TSH110-TSH111-TSH112-TSH113-TSH114

Wide band low noise operational amplifiers

Features

- Low noise: 3nV/√Hz
- Low supply current: 3.2mA
- 47mA output current
- Bandwidth: 100MHz
- 5V to 12V supply voltage
- Slew rate: 450V/µs
- Specified for 100Ω load
- Very low distortion
- Tiny SOT23-5, TSSOP and SO packages

Applications

- High-end video drivers
- Receiver for xDSL
- A/D converter driver
- High-end audio applications

Description

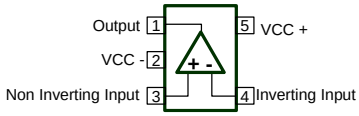
The single TSH110 and TSH111, the dual TSH112, the triple TSH113 and the quad TSH114 are current feedback operational amplifiers featuring a very high slew rate of 450V/µs and a large bandwidth of 100MHz, with only a 3.2mA quiescent supply current. The TSH111 and TSH113 feature a Standby function for each operator. This function is a power-down mode with a high output impedance.

These devices operate from ±2.5V to ±6V dual supply voltage or from 5V to 12V single supply voltage. They are able to drive a 100Ω load with a swing of 9V minimum (for a 12V power supply).

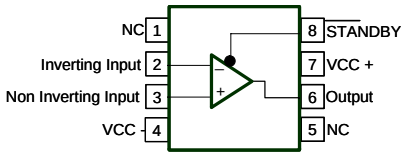
The harmonic and intermodulation distortions of these devices are very low, making this circuit a good choice for applications requiring wide bandwidth with multiple carriers.

For board space and weight saving, the TSH110 comes in miniature SOT23-5 package.

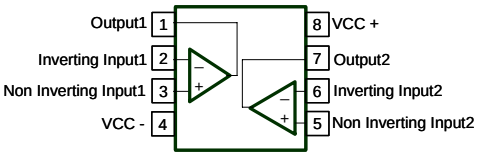
TSH110: SOT23-5



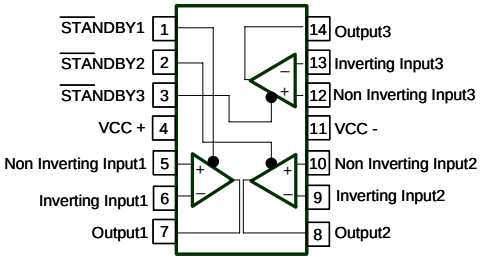
TSH111: SO-8/TSSOP8



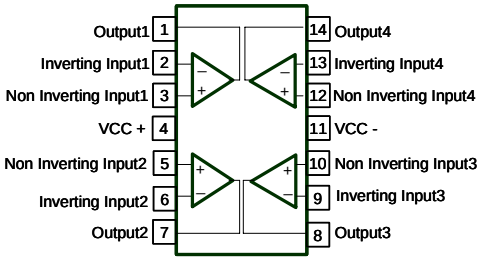
TSH112: SO-8/TSSOP8



TSH113: SO-14/TSSOP14



TSH114: SO-14/TSSOP14



The TSH111 comes in SO-8 and TSSOP8 packages, the TSH112 comes in SO-8 and TSSOP8 packages, the TSH113 and TSH114 come in SO-14 and TSSOP14 packages.

1 Absolute maximum ratings and operating conditions

Table 1. Absolute maximum ratings (AMR

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage (1)	14	V
V_{id}	Differential input voltage (2)	±1	V
V_i	Input voltage (3)	±6	V
T_{oper}	Operating free air temperature range	-40 to +85	°C
T_{stg}	Storage temperature	-65 to +150	°C
T_j	Maximum junction temperature	150	°C
R_{thjc}	Thermal resistance junction to case SOT23-5 SO-8 SO-14 TSSOP8 TSSOP14	 80 28 22 37 32	°C/W
R_{thja}	Thermal resistance junction to ambiant area SOT23-5 SO-8 SO-14 TSSOP8 TSSOP14	 250 157 125 130 110	°C/W
ESD	HBM: human body model(4)	2.0	kV
	MM: machine model(5)	0.2	
	CDM: charged device model(6)	1.5	
	Output short circuit duration (7)		

1. All voltage values, except differential voltage, are with respect to network ground terminal.
2. Differential voltages are the non-inverting input terminal with respect to the inverting terminal.
3. The magnitude of input and output voltages must never exceed V_{CC} +0.3V
4. Human body model: A 100pF capacitor is charged to the specified voltage, then discharged through a 1.5kΩ resistor between two pins of the device. This is done for all couples of connected pin combinations while the other pins are floating.
5. Machine model: A 200pF capacitor is charged to the specified voltage, then discharged directly between two pins of the device with no external series resistor (internal resistor < 5Ω). This is done for all couples of connected pin combinations while the other pins are floating.
6. Charged device model: all pins and the package are charged together to the specified voltage and then discharged directly to the ground through only one pin. This is done for all pins.
7. Short-circuits can cause excessive heating and can result in destructive dissipation.

Table 2. Operating conditions

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage	5 to 12	V
V_{icm}	Common mode input voltage range	V_{CC}^-+1.5 to V_{CC}^+-1.5	V

2 Electrical characteristics

Table 3. Dual supply voltage, V_{CC}= ±2.5V, R_{fb}(1)= 680Ω, T_{amb} = 25°C (unless otherwise specified)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
DC performance						
V_{io}	Input offset voltage	T_{amb}	-1.5	0.3	2.0	mV
		$T_{min} < T_{amb} < T_{max}$		1		mV
ΔV_{io}	Input offset voltage drift vs. temperature	$T_{min} < T_{amb} < T_{max}$		5		µV/°C
I_{ib+}	Non inverting input bias current	T_{amb}	-10	1.4	13	µA
		$T_{min} < T_{amb} < T_{max}$		2.5		µA
I_{ib-}	Inverting input bias current	T_{amb}	-3	1.9	7	µA
		$T_{min} < T_{amb} < T_{max}$		2.5		µA
R_{OL}	Transimpedance	R_L=100Ω	500	750		kΩ
I_{CC}	Supply current per operator	T_{amb}		3.2	4	mA
		$T_{min} < T_{amb} < T_{max}$		3.5		mA
CMR	Common mode rejection ratio ($\Delta V_{ic}/\Delta V_{io}$)		56	60		dB
SVR	Supply voltage rejection ratio ($\Delta V_{CC}/\Delta V_{io}$)		70	80		dB
PSR	Power supply rejection ratio ($\Delta V_{CC}/\Delta V_{out}$)	Gain=1, R_{load}=3.9kΩ		48		dB
Dynamic performance and output characteristics						
V_{oh}	High level output voltage	T_{amb} R_L = 100Ω	1.4	2		V
		$T_{min} < T_{amb} < T_{max}$ R_L = 100Ω GND		1.9		V
V_{ol}	Low level output voltage	T_{amb} R_L = 100Ω		-1.8	-1.3	V
		$T_{min} < T_{amb} < T_{max}$ R_L = 100Ω		-1.7		V
$\lvert I_{sink} \rvert$	Output sink current	$T_{min} < T_{amb} < T_{max}$		20		mA
I_{source}	Output source current	$T_{min} < T_{amb} < T_{max}$		18		mA
BW	-3dB bandwidth	V_{out}=1V_{pk}, R_{fb}(1)=820Ω//2pF Load=100Ω				
		A_{VCL}=+2		81		MHz
SR	Slew rate	A_{VCL}=+2, 2V step Load=100Ω	160	230		V/µs

Table 3. Dual supply voltage, V_{CC}= ±2.5V, R_{fb}(1)= 680Ω, T_{amb} = 25°C (unless otherwise specified) (continued)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
T_r	Rise time	for 200mV step A_{VCL}=+2, R_{fb}(1)=820Ω/2pF Load=100Ω		9		ns
T_f	Fall time			9		ns
Ov	Overshoot			16		%
St	Settling time @ 0.05%			60		ns
ΔG	Differential gain	A_{VCL}=+2, R_L=100Ω F=4.5MHz, V_{out}=1V_{peak}		0.05		%
Δϕ	Differential phase			0.05		°
Noise and harmonic performance						
en	Equivalent input voltage noise	Frequency : 1MHz		3		nV/√Hz
in	Equivalent input current noise			8.5		pA/√Hz
THD	Total harmonic distortion	A_{VCL}=+2, F=2MHz R_L=100Ω V_{out}=2V_{peak}		64.4		dB
IM3	Third order inter modulation product	A_{VCL}=+2, V_{out}=2V_{pp} R_L=100Ω F1=1MHz, F2=1.1MHz				dBc
		@900kHz		90		
		@1.2MHz		90		
		@3.1MHz		86		
		@3.2MHz		83		
Matching characteristics						
Gf	Gain flatness	F=(DC) to 6MHz A_{VCL}=+2, V_{out}=2V_{pp}		0.1		dB
Vo1/Vo2	Channel separation	F=1MHz to 10MHz		65		dB

1. R_{fb} is the feedback resistance between the output and the inverting input of the amplifier.

Table 4. Dual supply voltage, V_{CC}=±6V, R_{fb}(1)= 680Ω, T_{amb} = 25°C (unless otherwise specified)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
DC performance						
V_{io}	Input offset voltage	T_{amb}	-1.0	0.9	3.0	mV
		$T_{min} < T_{amb} < T_{max}$		1.3		mV
ΔV_{io}	Input offset voltage drift vs temperature	$T_{min} < T_{amb} < T_{max}$		5		µV/°C
I_{ib+}	Non inverting input bias current	T_{amb}	-12	1	14	µA
		$T_{min} < T_{amb} < T_{max}$		1.7		µA
I_{ib-}	Inverting input bias current	T_{amb}	-4	3	10	µA
		$T_{min} < T_{amb} < T_{max}$		3.4		µA
R_{OL}	Transimpedance	R_L=100Ω	600	900		kΩ
I_{CC}	Supply current per operator	T_{amb}		4	5	mA
		$T_{min} < T_{amb} < T_{max}$		4.1		mA
CMR	Common mode rejection ratio ($\Delta V_{ic}/\Delta V_{io}$)		58	63		dB
SVR	Supply voltage rejection ratio ($\Delta V_{CC}/\Delta V_{io}$)		72	80		dB
PSR	Power supply rejection ratio ($\Delta V_{CC}/\Delta V_{out}$)	Gain=1, R_{load}=3.9kΩ		49		dB
Dynamic performance and output characteristics						
V_{oh}	High level output voltage	T_{amb} R_L = 100Ω	4.5	4.7		V
		$T_{min} < T_{amb} < T_{max}$ R_L = 100Ω		4.6		V
V_{ol}	Low level output voltage	T_{amb} R_L = 100Ω		-4.7	-4.3	V
		$T_{min} < T_{amb} < T_{max}$ R_L = 100Ω		-4.6		V
$\lvert I_{sink} \rvert$	Output sink current	$T_{min} < T_{amb} < T_{max}$		47		mA
I_{source}	Output source current	$T_{min} < T_{amb} < T_{max}$		46		mA
Bw	-3dB bandwidth	V_{out}=1V_{pk}, R_{fb}(1)=680Ω//2pF Load=100Ω				
		A_{VCL}=+2		100		MHz
SR	Slew rate	A_{VCL}=+2, 6V step Load=100Ω	240	450		V/µs
T_r	Rise time	for 200mV step A_{VCL}=+2, R_{fb}(1)=680Ω//2pF Load=100Ω		10.4		ns
T_f	Fall time			12.2		ns
Ov	Overshoot			17		%
St	Settling time @ 0.05%			40		ns

Table 4. Dual supply voltage, V_{CC}=±6V, R_{fb}(1)= 680Ω, T_{amb} = 25°C (unless otherwise specified)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
ΔG	Differential gain	A_{VCL}=+2, R_L=100Ω F=4.5MHz, V_{out}=2V_{peak}		0.05		%
Δϕ	Differential phase			0.05		°
Noise and harmonic performance						
en	Equivalent input voltage noise	Frequency : 1MHz		3		nV/√Hz
in	Equivalent input current noise			8.6		pA/√Hz
THD	Total harmonic distortion	A_{VCL}=+2, F=2MHz R_L=100Ω V_{out}=4V_{pp}		67.7		dB
IM3	Third order inter modulation product	A_{VCL}=+2, V_{out}=4V_{pp} R_L=100Ω F1=1MHz, F2=1.1MHz				dBc
		@900kHz		82		
		@1.2MHz		84		
		@3.1MHz		77		
		@3.2MHz		73		
Matching characteristics						
Gf	Gain flatness	F=(DC) to 6MHz A_{VCL}=+2, V_{out}=4V_{pp}		0.1		dB
Vo1/Vo2	Channel separation	F=1MHz to 10MHz		65		dB

1. R_{fb} is the feedback resistance between the output and the inverting input of the amplifier.

3 Standby mode

Table 5. T_{amb} = 25°C (unless otherwise specified), V_{CC}=±6V

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{low}	Standby low level		V_{CC}^-		(V_{CC}^- +0.8)	V
V_{high}	Standby high level		(V_{CC}^- +2)		(V_{CC}^+)	V
$I_{CC-STBY}$	Current consumption per operator in Standby mode			26	40	µA
I_{sol}	Input/output isolation	F=1MHz		-90		dB
Z_{out}	Output impedance (R_{out} // C_{out})	R_{out} C_{out}		31 25		MΩ pF
T_{on}	Time from Standby mode to active mode			2		µs
T_{off}	Time from active mode to Standby mode	Down to $I_{CC-STBY}$=40µA		13		µs

Table 6. TSH111 standby control pin status

TSH111 standby control pin 8 ($\overline{SBY}$)	Operator status
V_{low}	Standby
V_{high}	Active

Table 7. TSH113 standby control pin status

TSH113 standby control			Operator status		
pin 1 ($\overline{SBY}$ OP1)	**pin 2** ($\overline{SBY}$ OP2)	**pin 3** ($\overline{SBY}$ OP)	OP1	OP1	OP3
V_{low}	x	x	Standby	x	x
V_{high}	x	x	Active	x	x
x	V_{low}	x	x	Standby	x
x	V_{high}		x	Active	x
x	x	V_{low}	x	x	Standby
x	x	V_{high}	x	x	Active

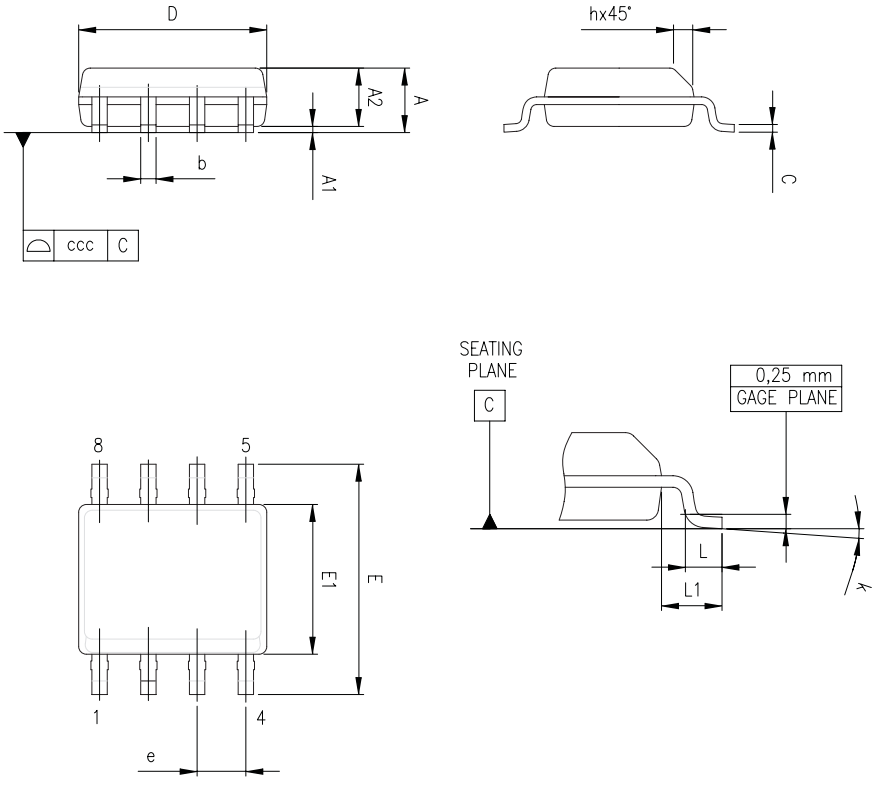
4 Package information

In order to meet environmental requirements, STMicroelectronics offers these devices in ECOPACK® packages. These packages have a lead-free second level interconnect. The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an STMicroelectronics trademark. ECOPACK specifications are available at: www.st.com.

4.1 SO-8 package mechanical data

Figure 1. SO-8 package mechanical data

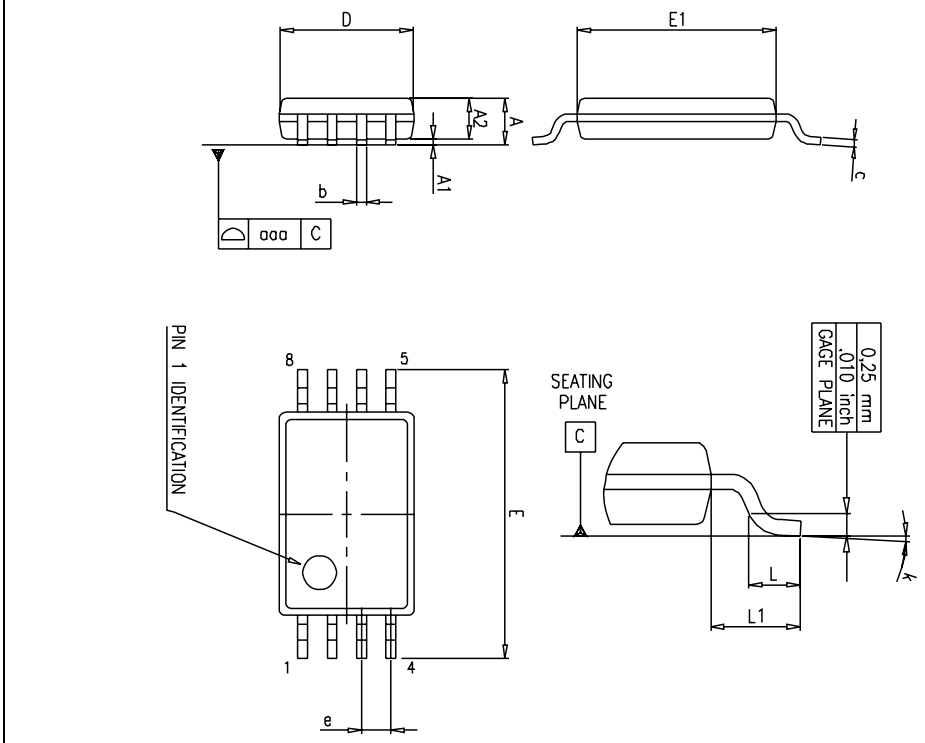
Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
A1	0.10		0.25	0.004		0.010
A2	1.25			0.049		
b	0.28		0.48	0.011		0.019
c	0.17		0.23	0.007		0.010
D	4.80	4.90	5.00	0.189	0.193	0.197
H	5.80	6.00	6.20	0.228	0.236	0.244
E1	3.80	3.90	4.00	0.150	0.154	0.157
e		1.27			0.050	
h	0.25		0.50	0.010		0.020
L	0.40		1.27	0.016		0.050
k	1°		8°	1°		8°
ccc			0.10			0.004



4.2 TSSOP8 package mechanical data

Figure 2. TSSOP8 package mechanical data

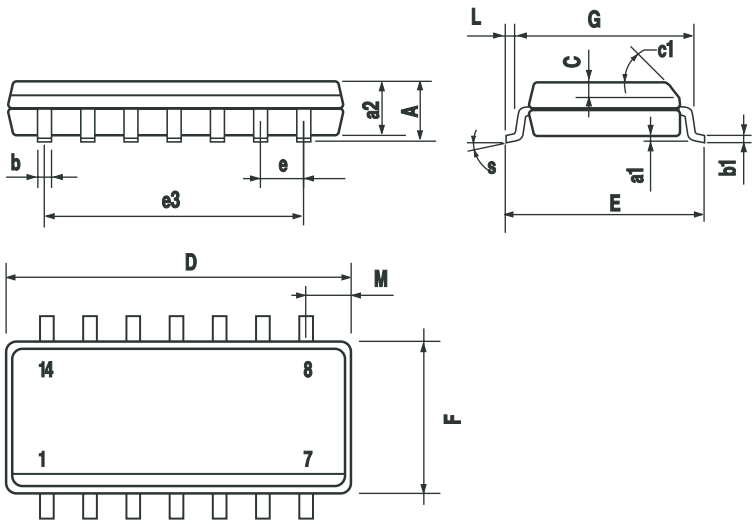
Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.2			0.047
A1	0.05		0.15	0.002		0.006
A2	0.80	1.00	1.05	0.031	0.039	0.041
b	0.19		0.30	0.007		0.012
c	0.09		0.20	0.004		0.008
D	2.90	3.00	3.10	0.114	0.118	0.122
E	6.20	6.40	6.60	0.244	0.252	0.260
E1	4.30	4.40	4.50	0.169	0.173	0.177
e		0.65			0.0256	
k	0°		8°	0°		8°
L	0.45	0.60	0.75	0.018	0.024	0.030
L1		1			0.039	
aaa		0.1			0.004	



4.3 SO-14 package mechanical data

Figure 3. SO-14 package mechanical data

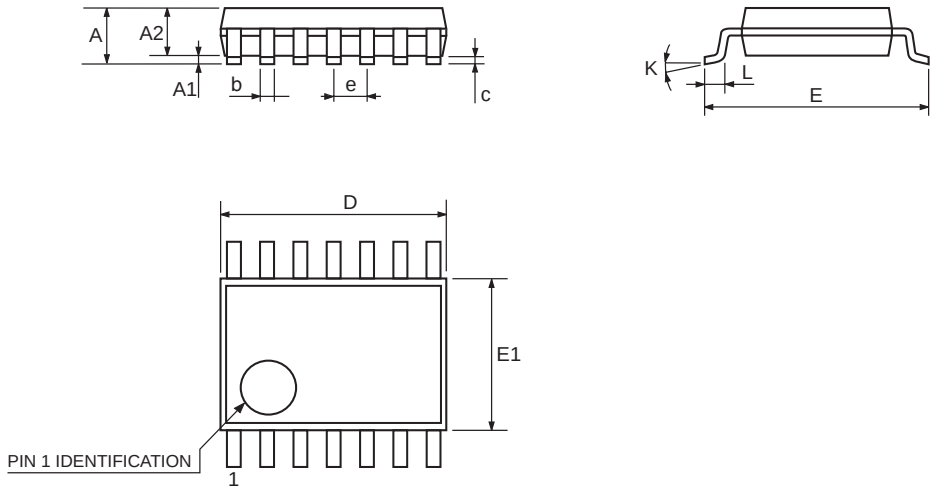
Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.068
a1	0.1		0.2	0.003		0.007
a2			1.65			0.064
b	0.35		0.46	0.013		0.018
b1	0.19		0.25	0.007		0.010
C		0.5			0.019	
c1	45° (typ.)					
D	8.55		8.75	0.336		0.344
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		7.62			0.300	
F	3.8		4.0	0.149		0.157
G	4.6		5.3	0.181		0.208
L	0.5		1.27	0.019		0.050
M			0.68			0.026
S	8° (max.)					



4.4 TSSOP14 package mechanical data

Figure 4. TSSOP14 package mechanical data

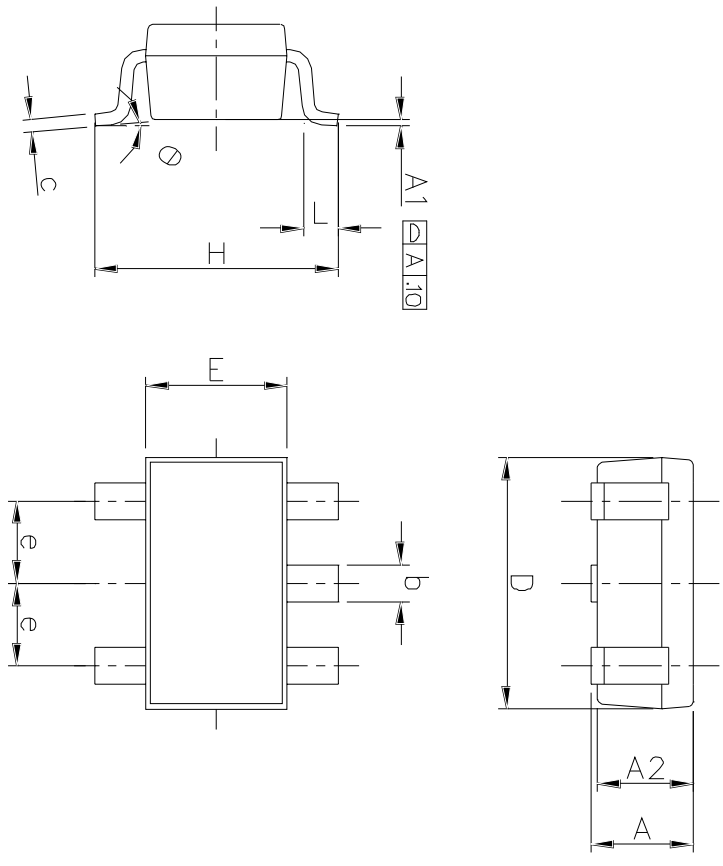
Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.2			0.047
A1	0.05		0.15	0.002	0.004	0.006
A2	0.8	1	1.05	0.031	0.039	0.041
b	0.19		0.30	0.007		0.012
c	0.09		0.20	0.004		0.0089
D	4.9	5	5.1	0.193	0.197	0.201
E	6.2	6.4	6.6	0.244	0.252	0.260
E1	4.3	4.4	4.48	0.169	0.173	0.176
e		0.65 BSC			0.0256 BSC	
K	0°		8°	0°		8°
L	0.45	0.60	0.75	0.018	0.024	0.030



4.5 SOT23-5 package mechanical data

Figure 5. SOT23-5 package (Inches)

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	0.90		1.45	0.035		0.057
A1	0.00		0.15	0.00		0.006
A2	0.90		1.30	0.035		0.051
b	0.35		0.50	0.014		0.02
C	0.09		0.20	0.003		0.008
D	2.80		3.00	0.110		0.118
H	2.60		3.00	0.102		0.118
E	1.50		1.75	0.059		0.069
e		0.95			0.037	
e1		1.9			0.075	
L	0.35		0.55	0.014		0.022



5 Ordering information

Table 8. Order codes

Part number	Temperature range	Package	Packing	Marking
TSH110ILT	-40°C to +85°C	SOT23-5	Tape & reel	K302
TSH110IYLT(1)		SOT23-5 (Automotive grade level)	Tape & reel	K309
TSH111ID TSH111IDT		SO-8	Tube or Tape & reel	H111I
TSH111IPT		TSSOP8 (Thin shrink outline package)	Tape & reel	H111I
TSH112ID TSH112IDT		SO-8	Tube or Tape & reel	H112I
TSH112IPT		TSSOP8 (Thin shrink outline package)	Tape & reel	H112I
TSH113ID TSH113IDT		SO-14	Tube or Tape & reel	TSH113I
TSH113IPT		TSSOP14	Tape & reel	TSH113I
TSH114ID TSH114IDT		SO-14	Tube or Tape & reel	TSH114I
TSH114IPT		TSSOP14	Tape & reel	TSH114I

1. Qualification and characterization according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 & Q 002 or equivalent are on-going.

6 Revision history

Table 9. Document revision history

Date	Revision	Changes
4-Oct-2001	1	Initial release.
22-Oct-2007	2	Added TSH110ILT/TSH110IYLT order codes to *Table 8: Order codes*. Document reformatted.

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