![ST logo]

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**
- 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 CODE

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

N = Dual in Line Package (DIP)
D = Small Outline Package (SO) - also available in Tape & Reel (DT)
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
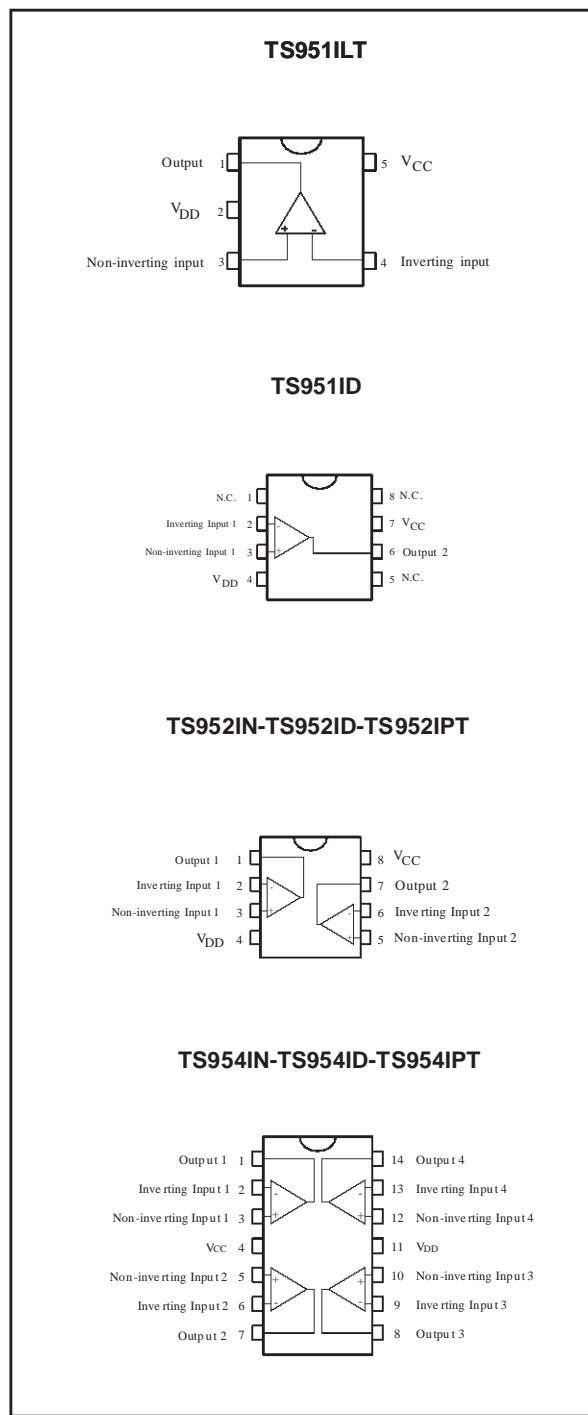
ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage [1]	12	V
V_{id}	Differential Input Voltage [2]	± 1	V
V_{in}	Input Voltage [3]	-0.3 to 12.3	V
T_{oper}	Operating Free Air Temperature Range	-40 to +125	°C
Tstg	Storage Temperature Range	-65 to +150	
T_j	Maximum Junction Temperature	150	°C
Rthjc	Thermal Resistance Junction to Case [4] SOT23-5 SO8 SO14 TSSOP8 TSSOP14	 81 28 22 26 21	°C/W
Rthja	Thermal Resistance Junction to Ambient - SOT23-5	256	°C/W
ESD	Human Body Model	2	kV
	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 t erminal.
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	2.7 to 12	V
V_{icm}	Common Mode Input Voltage Range	V_{DD} -0.2 to V_{CC} +0.1	V

ELECTRICAL CHARACTERISTICS

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

OPERATIONAL AMPLIFIER

| Symbol	Parameter		Min.	Typ.	Max.	Unit
V_{io}	Input Offset Voltage $T_{min} \leq T_{amb} \leq T_{max}$				6 8	mV
DV_{io}	Input Offset Voltage Drift			2		$\mu V/°C$
I_{io}	Input Offset Current $T_{min} \leq T_{amb} \leq T_{max}$			1	30 80	nA
I_{ib}	Input Bias Current $V_{icm} = V_{cc/2}$ $T_{min} \leq T_{amb} \leq T_{max}$			35	100 200	nA
V_{icm}	Common Mode Input Voltage Range		\multicolumn{2}{}{V_{DD} -0.2 to V_{CC} +0.2V}		V
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 $V_o = 2Vpk-pk$	$R_L = 600\Omega$		80		dB
V_{OH}	High Level Output Voltage	$R_L = 600\Omega$	2.8	2.9		V
V_{OL}	Low Level Output Voltage	$R_L = 600\Omega$		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 Bandwith Product	$R_L = 2k\Omega$		3		MHz
SR	Slew Rate			1		$V/\mu s$
$\varnothing m$	Phase Margin at Unit Gain	$R_L = 600\Omega$, $C_L = 100pF$		60		Degrees
Gm	Gain Margin	$R_L = 600\Omega$, $C_L = 100pF$		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, $A_V = 2$, $R_L = 10k\Omega$			0.01		%

ELECTRICAL CHARACTERISTICS

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

| Symbol	Parameter		Min.	Typ.	Max.	Unit
V_{io}	Input Offset Voltage $T_{min} \leq T_{amb} \leq T_{max}$				6 8	mV
DV_{io}	Input Offset Voltage Drift			2		μV/°C
I_{io}	Input Offset Current V_{icm} = $V_{cc/2}$ $T_{min} \leq T_{amb} \leq T_{max}$			1	30 80	nA
I_{ib}	Input Bias Current V_{icm} = $V_{cc/2}$ $T_{min} \leq T_{amb} \leq T_{max}$			35	100 200	nA
V_{icm}	Common Mode Input Voltage Range		V_{DD}^- -0.2 to V_{CC}^+ +0.2V			V
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 Bandwith 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		%

**SUPPLY CURRENT VERSUS SUPPLY VOLTAGE**
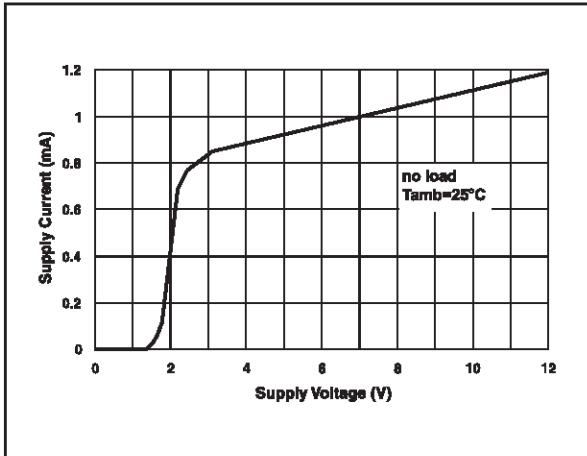

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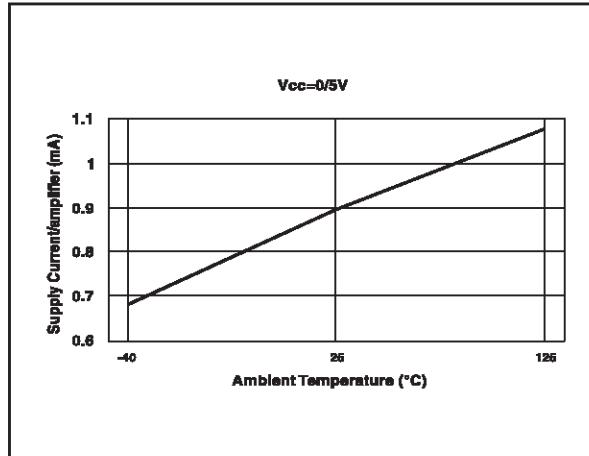
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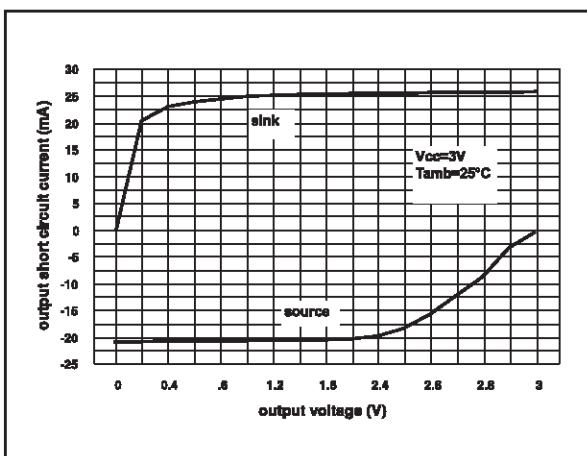
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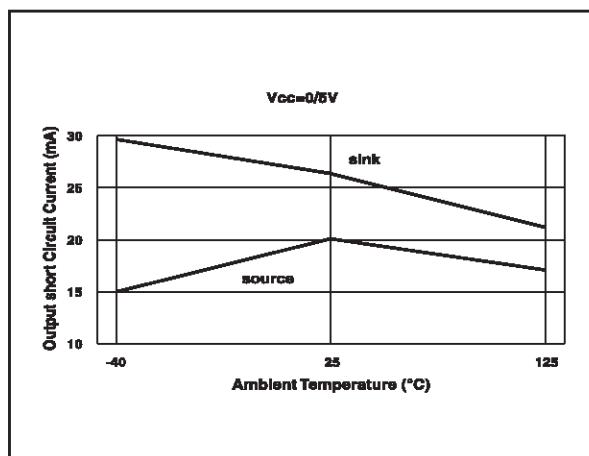

VOLTAGE GAIN AND PHASE VERSUS FREQUENCY
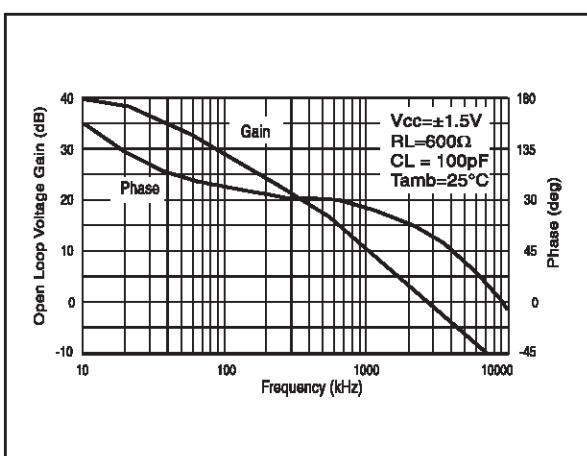
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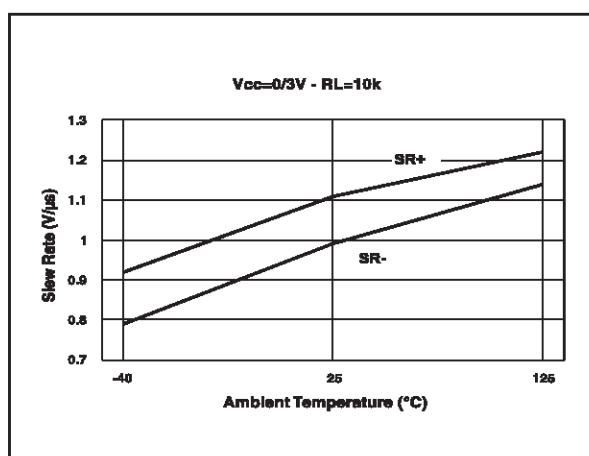
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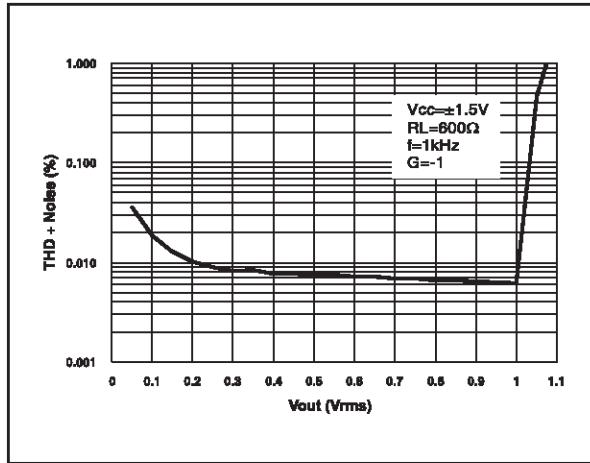
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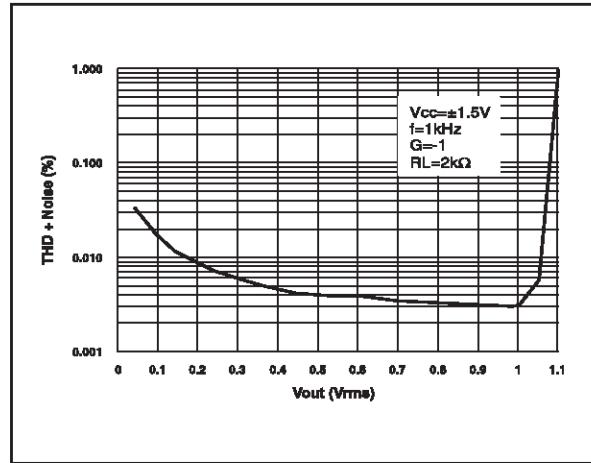
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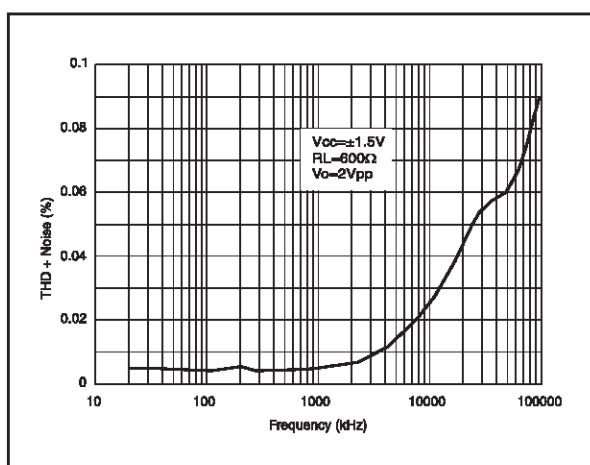
EQUIVALENT INPUT NOISE VOLTAGE VERSUS FREQUENCY
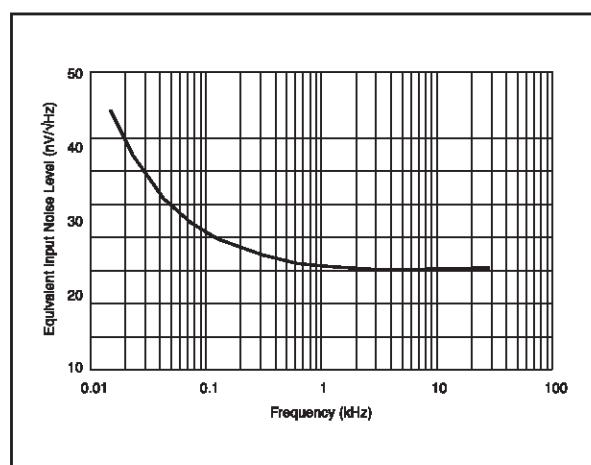
TS952IN
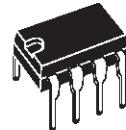

PACKAGE MECHANICAL DATA
8 PINS - PLASTIC PACKAGE
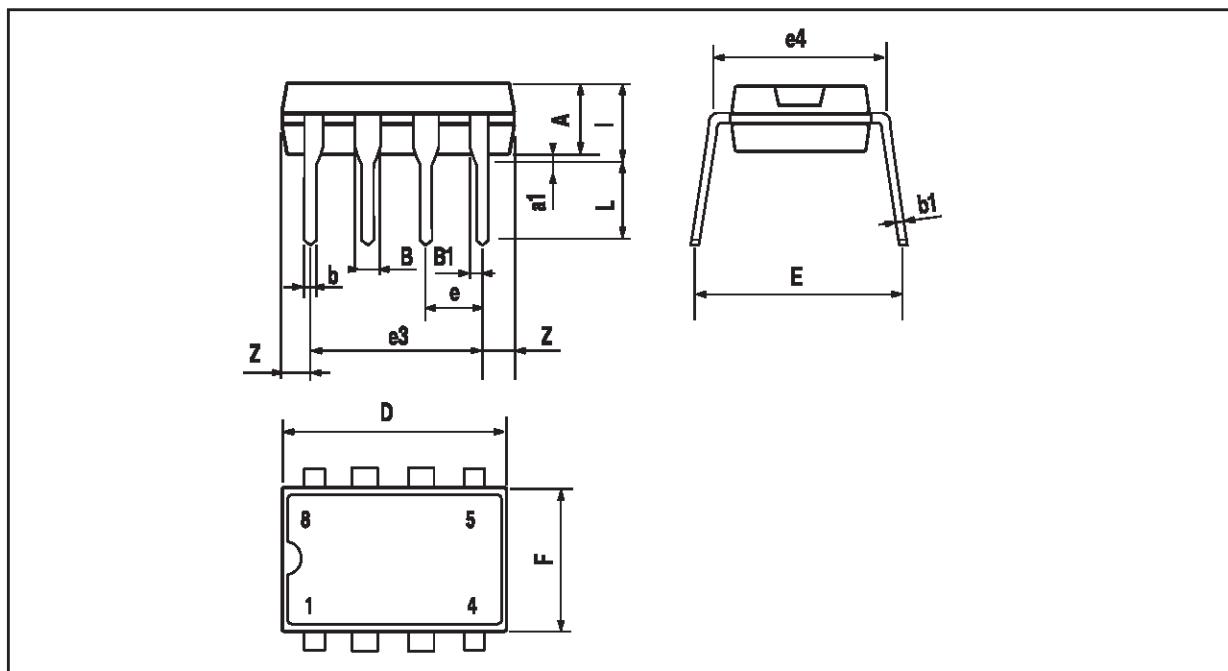
Dim.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A		3.32			0.131	
a1	0.51			0.020		
B	1.15		1.65	0.045		0.065
b	0.356		0.55	0.014		0.022
b1	0.204		0.304	0.008		0.012
D			10.92			0.430
E	7.95		9.75	0.313		0.384
e		2.54			0.100	
e3		7.62			0.300	
e4		7.62			0.300	
F			6.6			0260
i			5.08			0.200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

TS951-TS952-TS954

TS951ID-TS952ID
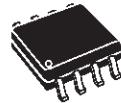
PACKAGE MECHANICAL DATA
8 PINS - PLASTIC MICROPACKAGE (SO)
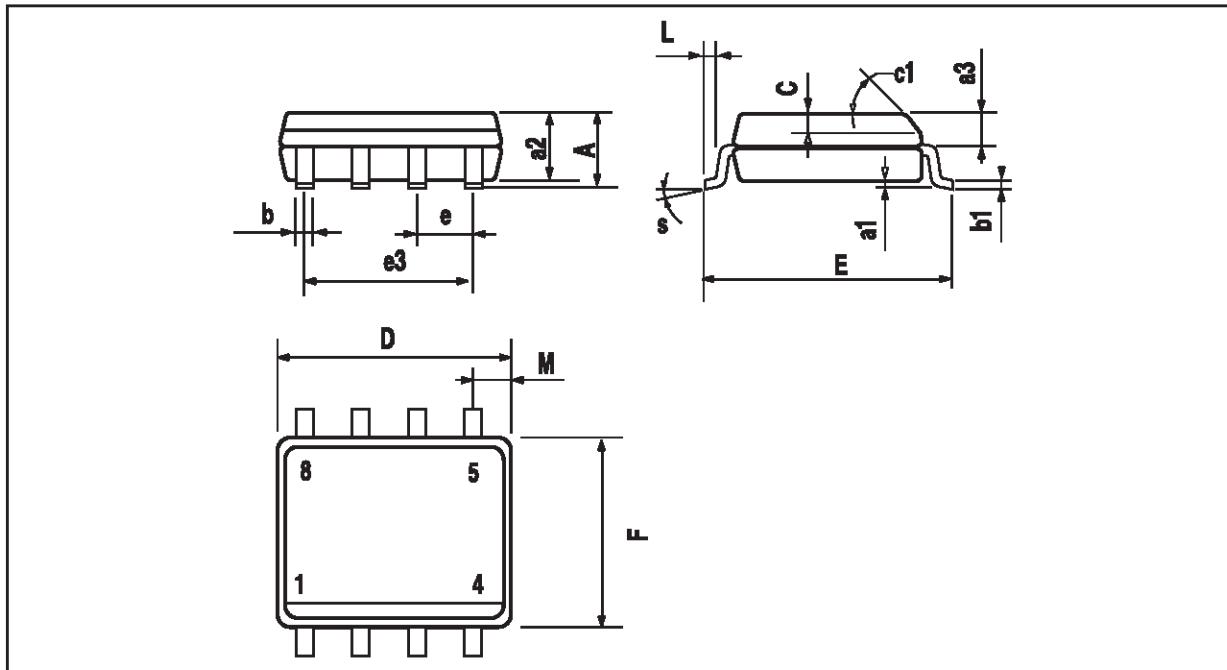
Dim.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
a1	0.1		0.25	0.004		0.010
a2			1.65			0.065
a3	0.65		0.85	0.026		0.033
b	0.35		0.48	0.014		0.019
b1	0.19		0.25	0.007		0.010
C	0.25		0.5	0.010		0.020
c1	45° (typ.)					
D	4.8		5.0	0.189		0.197
E	5.8		6.2	0.228		0.244
e		1.27			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.)					

TS952IPT
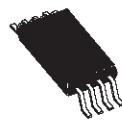
PACKAGE MECHANICAL DATA
8 PINS - THIN SHRINK SMALL OUTLINE PACKAGE
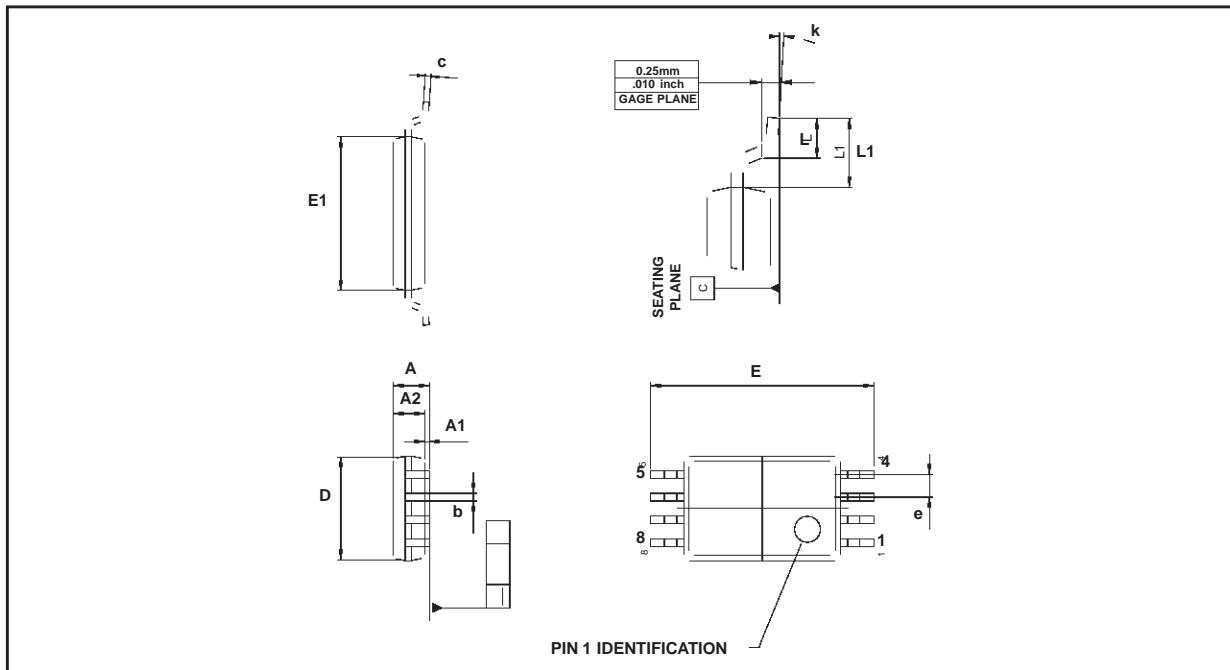
PIN 1 IDENTIFICATION

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°		8°	0°		8°
l	0.50	0.60	0.75	0.09	0.0236	0.030
L	0.45	0.600	0.75	0.018	0.024	0.030
L1		1.000			0.039	

TS954IN
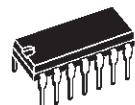
PACKAGE MECHANICAL DATA

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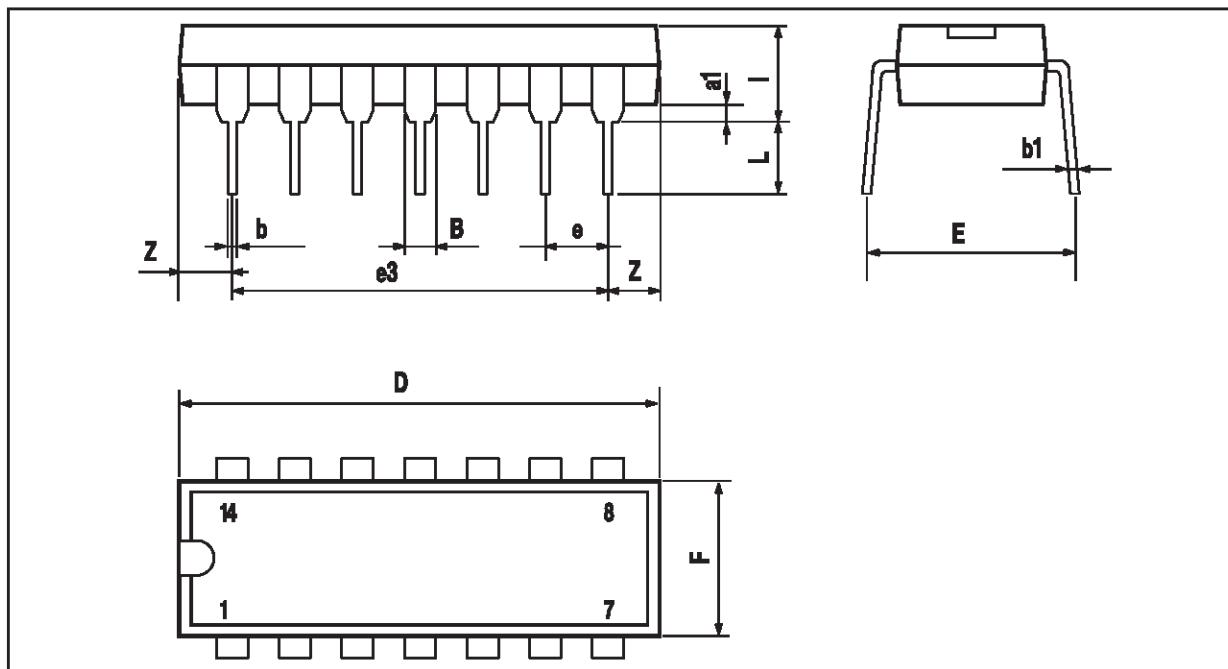
Dim.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
a1	0.51			0.020		
B	1.39		1.65	0.055		0.065
b		0.5			0.020	
b1		0.25			0.010	
D			20			0.787
E		8.5			0.335	
e		2.54			0.100	
e3		15.24			0.600	
F			7.1			0.280
i			5.1			0.201
L		3.3			0.130	
Z	1.27		2.54	0.050		0.100

TS954ID
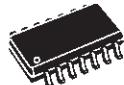
PACKAGE MECHANICAL DATA

14 PINS - PLASTIC MICROPACKAGE (SO)
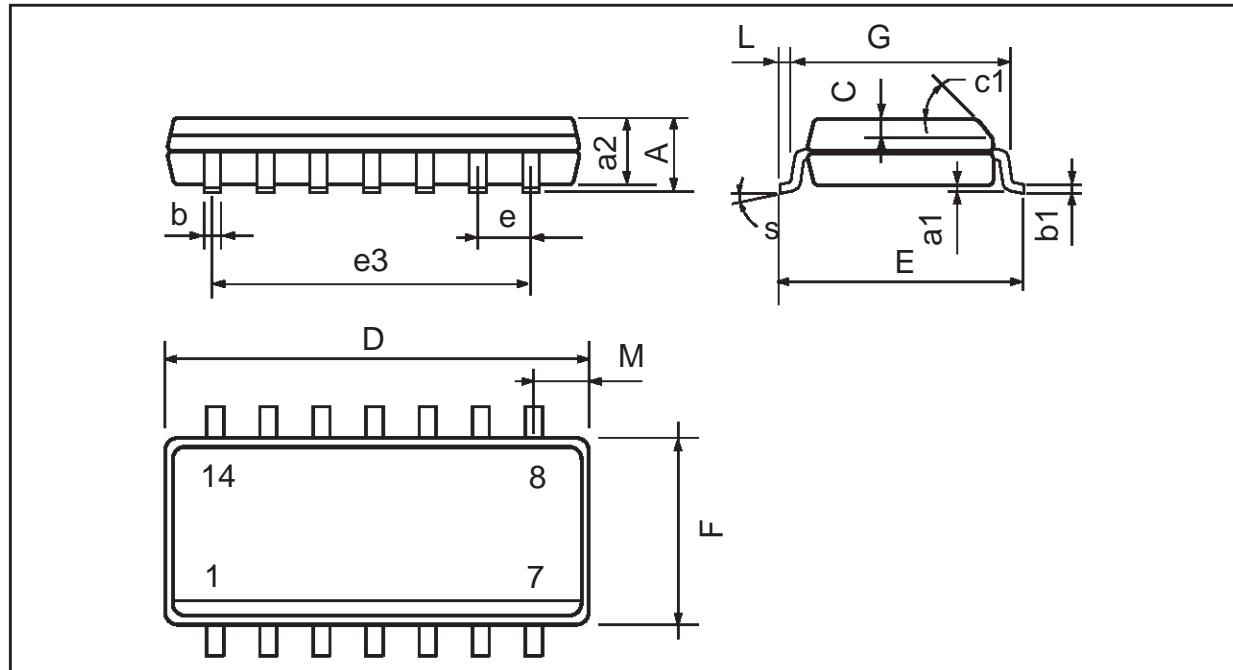
| Dim.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
a1	0.1		0.2	0.004		0.008
a2			1.6			0.063
b	0.35		0.46	0.014		0.018
b1	0.19		0.25	0.007		0.010
C		0.5			0.020	
c1	45° (typ.)					
D (1)	8.55		8.75	0.336		0.344
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		7.62			0.300	
F (1)	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.)					

Note : (1) D and F do not include mold flash or protrusions - Mold flash or protrusions shall not exceed 0.15mm (.066 inc) ONLY FOR DATA BOOK.

TS951-TS952-TS954

TS954IPT
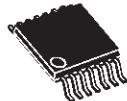
PACKAGE MECHANICAL DATA
14 PINS - THIN SHRINK SMALL OUTLINE PACKAGE
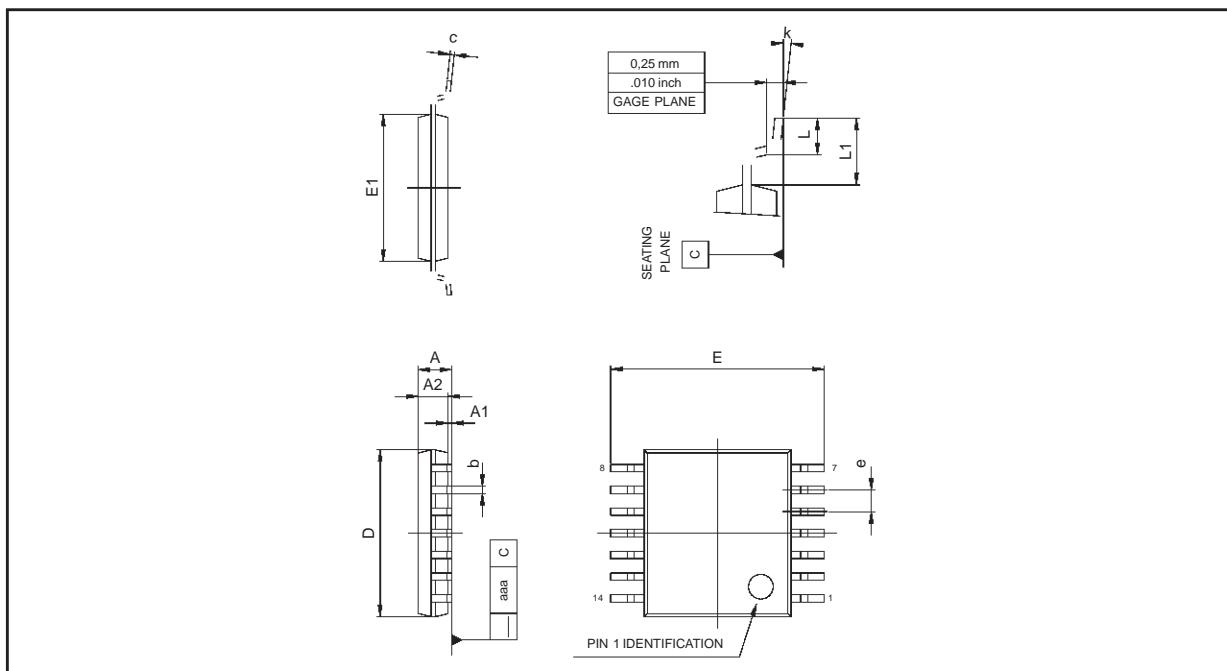
Dim.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.20			0.05
A1	0.05		0.15	0.01		0.006
A2	0.80	1.00	1.05	0.031	0.039	0.041
b	0.19		0.30	0.007		0.15
c	0.09		0.20	0.003		0.012
D	4.90	5.00	5.10	0.192	0.196	0.20
E		6.40			0.252	
E1	4.30	4.40	4.50	0.169	0.173	0.177
e		0.65			0.025	
k	0°		8°	0°		8°
l	0.50	0.60	0.75	0.09	0.0236	0.030

TS951ILT
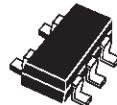
PACKAGE MECHANICAL DATA
5 PINS - TINY PACKAGE (SOT23)
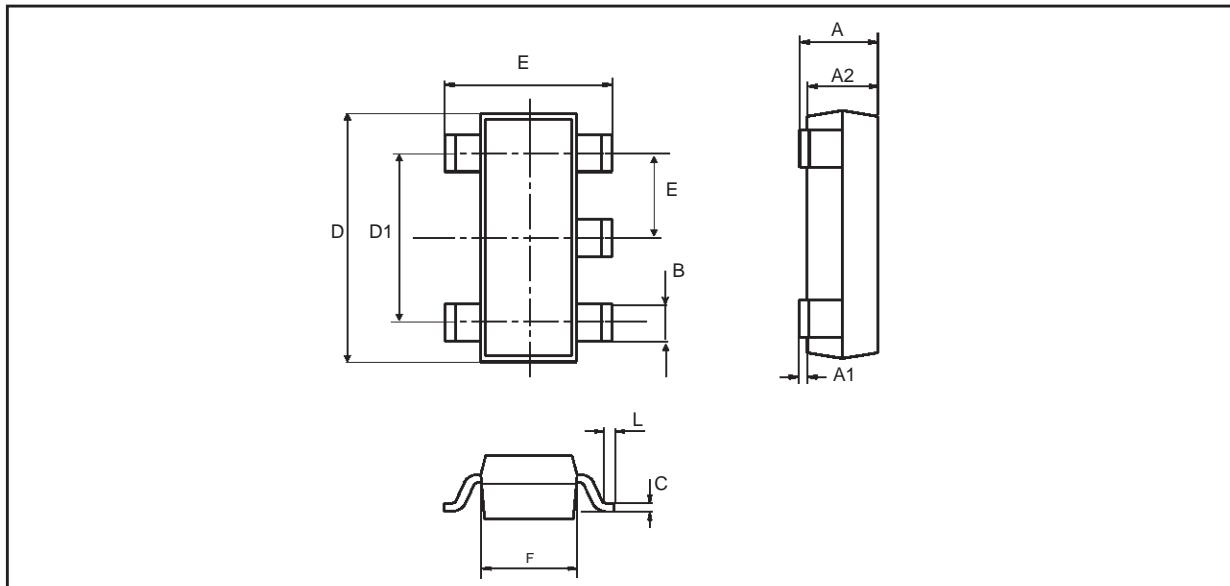
Dim.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	0.90	1.20	1.45	0.035	0.047	0.057
A1	0		0.15			0.006
A2	0.90	1.05	1.30	0.035	0.041	0.051
B	0.35	0.40	0.50	0.014	0.016	0.020
C	0.09	0.15	0.20	0.004	0.006	0.008
D	2.80	2.90	3.00	0.110	0.114	0.118
D1		1.90			0.075	
e		0.95			0.037	
E	2.60	2.80	3.00	0.102	0.110	0.118
F	1.50	1.60	1.75	0.059	0.063	0.069
L	0.10	0.5	0.60	0.004	0.014	0.024
K	0d		10d	0d		10d