HD Bass Operation in Wolfson Audio CODECs

INTRODUCTION

HD Bass is a dynamic bass boost enhancement technology which is designed to improve the bass response of small speakers for portable applications in particular. It is also effective on larger speaker systems and on headphones if desired. The HD Bass feature used in the latest Wolfson CODECs is part of the DAC DSP2 signal path enhancements which dynamically boosts bass frequencies without introducing distortion. The HD Bass feature is available on recent Wolfson Audio CODECs such as the WM8962.

TABLE OF CONTENTS

OPERATION

Small speakers generally are unable to reproduce low-frequencies. HD Bass can be used to apply additional boost which reduces the dynamic range of bass frequencies by dynamically controlling the compression of a selectable bandwidth. HD Bass is configurable with a maximum gain setting which is applied to small signals. As the input signal is increased the amount of gain applied decreases.

Unlike the dynamic range controller (DRC), the HD Bass boost is only applied to a narrow bandwidth which is governed by a peak filter. The centre frequency and bandwidth of this filter are adjustable via the WISCE™ control panel for HD Bass.

COMPATIBILITY OF DSP FUNCTIONS

The HD Bass function is part of the DAC Signal Enhancement path. Its location in the WM8962 filter chain is shown in Figure 1. However, the location in the filter chain may be different on other devices and are described in the appropriate datasheets.
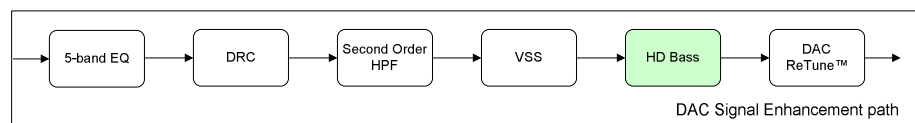
Figure 1 DAC Signal Enhancement Path (WM8962)

The following table indicates the various DSP features in the DAC signal paths that are available on some Wolfson devices. With each pairing of features a symbol is given to indicate the level of consideration which is required when using the feature combination:

	ReTune	HD Bass	VSS	HPF	DRC	EQ
MBC	☺	?	☺	✔	?	☺
EQ	?	?	☺	☺	☺	
DRC	☺	?	☺	☺		
HPF	☺	✔	✔			
VSS	✔	☺				
HD Bass	☺					

☺	Feature combination is good. There is no interaction between filter pair.	✔	This feature combination is a recommended pairing. See notes on how these features should be used together.	?	These features have overlapping functionality. Refer to the notes on these features before enabling both in the signal path.	X	These features will interact badly! Do not use together!

HD BASS + DYNAMIC RANGE CONTROLLER (DRC)

The function of the DRC is to dynamically adjust the signal gain in conditions where the input amplitude is unknown or varies over a wide range. The DRC can apply Compression, Expansion, and Automatic Level Control to the signal path.

Both the HD Bass and DRC features employ dynamic range compression to maximize perceived volume across the corresponding frequency range. While it is possible to use both features simultaneously, it is recommended that the fastest DRC attack and decay times possible are used that do not add distortion. It should be noted that the overall rate of gain change will be equal to the sum of the two filters response rates (i.e. if both filters have the same time constant then enabling both filters will cause a change in gain at a rate equal to twice the rate of the individual filters).

One issue to note is that the attack time of the HD Bass is typically not quick enough to prevent clipping at the start of a large signal. Be aware that clipping can still occur when both features are used even if the DRC anti-clip feature is enabled.

A detailed guide to the tuning process of the DRC is provided in Wolfson's applications note WAN_0215.

HD BASS + MULTIBAND COMPRESSOR (MBC)

Similarly to the DRC, the MBC employs dynamic range compression to maximize perceived volume. While it is possible to use both features simultaneously, it is recommended that the fastest DRC attack and decay times possible are used that do not add distortion. It should be noted that the overall rate of gain change will be equal to the sum of the two filters response rates (i.e. if both filters have the same time constant then enabling both filters will cause a change in gain at a rate equal to twice the rate of the individual filters).

HD BASS + 5-BAND EQ (RETUNE MOBILE)

In contrast to the DRC, the 5-band EQ applies a fixed gain to a given band, regardless of the signal amplitude at that frequency. It can be used to adjust the bass response of a system however the 5-Band EQ only applies a static gain to the signal. This can cause clipping if large amplitude transients occur in the signal. The advantage of the HD Bass is that it provides a dynamic bass boost which reduces the dynamic range of the bass frequencies by making quiet bass tones louder whilst preventing clipping of larger signals.

Both the HD Bass and the 5-band EQ can be configured to apply gain without need of caution regarding headroom (assuming that the 5 Band EQ doesn't cause clipping on its own). HD Bass will dynamically adjust its gain to compensate for the input signal and will therefore not increase distortion.

HD BASS + HIGH-PASS FILTER (HPF)

The first/second-order configurable high-pass filter in the DAC path can be used to protect the speakers during the reproduction of low frequencies. While low frequencies can't be reproduced by small speakers which are typically used in portable applications, they still cause a physical offset of the speaker cone. It is recommended to enable the HPF whenever HD Bass is used.

When configuring the HPF the cut-off and the order of the filter should be as high as possible without causing a loss in the low frequency content which the speakers can produce. Note that large speakers and good quality headphones typically have a good bass response and it is not necessary to remove as much bass with these systems. Tuning of the HPF is provided with help from a dedicated WISCE panel which provides a graphical representation of the applied filter. Setting the cut-off below the minimum frequency which the speaker can reproduce prevents any loss of fidelity in the signal (i.e. the HPF should be used to remove content from the reproduced signal which the speakers are unable to reproduce.)

CONFIGURATION

HD Bass provides an adaptive gain control of a narrow frequency band towards the low end of the audio spectrum. At low frequencies, where the loudspeaker response is poor, the HD Bass function applies gain in order to increase the bass content of the loudspeaker output. The amount of gain is controlled adaptively, to ensure that distortion is not introduced.

It is recommended to use the DAC DSP2 HPF in conjunction with HD Bass in order to prevent distortion and speaker damage.

HD Bass is enabled using the HDBASS_ENA register bit. It is pre-configured with a default set of parameters, but it is possible to select alternative settings. Refer to the datasheet of the relevant product for details. The WISCE™ configuration tool provides a graphical user interface to develop HD Bass coefficients. Note that specific sequences must be followed when enabling or configuring ADC ReTune™, DAC ReTune™, DAC HPF, VSS, MBC, and HD Bass sound enhancement functions, which are described in the device datasheet.

WISCE™ CONTROLS

The HD Bass feature can be controlled via its dedicated WISCE™ control panel. A combination of five parameters is available for configuration of the HD Bass feature and can be configured using listening tests according to system acoustics and personal preferences.
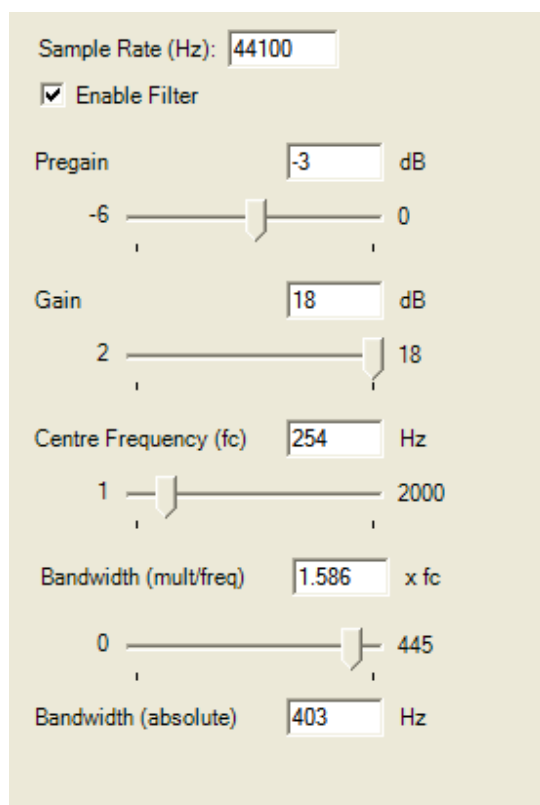
Figure 2 WISCE^{TM} Panel for HD Bass

SAMPLE RATE

The sample rate parameter is required by WISCE^{TM} to calculate the HD Bass coefficients correctly. Enter the chosen sample rate (eg. 44100Hz, 48000Hz,...).

PREGAIN

The pregain can be used to attenuate the audio signal across the entire frequency range before the HD Bass filter is applied. If distortion occurs due to clipping, the pregain value can be reduced from its default value of -3dB. It is advisable not to set the pregain to a value greater than -3dB.

GAIN

This is the maximum gain that HD Bass can apply to boost frequencies of the specified bandwidth. If the gain is set too high, distortion may occur. If the gain is too low, the bass will be less apparent.

CENTER FREQUENCY

The centre frequency of the HD Bass feature can be adjusted. If the centre frequency is too high, the bass will sound weak and midtones will be amplified. A low centre frequency will result in boomy bass and may reduce audio clarity.

BANDWIDTH (MULT/FREQ), BANDWIDTH (ABSOLUTE)

The bandwidth of the HD Bass peak filter can be defined either as a multiple of the centre frequency or as an absolute value. If the bandwidth is too narrow, bass appears to be focused around a single note. If the bandwidth is set too wide, bass may sound boomy and midtones coloured.

TUNING PROCEDURE

The flowcharts below can be used as a starting point for tuning HD Bass and the high-pass filter. The general flowchart in Figure 3 shows the recommended order of which the features of the WM8962 should be tuned to achieve best results.

Other Wolfson devices may contain a combination of different features, and therefore the tuning order may differ. Note that it isn't necessary to use enable all features listed in Figure 3.

Figure 4 and Figure 5 contain the recommended tuning flow for the high-pass filter and HD Bass, respectively.
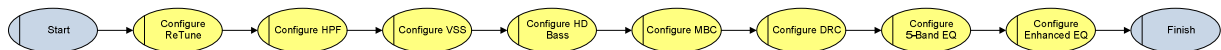
Figure 3 General Tuning Procedure (available feature set is device specific)
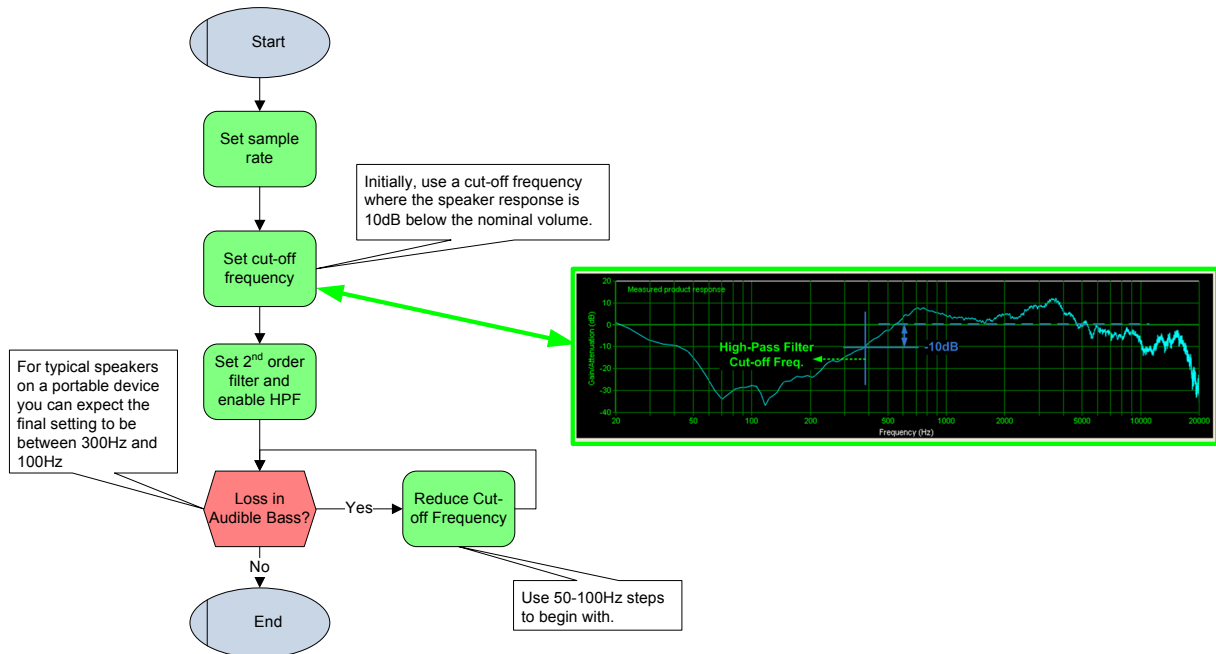
Figure 4 High-pass Filter Tuning Procedure

Start

Set sample rate

Use centre frequency = HPF cut-off +100Hz as starting point.

Set Centre Freq between HPF cut-off and Resonance

Defaults
Pregain = -3dB
Gain = 10dB
Bandwidth = 1.2*fc

Set Defaults and Enable

Enable HD Bass

Increase Bandwidth — Mono-tonal — Tone? — Boomy — Reduce Bandwidth

Decrease Centre Freq. — Too weak — Tone? — Too strong — Increase Centre Freq.

Increase Gain — Too Quiet — Bass Volume? — Too loud — Decrease Gain

Clipping? — Yes — Reduce Pre-gain

No

End

Measured product response
High-Pass Filter Cut-off Freq.
HD Bass Centre Freq.
Gain/Attenuation (dB)
Frequency (Hz)

Figure 5 HD Bass Tuning Flowchart

For detailed information on ReTune[TM], VSS, and the DRC, please refer to the following documents:

1. ReTune[TM]: Wolfson application note WAN_0218

2. VSS: Wolfson application note WAN_0259

3. DRC: Wolfson application note WAN_0215.

TECHNICAL SUPPORT

If you require more information or require technical support, please contact the nearest Wolfson Microelectronics regional office:

http://www.wolfsonmicro.com/contact

or one of our global distributors:

http://www.wolfsonmicro.com/distribution

IMPORTANT NOTICE

ADDRESS:

Wolfson Microelectronics plc

Westfield House

26 Westfield Road

Edinburgh

EH11 2QB

United Kingdom

Tel :: +44 (0)131 272 7000

Fax :: +44 (0)131 272 7001