

Impact detection

Introduction

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

Shock detection feature for different FM devices is available starting with these firmware versions:

- FM-Tco4 HCV - 00.02.20.10
- FM-Tco4 LCV - 00.02.20.10
- FM-Pro4 - 00.02.20.10
- FM-Eco4 / Eco4-light – 00.01.19.06

Rollover detection feature for different FM devices is available starting with these firmware versions:

- FM-Tco4 HCV - 00.02.22.02
- FM-Tco4 LCV - 00.02.22.02
- FM-Pro4 - 00.02.22.02
- FM-Eco4/4+ and FM-Eco4 light/light+ - 00.01.20.10

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

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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.

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 a shock in all three axis 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 axis. A magnitude of a resultant acceleration vector can be easily calculated as follows: $\|a\| = \sqrt{a_x^2 + a_y^2 + a_z^2}$

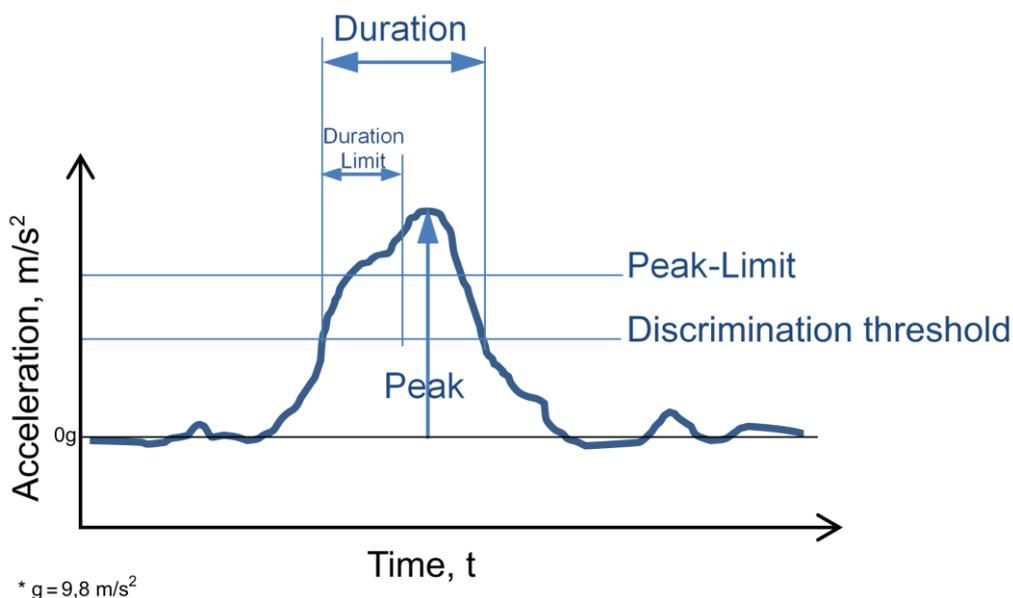
Boundary conditions for the resultant vector are defined by the "Discrimination threshold" and the "Peak-Limit". When the resultant vector crosses the discrimination threshold a shock event can be generated. Note that the resultant vector is then decomposed into its constituent accelerations and records with shock data contain values of these three acceleration components: a_x ; a_y ; a_z .

Note

Only acceleration experienced from the shock itself is included in the results. Permanent component due to earth's gravity, present in the z axis direction is subtracted from the results. Therefore, in a default state acceleration measured by the device will be 0 m/s² 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 the shock with an amplitude higher than a configurable "Peak-Limit" and a "Duration" longer than a configurable "Duration-Limit" is processed further.
5. Processing further means that the FM device sends an I/O event data 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

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

Shock detection configuration

Enable shock detection

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

1. In the main configurator window choose your device (*FM-Tco4 LCV, FM-Tco4 HCV, FM-Pro4, FM-Eco4*).
2. Under **Global** settings, in the **Impact detection** section locate and click on the "Options" button. It opens up a new "Impact Detection" popup window.
3. Tick the **Shock detection enable** check box. Configurable fields below will be active.
4. **Discrimination Threshold** – When the amplitude exceeds this level the measurement of the shock event starts. Range is from 0,98 m/s² to 39,2 m/s². Default value is 4,9 m/s².
5. **Peak-limit** - Only shock events with equal or higher amplitudes are processed further. Range is from 0,98 m/s² to 39,2 m/s². Default value is 9,8 m/s².
6. **Duration-limit** - Only shock events with equal or longer durations are processed further. Range is from 20 ms to 1000 ms. 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. Default frequency is 50Hz

The screenshot displays the Ruptela Transport Telematics configurator interface. The main window shows various settings for a device, including Global settings, Connection settings, Authorized numbers, Eco-drive, Authorized IDs, Driver registration, GNSS, Geofencing, Towing detection, Impact detection, and Profile settings. The Impact detection section is highlighted with a red box, and the 'Options' button is also highlighted with a red box and labeled '2.'. A red-bordered popup window titled 'Impact Detection' is open, showing the following settings:

- 3. Shock detection enabled
- 4. Discrimination Threshold: 4,90 m/s²
- 5. Peak-Limit: 9,80 m/s²
- 6. Duration-Limit: 50 ms
- 7. Frequency: 50 Hz

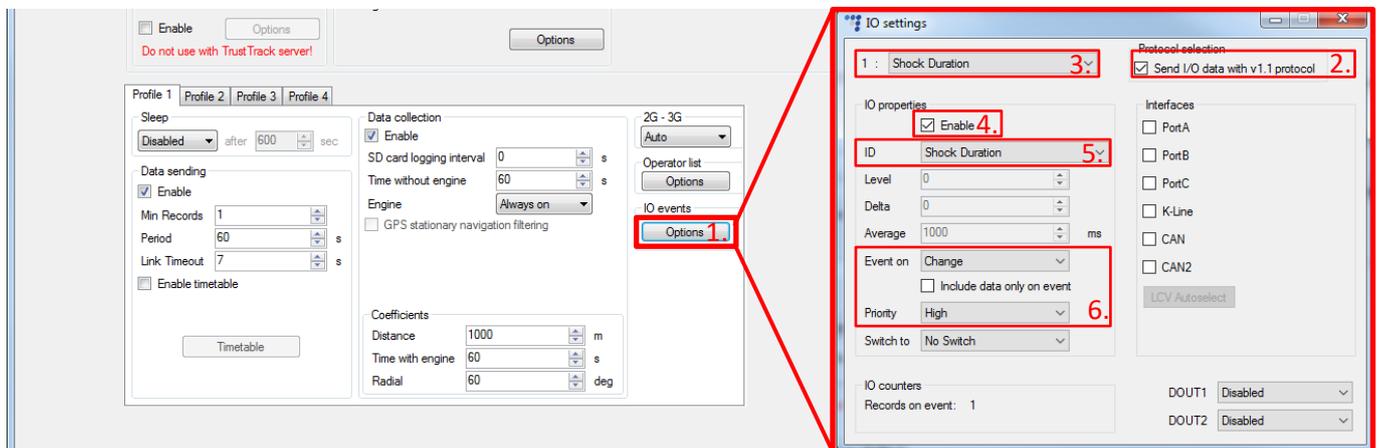
Below these settings, there are options for Rollover detection, which are currently disabled. The 'Close' button is visible at the bottom of the popup window.

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 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 $g=9,8m/s^2$

584,585 and 586 I/O ID parameters must be configured to generate records with Event on *Monitoring*. I/O parameter ID 576 must be configured to generate records with Event on *Change*.

There is possibility, that with other configurations shock detection will not work.

Note

To enable "Shock duration", "G Peak X", "G Peak Y" and "G Peak Z" parameters you have to use an extended v1.1 protocol version.

Axis notation

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

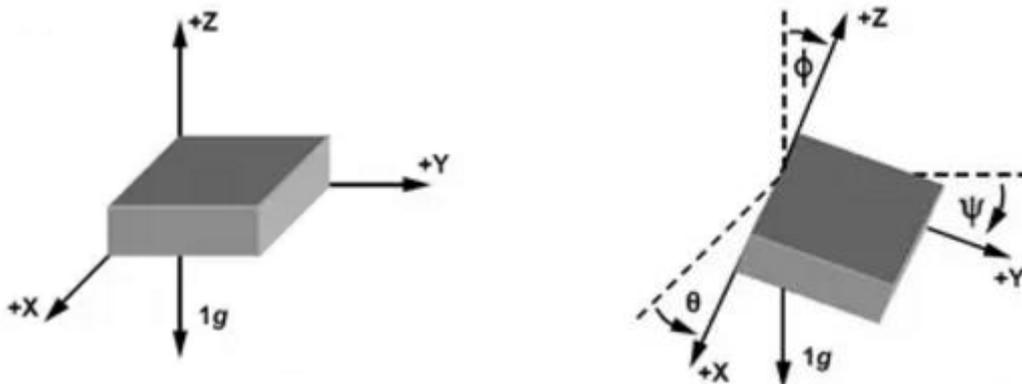
- G Peak X – Acceleration sideways
- G Peak Y - Acceleration forward / backward
- G Peak Z - Acceleration upward / downward

Impact type: Rollover detection

Definitions

- Θ (theta) angle between x-axis and a horizon;
- Ψ (psi) angle between y-axis and a horizon;
- Φ (phi) angle between the gravity vector and the z-axis.
- a_x – acceleration along the x-axis*;
- a_y – acceleration along the y-axis*;
- a_z – acceleration along the z-axis*;

* Acceleration along each axis expressed via gravitational (free-fall) acceleration constant $g=9,8m/s^2$



Operation principles

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

Rollover event will be registered, if these conditions are satisfied:

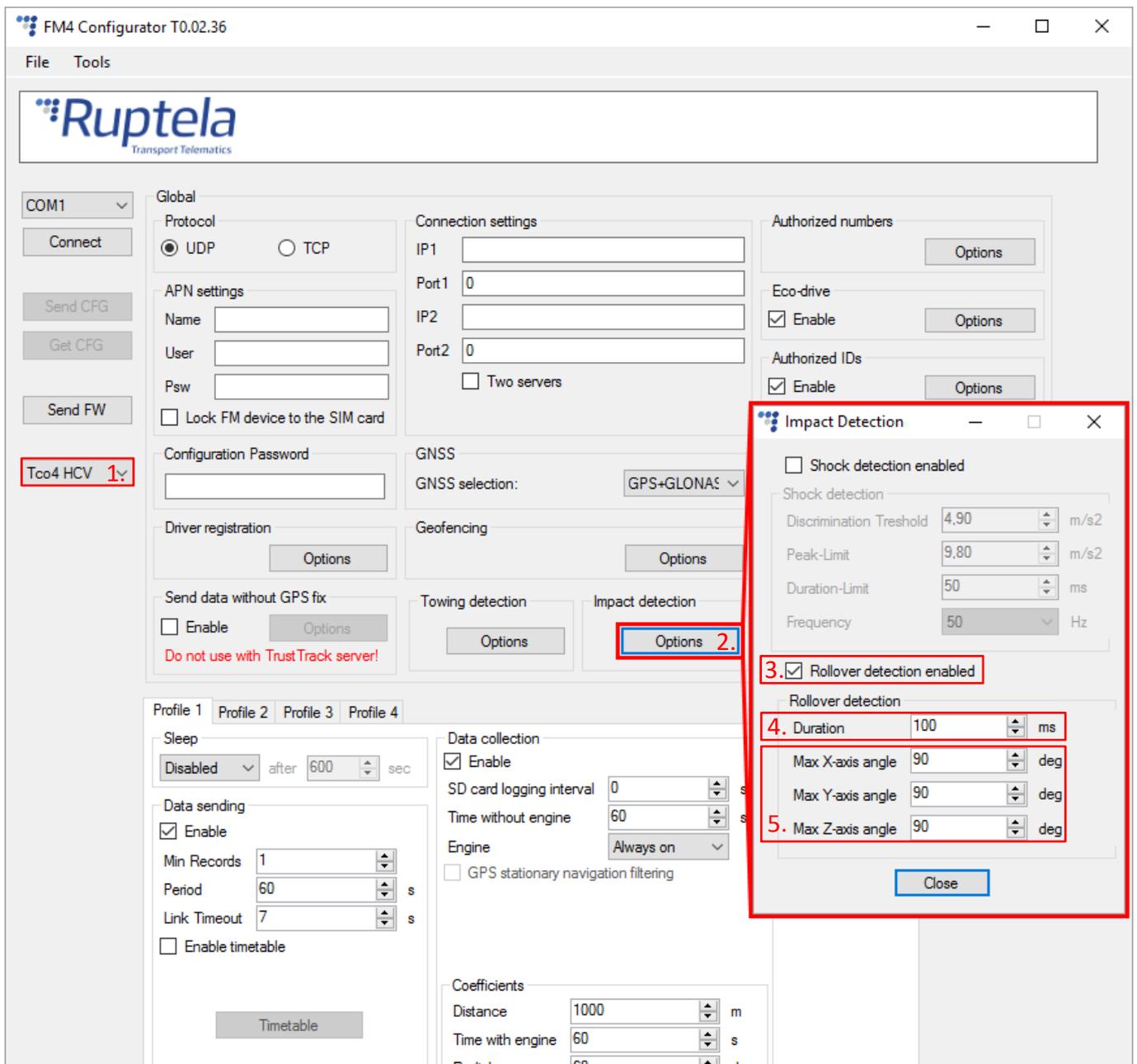
- Vehicle's tilt angle in any axis is higher than the predefined value.
- It remains in that position for longer time period, than the predefined duration.

Rollover detection configuration

Enable shock detection

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

1. In the main configurator window choose your device (*FM-Tco4 LCV, FM-Tco4 HCV, FM-Pro4, FM-Eco4*).
2. Under **Global** settings, in the **Impact detection** section locate and click on the "Options" button. It opens up a new "Impact Detection" popup window.
3. Tick the **Rollover detection enable** check box. Configurable fields below will be active.
4. **Duration** - Only rollover events with equal or longer durations are registered. Range is from 0 ms to 10000 ms. Default value is 100 ms.
5. **Max X-axis angle, Max Y-axis angle** and **Max Z-axis angle** – Maximum allowed vehicle's tilt value along each axis in relation to the horizontal plane. Range is from 0° to 180°. Default value is 90°.

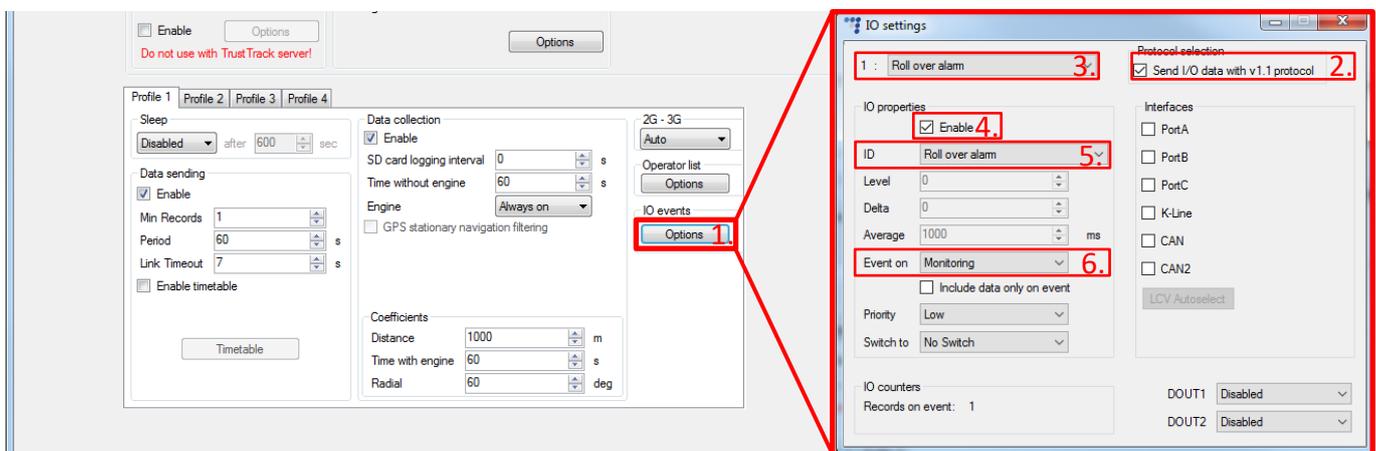


Enable rollover detection IO parameters

To register rollover events you have to enable corresponding 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 available below.



Rollover detection IO parameters

IO ID	Parameter name	Size, B	Min. value	Max. value	IO factor	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 x axis in relation to the horizontal plane
612	Y axis tilt angle	2	-180	180		Vehicle tilt angle along y axis in relation to the horizontal plane
613	Z axis tilt angle	2	-180	180		Vehicle tilt angle along z axis in relation to the horizontal plane

Accelerometer calibration

The FM device uses a built-in accelerometer to register shock and rollover events. Detection is largely based on accelerometer's measurements. To ensure proper operation you have to calibrate your accelerometer. Calibration must be performed after shock or rollover detection configuration (limiting values are set, IO events enabled). If accelerometer was calibrated earlier (before shock or rollover detection implementation), you must recalibrate it.

A detailed accelerometer calibration process description is available in the "[Eco-Drive from Accelerometer](#)" document.