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# AVR4200: Inertial One (ATAVRSBIN1) Hardware Users Guide

## Features

- Compatible with all Atmel® AVR® Xplain MCU boards
- Full nine-degree-of-freedom inertial sensing
- InvenSense three-axis MEMS gyroscope (ITG-3200)
- Bosch Sensortec three-axis MEMS accelerometer (BMA150)
- AKM three-axis electronic compass (AK8975)
- All sensor drivers available within the Atmel AVR Software Framework
- Temperature sensing through ITG-3200 or BMA150

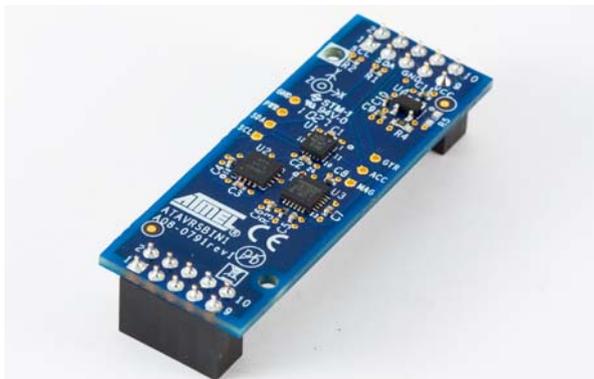
## 1 Introduction

The Atmel Sensors Xplained series of development boards and software are designed to be plug compatible with all Atmel Xplain MCU boards, providing a wide range of microcontroller performance depending on the application needs.

Atmel has partnered with leading suppliers of accelerometer, gyroscope, compass, pressure, and light sensors to provide a range of sensor boards that enable easy evaluation and development with a wide range of Atmel controller solutions.

To accelerate development with these sensor-based solutions, Atmel has worked with its partners to make the necessary sensor drivers available as part of the Atmel AVR Studio® development environment and the AVR Software Framework. The drivers are available directly from Atmel, and provide basic interface functionality with both raw data and calibrated engineering unit outputs integrated into a standard API.

The Atmel Inertial One sensor board delivers a full nine-degree-of-freedom sensor platform—combining accelerometer, compass, gyroscope, and temperature sensor—that is ideal for developing motion sensing or user interface applications.



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8-bit **AVR**<sup>®</sup>  
Microcontrollers

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Application Note

Rev. 8354A-AVR-11/10





## 2 Related items

### Application notes

- Sensors Xplained – Quick Start Guide (AVR4015)
- Sensors Xplained – Software Users Guide (AVR4016)
- Sensors Xplained – Oscilloscope Demo Application (AVR4017)
- Sensors Xplained – Sensor Top Board Design Notes (AVR4014)

## 3 Description

The Inertial One Sensors Xplained development board provides full nine-degree-of-freedom sensing capability from a set of three integrated three-axis inertial sensors. The sensors are interfaced via the I<sup>2</sup>C serial digital interface connected through a common header that is compatible with the full range of Atmel Xplain MCU boards. This sensor cluster is well suited for cell phones, handheld devices, computer peripherals, man-machine interfaces, virtual reality features, and game controllers.

The following sensors are incorporated into this development board, and detailed explanations of their operation can be obtained from the relevant partner's component data sheets.

- **Bosch Sensortec Three-Axis Accelerometer (BMA-150)**

The BMA-150 is a three-axis, low-g MEMS acceleration sensor with digital output for consumer market applications. It allows measurement of acceleration in perpendicular axes as well as tilt, motion, and shock vibration. The BMA-150 also incorporates absolute temperature measurement. The internal circuitry converts the output of the three-channel MEMS acceleration sensing structure to a digital output available through an I<sup>2</sup>C data bus.

- **InvenSense Three-Axis Gyroscope (ITG-3200)**

The ITG-3200 is a single-chip, digital-output, three-axis MEMS gyro IC optimized for gaming, 3D mice, and 3D remote control applications. The ITG-3200 features three 16-bit analog-to-digital converters (ADCs) for digitizing the gyro outputs, a user-selectable, internal low-pass filter bandwidth, and a fast-mode I<sup>2</sup>C (400kHz) interface. Additional features include an embedded temperature sensor and a 2% accurate internal oscillator.

- **AKM Three-Axis Electronic Compass (AK8975)**

The AK8975 contains highly sensitive Hall sensor technology that incorporates magnetic sensors for detecting terrestrial magnetism in the X-axis, Y-axis, and Z-axis; a sensor driving circuit; a signal amplifier chain; and an arithmetic circuit for processing the signal from each sensor. It is suitable for map heading purposes in GPS-equipped products to realize pedestrian navigation functionality.

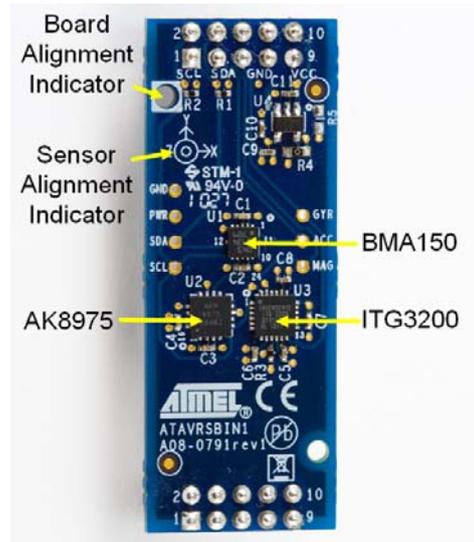
## 4 Hardware layout

Figure 4-1 shows the physical arrangement of the Inertial One Sensors Xplained development board.

NOTE

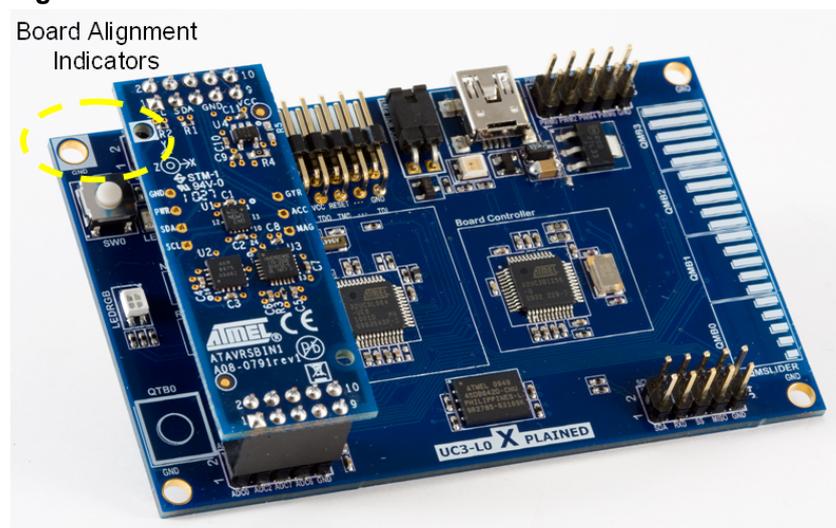
All three sensors have their X, Y, and Z axes aligned, and a symbol is provided to indicate their directional alignment.

Figure 4-1. Sensor arrangement.



The Inertial One Sensors Xplained development board must be attached to the correct headers on the Xplain MCU board to ensure proper operation. All the Sensors Xplained development boards attach to headers J1 and J2 on the MCU boards, and a board alignment indicator is printed on the board to provide to aid correct alignment. As an example, Figure 4-2 shows the orientation of the Pressure One Sensors Xplained development board when attached to the UC3-L0 Xplained MCU board.

Figure 4-2. Correct board attachment orientation.



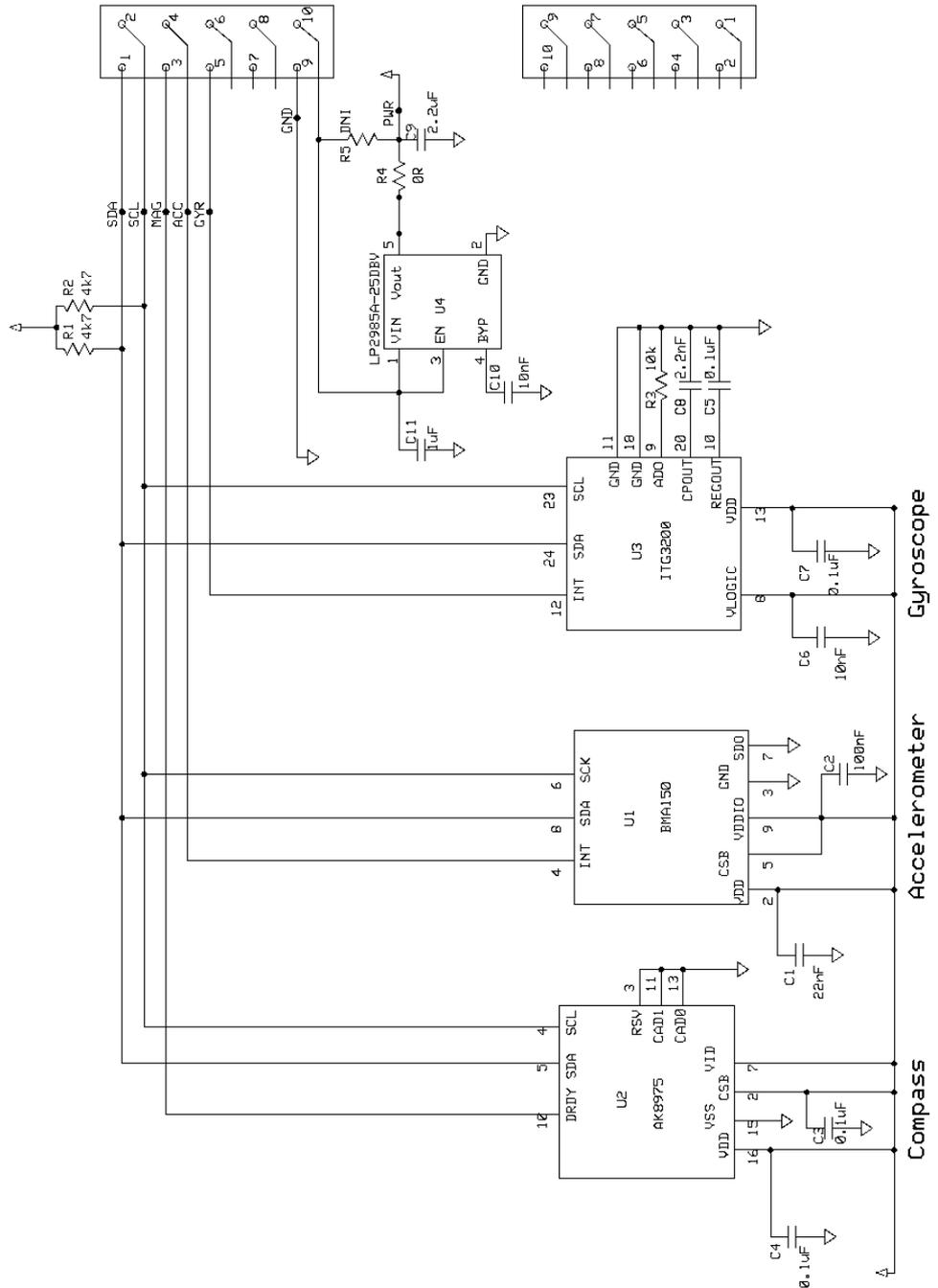
## 5 Schematic

Figure 5-1 shows the schematic for the Inertial One Sensors Xplained development board, and Table 5-1 gives the I<sup>2</sup>C addresses for the three sensors.

NOTE

The I<sup>2</sup>C pull-up resistors are included on the Inertial One Sensors Xplained board.

Figure 5-1. Inertial One schematic.



**Table 5-1.** Sensor I<sup>2</sup>C addresses.

Sensor	I <sup>2</sup> C address
AK8975	0x0C
BMA-150	0x38
ITG-3200	0x68

## 5.1 Circuit configuration options

A number of hardware options are available on the Inertial One Sensors Xplained development board to allow investigation of the sensors' functioning. These options are described below.

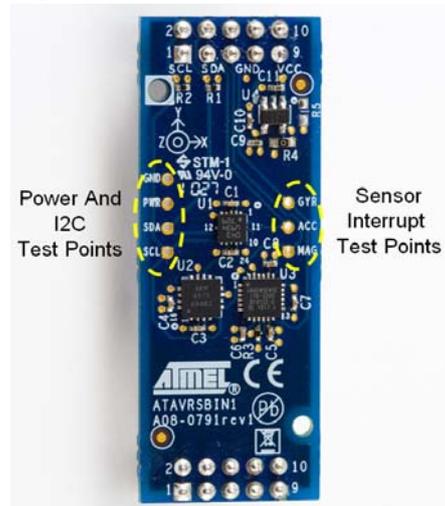
### 5.1.1 Power supply options

The power supplied to the digital header on the Xplained series of sensor boards is nominally set to 3.3V. The Inertial One Sensor Xplained development board has an on-board 2.5V regulator to supply power to all three sensors. The current from the regulator is supplied to the sensors through R4, a zero-ohm resistor. This resistor can be removed and replaced with a current monitor, if required, to investigate sensor power consumption. If it is desired to bypass the on-board regulator, R4 can be removed and a zero-ohm resistor placed in position R10. This will now supply the sensors directly from the 3.3V Xplained MCU board supply.

### 5.1.2 Test points

A number of test points are available for use with an oscilloscope to investigate the functioning of the sensors. The locations of the test points are indicated on the schematic, and [Figure 5-2](#) shows the physical locations of the test points on the board.

**Figure 5-2.** Locations of test points.



**IMPORTANT**

THE SDA, SCL, GND AND VCC MARKS NEAR THE UPPER HEADER ARE FOR TEST POINTS USED IN THE MANUFACTURING PROCESS, AND DO NOT REFER TO THE PINS ON THE HEADER.





## 6 EVALUATION BOARD/KIT IMPORTANT NOTICE

This evaluation board/kit is intended for use for **FURTHER ENGINEERING, DEVELOPMENT, DEMONSTRATION, OR EVALUATION PURPOSES ONLY**. It is not a finished product, and may not (yet) comply with some or any technical or legal requirements that are applicable to finished products, including, without limitation, directives regarding electromagnetic compatibility, recycling (WEEE), FCC, CE, or UL (except as may be otherwise noted on the board/kit). Atmel supplied this board/kit "AS IS," without any warranties, with all faults, at the buyer's and further users' sole risk. The user assumes all responsibility and liability for proper and safe handling of the goods. Further, the user indemnifies Atmel from all claims arising from the handling or use of the goods. Due to the open construction of the product, it is the user's responsibility to take any and all appropriate precautions with regard to electrostatic discharge and any other technical or legal concerns.

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