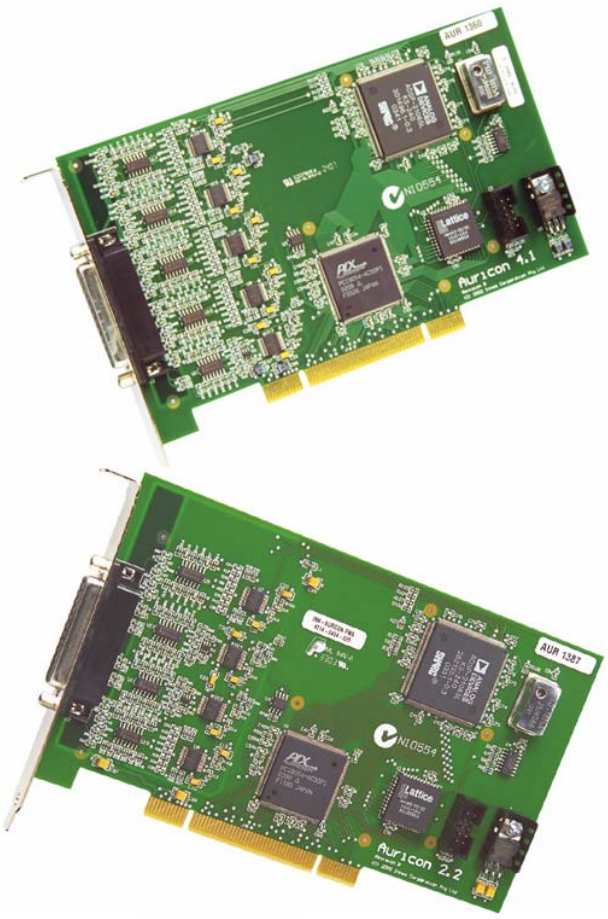
Innes Corporation

ABN 20 003 325 693

Auricon 2.2 & 4.1



Designed for Microsoft® Windows® XP Windows® 2000

Designed for Microsoft® Windows® Server 2003

Manual

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Overview

The Auricon is a professional-quality 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 Windows 2000, Windows XP, Windows Server 2003 and Windows Vista. Drivers for under Windows 98, Windows ME and Windows NT version 4 are also available on request.

Two versions of the card are available, the Auricon 2.2 having two stereo outputs and two stereo inputs, and the Auricon 4.1 having four stereo outputs and one stereo input. The inputs and outputs can be reconfigured as separate mono channels, giving four inputs and outputs on the 2.2, and eight outputs and two inputs on the 4.1.

The cards use 24 bit sigma-delta converters 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. Sampling rates of 48kHz, 44.1kHz, 32kHz, 24kHz, 22.05kHz, 16kHz, 12kHz, 11.025kHz and 8kHz are supported with 32, 24,16 or 8 bit PCM data and may be set independently for each input and output channel. All the standard Windows audio APIs are supported, including Wave, DirectSound, DirectShow, MCI and MIDI playback, as are a variety of audio compression modes via the Windows Audio Compression Manager or other software compression systems.

Specifications

Operating system:	Windows 2000, XP, Server 2003, Vista (Drivers for Windows 98, ME and NT4 available on request)
Sampling rates:	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
Dynamic range:	102dB typical (unweighted)
Input impedance:	20k (balanced)
Output impedance:	40 ohms (balanced)
Maximum signal:	+24dBu (34.6Vp-p)
Frequency response:	Input – 1Hz to 22kHz Output – DC to 22kHz

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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 provides complete support for WDM audio drivers, and we recommend these versions for any new installations. The following limitations apply when using the Auricon 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.

- The Windows NT4 driver is limited to one audio stream per input and output port, and does not support multiple cards, extended bit depth, MIDI or CD playback.

- The original version of Windows 98 has deficiencies in its support for WDM audio drivers, to the extent that Microsoft recommend that such drivers not be used on this platform. The Auricon driver will install and work on this version of Windows, however extended bit depth (24 or 32 bit) is not supported. Problems have also been observed with DirectSound applications on this platform. It is recommended that any Windows 98 systems be updated to Windows 98SE or later.

- Peak meters for WDM drivers are only available through the mixer API under Windows XP, Server 2003 and ME (and Windows Vista running in XP-compatibility mode). It is possible to access the meters programmatically under Windows 2000 and Windows 98 (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.

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- Under Windows 2000 and ME 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 and Server 2003.

- Windows Vista, XP, Server 2003 and Windows 2000 Service Pack 3 support true 24 and 32 bit playback. In earlier versions of Windows, extended bit depth audio was accepted by the wave and DirectSound API's but truncated internally to 16 bits. 24 bit (or 32 bit) capture is supported on all Windows versions except the original Windows 98.

- 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 (notably 11.025kHz and 22.05kHz to or from 48kHz).

- Audio capture splitting (running multiple capture applications from a single audio source) is only supported under Windows Vista, XP, Server 2003 and ME.

- Hardware mixing of multiple input sources for recording is not supported under Windows Vista, as each input source appears as a discrete audio endpoint device.

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

The Auricon 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 under 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.

The software package consists of the driver installation file (Auricon.inf), the kernel-mode driver (Auricon.sys), the configuration DLL (AurcnPrp32.dll) and the Microsoft digital signature file (Auricon.cat).

Switch off the computer and carefully install the Auricon 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 Auricon 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 Auricon 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**.

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Installation (Windows 98 / ME)

Auricon driver version 6.00.00.3505 (or later) does not support these platforms. Use version 5.10.00.3504 instead (available on request from Innes Corporation).

Note: While the WDM driver does at least partially work with Windows 98 Gold (the first edition), Microsoft strongly recommend that such systems be upgraded to Windows 98 Second Edition, Windows Millennium Edition or Windows XP. Innes Corporation does not sanction the use of this driver with Windows 98 Gold.

A bug in Windows 98/ME prevents a single driver from having more than one input and output mixer, so for these platforms the Auricon is implemented as a buss driver (AurcnBus.sys) upon which two (or four in mono mode) channel drivers (AurChan.sys) are loaded. The installation procedure below installs the parent buss driver, and after it has started Windows detects the presence of the child channels and then automatically installs the drivers for them as well. Windows 98/ME also requires a 16 bit configuration DLL, and this is Aurprop.dll.

If you are using **Windows 98** make sure that you have the original Windows CD handy, as this may be requested during the installation process.

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

Windows should report that it has found new hardware. Insert the driver CD supplied with the Auricon and proceed through the installation wizard. Allow Windows to search for the driver on the CD-ROM.

Once the buss driver has started, Windows will report that new hardware has been found for each of the channels. The channel drivers should install without any further need to insert the Auricon driver CD.

At the completion of the installation process a loudspeaker symbol should appear in the toolbar at the bottom of the screen. Your Auricon 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. Also check that the loudspeaker symbol is enabled in the Control Panel – Multimedia settings.

Finally, right-click on the loudspeaker symbol and select **Audio Properties**. Sometimes Windows 98/ME lists the channels in the reverse order to that in which they were installed, and makes the last channel the default. You will therefore need to change the default playback and recording devices to **Auricon Channel A**.

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Installation (Windows NT version 4)

Auricon driver version 6.00.00.3505 (or later) does not support this platform. Use version 4.00.3504 instead (available on request from Innes Corporation).

Windows NT version 4 does not support Plug and Play so it is necessary to manually install the driver after you have inserted the card.

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

The Auricon driver is installed through the Windows NT Control Panel. Insert the Auricon driver CD and follow these steps to complete the installation process.

- Click on **Start** - **Settings** - **Control Panel** and then double-click on the Multimedia icon.
- Click on the **Devices** tab then click on **Add…**
- Select **Unlisted or Updated Driver** then click on **OK**.
- In the Install Driver dialog box, type in the CD-ROM path (eg. **D:\NT4\)**.
- The Auricon driver should be found. Click on **OK** to complete the installation.

Note that it is not necessary to reboot your PC after installation as the drivers are automatically activated.

To activate the loudspeaker symbol on the taskbar, reopen **Control Panel**, double-click on the Multimedia icon and then tick the appropriate checkbox. The default playback and recording channels can also be selected.

Nominal line level and stereo/mono configuration may be changed by clicking on **Audio for Auricon** under **Audio Devices** on the **Devices** page of the multimedia control panel, clicking on **Properties** and then on **Settings**.

Limitations under Windows NT 4

The Auricon does not support the full suite of multimedia functions (such as MIDI playback, digital CD playback or multiple stream mixing and splitting) under Windows NT 4. The wave input and output functions are fully supported except for input low-priority mode.

The mixer functions provided are master input and output levels, mutes and peak meters, line input level controls and mutes, digital loopback level controls and mutes, and wave and monitor output level and mute controls. Refer to the topology diagram at the end of this manual.

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Configuration

There are three configuration settings for the Auricon, these being stereo/mono mode, nominal line level and input topology.

The **mode** may be configured as either stereo or mono. In mono mode the number of input and output channels that Windows sees is doubled.

The nominal **line level** can be set to +8dBu, +4dBu or 0dBu. In each case clipping level is 16dB above the nominal level.

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 any of the wave input streams, whereas with *selector* topology only one physical input can be selected for each wave input stream. Topology configuration is only available with driver version 3503 or later. **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, Server 2003 and Vista), select **Properties**, then click on **Device Manager**. Open **Sound, video and game controllers**, then right-click on **Auricon** (**Auricon WDM Driver** on Windows 98/ME) and select **Properties**. Now click on the **Configuration** tab and select the desired mode, line level and/or topology. Under Windows 2000, XP and Server 2003 it may take up to a minute for Windows to reconfigure itself and the screen may flicker during this time, while Windows 98 and Windows ME will need to restart when the configuration has been changed.

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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 Auricon 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 A/D converter.

In the case of the Auricon, each of the physical line inputs is represented by an endpoint device, and as the hardware has separate A/D converters 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 Auricon 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

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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 Auricon 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 Auricon driver sets this to 48kHz 24-bit for all the 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.

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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 Auricon 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 Vista, XP, Server 2003 and ME only) 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 Vista, XP and Server 2003). Not all CD-ROM drives support digital audio playback. On Windows XP, Server 2003 and ME there is also an option to enable error correction and this should be turned on for best results.

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Topology

The Auricon 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, ME and NT4 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, ME and NT4 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 ME this function is muted when Windows' Digital Rights Management detects that protected audio is being played, in accordance with Microsoft's specifications. **Note:** Under Windows Vista, the loopback endpoint is disabled by default. See the section on Windows Vista above for instructions on how to enable it.

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 XP, Server 2003 and earlier, 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.

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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. Note that the Auricon's NT4 driver does not support extended bit depth.

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

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Hyperthreading and Audio

Some of the modern processors support hyperthreading, a technology lying midway between single core and fully independent multiple processor cores. A hyperthreaded processor provides parallel execution paths for multiple threads, however there remain some shared resources such as the memory caches and floating point processor.

For most applications this is fine and results in a substantial improvement in performance for a given processor complexity, however for time-critical audio applications a problem can arise, when a low-priority thread is using a shared resource that the high-priority audio thread requires. Since the processor has no concept of thread priorities, the high-priority thread is blocked until that resource becomes free, resulting in gaps on playback or skipping while recording.

If this proves to be a problem on a hyperthreaded system, the hyperthreading can usually be disabled in one of the BIOS settings. Refer to the motherboard or system documentation for details on how to do this.

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Connecting the Auricon to Unbalanced Inputs and Outputs

Most professional audio equipment, including the Auricon sound card, uses high level balanced audio interconnections. Commercial radio stations in Australia typically use a nominal programme level of +8dBu, while the ABC, SBS and many production houses use +4dBu. In the USA 0dBu is commonly used.

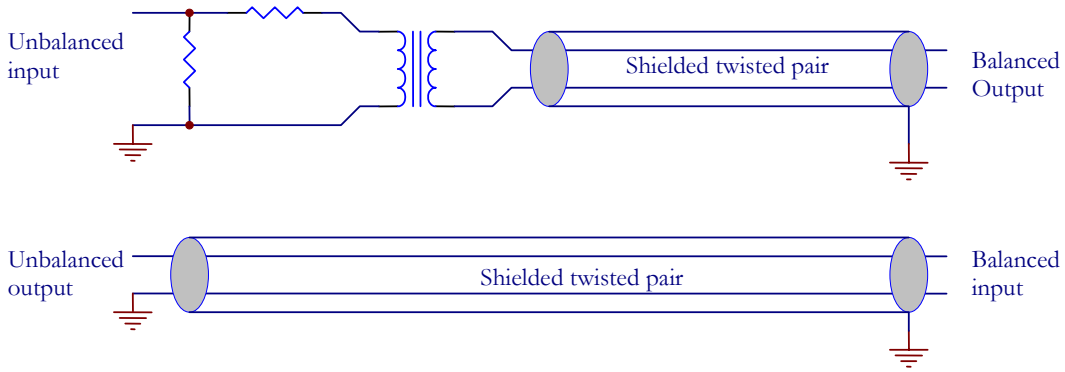
By contrast, domestic audio equipment uses low level unbalanced interconnections, typically at a level of about 100mV rms (about -18dBu). The best way to interconnect between these two systems is with a balancing amplifier. Failing that, it is still possible to achieve an acceptable interconnection, particularly when going from a high level balanced output to a low level unbalanced input.

In the diagram below, the transformer does the balanced to unbalanced conversion and the resistors adjust the level. It is preferable to use a 1:1 transformer and the resistive attenuator rather than a stepdown transformer as this will help minimise capacitive coupling of common mode noise across the transformer windings.

Note that you should **never** ground one side of a balanced output. Doing so will most likely damage the output drivers.

Going the other way from unbalanced to balanced is easy if the signal level is adequate. Simply connect the balanced input across the active and earth of the unbalanced output. In most cases, though, the level at the unbalanced output will be too low so you will need an amplifier. If this is the case it is probably best to do the job properly and use a balancing amplifier.

Finally, note that the shields on the audio cables should only be connected at one end. In the world of balanced audio, the shields are simply that - electrostatic screens - and should not be used for earth returns.



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Functional Description

The balanced audio inputs are buffered, attenuated and filtered prior to being coupled into the A/D converters. From the D/A converters, differential line driver amplifiers provide a maximum output level of +24dBm and also incorporate low pass filtering to attenuate the out-of-band noise produced by the converters.

Digitized audio is passed in serial form between the converters and the Analog Devices ADSP21065L 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 sampling rate conversion, level adjustment and mixing functions. Host-initiated bus mastering is used for audio data transfer through the PLX PCI9054 PCI interface.

The converters operate at a sampling rate of 49kHz (this frequency allows efficient sampling rate conversion to all the standard rates). Clocking for the converters, serial data transfer and DSP is provided from a 25.088MHz precision crystal oscillator.

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 Auricon device driver is started. The Auricon supports standby and hibernation power management modes.

A filtered analogue 5V plane is used in order to minimise any digital noise on the analogue inputs and outputs. The analogue ground is also fenced off from the digital ground, and clock and serial data signals crossing the ground plane division are filtered.

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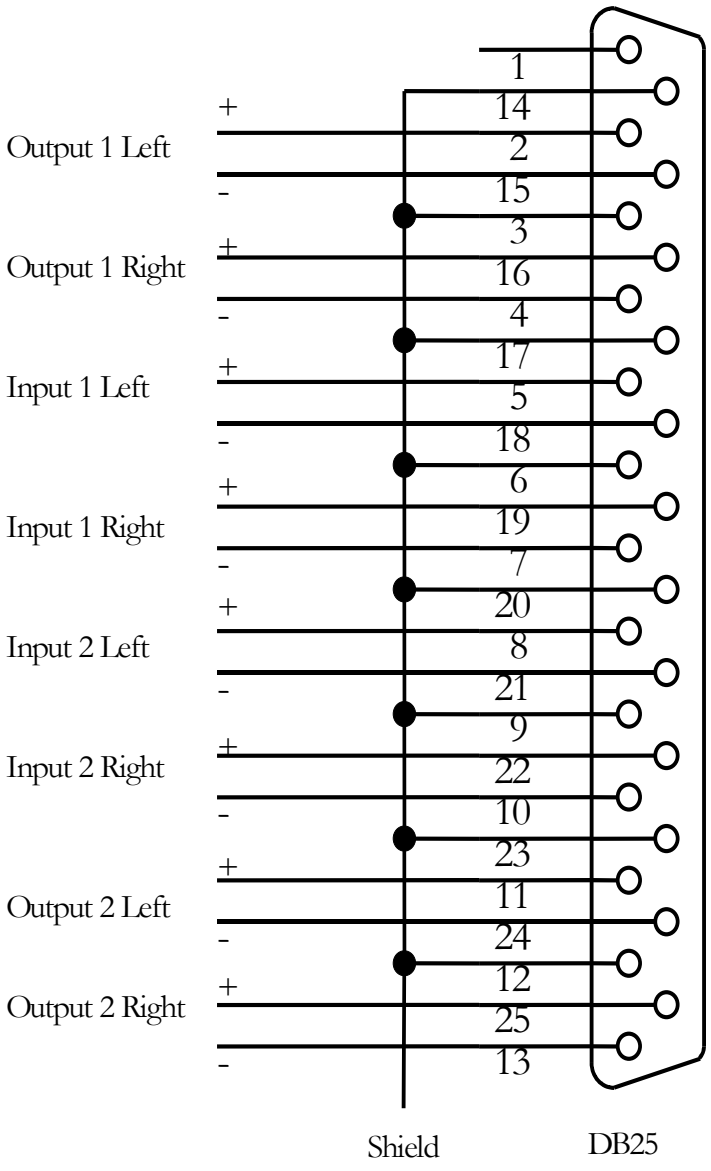
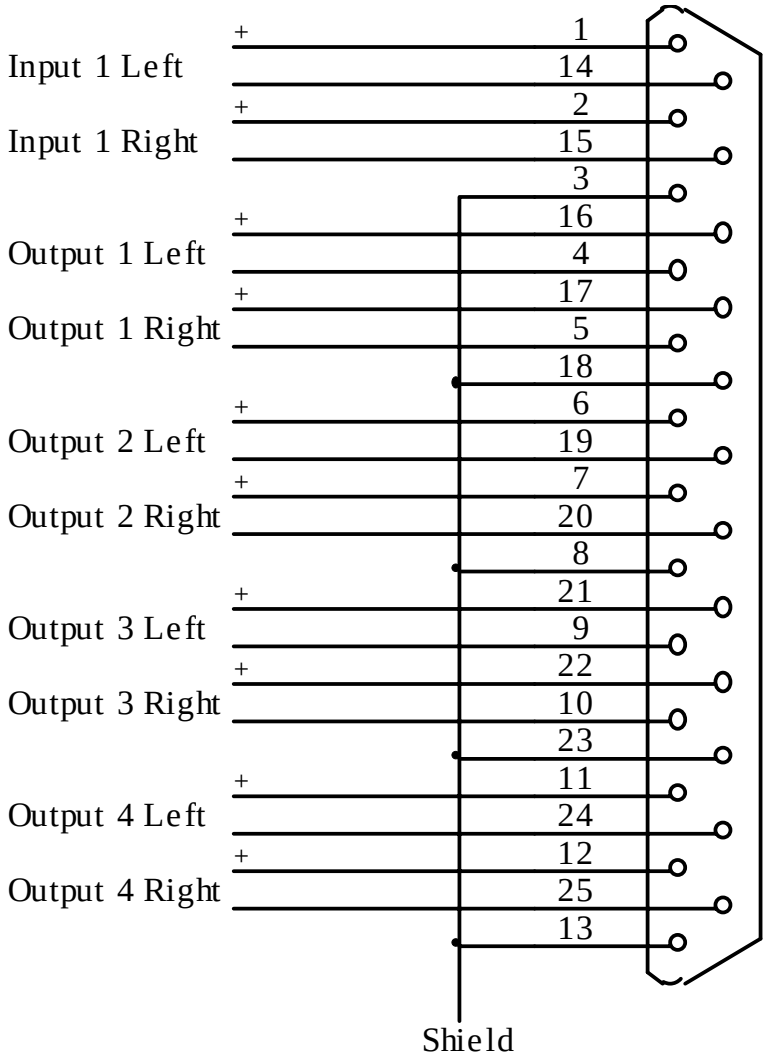
Auricon 2.2 Pinout

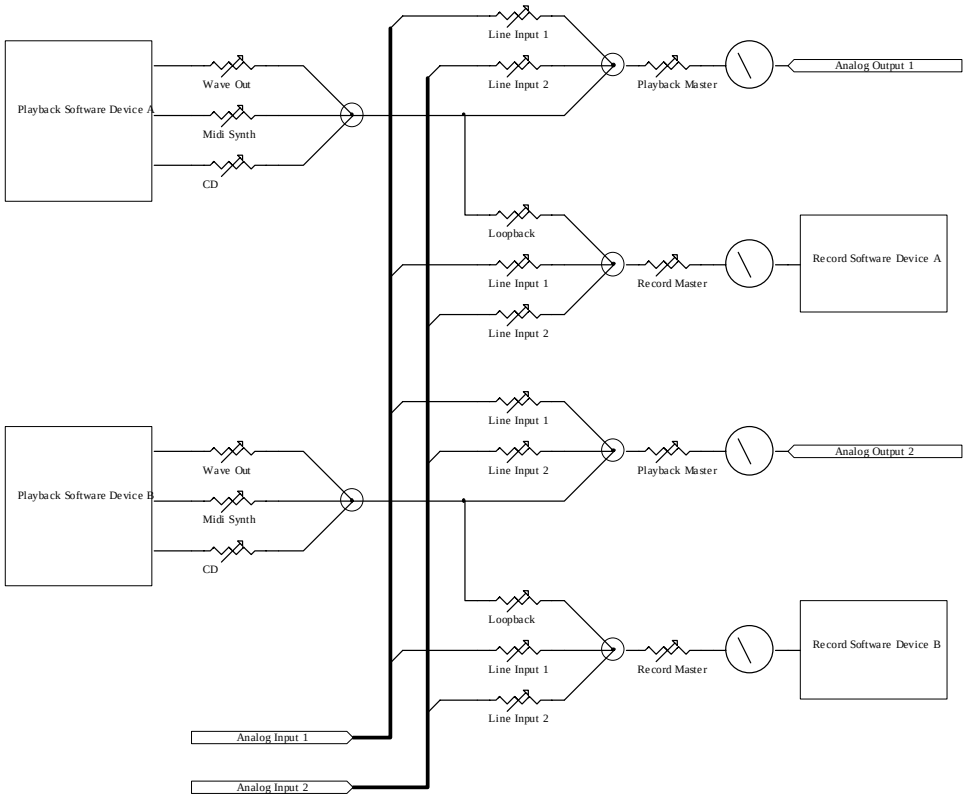


When configured for mono operation, channel A is 1 left, channel B is 1 right, channel C is 2 left and channel D is 2 right.

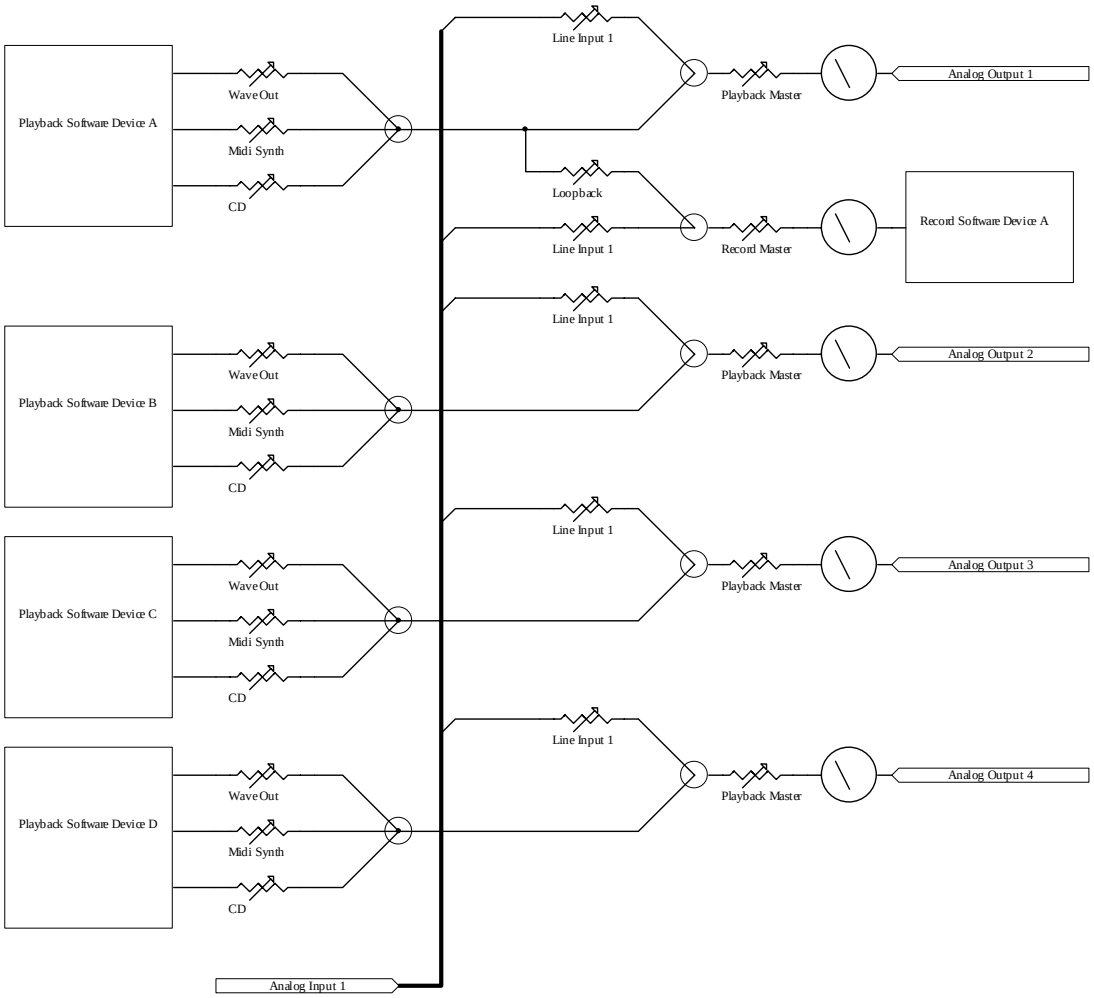
Auricon 4.1 Pinout



Auricon 2.2 Topology



Auricon 4.1 Topology

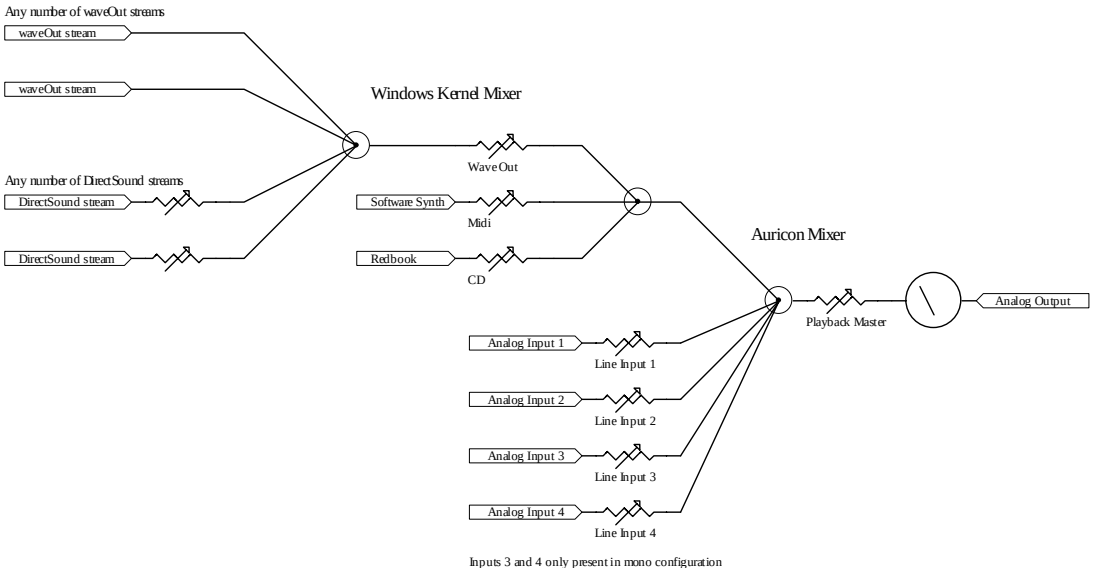


Output Mixing

(Windows 98/ME/2000/XP/Server 2003/Vista)

The Auricon presents itself to the operating system as multiple 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 Auricon 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.