



G+ COMAIR® Application Note V1.2

V1.2 –16 Dec. 2013

Revision History

Revision	Date	By	Remark
1.2	16 Dec 2013	Rison Lo	1. Update trademark 2. Add COMAIR® Mixer tool description
1.1	07 Nov 2012	Barry Liang	1. Remove 0.25sec mode.
1.0	20 Sep 2012	Barry Liang	1. Update Table1-1. 2. Modify descriptions.
0.4	14 Sep. 2012	Barry Liang	1. Modify COMAIR® for Android devices description. 2. Modify Overview description. 3. Change Design-note naming to Application-note.
0.3	07 Sep. 2012	Barry Liang	1. Add Index page 2. Add COMAIR® for Android devices , Trouble Shooting. 3. Modify RegisterCode and some other descriptions. 4. Modify Table1-1
0.2		Rison Lo	NA
0.1		-	NA

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1. COMAIR® Technology

A. Overview

COMAIR® is a technology to send or to receive data between two devices. It broadcasts data between multiple devices using speakers and (or) microphones. It can send data discretely or embed data with music, speech, or sound effect. It can also send data in compressed audio, such as mp3 or AAC with proper sample rate and data rate.

B. Available platform

	RX	TX(DAC mode)	TX(IO mode)
GPCE001A/128A/256A/512A	Yes	Yes	Yes
GPCE063A/064A/048A	Yes	N/A	Yes
GPCE2064A	Yes	NA	Yes
GPL169251A/256A	Yes	Yes	Yes
GPCD	N/A	Yes	Yes
GPL83110UA	NA	Yes	N/A
GPL85110A	NA	Yes	N/A

Table 1-1

2. Hardware Design

A. Selecting Microphone and Speaker

The transmitted distance and receiving correctness are highly related to the quality of speakers and microphone. Many brands of electret microphones have flat frequency response up to 20 KHz. But not all microphones meet this specification. Choosing a proper microphone with flat frequency response on the frequency band that COMAIR works is an important issue.

On the speaker side, it is more difficult. Many inexpensive speakers are not qualified. Thus, the best approach is to try several speakers and select one that produces audio signals that are sufficiently loud and that works as a sonic tone component to the distances required by the application.

An alternate approach for speakers is to use buzzer or pizero. Buzzer or pizero is capacitive devices and

can be used in LC resonator to generate strong enough acoustic signals. This way is suitable for platforms that have TX IO mode.

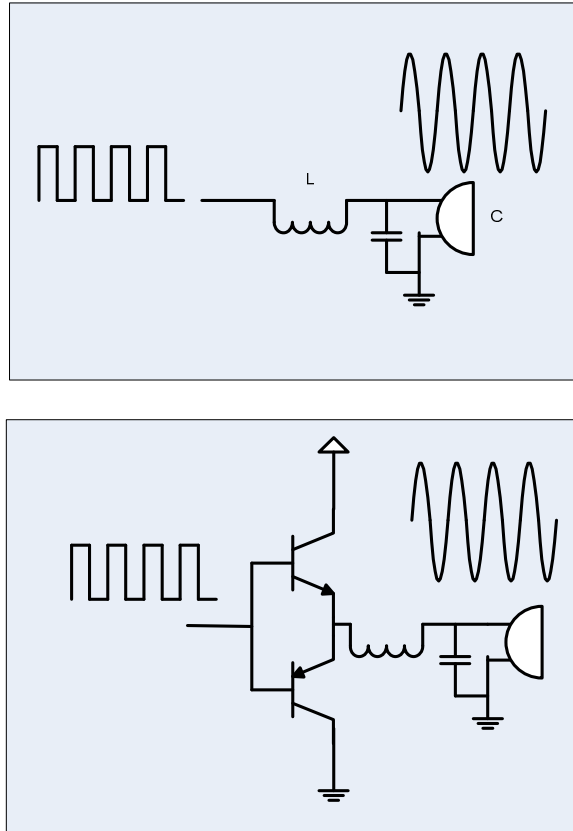


Figure 2-1.

In figure 2-1, use equation $f = 1/2\pi\sqrt{LC}$ to choose a proper L . Here, f is the center frequency used in COMAIR®. The capacitive value of buzzer or pizero is usually small and therefore let the value of L larger. Inductor with larger L is expensive, so add a parallel C to buzzer or pizero can let L here be a small one.

B. Distance and angle between microphone and speaker

The maximum separation distance between the transmitting speaker and the receiving microphone depends on room acoustics and echoes. The signal power decays a by a factor of four if the distance between microphone and speaker increase is doubled. User should design a suitable transmitting range. Too many echoes will cause multipath interference to COMAIR®. Try to avoid transmitting or receiving device in an environment with many echoes such as corner of your room.

Sound transmitting in the air with reflection and refraction is equal to go through a low pass filter; therefore the high frequency sound is easy to get attenuation. Use COMAIR® through reflection or refraction path will get poor correctness than direct path.

Figure 2-2 is a typical diagram of speaker energy versus beam angle. Sound has strongest energy in angle 330° to 30°, and it attenuates quickly as angle increases. In angle 60°, user got 5dBV energy loss comparing to that of 0°. And in angle 120°, more than 10dBV energy loss under the same condition. To avoid a big angle between the transmitting speaker and the receiving microphone increases the stability and correctness.

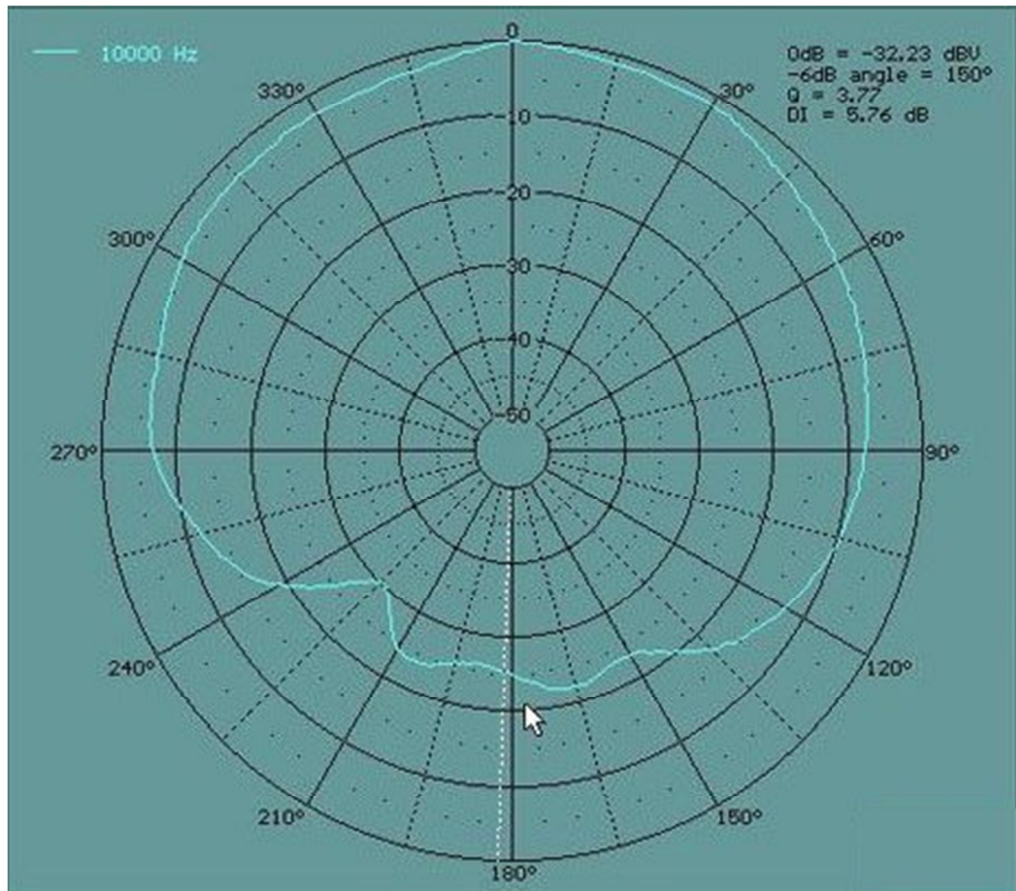


Figure 2-2

C. Prevent absorbent material between microphone and speaker

Sound absorbing material in front of the microphone or speaker degrades the performance. The material covering microphones and speakers must be as little as possible.

D. Housing of microphone and speaker

Proper design of microphone and speaker housing is important for COMAIR®. Figure 2-3a is a good mounting and 2-3b is a bad mounting. In the product, the microphone should be positioned as close to the mounting surface as possible and should be fully seated in the plastic housing. There should NOT be airspace between the microphone and the housing. Such airspace leads to acoustic resonance and reducing recognition accuracy.

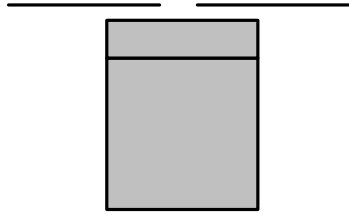


Figure 2-3a.

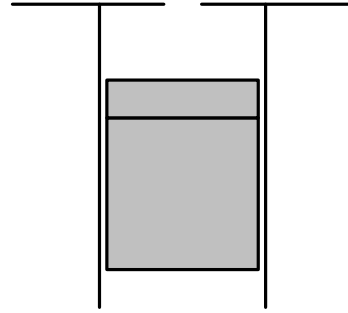


Figure 2-3b.

Same rule can apply to speaker mounting. Figure 2-4a shows a good mounting and figure 2-4b is the bad mounting. It is easy to have reflection if there is air gap between speaker and surface. Reflection can create interference on the phase of sound and decay its strength.

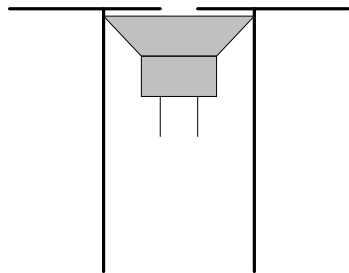


Figure 2-4a

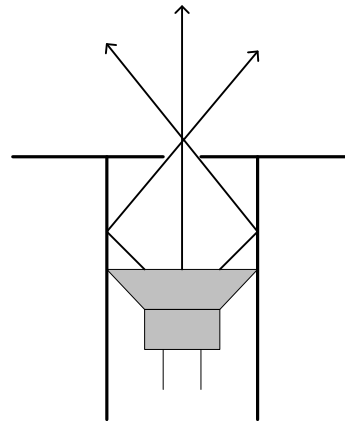


Figure 2-4b

E. Environment noise

Some environment noise such as metal strike or motor running are white noise or with high frequency part. This kind of noise will impact COMAIR® correctness. It is recommended to avoid those kinds of noise while COMAIR® is working or try to use 6bit/s mode to improve sound signal strength.

F. Choose proper frequency

COMAIR® can support frequency up to 20K Hz. Higher frequency is not prone to be audible, but its transmitting range is shorter than that of lower frequency. Based on application to choose the proper frequency is important.

G. Using DAC or IO

In DAC mode, the amplifier side can be a general audio amplifier or transistor amplifier. Software can

provide ramp up and ramp down to avoid pop sound. The shortcoming is high CPU loading. In IO mode, the signal is generated by hardware toggle IO and the amplifier side must be an audio amplifier with de-pop function inside to prevent undesired pop noise. IO mode also requires few external components for filtering. With the help of hardware toggle IO, the CPU loading is low compare to that of DAC mode. The IO mode with an external audio amplifier is recommended for most of the applications.

3. Software Design

A. Set proper data rate

COMAIR® adopts data format of 24-bit per packet. The packet definition is shown at Table 3-1. COMAIR® provides 2 transmission modes, 0.5 sec and 1 sec mode. The corresponding symbol rate is 2 packets/s and 1 packet/s. The effective data rate is 12/6 bps each. The faster the data rate, the higher risk of data loss it may take. User should choose proper data rate according to real environment.

2bits	6bits	4bits	4bits	8bits
SYNC	DATA	CHECKSUM	ECC	SYNC

Table 3-1

B. Frequency Step

The default frequency step is 562Hz. This step is related to sampling rate and Doppler Effect avoidance. It is recommended to keep this value. Please contact Generalplus if any special request.

C. RegisterCode

RegisterCode is provided by Generalplus, which is used to encrypt the “KEY” of COMAIR® symbol mapping. Transmitter and receiver must use the same RegisterCode to ensure a correct and successful transmission. This can prevent different products with COMAIR® Technology inside from talking to each other. User can contact Generalplus to get more information.

D. Handshake or Timeout

It is not possible, even in theory, to design a system which has a 0% chance of error during data transmission or reception. Sonic signals will be interfered by environment noise. It is recommended to have handshake or timeout mechanism to prevent false or dead behavior. Fuzzy response can also be a kind of solution.

E. Minimum delay between successive COMAIR® commands

If an application must transmit more than one command at a time, it is not necessary to have any delay between commands. User can immediately send the following commands when the previous command transmission is finished.

F. Mix COMAIR® signals at optimal locations of audio signal

When Mixing COMAIR® signals with audio, they should be placed in the part where the amplitude of the audio signal is large in order to hide them from perception. But remember the sum of COMAIR® signal and audio signal should not be distorted to impact audio quality.

G. Controlling of self-received commands

When a device transmits a COMAIR® signal, it also receives this command. There are two ways to control this issue. First one is to disable receiving function while sending commands. The side effect is a coming signal from other device will be ignored when disable receiver. The other is to reject or ignore the command that has just sent out from software side.

4. COMAIR® for iOS devices

COMAIR® supports the communication between iOS devices and Generalplus' chips.

A. Frequency response of iOS Devices

Even though iDevices and COMAIR® can support frequency up to 20KHz, iPhone4S has low pass filter to remove the frequency more than 20KHz. It is recommended to set frequency LOWER than 18.5KHz to communicate with iPhone4S.

B. COMAIR Signal strength for iPhone4S

Microphone in ihpone4S is more sensitive than that in other iOS devices. If the communication distance is very short, such as several inches, the signal amplitude transmitted to iphone4S should avoid to be too large to cause saturation.

C. Mechanism consideration

The microphone location of iPad1 is different with that of iPad2 and The-new-iPad. User has to take care of mechanism design.

D. Compatibility issue on iPod touch

iPod touch Gen2 and Gen3 are armv6 CPU, and Unity3D has some compatibility issue with COMAIR® library in these two devices. Please contact Generalplus for further information.

E. CPU loading issue on iPhone3GS

iPhone 3GS is easy to have insufficient CPU loading when running complicated Apps. This will cause the non-continuity when getting data from its microphone. User can increase buffer size to solve this problem.

```
int i32Ret = InitCOMAIRAudio();  
Float32 preferredBufferSize = .01;    // 0.01 sec  
AudioSessionSetProperty(kAudioSessionProperty_PreferredHardwareIOBufferDuration, sizeof(preferredBufferSize), &preferredBufferSize);
```

5. COMAIR® for Android devices

COMAIR® supports communication between Android devices and Generalplus' chips. Some Samsung mobile devices are tested, including Galaxy S2/S3/Note/Tabs. Because there are so many kinds of Android devices, it is almost impossible to test all of them. Users need to keep in mind that all common key factors described above still suit on Android devices. Generalplus provides COMAIR® demo App on Android system. Please contact Generalplus for further details.

6. COMAIR® application on DVD or TV

COMAIR® application on DVD or TV is a big challenge. There are various possible factors need to be considered. User must find a way to overcome below factors or can accept data loss in application.

A. Speaker response

There are many ways to play DVD, and each device has its own speaker, it is hard to control the quality of

speaker. Some cheap speaker has poor high frequency response.

B. Cable spectrum response

The frequency response of some AV cables only up to 16 KHz. Some audio/video chips resample signal on frequency lower than 48KHz. This makes higher frequency fail to fully pass audio cable.

C. Stereo interference

If the left and right signals are with opposite phase or close to opposite phase, it will be easy to have interference on COMAIR® signals.

D. Flyback transformer noise on CRT TV

Most CRT TV has strong 16.25 KHz noise produced by flyback transformer. This regular noise will impact COMAIR® receiving ability.

E. TV volume

Different volumes have different COMAIR working distance. User has to take care of this issue when designing the product.

F. Home Theater environment

Home theater uses multiple speakers to create the sound field or sound stage for human. Obviously, the multipath interference is a big challenge for COMAIR® technology.



Figure 6-1

G. DVD sound effect problem

Some DVD has post sound effects such as, EQ, Reverb, Resonance, and so forth. These sound effects will destroy sound signals or reproduce undesired sound signals for COMAIR®.

7. Trouble Shooting

There are many reasons that may cause COMAIR® communication failure. We list some frequently met situations and show techniques to debug.

A. Tx/Rx mode mismatch

- Center frequency
- Frequency step
- Tx time duration

B. Invalid Register code

- Make sure the Register code is a valid one. Please contact Generalplus to get a valid Register code.
- The Register code must match between Tx and Rx.

C. Quality issue

Sound quality is critical for COMAIR® communication. To analyze the sound quality, we need to record the sound that MIC received. This can be achieved by sound recording Apps or the debug App provided by Generalplus. Note that the file format should be *.wav/*.pcm.

- **Generalplus Apps for debugging:**

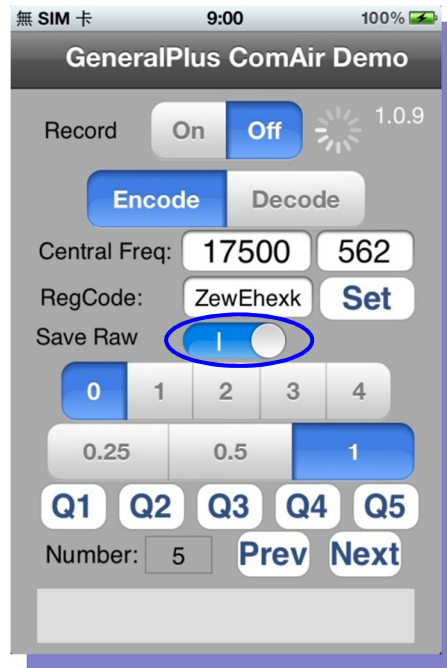


Figure 7-1

- **Where to find the PCM file:**

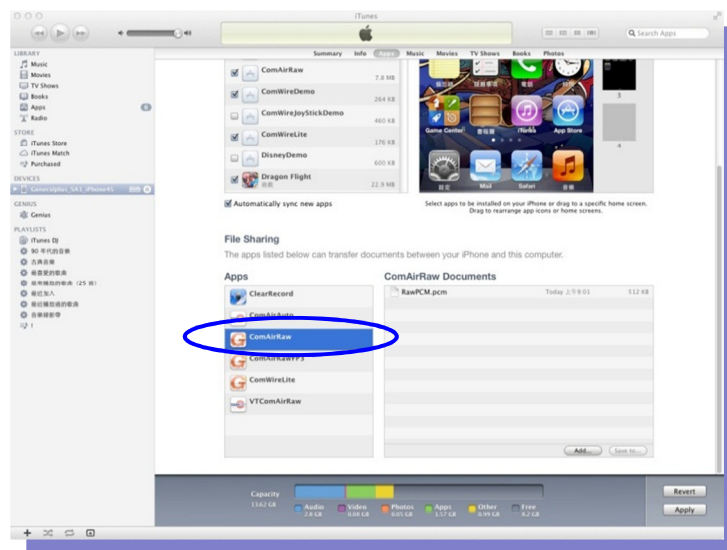


Figure 7-2

- **Spectrum Tells Everything:**

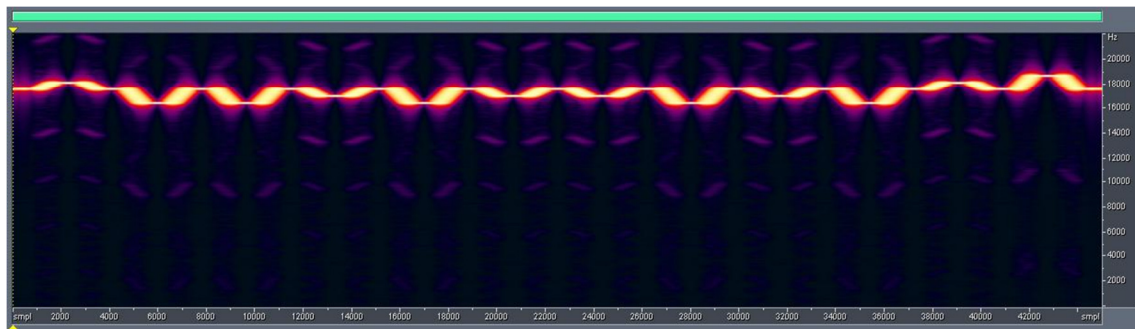


Figure 7-3

- Every frequency should be clear and good
- No interference or noise

- **Lose high frequency signals:**

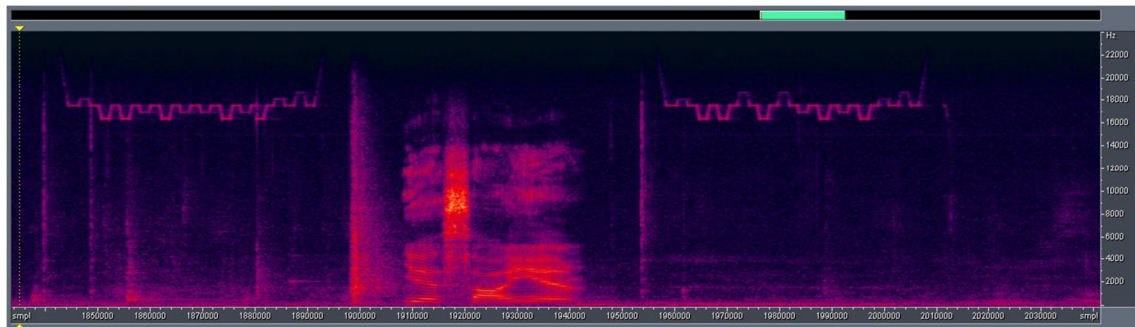


Figure 7-4

Check items:

- Use speaker or microphone with good frequency response
- Move center frequency
- Use 0.5 or 1 second mode

- **Signal Distortion:**

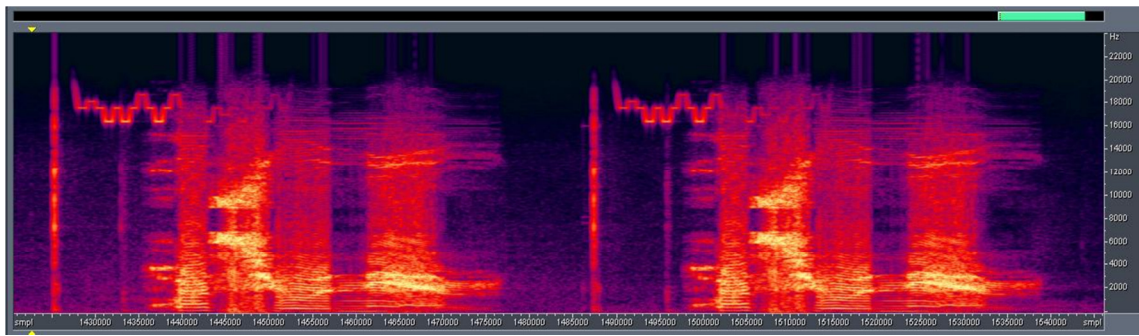


Figure 7-5

Check items:

- Reduce the audible sound volume
- Use LPF to compress audible sound

- **Multi-Path Delay:**

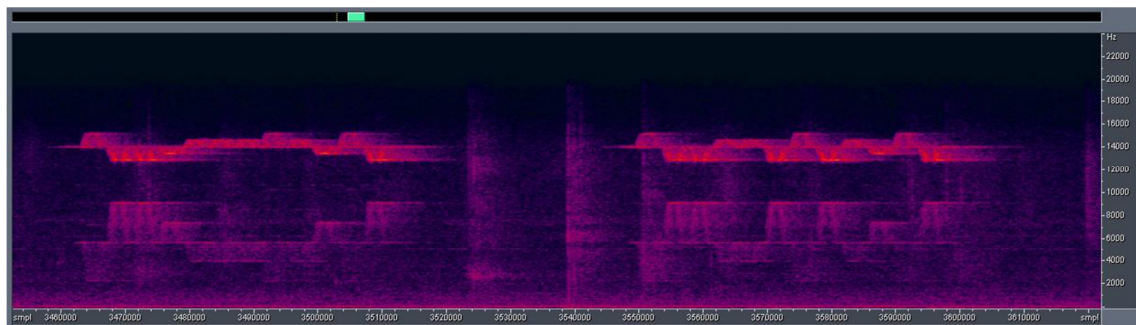


Figure 7-6

Check items:

- Prevent devices from working around the corner
- Use 1 second mode

- **Fail on Real Time Recording:**

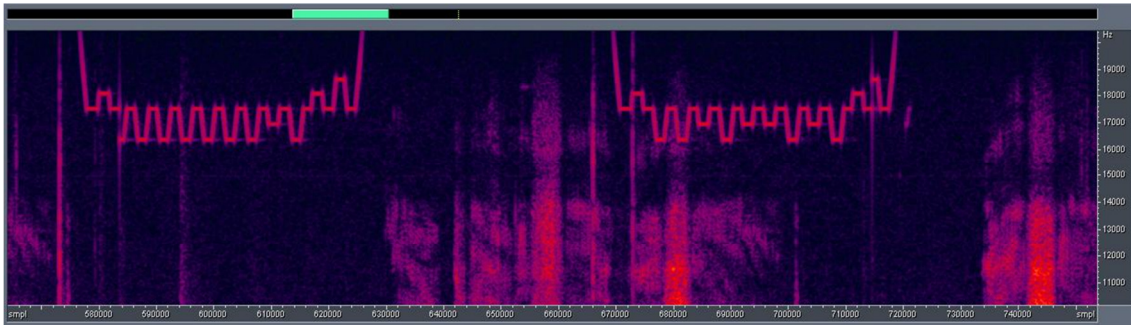


Figure 7-7

Check items:

- Increase ADC buffer
- Reduce task loading
- Rearrange task

- **Strong interference noise:**

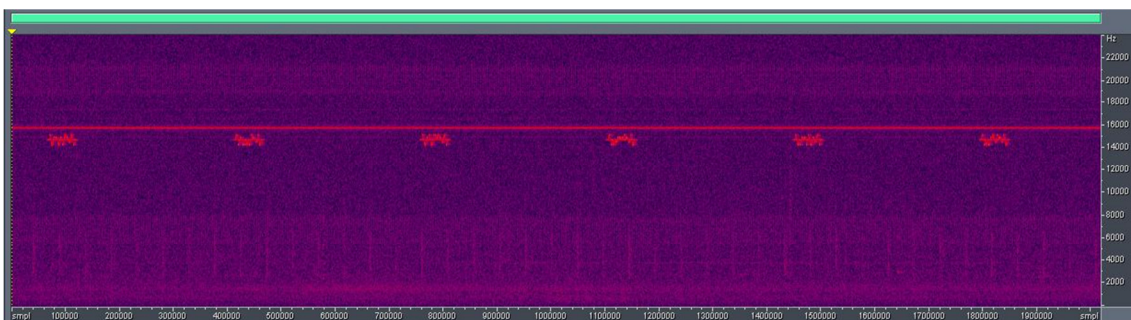


Figure 7-8

Check items:

- Change center frequency
- Adjust frequency step size

- **Poor SNR:**

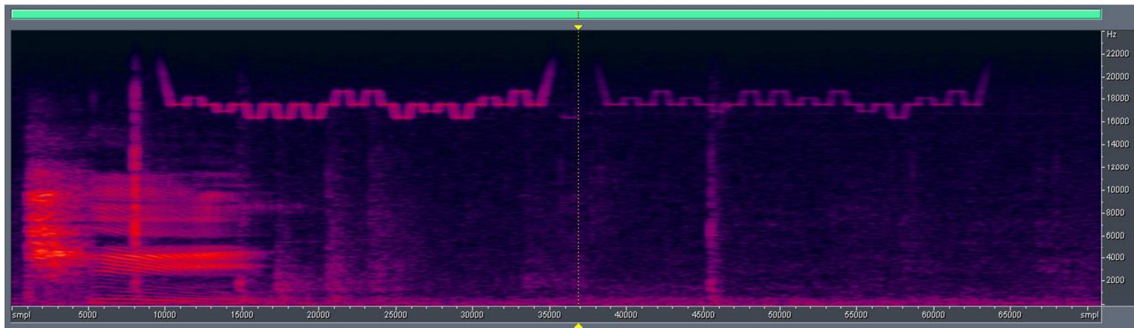


Figure 7-9

Check items:

- Enhance the TX power or RX gain
- Lower the center frequency
- Shorten the transmission distance
- Narrow the angle of speaker & microphone

- **iPhone4S Hardware Filter:**

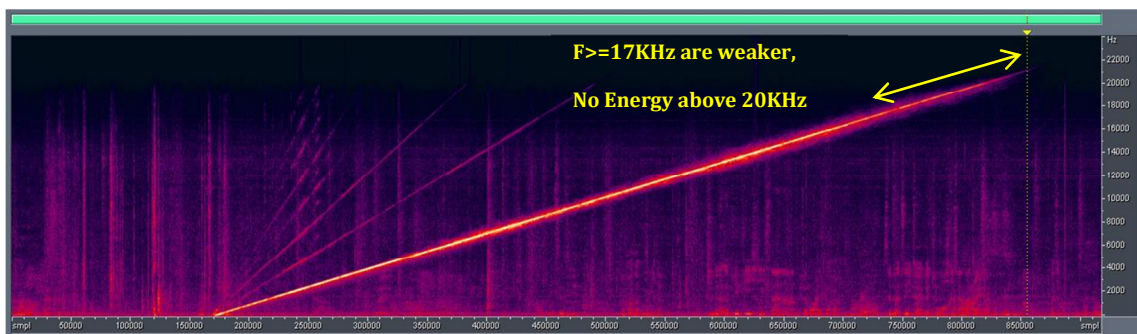


Figure 7-10

Check items:

- Lower the center frequency

8. Mixer Tool for COMAIR®

In some applications, user will need to embed the COMAIR® commands into a wave file. Then play it through any kind of audio playing devices such as DVD, mp3 player, and so on. Generalplus provides a tool called G+ Comair Mixer Tool that can help on these kinds of applications. Please get this tool and its documentation from the latest COMAIR® SDK.

The main interface is as below.

