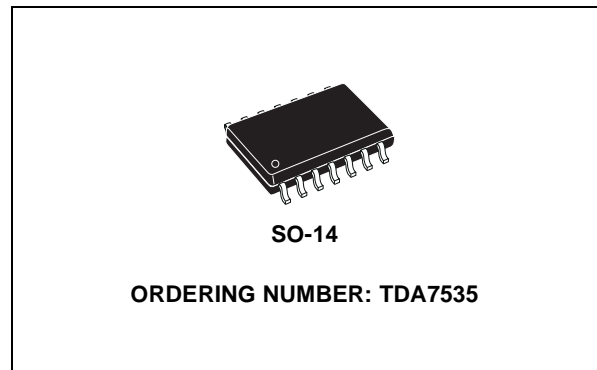




## DELTA/SIGMA CASCADE 20 BIT STEREO DAC

- 20-bit resolution single ended output
- Analog reconstruction third order Chebyshev filter
- I<sup>2</sup>S input data format
- On chip PLL
- System clock: 64 F<sub>s</sub>
- 2 output channels
- 0.9 VRMS single ended output dynamic
- 3.3V power supply
- Reset
- Sampling rate 36KHz to 48KHz



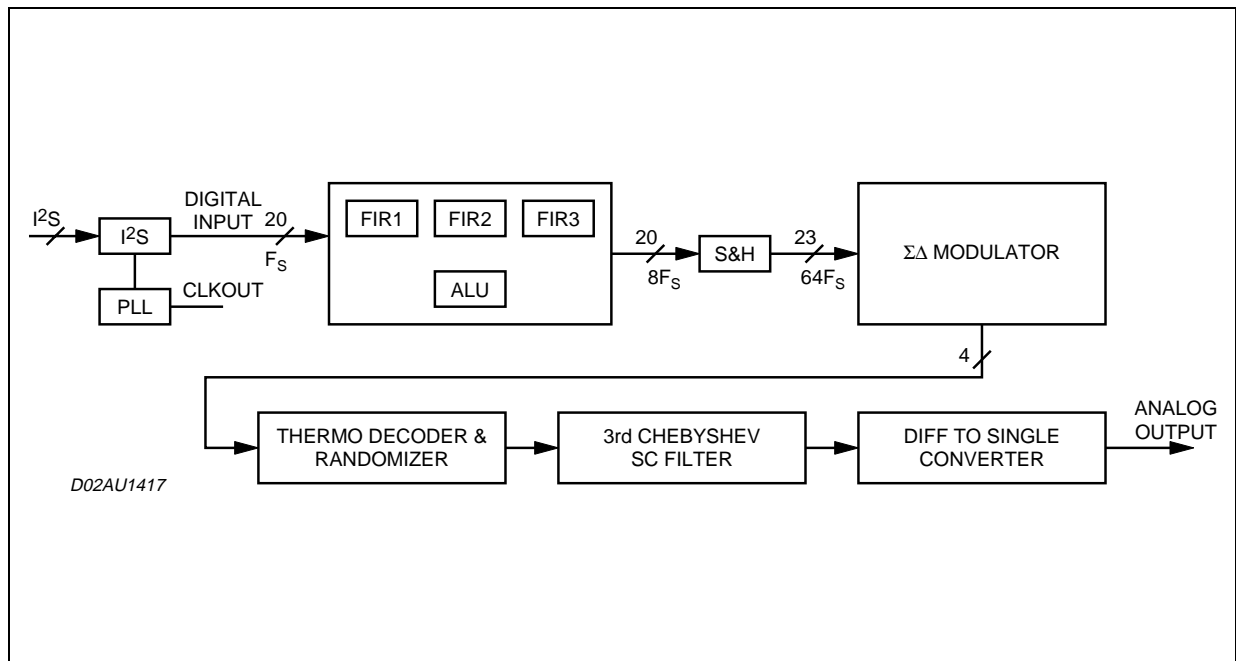
### DESCRIPTION

The TDA7535 is a stereo, digital-to-analog converter designed for audio application, including digital interpolation filter, a third order multibit Delta-Sigma DAC, a third order Chebyshev's reconstruction filter and a differential to single ended output converter. This device is fabricated in highly advanced CMOS, where high speed precision analog circuits are combined with high density logic circuits. The TDA7535, according to standard audio converters, can accept any I<sup>2</sup>S data format.

The TDA7535 is available in SO-14 package. The total power consumption is less than 75mW.

TDA7535 is suitable for a wide variety of applications where high performance are required. Its low cost and single 3.3V power supply make it ideal for several applications, such as CD players, MPEG audio, MIDI applications, CD-ROM drives, CD-Interactive, digital radio applications and so on. An evaluation board is available to perform measurement and to make listening tests.

### BLOCK DIAGRAM



# TDA7535

## ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V <sub>DD</sub> V <sub>CC</sub>	Power supplies Digital Analog	-0.5 to +4.6 -0.5 to +4.6	V V
V <sub>aio</sub>	Analog Input and Output Voltage	-0.5 to (V <sub>CC</sub> +0.5)	V
V <sub>dio</sub>	Digital Input and Output Voltage	-0.5 to (V <sub>DD</sub> +0.5)	V
V <sub>di5</sub>	Digital Input Voltage (5V tolerant)	-0.5 to 6.5	V
T <sub>j</sub>	Operating Junction Temperature Range	-40 to 125	°C
T <sub>stg</sub>	Storage Temperature	-55 to 150	°C

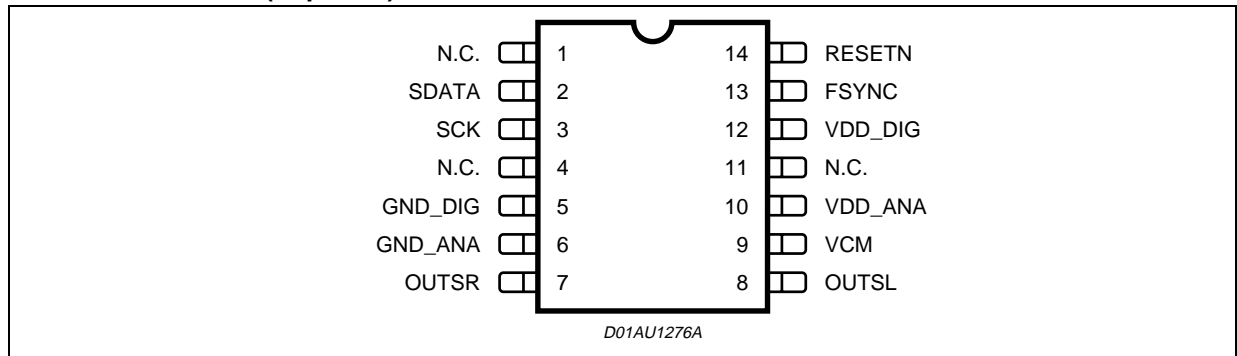
Warning: Operation at or beyond these limit may result in permanent damage to the device. Normal operation is not guaranteed at these extremes.

## THERMAL DATA

Symbol	Parameter	Value	Unit
R <sub>th j-amb</sub>	Thermal resistance junction to ambient <sup>(1)</sup>	85	°C/W

Note: 1. In still air

## PIN CONNECTIONS (Top view)



## PIN FUNCTION

Pin Number	Pin Name	Input/Output Power	Description
1	N.C.	-	-
2	SDATA	I	I2S Digital Data Input
3	SCK	I	I2S Clock Input
4	N.C.	-	-
5	GND_DIG	P	Digital Ground
6	GND_ANA	P	Analog Ground
7	OUTSR	O	Right Channel single ended Output
8	OUTSL	O	Left Channel single ended Output
9	VCM	P	Reference 1.65V externally filtered
10	VDD_ANA	P	Analog 3.3V-Supply
11	N.C.	-	-
12	VDD_DIG	P	Digital 3.3V-Supply
13	FSYNC	I	I2S Left-Right Channel selector
14	RESETN	I	Reset (active low)

**RECOMMENDED DC OPERATING CONDITIONS**

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
V <sub>DD</sub>	3.3V Digital Power Supply Voltage		3.15	3.3	3.45	V
V <sub>CC</sub>	3.3V Analog Power Supply Voltage		3.15	3.3	3.45	V

**POWER CONSUMPTION**

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
I <sub>dd</sub>	Total Maximum Current	power supply @ 3.3V and T <sub>j</sub> = 125°C		21.5	25	mA

**GENERAL INTERFACE ELECTRICAL CHARACTERISTICS**

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
I <sub>il</sub>	Low Level Input Current without pullup device	V <sub>i</sub> = 0V (note 1)			1	μA
I <sub>ih</sub>	High Level Input Current without pullup device	V <sub>i</sub> = V <sub>dd</sub> (note 1)			1	μA
I <sub>latchup</sub>	I/O latch-up current	V < 0V, V > V <sub>dd</sub>	200			mA
V <sub>esd</sub>	Electrostatic Protection	Leakage , 1μA (note 2)	2000			V

Note: 1. The leakage currents are generally very small, <1nA. The value given here, 1mA, is the maximum that can occur after an Electrostatic Stress on the pin.  
2. Human Body Model.

**LOW VOLTAGE CMOS INTERFACE DC ELECTRICAL CHARACTERISTICS**

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
V <sub>il</sub>	Low Level Input Voltage				0.2*V <sub>dd</sub>	V
V <sub>ih</sub>	High Level Input Voltage		0.8*V <sub>dd</sub>			V
V <sub>hyst</sub>	Schmitt trigger hysteresis		0.8			V

**DAC ELECTRICAL CHARACTERISTICS**

V<sub>dd</sub> = 3.3V; T<sub>amb</sub> = 25°C; Input signal frequency = sinus wave generated by Audio Precision Sys.2; Input Signal Amplitude = see notes; Noise Integration Bandwidth = 20Hz to 22KHz (A- weighted)

Parameter	Test Condition	Min.	Typ.	Max.	Unit
Noise + Distortion (see note 1)	@0dB		89		dB
	@-6dBb		94		dB
	@-40dB		96		dB
	@-60dB		96		dB
Total Harmonic Distortion	see note 2		94		dB
Dynamic range	see note 3		96		dB
Crosstalk	see note 4		-95		dB
Full Scale Output Voltage	V <sub>dd</sub> = 3.15 to 3.45V Full scale input	0.8	0.9	1.0	V <sub>rms</sub>
Input Sampling Rate		36		48	kHz

**DAC ELECTRICAL CHARACTERISTICS** (continued)

Vdd = 3.3V; Tamb = 25°C; Input signal frequency = sinus wave generated by Audio Precision Sys.2; Input Signal Amplitude = see notes; Noise Integration Bandwidth = 20Hz to 22KHz (A- weighted)

Parameter	Test Condition	Min.	Typ.	Max.	Unit
Passband Ripple			0.12		dB
Stopband	@ 3dB @ 90dB 44.1kHz Sampling Rate	21.53		24.80	kHz
Interchannel Gain Mismatch			0.05	0.1	dB

Note1: It is the ratio between the maximum input signal and the integration of the in-band noise after deducing the power of signal fundamental. It depends on the input signal amplitude. In this case 0dB means full scale digital, 1kHz frequency used.

Note 2: It is the ratio of the rms value of the signal fundamental component at 0dB (full scale digital) to the rms value of all of the harmonic components in the band.

Note 3: measured using the SNR at -60dB input signal, with 60dB added to compensate for small input signal.

Note 4: Left channel on with 0dB/1kHz input signal, Right channel on with DC input signal.

**Figure 1. I<sup>2</sup>S interface Diagram**

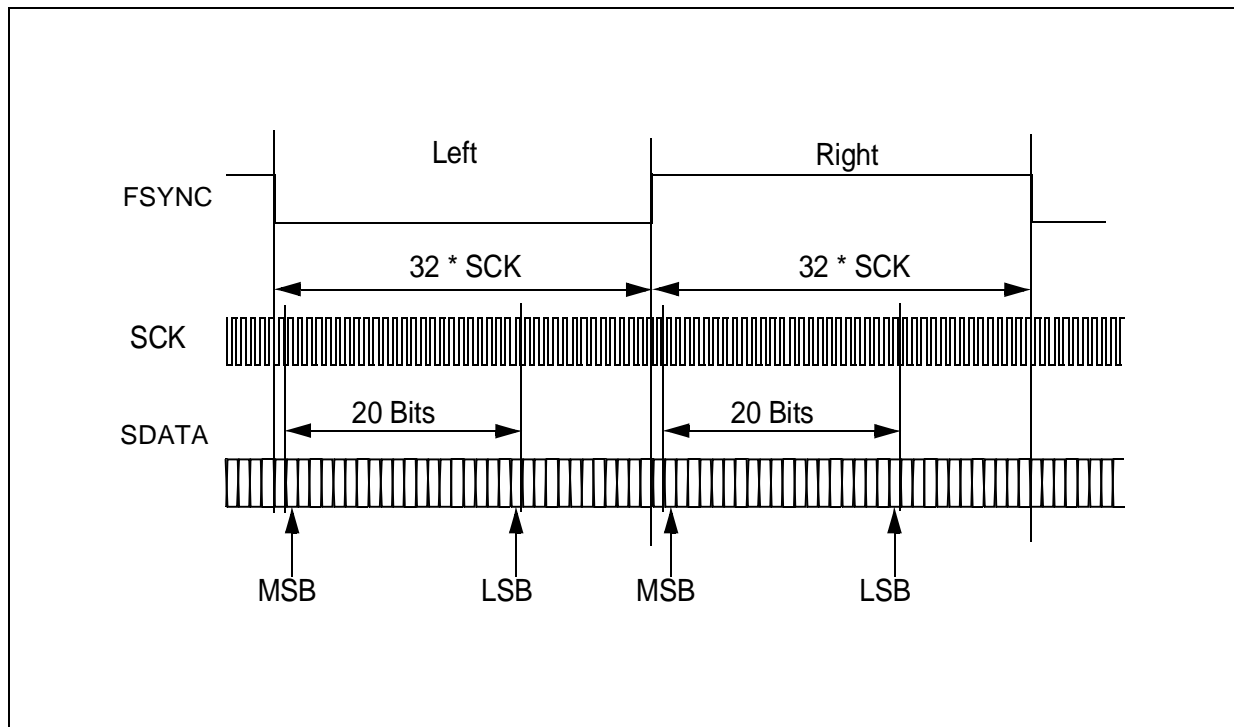
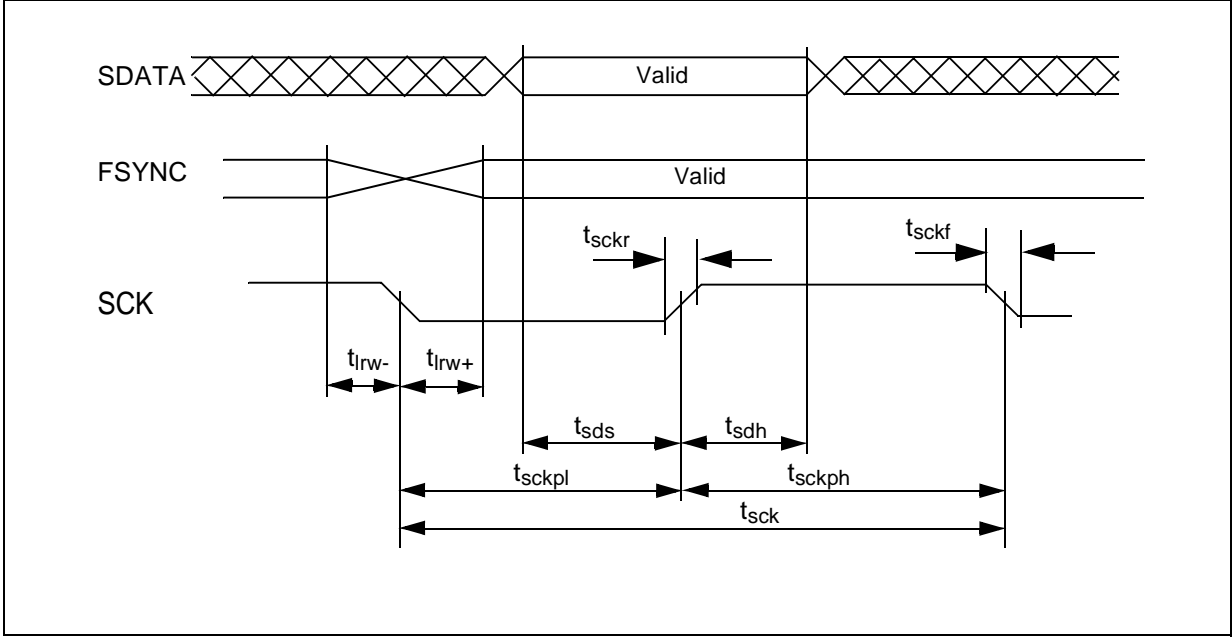


Figure 2. I<sup>2</sup>S Timings

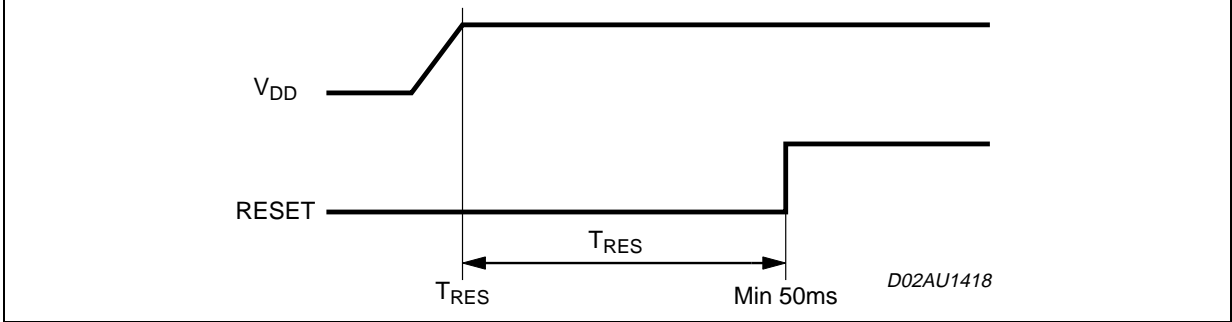


Timing	Description	Minimum	Maximum	Unit
$t_{sck}$	Clock Cycle <sup>(1)</sup>	$1/(64 \cdot F_s) - 150\text{psRMS}$	$1/(64 \cdot F_s) + 150\text{psRMS}$	ns
$t_{sckpl}$	SCK Phase Low	$0.5 \cdot t_{sck} - 1\%$	$0.5 \cdot t_{sck} + 1\%$	ns
$t_{sckph}$	SCK Phase High	$0.5 \cdot t_{sck} - 1\%$	$0.5 \cdot t_{sck} + 1\%$	ns
$t_{lrw-}$	FSYNC switching time window before SCK falling edge <sup>(2)</sup>	0	$0.125 \cdot t_{sck} - 10$	ns
$t_{lrw+}$	FSYNC switching time window after SCK falling edge <sup>(2)</sup>	0	$0.125 \cdot t_{sck} - 10$	ns
$t_{sds}$	SDATA setup time	60		ns
$t_{sdh}$	SDATA hold time	30		ns
$t_{sckr}$	SCK rise time		1.5	ns
$t_{sckf}$	SCK fall time		1.5	ns

(1) SCK clock defines the  $F_s$ , being the Sample Rate. This input clock needs a jitter below  $\sim 212\text{psRMS}$

(2) FSYNC switches inside the time window as specified w.r.t. to falling edge of SCK

Figure 3. Power Up & Reset Sequence



I<sup>2</sup>S bit clock (SCK) must be present 20ms before reset release to allow PLL locking.

Figure 4. Frequency response

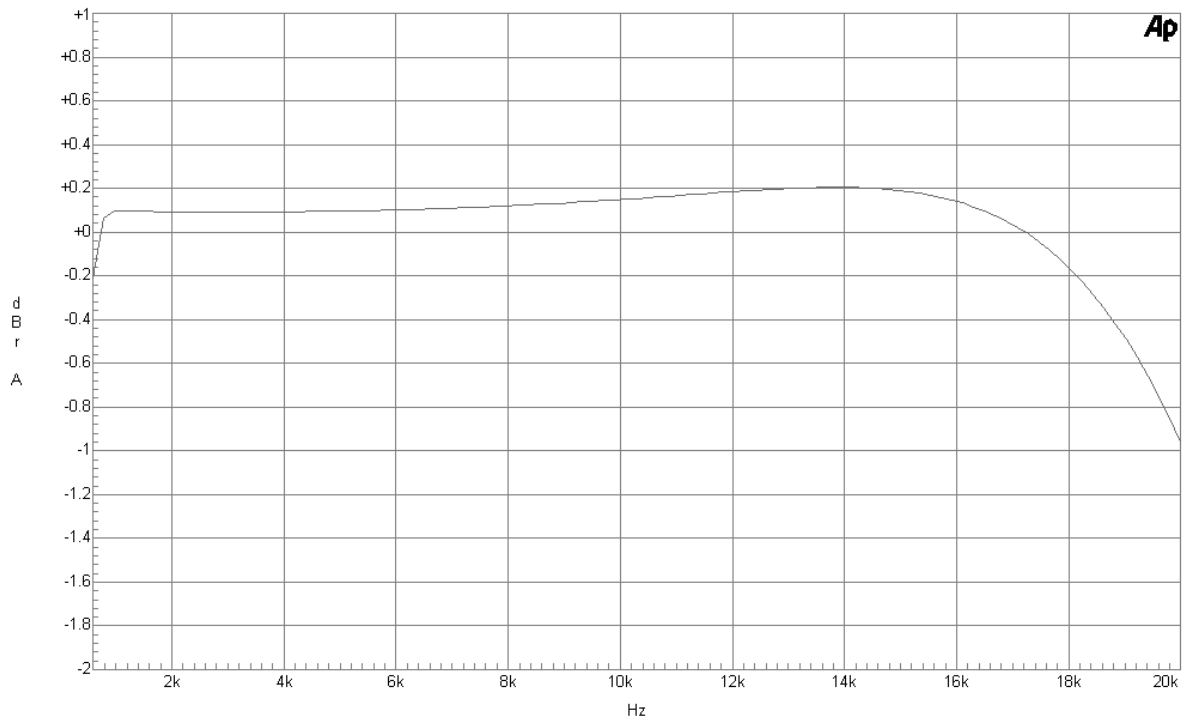
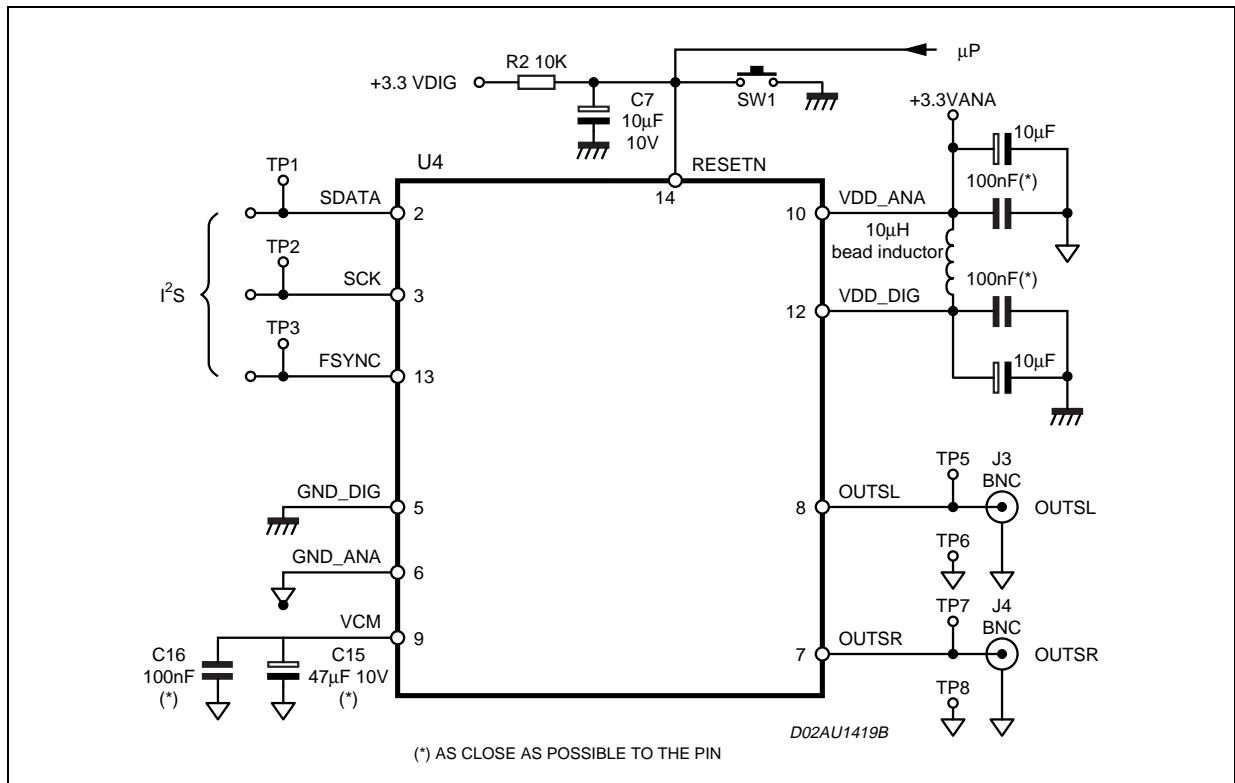


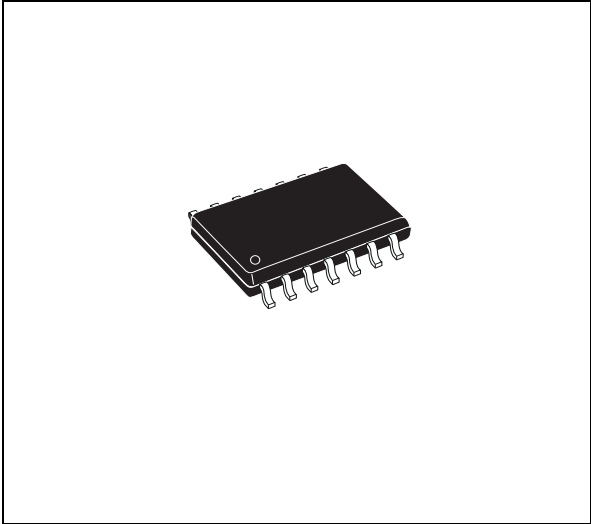
Figure 5.



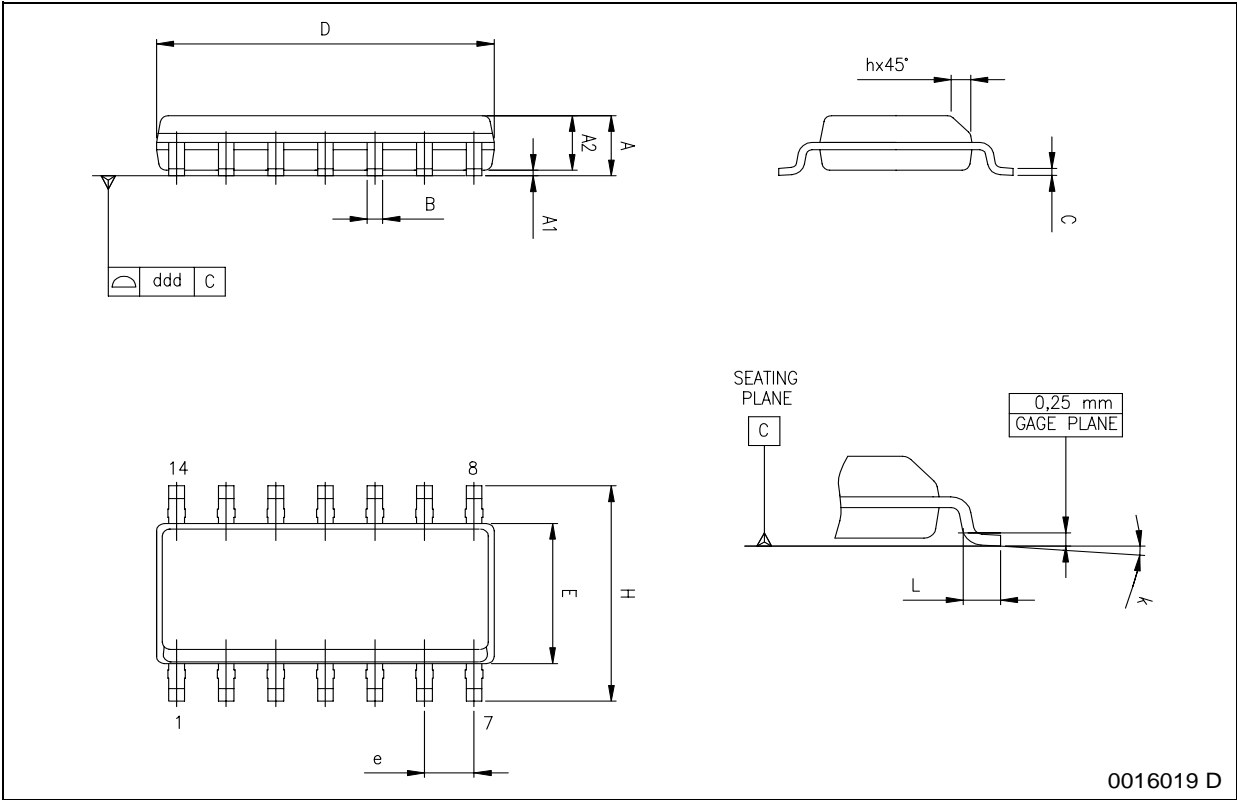
DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	1.35		1.75	0.053		0.069
A1	0.10		0.30	0.004		0.012
A2	1.10		1.65	0.043		0.065
B	0.33		0.51	0.013		0.020
C	0.19		0.25	0.007		0.01
D (1)	8.55		8.75	0.337		0.344
E	3.80		4.0	0.150		0.157
e		1.27			0.050	
H	5.8		6.20	0.228		0.244
h	0.25		0.50	0.01		0.02
L	0.40		1.27	0.016		0.050
k	0° (min.), 8° (max.)					
ddd			0.10			0.004

(1) "D" dimension does not include mold flash, protusions or gate burrs. Mold flash, protusions or gate burrs shall not exceed 0.15mm per side.

**OUTLINE AND MECHANICAL DATA**



**SO14**



0016019 D

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