TS951
TS952
TS954

INPUT/OUTPUT **RAIL TO RAIL** LOW POWER OPERATIONAL AMPLIFIERS

- 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**
- ESD PROTECTION **(2kV**)
- 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

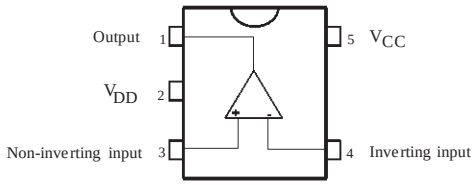
ORDER CODES

Part Number	Temperature Range	Package				SOT23 Marking
		N	D	P	L	
TS951I	-40, +125°C		•		•	K101
TS952I	-40, +125°C	•	•	•		
TS954I	-40, +125°C	•	•	•		

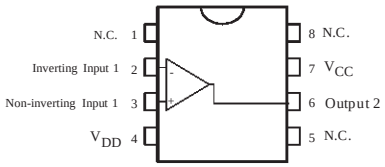
N = Dual in Line Package (DIP)
D = Small Outline Package (SO) - also available in Tape & Reel
P = Thin Shrink Small Outline Package (TSSOP) - only available in Tape & Reel (PT)
L = Tiny Package (SOT23-5) - only available in Tape & Reel (LT)

PIN CONNECTIONS (top view)

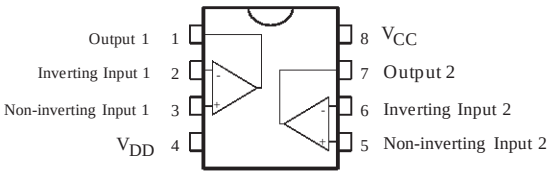
TS951ILT



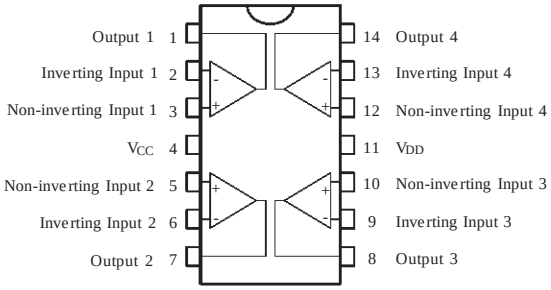
TS951ID



TS952IN-TS952ID-TS952IPT



TS954IN-TS954ID-TS954IPT



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_{CC}	Supply Voltage - note 1	12	V
V_{id}	Differential Input Voltage - note 2	±1	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 - SOT23-5	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 magnitude 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} - 0.2 to V_{CC} + 0.2	V

ELECTRICAL CHARACTERISTICS

V_{CC} = **+3V**, V_{DD} = **0V**, T_{amb} = 25°C (unless otherwise specified)

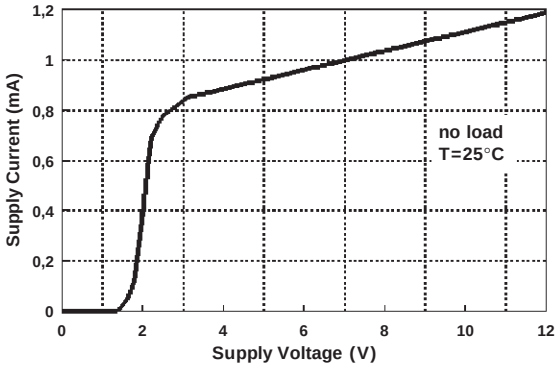
Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{io}	Input Offset Voltage $T_{min.} \le T_{amb} \le T_{max.}$			6 8	mV
DV_{io}	Input Offset Voltage Drift		2		µV/°C
I_{io}	Input Offset Current $T_{min.} \le T_{amb} \le T_{max.}$		1	30 80	nA
I_{ib}	Input Bias Current V_{icm} = 1.5V $T_{min.} \le T_{amb} \le T_{max.}$		35	100 200	nA
V_{icm}	Common Mode Input Voltage Range	V_{DD} - 0.2 to V_{CC} + 0.2			V
CMR	Common Mode Rejection Ratio	50	80		dB
SVR	Supply Voltage Rejection Ratio V_{CC} = 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, $V_o = V_{CC/2}$		0.9	1.3	mA
GBP	Gain Bandwidth Product R_L = 2kΩ		3		MHz
SR	Slew Rate		1		V/µs
∅m	Phase Margin at Unity Gain R_L = 600Ω, C_L = 100pF		60		Degrees
G_m	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_o = 4Vpk-pk, f = 10kHz, A_V = 2, R_L = 10kΩ		0.01		%

ELECTRICAL CHARACTERISTICS

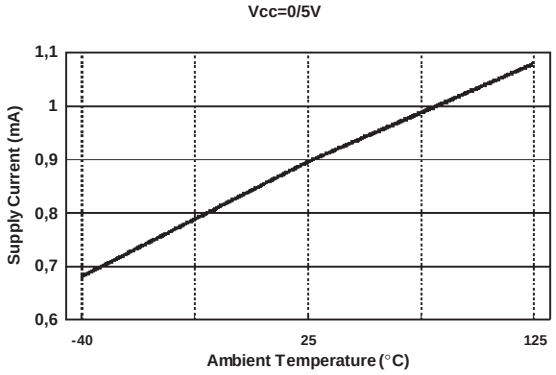
V_{CC} = **+5V**, V_{DD} = **0V**, T_{amb} = 25°C (unless otherwise specified)

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} = 1.5V $T_{min.} \le T_{amb} \le T_{max.}$		35	100 200	nA
V_{icm}	Common Mode Input Voltage Range	V_{DD} - 0.2 to V_{CC} + 0.2			V
CMR	Common Mode Rejection Ratio	50	80		dB
SVR	Supply Voltage Rejection Ratio V_{CC} = 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 amplifer) No load, $V_o = V_{CC/2}$		0.95	1.4	mA
GBP	Gain Bandwidth Product R_L = 2kΩ		3		MHz
SR	Slew Rate		1		V/µs
∅m	Phase Margin at Unity Gain R_L = 600Ω, C_L = 100pF		60		Degrees
G_m	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_o = 4Vpk-pk, f = 10kHz, A_V = 2, R_L = 10kΩ		0.01		%

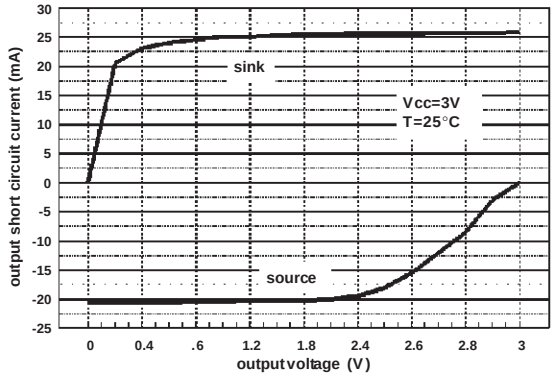
SUPPLY CURRENT VERSUS SUPPLY VOLTAGE



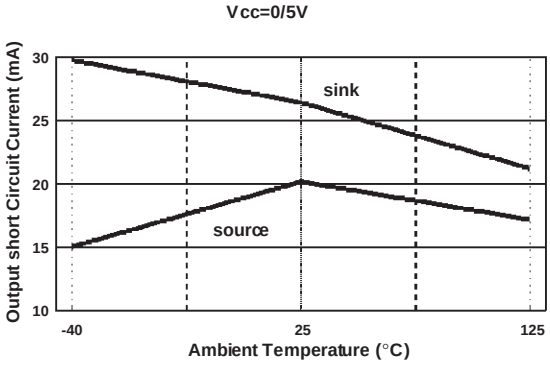
SUPPLY CURRENT VERSUS TEMPERATURE



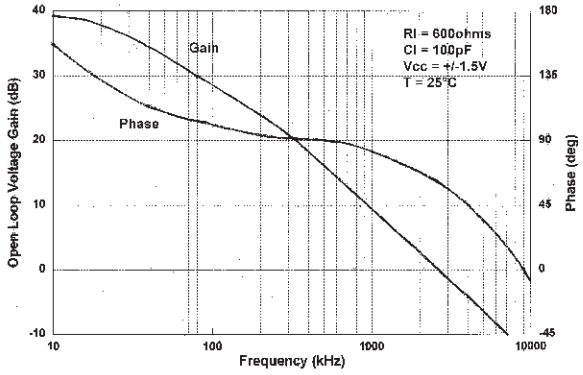
OUTPUT SHORT CIRCUIT CURRENT VERSUS OUTPUT VOLTAGE



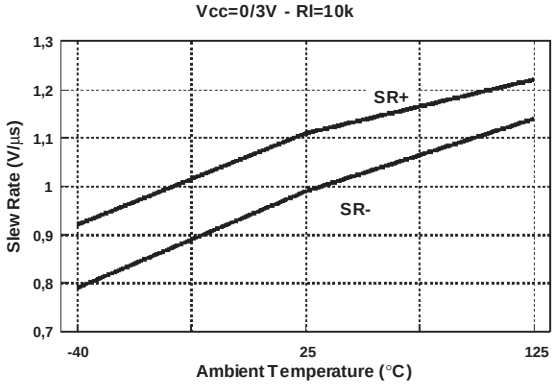
OUTPUT SHORT CIRCUIT CURRENT VERSUS TEMPERATURE



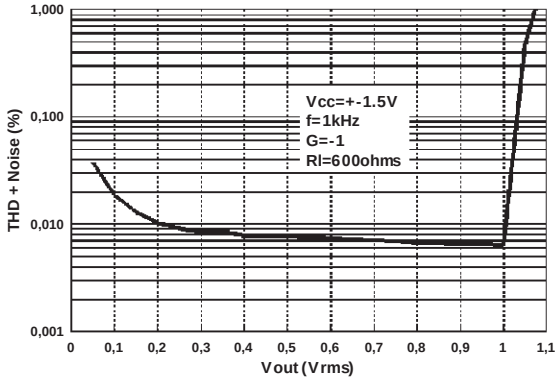
VOLTAGE GAIN AND PHASE VERSUS FREQUENCY



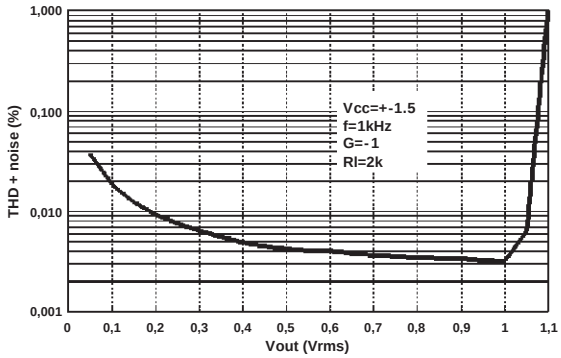
SLEW RATE VERSUS TEMPERATURE



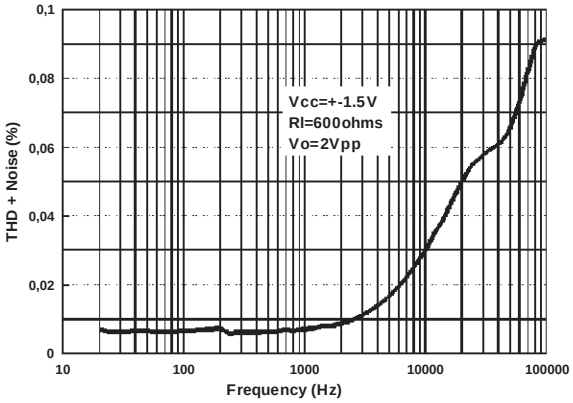
THD + NOISE VERSUS V_{out}



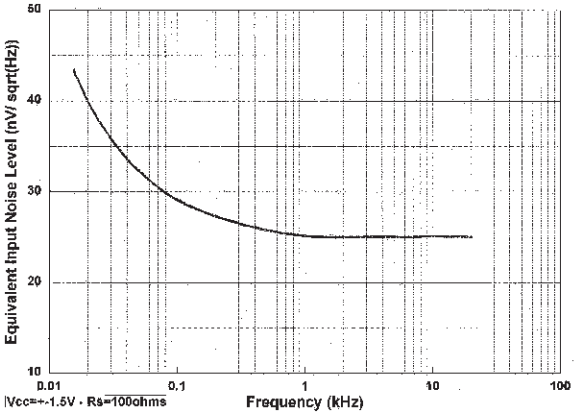
THD + NOISE VERSUS V_{out}



THD + NOISE VERSUS FREQUENCY



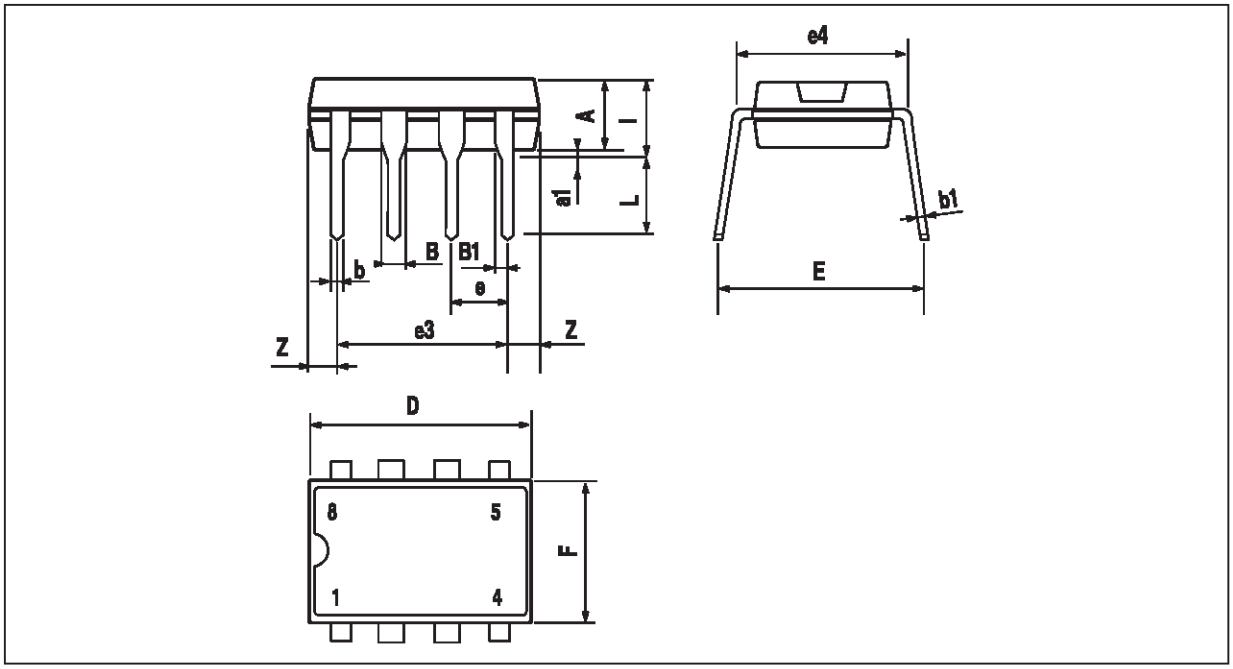
EQUIVALENT INPUT NOISE VOLTAGE VERSUS FREQUENCY



TS952IN



PACKAGE MECHANICAL DATA
8 PINS - PLASTIC PACKAGE

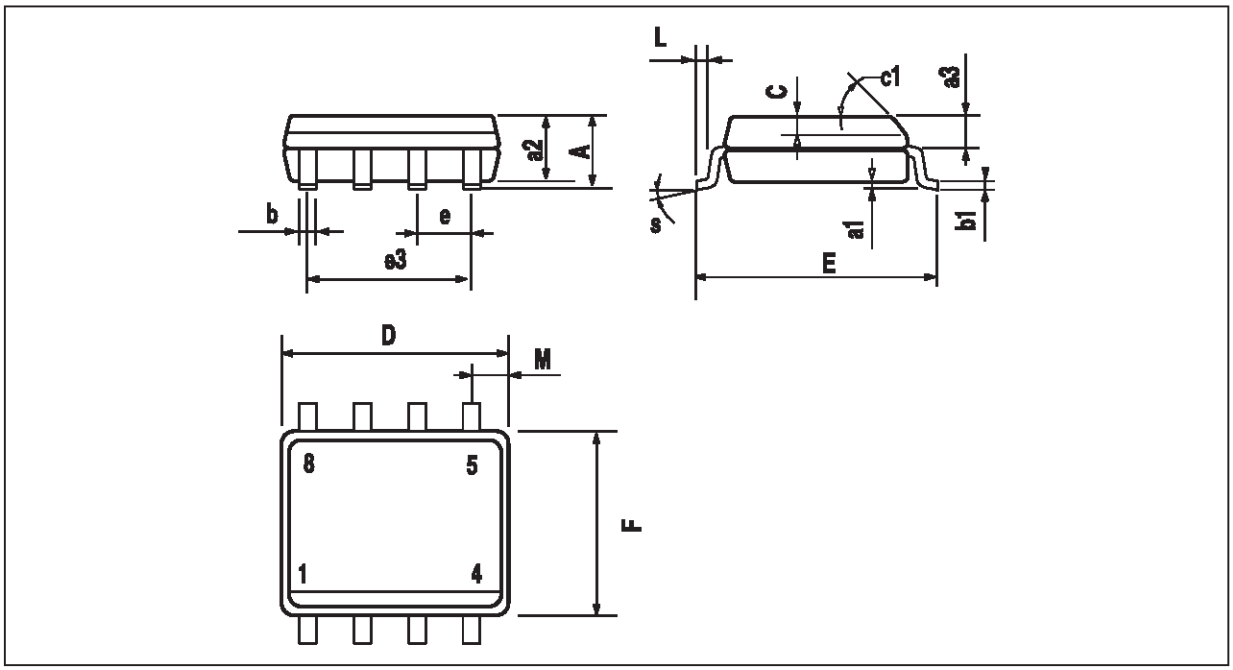


Dimensions	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A		3.32			0.131	
a1	0.51			0.020		
B	1.15		1.65	0.045		0.065
b	0.356		0.55	0.014		0.022
b1	0.204		0.304	0.008		0.012
D			10.92			0.430
E	7.95		9.75	0.313		0.384
e		2.54			0.100	
e3		7.62			0.300	
e4		7.62			0.300	
F			6.6			0260
i			5.08			0.200
L	3.18		3.81	0.125		0.150
Z			1.52			0.060

TS951ID-TS952ID



PACKAGE MECHANICAL DATA
8 PINS - PLASTIC MICROPACKAGE (SO)

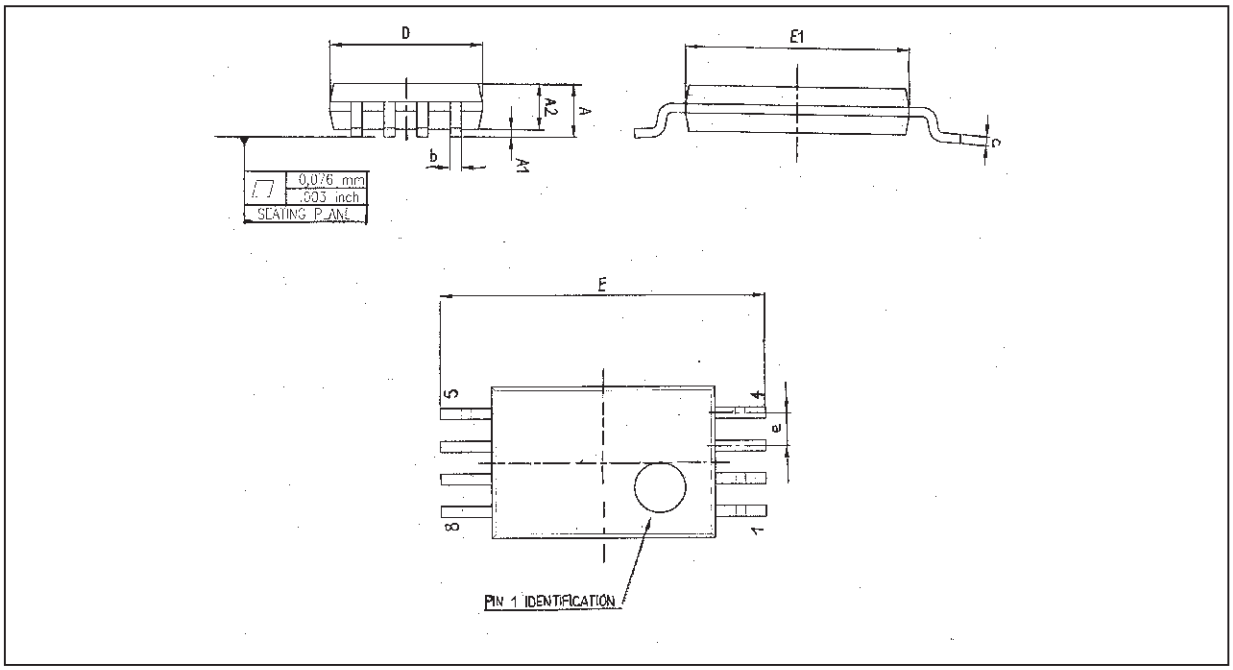


Dim.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
a1	0.1		0.25	0.004		0.010
a2			1.65			0.065
a3	0.65		0.85	0.026		0.033
b	0.35		0.48	0.014		0.019
b1	0.19		0.25	0.007		0.010
C	0.25		0.5	0.010		0.020
c1	45^o (typ.)					
D	4.8		5.0	0.189		0.197
E	5.8		6.2	0.228		0.244
e		1.27			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^o (max.)					

TS952IPT

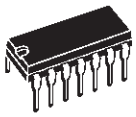


PACKAGE MECHANICAL DATA
8 PINS - THIN SHRINK SMALL OUTLINE PACKAGE



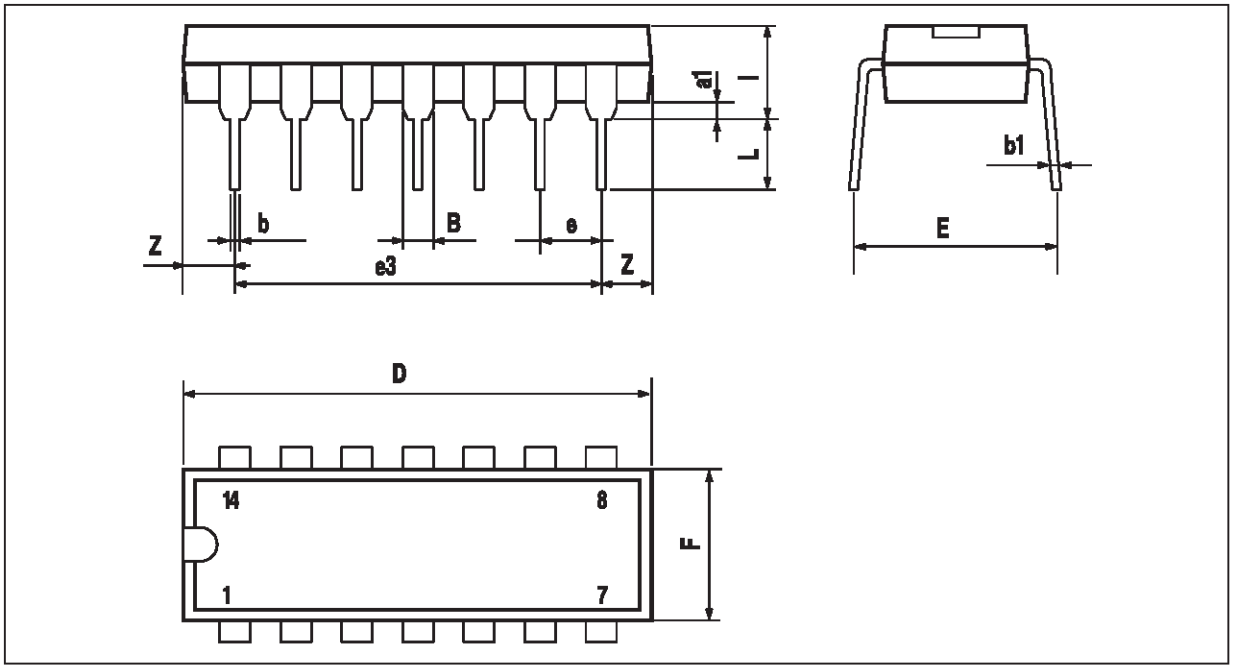
Dim.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.20			0.05
A1	0.05		0.15	0.01		0.006
A2	0.80	1.00	1.05	0.031	0.039	0.041
b	0.19		0.30	0.007		0.15
c	0.09		0.20	0.003		0.012
D	2.90	3.00	3.10	0.114	0.118	0.122
E		6.40			0.252	
E1	4.30	4.40	4.50	0.169	0.173	0.177
e		0.65			0.025	
k	0^o		8^o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

TS954IN



PACKAGE MECHANICAL DATA

14 PINS - PLASTIC PACKAGE

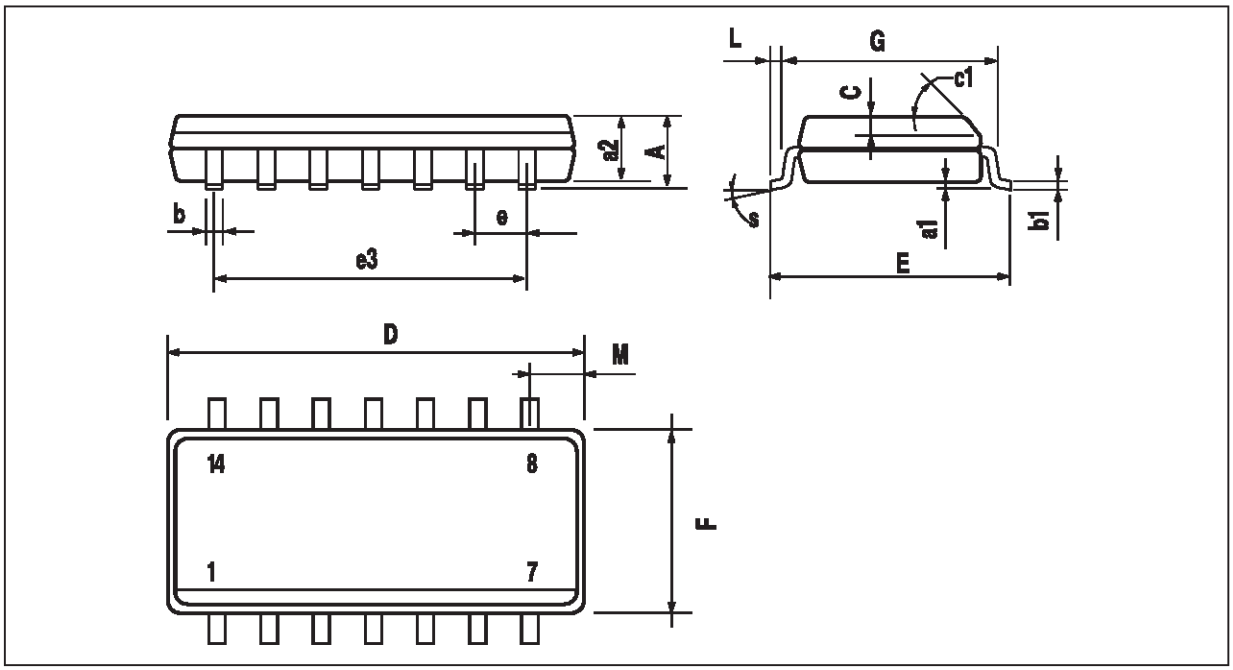


Dim.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
a1	0.51			0.020		
B	1.39		1.65	0.055		0.065
b		0.5			0.020	
b1		0.25			0.010	
D			20			0.787
E		8.5			0.335	
e		2.54			0.100	
e3		15.24			0.600	
F			7.1			0.280
i			5.1			0.201
L		3.3			0.130	
Z	1.27		2.54	0.050		0.100

TS954ID

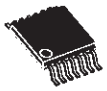


PACKAGE MECHANICAL DATA
14 PINS - PLASTIC MICROPACKAGE (SO)



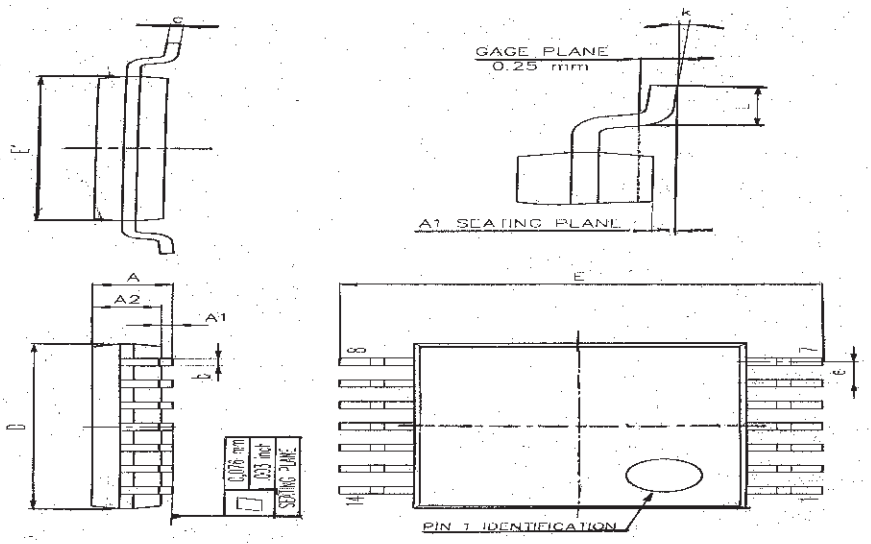
Dim.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
a1	0.1		0.2	0.004		0.008
a2			1.6			0.063
b	0.35		0.46	0.014		0.018
b1	0.19		0.25	0.007		0.010
C		0.5			0.020	
c1	45° (typ.)					
D	8.55		8.75	0.336		0.334
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		7.62			0.300	
F	3.8		4.0	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° (max.)					

TS954IPT



PACKAGE MECHANICAL DATA

14 PINS - THIN SHRINK SMALL OUTLINE PACKAGE



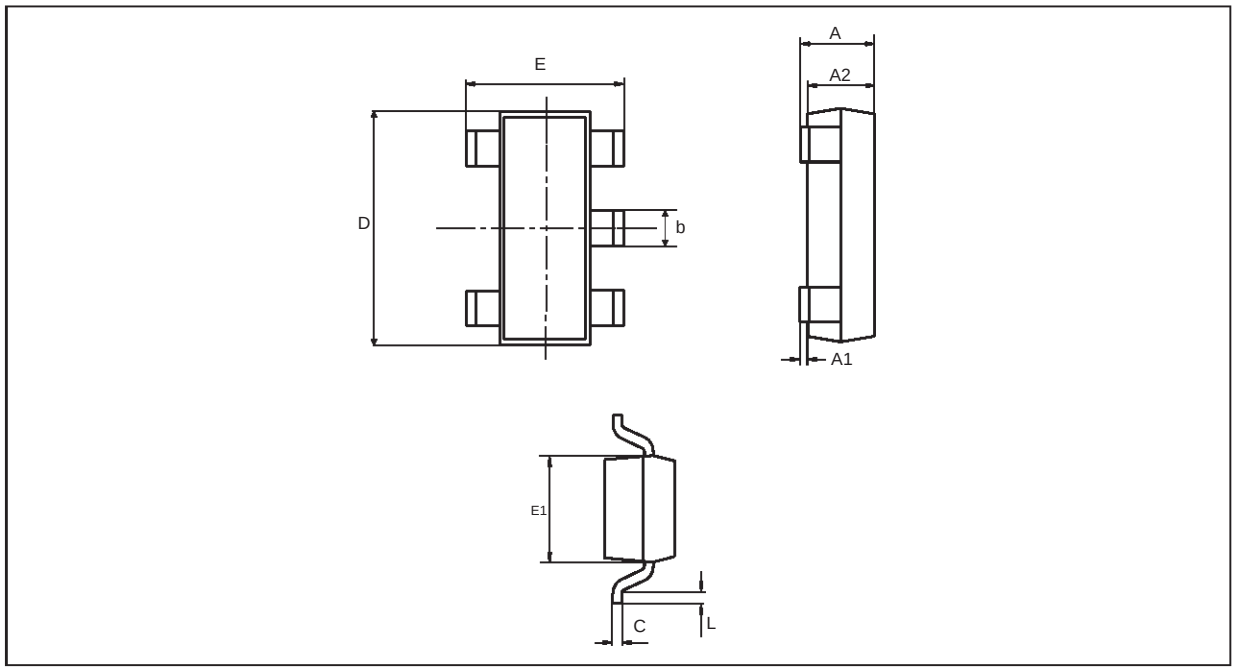
Dim.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.20			0.05
A1	0.05		0.15	0.01		0.006
A2	0.80	1.00	1.05	0.031	0.039	0.041
b	0.19		0.30	0.007		0.15
c	0.09		0.20	0.003		0.012
D	4.90	5.00	5.10	0.192	0.196	0.20
E		6.40			0.252	
E1	4.30	4.40	4.50	0.169	0.173	0.177
e		0.65			0.025	
k	0^o		8^o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

TS951ILT



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

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