

Solution of measuring noise by smart phone

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ABSTRACT

Now there're more and more people install Apps on their smart phones to measure noise. For the purpose of communication quality, most of smart phones are attenuated at the low frequency, therefore using mobile phone built-in microphone or external microphone to do noise measurement, the low-frequency response is poor and can't be compliant with IEC61672 standard. In order to solve this problem, we developed two type of digital microphones which convert analog signal to digital signal directly, then do communication with mobile phone through USB port or by WIFI. It completely solved the problem of mobile phone analog part. Based on professional noise measurement APPs, the combination of a digital microphone and a mobile phone meets for the standard of IEC 61672 Class 1.

Key word: digital microphone, smart phones, IEC61672 standard

1. OVERVIEW

For the purpose of communication quality, most smart phones are attenuated at the low frequency, so the low-frequency response is poor. At the same time, the smart phone will automatically control the high volume which limits the range of level linearity. Although several sound level meter "apps" may be a more cost-effective solution to determining noise levels in various environments(1), using mobile phone built-in microphone or external microphone even can't be compliant with the standard IEC61672 Class 2 which can't be taken as a professional noise measuring instrument.

In order to solve this problem, we developed two types of digital microphone which convert analog signal to digital signal directly, then do communication with mobile phone through USB port (Model iSV1610) or by WIFI (Model ASV8452). It completely solved the problem of analog part of mobile phone and achieved the unique functions by using the powerful processors and abundant external facilities.

2. SOLUTION OF DIGITAL MICROPHONE WITH USB

Model iSV1610 digital microphone with USB port is consist of measuring microphone, preamplifier, 24-bit A/D, CPU and USB port, shown in Figure 1 and 2. It is working with the APP installed on the mobile phone or tablet PC. The measuring microphone converts the sound signal to electrical signal, and the analog signal is converted to digital signal by preamplifier and A/D conversion, and then the digital signal is sent to the mobile phone or tablet PC by USB port which makes the Model iSV1600 be a digital sound level meter and real-time signal analyzer.



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Figure 1 – Model iSV1610

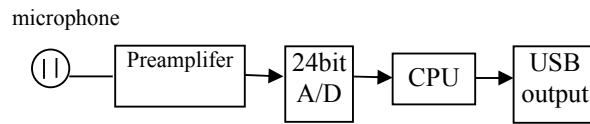


Figure 2 – ISV1610 digital microphone block diagram

Because the digital microphone has converted the analog signal to digital signal, so it avoids the shortage of smart devices hardware and makes the performance of sound level meter meet IEC 61672-2013 Class 1 and the 1/1OCT and 1/3OCT filters meets IEC 61260-1 2014 Class 1.

- (1) Main performance of iSV1610:
- (2) Measuring microphone: 1/2 inch AWA14425 with sensitivity of about 30 mV/Pa.
- (3) Frequency range: 10 Hz ~ 20 kHz.
- (4) Sampling frequency: 48 kHz
- (5) Output: USB
- (6) Power supply: powered by USB of mobile phone and Tablet PC

3. SOLUTION OF WIRELESS DIGITAL MICROPHONE

With the development of the internet, smart phones and other technology, more and more devices are connected wireless with WIFI technology. Model ASV8452 wireless digital microphone (Figure 3 and 4) sends the original waveform data through the WIFI and the receiving equipment can be smart phones, tablet PCs, laptops, desktops. We can use the powerful processing capacity and flexible collocation of these devices to do computation and analysis. In order to achieve the professional noise measurement, we developed a mobile software working with the ASV8452 which is installed in ANDROID or IOS operation system, realizing integral analysis, statistical analysis, and spectral analysis of 1/1OCT, 1/3OCT and FFT, etc.



Figure 3 – Model ASV8452

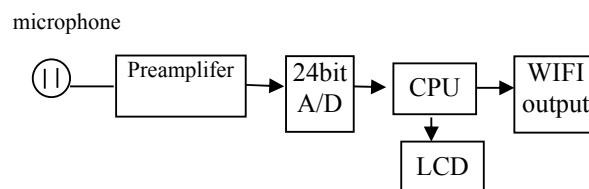


Figure 4 – ASV8452 wireless microphone block diagram

4. RESPONSE TESTING OF FREQUENCY WEIGHTINGS

Model iSV1610 and ASV8452 digital microphone both convert the analog signal to digital signal by pre-processor and send the digital signal to the mobile phone or tablet PC. The mobile phone and tablet PC only analyze the digital signal, so there is no difference between the signals received by different mobile phone. We only take the Xiaomi Note phone for measuring.

The mobile phone is connected to the iSV1610 or ASV8452 respectively, and test the frequency response according to the method below. The measuring data is shown in Table 1 and Figure 5.

Table 1 – Frequency response of Model iSV1610 and ASV8452 connected to the Xiaomi Note

Frequency (Hz)	Model iSV1610			Model ASV8452			Acceptance limits (dB)
	A weighting	C weighting	Z weighting	A weighting	C weighting	Z weighting	
10	-68.6	-13.3	1.1	-69.7	-15.1	-0.3	+3.0; -∞
12.5	-63.0	-10.8	0.5	-64.4	-12	-0.6	+2.5; -∞
16	-55.7	-8.1	0.7	-56.0	-8.2	0.7	+2.0; -4.0
20	-49.7	-5.4	0.7	-49.7	-5.6	0.9	±2.0
25	-44.5	-4.1	0.7	-44.2	-3.9	0.6	+2.0; -1.5
31.5	-39.3	-2.7	0.3	-39.1	-2.7	0.5	±1.5
40	-34.3	-1.7	0.4	-34.2	-1.7	0.3	±1.0
50	-30.1	-1.0	0.3	-30.0	-1.0	0.3	±1.0
63	-26.1	-0.7	0.2	-26.1	-0.8	0.2	±1.0
80	-22.3	-0.4	0.1	-22.3	-0.4	0.1	±1.0
100	-19.0	-0.2	0.2	-19.0	-0.2	0.1	±1.0
125	-16.2	-0.2	0.0	-16.2	-0.3	0.0	±1.0
160	-13.2	0.0	0.1	-13.2	-0.1	0.1	±1.0
200	-10.8	0.0	0.0	-10.8	-0.1	0.0	±1.0
250	-8.7	0.0	0.0	-8.7	-0.1	-0.1	±1.0
315	-6.6	0.1	0.1	-6.4	0.3	0.3	±1.0
400	-4.7	0.0	0.0	-4.6	0.1	0.1	±1.0
500	-3.2	0.0	0.0	-3.4	0.1	0.0	±1.0
630	-2.1	-0.2	-0.1	-1.9	0.1	0.1	±1.0
800	-0.9	-0.1	0.0	-0.7	0.1	0.1	±1.0
1k	0.0	0.0	0.1	0.0	0.0	0.0	±0.7
1.25k	0.8	0.1	0.1	0.6	0.1	0.1	±1.0
1.6k	1.1	0.0	0.2	0.7	-0.3	-0.2	±1.0
2k	1.3	-0.1	0.1	1.4	0.1	0.2	±1.0
2.5k	1.4	-0.2	0.1	1.5	0.0	0.2	±1.0
3.15k	1.6	-0.2	0.2	1.3	-0.3	0.0	±1.0
4k	0.9	-0.9	-0.3	0.9	-0.8	-0.3	±1.0
5k	1.2	-0.7	0.3	1.8	0.1	0.9	±1.5
6.3k	0.6	-1.3	0.2	1.2	-0.7	0.8	+1.5; -2.0
8k	-0.1	-2.0	0.5	0.4	-1.4	0.9	+1.5; -2.5
10k	-0.9	-2.8	1.2	-0.9	-2.8	1.0	+2.0; -3.0
12.5k	-4.4	-6.3	0.0	-2.7	-4.5	1.8	+2.0; -5.0
16k	-9.8	-11.7	0.1	-8.7	-10.5	1.2	+2.5; -16.0
20k	-30.0	-32.0	1.2	-21.0	-22.9	0.2	+3.0; -∞

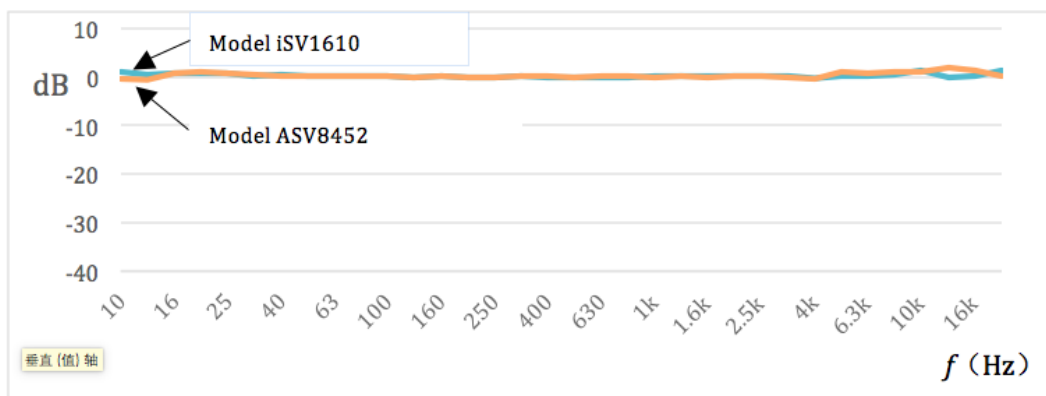


Figure 5 – Frequency response curve of Z weighting

5. LEVEL LINEARITY TESTING

Test the level linearity of Model iSV1600 and ASV8452, shown in Table 2.

Table 2 – Level linearity of iSV1610 and ASV8452(dB)

Expected Level(dB)	Measured level of iSV1610	Measured level of ASV8452
27	27.8	27.5
29	29.5	29.1
30	30.3	30.2
40	39.8	40.1
50	50.0	50.0
60	60.0	60.1
70	70.0	70.1
80	79.9	80.0
90	89.9	90.0
100	100.0	100.0
110	110.0	110.0
120	120.0	120.0
130	127.6	129.9
135	126.9	135.0

We can see that, with the method of separating analog signal from digital signal, the performance of model iSV1610 and ASV8452 have nothing to do with the analog part of mobile phone, the frequency response and level linearity can meet the requirements of sound level meter Class 1. The level linearity range of ASV8452 can reach 108dB and the iSV1610 can reach 96dB when connected to the mobile phone.

6. CONCLUSION

Measuring noise can choose different method according to different need. Because input signal of built-in microphone of smart phones are attenuated at the low frequency, the low- frequency response is poor. And it's not convenient to calibrate it, so using the built-in microphone to measure noise in daily life is not a precise method. Compared to the built-in microphone method, the external microphone method which is connected to the stereo socket of mobile phone can achieve wider frequency and level linearity range and it can be calibrated. Even the input signal is also attenuated at the low frequency, the performance is better than the in-built microphone. And the method of using external device such as ASV8452 wireless digital microphone which converts analog signal to digital signal can avoid poor analog part of mobile phone. We can also use the powerful processing capacity and flexible collocation of these devices to achieve the performance of sound level meter class 1 and use the ASV8452 in professional noise measurement.

Several projects of measuring noise by mobile phone are list in Table 3 which is provided for user to choose.

Table 3 – several solutions of measuring noise by mobile phone

Solution	Hardware	Software	Main function
Play version	Mobile phone with built-in microphone	Perfect noise APP	Noise measurement and spectrum analysis, is not convenient to calibrate it, poor frequency response, limited measurement range and not exact data
Amateur version	Smart phone + Model iSV1600		Noise measurement and spectrum analysis, can calibrate it, poor frequency response, limited measurement range and relatively precise data
Starter version	Smart phone + Model iSV1620		Noise measurement and spectrum analysis, can calibrate it, good frequency response, wide measurement range and close to sound level meter of class 2
Improved version	Smart phone + Model iSV1610		Noise measurement and spectrum analysis, can calibrate it, good frequency response, wide measurement range and meets sound level meter of class 2
Professional version (USB)	Smart phone + Model iSV1610	S8452 Measurement software	Class 1, total value measurement and integral analysis, connected by USB
Professional version (Wifi)	Smart phone + Model ASV8452		Class 1, total value measurement and integral analysis, connected by Wifi
High equipped version (USB)	Smart phone + Model iSV1610		Class 1, total value measurement, integral analysis, 1/1OCT, 1/3OCT, FFT and reverberation time measurement
High equipped version (Wifi)	Smart phone + Model ASV8452		Class 1, total value measurement, integral analysis, 1/1OCT, 1/3OCT, FFT and reverberation time measurement

Note:

- 1.The operating system of mobile phone connected to the iSV1610 should be Android 5.0 and above.
- 2.This is suitable for tablet PC.

REFERENCES

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