Benefits in using FIFO buffer embedded in ST MEMS sensors

By Petr Stukunjer

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Purpose and benefits

Most of ST MEMS sensors embed FIFO buffer to store samples. It can offload the microcontroller from reading data with every new sample. Thanks to its different modes of operation there are several other areas where FIFO buffer can be beneficial for applications with ST MEMS sensors.

This document describes how to use embedded FIFO buffer to utilize MEMS sensors in new application areas, e.g. to decrease power consumption, store information about a movement or avoid losing data.

Description

FIFO buffer allows decreasing the host MCU interaction with the sensor and therefore allows system power savings.

FIFO buffer can work in several different modes of operation for application flexibility reasons: Bypass, FIFO, Stream, Stream to FIFO, Bypass to Stream mode etc.

Events like FIFO programmable watermark level, FIFO overrun and FIFO empty can be enabled to generate interrupts.

Complete sample sets are released from sensor and stored to FIFO at selected output data rate (ODR).
Lowering power consumption – Achieving higher ODR

Figure 1. Lowering power consumption

MCU can be put to sleep mode for much longer period of time. MCU does not need to poll for new data frequently, because data is buffered inside the sensor. The same ODR can be achieved with lower power consumption or higher ODR can be achieved with the same power consumption.

Way of operation:

- Acceleration data is stored in the FIFO without MCU intervention.
- Once FIFO is full, MCU is woken up by interrupt signal coming from sensor.
- Data is read in a single read sequence using address auto-increment.

Saving history of an event

Figure 2. Saving history of an event
History of an event trigger can be read from the FIFO at any time. After occurrence of the event the FIFO will contain: 30 samples before trigger + trigger sample + 1 sample after trigger.

Way of operation:

- Data is being continuously stored in FIFO.
- When pre-selected trigger occurs, FIFO stops storing new data.

Avoiding data loss – Smooth data capture

Figure 3. Avoiding data loss – Smooth data capture

When MCU cannot read data at given ODR, MCU would lose data because of other operation. FIFO stores data at ODR and instructs MCU to read data only when FIFO is full or when user-selected watermark level (number of samples) is reached.

Easy data acquisition for filtering or oversampling

Figure 4. Easy data acquisition for filtering or oversampling

Oversampling example

FIFO is being filled until required number of samples is reached and then read in one shot by MCU. For example oversampling for averaging filter: $2^n$ samples is required to gain n extra bits in resolution.
Start data buffering when needed

Figure 5. Start data buffering when needed

Buffering the sensor data after occurrence of a trigger event

Way of operation

- FIFO starts working in the bypass mode (FIFO is not operational).
- FIFO switches to stream mode when the selected interrupt event occurs.
- Bypass-to-stream mode is used in order to start the FIFO buffering when the configured interrupt is generated.
- When the FIFO is full, next samples overwrite the oldest.
Buffer and store data after an event

Figure 6. Buffer and store data after an event

Buffering the sensor data (up to 32 samples) after occurrence of a trigger event.

Way of operation

- FIFO starts working in the bypass mode (FIFO buffering is not operational).
- FIFO operation switches to FIFO mode when the selected interrupt event occurs.
- Bypass-to-FIFO mode is be used in order to start the FIFO buffering when the configured interrupt is generated.
- When the FIFO is full (32 samples), capturing of samples is stopped

Support material

<table>
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<tr>
<th>Related design support material</th>
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<tr>
<td>STEVAL-MKI109V2 eMotion: ST MEMS adapters motherboard based on STM32. Compatible with all ST MEMS adapters based on STM32F103.</td>
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<tr>
<td>STEVAL-MKI105V1 LIS3DH adapter board for standard DIL 24 socket</td>
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<td>STEVAL-MKI134V1 LIS3DSH adapter board for standard DIL24 socket</td>
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<td>STEAVL-MKI107V2 L3GD20 adapter board for standard DIL 24 socket</td>
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<td>STEVA-MKI136V1 L3GD20H adapter board for standard DIL 24 socket</td>
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Documentation

- Datasheet LIS3DH MEMS digital output motion sensor ultra low-power high performance 3-axes “nano” accelerometer
- Datasheet LIS3DSH MEMS digital output motion sensor: ultra low-power high performance three-axis “nano” accelerometer
- Datasheet L3GD20 MEMS motion sensor: three-axis digital output gyroscope
## Related design support material

<table>
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<th>Datasheet L3GD20H</th>
<th>MEMS motion sensor: three-axis digital output gyroscope</th>
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<tr>
<td>Application note AN3308</td>
<td>LIS3DH: MEMS digital output motion sensor ultra low-power high performance 3-axis “nano” accelerometer</td>
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<tr>
<td>Application note AN3393</td>
<td>LIS3DSH: 3-axis digital output accelerometer</td>
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## Revision history

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<tr>
<th>Date</th>
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<tbody>
<tr>
<td>09-Nov-2013</td>
<td>1</td>
<td>Initial release</td>
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