TSV85x, TSV85xA

Low-power, high accuracy, general-purpose operational amplifier

Datasheet — production data

Features

- Low power consumption: 180 µA max at 5 V
- Low power shutdown mode: 50 nA max
- Low offset voltage: 0.8 mV max at 25°C
- Tiny packages
- Extended temperature range: -40°C to +125°C
- Low supply voltage: 2.3 V - 5.5 V
- Gain bandwidth product: 1.3 MHz
- Automotive qualification

Benefits

- Longer lifetime in battery-powered applications
- Higher accuracy without calibration
- Smaller form factor than equivalent competitor devices
- Application performances guaranteed over wide temperature ranges

Related products

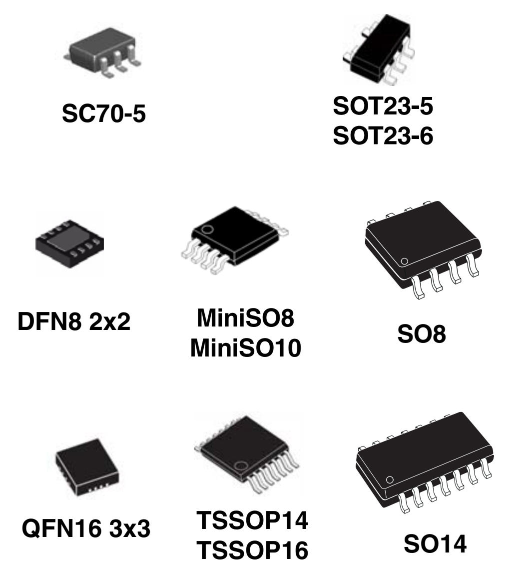
- See LMV82x series for higher gain bandwidth product (5.5 MHz)

Applications

- Battery-powered applications
- Portable devices
- Automotive signal conditioning
- Active filtering
- Medical instrumentation

Description

The TSV85x series of single, dual and quad operational amplifiers offers low voltage operation with a rail-to-rail output swing. The TSV85x series outperforms the industry standard LMV321, proposing lower supply voltage capability,



enhanced input offset voltage and smaller packages.

The devices are offered with either industry standard pinouts or with a power-saving shutdown feature that reduces the supply current to a maximum of 50 nA at 25°C.

The wide temperature range, high ESD tolerance and automotive grade qualification ease the use in harsh automotive applications.

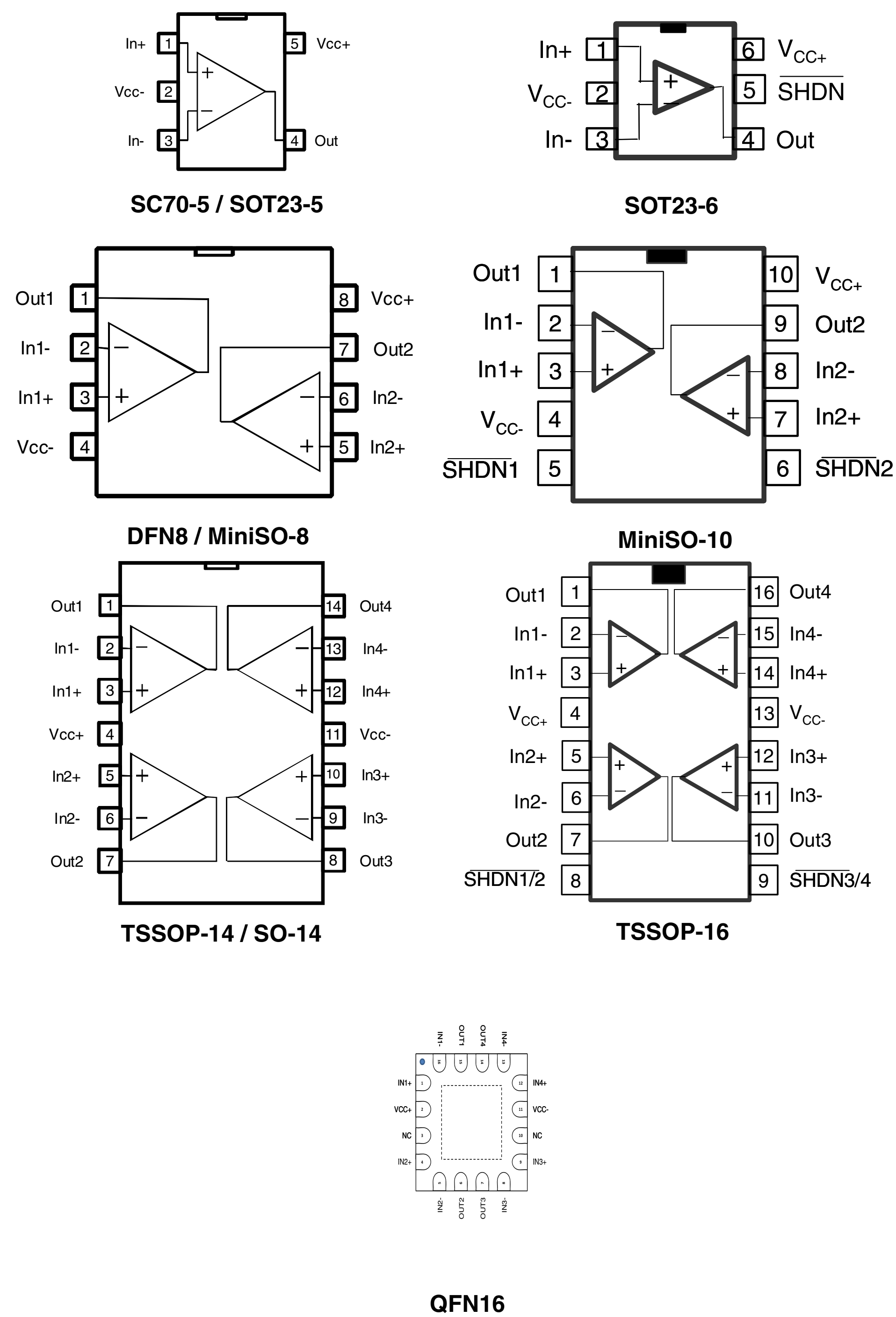
Table 1. Device summary

	Without shutdown feature		With shutdown feature	
	Standard Vio	Enhanced Vio	Standard Vio	Enhanced Vio
Single	TSV851	TSV851A	TSV850	TSV850A
Dual	TSV852	TSV852A	TSV853	TSV853A
Quad	TSV854	TSV854A	TSV855	TSV855A

Contents

1 Package pin connections

Figure 1. Pin connections for each package (top view)



2 Absolute maximum ratings and operating conditions

Table 2. Absolute maximum ratings (AMR)

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage[(1)]	6	V
V_{id}	Differential input voltage [(2)]	$\pm V_{CC}$	V
V_{in}	Input pins (IN+ and IN- pins) voltage [(3)]	V_{cc-} - 0.3 to V_{cc+}+ 0.3	V
I_{in}	Input current [(4)]	10	mA
$\overline{SHDN}$	Shutdown voltage[(5)]	V_{CC-} - 0.2 to V_{CC+}+ 0.2	V
T_{stg}	Storage temperature	-65 to +150	°C
R_{thja}	Thermal resistance junction to ambient[(6)(7)]		°C/W
	SC70-5	205	
	SOT23-5	250	
	DFN8 2x2	57	
	MiniSO8	190	
	SO8	125	
	TSSOP14	100	
	SO14	105	
	SOT23-6	240	
	MiniSO10	113	
	TSSOP16	95	
	QFN16 3x3	45	
T_j	Maximum junction temperature	150	°C
ESD	HBM: human body model (except shutdown pin)[(8)]	4	kV
	HBM: human body model (shutdown pin)[(8)]	3.5	kV
	MM: machine model[(9)]	250	V
	CDM: charged device model[(10)]	1.3	kV
	CDM: charged device model TSV855[(10)]	1	kV
	Latch-up immunity	200	mA

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 input terminal.
3. V_{CC}-V_{in} must not exceed 6 V, V_{in} must not exceed 6 V.
4. Input current must be limited by a resistor in series with the inputs.
5. V_{CC}-V_{shdn} must not exceed 6 V, V_{in} must not exceed 6 V.
6. Short-circuits can cause excessive heating and destructive dissipation.
7. R_{th} are typical values.
8. Human body model: 100 pF discharged through a 1.5 kΩ resistor between two pins of the device, done for all couples of pin combinations with other pins floating.
9. Machine model: a 200 pF cap is charged to the specified voltage, then discharged directly between two pins of the device with no external series resistor (internal resistor < 5 Ω), done for all couples of pin combinations with other pins floating.
10. Charged device model: all pins plus package are charged together to the specified voltage and then discharged directly to the ground.

Table 3. Operating conditions

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage	2.3 to 5.5	V
V_{icm}	Common mode input voltage range	V_{CC-} - 0.2 to V_{CC+} - 1	V
T_{oper}	Operating free air temperature range	-40 to +125	°C

3 Electrical characteristics

Table 4. Electrical characteristics at V_{CC+} = 2.7 V with V_{CC-} = 0 V, V_{icm} = V_{CC}/2, T_{amb} = 25° C, and R_L connected to V_{CC}/2 (unless otherwise specified)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
DC performance						
V_{io}	Input offset voltage	TSV85xA, T=25°C			0.8	mV
		TSV85x, T=25°C			4	
		TSV85xA, -40°C < T< 125°C			2	
		TSV85x, -40°C < T< 125°C			6	
$\Delta V_{io}/\Delta T$	Input offset voltage drift(1)	-40°C < T< 125°C		1		µV/°C
I_{io}	Input offset current (V_{out} = V_{cc}/2)	T=25°C		0.5	30	nA
		-40°C < T< 125°C		1	50	
I_{ib}	Input bias current (V_{out} = V_{cc}/2)	T=25°C		27	60	nA
		-40°C < T< 125°C			110	
CMR	Common mode rejection ratio 20 log ($\Delta V_{icm}/\Delta V_{io}$) ($V_{ic}$ = 0 V to V_{cc}-1V, V_{out} = V_{cc}/2)	T=25°C	70	75		dB
		-40°C < T< 125°C	68			
A_{vd}	Large signal voltage gain (V_{out} = 0.5V to (V_{cc}-0.5V))	R_L= 10 kΩ, T=25°C	100	110		dB
		R_L= 10 kΩ, -40°C < T< 125°C	90			
		R_L= 2 kΩ, T=25°C	90	100		
		R_L= 2 kΩ, -40°C < T< 125°C	80			
V_{CC}-V_{OH}	High level output voltage	R_L = 10 kΩ, T=25°C		10	100	mV
		R_L = 10 kΩ, -40°C < T< 125°C			200	
		R_L = 2 kΩ, T=25°C		40	300	
		R_L = 2 kΩ, -40°C < T< 125°C			400	
V_{OL}	Low level output voltage	R_L = 10 kΩ, T=25°C		65	180	mV
		R_L = 10 kΩ, -40°C < T< 125°C			280	
		R_L = 2 kΩ, T=25°C		120	300	
		R_L = 2 kΩ, -40°C < T< 125°C			400	
I_{out}	I_{sink} (V_{out} = V_{cc}) V_{id} = -1 V	T=25°C	15	26		mA
		-40°C < T< 125°C	15			
	I_{source} (V_{out} = 0 V) Vid = 1 V	T = 25°C	15	21		mA
		-40°C < T< 125°C	12			
I_{CC}	Supply current (per channel) No load, V_{out} = V_{CC}/2	T = 25°C		120	180	µA
		-40°C < T< 125°C			180	

Table 4. Electrical characteristics at V_{CC+} = 2.7 V with V_{CC-} = 0 V, V_{icm} = V_{CC}/2, T_{amb} = 25° C, and R_L connected to V_{CC}/2 (unless otherwise specified) (continued)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
AC performance						
GBP	Gain bandwidth product	R_L > 1 MΩ, C_L = 200 pF		1.3		MHz
F_u	Unity gain frequency	R_L > 1 MΩ, C_L = 200 pF		1		MHz
Φ_m	Phase margin	R_L > 1 MΩ, C_L = 200 pF		60		degrees
G_m	Gain margin	R_L > 1 MΩ, C_L = 200 pF		10		dB
SR	Slew rate	R_L > 1 MΩ, C_L = 200 pF V_{out} = 0.5 V to V_{CC} - 0.5V		0.6		V/μs
e_n	Equivalent input noise voltage	f = 1 kHz f = 10 kHz		31 20		$\frac{nV}{\sqrt{Hz}}$
i_n	Equivalent input noise current	f = 1 kHz		0.30		$\frac{pA}{\sqrt{Hz}}$
THD+N	Total harmonic distortion + noise	f_{in} = 1 kHz, A_{CL} = 1, R_L = 10 kΩ, Vicm = Vcc/2, BW = 22 kHz, Vout = 1 Vpp		0.002		%

Table 5. Shutdown characteristics V_{CC} = 2.7 V

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
DC performance						
I_{CC}	Supply current in shutdown mode (all operators)	$\overline{SHDN}$ = V_{CC-}		2.5	50	nA
		-40°C < T< 85°C			200	nA
		-40°C < T< 125°C			1.5	µA
t_{on}	Amplifier turn-on time(1)	R_L = 2 kΩ, V_{out} = V_{CC-} to V_{CC-} + 0.2 V		300		ns
t_{off}	Amplifier turn-off time(1)	R_L = 2 kΩ, Vout = V_{CC+} - 1 V to V_{CC+} - 1.2 V		20		ns
V_{IH}	$\overline{SHDN}$ logic high		V_{CC-} 0.5			V
V_{IL}	$\overline{SHDN}$ logic low				0.5	V
I_{IH}	$\overline{SHDN}$ current high	$\overline{SHDN}$ = V_{CC+}		10		pA
I_{IL}	$\overline{SHDN}$ current low	$\overline{SHDN}$ = V_{CC-}		10		pA
I_{OLeak}	Output leakage in shutdown mode	$\overline{SHDN}$ = V_{CC-}		50		pA
		-40°C < T< 125°C		1		nA

1. See *Section 4.7: Shutdown function on page 15*.

Table 6. Electrical characteristics at V_{CC+} = 5 V with V_{CC-} = 0 V, V_{icm} = $V_{CC}/2$, T_{amb} = 25° C, and R_L connected to $V_{CC}/2$ (unless otherwise specified)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
DC performance						
V_{io}	Input offset voltage	TSV85xA, T = 25°C			0.8	mV
		TSV85x, T = 25°C			4	
		TSV85xA, -40°C < T< 125°C			2	
		TSV85x, -40°C < T< 125°C			6	
$\Delta V_{io}/\Delta T$	Input offset voltage drift[1]	-40°C < T< 125°C		1		µV/°C
I_{io}	Input offset current ($V_{out} = V_{cc}/2$)	T = 25°C		0.5	30	nA
		-40°C < T< 125°C		1	50	
I_{ib}	Input bias current ($V_{out} = V_{cc}/2$)	T = 25°C		27	60	nA
		-40°C < T< 125°C			110	
CMR	Common mode rejection ratio 20 log ($\Delta V_{icm}/\Delta V_{io}$) (Vic = 0 V to V_{cc}-1V, $V_{out} = V_{cc}/2$)	T = 25°C	72	75		dB
		-40°C < T< 125°C	70			
SVR	Supply voltage rejection ratio: 20 log ($\Delta V_{cc}/\Delta V_{io}$) V_{cc} = 2.5 to 5 V	T = 25°C	72	79		dB
		-40°C < T< 125°C	70			
A_{vd}	Large signal voltage gain (V_{out} = 0.5V to (V_{CC}-0.5V))	R_L= 10 kΩ, T = 25°C	100	110		dB
		R_L= 10 kΩ, -40°C < T< 125°C	90			
		R_L= 2 kΩ, T=25°C	90	100		
		R_L= 2 kΩ, -40°C < T< 125°C	80			
$V_{CC}-V_{OH}$	High level output voltage	R_L = 10 kΩ, T=25°C		10	100	mV
		R_L = 10 kΩ, -40°C < T< 125°C			200	
		R_L = 2 kΩ, T=25°C		40	300	
		R_L = 2 kΩ, -40°C < T< 125°C			400	
V_{OL}	Low level output voltage	R_L = 10 kΩ, T = 25°C		65	180	mV
		R_L = 10 kΩ, -40°C < T< 125°C			280	
		R_L = 2 kΩ, T=25°C		120	300	
		R_L = 2 kΩ, -40°C < T< 125°C			400	
I_{out}	I_{sink} ($V_{out} = V_{CC}$) V_{id} = -1 V	T=25°C	35	43		mA
		-40°C < T< 125°C	25			
	I_{source} (V_{out} = 0 V) V_{id} = 1 V	T=25°C	60	70		mA
		-40°C < T< 125°C	50			
I_{CC}	Supply current (per channel) No load, $V_{out} = V_{CC}/2$	T = 25°C		130	180	µA
		-40°C < T< 125°C			180	

Table 6. Electrical characteristics at V_{CC+} = 5 V with V_{CC-} = 0 V, V_{icm} = V_{CC}/2, T_{amb} = 25° C, and R_L connected to V_{CC}/2 (unless otherwise specified) (continued)

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
AC performance						
GBP	Gain bandwidth product	R_L > 1 MΩ, C_L = 200 pF		1.3		MHz
F_u	Unity gain frequency	R_L > 1 MΩ, C_L = 200 pF		1		MHz
Φ_m	Phase margin	R_L > 1 MΩ, C_L = 200 pF		60		degrees
G_m	Gain margin	R_L > 1 MΩ, C_L = 200 pF		10		dB
SR	Slew rate	R_L > 1 MΩ, C_L = 200 pF V_{out} = 0.5 V to V_{CC} - 0.5V		0.7		V/μs
e_n	Equivalent input noise voltage	f = 1 kHz f = 10 kHz		30 20		$\frac{nV}{\sqrt{Hz}}$
i_n	Equivalent input noise current	f = 1 kHz		0.30		$\frac{pA}{\sqrt{Hz}}$
THD+N	Total harmonic distortion + noise	f_{in} = 1 kHz, A_{CL} = 1, R_L = 10 kΩ, Vicm = Vcc/2, BW = 22 kHz, Vout = 1 Vpp		0.002		%

1. See *Chapter 4.4: Input offset voltage drift over temperature*.

Table 7. Shutdown characteristics V_{CC} = 5 V

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
DC performance						
I_{CC}	Supply current in shutdown mode (per channel)	$\overline{SHDN}$ = V_{CC-}		2.5	50	nA
		-40°C < T< 85°C			200	nA
		-40°C < T< 125°C			1.5	µA
t_{on}	Amplifier turn-on time(1)	R_L = 2 kΩ, V_{out} = V_{CC-} to V_{CC-} + 0.2 V		300		ns
t_{off}	Amplifier turn-off time(1)	R_L = 2 kΩ, Vout = V_{CC+} - 1 V to V_{CC+} - 1.2 V		20		ns
V_{IH}	$\overline{SHDN}$ logic high		V_{CC}-0.5			V
V_{IL}	$\overline{SHDN}$ logic low				0.5	V
I_{IH}	$\overline{SHDN}$ current high	$\overline{SHDN}$ = V_{CC+}		10		pA
I_{IL}	$\overline{SHDN}$ current low	$\overline{SHDN}$ = V_{CC-}		10		pA
I_{OLeak}	Output leakage in shutdown mode	$\overline{SHDN}$ = V_{CC-}		50		pA
		-40°C < T< 125°C		1		nA

1. See *Section 4.7: Shutdown function on page 15*.

Figure 2. Supply current vs. supply voltage at $V_{icm} = V_{CC}/2$

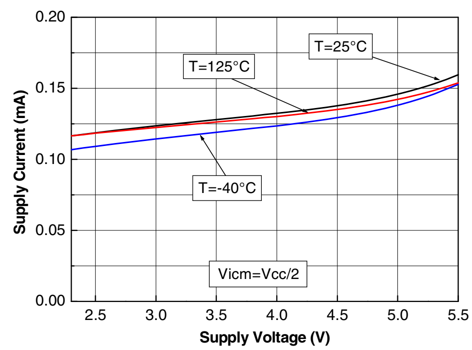


Figure 3. Vio distribution at V_{CC} = 5 V

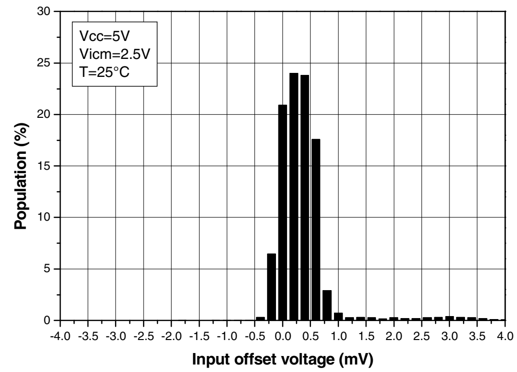


Figure 4. Input offset voltage vs. input common mode voltage at V_{CC} = 5 V

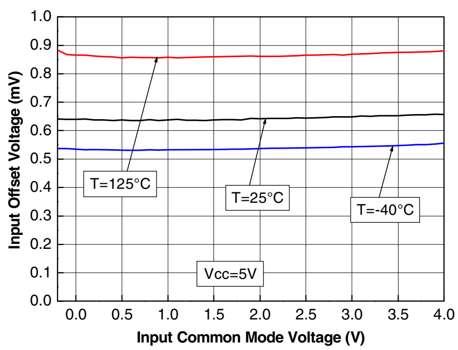


Figure 5. Output current vs. output voltage at V_{CC} = 2.7 V

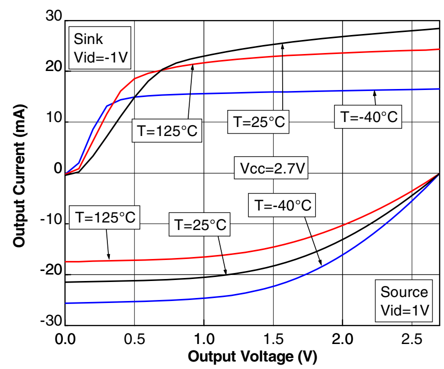


Figure 6. Output current vs. output voltage at V_{CC} = 5 V

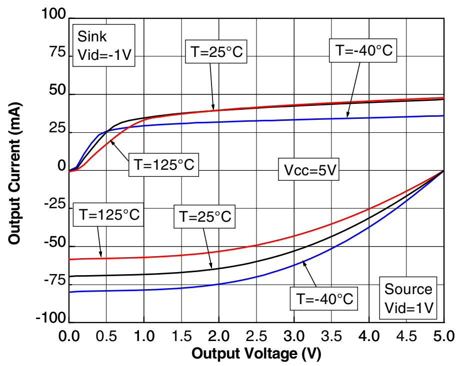


Figure 7. Output current vs. supply voltage at $V_{icm} = V_{CC}/2$

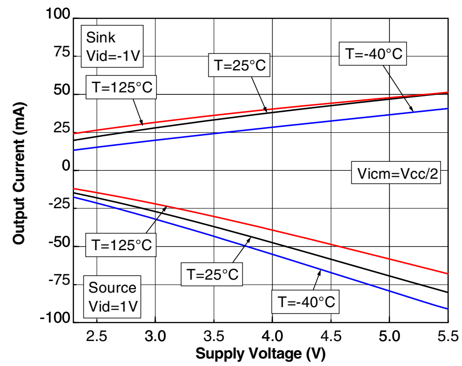


Figure 8. Voltage gain and phase with Cl = 100 pF

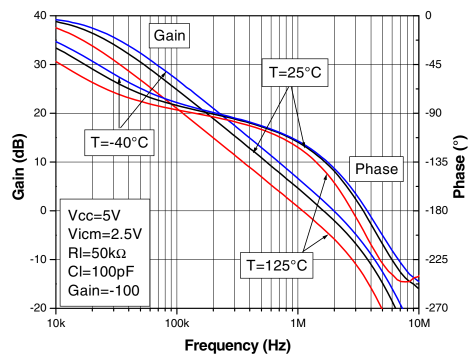


Figure 9. Voltage gain and phase with Cl = 200 pF

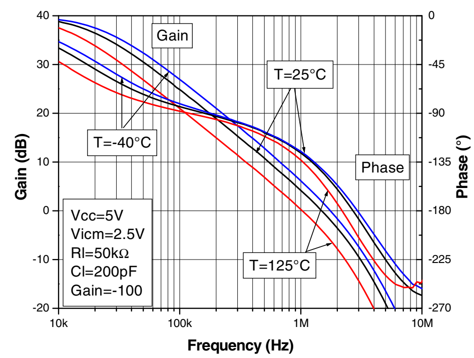


Figure 10. Gain margin vs. load capacitor at V_{CC} = 5 V

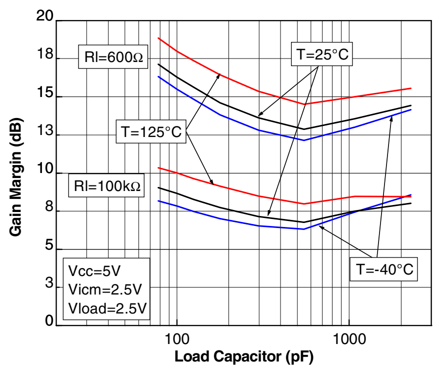


Figure 11. Phase margin vs. load capacitor at V_{CC} = 5 V

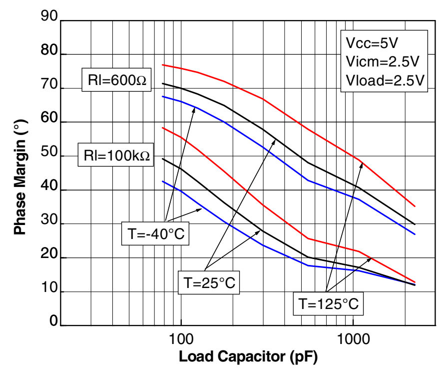


Figure 12. Closed-loop gain in voltage follower configuration for different capacitive loads

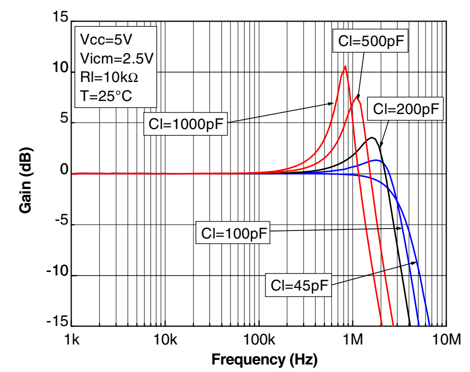


Figure 13. Phase margin vs. output current at V_{CC} = 5 V

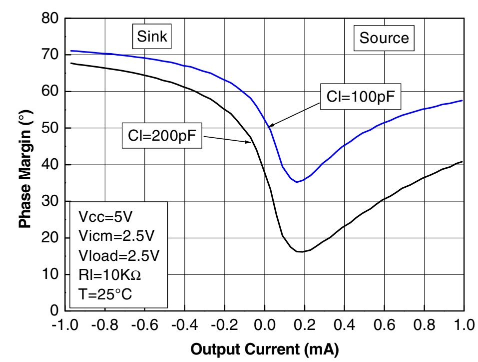


Figure 14. Positive and negative slew rate vs. supply voltage

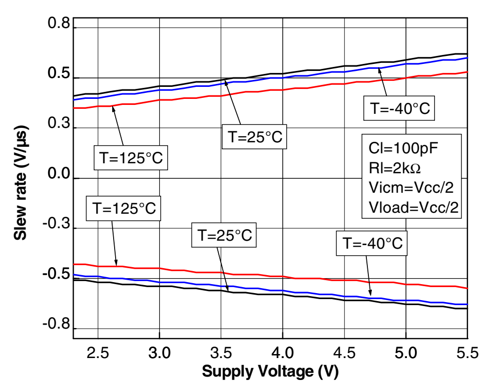


Figure 15. Positive slew rate at V_{CC} = 5 V with Cl = 100 pF

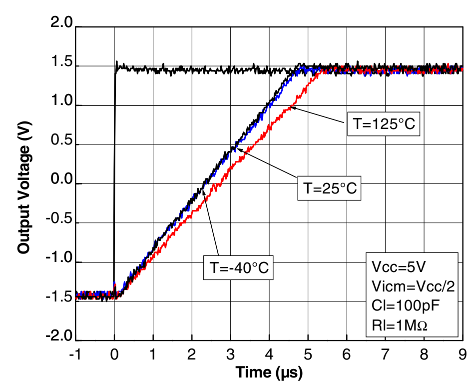


Figure 16. Negative slew rate at V_{CC} = 5 V with Cl = 100 pF

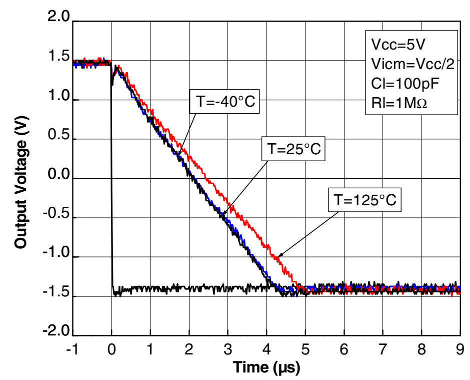


Figure 17. Noise vs. frequency

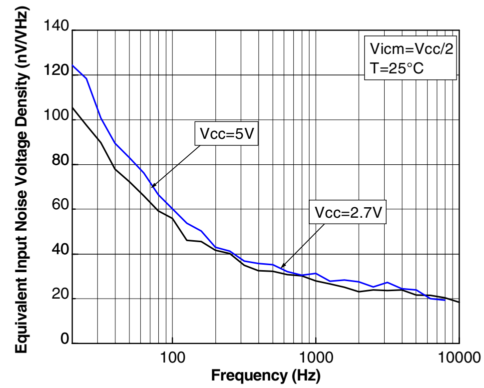


Figure 18. 0.1 Hz to 10 Hz noise at V_{CC} = 5 V

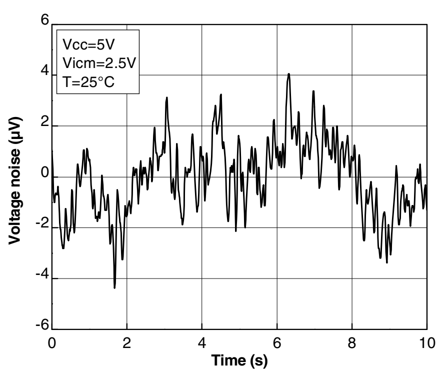


Figure 19. Distortion + noise vs. frequency

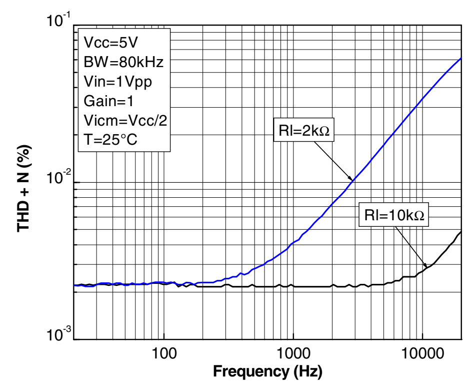
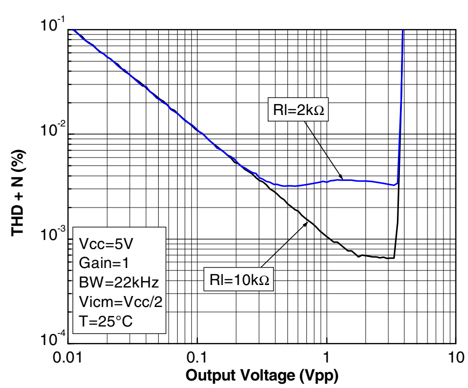


Figure 20. Distortion + noise vs. output voltage



4 Application information

4.1 Operating voltages

The TSV85x can operate from 2.3 to 5.5 V. The devices' parameters are fully specified for 2.7 and 5 V power supplies. Additionally, the main specifications are guaranteed in extended temperature ranges from -40° C to +125° C.

4.2 Input common-mode range

The TSV85x have an input common-mode range that includes ground. The input common-mode range is extended from V_{CC-} - 0.2 V to V_{CC+} - 1 V, with no output phase reversal.

4.3 Rail-to-rail output

The operational amplifiers' output levels can go close to the rails: 180 mV maximum above and below the rail when connected to a 10 kΩ resistive load to $V_{CC}/2$.

4.4 Input offset voltage drift over temperature

The maximum input voltage drift over the temperature variation is defined as follows.

$$\frac{\Delta Vio}{\Delta T} = \max\left|\frac{Vio(T) - Vio(25°C)}{T - 25°C}\right|$$

for $T_{min} < T < T_{max}$.

4.5 PCB layouts

For correct operation, it is advised to add 10 nF decoupling capacitors as close as possible to the power supply pins.

4.6 Macromodel

Accurate macromodels of the TSV85x are available on STMicroelectronics' web site at www.st.com. This model is a trade-off between accuracy and complexity (that is, time simulation) of the TSV85x operational amplifiers. It emulates the nominal performances of a typical device within the specified operating conditions mentioned in the datasheet. It also helps to validate a design approach and to select the right operational amplifier, *but it does not replace on-board measurements*.

4.7 Shutdown function

The operational amplifier is enabled when the $\overline{SHDN}$ pin is pulled high. To disable the amplifier, the $\overline{SHDN}$ pin must be pulled down to V_{CC-}. When in shutdown mode, the amplifier output is in a high impedance state. The $\overline{SHDN}$ pin must never be left floating but tied to V_{CC+} or V_{CC-}.

The turn-on and turn-off times are calculated for an output variation of ±200 mV (*Figure 21* and *Figure 22* show the test configurations).

Figure 21. Test configuration for turn-on time (Vout pulled down)

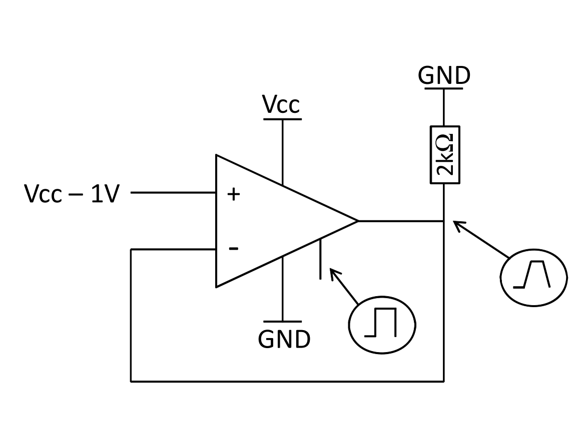


Figure 22. Test configuration for turn-off time (Vout pulled down)

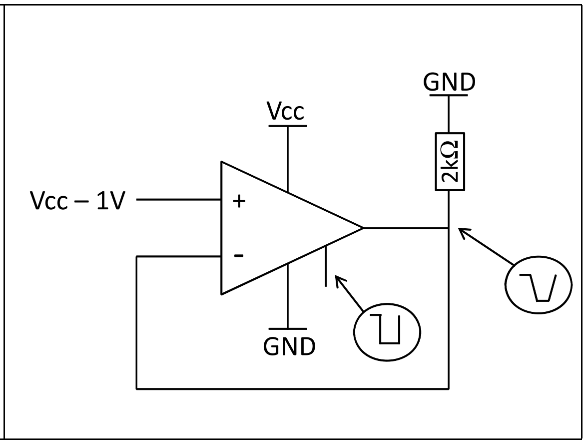


Figure 23. Turn-on time, V_{CC} = 5 V, Vout pulled down, T = 25° C

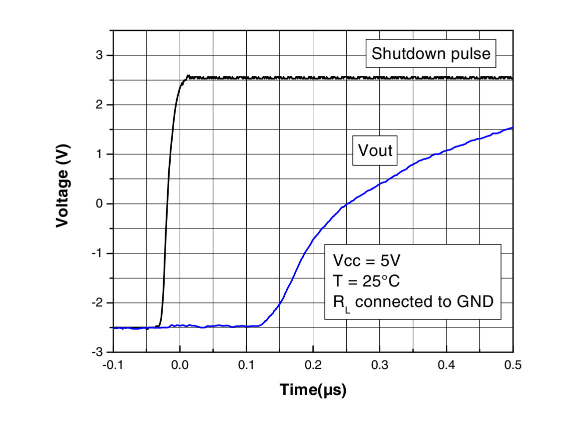
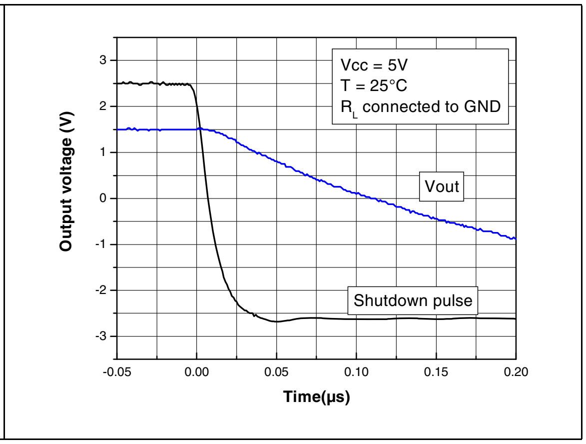


Figure 24. Turn-off time, V_{CC} = 5 V, Vout pulled down, T = 25° C



5 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: *www.st.com*. ECOPACK® is an ST trademark.

5.1 SO-8 package information

Figure 25. SO-8 package mechanical drawing

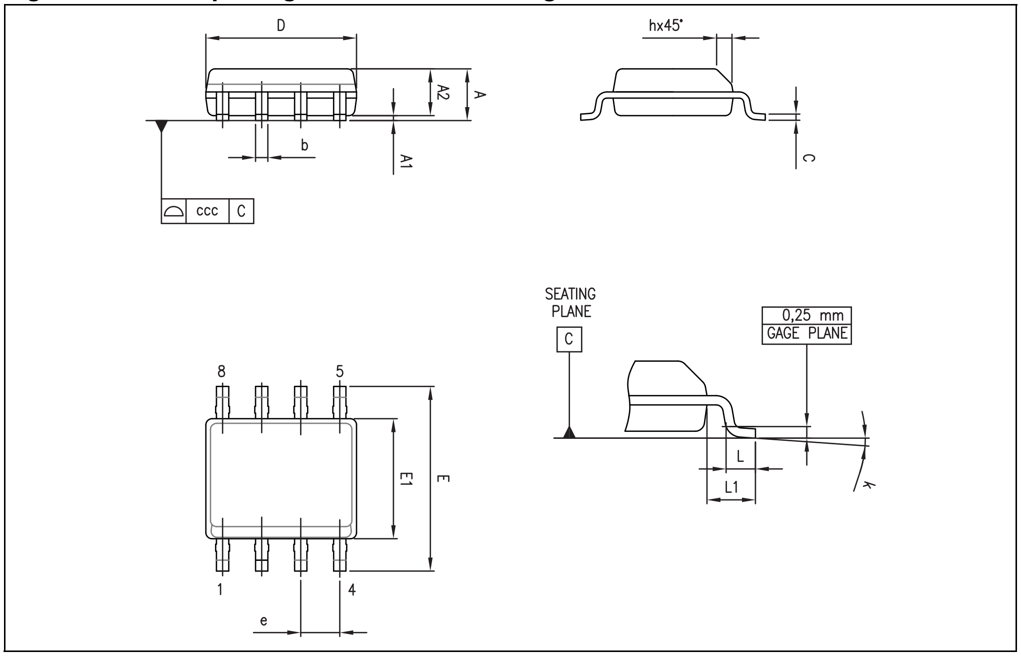


Table 8. SO-8 package mechanical data

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
E	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
L1		1.04			0.040	
k	1°		8°	1°		8°
ccc			0.10			0.004

5.2 SO-14 package information

Figure 26. SO-14 package mechanical drawing

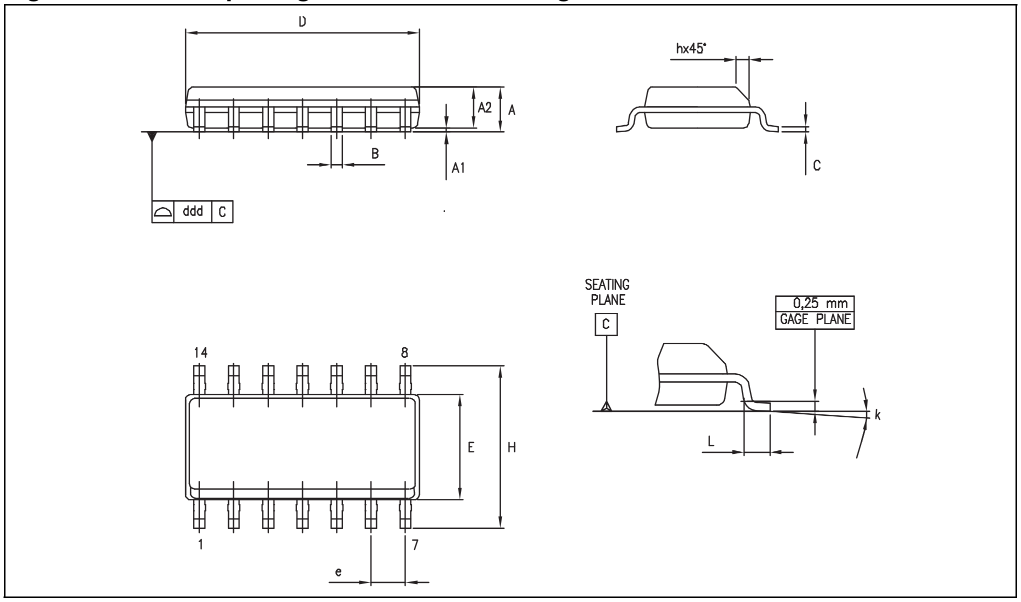


Table 9. SO-14 package mechanical data

Dimensions						
Ref.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	1.35		1.75	0.05		0.068
A1	0.10		0.25	0.004		0.009
A2	1.10		1.65	0.04		0.06
B	0.33		0.51	0.01		0.02
C	0.19		0.25	0.007		0.009
D	8.55		8.75	0.33		0.34
E	3.80		4.0	0.15		0.15
e		1.27			0.05	
H	5.80		6.20	0.22		0.24
h	0.25		0.50	0.009		0.02
L	0.40		1.27	0.015		0.05
k	8° (max.)					
ddd			0.10			0.004

5.3 TSSOP14 package information

Figure 27. TSSOP14 package mechanical drawing

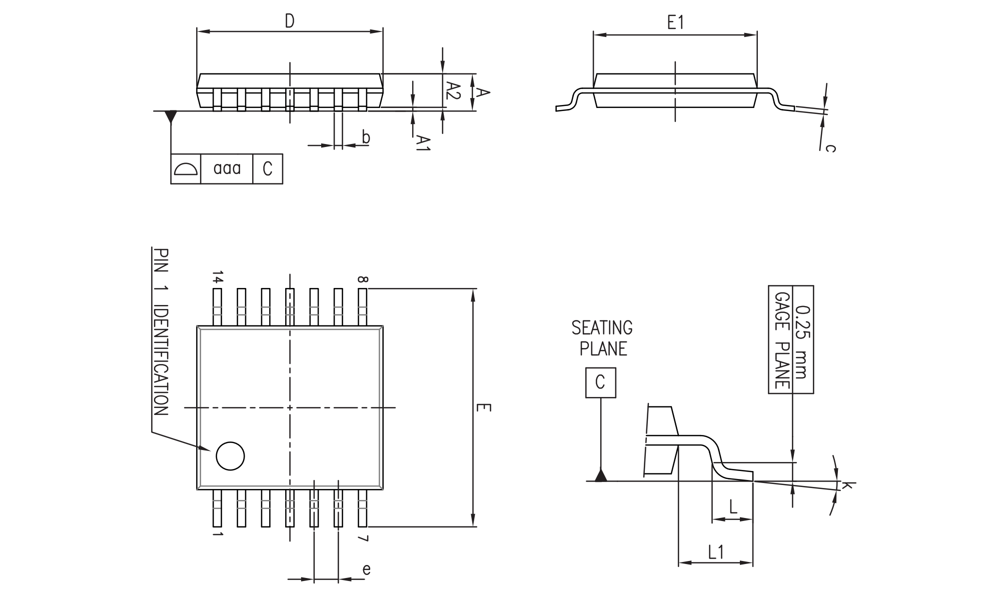


Table 10. TSSOP14 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.20			0.047
A1	0.05		0.15	0.002	0.004	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		0.0089
D	4.90	5.00	5.10	0.193	0.197	0.201
E	6.20	6.40	6.60	0.244	0.252	0.260
E1	4.30	4.40	4.50	0.169	0.173	0.176
e		0.65			0.0256	
L	0.45	0.60	0.75	0.018	0.024	0.030
L1		1.00			0.039	
k	0°		8°	0°		8°
aaa			0.10			0.004

5.4 TSSOP16 package information

Figure 28. TSSOP16 package mechanical drawing

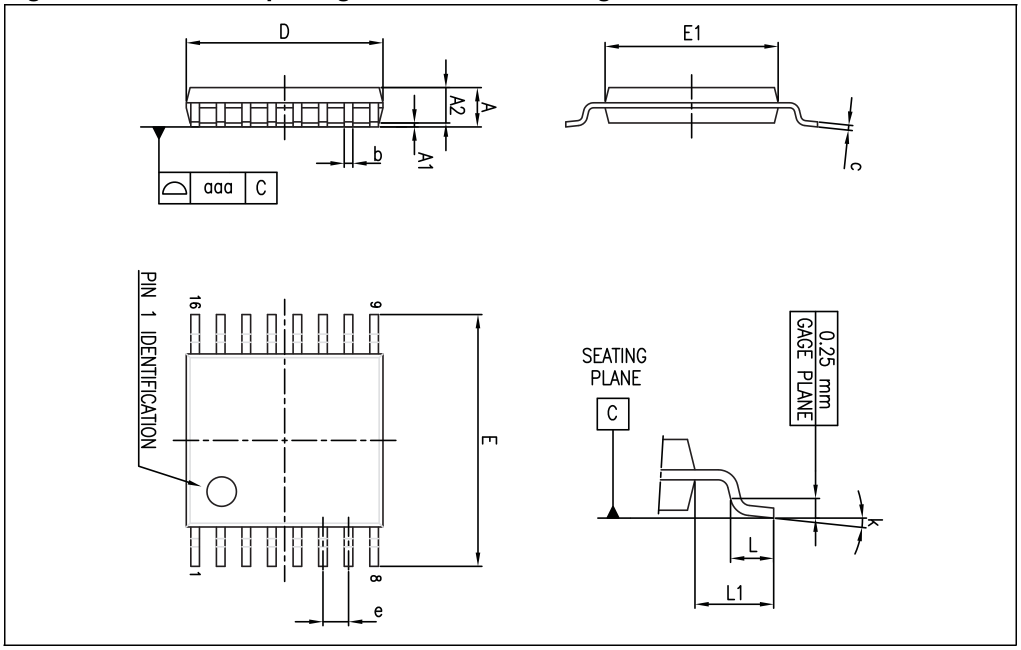


Table 11. TSSOP16 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.20			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	4.90	5.00	5.10	0.193	0.197	0.201
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		1.00			0.039	
aaa			0.10			0.004

5.5 MiniSO-8 package information

Figure 29. MiniSO-8 package mechanical drawing

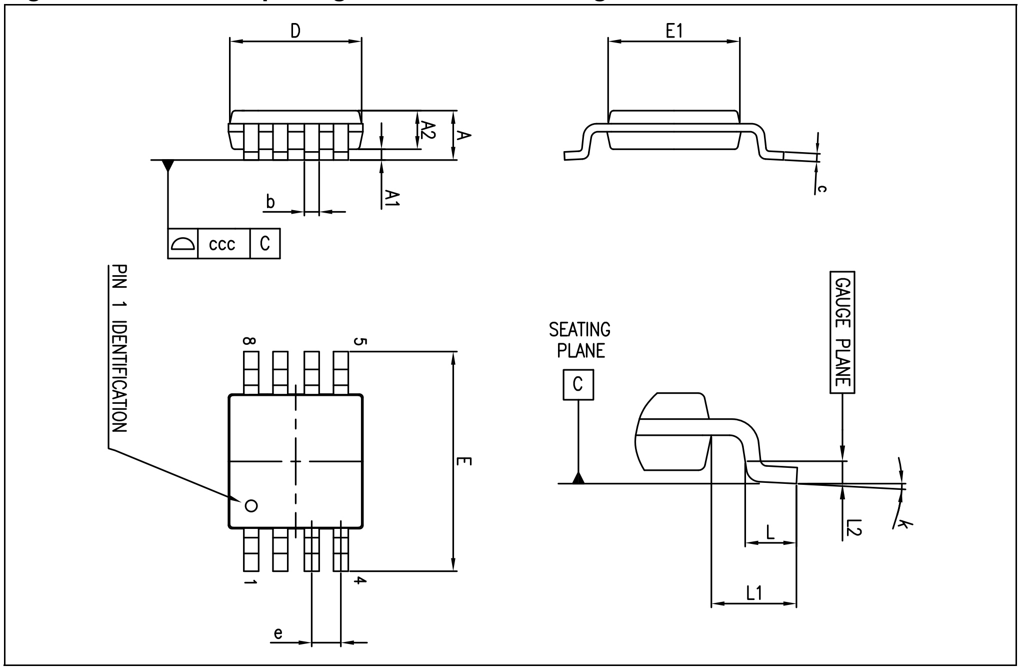


Table 12. MiniSO-8 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.1			0.043
A1	0		0.15	0		0.006
A2	0.75	0.85	0.95	0.030	0.033	0.037
b	0.22		0.40	0.009		0.016
c	0.08		0.23	0.003		0.009
D	2.80	3.00	3.20	0.11	0.118	0.126
E	4.65	4.90	5.15	0.183	0.193	0.203
E1	2.80	3.00	3.10	0.11	0.118	0.122
e		0.65			0.026	
L	0.40	0.60	0.80	0.016	0.024	0.031
L1		0.95			0.037	
L2		0.25			0.010	
k	0°		8°	0°		8°
ccc			0.10			0.004

5.6 MiniSO-10 package information

Figure 30. MiniSO-10 package mechanical drawing

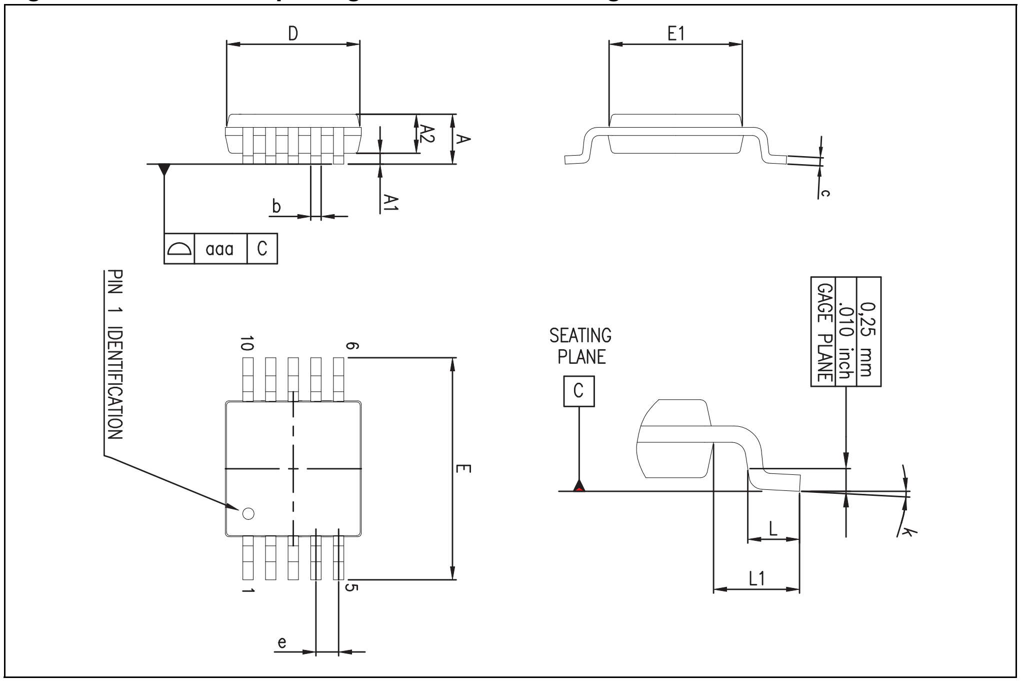


Table 13. MiniSO-10 package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.10			0.043
A1	0.05	0.10	0.15	0.002	0.004	0.006
A2	0.78	0.86	0.94	0.031	0.034	0.037
b	0.25	0.33	0.40	0.010	0.013	0.016
c	0.15	0.23	0.30	0.006	0.009	0.012
D	2.90	3.00	3.10	0.114	0.118	0.122
E	4.75	4.90	5.05	0.187	0.193	0.199
E1	2.90	3.00	3.10	0.114	0.118	0.122
e		0.50			0.020	
L	0.40	0.55	0.70	0.016	0.022	0.028
L1		0.95			0.037	
k	0°	3°	6°	0°	3°	6°
aaa			0.10			0.004

5.7 DFN8 package information

Figure 31. DFN8 2 x 2 mm package mechanical drawing (pitch 0.5 mm)

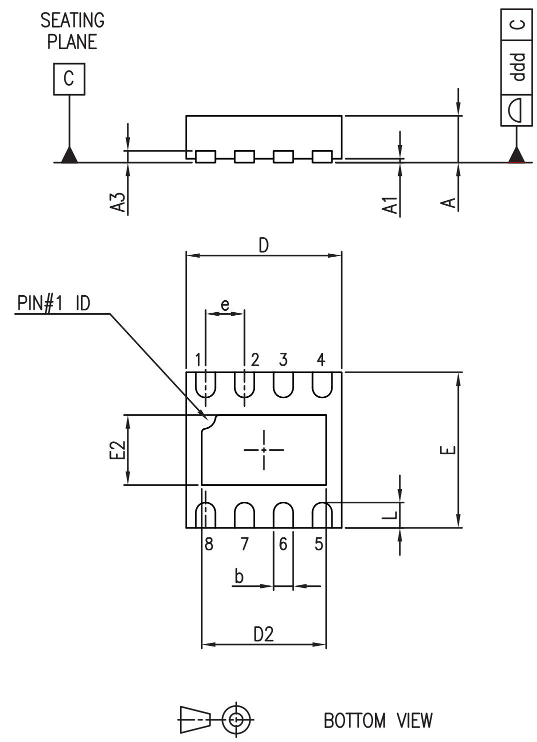


Table 14. DFN8 2 x 2 mm package mechanical data (pitch 0.5 mm)

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	0.51	0.55	0.60	0.020	0.022	0.024
A1			0.05			0.002
A3		0.15			0.006	
b	0.18	0.25	0.30	0.007	0.010	0.012
D	1.85	2.00	2.15	0.073	0.079	0.085
D2	1.45	1.60	1.70	0.057	0.063	0.067
E	1.85	2.00	2.15	0.073	0.079	0.085
E2	0.75	0.90	1.00	0.030	0.035	0.040
e		0.50			0.020	
L			0.50			0.020
ddd			0.08			0.003

5.8 QFN16 3x3 package information

Figure 32. QFN16 3x3 package mechanical drawing

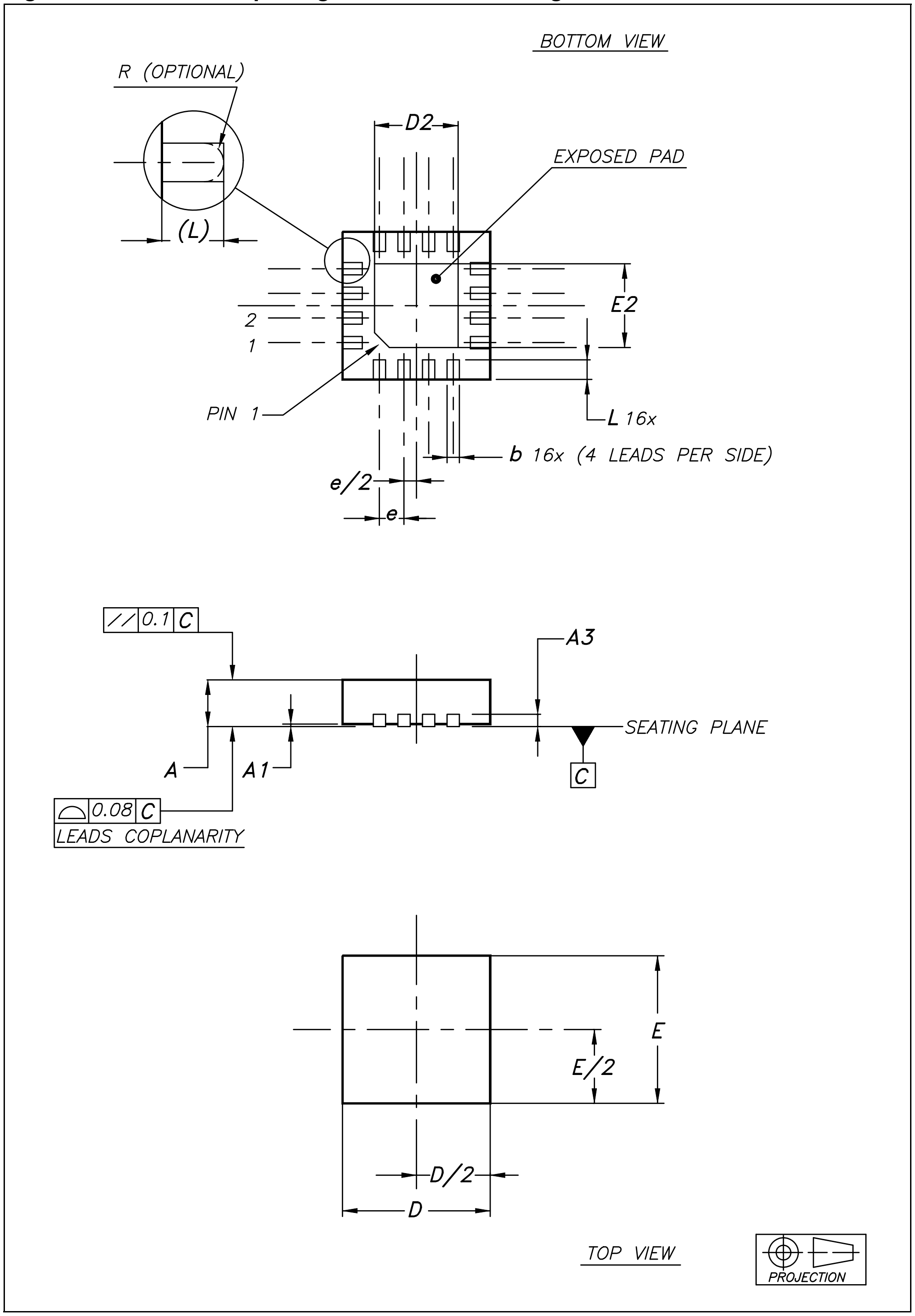
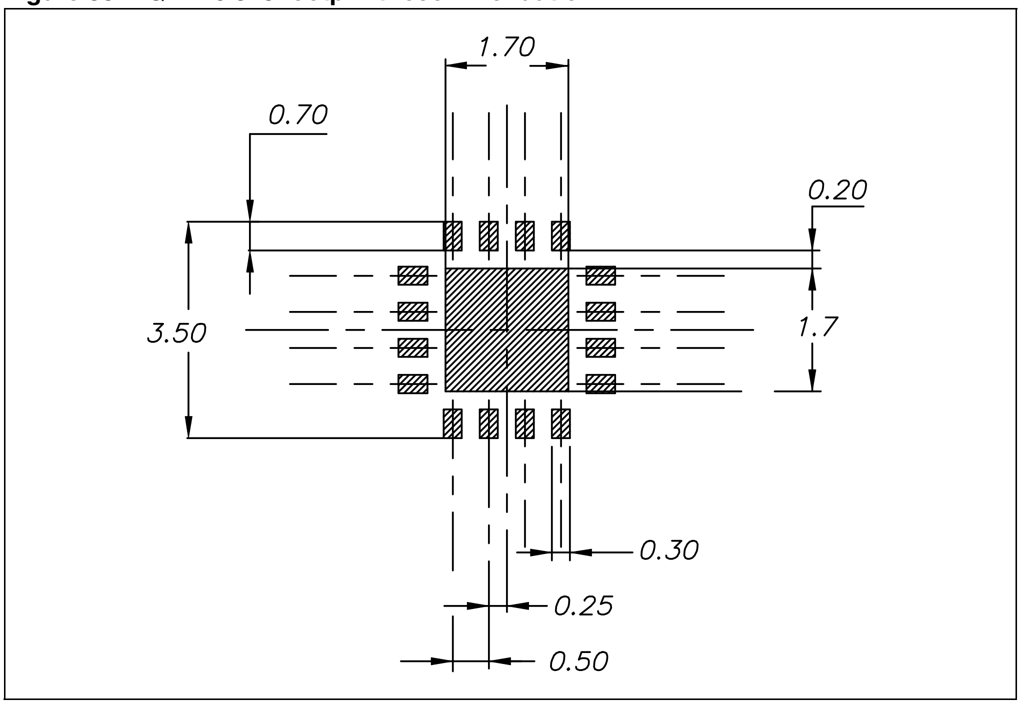


Table 15. QFN16 3x3 mm package mechanical data (pitch 0.5 mm)

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	0.80	0.90	1.00	0.031	0.035	0.039
A1	0		0.05	0		0.002
A3		0.20			0.008	
b	0.18		0.30	0.007		0.012
D	2.90	3.00	3.10	0.114	0.118	0.122
D2	1.50		1.80	0.059		0.071
E	2.90	3.00	3.10	0.114	0.118	0.122
E2	1.50		1.80	0.059		0.071
e		0.50			0.020	
L	0.30		0.50	0.012		0.020

Figure 33. QFN16 3x3 footprint recommendation



5.9 SOT23-5 package information

Figure 34. SOT23-5L package mechanical drawing

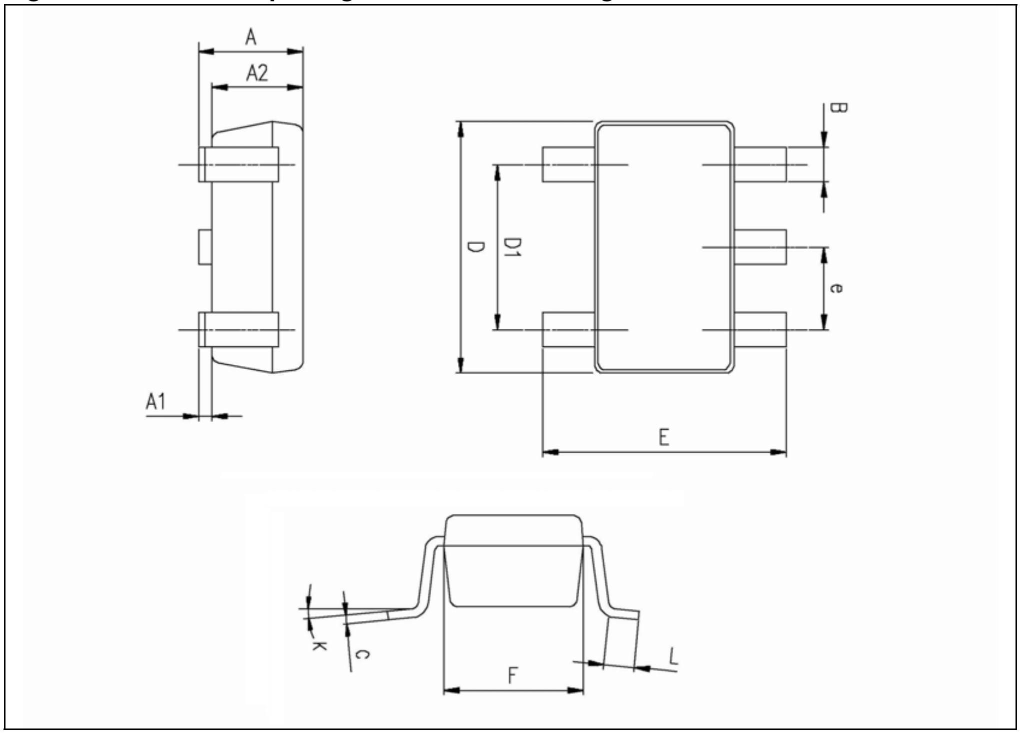


Table 16. SOT23-5L package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	0.90	1.20	1.45	0.035	0.047	0.057
A1			0.15			0.006
A2	0.90	1.05	1.30	0.035	0.041	0.051
B	0.35	0.40	0.50	0.013	0.015	0.019
C	0.09	0.15	0.20	0.003	0.006	0.008
D	2.80	2.90	3.00	0.110	0.114	0.118
D1		1.90			0.075	
e		0.95			0.037	
E	2.60	2.80	3.00	0.102	0.110	0.118
F	1.50	1.60	1.75	0.059	0.063	0.069
L	0.10	0.35	0.60	0.004	0.013	0.023
K	0 degrees		10 degrees			

5.10 SOT23-6 package information

Figure 35. SOT23-6L package mechanical drawing

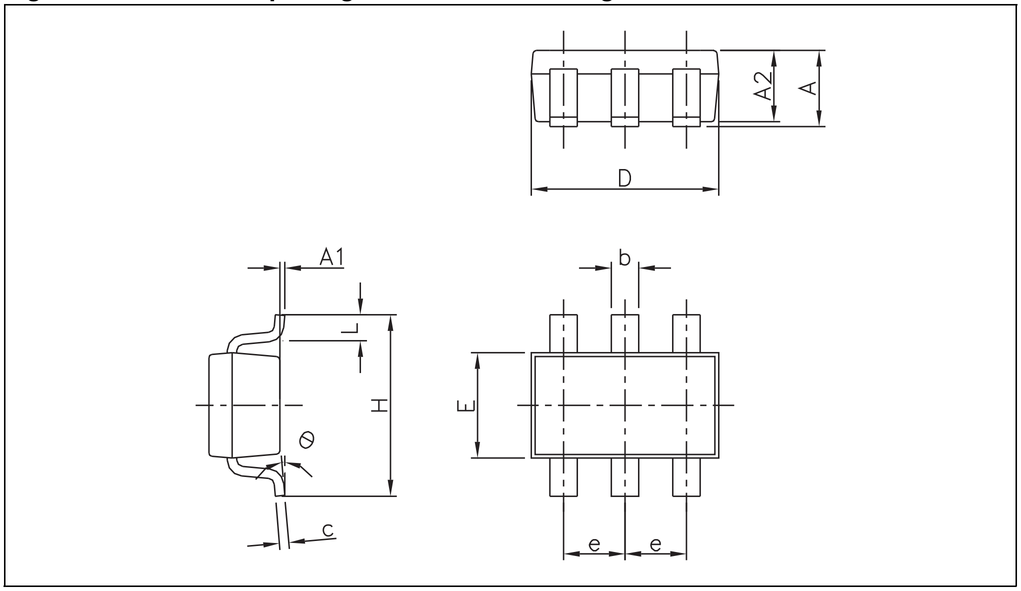


Table 17. SOT23-6L package mechanical data

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	0.90		1.45	0.035		0.057
A1			0.10			0.004
A2	0.90		1.30	0.035		0.051
b	0.35		0.50	0.013		0.019
c	0.09		0.20	0.003		0.008
D	2.80		3.05	0.110		0.120
E	1.50		1.75	0.060		0.069
e		0.95			0.037	
H	2.60		3.00	0.102		0.118
L	0.10		0.60	0.004		0.024
°	0		10°			

5.11 SC70-5 (or SOT323-5) package information

Figure 36. SC70-5 (or SOT323-5) package mechanical drawing

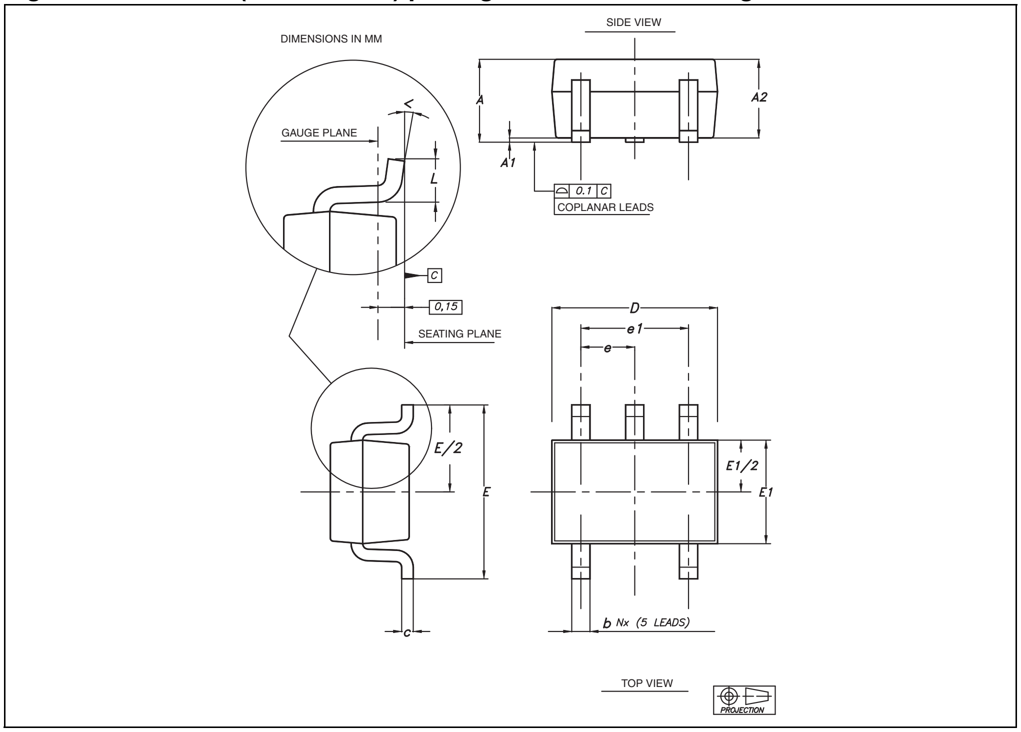


Table 18. SC70-5 (or SOT323-5) package mechanical data

Ref	Dimensions					
	Millimeters			Inches		
	Min	Typ	Max	Min	Typ	Max
A	0.80		1.10	0.032		0.043
A1			0.10			0.004
A2	0.80	0.90	1.00	0.032	0.035	0.039
b	0.15		0.30	0.006		0.012
c	0.10		0.22	0.004		0.009
D	1.80	2.00	2.20	0.071	0.079	0.087
E	1.80	2.10	2.40	0.071	0.083	0.094
E1	1.15	1.25	1.35	0.045	0.049	0.053
e		0.65			0.025	
e1		1.30			0.051	
L	0.26	0.36	0.46	0.010	0.014	0.018
<	0°		8°			

6 Ordering information

Table 19. Order codes for devices without shutdown feature

Order code	Temperature range	Package	Packing	Marking
TSV851ICT	-40° C to +125° C	SC70-5	Tape & reel	K5E
TSV851ILT		SOT23-5		K153
TSV852IQ2T		DFN8 2x2		K5E
TSV852IST		MiniSO8		K153
TSV852IDT		SO8		TSV852I
TSV854IPT		TSSOP14		TSV854I
TSV854IDT		SO14		TSV854I
TSV854IQ4T		QFN16 3x3		K157
TSV851AICT	-40° C to +125° C	SC70-5	Tape & reel	K5F
TSV851AILT		SOT23-5		K154
TSV852AIST		MiniSO8		K154
TSV852AIDT		SO8		TSV852AI
TSV854AIPT		TSSOP14		TSV854AI
TSV854AIDT		SO14		TSV854AI

Table 20. Order codes for devices with shutdown feature

Order code	Temperature range	Package	Packing	Marking
TSV850ILT	-40° C to +125° C	SOT23-6	Tape & reel	K153
TSV853IST		MiniSO10		K153
TSV855IPT		TSSOP16		TSV855I
TSV850AILT	-40° C to +125° C	SOT23-6	Tape & reel	K154
TSV853AIST		MiniSO10		K154
TSV855AIPT		TSSOP16		TSV855AI

Table 21. Order codes (automotive grade parts)

Order code	Temperature range	Package	Packing	Marking
TSV851IYLT	-40° C to +125° C Automotive grade(1)	SOT23-5	Tape & reel	K165
TSV852IYST		MiniSO8		K165
TSV852IYDT		SO8		TSV852IY
TSV854IYPT		TSSOP14		TSV854IY
TSV851AIYLT	-40° C to +125° C Automotive grade(1)	SOT23-5	Tape & reel	K166
TSV852AIYST		MiniSO8		K166
TSV852AIYDT		SO8		TSV852AY
TSV854AIYPT		TSSOP14		TSV854AIY

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.

7 Revision history

Table 22. Document revision history

Date	Revision	Changes
10-Nov-2011	1	Initial release.
06-Jul-2012	2	Added QFN16 package with related information. Minimum suplly voltage decreased down to 2.3 V. Modified *Figure 2*, *Figure 7* and *Figure 14*. Addition of automotive grade parts.

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