



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

Check for Samples: [PCM2900C](#), [PCM2902C](#)

FEATURES

- **PCM2900C: Without S/PDIF**
- **PCM2902C: With S/PDIF**
- **On-Chip USB Interface:**
 - With Full-Speed Transceivers
 - Fully Compliant with USB 2.0 Specification
 - Certified by USB-IF
 - Partially Programmable Descriptors
 - USB Adaptive Mode for Playback
 - USB Asynchronous Mode for Record
 - Bus Powered
- **16-Bit Delta-Sigma ADC and DAC**
- **Sampling Rate:**
 - DAC: 32 kHz, 44.1 kHz, 48 kHz
 - ADC: 8 kHz, 11.025 kHz, 16 kHz, 22.05 kHz, 32 kHz, 44.1 kHz, 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:
 - 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 PCM2900C/2902C are Texas Instruments' single-chip, USB, stereo audio codecs with a USB-compliant full-speed protocol controller and S/PDIF (PCM2902C only). The USB protocol controller requires no software code. The PCM2900C/2902C employ SpAct™ architecture, TI's unique system that recovers the audio clock from USB packet data. On-chip analog PLLs with SpAct architecture 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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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
PCM2900CDB	SSOP-28	DB	–25°C to +85°C	PCM2900C	PCM2900CDB	Rails, 47
					PCM2900CDBR	Tape and Reel, 2000
PCM2902CDB	SSOP-28	DB	–25°C to +85°C	PCM2902C	PCM2902CDB	Rails, 47
					PCM2902CDBR	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 device product folder at www.ti.com.

ABSOLUTE MAXIMUM RATINGS⁽¹⁾

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

PARAMETER		PCM2900C/PCM2902C	UNIT
V _{BUS}	Supply voltage	–0.3 to 6.5	V
	Ground voltage differences, AGND, AGNDP, AGNDX, DGND, DGNDU	±0.1	V
Digital input voltage	SEL0, SEL1, TEST0 (DIN) ⁽²⁾	–0.3 to 6.5	V
	D+, D–, HID0, HID1, HID2, XTI, XTO, TEST1 (DOUT) ⁽²⁾ , $\overline{\text{SSPND}}$	–0.3 to (V _{DDI} + 0.3) < 4	V
Analog input voltage	V _{INL} , V _{INR} , V _{COM} , V _{OUTR} , V _{OUTL}	–0.3 to (V _{CCCI} + 0.3) < 4	V
	V _{CCCI} , V _{CCP1I} , V _{CCP2I} , V _{CCXI} , V _{DDI}	–0.3 to 4	V
	Input current (any pins except supplies)	±10	mA
	Ambient temperature under bias	–40 to +125	°C
T _{stg}	Storage temperature	–55 to +150	°C
T _J	Junction temperature	+150	°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 is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
 (2) TEST0 and TEST1 apply to the PCM2900C; DIN and DOUT apply to the PCM2902C.

THERMAL INFORMATION

THERMAL METRIC ⁽¹⁾		PCM2900C	PCM2902C	UNITS
		DB	DB	
		28 PINS	28 PINS	
θ _{JA}	Junction-to-ambient thermal resistance	64.5	64.5	°C/W
θ _{JCtop}	Junction-to-case (top) thermal resistance	24.5	24.5	
θ _{JB}	Junction-to-board thermal resistance	25.4	25.4	
ψ _{JT}	Junction-to-top characterization parameter	2.0	2.0	
ψ _{JB}	Junction-to-board characterization parameter	25.0	25.0	
θ _{JCbot}	Junction-to-case (bottom) thermal resistance	N/A	N/A	

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

ELECTRICAL CHARACTERISTICS

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

PARAMETER		TEST CONDITIONS	PCM2900C, PCM2902C			UNIT		
			MIN	TYP	MAX			
DIGITAL INPUT/OUTPUT								
Host interface		Apply USB Revision 2.0, full speed						
Audio data format		USB isochronous data format						
INPUT LOGIC								
V_{IH}	High-level input voltage	D+, D–			2	3.3	VDC	
		XTI, HID0, HID1, and HID2			2.52	3.3	VDC	
		SEL0, SEL1			2	5.25	VDC	
		DIN (PCM2902C)			2.52	5.25	VDC	
V_{IL}	Low-level input voltage	D+, D–				0.8	VDC	
		XTI, HID0, HID1, and HID2				0.9	VDC	
		SEL0, SEL1				0.8	VDC	
		DIN (PCM2902C)				0.9	VDC	
I_{IH}	High-level input voltage	D+, D–, XTI, SEL0, SEL1	$V_{\text{IN}} = 3.3\text{ V}$			± 10	μA	
		HID0, HID1, and HID2			50	80	μA	
		DIN (PCM2902C)			65	100	μA	
I_{IL}	Low-level input voltage	D+, D–, XTI, SEL0, SEL1	$V_{\text{IN}} = 0\text{ V}$			± 10	μA	
		HID0, HID1, and HID2				± 10	μA	
		DIN (PCM2902C)				± 10	μA	
OUTPUT LOGIC								
V_{OH}	High-level output voltage	D+, D–			2.8		VDC	
		DOUT (PCM2902C)	$I_{\text{OH}} = -4\text{ mA}$		2.8		VDC	
		$\overline{\text{SSPND}}$	$I_{\text{OH}} = -2\text{ mA}$		2.8		VDC	
V_{OL}	Low-level output voltage	D+, D–				0.3	VDC	
		DOUT (PCM2902C)	$I_{\text{OL}} = 4\text{ mA}$			0.5	VDC	
		$\overline{\text{SSPND}}$	$I_{\text{OL}} = 2\text{ mA}$			0.5	VDC	
CLOCK FREQUENCY								
Input clock frequency, XTI					11.994	12	12.008	MHz

ELECTRICAL CHARACTERISTICS (continued)

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

PARAMETER	TEST CONDITIONS	PCM2900C, PCM2902C			UNIT
		MIN	TYP	MAX	
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⁽¹⁾					
THD+N Total harmonic distortion plus noise	$V_{\text{IN}} = -1\text{ dB}^{(2)}$, $V_{\text{CCCI}} = 3.67\text{ V}$		0.01	0.02	%
	$V_{\text{IN}} = -1\text{ dB}^{(3)}$		0.1		%
	$V_{\text{IN}} = -60\text{ dB}$		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			$0.6 V_{\text{CCCI}}$		V_{PP}
Center voltage			$0.5 V_{\text{CCCI}}$		V
Input impedance			30		k Ω
Antialiasing filter frequency response	-3 dB		150		kHz
	$f_{\text{IN}} = 20\text{ kHz}$		-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		$0.078 f_S/1000$		Hz

- (1) $f_{\text{IN}} = 1\text{ kHz}$, using a System Two™ audio measurement system by Audio Precision™ in RMS mode with 20-kHz LPF, 400-Hz HPF in calculation.
- (2) Using external voltage regulator for V_{CCCI} (as shown in Table 7 and Figure 37, using with REG103xA-A).
- (3) Using internal voltage regulator for V_{CCCI} (as shown in Figure 38 and Figure 39).

ELECTRICAL CHARACTERISTICS (continued)

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

PARAMETER	TEST CONDITIONS	PCM2900C, PCM2902C			UNIT
		MIN	TYP	MAX	
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⁽⁴⁾					
THD+N Total harmonic distortion plus noise	$V_{\text{OUT}} = 0\text{ dB}$		0.005	0.016	%
	$V_{\text{OUT}} = -60\text{ dB}$		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			$0.6 V_{\text{CCCI}}$		V_{PP}
Center voltage			$0.5 V_{\text{CCCI}}$		V
Load impedance	AC coupling	10			k Ω
LPF frequency response	-3 dB		250		kHz
	$f = 20\text{ kHz}$		-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 ⁽⁵⁾		250		μA
P_D Power dissipation	ADC, DAC operation		280	352	mW
	Suspend mode ⁽⁵⁾		1.25		mW
V_{CCCI} , V_{CCP1I} , V_{CCP2I} , V_{CCXI} , V_{DDI} Internal power-supply voltage		3.1	3.3	3.5	VDC
TEMPERATURE RANGE					
Operating temperature range		-25		+85	$^\circ\text{C}$

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

(5) Under USB suspend state.

PCM2900C PIN ASSIGNMENTS

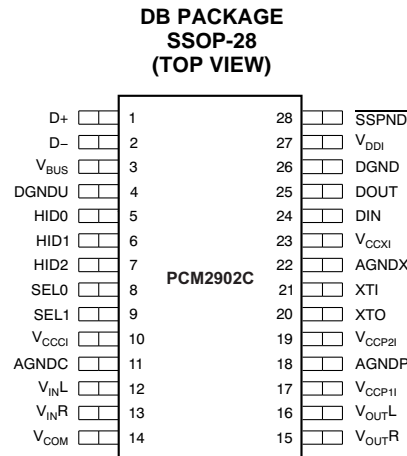


Table 1. PCM2900C TERMINAL FUNCTIONS

TERMINAL		I/O	DESCRIPTION
NAME	NO.		
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	O	Suspend flag, active-low (low: suspend, high: operational)
TEST0	24	I	Test pin, must be connected to GND
TEST1	25	O	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 _{INL}	12	I	ADC analog input for L-channel
V _{INR}	13	I	ADC analog input for R-channel
V _{OUTL}	16	O	DAC analog output for L-channel
V _{OUTR}	15	O	DAC analog output for R-channel
XTI	21	I	Crystal oscillator input ⁽⁵⁾
XTO	20	O	Crystal oscillator output

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

PCM2902C PIN ASSIGNMENTS


Table 2. PCM2902C TERMINAL FUNCTIONS

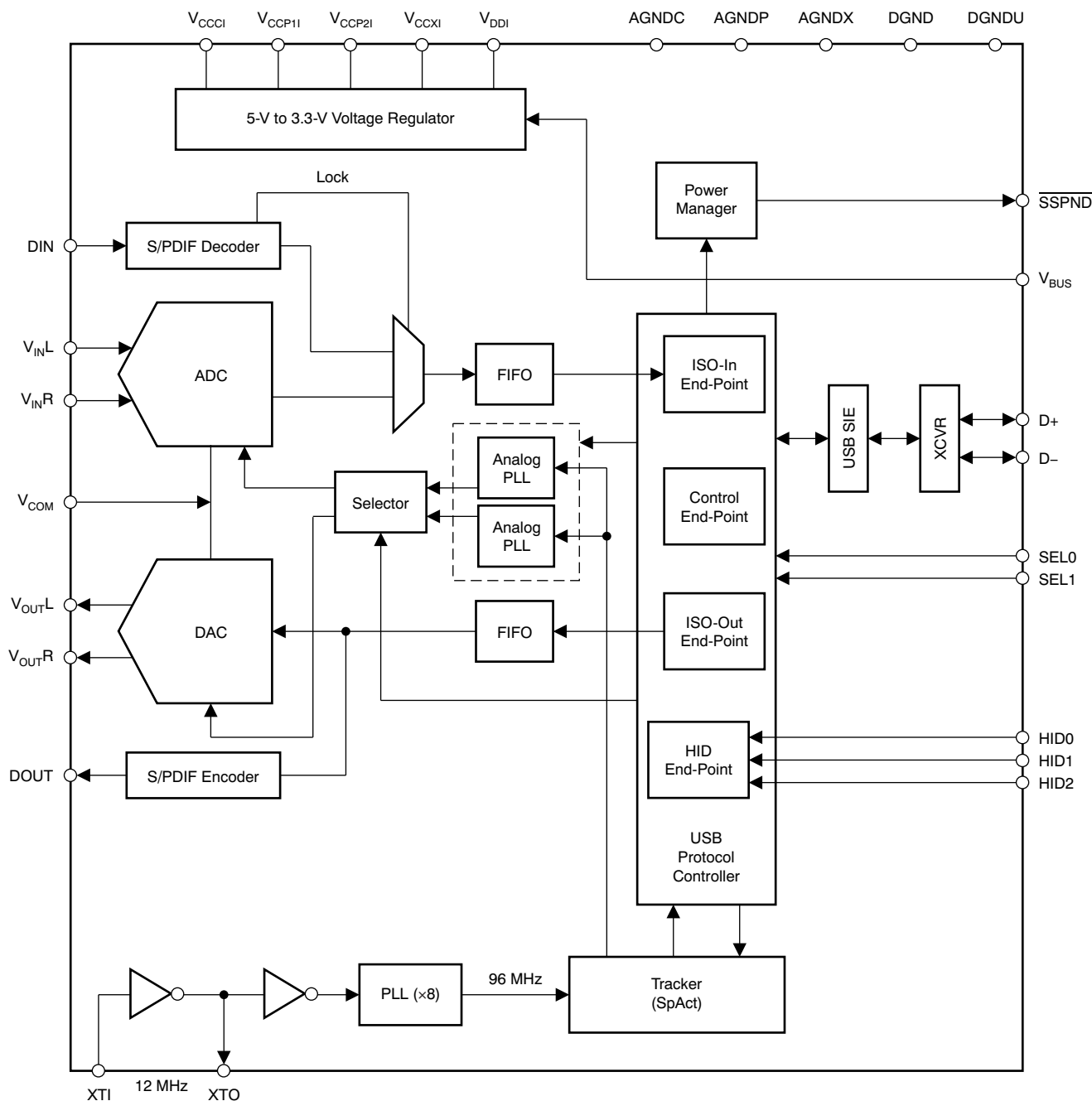
TERMINAL		I/O	DESCRIPTION
NAME	NO.		
AGNDC	11	–	Analog ground for codec
AGNDP	18	–	Analog ground for PLL
AGNDX	22	–	Analog ground for oscillator
D–	2	I/O	USB differential input/output minus ⁽¹⁾
D+	1	I/O	USB differential input/output plus ⁽¹⁾
DGND	26	–	Digital ground
DGNDU	4	–	Digital ground for USB transceiver
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⁾
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
V _{INL}	12	I	ADC analog input for L-channel
V _{INR}	13	I	ADC analog input for R-channel
V _{OUTL}	16	O	DAC analog output for L-channel
V _{OUTR}	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 pull-down, 5-V tolerant.
- (3) 3.3-V CMOS-level input with internal pull-down. This pin informs the PC of serviceable control signals such as mute, volume up, or volume down, which have no connection with the internal DAC or ADC directly. 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.

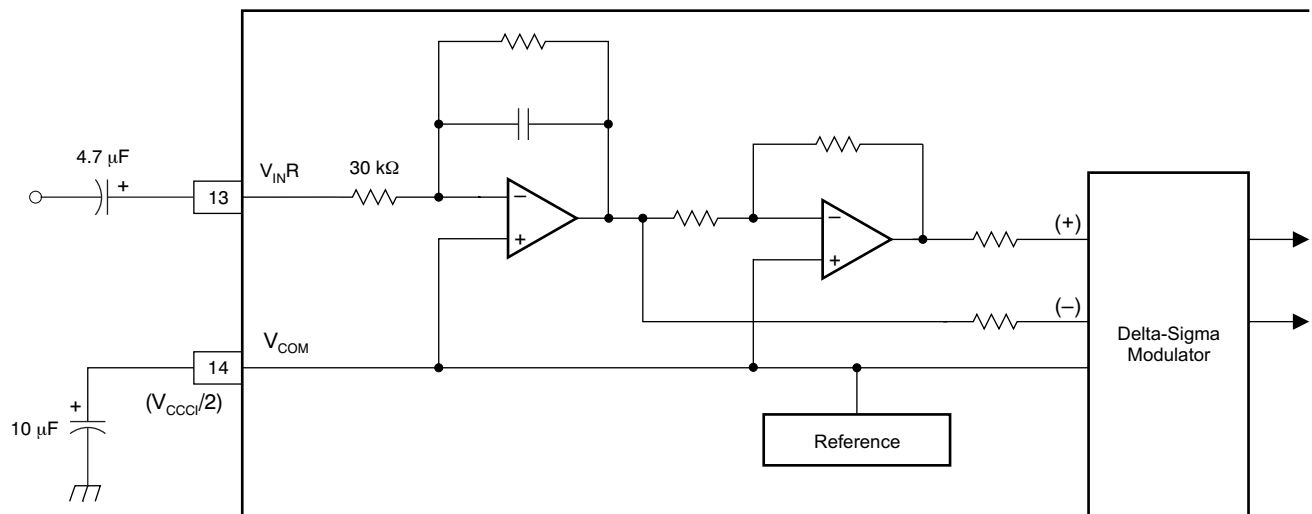
PCM2900C FUNCTIONAL BLOCK DIAGRAM



PCM2902C FUNCTIONAL BLOCK DIAGRAM



PCM2900C/2902C DIAGRAM OF ANALOG FRONT-END (RIGHT CHANNEL)



TYPICAL CHARACTERISTICS: ADC

All specifications at $T_A = +25^\circ\text{C}$, $V_{BUS} = 5\text{ V}$, $f_S = 44.1\text{ kHz}$, $f_{in} = 1\text{ kHz}$, 16-bit data, using REG 103xA-A, unless otherwise noted.

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

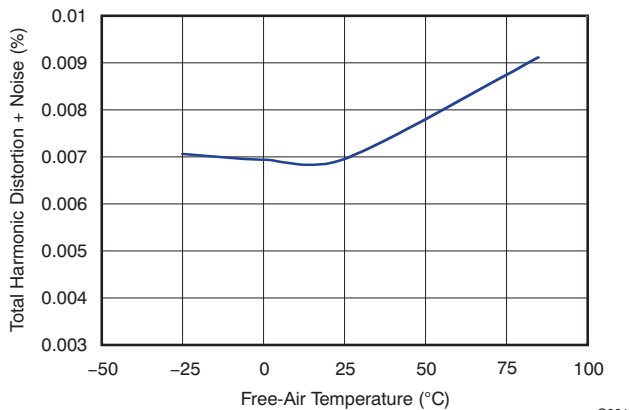


Figure 1.

G001

DYNAMIC RANGE and SNR vs FREE-AIR TEMPERATURE

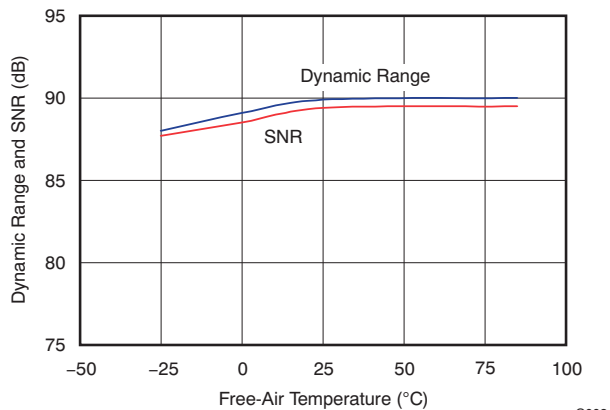


Figure 2.

G002

TOTAL HARMONIC DISTORTION + NOISE at -1 dB vs SUPPLY VOLTAGE

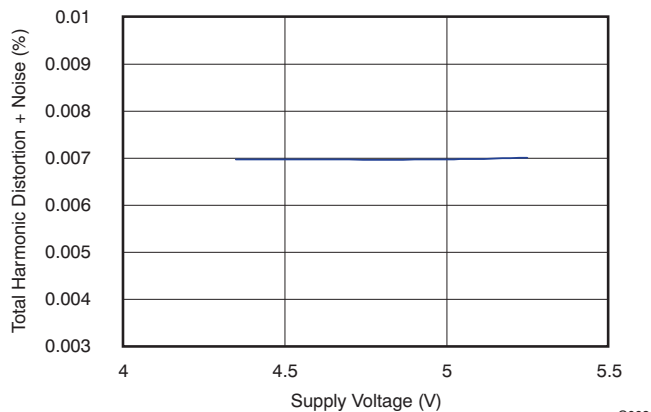


Figure 3.

G003

DYNAMIC RANGE and SNR vs SUPPLY VOLTAGE

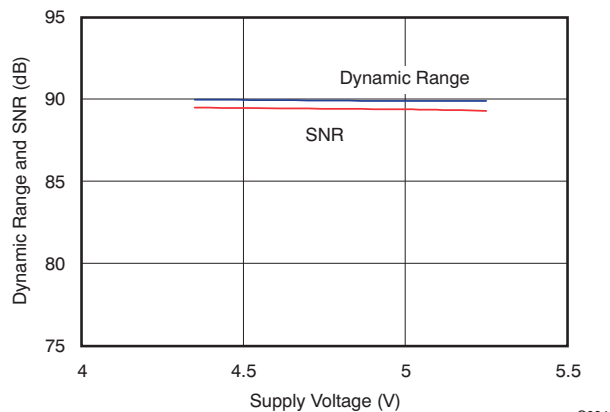


Figure 4.

G004

TOTAL HARMONIC DISTORTION + NOISE at -1 dB vs SAMPLING FREQUENCY

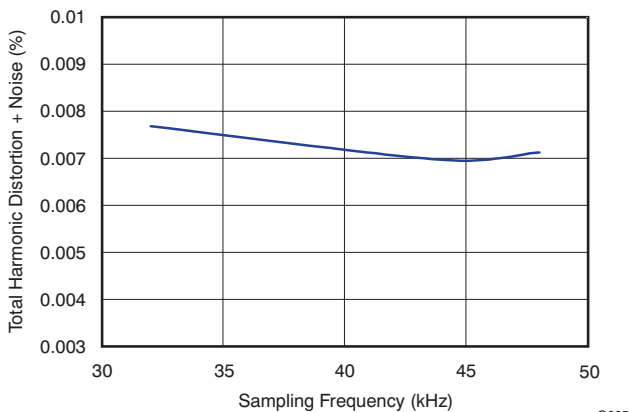


Figure 5.

G005

DYNAMIC RANGE AND SNR vs SAMPLING FREQUENCY

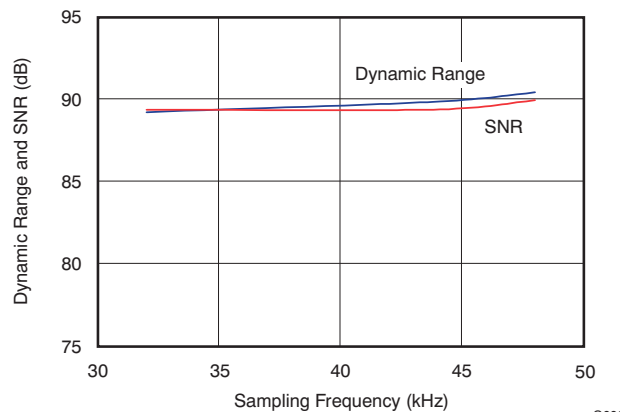


Figure 6.

G006

TYPICAL CHARACTERISTICS: DAC

All specifications at $T_A = +25^\circ\text{C}$, $V_{BUS} = 5\text{ V}$, $f_S = 44.1\text{ kHz}$, $f_{in} = 1\text{ kHz}$, 16-bit data, using REG 103xA-A, unless otherwise noted.

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

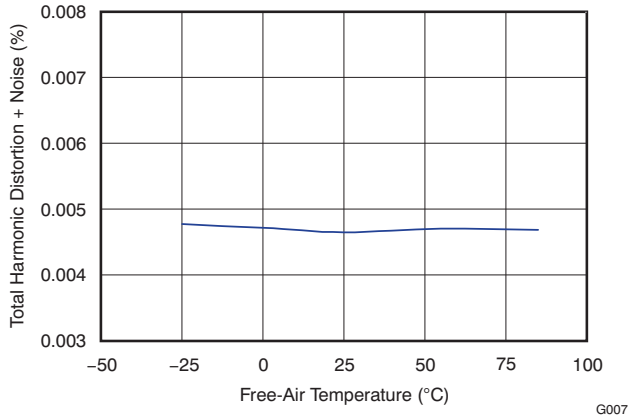


Figure 7.

**DYNAMIC RANGE AND SNR
vs FREE-AIR TEMPERATURE**

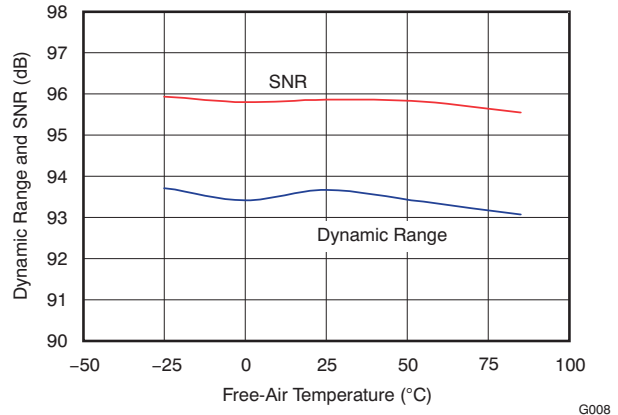


Figure 8.

**TOTAL HARMONIC DISTORTION + NOISE at 0 dB
vs SUPPLY VOLTAGE**

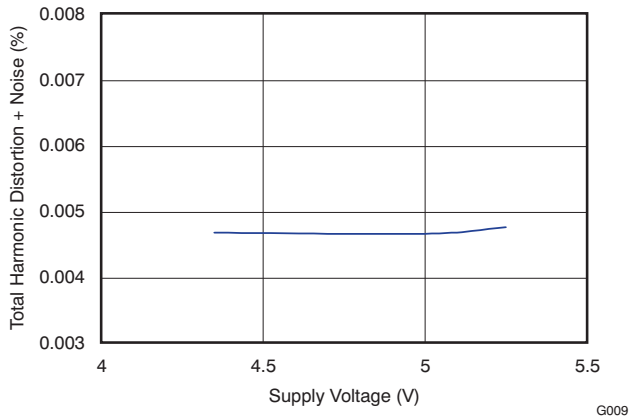


Figure 9.

**DYNAMIC RANGE AND SNR
vs SUPPLY VOLTAGE**

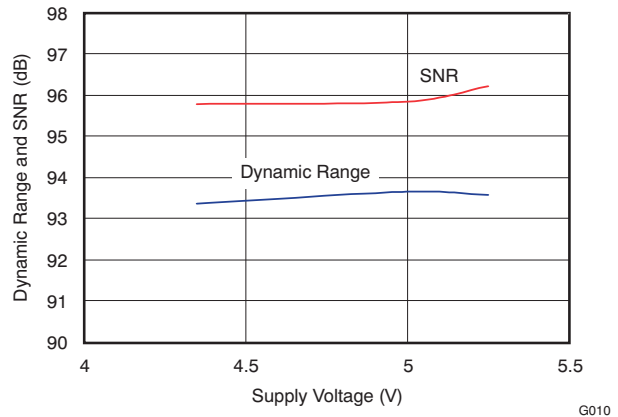


Figure 10.

**TOTAL HARMONIC DISTORTION + NOISE at 0 dB
vs SAMPLING FREQUENCY**

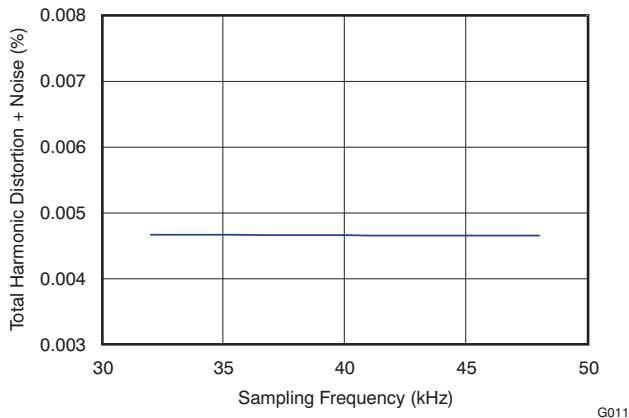


Figure 11.

**DYNAMIC RANGE AND SNR
vs SAMPLING FREQUENCY**

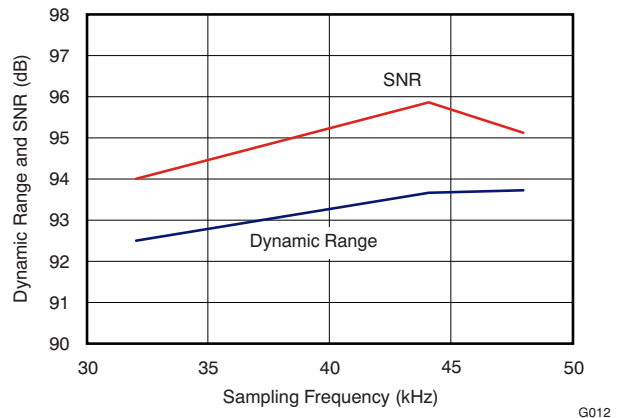


Figure 12.

TYPICAL CHARACTERISTICS: SUPPLY CURRENT

All specifications at $T_A = +25^\circ\text{C}$, $V_{BUS} = 5\text{ V}$, $f_S = 44.1\text{ kHz}$, $f_{in} = 1\text{ kHz}$, 16-bit data, using REG 103xA-A, unless otherwise noted.

OPERATIONAL AND SUSPEND SUPPLY CURRENT vs SUPPLY VOLTAGE

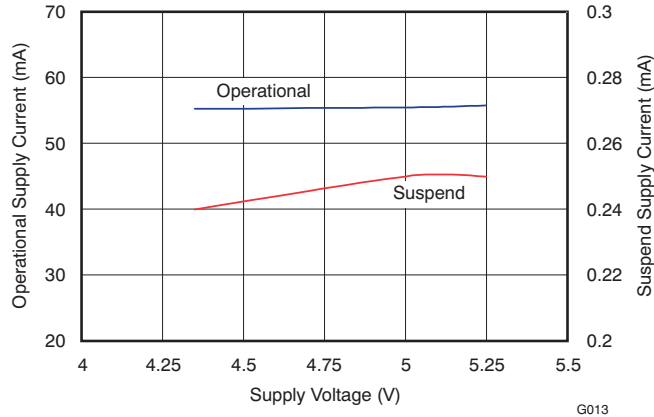


Figure 13.

OPERATIONAL SUPPLY CURRENT vs SAMPLING FREQUENCY

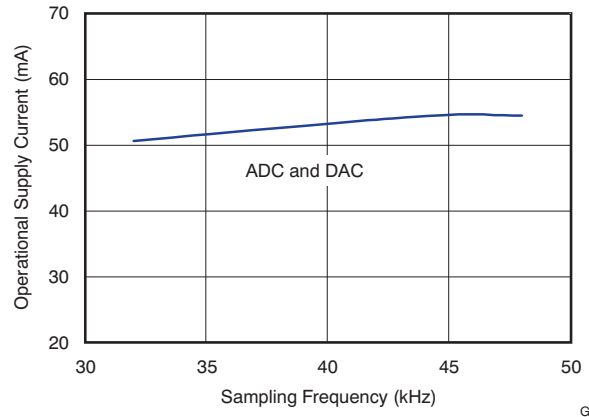


Figure 14.

SUSPEND SUPPLY CURRENT vs FREE-AIR TEMPERATURE



Figure 15.

TYPICAL CHARACTERISTICS: ADC DIGITAL DECIMATION FILTER FREQUENCY RESPONSE

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

OVERALL CHARACTERISTICS

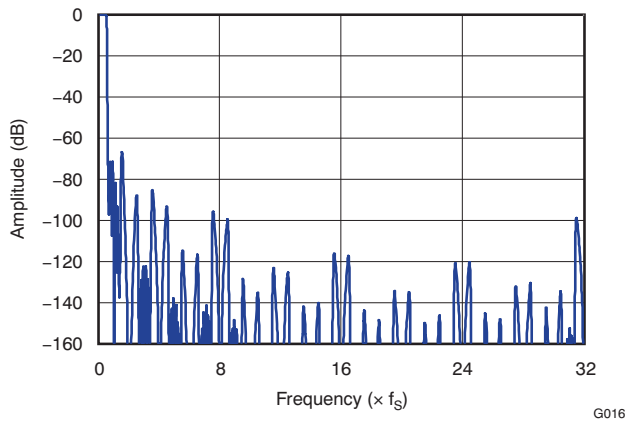


Figure 16.

STOP BAND ATTENUATION

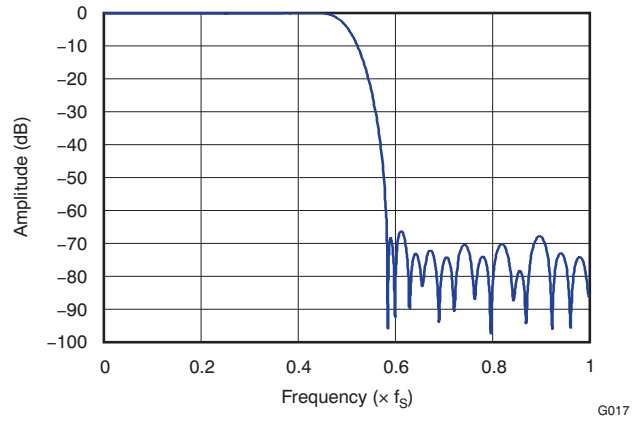


Figure 17.

PASSBAND RIPPLE

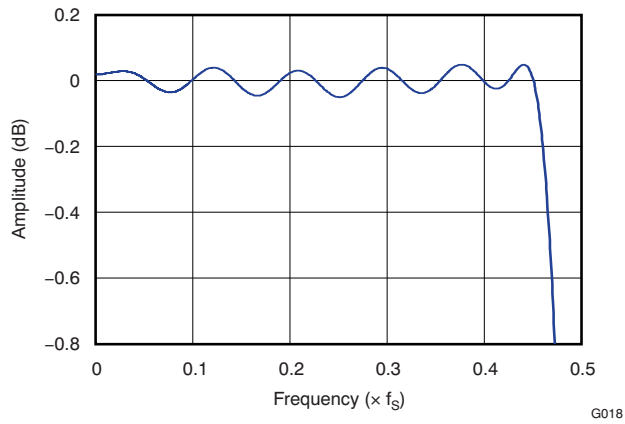


Figure 18.

TRANSITION-BAND RESPONSE

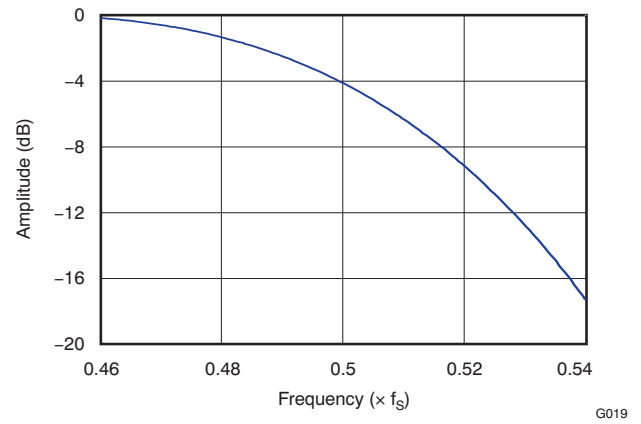


Figure 19.

TYPICAL CHARACTERISTICS: ADC DIGITAL HIGH-PASS FILTER FREQUENCY RESPONSE

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

STOP BAND CHARACTERISTICS

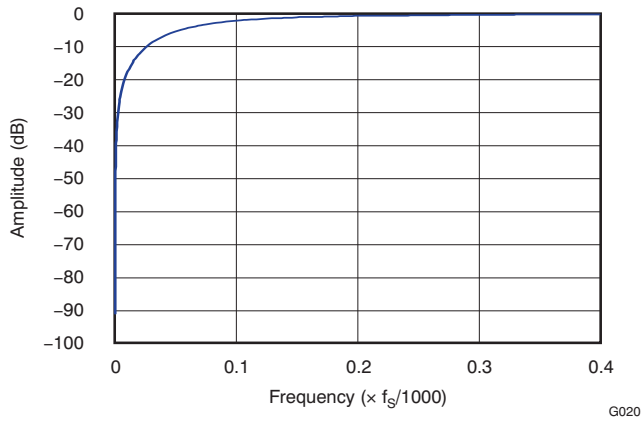


Figure 20.

PASSBAND CHARACTERISTICS

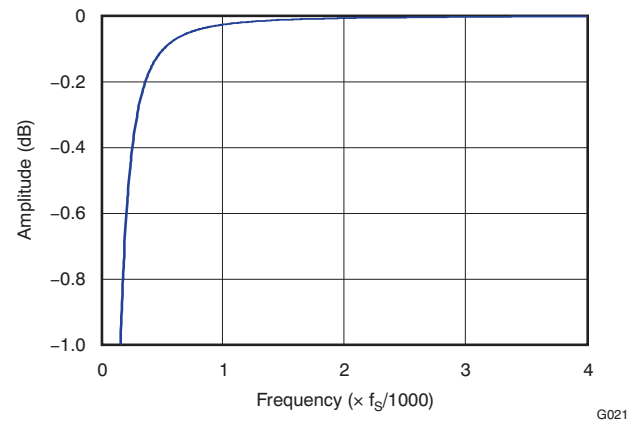


Figure 21.

TYPICAL CHARACTERISTICS: ADC ANALOG ANTIALIASING FILTER FREQUENCY RESPONSE

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

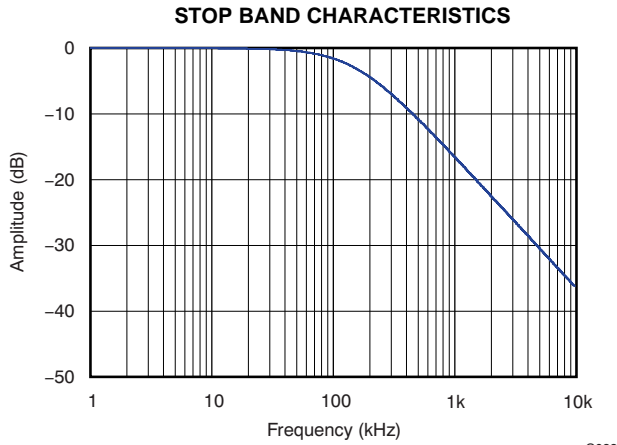


Figure 22.

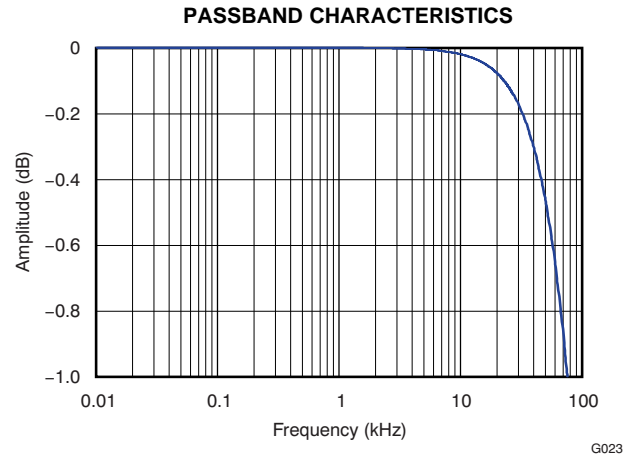


Figure 23.

TYPICAL CHARACTERISTICS: DAC DIGITAL INTERPOLATION FILTER FREQUENCY RESPONSE

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

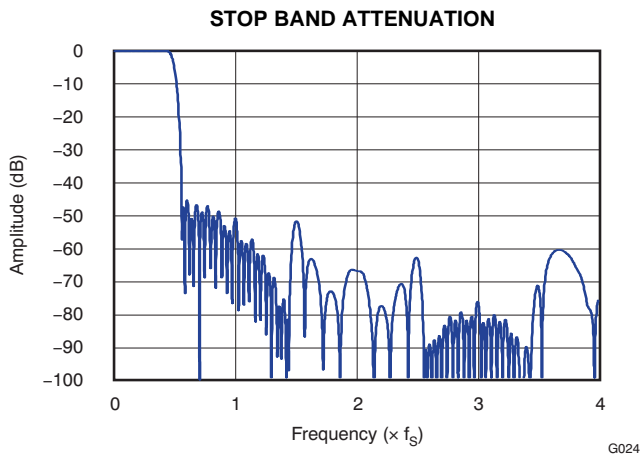


Figure 24.

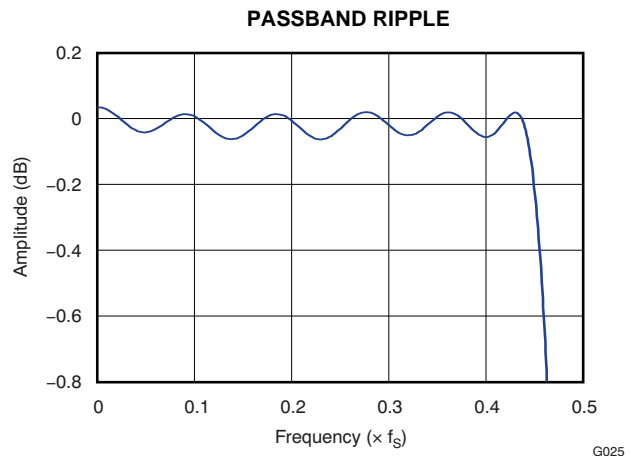


Figure 25.

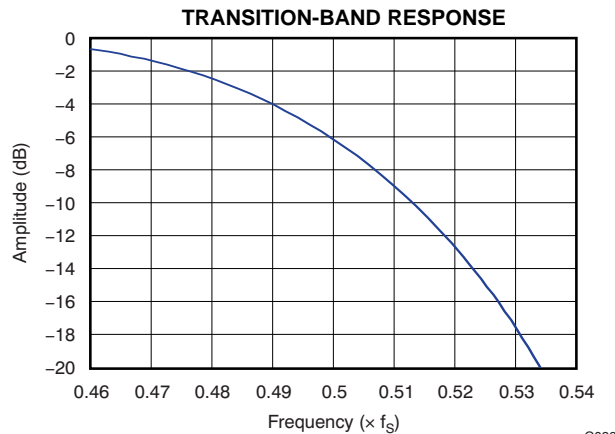


Figure 26.

TYPICAL CHARACTERISTICS: DAC ANALOG FIR FILTER FREQUENCY RESPONSE

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

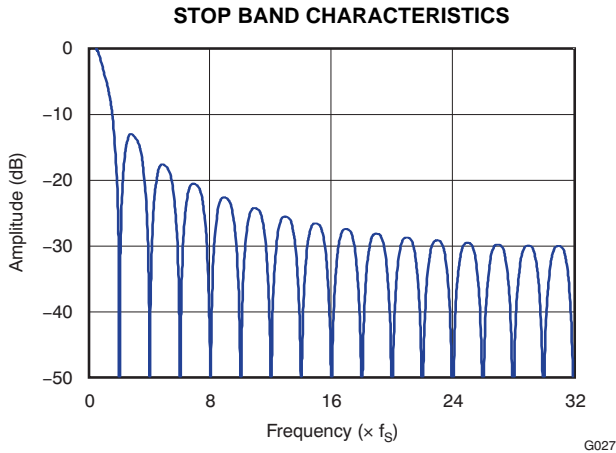


Figure 27.

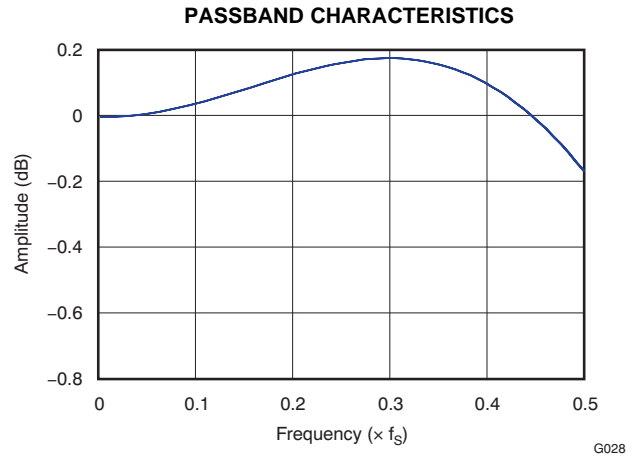


Figure 28.

TYPICAL CHARACTERISTICS: DAC ANALOG LOW-PASS FILTER FREQUENCY RESPONSE

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

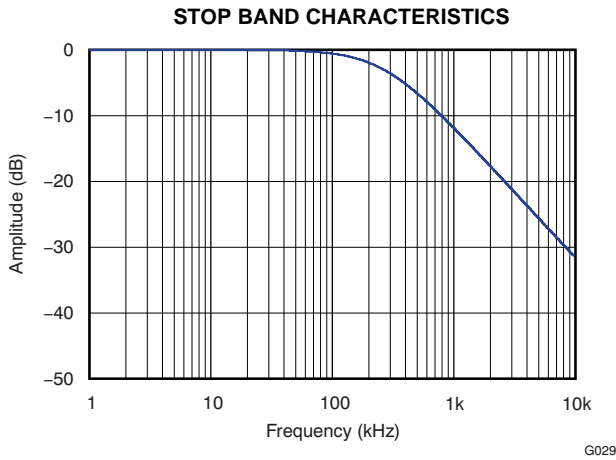


Figure 29.

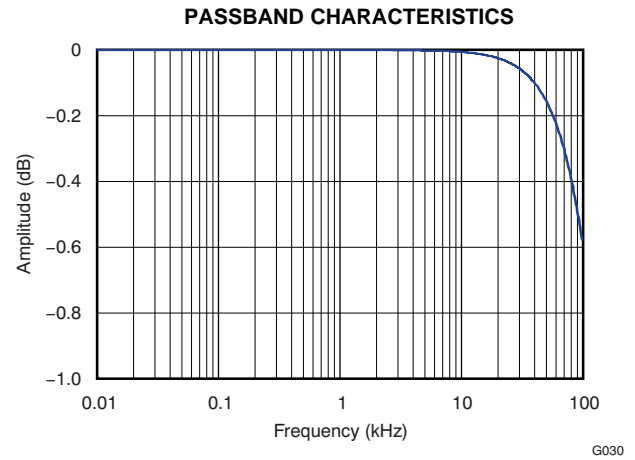


Figure 30.

DETAILED DESCRIPTION

USB INTERFACE

Control data and audio data are transferred to the PCM2900C/2902C via D+ (pin 1) and D– (pin 2). All data to/from the PCM2900C/2902C are transferred at full speed. The device descriptor contains the information described in [Table 3](#).

Table 3. Device Description

USB revision	2.0 compliant
Device class	0x00 (device-defined interface level)
Device subclass	0x00 (not specified)
Device protocol	0x00 (not specified)
Max packet size for end-point 0	8 bytes
Vendor ID	0x08BB
Product ID	0x29C0 / 0x29C2
Device release number	1.0 (0x0100)
Number of configurations	1
Vendor strings	String #1 (see Table 5)
Product strings	String #2 (see Table 5)
Serial number	Not supported

The configuration descriptor contains the information described in [Table 4](#).

Table 4. Configuration Descriptor

Interface	Four interfaces
Power attribute	0x80 (Bus-powered, no remote wakeup)
Max power	0x32 (100 mA)

The string descriptor contains the information described in [Table 5](#).

Table 5. String Descriptor

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

DEVICE CONFIGURATION

Figure 31 illustrates the USB audio function topology. The PCM2900C/2902C has four interfaces. Each interface consists of alternative settings.

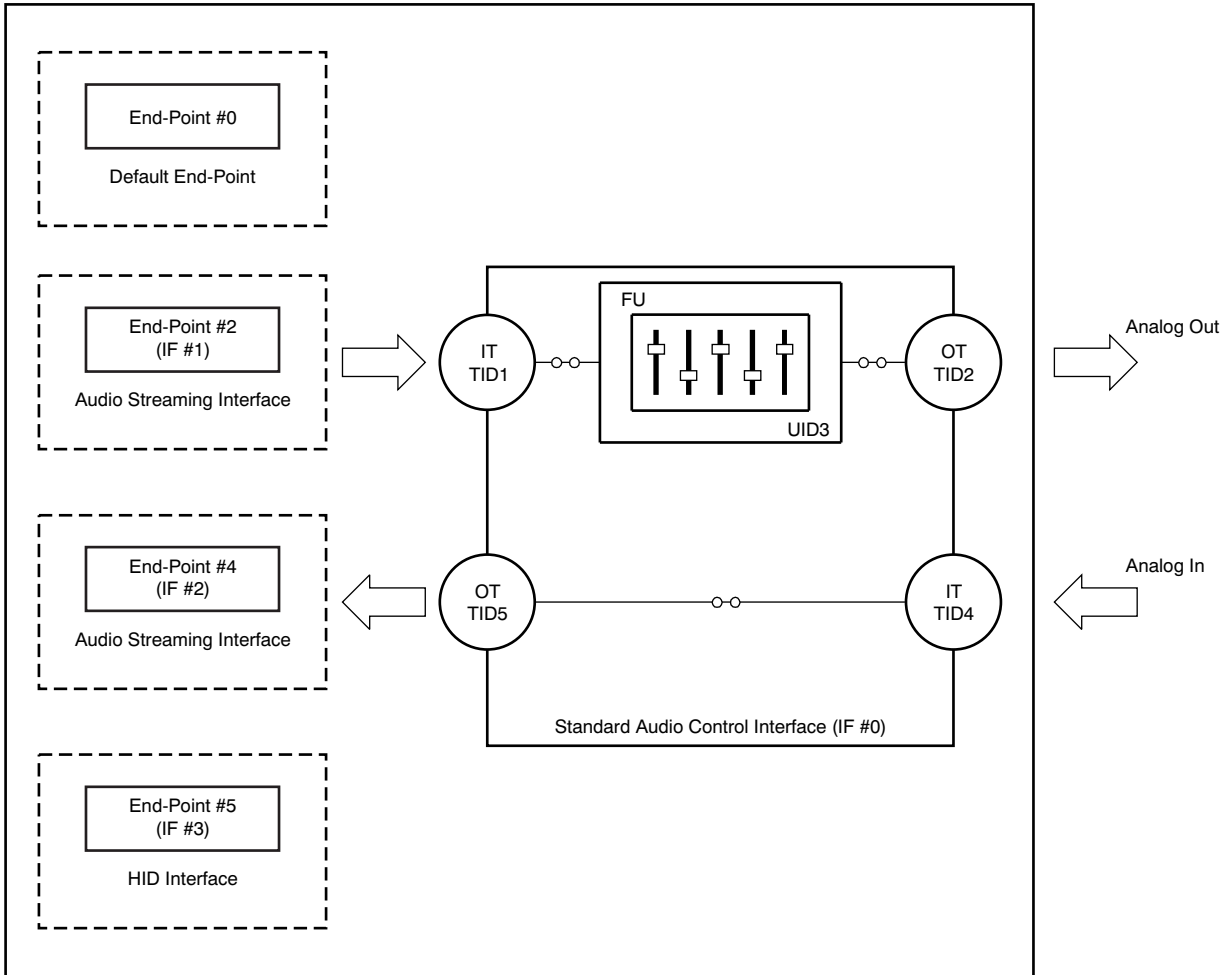


Figure 31. USB Audio Function Topology

Interface #0

Interface #0 is defined as 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 PCM2900C/2902C has 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 an 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 five alternative settings listed in [Table 6](#). Alternative setting #0 is the zero bandwidth setting. All other alternative settings are operational settings.

Table 6. 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

Interface #2

Interface #2 is the audio streaming data-in interface. Interface #2 has the 19 alternative settings listed in [Table 7](#). Alternative setting #0 is the zero bandwidth setting. All other alternative settings are operational settings.

Table 7. 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 three key parameters:

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

End-Points

The PCM2900C/2902C 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 PCM2900C/2902C by a standard USB request and an 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, which transmits the PCM audio data. The isochronous-in audio data stream end-point uses asynchronous transfer mode. The HID end-point is an interrupt-in end-point. 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.

Clock and Reset

The PCM2900C/2902C requires a 12-MHz (± 500 ppm) clock for the USB and audio functions, which can be generated by a built-in crystal 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 (1-M Ω) resistor and two small capacitors, the capacitance of which depends on the load capacitance of the crystal resonator. The external clock can be supplied from XTI (pin 21). If the external clock is supplied, XTO (pin 20) must be left open. Because there is no clock-disabling signal, it is not recommended to use the external clock supply. $\overline{\text{SSPND}}$ (pin 28) is unable to use clock disabling.

The PCM2900C/2902C 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 (PCM2902C)

The PCM2902C employs both S/PDIF 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 as either S/PDIF or ADC analog input. When the device detects an S/PDIF input and successfully locks the received data, the isochronous-in transfer data source is automatically selected from S/PDIF itself; otherwise, the data source is selected to ADC analog input.

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

Supported Input/Output Data (PCM2902C)

The following data formats are accepted by the S/PDIF input and output. All other data formats are unable to use 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 16-bit stereo format at the same source data rate.

Channel Status Information (PCM2902C)

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 (PCM2902C)

Isochronous-in data are affected by the serial copy management system (SCMS). When receiving digital audio data that are indicated as original data in the control bit, input digital audio data transfer 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.

INTERFACE SEQUENCE

Power On, Attach, and Playback Sequence

The PCM2900C/2902C is ready for setup when the reset sequence has finished and the USB bus is attached. After connection has been established by setup, the PCM2900C/2902C is ready to accept USB audio data. While waiting, the audio data (idle state) and analog output are set to bipolar zero (BPZ).

When receiving the audio data, the PCM2900C/2902C stores the first audio packet, which contains 1-ms audio data, into the internal storage buffer. The PCM2900C/2902C starts to play 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 playback, the PCM2900C/2902C stops playing after the last audio data have played, as shown in Figure 33.

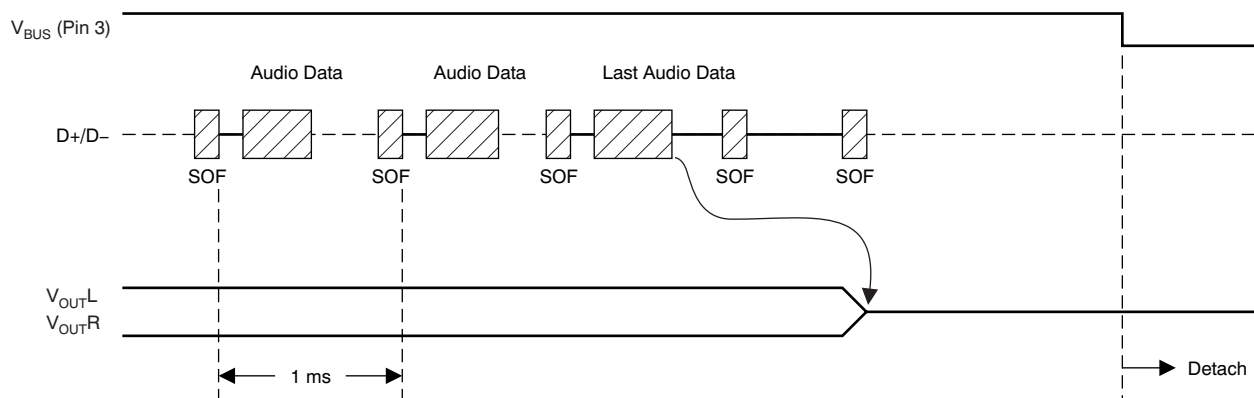


Figure 33. Play, Stop, and Detach Sequence

Record Sequence

The PCM2900C/2902C starts the audio capture into the internal memory after receiving the SET_INTERFACE command, as shown in Figure 34.

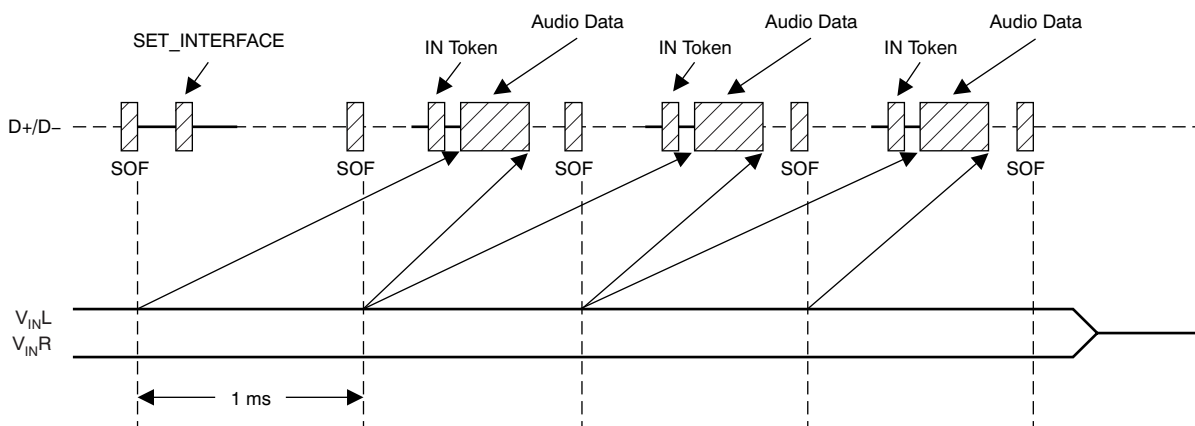


Figure 34. Record Sequence

Suspend and Resume Sequence

The PCM2900C/2902C enters the suspend state after it sees a constant idle state on the USB bus (approximately 5 ms), as shown in Figure 35. While the PCM2900C/2902C enters the suspend state, SSPND flag (pin 28) is asserted. The PCM2900C/2902C wakes up immediately upon detecting a non-idle state on the USB bus.

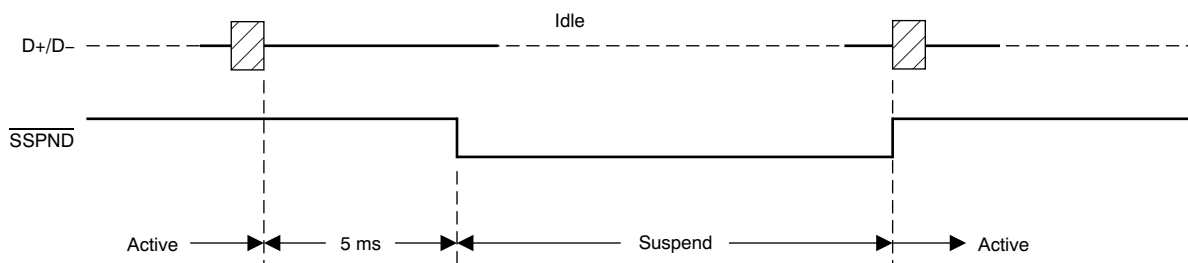
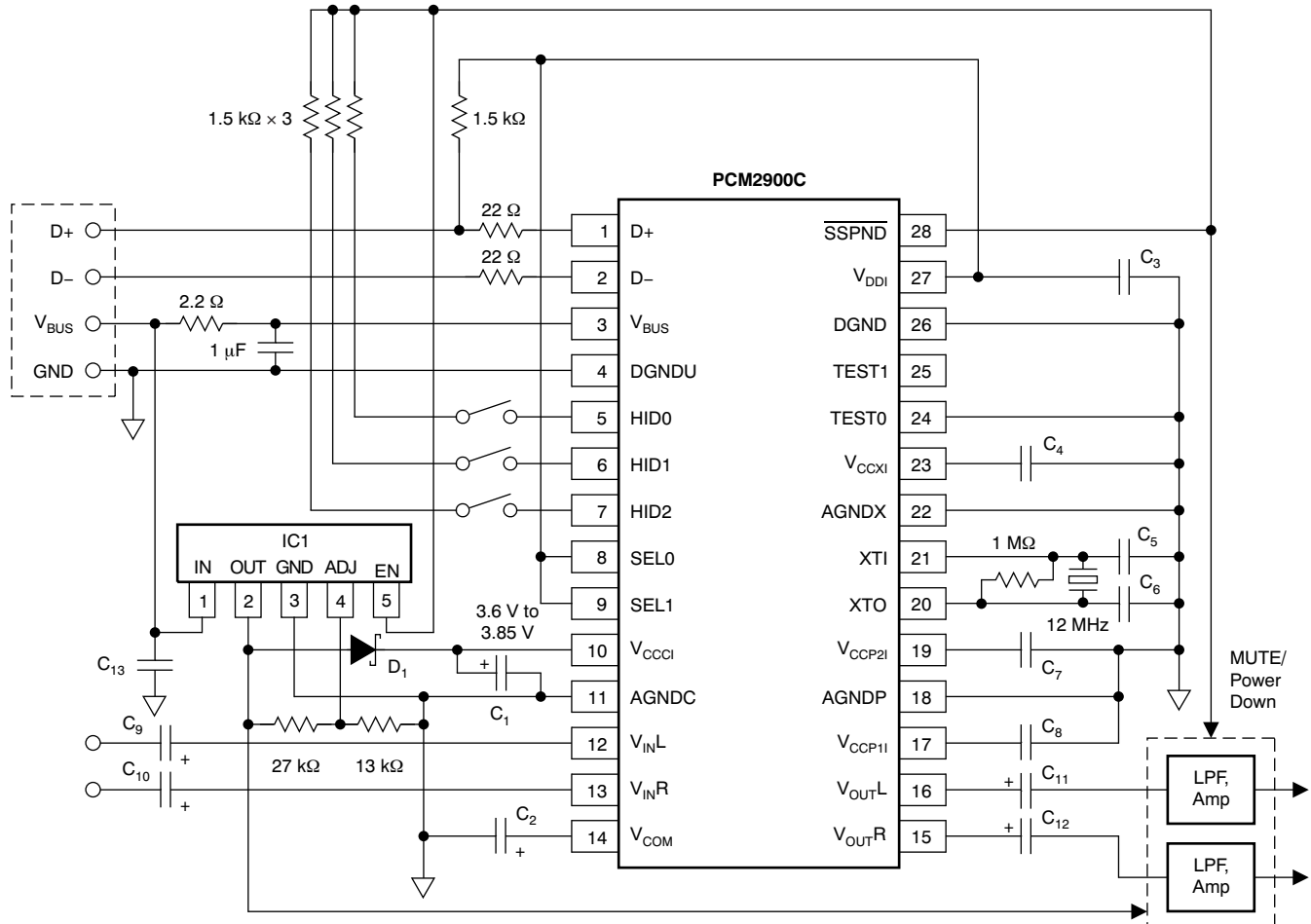


Figure 35. Suspend and Resume Sequence

APPLICATION INFORMATION

PCM2900C TYPICAL CIRCUIT CONNECTION 1

Figure 36 illustrates a typical circuit connection for a high-performance 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.

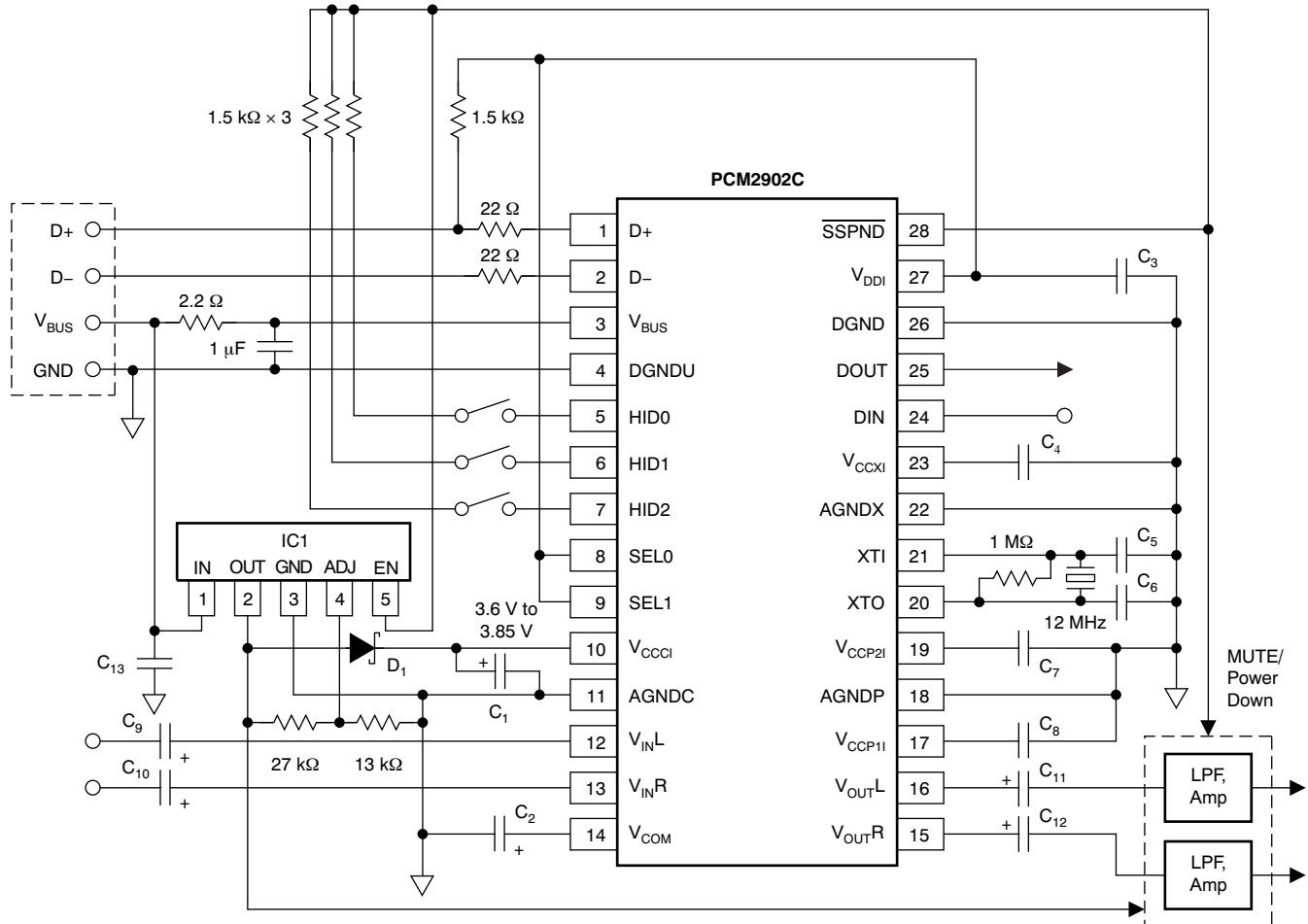


- NOTE: C₁, C₂: 10 μF
 C₃, C₄, C₇, C₈, C₁₃: 1 μF (These capacitors must be less than 2 μF.)
 C₅, C₆: 10 pF to 33 pF (depending on crystal resonator)
 C₉, C₁₀, C₁₁, C₁₂: The capacitance may vary depending on design.
 IC1: REG103xA-A (TI) or equivalent. Analog performance may vary depending on IC1.
 D₁: Schottky barrier diode (V_F ≤ 350 mV at 10 mA, I_R ≤ 2 μA at 4 V)

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

PCM2902C TYPICAL CIRCUIT CONNECTION 1

Figure 37 illustrates a typical circuit connection for a high-performance 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: C₁, C₂: 10 μF

C₃, C₄, C₇, C₈, C₁₃: 1 μF (These capacitors must be less than 2 μF.)

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

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

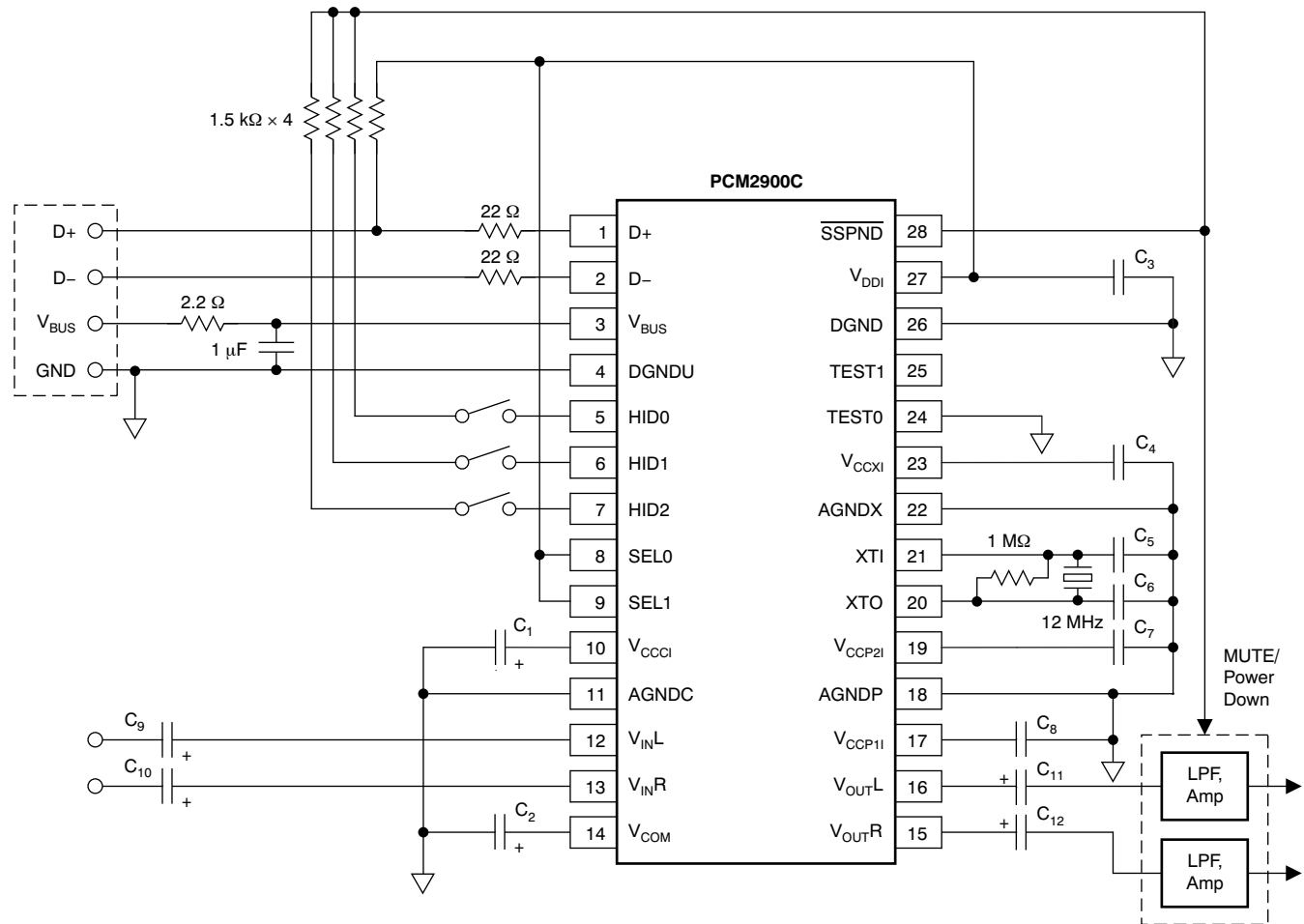
IC1: REG103xA-A (TI) or equivalent. Analog performance may vary depending on IC1.

D₁: Schottky barrier diode (V_F ≤ 350 mV at 10 mA, I_R ≤ 2 μA at 4 V)

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

PCM2900C TYPICAL CIRCUIT CONNECTION 2

Figure 38 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.

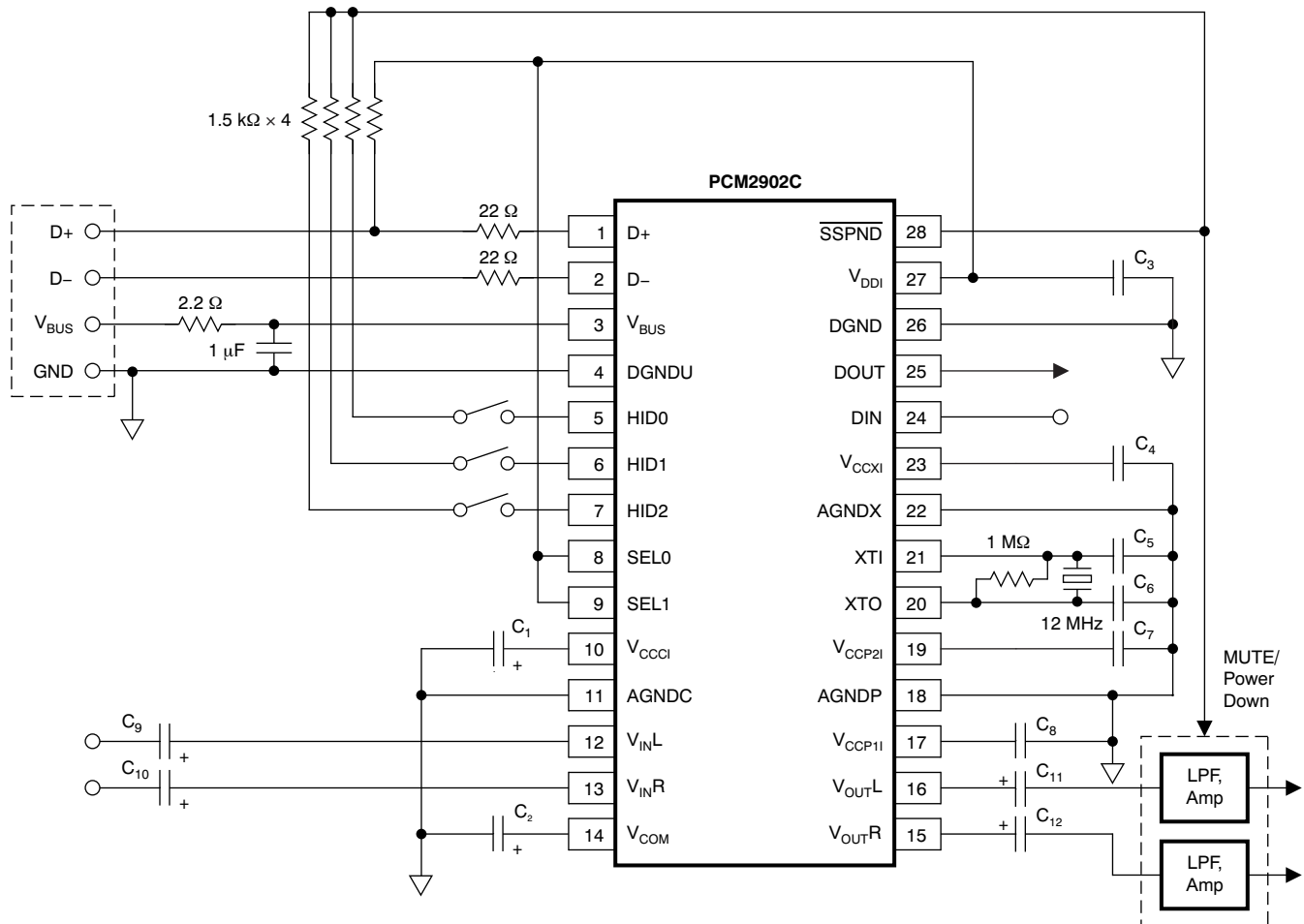


NOTE: C₁, C₂: 10 μF
 C₃, C₄, C₇, C₈: 1 μF (These capacitors must be less than 2 μF.)
 C₅, C₆: 10 pF to 33 pF (depending on crystal resonator)
 C₉, C₁₀, C₁₁, C₁₂: The capacitance may vary depending on design.
 In this case, the analog performance of the ADC may be degraded.

Figure 38. Bus-Powered Configuration

PCM2902C TYPICAL CIRCUIT CONNECTION 2

Figure 39 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: C₁, C₂: 10 μF
 C₃, C₄, C₇, C₈: 1 μF (These capacitors must be less than 2 μF.)
 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 ADC may be degraded.

Figure 39. Bus-Powered Configuration

OPERATING ENVIRONMENT

For current information on the PCM2900C/2902C operating environment, see the application report, *Updated Operating Environments for PCM270X, PCM290X Applications (SLAA374)*, available for download from the [TI website](#).

PACKAGING INFORMATION

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/ Ball Finish	MSL Peak Temp ⁽³⁾	Samples (Requires Login)
PCM2900CDB	PREVIEW	SSOP	DB	28	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
PCM2900CDBR	PREVIEW	SSOP	DB	28	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
PCM2902CDB	PREVIEW	SSOP	DB	28	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
PCM2902CDBR	PREVIEW	SSOP	DB	28	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	

⁽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.

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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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