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## **Transitioning from the CS4382 to the CS4382A or CS4385**

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### **1. Introduction**

This application note describes how to transition easily to the CS4385 or CS4382A from an existing design which uses the CS4382. The CS4382A was designed to give a simple upgrade path from the CS4382 whereas the CS4385 adds some additional features. Please refer to the CS4382A and CS4385 data sheets for supplemental information and specifications concerning operation of the device. A brief comparison between the product families is shown in Table 1.

#### **What the CS4382A offers over the CS4382:**

- Sixth order multi-bit delta-sigma modulator for lower out of band noise
- Increased fullscale output level for ease of board level noise management
- Improved lower latency PCM digital filter
- Non-decimating DSD processor with on chip 50 kHz filtering
- Uses identical register mapping

#### **Changes from the CS4382 that the CS4382A requires:**

- The VD supply must be changed to 2.5 V from either the 3.3 V or 5 V of the CS4382
- Depending on the desired output voltage requirements, attenuation may need to be added to the off-chip filter.
- Loss of simultaneous support for two synchronous sample rates mode which was available in the CS4382. This mode provided for dual sample rates such as 192 kHz front channels with 96 kHz surrounds for DVD audio and required the use of LRCK2 and SCLK2. This mode is not offered in the CS4382A or CS4385.

#### **What the CS4385 offers over the CS4382A:**

- Additional DSD functions of Volume control, Mute pattern detect, support for phase modulation mode, and offers a direct to switched capacitor path.
- 1/2 dB volume control steps (vs. 1 dB in CS4382/82A)
- One-Line and TDM modes
- Auto-mute polarity detection
- Auto-speed mode detection

#### **Changes from the CS4382 that the CS4385 requires:**

- The VD supply must be changed to 2.5 V from the either 3.3 V or 5 V of the CS4382
- Depending on the desired output voltage requirements, attenuation may need to be added to the off-chip filter.
- Simultaneous support for two synchronous sample rates is no longer available
- Additional resistors on MUTEC pins
- 4 pins change location or function for hardware mode. The changes aren't necessary for software mode.
- Requires different register mapping from the CS4382

		<b>CS4385</b>	<b>CS4382A</b>	<b>CS4382</b>
<b>Dynamic Range</b>	dB	<b>114</b>	114	114
<b>THD+N</b>	dB	<b>-100</b>	-100	-100
<b>Resolution</b>	bits	<b>24</b>	24	24
<b>Sample Rate</b>	kHz	<b>192</b>	192	192
<b>Power Supply</b>	VA	<b>5</b>	5	5
	VD	<b>2.5</b>	2.5	3.3 to 5
<b>Volume Control</b>		<b>0.5 dB</b>	1 dB	1 dB
<b>Auto Fs Detect</b>		<b>Yes</b>	No	No
<b>Package</b>		<b>48-LQFP</b>	48-LQFP	48-LQFP

**Table 1. Product Comparison**

For users of the CS4382, the CS4385 is a simple, yet affordable, upgrade to a richer feature set and lower out-of-band noise performance.

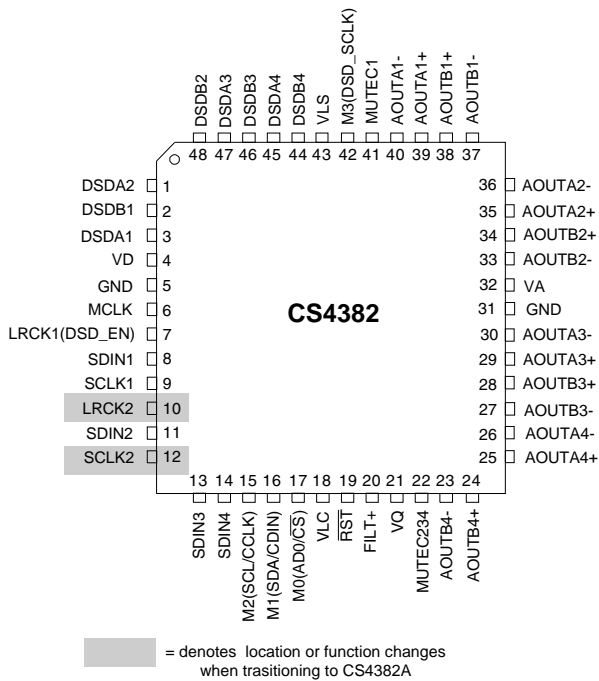
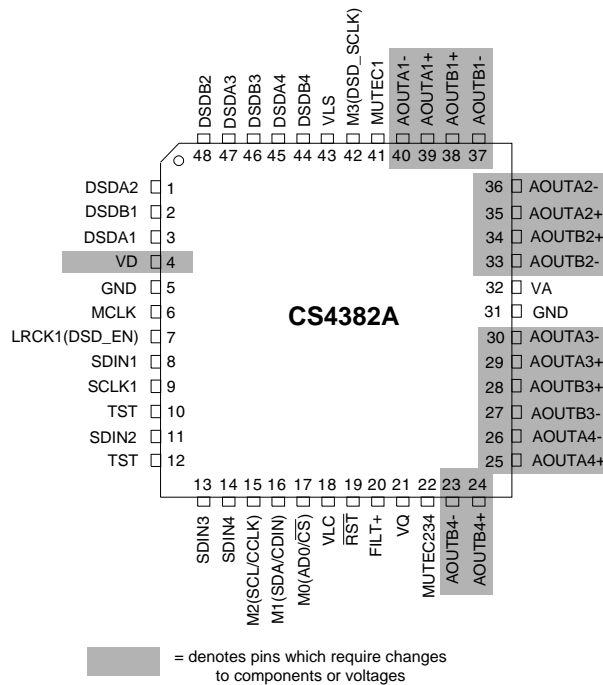
## 2. The Design Transition

### 2.1 Transitioning from the CS4382 to CS4382A

#### 2.1.1 Hardware changes

The CS4382A pinout was primarily based on the CS4382 with only 2 pins changing function. Other pins have new recommended components but the circuit topologies remain the same and thus do not require modification to the PCB. The most significant change is that the VD core of the CS4382A requires 2.5 V for operation, whereas the CS4382 was able to run from 3.3 V to 5 V. The CS4382A will NOT operate off of a VD supply of 3.3 V or 5 V.

Figure 1 and Figure 2 show the CS4382 and CS4382A pinouts respectively. The changes to the two pinouts are highlighted. Figure 1 highlights the pins which have changed function and which may require a PCB change. Figure 2 highlights the pins which have new recommended components.


**Figure 1. CS4382 pinout**

**Figure 2. CS4382A pinout**

Location or function changes as denoted in Figure 1 are as follows:

- The CS4385 does not support the simultaneous synchronous sample rate function of the CS4382. Pins 10 and 12 are now Test inputs.

Pins which require changes to external components or voltages as denoted in Figure 2 are as follows:

- Pin 4 (VD) requires 2.5 V for recommended operation. The CS4382 used either 3.3 V or 5 V, which, if left unchanged, would damage the CS4382A.
- Pins 23 - 30, 33 - 40 (AOUTs) have a new recommended filter circuit. This filter uses the same filter topology as the CS4382. The component values have been changed to account for the extra output level from the CS4382A and still provide 2 V<sub>rms</sub> on the output. A general optimization was also made in order to reduce the thermal noise contribution of the resistances (using smaller resistances where possible). Please refer to the CS4382A datasheet for details on the new recommended filter.

### 2.1.2 Functional changes

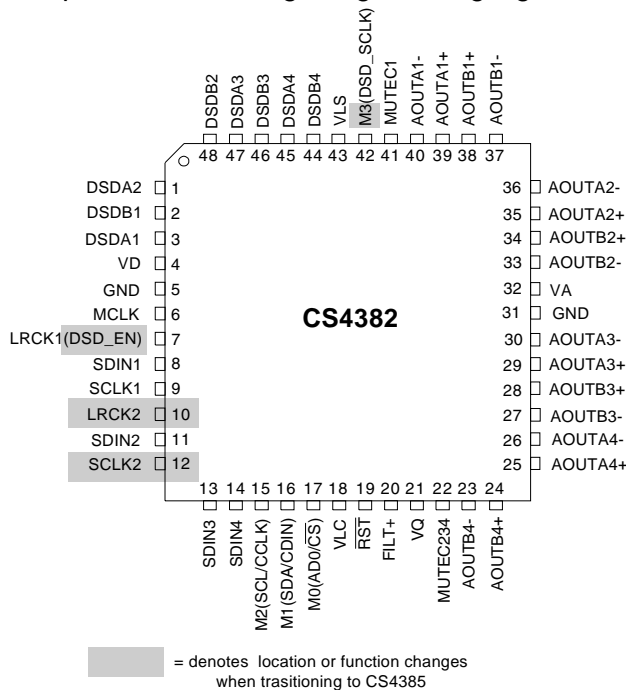
- With the addition of the non-decimating DSD processor mode comes the added benefits of matched PCM and DSD output levels and an on chip 50 kHz filter.
- The CS4382A uses a new multi-bit Delta-Sigma modulator core with mis-match shaping which allows for lower over-all out-of-band noise and improved audio quality.
- The CS4382A gained new digital filters with improved stop-band performance and lower latency.
- The full scale differential output voltage has increased which needs to be accounted for in the analog filter gain (if similar output level to the CS4382 is desired).
- The dual serial port function of the CS4382 which accepted two simultaneous synchronous sample rates (such as 192 kHz front and 96 kHz surrounds) is not supported.

## 2.2 Transitioning from the CS4382 to CS4385

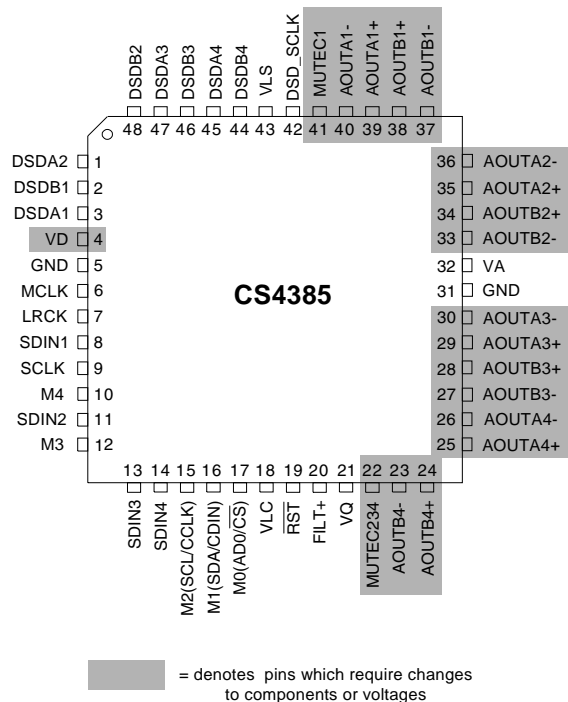
### 2.2.1 Hardware changes

The CS4385 pinout was primarily based on the CS4382 with only 3 pins changing function. Other pins have new recommended components but the circuit topologies remain the same and thus do not require modification to the PCB. The most significant change is that the VD core of the CS4385 requires 2.5 V for operation, whereas the CS4382 was able to run from 3.3 V to 5 V. The CS4385 will NOT operate off of a VD supply of 3.3 V or 5 V.

Figure 3 and Figure 4 show the CS4382 and CS4385 pinouts respectively. The changes to the two pinouts are highlighted. Figure 3 highlights the pins which have changed function and which may require a PCB change. Figure 4 highlights the pins which have new recommended components.



**Figure 3. CS4382 pinout**



**Figure 4. CS4385 pinout**

Location or function changes as denoted in Figure 3 are as follows:

- Pin 7 is no longer DSD\_EN in hardware mode. In order to enter DSD mode on the CS4385 you must either set the M4 and M3 pins accordingly or use SPI™ or I<sup>2</sup>C configuration.
- The CS4385 does not support the simultaneous synchronous sample rate function of the CS4382. Pins 10 and 12 are now dedicated for stand-alone configuration (voltage input on these pins are still referenced to VLS).
- Pin 42 no longer functions as M3 in stand-alone PCM modes. It is now a dedicated DSD\_SCLK pin.

Pins which require changes to external components or voltages as denoted in Figure 4 are as follows:

- Pin 4 (VD) requires 2.5 V for recommended operation. The CS4382 used either 3.3 V or 5 V, which, if left unchanged, would damage the CS4385.

- Pin 22 (MUTEC234) and pin 41 (MUTEC1) require an additional pull-up or down in order to indicate the desired direction of mute polarity. While reset is asserted these pins are high impedance and will not drive the mute circuitry. It is recommended that the pull-up/down resistance properly biases the off-chip mute circuit into muting.
- Pins 23 - 30, 33 - 40 (AOUTs) have a new recommended filter circuit. This filter uses the same filter topology as the CS4382. The component values have been changed to account for the extra output level from the CS4385 and still provide 2 V<sub>rms</sub> on the output. A general optimization was also made in order to reduce the thermal noise contribution of the resistances (using smaller resistances where possible). Please refer to the CS4385 datasheet for details on the new recommended filter.

### 2.2.2 Functional changes

- The CS4385 uses a new register mapping in order to accommodate the additional features which it provides over the CS4382. Please refer to the CS4385 datasheet for the new mapping
- With the addition of the non-decimating DSD processor mode comes the added benefits of matched PCM and DSD output levels, DSD volume control, an on chip 50 kHz filter, Phase Modulation input mode, and DSD mute pattern detection. A direct DSD path to the switched capacitor array is also offered. All of the features are accessed through the configuration registers.
- The CS4385 supports a setting for auto-selection of the speed mode to set what sample rate range the DAC is to expect. This allows the CS4385 to operate at sample rates from 4 kHz on up to 192 kHz without intervention (Note: there are a few reserved frequencies, see datasheet for details). This setting is available in both stand-alone and control-port operation.
- The volume control in the CS4385 offers 0.5 dB step sizes for more volume setting resolution.
- The CS4385 offers TDM and One-Line modes for compatibility with various multi-channel surround sound DSPs which helps reduce board real-estate from the additional data lines. These modes are not available in stand-alone mode.
- The CS4385 uses a new multi-bit Delta-Sigma modulator core with mis-match shaping which allows for lower over-all out-of-band noise and improved audio quality.
- The CS4385 gained new digital filters with improved stop-band performance and lower latency.
- The full scale differential output voltage has increased which needs to be accounted for in the analog filter gain (if similar output level to the CS4382 is desired).
- The mute control pins now support auto polarity detection. This allows for selection of active high or low mute circuitry without the need to set registers. An external pull-up or down is required to set the mute polarity.
- The MCLK divide by 2 bit is no longer necessary to access the 1024x MCLK/LRCK ratio (SSM), 512x MCLK/LRCK ratio (DSM) and 256x MCLK/LRCK ratio. A new ratio of 1152x has been added for 32 kHz operation.
- The dual serial port function of the CS4382 which accepted two simultaneous synchronous sample rates (such as 192 kHz front and 96 kHz surrounds) is not supported.

Table 2. Revision History

Release	Date	Changes
REV1	JAN 2005	Initial Release

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