Address: 2081 bits 0-3

Description: The unit promotes a "Work ID" counter on every power turn-ON operation by the user.

This 32-bit counter is initialized to 0 only at the production line.

This event is also used as a Unit Activation message.

These bits enable (=1) or disable (=0) the messaging for the work-ID counter feature.

Reserved	Work-ID (Activation) messaging			
	Type-11		Type-0	
	Logged	"Active log event"	Logged	Distress
Bits 4-7	Bit 3	Bit 2	Bit 1	Bit 0

Default value: 0x08 = Type-11 Logged is enabled, all the rest are disabled.

14.9.17 Exception Handling

All meanings of "out-of-range" are explained here.

14.9.17.1 Exception Indications Configuration #1

Address: 2082

Description: For each type of event the following can be configured:

- Whether the event activates the buzzer.
- Whether the event activates the LEDs.

Light sensor out-of-range LED indication	Light sensor out-of-range Buzzer indication	Reserved = 00		Accelerometer sensor out-of-range LED indication	Accelerometer sensor out-of-range Buzzer indication	Reserved = 00	
Bits 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Default value: 0x00 = All disabled

14.9.17.2 Exception Indications Configuration #2

Address: 2083

Description: For each type of event, the following can be configured:

- Whether the event activates the buzzer.
- Whether the event activates the LEDs.

Reserved = 00		Temperature out-of-range LED indication	Temperature out-of-range Buzzer indication	Geo-Fence General LED output indication	Geo-Fence General Buzzer output indication	Reserved = 00	
Bits 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Default value: 0x00 = All disabled

14.9.18 BLE Block

14.9.18.1 BLE Block Main Configuration

Address: 2084

Description: These bits enable (=1) or disable (=0) the BT classic and BLE (Bluetooth Low Energy) block functionally feature.

There are three types of "MultiSense Processing Mode" options:

1. "Ignore unpaired MultiSense units" = in this mode, the Nano device will only accept data from MultiSense units that are paired with the Nano device, and are in range.
2. "Tag Mode" = in this mode, the Nano will detect all MultiSense units that are in its range, but will not report sensor values from the MultiSense units. The data that will be reported include the "MAC address," "battery level, "RSSI", "TX-reason", "FW version", "BOM mask" and "Sensors mask" fields.
3. "Guest Mode" = in this mode, the Nano will detect all MultiSense units that is in its range, and will also report all sensor values from the MultiSense units that are enabled.

Additional Comments:

- In Guest mode, since the communication is bidirectional, it is recommended not to have more than one Cello/Nano unit in the same BLE coverage range (~100m radius/Nano).
- In Tag mode, since the communication is unidirectional, there is no such limitation. Users are allowed to place multiple Cello/Nano units within the same BLE coverage range.

Enable BLE	Reserved	MultiSense Processing mode 00 – Ignore unpaired MultiSense units 01 – "Tag mode": Only report on existence (advertisements) of unpaired MultiSense units 10 – "Guest mode": **Process** and report on unpaired MultiSense units 11 – Reserved		In use by BT Extender			In use by BT Extender
Bits 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Default value: 0x00 = Ignore unpaired MultiSense units

The following 4 parameters are common to all connected MultiSense units in a system.

14.9.18.2 Guest and Tag MultiSense reporting

Address: 2355 bits 6-7

Description: These bits enable (=1) or disable (=0) the messaging for the Guest and Tag mode reports.

Tag or Guest MultiSense event messaging (Both for Guest and Tag modes)	
Type-11	
Logged	"Active log event"
Bit 7	Bit 6

Important note: If none of the enable bits for the guest/tag messaging are enabled (bits 6-7 above), the entire functionality of guest/tag mode is cancelled and the Nano acts as if in normal mode (which is "Ignore unpaired MultiSense units").

Default value: 0x00 = All disabled

14.9.18.3 MultiSense added/removed reporting

Address: 2355 bits 2-3

Description: These bits enable (=1) or disable (=0) the messaging for the adding and removing of MultiSense units.

MultiSense added/ removed event messaging	
Type-11	
Logged	"Active log event"
Bit 3	Bit 2

Default value: 0x00 = All disabled

14.9.18.4 Proximity/Keep-Alive Transmission Timer

Address: 2085-2086

Description: This sets the timer via which MultiSense units transmit their keep-alive messages. These transmissions will occur only if this timer elapsed since last transmission. For example, if "Tx on violation only" mode is enabled and no violation occurred for more than this timer.

If data-logger is enabled this timer determines the transmission rate.

Resolution: 2 seconds

Data format: 2 byte, decimal value

Data range: 0÷65535, valid range is 2÷ 43200 = 4÷86400 seconds, but it is **not** recommended to set it below 20 seconds.

Default value: 0x0E10 = 3600 seconds = 1 hour

14.9.18.5 Active Sensors Sampling Relaxed Timer

Address: 2087-2088

Description: This sets the timer via which MultiSense units sample and transmit their measurements messages if **no** violation of thresholds occurred.

In case data-logger is enabled or "Tx on violation only" mode is enabled, this timer will determine the internal sampling rate of the sensors when there is no violation (of temperature or humidity).

Resolution: 2 seconds

Data format: 2 byte, decimal value

Data range: 0÷65535, valid range is 2÷43200 = 4÷86400 seconds, but it is **not** recommended to set it below 20 seconds.

Default value: 0x0096 = 300 seconds

14.9.18.6 Active Sensors Sampling Violating Timer

Address: 2089-2090

Description: This sets the timer via which MultiSense units sample and transmit their measurements messages if violation of thresholds occurred (of temperature or humidity).

Resolution: 2 seconds

Data format: 2 byte, decimal value

Data range: 0÷65535, valid range is 2÷43200 = 4÷86400 seconds, but it is **not** recommended to set it below 20 seconds.

Default value: 0x003C = 60 seconds

14.9.18.7 MultiSense Temperature/Humidity Alert Time Filter

Address: 2091

Description: Timeout before alert generation, after a TH is crossed; also used to exit alert state after reverting to defined limits.

Note: This parameter will be rounded to the closest sampling time units.

Resolution: 1 minute

Data format: 1 byte, decimal value

Data range: 0÷255, valid range is 1÷ 255 minutes

Default value: 0x02= 2 minutes

14.9.19 Dry contact input mode

Address: 2046 bits 4-5

Description: Sets the mode/meaning of the dry contact input value where:

Data range: 0= Normal
1= Extended battery charging indication
2÷3= Reserved

Default value: 0= Normal (Only reported in type-0 Inputs field, no extended battery).

14.9.20 Add module 44

Address: 2046 bit 6

Description: This bit determine if to add module 44 before any MultiSense related transmissions or not. Module 44 contains enhanced additional information about the relevant MultiSense. For more details, look at the wireless protocol doc.
Note that if using the MultiSense data-logger, then this module becomes mandatory.

Data range: 0= Disable, 1= Enable

Default value: 0= Disable

14.9.21 Prevent power button from shutting down (Nano)

Address: 2046 bit 7

Description: If this bit is set, the power button of the Nano is prohibited from shutting down the unit (the unit cannot go to inactive mode).

Data range: 0= Shutting down possible, 1= Shutting down impossible

Default value: 0= Shutting down possible

14.9.22 Pressure sudden change

14.9.22.1 Pressure sudden change event messaging

Address: 2042 bits 6-7

Description: These bits enable (=1) or disable (=0) the messaging for Pressure sudden change event.

Pressure sudden change event messaging	
Type-11	
Logged	"Active log event"
Bit 7	Bit 6

Default value: 0x00 = All disabled

14.9.22.2 Pressure sudden change threshold

Address: 2043

Description: Pressure change threshold to create an event.

Resolution: 0.1m

Data format: 1 byte, Unsigned.

Data range: 0÷255 (0=Disable the entire feature), Valid range is 0.1÷25.5m

Default value: 0x1E = 3m

14.9.23 Voice listen-in

14.9.23.1 Voice listen-in white list numbers

Address: 800-899

Description: 10 white list numbers, each one can contain up to 15 digits in national or international form.

Data format: First byte should contain the total amount of digits that make up the actual address (not including address type byte). Second byte is the address type byte, which should be 91h for international address (recommended type to use, to allow roaming) or 81h for local address. The rest of the bytes contain the actual address, encoded in BCD. The order of the transmission is bytes with lower address first, lower nibbles (nibble = 4 bit) first. If only the lower nibble of a byte is used (this is legal only in the last byte – in case this is the last digit of the address), the higher nibble should have all of its bits set

(the nibble should contain 15 dec). The rest of the bytes that are not used should contain FFh.

When the list is all empty, the unit will answer **any** caller.

Default value: Null (empty)

14.9.23.2 Voice listen-in timeout

Address: 1847

Description: The limiting timeout of a single listen-in session.

Resolution: 1 minute

Data format: 1 byte, Unsigned.

Data range: 0÷255 (0=Disable=No timeout, 1÷255 minutes)

Default value: 0x3C = 1 hour

14.9.24 Airplane mode

14.9.24.1 Automatic Airplane Mode

Address: 1848 bit 7

Description: This bit enables the entire feature of Airplane mode (aka Flight mode).

Data range: 0= Disable, 1= Enable

Default value: 0= Disable

14.9.24.2 BLE remain powered during Airplane Mode

Address: 1848 bit 6

Description: This bit determines whether the BLE block will be powered off too when airplane mode decide to shutdown the cellular modem or not.

Data range: 0= Disable, 1= Enable

Default value: 1= Enable

14.9.24.3 Enable early airplane mode

Address: 1848 bit 5

Description: When this bit is enabled, unit will shut down the radio (modem and if configured also the BLE) right after stage-1 of the airplane mode recognition, which is the

harsh and long acceleration (typical for take-offs), and also report it as Type-0 event with TR=207 and STR=12.

0 = Disable

1 = Enable

Default value: 0 = Disable

14.9.24.4 Timeout for longest flight

Address: 1852 bit 4÷7

Description: This parameter is protecting the unit from being in Airplane mode for too long time. For best results, set it to the real maximal flight duration with some spare.

Data format: 4 bits, Unsigned.

Resolution: 2 hours

Data range: 0÷15 (0=Disable=No timeout) valid range is 1÷15 = 2÷30 hours

Default value: 0x6 = 12 hours

14.9.25 Improved power consumption for high transmission rates

If this feature is enabled by setting the PL parameter of "Battery saving mode transmit interval" (**address 1854**) to a value ≥ 16 seconds, the unit will conserve up to 30% energy in high transmission rates.

These special transmissions will be with a new **TR=10**: "Periodic transmission".

If configuration bit "Periodic Transmission (in battery saving mode) - Type-0" (**address 526 bit-6**) is enabled, the event will be transmitted over Type-0, and if the bits of Type-11 encapsulation are enabled (bits 4-5 in address 542, set via "type-11 encapsulation" tab in MultiSense editor screen), it will be transmitted over type-11 as encapsulated. (or both, if all these bits are enabled).

14.9.25.1 Battery saving mode transmit interval

Address: 1854

Description: If this parameter is set to 16 or above, the system will enter battery saving mode and will transmit an independent transmissions in intervals regardless of ignition or other factors.
It will save more percentage of battery as much as the transmission rate is higher.
Maximum saving (in %) is with transmit interval of 16 seconds.

Format: 1 byte, decimal value.

Units: Seconds

Resolution: 2 Seconds

Valid Range: 0-7 (0-14 Seconds) = Disable, 8-255 (16-510 Seconds) = Active

Default value: 0 (entire feature is disabled).

14.9.25.2 Periodic Transmission (in battery saving mode) - Type-0

Address: 526, bit 6

Description: This parameter enables to send **only logged** events of type "Periodic Transmission (in battery saving mode)" in type-0.

Sending this event in Type-11 (encapsulated) either in addition to type-0 or instead of it, the bits 4-5 in address 542 should be set accordingly.

Data Range: 1 - Enable, 0 - Disable.

Default Value: 0 – Disable.

14.9.26 Sea mode

For better coping and conserving as much power as possible when the unit is without cellular coverage for long times, like when traveling by sea or staying at no-signal areas like underground parking lots and other no coverage zones, if the sea-mode is enabled, the unit will activate a limited back-off mechanism in the following way:

- When 3 transmissions attempts failed in a row due to lack of Cellular network coverage, the unit will increase the transmission interval to be twice the previous attempt/interval, until it reaches the value of >=24h. 24h will be the maximal value of transmission interval.
- Between every 2 attempts, the system will be in kind of radio-off (similar to airplane mode), so no periodic or immediate/asynchronous events will be transmitted. They will be inserted to the log instead, waiting to the next attempt.

14.9.26.1 Sea mode

Address: 1913 bit 0

Description: When this mode is enabled, the unit shall decrease its transmission rate gradually up to once every 24h in case there are no cellular network available. This way the power consumption will be significantly improved in cases the unit will be shipped by sea or put in place with no cellular coverage for long times.

0 = Disable

1 = Enable

Default value: 0 = Disable

14.10 Installations

The Nano unit can be installed in a variety of ways. For more details, refer to its Installation Guide document.

15 MultiSense and MultiSense-TH

15.1 Introduction

The MultiSense is a remote peripheral sensor, communicating and configured by the CelloTrack Nano via a short-range RF link.

There are 2 models of MultiSense: regular devices that can measure temperature called "MultiSense" and "MultiSense-TH" devices which have a combined temperature and humidity sensor.

The MultiSense device has the following sensors:

- Temperature sensor
- Humidity sensor (only in the MultiSense-TH model)
- Hall effect magnetic sensor
- Ambient Light Sensor (ALS)
- Accelerometer sensor

The system supports up to 16 fully programmable MultiSense devices.

If "Guest mode" is enabled here, the Nano unit will also connect with MultiSense units not in its list, read their sensors and pass the data (in raw format) to the server. Only listed MultiSense units also get configuration blocks and their readings are fully processed by the Nano.

If "Tag mode" is enabled here, the Nano unit will only report on existence (reception of advertisements) of unpaired MultiSense units, not reading their sensors.

15.2 Operation

15.2.1 Marking

The magnet icon symbolizes the location of the magnet sensor. The permanent magnet should be installed against it with distance of body-to-body of 1-3cm.

The eye icon symbolizes the light sensor direction, to which the source of light should be directed.

15.2.2 Battery

Use only CR2450 size battery. Be careful not to install the battery at the wrong polarity as it could damage the device.

Choose the exact battery model and manufacturer of the battery according to the required temperature range.

To install a battery, unscrew the upper half from the base half until the two triangles on the side are aligned, and then pull it.

15.2.3 Button and Blue LED

- When the battery is inserted, the unit always goes to active mode and the blue LED lights for 3 seconds.
- When active, every short press (up to 1 second long) triggers sampling and transmission and the blue LED blinks 5 times.
- When active, a long press (longer than 4 seconds) will turn the unit OFF (inactive mode), accompanied by 3 blue LED blinks.
- When the unit is off (inactive mode), a long press (longer than 4 seconds) will turn the unit ON and the blue LED lights up for 3 seconds (as per the battery insertion above).

15.2.4 Pairing Process

Closed loop pairing (in the field pairing, over BLE) is performed by pressing simultaneously on both Nano buttons for 5 consecutive seconds. However, note the following:

- If an active indications window exists, it will be closed.
- If the 2 buttons are pressed for more than 1 second but released before completing the 5 consecutive seconds, it will create a check-in event.
- If enabled here, a beep is heard for every elapsed second in the first 4 seconds; if the check-in buzzer enabled bit is set or not "Dual short beeps" after the 5th second (0.5 second each) indicate 'pairing time frame mode' is open for "BLE Pairing time window".

During this time window:

- The Nano's left LED flashes orange 0.5 Sec ON, 0.5 Sec OFF (assuming no charger or PC are connected; if connected it has higher priority on the LED).
- User powers-up a MultiSense device.
- As the Nano pairs with the MultiSense, a long beep (2 seconds) is heard. In addition, the MultiSense LED blinks twice (after the 3 second long power-on LED pulse): 200mS OFF, 200mS ON, 200mS OFF, 200mS ON.
- Only one MultiSense device can be paired during a single "BLE Pairing time window" (to avoid mistakes). The timer for the "BLE Pairing time window" is renewed automatically after each successful MultiSense pairing in order to give the operator the opportunity to pair devices one after the other.
- If enabled here, upon every newly added MultiSense to the system a "MultiSense added" event is created; for every unpaired device a "MultiSense removed" event is created.
- As the "BLE Pairing time window" expires, and at least one MultiSense was added/removed, the Nano will automatically perform a system reset.
- If no new MultiSense was paired, and the "BLE Pairing time window" expired, the red right LED will turn on for 2 seconds (with no beep).
- If all 16 devices are defined (MAC address ≠ 00:00:00:00:00:00), a new MultiSense unit cannot be paired.
- There are no retries for each step of this process.

IMPORTANT: After pairing and unpairing operations, the queue allocation should be restarted (by performing a reset to the entire unit).

Pre-configuration before field pairing of units is possible, just note that when a new MultiSense is paired in field, it will get the first vacant index, starting from #1 and up to #16, and will get the corresponding pre-configured parameters for its index.

15.2.5 Unpairing Process

As per the pairing process, except that during the "BLE Pairing time window" the user turn off the MultiSense device; the Nano recognizes it and approves the unpairing with dual long beeps (1 second each, with OFF time 200mS between them) and with the orange LED turning off.

If no approval was given, it is possible to reattempt the procedure.

15.3 Sensors

15.3.1 Accelerometer

The accelerometer sensor is sampled on every wake-up and Tx cycle and in addition triggers an interrupt (asynchronous transmission) when it has an impact larger than the preconfigured threshold.

The reported impacts create impact events, if enabled here.

The sampled X,Y,Z values are reported on every MultiSense provisioning message and the calculated RMS value on every impact/free-fall event.

15.3.2 Ambient Light Sensor (ALS)

This sensor is used mainly to detect if the package that holds the unit inside is closed (dark) or open (exposed to some light).

The light sensor is sampled once on every wake-up and Tx cycle.

The level is compared against the configured threshold and if events are enabled (as described here or here) the unit creates open package or closed package events respectively.

15.3.3 Accurate Temperature Sensor

This ±1°C accuracy sensor is sampled according to a configurable rate when it is within the configured limits and according to other configurable rates when out those limits for more than this time.

See more details in section 14.9.11.

15.3.4 Humidity Sensor

This ±4% accuracy relative-humidity sensor is sampled according to a configurable rate when it is within the configured limits and according to other configurable rates when out those limits for more than this time.

See more details in section 14.9.11 above.

15.3.5 Magnetic Sensor

This sensor is binary. It recognizes if a strong enough magnetic field exists or not.

If enabled here, upon any change of state, it triggers an interrupt and an asynchronous wake-up and Tx cycle.

15.4 Parameter Descriptions and Notes

15.4.1 MultiSense Units Provisioning

If 5 consequent keep alive **periods** (according to the parameter here) have passed and no messages whatsoever were received from it (**no advertisements at all**), the relevant MultiSense is considered "lost" and should be reported as a "MultiSense provisioning message" event with the problem code of "1 = Lost communication".

If a marked "lost" MultiSense is received again (**any advertisement**), a communication-restore event is sent ("MultiSense provisioning message" event with the problem code of "2 = Communication restored").

15.4.1.1 MultiSense Provisioning Event Messaging

Address: 2354 bits 0-3

Description: These bits enable (=1) or disable (=0) the messaging for the MultiSense provisioning.

MultiSense provisioning event messaging			
Type-11		Type-0	
Logged	"Active log event"	Logged	Distress
Bit 3	Bit 2	Bit 1	Bit 0

Default value: 0x0 = All disabled

15.4.2 MultiSense Open/Close Door/Window Feature

The MultiSense comprises a magnetic sensor that can give indication of the presence or absence of a strong magnetic field (permanent magnet, with specified strength, less than 30mm in distance).

Any change of state is reported immediately to the Nano.

15.4.2.1 MultiSense Open/Close Door/Window Event Messaging

Address: 2354 bits 4-7

Description: These bits enable (=1) or disable (=0) the messaging for the MultiSense Open/Close door/window feature.

MultiSense Open/Close door/window event messaging

Type-11		Type-0	
Logged	"Active log event"	Logged	Distress
Bit 7	Bit 6	Bit 5	Bit 4

Default value: 0x0 = All disabled

All these parameters are set using the Nano editor screen accessed from the Cellocator Programmer tool.

15.4.3 BLE Pairing Time Window

Address: 2353 bits 0-4

Description: Timeout before "in the field" pairing window is closed. See more details here.

Resolution: 10 seconds

Data format: 5 bits, decimal value

Data range: 0÷31, valid range is 1÷31 (10÷310 seconds)

Default value: 0x02 = 20 seconds

15.4.4 Specific MultiSense parameters

Each MultiSense have MAC address, hardware-ID byte (HW_ID), and 9 bytes of configuration.

The HW_ID of MultiSense is 0xDC and for MultiSense-TH it's 0xFC.

About MAC address: Deleting a MAC address is done by writing 00:00:00:00:00:00 as the address. Any other address is considered a valid one.

The address mapping is according to the following table:

MultiSense #	MAC address (6 bytes)	HW_ID byte	9 configuration bytes per MultiSense
1	2236÷2241	2332	2092÷2100
2	2242÷2247	2333	2101÷2109
3	2248÷2253	2334	2110÷2118
4	2254÷2259	2335	2119÷2127
5	2260÷2265	2336	2128÷2136
6	2266÷2271	2337	2137÷2145
7	2272÷2277	2338	2146÷2154

8	2278÷2283	2339	2155÷2163
9	2284÷2289	2340	2164÷2172
10	2290÷2295	2341	2173÷2181
11	2296÷2301	2342	2182÷2190
12	2302÷2307	2343	2191÷2199
13	2308÷2313	2344	2200÷2208
14	2314÷2319	2345	2209÷2217
15	2320÷2325	2346	2218÷2226
16	2326÷2331	2347	2227÷2235

These configuration areas can be read and/or written to by using the wireless commands "Inbound: Configuration Memory Read Request Module" mentioned in the wireless protocol doc at section 3.8.5 and "Inbound: Configuration Memory Write Module" mentioned in the wireless protocol doc at section 3.8.6 respectively.

Addresses: 2092÷2235

Description: These addresses contains an array of 16 configuration blocks; one block of 9 bytes per MultiSense.

Each one of the 16 blocks looks as described in the following parameters.

15.4.4.1 Sensors Enable Bitmask - 1st Byte

Description: Enable bit for every sensor and feature.

Data logger enable	Temperature sensor enable	Humidity sensor enable	Hall-effect sensor enable	Light sensor enable	Accelerometer sensor enable	Tx on violations only (mode) Keep-alive only and upon violations	Prevent pushbutton power down
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0

Default value: 0x00 = All disabled

15.4.4.2 MultiSense Data logger

Data-Logger mode	Tx-on-Violation - mode	Mode of operation	Timer-R (Relaxed)	Timer-V (Violation)	Timer-P (Proximity/ Keep-alive)
Disable	Disable	Real-time mode: Events are transmitted asynchronously, samples are transmitted periodically.	Sampling and transmission rate when no violation.	Sampling and transmission rate when there is a violation.	If P>R and P>V then transmissions according to P will never happen (otherwise it will sample and transmit according to P rate).
Disable	Enable	Tx-on-Violation mode: Events are transmitted asynchronously.	Internal sampling rate when no violation.	Transmission rate when there is a violation.	Transmission rate when no violation.
Enable	Disable	Logger mode: Events and samples are only logged internally.	Internal sampling (and logging) rate when no violation.	Internal sampling (and logging) rate when there is a violation.	Transmission rate of advertisements.
Enable	Enable	Logger mode with Tx-on-Violation enabled: Events are first logged and then transmitted immediately.	Internal sampling (and logging) rate when no violation.	Sampling, logging and transmission rate when there is a violation. Samples will be logged anyway.	Transmission rate of advertisements. (If there is a violation and V<P it will not be transmitted)

This new mode (last line in the table) can save a lot of energy at the MS battery, while maintaining a real-time and fast response when needed.

To activate this combined mode, both Data-logger and Tx-on-Violation-Only configuration bits should be enabled.

In this optimized solution:

- From one hand, the MS samples at the desired rate, according to the use-case needs and regulations.
- If there is any deviation from limits or any event occurred, it is passed immediately.
- All samples get eventually to the server.

15.4.4.3 MultiSense Temperature Upper Limit Threshold - 2nd Byte

Description: MultiSense Temperature upper limit threshold.

Resolution: 1ºC

Data format: Signed (2's complementary) decimal value

Data range: 0÷255, valid range is 0÷80, -1÷-40 = -40÷80 ºC

Default value: 0x00 = 0ºC

15.4.4.4 MultiSense Temperature Lower Limit Threshold - 3rd Byte

Description: MultiSense Temperature lower limit threshold.
Resolution: 1ºC
Data format: Signed (2's complementary) decimal value
Data range: 0÷255, valid range is 0÷80, -1÷-40 = -40÷80 ºC
Default value: 0xEC = -20ºC

15.4.4.5 MultiSense Humidity Upper Limit Threshold - 4th Byte

Description: MultiSense Humidity upper limit threshold.
Resolution: 1%
Data format: 1 byte, decimal value
Data range: 0÷255, valid range is 0÷100 %
Default value: 0x50 = 80%

15.4.4.6 MultiSense Humidity Lower Limit Threshold - 5th Byte

Description: MultiSense Humidity lower limit threshold.
Resolution: 1%
Data format: 1 byte, decimal value
Data range: 0÷255, valid range is 0÷100 %
Default value: 0x14 = 20%

15.4.4.7 MultiSense Impact or Free-fall Selection - 6th Byte, Bit 7

Description: MultiSense Impact or Free-fall selection; 0=Impact, 1=Free-fall.
Default value: 0 = Impact

15.4.4.8 MultiSense Impact/Free-fall Event Threshold - 6th Byte, Bits 0÷6

Description: MultiSense Impact/Free-fall event threshold in g (earth gravity) units.
Recommended values for Impact mode is >1.5g.
Recommended values for free-fall mode is <0.7g.
Resolution: 63mg (full scale is ±8g)
Data format: 7 bits, decimal value

Data range: 0÷127 = 0÷8g

Default value: 0x20 = 2g

15.4.4.9 MultiSense Package Open/Closed Light Threshold - 7th Byte

Description: MultiSense Package open/closed light threshold

Resolution: 2 lux

Data format: 7 bits, 1 byte, decimal value

Data range: 0÷255 = 0÷510 lux, **Valid range is 12÷500 lux** (values below 12 lux will disable the entire feature).

Default value: 0x0A = 20 lux

15.4.4.10 Motion detection enable - 8th Byte, bit 0

Description: Enable the motion detection (vibrations) feature. If enabled the features of impact/free-fall are disabled.

0 = Disable

1 = Enable

Default value: 0-Disable

15.4.4.11 MultiSense Tx power - 8th Byte, bits 4÷7

Description: MultiSense Transmission power, according to the below table:

0= +8dBm (Maximal)

1= +6dBm

2= +2dBm

3= -2dBm

4= -6dBm

5= -10dBm

6= -14dBm

7= -18dBm (Minimal)

8÷15= Reserved

Default value: 0x00 = +8dBm (Maximum)

15.4.4.12 Reserved Bytes - 8th (lower nibble) and 9th Bytes

Those bytes are empty and reserved (=0x00).

15.5 Advanced BLE settings

15.5.1 Data logger full processing

Address: 2084 bit 6

Description: When this bit is enabled (1), the unit will process the log from MS to module-40 (samples array) and module-28 (event) packets. If disabled (0) the raw log will be transferred via module-49.

0 = Disable

1 = Enable

Default value: 0 = Disable

15.5.2 Group-ID

Address: 1868

Description: This global (same value for all MS) parameter determines the Group-ID that will be injected to all paired MS if their initial Group-ID was 01 (=Not assigned).

Default value: (=0x01) 1 (no Group-ID was assigned)

15.5.3 MultiSense Tx duration

Address: 1864

Description: TX duration is a configurable parameter in a compressed form.

To get the duration in mS units, the value shall take this byte and perform this calculation $X^2/8$.

For example: 158 --> 3120mS which is also closest to the default value. 34 --> 144mS.

If this value is 0, the duration will be set to the legacy value of 3100mS (for backwards compatibility).

Data range: 2-8128 mS

Default value: 0x00 (= 3100mS)

15.5.4 MultiSense Connection Timeout

Address: 1865-1866

Description: This global (same value for all MS) 16-bit parameter determines the maximum allowed time a connection session can last with the MS. Usually (and in

previous versions) this would be short (3 Sec) to prevent human intervention in the connection process.

Data range: 1-2147 seconds (values above 2147 will be treated as 2147), 0=Infinite (unlimited time)

Default value: 0x003C = 60 Seconds

15.5.5 MultiSense Timers Multiplier

Address: 1867 bits 0-1

Description: The timers set of Relaxed/Violation/Proximity rates will be multiplied by the chosen multiplier.

0 = No multiplier = Legacy resolution where each bit is 2 Seconds.

1 = Minutes = Multiplier of 60, so each bit is 2 minutes

2-3 = Reserved

Default value: 0 = No multiplier

15.5.6 No MultiSense received timer

Address: 1861

Description: Regardless of the system mode (guest/tag/normal), if no transmission from any paired MultiSense or not paired one but from the same group-ID, was received for more than this timer, then the unit shall start sending a new type-11 message, via "Active log event" mechanism, with module 28, Event code=21, at the pace of "No MultiSense received message every" parameter.

Resolution: 10 seconds

Data range: 10-2550 Sec (0=Disable the entire feature)

Default value: 0 (Disable the entire feature)

15.5.7 No MultiSense received message every

Address: 1862

Description: Regardless of the system mode (guest/tag/normal), if no transmission from any paired MultiSense or not paired one but from the same group-ID, was received for more than the timer of "No MultiSense received timer", then the unit shall start sending a new type-11 message, via "Active log event" mechanism, with module 28, Event code=21, at the pace of this timer.

Resolution: 2 seconds

Data range: 2-510 Sec

Default value: 300 (5 minutes)

15.5.8 Magnetic sensor as pushbutton

Address: 1867 bit 2

Description: When this bit is enabled, the CelloSense will treat its magnetic sensor as a pushbutton. When there is magnet detected, it's like pressing the button.

If this bit configuration is disabled the magnetic sensor shall function as before (backward compatible).

0 = Disable

1 = Enable

Default value: 0 = Disable

15.5.9 Motion detection start filter

Address: 1870

Description: This parameter sets the MultiSense/CelloSense motion detection feature start filter (when the unit is inside the marked geo-fence).

Resolution: 1 Sec

Default value: 5 (5 Sec)

15.5.10 Motion detection stop filter

Address: 1871

Description: This parameter sets the MultiSense/CelloSense motion detection feature stop filter (when the unit is inside the marked geo-fence).

Resolution: 15 Sec

Default value: 8 (120 Sec = 2 Min)

15.5.11 2nd Alternative settings for zone 2

15.5.11.1 2nd alternative Relax timer

Address: 1874-1875

Description: This sets the timer via which MultiSense/CelloSense units sample and transmit their measurements messages when the unit is stationary and if no violation of temperature or humidity (where exist) thresholds occurred and the unit is not inside any marked geo-fence.

Resolution: 2 seconds

Data format: 2 byte, decimal value

Data range: 0÷65535, valid range is 2÷43200 = 4÷86400 seconds, but it is not recommended to set it below 20 seconds.

Default value: 0x2A30 = 21,600 seconds = 6 hours

15.5.11.2 2nd alternative Violation timer

Address: 1876-1877

Description: This sets the timer via which MultiSense/CelloSense units sample and transmit their measurements messages if motion was detected or a violation of temperature or humidity (where exist) thresholds occurred and the unit in not inside any marked geo-fence.

Resolution: 2 seconds

Data format: 2 byte, decimal value

Data range: 0÷65535, valid range is 2÷43200 = 4÷86400 seconds, but it is not recommended to set it below 20 seconds.

Default value: 0x000F = 30 seconds

15.5.11.3 2nd alternative Proximity/Keep-alive timer

Address: 1872-1873

Description: This sets the timer via which MultiSense/CelloSense units transmit their keep-alive messages if they are outside all marked geo-fences. These transmissions will occur only if this timer elapsed since last transmission. For example, if "Tx on violation only" mode is enabled and no violation occurred for more than this timer.

If data-logger is enabled this timer determines the transmission rate.

Resolution: 2 seconds

Data format: 2 byte, decimal value

Data range: 0÷65535, valid range is 2÷43200 = 4÷86400 seconds, but it is not recommended to set it below 20 seconds.

Default value: 0xA8C0 = 86,400 seconds = 24 hours

15.5.11.4 2nd alternative timers multiplier

Address: 1878 bits 0-1

Description: The 2nd set of timers set of Relaxed/Violation/Proximity rates shall be multiplied by the chosen multiplier. Used when the unit is not inside any marked geo-fence.

0 = No multiplier = Legacy resolution where each bit is 2 Seconds.

1 = Minutes = Multiplier of 60, so each bit is 2 minutes

2-3 = Reserved

Default value: 0 = No multiplier

15.5.11.5 2nd alternative Motion detection start filter (global)

Address: 1881

Description: This parameter sets the MultiSense/CelloSense motion detection feature start filter when the unit is not inside any marked geo-fence.

Resolution: 1 Sec

Default value: 5 (5 Sec)

15.5.11.6 2nd alternative Motion detection stop filter (global)

Address: 1882

Description: This parameter sets the MultiSense/CelloSense motion detection feature stop filter when the unit is not inside any marked geo-fence.

Resolution: 15 Sec

Default value: 8 (120 Sec = 2 Min)

15.5.11.7 2nd alternative acceleration activity filter

Address: 1883

Description: This parameter sets the MultiSense/CelloSense acceleration activity filter when the unit is not inside any marked geo-fence.

Resolution: 1 Sec

Default value: 5 (5 Sec)

15.5.11.8 2nd alternative acceleration inactivity filter

Address: 1884

Description: This parameter sets the MultiSense/CelloSense acceleration inactivity filter when the unit is not inside any marked geo-fence.

Resolution: 1 Sec

Default value: 5 (5 Sec)

15.5.11.9 Acceleration activity filter

Address: 1885

Description: This parameter sets the MultiSense/CelloSense acceleration activity filter when the unit is inside the marked geo-fence.

Resolution: 1 Sec

Default value: 5 (5 Sec)

15.5.11.10 Acceleration inactivity filter

Address: 1886

Description: This parameter sets the MultiSense/CelloSense acceleration inactivity filter when the unit is inside the marked geo-fence.

Resolution: 1 Sec

Default value: 5 (5 Sec)

15.5.11.11 Accelerometer ODR

Address: 1887 bits 0-2

Description: This parameter sets the internal sampling rate of the accelerometer chip.

Where:

0 - Reserved

1 - 1 Hz

2 - 10 Hz

3 - 25 Hz

4 - 50 Hz

5 - 100 Hz

6 - 200 Hz

7 - 400 Hz

Default value: 7 (400 Hz)

15.5.11.12 Acceleration motion pulse width

Address: 1888

Description: This parameter sets the Pulse width of physical motion detection signal.

Resolution: 0.1 Sec

Default value: 5 (0.5 Sec)

15.5.12 CBLE

15.5.12.1 CBLE scan cycle

Address: 2356

Description: Determines the BLE scan cycle.

Recommended range for normal scenarios is 2480÷3000mS.

Recommended range for always powered scenarios is 40÷520mS.

Resolution: 40 mS

Data Range: 40÷10200 mS

Default value: 0x49 = 2920 mS

15.5.12.2 CBLE scan duration

Address: 2357

Description: Determines the BLE scan duration in the cycle.

Recommended range for normal scenarios is 60÷101.25mS.

If value is set to 0, the FW shall override it to this default value.

Resolution: 3.75 mS

Data Range: 3.75÷956.25 mS

Default value: 0x11 = 63.75 mS

15.5.12.3 CBLE Tx power

Address: 1912 bits 4-7

Description: This parameter sets the transmit power output level of the CBLE according to the following table:

0= +8dBm (Maximal)

1= +6dBm

2= +2dBm

3= -2dBm

4= -6dBm

5= -10dBm

6= -14dBm

7= -18dBm (Minimal)

8÷15= Reserved

It's recommended to set it to the maximum value that was set for the 16 paired MS.

This is needed for many applications like beacons, child lost, some cases in logistics.

Default value: 0 = +8dBm (Maximal)

15.5.12.4 Advertisement duplications filter

Address: 1856

Description: This parameter sets the time filter done by the unit for advertisement duplications that often occur when scanning without connecting (i.e. not a paired MS/CS while unit is in Tag mode). 0=Disable filter

Resolution: 50 mS

Data range: 1÷255 = 50mS-12.75 Seconds , 0=Disable filter

Default value: 0 (Disable)