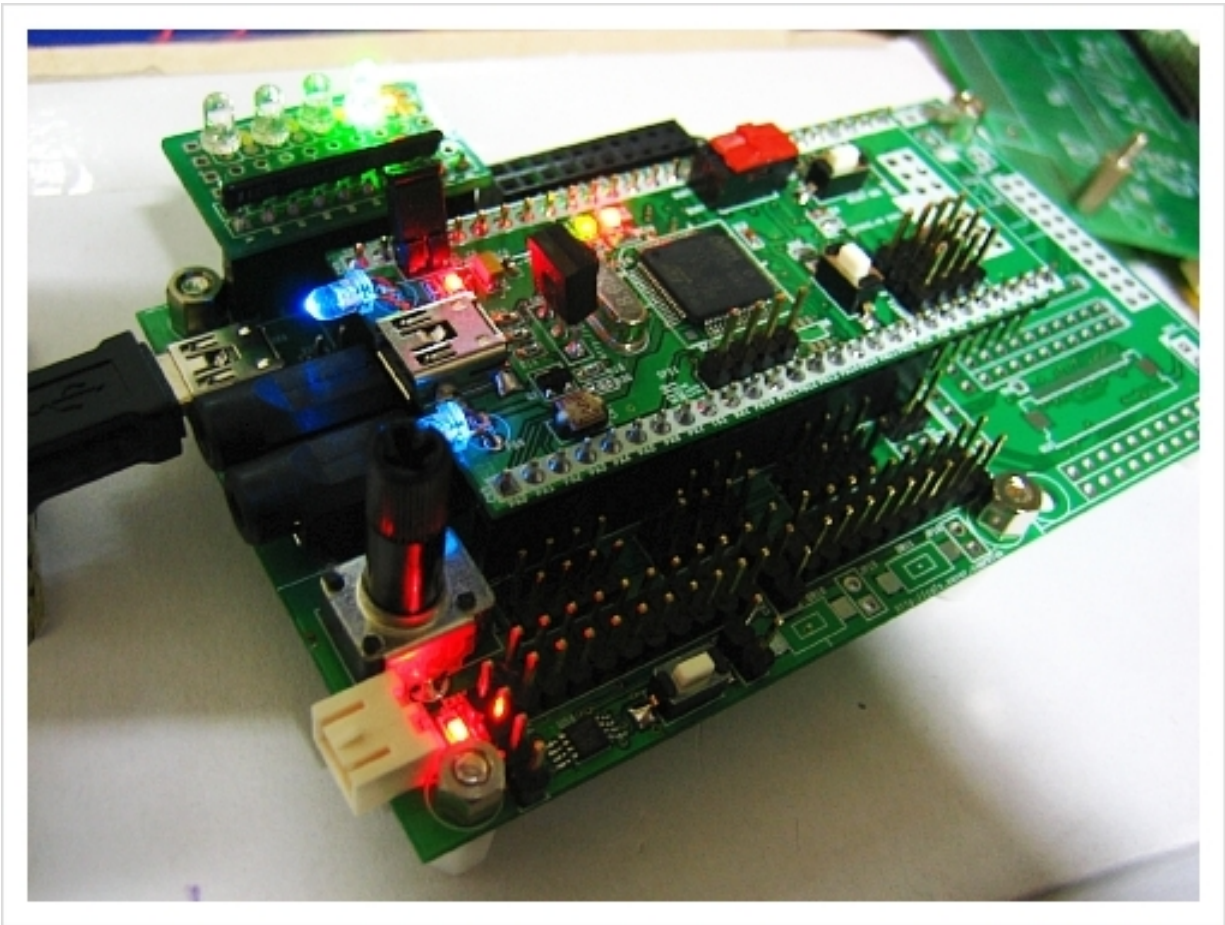




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# Firmware Development

## Project Description





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## Introduction

The purpose of this document is to define the high level requirements for a firmware development project of a sensor data collection system based on STM32 Primer 2 and ST MEMS sensors.

This project description intends to define a design for a complete firmware, ready-to-use for demonstration, operating on a system built from STM32 Primer2 and MEMS accelerometers. The accelerometers are low-power 3-axis linear accelerometers with digital output. The foreseen firmware needs to run an STM32 Primer2 device connecting the sensing elements via an I2C interface, capable of translating information from a number of sensing elements into a measured signal that can be used for external applications.

The system needs to utilize the USB functionality of the STM32 Primer2, which functions as a bridge between the sensors (connecting to the I2C bus) and the PC.



## Design Principles

This section provides the design principles with reasons driving these principles.

- **Simplicity**  
Very simple, if possible the simplest solutions are preferred.
- **I2C Bus**  
For the communication between the STM Primer The usage of I2C bus is flexible printed circuit board is required.
- **Portability**  
The preference it to create a firmware, which is portable between STM32 and ST7 microcontrollers (both present on the STM32 Primer2 development platform)

## Scope of Work

The following activities are in scope:

- **Connection of Sensor**
  - via Add-On Module [5] or
  - via breakout boards of MEMS sensors connecting to the E14 extension connector of STM32 Primer2, similar to [6] (Please note, that this is a different type of MEMS, although suitable for I2C integration development)
- **Firmware development**
- **Testing**

The following activities are out of scope:

- **Application development**

The following activities are limited to the necessary extent:

- **Electronic advice, design and verification with regards to SMT32 Primer2**

The following activities may be extended to the necessary extent:

- **Advice on electronic design and verification with regards to replacing SMT32 Primer 2 with SMT32 Primer1**



- Advice on electronic design and verification with regards to replacing the SMT32 Primer2 with an Atmel AVR based solution

## Block Diagram

The firmware allows demonstrating the performance of the sensor data collection device connected to a personal computer forming a sensor data collection system. The block diagram of the prototype is shown below.

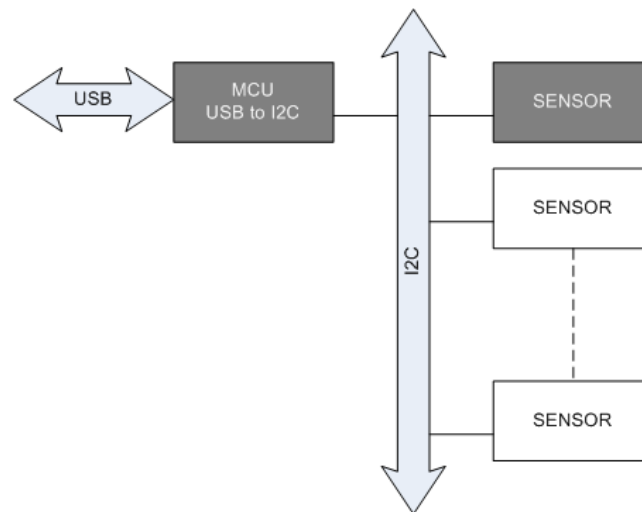


Figure 1 Block diagram

The following components are foreseen as a solution component in this system:

- Sensor
  - ST LIS331DL
  - ST LIS331DLH
- Hardware Development Platform
  - STM32 Primer2
- Communication
  - I2C
  - USB



## Accelerometers

- LIS331DL

[1] LIS331DL is the smallest ST's 3-axis smart motion sensor with SPI/I<sup>2</sup>C digital interface, not only able to measure the acceleration or inclination along X,Y and Z axes, but also capable for embedded detection of Free-Fall, Motion, Wake-up, Click/double Click, independently from space orientation (High pass filter), providing these information to the external world through dedicated high flexible and programmable interrupt lines.

Manufactured 100% in ST and Housed in a 3x3x1mm LGA-16 package, this sensor measures acceleration in a  $\pm 2/\pm 8g$  range and its robust design allows shock survivability up to 10000g per 0.1 sec.

- LIS331DLH

[1] The LIS331DLH is a new ultra-low-power 3-axis accelerometer that integrates a set of smart embedded features, including low-power mode, auto wake-up function, free-fall and 6D-orientation detection that are fully programmable through the SPI/I<sup>2</sup>C digital interface.

The device has dynamically user-selectable full scales of  $\pm 2g/\pm 4g/\pm 8g$  and is capable of measuring accelerations with output data rates from 0.5 Hz to 1 kHz.

## Hardware Development Platform

STM32 Primer2 is an innovative development tool package that provides a quick, easy introduction to the features of the STM32 and the powerful ARM Cortex™-M3 core. They plug directly into a host PC's USB port for in-circuit debugging/programming, and come with Raisonance's Ride software toolset (Debug up to 32K of code) and the GNU C/C++ compiler (unlimited compiling).

The Primer's STM32 drives ergonomic, MEMS-based controls (navigate by tilting the tool left, right, backward or forward) for fun, easy control of demonstration firmware including graphical user interface and games. The task scheduler firmware and demos provide implementation of low-level functions driving a range of STM32 peripherals, plus features for dynamic loading and management of new applications. All demos (C sources and project) and more future demos are available at [3].

## Other Development Tools

There are a number of further hardware development tools. Please refer to [7].



## Schematic Diagram – Sensor Connectivity

This section describes the wiring for the add-on module.

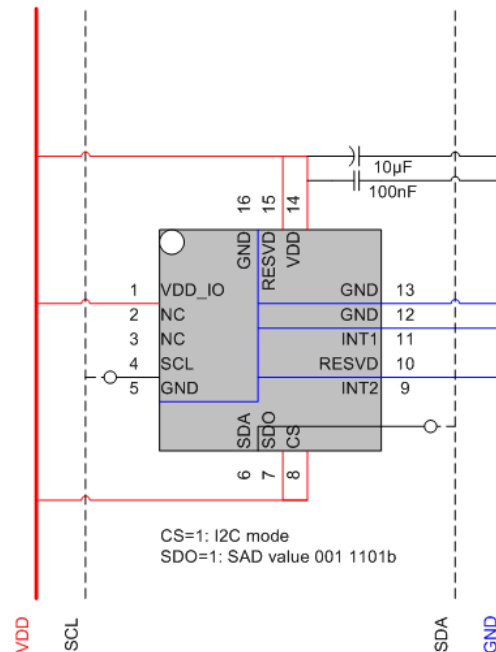


Figure 2 Sensor Connectivity

The dashed lines mean connectors on the bottom side of the PCB. The circle between the dotted line and the solid line is, connectivity between the top and the bottom side of the PCB e.g. a galvanized through hole. This diagram is not to scale.

## References

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3. Community, <http://www.stm32circle.com/hom/index.php>
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5. Add-On Module, [http://www.watterott.com/STM32-Primer2-Add-On-Modules-with-Wrapping-Area\\_1](http://www.watterott.com/STM32-Primer2-Add-On-Modules-with-Wrapping-Area_1)
6. Break-Out Board [http://www.sparkfun.com/commerce/product\\_info.php?products\\_id=8658](http://www.sparkfun.com/commerce/product_info.php?products_id=8658)



7. Other Hardware and Software Development Tools,  
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