AMS 5915 AN03
How to measure blood pressure using AMS 5915 and an Arduino

This application note describes a prototype measurement setup based on Analog Microelectronics' pressure sensor AMS 5915 [1] and an Arduino [2], which can be used to measure the blood pressure using the oscillometric principle.

The oscillometric principle [3] is a well-known method for non-invasive blood pressure measurement. Currently it is the most popular measurement method in automatic blood pressure monitors. It uses an inflatable cuff with an inflation and deflation mechanism, a pressure sensor and an evaluation unit like an Arduino Nano. After the cuff was inflated to a certain pressure it is slowly deflated while the pressure sensor measures the pressure inside the cuff. As soon as the pressure in the cuff decreases below a certain pressure the intra-arterial blood pulsation caused by the pulse induces pressure oscillations in the cuff. The amplitude of these oscillations depends on the cuff's pressure and can be used to estimate the systolic and diastolic blood pressure.

The blood pressure is measured against air pressure, therefore a differential / relative pressure sensor is necessary. In most cases the systolic blood pressure is lower than 180 mmHg (= 239.98 mbar). In our setup we chose AMS 5915-0350-D for the blood pressure measurement with a minimum pressure of 0 mbar and a maximum pressure of 350 mbar.

Figure 1: Measurement setup using an AMS 5915, Arduino Nano, the AMS 5915 Arduino Nano kit [4] and an inflatable cuff

To measure the pressure fluctuations inside the cuff AMS 5915's first pressure port is connected to the cuff using a silicone hose (see *Figure 1*). The second pressure port is left open to atmospheric pressure. The electrical connection to Arduino Nano is established using the AMS 5915 Arduino Nano Kit [4] provided by Analog Microelectronics (for more information on the kit please see AMS 5915 AN 02 [5]). Arduino Nano can be programmed using the AMS Arduino library which can be downloaded from www.analog-micro.com. A block diagram of the setup can be seen in *Figure 2*.

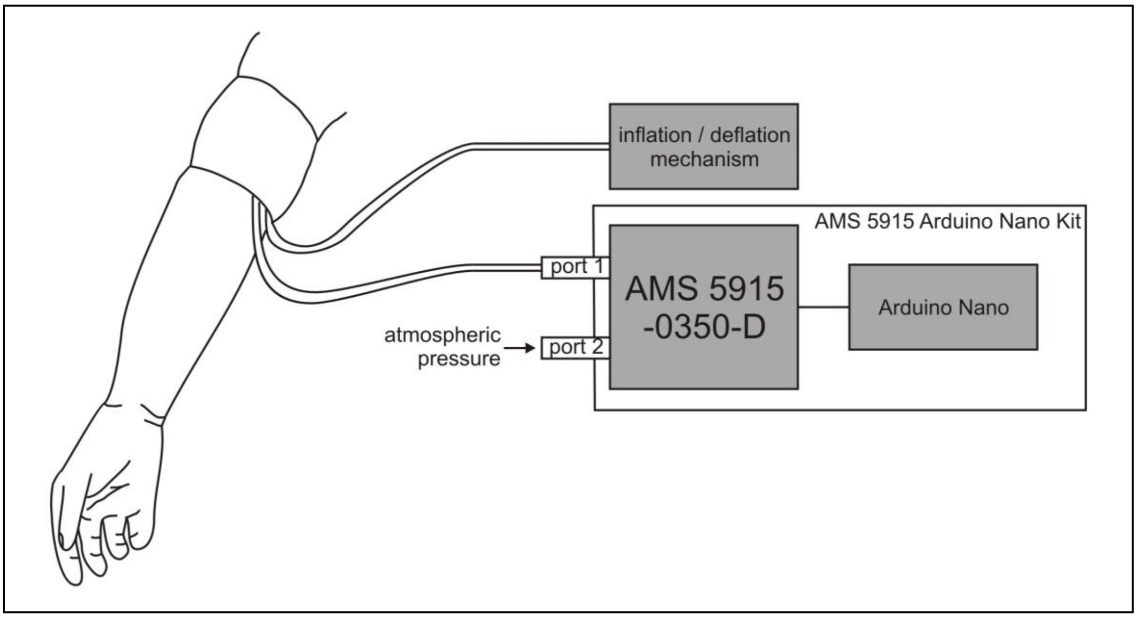

Figure 2: Block diagram of the used measurement setup

An example for the pressure data obtained using this setup can be seen in *Figure 3*. After the cuff was inflated to approximately 190 mmHg it is slowly deflated and the pressure is measured continuously using AMS 5915 and Arduino Nano. While the pressure is slowly falling, small periodically occurring spikes can be seen as soon as the pressure decreases beneath a certain pressure value. These pressure oscillations are induced by the person's pulse. Using a high pass filter the oscillations can be extracted from the slow falling pressure inside the cuff and evaluated. As shown in *Figure 3* the oscillation's amplitude increases as the pressure inside the cuff decreases and reaches a maximum if the pressure inside the cuff is equal to the mean arterial pressure. In our example the mean arterial pressure is approximately 97 mmHg. If the pressure inside the cuff decreases below the mean arterial pressure the pressure oscillation's amplitude decreases again.

Using these data the systolic and diastolic pressure can be derived easily. According to [3] the diastolic pressure can be found at 55 % of the maximum amplitude above the mean arterial pressure. In our example the diastolic pressure is circa 137 mmHg. The diastolic pressure is the pressure inside the cuff where the oscillation's amplitude is 85 % of the maximum amplitude below the mean arterial pressure. It can be found at approximately 85 mmHg.

Please note: This is an experimental prototype. Do not rely on measurements taken with this instrument. It is meant as proof of principle only.

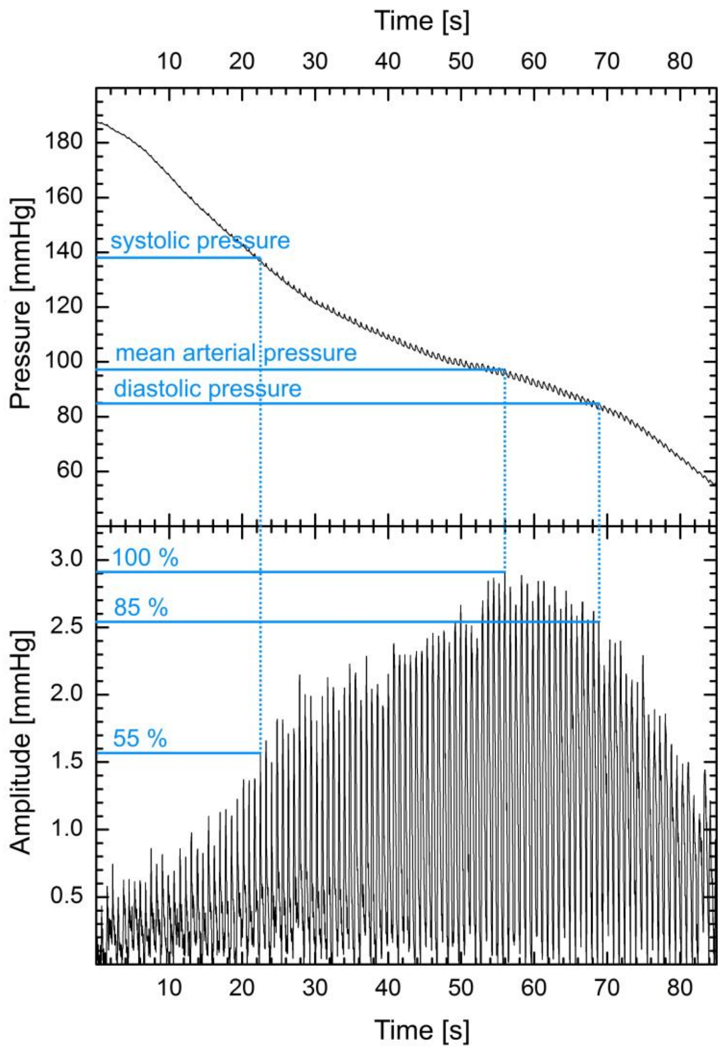

Figure 3: Data measured using the measurement setup described above and the data obtained if a high pass filter is applied on the measurement data

References:

1.) AMS 5915's data sheet (see https://www.analog-micro.com/products/pressure-sensors/board-mount-pressure-sensors/ams5915/ams5915-datasheet.pdf)
2.) Arduino Nano (https://www.arduino.cc/en/Main/ArduinoBoardNano)
3.) Medical Electronics, Dr. Neil Townsend, Michaelmas Term 2001, page 48 to 54
4.) AMS 5915 Arduino Nano kit (available at https://www.analog-micro.com)
5.) AMS 5915 AN02 (see https://www.analog-micro.com/products/pressure-sensors/board-mount-pressure-sensors/ams5915/ams5915-an02.pdf)
6.) Rosmina Jaafar et al., Noninvasive blood pressure (NIBP) measurement by oscillometric principle, DOI: 10.1109/ICICI-BME.2011.6108622

7.) Othmar Fischer, Markus Seidl, Elektronische Blutdruckmessung – Vergleich des oszillometrischen Verfahrens mit der Methode von Riva-Rocci (RR), PC News 44, September 1995
8.) Thomas G. Pickering MD et al., Recommendations for Blood Pressure Measurement in Humans: An AHA Scientific statement from the Council on High Blood Pressure Research Professional and Public Education Subcommitee, The Journal of Clinical Hypertension / Volume 7, Issue 2, DOI: 10.1111/j.1524-6175.2005.04377.x
9.) Charles F. Babbs, Oscillometric measurement of systolic and diastolic blood pressures validated in a physiologic mathematical model, DOI: 10.1186/1475-925X-11-56