



## M4334

CMOS IC

### STEREO AUDIO D/A CONVERTER 24BITS,96KHZ SAMPLING

#### DESCRIPTION

The UTC **M4334** is a complete low cost stereo audio digital to analog converter(DAC), its contains interpolation, 1-bit D/A conversion and analog output filtering. The **M4334** is based on a 4th order  $\Delta-\Sigma$  modulation, where the modulator output controls the reference voltage input to an ultra-linear analog low-pass filter. This architecture allows for infinite adjustment of sample rate between 2 kHz and 100 kHz simply by changing the master clock frequency.

The **M4334** also contains digital de-emphasis function, operates from a single +5V power supply, for best performance, decoupling capacitors should be located as close to the device package as possible with the smallest capacitor closest, the **M4334** requires minimal support circuitry.

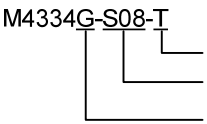
The **M4334** is ideal for DVD players, set-top boxes, SVCD players and A/V receivers.

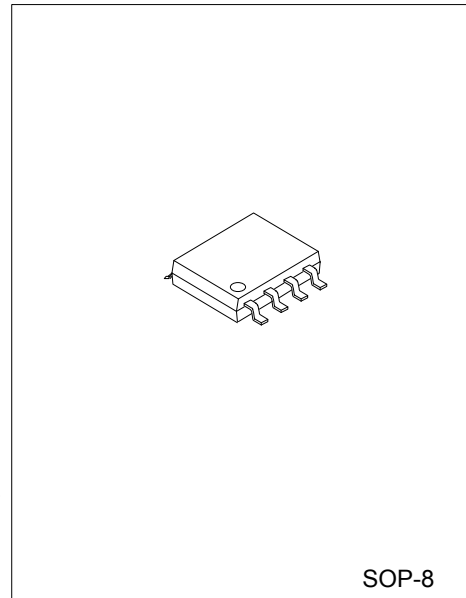
#### FEATURES

- \* Complete stereo DAC: Includes Output Analog Filter and DAC
- \* Dynamic Range: 96dB
- \* THD+N: -88dB
- \* Multiple Sampling Frequencies: 16kHz to 96kHz
- \* Low Clock Jitter Sensitivity
- \* Single Power Supply: 5V
- \* Filtered Line Level Outputs
- \* On-Chip Digital De-emphasis
- \* Normal or I2S Data Input Formats
- \* 24Bits Conversion

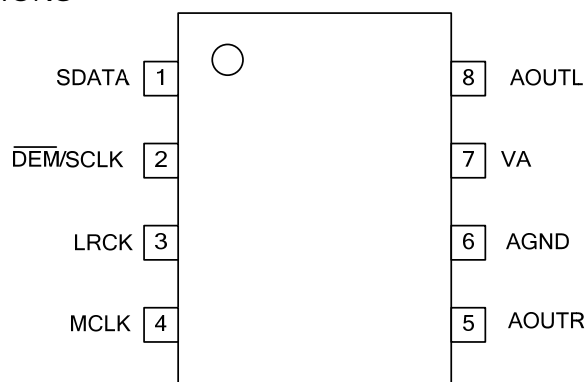
#### ORDERING INFORMATION

Ordering Number	Package	Packing
M4334G-S08-R	SOP-8	Tape Reel

 M4334G-S08-T	(1)Packing Type (2)Package Type (3)Halogen Free	(1) R: Tape Reel (2) S08: SOP-8 (3) G: Halogen Free
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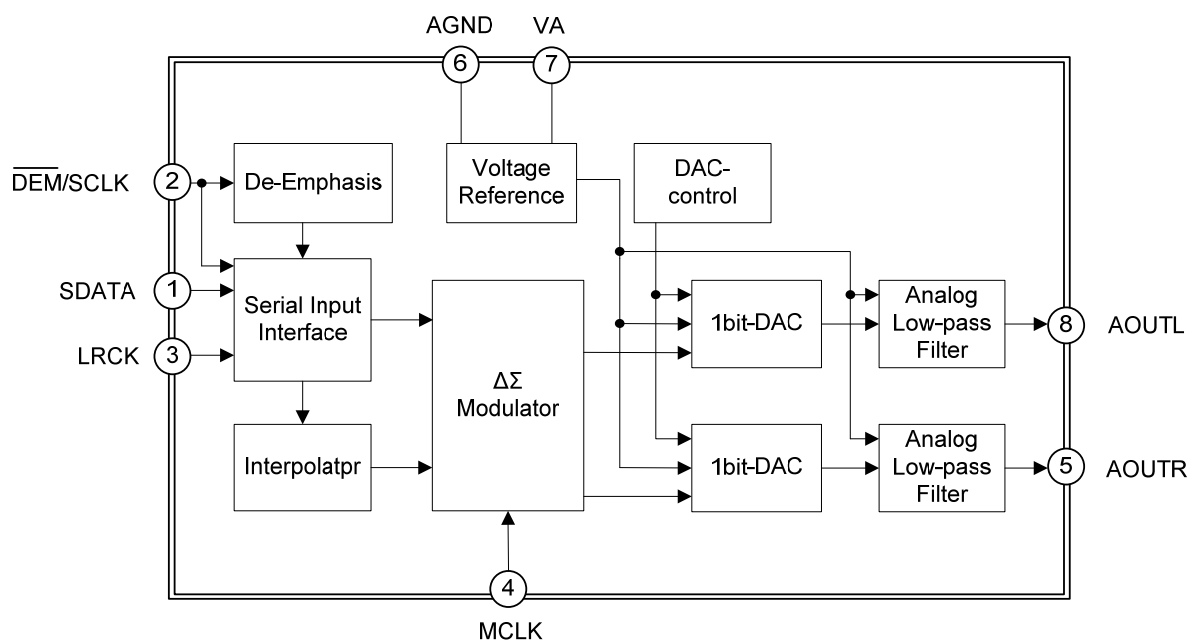
## ■ PIN CONFIGURATIONS



## ■ PIN DESCRIPTION

PIN NO	PIN NAME	PIN TYPE	PIN DESCRIPTION
1	SDATA	I	Serial audio data input: two's complement MSB-first serial data is input on this pin. The data is clocked into the <b>M4334</b> via internal or external SCLK, and the channel is determined by LRCK.
2	DEM/SCLK	I	De-emphasis control and clock input for audio data: used for de-emphasis filter control or external serial clock input.
3	LRCK	I	Sample rate clock input: determines which channel is currently being input on the audio serial data input pin.
4	MCLK	I	System clock input: frequency must be 256x, 384x, or 512x the input sample rate in BRM and either 128x or 192x the input sample rate in HRM.
5	AOUTR	O	Right-channel analog output
6	AGND	I	Ground pin
7	VA	I	Power supply pin for the internal control circuits
8	AOUTL	O	Left-channel analog output

## ■ BLOCK DIAGRAM



## ■ ABSOLUTE MAXIMUM RATING

PARAMETER	SYMBOL	RATINGS	UNIT
DC Power Supply	$V_A$	-0.3~6	V
Digital Input Voltage	$V_{IND}$	-0.3~ $V_A$ +0.4	V
Input Current, Any Pin Except Supplies	$I_{IN}$	±10	mA
Ambient Operating Temperature	$T_A$	-55 ~ +125	°C
Storage Temperature	$T_{STG}$	-65 ~ +150	°C

Note: Absolute maximum ratings are those values beyond which the device could be permanently damaged.

Absolute maximum ratings are stress ratings only and functional device operation is not implied.

## ■ RECOMMENDED OPERATING CONDITIONS(Note1)

PARAMETER	SYMBOL	RANGE	UNIT
DC Power Supply	$V_A$	4.75 ~ 5.5	V

Note: 1. All voltage values are with respect to the network ground terminal unless otherwise noted.

2. The  $V_{OUT}$  tracks the  $V_{REF}$  with additional voltage offset and load regulation.

## ■ ELECTRICAL CHARACTERISTICS

All specifications at 25°C,  $V_A$ =+5V, full-scale output sine wave, 997Hz; MCLK=12.288MHz;  $F_s$  for =48kHz, SCLK=3.072MHz, measurement bandwidth 10Hz to 20kHz, unless otherwise specified;  $f_s$  for HRM=96kHz, SCLK=6.144MHz, measurement bandwidth 10Hz to 40kHz, unless otherwise specified.  $R_L$ =10K $\Omega$ ,  $C_L$ =10pF.

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>POWER AND THERMAL</b>						
Power supply current	$I_A$	Normal operation		15	19	mA
		Power-down state		40		uA
Power Dissipation	$P_D$	Normal operation		75	104	mW
		Power-down state		0.2		
Package Thermal Resistance	$\theta_{JA}$			110		°C /W
Power Supply Rejection Ratio	PSRR	f=1kHz		79		dB
<b>DC ACCURACY</b>						
Inter Channel Gain Mismatch				0.1	0.4	dB
Gain Error				±5		%
Gain Drift				100		ppm/°C
<b>ANALOG OUTPUT</b>						
Full Scale Output Voltage			3.25	3.5	3.75	V <sub>pp</sub>
Quiescent Voltage	$V_Q$			2.2		V <sub>DC</sub>
Max AC-Load Resistance	$R_L$			3		K $\Omega$
Max Load Capacitance	$C_L$			100		pF
<b>DIGITAL INPUT/OUTPUT</b>						
High-Level Input Voltage	$V_{IH}$		2.0			V
Low-Level Input Voltage	$V_{IL}$				0.8	V
Input Leakage Current	$I_{I(Leak)}$				±10	μA
Input Capacitance	$C_{IN}$			8		pF

## ■ ELECTRICAL CHARACTERISTICS (Cont.)

PARAMETER	SYMBOL	TEST CONDITIONS	Base-Rate Mode			High-Rate Mode			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
Ambient Operating Temperature	T <sub>OPR</sub>		-40		85	-40		85	°C
Dynamic Range		16-bit , un-weighted	83	91			88		dB
		16-bit , a-weighted	86	94		86	94		
		18 to 24-bit, un-weighted	85	93			90		
		18 to 24-bit , a-weighted	88	96		88	96		
Total Harmonic Distortion +Noise	THD+N	16-bit, 0dB		-86	-70		-86	-80	dB
		16-bit, -20dB		-71	-63		-68	-60	
		16-bit, -60dB		-31	-23		-28	-20	
		18 to 24-bit, 0dB		-88	-82		-88	-82	
		18 to 24-bit, -20dB		-73	-65		-70	-62	
		18 to 24-bit, -60dB		-33	-25		-30	-22	

## ■ SWITCHING CHARACTERISTICS

(T<sub>A</sub>= -40 to 85°C; V<sub>A</sub>=4.75V~5.5V; Input: Logic 0=0V, Logic 1=V<sub>A</sub>, C<sub>L</sub>=20pF)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
Input Sample Rate	f <sub>s</sub>		2		100	kHz
MCLK Pulse Width High		MCLK/LRCK=512	10		1000	ns
MCLK Pulse Width Low		MCLK/LRCK=512	10		1000	ns
MCLK Pulse Width High		MCLK/LRCK=384 or 192	21		1000	ns
MCLK Pulse Width Low		MCLK/LRCK=384 or 192	21		1000	ns
MCLK Pulse Width High		MCLK/LRCK=256 or 128	31		1000	ns
MCLK Pulse Width Low		MCLK/LRCK=256 or 128	31		1000	ns
<b>EXTERNAL SCLK MODE</b>						
LRCK Duty Cycle			40	50	60	%
SCLK Pulse Width High	t <sub>SCLKH</sub>		20			ns
SCLK Pulse Width Low	t <sub>SCLKL</sub>		20			ns
SCLK Period	t <sub>SCLKW</sub>	MCLK/LRCK=512,256 or 384	$\frac{1}{(128) F_s}$			ns
		MCLK/LRCK=128 or 192	$\frac{1}{(64) F_s}$			ns
SCLK rising to LRCK edge delay	t <sub>SLRD</sub>		20			ns
SCLK rising to LRCK edge setup time	t <sub>SLRS</sub>		20			ns
SDATA valid to SCLK rising setup time	t <sub>SDLRS</sub>		20			ns
SCLK rising to SDATA hold time	t <sub>SDH</sub>		20			ns
<b>INTERNAL SCLK MODE</b>						
LRCK duty cycle				50		%
SCLK Period	t <sub>SCLKW</sub>		$\frac{1}{SCLK}$			ns
SCLK rising to LRCK edge	t <sub>SCLKR</sub>			$\frac{t_{sclkw}}{2}$		μs
SDATA valid to SCLK rising setup time	t <sub>SDLRS</sub>		$\frac{1}{(512) F_s} + 10$			ns
SCLK rising to SDATA hold time	t <sub>SDH</sub>	MCLK/LRCK=128, 256 or 512	$\frac{1}{(512) F_s} + 15$			ns
SCLK rising to SDATA hold time	t <sub>SDH</sub>	MCLK/LRCK=192 or 384	$\frac{1}{(384) F_s} + 15$			ns

■ TIMING DIAGRAMS

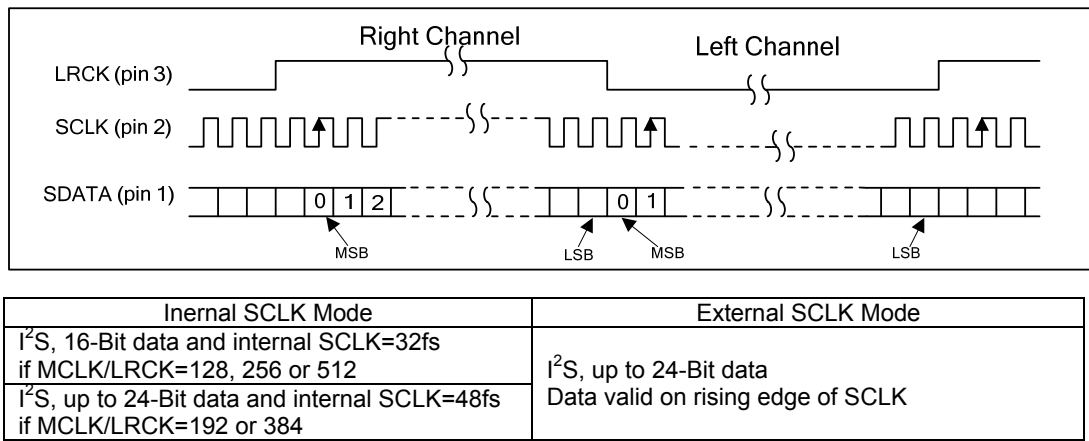


Figure 1. I²S Data Input Timing

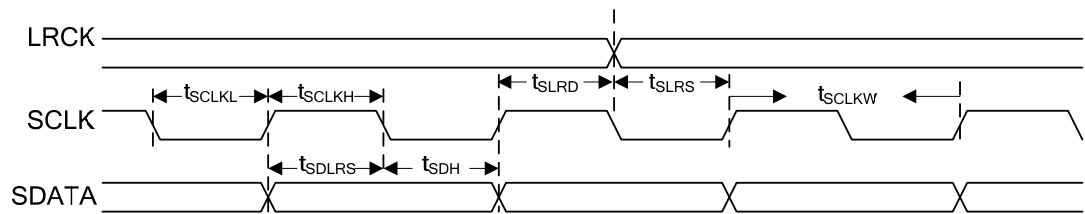


Figure 2. Audio Data Input Timing

■ TYPICAL APPLICATION CIRCUIT

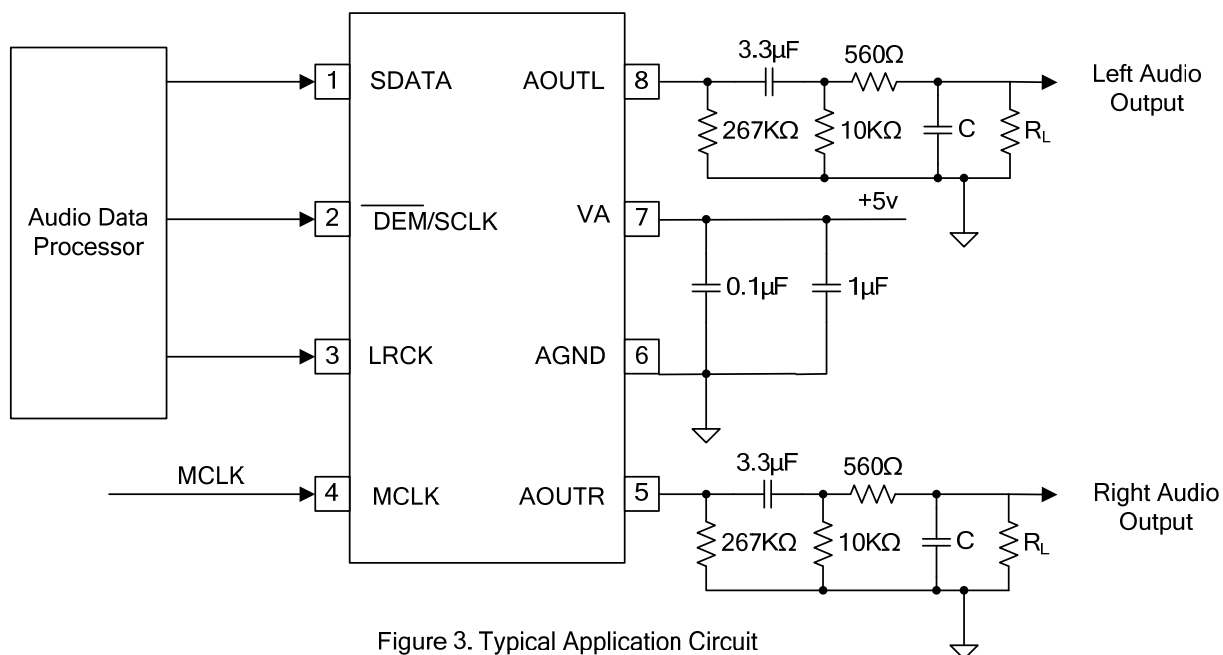


Figure 3. Typical Application Circuit

## ■ APPLICATION CONSIDERATION

The **M4334** is a complete low cost stereo digital-to-analog output system contains digital interpolation, fourth-order delta-sigma digital-to-analog conversion, digital de-emphasis and analog low pass filter. The **M4334** used the  $\Delta$ - $\Sigma$  modulation techniques is to avoid the limitations of resistive laser trimmed DAC architectures by using an inherently linear 1-bit DAC.

The **M4334** supports two modes of operation. The devices operate in Base Rate Mode (BRM) when MCLK/LRCK is 256, 384 or 512 and in High Rate Mode (HRM) when MCLK/LRCK is 128 or 192. HRM allows input sample rates up to 100 kHz.

The **M4334** also has the de-emphasis function, the de-emphasis filter is active when the DEM/SCLK pin is low for 5 consecutive falling edges of LRCK, but this function is available only in the internal SCLK mode.

When the **M4334** is initially powered-up, the audio outputs, AOUTL and AOUTR, are clamped to AGND. After a short delay of approximately 1000 sample periods, each output begins to ramp towards its quiescent voltage, VQ. Approximately 10,000 sample cycles later, the outputs reach VQ and audio output begins. This gradual voltage ramping allows time for the external DC-blocking capacitor to charge to VQ, effectively blocking the quiescent DC voltage.

To prevent transients at power-down, the device must first enter its power-down state. This is accomplished by removing MCLK or LRCK. When this occurs, audio output ceases and the internal output buffers are disconnected from AOUTL and AOUTR. A soft-start current sink is substituted in place of AOUTL and AOUTR which allows the DC-blocking capacitors to slowly discharge. Once this charge is dissipated, the power to the device may be turned off, and the system is ready for the next power-on.

To prevent an audio transient at the next power-on, the DC-blocking capacitors must fully discharge before turning off the power or exiting the power-down state. If full discharge does not occur, a transient will occur when the audio outputs are initially clamped to AGND. The time that the device must remain in the power-down state is related to the value of the DC-blocking capacitance.



## ■ SYSTEM CLOCK

The **M4334** accepts data at standard audio sample rates including 48, 44.1 and 32 kHz in BRM and 96, 88.2 and 64 kHz in HRM. The LRCK chooses the channel and delineation of data, and the SCLK clocks audio data into the input data buffer.

### MCLK

MCLK must be either 256x, 384x or 512x the desired input sample rate in BRM and either 128x or 192x the desired input sample rate in HRM. The LRCK frequency is equal to  $F_s$ , the frequency at which words for each channel are input to the device. The MCLK-to-LRCK frequency ratio is detected automatically during the initialization sequence by counting the number of MCLK transitions during a single LRCK period. Internal dividers are set to generate the proper clocks. The MCLK, LRCK and SCLK must be synchronous. Table 1 illustrates several standard audio sample rates and the required MCLK and LRCK frequencies.

LRCK(kHz)	MCLK(MHz)				
	HRM		BRM		
	128x	192x	256x	384x	512x
32	4.0960	6.1440	8.1920	12.2880	16.3840
44.1	5.6448	8.4672	11.2896	16.9344	22.5792
48	6.1440	9.2160	12.2880	18.4320	24.5760
64	8.1920	12.2880			
88.2	11.2896	16.9344			
96	12.2880	18.4320			

**Table 1. Common Clock Frequencies**

### SCLK

The SCLK controls the shifting of data into the input data buffers. The **M4334** supports both internal and external SCLK generation modes.

#### Internal SCLK Mode

In the Internal SCLK Mode, the SCLK is internally derived and synchronous with MCLK and LRCK. The SCLK/LRCK frequency ratio is either 32, 48, or 64 depending upon data format. Operation in this mode is identical to operation with an external SCLK synchronized with LRCK. This mode allows access to the digital de-emphasis function.

While the Internal SCLK Mode is provided to allow access to the de-emphasis filter, the Internal SCLK Mode also eliminates possible clock interference from an external SCLK.

#### External SCLK Mode

The **M4334** will enter the external SCLK mode when 16 low to high transitions are detected on the DEM/SCLK pin during any phase of the LRCK period. When this mode is enabled, the Internal SCLK Mode and de-emphasis filter cannot be accessed. The **M4334** will switch to Internal SCLK Mode if no low to high transitions are detected on the DEM/SCLK pin for 2 consecutive frames of LRCK.

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