Sen0232 and Digital Sound Level Meter 1358 sensor analysis

Written by:
Anton Bothin, Erik Flink, Nelly Friman, Jacob Klasmark,
Valter Lundegårdh, Isak Olsson, Andreas Sjödin, Carina Wickström

May 2019

Introduction

In this study the Digital Sound Level Meter 1358 and the Sen0232 Gravity Sound Level meters are analyzed.

The purpose of this study was to find out how the meters reacted to different frequencies at different dB levels. This was done so that we could test one microphone's accuracy against the other, in order to determine if the two microphones gave the same output, and reflect over their accuracy.

The comparison covers the meter's output data at different dB levels at different frequency levels.

Method

Equipment

- 1 Sennheiser Urbanite headphones
- 2 avr-rss2 MCU
- 1 Digital Sound Level Meter 1358
- 2 Sen0232 Gravity Sound Level Meter
- Voltmeter
- 1 Laptop
- 1 Quiet room

Software

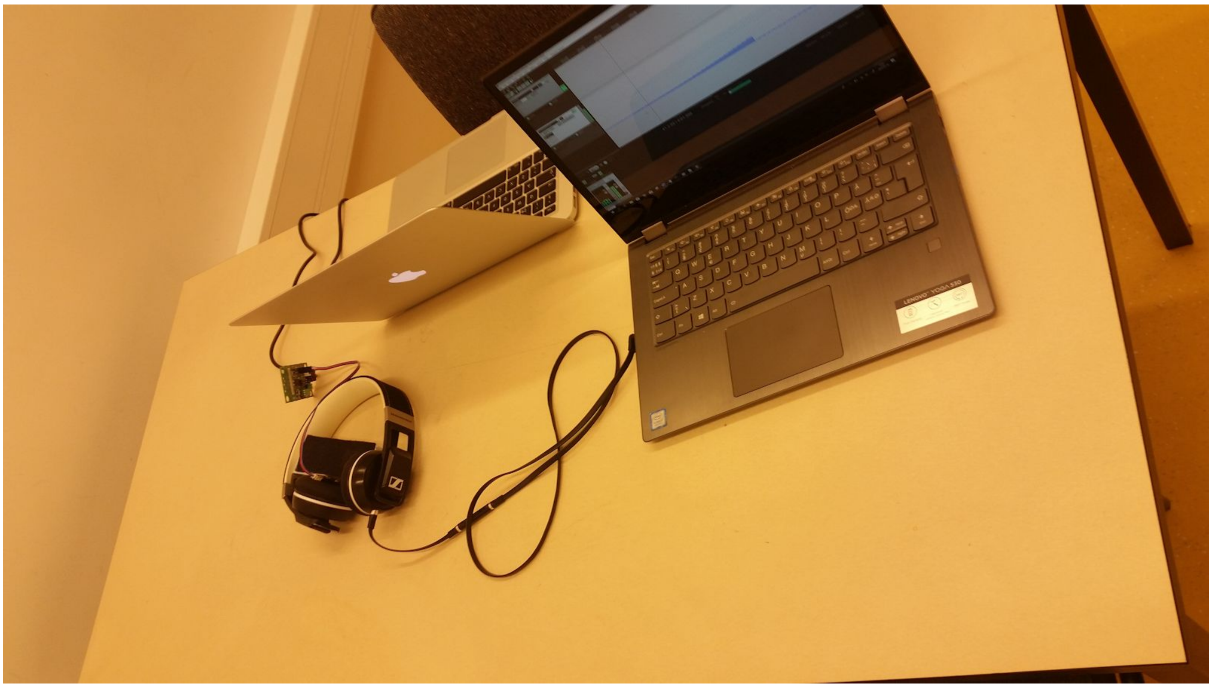
- Cockos Reaper
- Contiki OS
- PuTTY
- Google Docs Spreadsheets

Two meters were connected via the 2 avr-rss2 MCUs to the laptop where PuTTY was configured to read the outputs from the COM ports and log the data to two separate text files. Reaper was configured to play a sine wave at configurable frequencies and dB levels, beginning at 100 Hz and at -40 dB (RMS). The laptop sound output was set to 50%. The meters diaphragms were placed at equal distance from the speaker elements in the headphones.

The test was started by resetting both MCUs so it would be clear in the log files where the test began. After the first measurement was read by the meters and sent to PuTTY and logged in the text files, the frequency was increased in small steps up until 8.5 kHz.

The resulting text files with the logged data were imported into a spreadsheet.

The test continued by raising the volume to -30 dB, resetting the frequency back to 100 Hz, clearing the log files, restarting the MCUs, and redoing the method of raising the frequency after every measurement.



Results

The Sen0232 sensors have a margin of error at ±1.5 dB, which implies that the distance between any two sensor readings at the same measurement should not exceed 3 dB. The same goes for the Digital Sound Level Meter 1358.

Test 1.

The comparison of the two Sen0232 sensors. The two sensors have no id, we identify them by an small visual difference on the microphone chip. Hereinafter the sensors are referred as A och B.

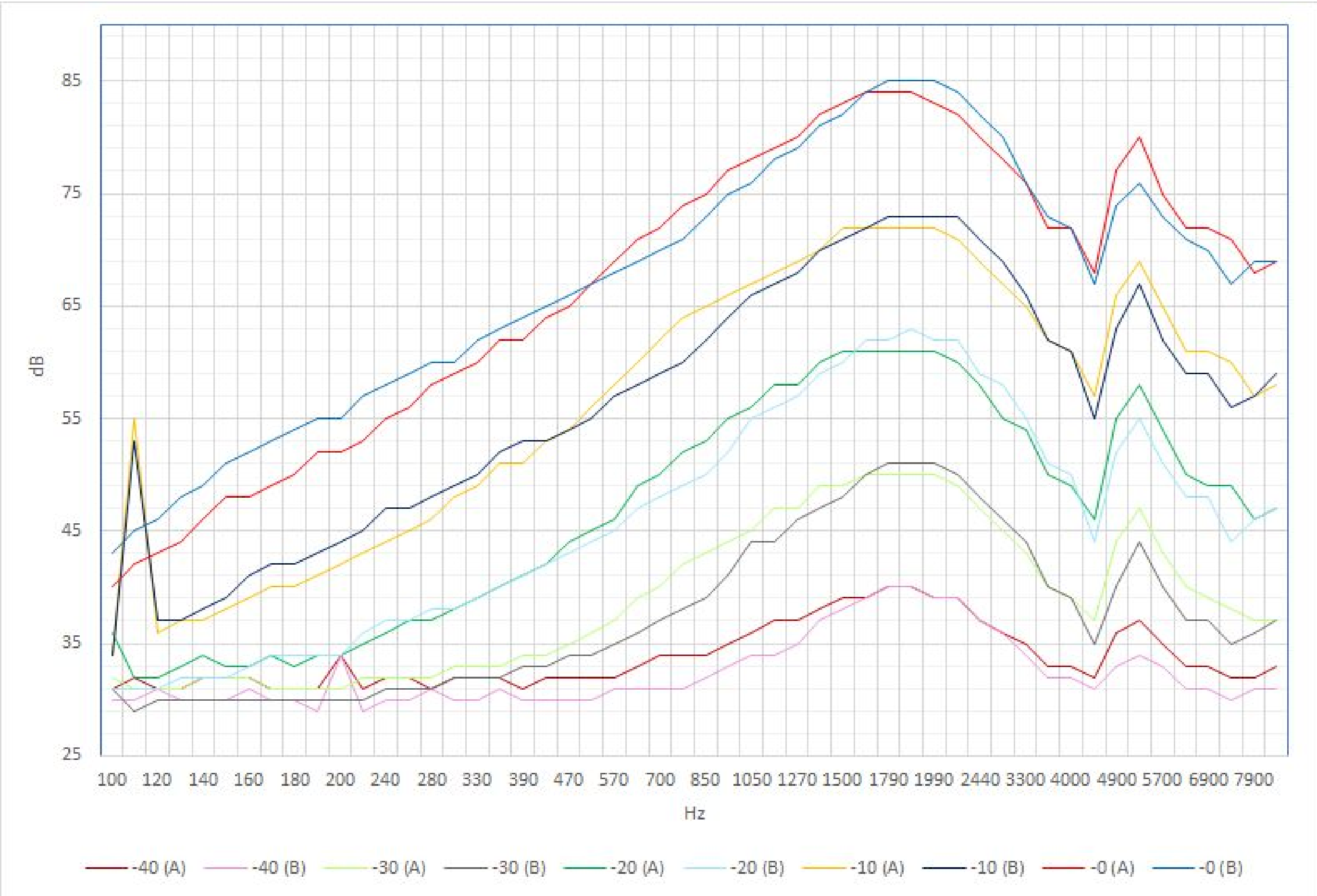


Fig 1. Comparison between two Sen0232 sensors, A and B

In the -10 dB test around 110 Hz we experienced a disturbance, which shows in fig 1.

From our measurements we see that the majority of sensor readings were within the 3 dB margin, but some sensor readings display a difference of up to 5 dB. This implies that at least one of the sensors display a small inaccuracy at a minimum of ±2.5 dB, which exceeds their documented margin of error.

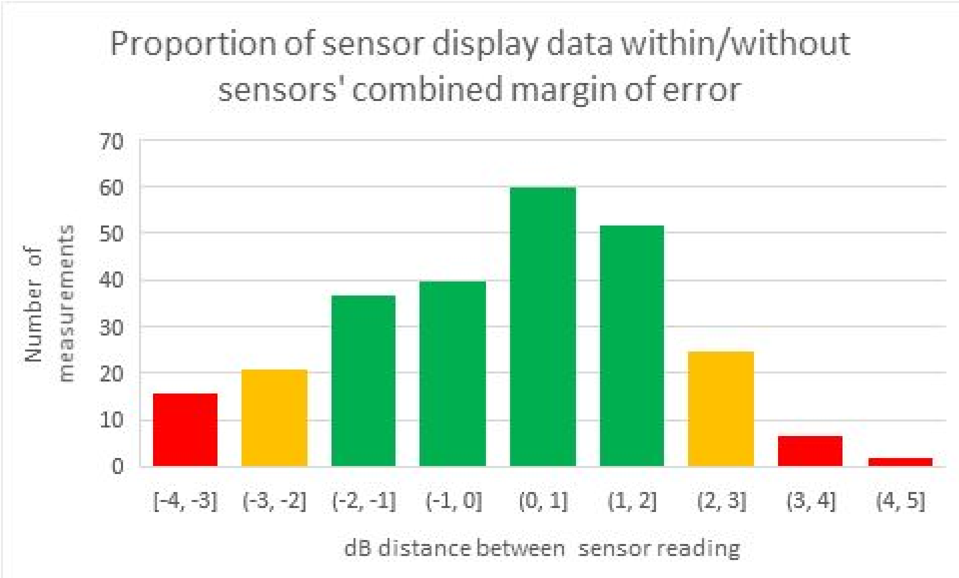


Fig 2. Shows the proportion of inaccuracy at sensor displays

From a total of 260 measurements, 25 overstepped the 3 dB margin. Those values are displayed red in the graph. That is 9.6 % of the total amount of measurements.

Test 2.

The comparison between one Sen0232 sensor and Digital Sound Level Meter 1358. The output voltage from the Sen0232 sensor is multiplied with 50, and the other meter is multiplied with a factor of 100. Both factors used is given by the manufacturer.

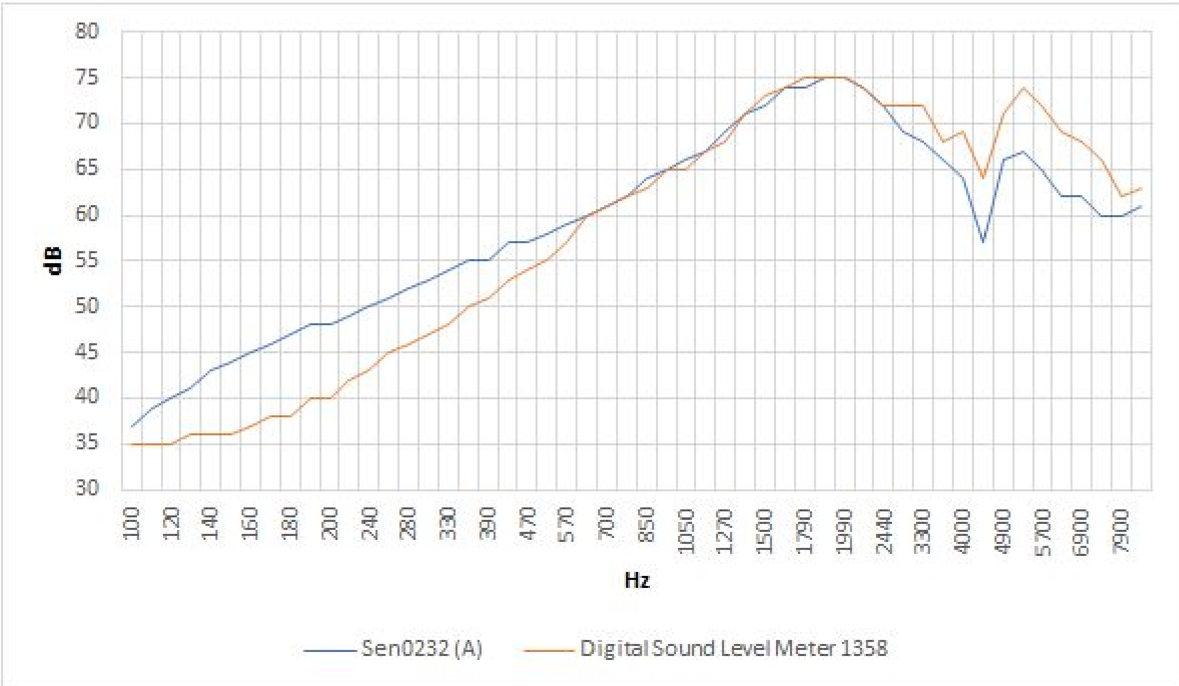


Fig 3. Comparison between the Sen0232 (A) and Digital Sound Level Meter 1358

The display data difference between Sen0232 and Digital Sound Level Meter 1358 range from 0 to 9 dB. This shows that at least one of the sensors display an inaccuracy at a minimum of ±4.5 dB.

Test 3.

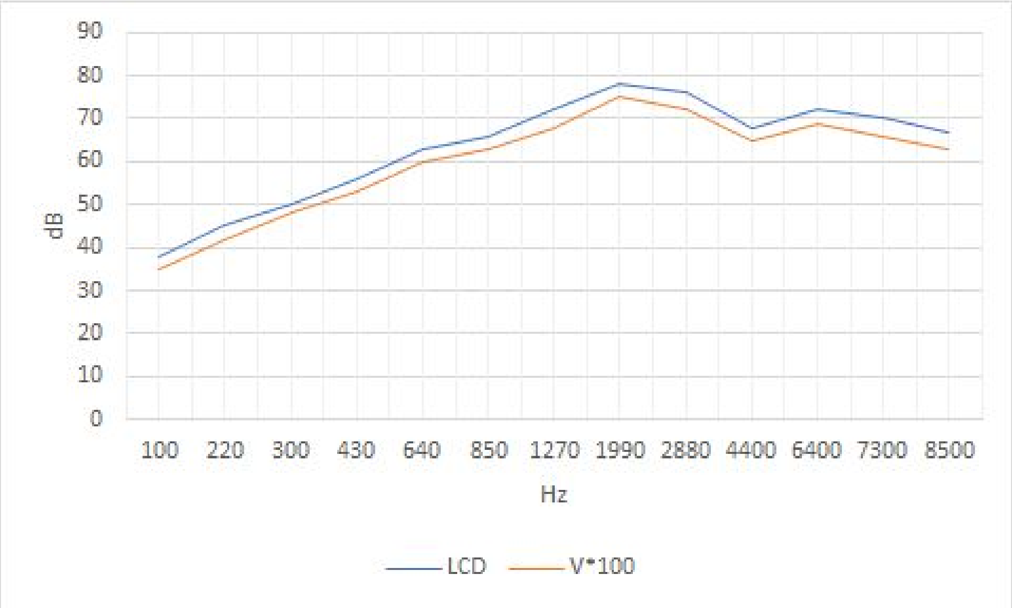


Fig 4. Comparison between the Digital Sound Level Meter 1358 LCD readings and its output voltage measured times 100.

The measured data show a constant offset that varies between 2 and 4 dB. From this data, we are inclined to think that the factor 100 (given from the manufacturer) used with the sound level meter or the LCD is inaccurate by a small constant.

Test 4.

This test evaluated the differences between the measured output voltage on the Sen0232 sensor and the decibel reading shown on PuTTY. The decibel reading was then divided by 50, to get the voltage. The two voltages is compared in the graph below.

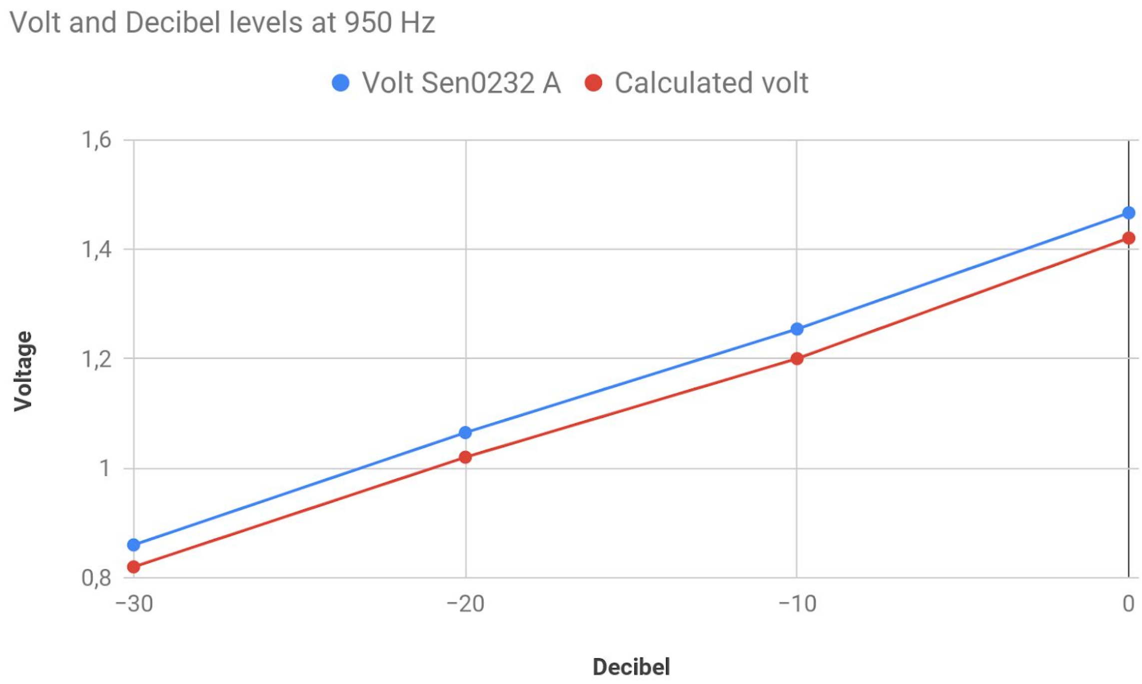


Fig 5. Shows the voltage measured on the Sen0232 A sensor at 950 Hz

The graph shows that there is an offset of 0.04 to 0.05 V, which corresponds to 2 to 2.5 dB.

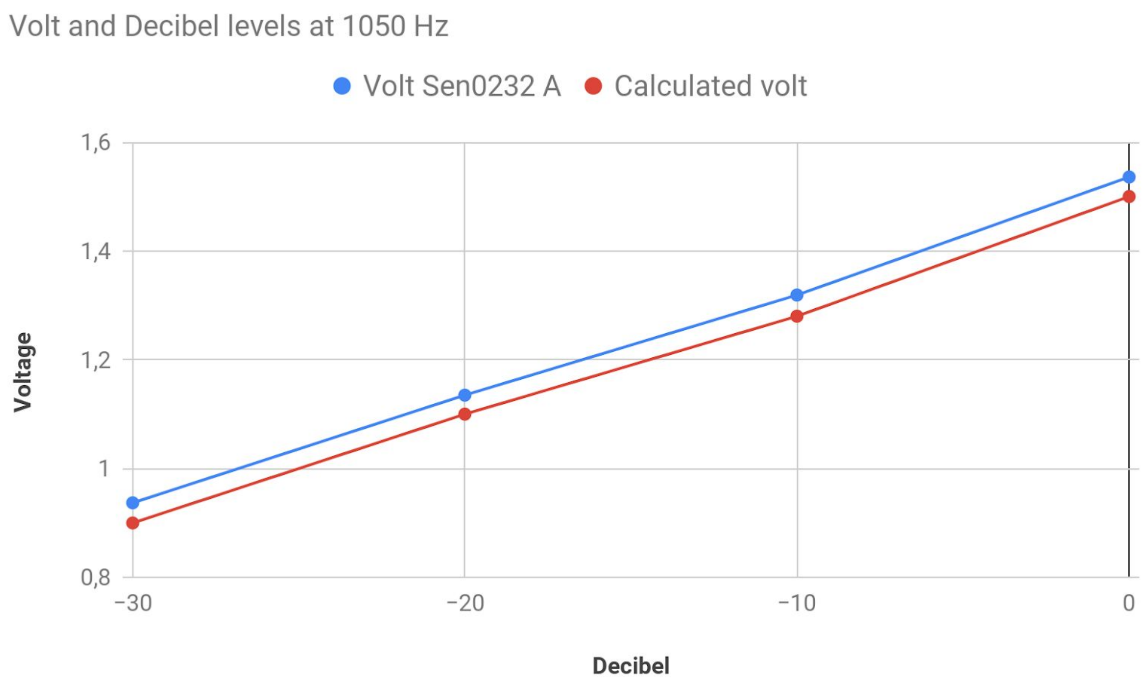


Fig 6. Shows the voltage measured on the Sen0232 A sensor at 1050 Hz

When the frequency is raised to 1050 Hz the offset is a bit smaller, but still visible. The offset is now 0.035 to 0.04 V which corresponds to 1.75 to 2 dB.

Conclusion

We have compared data from two Sen0232 sensors and one Digital Sound Level Meter 1358, and analyzed their output relative to each other.

We see from Test 1 that, between the Sen0232 sensors, at least one of the sensors is slightly inaccurate. According to our data, the sensors differ with ±2.5 dB.

From Test 2, between the sensors Sen0232 and Digital Sound Level Meter 1358, at least one of the sensors have an inaccuracy at a minimum of ±4.5 dB.

Test 3 shows that there is a constant offset between the dB readings from the Digital Sound Level Meter 1358's LCD and its output voltage * 100. This means that either the LCD or the output voltage is off by 2 to 4 dB.

All things considered, when we take into account the sources of error in our experiments, it is difficult to say exactly how much the sensors are off.

The last test shows that the output voltage from Sen0232 sensor is dropped by an offset when measured on the chip. This results in an offset that ranges between 1.75 to 2.5 dB, which should preferably be compensated for on the chip.

Error sources

1. The possibility that there was a difference in the two speaker elements was ruled out by switching which meter was listening to which element, the results were the same.

2. Some external noise was present sporadically in the room. This can generally be disregarded though due to the large amount of data points in the series. However if this study is to be conducted in the future a soundproof room is recommended.

3. As the resolution of the readings are given as integers, some rounding errors may have occurred and may therefore have misrepresented the actual reading from the meter. This can also be disregarded for the same reason as error source 2.

4. Low resolution of measurements are achieved in the lower spectrum of the frequencies as the frequency was increased by 100 for every step in the test. This could have been rectified by increasing it by smaller increments in the lower parts of the spectrum (below 1 kHz) and increasing the size of the increments in the higher parts of the spectrum.