Burr-Brown Products
from Texas Instruments

Application Note

Usage and Notice for USB Interface Audio Products, PCM270x, PCM290x/290xB, PCM2912/2912A

This application note provides general or technical information about usage, notice and board design for USB DAC, USB CODEC which enables audio signal output from PC or audio signal input to PC through USB Interface, which is standard interface on Windows and Mac OS.
This application note describes following issues listed below for USB DACs, PCM2702, PCM2704/5/6/7 and USB CODECs, PCM2900/1/2/3/4/6, PCM2900B/2B/3B/6B, PCM2912, PCM2912A.

TEXAS INSTRUMENTS

1. Operation Confirmed Environments (Chipset & OS)

All USB DACs (PCM270x), USB CODECs (PCM290x/290xB, PCM2912/2912A) do not require dedicated device driver, they can basically operate with standard USB driver with Audio and HID class driver which is provided by OS, including the Windows 98 SE/ME, 2000, XP, Vista and Mac OS V 10 and after.

In specific, the right operation has been confirmed on PC environments (Chipset & OS) listed on the Appendix 1. This means that the right operation has been actually confirmed on PC which is configured with listed environments, but it does not mean that right operation is assured for all PCs which are configured with listed environments. Also, it does not mean no work on unlisted environments, the right operation is expected on almost unlisted environments.

Applying newer environments (Chipset & OS) as possible as they can be is recommended as there might be some possibility of inconvenience or bug on some older version of chipset & OS.

Also, it should be considered that there is some possibility of error or undesirable response in device recognition and operation on the environments in which install or uninstall of driver or application have been repeated. The verification (confirmation of operation) is recommended using other PCs or PC after clean install of OS (OS install after formatting of hard disk) and removing unnecessary application and peripherals.

Regarding operation under Linux, there is no PC environments which are verified by ourselves, as there is no reference for OS and driver. But it does not mean no work under Linux, the right operation is expected on almost Linux environments if OS/driver would be based on USB specification. For further more, refer to http://www.linux-usb.org/.

2. Operation Confirmed Application

The proper operation of following applications has been confirmed on one of previously discussed environments in actual. (It does not mean that unlisted applications can not run on them.)
It does not mean that all functions which application provides are verified, but operation of basic audio and HID function related with USB has been confirmed.

- Windows Media Player (Microsoft)
- Sound Recorder (Microsoft)
- CD Player (Microsoft)
- QuickTime Player (Apple)
- Real Player (Real Networks)
- Shockwave Player (Macromedia)
- Flash Player (Macromedia)
- Audacity (audacity.sorceforge.net)
- Adobe Audition 3 (Adobe Systems)
- Sound it 5 (Internet)

3. USB General Information

This section describes the basic key words which are required for explanation and discussion in next or after section. This section can be skipped if you would have basic knowledge about USB interface, and for further information, usb11 or usb20 are available through following URL.

http://www.usb.org/home
http://www.usb.org/developers/docs/

3.1 Bus-Powered / Self-Powered

The power supply style of electric power for USB products. The style which V_{BUS} of USB cable supplies power for products is Bus-powered, and the style which local power unit supplies power for products is Self-powered.
There are two types products, one is fixed for either style, another is selected by pin setting.

3.2 Isochronous data transfer

One of the data transfer type which is applied to an Audio data or Video data. The data packet is transferred with pre-determined format, speed and without error detection and correction for transferred data, and it is basically different from other (Control, Interrupt, Bulk) data transfer types.
It is applied to an Audio data, Video data etc. which require real time processing.

3.3 Plug and Play

One of the useful feature or function of USB Interface which supports Run/Ready of application by just plugging. The application or application environment is established through device recognition and device driver loading if necessary by plugging USB products in power to host PC in power.

3.4 USB 2.0 and USB 1.1

The version of documents which describe the specification of USB interface. The USB 1.1 specifies interface of Low speed 1.5Mbps and Full speed 12Mbps, meanwhile the USB 2.0 specifies interface of High speed 480Mbps in addition to former two options.
All released USB DACs and CODECs, which are listed up in this note, have been certified to either of “USB 1.1 Compliant” or “USB 2.0 Compliant” except for USB1.0 of PCM2702, according to time of their development and application to compliance test, because they are developed under USB 1.1 and their descriptor is “USB 1.1”. All “USB1.x Compliant” products can be connected with USB 2.0 host controller, as USB 2.0 specification includes USB1.x specification, i.e. USB 2.0 specification for Low/Full Speed is as same as USB1.1 specification.

3.5 Device Driver

In general, the devices or equipments which are newly connected with PC require device driver for operation. There are two cases, one is newly device driver is required, another is already installed device driver can be used.
All USB DACs, PCM270x and USB CODECs, PCM290x/290xB, 2912/2912A can operate with standard device driver which is generally installed in standard OS.

3.6 Audio Class

The specification for devices/products which are categorized as Audio Device that deals with audio data processing or input/output. The Function, Transfer mode, Sampling rate, Data format, Volume control, Mute control, etc. are specified, and all USB DACs and CODECs are based on the description of Audio class 1.0.

3.7 HID Class

The specification for devices/products which are categorized as HID (Human Interface Device), and KB (Key Board), Mouse, etc. are applicable products. A part of USB DACs and CODECs have key input or equivalent function for Volume control, Mute control, etc., which are audio functions they have, and HID class is applied to this added HID function.

3.8 Descriptor

The group of described information which specifies property of USB device (PCM270x, PCM290x etc.), this information including listed below is sent to host PC in reply to request form PC just after USB cable is attached.
The host PC can know the property of connected device/product by this information, and it makes PC enable to load device driver, and/or other processing after that if required.
A part of these descriptors can be changed for some products as described in Section 4 and Appendix 2.

- Device Descriptor (Vendor ID, Product ID, etc.)
- Configuration Descriptor (Power Attribute, Max Power)
- Strings Descriptor (Vendor Strings, Product Strings)
- Other information which is specified for each device class or category

3.9 Synchronous Transfer

The data transfer type in which data transfer is performed with clock speed of USB (PC) side, number of data packet per 1ms is constant, and data reproduction speed depends on clock accuracy of USB (PC) side.

3.10 Asynchronous Transfer

The data transfer type in which data transfer is performed with local clock speed, which is independent from USB (PC) side, and the number of data packet per 1ms is not constant.

3.11 Adaptive Transfer

The data transfer type in which data transfer is performed with average clock speed which is determined by the number of data packet in long term.

4. Descriptor Change

All USB DACs and CODECs except for PCM2702 can be changed some part of its Device descriptor, Configuration descriptor and Strings descriptor by the way listed below.
But this change requires that the customer has own Vendor ID which is assigned from USB implementers forum.

4.1 Changeable Descriptor

- Vendor ID, Strings
- Product ID, Strings
- Power Attribute, Max Power

4.2 Change Method

External ROM	: PCM2704/6 (The details are described in PCM2704/5/6/7 Data Sheet)
SPI Port	: PCM2705/7 (The details are described in PCM2704/5/6/7 Data Sheet)
Mask Option	: PCM2704/5/6/7, PCM2900/1/2/3/4/6, PCM2900B/2B/3B/6B, PCM2912, PCM2912A

The details of descriptor change by mask option are described in Appendix 2, but most latest one might be revised after this document would be released.

5. USB DAC & CODEC Product Selection

5.1 USB Products Selection Table

Table for product selection which are classified based on USB function, Power configuration, HID function, Optional function (SPDIF, I2S, SPI, Ext ROM, etc.) is shown below.

USB	DAC/ CODEC	Product	Package	Bus/ Self	Analog Out/In	SPDIF	HID	I2S	ROM/ SPI
USB 1.0	DAC	PCM2702	28 SSOP	Self	Line/				
USB 1.1	DAC	PCM2704	28 SSOP	Bus/Self	HP/	OUT	3 pins		ROM
		PCM2705	28 SSOP	Bus/Self	HP/	OUT	8 via SPI		SPI
		PCM2706	32 QFP	Bus/Self	HP/	OUT	7 pins	IN/OUT (2)	ROM
		PCM2707	32 QFP	Bus/Self	HP/	OUT	8 via SPI	IN/OUT (2)	SPI
USB 1.1	CODEC	PCM2900 (3)	28 SSOP	Bus	Line/Line		3 pins		
		PCM2901 (3)	28 SSOP	Self	Line/Line		3 pins		
		PCM2902 (3)	28 SSOP	Bus	Line/Line	IN/OUT	3 pins		
		PCM2903 (3)	28 SSOP	Self	Line/Line	IN/OUT	3 pins		
		PCM2904 (3)	28 SSOP	Bus (500)	Line/Line		3 pins		
		PCM2906 (3)	28 SSOP	Bus (500)	Line/Line	IN/OUT	3 pins		
USB2.0	CODEC	PCM2912 (4)	32 QFP	Bus	HP/Mic				
USB2.0	CODEC	PCM2900B	28 SSOP	Bus	Line/Line		3 pins		
		PCM2902B	28 SSOP	Bus	Line/Line	IN/OUT	3 pins		
		PCM2903B	28 SSOP	Self	Line/Line	IN/OUT	3 pins		
		PCM2906B	28 SSOP	Bus (500)	Line/Line	IN/OUT	3 pins		
USB2.0	CODEC	PCM2912A	32 QFP	Bus	HP/Mic				

Note:

(1) Blank means “Not Applicable”.

(2) IN/OUT does not mean independent I2S Input and I2S Output, I2S input is limited in Data Input with clock of I2S Output, and I2S Output is data from PC/USB and I2S Input is data to DAC of PCM2706/7.

(3) PCM290x is recommended to be transferred to PCM290xB (PCM2903 and PM2906 cover PCM2901 and PCM2904, respectively)

(4) PCM2912 is recommended to be transferred to PCM2912A

5.2 Available Products for Typical Application

- USB Speaker, Headphone
  PCM270x
- USB Hand Set, Head Set
  PCM290xB, PCM2912A
- LCD Monitor with Audio
  PCM290xB, PCM2912A
- Video Conference System
  PCM290xB, PCM2912A
- Noise Cancellation System
  PCM290xB, PCM2912A
- USB to I2S Convertor
  PCM2706/7
- USB to/from S/PDIF Convertor
  PCM270x, PCM290xB

6. Known Bug or Issue

6.1 Inter-Channel Phase Difference (PCM290x)

Following issue has been confirmed in the data transfer between PCM2900/1/2/3/4/6 and host PC.

- One sample delay on Rch data for upstream data from ADC or S/PDIF in to PC,
- One sample delay on Lch data for downstream data from PC to DAC and S/PDIF out,

There is one sample phase error between Lch and Rch for host data ↔PCM290x In/Out data, this phase error is cancelled for data which pass both direction paths, ie. ADC→PC→DAC path or DAC→PC→ADC path.

Recording or playback of general audio or S/PDIF In/Out of Linear PCM makes minimal difference to the listener, and no problem in general. However, the critical application for the inter-channel phase difference, data transfer between USB and S/PDIF In/Out, can not be used. This issue can not be avoided by any condition change of application, and software patch for driver or application is only way for solution.

As this issue has been fixed on PCM290xB, transfer to PCM290xB is recommended.

6.2 1-kHz Noise During 16 kHz, 16 bits, Mono mode Recording (PCM290x)

Incomplete data transfer, which may result in 1-kHz noise on the transferred audio data, has been confirmed for the alternative setting condition (“0A”, “0B”, “0”C”, “0D”, “0E”) of streaming data-in (ADC, S/PDIF in -> Host PC) during recording.

As 8-bit data transfer request, the setting of “0B”, “0”C”, “0D”, “0E”, from the application software is automatically changed to a sampling condition of 48 kHz, 16 bits, stereo in application software using a standard API and working on a standard Windows™ system, only the ”0A” (16 kHz, 16 bits, Mono mode) setting causes the noise problem in actual.

There is a 5% probability that the condition will appear at the start of a recording; however, it depends on the sampling conditions.

It is impossible to solve this problem by any modification of external circuit, the user must apply the setting other than ”0A” to avoid the problem in application software, or must apply filter driver provided on Web shown below;

PCM290x USB Audio Filter Driver Installation Software from http://focus.ti.com/docs/prod/folders/print/pcm2900.html

As this issue has been fixed on PCM290xB, transfer to PCM290xB is recommended.

6.3 Exceeding Max-Packet Size (PCM290x, PCM2912)

Pop noise at irregular timing, intermittent continuous noise, or L/R channel inverse during recording has been observed, though the frequency of it is very low between several hours and days depending on environment.

It has been already confirmed that the root cause of these problems is PCM29xx’s data sending over the "Max-Packet Size" defined by the descriptor contents. Observed phenomena are,

1. Pop noise at irregular timing: Under Windows XP/Vista, and Mac OS X
2. Intermittent continuous noise: Under Mac OS X V10.5
3. L/R inverse: Under Windows XP/Vista

A specific solution/workaround has not been identified by any external circuit modification or change in software settings, but reducing common mode noise to the products has some effect of reducing the frequency of it.

As this issue has been fixed on PCM290xB/PCM2912A, transfer to PCM290xB/PCM2912A is recommended.

6.4 Continuous Noise for Momentary Illegal Data Packet (PCM2702)

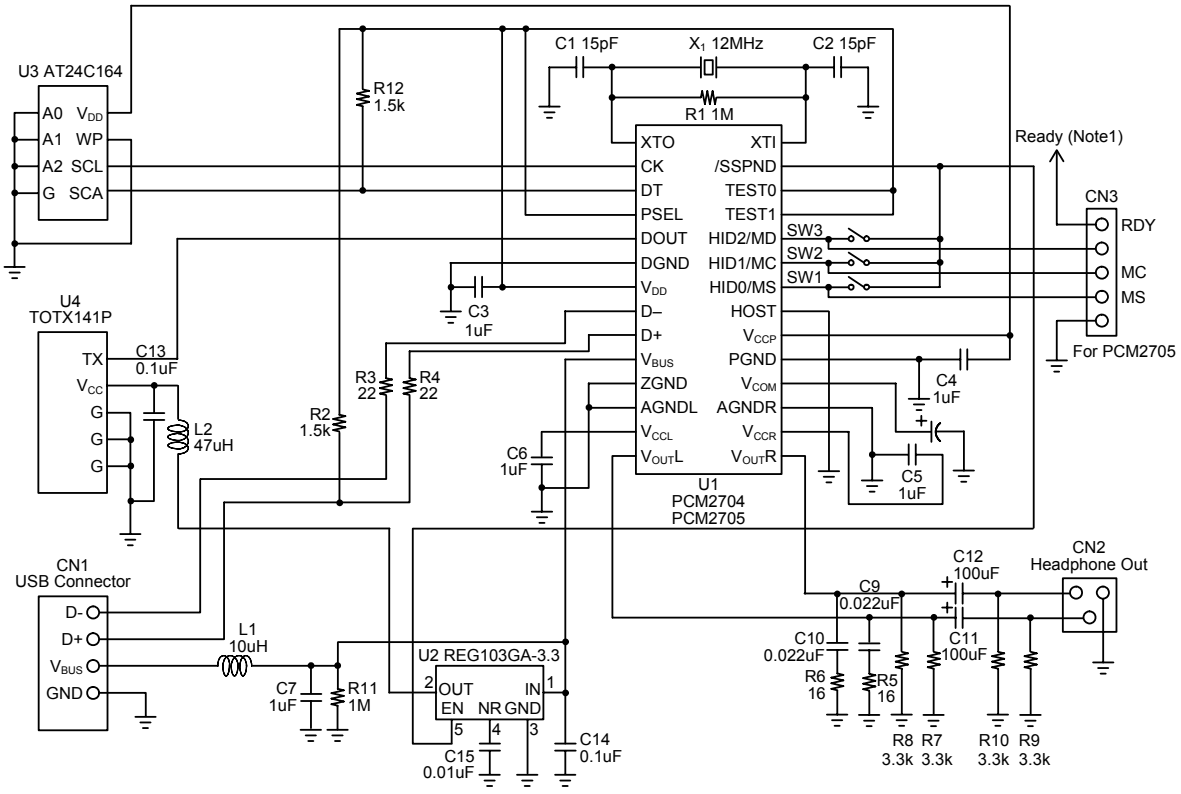
An issue that illegal data with fragment error from host PC makes continuous wrong data transfer until data transfer is once closed has been confirmed, though the issue has been limited on specific Chip set & OS.

It has been confirmed that the root cause is no ability of abnormal detection and correction for data from host PC, and there is no way of solving by hardware or software condition change of application.

All USB products except for PCM2702 have been improved in robustness against illegal data transfer, and the influence on following data transfer has been minimized.

7. Application Circuit Example

7.1 PCM2704/05 Bus-Powered (100mA) Headphone Output with Optical S/PDIF Output



The application example of PCM2704/2705 for bus-powered headphone output with optical S/PDIF output and with descriptor change capability through EEPROM (PCM2704) or SPI (PCM2705).

Descriptor change is supported only for HOST = High, and if descriptor change is not needed, EEPROM U3 and SPI connection via CN3 are not required. Power supply for general EEPROM can be supplied through V_{CCP} of PCM2704 if supply current is less than 10mA. If optional S/PDIF output is not needed, TOTX141P U4 and regulator U2 are not required. Regulator U2 must have driving capability more than 100mA and enable/disable control function for limiting total supply current during suspend state.

For controlling inrush current, C3/4/5/6 must be less than 10µF in total. Also, power source for PCM2704 HID function control should be supplied through /SSPND pin for limiting supply current during suspend period, and no external resistor and open state is allowed as HID pins have built-in pull-down resistors.

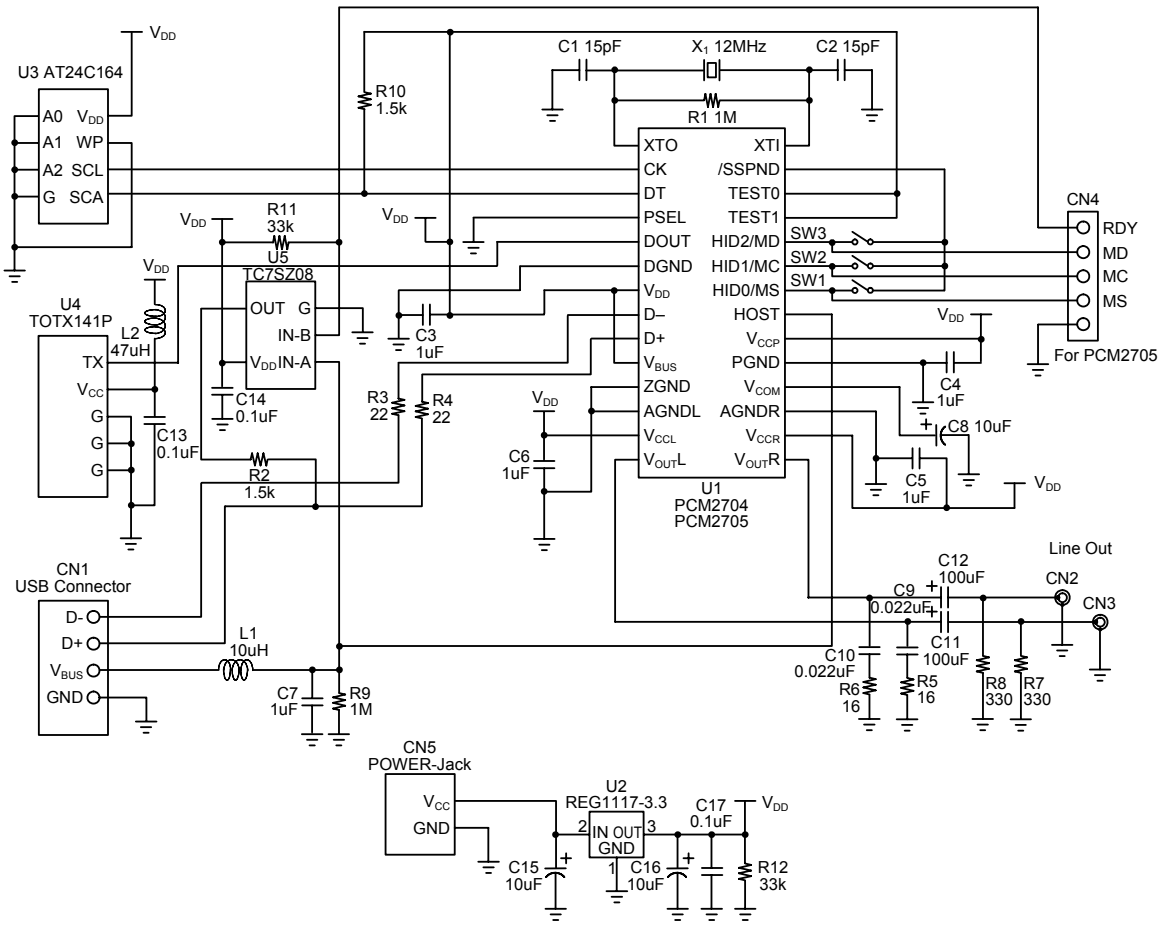
C1, C2 should have a capacitance which crystal resonator recommends. R3, R4 must be adjusted so that the D+, D- response keep right electrical characteristic (Eye Pattern) of USB interface if other protection circuit etc. are added on D+, D- in addition to R3, R4. Also, R2 tolerance is less than ±5%.

In case of PCM2705, if descriptor change is applied and it takes more than 20msec after USB cable is attached, R2 pull-up delay control is required so that D+ pull-up is activated after descriptor load through SPI is completed (Note 1). Also, MS must be kept with high until MC and MD line get ready.

An appropriate GND layout is recommended so that return current from PCM2704/2705 U1 to USB connector CN1, current from Headphone out CN2 to USB connector CN1, and current from TOTX141P U4 to USB connector CN1 flows separately and returns directly.

Refer to Section 8. for the countermeasure against pop noise at suspend on/off or power on/off.

7.2 PCM2704/05 Self-Powered Line Output with Optical S/PDIF Output



The application example of PCM2704/2705 for self-powered line output with optical S/PDIF output and with descriptor change capability through EEPROM (PCM2704) or SPI (PCM2705).

Descriptor change in self-powered configuration is not supported formally as power attribute can not be reported properly for actual state. If descriptor change is not needed, i.e. in formal application, EEPROM U3 and SPI connection via CN3 are not required. If optional S/PDIF output is not needed, TOTX141P U4 is not required. Also, regulator U2 must have driving capability more than 200mA. There is no limitation for capacitance of C3/4/5/6. Power source for PCM2704 HID function control can be supplied through /SSPND pin, and no external resistor and open state is allowed as HID pins have built-in pull-down resistors.

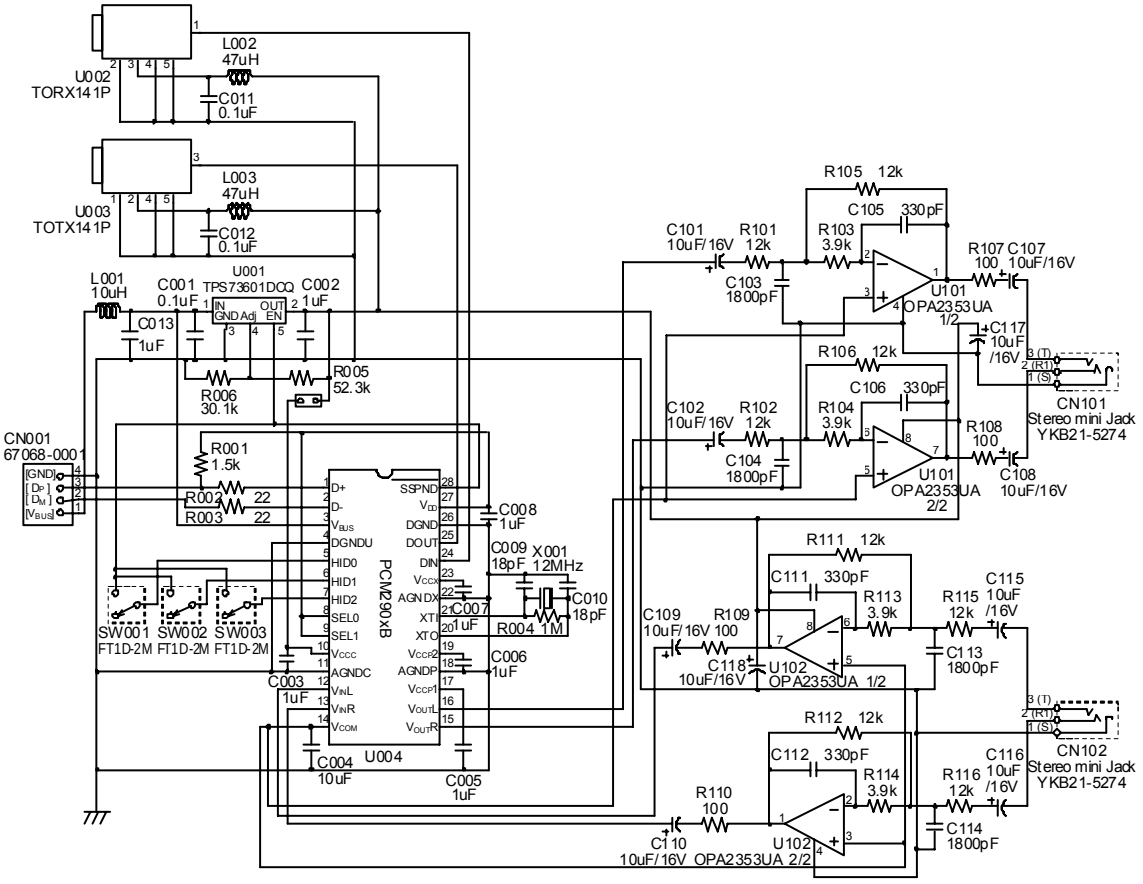
C1, C2 should have a capacitance which crystal resonator recommends. R3, R4 must be adjusted so that the D+, D- response keep right electrical characteristic (Eye Pattern) of USB interface if other protection circuit etc. are added on D+, D- in addition to R3, R4. Also, R2 tolerance is less than ±5%.

The anti back-voltage circuit by TC7SZ08 U5 is required so that D+ pull-up resistor R2 is activated after VBUS of USB connector CN1 gets active. Also, in case of PCM2705, if descriptor change is applied and it takes more than 20msec after USB cable is attached, R2 pull-up delay control is required so that D+ pull-up is activated after descriptor load is completed. Also, MS must be kept with high until MC and MD line get ready.

An appropriate GND layout is recommended so that return current from PCM2704/2705 U1 to regulator U2 & Power Jack CN5, current from Line out CN2, CN3 to regulator U2 & Power Jack CN5, and current from TOTX141P U4 to regulator U2 & Power Jack CN5 flows separately and returns directly.

Refer to Section 8. for the countermeasure against pop noise at suspend on/off or power on/off.

7.3 PCM2900B/2902B/2906B Bus-Powered Line Input and Output with Optical SPDIF Input and Output



The application example of PCM2900B/2902B/2906B for bus-powered 2Vpp full scale line input & output configuration with optical S/PDIF input & output (PCM2902B/2906B).

If optional S/PDIF input & output is not needed, TORX141P U002 and TOTX141P U003 are not required. Regulator U001 must have driving capability more than 200mA and enable/disable control function for limiting total supply current during suspend state. If U001 output is applied on Vccc of PCM290xB U004, output voltage 3.3V must be changed to 3.75V with full scale change by changing R005/006 to 59.0k/28.0k with 1% tolerance.

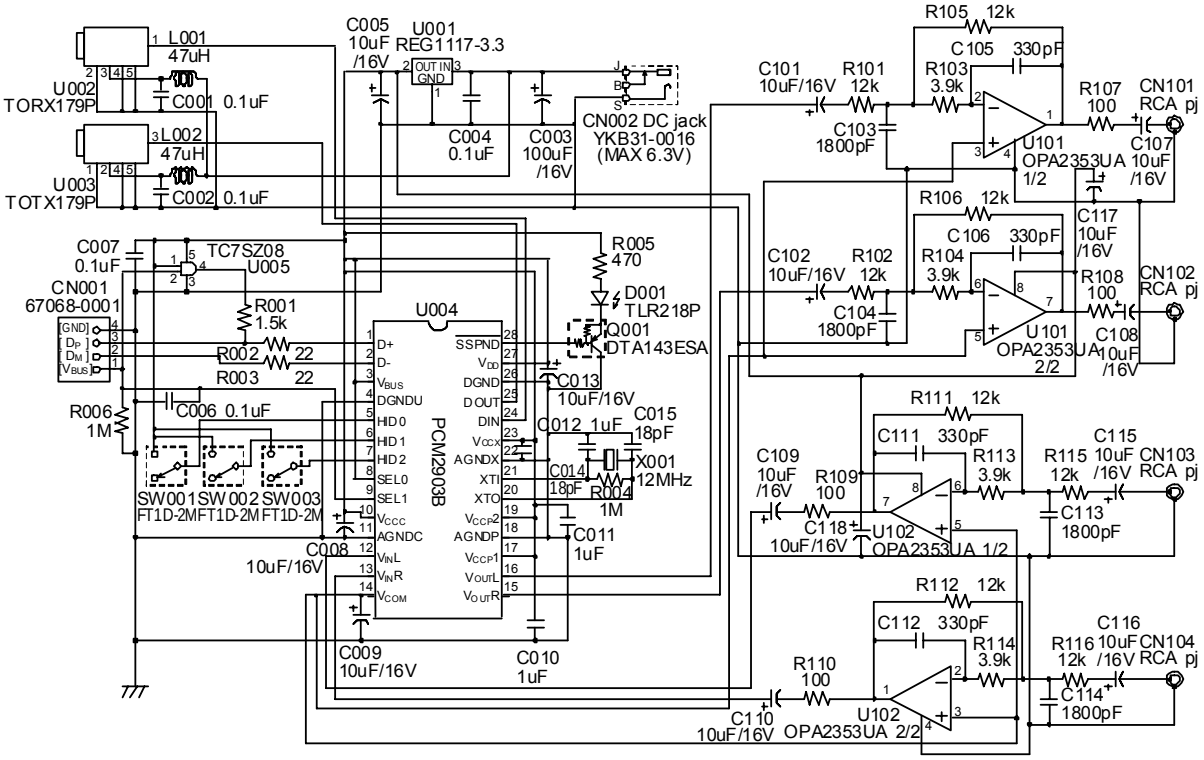
For controlling inrush current, C003/005/006/007/008 must be less than 10µF in total. Power source for PCM2900B/2902B/2906B HID function control should be supplied through /SSPND pin for limiting supply current during suspend period, no external resistor and open state is allowed as HID pins have built-in pull-down resistors.

C009, C010 should have a capacitance which crystal resonator recommends. R002, R003 must be adjusted so that the D+, D- response keep right electrical characteristic (Eye Pattern) of USB interface if other protection circuit etc. are added on D+, D- in addition to R002, R003. Also, R001 tolerance is less than ±5%.

An appropriate GND layout is recommended so that return current from PCM2900B/2902B/2906B U004 to USB connector CN001, current from TORX141P U002, TOTX141P U003 to regulator U001 & USB connector CN001, and current from input & output buffer amplifier U101, U102 to regulator U001 & USB connector CN001 flows separately and returns directly.

A mute circuit in front of Min Jack CN101 is recommended if needed, as pop noise may be generated by supply voltage change of output buffer amplifier U101 when suspend on/off or power on/off happens.

7.4 PCM2903B Self-Powered Line Input and Output with Optical SPDIF Input and Output



The application example of PCM2903B for self-powered 2Vpp full scale line input & output configuration with optical S/PDIF input & output.

If optional S/PDIF input & output is not needed, TORX179P U002 and TOTX179P U003 are not required. Regulator U001 must have driving capability more than 200mA.

There is no limitation for capacitance of C008/010/011/012/013, as it is different from bus-powered configuration. Power source for PCM2903B HID function control can be supplied through /SSPND pin, no external resistor and open state is allowed as HID pins have built-in pull-up resistors.

C014, C015 should have a capacitance which crystal resonator recommends. R002, R003 must be adjusted so that the D+, D- response keep right electrical characteristic (Eye Pattern) of USB interface if other protection circuit etc. are added on D+, D- in addition to R002, R003. Also, R001 tolerance is less than ±5%.

The anti back-voltage circuit by TC7SZ08 U005 is required so that D+ pull-up resistor R001 is activated after VBUS of USB connector CN1 gets active.

An appropriate GND layout is recommended so that return current from PCM2903B U004 to regulator U001 & DC Jack CN002, current from TORX179P U002, TOTX179P U003 to DC Jack CN002, and current from input & output buffer amplifier U101, U102 to regulator U001 & DC Jack CN002 flows separately and returns directly.

A mute circuit in front of RCA Jack CN101, CN102 is recommended if needed, as pop noise may be generated by supply voltage change of output buffer amplifier U101 when power on/off happens.

8. Application Tips for Pop Noise Reduction (For PCM2704/5/6/7 Line Out Application)

As the Head Phone amp output pins are terminated to GND with about 26kΩ typical during suspend on and power off state, some workaround in circuit for pop/click noise reduction is required for line out application of PCM2704/5/6/7.

8.1 Example of 32Ω Head Phone Load (Fig. 1)

The "RC" in Figure 1 is phase compensation circuit which consist of C = 0.022μF and R = 16Ω in order to make PCM270x to work in stable against load impedance variation.
The "Roff" is output impedance of HP amp which is defined from V_{OUT}L/R pin, during suspend and power off state. 12mW at 32Ω load can be provided full scale output, and cut-off frequency of HPF is f_L = 50Hz which is configured by DC blocking capacitor C_1 = 100uF and Head Phone load 32Ω.
Pop/click noise at suspend on or power off is reduced into allowable level for usual application by 32Ω termination and as discharge time of C_1 = 100uF is toff = 300ms with Head Phone, or toff = 600ms without Head Phone, 1-2sec wait time is required for restart, because pop/click noise is generated at suspend off or power on if discharging of C_1 would be incomplete.

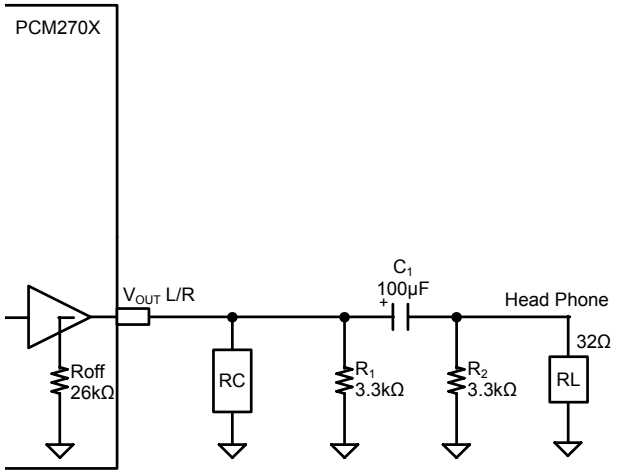


Figure 1

8.2 Example of 10kΩ Line Out Load (Fig. 2)

R_2 = 330Ω in Figure 2 is dummy resistor for reducing pop/click noise level at suspend on and power off. Smaller resistor reduces it lower, but it changes cut-off frequency f_L higher, which is determined by R_2 and C_1, and it is f_L = 5Hz for R_2 = 330Ω, C_1 = 100uF.
Pop/click noise level at suspend on and power off is reduced into about 1/30 by R_2 330Ω, and as C_1 discharge time is toff = 2.6sec, about 10sec wait time is required for restart so that pop/click noise at suspend off and power on is restrained.

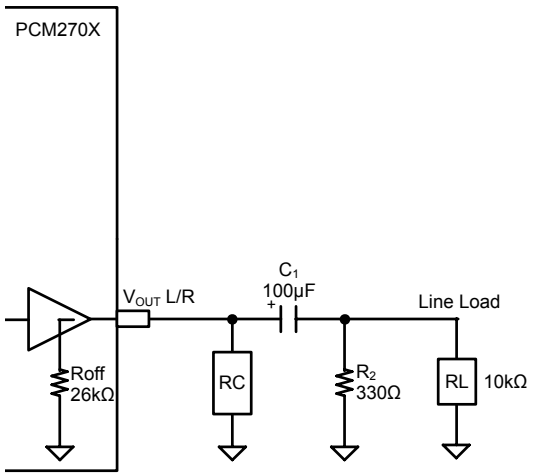


Figure 2

8.3 Example1 of Restart Wait Time Reduction (Fig. 3)

The application example in which wait time for restart is reduced by using /SSPND signal as compared with Figure 2 case.
The low cut-off frequency of normal operation is f_L = 1.7Hz, and as C_1 discharge time is toff = 370ms, wait time for restart is improved in 1-2sec.
Pop/click noise level at suspend on or power off is reduced into about 1/30–1/50 (depends on resistors accuracy) by R_3, R_1, R_4 and 3.3V which is charged in C_2.

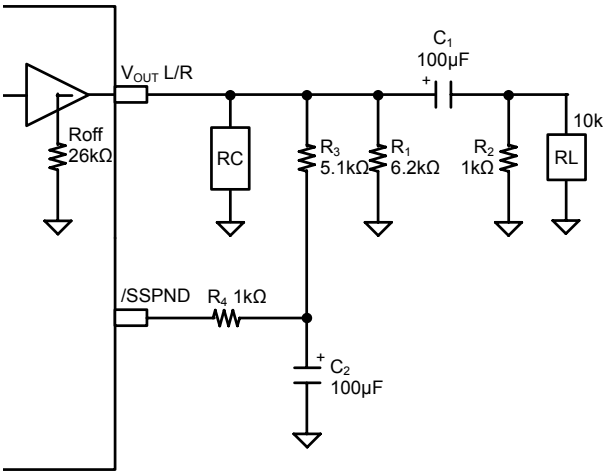


Figure 3

8.4 Example2 of Restart Wait Time Reduction (Fig. 4)

The application example similar to Figure 3 case in which wait time for restart and numbers of parts are reduced as compared with Figure 3 case.
The low cut-off frequency of normal operation is f_L = 1.6Hz, and as C_1 discharge time is toff = 240ms, wait time for restart is improved in 1sec.
Pop/click noise level at suspend on or power off is reduced to about 1/30– /50 (depends on Roff 26kΩ, i.e. varies by process variation) by R_3, R_4 and 3.3V which is charged on C_2.

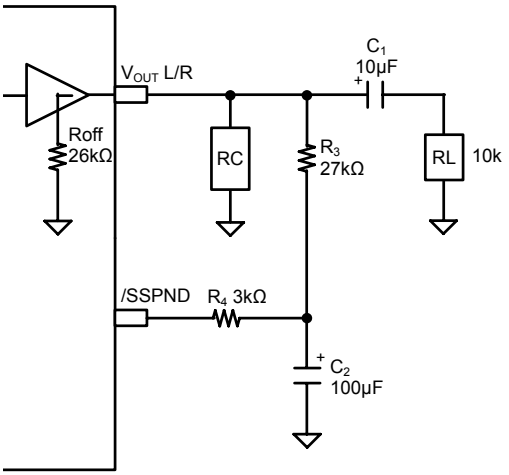


Figure 4

9. FAQ

Frequently asked questions and answers, mainly application with Windows, are shown below.
Following URL is referred for more USB general or more USB specific questions.

http://www.usb.org/developers/usbfaq/

Q1: There is not Device Driver, It does not require its own one ?
A1: All TI/BB USB Products, PCM270x, PCM290x/290xB, PCM2912/2912A, do not require their own Device Driver. They can run on standard device driver which OS and chipset provides in Windows or Mac OS.

Q2: The product is not recognized properly for plug-in with my computer, why ?
A2: Is an environment (OS and Chipset) appropriate for the USB products ?
Is it listed on Updated Operating Environments, http://focus.ti.com/lit/er/slaa374/slaa374.pdf ?
If No, try plug-in on one of listed environments at first, and then try it on others carefully once recognition is verified.
If Yes, try plug-in without other USB audio products/application, and/or try it after clean install of OS with update.

Q3: The Product is recognized properly for Plug-in, but it does not work, no audio output, why ?
A3: Is application software launched after USB product's plug-in and recognition ?
Is mute off and appropriate volume set in volume control window ?
Is music source selected properly in mixing window ?
Launch application after USB product's plug-in and check source/volume setting in volume control window for it.

Q4: We want to use our own Vendor ID and name, Can we change them ?
A4: Yes, you can change them in following ways,
- Through External ROM for PCM2704/6,
- Through SPI (i.e. By MCU or local CPU) for PCM2705/7,
- By mask option for all products except for PCM2702.
  (Regarding details, refer to descriptor change Appendix 2)

Q5: We want to send encoded data to SPDIF out via USB, is it possible ?
A5: All TI/BB USB products support only linear PCM data, not support non-PCM data in official.
However, PCM2704/5/6/7 and PCM2902B/3B/6B has a theoretical potential of transferring PCM emulated data as linear PCM data on SPDIF out, though DAC analog out must be muted while such data is being transferred.
There is no potential on PCM2902/3/6, because of inter-channel phase error.

Q6: De-coupling capacitor size in bus-powered can be increased ?
A6: Some increase is possible, but allowable it is limited "In-rush" current flow on V_{BUS}, which is specified in USB specification and tested in USB compliance test.
We recommend to check the limit of this item prior to fix it if it would be increased as compared with typical application circuit.

Q7: Why D+ pull-up control is required in self-powered configuration or descriptor change application ?
A7: In self-powered configuration, D+ pull-up must be activated while both local power for USB products and USB power form PC is active, and this is required for avoiding un-expecting biasing a circuit of PC by local power for USB products through D+ pull-up resistor while PC is not activated yet.
Also, in descriptor change application, D+ pull-up must be activated after completion of descriptor change by external ROM via I2C or MCU via SPI, and this is required for ensuring USB products to report proper data to PC in initialization sequence with PC.

Q8: In USB certification of E/E (End Equipments) application, can USB 2.0 certification be applicable ?

A8: If E/E application would use PCM290xB or PCM2912/2912A, USB 2.0 can be applicable, but if it would use PCM270x or PCM290x, USB 2.0 can not be applicable, E/E Application can not exceed this limitation of interface device. However, even if USB certification is 1.1, not 2.0, E/E applications can be applicable with USB 2.0 host PC or USB 2.0 bus, as they are same in effective for Low/Full speed specification.

Q9: USB application with Linux, PCM270x, PCM290xB, PCM2912A support Linux and USB application on Linux ?

A9: As there is not reference environment (OS and USB driver) in Linux like Windows or Mac OS, actual verification using specific PC/environments and specific USB products have not been performed by TI in official, therefore, Linux is not listed up as "Operating Environments" in Appendix 1, but this does not mean TI/BB USB products do not support Linux or USB application on Linux, right operation will be expected with most Linux environments, but it can not be assured without any verification. For further more, refer to http://www.linux-usb.org/.

Q10: Two or more PCM290xBs (or other two or more of same model) can be connected and used properly ?

A10: Basically, two or more PCM290xBs can be recognized as different devices of "USB Audio CODEC" with (1), (2), (3) … in accordance with PC's hardware and plug-in sequence, and they use same driver. However, as Serial Number is not supported, the relation between this logical address assignment and physical devices is not absolute in every start-up and/or every system. Daisy chain using Suspend Flag and D+ pull-up control is required for fixing the relation between logical address and physical devices. Also, be careful for application software, standard application software works only with default device, which is recognized in most latest in general.

Q11: Playback is fine, but Recording is not, volume control window is not shown in recording, why ? (PCM290x/xB)

A11: It (Grayed out of volume control window in recording) is not wrong for PCM290x/290xB, it is right response of PC/OS to plug-in of PCM290x/PCM290xB, as they do not have volume control and mute function for recording data, i.e. in front of ADC. If volume control and/or mute function would be required in recording, PCM2912A is recommended in place of PCM290x/PCM290xB.

Q12: In PCM2902B/3B/6B, ADC data is captured properly but SPDIF one is not, why ? (PCM290x/xB)

A12: Data transfer from SPDIF in to Host PC is performed only for following conditions,

- 1) Need to match actual data on SPDIF in and instruction form PC in sampling frequency and audio data format (stereo/mono, word length). Regarding PCM2902/3/6, need to match actual data of SPDIF in and channel status information in sampling frequency in addition to above requirements.
- 2) Need to "Valid" on validity bit, and not copy protected or protected with original for SCMS in channel status.

Otherwise, PCM2902B/3B/6B selects ADC output or Muted Data for SPDIF in as upstream data source.

Q13: Volume control in playback, actual volume control is done on PC side or device side ?

A13: Slider change for volume control or check box on/off for mute function of section named Volume Control or Speaker Function (at most left side) in volume control window is performed on PCM devices, not PC side, therefore, data transferred from PC to USB devices are not changed by this volume or mute control. Meanwhile, if slider for volume control or check box for mute control of section named Wave for example would be changed, this is processed in PC, therefore, data transferred from PC to USB devices are changed in actual.

Also, former volume control and mute function which is done in PCM devices is not applied on data on SPDIF output of PCM270x and PCM290x/290xB.

Q14: What is the default volume setting ? How is it control ?

A14: All TI/BB USB products start up basically in normal operation without any attenuation and mute on DAC analog outputs, and then they set attenuation in accordance with instruction from PC if it is available during initialization sequence, therefore, initial volume control/setting depends on OS/driver and application software on PC. Typically, in first plug-in for which USB driver is installed, center level of volume control slider is set as default level,

meanwhile, in second or after plug-in for which install of USB driver is not performed, last volume setting is revived. However, this rule seems to be not absolute, occasionally, this response may be changed by unknown reason.

Q15: How does volume up/down control by HID input in actual ?

A15: HID (Human Interface Device) input is basically independent from Audio input/output and processing function, but as HID inputs which PCM270x and PCM290x/290xB provide are assigned to the function related with audio playback (defined in HID usage table of USB specification), they are applied on default device for audio playback as volume control, mute on/off or other audio playback related function. Therefore, HID is controlled as follows.
< HID inputs -> Slider change in Volume Control -> Attenuation change of default device for audio playback >

Q16: HID does not work properly though HID command is sent through SPI bus correctly, why ? (PCM2705/07)

A16: HID input state is sampled by 10msec interval by PC, therefore, effective HID input must have its state change with period more than 10msec, otherwise, state change might be ignored or changed in sampling. Also, HID input must be null in initial state after plug-in.

Q17: Can I2S input (to DAC) work without USB connection with PC ? (PCM2706/07)

A17: No, it (I2S input to DAC) can not be supported without USB connection, I2S input is supported only just for I2S output from USB input, i.e. this I2S input assumes using internal DAC for I2S output from USB input, 1) in parallel operation with external processing of I2S output, or 2) as input signal to DAC of externally processed I2S output. Also, be careful in I2S clock's (BCK & LRCK) limitation to clock recovered from USB, not free for any other signal.

Q18: Descriptor change can not be done properly even if default data would be used, why ? (PCM2704/5/6/7)

A18: Data for descriptor change using EEPROM or SPI must be sent with LSB first, not MSB first in general, therefore, each byte data in EEPROM is stored with its bits in reverse order to data expressed generally. Also, first data must be stored in address 0x00, and all descriptor data (57bytes), not only changed data and including not changed data, must be loaded continuously. This restriction is applied on descriptor change through SPI, and MS must be High during no data sending through SPI.

Q19: Any EEPROM can be used for descriptor change ? and it can be applicable with any condition ? (PCM2704/6)

A19: Any EEPROM can be available if it has I2C interface with slave address 0xA0 and 512 bits or more in capacity. For proper descriptor programming, both PSEL pin and HOST pin must be High, therefore, proper descriptor change in self-powered configuration is not supported.

Q20: Large pop-noise at entering suspend mode in line-out application, can it be improved ? (PCM2704/5/6/7)

A20: Large pop-noise at entering suspend mode in line-out application has been confirmed for PCM2704/5/6/7 family, due to change of VoutL/R output impedance by entering into suspend mode. The workaround is shown in Section 8. Application Tips for Pop Noise Reduction (for PCM2704/5/6/7 Line-Out Application) in this application note.

Q21: Occasionally, 1kHz noise with audio signal in capturing data of video conference application, why ? (PCM290x)

A21: In 16kHz, 16bits, mono recording application using PCM290x, there is a possibility of data sending error which cause intermittent 1kHz noise with audio signal captured on Windows and Mac OS. The root cause is verified as a bug of PCM290x, and applying filter driver from TI Web or replacing by PCM290xB is recommended as solution.

Q22: Occasionally, intermittent continuous noise in recording application on Mac OS V10.5, why ? (PCM290x/2912)

A22: In recording application using PCM290x/PCM2912, there is a possibility of data sending error which cause intermittent pop-noise on Windows, Mac OS and intermittent continuous noise on Mac OS V10.5, though frequency of noise occurrence is very low and unstable like once an hour to once a day depending application environments. The root cause is verified as a bug of PCM290x/PCM2912, and replacing by PCM290xB/PCM2912A is recommended.

10. USB Compliance & Logo Mark

USB logo mark can be applied on USB products which pass through USB compliance test, which is specified by the USB Implementers forum (USB-IF).
All TI/BB USB products listed in this application note have passed and have been qualified through USB compliance test as Silicon Building Block, but this does not mean that final application products (E/E application) which use these listed USB DAC or CODEC will pass and will be qualified through USB Compliance test automatically.
For application of USB logo mark, final application products are also required to pass through USB Compliance test in each category.
All TI/BB USB products certified through USB compliance test can be seen on Product Search of USB-IF Web site below

http://www.usb.org/kcompliance/view

Writing "Texas Instruments Japan" on Box 1 in "To Select a Single Company of Search by Company", pressing "Lookup" and selecting "Texas Instruments Japan" on Box 2, and then pressing "Search" button at the right bottom of window will list all TI/BB USB products certified by USB-IF.

11. WHQL & WLP

Following USB products have been tested and certified by WHQL/DTM with marketing models by similarity to tested model.

Tested Model	Marketing Model
PCM2912A	
PCM2906B	PCM2900B/02B (*1)
PCM2705 (Bus)	PCM2704/6/7 (Bus)
PCM2705 (Self)	PCM2704/6/7 (Self)

*1 : PCM 2903B can not be added on the list of marketing model due to the difference of power attribute (bus/self), but it does not mean PCM2903B would be failed in certification, just not applied in certification test by similarity to others, no specific issue for E/E application's application to USB certification.

All TI/BB USB products certified through WHQL/DTM test can be seen on following WHQL Web site of Microsoft.

http://winqual.microsoft.com/HCL/ProductList.aspx?m=v&g=d&cid=110&f=86p

Selecting "Texas Instruments Incorporated" at Company, and pressing Go for search will list all TI/BB USB products certified by WHQL.

For further questions, contact the xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx at

Telephone: xxxxxxxxxx
Email: xxxxxxxxxx

APPENDIX 1

Operating Environment

For appropriate operation, one of these operating systems must be running on a host PC and equipped with a USB port certified by the manufacturer. If these condition are met, the operation of the PCM270X and PCM290X does not depend on the CPU operating speed. Texas Instruments has tested and confirmed the listed operating systems. The PCM270X and PCM290X may work with other PCs and operating systems also, but proper operation has not been tested and cannot be assured by TI.

Operating Systems

- Microsoft™ Windows™ 98SE/Windows Me Japanese/English edition
  (For Windows 98SE and Windows Me, the HID function is not fully functional with the default class driver.)
- Microsoft Windows 2000 Professional Japanese/English edition
- Microsoft Windows XP Home/Professional Japanese/English edition
  (For Windows XP, use the latest version of the USB audio driver available from the Windows Internet site, or apply Service Pack 1 or later. See the Q310507 white paper available from Microsoft.)
- Microsoft Windows Vista™ Business Japanese/English edition
- Apple Computer Mac OS™ 9.1 or later Japanese/English edition
- Apple Computer Mac OS X 10.0 or later English edition
- Apple Computer Mac OS X 10.1 or later Japanese edition SP
  (For the Mac OS X 10.0 Japanese edition, plug and play does not work appropriately for USB audio devices.)

A PC-AT Compatible Computer Running a Required OS

- Motherboard using Intel™ 440 BX or ZX chipset (chipset USB controller)
- Motherboard using Intel i810 chipset (chipset USB controller)
- Motherboard using Intel i815 chipset (chipset USB controller)
- Motherboard using Intel i820 chipset (chipset USB controller)
- Motherboard using Intel i845 chipset (ICH2 USB controller in the chipset)
- Motherboard using Intel i845 chipset (ICH4 USB controller in the chipset)
- Motherboard using Intel i850 chipset (chipset USB controller)
- Motherboard using Intel i848 chipset (ICH5/R USB controller in the chipset)
- Motherboard using Intel i865 chipset (ICH5/R USB controller in the chipset)
- Motherboard using Intel i875 chipset (ICH5/R USB controller in the chipset)
- Motherboard using Intel core Duo and Intel 945 GM chipset (chipset USB controller)
- Motherboard using Apollo KT133 chipset (chipset USB controller)
- Motherboard using Apollo KT333 chipset (chipset USB controller)
- Motherboard using Apollo Pro plus chipset (chipset USB controller)
- Motherboard using MVP4 or MVP3 chipset (chipset USB controller)
- Motherboard using Aladdin V chipset (chipset USB controller)
- Motherboard using SiS530 or SiS559 chipset (chipset USB controller)
- Motherboard using SiS735 chipset (chipset USB controller)

Note:

The PCM270X and PCM290X have been acknowledged in a USB compliance test. However, the acknowledgment is for the PCM270X and PCM290X device only, and does not apply to the customer's application system using the PCM270X and PCM290X. If the customer's application system requires a USB certification, this certification must be applied for separately by the customer, using the appropriate category USB-IF instructions. The testing environment is defined by the USB-IF and it can not be chosen by an applicant.

APPENDIX 2

The Summary of Descriptors Change by Optional Mask upon Customer's Request

Applicable Model

- PCM2704/5/6/7
- PCM2900B/2B/3B/6B
- PCM2912A

Contact

- Marketing or Sales Representative for Each Area

Applicable (Programmable) Descriptors, (Refer to Data Sheet for Default Data)

- Vendor ID (2 bytes)
- Product ID (2 bytes)
- Vendor String (32 bytes in ANSI ASCII code)
- Product String (16 bytes in ANSI ASCII code)
- Power Attribute (1 byte)
- Max Power (1 byte)

Development Cost & Term

- Initial Charge: $35k (*1) for 2k units Samples per Model ($17.5/unit for Payment)
- Delivery Schedule: 12 weeks (*1) after Descriptors Confirmations and PO Receipt

  *1: There is a possibility of revision due to change of actual cost and term for fabrication and others.

Volume Production

- Unit Price: Same as Standard Products
- Delivery schedule: Same as Standard Products
- Minimum Quantity for Order: 60k units per Model for PCM2704/5/6/7
  40k units per Model for PCM2900B/2B/3B/6B, PCM2912A