Andrea Electronics

Audio Filters
Performance

Revision 2.0
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1. Filters

Andrea has four primary audio filters:

1. Noise Cancellation (PureAudio): Removes background ambient noise, such as, fan noise.
2. Aggressive Noise Cancellation (PureAudio2): Removes background ambient noise, such as, fan noise. This option will remove more noise, but in a very noisy environment the remaining noise may have musical sounding artifacts in it.
3. Light Beam Forming (DSDA2): Non-aggressive beam former, which removes some of the sounds coming from outside of a 30 degree cone.
4. Aggressive Beam Forming (DSDA3): Aggressive beam former, which removes most of the sounds coming from outside of a 30 degree cone.
5. Acoustic Echo Canceller (EchoStop): Full-duplex acoustic echo canceller, which removes the audio coming from the computer's loudspeakers. EchoStop has a built-in PureAudio noise cancellation filter, so you always get the benefit of noise cancellation when EchoStop is enabled.

These filters have been tightly integrated, allowing multiple filters to be enabled at the same time.

2. Beam Forming (DSDA2 & DSDA3)

The beam forming filters (DSDA2 & DSDA3) remove sounds coming from outside of a 30 degree cone, as shown in this picture.

While this document talks about a 30 degree cone, the width of the cone is determined by the spacing between the two microphone elements. The following table shows the cone width at the indicated microphone spacing.

Microphone Spacing	Cone Angle
2.0 inches (51 mm)	60 degrees
2.5 inches (64 mm)	54 degrees
3.0 inches (76 mm)	45 degrees
3.5 inches (89 mm)	37 degrees
4.0 inches (102 mm)	30 degrees

Andrea Electronics recommends microphone spacing between 3 and 4 inches.

3. CPU Usage

Computers have been getting faster and faster, which meant the CPU usage was not a critical factor. However, with the advent of net book computers, CPU usage has become a critical factor.

To accommodate these slower computers, Andrea has made the following two optimizations to the filters:

1.   All filters have been optimized, reducing the CPU usage significantly.

2.   A "Slow Machine" mode has been introduced to further reduce the CPU usage. A system can be configured to always use the "Slow Machine" mode. In addition, the filters will monitor their CPU usage and if it is too high, the filters will automatically shift into "Slow Machine" mode.

The following table shows the CPU usage in MIPS of the new filters, plus the usage in "Slow Machine" mode. In normal mode ("Fast Machine") mode, the CPU usage has been reduced between 22% and 42%. In "Slow Machine" mode the CPU usage has been reduced between 36% and 83%.

	Fast Machine Mode (MIPS)	Slow Machine Mode (MIPS)
PureAudio	7	2
PureAudio2	8	3
DSDA2	9	5
DSDA2 & PureAudio	10	6
DSDA2 & PureAudio2	11	7
DSDA3	6	6
DSDA3 & PureAudio	7	7
DSDA3 & PureAudio2	8	8
EchoStop	9	5
EchoStop & DSDA2	12	NA
EchoStop & DSDA3	14	NA

These figures are based on a sampling rate of 48000Hz.

In "Slow Machine" mode if you enable EchoStop and DSDA, DSDA will be applied if there is not any render audio streaming and EchoStop will be applied if there is render audio streaming. So, you get one, or the other, but not both.

4. Performance

The results of enabling the filters in various combinations are shown in this section.

The tests were run in a typical quiet office, with the normal background noise, such as, fan noise. The hardware setup was an array microphone sitting on top of the monitor with loudspeakers on each side of the monitor. The audio device is an Andrea PureAudio USB-SA. The results are similar when using a codec that's embedded on the motherboard.

The performance of the filters will vary from these results because of factors such as room acoustics and the amount of noise in the room.

Noise Cancellation (PureAudio)

This test shows the removal of background noise, such as fan noise, without affecting the voice in the recording.

While this test shows the results of applying PureAudio to the audio captured by the microphone, the results are the same when applying PureAudio to the render audio being sent to the loudspeakers.
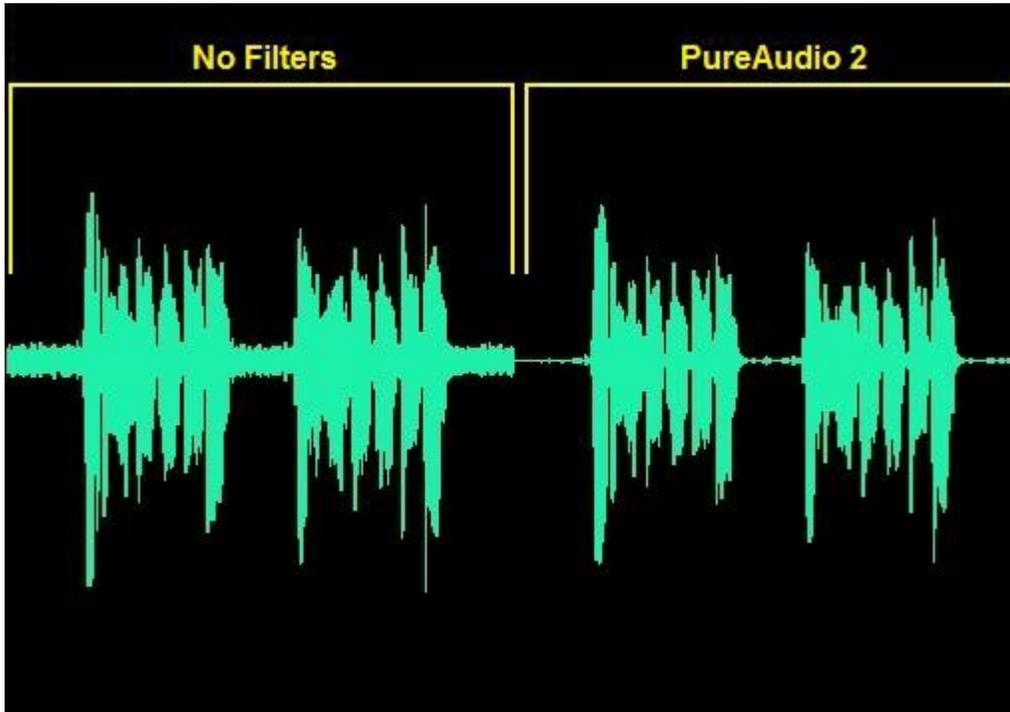
The result is a 12 dB reduction of back ground noise.
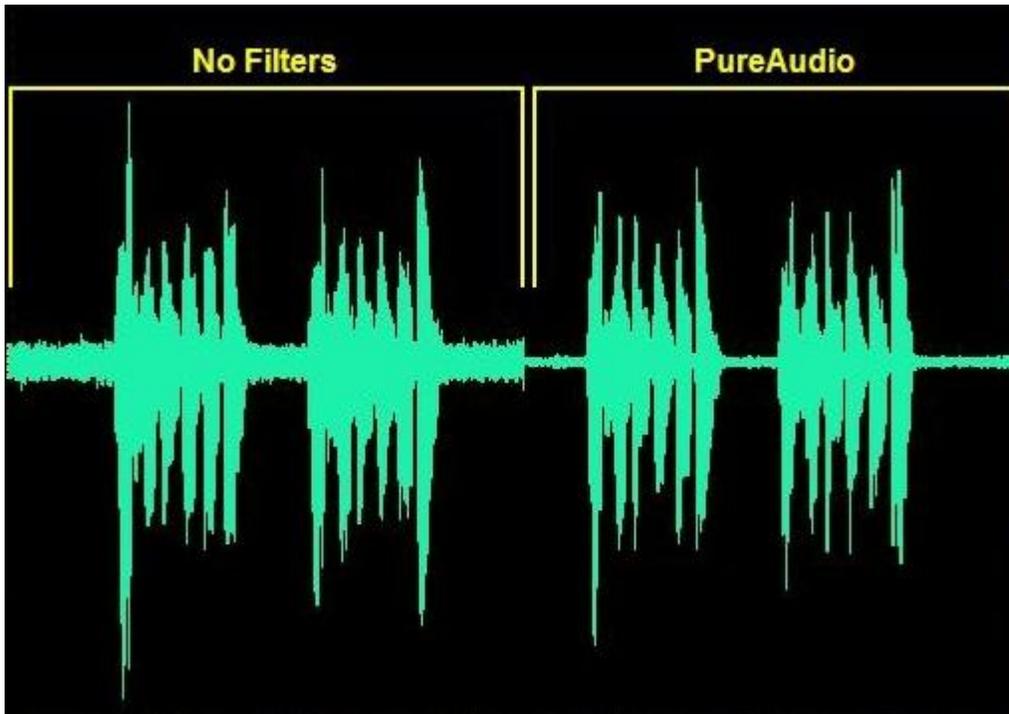
Aggressive Noise Cancellation (PureAudio2)

This test shows the removal of background noise, such as fan noise, without affecting the voice in the recording. This option will remove more noise, but in a very noisy environment the remaining noise may have musical sounding artifacts in it.

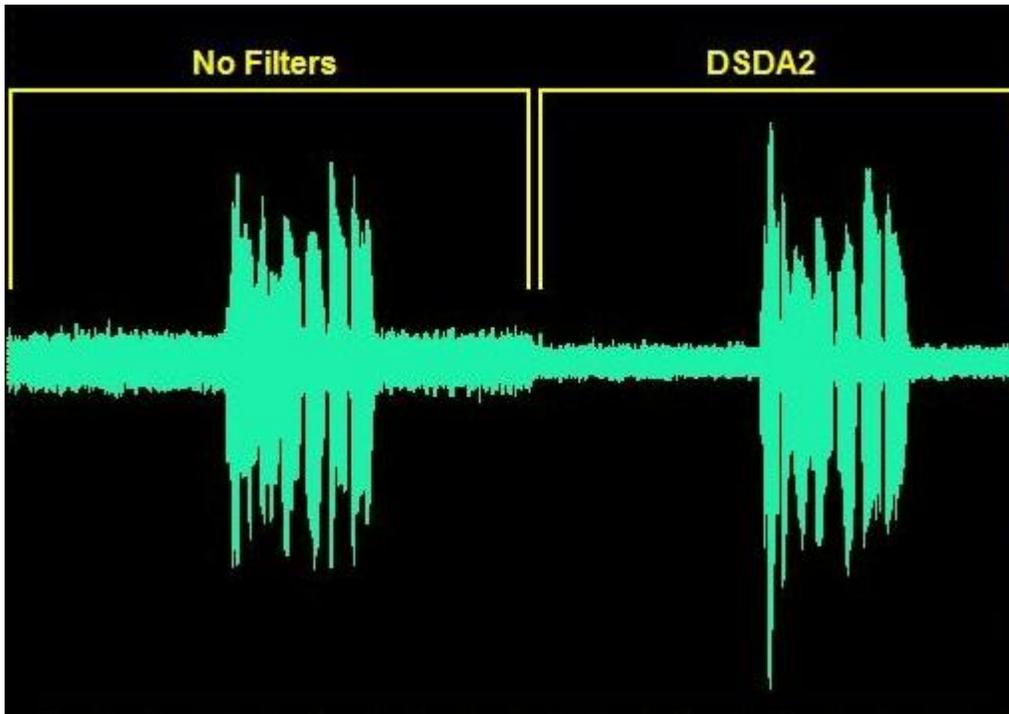The result is a 24 dB reduction of back ground noise.

Light Beam Forming (DSDA2)

This test shows the removal of some of the noise coming from outside of a 30 degree cone. It consists of a low volume white noise being played at a 45 degree angle to the microphone.

It takes several seconds for this filter to converge. To highlight the true performance of the filter, the recording of the converging was removed from these screen shots.

This test uses the DSDA2 filter. The result is a 4 dB noise reduction.

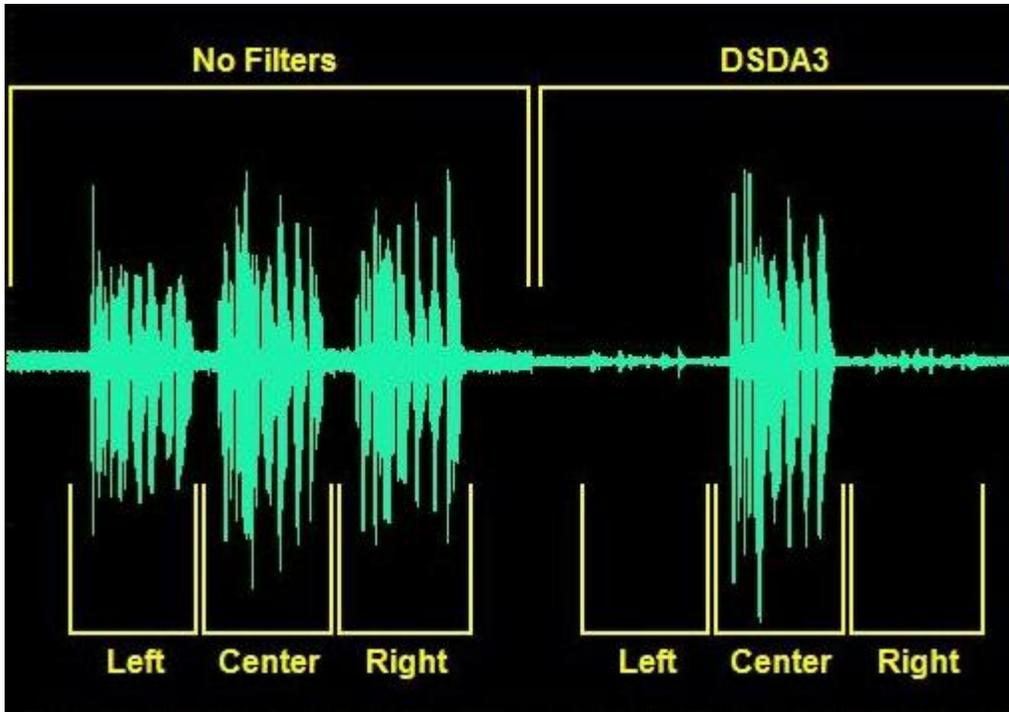## Light Beam Forming & Noise Cancellation (DSDA2 & PureAudio)

This test uses both the DSDA2 filter and the PureAudio filter. The result is a 15 dB noise reduction.
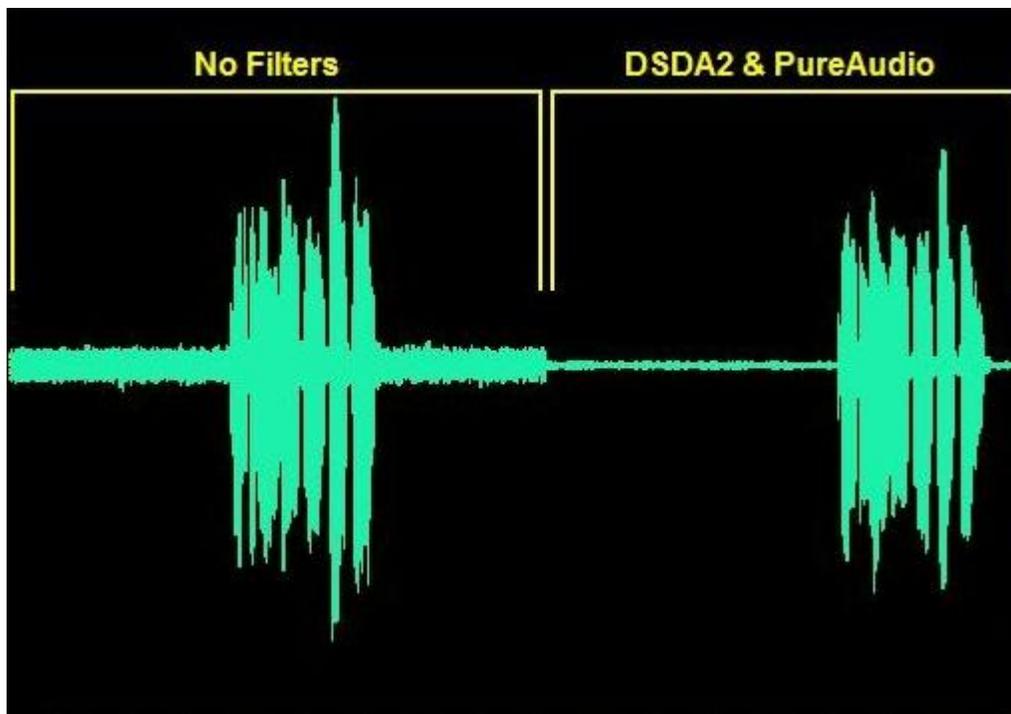
### Aggressive Beam Forming (DSDA3)

This test shows the removal of most the sounds coming from outside of a 30 degree cone. It consists of speaking at three different locations: (1) 45 degrees to the left of the microphone, (2) directly in front of the microphones, and (3) 45 degrees to the right of the microphone.

This test uses the DSDA3 filter. The result is a 30 dB reduction in the audio coming from outside of the cone.

Aggressive Beam Forming & Noise Cancellation (DSDA3 & PureAudio)

This test uses both the DSDA3 filter and the PureAudio filter. The result is a 37 dB reduction in the audio coming from outside of the cone.
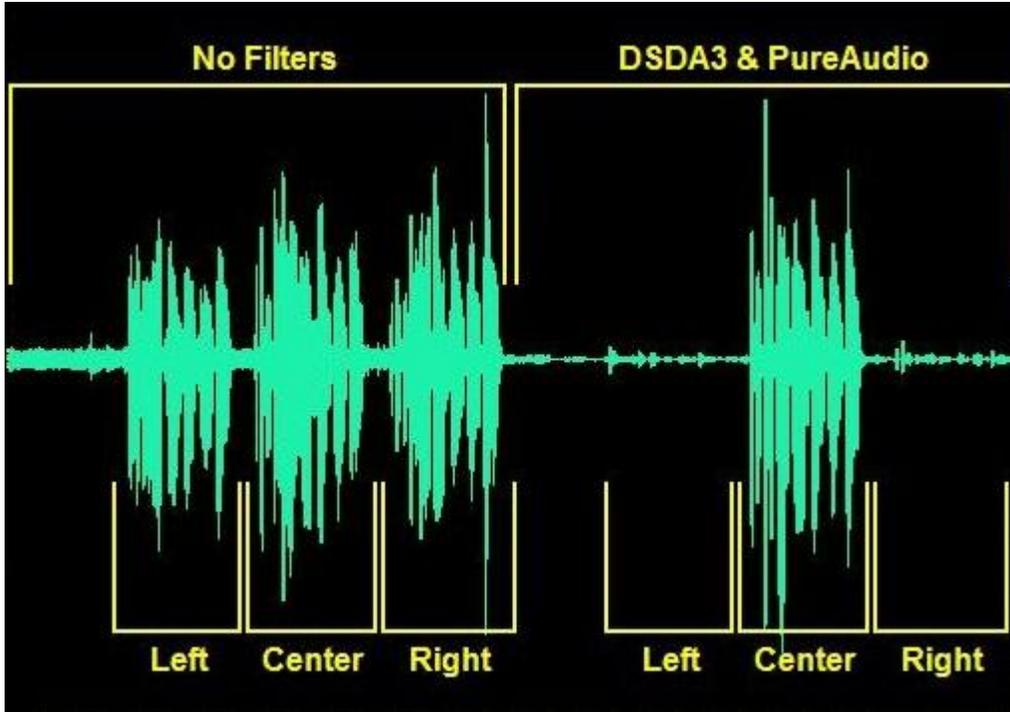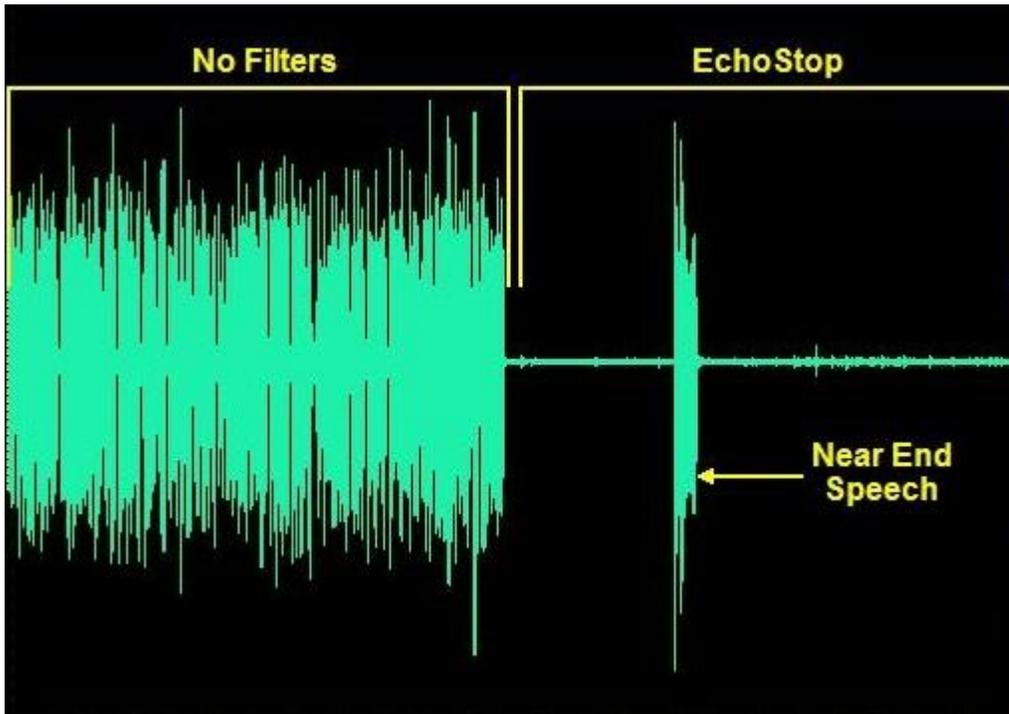
Echo Cancellation (EchoStop)

The EchoStop tests consist of playing about one minute of audio out the loudspeakers. The audio is a person talking with some background music. While the audio is playing out of the loudspeakers, a recording is made with the various combinations of filters running.

About 20 seconds into the recording there is some near end talking to show that the echo canceller is not removing the near end talking. This near end talking is a worst case scenario for an echo canceller since it is removing the voice coming out of the loudspeaker and leaving the near end voice. Removing voice from voice is non-typical. In an actual VOIP conversation, this only happens in short bursts when one person is interrupting the other person. This is sometimes referred to as double talk.

This test uses just the EchoStop filter, with built-in PureAudio noise cancellation. The amount of echo cancellation is 32 dB.

Echo Cancellation & Light Beam Forming (EchoStop & DSDA2)

This test uses both the EchoStop filter and the DSDA2 filter, with built-in PureAudio noise cancellation. The amount of echo cancellation is 36 dB.
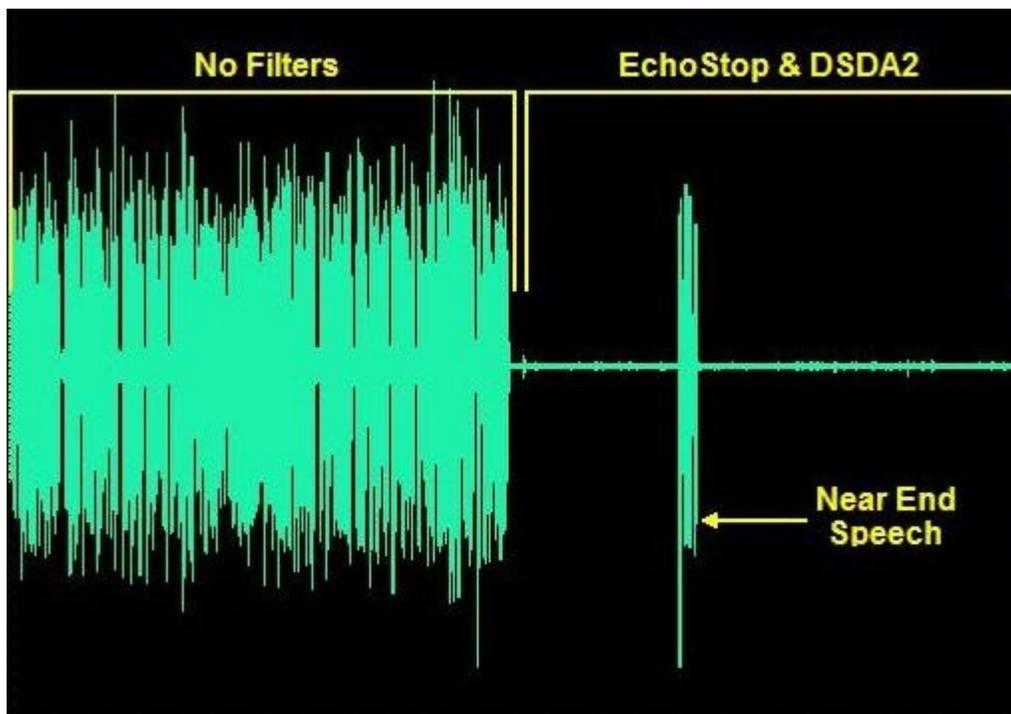
Echo Cancellation & Aggressive Beam Forming (EchoStop & DSDA3)

This test uses both the EchoStop filter and the DSDA2 filter, with built-in PureAudio noise cancellation. The amount of echo cancellation is 40 dB.