# Technical Documentation

## ANR 2.1 - API definition

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## Change History

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## Notes

(1) Creation & approval of document.
(2) Approval.
(3) Updates.

## Acronyms

**ANR** Ambient Noise Reduction

**FFT** Fast Fourier Transform

**iFFT** Inverse Fast Fourier Transform

**VAD** Voice Activity Detection / Detector

**AGC** Automatic Gain Control

**API** Application Protocol Interface

**FTA** Full Type Agreement

## List of References

[1] L1D_AS110, ANR - Overview
[2] L1D_AS118-1, TRD for the Ambient Noise Reduction – ANR 2.x, ANR 3.x
[3] L1D_AS250 – VAD 1.x, 2.x - Overview
[4] L1D_AS251-1 – VAD 1.x - API Definition

## Table of Contents



## List of Figures and Tables

# 1 Introduction

The purpose of this document is to describe the Application Protocol Interface (API) related to the Ambient Noise Reduction (ANR) module version 2.1 [1], [2].

# 2 Module Overview

The module holds the functional blocs presented below (Figure 2.1). The ANR module is made up of the spectral subtraction between the Fast Fourier Transform (FFT) and the inverse Fast Fourier Transform (iFFT) functions. The Voice Activity detection (VAD) module is re-used from the VAD 1.x module [3]. It has also been added a tone detector to avoid modification of test signals like pure sinusoids.

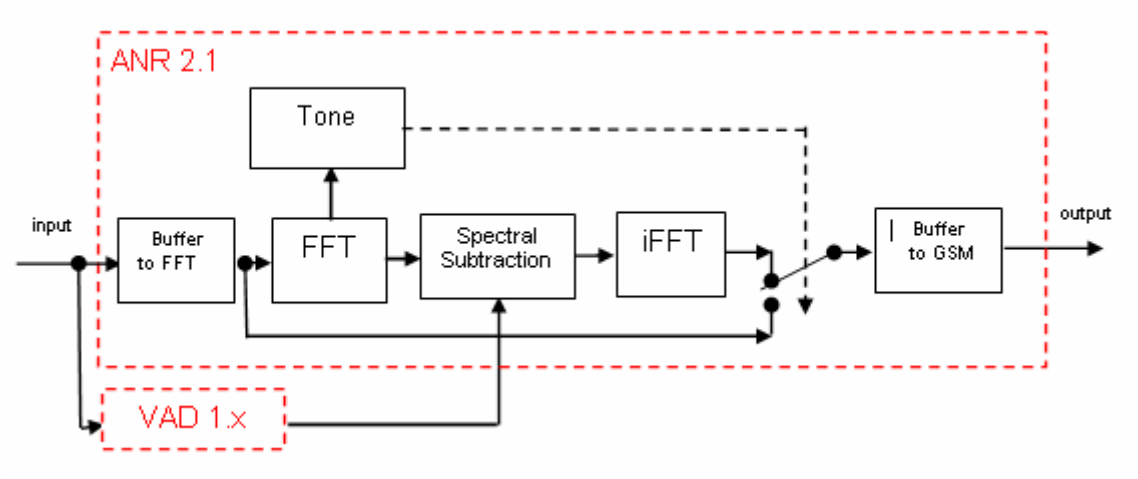


**Figure 2.1 The ANR 2.1 Block Diagram**

# 3 ANR 2.1 Module API

## 3.1 Module Entry Functions

This chapter describes the assembly interfaces of the ANR module. It is up to the caller to backup the DSP registers and configure the DSP to assembly mode before calling these APIs.

### 3.1.1 VAD 1.x Assembly Entry Functions

Refer to [4]

### 3.1.2 ANR 2.1 Assembly Entry Functions

#### 3.1.2.1 f_anr_init_default_param()

Prototype:

```
void    f_anr_init_default_param(T_ANR_STATIC_VAR);
```

Description:

This function is used to initializes the ANR 2.1 API with the default values if no parameters are given. This function is to be called before f_anr_init().

Requirements:

All the ANR code must be mapped on a single DSP page as it does not support extended addressing.

Reentrancy:

This API is not reentrant.

Parameters:

Uses ANR static variables structure pointer.

| | | |
|---|---|---|
| T_ANR_STATIC_VAR | p_anr_stc_var | IN |

Return value:

| | |
|---|---|
| void | OUT |

#### 3.1.2.2 f_anr_init ()

Prototype:

```
void      f_anr_init (T_ANR_STATIC_VAR);
```

Description:

This function is used to execute initialization of the ANR module before the first processing block.

Requirements:

All the ANR code must be mapped on a single DSP page as it does not support extended addressing.

Reentrancy:

This API is not reentrant.

Parameters:

Uses ANR static variables structure pointer.

| | | |
|---|---|---|
| T_ANR_STATIC_VAR | p_anr_stc_var | IN |

Return value:

| | |
|---|---|
| void | OUT |

#### 3.1.2.3 f_anr ()

Prototype:

```
void      f_anr (T_ANR_STATIC_VAR);
```

Description:

This function is used to execute the ANR processing for uplink path on 160 samples.

Requirements:

All the ANR code must be mapped on a single DSP page as it does not support extended addressing.

Reentrancy:

This API is not reentrant.

Parameters:

Uses ANR static variables structure pointer.

T_ANR_STATIC_VAR p_anr_stc_var IN/OUT Input/output GSM audio buffer of 160 samples

Return value:

T_SINt16 a_anr_input_new OUT Input/Output audio buffer of 160 samples

## 3.2 ANR 2.1 Module Interface

### 3.2.1 VAD 1.x API Parameters

In place of internal VAD, the ANR 2.1 uses the external VAD 1.x module (Figure 2.1). For the VAD 1.x API description, refer to [4]. The VAD 1.x parameters values to be used when running with ANR 2.1 are given in (C. Appendix).

### 3.2.2 ANR 2.1 API Parameters

The DSP API description and possible values is given in the table below (Table 3-1).

| Type | Name | Description/Possible Values |
|---|---|---|
| T_SINT16 | d_anr_control | Control of the module.<br><br>0x0000 : module is bypassed (ANR disabled)<br>0x0001 : ANR and tone detector are enabled (default value)<br>0x0003 : ANR is enabled and tone detector is disabled |
| T_SINT16 | d_anr_ns_level | Spectral subtraction attenuation level.<br><br>0x0000 : noise attenuation depends on incoming signal SNR<br>0x0001 : 6 dB noise attenuation<br>0x0002 : 12 dB noise attenuation (default value) |
| T_SINT16 | d_anr_tone_ene_th | SNR threshold for tone detection.<br><br>0x0007 : (21 dB) is default value |
| T_SINT16 | d_anr_tone_cnt_th | Maximum number of tones to be detected.<br><br>0x0001 : is default value |

**Table 3-1 ANR 2.1 Configuration Parameters**

The ANR 2.1 has no more internal VAD and time domain attenuation. As a consequence, a lot of parameters used in the previous version (ANR 2.0) are no longer in used and were removed. The tone detector can be enabled/disabled through the API. The recommended values of API parameters for ANR 2.1 are presented in (A. Appendix).

Two parameters linked to the tone detector have been added into the ANR 2.1 API: d_anr_tone_en_th and d_anr_tone_cnt_th:

- **Formula for d_anr_tone_cnt_th:**

  If the incoming signal is not detected as speech by the VAD and if a particular frequency bin energy is higher than the sum of broadband noise energy by a threshold of **d_anr_tone_ene_th**,in (dB), the signal related to the frequency bin is detected as tone.

  The threshold can be set with step size of 3 dB and is computed from the Signal to Noise Ratio (SNR) as follow:

$$\text{d\_anr\_tone\_ene\_th} = \frac{\text{SNR (dB)}}{3}. \quad (3.1)$$

  For example, if current SNR is 21dB, d_anr_tone_ene_th = 0x0007.

  Lowering threshold would cause over-detection of tone and, in turn, would cause sputtered noise in speech. Increasing threshold would cause under-detection and might modify audio test cases FTA test signals.

- **Formula for d_anr_tone_cnt_th:**

  The number of tones to be detected corresponds to the value of **d_anr_tone_cnt_th**. Default setting is single tone detection 0x0001. Changing value to 0x0002 allows detecting dual-tone such as DTMF tone, but it could cause over detection (annoying sputtered noise in speech). Therefore, the value of 0x0001 is recommended. Even if DTMF tone is not detected, ANR 2.1 attenuates DTMF tone level only with very small amount and it should not be a problem.

# Appendices

## A. Appendix: ANR 2.1 Parameters – Recommended Values for Speech

Below are the recommended values of ANR 2.1 parameter for normal speech applications (Table 3-2):

| Type | Name | Value |
|---|---|---|
| T_SINT16 | d_anr_control | 0x0003 (ANR is enabled, tone detector is disabled) |
| T_SINT16 | d_anr_ns_level | 0x0002 (12 dB) |
| T_SINT16 | d_anr_tone_ene_th | 0x0007 (21dB) |
| T_SINT16 | d_anr_tone_cnt_th | 0x0001 (single tone detection) |

**Table 3-2 ANR 2.1 Recommended Values**

## B. Appendix: ANR 2.1 Parameters –Recommended Values for FTA

Below are the recommended values of ANR 2.1 parameter (Table 3-3) to pass FTA test.

| Type | Name | Value |
|---|---|---|
| T_SINT16 | d_anr_control | 0x0001 (ANR and tone detector enabled) |
| T_SINT16 | d_anr_ns_level | 0x0002 (12 dB) |
| T_SINT16 | d_anr_tone_ene_th | 0x0007 (21dB) |
| T_SINT16 | d_anr_tone_cnt_th | 0x0001 (single tone detection) |

**Table 3-3 ANR 2.1 Required Values for FTA**

## C. Appendix: VAD 1.x Parameters – Mandatory Values for Use with ANR 2.1

The ANR 2.1 is used with VAD 1.x module [3], [4]. For optimal ANR 2.1 performances, it is mandatory to use the parameters given in (Table 3-4).

| & | Type | Name | Values | Reference |
|---|---|---|---|---|
| +0 | T_SINT16 | d_vad_frame_size | 0x00A0 | 160 samples |
| +1 | T_SINT16 | d_vad_learn_idx | 0x0004 | 4 frames |
| +2 | T_SINT16 | d_vad_ns_gain_up | 0x40E4 | +3dB/s |
| +3 | T_SINT16 | d_vad_ns_gain_dw | 0x729B | -24dB/s |
| +4 | T_SINT16 | d_vad_ns_floor_1 | 0x007D | 200 |
| +5 | T_SINT16 | d_vad_ns_floor_2 | 0x0465 | 1800 |
| +6 | T_SINT16 | d_vad_dec_thr_1 | 0x6531 | +5dB |
| +7 | T_SINT16 | d_vad_dec_thr_2 | 0x2800 | +10dB |

**Table 3-4 VAD 1.x Parameters Mandatory with ANR 2.1**