

STEREO AUDIO CODEC WITH USB INTERFACE, SINGLE-ENDED ANALOG INPUT/OUTPUT AND S/PDIF

FEATURES

- PCM2904: Without S/PDIF
- PCM2906: With S/PDIF
- On-Chip USB Interface:
 - With Full-Speed Transceivers
 - Fully Compliant With USB 1.1 Specification
 - Certified by USB-IF
 - Partially Programmable Descriptors (1)
 - USB Adaptive Mode for Playback
 - USB Asynchronous Mode for Record
 - Bus Powered
- 16-Bit Delta-Sigma ADC and DAC
- · Sampling Rate:
 - DAC: 32, 44.1, 48 kHz
 - ADC: 8, 11.025, 16, 22.05, 32, 44.1, 48 kHz
- On-Chip Clock Generator With Single 12-MHz Clock Source
- Single Power Supply: 5 V Typical (V_{BUS})
- Stereo ADC
 - Analog Performance at V_{BUS} = 5 V
 - THD+N = 0.01%
 - SNR = 89 dB
 - Dynamic Range = 89 dB
 - Decimation Digital Filter
 - Pass-Band Ripple = ±0.05 dB
 - Stop-Band Attenuation = -65 dB
 - Single-Ended Voltage Input
 - Antialiasing Filter Included
 - Digital LCF Included
- Stereo DAC:
 - Analog Performance at V_{BUS} = 5 V
 - THD+N = 0.005%
 - SNR = 96 dB
 - Dynamic Range = 93 dB
 - Oversampling Digital Filter
- (1) The descriptor can be modified by changing a mask.

- Pass-Band Ripple = ±0.1 dB
- Stop-Band Attenuation = -43 dB
- Single-Ended Voltage Output
- Analog LPF Included
- Multifunctions:
 - Human Interface Device (HID) Volume ± Control and Mute Control
 - Suspend Flag
- Package: 28-Pin SSOP

APPLICATIONS

- USB Audio Speaker
- USB Headset
- USB Monitor
- USB Audio Interface Box

DESCRIPTION

The PCM2904/2906 is Texas Instruments single-chip USB stereo audio codec with USB-compliant full-speed protocol controller and S/PDIF (PCM2906 only). The USB protocol controller works with no software code, but the USB descriptors can be modified in some areas (for example, vendor ID/product ID). The PCM2904/2906 employs SpAct™ architecture, TI's unique system that recovers the audio clock from USB packet data. On-chip analog PLLs with SpAct enable playback and record with low clock jitter and with independent playback and record sampling rates.



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

SpAct is a trademark of Texas Instruments.

System Two, Audio Precision are trademarks of Audio Precision, Inc.





This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

PACKAGING ORDERING INFORMATION

PRODUCT	PACKAGE-LEAD	PACKAGE DESIGNATOR	SPECIFIED TEMPERATURE RANGE	PACKAGE MARKING	ORDERING NUMBER	TRANSPORT MEDIA
PCM2904DB	28-lead SSOP	28DB	–25°C to 85°C	PCM2904	PCM2904DB	Rails
FCW2904DB	20 1044 0001	2006	23 0 10 03 0	F CIVI2904	PCM2904DBR	Tape and reel
PCM2906DB	28-lead SSOP	28DB	–25°C to 85°C	PCM2906	PCM2906DB	Rails
PCIVIZ906DB	Zo-lead SSOP	2008	-25°C 10 85°C	PGIVI2906	PCM2906DBR	Tape and reel

ABSOLUTE MAXIMUM RATINGS

over operating free-air temperature range (unless otherwise noted)(1)

		PCM2904/PCM2906	UNIT
Supply voltage,	V _{BUS}	-0.3 to 6.5	V
Ground voltage	differences, AGNDC, AGNDP, AGNDX, DGND, DGNDU	±0.1	V
Digital input	SEL0, SEL1, TEST0 (DIN) ⁽²⁾	-0.3 to 6.5	
voltage	D+, D-, HID0, HID1, HID2, XTI, XTO, TEST1 (DOUT)(2), SSPND	-0.3 to (V _{DDI} + 0.3) < 4	V
Analog input	V _{IN} L, V _{IN} R, V _{COM} , V _{OUT} R, V _{OUT} L	-0.3 to $(V_{CCCI} + 0.3) < 4$	V
voltage	V _{CCCI} , V _{CCP1I} , V _{CCP2I} , V _{CCXI} , V _{DDI}	-0.3 to 4	\ \ \
Input current (an	y pins except supplies)	±10	mA
Ambient tempera	ature under bias	-40 to 125	°C
Storage tempera	iture, T _{stg}	-55 to 150	°C
Junction tempera	ature, T _J	150	°C
Lead temperatur	e (soldering)	260	°C, 5 s
Package temper	ature (IR reflow, peak)	250	°C

⁽¹⁾ Stresses beyond those listed under absolute maximum ratings may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under recommended operating conditions is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

(2) (): PCM2906



ELECTRICAL CHARACTERISTICS

All specifications at $T_A = 25$ °C, V_{BUS} , = 5 V, $f_S = 44.1$ kHz, $f_{IN} = 1$ kHz, 16-bit data (unless otherwise noted)

	PARAMETER	TEST CONDITIONS	PCM2904D	B, PCM2	906DB	UNIT
	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
DIGITAL INPUT	OUTPUT					
	Host interface	Apply USB Revision 1.1, full speed				
	Audio data format	USB isochronous data format				
INPUT LOGIC						
V _{IH} ⁽¹⁾			2		3.3	
V _{IL} ⁽¹⁾					0.8	
V _{IH} ⁽²⁾⁽³⁾			2.52		3.3	
V _{IL} ⁽²⁾⁽³⁾	Input logic level				0.9	Vdo
V _{IH} ⁽⁴⁾	Input logic level		2		5.25	Vdc
V _{IL} ⁽⁴⁾					0.8	
V _{IH} ⁽⁵⁾			2.52		5.25	
V _{IL} ⁽⁵⁾					0.9	
I _{IH} ⁽¹⁾ (2) (4)		V _{IN} = 3.3 V			±10	
I _{IL} ⁽¹⁾ (2) (4)		V _{IN} = 0 V			±10	μΑ
I _{IH} ⁽³⁾	Input logic current	V _{IN} = 3.3 V		50	80	
I _{IL} (3)		V _{IN} = 0 V			±10	
I _{IH} (5)		V _{IN} = 3.3 V		65	100	
I _{IL} (5)		V _{IN} = 0 V			±10	
OUTPUT LOGIC			•			
V _{OH} ⁽¹⁾			2.8			
V _{OL} ⁽¹⁾					0.3	
V _{OH} ⁽⁶⁾	Output la rie laurel	$I_{OH} = -4 \text{ mA}$	2.8			V/-I-
V _{OL} ⁽⁶⁾	Output logic level	I _{OL} = 4 mA			0.5	Vdc
V _{OH} ⁽⁷⁾		$I_{OH} = -2 \text{ mA}$	2.8			
V _{OL} ⁽⁷⁾		I _{OL} = 2 mA			0.5	
CLOCK FREQU	ENCY		•			
	Input clock frequency, XTI		11.994	12	12.006	MHz
ADC CHARACT	ERISTICS		•			
	Resolution			8, 16		bits
	Audio data channel			1, 2		channel
CLOCK FREQU	IENCY		•			
f _s	Sampling frequency		8, 11.025, 44	, 16, 22.0 4.1, 48	5, 32,	kHz
DC ACCURACY	(
	Gain mismatch, channel-to-channel			±1	±5	% of FSR
	Gain error			±2	±10	% of FSF
	Bipolar zero error			±0		% of FSR

⁽¹⁾ Pins 1, 2: D+, D-

⁽²⁾ (3) Pin 21: XTI

⁽³⁾ Pins 5, 6, 7: HID0, HID1, HID2 (4) Pins 8, 9: SEL0, SEL1

⁽⁵⁾ Pin 24: DIN (6) Pin 25: DOUT (7) Pin 28: SSPND



ELECTRICAL CHARACTERISTICS (Continued)

All specifications at $T_A = 25$ °C, V_{BUS} , = 5 V, $f_S = 44.1$ kHz, $f_{IN} = 1$ kHz, 16-bit data (unless otherwise noted)

	DADAMETED	TEST CONDITIONS	PCM2904	IDB, PCM29	06DB	UNIT
	PARAMETER		MIN	TYP	MAX	UNIT
DYNAMI	C PERFORMANCE ⁽¹⁾					
		$V_{IN} = -0.5 \text{ dB}^{(2)}, V_{CCCI} = 3.67 \text{ V}$		0.01%	0.02%	
THD+N	Total harmonic distortion plus noise	$V_{IN} = -0.5 \text{ dB}^{(3)}$		0.1%		
		$V_{IN} = -60 \text{ dB}$		5%		
	Dynamic range	A-weighted	81	89		dB
	S/N ratio	A-weighted	81	89		dB
	Channel separation		80	85		dB
ANALOG	S INPUT					
	Input voltage			0.6 V _{CCCI}		Vp-p
	Center voltage			0.5 V _{CCCI}		V
	Input impedance			30		kΩ
	A sticling in a filter from the state of the	-3 dB		150		kHz
	Antialiasing filter frequency response	f _{IN} = 20 kHz		-0.08		dB
DIGITAL	FILTER PERFORMANCE					
	Pass band				0.454 f _s	Hz
	Stop band		0.583 f _s			Hz
	Pass-band ripple				±0.05	dB
	Stop-band attenuation		-65			dB
t _d	Delay time			17.4/f _s		S
	LCF frequency response	-3 dB		0.078 _{fs}		MHz
DAC CH	ARACTERISTICS					
	Resolution			8, 16		bits
	Audio data channel			1, 2		channel
CLOCK I	FREQUENCY					
f_s	Sampling frequency		3	2, 44.1, 48		kHz
DC ACC	URACY					
	Gain mismatch, channel-to-channel			±1	±5	% of FSR
	Gain error			±2	±10	% of FSR
	Bipolar zero error			±2		% of FSR
DYNAMI	C PERFORMANCE ⁽⁴⁾					
THD+N	Total harmonic distortion plus noise	V _{OUT} = 0 dB		0.005%	0.016%	
I LID+IN	rotal narmonic distortion plus noise	V _{OUT} = -60 dB		3%		
	Dynamic range	EIAJ, A-weighted	87	93		dB
SNR	Signal-to-noise ratio	EIAJ, A-weighted	90	96		dB
	Channel separation		86	92		dB

⁽¹⁾ $f_{IN} = 1 \text{ kHz}$, using the System TwoTM audio measurement system by Audio PrecisionTM in RMS mode with 20-kHz LPF, 400-Hz HPF in calculation.

 ⁽²⁾ Using external voltage regulator for V_{CCCI} (as shown in Figure 36 and Figure 37, using REG103xA-A)
 (3) Using internal voltage regulator for V_{CCCI} (as shown in Figure 38 and Figure 39)

⁽⁴⁾ f_{OUT} = 1 kHz, using the System Two audio measurement system by Audio Precision in RMS mode with 20-kHz LPF, 400-Hz HPF.



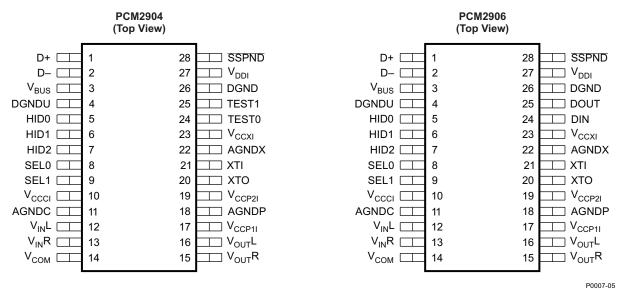
ELECTRICAL CHARACTERISTICS (Continued)

All specifications at $T_A = 25$ °C, V_{BUS} , = 5 V, $f_S = 44.1$ kHz, $f_{IN} = 1$ kHz, 16-bit data (unless otherwise noted)

	DADAMETED	RAMETER TEST CONDITIONS PCM		B, PCM2	906DB	UNIT	
	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	ONII	
ANALO	G OUTPUT		1		•		
Vo	Output voltage		(0.6 V _{CCCI}		Vp-p	
	Center voltage		(0.5 V _{CCCI}		V	
	Load impedance	AC coupling	10			kΩ	
·	LDE (common and and and and and and and and and an	–3 dB		250		kHz	
	LPF frequency response	f = 20 kHz		-0.03		dB	
DIGITA	L FILTER PERFORMANCE						
	Pass band				0.445 f _s	Hz	
	Stop band		0.555 f _s			Hz	
	Pass-band ripple				±0.1	dB	
	Stop-band attenuation		-43			dB	
t _d	Delay time			14.3 f _s		s	
POWER	R SUPPLY REQUIREMENTS		·				
V _{BUS}	Voltage range		4.36	5	5.25	VDC	
	Complex compant	ADC, DAC operation		56	67	mA	
	Supply current	Suspend mode ⁽¹⁾		210		μΑ	
D	Device dissination	ADC, DAC operation		280	352		
P_D	Power dissipation	Suspend mode ⁽¹⁾		1.05		mW	
	Internal power supply voltage (2)		3.25	3.35	3.5	VDC	
TEMPE	RATURE RANGE		-		,		
	Operating temperature		-25		85	°C	
θ_{JA}	Thermal resistance	28-pin SSOP		100		°C/W	

⁽¹⁾ In USB suspend state

PIN ASSIGNMENTS



P0007-05

⁽²⁾ Pins 10, 17, 19, 23, 27: V_{CCCI}, V_{CCP1I}, V_{CCP2I}, V_{CCXI}, V_{DDI}



Table 1. PCM2904 TERMINAL FUNCTIONS

TERM	TERMINAL		DECORPORTION
NAME	NO.	I/O	DESCRIPTION
AGNDC	11	_	Analog ground for codec
AGNDP	18	_	Analog ground for PLL
AGNDX	22	-	Analog ground for oscillator
D-	2	I/O	USB differential input/output minus ⁽¹⁾
D+	1	I/O	USB differential input/output plus ⁽¹⁾
DGND	26	_	Digital ground
DGNDU	4	-	Digital ground for USB transceiver
HID0	5	I	HID key state input (mute), active-high (2)
HID1	6	I	HID key state input (volume up), active-high ⁽²⁾
HID2	7	I	HID key state input (volume down), active-high ⁽²⁾
SEL0	8	I	Must be set to high ⁽³⁾
SEL1	9	I	Must be set to high ⁽³⁾
SSPND	28	0	Suspend flag, active-low (Low: suspend, High: operational)
TEST0	24	I	Test pin, must be connected to GND
TEST1	25	0	Test pin, must be left open
V_{BUS}	3	_	Connect to USB power (V _{BUS})
V _{CCCI}	10	_	Internal analog power supply for codec ⁽⁴⁾
V _{CCP1I}	17	_	Internal analog power supply for PLL ⁽⁴⁾
V _{CCP2I}	19	_	Internal analog power supply for PLL ⁽⁴⁾
V _{CCXI}	23	_	Internal analog power supply for oscillator ⁽⁴⁾
V _{COM}	14	_	Common for ADC/DAC (V _{CCCI} /2) ⁽⁴⁾
V_{DDI}	27	_	Internal digital power supply ⁽⁴⁾
$V_{IN}L$	12	I	ADC analog input for L-channel
$V_{IN}R$	13	I	ADC analog input for R-channel
V _{OUT} L	16	0	DAC analog output for L-channel
V _{OUT} R	15	0	DAC analog output for R-channel
XTI	21	I	Crystal oscillator input ⁽⁵⁾
XTO	20	0	Crystal oscillator output

⁽¹⁾ LV-TTL leveL

^{3.3-}V CMOS-level input with internal pulldown. This pin informs the PC of serviceable control signals such as mute, volume up, or volume down, which have no direct connection with the internal DAC or ADC. See the *Interface #3* and *End-Points sections*.

TTL Schmitt trigger, 5-V tolerant

Connect a decoupling capacitor to GND. 3.3-V CMOS-level input



Table 2. PCM2906 TERMINAL FUNCTIONS

TERMINAL		1/0	DESCRIPTION
NAME	NO.	1/0	DESCRIPTION
AGNDC	11	_	Analog ground for codec
AGNDP	18	_	Analog ground for PLL
AGNDX	22	_	Analog ground for oscillator
D-	2	I/O	USB differential input/output minus ⁽¹⁾
D+	1	I/O	USB differential input/output plus ⁽¹⁾
DGND	26	_	Digital ground
DGNDU	4	_	Digital ground for USB transceiver
DIN	24	I	S/PDIF input ⁽²⁾
DOUT	25	0	S/PDIF output
HID0	5	I	HID key state input (mute), active-high (3)
HID1	6	I	HID key state input (volume up), active-high (3)
HID2	7	I	HID key state input (volume down), active-high (3)
SEL0	8	I	Must be set to high ⁽⁴⁾
SEL1	9	I	Must be set to high ⁽⁴⁾
SSPND	28	0	Suspend flag, active-low (Low: suspend, High: operational)
V_{BUS}	3	_	Connect to USB power (V _{BUS})
V _{CCCI}	10	_	Internal analog power supply for codec ⁽⁵⁾
V _{CCP1I}	17	_	Internal analog power supply for PLL ⁽⁵⁾
V _{CCP2I}	19	_	Internal analog power supply for PLL ⁽⁵⁾
V_{CCXI}	23	_	Internal analog power supply for oscillator ⁽⁵⁾
V_{COM}	14	_	Common for ADC/DAC (V _{CCCI} /2) ⁽⁵⁾
V_{DDI}	27	_	Internal digital power supply ⁽⁵⁾
$V_{IN}L$	12	1	ADC analog input for L-channel
$V_{IN}R$	13	1	ADC analog input for R-channel
$V_{OUT}L$	16	0	DAC analog output for L-channel
$V_{OUT}R$	15	0	DAC analog output for R-channel
XTI	21	I	Crystal oscillator input ⁽⁶⁾
XTO	20	0	Crystal oscillator output

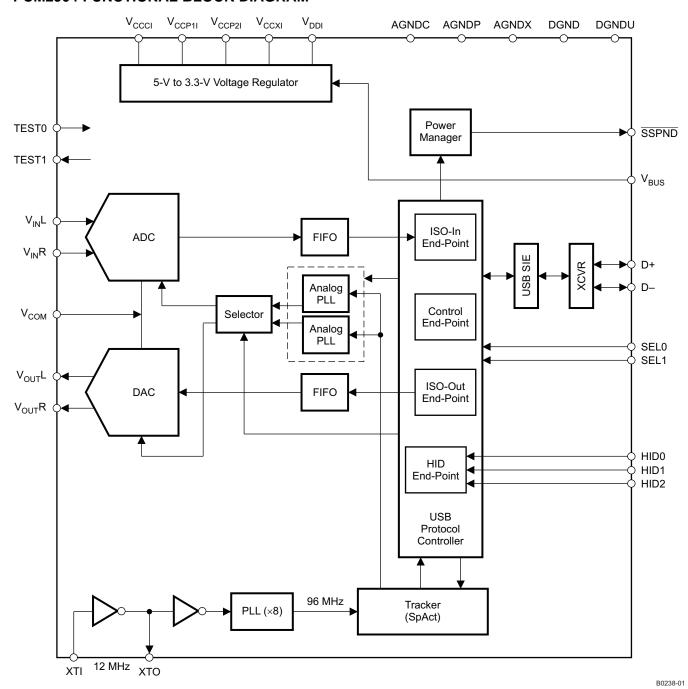
- (1) LV-TTL level
- 3.3-V CMOS-level input with internal pulldown, 5-V tolerant
 3.3-V CMOS-level input with internal pulldown. This pin informs the PC of serviceable control signals such as mute, volume up, or volume down, which have no direct connection with the internal DAC or ADC. See the *Interface #3* and *End-Points sections*.

 TTL Schmitt trigger, 5-V tolerant
 Connect a decoupling capacitor to GND.

 3.3-V CMOS-level input

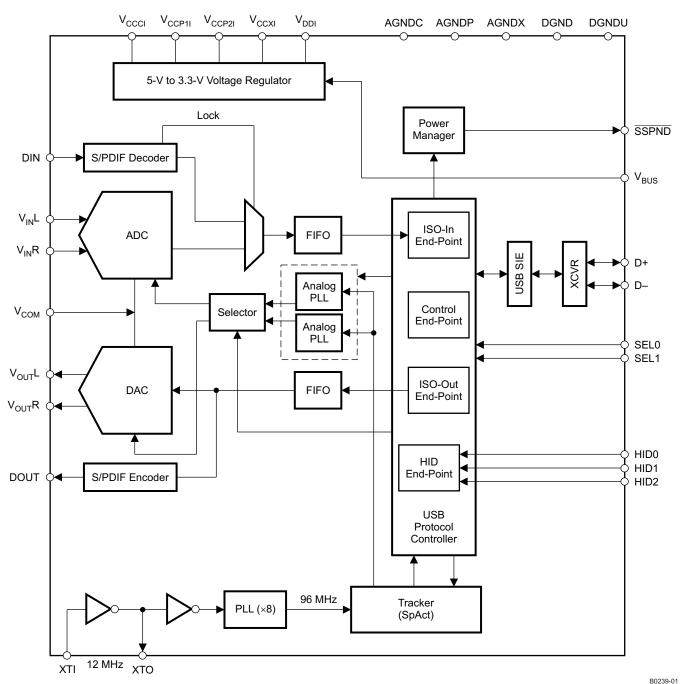


PCM2904 FUNCTIONAL BLOCK DIAGRAM



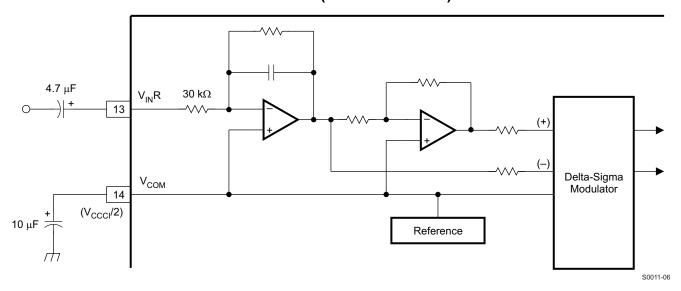


PCM2906 FUNCTIONAL BLOCK DIAGRAM





BLOCK DIAGRAM OF ANALOG FRONT-END (RIGHT CHANNEL)





TYPICAL CHARACTERISTICS

All specifications at $T_A = 25$ °C, $V_{BUS} = 5$ V, $f_s = 44.1$ kHz, $f_{IN} = 1$ kHz, 16-bit data, using REG103xA-A, unless otherwise noted.

ADC

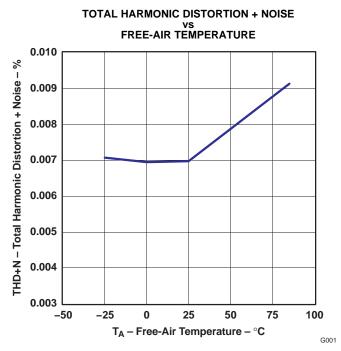


Figure 1. THD+N at -0.5 dB vs Temperature

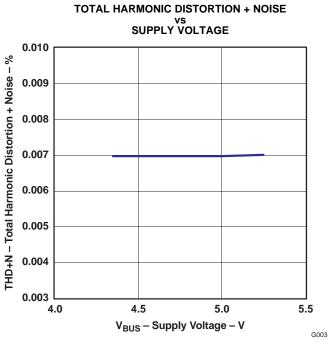


Figure 3. THD+N at -0.5 dB vs Supply Voltage

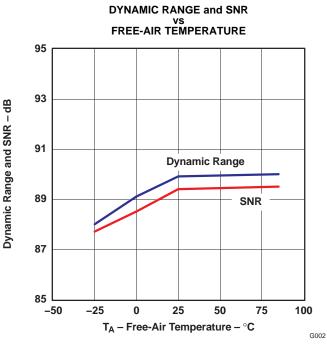
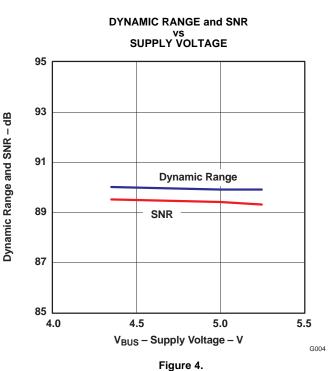


Figure 2.



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All specifications at $T_A = 25$ °C, $V_{BUS} = 5$ V, $f_s = 44.1$ kHz, $f_{IN} = 1$ kHz, 16-bit data, using REG103xA-A, unless otherwise noted.

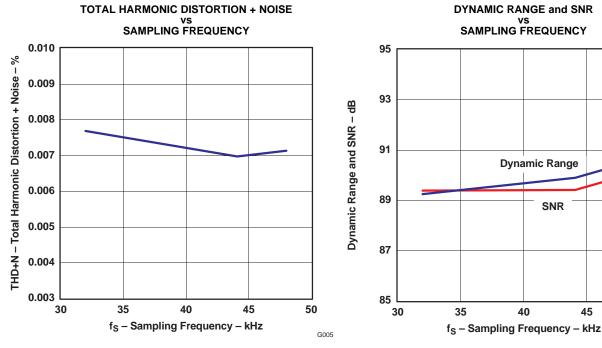


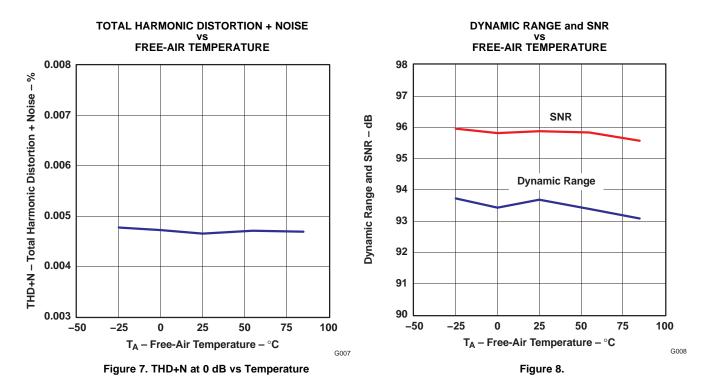
Figure 5. THD+N at -0.5 dB vs Sampling Frequency

Figure 6.

45

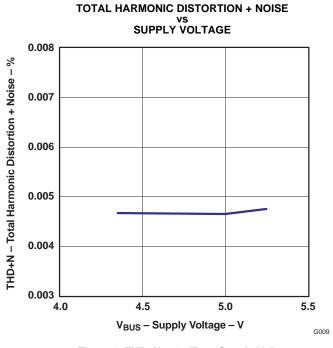
50

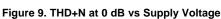
DAC





All specifications at $T_A = 25$ °C, $V_{BUS} = 5$ V, $f_s = 44.1$ kHz, $f_{IN} = 1$ kHz, 16-bit data, using REG103xA-A, unless otherwise noted.





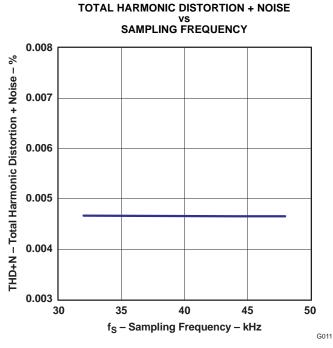


Figure 11. THD+N at 0 dB vs Sampling Frequency

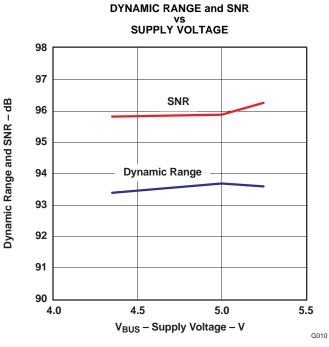


Figure 10.

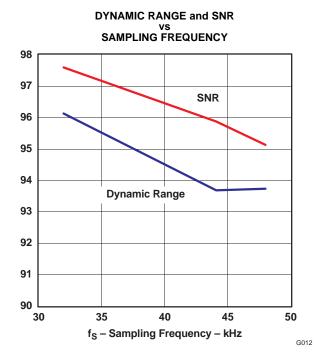


Figure 12.

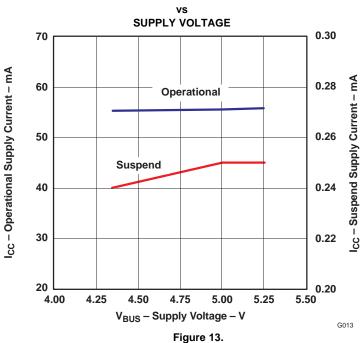
Dynamic Range and SNR - dB



All specifications at $T_A = 25$ °C, $V_{BUS} = 5$ V, $f_s = 44.1$ kHz, $f_{IN} = 1$ kHz, 16-bit data, using REG103xA-A, unless otherwise noted.

SUPPLY CURRENT





OPERATIONAL SUPPLY CURRENT vs

SAMPLING FREQUENCY 70 70 60 50 40 20 30 35 40 45 50 f_S - Sampling Frequency - kHz

Figure 14. Supply Current vs Sampling Frequency, ADC and DAC at Same f_S

SUSPEND SUPPLY CURRENT vs FREE-AIR TEMPERATURE

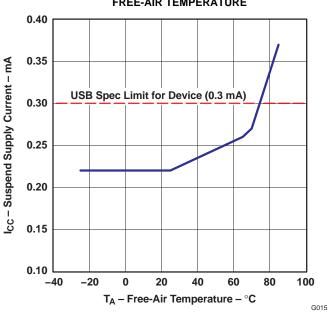
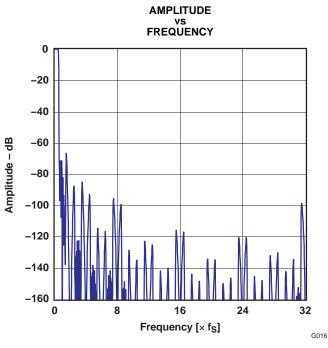


Figure 15. Supply Current vs Temperature in Suspend Mode



All specifications at $T_A = 25^{\circ}C$, $V_{BUS} = 5$ V, $f_s = 44.1$ kHz, $f_{IN} = 1$ kHz, 16-bit data, unless otherwise noted.

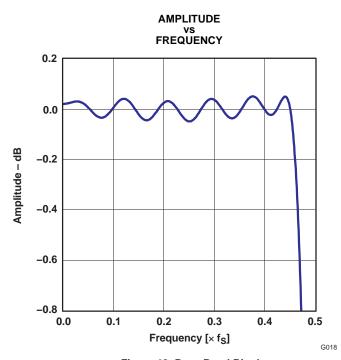
ADC DIGITAL DECIMATION FILTER FREQUENCY RESPONSE



AMPLITUDE vs FREQUENCY 0 -10 -20 -30 Amplitude – dB -40 -50 -60 -70 -80 -90 -100 0.0 0.2 0.4 0.6 0.8 1.0 Frequency [x fs] G017

Figure 16. Overall Characteristic

Figure 17. Stop-Band Attenuation



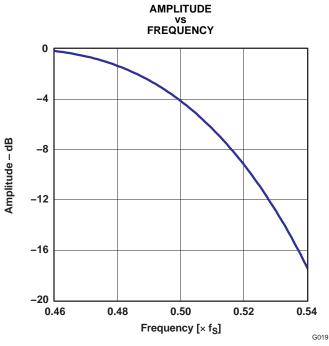


Figure 18. Pass-Band Ripple

Figure 19. Transition-Band Response



All specifications at $T_A = 25$ °C, $V_{BUS} = 5$ V, $f_s = 44.1$ kHz, $f_{IN} = 1$ kHz, 16-bit data, unless otherwise noted.

ADC DIGITAL HIGH-PASS FILTER FREQUENCY RESPONSE

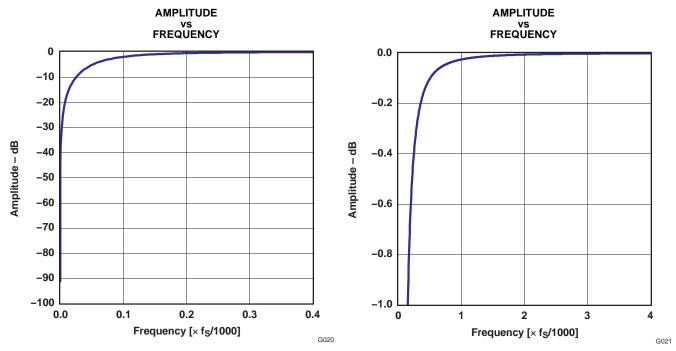
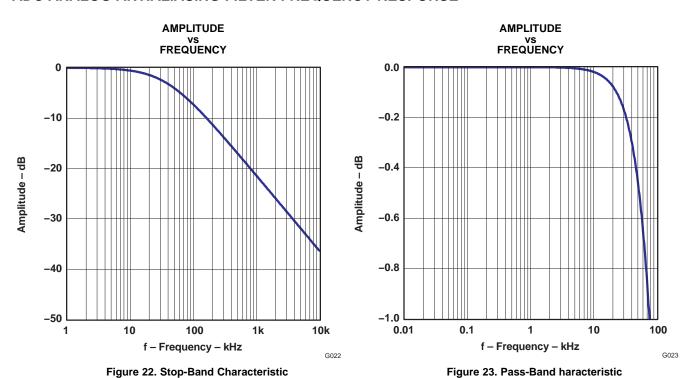


Figure 20. Stop-Band Characteristic

Figure 21. Pass-Band Characteristic

ADC ANALOG ANTIALIASING FILTER FREQUENCY RESPONSE



Submit Documentation Feedback



All specifications at $T_A = 25$ °C, $V_{BUS} = 5$ V, $f_s = 44.1$ kHz, $f_{IN} = 1$ kHz, 16-bit data, unless otherwise noted.

DAC DIGITAL INTERPOLATION AND DE-EMPHASIS FILTER FREQUENCY RESPONSE

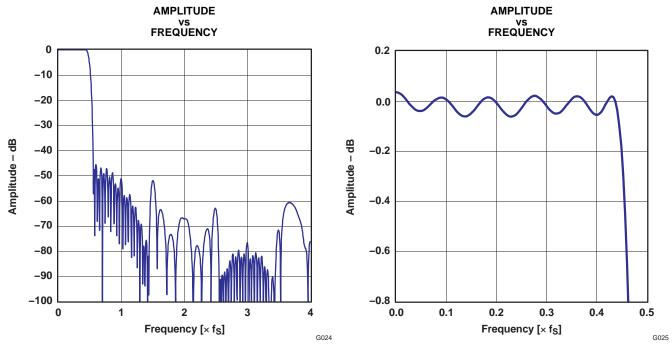


Figure 24. Stop-Band Attenuation

Figure 25. Pass-Band Ripple

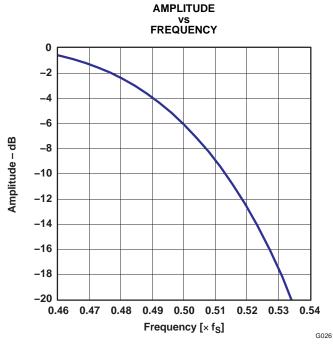


Figure 26. Transition-Band Response



All specifications at $T_A = 25$ °C, $V_{BUS} = 5$ V, $f_s = 44.1$ kHz, $f_{IN} = 1$ kHz, 16-bit data, unless otherwise noted.

DAC ANALOG FIR FILTER FREQUENCY RESPONSE

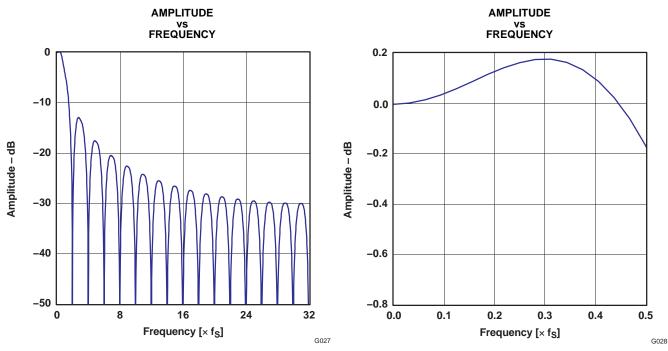


Figure 27. Stop-Band Characteristic

Figure 28. Pass-Band Characteristic

DAC ANALOG LOW-PASS FILTER FREQUENCY RESPONSE

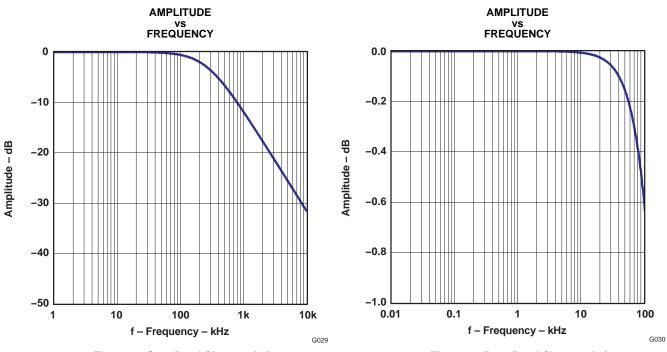


Figure 29. Stop-Band Characteristic

Figure 30. Pass-Band Characteristic



USB INTERFACE

Control data and audio data are transferred to the PCM2904/2906 via D+ (pin 1) and D- (pin 2). All data to/from the PCM2904/2906 is transferred at full speed. The device descriptor contains the information described in Table 3. The device descriptor can be modified on request; contact a Texas Instruments representative about the details.

Table 3. Device Descriptor

USB revision	1.1 compliant
Device class	0x00 (device defined interface level)
Device sub class	0x00 (not specified)
Device protocol	0x00 (not specified)
Max packet size for end-point 0	8 byte
Vendor ID	0x08BB (default value, can be modified)
Product ID	0x2904/0x2906 (default value, can be modified)
Device release number	1.0 (0x0100)
Number of configurations	1
Vendor string	String #1 (see Table 5)
Product string	String #2 (see Table 5)
Serial number	Not supported

The configuration descriptor contains the information described in Table 4. The configuration descriptor can be modified on request; contact a Texas Instruments representative about the details.

Table 4. Configuration Descriptor

Interface	Four interfaces		
Power attribute	0x80 (Bus powered, no remote wakeup)		
Max power	0xFA (500 mA. Default value, can be modified)		

The string descriptor contains the information described in Table 5. The string descriptor can be modified on request; contact a Texas Instruments representative about the details.

Table 5. String Descriptor

#0	0x0409
#1	Burr-Brown from TI (default value, can be modified)
#2	USB audio codec (default value, can be modified)



DEVICE CONFIGURATION

Figure 31 illustrates the USB audio function topology. The PCM2904/2906 has four interfaces. Each interface is constructed by alternative settings.

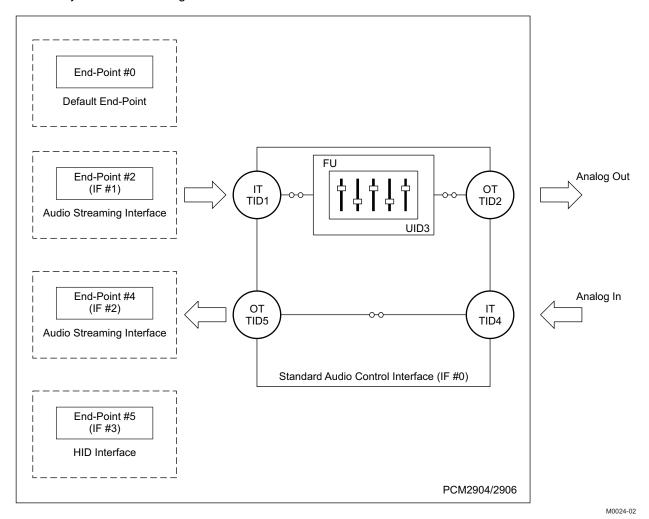


Figure 31. USB Audio Function Topology



Interface #0

Interface #0 is the control interface. Alternative setting #0 is the only possible setting for interface #0. Alternative setting #0 describes the standard audio control interface. The audio control interface is constructed by a terminal. The PCM2904/2906 has the following five terminals.

- Input terminal (IT #1) for isochronous-out stream
- Output terminal (OT #2) for audio analog output
- Feature unit (FU #3) for DAC digital attenuator
- Input terminal (IT #4) for audio analog input
- Output terminal (OT #5) for isochronous-in stream

Input terminal #1 is defined as a *USB stream* (terminal type 0x0101). Input terminal #1 can accept 2-channel audio streams consisting of left and right channels. Output terminal #2 is defined as a *speaker* (terminal type 0x0301). Input terminal #4 is defined as a *microphone* (terminal type 0x0201). Output terminal #5 is defined as a *USB stream* (terminal type 0x0101). Output terminal #5 can generate 2-channel audio streams consisting of left and right channels. Feature unit #3 supports the following sound control features.

- Volume control
- Mute control

The built-in digital volume controller can be manipulated by an audio-class-specific request from 0 dB to -64 dB in steps of 1 dB. Each channel can be set for different values. The master volume control is not supported. A request to the master volume is stalled and ignored. The built-in digital mute controller can be manipulated by audio-class-specific request. A master mute control request is acceptable. A request to an individual channel is stalled and ignored.

Interface #1

Interface #1 is the audio streaming data-out interface. Interface #1 has the following seven alternative settings. Alternative setting #0 is the zero-bandwidth setting. All other alternative settings are operational settings.

ALTERNATIVE SETTING	DATA FORMAT			TRANSFER MODE	SAMPLING RATE (kHz)
00			Zero bandwid	th	
01	16 bit	Stereo	2s complement (PCM)	Adaptive	32, 44.1, 48
02	16 bit	Mono	2s complement (PCM)	Adaptive	32, 44.1, 48
03	8 bit	Stereo	2s complement (PCM)	Adaptive	32, 44.1, 48
04	8 bit	Mono	2s complement (PCM)	Adaptive	32, 44.1, 48
05	8 bit	Stereo	Offset binary (PCM8)	Adaptive	32, 44.1, 48
06	8 bit	Mono	Offset binary (PCM8)	Adaptive	32, 44.1, 48



Interface #2

Interface #2 is the audio streaming data-in interface. Interface #2 has the following 19 alternative settings. Alternative setting #0 is the zero-bandwidth setting. All other alternative settings are operational settings.

ALTERNATIVE SETTING		DA	TA FORMAT	TRANSFER MODE	SAMPLING RATE (kHz)
00			ZERO BANDW	/IDTH	
01	16 bit	Stereo	2s complement (PCM)	Asynchronous	48
02	16 bit	Mono	2s complement (PCM)	Asynchronous	48
03	16 bit	Stereo	2s complement (PCM)	Asynchronous	44.1
04	16 bit	Mono	2s complement (PCM)	Asynchronous	44.1
05	16 bit	Stereo	2s complement (PCM)	Asynchronous	32
06	16 bit	Mono	2s complement (PCM)	Asynchronous	32
07	16 bit	Stereo	2s complement (PCM)	Asynchronous	22.05
08	16 bit	Mono	2s complement (PCM)	Asynchronous	22.05
09	16 bit	Stereo	2s complement (PCM)	Asynchronous	16
0A	16 bit	Mono	2s complement (PCM)	Asynchronous	16
0B	8 bit	Stereo	2s complement (PCM)	Asynchronous	16
0C	8 bit	Mono	2s complement (PCM)	Asynchronous	16
0D	8 bit	Stereo	2s complement (PCM)	Asynchronous	8
0E	8 bit	Mono	2s complement (PCM)	Asynchronous	8
0F	16 bit	Stereo	2s complement (PCM)	Synchronous	11.025
10	16 bit	Mono	2s complement (PCM)	Synchronous	11.025
11	8 bit	Stereo	2s complement (PCM)	Synchronous	11.025
12	8 bit	Mono	2s complement (PCM)	Synchronous	11.025

Interface #3

Interface #3 is the interrupt data-in interface. Alternative setting #0 is the only possible setting for interface #3. Interface #3 constructs the HID consumer control device. Interface #3 reports the following three key statuses.

- Mute (0xE209)
- Volume up (0xE909)
- Volume down (0xEA09)

End-Points

The PCM2904/2906 has the following four end-points.

- Control end-point (EP #0)
- Isochronous-out audio data stream end-point (EP #2)
- Isochronous-in audio data stream end-point (EP #4)
- HID end-point (EP #5)

The control end-point is a default end-point. The control end-point is used to control all functions of the PCM2904/2906 by the standard USB request and USB audio class specific request from the host. The isochronous-out audio data stream end-point is an audio sink end-point, which receives the PCM audio data. The isochronous-out audio data stream end-point accepts the adaptive transfer mode. The isochronous-in audio data stream end-point is an audio source end-point that transmits the PCM audio data. The isochronous-in audio data stream end-point uses the asynchronous transfer mode. The HID end-point is an interrupt-in end-point. The HID end-point reports HID0, HID1, and HID2 pin status every 32 ms.

The human interface device (HID) pins are defined as consumer control devices. The HID function is designed as an independent end-point from both isochronous-in and -out end-points. This means that the result obtained from the HID operation depends on the host software. Typically, the HID function is used as a primary audio-out device.



Clock and Reset

The PCM2904/2906 requires a 12-MHz (\pm 500 ppm) clock for the USB and audio functions. The clock can be generated by a built-in oscillator with a 12-MHz crystal resonator. The 12-MHz crystal resonator must be connected to XTI (pin 21) and XTO (pin 20) with one high-value (1-M Ω) resistor and two small capacitors, the capacitance of which depends on the load capacitance of the crystal resonator. An external clock can be supplied to XTI (pin 21). If an external clock is used, XTO (pin 20) must be left open. Because there is no clock disabling signal, use of the external clock supply is not recommended. SSPND (pin 28) is unable to use clock disabling.

The PCM2904/2906 has an internal power-on reset circuit, which is triggered automatically when V_{BUS} (pin 3) exceeds 2.5 V typical (2.7 V to 2.2 V). About 700 μ s is required until internal reset release.

Digital Audio Interface (PCM2906)

The PCM2906 employs S/PDIF for both input and output. Isochronous-out data from the host is encoded to the S/PDIF output and the DAC analog output. Input data is selected from either the S/PDIF or ADC analog input. When the device detects S/PDIF input and successfully locks the received data, the isochronous-in transfer data source automatically selected is S/PDIF; otherwise, the data source selected is the ADC analog input.

Supported Input Data (PCM2906)

The following data formats are accepted by S/PDIF for input and output. All other data formats are unusable as S/PDIF.

- 48-kHz 16-bit stereo
- 44.1-kHz 16-bit stereo
- 32-kHz 16-bit stereo

Mismatch between the input data format and the host command may cause unexpected results, with the following exceptions:

- Recording in monaural format from stereo data input at the same data rate
- Recording in 8-bit format from 16-bit data input at the same data rate

A combination of the two foregoing conditions is not accepted.

For playback, all possible data-rate sources are converted to the 16-bit stereo format at the same source data rate.

Channel Status Information (PCM2906)

The channel status information is fixed as consumer application, PCM mode, copyright, and digital/digital converter. All other bits are fixed as 0s except for the sample frequency, which is set automatically according to the data received through the USB.

Copyright Management (PCM2906)

Isochronous-in data is affected by the serial copy management system (SCMS). When the control bit indicates that the received digital audio data is original, the input digital audio data is transferred to the host. If the data is indicated as first generation or higher, the transferred data is routed to the analog input.

Digital audio data output is always encoded as original with SCMS control.

The implementation of this feature is optional. It is the designer's responsibility to determine whether to implement this feature in a product or not.

INTERFACE SEQUENCE

Power-On, Attach, and Playback Sequence

The PCM2904/2906 is ready for setup when the reset sequence has finished and the USB device is attached. After a connection has been established by setup, the PCM2904/PCM2906 is ready to accept USB audio data. While waiting for the audio data (idle state), the analog output is set to bipolar zero (BPZ).

When receiving the audio data, the PCM2904/2906 stores the first audio packet, which contained 1-ms audio data, into the internal storage buffer. The PCM2904/2906 starts playing the audio data when detecting the following start-of-frame (SOF) packet.

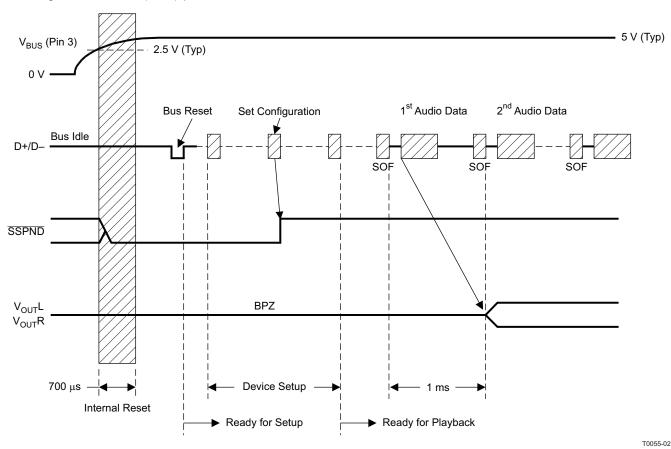


Figure 32. Initial Sequence

Play, Stop, and Detach Sequence

When the host finishes or aborts the playback, the PCM2904/2906 stops playing after the last audio data has played.

Record Sequence

The PCM2904/2906 starts audio capture into the internal memory after receiving the SET_INTERFACE command.

Suspend and Resume Sequence

The PCM2904/2906 enters the suspend state after a constant idle state on the USB bus, approximately 5 ms. While the PCM2904/2906 enters the suspend state, the SSPND flag (pin 28) is asserted. The PCM2904/2906 wakes up immediately on detecting a non-idle state on the USB.



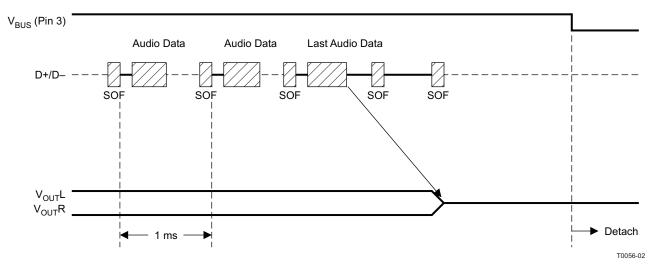


Figure 33. Play, Stop, and Detach

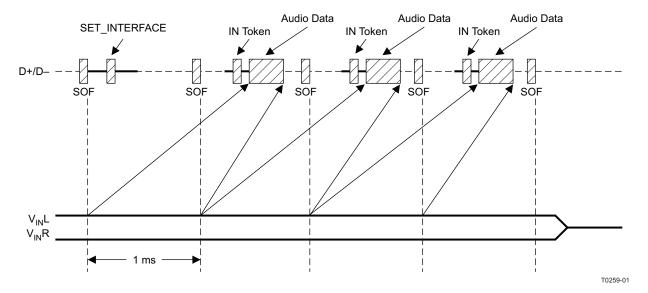


Figure 34. Record Sequence

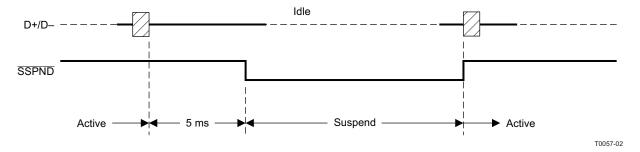
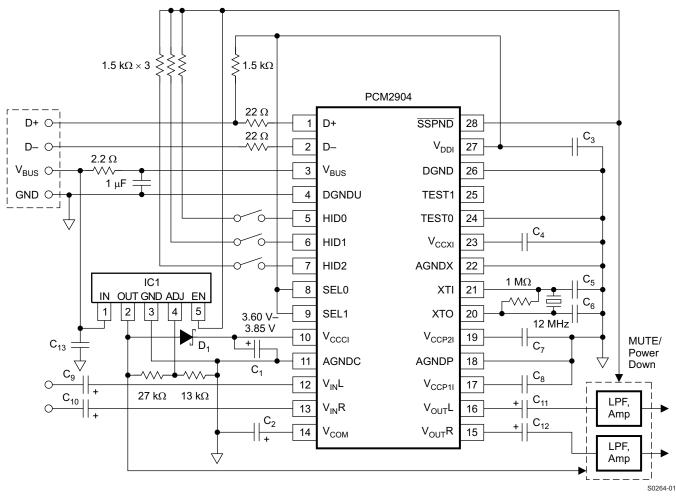


Figure 35. Suspend and Resume



PCM2904 TYPICAL CIRCUIT CONNECTION 1

Figure 36 illustrates a typical circuit connection for a simple application. The circuit illustrated is for information only. The whole board design should be considered to meet the USB specification as a USB compliant product.



NOTE: C₁, C₂: 10 μF

 $C_3,\,C_4,\,C_7,\,C_8,\,C_{13};\,1~\mu F$ (These capacitors must be less than 2 $\mu F.)$

C₅, C₆: 10 pF to 33 pF (depending on crystal resonator)

C₉, C₁₀, C₁₁, C₁₂: The capacitance may vary depending on design.

IC1: REG103xA-A (TI) or equivalent. Analog performance may vary depending on IC1.

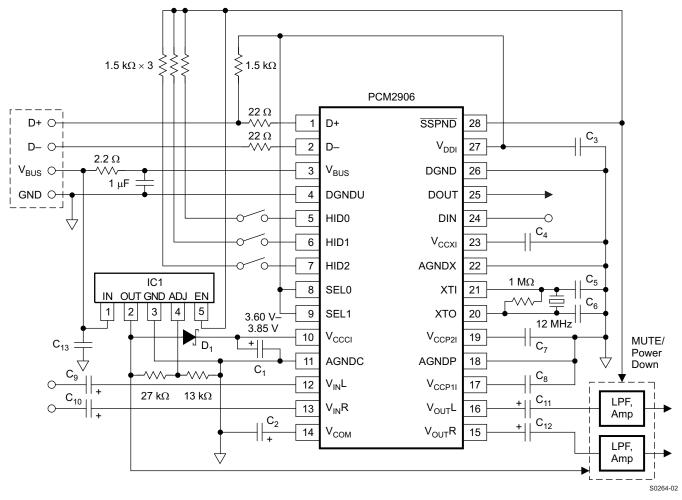
D₁: Schottky barrier diode ($V_F \le 350 \text{ mV}$ at 10 mA, $I_R \le 2 \mu A$ at 4 V)

Figure 36. Bus-Powered Configuration for High-Performance PCM2904 Application



PCM2906 TYPICAL CIRCUIT CONNECTION 1

Figure 37 illustrates a typical circuit connection for a simple application. The circuit illustrated is for information only. The whole board design should be considered to meet the USB specification as a USB compliant product.



NOTE: C_1 , C_2 : 10 μF

 $C_3,\,C_4,\,C_7,\,C_8,\,C_{13};\,1~\mu F$ (These capacitors must be less than 2 $\mu F.)$

C₅, C₆: 10 pF to 33 pF (depending on crystal resonator)

C₉, C₁₀, C₁₁, C₁₂: The capacitance may vary depending on design.

IC1: REG103xA-A (TI) or equivalent. Analog performance may vary depending on IC1.

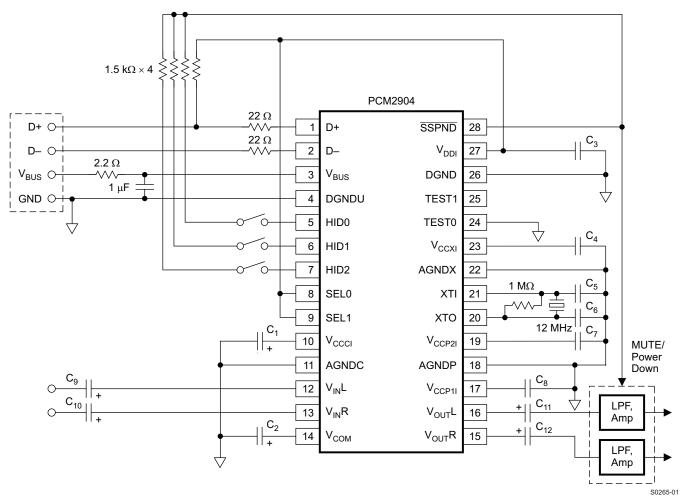
D₁: Schottky barrier diode ($V_F \le 350 \text{ mV}$ at 10 mA, $I_R \le 2 \mu A$ at 4 V)

Figure 37. Bus-Powered Configuration for High-Performance PCM2906 Application



PCM2904 TYPICAL CIRCUIT CONNECTION 2

Figure 38 illustrates a typical circuit connection for a simple application. The circuit illustrated is for information only. The whole board design should be considered to meet the USB specification as a USB compliant product.



NOTE: C_1 , C_2 : 10 μF

 $C_3,\,C_4,\,C_7,\,C_8{:}$ 1 μF (These capacitors must be less than 2 $\mu F.)$

C₅, C₆: 10 pF to 33 pF (depending on crystal resonator)

C₉, C₁₀, C₁₁, C₁₂: The capacitance may vary depending on design.

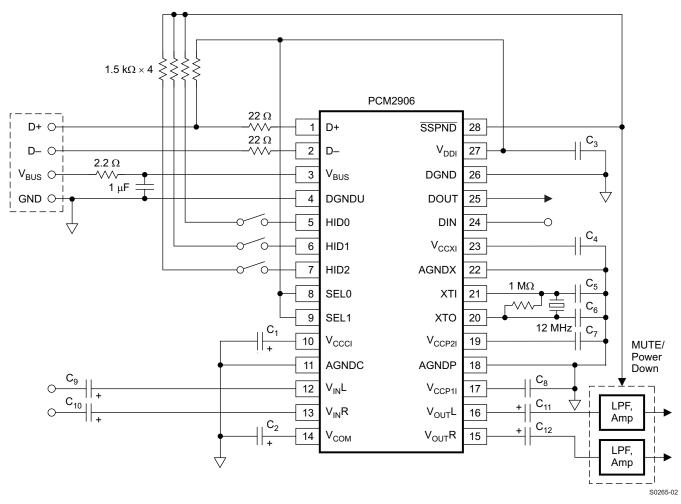
In this case, the analog performance of the A/D converter may be degraded.

Figure 38. PCM2904 Bus-Powered Configuration



PCM2906 TYPICAL CIRCUIT CONNECTION 2

Figure 39 illustrates a typical circuit connection for a simple application. The circuit illustrated is for information only. The whole board design should be considered to meet the USB specification as a USB compliant product.



NOTE: C_1 , C_2 : 10 μF

 $C_3,\,C_4,\,C_7,\,C_8{:}$ 1 μF (These capacitors must be less than 2 $\mu F.)$

C₅, C₆: 10 pF to 33 pF (depending on crystal resonator)

C₉, C₁₀, C₁₁, C₁₂: The capacitance may vary depending on design.

In this case, the analog performance of the A/D converter may be degraded.

Figure 39. PCM2906 Bus-Powered Configuration



APPLICATION INFORMATION

OPERATING ENVIRONMENT

For current information on the PCM2904/2906 operating environment, see the *Updated Operating Environments* for PCM270X, PCM290X Applications application report, SLAA374.



REVISION HISTORY

Changes from Revision B (March 2007) to Revision C		Page
•	Deleted operating environment information from data sheet and added reference to application report	30

DB (R-PDSO-G**)

PLASTIC SMALL-OUTLINE

28 PINS SHOWN



NOTES: A. All linear dimensions are in millimeters.

B. This drawing is subject to change without notice.

C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.

D. Falls within JEDEC MO-150

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