

CS5333 to CS5343/4 Transition

1. INTRODUCTION

The CS5333 and CS5343/4 are complete stereo analog-to-digital converters for digital audio systems. These converters perform sampling, analog-to-digital conversion and anti-alias filtering, generating 24-bit values for both left and right channels. These small, low-power converters are ideal for systems requiring wide dynamic range and low noise such as set-top boxes, A/V receivers, DVD-karaoke players, DVD recorders, and automotive applications. The CS5333 is no longer recommended for new designs, and the CS5343/4 is the suggested replacement.

This application note identifies the implementation differences between these two devices, including:

- Key specifications
- Pinout differences
- Startup mode selections
- System clocking
- Input filter topology
- Reference voltage

The CS5333 and CS5343/4 datasheets contain detailed information regarding device specifications, performance and ordering information. Please reference the CS5333 and CS5343/4 datasheets while reading this document.

2. KEY SPECIFICATIONS

Table 1 shows a comparison of the key specifications of these two device families, and Table 2 shows the pin comparison between the CS5333 and the CS5343/4. Although these two devices are not pin compatible, they are very similar in terms of overall functionality and feature set.

Parameter	CS5333	CS5343/4	Units
Conversion	24	24	Bits
Dynamic Range (A-Weighted)	98	98	dB
THD+N	-88	-90	dB
Analog Core Power Supply (VA)	+1.8 to +3.3	+3.3 to 5	V
Digital Core Power Supply (VD)	Powered from VA	Powered from VA	V
Digital Interface Power Supply (VL)	+1.8 to +3.3	Powered from VA	V
Typical Power Consumption All supplies = +3.3 V	36	50	mW
Maximum Sample Rate	100	108	kHz
Package	16-pin TSSOP	10-pin TSSOP	

Table 1. Comparison of Key Specifications

CS5333		CS5343/4		Description
Pin Number	Pin Name	Pin Number	Pin Name	
1	VL	-	-	Logic Power
2	MCLK	4	MCLK	Master Clock
3	SCLK	2	SCLK	Serial Clock
4	SDATA	1	SDOUT	Serial Data
5	VA	10	VA	Power
6	GND	9	GND	Ground Reference
7	LRCK	3	LRCK	Left/Right Clock
8	DIV	-	-	Speed Mode Select/MCLK Divider
9	DIF	-	-	Digital Interface Format
10	TST	-	-	Test Pin
11	FILT+	5	FILT+	Full-Scale Voltage Reference
12	REF_GND	-	-	Ground Reference
13	AINR	8	AINR	Right Channel Analog Input
14	AINL	6	AINL	Left Channel Analog Input
15	VQ	7	VQ	Quiescent Voltage Reference
16	RST	-	-	Reset

Table 2. Pin Compatibility between the CS5333 and CS5343/4

3. TYPICAL CONNECTION DIAGRAMS

Figures 1 and 2 are the typical connection diagrams for the CS5333 and the CS5343/4 respectively. These diagrams demonstrate optimal power arrangements and the options available with pull-up or pull-down resistors on various I/O pins for each device.

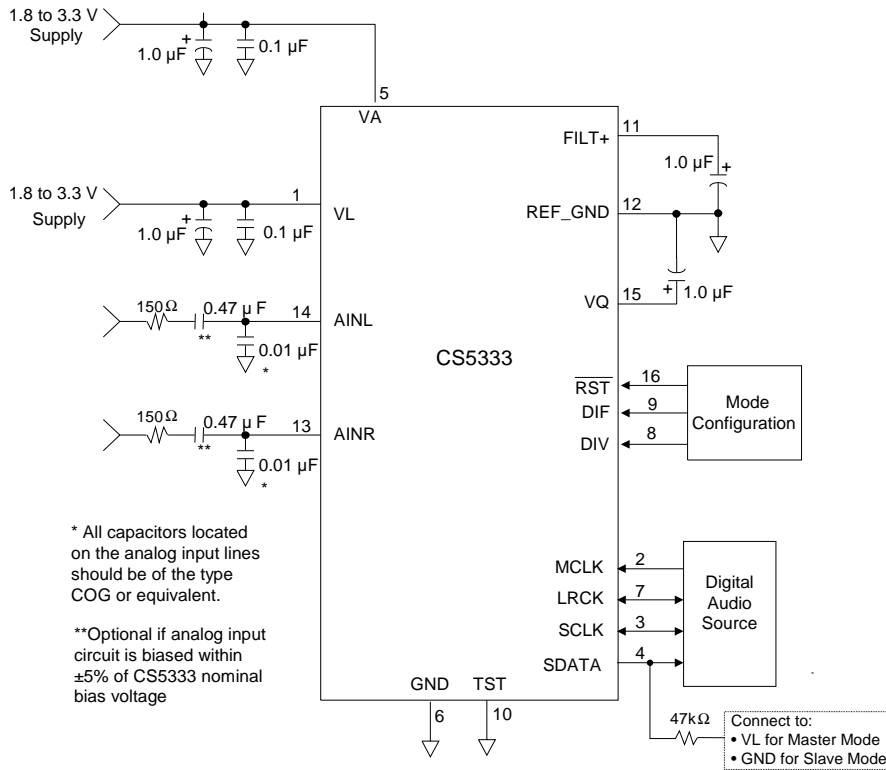


Figure 1. CS5333 Typical Connection Diagram

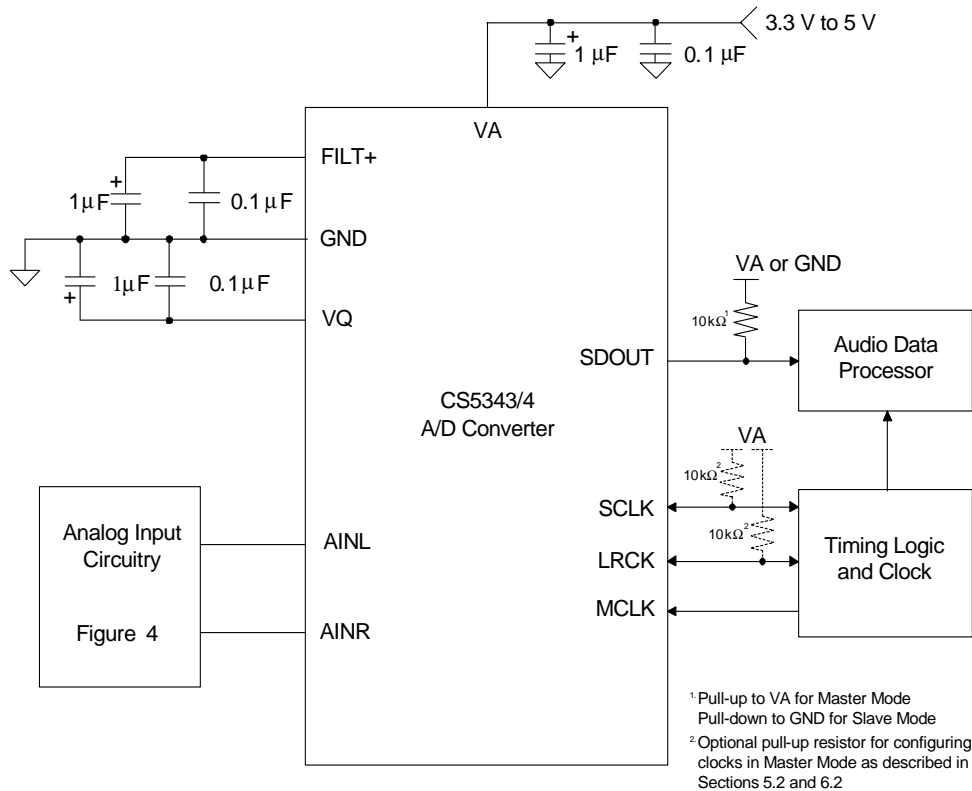


Figure 2. CS5343/4 Typical Connection Diagram

4. POWER

4.1 CS5333 Power

The CS5333 receives power to the analog and digital cores through the VA supply pin, while VL powers the digital interface logic. Both VA and VL on the CS5333 can accept power ranging from +1.7 V to +3.6 V. The full-scale reference voltage scales with VA such that nominal full-scale voltage is $VA/3.6$ Vrms. VL determines the digital interface voltage to within the specifications listed under “Digital Characteristics” in the CS5333 datasheet.

4.2 CS5343/4 Power

The CS5343/4 features a single supply pin, VA, which powers the analog and digital cores as well as the digital interface logic. With a range from +3.13 to +5.25 V, VA determines the nominal full-scale input voltage according to $0.56 \times VA$ Vpp. Additionally, VA also determines the digital interface voltage as described further under “Digital Characteristics” in the CS5343/4 datasheet.

5. MODE SELECTIONS: MASTER/SLAVE & SPEED MODES

5.1 CS5333 Mode Selections

5.1.1 *Master/Slave Mode Selection*

The CS5333 operates in either Master Mode or Slave Mode depending on the pull-up or pull-down resistor on the SDATA pin. A 47 k Ω pull-up resistor between SDATA and VL selects Master Mode while a 47 k Ω resistor between SDATA and GND will select Slave Mode.

5.1.2 *Speed Mode Selection*

The CS5333 features a DIV pin which allows the user to configure speed in Master Mode. In Master Mode, the user can tie DIV high (VL) to select Base-Rate mode or low (GND) to select High-Rate mode. In Slave Mode, the CS5333 auto-detects speed mode and the DIV pin enables an MCLK divide-by-two function when set high.

5.2 CS5343/4 Mode Selections

5.2.1 *Master/Slave Mode Selection*

The CS5343/4 enters Master Mode when a 10 k Ω pull-up resistor is present between SDOOUT and the VA supply. Conversely, Slave Mode is selected via a pull-down resistor between SDOOUT and GND.

5.2.2 *Speed Mode Selection*

Similar to the CS5333, the CS5343/4 auto-detects Speed Mode when operating as a slave. In Master Mode, an internal 100 k Ω pull-down resistor on the LRCK pin will set the device for Single-Speed Mode by default. An external 10 k Ω pull-up resistor from the LRCK pin to VA will over-ride the default setting and select for Double-Speed Mode.

Unlike the CS5333, the CS5343/4 features additional auto-detect circuitry to automatically enable an MCLK divide-by-two function.

6. SYSTEM CLOCKING

6.1 CS5333 Clock Options

The CS5333 supports an MCLK/LRCK ratio of 256x, 384x, 512x, and 768x in Base-Rate Mode, and 128x, 192x, 256x, and 384x in High-Rate Mode. However, in Master Mode, MCLK/LRCK ratios of 384x, 768x, and 192x are not accessible. Table 3 shows the available MCLK/LRCK ratios in each mode of operation for the CS5333.

Furthermore, the CS5333 supports sample rates from 2 to 50 kHz in Base-Rate Mode and 50 to 100 kHz in High-Rate Mode.

Device	Master/Slave	Speed	Supported MCLK/LRCK Ratio
CS5333	Master	Base-Rate	256x
		High-Rate	128x
	Slave	Base-Rate	256x, 384x, 512x, 768x, 1024x
		High-Rate	128x, 192x, 256x, 384x

Table 3. CS5333 Supported MCLK/LRCK Ratios

6.2 CS5343/4 Clock Options

Table 4 shows the MCLK/LRCK ratios the CS5343/4 can support in the various modes of operation.

In Slave Mode, the CS5343/4 supports MCLK/LRCK ratios of 128x, 192x, 256x and 384x when running in either Single-Speed or Double-Speed. Also in Slave Mode, the CS5343/4 sample-rate can range continuously from 4 to 54 kHz in Single-Speed Mode or 86 - 108 kHz in Double-Speed Mode.

In Master Mode, the CS5343/4 defaults to an MCLK/LRCK ratio of 256x due to the presence of a 100 k Ω internal pull-down resistor between the SCLK pin and GND. An external 10 k Ω pull-up resistor from the SCLK pin to VA will configure the device to output an LRCK corresponding to an MCLK/LRCK ratio of 384x, depending on MCLK frequency. With the correct MCLK frequency and clock divider settings, the CS5343/4 sample-rate can range continuously from 4 to 54 kHz in Single-Speed Mode or 50 to 108 kHz in Double-Speed Mode.

Device	Master/Slave	Speed	Supported MCLK/LRCK Ratio
CS5343/4	Master	Single-Speed	256x, 384x
		Double-Speed	256x, 384x
	Slave	Single-Speed	128x, 192x, 256x, 384x
		Double-Speed	128x, 192x, 256x, 384x

Table 4. CS5343/4 Supported MCLK/LRCK Ratios

7. INPUT FILTER TOPOLOGY

7.1 CS5333 Input Filter

Figure 3 shows the recommended input circuit for the CS5333. The CS5333 contains an internal continuous-time buffer. The external circuit provides filtering of high-frequency noise via the single-pole RC filter. The CS5333 will self-bias the input to the reference voltage (half of V_A). If the incoming signal is not DC biased to within 5% of this value, then the series DC-blocking capacitor is necessary.

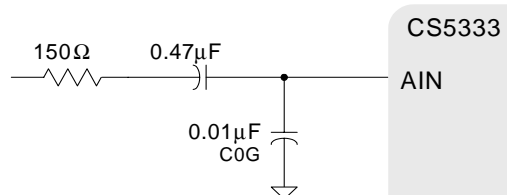


Figure 3. CS5333 Input Circuit

7.2 CS5343/4 Input Filter

7.2.1 CS5343/4 Recommended Circuit

Figure 4 shows the typical analog input network for the CS5343/4. The component values shown are not mandatory, but this particular circuit has four features that make it ideal for most applications, as discussed below. Please see the CS534/4 datasheet for more information regarding component selection.

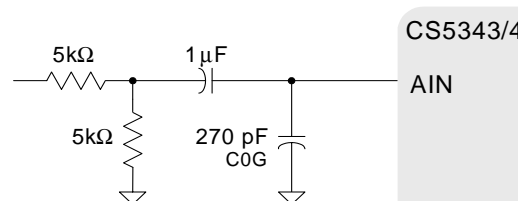


Figure 4. CS5343/4 Typical Input Circuit

- **Input Impedance:** This circuit's input impedance as seen from the analog source looking into the circuit is 10 k Ω , which means this circuit will provide the ideal interface to most consumer equipment.
- **Attenuation:** This circuit also attenuates the analog input signal by 6 dB. This further simplifies the interface between consumer equipment and the ADC because most consumer equipment generate 2 V_{rms} line voltage. The circuit in Figure 4 attenuates the incoming signal from 2 V_{rms} to 1 V_{rms}, which is the full-scale input voltage of the CS5343/4 when $V_A = 5V$.
- **Source Impedance:** The CS5343/4 achieves optimal analog performance when the source impedance as seen from the ADC looking into this network remains at or below 2.5 k Ω . The ADC effectively "sees" two 5 k Ω resistors in parallel, or 2.5 k Ω !
- **Noise Rejection:** Under typical conditions, the modulators in the ADC generate switching noise at 6.144 MHz, or half of the MCLK frequency. The single-pole RC filter formed by the shunt capacitor and the input impedance of the device will provide approximately 20 dB of attenuation at the modulator switching frequency. For this and other capacitors in the signal path, capacitors with C0G or other high-quality dielectric will produce the best results.

7.2.2 CS5343/4 Full-Scale Voltage

The CS5333 full-scale input voltage is $0.78 \times V_A$ V_{pp} whereas the CS5343/4 full-scale input voltage is $0.56 \times V_A$ V_{pp} , a difference of nearly 3 dB. This means that without attenuation, a full-scale signal to the CS5333 will over-range the CS5343/4. In migrating from the CS5333 to the CS5343/4, the input signal should either be reduced by 3 dB at the source or resistor values should be chosen such that the CS5343/4 input network provides 3 dB of attenuation. The following equation yields the attenuation (in dB) of the input network where R1 represents the series resistor and R2 is the resistor to ground:

$$20 \times \log\left(\frac{R2}{R1 + R2}\right)$$

8. REFERENCE VOLTAGES

The reference voltage pins have the same configuration and usage on the CS5343/4 as the CS5333. FILT+ on both devices outputs the full-scale voltage reference (V_A), while the VQ pin outputs the common-mode voltage ($V_A \times 0.5$ for the CS5333; $V_A \times 0.44$ for the CS5343/4). Neither FILT+ nor VQ on either device can source current without degrading the analog performance of the device.

8.1 Filter Capacitors

The filter capacitors on these pins provide rejection of power-supply noise and consequently affect THD+N performance. Both devices require 1 μ F filter capacitors from the voltage reference pins to GND. Larger capacitors will improve low-frequency THD+N to within the limitations of the device. A small capacitor, such as a 0.1 μ F, placed close to the device will filter high-frequency noise.

8.2 Settling Time

Following initial power-up, the analog reference voltage requires time to settle before conversion can be considered valid. Settling time of the reference voltage depends on the output impedance (R_{out}) and the value of the external capacitance (C_{ext}) according to the following equation (time given in seconds):

$$SettlingTime(s) = 5 \times R_{out} \times C_{ext}$$

For the same value capacitors on the CS5333 and CS5343/4 voltage reference pins, the CS5343/4 will require *shorter* settling time than the CS5333 due to the higher output impedance of the CS5333 FILT+. Typical output impedance of the CS5333 FILT+ is 250 k Ω whereas CS5343/4 typical FILT+ output impedance is 220 k Ω . This means the CS5343/4 reference voltage will settle 12% faster than the CS5333 reference voltage.

9. DIGITAL INTERFACE FORMAT

Please see Application Note AN282 for a complete overview of the serial audio interface (SAI).

9.1 CS5333 Interface Format

The CS5333 features a DIF pin to select between I²S and LJ digital audio formats. I²S digital audio format is selected when DIF is tied low at start-up whereas the CS5333 will output LJ audio data when DIF is tied to VL at start-up.

9.2 CS5343/4 Interface Format

The CS5343/4 family of converters supports both I²S and LJ digital audio format. Specifically, the CS5343 will support only I²S digital audio format while the CS5344 will output only LJ audio data.

10.CONCLUSION

With special attention to power arrangements, mode and clocking configurations, analog input circuitry, and reference voltage filtering, the transition from CS5333 to CS5343/4 should be simple and seamless. Furthermore, the CS5343/4 can improve system design by offering superior performance to the CS5333 while significantly reducing board space.

11.REVISION HISTORY

Release	Date	Changes
A1	September 2005	Initial Advance Release.

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