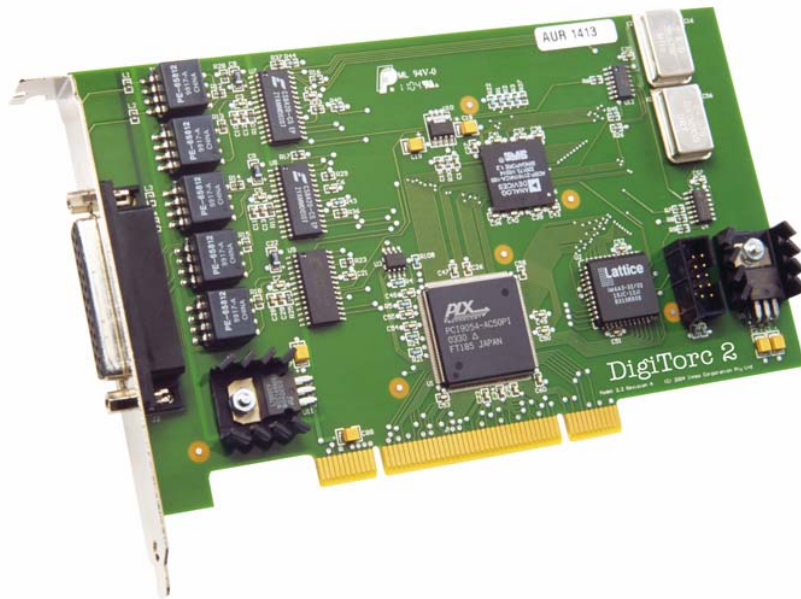


DigiTorc M



Manual

Overview

The DigiTorc is a professional-quality AES3 (formerly AES/EBU) audio input-output card designed and manufactured in Australia by Innes Corporation Pty Ltd. It is supplied with DSP software and a Windows WDM driver to provide full sound card functionality under Windows 2000, XP, Server 2003 and Vista.

The card has two AES3 inputs and two AES3 outputs, all of which operate independently. An AES11 external synchronisation input and output is also provided.

The card uses 24 bit AES3 transceivers, which pass data to and from the PC via a 32-bit bus mastering PCI interface. An onboard 32-bit digital signal processor provides audio buffering, sampling rate conversion, level adjustment and mixing functions. Output physical sampling rates of 96kHz, 48kHz or 44.1kHz are available, with on-board sampling rate conversion for the full range of software sampling rates and bit depths. The AES3 inputs will accept any rate from 32kHz to 96kHz and are automatically converted to whatever software recording rate and bit-depth is requested. The Windows Wave, MCI, DirectSound and DirectShow API's are supported, as are a variety of audio compression modes via the Windows Audio Compression Manager or other software compression systems. The ASIO API is also supported for multi-channel recording and playback.

The AES11 sync input will lock the card to an external AES3 audio source at 44.1kHz, 48kHz or 96kHz, providing both bit rate and L/R timing synchronisation. Multiple cards can be synchronised together by daisy-chaining the sync inputs and outputs.

Specifications

Operating system:	Windows 2000, XP, Server 2003, Vista
Digital audio interface:	AES3 (formerly known as AES/EBU)
External sync input/output:	AES11
Output sampling rates:	96kHz, 48kHz, and 44.1kHz
Input sampling rates:	32kHz to 96kHz
Software sampling rates:	96kHz, 48kHz, 44.1kHz, 32kHz, 24kHz, 22.05kHz, 16kHz, 12kHz, 11.025kHz and 8kHz
Hardware resolution:	24 bits
Software resolution:	32, 24, 16 or 8 bits

Electromagnetic Compatibility

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

This equipment complies with the Class A radiated and conducted EMI requirements of Australian Standard AS3548:1995, including Amendments 1 & 2.

Notes Regarding Windows Version Differences

Windows XP and Server 2003 are the only current versions of Windows that provide complete support for WDM audio drivers, and we recommend these versions for any new installations. The following limitations apply when using the DigiTorc with other versions of Windows.

- Windows Vista virtualises the mixer API to each application, providing only a mute and volume control on each input and output. These controls affect only the audio levels going to and from that application. A Windows XP compatibility mode is available to provide full mixer access to the hardware if needed.
- Peak meters for WDM drivers are only available through the mixer API under Windows XP and Server 2003 (and Windows Vista running in XP-compatibility mode). It is possible to access the meters programmatically under Windows 2000 (contact Innes Corporation for details and sample code). Windows Vista provides an `IAudioMeterInformation` interface as part of its `EndpointVolume` API, but this isn't supported on any of the earlier platforms.
- On Windows 2000 it has been observed that sometimes the mixer control settings are not preserved after rebooting. When this happens the settings revert to their defaults. This has been fixed by Microsoft in Windows XP, Server 2003 and Vista.
- Windows XP, Server 2003, Vista and Windows 2000 Service Pack 3 (or later) support true 24 and 32 bit playback. In earlier versions of Windows 2000, extended bit depth audio was accepted by the wave and DirectSound API's but truncated internally to 16 bits. Note that 24 bit (or 32 bit) capture is supported on all Windows versions.
- In all versions prior to Windows Vista, Microsoft's sampling rate converter, which is automatically switched in when playing multiple audio streams of differing sampling rates

through a single physical output, is slightly inaccurate when doing some conversions. The error is typically at most about 0.3%.

- Audio capture splitting (running multiple capture applications from a single audio source) is not supported on Windows 2000.

Installation (Windows 2000 / XP / Server 2003 / Vista)

The DigiTorc WDM driver has been certified by Microsoft's Hardware Compatibility Labs for Windows 2000, Windows XP and Windows Server 2003. Because only sound cards based on the Intel *High Definition Audio* chipset can be certified for Windows Vista, we are unable to obtain certification for that platform, however our version 6.00.00.3505 (or later) driver has been designed for use with Windows Vista.

Switch off the computer and carefully install the DigiTorc card in any free PCI slot, observing the normal precautions against static electricity discharge. Then switch the computer back on and boot Windows.

If Windows XP or Server 2003 is being used and it is configured for automatic Windows Update, the driver will be downloaded from the Windows Update website. Otherwise, Windows will report that new hardware has been found. Insert the driver CD supplied with the DigiTorc and proceed through the installation wizard. Allow Windows to search for the driver – do NOT specify a driver location or file name.

At the completion of the installation process, a loudspeaker symbol should appear in the toolbar at the bottom of the screen. Your DigiTorc is now fully operational. If the speaker does not appear, it may be necessary to reboot your PC. This typically happens if there has been no sound card previously installed in the PC. Windows XP (prior to Service Pack 1) and Server 2003 by default have the loudspeaker symbol turned off. To enable it, go into **Control Panel**, select **Sounds, Speech and Audio Devices**, then click on **Sounds and Audio Devices**, and finally tick the box marked **Place volume icon in the task bar**.

Configuration

There are two configuration settings for the DigiTorc, these being Output Sampling Rate and Input Topology.

The **output sampling rate** can be set to 44.1kHz, 48kHz or 96kHz, or an external AES11 synchronisation input may be used to set the rate. Note that this sets only the physical output sampling rate – the card can play audio files recorded at any sampling rate as rate-conversion is automatically inserted when required.

The **input topology** can be configured as either a mixer or a selector. With mixer topology, any or all of the physical inputs can be mixed down into each of the wave input streams, whereas with selector topology only one physical input can be selected in each wave input stream. **Note:** The input topology is always set to *selector* under Windows Vista, as this platform does not support input mixing.

To change the configuration, right-click on the **My Computer** icon on the desktop (or in the Start menu in the case of XP and Server 2003), select **Properties**, then click on **Device Manager**. Open **Sound, video and game controllers**, then right-click on **DigiTorc 2** and select **Properties**. Now click on the **Configuration** tab and select the desired output rate and/or topology. After clicking on OK it may take up to a minute for Windows to reconfigure itself and the screen may flicker during this time.

Topology

The DigiTorc topology is shown in the diagrams at the end of this manual.

The playback topology consists of a master output level, mute control and peak meter (Windows XP, Server 2003 and Vista only), and input monitor level and mute controls for each of the line inputs. To these the kernel mixer adds virtual level and mute controls for wave, synthesizer and CD outputs.

The record topology consists of a master input level, mute control and peak meter (Windows XP, Server 2003 and Vista only), line input level controls for each of the physical inputs and a digital loopback level control and mute.

The digital loopback allows the output of the card to be digitally mixed back into the input. Under Windows XP, Server 2003 and Vista, this function is muted when Windows' Digital Rights Management detects that protected audio is being played, in accordance with Microsoft's specifications.

The range on the input and output master controls is -96dB to +6dB, while the individual line controls range from -96dB to 0dB.

To access the playback and record mixer controls on Windows 2000, XP and Server 2003, double-click on the loudspeaker symbol at the bottom right hand corner of the screen. On Windows Vista, right-click on the loudspeaker symbol, select Playback Devices or Recording Devices, select the desired endpoint, click on Properties, and then click on the Levels tab.

ASIO Driver

The DigiTorc driver now supports the ASIO 2.1 API for efficient multi-track recording and playback. When using an application that supports ASIO, be sure to select the DigiTorc ASIO interface.

Because of incompatibilities, the ASIO driver and the other Windows audio interfaces cannot operate simultaneously. Therefore before using the ASIO driver it is necessary to stop any other applications that may be accessing the DigiTorc. A message box will appear if attempting to open the ASIO driver while other applications are accessing the card.

In ASIO mode, multiple DigiTorc cards can be daisy-chained together to increase the number of channels. The card with the lowest PCI slot number (this is usually the left-most card when viewed from the rear of the PC) provides the master clock and its sync output must be connected to the sync input of the next DigiTorc card, and so on down the line. Configure all but the first DigiTorc to use external synchronisation (see above for setting the DigiTorc configuration).

To ensure the highest audio quality, no sampling rate converters are used for playback in ASIO mode. The only sampling rates supported are 96kHz, 48kHz and 44.1kHz, and the hardware output rate is set to the selected software rate. The AES3 inputs use the on-chip sampling rate converters to convert from the physical input rate to the current software rate.

Digital Rights Management

The DigiTorc complies with Microsoft's Digital Rights Management scheme, which allows copy-protected audio files to inhibit digital loopback and/or digital playback in the sound card. As a result it may not be possible to play certain copy-protected files through this card, which would otherwise be playable through a Microsoft-certified analogue sound card.

Operation on Windows Vista

The audio subsystem of Windows Vista has changed substantially from earlier versions of Windows, although most applications should continue to work without modification. The major differences likely to affect users of the DigiTorc are described below.

Audio Endpoints

Key to the new system is the concept of *audio endpoints*. These are the physical audio sources and destinations, such as microphones, speakers and line connectors.

Previously, an audio capture device would typically have multiple inputs which were combined in a mixer or selector. Under Windows Vista, each input is represented by its own device, and Windows itself operates the card's selector to route the chosen source to the input stream.

In the case of the DigiTorc, each of the physical line inputs is represented by an endpoint device, and as the hardware has separate AES3 transceivers for each one, they can be used simultaneously. There are also endpoint devices for the digital loopback sources, although by default these are disabled. To enable these sources, right-click on the loudspeaker symbol at the bottom right-hand corner of the screen, select Recording Devices, right-click anywhere in the window and select Show Disabled Devices. Now right-click on the desired Wave Out Mix device and select Enable. This source will now appear as one of the available audio recording devices. Note that when an application is recording from a loopback endpoint, the corresponding line input is unavailable, and vice versa.

Windows Vista has a default playback endpoint and a default recording endpoint, which are typically used by applications where the input or output device cannot be explicitly chosen. After the DigiTorc driver is first installed, these may be randomly set to any of the outputs and inputs. To set the default endpoints, right-click on the loudspeaker symbol, select Playback Devices or Recording Devices, and then right-click on the desired endpoint and select Set as Default Device. The default device is remembered across reboots and should not need to be set again.

Mixer API

By default, the mixer API under Windows Vista is virtualised for each application, providing just a mute and volume control for each endpoint and affecting only the audio going to and from that application. The hardware controls on the card itself are not accessible from the mixer API in this default mode.

For applications that need direct access to the hardware mixer controls, or that need access to the line input monitor controls or peak meter nodes, there are two options. Firstly, if it is a new application being written specifically for Windows Vista, it can be designed to use the Core Audio APIs, which include the DeviceTopology API and the EndpointVolume API (which

includes the `IAudioEndpointVolume` and `IAudioMeterInformation` interfaces). These are documented in the Windows Vista SDK which is available from Microsoft, however note that these APIs don't work with earlier versions of Windows.

Alternatively, applications can be given access to the hardware mixer controls through the mixer API by right-clicking on the application's icon, selecting Properties, clicking on the Compatibility tab and selecting *Run this program in compatibility mode for Windows XP Service Pack 2*. Be aware, though, that in this compatibility mode, the DigiTorc card is represented by a single mixer device with destination lines for each of the individual inputs and outputs, which is slightly different to its behaviour under Windows XP where each input/output pair had its own mixer device. How this will work with any particular application that uses the mixer API can only be determined by experimentation.

Audio Engine

The audio engine in Windows Vista runs at a fixed sampling rate and bit depth. By default, the DigiTorc driver sets this to be the same as the card's hardware sampling rate and with 24-bit resolution for all inputs and outputs. The Windows sampling rate converter is used whenever a different sampling rate or bit depth is requested by applications. The engine sampling rate and bit depth for each endpoint can be changed if need be by selecting the endpoint, clicking on Properties, and then clicking on the Advanced tab, however changing to a rate other than the hardware sampling rate will introduce an additional rate converter.

If the AES11 sync input is used to set the hardware sampling rate, the engine rate defaults to 96kHz. If a fixed lower sampling rate is used, the audio engine rate for each endpoint can be manually set to equal this rate, and doing so will eliminate an extra rate conversion stage and reduce the load on the PCI buss.

DirectSound and WDM Kernel Streaming

Microsoft's DirectSound and Windows Driver Model (WDM) are designed to work hand in hand to take full advantage of audio card hardware and provide kernel-mode software emulation of features not directly supported. Kernel streaming allows audio data to be passed directly between driver modules resulting in a robust, high performance integrated sound processing system.

With its WDM driver, the DigiTorc can play MIDI files and audio CD's, in addition to Wave files. The kernel mixer allows multiple sounds from the same or different applications to be played simultaneously, while the kernel splitter (Windows XP, Server 2003 and Vista) automatically splits an input source to multiple applications. Sampling rate conversion is automatically inserted if any of the multiple playback or recording streams have different sampling rates.

Note: To use direct CD playback, you need to enable this by going to **Settings - Control Panel - Multimedia - CD Music** and then clicking on the **Enable Digital CD Audio** checkbox (this is enabled by default in Windows XP, Server 2003 and Vista). Not all CD-ROM drives support digital audio playback. On Windows XP, Server 2003 and Vista there is also an option to enable error correction and this should be turned on for best results.

Extended Bit Depth Audio

Traditionally, PC-based audio capture and playback has been restricted to either 8 bit or 16 bit encoding, with the WAVE_FORMAT_PCM descriptor used to define the audio parameters such as samples per second, bits per sample and number of channels.

With the advent of 24 bit A/D and D/A converters, there was a need to support extended bit depth. To achieve this, Microsoft introduced a new data format descriptor called WAVE_FORMAT_EXTENSIBLE. This provides additional information, including the number of valid bits per sample and support for specifying channel placement in multichannel streams.

The WAVE_FORMAT_EXTENSIBLE descriptor may be used in place of the normal WAVE_FORMAT_PCM in setting up playback and recording through either the Winmm (wave) API or the DirectSound API. For further information refer to the Microsoft DirectX 8 documentation.

Some audio editing applications, such as Syntrillium's Cooledit 2000 and Adobe Audition, support extended bit depth audio and work well with the DigiTorc using 24 or 32 bit recording.

Functional Description

The AES3 inputs are decoded and sample-rate converted to the output-sampling rate by the CS8420 transceivers, which also generate the AES3 outputs directly from the outputs of the digital signal processor. A CS8427 is used for the AES11 synchronisation receiver.

Digitized audio is passed in serial form between the transceivers and the Analog Devices ADSP21161 digital signal processor. The DSP provides a circular buffer as short term FIFO storage to cover latency times between PCI transfers, and also performs the software sampling rate conversion, level adjustment and mixing functions. Host-initiated bus mastering is used for audio data transfer through the PLX PCI9054 PCI interface.

Configuration data for the PCI interface is stored in a serial EEPROM, which is programmed in the factory during initial setup of the board.

The DSP software is uploaded from the PC whenever the DigiTorc device driver is started. The DigiTorc supports standby and hibernation power management modes.

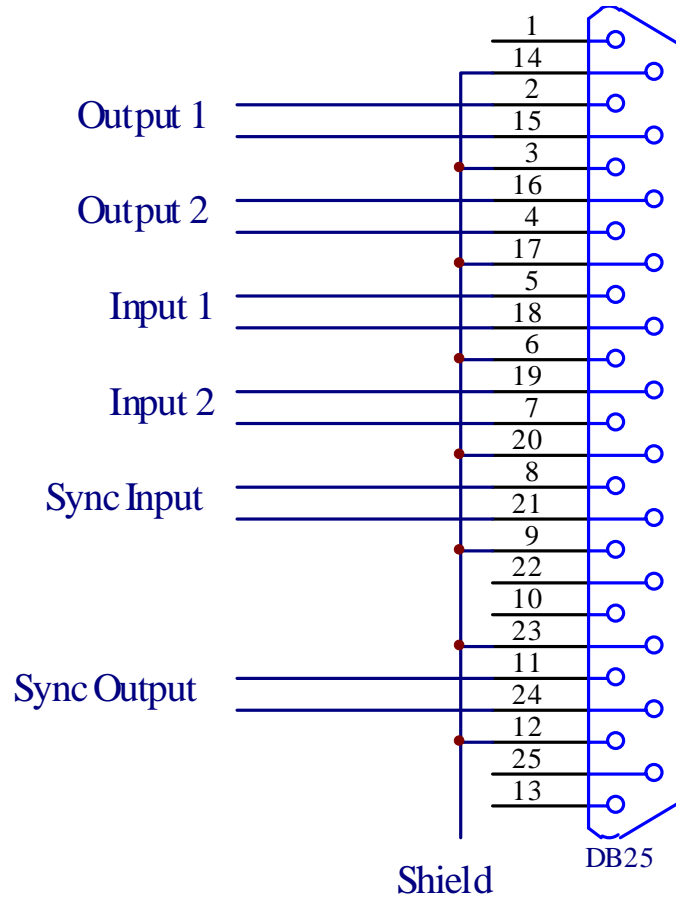
A separately regulated analog 5V plane is used for the AES3 and AES11 input phase-locked-loops in order to minimise any digital noise on the recovered clock signals.

On playback, the audio stream from the Windows application is first converted to 32-bit stereo by the Windows kernel mixer and then passed to the DSP where it is rate-converted to the hardware output sampling rate and mixed with the other output sources.

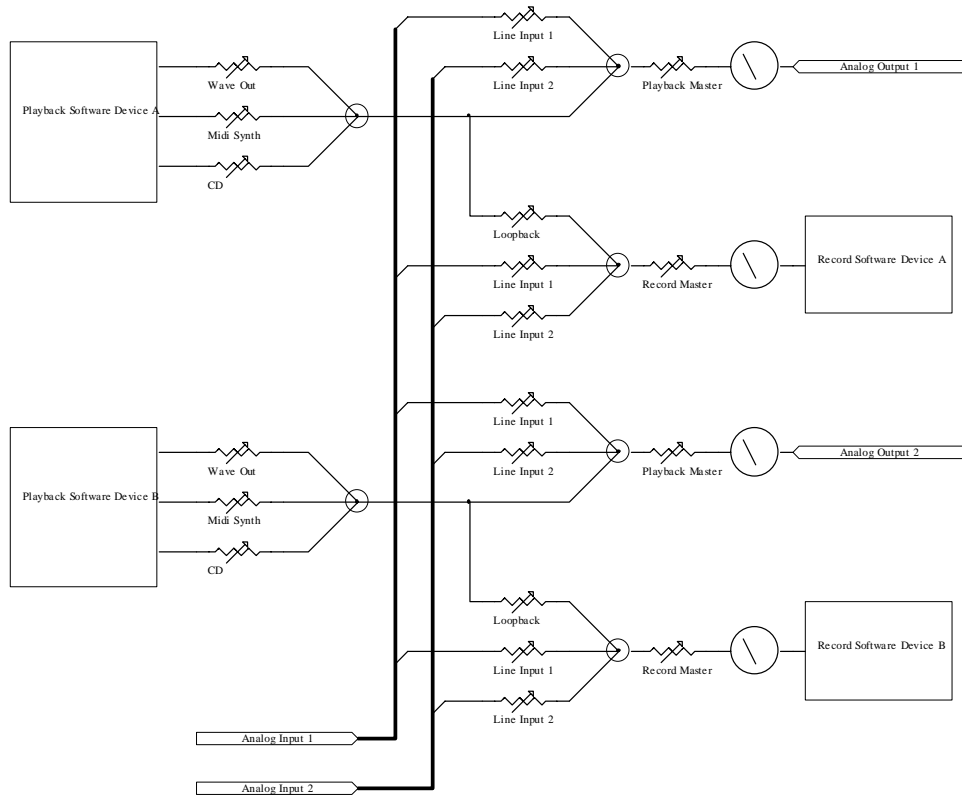
On record, the audio stream is firstly rate-converted to the hardware output sampling rate using the sampling rate converter in the CS8420 transceiver, and is then converted again to the requested software rate and bit depth by the DSP before being passed to the Windows application.

On both record and playback, if the software sampling rate is equal to the hardware output rate the DSP's sampling rate conversion is bypassed.

DigiTorc Pinout



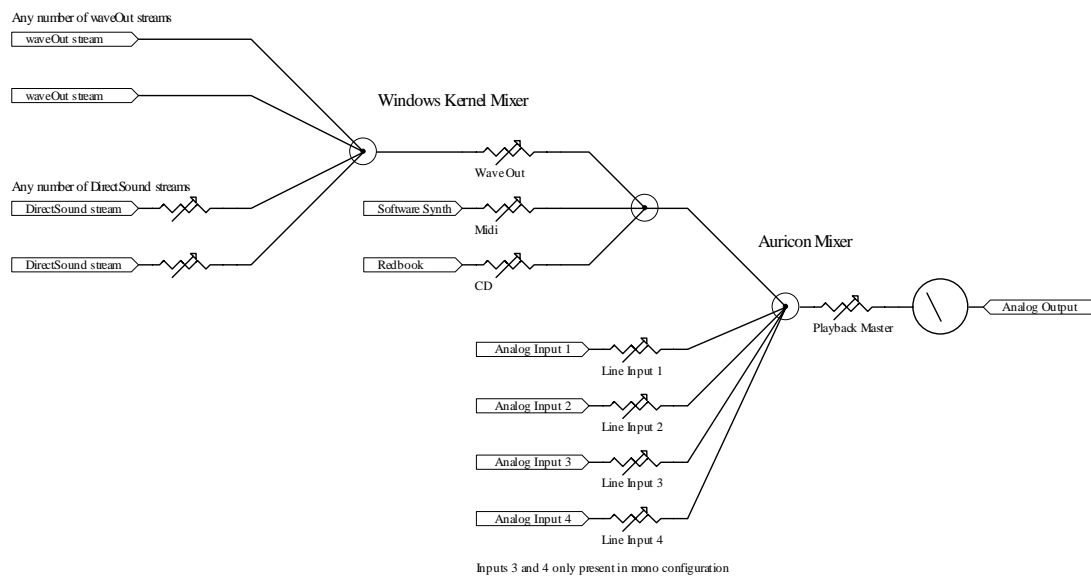
DigiTorc Topology



Output Mixing

The DigiTorc presents itself to the operating system as two independent wave output devices. Each device can support any number of output streams, courtesy of the Windows Kernel Mixer.

The topology of each output device is shown below. It consists of the kernel mixer that combines any number of individual waveOut and DirectSound audio streams (applying sampling rate conversion if need be), followed by the “Wave Out” level control. Midi and CD streams are also added at this point. This is then followed by the DigiTorc mixer (implemented in the on-card DSP) that adds the input sources (two if configured as stereo and four if configured as mono), master level control and peakmeter. All level controls include a mute control as well.



Each waveOut stream is created by opening an instance of the waveOut device. Each DirectSound stream corresponds to a DirectSoundBuffer object. There is no limit to the number of streams that can be opened on each device. Note that with versions of Windows prior to Vista, only DirectSound streams have individual level controls – these are set using the DirectSoundBuffer.SetVolume method. The Windows documentation suggests that waveOutSetVolume should also adjust the level of individual waveOut streams but this doesn't seem to work - instead changing the level of one stream actually changes the setting of the kernel mixer's “Wave Out” fader and thus affects the level of every stream on that device.