

Environmental Noise Compensation

Overview

Environmental Noise compensation (ENC) is an approach to increase the intelligibility of clean speech in noisy environments. This is done by changing the volume and the frequency content of speech by based on the ambient noise.

Description

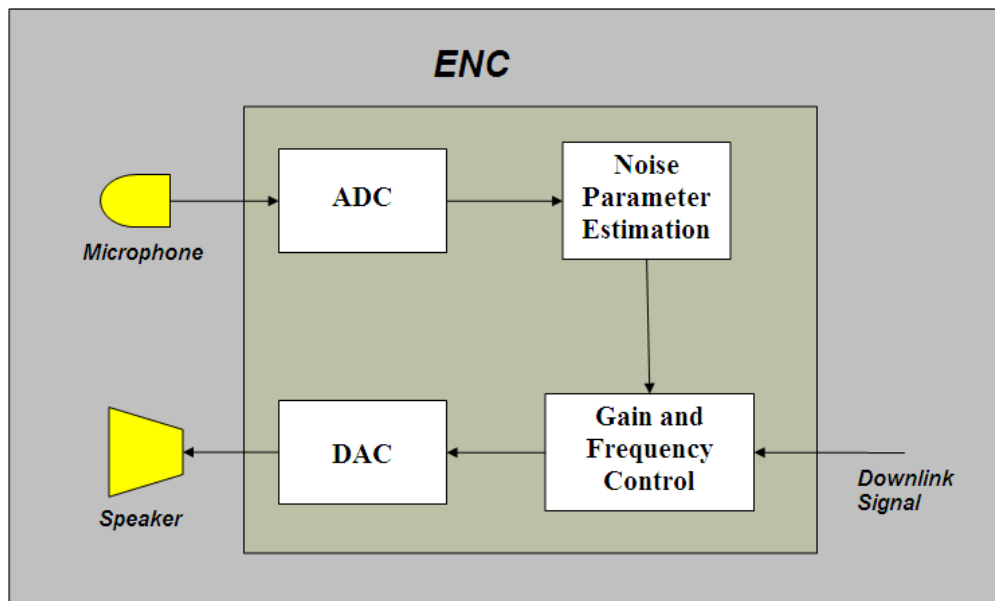


Figure 1: ENC System Overview

Figure1 describes the ENC block diagram; the environment information is estimated by the noise estimation block using the microphone input. These parameters are used by the gain and frequency control block to estimate the required gain at the downlink end. This gain is then applied to the downlink signal that is played through the speaker.

ENC I/O ports

ENC has 3 input ports.

Port 1: Is the input uplink signal from the microphone for noise estimation.

Port 2: Is the clean downlink signal from the DRC output.

Port 3: Is the filtered downlink signal from the DRC output.

ENC PROCESS FLOW:

This section describes the various blocks involved with a typical ENC process flow. This is described in Figure 2.

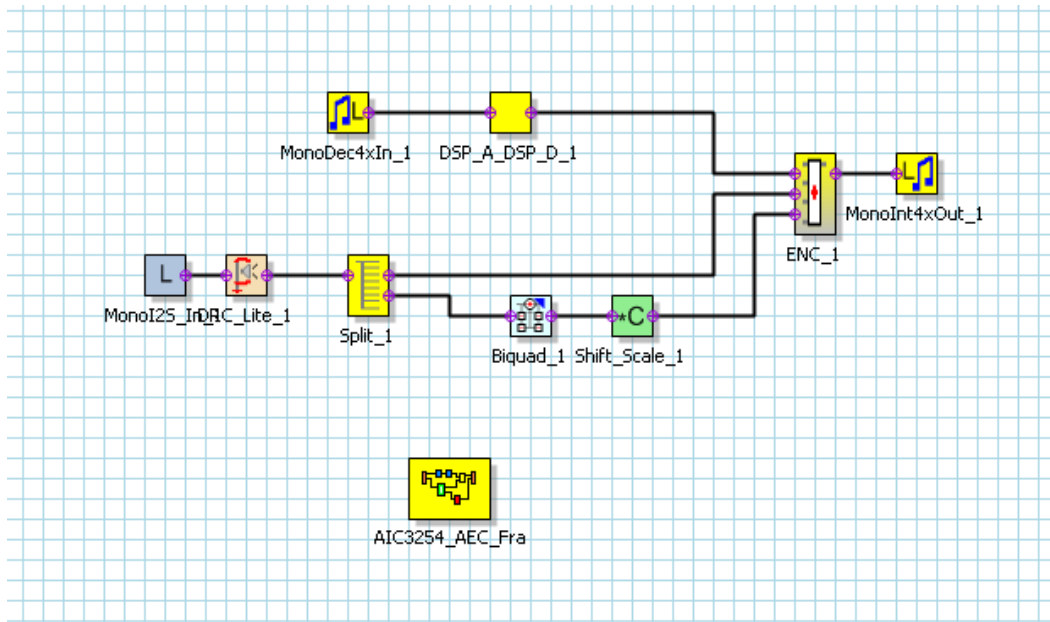


Figure 2: Pure Path Studio View menu

1) Decimator:

The 4x decimator provides us with the microphone input at 8K. This is then transferred from miniDSP_A to miniDSP_D for ENC gain estimation in the ENC component.

2) ENC

The ENC component takes in the microphone input from Port 1 to estimate the gain required. This gain is then applied to the downlink signal at Ports 2 and 3.

3) DRC_Lite

The DRC component is used to limit the downlink signal power to provide headroom for ENC. Adequate headroom provided by the DRC ensures that clipping is minimized during the ENC process. The DRC tuning procedure is described in DRC help.

4) Biquad and Shift_Scale

The programmable Bi-quad is used to filter the downlink ENC signal for better intelligibility in noise. The Shift scale is used to compensate for the gain from the Biquad. In the handset scenario below, output from the Bi-quads is -6db, this is corrected using the shift scale block having a shift of 2 and a scale of 0.5.

5) Output

The ENC output downlink signal is played using the Interpolator to the speaker.

ENC Tuning Parameters

There are 3 tuning parameters controlling the input level, max gain of the ENC and the speed of response respectively.

- 1) **MIC_LEVEL_COMP**: The mic-level comp parameter is tuned so that input speech level to ENC block in the handset mode is -23dBFS. If the ENC microphone input is greater than this, then this parameter is used to compensate for this level. In the default settings it is set to 1.
- 2) **MAX_GAIN**: The maximum gain provided by the ENC block. The DRC should be set to limit the signal power greater than this, for example if the maximum allowable gain in the ENC is set to 12dB, the DRC should limit power at a value lesser than -12dB. In the receiver mode, this value is set to -23dB.

$$MAX_GAIN = \sqrt[10]{\frac{\max_gain_dB}{10}} - 1$$

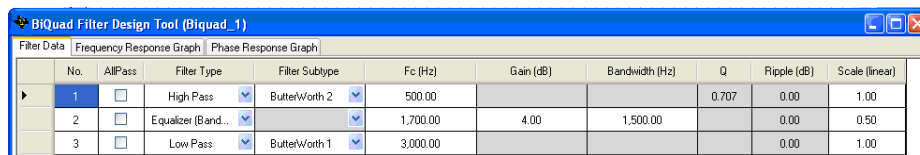
- 3) **NOISE_TRACK_SPEED**: It is a number between 0.03 and 0.7. It is strongly recommended to keep it below 0.07402308861 for the ENC to be robust to near end speech. Also, when this value is high, the response time to varying noise is fast but the system also responds to some near-end speech.

Tuning Procedure

- 1) Measure the speech level at handset mode.
- 2) Compensate the speech level using the MIC_LEVEL_COMP to be -23dBFS.
- 3) Set the MAX_GAIN desired by the ENC. It is currently set at 2.981.
- 4) For further robustness to near end speech reduce the NOISE_TRACK_SPEED.

Recommended Configuration for the Receiver Mode (Default)

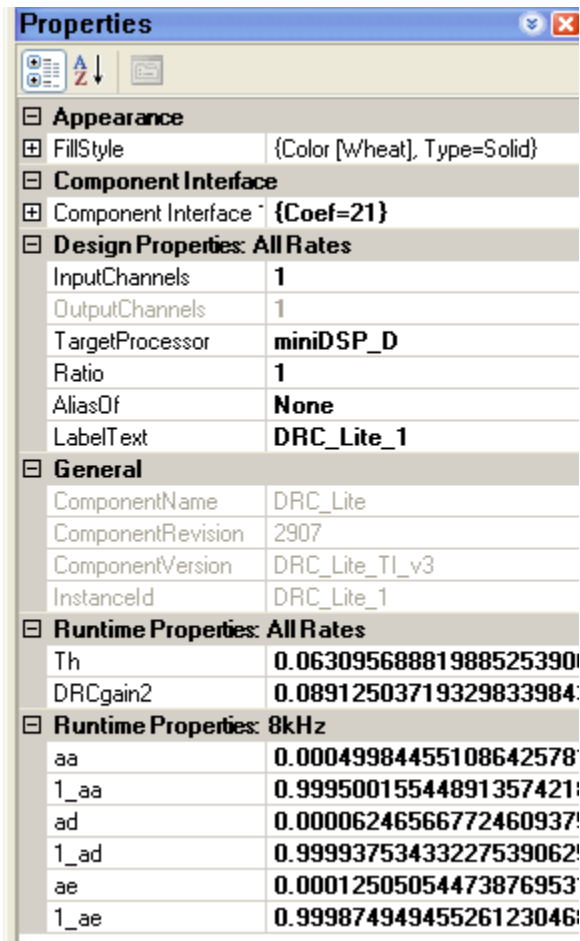
1) Filter settings for Receiver Mode



No.	AllPass	Filter Type	Filter Subtype	Fc (Hz)	Gain (dB)	Bandwidth (Hz)	Q	Ripple (dB)	Scale (linear)
1	<input type="checkbox"/>	High Pass	ButterWorth 2	500.00			0.707	0.00	1.00
2	<input type="checkbox"/>	Equalizer (Band..		1,700.00	4.00	1,500.00		0.00	0.50
3	<input type="checkbox"/>	Low Pass	ButterWorth 1	3,000.00				0.00	1.00

2) DRC Settings

These DRC Settings correspond to -23dB power limiting with a compression ratio of 8:1 as seen from the DRC_lite help file.



3) Configurable Properties

Property	Tuning Parameter Value	Value
PGA_COMP	-	1.0
ENC_VOL	12dB	2.9810695648193359375
NOISE_UP_SPEED	-	0.074023088613476

A gap of 11dB (MAX_VOL 12 dB and DRC limit 23dB) is chosen to allow for the power surge during attack time of the DRC which might cause some clipping when high ENC gain is chosen