TS951-TS952-TS954

Input/Output Rail-to-Rail Low Power Operational Amplifier

- Rail-to-rail input common-mode voltage range
- Rail-to-rail output voltage swing
- Operating from 2.7V to 12V
- High-speed (3MHz, 1V/µs)
- Low consumption (0.9mA @ 3V)
- Supply voltage rejection ratio: 80dB
- Latch-up immunity
- Available in SOT23-5 micropackage

Description

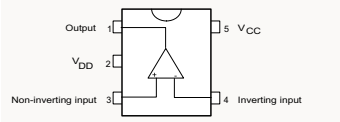
The TS95x family are rail-to-rail BiCMOS operational amplifiers optimized and fully specified for 3V and 5V operation.

The TS951 is housed in the space-saving 5 pins SOT23 package that makes it well suited for battery-powered systems. This micropackage simplifies the PC board design because of it's ability to be placed in tight spaces (outside dimensions are: 2.8mm x 2.9mm)

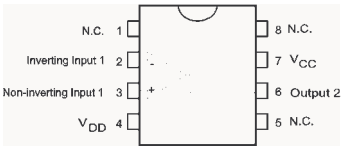
Applications

- Set-top boxes
- Laptop/notebook computers
- Transformer/line drivers
- Personal entertainments (CD players)
- Portable communication (cell phones, pagers)
- Instrumentation & sensoring
- Digital to analog converter buffers
- Portable headphone speaker drivers

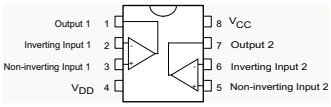
TS951ILT



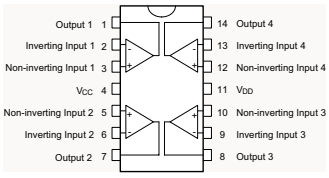
TS951ID



TS952IN-TS952ID-TS952IPT



TS954IN-TS954ID-TS954IPT



Order Codes

Part Number	Temperature Range	Package	Packing	Marking
TS951IN	-40°C, +125°C	DIP	Tube	TS951IN
TS951ILT		SOT23-5L	Tape & Reel	K101
TS951IYLT				K102
TS952IN		DIP	Tube	TS952IN
TS952ID/IDT		SO	Tube or Tape & Reel	952I
TS952IPT		TSSOP (Thin Shrink Outline Package)	Tape & Reel	952I
TS954IN		DIP	Tube	TS954IN
TS954ID/IDT		SO	Tube or Tape & Reel	954I
TS954IPT		TSSOP (Thin Shrink Outline Package)	Tape & Reel	954I
TS952IYD/IYDT		SO (automotive grade level)	Tube or Tape & Reel	952IY

1 Absolute Maximum Ratings

Table 1. Key parameters and their absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage (1)	14	V
V_{id}	Differential Input Voltage (2)	±1	V
V_{in}	Input Voltage (3)	V_{DD}-0.3 to V_{CC}+0.3	V
Tstg	Storage Temperature Range	-65 to +150	
T_j	Maximum Junction Temperature	150	°C
Rthja	Thermal Resistance Junction to Ambient (4) SOT23-5 SO8 SO14 TSSOP8 TSSOP14	 250 125 103 120 100	°C/W
ESD	HBM: Human Body Model(5) TS951 TS952 TS954	 1 2 3	kV
	MM: Machine Model(6)	100	V
	CDM: Charged Device Model	1.5	kV
	Latch-up Immunity	200	mA
	Lead Temperature (soldering, 10sec)	260	°C

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. If Vid > ±1V, the maximum input current must not exceed ±1mA. In this case (Vid > ±1V) an input serie resistor must be added to limit input current.
3. Do not exceed 14V.
4. Short-circuits can cause excessive heating and destructive dissipation.
5. Human body model, 100pF discharged through a 1.5kΩ resistor into pin of device.
6. Machine model ESD, a 200pF cap is charged to the specified voltage, then discharged directly into the IC with no external series resistor (internal resistor < 5Ω), into pin to pin of device.

Table 2. Operating conditions

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage	2.7 to 12	V
V_{icm}	Common Mode Input Voltage Range	V_{DD} -0.2 to V_{CC} +0.2	V
T_{oper}	Operating Free Air Temperature Range	-40 to +125	°C

2 Electrical Characteristics

Table 3. V_{CC} = +3V, V_{DD} = 0V, R_L connected to $V_{CC}/2$, T_{amb} = 25°C (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{io}	Input Offset Voltage $T_{min} \le T_{amb} \le T_{max}$			6 8	mV
DV_{io}	Input Offset Voltage Drift		2		µV/°C
I_{io}	Input Offset Current $T_{min} \le T_{amb} \le T_{max}$		1	30 80	nA
I_{ib}	Input Bias Current $V_{icm} = V_{cc/2}$ $T_{min} \le T_{amb} \le T_{max}$		35	100 200	nA
CMR	Common Mode Rejection Ratio	50	80		dB
SVR	Supply Voltage Rejection Ratio Vcc = 2.7V to 3.3V	60	80		dB
A_{vd}	Large Signal Voltage Gain V_o = 2Vpk-pk R_L = 600Ω		80		dB
V_{OH}	High Level Output Voltage R_L = 600Ω	2.8	2.9		V
V_{OL}	Low Level Output Voltage R_L = 600Ω		80	250	mV
I_{sc}	Output Short Circuit Current	10			mA
I_{cc}	Supply Current (per Amplifier) No load, $V_{icm} = V_{cc/2}$		0.9	1.3	mA
GBP	Gain Bandwidth Product R_L = 2kΩ		3		MHz
SR	Slew Rate		1		V/µs
∅m	Phase Margin at Unit Gain R_L = 600Ω, C_L =100pF		60		Degrees
Gm	Gain Margin R_L = 600Ω, C_L =100pF		10		dB
e_n	Equivalent Input Noise Voltage f = 1kHz		25		$\frac{nV}{\sqrt{Hz}}$
THD	Total Harmonic Distortion V_{out} = 4Vpk-pk, F = 10kHz, A_v = 2, R_L =10kΩ		0.01		%

Table 4. V_{CC} = +5V, V_{DD} = 0V, R_L connected to $V_{cc}/2$, T_{amb} = 25°C (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{io}	Input Offset Voltage $T_{min} \le T_{amb} \le T_{max}$			6 8	mV
DV_{io}	Input Offset Voltage Drift		2		µV/°C
I_{io}	Input Offset Current $V_{icm} = V_{cc/2}$ $T_{min} \le T_{amb} \le T_{max}$		1	30 80	nA
I_{ib}	Input Bias Current $V_{icm} = V_{cc/2}$ $T_{min} \le T_{amb} \le T_{max}$		35	100 200	nA
CMR	Common Mode Rejection Ratio	50	80		dB
SVR	Supply Voltage Rejection Ratio Vcc = 2.7V to 3.3V	60	80		dB
A_{vd}	Large Signal Voltage Gain V_o = 2Vpk-pk R_L = 600Ω		86		dB
V_{OH}	High Level Output Voltage R_L = 600Ω	4.7	4.8		V
V_{OL}	Low Level Output Voltage R_L = 600Ω		80	300	mV
I_{sc}	Output Short Circuit Current	10			mA
I_{cc}	Supply Current (per Amplifier) No load, $V_{icm} = V_{cc/2}$		0.95	1.4	mA
GBP	Gain Bandwidth Product R_L = 2kΩ		3		MHz
SR	Slew Rate		1		V/µs
∅m	Phase Margin at Unit Gain R_L = 600Ω, C_L =100pF		60		Degrees
Gm	Gain Margin R_L = 600Ω, C_L =100pF		10		dB
e_n	Equivalent Input Noise Voltage f = 1kHz		25		$\frac{nV}{\sqrt{Hz}}$
THD	Total Harmonic Distortion V_{out} = 4Vpk-pk, F = 10kHz, A_V = 2, R_L =10kΩ		0.01		%

Figure 1. Supply current vs. supply voltage

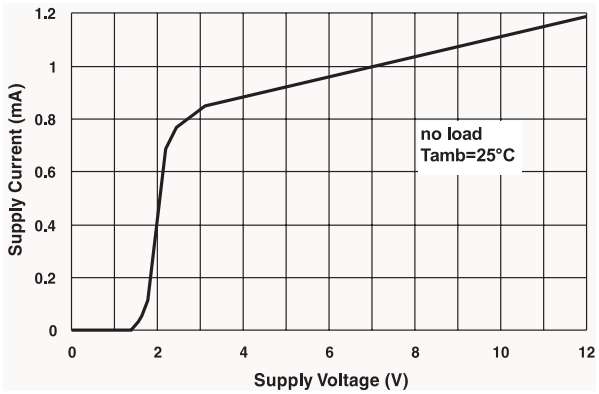


Figure 2. Output short circuit current vs. output voltage

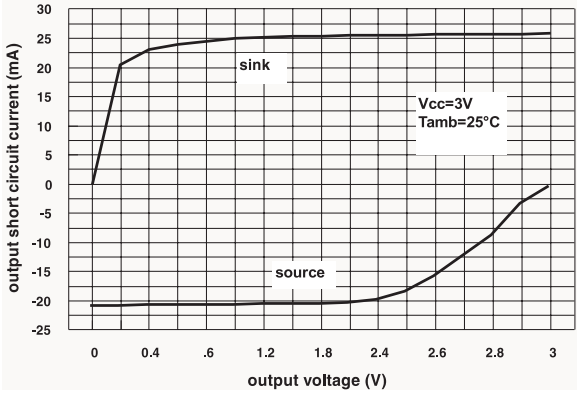


Figure 3. Voltage gain and phase vs. frequency

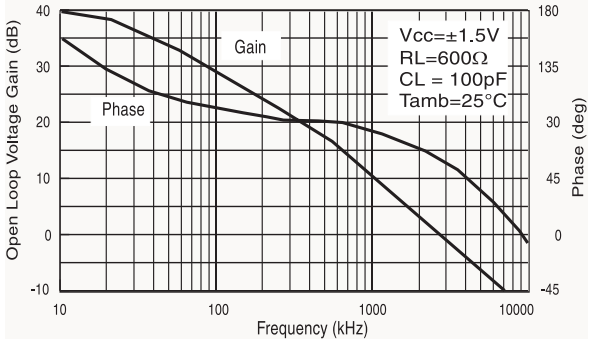


Figure 4. Supply current vs. temperature

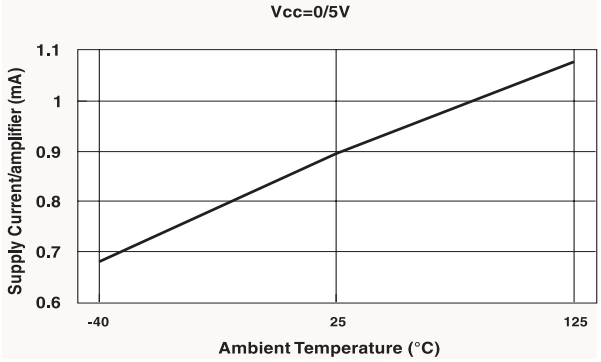


Figure 5. Output short circuit current vs. temperature

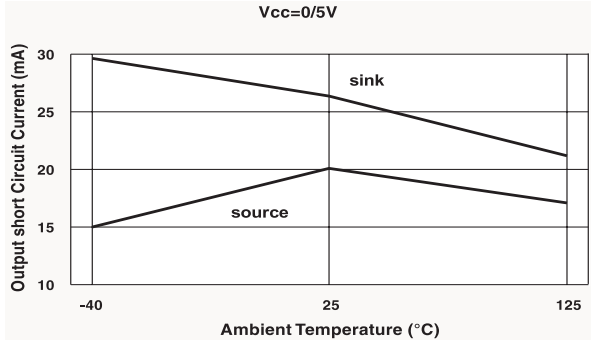


Figure 6. Slew rate vs. temperature

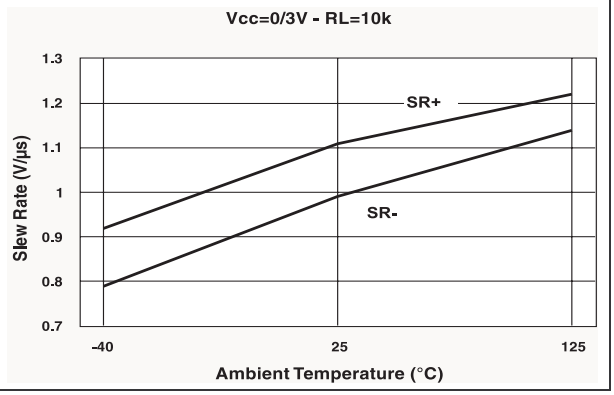


Figure 7. THD + noise vs. Vout

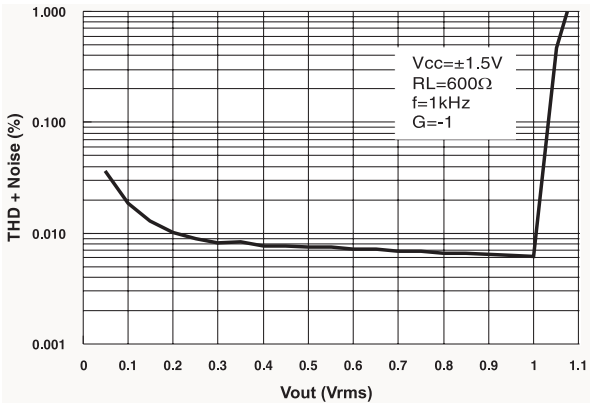


Figure 8. THD + noise vs. frequency

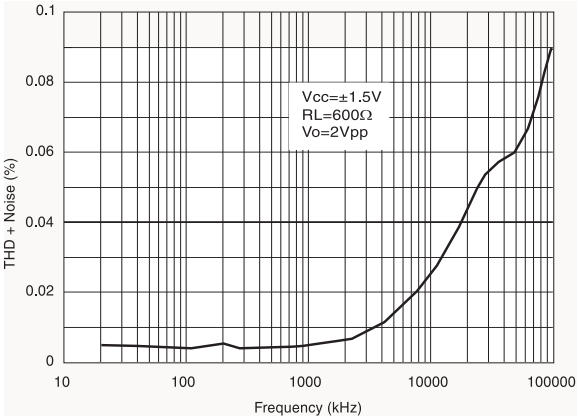


Figure 9. THD + noise vs. Vout

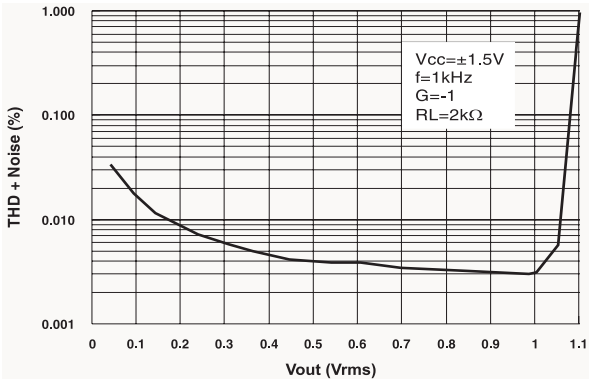
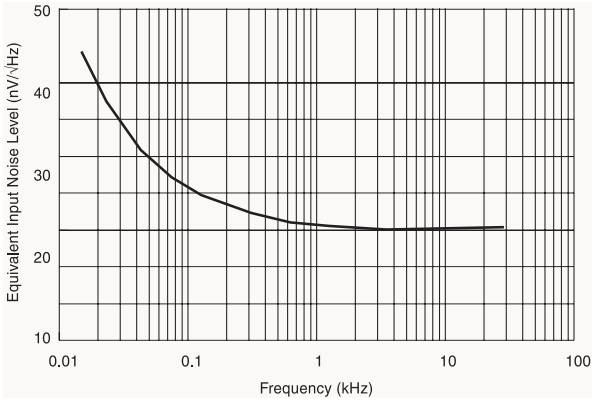


Figure 10. Equivalent input noise voltage vs. frequency



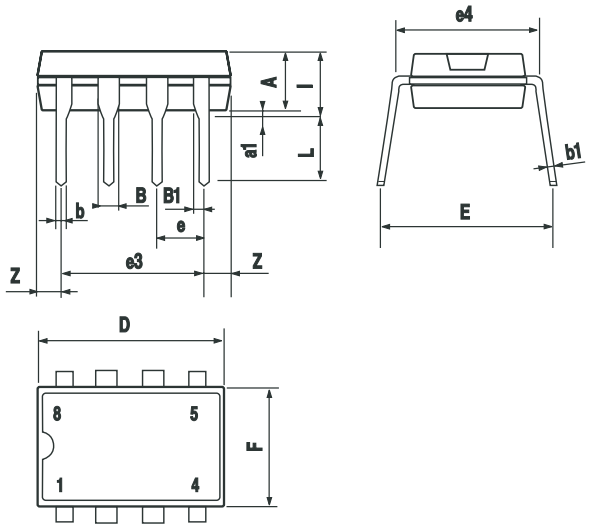
3 Package Mechanical Data

In order to meet environmental requirements, ST 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 ST trademark. ECOPACK specifications are available at: www.st.com.

3.1 DIP8 Package

Plastic DIP-8 MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A		3.3			0.130	
a1	0.7			0.028		
B	1.39		1.65	0.055		0.065
B1	0.91		1.04	0.036		0.041
b		0.5			0.020	
b1	0.38		0.5	0.015		0.020
D			9.8			0.386
E		8.8			0.346	
e		2.54			0.100	
e3		7.62			0.300	
e4		7.62			0.300	
F			7.1			0.280
I			4.8			0.189
L		3.3			0.130	
Z	0.44		1.6	0.017		0.063

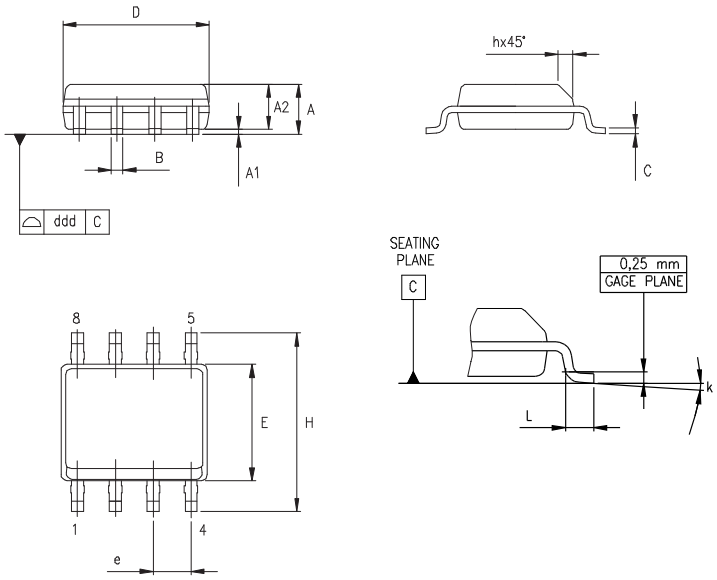


P001F

3.2 SO-8 Package

SO-8 MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	1.35		1.75	0.053		0.069
A1	0.10		0.25	0.04		0.010
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		0.010
D	4.80		5.00	0.189		0.197
E	3.80		4.00	0.150		0.157
e		1.27			0.050	
H	5.80		6.20	0.228		0.244
h	0.25		0.50	0.010		0.020
L	0.40		1.27	0.016		0.050
k	8° (max.)					
ddd			0.1			0.04

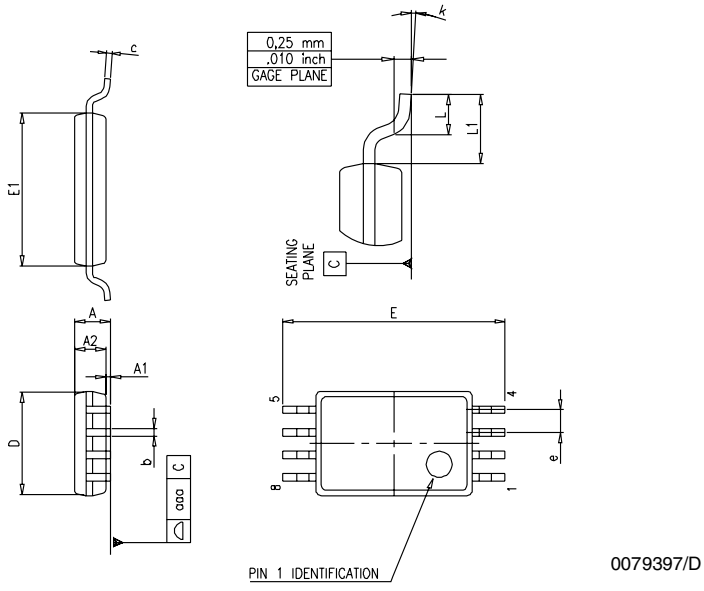


0016023/C

3.3 TSSOP8 Package

TSSOP8 MECHANICAL DATA

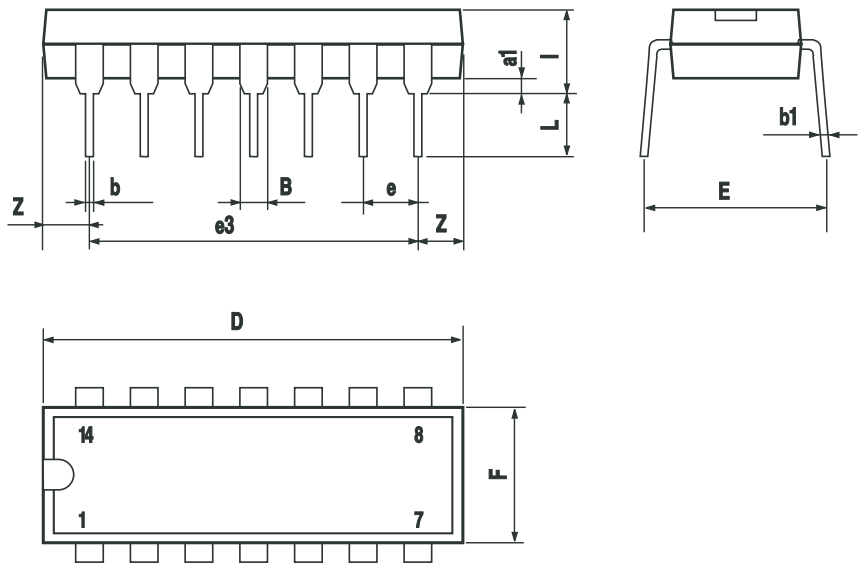
DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A			1.2			0.047
A1	0.05		0.15	0.002		0.006
A2	0.80	1.00	1.05	0.031	0.039	0.041
b	0.19		0.30	0.007		0.012
c	0.09		0.20	0.004		0.008
D	2.90	3.00	3.10	0.114	0.118	0.122
E	6.20	6.40	6.60	0.244	0.252	0.260
E1	4.30	4.40	4.50	0.169	0.173	0.177
e		0.65			0.0256	
K	0°		8°	0°		8°
L	0.45	0.60	0.75	0.018	0.024	0.030
L1		1			0.039	



3.4 DIP14 Package

Plastic DIP-14 MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
a1	0.51			0.020		
B	1.39		1.65	0.055		0.065
b		0.5			0.020	
b1		0.25			0.010	
D			20			0.787
E		8.5			0.335	
e		2.54			0.100	
e3		15.24			0.600	
F			7.1			0.280
I			5.1			0.201
L		3.3			0.130	
Z	1.27		2.54	0.050		0.100

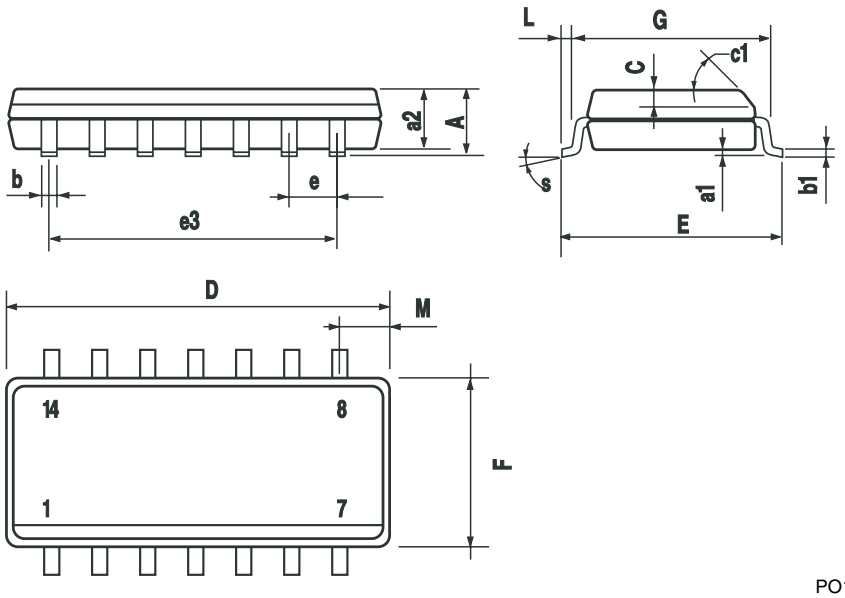


P001A

3.5 SO-14 Package

SO-14 MECHANICAL DATA

DIM.	mm.			inch		
	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.)					

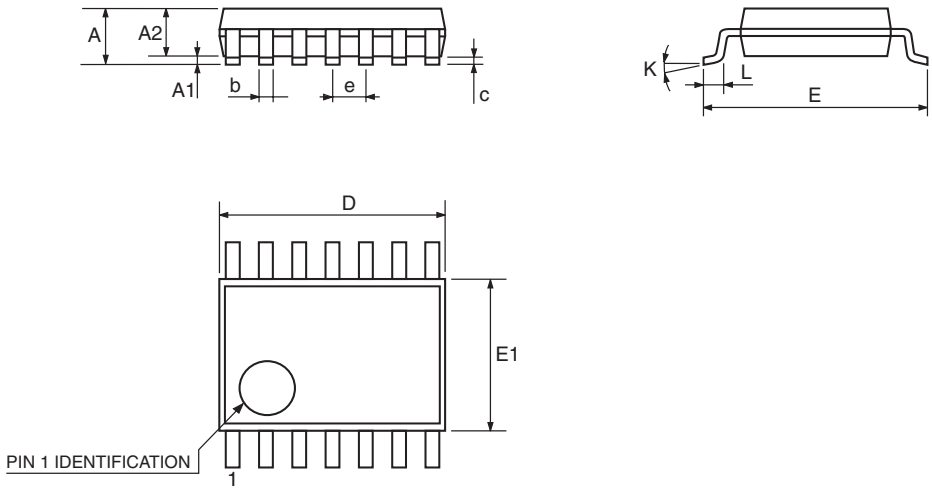


PO13G

3.6 TSSOP14 Package

TSSOP14 MECHANICAL DATA

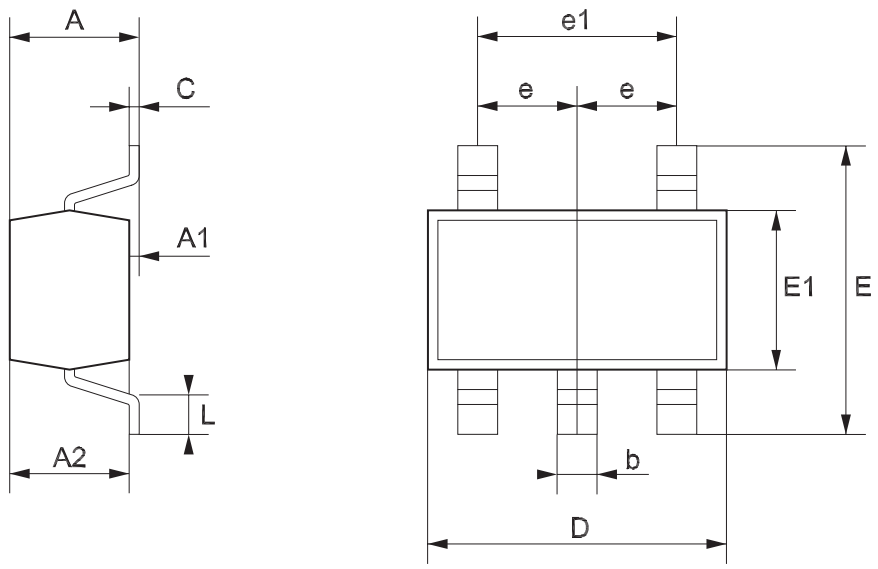
DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A			1.2			0.047
A1	0.05		0.15	0.002	0.004	0.006
A2	0.8	1	1.05	0.031	0.039	0.041
b	0.19		0.30	0.007		0.012
c	0.09		0.20	0.004		0.0089
D	4.9	5	5.1	0.193	0.197	0.201
E	6.2	6.4	6.6	0.244	0.252	0.260
E1	4.3	4.4	4.48	0.169	0.173	0.176
e		0.65 BSC			0.0256 BSC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



3.7 SOT23-5 Package

SOT23-5L MECHANICAL DATA

DIM.	mm.			mils		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	0.90		1.45	35.4		57.1
A1	0.00		0.15	0.0		5.9
A2	0.90		1.30	35.4		51.2
b	0.35		0.50	13.7		19.7
C	0.09		0.20	3.5		7.8
D	2.80		3.00	110.2		118.1
E	2.60		3.00	102.3		118.1
E1	1.50		1.75	59.0		68.8
e		0.95			37.4	
e1		1.9			74.8	
L	0.35		0.55	13.7		21.6



4 Revision History

Date	Revision	Changes
May 2001	1	First Release.
Jan. 2005	2	Modifications on AMR *Table 1 on page 3* (explanation of Vid and Vi limits, ESD MM and CDM values added, Rthja added).
July 2005	3	PPAP references inserted in the datasheet see *Table : Order Codes on page 2*.
Aug. 2005	4	Table data was badly formatted see *Table 4 on page 5*.
Dec. 2005	5	TS951IYLT PPAP reference added see *Table : Order Codes on page 2*.

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