TS971
TS972
TS974

OUTPUT **RAIL TO RAIL**
VERY LOW NOISE OPERATIONAL AMPLIFIERS

- RAIL TO RAIL **OUTPUT** VOLTAGE SWING (±**2.4V @ V_{CC} = ±2.5V)**
- VERY LOW NOISE LEVEL : **4nV/$\sqrt{Hz}$**
- ULTRA LOW DISTORTION : **0.003%**
- HIGH DYNAMIC FEATURES **(12MHz, 4V/µs)**
- OPERATING RANGE : **2.7V to 12V**
- ESD PROTECTION **(2kV)**
- LATCH-UP IMMUNITY
- AVAILABLE IN **SOT23-5 MICROPACKAGE**

DESCRIPTION

The TS97x family operational amplifiers is able to operate with voltages as low as ±1.35V and featuring output Rail to Rail signal swing. The TS97x boasts characteristics that make them particularly well suited for portable and battery-supplied equipment. Very low noise and low distortion characteristics make them ideal for audio pre-amplification.
The TS971 is housed in the space-saving 5 pins SOT23 package which simplifies the board design because of the ability to be placed everywhere (outside dimensions are 2.8mm x 2.9mm)

APPLICATIONS

- Portable equipments (CD players, PDA)
- Portable communications (cell phones, pagers)
- Instrumentation & sensoring
- Professional audio circuits

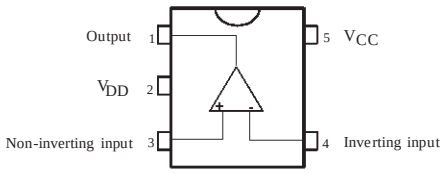
ORDER CODES

Part Number	Temperature Range	Package				SOT23 Marking
		N	D	P	L	
TS971I	-40, +125°C		•		•	K120
TS972I	-40, +125°C	•	•	•		
TS974I	-40, +125°C	•	•	•		

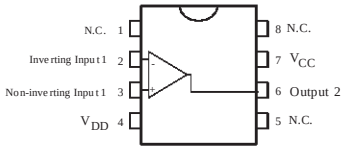
N = Dual in Line Package (DIP)
D = Small Outline Package (SO) - also available in Tape & Reel
P = Thin Shrink Small Outline Package (TSSOP) - only available in Tape & Reel (PT)
L = Tiny Package (SOT23-5) - only available in Tape & Reel (LT)

PIN CONNECTIONS (top view)

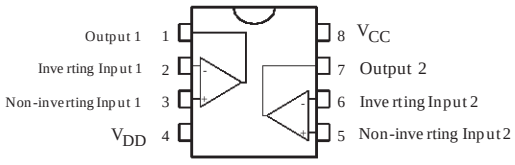
TS971ILT



TS971ID



TS972IN-TS972ID-TS972IPT



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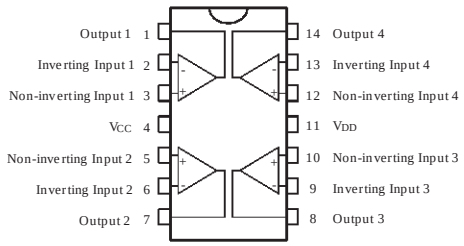


ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_{CC}	Supply Voltage - note 1	12	V
V_{id}	Differential Input Voltage - note 2	$\pm V_{CC}$	V
V_{in}	Input Voltage Range - note 3	-0.3 to 12.3	V
T_{oper}	Operating Free Air Temperature Range	-40 to +125	°C
T_{stg}	Storage Temperature Range	-65 to +150	°C
T_j	Maximum Junction Temperation	150	°C
R_{thjc}	Thermal Resistance Junction to Case - note 4 SOT23-5 SO8 SO14 TSSOP8 TSSOP14	 81 28 22 26 21	°C/W
R_{thja}	Thermal Resistance Junction to Ambient	256	°C/W
ESD	Human Body Model	2	kV
	Lead Temperature (soldering, 10sec)	260	°C

Notes: 1. All voltages values, except differential voltage are with respect to network ground terminal.
2. Differential voltages are non-inverting input terminal with respect to the inverting input terminal.
3. The magniture of input and output voltages must never exceed V_{CC} +0.3V.
4. Short-circuits can cause excessive heating and destructive dissipation.

OPERATING CONDITIONS

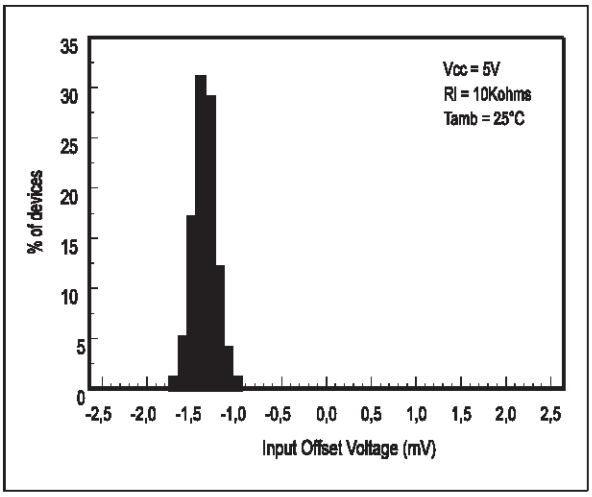
Symbol	Parameter	Value	Unit
V_{CC}	Supply Voltage Range	2.7 to 12	V
V_{icm}	Common Mode Input Voltage Range	V_{DD} + 1.15 to V_{CC} - 1.15	V

ELECTRICAL CHARACTERISTICS

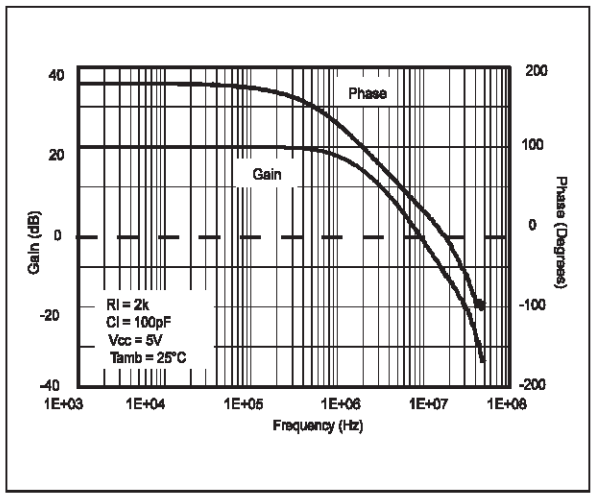
V_{CC} = **2.5V**, V_{DD} = **-2.5V,** T_{amb} = 25°C (unless otherwise specified)

Symbol	Parameter		Min.	Typ.	Max.	Unit
V_{io}	Input Offset Voltage $T_{min.} < T_{amb} < T_{max.}$			1	5 7	mV
DV_{io}	Input Offset Voltage Drift V_{icm} = 0V, V_o = 0V			5		µV/°C
I_{io}	Input Offset Current V_{icm} = 0V, V_o = 0V			10	150	nA
I_{ib}	Input Bias Current V_{icm} = 0V, V_o = 0V $T_{min.} < T_{amb} < T_{max.}$			200 200	750 1000	nA
V_{icm}	Common Mode Input Voltage Range		-1.35	±1.5	1.35	V
CMR	Common Mode Rejection Ratio V_{icm} = ±1.35V		60	85		dB
SVR	Supply Voltage Rejection Ratio V_{CC} = ±2V to ±3V		60	70		dB
A_{vd}	Large Signal Voltage Gain	R_L = 2kΩ	70	80		dB
V_{OH}	High Level Output Voltage	R_L = 2kΩ	2	2.4		V
V_{OL}	Low Level Output Voltage	R_L = 2kΩ		-2.4	-2	V
I_{source}	Output Source Current			1.5		mA
I_{sink}	Output Sink Current			100		mA
I_{CC}	Supply Current Unity gain - no load			2	2.8	mA
GBP	Gain Bandwidth Product f = 100kHz	R_L = 2kΩ, C_L = 100pF	8.5	12		MHz
SR	Slew Rate A_V = 1, V_{in} = ±1V		2.8	4		V/µs
∅m	Phase Margin at Unity Gain	R_L = 2kΩ, C_L = 100pF		60		Degrees
Gm	Gain Margin	R_L = 2kΩ, C_L = 100pF		10		dB
e_n	Equivalent Input Noise Voltage f = 100kHz			4		$\frac{nV}{\sqrt{Hz}}$
THD	Total Harmonic Distortion f = 1kHz, A_V = -1	R_L = 10kΩ		0.003		%

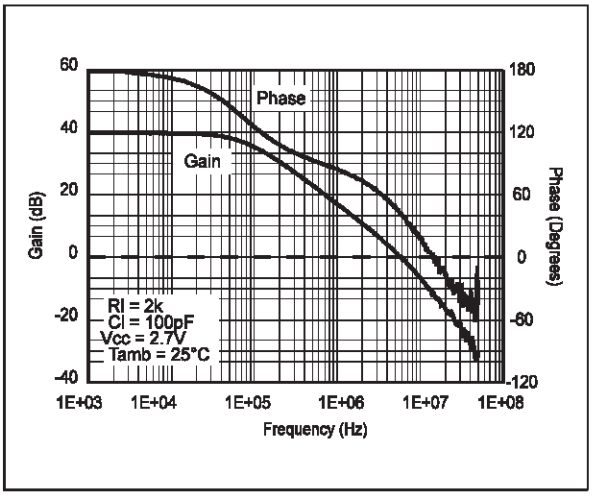
INPUT OFFSET VOLTAGE DISTRIBUTION



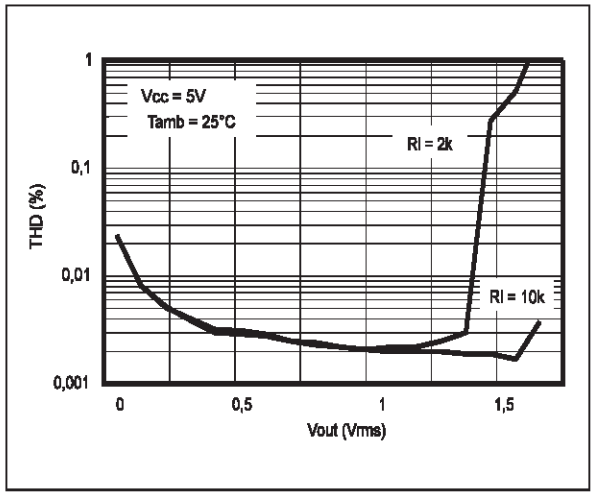
VOLTAGE GAIN & PHASE vs FREQUENCY



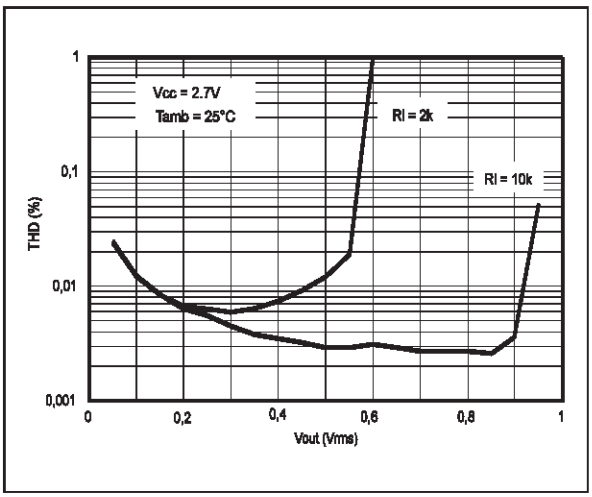
VOLTAGE GAIN & PHASE vs FREQUENCY



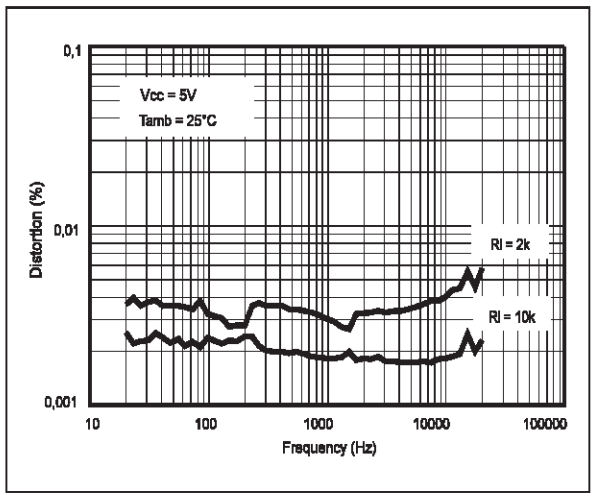
THD vs Vout



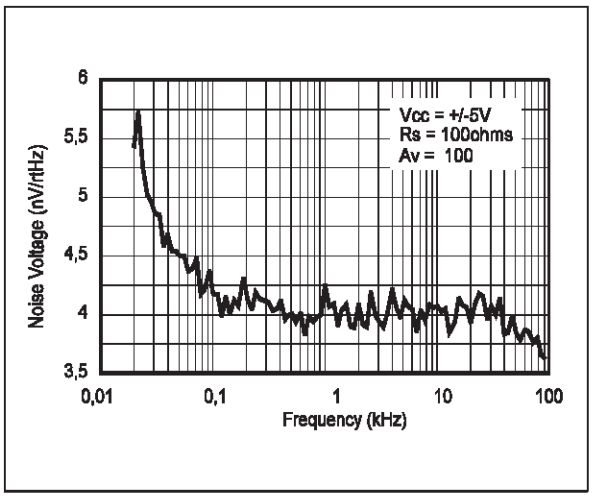
THD vs Vout



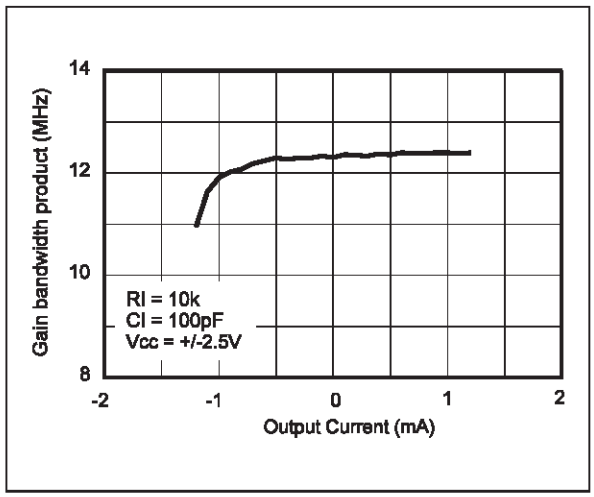
THD vs FREQUENCY



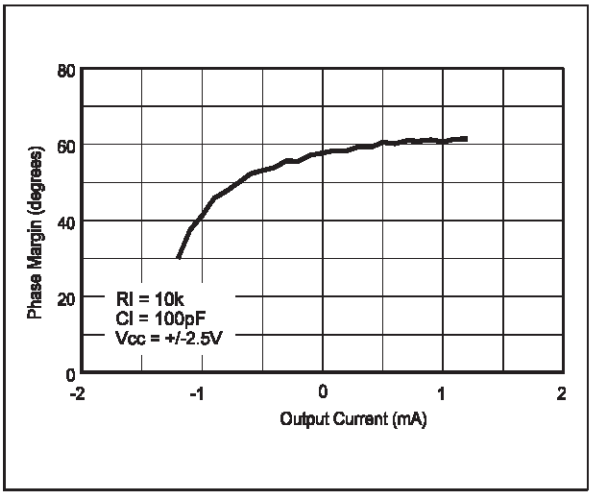
NOISE VOLTAGE vs FREQUENCY



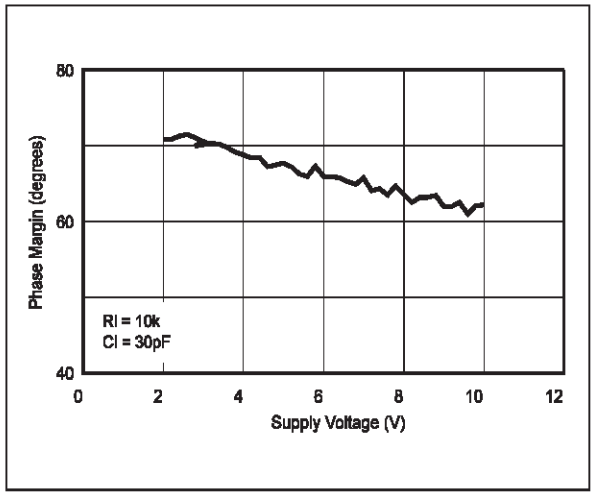
GAIN BANDWIDTH PRODUCT vs Iout



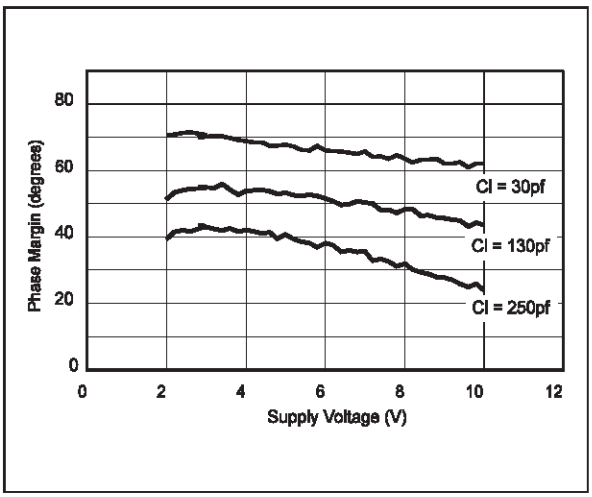
PHASE MARGIN vs Iout



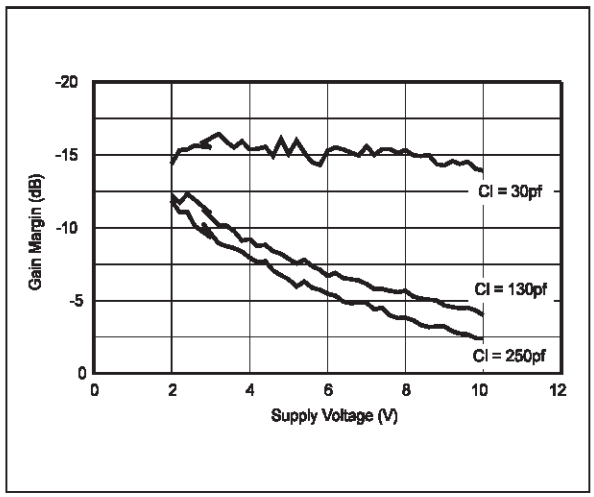
PHASE MARGIN vs V_{CC}



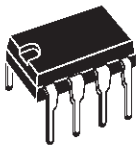
PHASE MARGIN vs V_{CC}



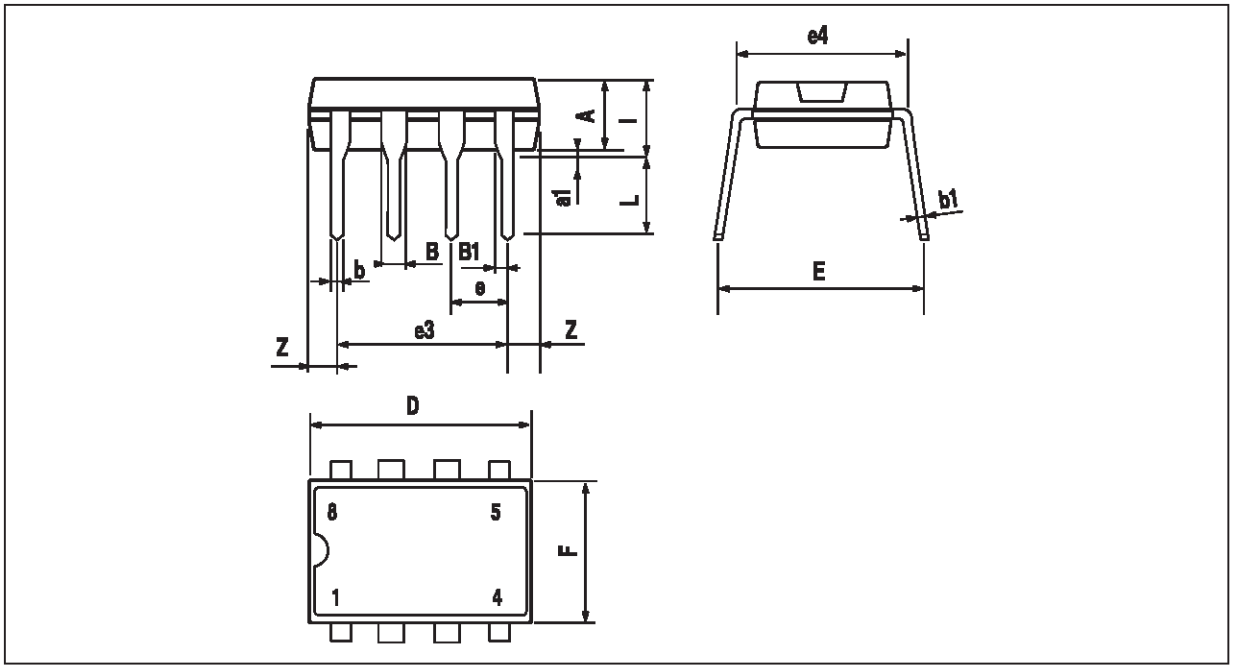
GAIN MARGIN vs V_{CC}



TS972IN

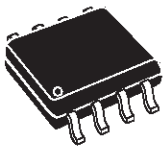


PACKAGE MECHANICAL DATA
8 PINS - PLASTIC DIP

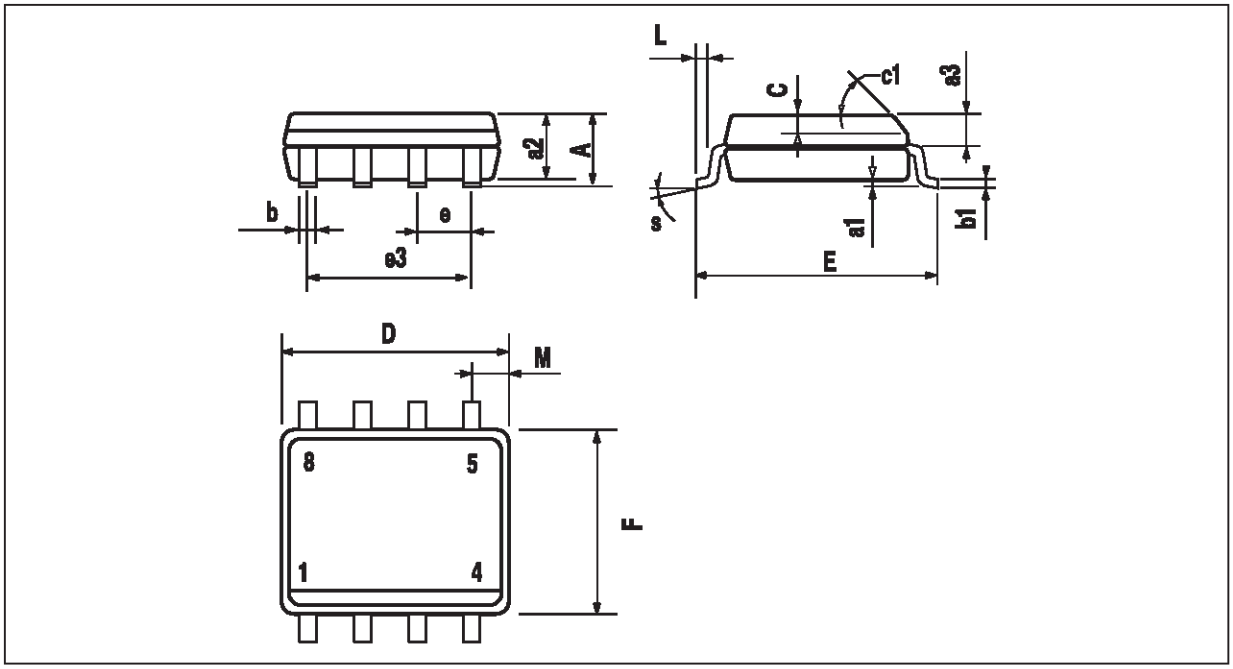


Dimensions	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A		3.32			0.131	
a1	0.51			0.020		
B	1.15		1.65	0.045		0.065
b	0.356		0.55	0.014		0.022
b1	0.204		0.304	0.008		0.012
D			10.92			0.430
E	7.95		9.75	0.313		0.384
e		2.54			0.100	
e3		7.62			0.300	

TS971ID - TS972ID



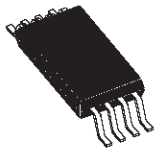
PACKAGE MECHANICAL DATA
8 PINS - PLASTIC MICROPACKAGE (SO)



Dimensions	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
a1*	0.1		0.25	0.004		0.010
a2			1.65			0.065
a3	0.65		0.85	0.026		0.033
b	0.35		0.48	0.014		0.019
b1	0.19		0.25	0.007		0.010
C	0.25		0.5	0.010		0.020
c1	45° (typ.)					
D	4.8		5.0	0.189		0.197
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		3.81			0.150	
F	3.8		4.0	0.150		0.157
L	0.4		1.27	0.016		0.050
M			0.6			0.024
S	8° (max.)					

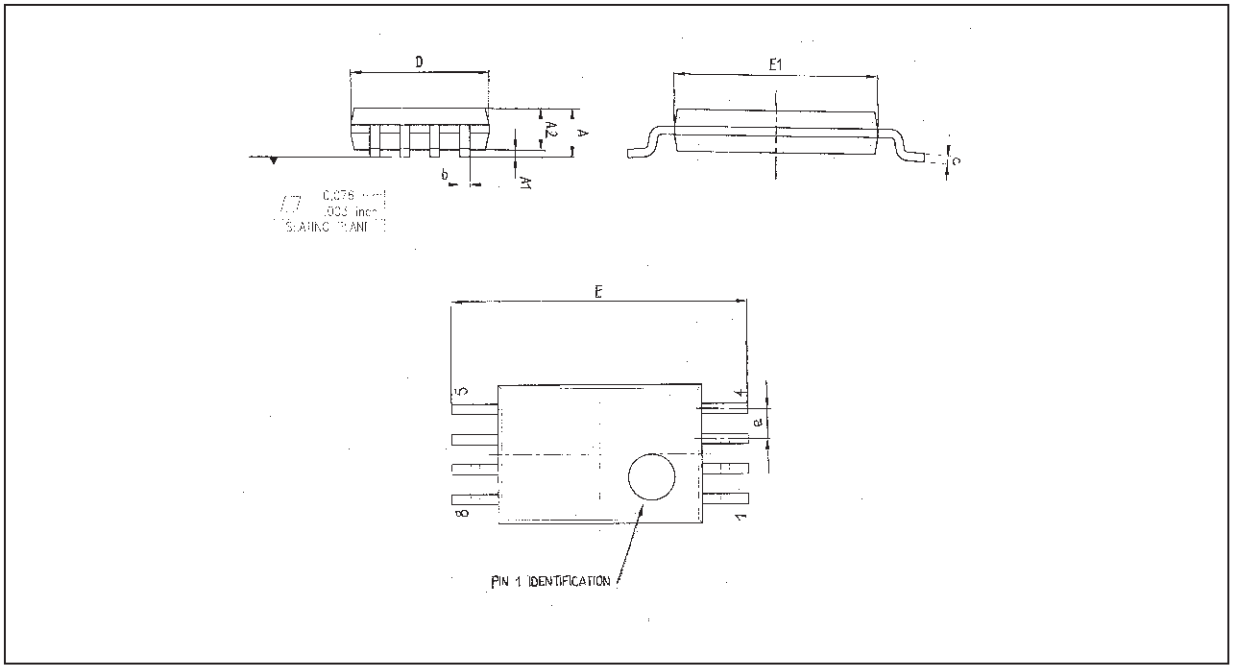
* coplanarity between all the leads : 0.1mm

TS972IPT



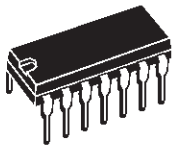
PACKAGE MECHANICAL DATA

8 PINS - THIN SHRINK SMALL OUTLINE PACKAGE (TSSOP)

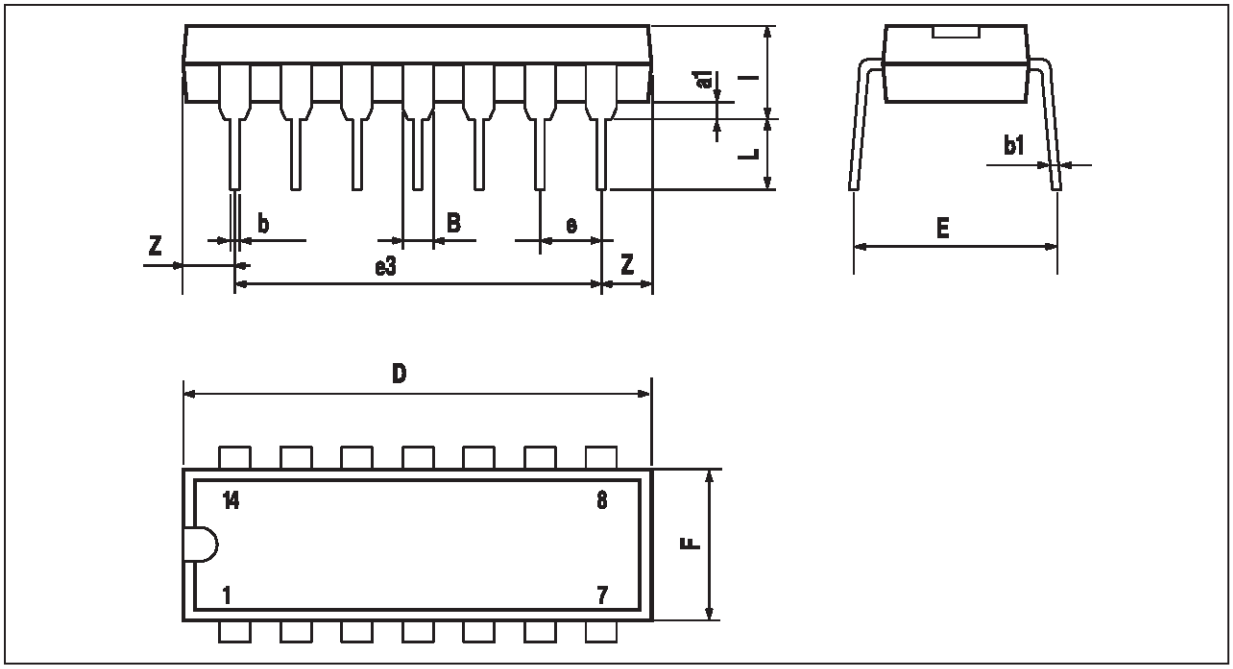


Dim.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.20			0.05
A1	0.05		0.15	0.01		0.006
A2	0.80	1.00	1.05	0.031	0.039	0.041
b	0.19		0.30	0.007		0.15
c	0.09		0.20	0.003		0.012
D	2.90	3.00	3.10	0.114	0.118	0.122
E		6.40			0.252	
E1	4.30	4.40	4.50	0.169	0.173	0.177
e		0.65			0.025	
k	0^o		8^o	0^o		8^o
l	0.50	0.60	0.75	0.09	0.0236	0.030

TS974IN

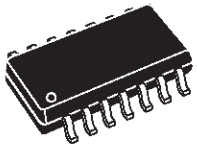


PACKAGE MECHANICAL DATA
14 PINS - PLASTIC DIP



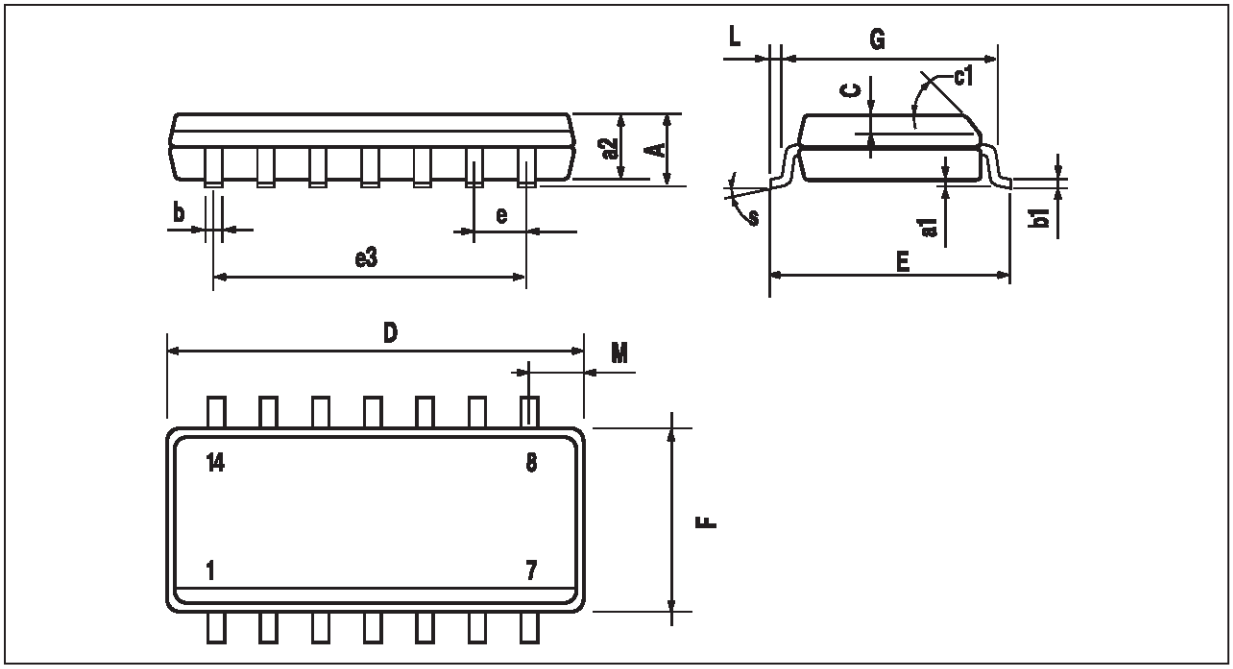
Dim.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
a1	0.51			0.020		
B	1.39		1.65	0.055		0.065
b		0.5			0.020	
b1		0.25			0.010	
D			20			0.787
E		8.5			0.335	
e		2.54			0.100	
e3		15.24			0.600	

TS974ID



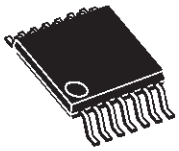
PACKAGE MECHANICAL DATA

14 PINS - PLASTIC MICROPACKAGE (SO)



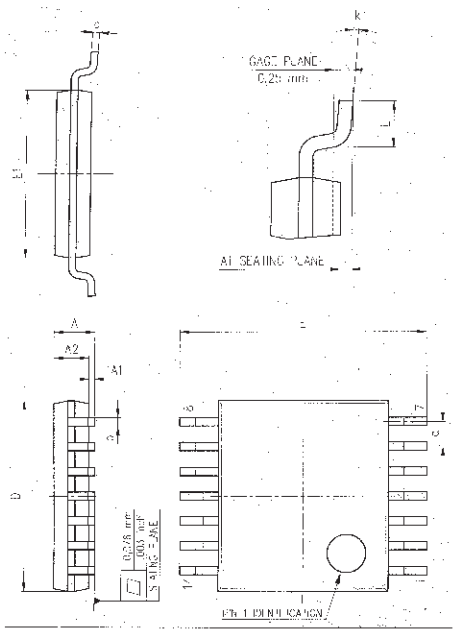
Dim.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
a1	0.1		0.2	0.004		0.008
a2			1.6			0.063
b	0.35		0.46	0.014		0.018
b1	0.19		0.25	0.007		0.010
C		0.5			0.020	
c1	45^o (typ.)					
D	8.55		8.75	0.336		0.334
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		7.62			0.300	
F	3.8		4.0	0.150		0.157
G	4.6		5.3	0.181		0.208
L	0.5		1.27	0.020		0.050
M			0.68			0.027
S	8^o (max.)					

TS974IPT



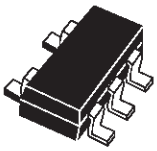
PACKAGE MECHANICAL DATA

14 PINS - THIN SHRINK SMALL OUTLINE PACKAGE (TSSOP)



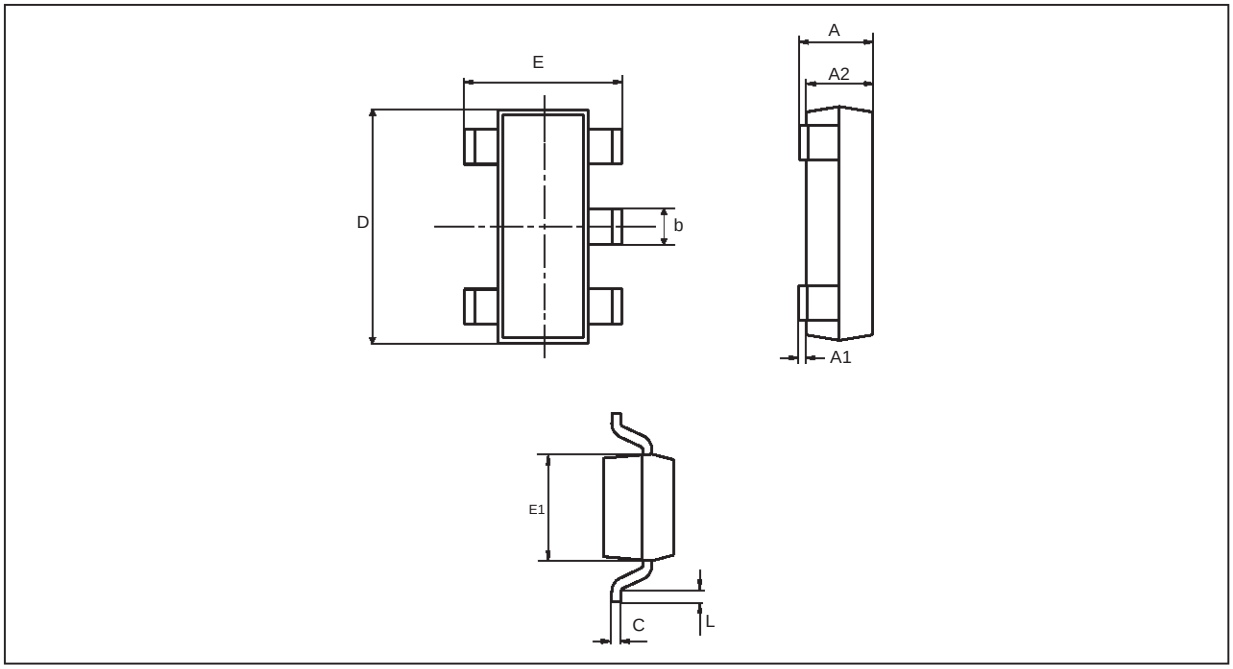
Dim.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.20			0.05
A1	0.05		0.15	0.01		0.006
A2	0.80	1.00	1.05	0.031	0.039	0.041
b	0.19		0.30	0.007		0.15
c	0.09		0.20	0.003		0.012
D	4.90	5.00	5.10	0.192	0.196	0.20
E		6.40			0.252	
E1	4.30	4.40	4.50	0.169	0.173	0.177
e		0.65			0.025	
k	0^o		8^o	0^o		8^o
l	0.50	0.60	0.75	0.09	0.0236	0.030

TS971ILT



PACKAGE MECHANICAL DATA

5 PINS -TINY PACKAGE (SOT23)



Dim.	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	0.90	1.45	0.034	0.057
A1	0	0.15		0.006
A2	0.90	1.30	0.034	0.051
b	0.35	0.50	0.013	0.020
C	0.09	0.20	0.003	0.008
D	2.80	3.00	0.110	0.118
E	2.60	3.00	0.102	0.118
E1	1.50	1.75	0.059	0.069
L	0.10	0.60	0.003	0.024