

# Intelligent Digital Amplifier and Sound Processor

## D2-7xx83

The D2-7xx83 family of the DAE-6™ Digital Audio Engine™ devices are complete System-on Chip (SoC) audio processor and Class-D amplifier controllers. Integrated DSP processing and configurable audio processing algorithms provide an extremely flexible platform for feature rich and cost-effective quality audio solutions which benefit from the addition of Class-D amplifiers and DSP audio processing, meeting demands of consumer electronics applications.

The 12 integrated digital PWM controllers can be used in a variety of multi-channel audio system configurations, supporting powered as well as line outputs. Fully protected amplifier control provides efficient and clean Class-D power output support.

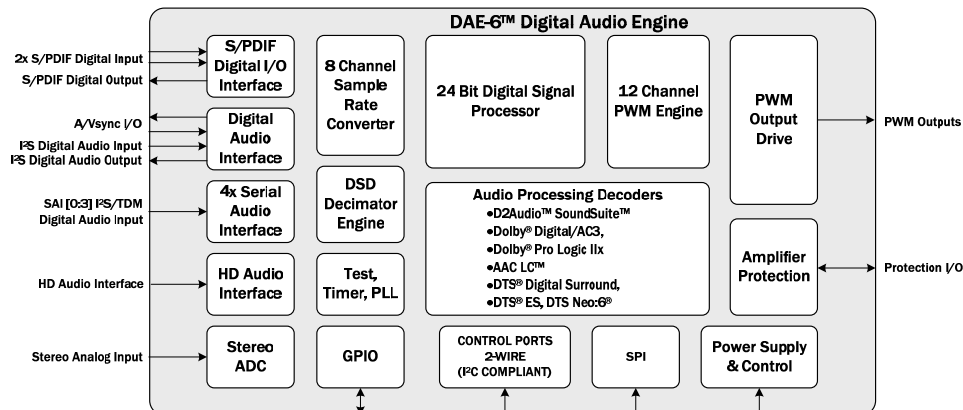
The DAE-6™ device family supports full audio decoding for formats including Dolby® Digital, Dolby® Pro Logic IIx, AAC™ LC, DTS® Digital Surround, DTS® ES, and DTS Neo:6®. The DAE-6 is pin-compatible and function/feature compatible with the DAE-3™ devices, enabling additional decoding capability to existing designs, or providing cost optimization to lower-featured systems not requiring the additional audio processing and decode capability.

## Applications

- Audio Video Receiver (AVR)
- DTV Soundbar
- Home Theater in A Box (HTiB)
- Multi-Channel Multi-Media (MM) Systems
- Multi-Room Distributed Audio (MRDA)
- Powered Speaker Systems
- Automotive Trunk/Amplified Solutions

## Features

- Advanced DAE-6™ Digital Audio Engine™ IC
  - Pin Compatible and Function/Feature Compatible with the D2Audio® DAE-3™ Device
- Total System on Chip (SoC)
  - All Digital Class-D Amplifier Controller
  - Full 5.1/7.1/9.1-Channel Amplifier Platform Support
- Enhanced Audio Processing Decoders
  - Dolby® Digital/AC3
  - Dolby® Pro Logic IIx
  - AAC LC™
  - DTS® Digital Surround
  - DTS® ES
  - DTS Neo:6®
- D2Audio® SoundSuite™ Enhancement and Virtualization
- Mark Levinson MightyCat™ Audio Enhancement
- Expanded On-Chip Memory Capacity
- Integrated DSP Processing
  - 12 Channels of Digital Signal Processing (DSP) including Equalizers, Filters, Mixers and Other Common Audio Processing Blocks
  - Fully Configurable and Rutable Audio Signal Paths
- Flexible Audio Input and Output Configurations
- Embedded 8-Channel Sample Rate Converter
  - Sample Rates from 32kHz up to 192kHz
- Real-Time Amplifier Control and Monitoring
  - Supports Bridged, Half-Bridged, and Bridge-Tied Load (BTL) Topologies, Using Discrete or Integrated Power Stages from 10W to Over 500W
  - Complete Fault Protection with Automatic Recovery



# D2-7xx83

## Ordering Information

PART NUMBER (Note 2)	PART MARKING	AUDIO PROCESSING FEATURE SET SUPPORT (Note 1)	TEMP. RANGE (°C)	PACKAGE (Pb-Free)	PKG. DWG. #
D2-71083-LR	D2-71083-LR	Refer to Table 1	-10 to +85	128 Ld LQFP	Q128.14x14
D2-74083-LR	D2-74083-LR	Refer to Table 1	-10 to +85	128 Ld LQFP	Q128.14x14
D2-71583-LR	D2-71583-LR	Refer to Table 1	-10 to +85	128 Ld LQFP	Q128.14x14
D2-74583-LR	D2-74583-LR	Refer to Table 1	-10 to +85	128 Ld LQFP	Q128.14x14
D2-71683-LR	D2-71683-LR	Refer to Table 1	-10 to +85	128 Ld LQFP	Q128.14x14
D2MC-72083-LR	D2MC-72083-LR	Refer to Table 1	-10 to +85	128 Ld LQFP	Q128.14x14
D2MC-76083-LR	D2MC-76083-LR	Refer to Table 1	-10 to +85	128 Ld LQFP	Q128.14x14

### NOTES:

1. The D2-7xx83 devices support multiple audio processing algorithms and decoders, and support is device-dependent. Refer to Table 1 for the supported features for each device part number.
2. These Intersil Pb-free plastic packaged products employ special Pb-free material sets, molding compounds/die attach materials, and 100% matte tin plate plus anneal (e3 termination finish, which is RoHS compliant and compatible with both SnPb and Pb-free soldering operations). Intersil Pb-free products are MSL classified at Pb-free peak reflow temperatures that meet or exceed the Pb-free requirements of IPC/JEDEC J STD-020.

## DAE-6 Device Feature Set Offering

The D2-7xx83 family has specific part numbers to specify the features and algorithms supported in the device. These part numbers their supported features are shown in Table 1.

**TABLE 1. DAE-6 DEVICE PART NUMBERS AND FEATURES**

PART NUMBER	FEATURES	ALGORITHM SUPPORT	DSP CLOCK AND MEMORY (Note 3)
D2-71083-LR	8-Channels Audio of I <sup>2</sup> S Digital Inputs 2 S/PDIF Digital Inputs 8 Audio Processing Channels with PWM Outputs Embedded 8-Channel Sample Rate Converter	D2Audio <sup>®</sup> SoundSuite™ Audio Processing	147MHz DSP Clock 24k X and Y Memory Capacities 32k P Memory Capacity
D2-74083-LR	8-Channels Audio of I <sup>2</sup> S Digital Inputs 2 S/PDIF Digital Inputs 8 Audio Processing Channels with PWM Outputs Embedded 8-Channel Sample Rate Converter	D2Audio <sup>®</sup> SoundSuite™ Audio Processing	160MHz DSP Clock 40k X and Y Memory Capacities 56k P Memory Capacity
D2-71583-LR	8-Channels Audio of I <sup>2</sup> S Digital Inputs 2 S/PDIF Digital Inputs 8 Audio Processing Channels with PWM Outputs Embedded 8-Channel Sample Rate Converter	Dolby <sup>®</sup> Digital/AC3 Decode Processing Dolby <sup>®</sup> Pro Logic IIx Surround Processing DTS <sup>®</sup> Digital Surround Decode Processing	147MHz DSP Clock 24k X and Y Memory Capacities 32k P Memory Capacity
D2-74583-LR	8-Channels Audio of I <sup>2</sup> S Digital Inputs 2 S/PDIF Digital Inputs 8 Audio Processing Channels with PWM Outputs Embedded 8-Channel Sample Rate Converter	Dolby <sup>®</sup> Digital/AC3 Decode Processing Dolby <sup>®</sup> Pro Logic IIx Surround Processing DTS <sup>®</sup> Digital Surround Decode Processing	160MHz DSP Clock 40k X and Y Memory Capacities 56k P Memory Capacity
D2-71683-LR	8-Channels Audio of I <sup>2</sup> S Digital Inputs 2 S/PDIF Digital Inputs 8 Audio Processing Channels with PWM Outputs Embedded 8-Channel Sample Rate Converter	Dolby <sup>®</sup> Digital/AC3 Decode Processing Dolby <sup>®</sup> Pro Logic IIx Surround Processing DTS <sup>®</sup> Digital Surround Decode Processing AAC LC™ Decode Processing	147MHz DSP Clock 24k X and Y Memory Capacities 32k P Memory Capacity
D2MC-72083-LR	8-Channels Audio of I <sup>2</sup> S Digital Inputs 2 S/PDIF Digital Inputs 8 Audio Processing Channels with PWM Outputs Embedded 8-Channel Sample Rate Converter	Mark Levinson MightyCat™ Audio Processing	147MHz DSP Clock 24k X and Y Memory Capacities 32k P Memory Capacity
D2MC-76083-LR	8-Channels Audio of I <sup>2</sup> S Digital Inputs 2 S/PDIF Digital Inputs 8 Audio Processing Channels with PWM Outputs Embedded 8-Channel Sample Rate Converter	Mark Levinson MightyCat™ Audio Processing	160MHz DSP Clock 40k X and Y Memory Capacities 56k P Memory Capacity

**NOTE:**

3. 147MHz DSP clock speed represents an actual DSP clock of 147.456MHz, and 160MHz DSP clock speed represents an actual DSP clock of 159.744MHz, when using a crystal frequency of 24.576MHz.

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## Absolute Maximum Ratings (Note 6)

Supply Voltage	
RVDD, PWMVDD, ADCVDD	-0.3V to 4.0V
CVDD, PLLVDD	-0.3V to 2.4V
Input Voltage	
Any Input but XTALI	-0.3V to RVDD +0.3V
XTALI	-0.3V to PLLVDD +0.3V
Input Current, Any Pin but Supplies	±10mA

## Thermal Information

Thermal Resistance (Typical)	$\theta_{JA}$ (°C/W)	$\theta_{JC}$ (°C/W)
128 Ld LQFP Package (Notes 4, 5)	40	6.5
Maximum Storage Temperature	-55°C to +150°C	
Pb-Free Reflow Profile	see link below	
	<a href="http://www.intersil.com/pbfree/Pb-FreeReflow.asp">http://www.intersil.com/pbfree/Pb-FreeReflow.asp</a>	

## Recommended Operating Conditions

Temperature Range	-10°C to +85°C
Digital I/O Supply Voltage, PWMVDD	3.3V
Core Supply Voltage, CVDD	1.8V
Analog Supply Voltage, PLLVDD	1.8V

CAUTION: Do not operate at or near the maximum ratings listed for extended periods of time. Exposure to such conditions may adversely impact product reliability and result in failures not covered by warranty.

### NOTES:

- $\theta_{JA}$  is measured with the component mounted on a high effective thermal conductivity test board in free air. See Tech Brief [TB379](#) for details.
- For  $\theta_{JC}$ , the “case temp” location is taken at the package top center.
- Absolute Maximum parameters are not tested in production.

**Electrical Specifications**  $T_A = +25^\circ\text{C}$ , CVDD = PLLVDD = 1.8V ±5%, RVDD = PWMVDD = 3.3V ±10%. All grounds at 0.0V. All voltages referenced to ground. PLL at 294.912MHz, OSC at 24.576MHz, core running at 147.456MHz with typical audio data traffic. Minimum supply currents are measured in full power down configuration.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN (Note 10)	TYP	MAX (Note 10)	UNIT
$V_{IH}$	Digital Input High Logic Level (Note 7)	RVDD = 3.3V (Scales with RVDD)	2.0	-	-	V
$V_{IL}$	Digital Input Low Logic Level (Note 7)	RVDD = 3.3V (Scales with RVDD)	-	-	0.8	V
$V_{OH}$	High Level Output Drive Voltage ( $I_{OUT}$ at - Pin Drive Strength Current, see “Pin Descriptions” on page 12)		RVDD - 0.4	-	-	V
$V_{OL}$	Low Level Output Drive Voltage ( $I_{OUT}$ at + Pin Drive Strength Current, see “Pin Descriptions” on page 12)		-	-	0.4	V
$V_{IHx}$	High Level Input Drive Voltage XTALI Pin		0.7	-	PLLVDD	V
$V_{ILx}$	Low Level Input Drive Voltage XTALI Pin		-	-	0.3	V
$I_{IN}$	Input Leakage Current (Note 8)		-	-	±10	µA
$C_{IN}$	Input Capacitance		-	9	-	pF
$V_{OH0}$	High Level Output Drive Voltage OSCOUT Pin		PLLVDD - 0.3	-	-	V
$V_{OL0}$	Low Level Output Drive Voltage OSCOUT Pin		-	-	0.3	V
$C_{OUT}$	Output Capacitance		-	9	-	pF
$t_{RST}$	nRESET Pulse Width		-	10	-	ns
$R_{VDD}/$ $PWMVDD$	Typical Digital and PWM I/O Pad Ring Supply (Voltage) (Current, Active) (Current, Power-down)		3.0	3.3	3.6	V
			-	15	-	mA
			-	<1	-	mA
CVDD	Typical Core Supply (Voltage) (Current, Active) (Current, Power-down)		1.7	1.8	1.9	V
			-	450	-	mA
			-	15	-	mA
PLLVDD	Typical PLL Analog Supply (Voltage) (Current, Active) (Current, Power-down)		1.7	1.8	1.9	V
			-	25	-	mA
			-	10	-	mA

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**Electrical Specifications**  $T_A = +25^\circ\text{C}$ ,  $CVDD = PLLVDD = 1.8\text{V} \pm 5\%$ ,  $RVDD = PWMVDD = 3.3\text{V} \pm 10\%$ . All grounds at 0.0V. All voltages referenced to ground. PLL at 294.912MHz, OSC at 24.576MHz, core running at 147.456MHz with typical audio data traffic. Minimum supply currents are measured in full power down configuration. (Continued)

SYMBOL	PARAMETER	TEST CONDITIONS	MIN (Note 10)	TYP	MAX (Note 10)	UNIT
ADCVDD	Typical ADC Analog Supply (Voltage) (Current, Active, Power-Down)		3.0	3.3	3.6	V
			-	12	-	mA
<b>CRYSTAL OSCILLATOR</b>						
Xo	Crystal Frequency (Fundamental Mode Crystal)		20	24.576	24.822 (24.576 + 1%)	MHz
Dt	Duty Cycle		40	-	60	%
t <sub>START</sub>	Start-up Time (Start-up Time is Oscillator Enabled (with Valid Supply) to Stable Oscillation)		-	5	20	ms
<b>PLL</b>						
F <sub>VCO</sub>	VCO Frequency		80.00	294.912	297.86	MHz
F <sub>IN</sub>	Input Reference Frequency		20	-	24.822 (24.576 + 1%)	MHz
	Feedback Dividers (Integer)		4	12	15	
	PLL Lock Time from any Input Change		-	2	-	ms
<b>1.8V POWER-ON RESET</b>						
V <sub>EN</sub>	Reset Enabled Voltage Level		-	1.1	1.4	V
t <sub>REJ</sub>	POR Pulse Width Rejection		-	150	500 (Note 11)	μs
t <sub>DIS</sub>	POR Minimum Output Pulse Width		-	5	-	μs
<b>1.8V BROWNOUT DETECTION</b>						
	Detect Level		1.4	1.5	1.6	V
t <sub>BOD1</sub>	Pulse Width Rejection		-	100	-	ns
t <sub>01</sub>	Minimum Output Pulse Width		20	-	-	ns
<b>3.3V BROWNOUT DETECTION</b>						
	Detect Level		2.5	2.7	2.9	V
t <sub>BOD3</sub>	Pulse Width Rejection		-	100	-	ns
t <sub>03</sub>	Minimum Output Pulse Width		20	-	-	ns
<b>ADC PERFORMANCE SPECIFICATIONS</b>						
V <sub>REF</sub>	ADCREF DC Level	I <sub>REF</sub> = 0	1.3	1.4	1.5	V
I <sub>REF</sub>	ADCREF Load Current		-	-	±20	μA
R <sub>REF</sub>	ADCREF Source Impedance		-	14	-	kΩ
V <sub>AIN</sub>	Analog Input Level		V <sub>REF</sub> - 0.6	-	V <sub>REF</sub> + 0.6	V
	Dynamic Range		-	94	-	dB
	THD+N		-	-80	-	dB
	Gain Mismatch		-	0.1	-	dB
	Crosstalk		-	-80	-	dB
	Power Supply Rejection		-	-70	-	dB

**NOTES:**

7. All input pins except XTALI.
8. Input leakage applies to all pins except XTALO.
9. Power-down is with device in reset and clocks stopped.
10. Compliance to datasheet limits is assured by one or more methods: production test, characterization and/or design.
11. Limits established by characterization and are not production tested.

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**Serial Audio Interface Port Timing** (Figure 1)  $T_A = +25^\circ\text{C}$ ,  $CVDD = PLLVDD = 1.8\text{V} \pm 5\%$ ,  $RVDD = PWMVDD = 3.3\text{V} \pm 10\%$ . All grounds at 0.0V. All voltages referenced to ground.

SYMBOL	DESCRIPTION	MIN (Note 10)	TYP	MAX (Note 10)	UNIT
$t_{cSCLK}$	SCKRx Frequency - SCKR0, SCKR1			12.5	MHz
$t_{wSCLK}$	SCKRx Pulse Width (High and Low) - SCKR0, SCKR1	40			ns
$t_{sLRCLK}$	LRCKRx Setup to SCLK Rising - LRCKR0, LRCKR1	20			ns
$t_{hLRCLK}$	LRCKRx Hold from SCLK Rising - LRCKR0, LRCKR1	20			ns
$t_{sSDI}$	SDINx Setup to SCLK Rising - SDIN0, SDIN1	20			ns
$t_{hSDI}$	SDINx Hold from SCLK Rising - SDIN0, SDIN1	20			ns
$t_{dSDO}$	SDOUTx Delay from SCLK Falling			20	ns

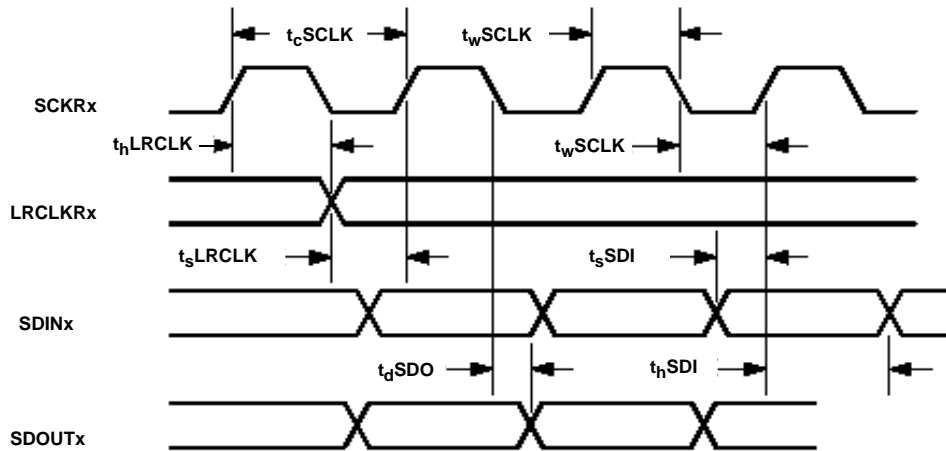


FIGURE 1. SERIAL AUDIO INTERFACE PORT TIMING



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## Two-Wire (I<sup>2</sup>C) Interface Port Timing

(Figure 2)  $T_A = +25^\circ\text{C}$ ,  $CVDD = PLLVDD = 1.8\text{V} \pm 5\%$ ,  $RVDD = PWMVDD = 3.3\text{V} \pm 10\%$ .

All grounds at 0.0V. All voltages referenced to ground.

SYMBOL	DESCRIPTION	MIN (Note 10)	TYPICAL	MAX (Note 10)	UNIT
$f_{\text{SCL}}$	SCL Frequency			100	kHz
$t_{\text{buf}}$	Bus Free Time Between Transmissions	4.7			$\mu\text{s}$
$t_{\text{wlowSCLx}}$	SCL Clock Low	4.7			$\mu\text{s}$
$t_{\text{whighSCLx}}$	SCL Clock High	4.0			$\mu\text{s}$
$t_{\text{sSTA}}$	Setup Time For a (Repeated) Start	4.7			$\mu\text{s}$
$t_{\text{hSTA}}$	Start Condition Hold Time	4.0			$\mu\text{s}$
$t_{\text{hSDAx}}$	SDA Hold From SCL Falling (Note 12)		1		$\mu\text{s}$
$t_{\text{sSDAx}}$	SDA Setup Time to SCL Rising	250			ns
$t_{\text{dSDAx}}$	SDA Output Delay Time From SCL Falling (Note 13)			3.5	$\mu\text{s}$
$t_{\text{r}}$	Rise Time of Both SDA and SCL (Note 13)			1	$\mu\text{s}$
$t_{\text{f}}$	Fall Time of Both SDA and SCL (Note 13)			300	ns
$t_{\text{sSTO}}$	Setup Time For a Stop Condition	4.7			$\mu\text{s}$

**NOTE:**

12. Data is clocked in as valid on next XTALI rising edge after SCL goes low.

13. Limits established by characterization and not production tested.

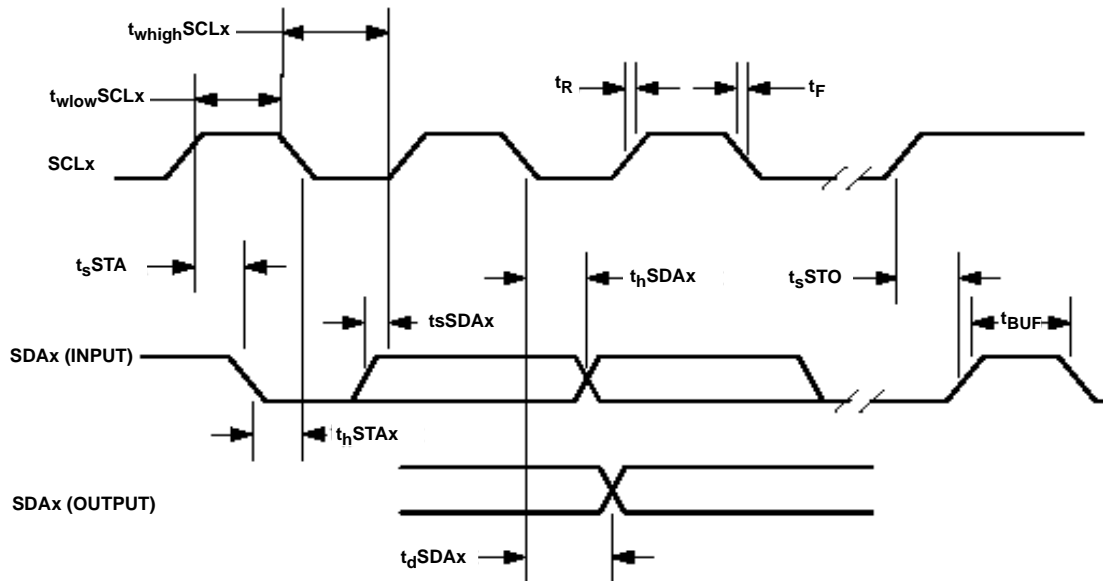


FIGURE 2. I<sup>2</sup>C INTERFACE TIMING

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**SPI™ Interface Port Timing** (Figure 3) TA = +25 °C, CVDD = PLLVDD = 1.8V ±5%, RVDD = PWMVDD = 3.3V ±10%. All grounds at 0.0V. All voltages referenced to ground.

SYMBOL	DESCRIPTION	MIN (Note 10)	MAX (Note 10)	UNIT
<b>SPI MASTER MODE TIMING</b>				
t <sub>v</sub>	MOSI Valid From Clock Edge	-	8	ns
t <sub>s</sub>	MISO Setup to Clock Edge	10	-	ns
t <sub>H</sub>	MISO Hold From Clock Edge	1 system clock + 2ns		
t <sub>wl</sub>	nSS Minimum Width	3 system clocks + 2ns		
<b>SPI SLAVE MODE TIMING</b>				
t <sub>v</sub>	MISO Valid From Clock Edge	3 system clocks + 2ns		
t <sub>s</sub>	MOSI Setup to Clock Edge	10	-	ns
t <sub>H</sub>	MOSI Hold From Clock Edge	1 system clock + 2ns		
t <sub>wl</sub>	nSS Minimum Width	3 system clocks + 2ns		

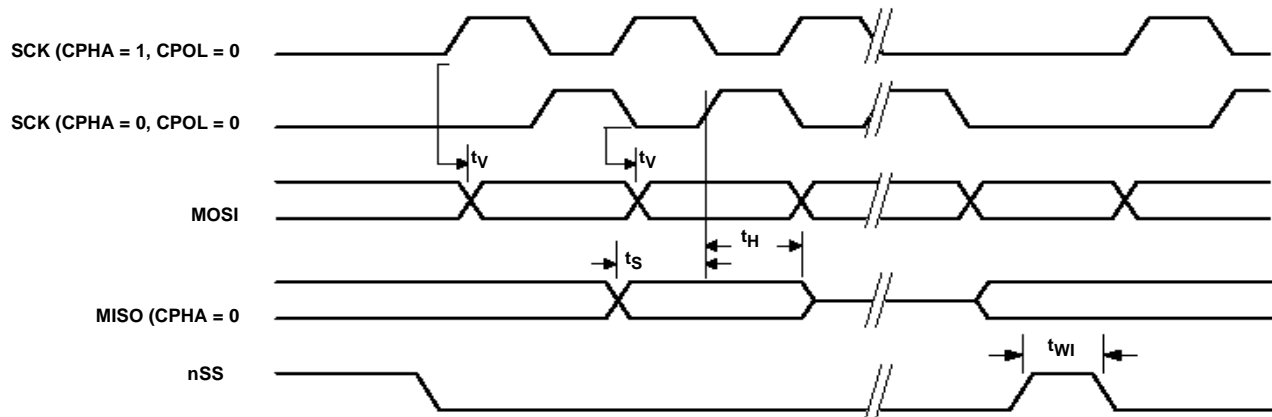
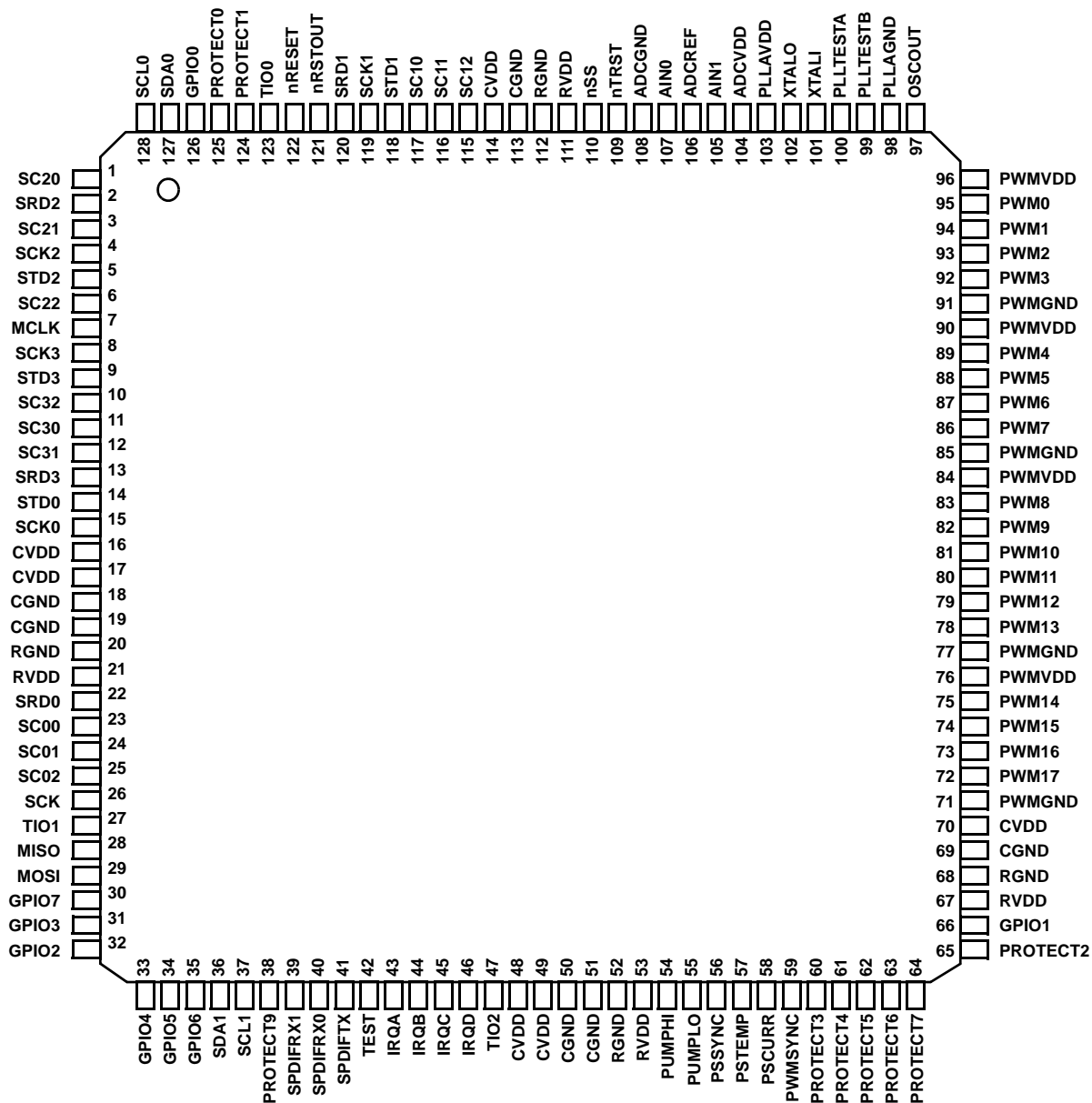


FIGURE 3. SPI TIMING

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## Pin Configuration

D2-71083, D2-74083, D2-71583, D2-74583, D2-71683, D2MC-72083, D2MC-76083  
(128 LD LQFP)  
TOP VIEW



## Pin Descriptions

PIN	PIN NAME (Note 14)	TYPE	VOLTAGE LEVEL (V)	DRIVE STRENGTH (mA)	DESCRIPTION
1	SC20	I/O	3.3	8	Serial Audio Interface 2, I <sup>2</sup> S0 SCLK
2	SRD2	I/O	3.3	4	Serial Audio Interface 2, I <sup>2</sup> S0 SDIN
3	SC21	I/O	3.3	8	Serial Audio Interface 2, I <sup>2</sup> S0 LRCK
4	SCK2	I/O	3.3	8	Serial Audio Interface 2, I <sup>2</sup> S1 SCLK
5	STD2	I/O	3.3	8	Serial Audio Interface 2, I <sup>2</sup> S1 SDIN
6	SC22	I/O	3.3	4	Serial Audio Interface 2, I <sup>2</sup> S1 LRCK
7	MCLK	O	3.3	16	I <sup>2</sup> S Serial Audio Master Clock output for external ADC/DAC components, drives low on reset and is enabled by firmware assignment.
8	SCK3	I/O	3.3	8	Serial Audio Interface 3, I <sup>2</sup> S3 SCLK
9	STD3	I/O	3.3	8	Serial Audio Interface 3, I <sup>2</sup> S3 SDIN
10	SC32	I/O	3.3	8	Serial Audio Interface 3, I <sup>2</sup> S3 LRCK
11	SC30	I/O	3.3	8	Serial Audio Interface 3, I <sup>2</sup> S2 SCLK
12	SC31	I/O	3.3	8	Serial Audio Interface 3, I <sup>2</sup> S2 LRCK
13	SRD3	I/O	3.3	4	Serial Audio Interface 3, I <sup>2</sup> S2 SDIN
14	STD0	I/O	3.3	8	Serial Audio Interface 0, I <sup>2</sup> S SDAT0
15	SCK0	I/O	3.3	8	Serial Audio Interface 0, I <sup>2</sup> S LRCK0
16	CVDD	P	3.3		Core power, 1.8V
17	CVDD	P	3.3		Core power, 1.8V
18	CGND	P	3.3		Core ground
19	CGND	P	3.3		Core ground
20	RGND	P	3.3		Digital pad ring ground. Internally connected to PWMGND.
21	RVDD	P	3.3		Digital pad ring power, 3.3V. This 3.3V supply is used for all the digital I/O pad drivers and receivers, except for the analog pads. Internally connected to PWMVDD.
22	SRD0	I/O	3.3	4	Serial Audio Interface 0, SDIO, Defaults to input, and may be configured as GPIO by firmware.
23	SC00	I/O	3.3	8	Serial Audio Interface 0, SDIO, Defaults to input, and may be configured as GPIO by firmware.
24	SC01	I/O	3.3	8	Serial Audio Interface 0, I <sup>2</sup> S SDAT1
25	SC02	I/O	3.3	8	Serial Audio Interface 0, I <sup>2</sup> S LRCK1
26	SCK	I/O	3.3	4	SPI clock I/O with hysteresis input.
27	TIO1	I/O	3.3	16	Timer I/O port 1. Operation and assignment is controlled by firmware. Leave unconnected when not in use.
28	MISO	I/O	3.3	4	SPI master input, slave output data signal.
29	MOSI	I/O	3.3	4	SPI master output, slave input data signal.
30	GPIO7	I/O	3.3	16	General purpose I/O Bidirectional GPIO port. (One of 8 GPIO. Resets to input port. Operation and assignment is defined by product application's firmware.)
31	GPIO3	I/O	3.3	16	General purpose I/O Bidirectional GPIO port. (One of 8 GPIO. Resets to input port. Operation and assignment is defined by product application's firmware.)
32	GPIO2	I/O	3.3	16	General purpose I/O Bidirectional GPIO port. (One of 8 GPIO. Resets to input port. Operation and assignment is defined by product application's firmware.)
33	GPIO4	I/O	3.3	16	General purpose I/O Bidirectional GPIO port. (One of 8 GPIO. Resets to input port. Operation and assignment is defined by product application's firmware.)

# D2-7xx83

## Pin Descriptions (Continued)

PIN	PIN NAME (Note 14)	TYPE	VOLTAGE LEVEL (V)	DRIVE STRENGTH (mA)	DESCRIPTION
34	GPIO5	I/O	3.3	16	General purpose I/O Bidirectional GPIO port. (One of 8 GPIO. Resets to input port. Operation and assignment is defined by product application's firmware.)
35	GPIO6	I/O	3.3	16	General purpose I/O Bidirectional GPIO port. (One of 8 GPIO. Resets to input port. Operation and assignment is defined by product application's firmware.)
36	SDA1	I/O	3.3	8 - OD	Two-Wire Serial data port 1. Bidirectional signal used by both the master and slave controllers for data transport.
37	SCL1	I/O	3.3	8 - OD	Two-Wire Serial clock port 1. Bidirectional signal is used by both the master and slave controllers for clock signaling.
38	PROTECT9	I/O	3.3	4	PWM protection input with hysteresis. (One of 9 protection inputs. Specific function and channel assignment is defined by firmware.)
39	SPDIFRX1	I	3.3	-	S/PDIF Digital audio data input 1
40	SPDIFRX0	I	3.3	-	S/PDIF Digital audio data input 0
41	SPDIFTX	O	3.3	4	S/PDIF Digital audio output. (Audio content and audio processing signal flow is dependent upon firmware, driving stereo output up to 192kHz.)
42	TEST	I	3.3	-	Factory test use only. Must be tied low.
43	IRQA	I	3.3	-	Interrupt request port A, Boot Mode Select. One of 4 IRQ pins. Connects to logic high (3.3V) or to ground & High/Low logic status establishes boot mode selection upon de-assertion of reset (nRESET) cycle.
44	IRQB	I	3.3	-	Interrupt request port B, Boot Mode Select. One of 4 IRQ pins. Connects to logic high (3.3V) or to ground & High/Low logic status establishes boot mode selection upon de-assertion of reset (nRESET) cycle.
45	IRQC	I	3.3	-	Interrupt request port C, Boot Mode Select. One of 4 IRQ pins. Connects to logic high (3.3V) or to ground & High/Low logic status establishes boot mode selection upon de-assertion of reset (nRESET) cycle.
46	IRQD	I	3.3	-	Interrupt request port D, Boot Mode Select. One of 4 IRQ pins. Connects to logic high (3.3V) or to ground & High/Low logic status establishes boot mode selection upon de-assertion of reset (nRESET) cycle.
47	TIO2	I/O	3.3	16	Timer I/O port 2. Operation and assignment is controlled by firmware. Leave unconnected when not in use.
48	CVDD	P	3.3	-	Core power, 1.8V
49	CVDD	P	3.3	-	Core power, 1.8V
50	CGND	P	3.3	-	Core ground
51	CGND	P	3.3	-	Core ground
52	RGND	P	3.3	-	Digital pad ring ground. Internally connected to PWMGND.
53	RVDD	P	3.3	-	Digital pad ring power, 3.3V. This 3.3V supply is used for all the digital I/O pad drivers and receivers, except for the analog pads. Internally connected to PWMVDD.
54	PUMPHI	I/O	3.3	16	Assignable I/O. Function and operation defined by firmware.
55	PUMPLO	I/O	3.3	16	Assignable I/O. Function and operation defined by firmware.
56	PSSYNC	I/O	3.3	16	Synchronizing output signal to switching power supply. (Operates under specification of firmware and resets to high impedance inactive state when not used.)
57	PSTEMP	I/O	3.3	4	Assignable I/O. Function and operation defined by firmware.
58	PSCURR	I/O	3.3	4	Assignable I/O. Function and operation defined by firmware.
59	PWMSYNC	I/O	3.3	16	PWM synchronization port. (Function and operation is defined by firmware.)
60	PROTECT3	I/O	3.3	4	PWM protection input with hysteresis. (One of 9 protection inputs. Specific function and channel assignment is defined by firmware.)

## Pin Descriptions (Continued)

PIN	PIN NAME (Note 14)	TYPE	VOLTAGE LEVEL (V)	DRIVE STRENGTH (mA)	DESCRIPTION
61	PROTECT4	I/O	3.3	4	PWM protection input with hysteresis. (One of 9 protection inputs. Specific function and channel assignment is defined by firmware.)
62	PROTECT5	I/O	3.3	4	PWM protection input with hysteresis. (One of 9 protection inputs. Specific function and channel assignment is defined by firmware.)
63	PROTECT6	I/O	3.3	4	PWM protection input with hysteresis. (One of 9 protection inputs. Specific function and channel assignment is defined by firmware.)
64	PROTECT7	I/O	3.3	4	PWM protection input with hysteresis. (One of 9 protection inputs. Specific function and channel assignment is defined by firmware.)
65	PROTECT2	I/O	3.3	4	PWM protection input with hysteresis. (One of 9 protection inputs. Specific function and channel assignment is defined by firmware.)
66	GPIO1	I/O	3.3	16	General purpose I/O Bidirectional GPIO port. (One of 8 GPIO. Resets to input port. Operation and assignment is defined by product application's firmware.)
67	RVDD	P	3.3	-	Digital pad ring power, 3.3V. This 3.3V supply is used for all the digital I/O pad drivers and receivers, except for the analog pads. Internally connected to PWMVDD.
68	RGND	P	3.3	-	Digital pad ring ground. Internally connected to PWMGND.
69	CGND	P	3.3	-	Core ground
70	CVDD	P	3.3	-	Core power, 1.8V
71	PWVGND	P	3.3	-	PWM output pin ground. Internally connected to RGND.
72	PWM17	I/O	3.3	8 or 16	PWM output pin. (One of 18 PWM output pins. Channel and operation assignment is defined by firmware.)
73	PWM16	I/O	3.3	8 or 16	PWM output pin. (One of 18 PWM output pins. Channel and operation assignment is defined by firmware.)
74	PWM15	I/O	3.3	8 or 16	PWM output pin. (One of 18 PWM output pins. Channel and operation assignment is defined by firmware.)
75	PWM14	I/O	3.3	8 or 16	PWM output pin. (One of 18 PWM output pins. Channel and operation assignment is defined by firmware.)
76	PWMVDD	P	3.3	-	PWM output pin power. This 3.3V supply is used for the PWM pad drivers. Internally connected to RVDD.
77	PWVGND	P	3.3	-	PWM output pin ground. Internally connected to RGND.
78	PWM13	I/O	3.3	8 or 16	PWM output pin. (One of 18 PWM output pins. Channel and operation assignment is defined by firmware.)
79	PWM12	I/O	3.3	8 or 16	PWM output pin. (One of 18 PWM output pins. Channel and operation assignment is defined by firmware.)
80	PWM11	I/O	3.3	8 or 16	PWM output pin. (One of 18 PWM output pins. Channel and operation assignment is defined by firmware.)
81	PWM10	I/O	3.3	8 or 16	PWM output pin. (One of 18 PWM output pins. Channel and operation assignment is defined by firmware.)
82	PWM9	I/O	3.3	8 or 16	PWM output pin. (One of 18 PWM output pins. Channel and operation assignment is defined by firmware.)
83	PWM8	I/O	3.3	8 or 16	PWM output pin. (One of 18 PWM output pins. Channel and operation assignment is defined by firmware.)
84	PWMVDD	P	3.3	-	PWM output pin power. This 3.3V supply is used for the PWM pad drivers. Internally connected to RVDD.
85	PWVGND	P	3.3	-	PWM output pin ground. Internally connected to RGND.
86	PWM7	I/O	3.3	8 or 16	PWM output pin. (One of 18 PWM output pins. Channel and operation assignment is defined by firmware.)

# D2-7xx83

## Pin Descriptions (Continued)

PIN	PIN NAME (Note 14)	TYPE	VOLTAGE LEVEL (V)	DRIVE STRENGTH (mA)	DESCRIPTION
87	PWM6	I/O	3.3	8 or 16	PWM output pin. (One of 18 PWM output pins. Channel and operation assignment is defined by firmware.)
88	PWM5	I/O	3.3	8 or 16	PWM output pin. (One of 18 PWM output pins. Channel and operation assignment is defined by firmware.)
89	PWM4	I/O	3.3	8 or 16	PWM output pin. (One of 18 PWM output pins. Channel and operation assignment is defined by firmware.)
90	PWMVDD	P	3.3	-	PWM output pin power. This 3.3V supply is used for the PWM pad drivers. Internally connected to RVDD.
91	PWMGND	P	3.3	-	PWM output pin ground. Internally connected to RGND.
92	PWM3	I/O	3.3	8 or 16	PWM output pin. (One of 18 PWM output pins. Channel and operation assignment is defined by firmware.)
93	PWM2	I/O	3.3	8 or 16	PWM output pin. (One of 18 PWM output pins. Channel and operation assignment is defined by firmware.)
94	PWM1	I/O	3.3	8 or 16	PWM output pin. (One of 18 PWM output pins. Channel and operation assignment is defined by firmware.)
95	PWM0	I/O	3.3	8 or 16	PWM output pin. (One of 18 PWM output pins. Channel and operation assignment is defined by firmware.)
96	PWMVDD	P	3.3	-	PWM output pin power. This 3.3V supply is used for the PWM pad drivers. Internally connected to RVDD.
97	OSCOUT	P	1.8	-	Analog oscillator output to slave D2-71x83 devices. OSCOUT drives a buffered version of the crystal oscillator signal from the XTALI pin.
98	PLLAGND	P	1.8	-	PLL Analog ground
99	PLLTESTB	O	1.8	-	Factory test use only. Must be tied low.
100	PLLTESTA	O	1.8	-	Factory test use only. Must be tied low.
101	XTALI	P	1.8	-	Crystal oscillator analog input port. An external clock source would be driven into the this port. In multi-D2-71x83 systems, the OSCOUT from the master D2-71x83 would drive the XTALI pin.
102	XTALO	P	1.8	-	Crystal oscillator analog output port. When using an external clock source, this pin must be open. XTALO does not have a drive strength specification.
103	PLLAVDD	P	1.8	-	PLL Analog power, 1.8V
104	ADCVDD	P	3.3	-	Analog power for internal ADC, 3.3V
105	AIN1	I	3.3	-	Analog input 1 to internal ADC
106	ADCREF	O	3.3	-	Analog voltage reference output. Must be de-coupled to analog ground with 1 $\mu$ F capacitor.
107	AIN0	I	3.3	-	Analog input 0 to internal ADC
108	ADCGND	P	3.3	-	Analog ground for internal ADC
109	nTRST	I	3.3	-	Factory test only. Must be tied high at all times.
110	nSS	I/O	3.3	4	SPI slave select I/O.
111	RVDD	P	3.3	-	Digital pad ring power, 3.3V. This 3.3V supply is used for all the digital I/O pad drivers and receivers, except for the analog pads. Internally connected to PWMVDD.
112	RGND	P	3.3	-	Digital pad ring ground. Internally connected to PWMGND.
113	CGND	P	3.3	-	Core ground
114	CVDD	P	3.3	-	Core power, 1.8V
115	SC12	I/O	3.3	8	Serial Audio Interface 1, LRCK
116	SC11	I/O	3.3	8	Serial Audio Interface 1, SDAT3

## Pin Descriptions (Continued)

PIN	PIN NAME (Note 14)	TYPE	VOLTAGE LEVEL (V)	DRIVE STRENGTH (mA)	DESCRIPTION
117	SC10	I/O	3.3	8	Serial Audio Interface 1, data (Assignment by firmware control.)
118	STD1	I/O	3.3	8	Serial Audio Interface 1, SDAT2
119	SCK1	I/O	3.3	8	Serial Audio Interface 1, SCK
120	SRD1	I/O	3.3	4	Serial Audio Interface 1, data (Assignment by firmware control.)
121	nRSTOUT	O	3.3	16 - OD	Active low open drain reset output. Pin drives low from POR generator, 3.3V brown out detector going active, or from 1.8V brown out detector going active. This output should be used to initiate a system reset to the nRESET pin upon brownout event detection.
122	nRESET	I	3.3	-	Active low reset input with hysteresis. Activates system level reset when pulled low, initializing all internal logic and program operations. System latches boot mode selection of the IRQ input pins on the rising edge.
123	TI00	I/O	3.3	16	Timer I/O port 0. Operation and assignment is controlled by firmware. Leave unconnected when not in use.
124	PROTECT1	I/O	3.3	4	PWM protection input with hysteresis. (One of 9 protection inputs. Specific function and channel assignment is defined by firmware.)
125	PROTECT0	I/O	3.3	4	PWM protection input with hysteresis. (One of 9 protection inputs. Specific function and channel assignment is defined by firmware.)
126	GPIO0	I/O	3.3	16	General purpose I/O Bidirectional GPIO port. (One of 8 GPIO. Resets to input port. Operation and assignment is defined by product application's firmware.)
127	SDA0	I/O	3.3	8 - OD	Two-Wire Serial data port 0. Bidirectional signal used by both the master and slave controllers for data transport.
128	SCL0	I/O	3.3	8 - OD	Two-Wire Serial clock port 0. Bidirectional signal is used by both the master and slave controllers for clock signaling.

### NOTES:

14. Unless otherwise specified all pin names are active high. Those that are active low have an "n" prefix.
15. All power and ground pins of same names are to be tied together to all other pins of their same name. (i.e., CVDD pins to be tied together, CGND pins to be tied together, RVDD pins to be tied together, and RGND pins to be tied together.) CGND and RGND are to be tied together on board. RGND and PWMGND pins are also internally connected and are to be tied together.



## Functional Block Diagram

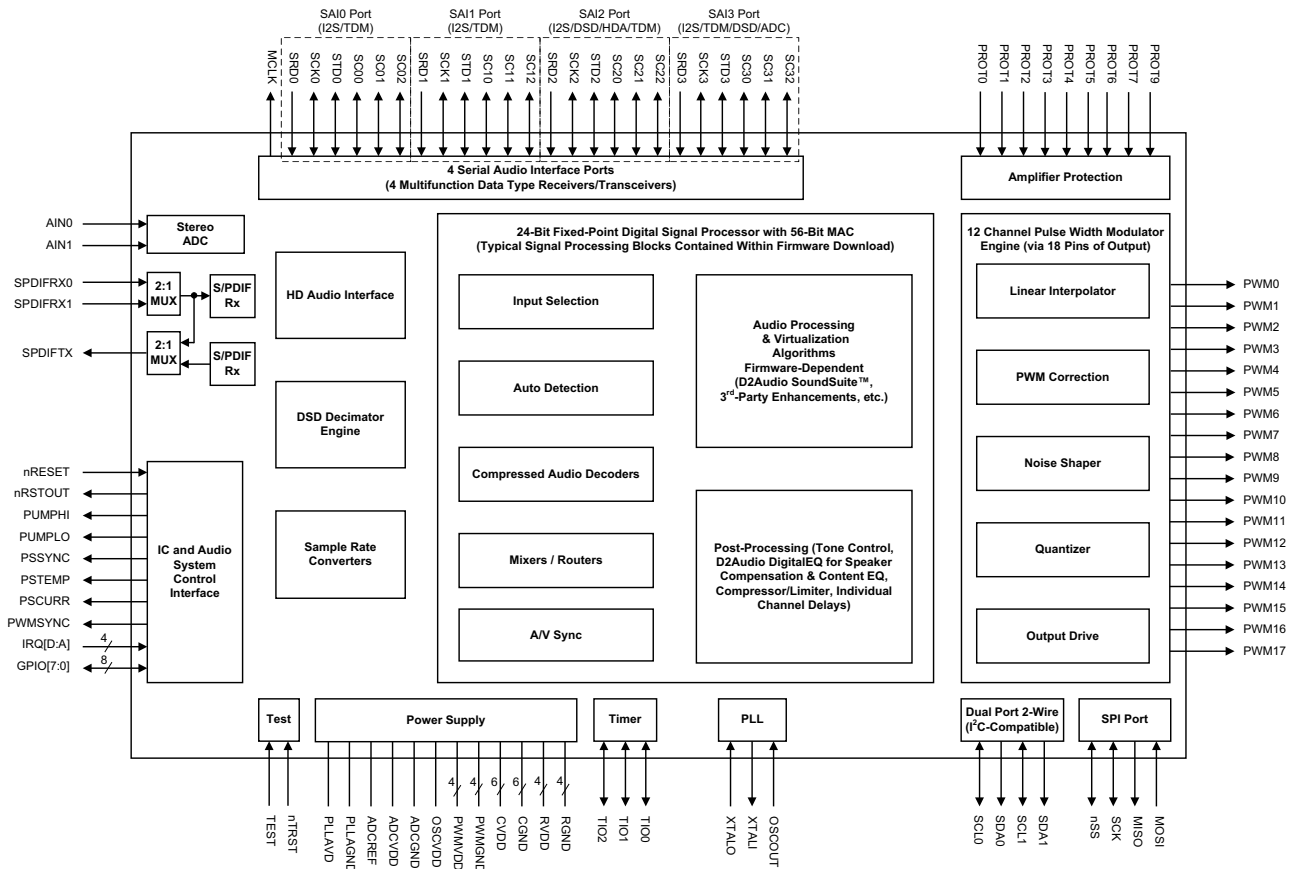


FIGURE 4. D2-7xx83 IC FUNCTIONAL BLOCK DIAGRAM

## Introduction

The DAE-6 family of ICs provide the core functionality, amplifier control, and complete audio signal processing for D2Audio's Class-D amplifier solutions. A variety of Reference Designs from Intersil D2Audio Corporation include specific signal flows designed for their applications, supporting today's design features. Support is also provided for future planned features, with little or no additional hardware or logic to enable new features. The signal flow, digital audio I/O, and amplifier hardware control support is handled completely by the DAE-6 firmware.

The products are targeted at high-volume Home Theater in a Box (HTiB), Multimedia, Soundbar, and similar solutions, where rich features and cost-effective quality audio are required to meeting demands of current consumer electronics markets.

The DAE-6 devices are completely pin-compatible with the DAE-3 devices, allowing full flexibility for function vs cost trade-off, providing cost-effective solutions for applications of varying end-user features and capabilities.

## Target Performance

Typical systems built around the DAE-6 support performances that includes or exceeds:

- >110 dB SNR/Dynamic Range System Support
- <0.06% THD+N at Full Scale at 1kHz
- 20Hz to 20kHz Audio Frequency Response
- Scalable Amplifier Power Control Capability
- Discrete Component and Integrated Power Stages using Full-Bridge, Half-Bridge, and BTL Output Topologies
- Encrypted Code Loads and Unique Decryption for each IC Part Number
- Support for all Standard Audio Data Delivery Formats and Protocols Employed in the Target Markets
- The Delivery Formats Include: I<sup>2</sup>S, Left-Justified, Time-Division Multiplexed (TDM), S/PDIF, DSD, HDA, 2-Channel Analog

## Application Markets

The powerful DSP coupled with flexible peripherals and excellent signal processing hardware results in a chip for solutions that cover many markets. All are characterized by the need for complex signal processing and high audio channel count. Typical applications include a wide variety of cost sensitive but feature-demanding performance such as in:

- Multimedia Speaker Solutions
- Multi-Driver (Bi-Amp, Tri-Amp) Speaker Arrays
- Home Theater Systems with Compressed Audio Decoder
- Soundbar System Solutions
- Set-Top Box Solutions
- Low-Cost Virtualized Stereo, 5.1, 7.1, and 9.1 AVR Systems
- MRDA distributed and networked audio systems with multiple powered channels
- Aftermarket/OEM Automotive Amplifiers

## System Features and Support

The DAE-6 enables multiple solutions consisting of a Class-D amplifier system built around internal audio processing functional blocks. Features include:

- Flexible Audio Input and Output Configurations
  - 4 Independent Asynchronous I<sup>2</sup>S Digital Inputs
  - Support of 8 Audio Channels of HDMI
  - HD Audio (HDA)
  - Direct Stream Digital™ (DSD) Input Support
  - Integrated high-performance stereo ADC
  - Dual Multiplexed S/PDIF™ Digital Audio Inputs (Linear IEC-61958 PCM or Compressed IEC-61937 Audio)
  - S/PDIF Digital Audio PCM Output
  - Line-level Outputs (Left, Right, Subwoofer) using passive or active output filter stages
- Flexible DSP Clock Speed and DSP Memory Capacity Options
  - 147.456MHz DSP Clock Speed Devices, with 24k X and Y Memory and 32k P Memory Capacity
  - 159.744MHz DSP Clock Speed Devices, with 24k X and Y Memory and 32k P Memory Capacity
- Real-Time Amplifier Control and Monitoring
  - Supports Bridged, Half-Bridged, and Bridge-Tied Load (BTL) Topologies, using Discrete or Integrated Power Stages from 10W to Over 500W
  - Graceful Protection and Recovery
  - Complete Fault Protection with Automatic Recovery
- Serial Control Interface via I<sup>2</sup>C, HDA, SPI, or SCI
- Decoding of Compressed Audio Formats, Including
  - Dolby® Digital/AC3
  - Dolby® Pro Logic IIx
  - AAC™ LC
  - DTS® Digital Surround
  - DTS® ES
  - DTS Neo:6®
- Audio Enhancement Feature Support
  - D2Audio® SoundSuite™ Audio Processing Enhancement
  - Mark Levinson MightyCat™ Audio Processing Enhancement

## Audio Processing Signal Flow Support

The D2-7xx83-series of ICs supports a wide variety of signal flows and audio processing options that are fully programmable and are completely defined by the system firmware and system architecture.

The firmware provided for the D2-7xx83 devices is application-specific and includes its own specific signal flow and associated performance level. Much of the signal flow is also hardware dependent and that hardware integrates with the full system architecture that is defined within that system's programmed firmware. Each firmware design includes a specific set of control tool support, including the D2Audio™ Audio Canvas™ software and system design data.

Additional design-specific reference documentation is included within each firmware application design, that includes platform-specific signal flows, control registers, and descriptions of advanced processing features.

The various system support capabilities include:

- Flexible system configuration with 8 audio input and audio processing channels, with up to 12 audio output PWM channels, supporting differential or single-end PWM outputs with up to 18 PWM output pins.
- Audio processing for up to 4 simultaneous stereo asynchronous digital audio inputs from a variety of sources (HDA, I<sup>2</sup>S, HDMI, DSD, S/PDIF Digital)
- Multiple D2-7xx83 devices may be cascaded to support higher channel count designs.

## Functional Description

The D2-7xx83 Family of ICs, integrated into D2Audio's offerings of reference design platforms support present and future design features with little or no additional hardware or logic to enable new features.

### Audio Input

Multiple versions of the D2-7xx83 family IC-based reference designs support a wide range of market applications and each of

these market applications has a variety of potential audio sources such as:

- Mono and Stereo Analog Inputs
- Serial Audio, I<sup>2</sup>S and Time Division Multiplexed (TDM) Single Line "Network" Mode
- HD-Audio Interface (UAA-Class Driver Capable)
- Stereo and Multichannel DSD
- S/PDIF Digital (IEC60958-Compliant and IEC61937-Compliant)

### SERIAL AUDIO INPUT

Since most systems incorporate some mix of digital and analog inputs, the DAE-6 offers a very flexible digital audio peripheral interface. The DAE-6 features four independent Serial Audio Interface (SAI) ports. All SAI ports support both master or slave clocking and can support sample rates from 32kHz to 192kHz.

Each SAI port supports the digital audio industry I<sup>2</sup>S standard, which supports carrying up to 24-bit Linear PCM audio words per subframe IEC60958, or compressed digital audio (Dolby® Digital, AAC, DTS®, MPEG, etc.) packing per the IEC61937 specification. The SAI port also supports Left-Justified formatted Linear PCM or compressed digital audio. Each SAI port supports time division multiplexing (TDM) capability (a.k.a. "Network mode") with up to 32 words per frame.

SAI ports 2 and 3 (the 3rd and 4th ports) have multiplexed inputs to provide a standard input signal flow for the ADC, DSD, and HDA audio interfaces. All serial audio input data streams go through an SAI interface, which simplifies the data flow configuration.

SAI data formats are shown in Figure 5. For I<sup>2</sup>S format, the left channel data is read when LRCK is low. For the Left-Justified format, the left channel data is read when LRCK is high. Either format requires data to be valid on the rising edge of SCLK and sent MSB-first on SDIN with 32 bits of data per channel. Each set of digital inputs runs asynchronously to the others and may accept different sample rates and formats.

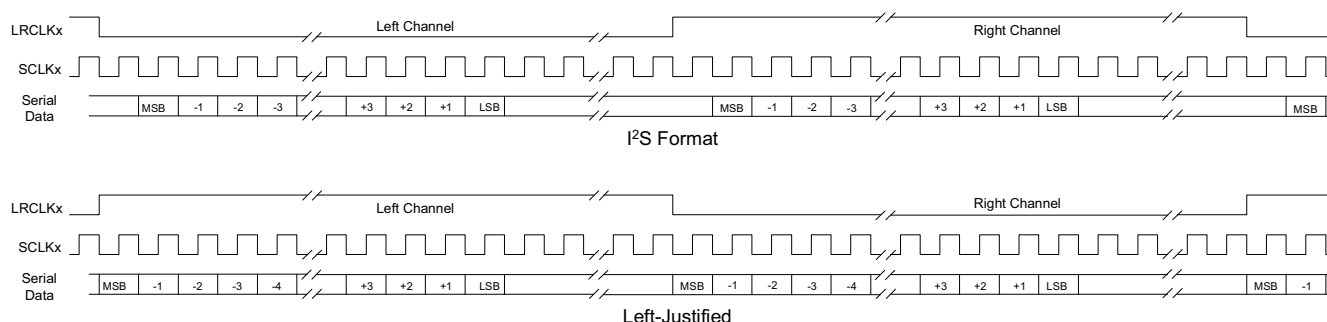


FIGURE 5. SAI PORT SUPPORTED DATA FORMATS FOR DELIVERY OF LINEAR PCM OR COMPRESSED AUDIO DATA

## S/PDIF RECEIVER

The D2-7xx83 contains two input pins internally multiplexed into one IEC60958 compliant S/PDIF Digital receiver. The receiver input pins are 3.3V CMOS input level compatible, requiring external circuitry to condition the serial input. The receiver contains an input transition detector, digital PLL clock recovery, and a decoder to separate audio, channel status, and user data. Only the first 24-Channel status bits are supported. The receiver constantly monitors the incoming data stream to detect the IEC61937-1 packet headers, and if found, captures the Pc and Pd data words into registers. The receiver meets the jitter tolerance specified in IEC60958-4.

S/PDIF is a commonly used interface for receiving compressed (IEC61937-compliant) and stereo PCM (IEC60958-compliant) audio data. This interface also supports receipt of compressed audio data that is not compliant with the IEC61937 specification, but instead meets the IEC60958 specification.

## ADC INPUT

The D2-7xx83 contains a high-performance Analog-to-Digital Converter (ADC) that connects to input analog sources with a minimum of interface circuitry. At a bandwidth of 20kHz at nominal voltage and temperature, the ADC input of the DAE-6 provides a typical THD+N (unweighted) value of -81dB and an SNR/Dynamic Range of 94dB.

The ADC master clock can be supplied from either the low jitter PLL of the D2-7xx83, or from the HD Audio interface. When the PLL provides the ADC master clock, the ADC operates synchronous to the DSP processing, which minimizes noise pickup. When operated from the HD Audio clock system, the ADC decimator output is synchronous to the HDA frame rate, eliminating the need for sample rate conversion to the HDA frame rate. Figure 6 shows the ADC decimator frequency response over full bandwidth and passband, and Figure 7 shows the ADC performance with full scale input processed through the SRC to a 48kHz sample rate.

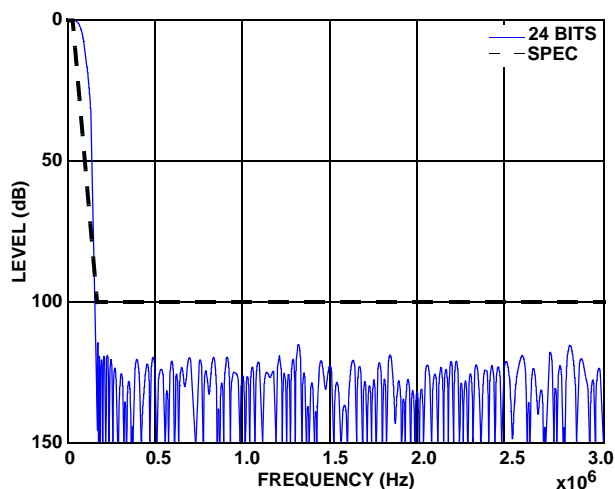


FIGURE 6. ADC DECIMATOR FREQUENCY RESPONSE (256 TAPS DECIMATE BY 32)

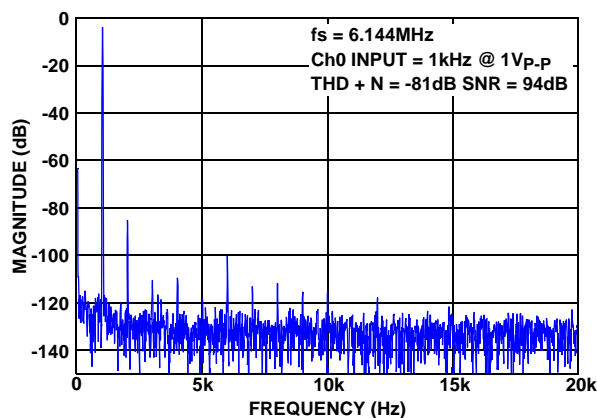
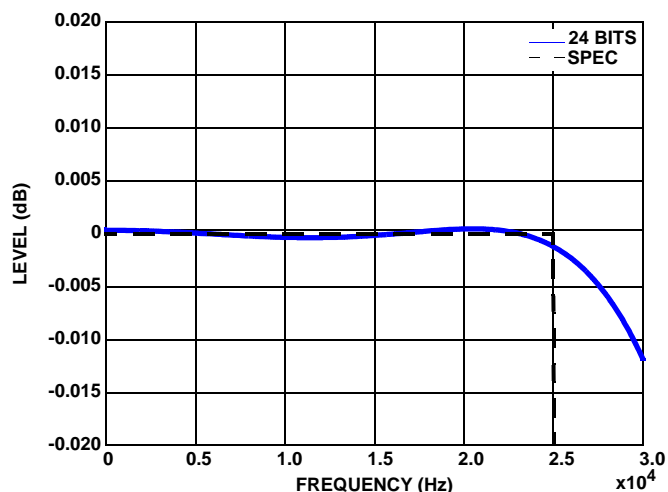


FIGURE 7. ADC PERFORMANCE AT FULL SCALE INPUT

## DSD

The HDMI specification (version 1.2 and later) used in TV systems supports streaming DSD encoded audio over HDMI. To support this, the system can receive and process up to 6 DSD audio streams. The DSD interface supports both standard and phase-modulated data formats. A high-quality 16x decimator engine converts all of the DSD data streams into 24-bit PCM words with an FS of 176.4kHz using a 128-tap FIR filter. The DSD decimation filter has a cutoff frequency of 50kHz and is optimized for passband flatness.

SAI ports 2 and 3 support DSD format inputs. When the DSD interface is enabled, all the pins of SAI 2 and the SC21 pin of SAI3 become the DSD input signals. The 6 channels of DSD audio are merged into 3 I<sup>2</sup>S PCM streams at a 176.4kHz sample rate. These I<sup>2</sup>S streams are routed into both receivers on SAI 2 and the first receiver of SAI 3. The data is then passed to the Sample Rate Converter (SRC). The SRC will rate-lock to the DSD input clock and attenuate any jitter in the DSD input stream.

The DSD input processing clusters the DSD data into channel pairs. This allows a flexible channel count of 2, 4, or all 6 DSD data streams to be handled. Using 4-channel DSD frees the SAI 3 port for other uses. Similarly, using only 2-Channel DSD frees the second SAI 2 port and the SAI 3 port for other uses.

The D2-7xx83 family of ICs also offers digital audio format conversion support for DSD stereo format input to S/PDIF or I<sup>2</sup>S format output, as well as DSD multichannel format input to multiple I<sup>2</sup>S format output. This high-quality digital audio format conversion path also offers the ability to reduce clock jitter in the audio system introduced by certain transmission paths such as HDMI.

This technique also enables consumer products to output a downsampled and/or downmixed (if necessary) digital audio output for audio that may not otherwise be made available to the consumer in the original higher-bandwidth format due to certain consumer electronic/content protection licensing restrictions.

The graphs in Figure 8 show the DSD decimation filter frequency response at 2 different frequency zoom levels.

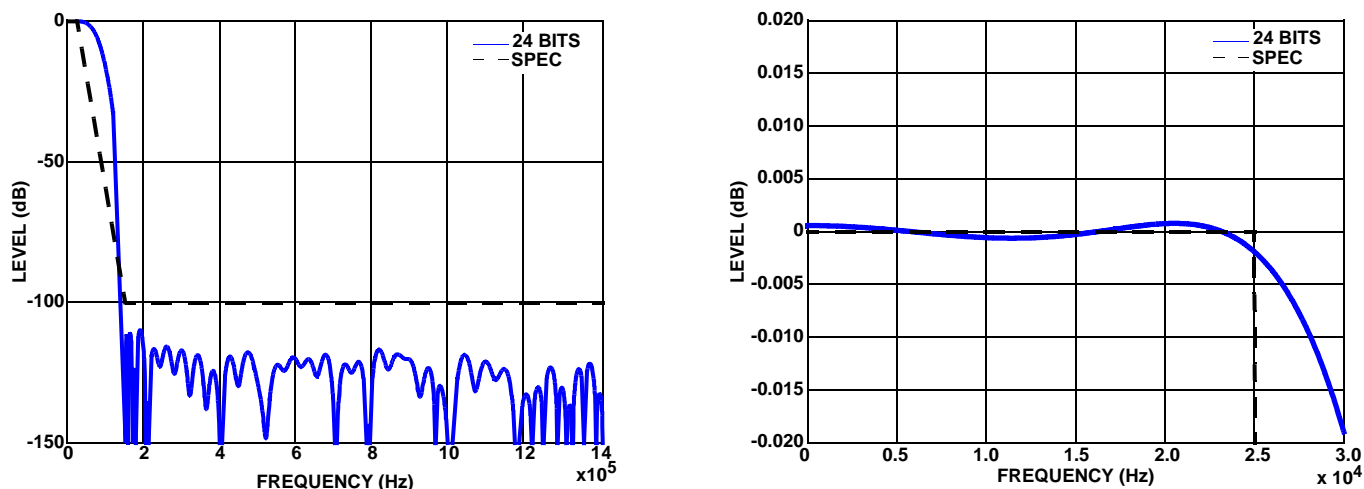


FIGURE 8. DSD DECIMATOR FREQUENCY RESPONSE (128 TAPS DECIMATE BY 16)

## Audio Output

### PWM AUDIO AMPLIFIER OUTPUT

The D2-7xx83 family supports multiple PWM output topologies, which enables system designs to use an output stage, which meets the cost and performance requirements of the particular application. Twelve PWM channels are mapped to 18 PWM output pins by the programmed firmware. The PWM output pins are 3.3V CMOS levels with either 8mA or 16mA drive capability.

Output topologies supported include:

- Half-bridge, N+N or N+P
- Full-bridge, N+N or N+P using 2-level modulation, 2 or 4-quadrant control

### LINE LEVEL OUTPUT

In addition to amplified outputs, the D2-7xx83 family IC also supports line-level outputs that generate a nominal  $1V_{RMS}$  output using a simple passive filter.

Headphone outputs or line-level outputs that require a  $2V_{RMS}$  (or higher output level) are also supported, using an active filter to accomplish the signal level needs.

### S/PDIF TRANSMITTER

The D2-7xx83 contains one IEC60958 compatible S/PDIF Digital transmitter. The transmitter complies with the consumer applications defined in IEC60958-3. The transmitter supports 24-bit audio data, 24-bit user data, and 30-bit channel status data.

A bit-exact pass-through mode from the selected SPDIFRX[1:0] input is also supported. This simplifies system designs that require that the IEC61937-compliant original compressed audio bitstream be made available at the back panel of the product, as well as giving the user the capability to select a decoded (and downmixed, if necessary) IEC60958-compliant stereo or mono Linear PCM output for digital audio recording/playback capabilities.

The D2-7xx83 family optional firmware offers digital audio format conversion support for I<sup>2</sup>S Digital format input to S/PDIF Digital format output, as well as S/PDIF Digital format input to I<sup>2</sup>S Digital format output, for all digital audio Linear PCM (non-compressed) audio sources. This functionality is not available for compressed audio inputs, unless the compressed audio data is first decoded by the internal DSP, and if necessary, downmixed to 2 channels.

This format conversion path offers the ability to reduce the clock jitter on the output due to the fact that both inputs (when in this mode) pass through the professional-grade Sample-Rate Converters (SRC). This approach also enables consumer products to output a downsampled digital audio output for audio that may not otherwise be made available to the consumer in the original higher-bandwidth format due to certain consumer electronic/content protection licensing restrictions.

### SERIAL AUDIO OUTPUT

D2-7xx83 family IC-based systems support outputting a bit-exact pass-through of a compressed audio bitstream, or a decoded, down-mixed (Lt/Rt or Lo/Ro) and downsampled 2 channel Linear

PCM audio bitstream via a specified SAI port, or S/PDIF Digital transmitter. In addition, depending on the firmware functionality, it is possible for unused SAI (Serial Audio Interfaces) to also support I<sup>2</sup>S output as well, in either slave or master mode. The output audio sample rate is determined by the firmware and can vary from 32kHz up to 192kHz.

## HD Audio

### HDA INTERFACE

The HD Audio interface also provides a control interface. This control interface uses the HD Audio GPI, GPO, and GPIO 8-bit ports to provide a message passing facility between the D2-7xx83 and the PC.

The D2-7xx83 fully supports Windows® Hardware Quality Labs (WHQL™)-certification as, it is a UAA-Compliant Secondary HD Audio CODEC. The devices may be used either as the primary HDA CODEC, or as the second HDA CODEC in the system.

Features supported are:

- Message passing to other devices located on the motherboard (e.g. HP jack detection and reporting.)
- Amplifier firmware download.
- Amplifier code load during system boot.
- Amplifier control protocol (D2Audio Canvas II support).

### HD AUDIO PLAY

The D2-7xx83 provides for direct connection of a PC's HD Audio (HDA) Controller to the device. In this configuration, the D2-7xx83 functions as an HDA CODEC with powered (amplified) outputs.

Supported Features Include:

- 2, 4, 6, or 8 Amplified or PWM DAC Channels
- Audio Sample Rates 48kHz, 96kHz, 192kHz
- Data Widths of 16-bit, 20-bit, and 24-bit
- Independent Channel Gain Control

The HDA interface uses 5 of the 6 pins of the SAI 3 port. The HDA interface captures the audio streams and converts them into one to four I<sup>2</sup>S data streams, depending on the number of channels used. These I<sup>2</sup>S stereo streams are routed through SAI 3 and SAI 4 and then on to the Sample Rate Converter. The SRC will rate lock to the HDA stream and remove any jitter while converting the data to the output sample rate.

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## HD AUDIO FUNCTIONS AND FUNCTION TYPES

TABLE 2.

FUNCTION	FUNCTION TYPE	NODE ID	CONNECTIONS
Audio Function Group	Function Group	01	Parent of all other nodes, also holds GPIO functions
Front L/R DAC	Stereo DAC	02	To Front L/R Mixer
Center/LFE DAC	Stereo DAC	03	To Center/LFE Mixer
Surround L/R DAC	Stereo DAC	04	To Surround L/R Mixer
Side Surround L/R DAC	Stereo DAC	05	To Side Surround Mixer
Front L/R Mixer	Sum/Mixer Node	06	To Front L/R Pin
Center/LFE Mixer	Sum/Mixer Node	07	To Center/LFE Pin
Surround L/R Mixer	Sum/Mixer Node	08	To Surround L/R Pin
Side Surround L/R Mixer	Sum/Mixer Node	09	To Side Surround L/R Pin
Front L/R Output Pin	Pin Complex	0A	To system per configuration default register
Center/LFE Output Pin	Pin Complex	0B	To system per configuration default register
Surround L/R Output Pin	Pin Complex	0C	To system per configuration default register
Side Surround L/R Output Pin	Pin Complex	0D	To system per configuration default register

## HD AUDIO VERBS SUPPORTED

TABLE 3.

VERB FUNCTION	GET CODE	SET CODE	WIDGET NID			
			01	02 - 05	06 - 09	0A - 0D
Converter Format	A	2		Y		
Gain/Mute	B	3				Y
Processing Coefficient	C	4				
Coefficient Index	D	5				
Get Parameter	F00		Y	Y	Y	Y
Connection Select	F01	701				
Get Connection List	F02				Y	Y
Processing	F03					
SDI Select	F04	704				
Power State	F05	705	Y			
Channel/Stream ID	F06	706		Y		
Pin Widget	F07	707				Y
Unsolicited Response	F08	708				
Pin Sense	F09	709				Y
Beep	F0A	70A				
EAPD/BTL	F0C	70C				
Digital Converter	F0D	70D - 70E				
Volume Knob	F0F	70F				
GPI	F10 - F1A	710 - 71A	Y			
Config Default	F1C	71C - 71F				Y
Subsystem ID	F20	720 - 723	Y			

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TABLE 3. (Continued)

VERB FUNCTION	GET CODE	SET CODE	WIDGET NID			
			01	02 - 05	06 - 09	0A - 0D
Stripe	F24	724				
Reset		7FF	Y			

## HD AUDIO WIDGET REQUIRED PARAMETERS

VERB ID - 0xF00; PARAMETERS 0x9 - 0xD

NODE ID	FUNCTION	WIDGET CAP.	PCM SIZE RATE	FORMAT	PIN CAP.	INPUT AMP CAP.
		PID 0x9	PID 0xA	PID 0xB	PID 0xC	PID 0xD
01	Function		Y	Y		
02	DAC	Y	Y	Y		
03	DAC	Y	Y	Y		
04	DAC	Y	Y	Y		
05	DAC	Y	Y	Y		
06	Mixer	Y				Y
07	Mixer	Y				Y
08	Mixer	Y				Y
09	Mixer	Y				Y
0A	Pin	Y			Y	
0B	Pin	Y			Y	
0C	Pin	Y			Y	
0D	Pin	Y			Y	

VERB ID - 0xF00; PARAMETERS 0xE - 0x13

NODE ID	FUNCTION	CONNECT LIST LENGTH	POWER STATES	PROCESS CAP.	OUTPUT AMP CAP.	VOLUME KNOB
		PID 0xE	PID 0xF	PID 0x10	PID 0x12	PID 0x13
01	Function		Y			
02	DAC					
03	DAC					
04	DAC					
05	DAC					
06	Mixer	Y			Y	
07	Mixer	Y			Y	
08	Mixer	Y			Y	
09	Mixer	Y			Y	
0A	Pin	Y			Y	
0B	Pin	Y			Y	
0C	Pin	Y			Y	
0D	Pin	Y			Y	



## HD AUDIO SYSTEM TOPOLOGY

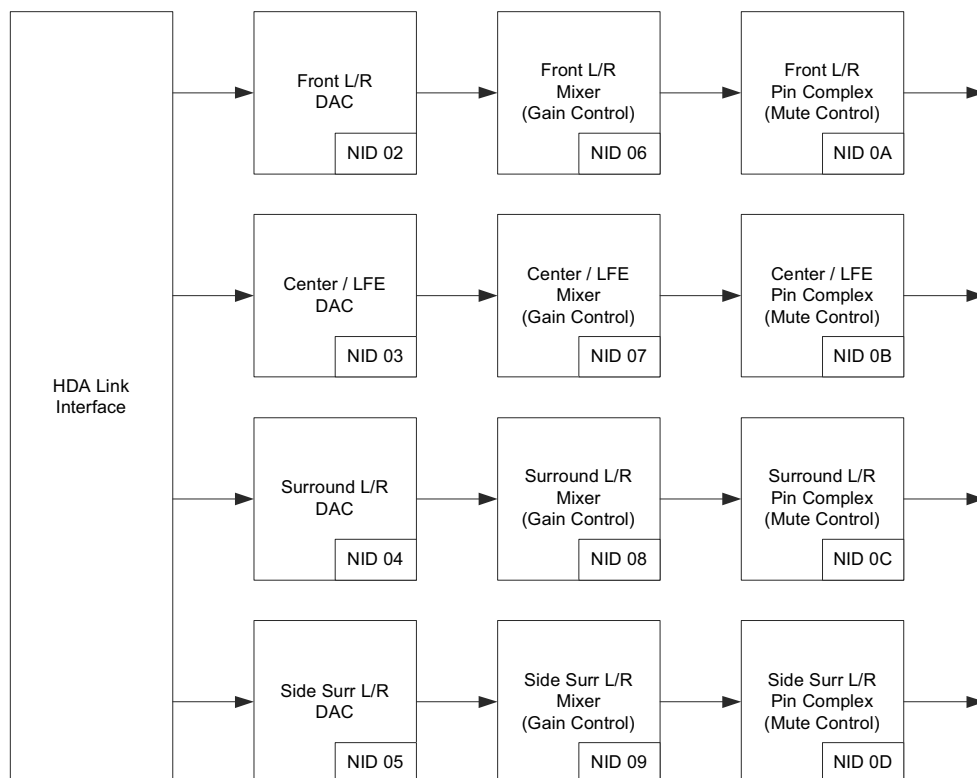


FIGURE 9. HD AUDIO SYSTEM TOPOLOGY

### Sample Rate Converters (SRC)

D2-7xx83 family ICs support internal asynchronous sample rate conversion to align input audio streams to a single rate compatible with the DSP processing rate and PWM switch rate. D2-7xx83 device family has 4 independent rate estimators, allowing up to 4 asynchronous stereo inputs (8 channels) to be sample rate converted and processed simultaneously. The sample rate converter has a measured SNR that exceeds 140dB and a THD+N that exceeds -125dB.

### DSP

The majority of the D2-7xx83 audio processing functions as well as system control occur within the DSP core. The core is a 24-bit fixed-point Digital Signal Processor, tightly integrated with its own DMA, interrupt control, memory, and control interfaces. Software configurable processing blocks and signal routings are implemented within the DSP, allowing a wide range of functionality and system implementations through the programmed definitions that are read into memory upon device initialization. Signal flows through the device are buffered and processed through hardware specific-function blocks (such as the Sample Rate Converter) and allow considerable overall signal processing capability through interface to the DSP.

### Clocks And PLL

The clock generation contains a low jitter PLL critical for low noise PWM output and a precise master clock source for the

ADC, sample rate conversion, and the audio data paths. The serial audio interfaces can function as either a master or a slave.

The PLL block contains the following components:

- Low noise crystal oscillator
- Low jitter PLL clock multiplier
- Power on reset generator
- Brown out detectors on the CVDD and RVDD supplies
- System reset generation logic
- Clock generators for the DSP, S/PDIF transmitter, ADC, and MCLK output pin

The PLL block is completely managed by the system firmware. The system clock is provided by the crystal oscillator block, using either a fundamental mode crystal or a clock input to the XTALI pin. If the clock input is used, it must be a 1.8V signal level. The input signal on the XTALI pin is analog buffered and driven onto the OSCOUT pin for use in driving the XTALI input of other D2-7xx83 controllers.

The PLL uses the signal on the XTALI pin as the reference clock. The reference clock frequency is multiplied by an integer multiple of 4 to 15 to get the PLL output clock. The PLL output is used to time the PWM outputs and to generate the DSP clock. During system start-up, before the PLL has been configured and locked, the PLL is bypassed and the system operates at XTALI speed.

The power on reset circuit senses the rise of the PLLVDD supply. When the supply reaches the sense threshold, the power on reset pulse is generated. If the PLLVDD supply droops below the sense threshold, the reset pulse will occur when the supply rises above the threshold. The power on reset signal will drive the nRSTOUT output pin low.

The two power supply brown out detectors monitor the CVDD and PWMVDD power rails. If the power rail droops below the threshold, the brown out detector will activate and drive the nRSTOUT output pin low.

The system reset generation logic is activated by a low level on the nRESET input pin or by the power on reset sensor pulse. Upon de-assertion of nRESET a sequential counter ensures sufficient time and clock cycle count for the internal synchronous logic to reset.

Multiple D2-7xx83 ICs are capable of running on a common timebase. Multiple D2-7xx83 ICs synchronize themselves onto a single crystal oscillator so that all ICs run at identical frequencies.

## DSP CLOCK SPEED AND MEMORY CAPACITY SUPPORT

The D2-7xx83 devices are offered in part number-specific devices that support multiple DSP clock speeds and memory capacity. Depending on the device part number, the D2-7xx83 operates up to clock rates of 147.456MHz or 159.744MHz, and offers memory capacity of 24k/24k/32k or 40k/40k, 56k of X/Y/P memory space.

The higher speed and larger memory devices support designs requiring higher processing capacity, while the lower speed devices provide cost optimization to systems not requiring the additional audio processing and decode capability.

Refer to “DAE-6 Device Feature Set Offering” on page 3 for the device part numbers and definitions of clock speed and memory capacity.

## Hardware I/O Functions

The D2-7xx83 provides programmable I/O pins used for various hardware functions of the system design. Pin functions are defined by the product firmware, and may be different from one design to another.

### GENERAL-PURPOSE (GPIO) I/O PINS,

Eight dedicated General Purpose I/O (GPIO) pins are available for system use. These are controlled only by the D2-7xx83 device family firmware.

### TIMERS

A timer block consisting of 3 separate general purpose timers provides programmed control of event or count down timing functions. The timer functions are controlled through the firmware, where these timers can operate as timed pulse generators, as pulse-width modulators, or as event counters to capture an event or to measure the width or period of a connected signal. These timers are connected to the 3 timer pins (TIO[0:2]), which are also assignable as I/O by firmware.

## POWER SUPPLY SYNCHRONIZATION

The PSSYNC pin provides a power supply synchronization signal for switching power supplies. Firmware configures PSSYNC to the frequency and duty cycle needed by the system switching regulator. The proper configuration eliminates audio output tones generated if the switching power supply is not locked to the amplifier switching.

## POWER SUPPLY ANTI-PUMP

D2-7xx83 supports designs to correct for power supply pumping that occurs in half-bridge output stage topologies. The PUMPHI and PUMPLO pins provide a differential PWM signal pair that drive an anti-pump correction stage. The dead time and duty cycle are adjustable to eliminate the power supply DC offset.

## Amplifier Protection

The D2-7xx83 supports individual PWM channel protection through individual protection input pins. These PROTECT pins are primarily intended for protecting the PWM powered output stages. The protection inputs are activated by either a pulse or level driven into the pin. Firmware configures the input processing logic to properly interpret the input signal as rising edge triggered, falling edge triggered, high level, or low level.

The protection input signal is generated by specialized sensing circuits. There are several kinds of sensing circuits for detecting current, temperature, or voltage. A powered PWM output stage or a power supply pump driver typically uses an overcurrent sensor. This sensor will detect power FET current, load current, or both. These circuits are unique to the specific power stage design, and may be embedded inside an integrated power stage. Temperature and voltage sensing are accomplished in a variety of ways and usually create a DC level representing a fault condition.

D2-7xx83 designs incorporate a variety of protection strategies to prevent damage from the high voltages, currents, and temperatures present in class-D amplifier designs. This protection is also effective against user-induced faults, such as clipping, output overload, or output shorts, including both shorted outputs or short-to-ground faults.

The D2-92xx IC works in conjunction with specific surrounding parts to provide continuous system monitoring for destructive events. These events include:

- Output Overcurrent
- Output Short Circuit
- Over-Temperature (Thermal Event)
- Power Supply Brown Out
- Shoot Through Overcurrent

Protection features and their details are firmware application dependent.

Firmware functions running on the D2-7xx83 can be assigned to observe the temperature at critical points in the hardware and automatically respond to excessive temperature. Depending on the specific implementation, this response can be as simple as turning on an optional fan to reduce temperature, or managing the audio signal to reduce power consumption.

## GRACEFUL OVERCURRENT AND SHORT CIRCUIT

Overcurrent sensing requires a current sensor in the power device to be protected, usually a powered PWM output. The typical sensor creates a pulse that is active when the current exceeds a specified threshold.

The D2-7xx83 IC observes the overcurrent protection inputs and provides graceful protection for the output stage. The hardware is configured to provide immediate current reduction, cycle-by-cycle output clipping, output signal control, and output stage deactivation depending on the severity and duration of high current events. The combination of hardware features and firmware monitoring allows the system to differentiate between an overcurrent situation or a more serious short circuit condition.

## THERMAL PROTECTION

The D2-7xx83 IC can connect to an optional low-cost thermal sensing circuit and monitor temperatures in the system. Firmware monitoring can record the system temperature and provide system responses including enabling a fan and managing the audio output signal.

## Device Operation

### RESET AND INITIALIZATION

The D2-7xx83 must be reset after power up to begin proper operation, and in normal system hardware configurations, the reset occurs automatically via the reset hardware circuitry. The chip contains power rail sensors, brown out detectors, on the 3.3V and 1.8V power supplies. These brown out sensors will assert and hold an internal Power-on Reset, which will disable the device until the power supplies are at a safe level for the DSP to start. These same brownout sensors will detect a power supply voltage droop while the system is active and provide a safe amplifier shutdown.

### POWER SEQUENCING

The CVDD and RVDD (including PWMVDD) supplies should be brought up together to avoid high current transients that could fold back a power supply regulator. The ADCVDD and PLLVDD may be brought up separately. Best practice would be for all supplies to feed from regulators with a common power source. Typically this can be achieved by using a single 5V power source and regulating the 3.3V and 1.8V supplies from that 5V source.

### RESET

D2-7xx83 has one reset input: the nRESET pin. The nRESET input pin (active low, non-reset high) is effectively a power-on system reset. All internal state logic, except internal test hardware, is

initialized by nRESET. While reset is active the system is held in the reset condition. The reset condition is defined as all internal reset signals being active, the crystal oscillator is running, and the PLL disabled.

At the de-assertion of nRESET, the chip will capture the boot mode selection and begin the boot process.

## Bootling and Boot Modes

### CODE INITIALIZATION AND BOOT MODES

D2-7xx83 includes a fully-programmable DSP with internal boot ROM. The boot ROM's primary function is to download a second-stage boot image from one of several possible peripheral sources:

- I<sup>2</sup>C Interface EEPROM
- I<sup>2</sup>C Interface Slave
- SPI ROM
- SPI Interface Slave
- HDA Bus

The specific boot mode is selected based on the state of the IRQD, IRQC, IRQB, and IRQA pins at the time of reset de-assertion. The boot ROM code has been designed to handle both encrypted and non-encrypted boot images from any of the above storage locations. Boot modes are shown in Table 4.

The system requires external firmware to boot the internal DSP. Internal ROM within the DAE-6 initiates the boot process to read the boot records and firmware, to load into the internal DAE-6 memory.

There are multiple boot modes provided on the DAE-6 devices, as shown in Table 4. The mode is selected by a hardware pull-up or pull-down connection to each of the four boot mode (IRQ[D:A]) pins. (Modes not listed are reserved.) Boot sources include:

- I<sup>2</sup>C EEPROM
- SPI EEPROM or SPI Flash
- I<sup>2</sup>C Slave (to external Microcontroller)
- SPI Slave (to external Microcontroller)
- Asynchronous UART (RS-232 for PC Communication Mode as well as D2-7xx83 Device to Device Communication Mode)
- HD Audio Bus
- Combo Mode with I<sup>2</sup>C EEPROM or SPI

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TABLE 4. BOOT MODES

MODE	IRQ[D:A]	M/S	XTALI RANGE	INTERFACE SPEED	DESCRIPTION	USAGE
0	0000	S	N/A	per Master	I <sup>2</sup> C port 1 slave boot @ address 88	System
1	0001	M	24.576 MHz	400kb/s (See Note 16)	Combo Master - ROM On I <sup>2</sup> C port 0 or SPI	System
2	0010	M	24.576MHz	1.53MHz	ROM On SPI (EE or FLASH) (Copy of Mode 1 for pin compatibility)	System
3	0011	S	N/A	per Master	SPI slave boot	System
7	0111	S	24.576MHz	384kb/s	Fast Asynchronous SCI boot	Multi-IC
B	1011	S	24.576 MHz	9600 b/s	Asynchronous SCI interface boot (RS232 Compatible)	System
C	1100	M	24.576MHz	1.53MHz (See Note 16)	HDA enabled, Combo Master - ROM on SPI (EE or FLASH)	System
D	1101	M	24.576MHz	400kb/s	Copy of mode C for pin compatibility	System
E	1110	M	24.576MHz	per Master	HDA boot	System
F	1111	M	24.576 MHz	400Kb/s	2 wire ROM on GPIO port (SCL= GPIO1,SDA = GPIO0)	System/ Fail-safe

NOTE:

16. For the “per Master” and “N/A” entries above, there is a maximum transfer rate that is a fraction of XTALI speed. This maximum transfer rate is peripheral port specific.

## APPLICATION FIRMWARE LOAD

The application firmware is loaded either by the boot code or by a multi-step process. Direct boot code loading occurs when the selected boot mode successfully finds a boot image on the expected peripheral interface and the image is successfully loaded in memory. A multi-step boot is one in which the boot code loads a program that manages the system boot.

## Control Interfaces

### I<sup>2</sup>C 2-WIRE INTERFACE

The D2-7xx83 family IC has two separate I<sup>2</sup>C 2-Wire compatible ports. One is typically used for the external microcontroller interface, and the other for D2-7xx83 family IC communication to EEPROMs, or other compatible peripheral chips. Both I<sup>2</sup>C interfaces are multi-master capable.

Registers are accessed through the I<sup>2</sup>C control interface. Since the I<sup>2</sup>C bus has multiple slaves, the desired I<sup>2</sup>C target device must be addressed. The specific I<sup>2</sup>C channel control address is defined within the firmware that is loaded into the DAE-6 at boot and initialization time. Typical addresses used in various reference designs use the address of 0xB2, but the actual address should be confirmed based on the firmware design being used in the application.

### SERIAL PERIPHERAL INTERFACE (SPI™)

The Serial Peripheral Interface (SPI) is an alternate serial interface to the I<sup>2</sup>C interfaces. As a master, this interface supports port extenders, EEPROMs, Flash, and various control interfaces for more complex chips. As a slave, this provides an alternate method for customers to communicate with the system.

## MULTI-CONTROLLER IC COMMUNICATION

The D2-7xx83 IC is capable of communicating and synchronizing data and control information across multiple D2-7xx83 ICs. This communication is to facilitate matrix mixing of all input channels in a system and to allow precise phase alignment of the output audio. Systems designs are capable of achieving outputs phase aligned to within 1/2 sample at 192kHz. One D2-7xx83 IC acts as the timing master, so all other D2-7xx83 ICs must then operate as timing slaves. The setting of the each of the D2-7xx83 ICs is system-configuration specific and is detailed in the specific RDP documentation.

## AUDIO SYNCHRONIZATION

Multiple D2-7xx83 ICs can be connected together and synchronized for controlling events to meet phase alignment requirements.

Control Protocols provide for an external device communication with the D2-7xx83 firmware while the amplifier is running. The D2-7xx83 firmware has a peripheral device driver that establishes communication with the external controller device. The D2-7xx83 is always a slave. Communication can occur through the HDA, I<sup>2</sup>C, and SPI ports. However control is provided through only the I<sup>2</sup>C, and HDA ports, and control through the SPI port is not supported.

## CONTROL REGISTER SUMMARY

The control register interface provides a mechanism for an external controller to manipulate the amplifier signal flow, and provides access to the internal registers.

Each system design has its own firmware-dependent register Application Programming Interface (API) and its own unique

signal flow. The control register definitions, bit fields, and data format for each register are specified in that firmware API.

## READING AND WRITING CONTROL REGISTERS

Registers and memory spaces are defined within the DAE-6 firmware for specific internal operation and control. In typical reference designs, the highest-order byte of the register address (bits 23:16) determines the internal address space used for control read or write access, and the remaining 16 bits (bits 15:0) describe the actual address within that space. Refer to the descriptions of the actual reference design firmware being used in the application for specific definitions.

All reads or writes to registers (shown in Figures 10 and 11) begin with a Start Condition, followed by the Device Address byte, three Register Address bytes, three Data bytes and a Stop Condition.

Register writes through the I<sup>2</sup>C interface are initiated by setting the read/write bit that is within the device address byte. The device write function as, shown in Figure 10, executes the following 9 steps as the I<sup>2</sup>C bus master:

1. I<sup>2</sup>C START command
2. Transmit device I<sup>2</sup>C address with W
3. Transmit mode byte
4. Transmit upper memory address byte
5. Transmit lower memory address byte
6. Transmit data upper byte
7. Transmit data middle byte
8. Transmit data lower byte
9. I<sup>2</sup>C STOP command

All reads to registers require two steps. First, the master must send a dummy write, which consists of sending a Start, followed by the device address with the write bit set, and three register address bytes. Next, the master must send a repeated Start, following with the device address with the read/write bit set to read, and then read the next three data bytes. The master must Acknowledge (ACK) the first two read bytes and send a Not Acknowledge (NACK) on the third byte received and a Stop condition to complete the transaction. The device's control interface acknowledges each byte by pulling SDA low on the bit immediately following each write byte. The device read function, as shown in Figure 11, executes the following 11 steps as the I<sup>2</sup>C bus master:

1. I<sup>2</sup>C START command
2. Transmit device I<sup>2</sup>C address with W
3. Transmit mode byte
4. Transmit upper memory address byte
5. Transmit lower memory address byte
6. Repeat START command
7. Transmit device I<sup>2</sup>C address with R
8. Receive data upper byte
9. Receive data middle byte
10. Receive data lower byte
11. I<sup>2</sup>C STOP command or NACK

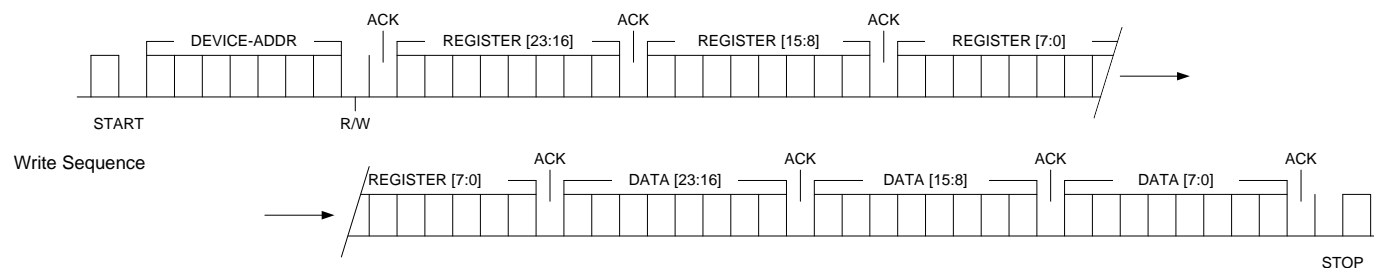


FIGURE 10. I<sup>2</sup>C WRITE SEQUENCE OPERATION

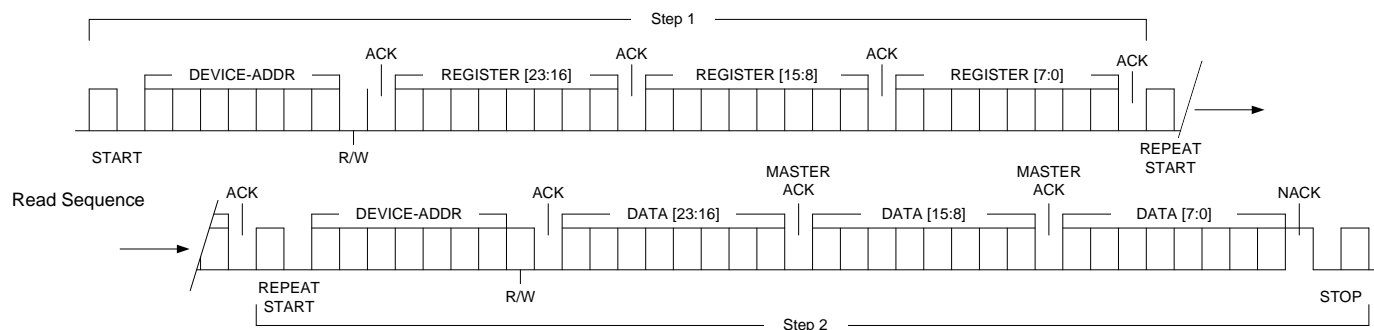


FIGURE 11. I<sup>2</sup>C READ SEQUENCE OPERATION



## Audio Processing Functions

Each system design has its own firmware-dependent signal flow. This signal flow may be generic, or specifically designed for a particular amplifier application and consists of input elements connected to various signal processing blocks, routing the audio data to an output element. The input elements consist of chip peripherals used for audio input (I<sup>2</sup>S input, S/PDIF Digital receiver, and ADC). The output elements include the chip I<sup>2</sup>S output, S/PDIF Digital transmitter, and PWM outputs.

Typical audio processing blocks include gain stages, mixers, tone controls, compressors, limiters, equalizers, routers, loudness contour, crossover filters, delays, as well as audio enhancement features provided within the specific application firmware.

The input and output elements are configured by the firmware application and the scope of I/O selection is generally specific to the hardware of the particular application.

The signal processing blocks contain one or more parameters that define the signal transfer characteristic of the block and a mechanism for choosing the source and destination data locations. The signal flow is created by connecting together the signal processing blocks in the proper order to achieve the overall system audio processing function.

### FIRMWARE FUNCTIONS

D2-7xx83 IC contains a DSP supporting powerful audio processing algorithms. Some of the standard audio algorithms that are typically supported in all firmware loads. Other algorithms are specific system design and firmware load dependent.

Additional features support multiple system capabilities such as:

- Automatic power-on amplifier calibration
- Parameter control and status reporting
- Integrated power supply control and clock synchronization
- Automatic power supply high-voltage rail anti-pump control
- Automatic negative rail generation and bring-up control (for select half-bridge designs where a  $\pm$  rail is not already supplied)
- Automatic cycle-by-cycle temperature sensing and system response
- Automatic cycle-by-cycle current sensing and system response
- Input audio signal sensing and pop-free power-on/off via D2Audio's patented "Green Mode" algorithm with adjustable threshold
- Dynamic adjustment of efficiency vs. distortion vs. output power level via D2Audio's patented "DynaTiming" algorithm
- AM radio interference avoidance mode allows for dynamic switching of PWM engines when system microcontroller is in AM Radio model

### INPUT SOURCE SELECTION

A source selection register specifies the action of a signal multiplexer, which will implement a simple switching function. The selected input will be routed to the block output unaltered. All non-selected inputs will be ignored. Selections typically

include I<sup>2</sup>S inputs, S/PDIF Digital inputs, HD Audio inputs, and ADC inputs.

### MASTER VOLUME

A master volume function alters the level on all channels simultaneously by applying the same gain/attenuation function to each. A single parameter controls all channels.

### CHANNEL ATTENUATION

A channel attenuation function alters the level of a single channel. A single parameter is provided for each channel.

### EQUALIZATION

An equalization processing block consists of a single input and output, and is characterized by how many frequency bands are supported. Typical equalizers have 3-bands or 5-bands, although multiple combinations are directly supported. Each frequency band has 3 parameters - the center frequency, the filter Q, and the filter gain.

### tone control

Tone control provide simple bass and treble processing to the audio signal. Each tone processing block includes two first-order (6dB/octave) shelving filters, one each for bass and treble. Filters include programmable corner frequency and gain settings.

### EXCURSION CONTROL

Excursion processing provides dynamic control of the subwoofer response. Three audio processing control adjustments are provided for frequency settings, and three adjustments are provided for Q parameter settings.

### MIXER

Mixer configuration blocks have multiple input channels and as many output channels as required by the system implementation. The mixer has an input gain parameter for each input to every mixing node. (e.g. An 8-input mixer with 12 outputs incorporates a total of 96 independent gain adjustment parameters.) The minimum gain parameter value is infinite attenuation, or mute.

### MIXERS

An input mixer provides a two-input, two-output mixing and routing path. All inputs can be mixed at adjustable gain into any combination of outputs. Programmable settings are continuously adjustable from unity (0 dB) gain, through full cut-off.

### COMPRESSOR/LIMITER

The compressor/limiter processor is used to gracefully limit the dynamic range of the audio signal. This is useful to prevent the amplifier from clipping or to limit the amplifier output power. Each compressor/limiter has configurable Compression Ratio, Threshold, Attack and Release Time, as well as Makeup Gain.

### UPWARD COMPRESSOR

Upward Compressors provide audio compression and limiting functions but also provide an increase of signal level to inputs below the threshold setting. Upward Compressors have configurable Expansion Ratio, Threshold, Attack and Release Time, as well as Makeup Gain. Controls are supported for Global settings, Gate adjustment, and for Low Level Expansion.

Upward compressors support two inputs. One input receives the audio that is processed by the compressor and passed to its output. A separate side chain input is used as the reference input for the processing algorithms.

## DELAY

A delay block simply adds delay to the audio signal. A single delay parameter is used.

## CROSSOVER

Low-pass and high-pass filter blocks add frequency filtering to the audio paths, providing appropriate signal processing for speaker crossover functionality, including bi-amplified solutions, and subwoofer low-pass filtering.

## HIGH/LOW-PASS FILTERS

High-Pass and Low-Pass filter blocks are provided for each of the 5 output channels downstream of the Router and Stereo Mixer. These provide a flexible Crossover function for all the output channels, including provision for defining the subwoofer channel's frequency response.

Filters are implemented as cascaded elements, with elements allocated for high-pass as well as for low-pass functionality, with complete flexibility of assignment. Pre-defined filter types including Butterworth, Bessel, and Linkwitz-Riley implementations are also provided.

## ROUTERS

Routers provide individual audio path selection to any one of available input channels. The router performs path assignment only. It does not have a provision for gain or signal level adjustment.

## LOUDNESS CONTOUR

Loudness contour provides adjustment to allow for dynamically and automatically enhancing the frequency response of the audio program material relative to the master volume Level setting. The Loudness Contour models the frequency response correction as defined by the Fletcher/Munson audio response curve. It provides for amplitude or volume changes to those signals to which the ear does not respond equally at very low listening levels.

## AUDIO PROCESSING ENHANCEMENTS AND DECODING

Depending on the device part number and design-specific firmware definitions, the DAE-6 device supports a variety of processing, decoding, virtualization, and pre/post processing feature sets, as well as options for DSP clock speed and memory capacity. Features and processing support are shown in "DAE-6 Device Feature Set Offering" on page 3.

## SOUNDSUITE™ PROCESSING

The D2Audio SoundSuite™ audio processing provides a full set of enhancements to audio that greatly add to the quality and listening experience of sound in wide scopes of consumer devices. The D2Audio SoundSuite™ algorithms use psycho-acoustic processing that create a rich-sounding environment from small speakers, and synthesizes the sound and quality equivalent to more complex systems. It is especially

suitable to consumer products that include televisions, docking stations, and mini hi-fi stereo products.

The DAE-6 includes enhanced SoundSuite Processing that includes:

- D2Audio® WideSound™
- D2Audio® DeepBass™
- D2Audio® AudioAlign™
- D2Audio® ClearVoice™

The D2Audio® SoundSuite™ algorithms are completely included within the D2-71083 and D2-74083 DAE-6 devices.

## MARK LEVINSON MIGHTYCAT™ PROCESSING

The Mark Levinson MightyCat™ Series of Processors provide an exclusive set of Mastering Tools and Tuning Capabilities, and have been developed and refined by Mark Levinson over the course of his many years of recording experience. The Tools and Capabilities allow for an extended Studio Quality Tuning that is only available in the MightyCat™ Series of DAE-6 Processors.

The MightyCat™ algorithms are included within the D2MC-72083 and D2MC-76083 devices. Refer also to the "DAE-6 Device Feature Set Offering" on page 3.

## Revision History

The revision history provided is for informational purposes only and is believed to be accurate, but not warranted. Please go to web to make sure you have the latest Rev.

DATE	REVISION	CHANGE
June 23, 2011	FN7838.1	Initial release.
September 20, 2011	FN7838.2	Revise/add available device part numbers and related descriptions.

## Products

Intersil Corporation is a leader in the design and manufacture of high-performance analog semiconductors. The Company's products address some of the industry's fastest growing markets, such as, flat panel displays, cell phones, handheld products, and notebooks. Intersil's product families address power management and analog signal processing functions. Go to [www.intersil.com/products](http://www.intersil.com/products) for a complete list of Intersil product families.

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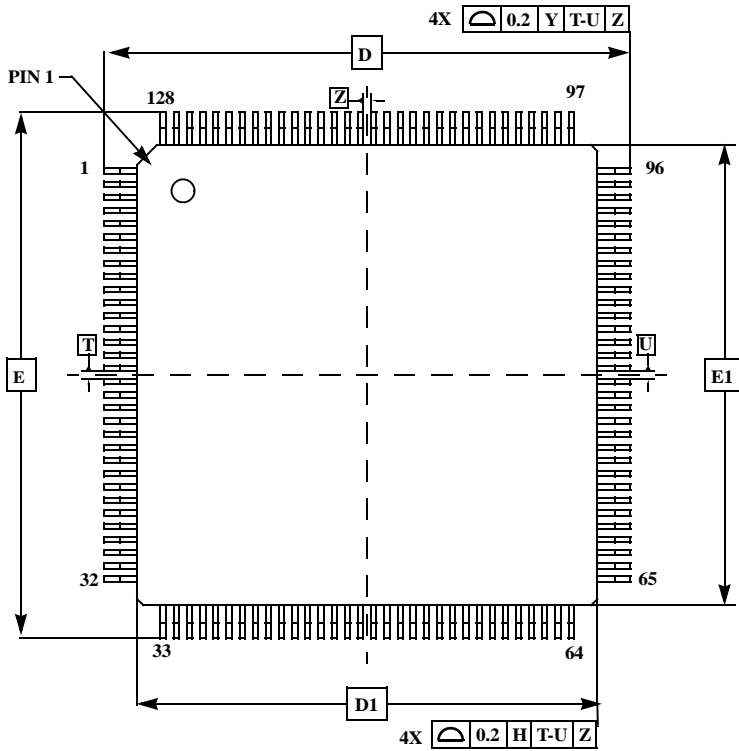


# D2-7xx83

## Low Plastic Quad Flatpack Packages (LQFP)

### Q128.14x14

128 LEAD LOW PLASTIC QUAD FLATPACK PACKAGE .4 MM PITCH



SYMBOL	MILLIMETERS			NOTES
	MIN	NOM	MAX	
A	-		1.60	-
A1	0.05		0.15	-
A2	1.35	1.40	1.45	-
b	0.13	0.16	0.23	4
b1	0.13	-	0.19	-
c	0.09	-	0.20	-
c1	0.09	-	0.16	-
D	16 BSC			-
D1	14 BSC			3
E	16 BSC			-
E1	14 BSC			3
L	0.45	0.60	0.75	-
L1	1.00 REF			-
R1	0.08	-	-	-
R2	0.08	-	0.20	-
S	0.20	-	-	-
0	0°	3.5°	7°	-
01	0°	-	-	-
02	11°	12°	13°	-
03	11°	12°	13°	-
N	128			-
e	0.40 BSC			-

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#### NOTES:

1. Dimensions are in millimeters. Dimensions in ( ) for Reference Only.
2. Dimensions and tolerances per AMSEY14.5M-1994.
3. Dimensions D1 and E1 are excluding mold protrusion. Allowable protrusion is 0.25 per side. Dimensions D1 and E1 are exclusive of mold mismatch and determined by datum plane H.
4. Dimension b does not include dambar protrusion. Allowable dambar protrusion shall not cause the lead width to exceed the maximum b dimension by more than 0.08mm. Dambar cannot be located at the lower radius or the foot. Minimum space between protrusion and an adjacent lead is 0.07 mm.

