VS1103b FeedBack Eliminator

VSMPG "VLSI Solution Audio Decoder"

Project Code:
Project Name: VSMPG

Revision History			
Rev.	**Date**	**Author**	**Description**
1.10	2009-04-27	ToV	New chapters and figures, noise gate/limiter
1.00	2009-02-12	ToV	Initial version.

Table of Contents

1 Acoustic Feedback

Acoustic feedback occurs when a microphone picks up sound from a loudspeaker, amplifies the signal and passes it out of the loudspeaker. It is a closed loop for the audio signal. If the gain for the specific frequency is more than unity, there is acoustic feedback. The principle of acoustic feedback is shown in figure 1.1.

The bigger the gain and the shorter the delay of the acoustic loop is, the faster the feedback amplitude will rise. For example if the loop gain for the feedback frequency is 0.5 dB and the delay is 20 milliseconds, the feedback signal amplitude will rise 25 dB/s. 3 dB gain and 5 ms delay result in 600 dB/s rise in feedback amplitude.

Many things affect the behaviour of the feedback:

- Microphone - Pick-up pattern (directivity), sensitivity and frequency responce
- Loudspeaker - Emission pattern (directivity), sensitivity and frequency responce
- Room acoustics - Size and shape, surface materials and shapes, air temperature,how many people etc.
- Distance between microphone and loudspeaker
- Position of the microphone - Open-air, close to surfaces (mouth, hand, table, wall)

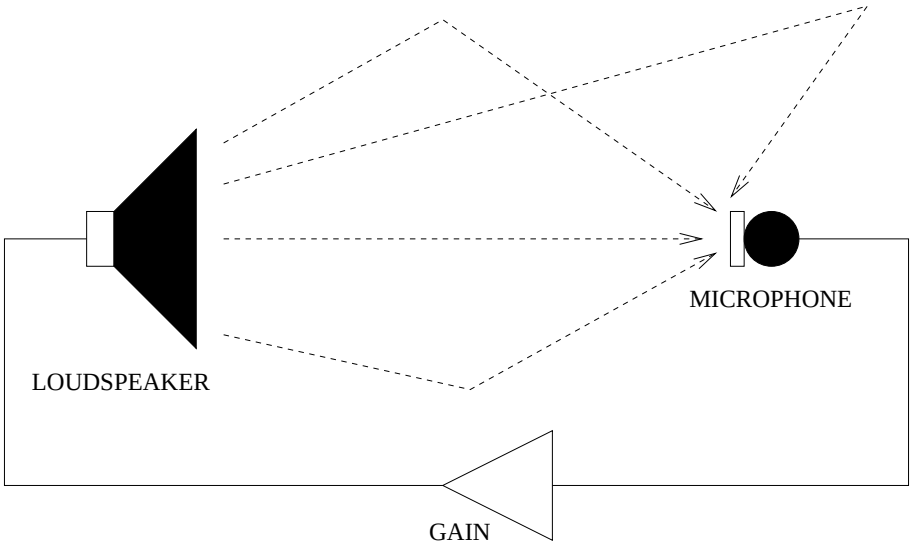

Figure 1.1: Acoustic Feedback

2 How to Avoid Acoustic Feedback

The number one rule for avoiding acoustic feedback is locating a microphone and a loudspeaker the right way; the less the microphone pics up the sound from the loudspeaker the less feedback is present. Therefore the loudspeaker should be directed away from the talker and the microphone as shown in figure 2.1. The loudspeaker should be positioned as far from the microphone as possible.

The microphone should be kept as much in open air as possible. When brought near to any surface (like putting a microphone on a table) there is always more risk for feedback.

Also selecting an appropriate microphone for a system makes eliminating feedback easier. A microphone with a unidirectional pickup pattern is a better choise than an omnidirectional microphone which picks up sound from every direction alike.

Finally a comprehensive sound check should be performed. The gain of the amplifier should be set to the right level; Not too high for avoiding feedback but high enough for acquiring sufficient playback volume.

Figure 2.1: Microphone Behind the Loudspeker

3 VS1103b FeedBack Eliminator

3.1 Introduction

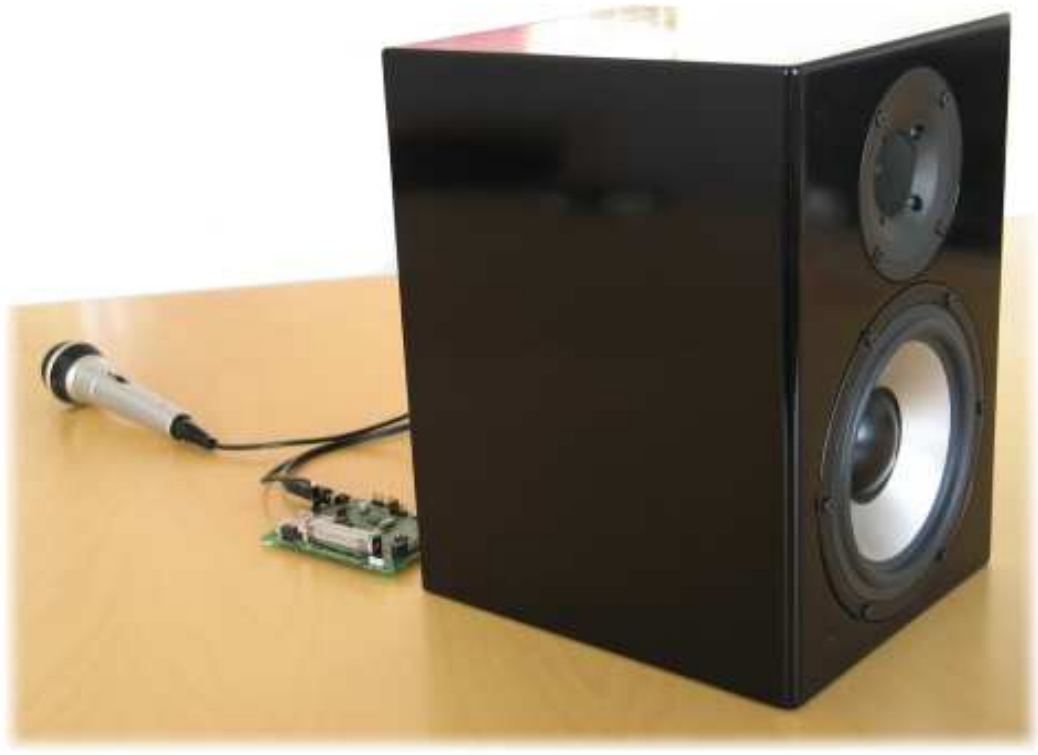

Figure 3.1: VS1103b Feedback Eliminator with Microphone and Active Loudspeaker

The VS1103b Acoustic Feedback Eliminator (VSFBE) application is a low-power application for dynamically cutting down acoustic feedback like shown in figure 3.3. It prevents the feedback from rising too loud and from lasting too long to harm the listeners' ears. It also decreases the possibility of damaging the loudspeaker(s) in case of extreme feedback.

3.2 Function

The application takes the microphone signal as an input. The VSFBE makes frequency analysis for the input signal and based on the frequency information the VSFBE detects high frequency feedback signals. Feedback frequencies are immediately filtered out of the

output signal with a multiband filterbank. The filtered audio signal (the output of the VSFBE) is fed to the loudspeaker(s).

The VSFBE also implements a noise gate; the microphone signal amplitude must reach a certain level before the audio signal is passed through the audio path. The feedback eliminating algorithm is inactive when the noise gate is on. The noise gate prevents acoustic feedback in situations when the system is idle and the microphone is on a feedback-prone position (like the microphone on a table near the loudspeaker(s)).

The VSFBE needs to measure some feedback before it can be removed. Short periods of feedback howling are heard. The attenuation time is typically less than 150 ms. This time consists of the detection of the feedback signal and removal of the specific frequency band from the output signal. The VSFBE performance can be seen in figure 3.2. In figure 3.3 there are two real world measurement plots. The first plot shows the signal measured from the VSFBE line-out when the algorithm is bypassed. The second plot shows a line-out signal with the VSFBE algorithm.

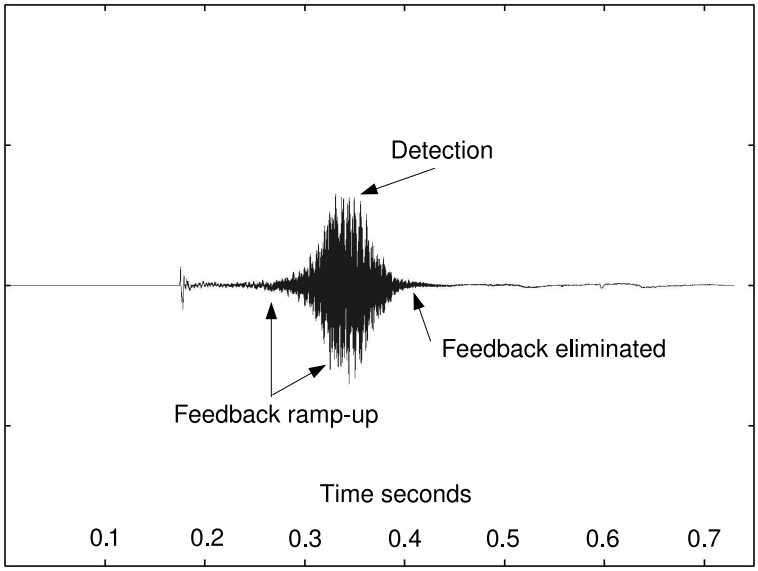

Figure 3.2: VS1103b Feedback Eliminator Performance Graph

Note: Because the VSFBE uses a dynamic process for detecting and eliminating feedback frequencies, the application is ideal for setups where a microphone and/or a loudspeaker are/is constantly moving.

3.3 Sound Quality

The frequency band of the VSFBE is 12 kHz which allows a high quality human voice reproduction. When VSFBE performs feedback elimination and removes certain frequency components from the audio signal, the frequency responce of the ouput sound changes temporarily. When the microphone is moved to position that is less prone to feedback, the frequency responce is automatically restored in a few seconds.

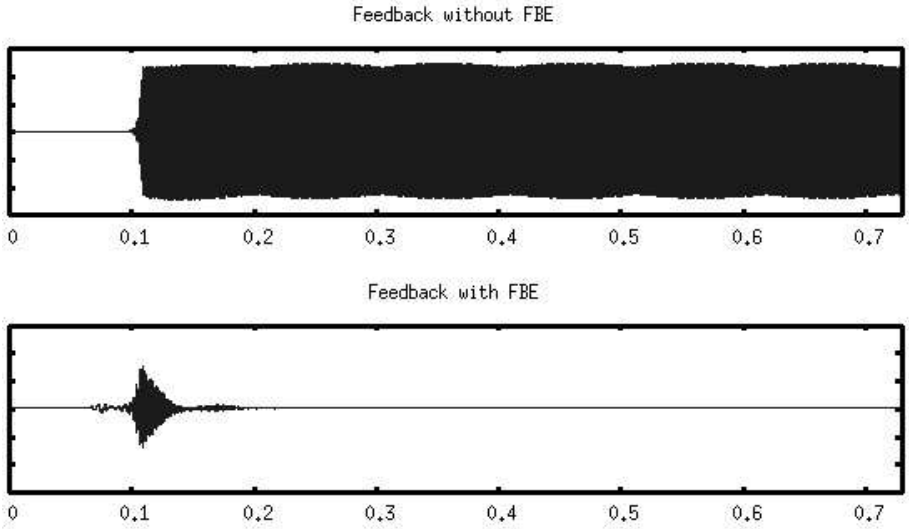

Figure 3.3: VS1103b Feedback Eliminator Eliminates Feedback

4 The Demonstration Board

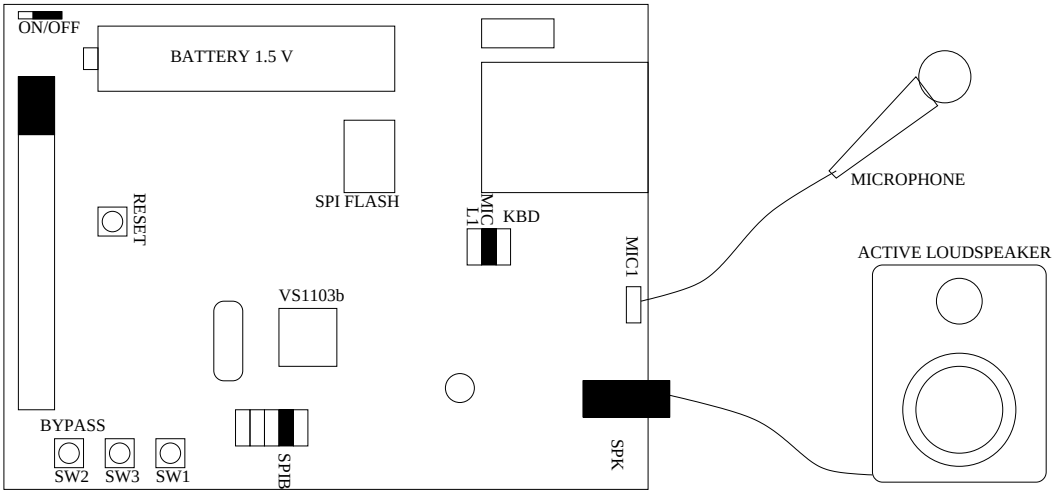

Figure 4.1: VS1103b Feedback Eliminator Main Components

Figure 4.1 shows the main components of the VS1103b Feedback Eliminator.

- The jumper J10 (SPIB) should be jumpered to allow the device to boot the FBE application software (firmware) from the SPI FLASH memory.
- Switching the Power ON starts the application.
- The MIC1 pins are used for connecting an external microphone to the demonstration board.
- The 3.5 mm mini audio plug connector (SPK) is used for connecting an active loudspeaker or an audio power amplifier with a passive loudspeaker.
- MIC pins on jumper connector J18, J20 should be jumpered
- The SW2 is a bypass button; By keeping the button pushied the FBE algorithm is bypassed and the microphone signal is lead directly to the speaker. - No acoustic feedback is removed in this mode!
- The RS232 port can be used to connect the board to a computer and load the initial firmware to the FLASH. If the FLASH has been preprogrammed, there is no need to populate these pins.
- VS1103b power pins are used for supplying digital power to VS1103b and SPI FLASH memory.
- The firmware is stored on an SPI FLASH memory.
- VS1103b is a digital signal processor (DSP) that controls the device.

The VS1103b should be powered up with an AA-type (1.2 - 1.5 V) battery cell.

Figure 4.2: VS1103b Feedback Eliminator Demonstration Board

5 Loading New Firmware

The firmware is a file named `boot.img`. To load the firmware to a board, first connect an RS232 adapter to a computer and the board. If you don't have an adapter, you can order one from VLSI Solution or build it yourself: the adapter consists of one single MAX3232 compatible RS232 signal converter. Then check whether the board is connected to COM1, COM2 or COM3.

Remove the jumper from SPIB.

First turn the card power on. Then program the SPI FLASH using `fbe1.bat`, `fbe2.bat` or `fbe3.bat`, depending on the COM port. If your COM port has a higher number than 3, change the "-p" parameter in the `.BAT` file. When running the script, you should see output that looks roughly like this:

```
VSEMU 2.1 Feb 17 2009 15:43:33(c)1995-2007 VLSI Solution Oy
Using serial port 1, COM speed 9600
Waiting for a connection to the board...
Chip version "1033"
Stack pointer 0x1920, bpTable 0x594f
User program entry address 0x30
Speed changed to 38400
Speed changed to 115200
prom.bin: includes optional header, 19 sections, 782 symbols
Section 1: boot        page:0 start:48 size:9 relocs:3 fixed
Section 2: puthex      page:0 start:57 size:52 relocs:5
[Many similar lines removed!]
>
```

Start programming the eeprom by entering the letter e on the command prompt:

```
> e
006b
 div
0000
 status
5026
4800
1238
0030
0000
800a
0006
2016
[More 4-digit numbers]
.............
Finished!!
```

Programming should last less than 10 seconds.

6 Files

Files in this software package are as follows.

- `VS1103bFeedbackEliminatorV110.pdf` Instructions; this file.
- `boot.img` Feedback Eliminator application
- `fbe1.bat, fbe2.bat, fbe3.bat` Program file called `boot.img` to the board from serial ports COM1, COM2 and COM3, respectively.
- `hw_desc` VS1103 hardware description file.
- `mem_desc.vs1103` VS1103 memory description file.
- `prom.bin` FLASH programmer.
- `vs3emu.exe` VS1103 emulator.

7 Contact Information

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