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Indice

Introducción

Mediante el uso de tarjetas o places de sonido nuestra computadora puede reproducir y grabar señales de audio de alta, media y baja calidad, sin ella esto no sería posible. De ahí la importancia de tener conciencia acerca de qué placa tenemos, qué utilidades le damos y qué se puede lograr a través de la misma.

En el presente trabajo, basándonos en computadoras de escritorio, desarrollaremos una introducción a lo que es una placa de sonido, sus partes y funcionalidades. Anclando el contenido a través de imágenes que representan lo desarrollado y haciendo diferencias entre los distintos tipos de placas, pasando por los conceptos básicos a tener en cuenta para la elección y adquisición de dicha placa. Al final del trabajo, y de una forma práctica se realizaron pruebas en las cuales, mediante el uso de determinados programas, se evidencia la diferencia entre una tarjeta de sonido integrada y una placa de sonido para uso profesional.

Concepto

Una tarjeta de sonido es un dispositivo de hardware que se usa en las computadoras para entrada y salida de audio, esto se logra gracias al controlador. Sin él, las aplicaciones multimedia a usar en nuestra computadora no podrían ser gestionadas, o no sonarían. Dichas aplicaciones permiten la composición y edición de video/audio, presentaciones multimedia y entretenimiento. Las tarjetas de sonido pueden estar o no incorporadas en el equipo, estas tarjetas poseen conexiones para auriculares, altavoces, micrófonos, instrumentos, etc.

Físicamente es una placa rectangular de plástico plano que posee una serie de microcircuitos integrados en su superficie. Los conectores se encuentran en uno de sus extremos, el cual se inserta en una de las ranuras del ordenador (cuando este sea para computadoras de escritorio), logrando así que los conectores queden a la vista y sean accesibles al usuario.

Funciones

Las placas de sonido poseen diversas utilidades, pero las principales son: reproducción y grabación.

Grabación: la placa recibe la señal acústica por los conectores, dicha señal es procedente de un micrófono u otras fuentes. La función que cumple la placa con respecto a la señal acústica recibida es transformada y enviada a la computadora y allí se almacena en un formato especifico

Reproducción: es otra función básica de la placa de sonido, es la que se encarga de expulsar por los conectores de salida las ondas digitales que existen en la máquina, para que estas sean interpretadas por un altavoz u otro dispositivo.

Partes de una tarjeta

Interfaz: Es el medio por el cual se transmite información entre la tarjeta y la computadora, puede ser de tipo PCI, PCIe, USB, etc. Se conecta directo a la placa madre.

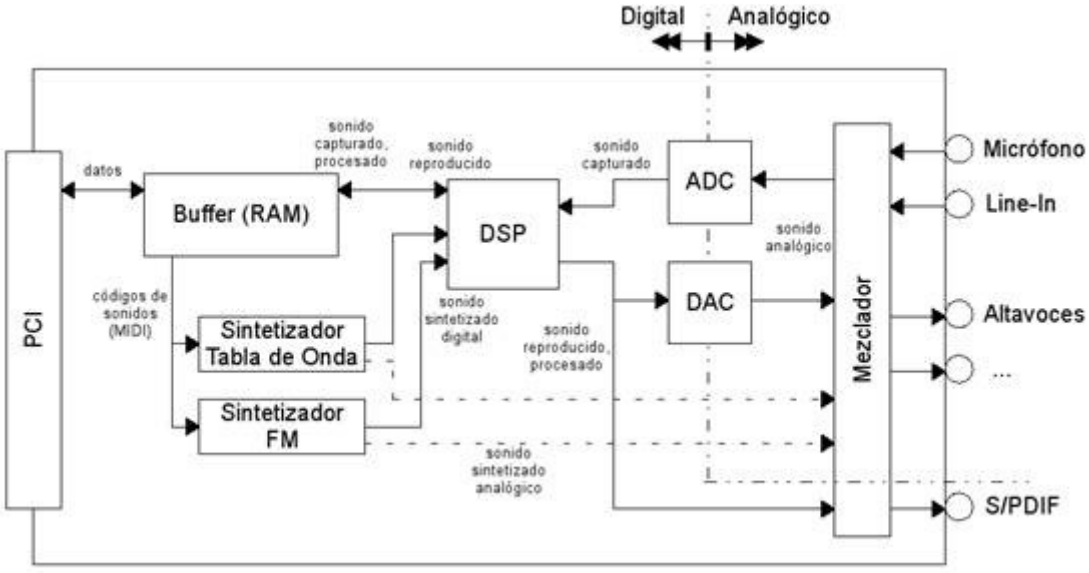
Buffer: Es el encargado de almacenar temporalmente los datos que viajan entre la computadora y la tarjeta.

Procesador de señal digital (DSP): Es el microprocesador de la tarjeta de sonido, realiza cálculos y tratamientos sobre la señal de sonido, liberando asi a la CPU de ese trabajo.

Conversor analógico-digital (ADC): Transforma la señal de sonido analógica en digital.

Conversor digital-analógico (DAC): Reconstruye la señal analógica a partir de la digital.

Mezclador: Es el encargado de recibir, combinar y encaminar múltiples entradas, mezclándolas o seleccionando alguna de ellas. Éste se configura mediante un software.



El componente fundamental de las tarjetas de sonido es el chip sintetizador, el cual es capaz de generar ondas musicales permitiendo así que la tarjeta pueda reproducir/producir el sonido.

Las primeras primeras placas de sonido (Adlib) poseían un chip sintetizador con **tecnología FM**, este era capaz de simular el sonido de instrumentos reales (piano, guitarra, etc) mediante programación. Luego, con la evolución de las tarjetas de sonido, llega otra tecnología que no se limitaba a generar el sonido mediante programación, sino que, eran capaces de reproducir y emitir sonido real; esta tecnología es conocida como síntesis de tabla de ondas o Wave Table. Hoy en día, la síntesis FM está en desuso y hoy cualquier tarjeta usara el sintetizador por tabla de ondas.

Sintetizador por tabla de ondas o (Wave Table): Posee los sonidos de los instrumentos grabados, estos sonidos están alojadas en formato digital en una memoria ROM incorporada. Éste sintetizador antes de enviar la señal, realiza unos ajustes que se ajusten al sonido requerido.

Conectores - Entrada/Salida

La mayoría de las tarjetas internas de sonido cuentan con conectores de diferentes colores. A continuación, se hace referencia de cada conector y su descripción:

Rosa	Entrada analógica para micrófono
Azul	Entrada digital “Line-In”
Verde	Salida analógica para la señal estéreo principal (altavoces frontales
Negro	Salida analógica para altavoces traseros
Gris	Salida analógica para altavoces laterales (altavoces medio)
Naranja	Salida digital SPDIF (usada a veces para salida analógica para altavoces centrales y subwoofer)

Tipos de conectores integrados

En los conectores anteriores mencionados, podemos realizar la conexión de dispositivos para jack 3.5 mm. (altavoces, auriculares, micrófonos, etc). El puerto MIDI, se la incluye en alguna placas.

Puerto MIDI: permite la conexión de cualquier instrumento que cumpla con esta norma, permitiendo así el intercambio de sonido y datos entre si, con la posibilidad de controlar un instrumento desde la computadora. También este puerto se utiliza para conectar un periférico para los juegos.

Datos para la adquisición de una placa de sonido

Polifonía: A la hora de adquirir una tarjeta de sonido es importante tener en cuenta el numero de bits de la misma, éste se refiere al numero de notas que podemos procesar, reproducir o grabar simultáneamente en la tarjeta, estas notas pueden o no ser procedentes de la misma fuente. Si nuestro objetivo es lograr una buena calidad de sonido de reproducción y grabación, es aconsejable una tarjeta que disponga de 24 o mas bits.

Frecuencia de muestreo: La placa transforma la señal analógica en digital, en este proceso de digitalización se produce el muestreo, la frecuencia de muestreo

es el numero de veces por segundo que cambia el nivel de una señal digital, esto cambios se convierten en onda sonoras que identificaremos como música. En cuanto a calidad de reproducción y grabación, a más frecuencia, mayor será la calidad del sonido.

Half dúplex y full dúplex: Una de las características que debemos tener en cuenta es que si nuestra placa es half dúplex entonces no es capaz de grabar y escuchar a la vez. Por otro lado, si dicha placa es full dúplex ésta si nos permitirá grabar y escuchar a la vez.

Tipos de placas de sonido

Pueden clasificarse en: tarjetas integradas básicas, tarjetas profesionales y tarjetas profesionales de sonido.

Tarjeta integrada básica: esta tarjeta reproduce el audio en la mínima calidad, su frecuencia de muestreo es de 44,100 KHz y resolución de 16 bits. Generalmente el conector de color rojo es una entrada de línea desbalanceada MiniPlug, la salida de color verde con la misma característica y suele tener otra salida auxiliar de color azul.

Tarjeta semi-profesional: Esta tarjeta reproduce el audio en una calidad media, trabaja en resoluciones superiores a la mínima (mayor a 16 bits). Es decir, sirve para aquellos usuarios que desean obtener una mayor calidad de reproducción, pero no para el ámbito profesional.

Tarjeta profesional: Esta tarjeta trabaja con alta calidad de sonido, diseñadas para ser utilizadas en estudios de grabaciones, sonido en vivo, post-producción audio y video, trabaja en resoluciones mayores a 24 bits , su frecuencia de muestreo superiores a 44,100 KHz, soporta múltiples procesos en simultaneo. Posee generalmente entradas y salidas RCA, MIDI y S/PDIF.

Otras categorías de tarjetas

Tarjeta estéreo: Poseen dos canales, uno para cada altavoz, algunas de ellas recrean el sonido 3D aunque no pueden hacerlo con mayor calidad.

Tarjeta cuadrafónica: Posee 2 salidas estéreo, con dos canales cada una, por lo tanto brinda señal a 4 altavoces, esta tarjeta logra el sonido 3D, algunas contienen subwoofer (altavoz, mas grande que los anteriores, mediante el cual reproduce los sonidos mas graves).

Dolby Digital 5.1: Posee 5 canales para alta frecuencia y un canal para baja frecuencia.

Tarjeta de 6.1, 7.1, 8.1 y más: Brinda un efecto de sonido de 360 grados y mayor calidad de sonido.

Instalar una placa de sonido

Parte 1: Abrir la carcasa de la computadora.

1º Paso: Asegurarse de que su pc necesita placa de sonido (Que ésta no esté integrada en la placa base).

2º Paso: Apagar la computadora y retirar los cables. Colocar la computadora de modo que quede en una posición de fácil manejo de la misma (visual y manual).

3º Paso: Retira el panel lateral de la computadora. Es necesario retirar los tornillos que se encuentran en la parte posterior de la misma.

4º Paso: Conéctate a tierra. De lo contrario se pueden dañar los componentes internos de la placa madre. Esto puede hacerse mediante la vestimenta adecuada o un pulsera antiestática.

5º Paso: Limpia el polvo. Limpiar todo el polvo que encuentres asegurará un correcto funcionamiento de la computadora en general.

Parte 2: Instalar la tarjeta

1º Paso: Ubica las ranuras PCI. Son generalmente blancas y se alinean con los paneles desmontables de la parte posterior de la carcasa. Generalmente hay de 1 a 5 por placa madre.

2º Paso: Retira la tarjeta de sonido existente. Si posees una tarjeta de sonido, es necesario quitarla para el buen funcionamiento de la computadora. Retira los tornillos que la aseguran a la carcasa y desconecta la tarjeta.

3º Paso: Coloca la nueva. Retira el panel de protección contra el polvo de la parte posterior. Asegúrate de que las marcas de la ranura se alineen con la tarjeta y presiona hacia abajo. No es necesario forzar nada.

4º Paso: Fija la tarjeta. Coloca un solo tornillo en la ranura de metal que asegura la tarjeta a la carcasa sin ajustar demasiado.

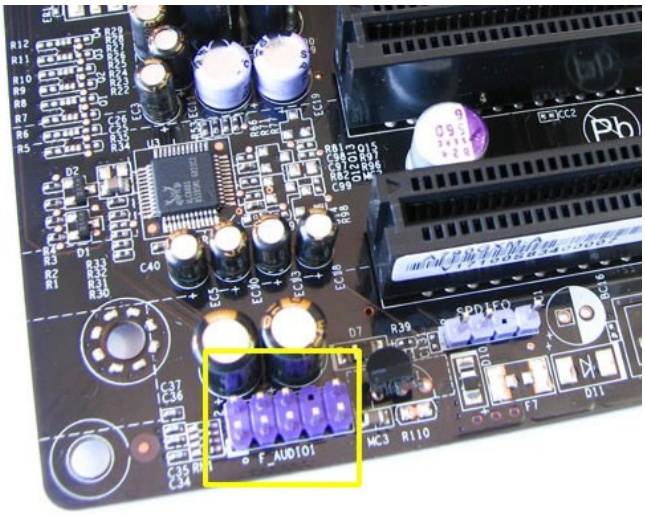
5º Paso: Cierra la carcasa. Vuelve a colocar el panel lateral de la computadora y asegúralo.

AC’97 y HD-Audio

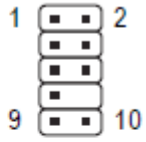
AC’97: Es un codificador de audio desarrollado por los laboratorios de Intel en 1997. Este estandar se usó en placas base, módems y tarjetas de sonido. Posee una arquitectura de alta calidad de 16 o 20 bits y admite una frecuencia de 96 kHz con una resolución estéreo de 20 bits para grabación y reproducción multicanal.

HD Audio (Intel High Definition Audio): Es un sucesor, el cual no es compatible con versiones anteriores de AC’97. Es una especificación publicada por Intel en 2004. Es capaz de reproducir más canales con mayor calidad que los códecs de audio integrados anteriormente. Éste posee un hardware capaz de entregar 192 kHz de calidad de 32 bits en dos canales y 96 kHz de 32 bits para un máximo de ocho canales.

En la placa madre generalmente se la encuentra en un extremo como F_AUDIO, AUD, u otras formas.



Esquema de conexiones de AC’97 y HD AUDIO en la placa madre



HD Audio:

Pin No.	Definition
1	MIC2_L
2	GND
3	MIC2_R
4	-ACZ_DET
5	LINE2_R
6	FSENSE1
7	FAUDIO_JD
8	No Pin
9	LINE2_L
10	FSENSE2

AC'97 Audio:

Pin No.	Definition
1	MIC
2	GND
3	MIC Power
4	NC
5	Line Out (R)
6	NC
7	NC
8	No Pin
9	Line Out (L)
10	NC

Relación puente sur y placa de sonido

El puente Sur, también conocido por Southbridge o Concentrador de Controladores de Entrada/Salida es el encargado de coordinar los dispositivos de entrada/salida y algunas funcionalidades de baja velocidad dentro de la tarjeta madre. Entre sus funcionalidades, y lo que a nosotros nos concierne, el southbridge incluye soporte para la interfaz de sonido AC’97 o HD Audio.

Sistema de sonido multicanal:

Se refiere al uso de múltiples pistas de audio para la reconstrucción del sonido en un sistema de varios altavoces. Se usan dos dígitos separados por un punto para clasificar los tipos de configuraciones de altavoces. El primer dígito se refiere al número de canales primarios, cada uno reproduce un altavoz individual. El segundo dígito se refiere a la presencia de un efecto de baja frecuencia.

Sistema 2.1: Tres altavoces, uno izquierdo, uno derecho y uno para la frecuencia de graves (subwoofer).

Sistema 5.1: Consta con cinco altavoces y un subwoofer.

Sistema 6.1: Se añade un altavoz central con respecto al 5.1.

Sistema 7.1: Dos altavoces más en la parte central con respecto al 5.1.

Sistema 7.2: Se añade un subwoofer en la parte posterior con respecto al 7.1.

Sistema 9.1: Se añade dos altavoces en el techo, o en la parte frontal.

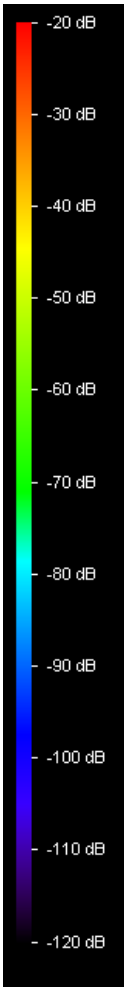
Comparación entre placas

Pondremos en práctica un programa llamado Spek para demostrar la calidad de grabación entre dos placas de sonido, la primera es High Definition Audio (que viene en una integrada en una pc cuando se la compró) y una steinberg ur12 (placa externa comprada para el uso de grabaciones).

Para medir la calidad de lo grabado en ambas placas, debemos comparar sus niveles de frecuencia y decibeles. Pero antes tendremos que explicar que son los decibeles.

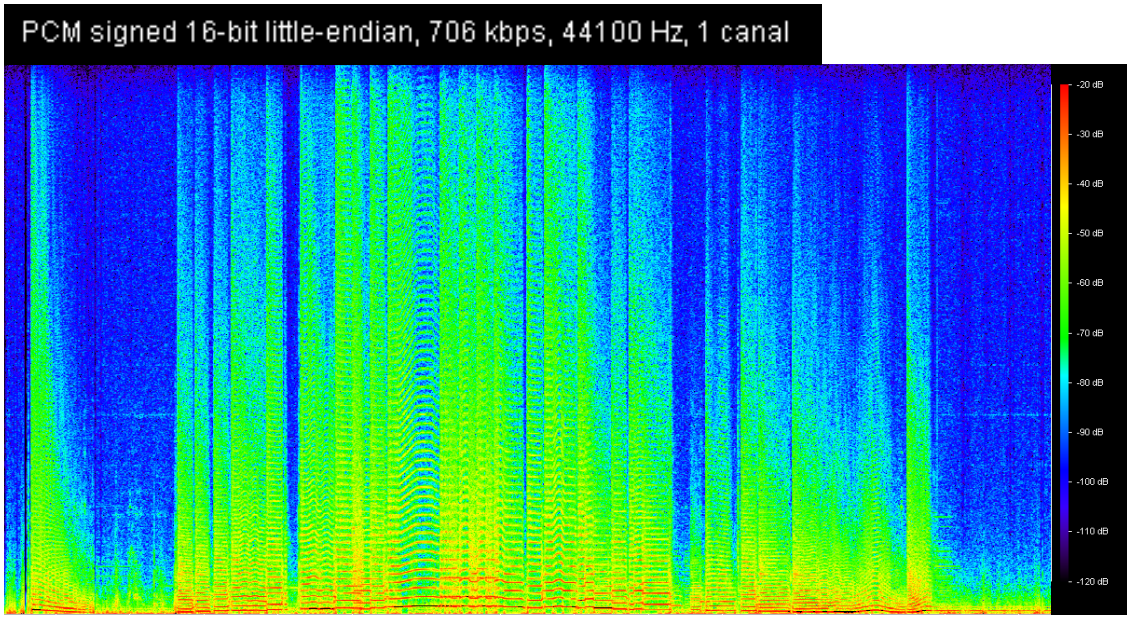
Decibeles (db): es la unidad de medida para expresar la intensidad de los sonidos. Existe una tabla que describe los decibeles y nivel de intensidad.

Lo recomendable en un audio para una buena reproducción y grabación, es que llegue a un rango de 70 db, si supera ese rango el sonido empieza a distorsionarse.



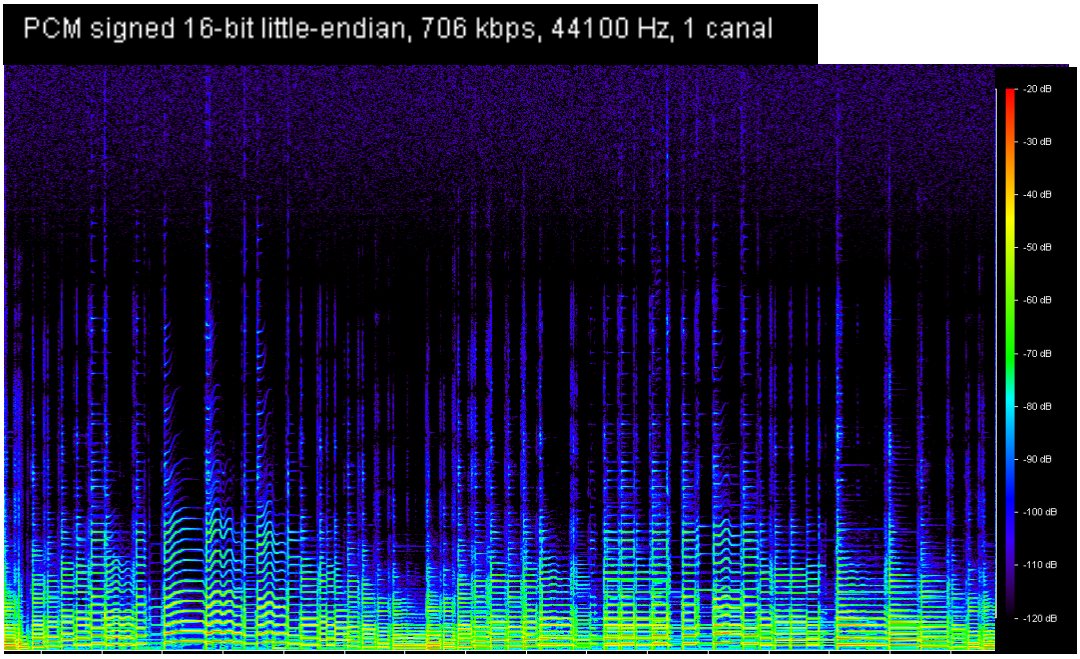
Ahora procedemos a la comparación de ambas placas, hemos grabado en audacity, las mismas notas. Utilizamos una guitarra eléctrica, el mismo cable, grabación hecha en un solo canal, exportamos el audio en formato WAV, y luego utilizamos el programa Spek para verificar sus decibeles y kHz.

High Definition Audio



Como podemos ver en esta imagen, la grabación varia sus decibeles, mucha información llega hasta los -20 db y en la reproducción se hace notar sonando de una forma ruidosa, inentendible, no es una buena calidad.

Placa Steinberg UR12



Usando lo mismo que el anterior proyecto, se observa que quizás menos información enviada, pero que no varia tanto sus db, varia entre los -100 db y -60db, muy poco a sido los datos enviados entre los -40 db y -30 db. Observamos que la grabación es mejor, y en la reproducción se escucha delicado el audio.

Para finalizar esta comparación podemos decir que, a pesar de usar el mismo instrumento, las mismas notas, el mismo programa, una placa agrega mas datos de lo que debería. Para hacer una grabación de calidad media, se debe tener una placa que no generé sonido de más, para que sea agradable para la reproducción luego.

Conclusión

Mediante la realización y producción de este trabajo, hemos hondado sobre las placas de sonido, sus diferentes tipos y conceptos básicos. Abordamos temas referidos al sonido en general, como así también especificaciones sobre el mismo, siempre articulándolo con referencias hacia la placa de sonido en sí. Incluimos también, porque nos pareció de suma importancia, los conceptos básicos sobre audio, sobre datos a tener en cuenta para la adquisición de una placa y mencionamos cómo y dónde se instala la misma. Se desarrolló posteriormente, como forma de resumen teórico, una parte práctica, la cual consta con la grabación de sonidos en diferentes placas (una externa para uso profesional de grabación y una integrada desde que se la compra a la PC) para luego ser comparadas y diferenciadas una de otra. Anhelamos que luego de la lectura de este trabajo, puedan incorporar nociones básicas referidas tanto al sonido como a las placas para una posterior adquisición e instalación de los mismos.

Bibliografía

http://es.ccm.net/contents/50-audio-multicanal-5-1-6-1-7-1

https://es.wikipedia.org/wiki/Sistemas_de_sonido_multicanal

https://es.wikipedia.org/wiki/Intel_High_Definition_Audio

https://en.wikipedia.org/wiki/AC%2797

https://www.mastermagazine.info/termino/6823.php

https://miriancarvar.wordpress.com/tarjetas-de-sonido/

https://www.newegg.com/Product/Product.aspx?Item=N82E16829121123

https://www.unimusica-peru.com/produccion_musical_tarjeta_sonido.htm

http://servicioseducativos.over-blog.org/article-los-decibeles-72411455.html

https://es.wikihow.com/instalar-un-tarjeta-de-sonido

https://www.lpi.tel.uva.es/~nacho/docencia/ing_ond_1/trabajos_04_05/io8/public_html/tarjson.html

http://www.profesorsebastian.com.ar/secundariasegundosonido.htm

http://www.fotonostra.com/digital/muestreoaudio.htm

https://www.taringa.net/posts/apuntes-y-monografias/10417762/Placas-de-sonido-de-pc.html

http://spek.cc/

http://musiki.org.ar/NPS_(nivel_de_presi%C3%B3n_sonora)

http://www.chw.net/foro/placas-madre/1089568-se-si-una-placa-soporta-audio-7-1-a.html

https://superuser.com/questions/378082/how-to-connect-my-front-audio-panel
http://motherboard95.blogspot.com.ar/p/puertos-de-una-motherboard.html

https://www.taringa.net/posts/hazlo-tu-mismo/14907037/Amplificar-audio-de-panel-frontal-de-PC-para-audifonos.html

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