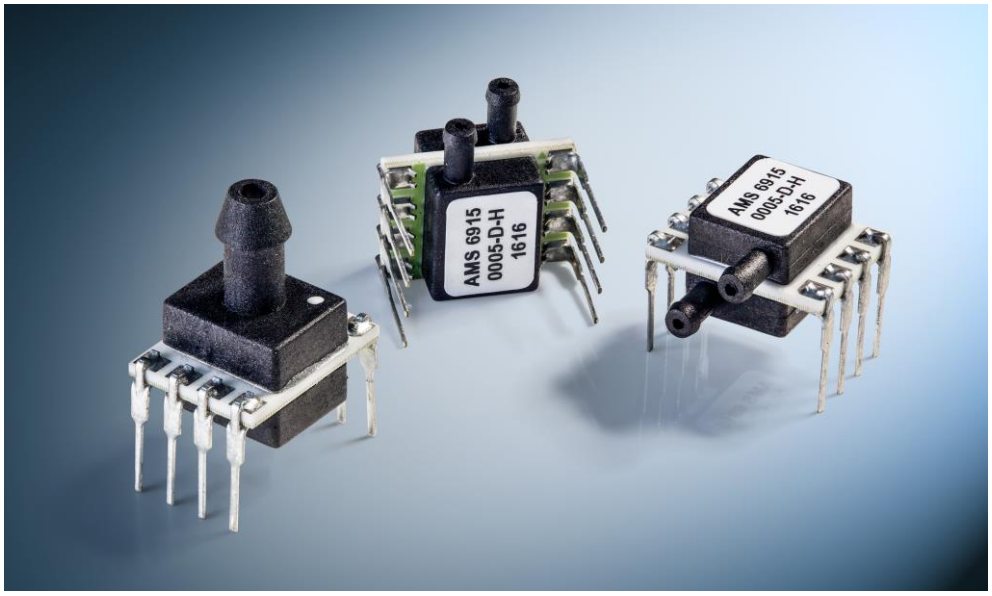
AMS 6915 – prototyping with a multifunctional USB interface for a miniature pressure sensor

OEM or original equipment manufacturer sensors are electronic modules which are mounted in customer products by an assembler, for example. As today's electronic devices are almost always equipped with processors, it goes without saying that OEM sensors have to be adapted to suit the product configurations. This includes providing digital signals in I²C format and a voltage supply of 3.3 V, for instance.

Pressure sensor AMS 6915 [1] exhibits these properties and is available for all types of pressure (absolute, relative and differential) in several different pressure ranges.

To considerably speed up prototype development with the AMS 6915 a suitable USB interface is provided as an accessory. This USB starter kit facilitates fast commissioning or uncomplicated pressure and/or temperature measurements on the computer. The AMS 6915 OEM sensor and USB starter kit are described in the following.



Description of pressure sensor AMS 6915

Pressure is measured on the AMS 6915 by a modern, piezoresistive silicon pressure sensing element. The pressure applied to the MEMS or microelectromechanical system sensing element is converted into an analog signal which is almost proportional to the applied pressure. This voltage signal is then amplified by an ASIC and converted into a digital value in the integrated 14-bit ADC. The same occurs with the temperature which is measured in the ASCI and also digitized.
The ASIC in question is a CMOS IC which consists of an instrumentation amplifier, a 14-bit A/D converter, an EEPROM, a processor and an output stage (see *Figure 1*).

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The silicon sensing element has been specially developed for the low pressure range and its dimensions greatly reduced, enabling a miniaturized version to be produced.

In order to obtain standardized output values the digitized signals are electronically calibrated in the microprocessor block, temperature compensated (within a temperature range of 0...60°C and an operating temperature range of -25...85°C) and linearized.
During calibration correction coefficients are determined at various pressures and temperatures for each individual sensor regarding the ideal transfer characteristic and stored in the EEPROM. The program running in the integrated microprocessor calibrates the digital pressure and temperature signal based on the coefficients. The calibrated values are written to the ASIC output register and continuously updated, typically every 0.5 ms. Both the pressure and temperature are available as digital data in I²C format.

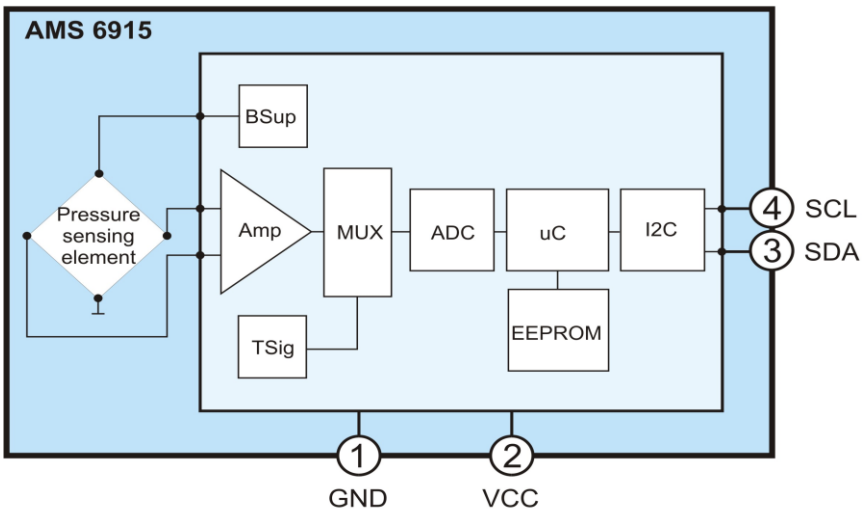

Figure 1: *schematic circuit diagram of AMS 6915.*

Design of AMS 6915

The AMS 6915 series is supplied in a robust dual inline package (DIP) for circuit board assembly and is ready for operation without the need for any other components. Electrical connection is through soldering pins, with the pressure for relative and absolute sensors linked in through a vertical connector and that for differential sensors through a horizontal connector. The sensors are mounted on a ceramic substrate and protected by a plastic cap made of PA or nylon 66 which ensures optimum mechanical stability.

The OEM sensors are produced for different pressure ranges in a number of variants. They are available as differential and relative sensors for pressure ranges of 0–5 mbar to 0–10 bar with numerous intermediate ranges. In a pressure range of up to 1 bar they are supplied as absolute pressure sensors and as a barometric variant in a range of 700–1,200 mbar. For the ±2.5 mbar to ±1,000 mbar pressure range they are manufactured as bidirectional differential sensors. This version permits both positive and negative pressure to be measured by the same sensor.

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Description of the multifunctional USB interface: AMS 6915 starter kit

The AMS 6915 starter kit has three main functions, described as follows:

1) Support during commissioning and for fast prototyping

The USB starter kit enables pressure sensors in the AMS 6915 series to be put into operation without any soldering work being necessary. All that is required are a Windows PC (from XP SP3) with the CS 6915 software installed and a free USB port. Both the sensor and starter kit are powered through the computer's USB connection. No further voltage source is needed. This makes setup very mobile and extremely simple, especially on a laptop.
A selection menu in the software enables the pressure range of the connected sensor to be chosen according to the model used. The software computes the applied pressure based on the digital values read out.
Besides the pressure the sensor temperature is also output as a digital or physical value. Here, the user can select whether the measurements are to be read out once only or continuously in a loop (this can be set to every 100...1,000 ms). It is also possible to save the digitized measurements in a file for documentation.

The sensor is supplied with voltage by the computer's USB port; this can be set to 3.3 V or 5 V. The sensor and PC are electrically isolated by the interface to protect the computer.

Fast commissioning allows the sensor to be rapidly evaluated within its area of application and thus a demonstrator to be quickly set up. As power is supplied by a laptop, for example, this is also possible out in the field. It is not necessary to create an individual development environment with all of the relevant electronics and programs at this initial stage.

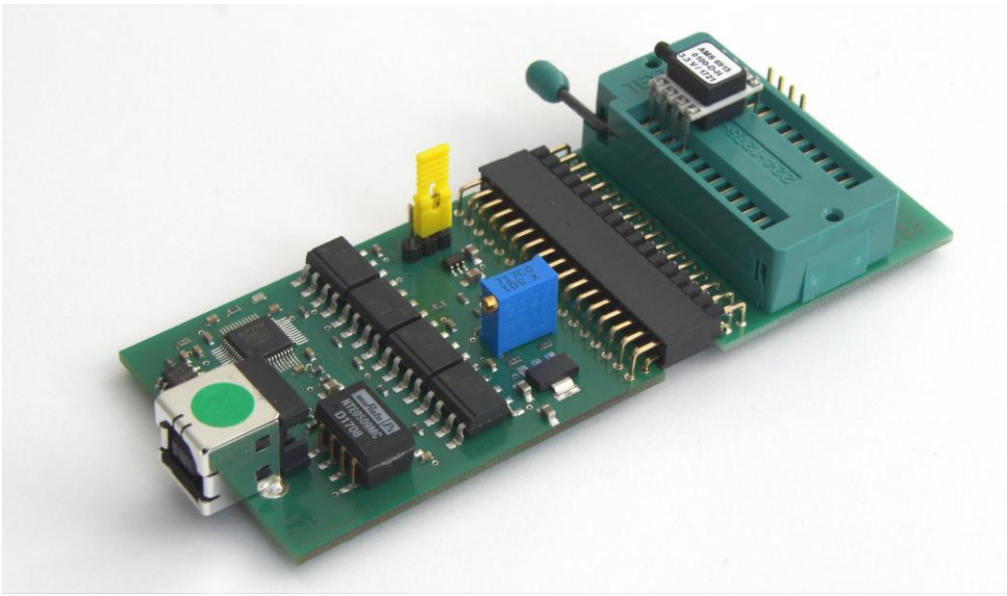

Figure 2: *sensor USB interface: starter kit with a ZIF socket and mounted AMS 6915.*

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2) Individual addressing

Another advantage of the starter kit is that the sensor's I^2C address can be changed. AMS 6915 devices have a 7-bit slave address ($0x28_{hex}$(0101000_{bin}) as the factory setting.
If several sensors are to be connected up to an I²C bus for a network with several measurement points and/or different pressure ranges, for example, each sensor must be assigned a clear address so that only one sensor answers when an address is requested. Individual addresses can be assigned with the help of the starter kit or programmed during production by the manufacturer at the customer's request. The factory address setting is then overwritten and the sensor can be operated by its own individual address.

3) Starter kit as a test medium

The starter kit's third area of application centers on troubleshooting.

Where on a sensor with an analog output and using a multimeter it can be easily ascertained whether the sensor reacts to the applied pressure as expected or nor, with a digital interface this is much more difficult. A microcontroller or PC with a suitable program is first required for communication; this establishes a connection to the sensor which reads out and displays the data. If the readout fails, this could be attributable to a number of sources of error in both the hardware and software. In addition to errors in the actual program the following points should also be checked:

- Have the right pull-up resistors been selected?
- Have the SCL and SDA lines possibly been switched over?
- Has the correct I^2C address been selected?
- Is the bus speed correct?
- Are the levels and bit sequence correctly interpreted?

Many of these faults can only be detected using an oscilloscope or a logic analyzer and by measuring the voltage levels and decoding the bits.

The USB starter kit assists with all these problems by acting as a reference which can check the operability of the sensor. The starter kit can also be used to rule out a number of errors as the bus address of the test object can be determined, the measurements read out and, if required, compared to reference values.

The bus lines and power supply for the sensor are lead out on a connector plug on the starter kit. This allows sensors which have already been assembled (in a demonstrator, for example) to be connected up to the starter kit and read out. The sensors can also be placed on the interface using a ZIF socket (Textool socket) so that the sensors can be easily interchanged for selection purposes (see *Figure 2*).

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Applications

Depending on their specific configuration AMS 6915 OEM pressure sensors are suitable for various applications:

- AMS 6915 differential pressure sensors are used to measure gas flow and dynamic pressure, for instance, in particular for filter control. With its underside pressurization [3] AMS 6915 can also be used for level sensing with one-sided media application. Underside pressurization means that when the system is configured the fact is taken into account that the media-insensitive underside of the pressure sensor comes into contact with the medium.
- The relative pressure sensors in the AMS 6915 series can be used in the low pressure range to measure fill heights of 0–50 cm and more in open receptacles. These OEM sensors are also often used in medical applications such as patient monitoring, infusion and syringe pumps or modern wound therapy (NPWT).
- The absolute pressure sensors in this series are suitable for vacuum control and barometric measurements. The small dimensions of the AMS 6915 make the pressure sensor ideal for use in devices where space is at a premium.

The fields of application for the USB starter kit are just as diverse as those of the pressure sensor. The AMS 6915 starter kit can be used both to collect measurements during prototype construction and also in test engineering.

Summary

AMS 6915 is a miniaturized, OEM pressure sensor in a dual inline package which enables pressure and temperature to be measured in 3 V or 5 V operation in I^2C format.
Using the USB starter kit can drastically reduce the time required to develop a prototype. Measurement values from the sensor can be effortlessly displayed, individual addressing is possible and the sensor can be tested.

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Further information

[1] AMS 6915 product details and datasheet:
https://www.amsys-sensor.com/produkte/drucksensoren/ams-6915-mini-drucksensor-mit-i2c-schnittstelle/

[2] Description of the AMS 6915 starter kit:
https://www.amsys-sensor.com/downloads/data/ams6915-pressuresensor-UsersGuide-Starterkit-AMSYS.pdf

[3] Underside pressurization:
https://www.amsys-sensor.com/downloads/notes/ams5812-media-compatibility-of-silicon-pressure-sensors-amsys-508e.pdf

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