Impact detection

Introduction

When the impact detection feature is active, the FM device monitors its acceleration in all directions and generates records every time when the acceleration exceeds the configured limits. Clients can use impact detection to receive notifications to the server about irresponsible drivers, who hit sidewalks or other obstacles. This feature can also be used for rollover detection in environments, where vehicle rollover is possible.

This feature is available for the following devices with the latest firmware version:

- FM-Tco4 HCV
- FM-Tco4 LCV
- FM-Pro4
- FM-Eco4/Eco4-light
- FM-Eco4 S
- FM-Plug4

You can get the latest firmware and configurator from our documentation website: doc.ruptela.lt

Legal notice

Document change log

Date	Version	Change details
2016-09-07	1.0	Initial draft.
2016-09-23	1.1	Shock detection feature now available for the FM-Eco4 / Eco4-light devices.
2016-10-06	1.2	Added Rollover detection feature description.
2016-10-24	1.3	Shock detection operation in sleep mode and in deep sleep mode.
2016-11-18	1.4	Rollover detection feature available for FM-Eco4/4+ and FM-Eco4 light/light+ devices. Updated recommendations for shock detection IO parameters.
2018-08-29	1.5	Compatible device list updated. Added description of optional impact calculation on the Z axis. Rollover detection default values updated.
2018-10-08	1.6	Updated calibration description.
2018-11-08	1.7	Shock detection and rollover detection are now available for FM-Plug4.

Impact type: Shock detection

Definitions

- Discrimination threshold – all acceleration values below this limit will be ignored.
- Peak-Limit – a minimum acceleration value that needs to be reached in order to register a shock event.
- Duration-Limit – a minimum shock duration required for it to be registered as a shock event.

Operation principles

The device can detect shock in all three axes separately. In our calculations we use a magnitude (or length) of a resultant acceleration vector, which is composed of three acceleration components. These components are accelerations in X, Y and Z axes. The magnitude of the resultant acceleration vector can easily be calculated as follows: $\|\boldsymbol{a}\| = \sqrt{\boldsymbol{a}_x^2 + \boldsymbol{a}_y^2 + \boldsymbol{a}_z^2}$

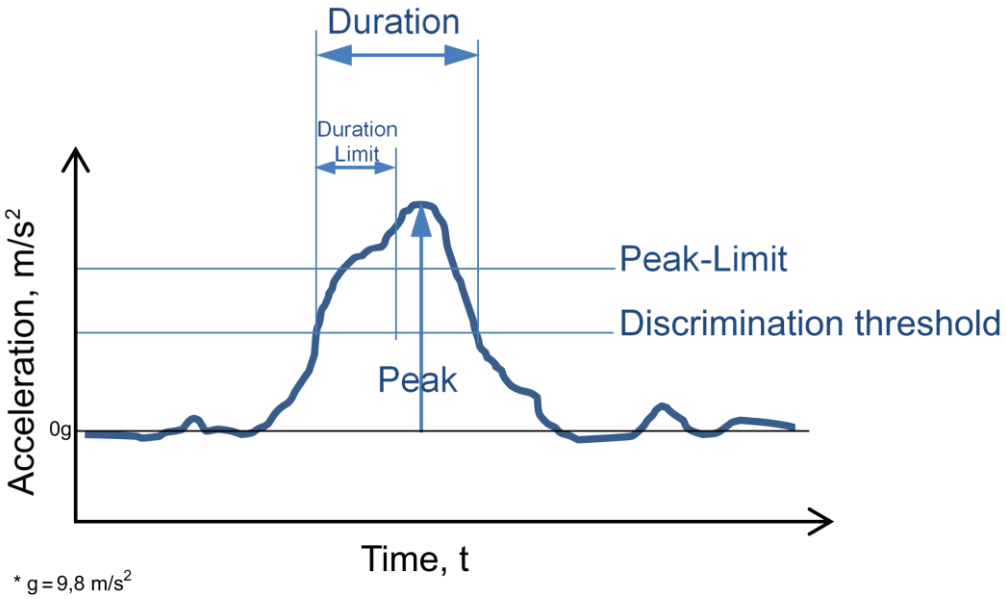
The boundary conditions for the resultant vector are defined by the discrimination threshold and the peak-limit. When the resultant vector crosses the discrimination threshold a shock event can be generated. Note that the resultant vector is then decomposed into its constituent accelerations and shock data records contain values of these three acceleration components: $\boldsymbol{a}_x;\ \boldsymbol{a}_y;\ \boldsymbol{a}_z$.

Note

Only acceleration experienced from the shock itself is included in the results. The permanent component due to Earth's gravity, present in the z axis direction, is subtracted from the results. Therefore, in a default state, the acceleration measured by the device will be 0 m/s^2 in all directions.

Shock evaluation procedure:

1. Only shock events with an acceleration amplitude that exceeds the configurable discrimination threshold are processed.
2. The shock duration is measured at the discrimination threshold level.
3. The shock acceleration amplitude is measured at the peak acceleration value.
4. Only a shock with an amplitude higher than the configurable peak-limit and a duration longer than the configurable duration limit is processed further.
5. Processing further means that the FM device sends an I/O event with the records to the server (or stores the event data and sends it the next time, when a transmission occurs).



Shock detection operation in sleep/deep sleep mode

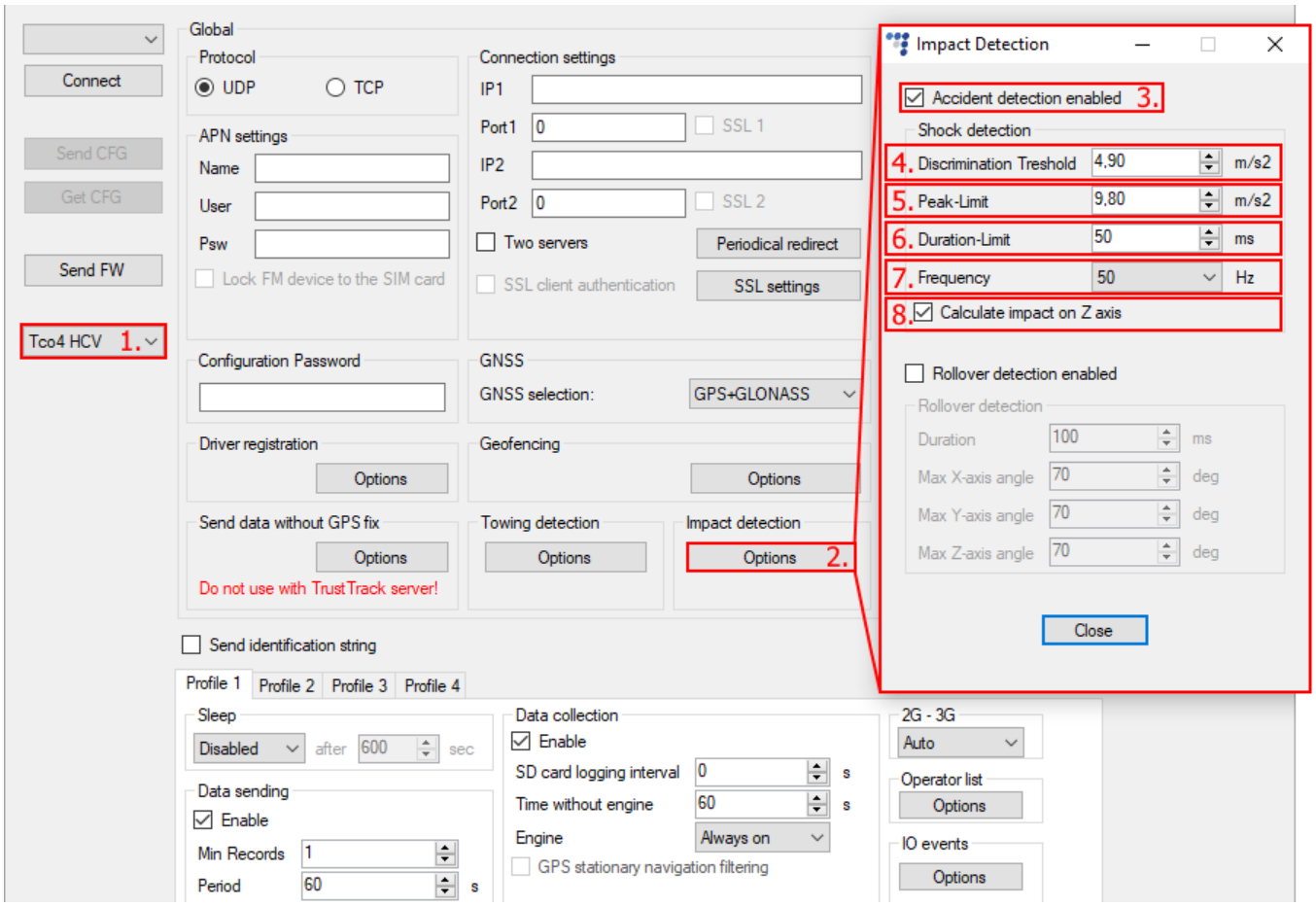
If shock detection is enabled, the device cannot enter sleep mode or deep sleep mode.

Shock detection configuration

Enabling shock detection

The first part of configuration is about setting correct the limiting values for shock detection.

1. In the main configurator window choose your device.
2. Under **Global** settings, in the **Impact detection** section locate and click the "Options" button. It opens up a new **Impact Detection** popup window.
3. Tick the **Accident detection enabled** checkbox. The configurable fields below will become active.
4. **Discrimination Threshold** – when the amplitude exceeds this level, the measurement of the shock event starts. The range is from 0,98 m/s^2 to 39,2 m/s^2. The default value is 4,9 m/s^2.
5. **Peak-limit** – only shock events with equal or higher amplitudes are processed further. The range is from 0,98 m/s^2 to 39,2 m/s^2. The default value is 9,8 m/s^2.
6. **Duration-limit** – only shock events with equal or longer durations are processed further. The range is from 20 ms to 1000 ms. The default value is 50 ms.
7. **Frequency** – determines how often the device uses the accelerometer to check, if a shock event has occurred. Values to choose from: 2, 4, 5, 10, 20, 25, 50 Hz. The default frequency is 50Hz.
8. **Calculate impact on Z axis** – if this checkbox is ticked, the Z axis will be included in shock detection measurements. Unticking the checkbox will include only the X and Y axes. This checkbox is ticked by default.

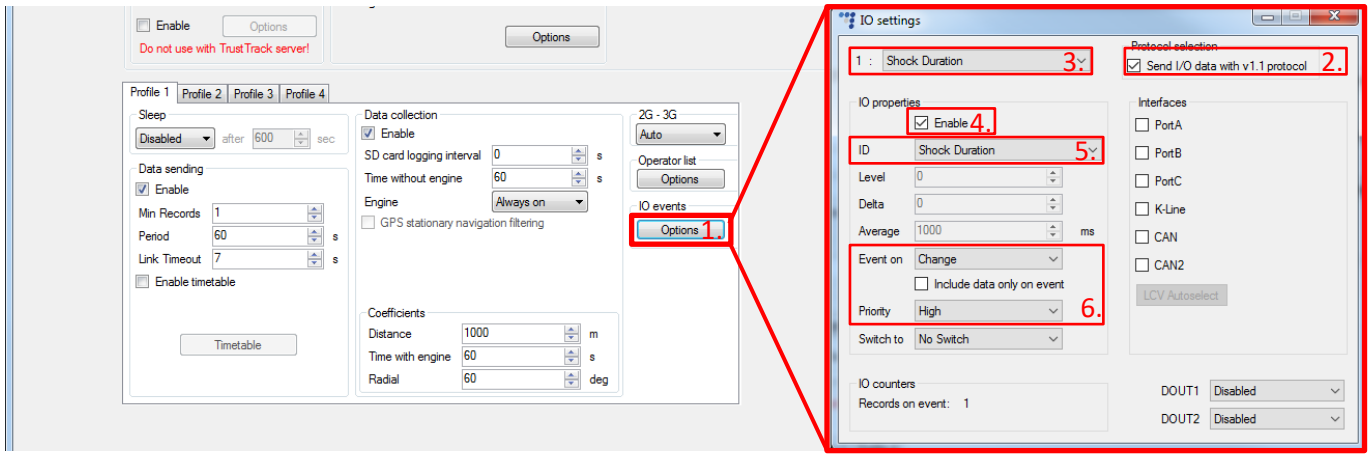


Enable shock detection IO parameters

To register shock events, you have to enable shock detection IO parameters:

1. In the **IO events** section click on the "Options" button. It opens up a new **IO settings** window, here you can enable or disable IO parameters.
2. In **Protocol selection** section put a tick in **Send I/O data with v1.1 protocol** checkbox. After this step, shock detection IO parameters will be displayed in the IO list.
3. Select a slot that you want to enable.
4. In the **IO properties** section tick the **Enable** check box, otherwise the slot will remain empty.
5. **ID** contains the parameters list. Choose a parameter you want to enable for the selected slot. For the shock detection functionality choose *Shock duration, G Peak X, G Peak Y, G Peak Z* IO parameters.
6. Parameters can be configured to generate records with Event on *Monitoring* or on *Change*. We recommend to set at least one shock detection IO parameter to generate records with Event on *Change*, Priority *High*. With this configuration you would get notifications about shock events as soon as they occur.

   More details about these parameters are available below.



Shock detection IO parameters

IO ID	Parameter name	Size, B	Min. value	Max. value	IO factor	Description
576	Shock Duration	2	20	5000	1ms per bit	Shock duration in milliseconds
584	G Peak X	2	-4000	4000	$\frac{g}{1000}$ per bit	Acceleration in X axis expressed via gravitational (free-fall) acceleration constant g=9,8m/s^2
585	G Peak Y	2	-4000	4000	$\frac{g}{1000}$ per bit	Acceleration in Y axis expressed via gravitational (free-fall) acceleration constant g=9,8m/s^2
586	G Peak Z	2	-4000	4000	$\frac{g}{1000}$ per bit	Acceleration in Z axis expressed via gravitational (free-fall) acceleration constant g=9,8m/s^2

IO parameters with ID 584, 585 and 586 must be configured to generate records with Event on *Monitoring.*
IO parameter ID 576 must be configured to generate records with Event on *Change*.
There is a possibility, that with other configurations shock detection will not work.

Note

To enable the *Shock duration*, *G Peak X*, *G Peak Y* and *G Peak Z* IO parameters you must use the extended v1.1 protocol version.

Axis notation

After calibration, accelerations in different axis directions will be arranged as follows:

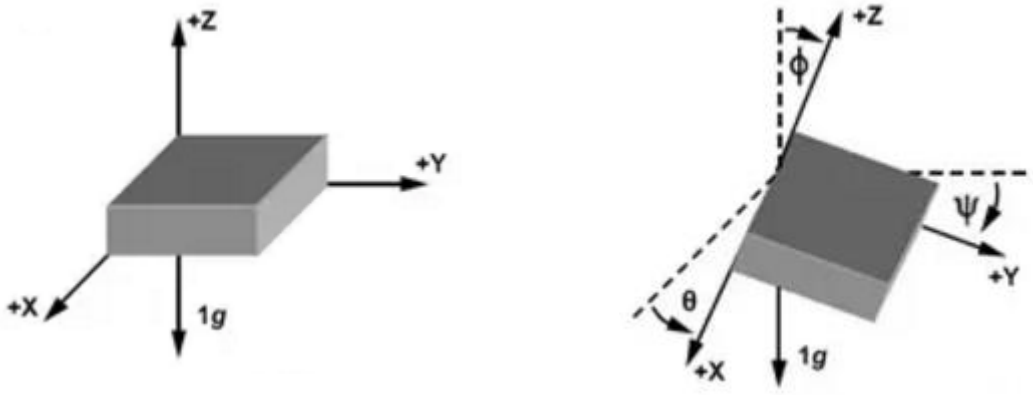
- G Peak X – acceleration sideways
- G Peak Y - acceleration forward/backward
- G Peak Z - acceleration upward/downward

Impact type: Rollover detection

Definitions

- Θ (theta) – the angle between x-axis and the horizon;
- Ψ (psi) – the angle between y-axis and the horizon;
- Φ (phi) – the angle between the gravity vector and the z-axis.
- $\mathbf{a}_X$ – the acceleration along the x-axis*;
- $\mathbf{a}_Y$ – the acceleration along the y-axis*;
- $\mathbf{a}_Z$ – the acceleration along the z-axis*;

** The acceleration along each axis is expressed via gravitational (free-fall) acceleration constant g=9,8m/s²*



Principles of operation

If this functionality is enabled, the FM device constantly monitors the vehicle's angles in relation to the horizontal plane. The horizontal plane orientation in relation to the FM device is determined during accelerometer calibration.

A rollover event will be registered, if these conditions are satisfied:

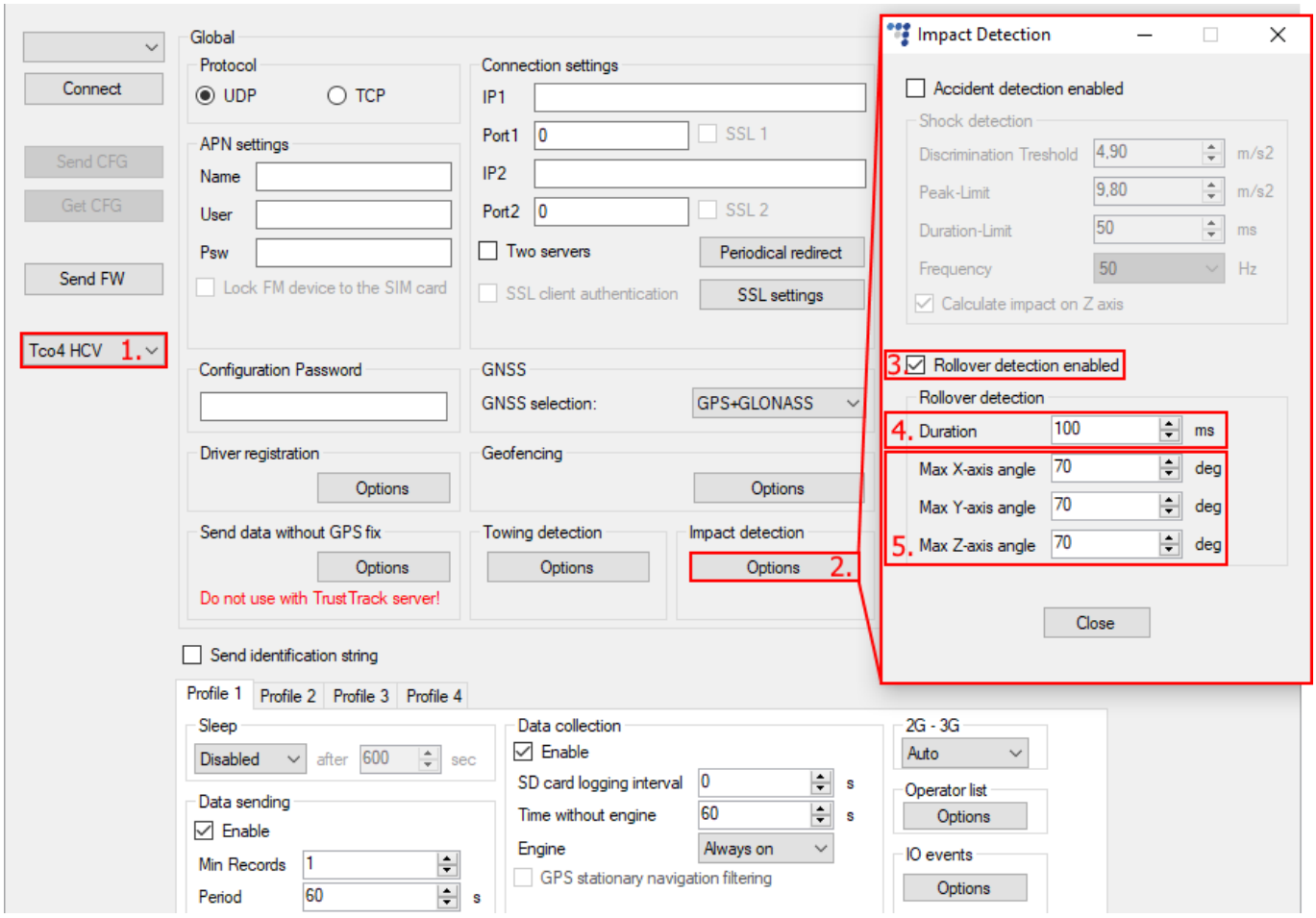
- The vehicle's tilt angle in any axis is bigger than the predefined value.
- It remains in that position for a longer time period than the predefined duration.

Rollover detection configuration

Enabling rollover detection

The first part of the configuration is about setting the correct limiting values for rollover detection.

1. In the main configurator window choose your device.
2. Under **Global** settings, in the **Impact detection** section locate and click the "Options" button. It opens up a new **Impact Detection** popup window.
3. Tick the **Rollover detection enable** checkbox. The configurable fields below will become active.
4. **Duration** - only rollover events with equal or longer durations are registered. The range is from 0 ms to 10000 ms. The default value is 100 ms.
5. **Max X-axis angle**, **Max Y-axis angle** and **Max Z-axis angle** – the maximum allowed vehicle tilt value along each axis in relation to the horizontal plane. The range is from 0° to 180°. The default value is 70°.



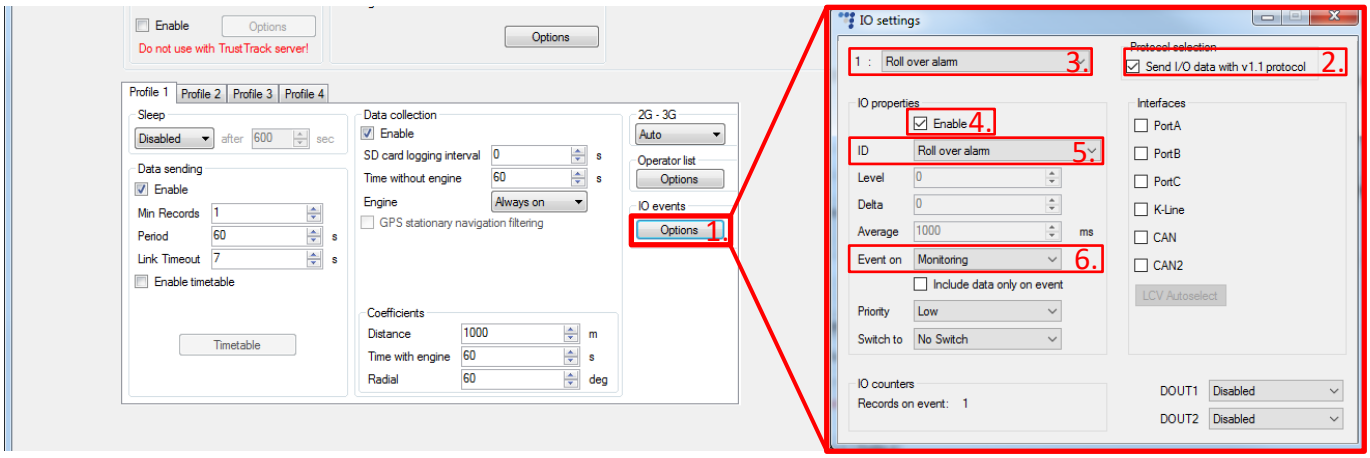
Enable rollover detection IO parameters

To register rollover events, you have to enable rollover detection IO parameters:

1. In the **IO events** section click on the "Options" button. It opens up a new "IO settings" window, here you can enable or disable IO parameters.
2. In **Protocol selection** section put a tick in **Send I/O data with v1.1 protocol** checkbox. After this step, rollover detection IO parameters will be displayed in the IO list.
3. Select a slot that you want to enable.
4. In the **IO properties** section tick the **Enable** check box, otherwise the slot will remain empty.

5. **ID** contains the parameters list. Choose a parameter you want to enable for the selected slot. For the rollover detection functionality choose *Roll over alarm, X axis tilt angle, Y axis tilt angle, Z axis tilt angle IO* parameters.
6. Parameters can be configured to generate records with Event on *Monitoring* or on *On Hysteresis*.

More details about these parameters are available below.



Rollover detection IO parameters

IO ID	Parameter name	Size, B	Min. value	Max. value	Description
411	Roll over detection	1	0	1	0 - no alarm, 1 - roll over detected
611	X axis tilt angle	2	-180	180	Vehicle tilt angle along the X axis in relation to the horizontal plane
612	Y axis tilt angle	2	-180	180	Vehicle tilt angle along the Y axis in relation to the horizontal plane
613	Z axis tilt angle	2	-180	180	Vehicle tilt angle along the Z axis in relation to the horizontal plane

Accelerometer calibration

The FM device uses a built-in accelerometer to register shock and rollover events. The detection is largely based on accelerometer's measurements. To ensure proper operation, the accelerometer must be calibrated. The accelerometer is calibrated automatically, the existing calibration can be reset using the *accreset* SMS command.

A detailed accelerometer calibration process description is available in the "Eco-Drive configuration" manual.