# LSM6DSL - iNEMO inertial module: always-on 3D accelerometer and 3D gyroscope

Milano, October 19th-20th 2016

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# Summary

- XL/Gyro filtering chain

- Embedded digital features:
  - Free-fall
  - Wake-up
  - 6D/4D orientation detection
  - Single-tap and double-tap sensing
  - Activity/Inactivity recognition

- Embedded Android functions:
  - Pedometer functions (step counter and step detector)
  - Significant Motion detection
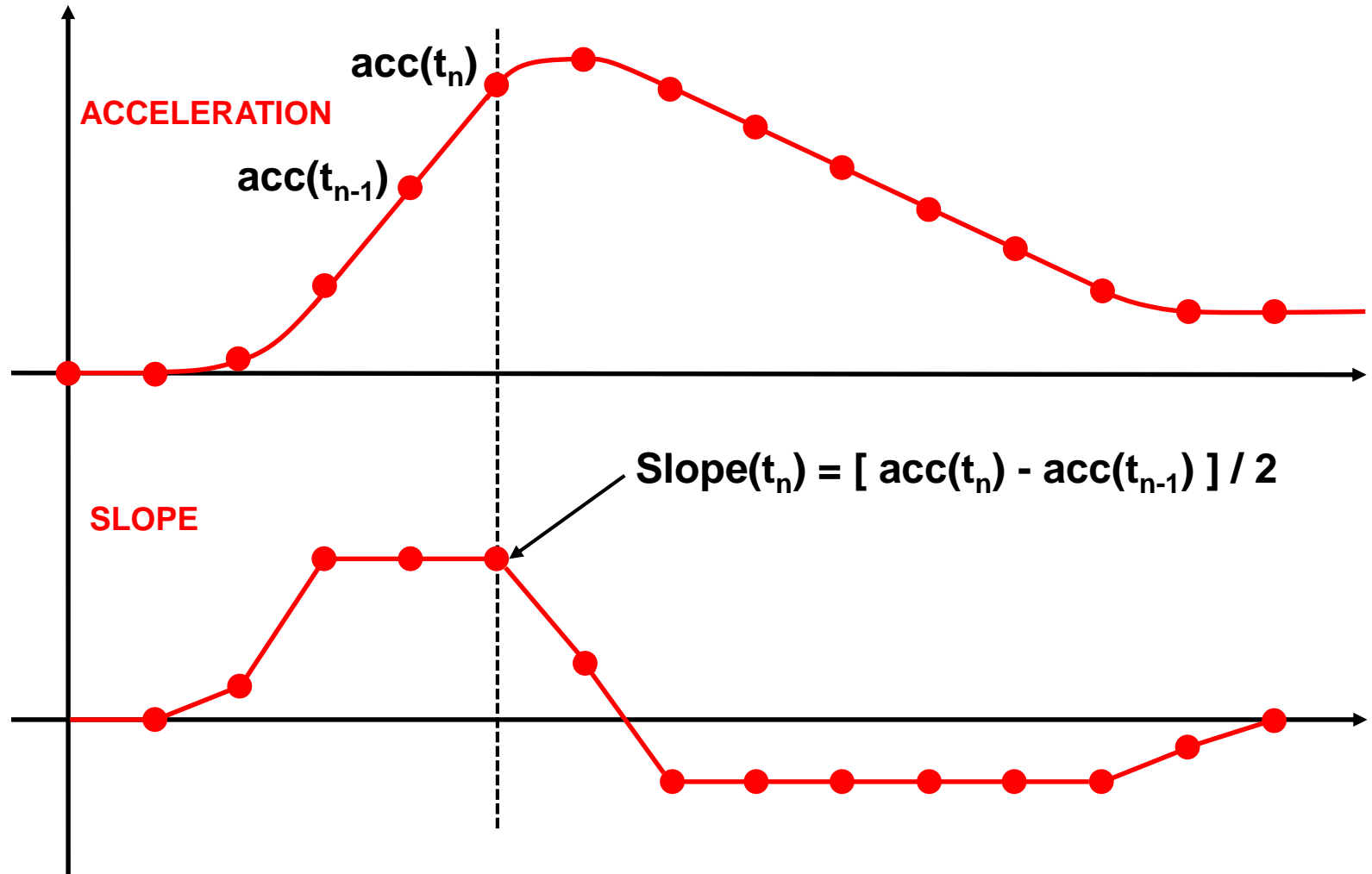  - Relative Tilt

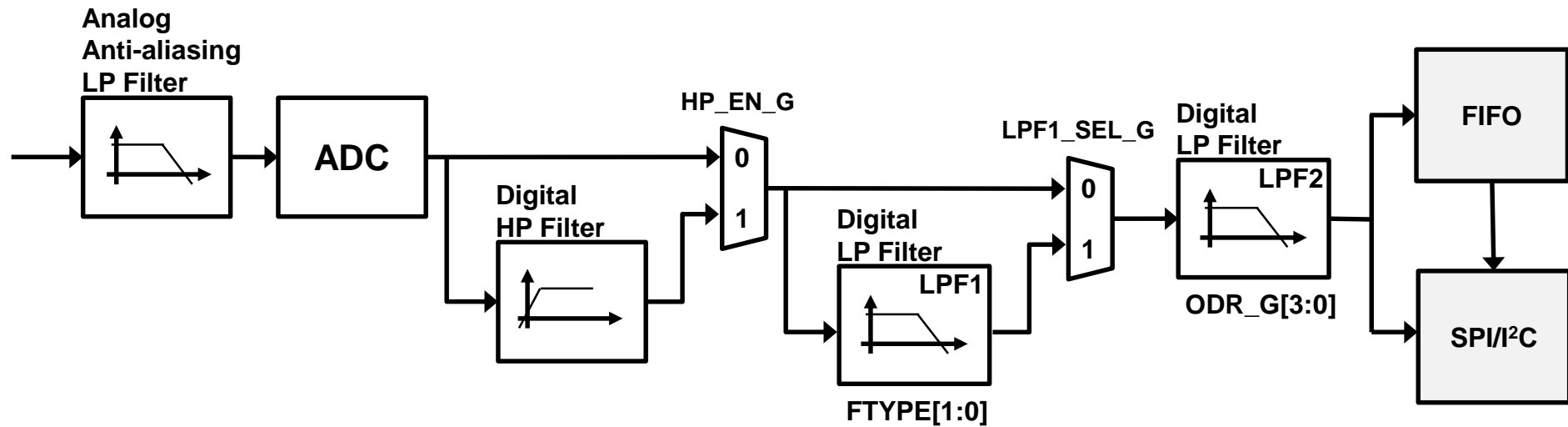- Mode 2: Sensor Hub mode

- FIFO

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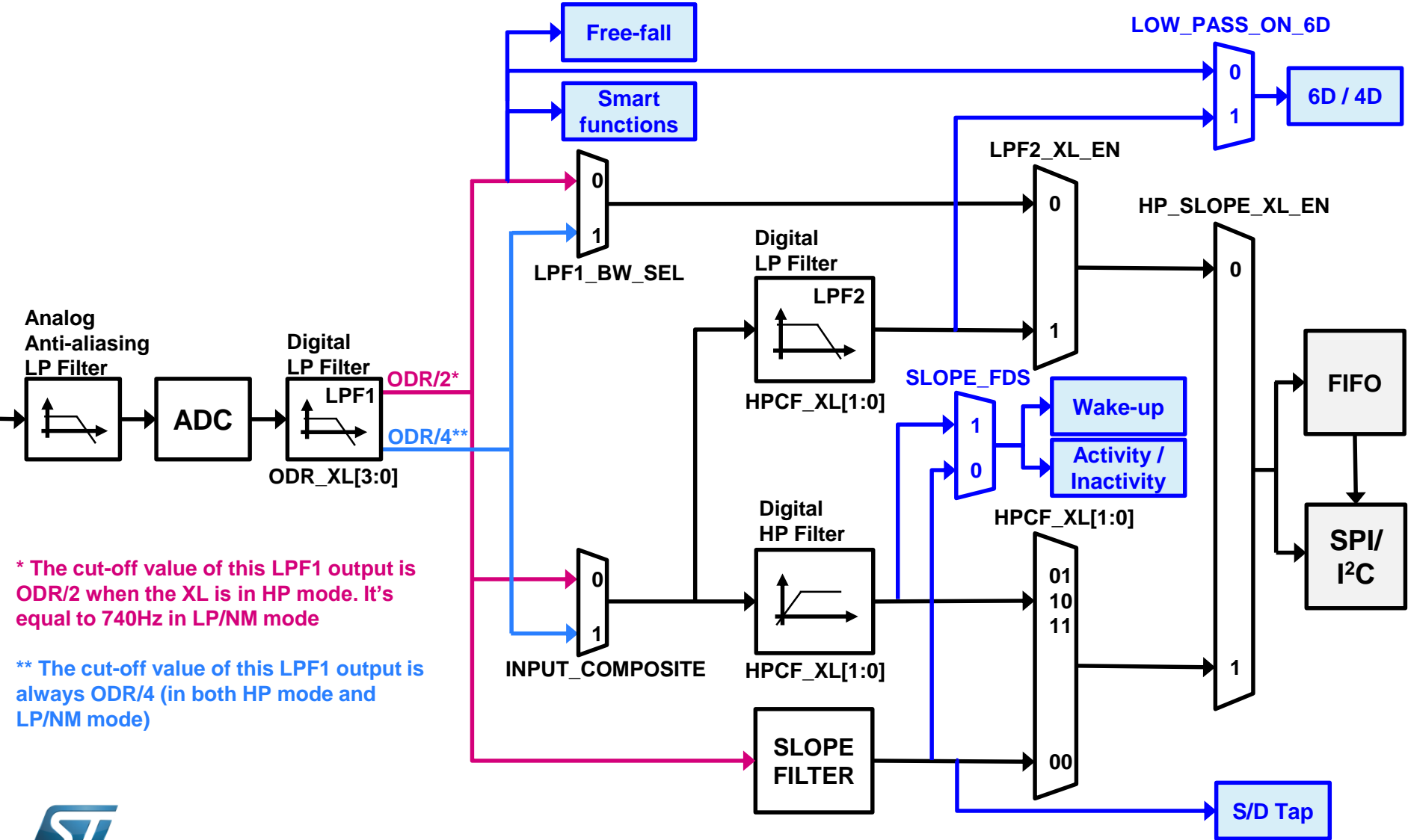
**\* The cut-off value of this LPF1 output is ODR/2 when the XL is in HP mode. It's equal to 740Hz in LP/NM mode**

**\*\* The cut-off value of this LPF1 output is always ODR/4 (in both HP mode and LP/NM mode)**

ACCELERATION

$acc(t_n)$

$acc(t_{n-1})$

SLOPE

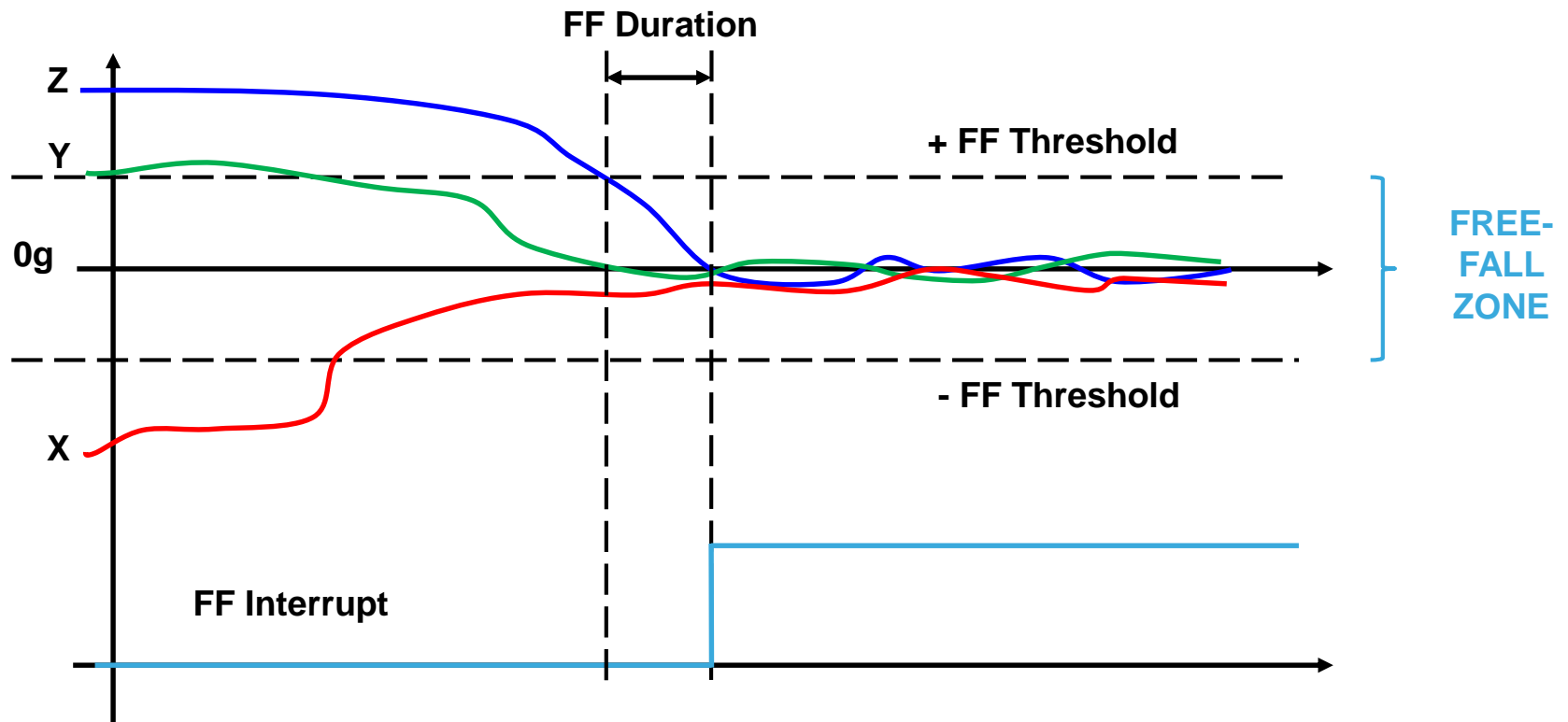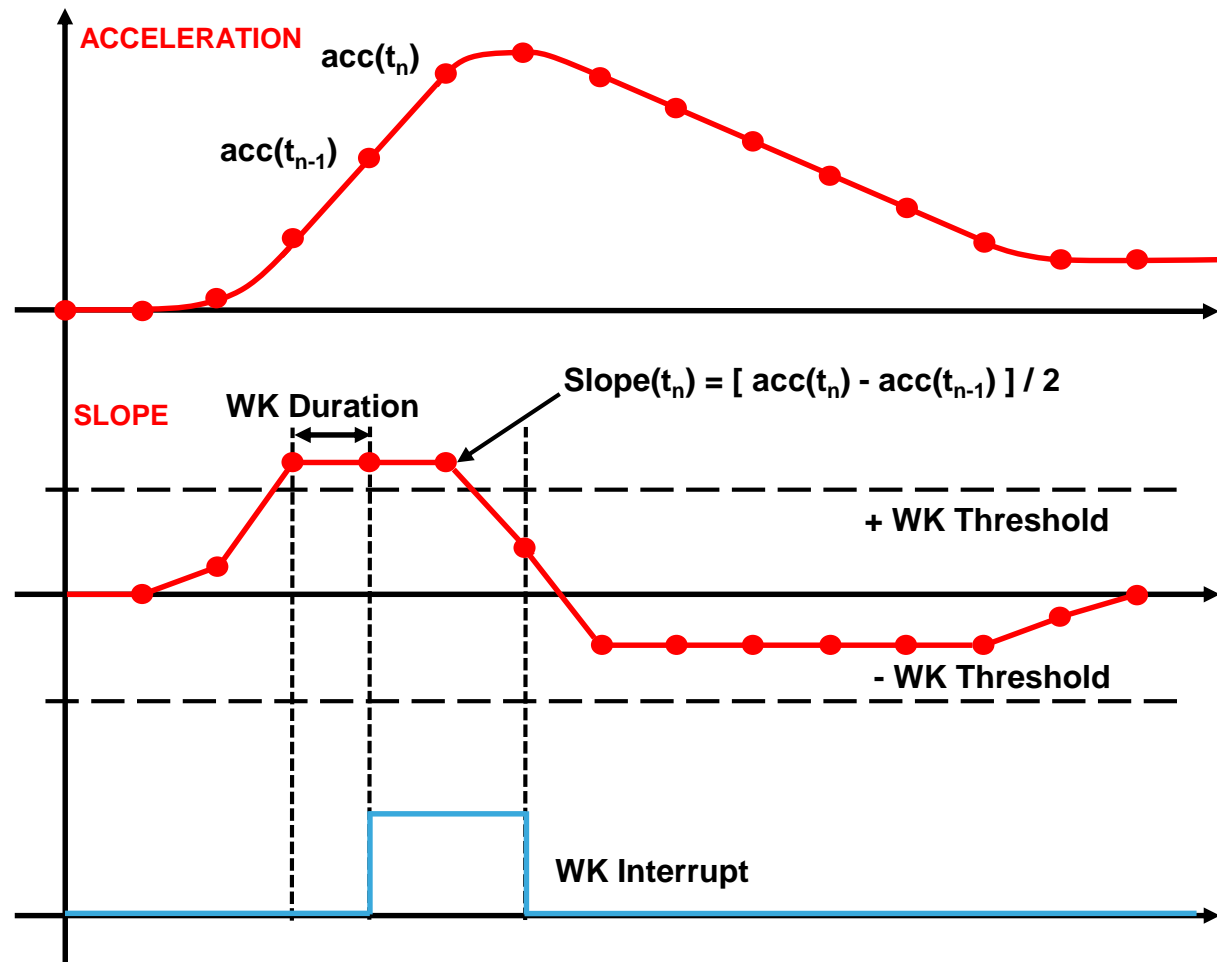$Slope(t_n) = [\ acc(t_n) - acc(t_{n-1})\ ]\ /\ 2$

# Gyroscope Filtering Chain

# Free-fall detection

- Recognize when the device is in free-fall

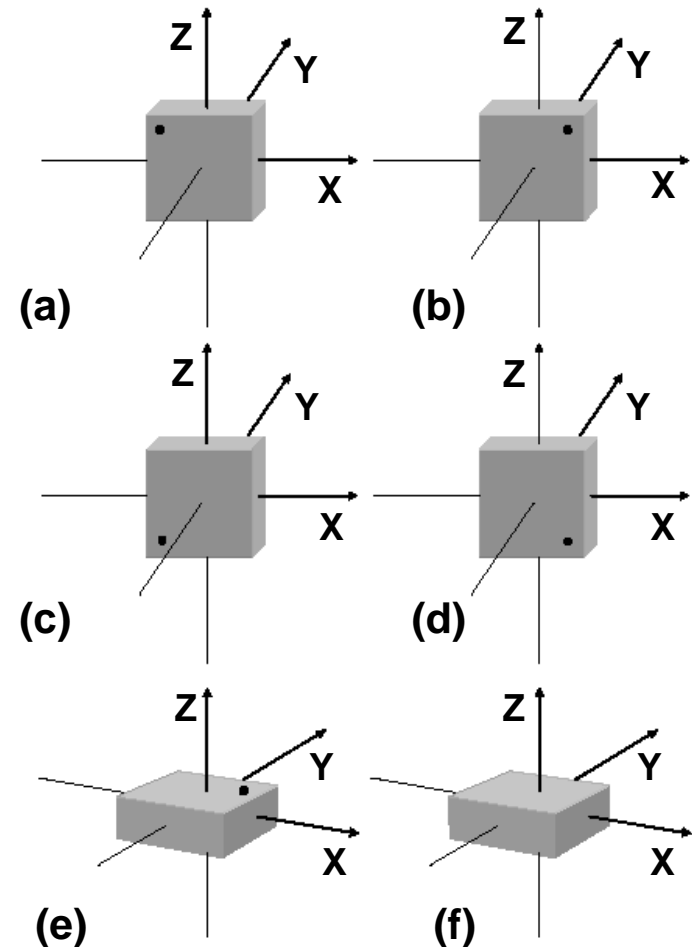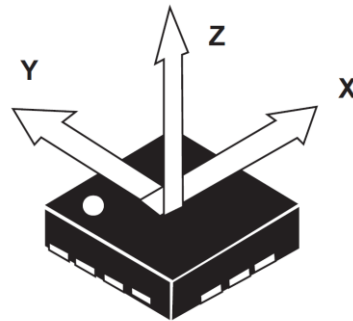- Configurable parameters:
  - FF Threshold
  - FF Duration

**FF Duration**

Z

Y

**+ FF Threshold**

0g

**FREE-FALL ZONE**

**- FF Threshold**

X

**FF Interrupt**

# Wake-up

- Recognize when the device is moved

- Configurable parameters:
  - WK Threshold
  - WK Duration

**ACCELERATION**

acc($t_n$)

acc($t_{n-1}$)

Slope($t_n$) = [ acc($t_n$) - acc($t_{n-1}$) ] / 2

**SLOPE**

**WK Duration**

**+ WK Threshold**

**- WK Threshold**

**WK Interrupt**

# 6D/4D orientation detection

- Detect the orientation of the device in space, enabling easy implementation of energy-saving procedures and automatic image rotation for mobile devices

- Configurable parameters:
  - 6D Threshold (50°, 60°, 70°, 80°)
  - 6D/4D detection mode

# Single-tap and double-tap sensing

- Generate interrupt signal when the device is single/double tapped in any direction (recommended XL ODR >= 400Hz)

- Configurable parameters:
  - Tap Threshold
  - Shock time
  - Quiet time (Double tap)
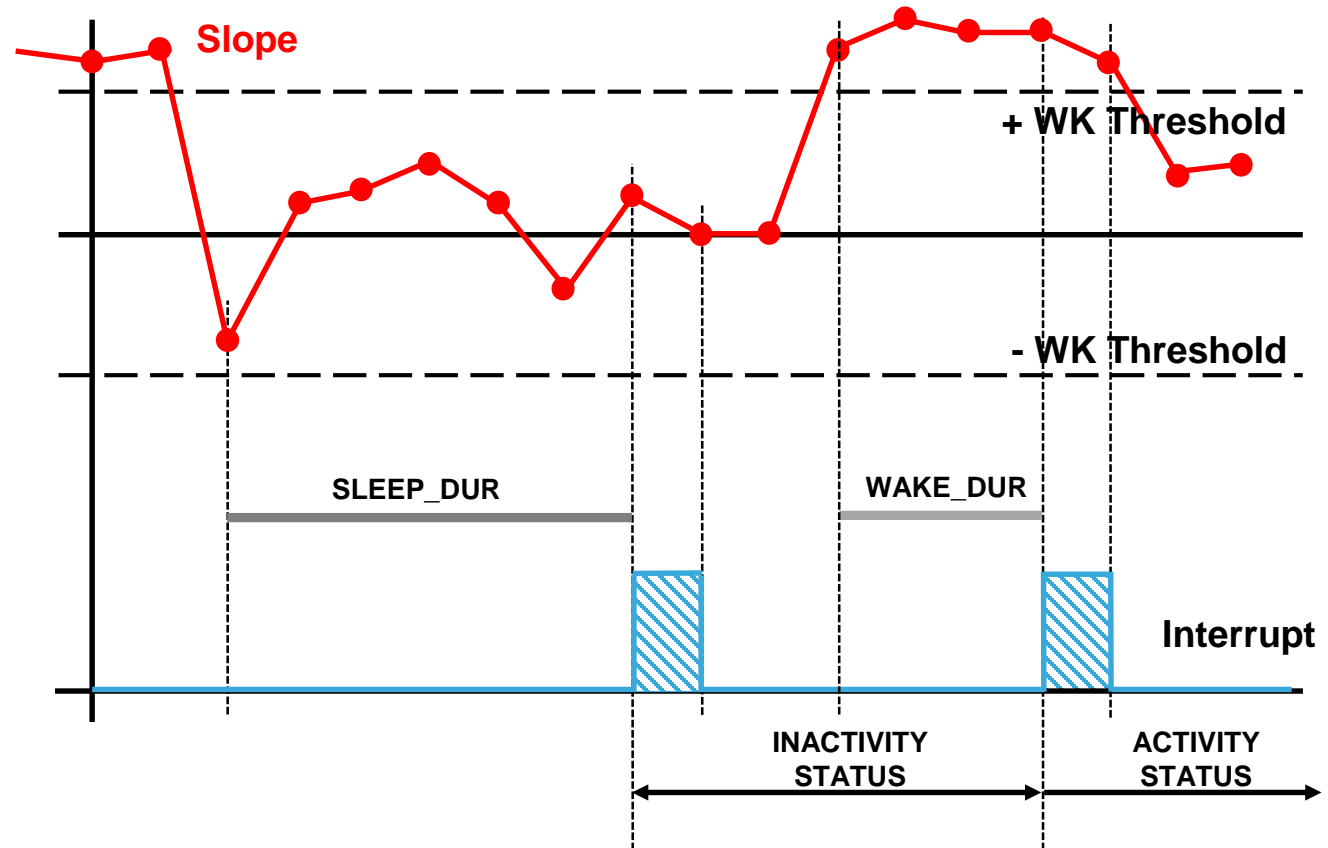  - Duration time (Double tap)
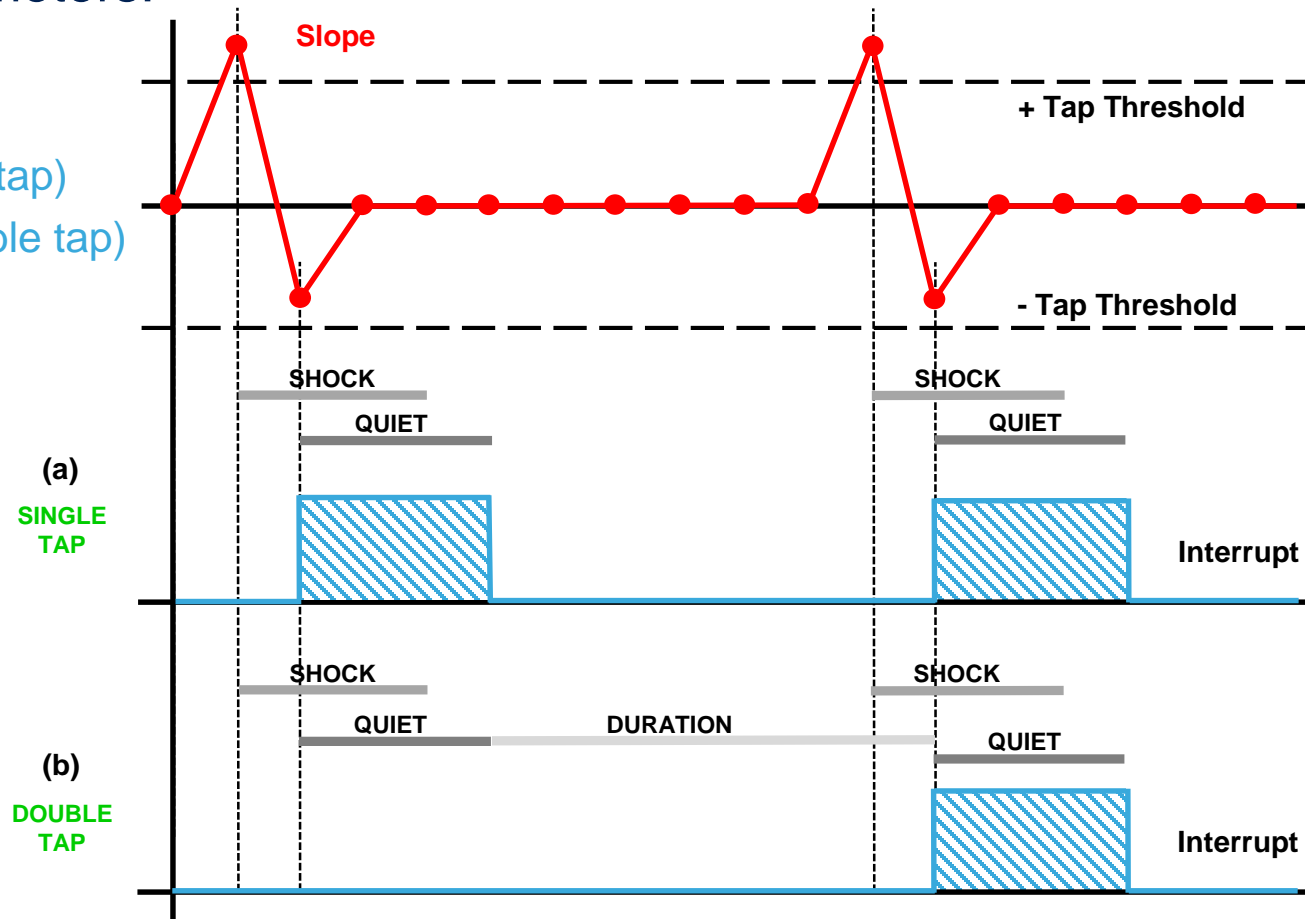
# Activity/Inactivity recognition

- Automatically decrease the accelerometer sampling rate to 12.5 Hz, increasing the accelerometer ODR and bandwidth as soon as the wake-up interrupt event has been detected
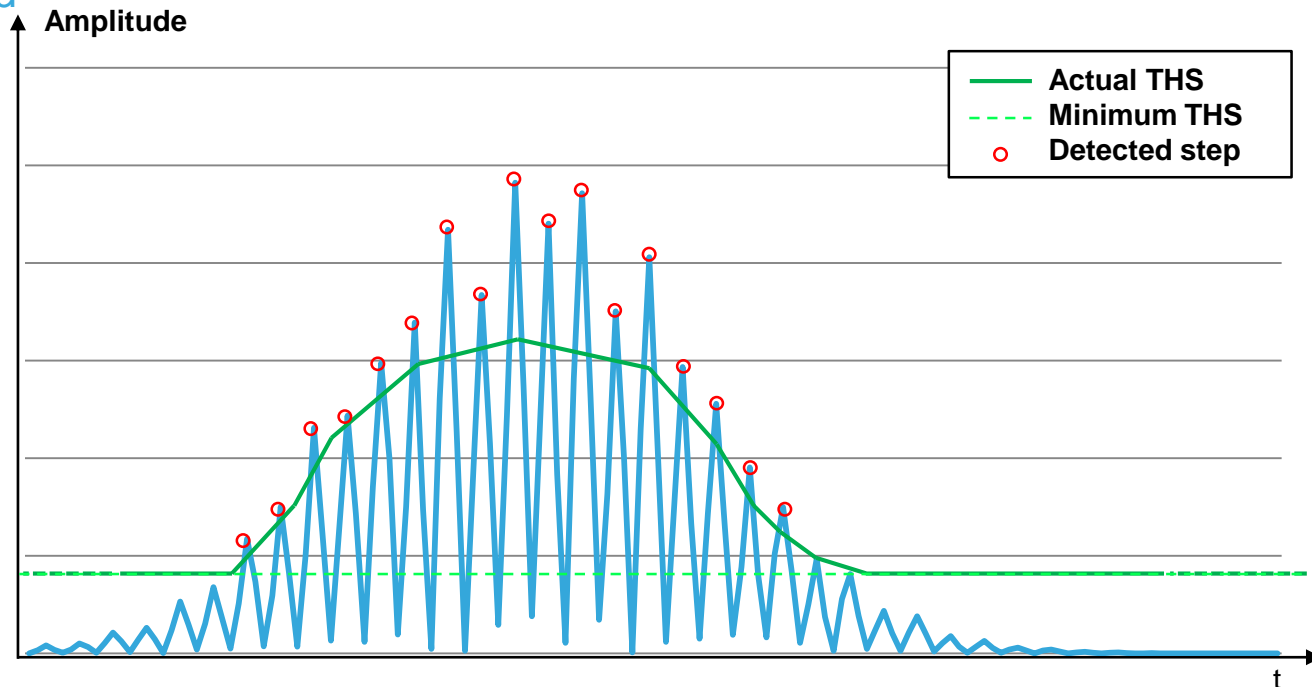
- Configurable parameters:
  - WK Threshold
  - Sleep Duration
  - WK Duration

- A specific IP block dedicated to pedometer functions: the step detector and the step counter. Pedometer functions work at 26 Hz (XL only)

- Configurable parameters:
  - Number of debounce steps
  - Debounce restart time
  - Pedo Full-scale (2g / 4g)
  - Minimum Threshold



Legend:
- Actual THS
- Minimum THS
- o Detected step

# Significant Motion Detection

- The Significant Motion function generates an interrupt when a 'significant motion', that could be due to a change in user location, is detected. Significant Motion function works at 26 Hz (XL only)

- Configurable parameters:
    - Number of steps to be performed before an SMD interrupt is generated

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- The Tilt function allows detecting when an activity change occurs (e.g. when phone is in a front pocket and the user goes from sitting to standing or standing to sitting). Tilt algo works at 26Hz (XL only)

- First Tilt interrupt: tilt angle > 35° for a period of time >= 2 sec

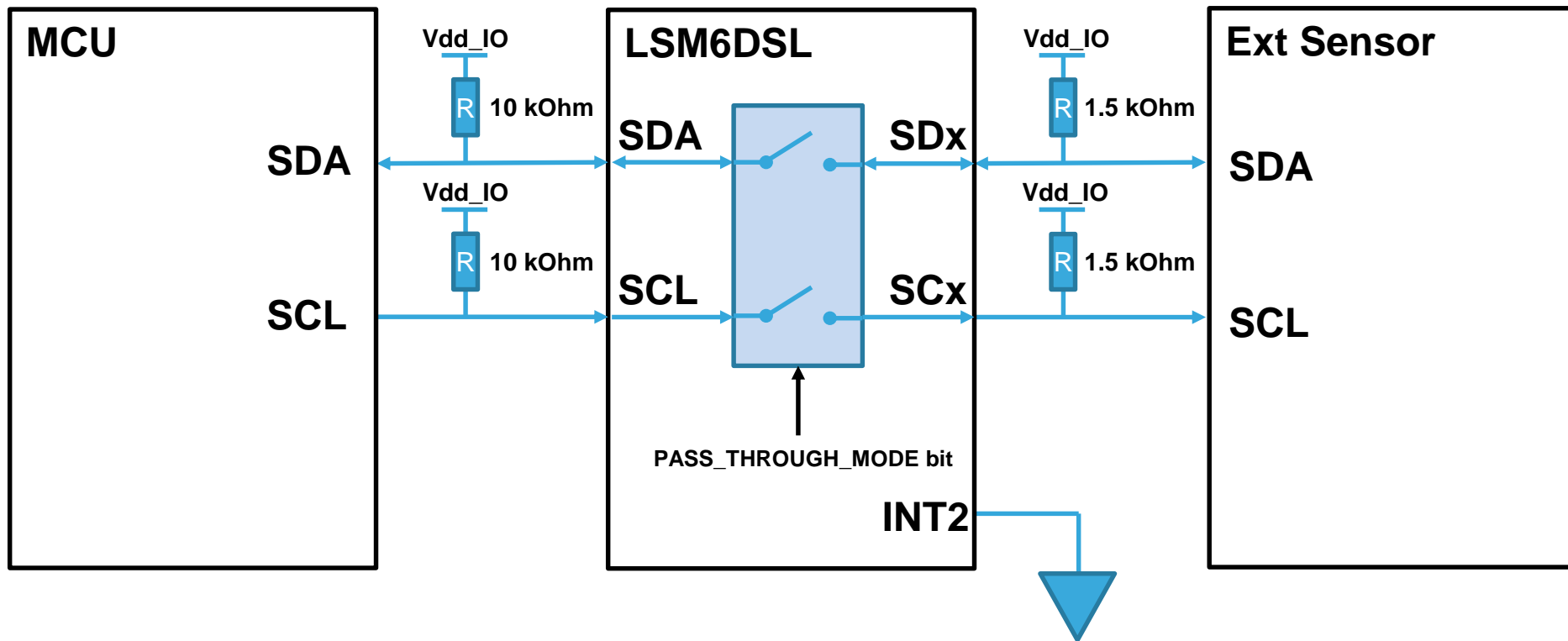- Next Tilt interrupts: as soon as tilt angle > 35° (no need to wait 2 sec)
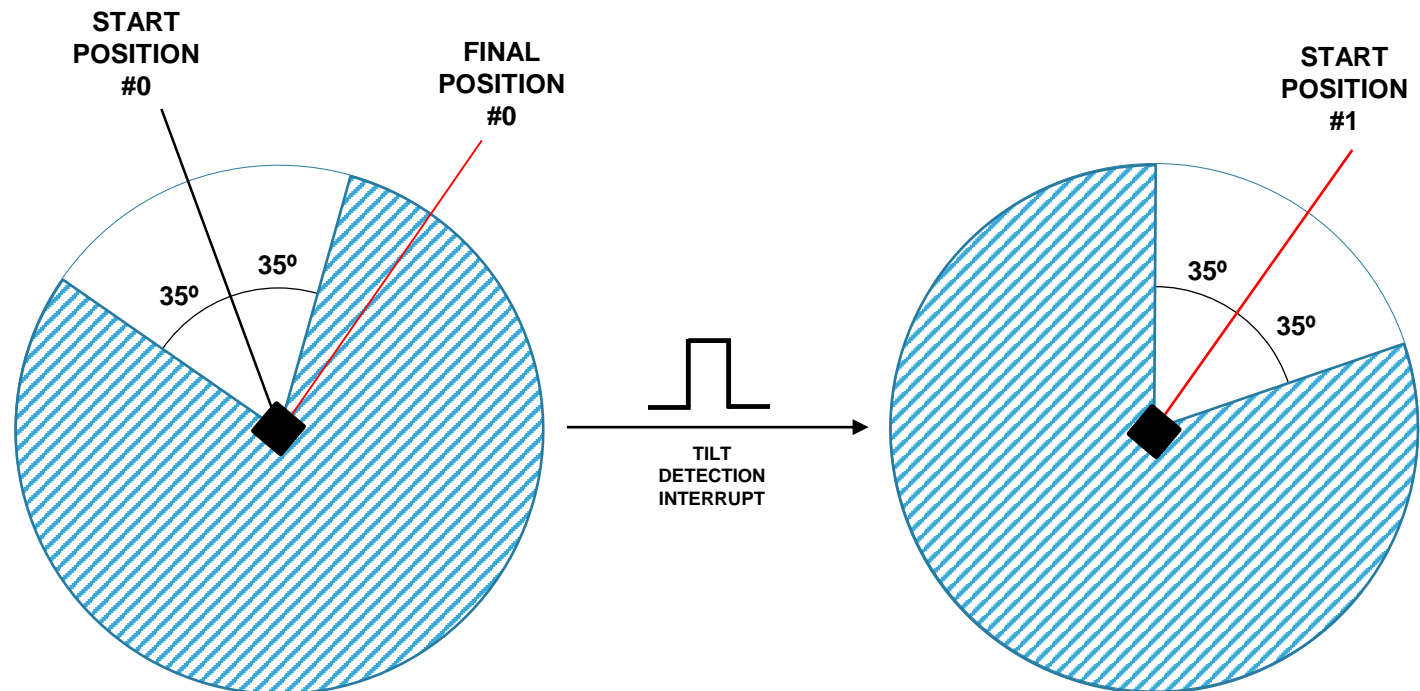
# Mode 2 - Sensor Hub mode (1/2)

- In Sensor Hub mode (Mode 2) up to 4 external sensors can be connected to the I2C master interface

- External sensor data can also be stored in FIFO

- Magnetometer hard-iron / soft-iron correction
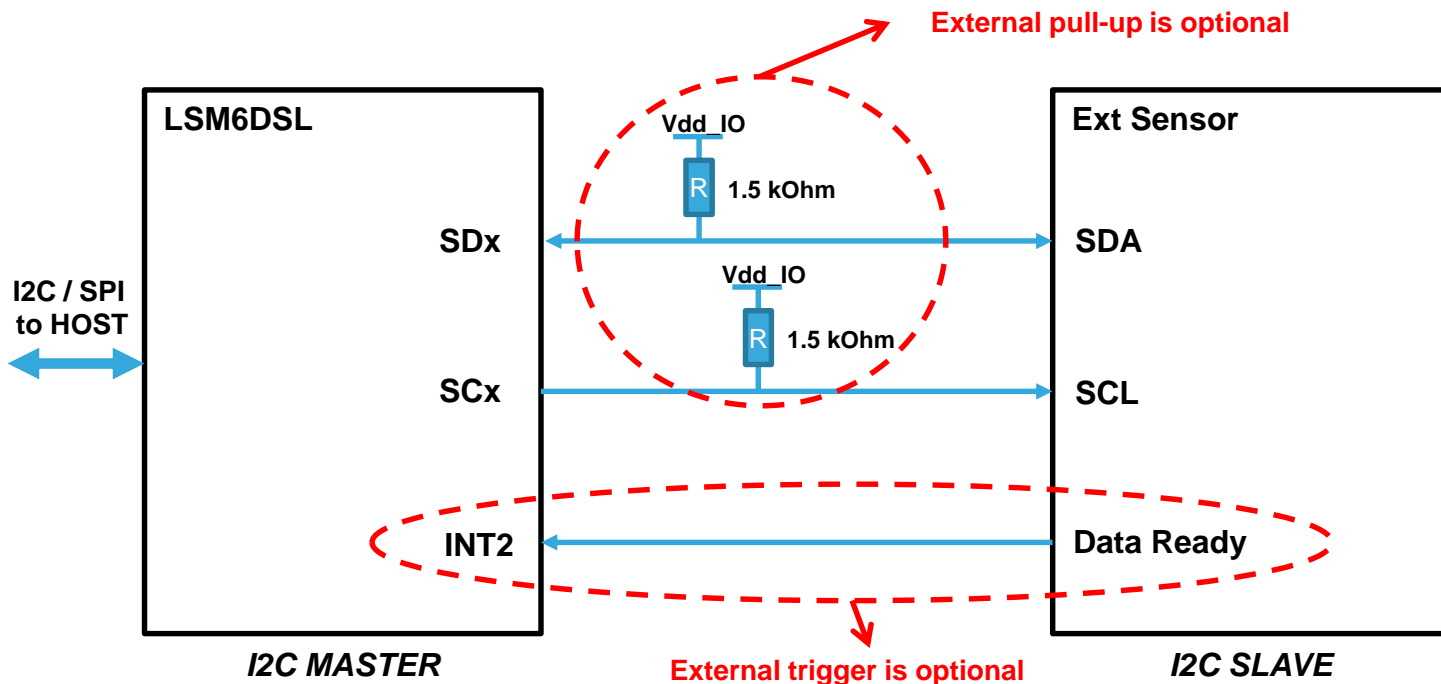
# Mode 2 - Sensor Hub mode (2/2)

- I2C interface pass-through mode

# FIFO (1/2)

- LSM6DSL embeds an 4 kbyte first-in first-out buffer (FIFO) allowing to limit intervention by the host processor and facilitate post-processing data for event recognition

- The FIFO can be configured to store the following data:
    - Gyroscope sensor data
    - Accelerometer sensor data
    - External sensors (connected to sensor hub interface) data
    - Step counter and timestamp data
    - Temperature sensor data

- Five different FIFO operating modes:
    - Bypass mode (FIFO disabled)
    - FIFO mode
    - Continuous mode
    - Continuous-to-FIFO mode
    - Bypass-to-Continuous mode

- All data sets can be stored in FIFO at different ODRs, by setting the decimation factors

- FIFO status signals:
    - FIFO overrun events
    - FIFO full status
    - FIFO empty status
    - FIFO threshold status
    - Number of unread samples stored in the FIFO

- Stop on watermark

- 'High part of data only' mode

# Thank You!