Stereo Audio Codec with USB Interface, Single-Ended Analog Input/Output, and S/PDIF

Check for Samples: PCM2906C

FEATURES

- On-Chip USB Interface:
  - With Full-Speed Transceivers
  - Fully Compliant with USB 2.0 Specification
  - Certified by USB-IF
  - 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
- S/PDIF Input/Output
- 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:
    - Passband Ripple = ±0.05 dB
    - Stop-Band Attenuation = –65 dB
  - Single-Ended Voltage Input
  - Antialiasing Filter Included
  - Digital HPF Included
- Stereo DAC:
  - Analog Performance at V_{BUS} = 5 V:
    - THD+N = 0.005%
    - SNR = 96 dB
    - Dynamic Range = 93 dB
  - Oversampling Digital Filter:
    - Passband Ripple = ±0.1 dB
    - Stop-Band Attenuation = –43 dB
  - Single-Ended Voltage Output
  - Analog LPF Included
- Multifunctions:
  - Human Interface Device (HID) Function:
    - Volume and Mute Controls
  - Suspend Flag Function
- 28-Pin SSOP Package

APPLICATIONS

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

DESCRIPTION

The PCM2906C is Texas Instruments' single-chip, USB, stereo audio codec with a USB-compliant full-speed protocol controller and S/PDIF. The USB protocol controller requires no software code. The PCM2906C 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, as well as 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.

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System Two, Audio Precision are trademarks of Audio Precision, Inc.
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PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of the Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

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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(1)

PRODUCT	PACKAGE-LEAD	PACKAGE DESIGNATOR	SPECIFIED TEMPERATURE RANGE	PACKAGE MARKING	ORDERING NUMBER	TRANSPORT MEDIA, QUANTITY
PCM2906CDB	SSOP-28	DB	–25°C to +85°C	PCM2906C	PCM2906CDB	Rails, 47
					PCM2906CDBR	Tape and Reel, 2000

(1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI website at www.ti.com.

ABSOLUTE MAXIMUM RATINGS(1)

Over operating free-air temperature range (unless otherwise noted).

PARAMETER		PCM2906C	UNIT
Supply voltage, V_{BUS}		–0.3 to 6.5	V
Ground voltage differences, AGNDC, AGNDP, AGNDX, DGND, DGNDU		±0.1	V
Digital input voltage	SEL0, SEL1, DIN	–0.3 to 6.5	V
	D+, D–, HID0, HID1, HID2, XTI, XTO, DOUT, $\overline{SSPND}$	–0.3 to (V_{DDI} + 0.3) < 4	
Analog input voltage	$V_{IN}L$, $V_{IN}R$, V_{COM}, $V_{OUT}R$, $V_{OUT}L$	–0.3 to (V_{CCCI} + 0.3) < 4	V
	V_{CCCI}, V_{CCP1I}, V_{CCP2I}, V_{CCXI}, V_{DDI}	–0.3 to 4	
Input current (any pins except supplies)		±10	mA
Ambient temperature under bias		–40 to +125	°C
Storage temperature, T_{stg}		–55 to +150	°C
Junction temperature, T_J		+150	°C
Lead temperature (soldering, 5s)		+260	°C
Package temperature (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 is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

THERMAL INFORMATION

THERMAL METRIC(1)		PCM2906C DB (SSOP) 28 PINS	UNITS
θ_{JA}	Junction-to-ambient thermal resistance	64.5	°C/W
θ_{JCtop}	Junction-to-case (top) thermal resistance	24.5	
θ_{JB}	Junction-to-board thermal resistance	25.4	
ψ_{JT}	Junction-to-top characterization parameter	2.0	
ψ_{JB}	Junction-to-board characterization parameter	25.0	
θ_{JCbot}	Junction-to-case (bottom) thermal resistance	N/A	

(1) For more information about traditional and new thermal metrics, see the *IC Package Thermal Metrics* application report, SPRA953.

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ELECTRICAL CHARACTERISTICS

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

PARAMETER		TEST CONDITIONS	PCM2906C MIN	PCM2906C TYP	PCM2906C MAX	UNIT
DIGITAL INPUT/OUTPUT						
Host interface		Apply USB Revision 2.0, full speed				
Audio data format		USB isochronous data format				
INPUT LOGIC						
V_{IH} (1)	Input logic level		2		3.3	VDC
V_{IL} (1)					0.8	
V_{IH} (2) (3)			2.52		3.3	
V_{IL} (2) (3)					0.9	
V_{IH} (4)			2		5.25	
V_{IL} (4)					0.8	
V_{IH} (5)			2.52		5.25	
V_{IL} (5)					0.9	
I_{IH} (1) (2) (4)	Input logic current	V_{IN} = 3.3 V			±10	µA
I_{IL} (1) (2) (4)		V_{IN} = 0 V			±10	
I_{IH} (3)		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)	Output logic level		2.8			VDC
V_{OL} (1)					0.3	
V_{OH} (6)		I_{OH} = –4 mA	2.8			
V_{OL} (6)		I_{OL} = 4 mA			0.5	
V_{OH} (7)		I_{OH} = –2 mA	2.8			
V_{OL} (7)		I_{OL} = 2 mA			0.5	
CLOCK FREQUENCY						
Input clock frequency, XTI			11.994	12	12.006	MHz

(1) Pins 1, 2: D+, D–.
(2) Pin 21: XTI.
(3) Pins 5, 6, 7: HID0, HID1, HID2.
(4) Pins 8, 9: SEL0, SEL1.
(5) Pin 24: DIN.
(6) Pin 25: $\overline{\text{DOUT}}$.
(7) Pin 28: $\overline{\text{SSPND}}$.

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ELECTRICAL CHARACTERISTICS (continued)

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

PARAMETER		TEST CONDITIONS	PCM2906C MIN	PCM2906C TYP	PCM2906C MAX	UNIT
ADC CHARACTERISTICS						
	Resolution			8, 16		Bits
	Audio data channel			1, 2		Channel
ADC Clock Frequency						
f_S	Sampling frequency			8, 11.025, 16, 22.05, 32, 44.1, 48		kHz
ADC DC Accuracy						
	Gain mismatch, channel-to-channel			±1	±5	% of FSR
	Gain error			±2	±10	% of FSR
	Bipolar zero error			±0		% of FSR
ADC Dynamic Performance(8)						
THD+N	Total harmonic distortion plus noise	V_{IN} = –1 dB(9), V_{CCCI} = 3.67 V		0.01	0.02	%
		V_{IN} = –1 dB(10)		0.1		%
		V_{IN} = –60 dB		5		%
	Dynamic range	A-weighted	81	89		dB
SNR	Signal-to-noise ratio	A-weighted	81	89		dB
	Channel separation		80	85		dB
Analog Input						
	Input voltage			0.6 V_{CCCI}		V_{PP}
	Center voltage			0.5 V_{CCCI}		V
	Input impedance			30		kΩ
	Antialiasing filter frequency response	–3 dB		150		kHz
		f_{IN} = 20 kHz		–0.08		dB
ADC Digital Filter Performance						
	Passband				0.454 f_S	Hz
	Stop band		0.583 f_S			Hz
	Passband ripple				±0.05	dB
	Stop-band attenuation		–65			dB
t_d	Delay time			17.4/f_S		s
	HPF frequency response	–3 dB		0.078f_S/1000		Hz

(8) f_{IN} = 1 kHz, using the System Two™ audio measurement system by Audio Precision™ in RMS mode with 20-kHz LPF, 400-Hz HPF in calculation.
(9) Using external voltage regulator for V_{CCCI} (see Figure 36).
(10) Using internal voltage regulator for V_{CCCI} (see Figure 37).

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ELECTRICAL CHARACTERISTICS (continued)

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

PARAMETER		TEST CONDITIONS	PCM2906C MIN	PCM2906C TYP	PCM2906C MAX	UNIT
DAC CHARACTERISTICS						
	Resolution			8, 16		Bits
	Audio data channel			1, 2		Channel
DAC Clock Frequency						
f_s	Sampling frequency			32, 44.1, 48		kHz
DAC DC Accuracy						
	Gain mismatch, channel-to-channel			±1	±5	% of FSR
	Gain error			±2	±10	% of FSR
	Bipolar zero error			±2		% of FSR
DAC Dynamic Performance(11)						
THD+N	Total harmonic distortion plus noise	V_{OUT} = 0 dB		0.005	0.016	%
		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
Analog Output						
V_O	Output voltage			0.6 V_{CCCI}		V_{PP}
	Center voltage			0.5 V_{CCCI}		V
	Load impedance	AC coupling	10			kΩ
	LPF frequency response	–3 dB		250		kHz
		f = 20 kHz		–0.03		dB
DAC Digital Filter Performance						
	Passband				0.445 f_s	Hz
	Stop band		0.555 f_s			Hz
	Passband ripple				±0.1	dB
	Stop-band attenuation		–43			dB
t_d	Delay time			14.3 f_s		s
POWER-SUPPLY REQUIREMENTS						
V_{BUS}	Voltage range		4.35	5	5.25	VDC
	Supply current	ADC, DAC operation		56	67	mA
		Suspend mode(12)		250		µA
P_D	Power dissipation	ADC, DAC operation		280	352	mW
		Suspend mode(12)		1.25		mW
	Internal power-supply voltage(13)		3.1	3.3	3.5	VDC
TEMPERATURE RANGE						
	Operating temperature range		–25		+85	°C

(11) f_{OUT} = 1 kHz, using the System Two audio measurement system by Audio Precision in RMS mode with 20-kHz LPF, 400-Hz HPF.
(12) In USB suspend state.
(13) Pins 10, 17, 19, 23, 27: V_{CCCI}, V_{CCP1I}, V_{CCP2I}, V_{CCXI}, V_{DDI}.

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PIN ASSIGNMENTS

DB PACKAGE
SSOP-28
(TOP VIEW)

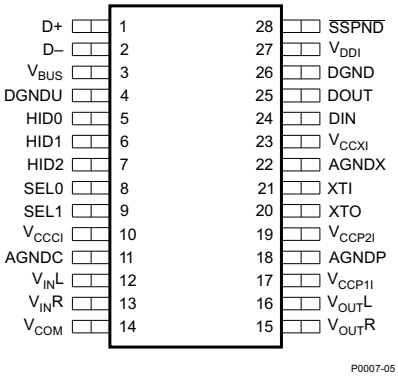


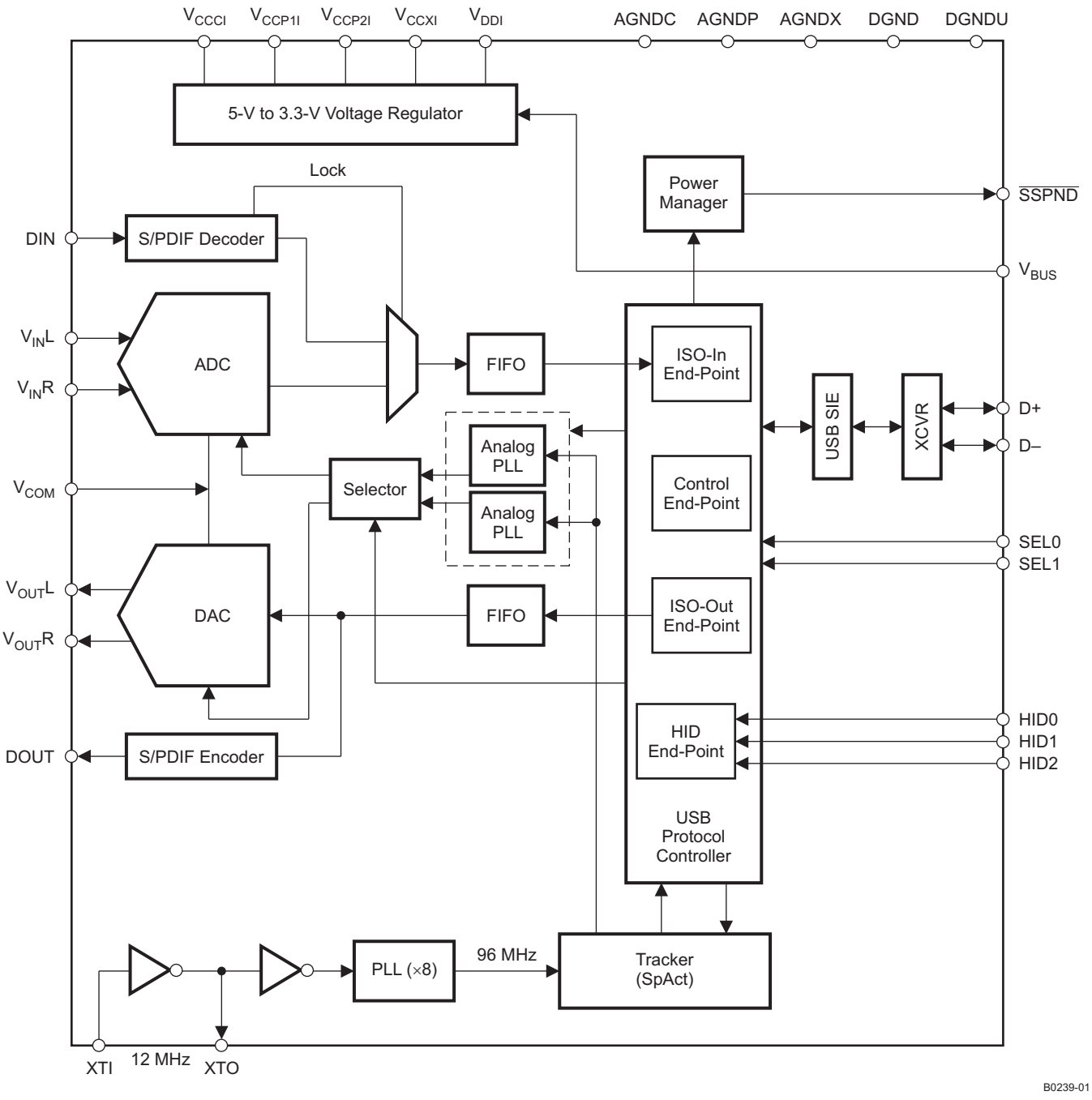
Table 1. TERMINAL FUNCTIONS

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
DIN	24	I	S/PDIF input(2)
DOUT	25	O	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)
$\overline{\text{SSPND}}$	28	O	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	I	ADC analog input for L-channel
$V_{IN}R$	13	I	ADC analog input for R-channel
$V_{OUT}L$	16	O	DAC analog output for L-channel
$V_{OUT}R$	15	O	DAC analog output for R-channel
XTI	21	I	Crystal oscillator input(6)
XTO	20	O	Crystal oscillator output

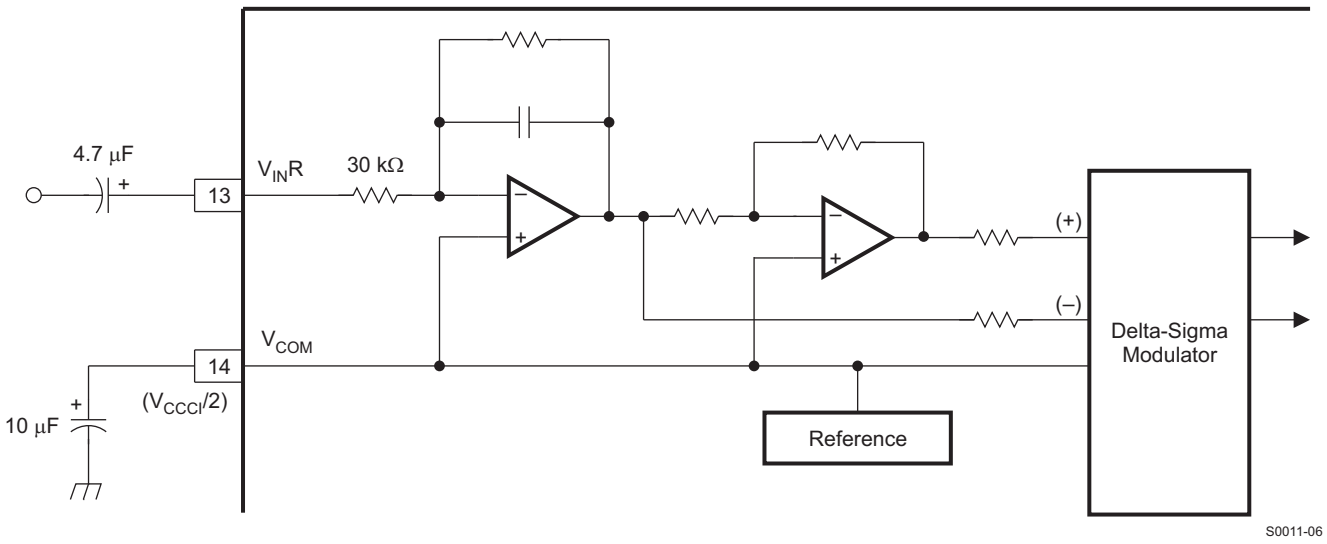
(1) LV-TTL level.
(2) 3.3-V CMOS-level input with internal pulldown, 5-V tolerant.
(3) 3.3-V CMOS-level input with internal pulldown. This pin informs the PC of serviceable control signals such as mute, volume up, or volume down, which have no direct connection with the internal DAC or ADC. See the *Interface #3* and *End-Points* sections.
(4) TTL Schmitt trigger, 5-V tolerant.
(5) Connect a decoupling capacitor to GND.
(6) 3.3-V CMOS-level input.

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FUNCTIONAL BLOCK DIAGRAM



BLOCK DIAGRAM OF ANALOG FRONT-END (RIGHT CHANNEL)



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TYPICAL CHARACTERISTICS: ADC

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.

TOTAL HARMONIC DISTORTION + NOISE AT –1 dB vs FREE-AIR TEMPERATURE

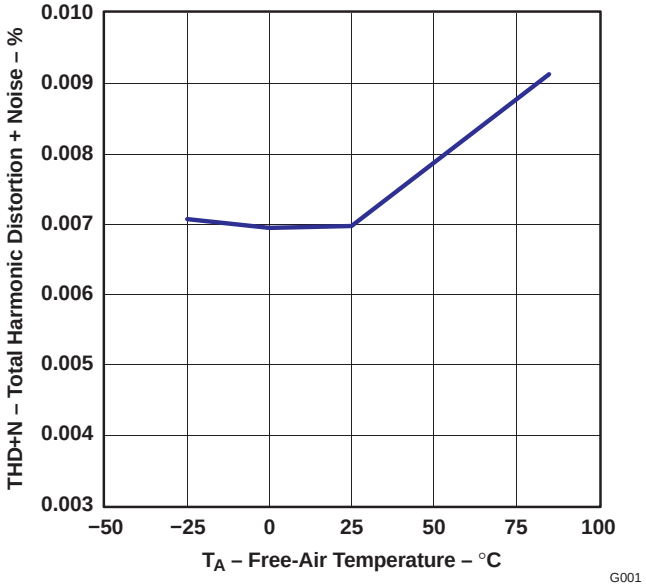


Figure 1.

DYNAMIC RANGE and SNR vs FREE-AIR TEMPERATURE

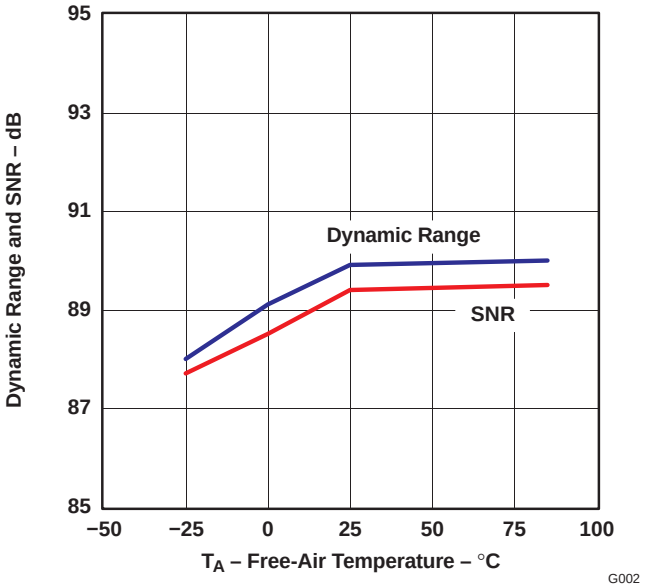


Figure 2.

TOTAL HARMONIC DISTORTION + NOISE AT –1 dB vs SUPPLY VOLTAGE

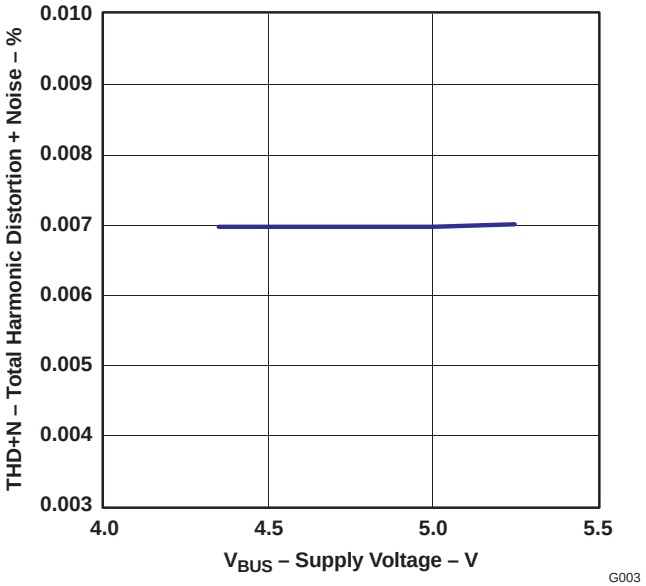


Figure 3.

DYNAMIC RANGE and SNR vs SUPPLY VOLTAGE

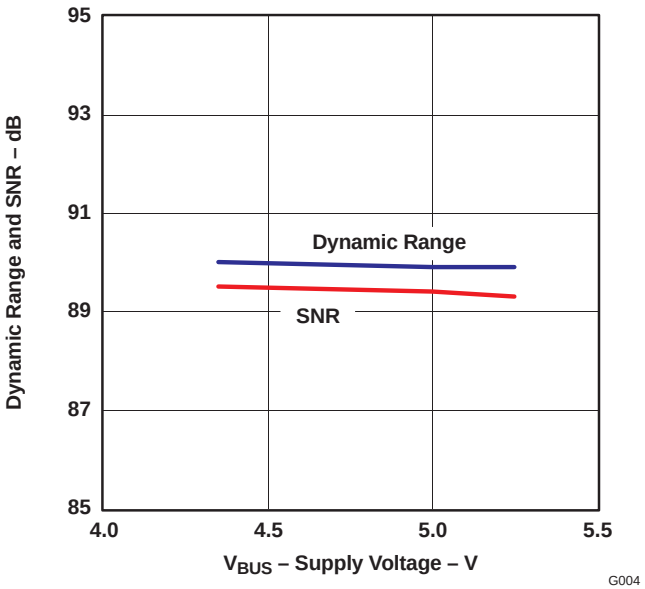


Figure 4.

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TYPICAL CHARACTERISTICS: ADC (continued)

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.

TOTAL HARMONIC DISTORTION + NOISE AT –1 dB vs SAMPLING FREQUENCY

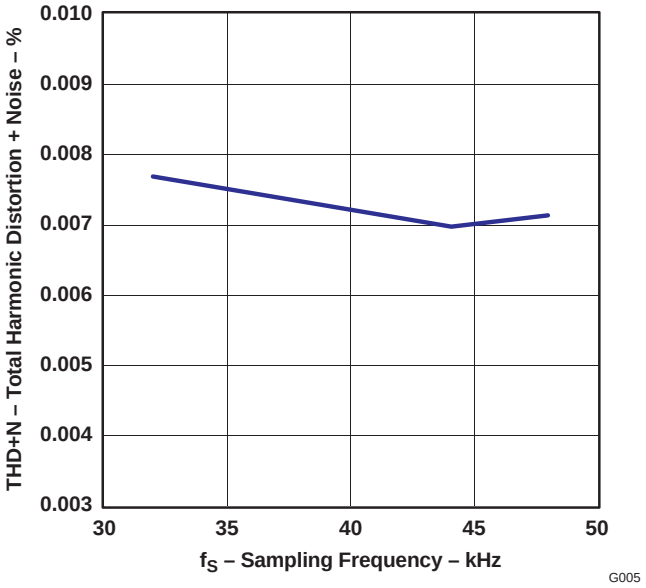


Figure 5.

DYNAMIC RANGE and SNR vs SAMPLING FREQUENCY

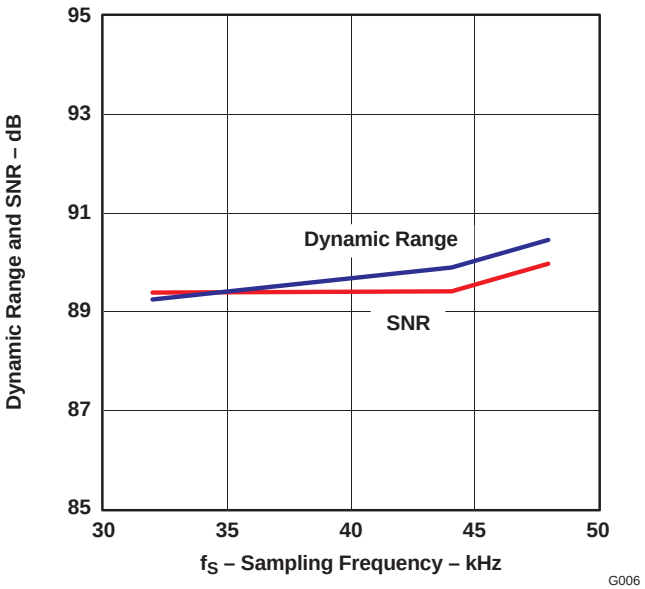


Figure 6.

TYPICAL CHARACTERISTICS: 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.

TOTAL HARMONIC DISTORTION + NOISE AT 0 dB vs FREE-AIR TEMPERATURE

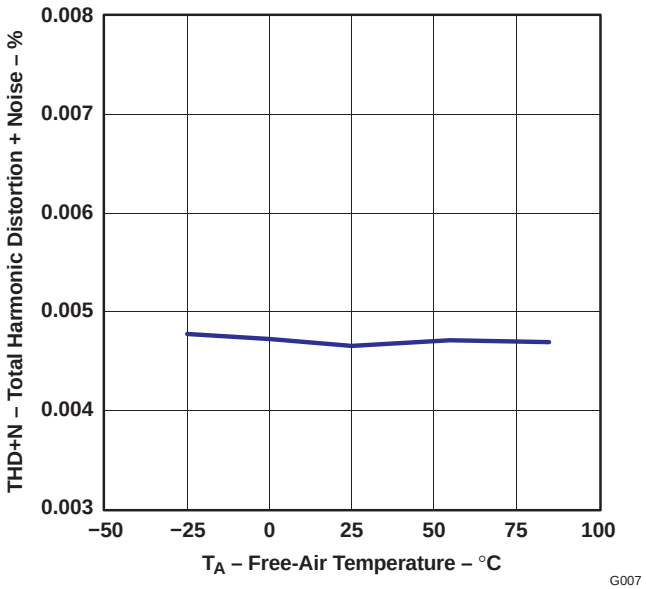


Figure 7.

DYNAMIC RANGE and SNR vs FREE-AIR TEMPERATURE

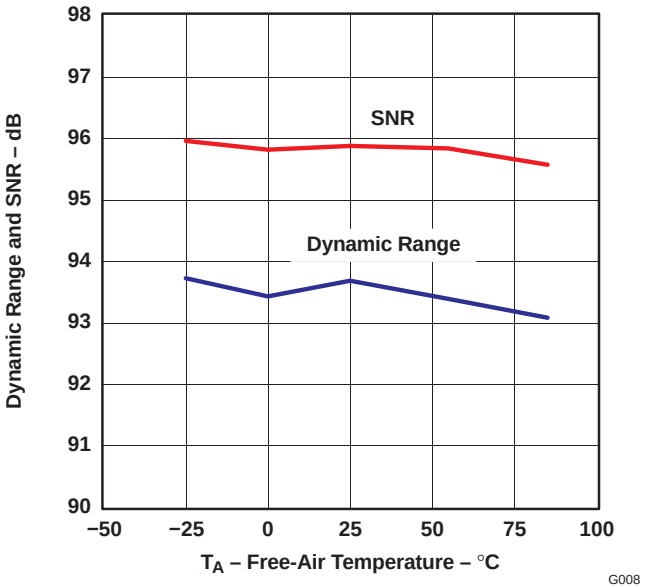


Figure 8.

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TYPICAL CHARACTERISTICS: DAC (continued)

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.

TOTAL HARMONIC DISTORTION + NOISE AT 0 dB vs SUPPLY VOLTAGE

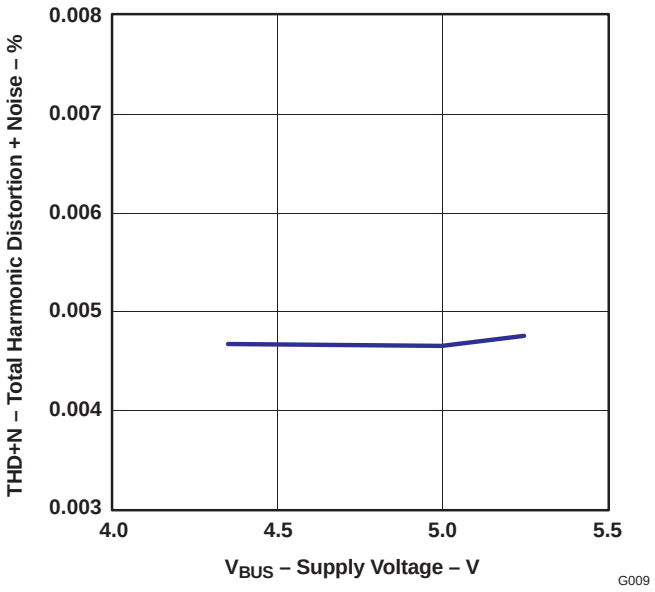


Figure 9.

DYNAMIC RANGE and SNR vs SUPPLY VOLTAGE

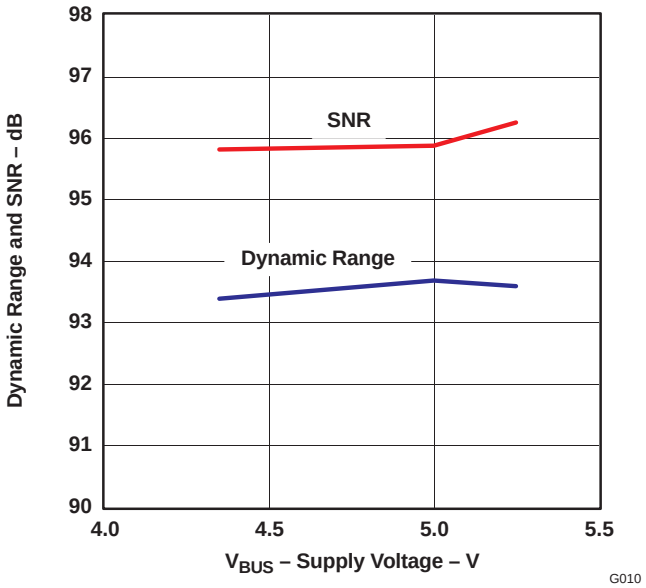


Figure 10.

TOTAL HARMONIC DISTORTION + NOISE AT 0 dB vs SAMPLING FREQUENCY

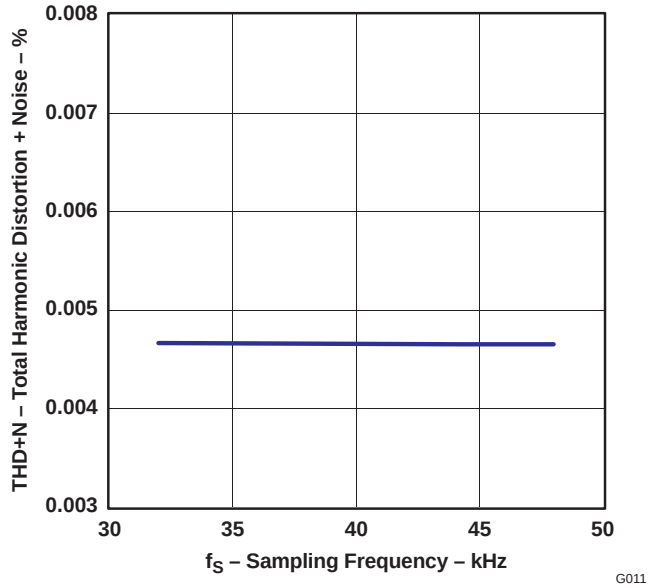


Figure 11.

DYNAMIC RANGE and SNR vs SAMPLING FREQUENCY

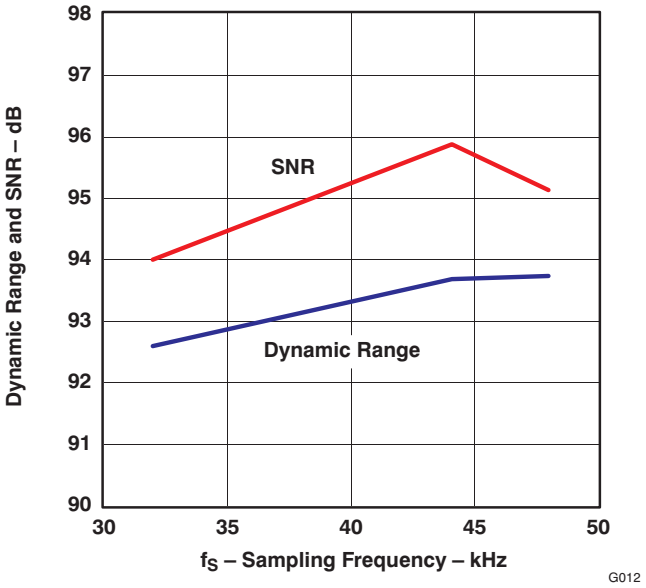


Figure 12.

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TYPICAL CHARACTERISTICS: SUPPLY CURRENT

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.

OPERATIONAL and SUSPEND SUPPLY CURRENT vs SUPPLY VOLTAGE

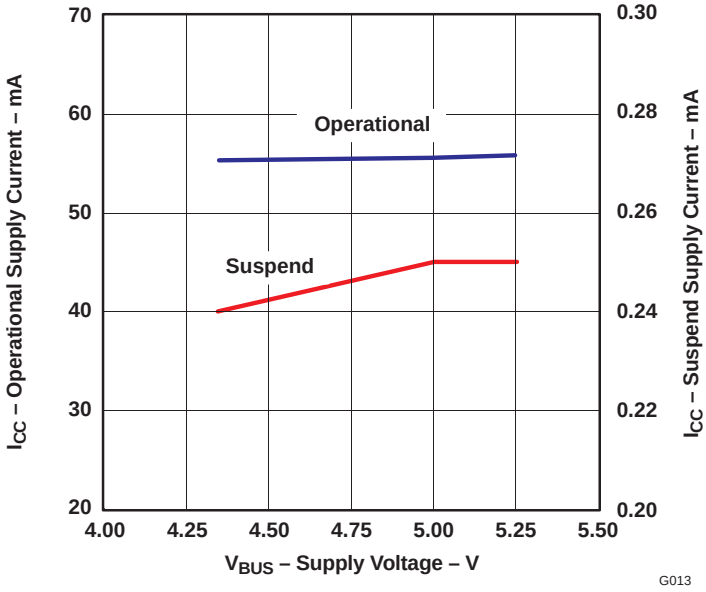


Figure 13.

OPERATIONAL SUPPLY CURRENT vs SAMPLING FREQUENCY

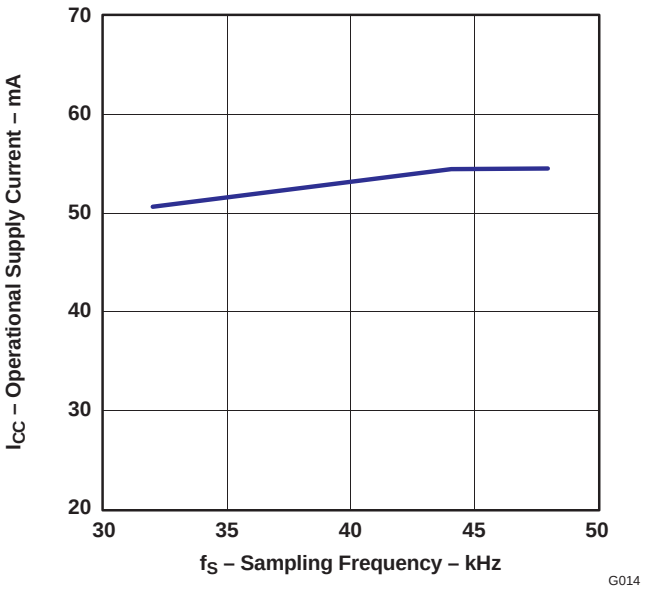


Figure 14.

SUSPEND SUPPLY CURRENT vs FREE-AIR TEMPERATURE

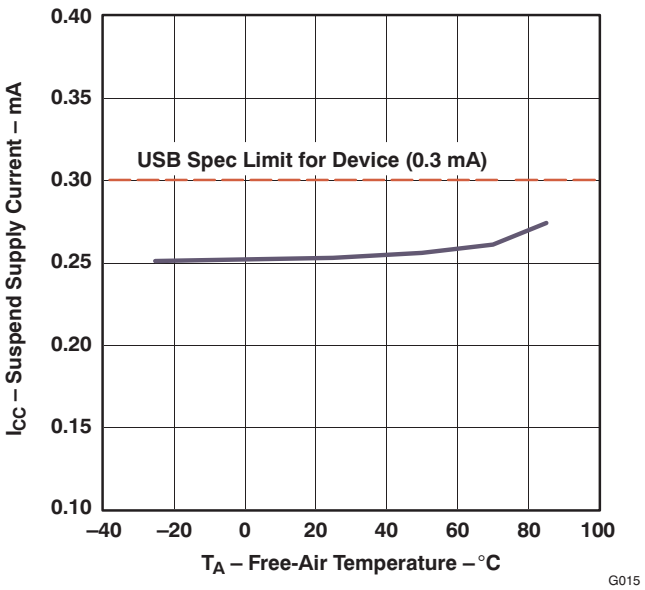


Figure 15.

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TYPICAL CHARACTERISTICS: ADC DIGITAL DECIMATION FILTER FREQUENCY 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.

OVERALL CHARACTERISTICS

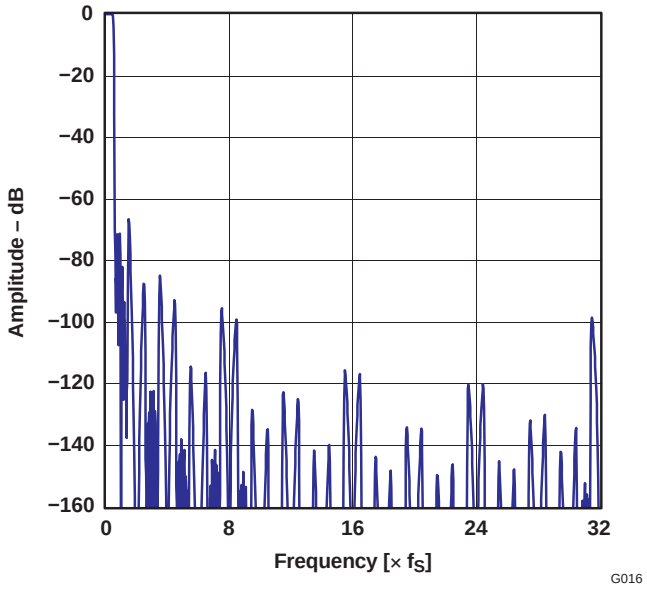


Figure 16.

STOP-BAND ATTENUATION

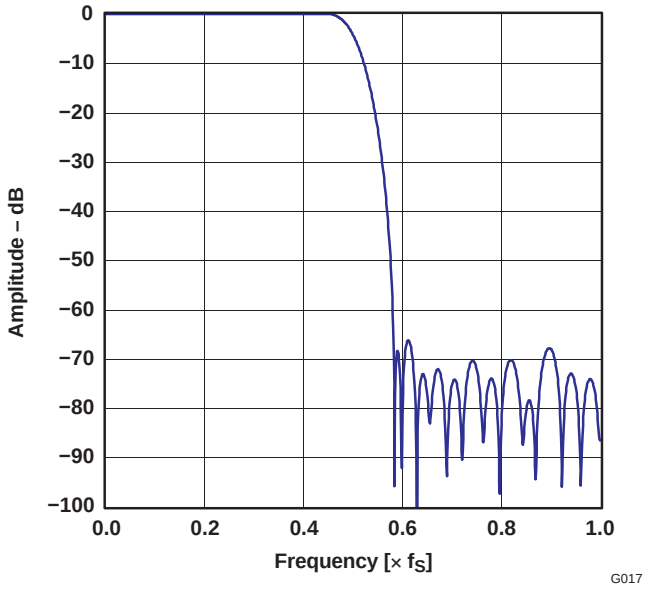


Figure 17.

PASSBAND RIPPLE

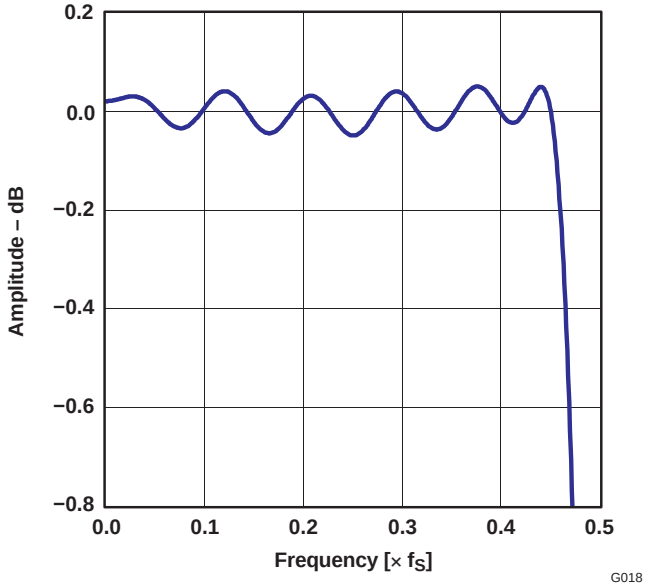


Figure 18.

TRANSITION-BAND RESPONSE

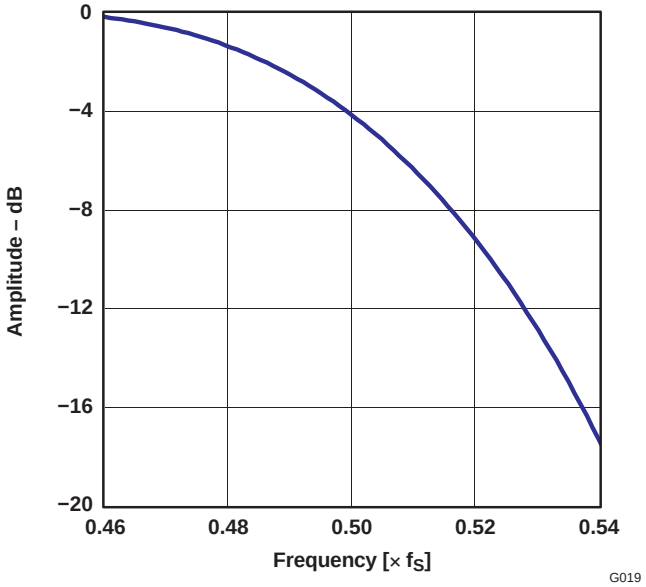


Figure 19.

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TYPICAL CHARACTERISTICS: ADC DIGITAL HIGH-PASS FILTER FREQUENCY 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.

STOP-BAND CHARACTERISTICS

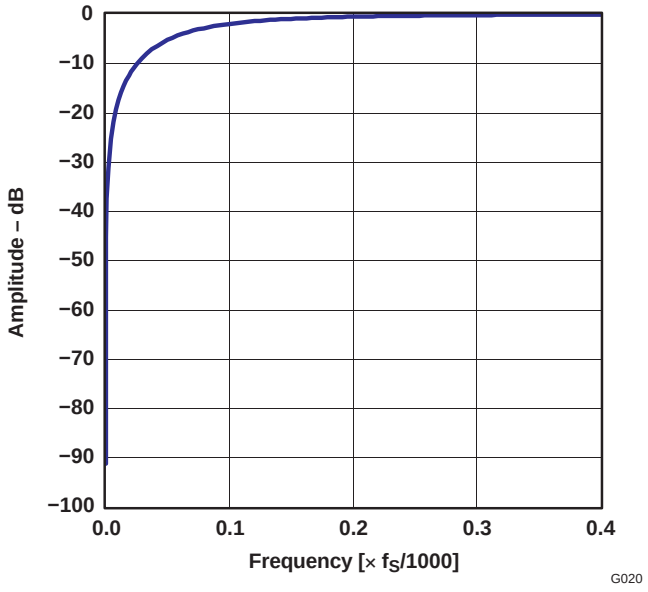


Figure 20.

PASSBAND CHARACTERISTICS

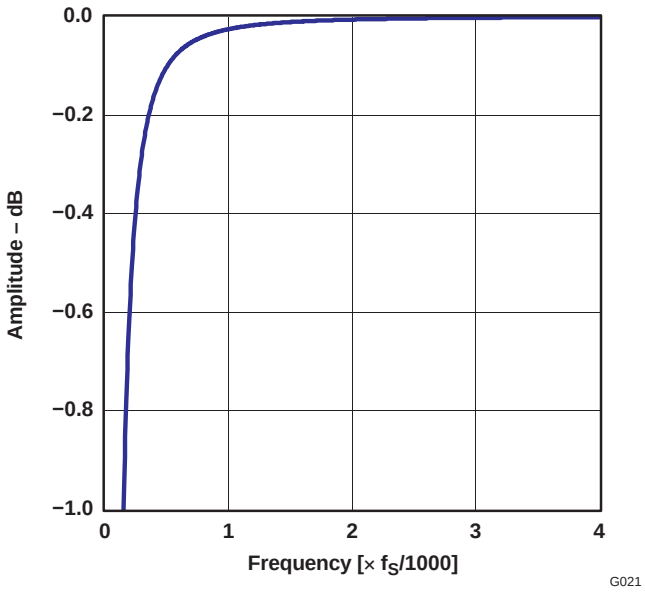


Figure 21.

TYPICAL CHARACTERISTICS: ADC ANALOG ANTIALIASING FILTER FREQUENCY 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.

STOP-BAND CHARACTERISTICS

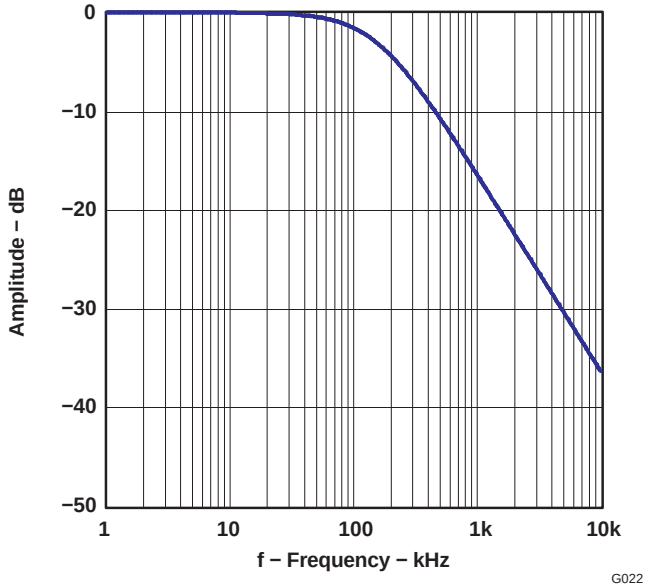


Figure 22.

PASSBAND CHARACTERISTICS

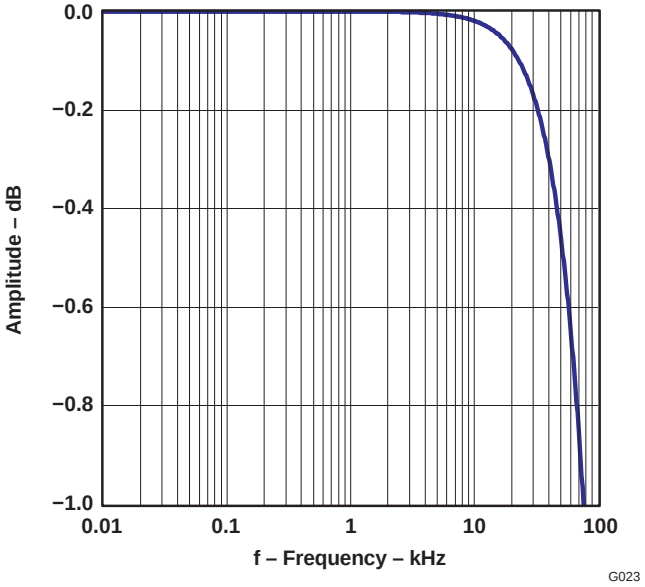


Figure 23.

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TYPICAL CHARACTERISTICS: DAC DIGITAL INTERPOLATION FILTER FREQUENCY 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.

STOP-BAND ATTENUATION

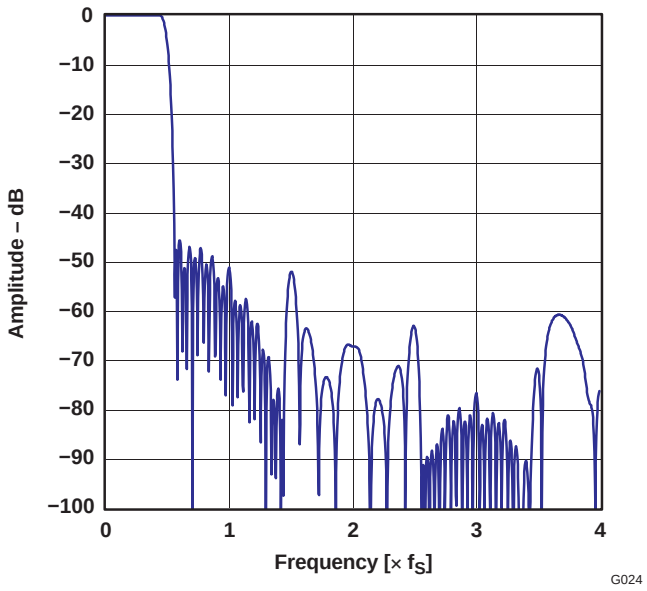


Figure 24.

PASSBAND RIPPLE

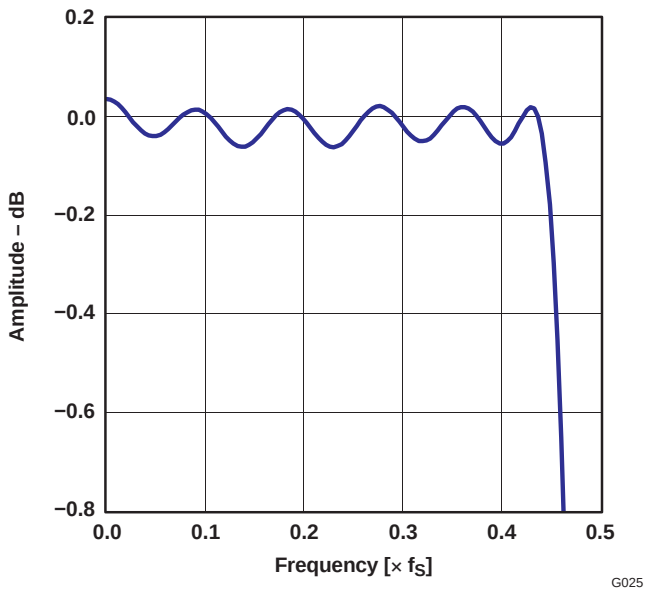


Figure 25.

TRANSITION-BAND RESPONSE

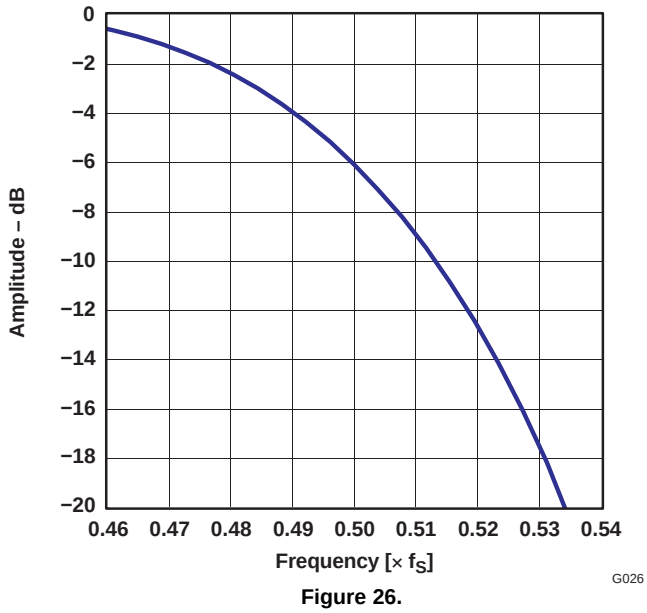


Figure 26.

TYPICAL CHARACTERISTICS: DAC ANALOG FIR FILTER FREQUENCY 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.

STOP-BAND CHARACTERISTICS

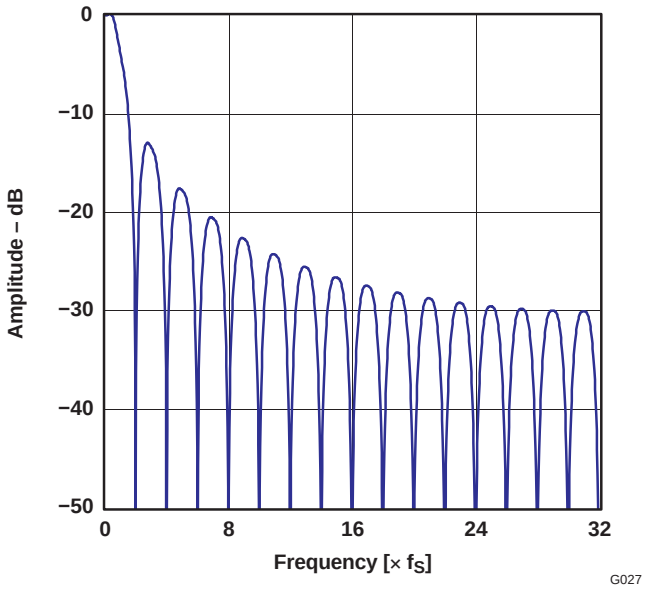


Figure 27.

PASSBAND CHARACTERISTICS

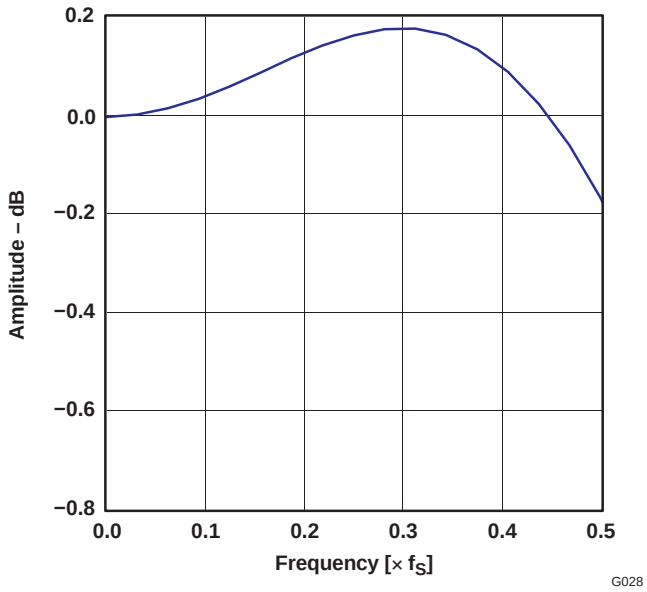


Figure 28.

TYPICAL CHARACTERISTICS: DAC ANALOG LOW-PASS FILTER FREQUENCY 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.

STOP-BAND CHARACTERISTICS

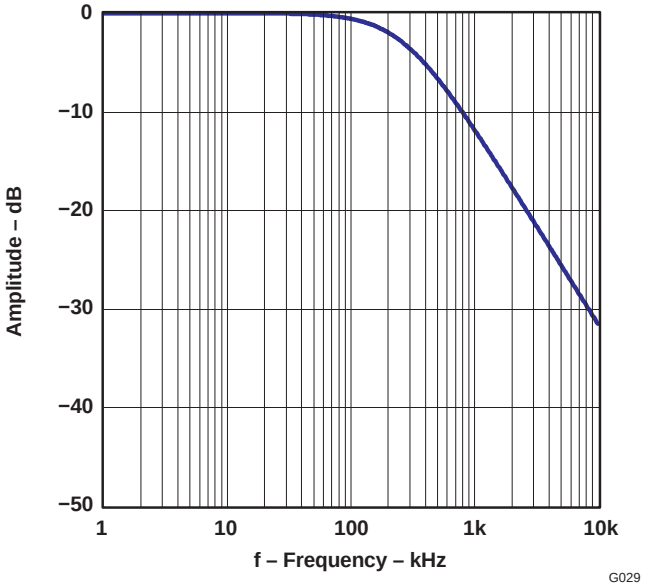


Figure 29.

PASSBAND CHARACTERISTICS

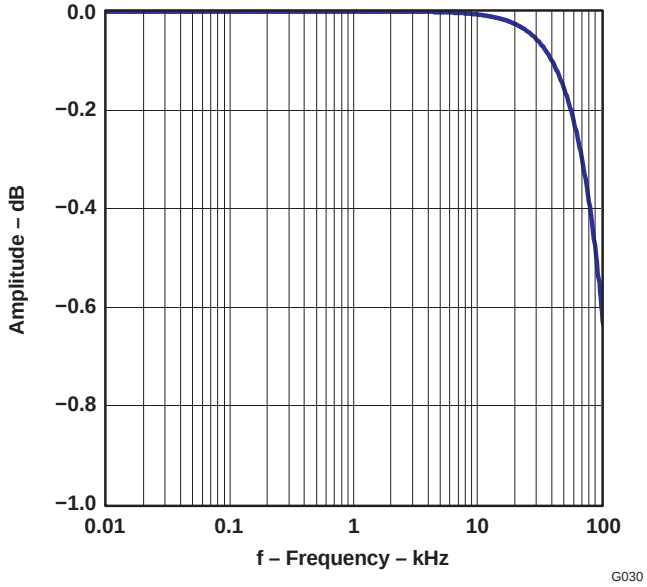


Figure 30.

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DETAILED DESCRIPTION

USB INTERFACE

Control data and audio data are transferred to the PCM2906C via D+ (pin 1) and D– (pin 2). All data to/from the PCM2906C are transferred at full speed. The device descriptor contains the information described in Table 2.

Table 2. Device Descriptor

USB revision	2.0 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
Product ID	0x29C6
Device release number	1.0 (0x0100)
Number of configurations	1
Vendor string	String #1 (see Table 4)
Product string	String #2 (see Table 4)
Serial number	Not supported

The configuration descriptor contains the information described in Table 3.

Table 3. Configuration Descriptor

Interface	Four interfaces
Power attribute	0x80 (Bus powered, no remote wakeup)
Max power	0xFA (500 mA)

The string descriptor contains the information described in Table 4.

Table 4. String Descriptor

#0	0x0409
#1	BurrBrown from Texas Instruments
#2	USB AUDIO CODEC

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DEVICE CONFIGURATION

Figure 31 illustrates the USB audio function topology. The PCM2906C has four interfaces. Each interface consists of alternative settings.

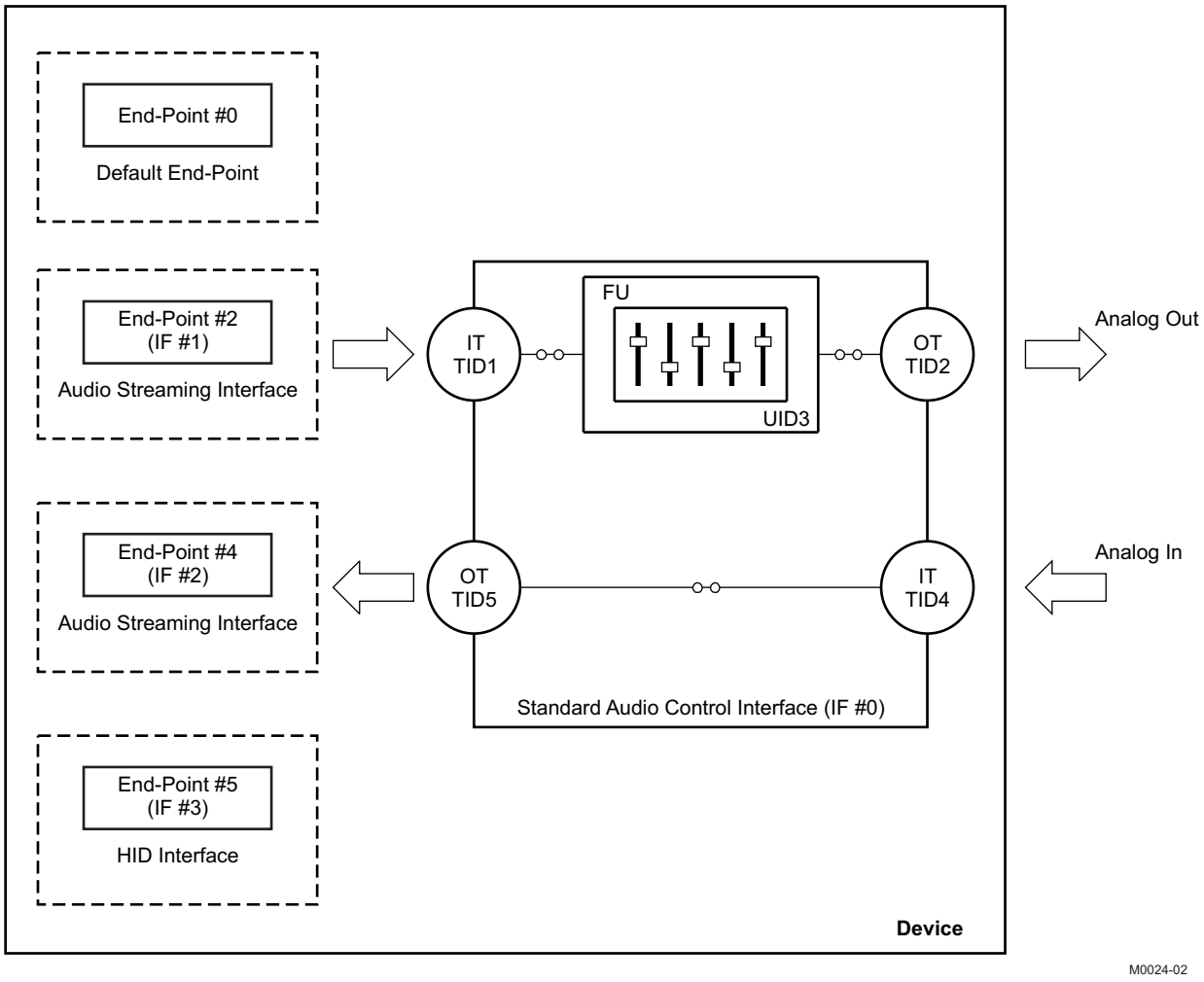


Figure 31. USB Audio Function Topology

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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 consists of a single terminal. The PCM2906C 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 two-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 *line connector* (terminal type 0x0603). Output terminal #5 is defined as a *USB stream* (terminal type 0x0101). Output terminal #5 can generate two-channel audio streams composed of left and right channel data. 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 1-dB steps. Changes are made by incrementing or decrementing by one step (1 dB) for every $1/f_S$ time interval until the volume level has reached the requested value. 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 five alternative settings listed in Table 5. Alternative setting #0 is the zero-bandwidth setting. All other alternative settings are operational settings.

Table 5. Interface #1 Alternative Settings

ALTERNATIVE SETTING	DATA FORMAT			TRANSFER MODE	SAMPLING RATE (kHz)
00	Zero bandwidth				
01	16-bit	Stereo	Twos complement (PCM)	Adaptive	32, 44.1, 48
02	16-bit	Mono	Twos complement (PCM)	Adaptive	32, 44.1, 48
03	8-bit	Stereo	Twos complement (PCM)	Adaptive	32, 44.1, 48
04	8-bit	Mono	Twos complement (PCM)	Adaptive	32, 44.1, 48

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Interface #2

Interface #2 is the audio streaming data-in interface. Interface #2 has the 19 alternative settings listed in Table 6. Alternative setting #0 is the zero-bandwidth setting. All other alternative settings are operational settings.

Table 6. Interface #2 Alternative Settings

ALTERNATIVE SETTING	DATA FORMAT			TRANSFER MODE	SAMPLING RATE (kHz)
00	Zero Bandwidth				
01	16-bit	Stereo	Twos complement (PCM)	Asynchronous	48
02	16-bit	Mono	Twos complement (PCM)	Asynchronous	48
03	16-bit	Stereo	Twos complement (PCM)	Asynchronous	44.1
04	16-bit	Mono	Twos complement (PCM)	Asynchronous	44.1
05	16-bit	Stereo	Twos complement (PCM)	Asynchronous	32
06	16-bit	Mono	Twos complement (PCM)	Asynchronous	32
07	16-bit	Stereo	Twos complement (PCM)	Asynchronous	22.05
08	16-bit	Mono	Twos complement (PCM)	Asynchronous	22.05
09	16-bit	Stereo	Twos complement (PCM)	Asynchronous	16
0A	16-bit	Mono	Twos complement (PCM)	Asynchronous	16
0B	8-bit	Stereo	Twos complement (PCM)	Asynchronous	16
0C	8-bit	Mono	Twos complement (PCM)	Asynchronous	16
0D	8-bit	Stereo	Twos complement (PCM)	Asynchronous	8
0E	8-bit	Mono	Twos complement (PCM)	Asynchronous	8
0F	16-bit	Stereo	Twos complement (PCM)	Synchronous	11.025
10	16-bit	Mono	Twos complement (PCM)	Synchronous	11.025
11	8-bit	Stereo	Twos complement (PCM)	Synchronous	11.025
12	8-bit	Mono	Twos 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 consists of the HID consumer control device and reports the status of these three key parameters:

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

End-Points

The PCM2906C 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 PCM2906C 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. Therefore, the result obtained from the HID operation depends on the host software. Typically, the HID function is used as the primary audio-out device.

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Clock and Reset

The PCM2906C requires a 12-MHz (±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-MΩ) 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. $\overline{\text{SSPND}}$ (pin 28) is unable to use clock disabling.

The PCM2906C has an internal power-on reset circuit, which triggers automatically when V_{BUS} (pin 3) exceeds 2.5 V typical (2.7 V to 2.2 V). Approximately 700 µs is required until internal reset release.

Digital Audio Interface

The PCM2906 employs S/PDIF for both input and output. Isochronous-out data from the host are encoded to the S/PDIF output and the DAC analog output. Input data are 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.

This feature is a customer option. It is the responsibility of the user to implement this feature.

Supported Input/Output Data

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

Any mismatch of the sampling rate between the input S/PDIF signal and the host command is not acceptable. Any mismatch of the data format between the input S/PDIF signal 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 these two conditions is not acceptable.

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

Channel Status Information

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

Copyright Management

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

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

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INTERFACE SEQUENCE

Power-On, Attach, and Playback Sequence

The PCM2906C 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 PCM2906C 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 PCM2906C stores the first audio packet, which contains 1-ms audio data, into the internal storage buffer. The PCM2906C starts playing the audio data when detecting the next start-of-frame (SOF) packet, as illustrated in Figure 32.

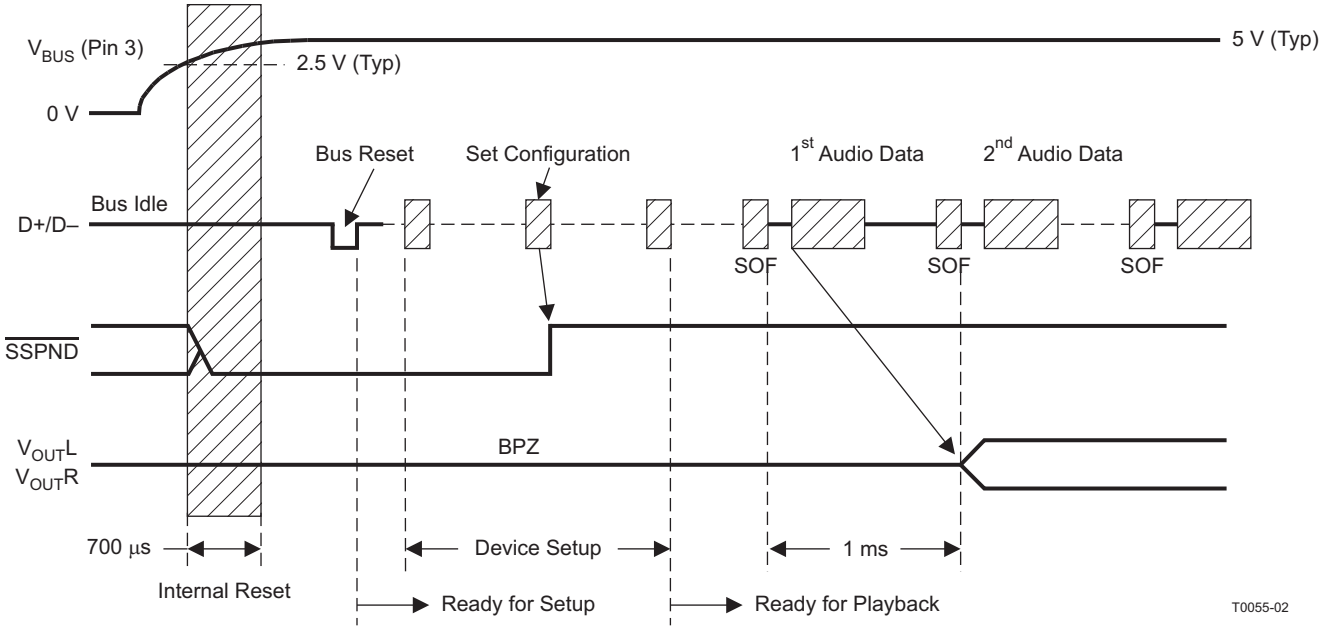


Figure 32. Initial Sequence

Play, Stop, and Detach Sequence

When the host finishes or aborts the playback, the PCM2906C stops playing after the last audio data have played, as shown in Figure 33.

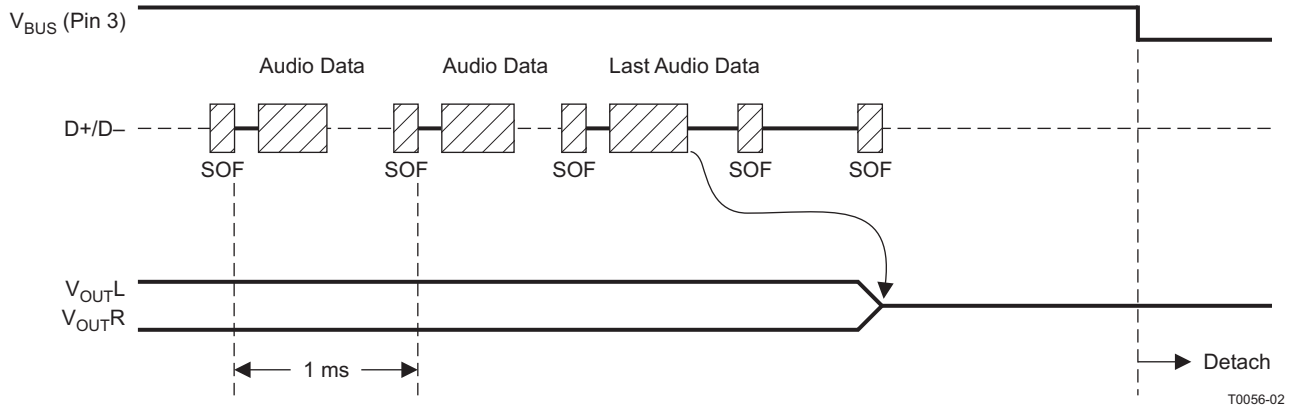


Figure 33. Play, Stop, and Detach Sequence

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Record Sequence

The PCM2906C starts audio capture into the internal memory after receiving the SET_INTERFACE command, as shown in Figure 34.

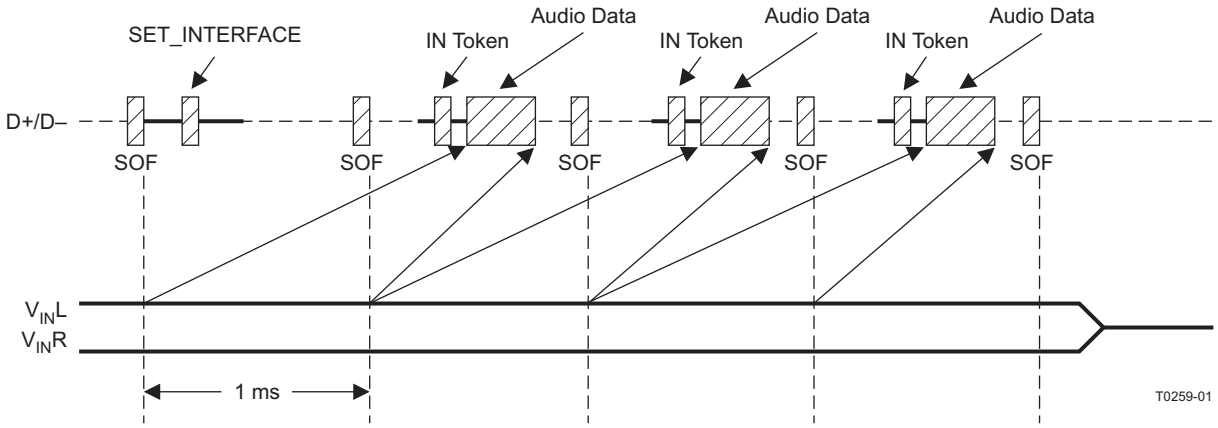


Figure 34. Record Sequence

Suspend and Resume Sequence

The PCM2906C enters the suspend state after a constant idle state on the USB bus (approximately 5 ms), as shown in Figure 35. While the PCM2906C enters the suspend state, the $\overline{\text{SSPND}}$ flag (pin 28) is asserted. The PCM2906C wakes up immediately upon detecting a non-idle state on the USB.

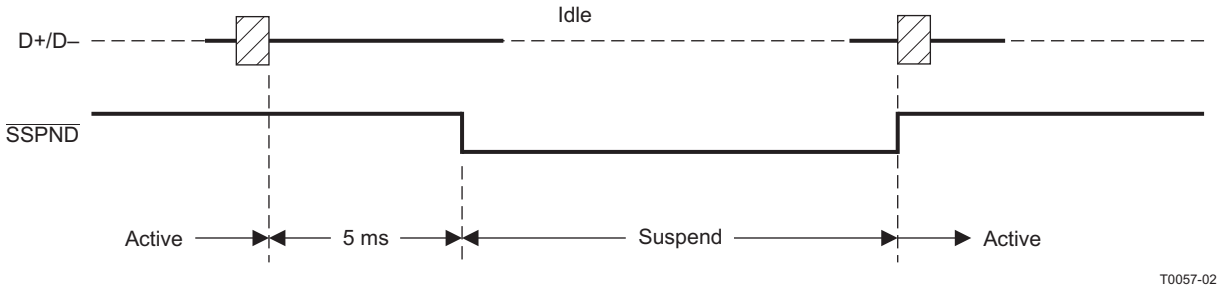
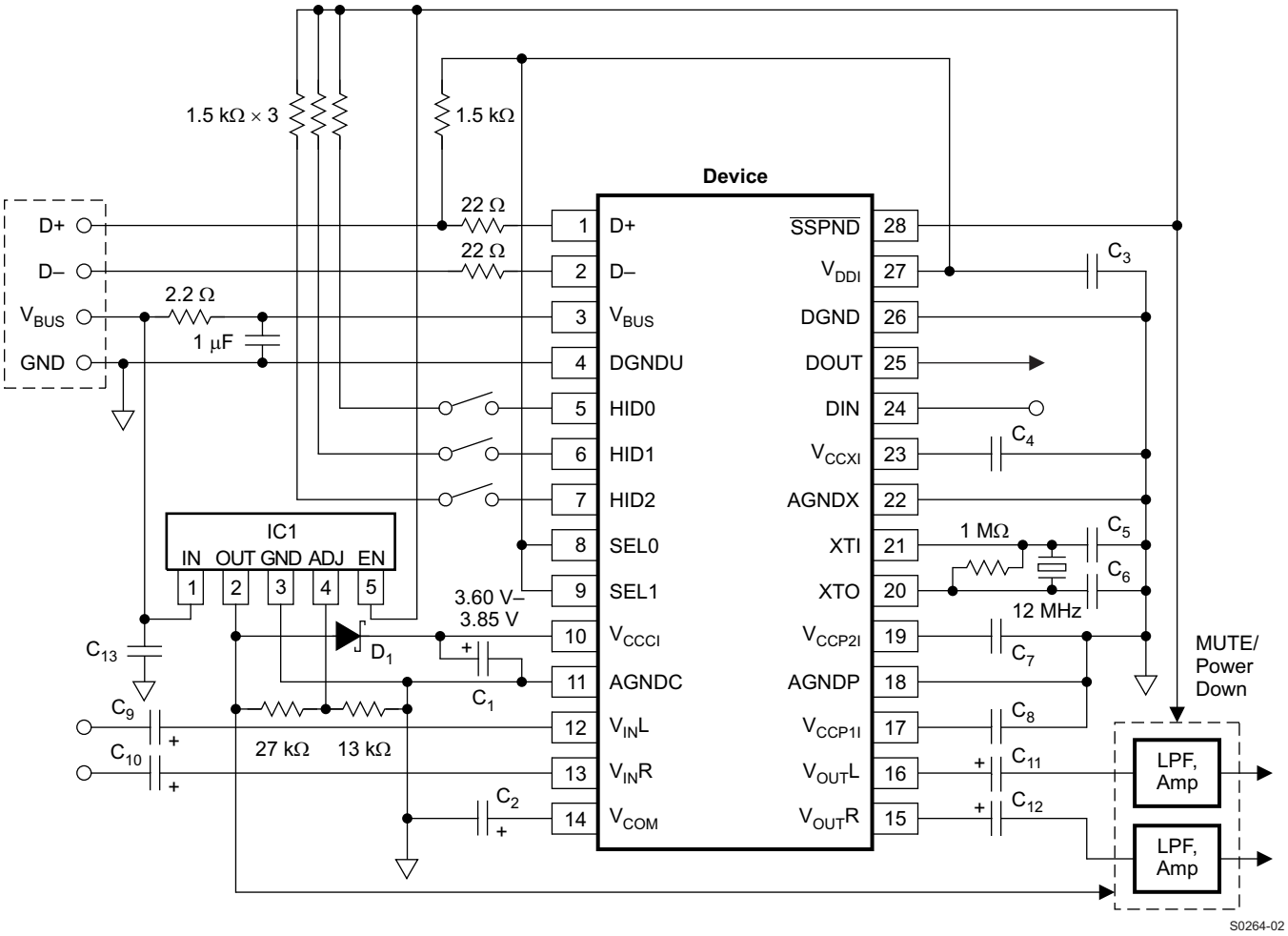


Figure 35. Suspend and Resume Sequence

APPLICATION INFORMATION

TYPICAL CIRCUIT CONNECTION 1

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



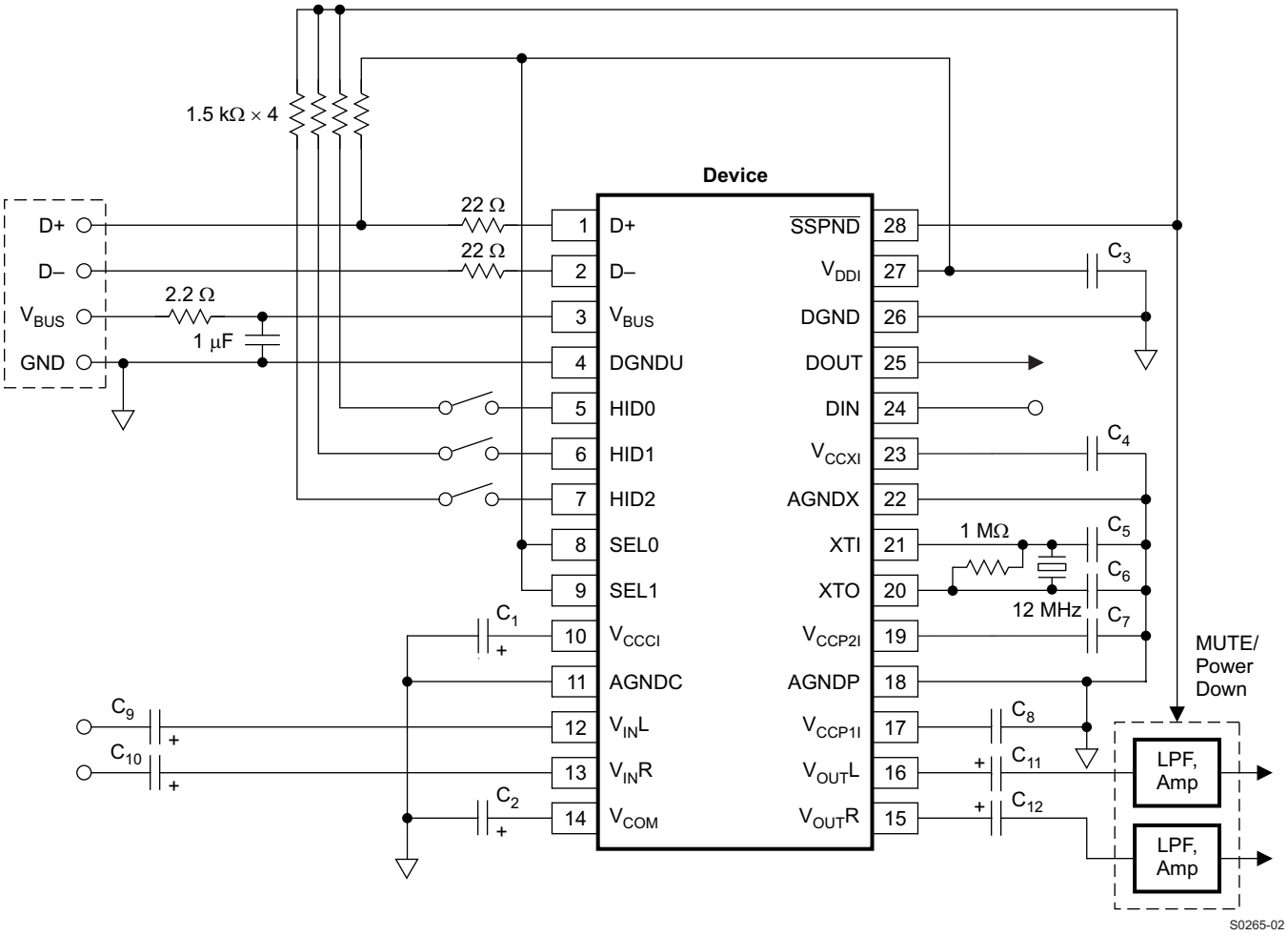
NOTE: C_1, C_2: 10 µF
C_3, C_4, C_7, C_8, C_{13}: 1 µF (These capacitors must be less than 2 µF.)
C_5, C_6: 10 pF to 33 pF (depending on crystal resonator)
C_9, C_{10}, C_{11}, C_{12}: The capacitance may vary depending on design.
IC1: REG103xA-A (TI) or equivalent. Analog performance may vary depending on IC1.
D_1: Schottky barrier diode (V_F ≤ 350 mV at 10 mA, I_R ≤ 2 µA at 4 V)

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

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TYPICAL CIRCUIT CONNECTION 2

Figure 37 illustrates a typical circuit connection for a simple application. The circuit illustrated is for information only. The entire 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 µF.)
C_5, C_6: 10 pF to 33 pF (depending on crystal resonator)
C_9, C_{10}, C_{11}, C_{12}: The capacitance may vary depending on design.
In this case, the analog performance of the ADC may be degraded.

Figure 37. Bus-Powered Configuration

OPERATING ENVIRONMENT

For current information on the PCM2906C operating environment, see the *Updated Operating Environments for PCM270X, PCM290X Applications* application report, SLAA374.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Top-Side Markings (4)	Samples
PCM2906CDB	ACTIVE	SSOP	DB	28	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-25 to 85	PCM2906C	Samples
PCM2906CDBR	ACTIVE	SSOP	DB	28	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-25 to 85	PCM2906C	Samples

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) Multiple Top-Side Markings will be inside parentheses. Only one Top-Side Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Top-Side Marking for that device.

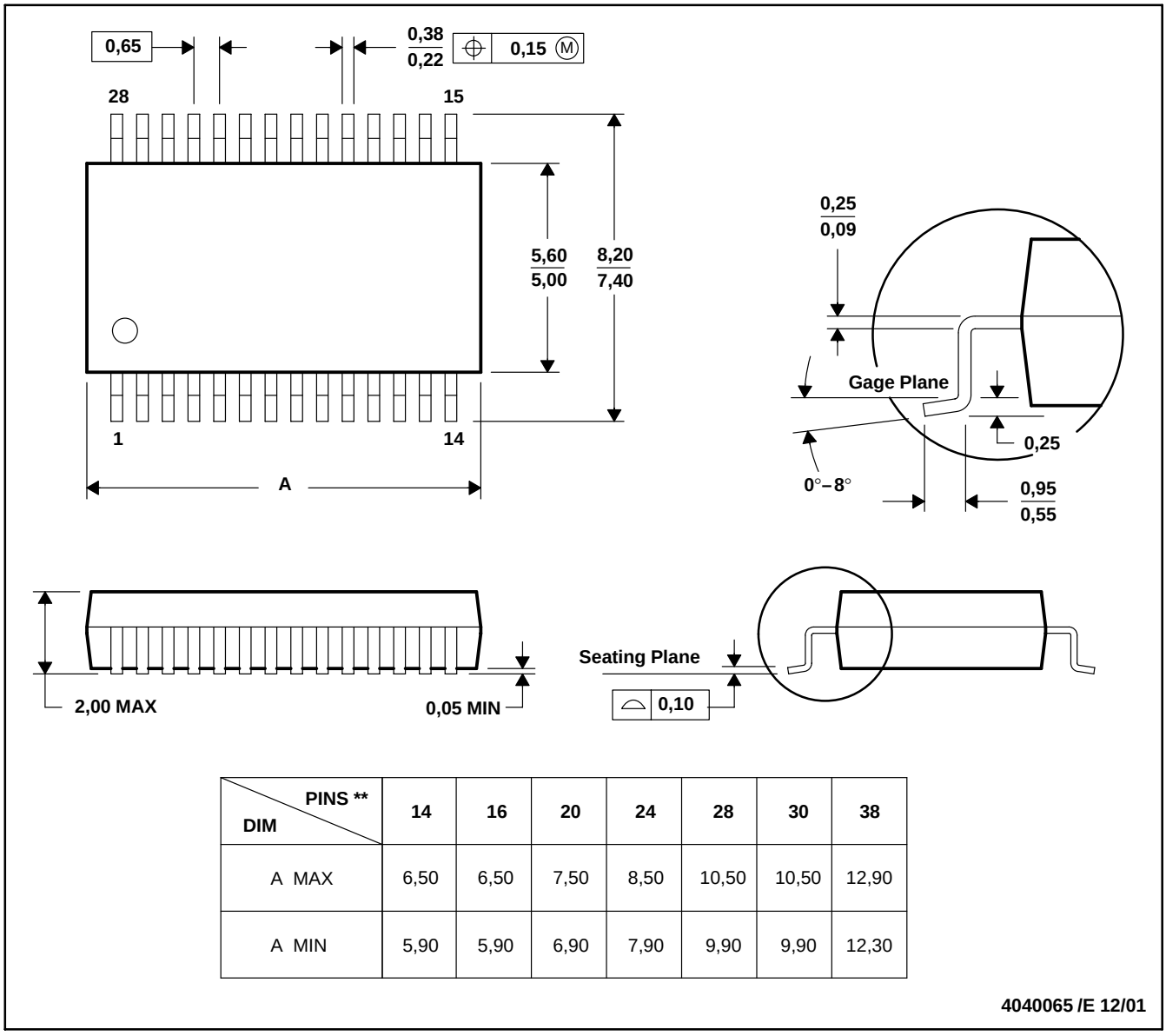
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MSSO002E – JANUARY 1995 – REVISED DECEMBER 2001

DB (R-PDSO-G)** **PLASTIC SMALL-OUTLINE**

28 PINS SHOWN



DIM \ PINS **	14	16	20	24	28	30	38
A MAX	6,50	6,50	7,50	8,50	10,50	10,50	12,90
A MIN	5,90	5,90	6,90	7,90	9,90	9,90	12,30

4040065 /E 12/01

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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