Surround-Sound with 6 Channel Soundcards

A short introduction to the world of Surround-Sound - ideal for SixPack, DMX6fire, Aureon or Phase 26 users.

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Why more than two speakers? The history of Surround-Sound

Why more than two speakers?

Way back in the early 80s, when the audio CD standard was established, the call for quadraphonic sound was born. This desire arose from, among other things, the lack of audio dynamics present in sterile stereo recordings compared to the original experience of the live show, complete with hall concert resonance or the atmosphere of an open-air festival.

There are actually a few audio CDs that were recorded in four channel stereo, but to enjoy them one had to purchase a special player, whose price reflected several complete stereo systems together. The price for such a device, as well as the all too common lack of compatibility for normal audio CDs, impressed no-one but a few hardcore audiophiles. Who wanted to deal with the funny business of having a second device whose all-round functionality was doubtful at best?

Regardless, for many HiFi fans it was simply unacceptable to forego the additional surround sound provided by the rear stereo speakers. Too impressive were the acoustic experiences of the movie theatres, what with their shoot-outs buzzing past your ears and the last resonate clang of an acoustic guitar raising the hair on your arms as if you were standing right next to the band – there simply had to be more to hold ones attention.

In the film industry, and in particular in movie theatres, numerous tricks had already been implemented to achieve better sound (the freaks among us may remember the analogue and digital marks in the perforation of film roles) and more than two audio tracks. And even as the dawn of VHS came upon the earth, we were forced to suffer longer at home – these techniques simply weren't useable in the home cinema world.

The Standards

In the consumer field an interesting idea from Dolby Labs quickly established itself, implementing a surround channel (with substantial quality loss) into a stereo signal. An interesting sound property was made use of – in general, the sound within a speaker set is phase-shifted 90° (the right membrane goes out - the left in) and isn't noticeable – or at least cannot be located.

This alternative signal was then routed per simple electronic switch to another amplifier to drive the rear speakers without any real technical challenge.
A further phase analyzed the two channels and sent all the matching levels and frequencies that existed on both to the so-called center speaker. This was particularly useful for enhancing dialogue.

This technique has come to be known as the **Dolby Surround / ProLogic Standard**. The disadvantage to this technique is that this is not true multi-channel sound. The additional signal is simply extracted from the stereo signal and can contain significant errors. The rear channel's frequency range is also limited (experience shows from 300Hz to 7kHz) and exists only in mono format.
In particular when dealing with weak VHS tapes, the supporting Surround-Sound often mutated into distortion over the rear speakers, sometimes accompanied by random, unidentifiable noise. From an audio CD however, incredible audio landscapes can be conjured into existence thanks to the Surround-Sound technique, in particular by classical recordings, but also quite effective at enhancing pop and electronic music.

Dolby Surround / ProLogic technology remains the standard for the audio CD enhancement, while in the video field much has changed since the invention of the laserdisc.

The abundant audio space made available by the implementation of digital audio and Laserdisc/DVDs has relegated **Dolby Surround / ProLogic** further and further to the background and a new standard offering **five discrete, full-fledged** audio channels (also five times the full frequency band without crosstalk between the channels) has replaced it. Known today as the **Dolby Digital / AC3** standard, this advancement uses a normal digital audio signal which is transferred per standard coaxial or optical cable. This 48kHz signal is then decoded by an external receiver and converted back into five discrete channels as well as a subwoofer channel (also called the bass channel or LFE [Low Frequency Effects]).

It is important to note that bringing 6 audio channels into a 48kHz signal is only possible through use of compression techniques similar to MP3. Here, the channels are compressed using high quality algorithms and then combined into a single signal by special software. This demands a lot of CPU power and is all but impossible in real-time. The conversion process for the 5.1 sound from the DVD film „Matrix", including all the optimizations, takes several days.

And as an enhancement to AC3 we come to the format standard **DTS**. While both systems are principally identical, they are not compatible to one another. Home theatre fans claim that DTS brings more oomph to the speakers, particularly in regard to sometimes measurable bass weaknesses found in some AC3 streams.
Our soundcards can forward a DTS signal to an external DTS amplifier (decoder) or, with help of a DTS capable software DVD player, can play the stream directly over the analogue outputs.

The Individual Speakers

In order to convey these spatial impressions surround systems traditionally use a combination of one stereo pair each for Front and Rear as well as a Center and Subwoofer channel.

Front Left (FL) (OUT 1-L)	Full frequency band for the front right speaker. Can also be split with a subwoofer.
Front Right (FR) (OUT 1-R)	Full frequency band for the front left speaker. Can also be split with a subwoofer.
Center (C) (OUT 3-C)	Full frequency band for the center speaker. Usually for dialogue or special effects.
Rear Left (SL) (OUT2-L)	Full frequency band for the rear left speaker. Can also be split with a subwoofer.
Rear Right (SR) (OUT2-R)	Full frequency band for the rear right speaker. Can also be split with a subwoofer.
LFE Low Frequency Effects (SW) (OUT3-B)	Special effects channel for a subwoofer. This is not the subwoofer channel that supports the other speakers. Sound is only produced here under certain circumstances. Additionally this output is limited to low frequencies and cannot produce „normal“ sounds.

Take note however, that AC3 tracks are not limited to the standard „3:2:1 streams„ (three front sources, two rear, and a subwoofer channel). There are also AC3 tracks that only contain stereo data (2:0:0), where a Dolby Surround decoder is then recommended. Most likely though, the number of simple stereo DVDs will remain small as the original film material typically exists in 5.1 format and the quality of such a stereo AC3 stream is inferior to a stereo PCM stream (i.e. CD audio streams).

The DSP

This is all only applicable when a PC or DVD delivers the audio in surround format. What happen then, when a film or audio stream containing only simple stereo is played on the PC? Many users wonder why the stereo signal is typically only played back over the front speaker pair although the amplifier is actually surround capable. The reason is grounded in the fact that surround receivers weren't designed to blindly provide rear channel support at the cost of possibly distorting the volume, location, and phase properties of the original signal. The rear channel should either be used solely in conjunction with surround signals - or not at all.

Worthy of careful consideration: The SixPack 3D Source Positioning

But of course since the invent of digital receivers there is another option. Labelled an inapt trick by purists and an optimal stereo expansion technique by beginners, this feature carries the name DSP. These modes, with help of the DSPs (Digital Signal Processors) turn a stereo stream into a multi-channel stream by simply adding a hall signal to the original, thereby obliging an external receiver, DVD player, or soundcard to insert this into the original material.

The Terratec SixPack / 6Fire soundcards posses another function for cases where an external amplifier is unable to accept this so-called Phantom Mode signal. This allows the source

positioning of a single stereo stream to be freely distributed among the front and rear speakers. This is achieved in the SixPack control panel under 3D- > Source Positioning, and in the 6Fire control panel under Surround- > Sensaura 3D.

The Source of all the Racket

The Speakers

The sound must, of course, be produced somehow. Optimally this occurs over large speakers, capable of affecting a lot of air.
Here there are several standards as well, like the various THX certifications, though the smallest THX Select standard is most likely the only affordable home cinema solution.

Subwoofer Systems

The subwoofer satellite systems have established themselves in the home arena. This technique implements a bass-box for the „booms“, and small satellite speakers, which can typically be hidden, provide the rest of the sound. A crossover network in the subwoofer separates the bass from the high tones and provides an impressive channel separation.

Unfortunately there are a few „el cheapo“ subwoofer systems that cause problems because they don't meet the following minimum requirements:

1. Bass signal location is indiscernible to humans. This weakness of the human ear is used by all subwoofer systems. The bass definitely becomes locatable when very small satellites force the subwoofer to find the crossover point in unusually high frequencies. The subwoofer should really only play the bass and pass the other sound over to the satellites.

2. The subwoofer must separate the bass completely from the rest of the signal, which we have learned occurs according to the crossover frequency. The cheaper systems do not implement the crossover technique, relying on special devices who then „misuse“ the LFE channel for bass playback. This of course in no way complies with the standard and guaranties a massive loss in quality.

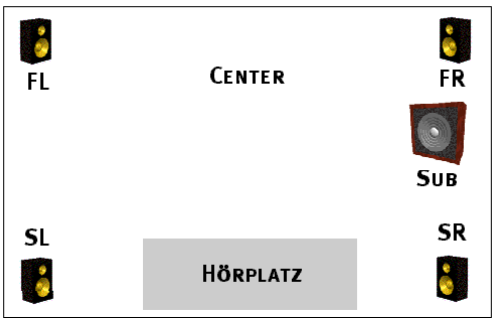
3. The subwoofer and satellites must be of proper dimension for the room they are to be implemented in. A subwoofer suffering from hyperventilation doesn't sound very impressive.

One should certainly consult a professional salesperson regarding the above mentioned points before making any purchase decisions. They will most likely have a few favorites to recommend for your specific situation.

Positioning: Subwoofers and Satellites

Subwoofer system positioning is also very important. In general the center should be placed where ones view is focused. The TV or PC monitor offers the best placement location. The front speakers should be placed at the same height and both should be placed the same distance from the center speaker.

The rear speakers should be placed at the same height as - and directly pointed at - the listeners head. Important: One should take care to avoid turning the rear speakers up too loud. You only want to enhance the sound, not compromise it by letting the background noise get out of control.



The advantage to the subwoofer is that it can be hidden practically anywhere. Unfortunately not many users make use of this fact and place it directly under the center speaker or even in a cabinet. The subwoofer has no chance to unfold its true potential in such a position. In general the corner of a room offers the best reflex ratio - and spacious breathing room will ensure you thunderous bass.
Home cinema freaks place the subwoofer near the future listening position (i.e. in front of the new couch) and play a test CD. Then begins the long journey through the room to establish the point where the bass can be heard subjectively. And that's where the subwoofer finds its new home. Be warned, subwoofer suitable positions are often found in places one would not expect...

Body Shakers and other Tuning Methods

Another interesting add-on is the so-called Body Shaker, which is normally mounted under the seat. These devices are connected to the LFE output and create no audible sound, but are noticeable nonetheless (through vibration) giving explosions and related sound effects a more realistic kick.

The Central Nervous System: Interaction with the PC

This is where the soundcard enters the game. It provides the speakers with sound via amplifier. During normal application it drives the front speakers – unless you have decided to use the Source Positioning to manipulate this, which is quite intrusive when using weaker type speakers. Even reasonable good speakers lose some quality when Source Positioning or Phantom Mode is used.

Now PowerDVD knows whats up :)

So far so good – should you be fortunate enough to leave the dull world of work behind for a while and start a 3D game or a DVD - then the fun can really begin :). Usually the DVD player must be set to 6 channel output mode (or SPDIF output if you have an external digital decoder and want to forward the signal out through the digital output on the soundcard). Games find their counterpart in the A3D/EAX/Sensaura3D modes.

What do I play it all with and what is the standard?

Depending of the file type there can be more than one sound format within one file. As a matter of principle all stereo compatible formats are also Dolby Surround compatible because Surround is technically a stereo signal.

	Dolby Surround	Dolby Digital AC3	DTS	EAX/A3D/Sensaura
WAVE (*.wav)	Yes	No	No	No
MPEG1 Layer3 (*.mp3)	Possible, but usually eliminated through MP3 compression.	No	No	No
Spiele	Yes - i.e. Unreal Tournament	Yes	Theoretically possible.	Yes
DVD-Spuren (*.vob)	Yes	Yes	Yes	No
AC3-Tonspuren (*.ac3)	Yes, by 2:0:0 AC3 tracks	Yes	No	No
DVSs	Yes, mostly by older DVDs	Yes, by now the established sound standard for DVDs.	Only permissible as a supplement to Dolby Digital.	No

The Proper Software for the First Test

The following titles are *not only* recommended as appropriate Test-CDs:

Computerspiele	
Title	Comment
Unreal Tournament	Very intensive use of the rear channels via Sensaura 3D. Should the player hear a weapon fired from the rear they can easily locate the positioning and (should) swiftly react accordingly :)

Audio-CDs	
Title	Comment
Ronan Hardiman - „Solas“	Constant implementation of Surround-Sound provides an excellent 3D listening experience when an external ProLogic amplifier is used.
Yello - Motion Picture	Is used in many cinemas as a warm-up or sound-check CD. After the first few minutes the listener will know why.

DVDs	
Title	Comment
Titanic	A merciless test for any DVD system. Incorrect sound settings quickly become noticeable here. In particular the sounds in the engine room scene, the sound of the motor starting at the beginning, and the sound placement manipulation evident at the end of the film which seems to come from behind.
Matrix	A great test to determine the acceptable bass noise tolerance level during the famous „Lobby Shooting Spree“ scene.