Application Note: AN00234

xCORE-VOICE - AEC Tuning Guide

This application note describes how to tune the xCORE-VOICE XVSM-2000 Acoustic Echo Cancellation (AEC) to the properties of the end solution.

Required tools and libraries

- xTIMEcomposer Tools - Version 14.1.0
- USB Audio 2.0 Device Software - *Version 6.17.0*[1]
- lib_xvsm_support - *Version 0.1.0*
- XVSM-2000 control utility

Alternatively a pre-built binary file may be used. Please contact your XMOS sales representative for assistance.

Required hardware

An xCORE-VOICE Smart Microphone evalutaion board.

Prerequisites

- This document assumes familiarity with the XMOS xCORE architecture, the XMOS tool chain and the xC language. Documentation related to these aspects which are not specific to this application note are linked to in the references appendix.
- For descriptions of XMOS related terms found in this document please see the *XMOS glossary*[2].
- For an overview of XMOS USB Audio 2.0 Device Software please see the *USB Audio Design Guide*[3] for reference.

[1] https://www.xmos.com/published/usb-audio-20-device-software-source-code?version=latest
[2] http://www.xmos.com/published/glossary
[3] https://www.xmos.com/support/boards?product=18334&component=14442

1 Echo path modeling tuning

In order to get the best trade-off between echo removal and doubletalk performance, the echo path modelling parameters should be adapted to the properties of the device. The effect of these parameters is tested using an echo-only scenario (no near-end speech, no doubletalk).

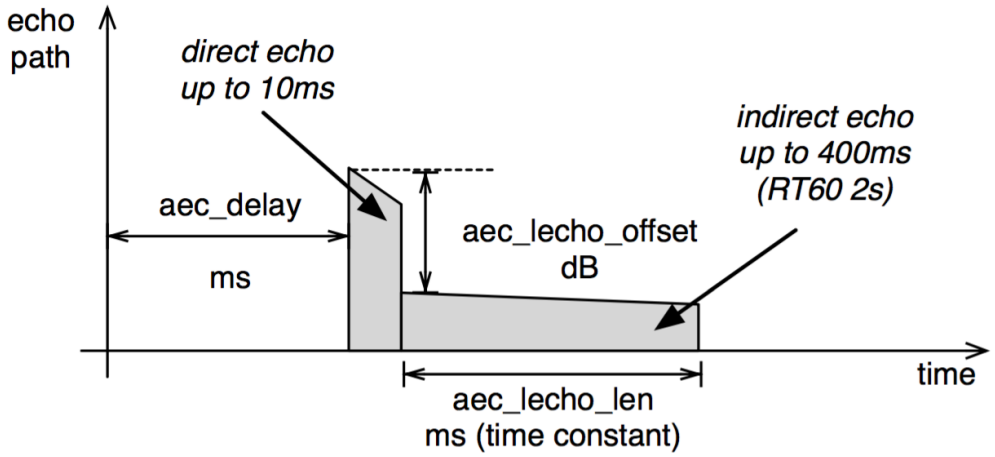

Figure 1: Echo path modelling

The figure above illustrates the echo path modelling. A direct echo path is estimated and late echo is also modelled. The following steps should be followed:

- Setting aec_lecho_offset to -80 dB and aec_lecho_len to 0 dB.
- Tune the delay - if the delay is variable, set aec_delay to -1 ms. Otherwise, test different values and choose the one with the best echo removal performance (at this point, it is not an issue if echo removal is not perfect, because late echo modelling is disabled with the previously mentioned parameter values).
- Tune aec_lecho_offset set and aec_lecho_len. If the device is in a normal size office for example, set aec_lecho_len to a smaller default value of around 60 ms. Steadily increase aec_lecho_offset until residual echoes are gone (typical values are from -24 to -12 dB). Very weak residual echoes may remain after this step, which will be addressed in the next section.

2 Full echo removal and non-linearity

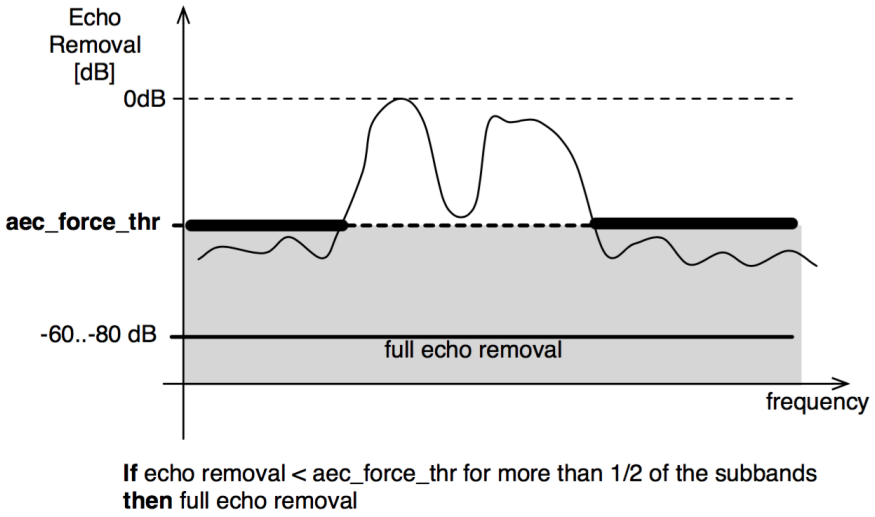

Figure 2: Full echo removal

Usually, small loudspeakers feature a certain degree of non-linearity. Even if this is very small, this can result in a weak echo that is always heard. In order to fully remove such weak echoes, the aec_force_thr parameter can be used. The operation of this parameter is illustrated in the figure above. When echo is removed at a specific frequency by at least aec_force_thr dB, then it is fully suppressed at this frequency. Recommended values for aec_force_thr are in the range [-30.. -10] dB.

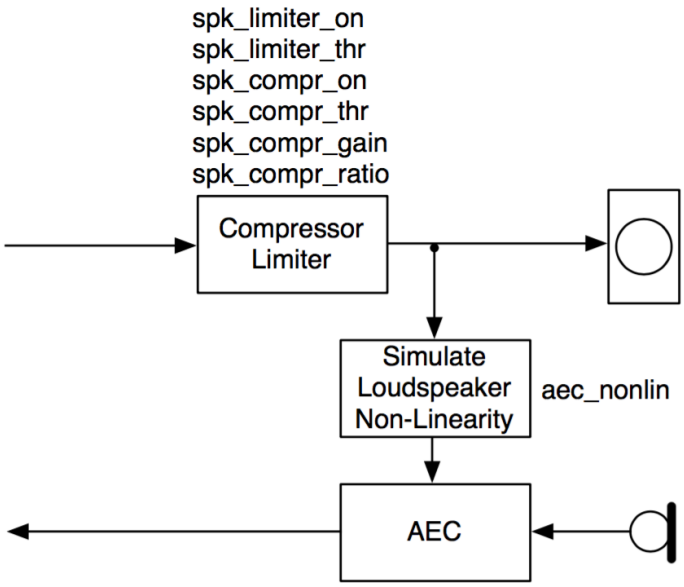

Figure 3: Non-linearity removal

At higher volumes or with modestly dimensioned loudspeakers a higher degree of non-linearity may occur. In this case, a compressor/limiter may be placed before the loudspeaker, to ensure that it operates in a more linear range. Additionally, aec_nonlin can be used to model a loudspeaker's non-linearities before the AEC.

3 Doubletalk Tuning

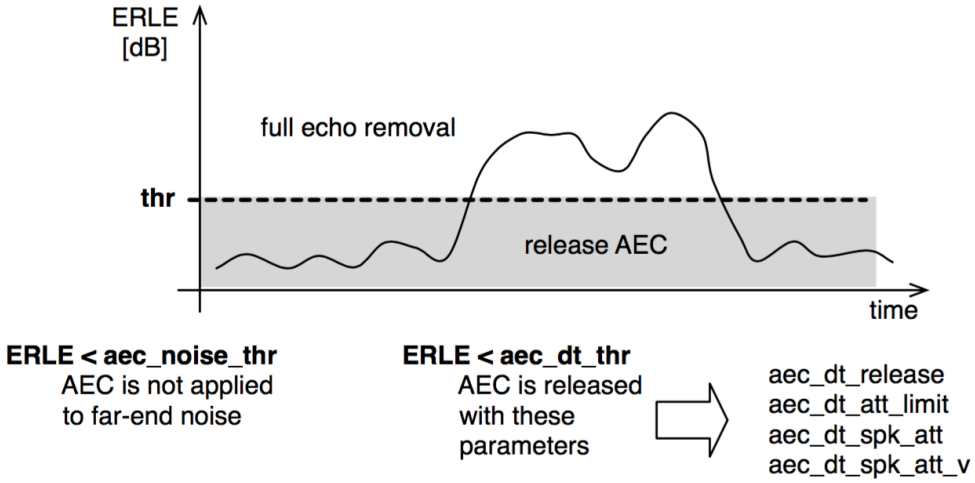

Figure 4: ERLE (Echo Return Loss Enhancement) threshold

The figure above illustrates the Echo Return Loss Enhancement (ERLE) threshold which is used to decide whether AEC is in near-end/doubletalk or echo removal mode. There are two such thresholds, which work as follows:

3.1 aec_noise_thr

When ERLE is smaller than this threshold, the AEC's suppressor will ignore the noise in the loudspeaker. This means that microphone noise will not always be suppressed when there is noise in the loudspeaker signal. This also contributes to better near-end speech quality. Usually, a good value for aec_noise_thr is 15 dB.

3.2 aec_dt_thr

When ERLE is smaller than this threshold, AEC will generally be "released". During doubletalk, AEC will act less aggressively, letting more doubletalk through. The different parameters, determining the degree to which AEC is released are:

- aec_dt_release: AEC's suppressor is released by aec_dt_release dB. For example, from -20 dB to -8 dB, when aec_dt_release is 12 dB. Usually a good value for aec_dt_release is 12 dB.
- aec_dt_att_limit: AEC's suppressor is limited to avoid suppression of signals stronger than aec_dt_att_limit dB. During doubletalk, echo is thus only suppressed by aec_dt_att_limit dB (as opposed to total removal).