Clarity Clear Voice Capture (CVC) Hands-Free Kit Suite of Application Reports

Texas Instruments
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HFK DP Software Applications

ABSTRACT

Clarity Clear Voice Capture Hands-Free Kit (CVC-HFK®) is an eXpressDSP-compliant, acoustic echo and noise suppression algorithm suite. The user is allowed to fully customize the performance of the system, by adjusting the parameters which control the adaptation of the algorithms. This document describes the functionality of each parameter and the system-level design requirements that must be met to integrate the CVC-HFK and achieve optimal performance levels.

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1 Overview

The CVC-HFK is available as a TMS320C54x™ eXpressDSP-compliant library that can be integrated into hands free applications to achieve near Type I acoustic echo cancellation performance.

Figure 1 shows a typical DSP circuit configuration that would be used to implement the hands-free kit. The CVC-HFK requires two audio inputs and provides one audio output, and is parameterized, which allows the DSP sub-circuit to be configured by an external microprocessor.

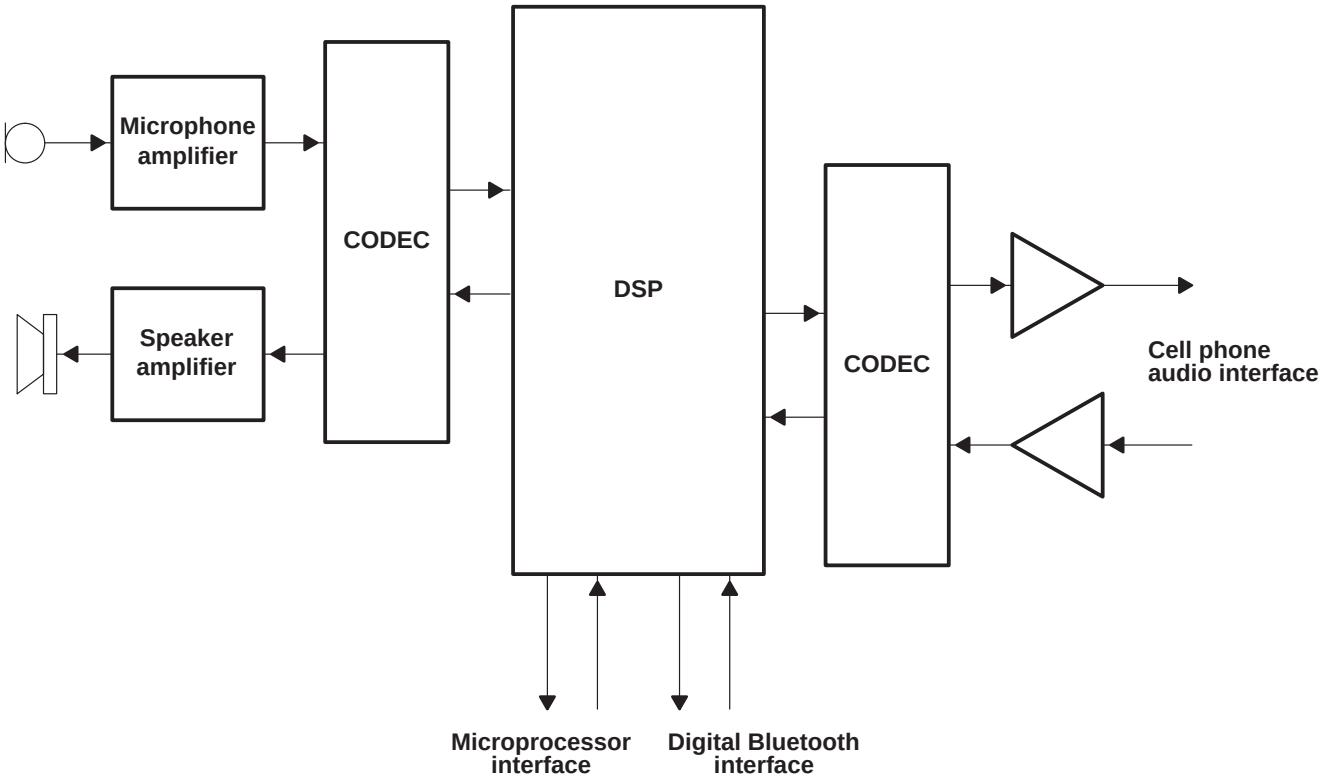

Figure 1. Generic Hands-Free DSP Circuit

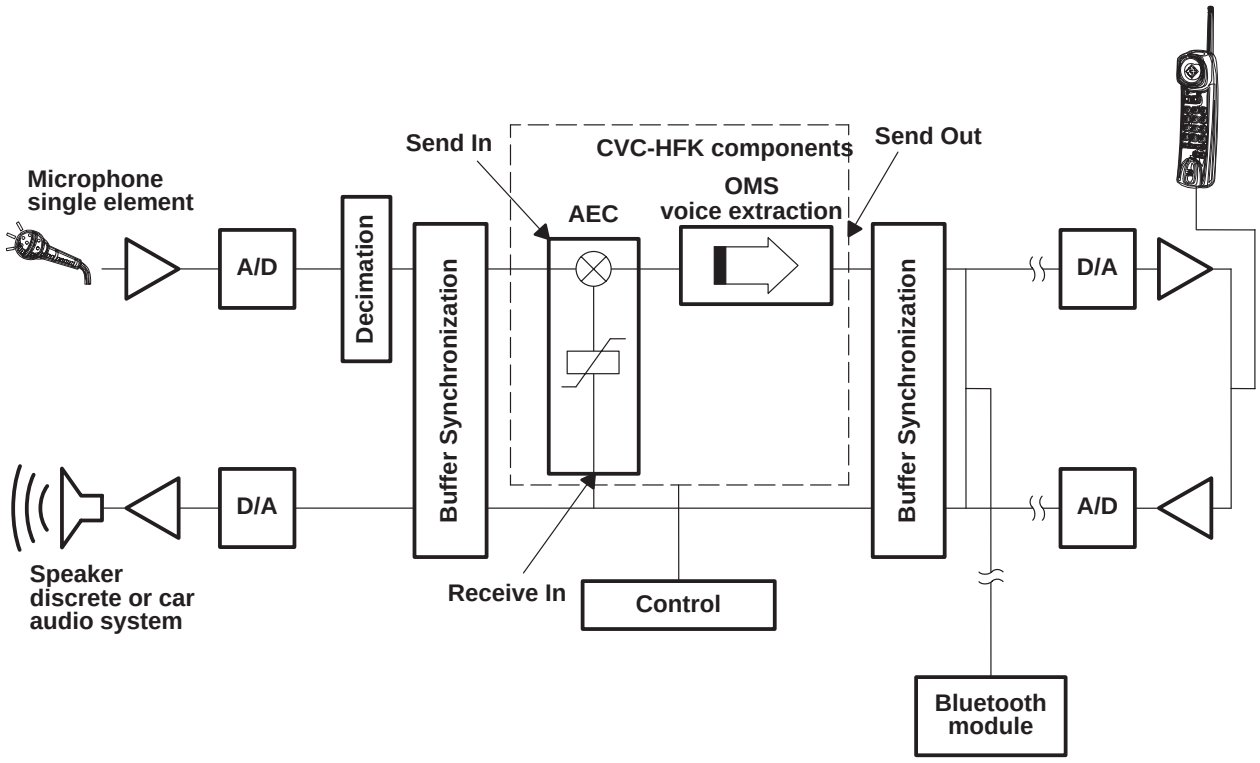

Figure 2. Processing Flow Diagram

Figure 2 shows the CVC-HFK system audio processing flow with the CVC-HFK suite in a typical configuration. The hands-free kit requires a framework which includes a codec driver and parameter control to interface to the codec and external processing functions. The Send In, Send Out, and Receive In points shown in Figure 2 for the audio path, correspond to the pointers described in Table 1. The code is shown here:

```
void HFK_CLARITY_process (IHFK_Handle handle, XDAS_Int16 *input, XDAS_Int16
*reference, XDAS_Int16 *output);
```

Table 1. CVC-HFK Functions

Parameter	Type	Description
Handle	IHFK_Handle	Handle for instance of algorithm.
input	XDAS_Int16 *	Pointer to 32 sample input buffer (Send In− from MIC)
reference	XDAS_Int16 *	Pointer to 32 sample input buffer (Receive In − from PHONE)
output	XDAS_Int16 *	Pointer to 32 sample output buffer (Send Out − to PHONE)

To achieve acceptable performance, careful attention must be paid to the system gains, frequency response, and distortion as measured at the Send IN, Send Out, Receive In, and Receive Out points.

2 System Signal Requirements

To achieve optimal audio performance the audio gain levels, frequency response and system distortion must be within tolerable levels. Non-linear signal processing should not be placed in the audio path after the Receive Out point, or prior to the Send In point.

- **Frequency Response**

  The frequency response measured at Send In and Receive In should be 0 dB ± 0.5 dB (referenced to a 1 kHz 80% full scale sine wave at the codec), from 200 Hz to 3.6 kHz (flat frequency response), and have a minimum of a second-order analog roll-off from 0−200 Hz before the A/D converter. For optimal voice quality, the microphone signal should be sampled at 16 kHz and decimated by 2 kHz − 8 kHz to obtain a flat frequency response up to 3.6 kHz, if the anti-aliasing filters of the chosen A/D converter do not provide a satisfactory response. The anti-aliasing filter should provide a minimum of 40 dB attenuation at the sub-sampled Nyquist rate.

- **THD+N**

  The harmonic distortion measured between Receive In and Send In must be minimized to achieve optimal performance. The maximum achievable echo return loss is primarily limited by the distortion created in the system between the Receive In point and the Send In point. The maximum achievable Echo Return Loss Enhancement is directly proportional to the distortion introduced in the Receive In to Send In path. Other non linear components such as fast time constant dynamic gain and equalization, and audio effects such as concert halls, must not be placed in the audio path after the Receive In point.

- **Electrical Noise Floor**

  The electrical noise floor of the system should be less than −65 dB referenced to an 80% full scale sine wave at 1 kHz.

- **Gain Levels For Speaker Reference (Receive In)**

  Nominal speech should measure at 50% of a full scale 16-bit two’s complement number at the Receive In point.

- **Gain Levels For Microphone Input (Send In)**

  Nominal speech should measure at 50% of a full scale 16-bit two’s complement number at the Send In point.

- **Gain Levels For Microphone Output (Send Out)**

  Send Out gain levels of the CVC-HFK are set by the configurable parameters according to the system needs.

3 User Adjustable Parameters

- Aggressiveness

The CVC-HFK provides a means to increase/decrease Send Out noise cancellation aggressiveness according to the desired noise suppression and voice quality preferences. The normal usable range is from 0 to 32767. The more aggressive the value, the greater the noise suppression. However, voice quality will degrade as the noise suppression level is increased.

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