TECHNICAL REPORT

USB - Audio Playback Recording Peripheral

UDA1335H
EVALUATION BOARD
AND
APPLICATION DOCUMENTATION
Version 1.6

DML98011

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Abstract

This application note describes the installation and application of the Philips Semiconductors USB-APRP solutions UDA1325H and UDA1335H for the Universal Serial Bus (USB). Specific information is given about hardware and software requirements necessary to make the USB-Audio function work in a USB-enabled computer system.

Table of Contents

1. Introduction

1.1 General Information

This application note describes the installation and use of the Philips Semiconductors USB- UDA1335H evaluation board (version 1.5). It furthermore explains the application of the USB-APRP in an environment as a USB-Audio Device.

The type number UDA1325H refers to the ROM-less QFP64 package version of the UDA1335H. The UDA1335H is used with an external (E)PROM that holds it's firmware. This allows for easy upgrades and optimizations of the system during the time that the Windows™98 operating system is not officially released. The ongoing firmware development for the UDA1335H will result in a final firmware version for the UDA1335H chip. This latest version of the firmware will be integrated in the UDA1325x, then being a single chip solution without the external (E)PROM. The QFP64 versions of the UDA1325H and UDA1335H, are pin compatible.

While a lot of the information in this document will be applicable to the UDA1325H, for simplicity reasons in this document reference will only be made to the UDA1335H.

This application note will explain the Universal Serial Bus only in a few brief words (see section 1.2). If you want (or need) any further information or specific details please refer to the USB Specification, to the USB Audio Device Class Description and other relevant documents. You will find details about these documents in Chapter 5 - References.

The application of the USB-APRP UDA1335H requires a USB enabled PC running Windows 98. Beta versions and 'Release Candidates' of this operating system are being distributed in the hardware o use is related to the UDA1335H firmware releases and Philips can not give any guarantee that a specific firmware release will work with the pre-release operating systems version you are using. It is highly advisable to check whether for a version match before evaluation starts. Updates of the firmware will be available through the standard distribution channels.

NOTE: The UDA1335H, as most other USB solutions, cannot be used with other or earlier Windows operating systems. These operating systems do not provide the drivers and system support, USB Audio Class and Streaming Class drivers necessary to operate audio devices attached to the Universal Serial Bus. The development of Win98 is still continuing even after the official release last june. The current build version (4.10.2222) has been released and is known as Second Edition (SE) . This version has several improvements also in regard of USB functionality. The HID -functionality for the USB-APRP has been corrected and also some other issues regarding connect / disconnect of the USB-plug has been improved in terms of stability.

Legal usage of the Philips USB-AUDIO CODEC:

It is very important that you are aware that use of one of the four internal maps (within the implemented firmware) is legal if you are the legal owner of the internal map. In any other case, you may **NOT** use any of the internal maps, other than for test purposes ! Otherwise you can and will be prosecuted to the maximum extent possible under law and you can count on severe civil and criminal penalties. So, if you are not a legal owner of one of the internal maps, you must implement your own configuration by means of an external I²C-EEPROM and program your companies VID as explained in application note 2 of the UDA1335H. The internal maps are dedicated to either Philips products or customers of Philips who have a legal agreement / contract to use one of the internal maps.

1.2 Universal Serial Bus Overview

The Universal Serial Bus (USB) is a “medium speed” serial bus designed to be part of every computer system (i.e. desktop as well as laptop, home as well as business…). USB is a royalty free bus that was invented for PC’s with basically two important goals in mind:

- To allow installation of additional hardware without opening the computer case
- To allow easy and intuitive installation and configuration of additional Hardware without additional user installable software (Plug‘n’Play).

The maximum speed of USB is 12 Mbit/s. This allows for a maximum “bulk” data rate in the order of 1 MByte/s. This is obviously plenty for peripheral devices such as keyboards, mice etc. that only generate data in small amounts “once in a while”. More than that, it is perfectly suited for Digital Audio Applications. Good quality Digital Audio requires data rates of less than 200 kByte/s (full-blown CD-Audio e.g. at 48kHz, 16 bit Stereo requires only about 13% of the bus bandwidth).

USB has the topology of a “Tiered Star”. The one (and only) host in the system is connected to the t on the PC’s motherboard) and is responsible for all data traffic. This means that all data interactions are initiated by the host. The host polls all devices to find out which devices want to receive or transmit data. All other devices need to wait to be polled, they can not initiate data traffic by themselves.
The Root Hub can have one or more so called “Downstream Ports” (since they are facing away from the Host). In the simplest form the USB has only one other USB device connected directly to one of the Root Hub’s downstream ports.

Figure 1-1 below gives the simplest USB topology possible. It contains a ‘Host Processor’, the ‘Root Hub’ and a single USB device connected to one of the Root Hub’s ports. The USB-Device could in this case e.g. be the UDA1335H evaluation board.

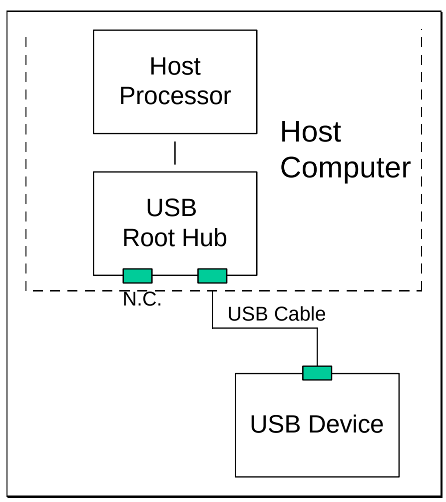


Figure 1-1 *Simplest possible USB Topology*

The ‘Host Processor’ is responsible to control all USB ‘Data Traffic’. It can send, for example, digital audio data on the bus to a specific USB audio device, which is capable of playing this audio data and receiving control data to control, for example, the volume settings.

An additional USB Hub device is only needed to build more complex topologies, it doesn't add real functionality to a USB environment.

Figure 1-2 shows a typical, more complex USB topology:

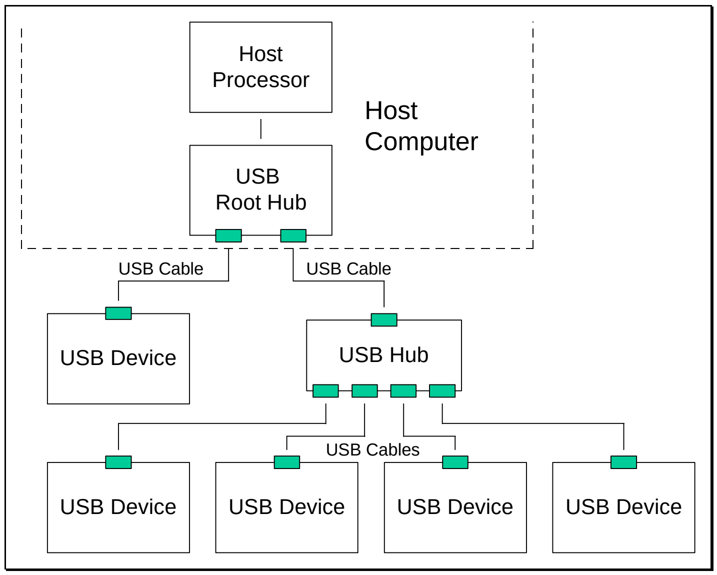


Figure 1-2 *Typical, more complex USB Topology*

There are a whole variety of USB devices that will make their appearance in the market in the near future. The most popular applications are:

- Keyboards
- Mice
- Joysticks
- Monitors
- Audio / Speakers
- Printers
- Scanners
- Video Conferencing Cameras
- Modems / Phones

Given these applications, a typical "real life" application could look like the example shown in Figure 1-3.

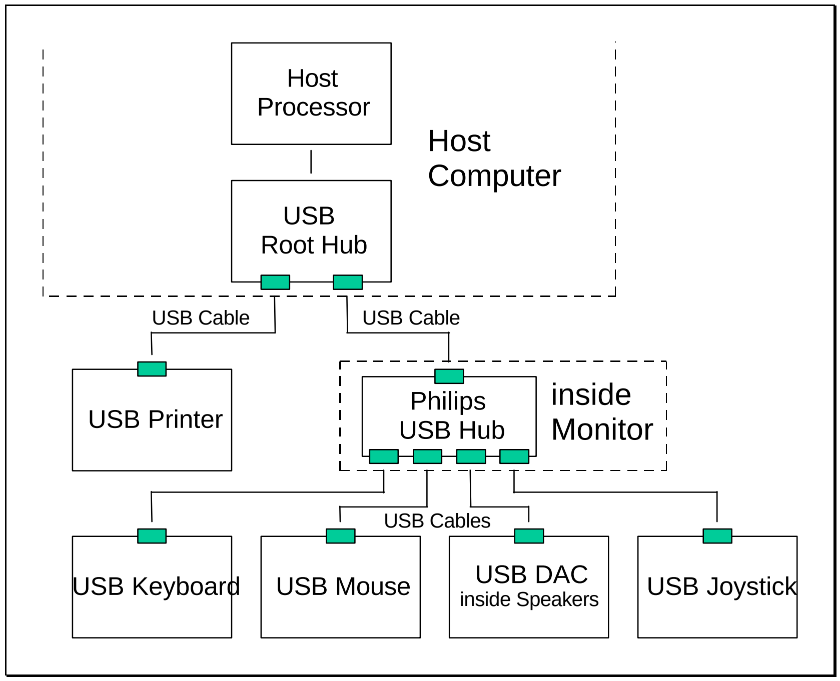


Figure 1-3 *Complex "Real Life" USB Topology*

The maximum number of devices that can be connected to the USB is limited to 127 (using 7 address bits. Remark: Since the Root Hub already counts as one device the number of external devices on the bus is actually limited to 126). Given the fact that all these devices would have to be *outside* of the computer case, this number should be sufficient for most computer systems.

One of the interesting features of USB is that it allows for devices to be either

- Self powered or
- Bus powered

Self-powered devices have some kind of connection to an external power source, e.g. to a DC power supply or a mains power outlet. They draw all their current from this external power source whereas the USB connection delivers only regular data and control information.

Bus powered devices, on the other hand, do not have any connections to external power sources. They draw all the necessary current through the USB cables from the hub to which they are connected. However, the maximum current that a single device can draw is limited to 500 mA @ Vbus=5V (thus the total power consumption is limited to 2.5 W). This is, of course, is only possible if the hub is self powered and allows attached devices to pull the mentioned current. To ensure that the mentioned limits are not exceeded a device has to start up in a "low power mode" with a maximum of 100 mA. It then negotiates whether the hub can provide the necessary current or not. It is possible that a desired bus topology is not possible because of certain power / current constraints of the various devices involved. It's within the responsibility of the operating system to notify a user of these conflicts.

There are basically 4 different “Data Types”. These are:

- Isochronous
- Control
- Interrupt
- Bulk

Isochronous (“Equally spaced in time“) Data Transfers are used for devices where data delivery to or from the host is absolutely time critical. These include Audio or Video Conferencing devices where the data is basically “useless” when not delivered in time. Devices that need isochronous data delivery need to negotiate a guaranteed time slot from the host. Once granted, the specific time slot will be reserved whether actual data needs to be transmitted or not.

Control Data is usually not as time critical as audio or video data. For that reason, control data is transmitted “asynchronously”, meaning that it will be transmitted “on demand only”. Control data does not have a guaranteed time slot and can thus experience a delay.

Interrupt data are actually not really interrupts. Since all data traffic has to be initiated by the host, devices don’t have a chance to announce that they need service. Fact is that the host needs to poll the different devices that can generate interrupt data to find out if they need service. The polling mechanism itself can consequently be described as “isochronous” whereas the interrupt data itself will only be transmitted “on demand”, meaning “asynchronously”.

Bulk data is the transfer of a large amount of data. This could be the data transferred to a printer in order to print a postscript or bitmap file. This kind of data transmission is not time-critical and will not be handled using “isochronous” transfer. It will actually be used to “fill” an opening in a time slot during a certain transmission. This means that if the bus is already heavily loaded with isochronous data transfers like audio or video it can take a very long time to print a single page. If there is no load at all on the bus, data rates of about 1 MByte/s can be achieved.

A specific feature of USB devices is that they consist of more than one “real device”. They are for that -APRP is a good example since it can host an audio device as well as a Human Interface Device (HID) used to control the volume, bass and treble. All these specific devices need to negotiate their own special kind of data traffic and their own time slot with the host.

Every single device on the USB can have one or more so-called “Endpoints”. Endpoints are the real “data sources and sinks”. Every device must have at least ONE endpoint (using the internal number ID=0) which is used to communicate with the host. Endpoint zero contains the descriptors that explain the type of device and the data transfer needs to the host. On top of that, a device can have up to 15 more endpoints that communicate using different types of data transfer. Please note that the actual maximum number of endpoints in a system is 127 x 16 = 2032.

1.3 Definitions, Acronyms and Abbreviations

The following explains a number of terms and acronyms that are used in this document.

ADAC	Asynchronous Digital Audio Converter
APRP	Audio Playback Recording Peripheral
ASR	Audio Sample rate Redistributor
DAC	Digital to Analog Converter
CODEC	CODer - DECoder
Descriptor	Group of Registers inside the chip containing descriptive information about the device
Device Class	Collection of devices that share certain properties.
GPIO	General Purpose Input / Output
EEPROM	Electrical Erasable Programmable Read Only Memory
Endpoint	Actual final data sink in a device. Every device has at least one endpoint.
Hub	A USB device that has one upstream connector (towards the Host) and a number of downstream ports (usually between 4 and 7). A Hub Device enhances the number of USB devices (including other hubs) that can be connected to the USB bus. It does not add any further functionality to the bus.
Port	USB connection on a Hub Device, enabling one USB Device (possibly a Hub) to be connected.
USB	Universal Serial Bus
USB-CODEC	All parts of the implementation of the USB-APRP including the hardware and the software/firmware
Windows™ 98	Microsoft® Operating System, upgrade to Windows™ 95.

See additionally the Terms, definitions, acronyms and abbreviations section as given in the USB specification version 1.1 July 1998 for those terms not mentioned in this section.

2. Installing the USB-APRP Evaluation Board

To ensure that the USB-APRP Evaluation Board is working, a number of things have to be checked and possibly adjusted:

- The hardware of the PC you intend to use as a host computer system,
- The version of the operating system that your host computer system is running,
- The version of the firmware inside the chip on the evaluation board.

As pointed out earlier, USB is a new and emerging technology that is continuously developing so that the compatibility between versions is not guaranteed. Continuous efforts of all parties involved has solved many problems before the final version of Microsoft Windows98 was released to the public in June '98. At time of release of this document the proven combination was Windows 98 build 2106 and USB-APRP firmware version 1.1.1.9 (label on top of the uC firmware EPROM) and also it's successor the firmware version 1.1.1.19.

Build version 2106 has many improvements regarding USB implementation vs. USB-APRP which is worth (and in some cases also needed) to install on your PC. Win98 Second Edition (SE) has the improvements of the previous Win98 builds implemented and is currently available to everybody on this globe.

The following paragraphs give details about the installation procedure.

2.1 PC Hardware Requirements

The PC used to install the UDA1335H evaluation board needs to be based on a motherboard that has USB support and on which the USB circuitry is fully assembled. These motherboards first appeared in the second half of 1996 and are now basically standard. Accordingly, chances are that you will find an assembled and enabled USB port on a new computer with a 133 MHz Pentium Processor or better. It is possible that the USB option on the motherboard is assembled but still needs the connectors to the outside to be hooked up (non ATX-type motherboards). These should be available for purchase in computer stores. Most Desktop Systems have two USB ports in the back, newer laptops usually offer one USB port.

2.2 PC Software Requirements

It is necessary that the PC running the USB hardware has the Microsoft® Windows™98 operating system installed. It is thus necessary to look carefully which version is installed and whether it complies with the firmware in the UDA1335H. There should be no problems if you have received a demo board from Philips Semiconductors after beginning of August 1998. The label on the firmware (E)PROM should show a version number higher or equal to 1.1.1.19, which is the same firmware implemented into the UDA1325x / N106 IC's.

2.3 Board Installation

Once it has been checked that the PC operating system and the chip's firmware are compatible, the installation is very simple and intuitive. After all, this is one of the key ideas behind the USB concept.

There are so called "A" and "B" type USB connectors. Every USB cable must have a type A connector on one side and a type B connector on the other. Type "A" connectors are used for "Downstream Ports" (facing away from the host computer - to be found e.g. on the back of a USB equipped desktop computer) whereas type "B" connectors are used on "Upstream Ports" (facing towards the host computer).

Plug the type B connector of a USB cable into the USB port connector on the evaluation board. In case of doubt, just try it, there is only one way to do it. Now connect the other side of the USB cable (the type A connector) into the USB port on the back of your USB enabled computer. It is not necessary to connect any power source to the USB-APRP since the device is bus-powered (meaning that all necessary supplies are provided through the USB cable - please check the jumper setting on the board for correct setting). If you already have other USB devices connected to your system and the usual two USB connectors on your desktop system (one on laptops), you can connect the USB-APRP into a downstream port of any hub device connected to the system.

As soon as the USB-APRP is connected to the system the host is notified of the existence of a new device. The operating system interrogates the new device and makes an attempt to install the necessary software from its internal database. The user will see a number of message boxes that announce the fact that new hardware has been found and that the software for it is being installed.

The evaluation board can operate in bus and in standalone modes. When bus powered, no external power supply is needed, and power from the PC is used. In standalone mode, a 3.3V DC power supply must be used.

A headphone can be directly connected to the evaluation board but it can also be connected to a standard loudspeaker system. In this case it is necessary to connect the "Line out" stereo jack on the evaluation board to the amplifier inputs of a stereo system or a pair of powered speakers.

Remark: You will probably need to have your Windows™ CD in the CD-ROM drive since the operating system will look for the latest drivers in that location. Make sure to have the CD handy.

Since the USB-APRP is a Composite Device - consisting of an Audio Device as well as a HID control device - the installation will happen in stages announcing first the Philips USB System itself, followed by a Composite Device, then a USB Audio Device and finally a HID device. Once all these installations have been successfully completed the USB_APRP should be ready to play audio. An easy way to verify this is to play a wave file through the USB devices (using the "Media Player" application that comes with the operating system). The music should be playing through the speakers attached to the USB-APRP evaluation board.

2.4 In case of problems

The following are a number of common problems that have been observed. Experience shows that they are in most cases related to incompatibilities between different versions of the Windows™ 98 operating system, the USB-APRP drivers and the firmware built into the USB-APRP or wrong mixer volume settings.

One specific check that is generally advisable is to check the entries in the “Control Panel -> System -> System Properties -> General “ section of the Windows™ operating system registry. The different USB devices need to be listed there and should have no remarks (such as exclamation marks or red tags). In case of the USB-APRP, you need to find at least one entry under *System Devices* for the USB Root Hub. Furthermore there should be two entries in the *Sound, Video and Game Controller* section for the USB Audio Device and for the Human Interface Device (which is part of the audio device and used for functions such as volume, bass and treble control).

If you can’t find the mentioned devices or they are tagged as not being fully functional you need to reinstall the USB-APRP or investigate further details (see below).

2.4.1 “USB Device not responding” or “Unknown Device”

This message appears on the screen during the interrogation process when the operating system has detected a new device on the USB but is not able to properly receive a description of the device. Since the OS doesn’t know who the new client is, the necessary software can and will not be installed. There are various ways you can try to solve this:

- Verify once more the Operating System version number and the USB-APRP firmware version number. Make sure that they are compatible. Contact the Philips Semiconductors support if you don’t have enough information or can’t match the versions.
- Make sure that you have the latest drivers from the Window™ 98 CD. If you had an earlier version of the driver installed you will have to explicitly specify that you want newer drivers to be used. You can do so after the fact by checking the driver version in the “Control Panel -> System- > System Properties -> General “ section and then ask to “Update Driver”. You will have to specify the location where these new drivers can be found (this will generally be the Windows™ 98 CD.
- Reboot the host computer system and try again to attach the USB-APRP once the OS is up and running.
- Leave the USB device attached and reboot the host computer system.
- Change the bus topology - if you have been using an extra hub eliminate it. If you didn’t use an extra hub, try and insert a hub into the system now.
- Try and use another port on the host computer system or on the hub (if you are using one). A working port on a hub is frequently indicated through a lit LED.
- Unplug and re-plug the device. Make sure to give the operating system enough time to recognize the new device.

2.4.2 Device is recognized but there is no sound

If the device has been recognized but there is no sound, it is possible that your system audio mixer is at a very low volume or muted. You can check that by accessing the “Programs -> Accessories -> Multimedia -> Volume Control” application on the “Start” Menu. Make sure that the “Wave” and the “Speaker” Devices are not muted and at a reasonable level.

Should this not help, it is possible that you still have an old ‘legacy” sound card in your system (which might not be hooked up to speakers or an amplifier anymore). Please refer to the following section 2.4.3 how to handle this case.

2.4.3 Sound is still coming from the ‘old legacy’ sound system

If you installed the USB-APRP evaluation board on a computer system that already had a sound card (e.g. a Soundblaster™ type system or similar) installed, it is possible that the sound still plays through the old channels instead of the new USB system. It is in this case necessary to change the routing inside the Windows ™ operating system. This can be done in the “Settings -> Control Panel -> Multimedia” section under the Audio tab in the “Preferred Device” slot. Choose the USB Audio System as your playback device.

The other (more radical) possibility is to delete the “legacy” audio device from the computer system. -> System -> System Properties -> Device Manager” dialog box. Select the device(s) by clicking the right mouse button on them and choose “Delete”. You will be prompted whether you really want to permanently delete the specific device from the system. Boldly answer “Yes” (you can always reinstall it later if you have to).

Once all the “legacy” audio devices are deleted, try again to see if the USB Audio Device now plays your audio. If this is still not the case you might need to reboot the system. When the system is powered down it is a good time to remove the “legacy” hardware from your system. Should you decide not to remove the hardware and your hardware is Plug’n’Play compatible your system will detect the “legacy” sound card again and will prompt you to install drivers for it. In this case it is necessary that option. Otherwise the device(s) will be installed again.

2.4.4 Recording doesn’t work or the sound quality of recorded data is bad

To evaluate the recording capabilities of the device it is necessary to connect a suitable device to the device’s input. This could for example be the analog stereo output of a CD player.

Note : Due to a layout error the two input jacks on the UDA1335H evaluation board are unfortunately mislabeled as “Left Input” and “Right Input”. Both inputs are actually stereo inputs of which one is used as a “Line Input” (Right Input) while the other one serves as a “Microphone Input” (Left Input). If you are e.g. using the mentioned CD Player as an input source make sure to use the “Right Input”.

Another possibility for no input signal during recording is that the USB-APRP has not been selected as the preferred input device. This can be changed in the “Settings->Control Panel -> Multimedia” section under the Audio tab in the “Preferred Device” slot. Choose the USB Audio System as your recording device.

If you are using a recording program other than the ‘standard’ Windows 98 programs (e.g. Syntrillium CoolEdit or SoundForge) you might as well have to change the settings inside the program rather than in the Control Panel. This can usually be done in the ‘Options’ menu of the software package. Look around for a possibility to adjust the hardware settings and select the USB device in there.

If you have a recording signal from the USB-APRP but the sound quality is really bad (e.g. a lot of noise with some feeble sound in the background consider the following:

- Try to connect your source to the other input jack.
- Change the recording format in your recording software. A setting of 8kHz, 8-bit, mono will certainly disappoint you if you are hoping for CD quality. We recommend to start with 44.1 kHz, 16 bit, stereo. This is equivalent to CD quality and should give you a good representation of whatever your input source may be.

2.4.5 Known bugs on the current evaluation board

Here is a list of known bugs on the corresponding version of evalution / demo boards:

Board version 1.4 :

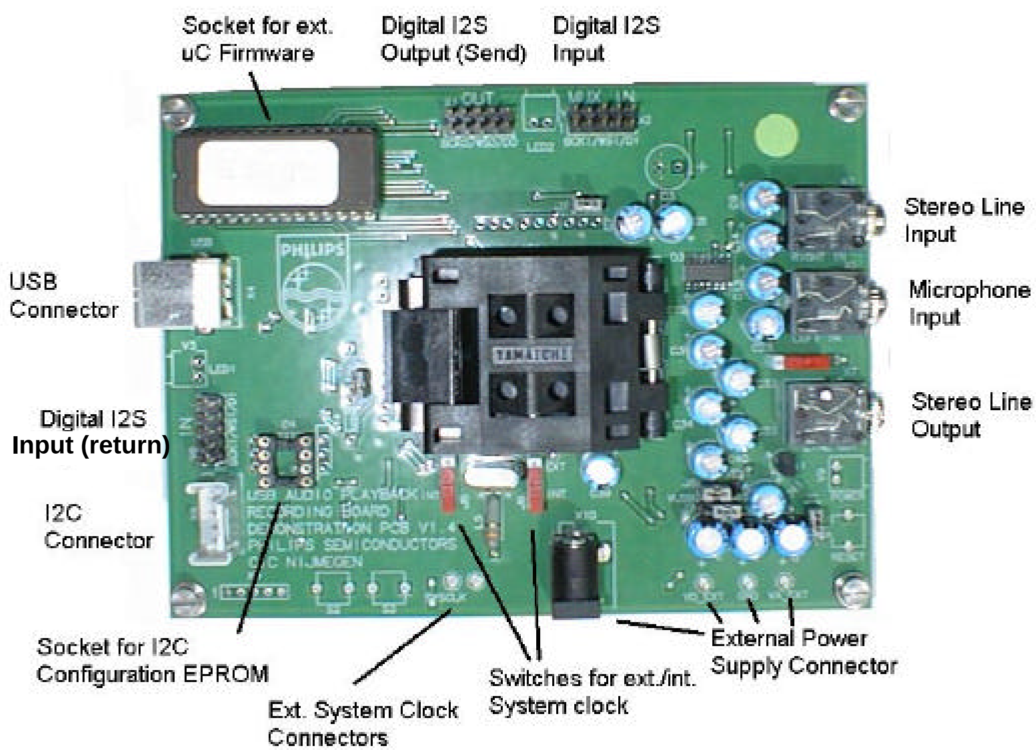
- Instead of GP3 and GP4, GP0 and GP3 are connected for selecting an internal map.
- R9 and R11 are implemented which should be removed.
- The left-and right utputs are mixed-up at the jack-connector.

Board version 1.5 :

- The anode of V4 is connected to header X6 at the BCKI pin. GP0 should be connected instead.
- C41 should be < 2 uF instead of 47uF.
- The Disconnect/Connect circuit has been revised, the new proposed circuit is **not** implemented on v1.5 of the demoboard. Ask your local FAE for the report **REP0021.PDF** or check the USB-AUDIO website for this file to utilize the latest circuit in your own USB-APRP design. Read the report to understand why & how to use the new proposed solution.

3. Hardware Description

The following shows a descriptive Photograph of the USB-APRP evaluation / demo board:



3.1 Input and Output Connectors

The UDA1335H Evaluation Board has the following connectors:

1	USB Type B Input Connector	Connects the boards upstream port to a downstream port on the bus (e.g. a hub device).
2	Mini Stereo Jack for Analog Audio Output	Connects the right and left analog output signals to an audio amplifier.
3	2x Mini Stereo Jack for Analog Audio Input	Connects the right and left analog input signals of a sound source to the system recording path.
4	DC Voltage Adapter*	External supply of an external DC Voltage.

3.2 Jumpers, Headers and Switches

1	J1*	Jumper for Selector	Selects GP-pin controlled selection of terminal or default (Line IN) if jumper is removed.
2	J2*	Jumper Startup circuit	Selects whether the startup-circuit is active or not. Escpecially if 6-pins communication is configured, this jumper should be removed.
3	J3*	Jumper Ext./ Int. ROM	Selects whether the device boots from the internal ROM (floating or Vdd) or from the external (E)PROM (Grounded).
4	J4*	Jumper for Multiple write-mode	Only if ST24C16 is used, it is possible to enable set the multiple writing mode of the EEPROM. If not used set to GND.
5	J5*	Jumper Ext./ Int. System clock	Selects whether the device is running from the on-board crystal or of an external system clock by disconnecting the crystal.
6	J6*	same as J2	Other side of the crystal oscillator
7	J7*	Jumper 5V or 3.3V	Selects whether VD+ is on 5V or 3.3V.
8	J8*	Jumper Ext. / Int. Power	Selects whether device is self- or bus-powered
9	J9*	Jumper Ext. / Int. Power	Selects whether device is self- or bus-powered
10	X1	10-pin Header	Provides Digital Audio (I2S) Output signals to interface e.g. to an external DSP
	X2	10-pin Header	Provides Digital Audio (I2S) Input signals to interface e.g. to an external DSP or I2S source.
11	X4	4-pin Header	Provides USB communication with USB - host.
12	X6	10-pin Header	Provides Digital Audio (I2S) Input signals to interface e.g. to an external DSP.
13	X8	4-pin Header	I2C signal SDA and SCL
14	X9*	5-pin Header	Test signals SHTCB, RTCB, TC
15		2-pin Header	To feed in an external SYSCLK signal
16	X10*	3 pins	To feed in 5.0 Volt or 3.3 Volts from an external power supply.
17	S1*	Reset Switch	“Hard” resets the USB-CODEC, for test-puposes ONLY.

3.3 Chip pin out

The following table describes the pins of the QFP64 versions of the UDA1335H / UDA1325H :

Name	Pin QFP64	I/O	Pin Description
GP3/WSO	1	I/O	General purpose pin 3 word select output
GP4/BCKO	2	I/O	General purpose pin 4 bit clock output
P0.5	3	I/O	port 0.5 of the microcontroller
SHTCB	4	I	shift clock of the test control block (active high)
P0.6	5	I/O	port 0.6 of the microcontroller
D-	6	I/O	Negative data line of the differential data bus
P0.7	7	I/O	port 0.7 of the microcontroller
D+	8	I/O	Positive data line of the differential data bus
V_{DDI}	9	-	digital supply voltage for core
V_{SSI}	10	-	digital ground for core
V_{SSE}	11	-	digital ground for I/O pads
V_{DDE}	12	-	digital supply voltage for I/O pads
GP1/DI	13	I/O	General purpose pin 1 or data input
P2.0	14	I/O	port 2.0 of the microcontroller
GP5/WSI	15	I/O	General purpose pin 5 or word select input
P2.1	16	I/O	port 2.1 of the microcontroller
GP0/BCKI	17	I/O	General purpose pin 0 or bit clock input
P2.2	18	I/O	port 2.2 of the microcontroller
SCL	19	I/O	serial clock line I^2C-bus
P2.3	20	I/O	port 2.3 of the microcontroller
SDA	21	I/O	serial data line I^2C-bus
P2.4	22	I/O	port 2.4 of the microcontroller
P2.5	23	I/O	port 2.5 of the microcontroller
V_{SSX}	24	-	crystal oscillator ground (48MHz)
XTAL1b	25	I	crystal input (analog; 48MHz)
XTAL2b	26	O	crystal output (analog; 48MHz)
CLK	27	O	48mhz clock output signal
V_{DDX}	28	-	supply crystal oscillator (48MHz)
P2.6	29	I/O	port 2.6 of the microcontroller
P2.7	30	I/O	port 2.7 of the microcontroller

PSEN	31	I/O	Program Store Enable (active LOW)
V_{DDO}	32	-	Supply voltage for OPAMP
V_{SSO}	33	-	OPAMP ground
VOUTL	34	O	Voltage output left channel
TC	35	I	test control input (active HIGH)
RTCB	36	I	asynchronious reset input of the test control block
VOUTR	37	O	voltage output right channel
V_{DDA1}	38	-	analog supply voltage 1
V_{SSA1}	39	-	analog ground 1
$V_{ref(DA)}$	40	O	reference voltage output DAC
$V_{ref(AD)}$	41	O	reference voltage output ADC
V_{DDA2}	42	-	analog supply voltage 2
VINL	43	I	input signal left channel PGA
V_{SSA2}	44	-	analog ground 2
n.c.	45	-	not connected
n.c	46	-	not connected
VINR	47	I	input signal right channel PGA
EA	48	-	external access (active LOW)
VRN	49	I	negative reference input voltage ADC
ALE	50	-	address latch enable (active HIGH)
VRP	51	I	positive reference input voltage ADC
V_{DDA3}	52	-	supply voltage for crystal oscillator and analog PLL
XTAL2a	53	O	crystal output (analog; ADC)
XTAL1a	54	I	crystal input (analog; ADC)
V_{SSA3}	55	-	crystal oscillator and analog PLL ground
P0.0	56	I/O	port 0.0 of the microcontroller
DA	57	I	data input (digital)
P0.1	58	I/O	port 0.1 of the microcontroller
WS	59	I	word select input (digital)
P0.2	60	I/O	port 0.2 of the microcontroller
BCK	61	I	bit clock input (digital)
P0.3	62	I/O	port 0.3 of the microcontroller
GP2/DO	63	I/O	general purpose pin 2 or data output
P0.4	64	I/O	port 0.4 of the microcontroller

Pins only found on the QFP64 package (UDA1335H)

Name	Pin QFP64	I/O	Pin Description
P0.0	56	**I/O**	µC Data Port 0, Pin 0
P0.1	58	**I/O**	µC Data Port 0, Pin 1
P0.2	60	**I/O**	µC Data Port 0, Pin 2
P0.3	62	**I/O**	µC Data Port 0, Pin 3
P0.4	64	**I/O**	µC Data Port 0, Pin 4
P0.5	3	**I/O**	µC Data Port 0, Pin 5
P0.6	5	**I/O**	µC Data Port 0, Pin 6
P0.7	7	**I/O**	µC Data Port 0, Pin 7
P2.0	14	**I/O**	µC Data Port 2, Pin 0
P2.1	16	**I/O**	µC Data Port 2, Pin 1
P2.2	18	**I/O**	µC Data Port 2, Pin 2
P2.3	20	**I/O**	µC Data Port 2, Pin 3
P2.4	22	**I/O**	µC Data Port 2, Pin 4
P2.5	23	**I/O**	µC Data Port 2, Pin 5
P2.6	29	**I/O**	µC Data Port 2, Pin 6
P2.7	30	**I/O**	µC Data Port 2, Pin 7
/EA	48	**I/O**	External access (active low)
/PSEN	31	**I/O**	Program Store Enable (active low)
ALE	50	**I/O**	Address Latch Enable (active high)

3.4 Schematics

Only version 1.5 is available in electronic file (PDF) format and can be requested from your local Philips FAE. Version 1.4 boards are no longer supported.
See also chapter References for the URL address to download the schematic from the Philips USB-AUDIO internet-webpage.

3.5 List of Active Components

3.5.1 Integrated Circuits

Name	Description	Remark
IC1	USB-APRP UDA1335H QFP64 package	
D1	74HCT373D	
D2	Socket to be used with EPROM for external µController code	suggested EPROM's are EEPM27128 or AM27C128-120
D3	HEF4066 bilateral switch	Not for HIGH-END audio.
D4	Socket for external EEPROM	(not stuffed)
D5	LK115033 or ZR78L033	Voltage Regulator 3.3V

3.5.2 Transistors & LED's

Name	Value	Description	Remark
V1*		LED2, status GP2	
V2		Selector transistor	BC848B
V3*		LED1, status GP1	
V4		Diode matrix, GP3	
V5		Diode matrix, GP4	
V6		Startup circuitry transistor	BC848B
V7		Startup circuitry transistor	BC848B
V8		Startup circuitry transistor	BC858B
V9*		LED3, Stabilisator power status	

3.6 List of Passive Components

The following table gives a list of all active and passive components used on the UDA1335H evaluation board. Please note that the components marked with an asterisk (*) in the following and previous tables are for test purposes only and will not be required in a final application.

3.6.1 Resistors

Name	Value	Description	Remark
R1*	1k	Serial resistor for current limitation	
R2	1k	Voltage devider for VD1	
R3*	22k	Pull-up resistor for GP4	
R4	22k	Pull-up resistor for RIGHT IN	
R5	1k	Voltage devider for VD1	
R6	22k	“Memory” resistor for RIGHT IN, mic IN	
R7	22 Ω	Serial resistor for current limitation to D-	
R8	1 Ω	EMC related series resistor	
R9*	100k	for test purpose	Not on board v1.5
R10	1 Ω	EMC related series resistor	
R11*	100k	for test purpose	Not on board v1.5
R12	22k	Base resistor for V2	
R13	22k	Collector resistor for V2	
R14	22k	“Memory” resistor for RIGHT IN, line IN	
R15	22k	“Memory” resistor for LEFT IN, mic IN	
R16	22 Ω	Serial resistor for current limitation to D+	
R17	1 Ω	EMC related series resistor	
R18*	0 Ω	Short-circuit to ground for pin SHTCB	
R19	22k	“Memory” resistor for LEFT IN	
R20	22k	“Memory” resistor for LEFT IN, line IN	
R21*	1k	Serial resistor for current limitation	
R22	22k	For startup circuit	
R23	22k	For startup circuit	
R24	22k	For startup circuit	
R25	1 Ω	EMC related series resistor	
R26	1 Ω	EMC related series resistor	
R27	1 Ω	EMC related series resistor	

R28	4k7	Pull-up resistor for /EA pin	
R29	1 Ω	EMC related series resistor	
R30	22k	For startup circuit	
R31	22k	For startup circuit	
R32*	0 Ω	Short-circuit to ground for pin TC	
R33*	0 Ω	Short-circuit to ground for pin RTCB	
R34	10k	Pull-down for VoutR	
R35	1 Ω	EMC related series resistor	
R36	10k	Pull-down for VoutL	
R37	100 Ω	Output resistance Right	
R38	10k	Pull-up resistor for I2C SCL line	
R39	10k	Pull-up resistor for I2C SDA line	
R40	1k5	Startup Circuitry	
R41	22k	Startup Circuitry	
R42	22k	Startup Circuitry	
R43	1 Ω	EMC related series resistor	
R44	100 Ω	Output resistance Left	
R45*	1k	Serial resistor for current limitation	
R46	47 Ω	System clock input series resistor	
R47	10k	Pull-up resistor for GP0.	

3.6.2 Capacitors

Name	Value	Description	Remark
C1	100nF	DC Filtering/ Smoothing capacitor	63 Volt
C2	100nF	DC Filtering/ Smoothing capacitor	63 Volt
C3	100μF	DC Smoothing capacitor	16 Volt
C4	100nF	DC Filtering/ Smoothing capacitor	63 Volt
C5*	18pF	External Oscillator capacitor	63 Volt
C6*	18pF	External Oscillator capacitor	63 Volt
C7	47μF	DC Filtering/ Smoothing capacitor	16 Volt
C8	47μF	Input DC coupling Right	16 Volt
C9	47μF	Input DC coupling Right, mic IN	16 Volt
C10	22pF	Rise/fall time adjustment & impedance matching on D-	63 Volt
C11	100nF	HF supply filtering capacitor for pin Vrp	63 Volt

C12	100nF	DC Supply filtering capacitor for HEF4066 switch	63 Volt
C13	47µF	Input DC coupling Right, line IN	16 Volt
C14	47µF	Input DC coupling Left, mic IN	16 Volt
C15	10nF	HF-filter for USB-cable shield.	63 Volt
C16	100nF	DC Supply filtering capacitor for USB (+5V)	63 Volt
C17	22pF	Rise/fall time adjustment & impedance matching on D+	63 Volt
C18	100nF	HF supply filtering capacitor for pin VDDX	63 Volt
C19	100nF	HF supply filtering capacitor for pin VDDA3	63 Volt
C20	100nF	HF filtering capacitor for Reference voltage (AD)	63 Volt
C21	100nF	HF supply filtering capacitor for pin VDDA2	63 Volt
C22	47µF	Input DC coupling Left	16 Volt
C23	47µF	Input DC coupling Left, line IN	63 Volt
C24	100nF	HF supply filtering capacitor for VDDI	63 Volt
C25	100nF	HF supply filtering capacitor for VDDI	63 Volt
C26	100nF	HF supply filtering capacitor for VDDE	63 Volt
C27	100nF	HF supply filtering capacitor for VDDE	63 Volt
C28	100nF	HF supply filtering capacitor for VDDX	63 Volt
C29	100nF	HF filtering capacitor for Reference voltage (DA)	63 Volt
C30	12p	HF supply filtering capacitor for VDDA1	63 Volt
C31	47µF	DC smoothing capacitor for Reference voltage (AD)	16 Volt
C32	47µF	DC smoothing capacitor for VDDA2	16 Volt
C33	47µF	DC smoothing capacitor for VDDO	16 Volt
C34	47µF	DC smoothing capacitor for VDDA1	16 Volt
C35	47µF	Output AC coupling Right	16 Volt
C36	100nF	HF supply filtering capacitor for EEPROM	63 Volt
C37	12pF	Filter capacitor for 3rd overtone crystal	50 Volt
C38	12pF	Filter capacitor for 3rd overtone crystal	63 Volt
C39	47µF	HF supply filtering capacitor for pin VDDO	16 volt
C40	47µF	Output AC coupling Left	16 Volt
C41	47µF	DC Filter capacitor for Reference voltage (DA)	16 Volt
C42	100nF	HF supply filtering capacitor for 3.3V stabilisator	50 Volt
C43	100nF	HF supply filtering capacitor for 3.3V stabilisator	50 Volt
C44	10nF	Filter capacitor for 3rd overtone crystal	50 Volt
C45	100µF	DC smoothing capacitor for +VD	16 Volt
C46	100µF	DC smoothing capacitor for +VC	16 Volt

C47	100µF	DC smoothing capacitor for +VA	16 Volt

3.6.3 Inductors

Name	Value	Description	Remark
L1		4 inductors in one 8-pins package, EMI countermeasure	TDK ZJY-M4A
L2		Ferrite bead for FCC rule compliance	BLM32A07
L3		Ferrite bead for FCC rule compliance	BLM32A07
L4		Ferrite bead for FCC rule compliance	BLM32A07
L5	1.5µH	Oscillator inductor (3rd overtone)	
L6		Ferrite bead for FCC rule compliance	BLM32A07
L7		Ferrite bead for FCC rule compliance	BLM32A07
L8		Ferrite bead for FCC rule compliance	BLM32A07

3.6.4 Crystal Oscillators

Name	Value	Description	Remark
B1	48MHz	3rd Overtone Crystal for Oscillator Circuit	*Klove*

4. References

More information on the different topics can be found in the following publications:

[1] UDA1335H specification

[2] USB-Specification version 1.0 and version 1.1

[3] USB Device Class Definition for Audio Devices

[4] USB Human interface Device Class specification

[5] USB Human Interface Device Class Usage Table

A lot of the above and additional useful information can further be found on the following Internet web site that is fully dedicated to USB support and information:

http://www.usb.org

For downloading the latest documents, software tools and more, please regularly check our USB-AUDIO website:

http://www.semiconductors.philips.com/usb/products/audio/

5. In case of Problems

Should you still experience problems in operating the Philips Semiconductors UDA1335H demonstration board, we recommend that you get into contact with your local Philips Semiconductors Field Applications Engineer. The local Philips FAE will be able to help you to get your system up and running.