TS931
TS932
TS934

OUTPUT **RAIL TO RAIL**
MICROPOWER OPERATIONAL AMPLIFIERS

- RAIL TO RAIL **OUTPUT** VOLTAGE SWING
- **MICROPOWER** CONSUMPTION **(20µA)**
- SINGLE SUPPLY OPERATION **(2.7V to 10V**
- LOW **OFFSET (2mV max for TS93xB)**
- CMOS **INPUTS**
- ULTRA LOW INPUT BIAS CURRENT (**1pA**)
- ESD PROTECTION **(2kV)**
- LATCH-UP IMMUNITY **(Class A)**
- AVAILABLE IN **SOT23-5 MICROPACKAGE**

DESCRIPTION

The TS93x (Single, Dual & Quad) is Operational Amplifier able to operate with voltage as low as 2.7V and to reach 2.9Vpp of output swing with

R_L = 100kΩ when supplied @ 3V. Offering a typical consumption of only 20µA, it is particularly well-suited for every kind of battery-supplied applications.

The TS93x is housed in the space-saving 5 pins SOT23-5 package which simplifies the board design because of the ability to be placed everywhere (outside dimensions are : 2.8mm x 2.9mm).

APPLICATION

- Battery-powered systems
- Portable communication systems
- Alarm, smoke detectors
- Instrumentation & sensoring
- PH Meter
- Digital scales

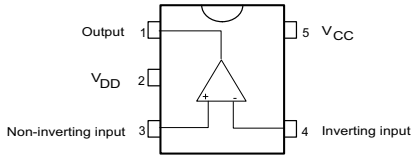
ORDER CODE

Part Number	Temperature Range	Package				SOT23 Marking
		N	D	P	L	
TS931I TS931A/BI	-40, +85°C		• •		• •	K205 K206/207
TS932I TS932A/BI	-40, +85°C	• •	• •			
TS934I TS934A/BI	-40, +85°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)

TS931ILT



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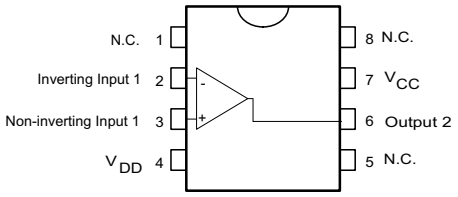

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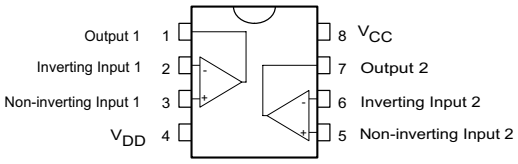

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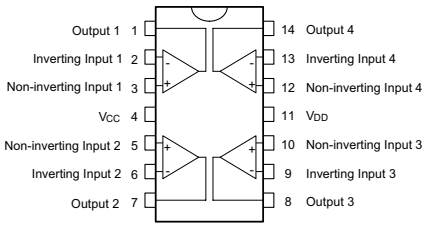

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ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage [1)]	12	V
V_{id}	Differential Input Voltage [2)]	±12	V
V_{in}	Input Voltage Range [3)]	-0.3 to 12.3	V
T_{oper}	Operating Free Air Temperature Range	-40 to + 85	°C
T_{std}	Storage Temperature Range	-65 to +150	°C
T_j	Maximum Junction Temperature	150	°C
R_{thjc}	Thermal Resistance Junction to Case [4)] SOT23-5 DIP8 DIP14 SO8 SO14 TSSOP8 TSSOP14	 81 42 32 28 22 26 21	°C/W
R_{thja}	Thermal Resistance Junction to Ambient - SOT23-5	256	°C/W
ESD	Human Body Model	2	kV
	Latch-up Immunity	Class A	
	Lead Temperature (soldering, 10sec)	260	°C

1. All voltages values, except differential voltage are with respect to network 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	2.7 to 10	V
V_{icm}	Common Mode Input Voltage Range	V_{ee} - 0.2 to V_{CC} - 1.5	V

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ELECTRICAL CHARACTERISTICS

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

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{io}	Input Offset Voltage TS931/2/4 TS931/2/4A TS931/2/4B			10 5 2	mV
ΔV_{io}	Input Offset Voltage Drift		3		µV/°C
I_{io}	Input Offset Current [1]		1	100	pA
I_{ib}	Input Bias Current [1]		1	150	pA
CMR	Common Mode Rejection Ratio $0 \le V_{icm} \le V_{CC}$ - 1.7		85		dB
SVR	Supply Voltage Rejection Ratio [2]		85		dB
A_{vd}	Large Signal Voltage Gain V_O = 2Vpp R_L = 1MΩ R_L = 100kΩ		120 106		dB
V_{OH}	High Level Output Voltage V_{ID} = 100mV R_L = 100kΩ	2.95			V
V_{OL}	Low Level Output Voltage V_{ID} = -100mV R_L = 100kΩ			50	mV
I_o	Output Source Current V_{ID} = 100mV, V_O = V_{DD} Output Sink Current V_{ID} = -100mV, V_O = V_{CC}		1.5 1.5		mA
I_{CC}	Supply Current (per amplifier) A_{VCL} = 1, no load		20	31	µA
GBP	Gain Bandwith Product R_L = 100kΩ, C_L = 50pF		100		kHz
SR	Slew Rate R_L = 100kΩ, C_L = 50pF		50		V/ms
ϕm	Phase Margin C_L = 50pF		65		Degrees
en	Input Voltage Noise		75		nV/√Hz

1. Maximum values including unavoidable inaccurates of the industrial test.
2. V_{CC} has a 0.2V variation.

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ELECTRICAL CHARACTERISTICS

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

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{io}	Input Offset Voltage TS931/2/4 TS931/2/4A TS931/2/4B			10 5 2	mV
ΔV_{io}	Input Offset Voltage Drift		3		µV/°C
I_{io}	Input Offset Current [1]		1	100	pA
I_{ib}	Input Bias Current [1]		1	150	pA
CMR	Common Mode Rejection Ratio $0 \le V_{icm} \le V_{CC}$ - 1.7		85		dB
SVR	Supply Voltage Rejection Ratio [2]		85		dB
A_{vd}	Large Signal Voltage Gain V_O = 4Vpp R_L = 1MΩ R_L = 100kΩ		120 112		dB
V_{OH}	High Level Output Voltage V_{ID} = 100mV R_L = 100kΩ	4.95			V
V_{OL}	Low Level Output Voltage V_{ID} = -100mV R_L = 100kΩ			50	mV
I_o	Output Source Current V_{ID} = 100mV, V_O = V_{DD} Output Sink Current V_{ID} = -100mV, V_O = V_{CC}		5 5		mA
I_{CC}	Supply Current (per amplifier) A_{VCL} = 1, no load		20	33	µA
GBP	Gain Bandwith Product R_L = 100KΩ, C_L = 50pF		100		kHz
SR	Slew Rate R_L = 100KΩ, C_L = 50pF		50		V/ms
ϕm	Phase Margin C_L = 50pF		65		Degrees
en	Input Voltage Noise		76		nV/√Hz

1. Maximum values including unavoidable inaccurates of the industrial test.
2. V_{CC} has a 0.2V variation.

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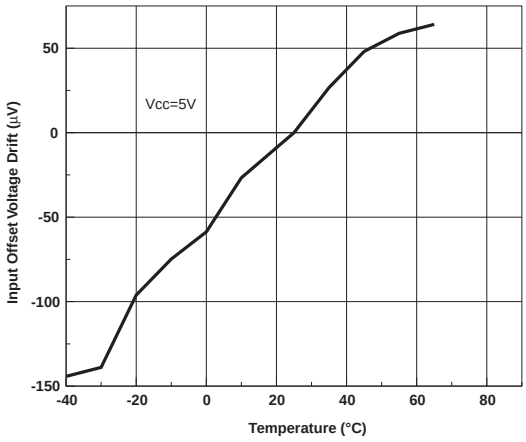

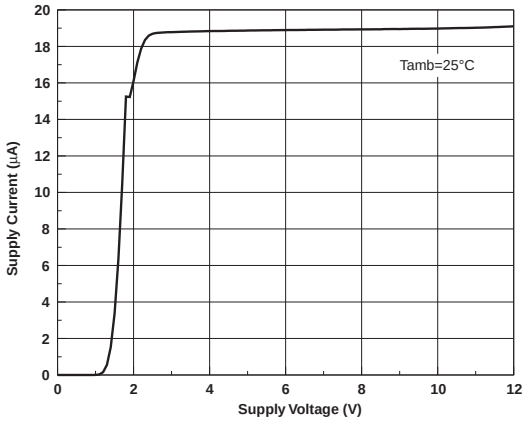

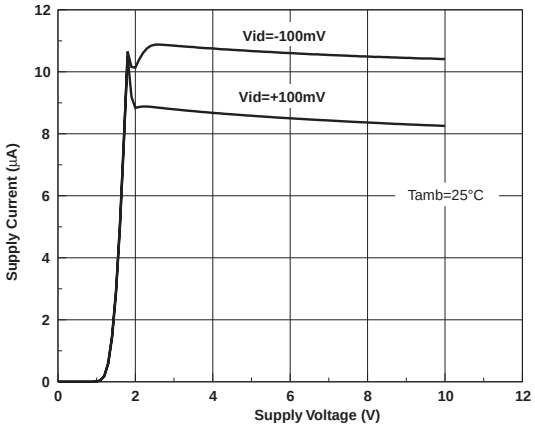

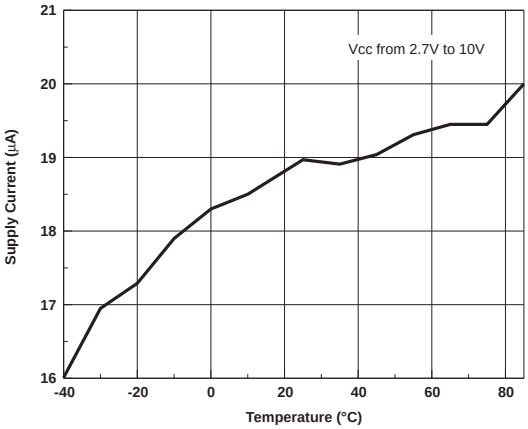

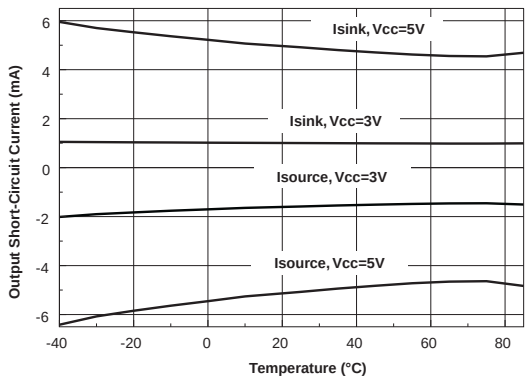

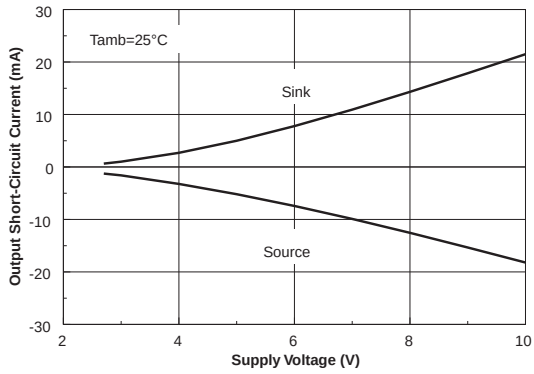

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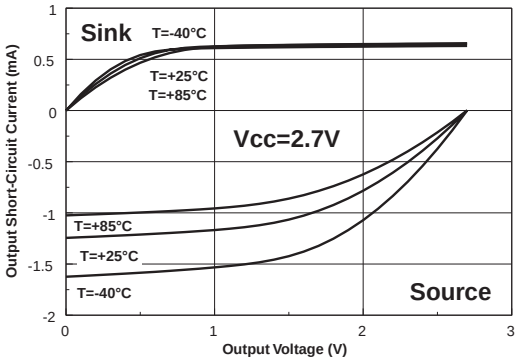

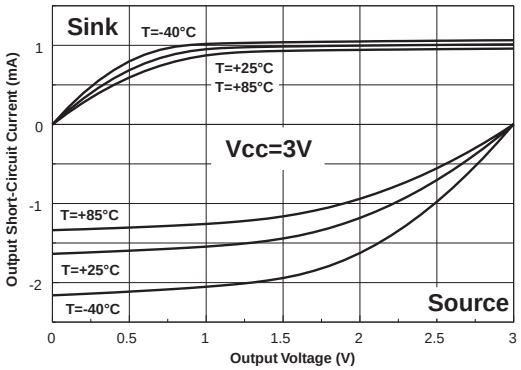

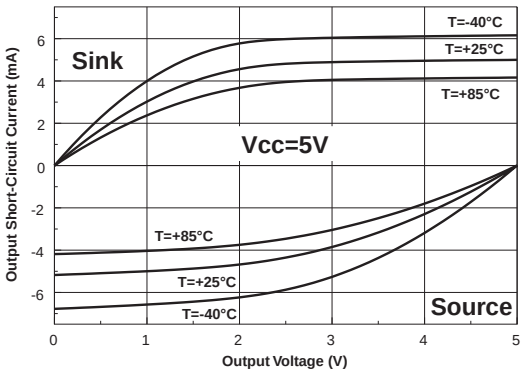

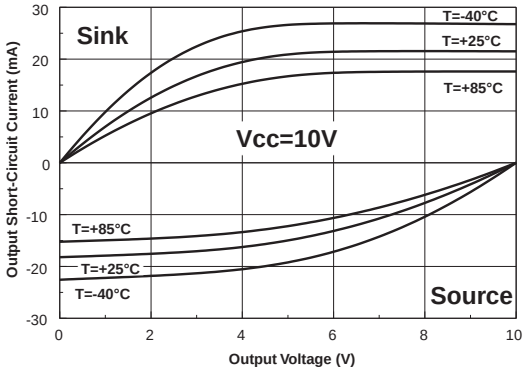

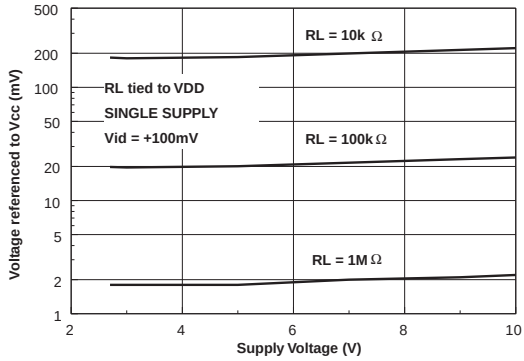

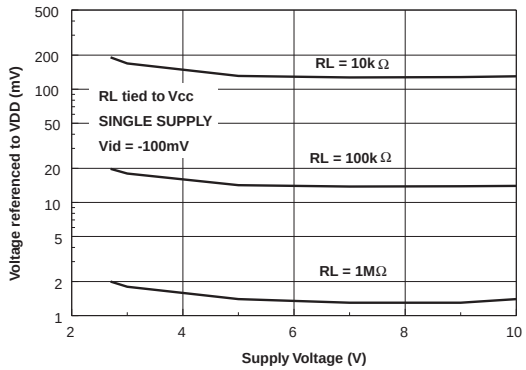

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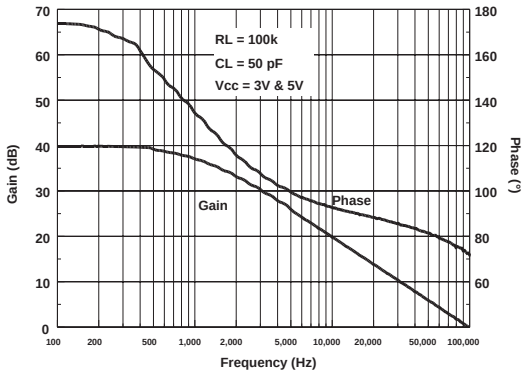

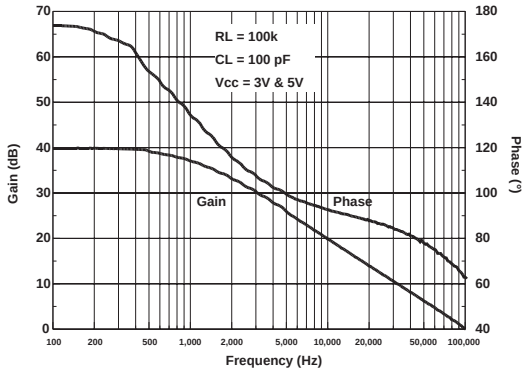

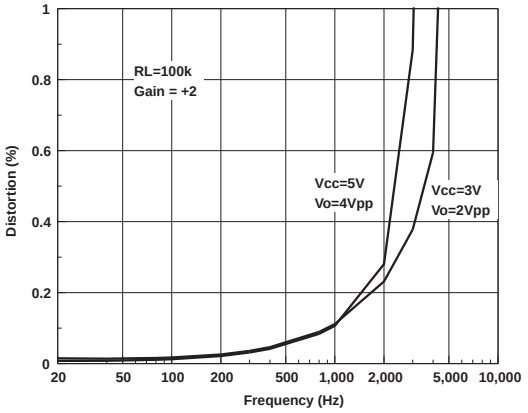

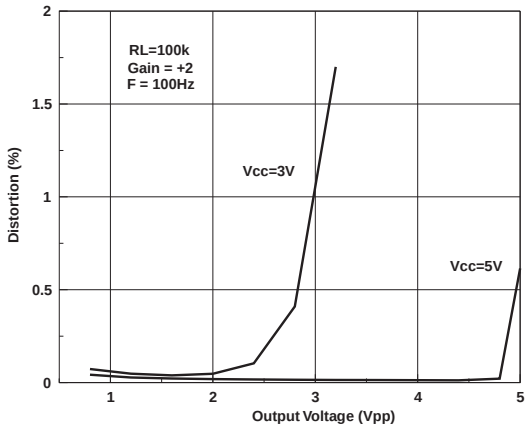

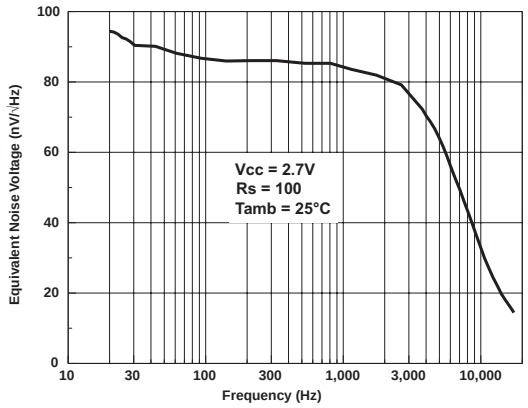

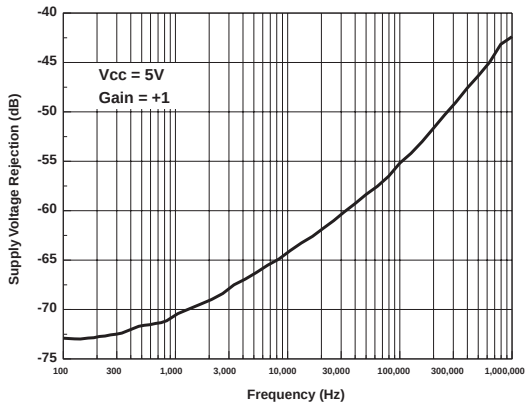

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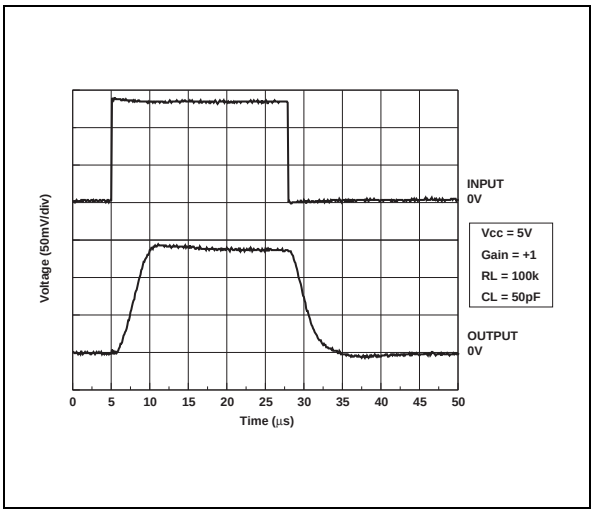

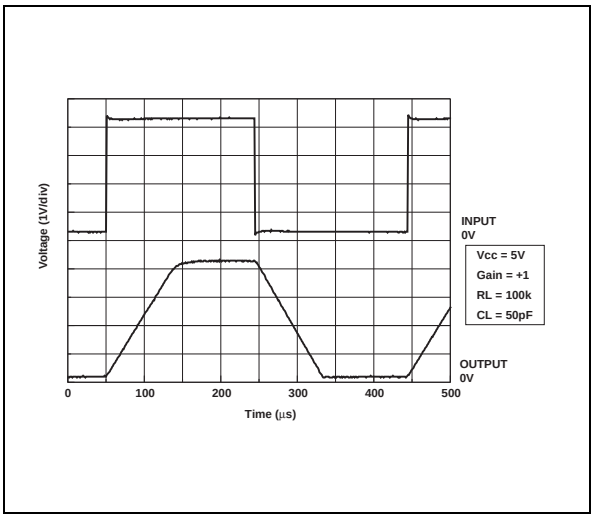

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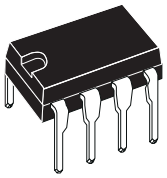
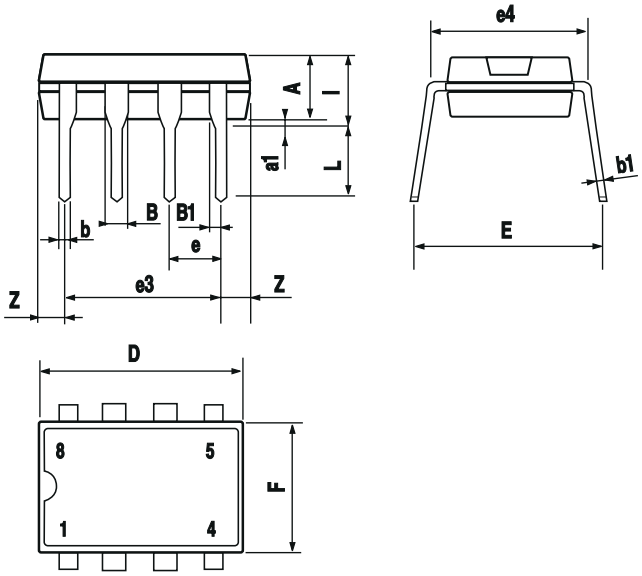
TS932IN



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

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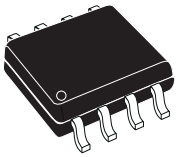
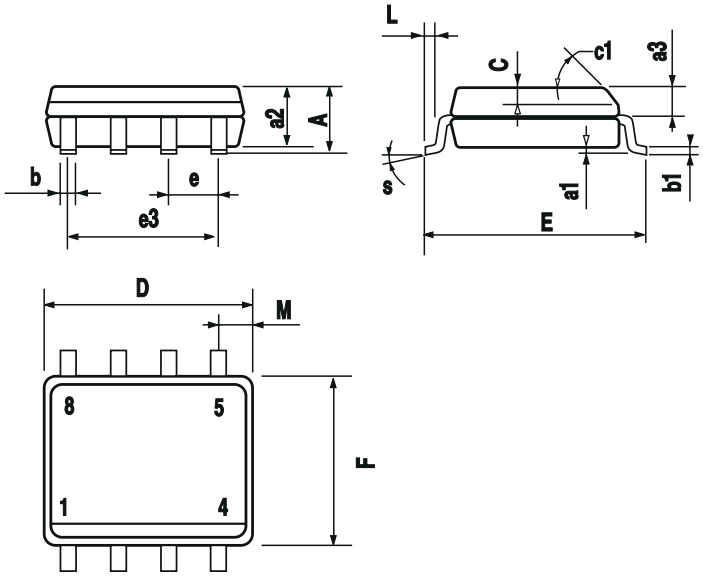
TS931ID - TS932ID



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.)					

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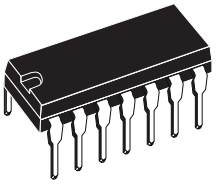
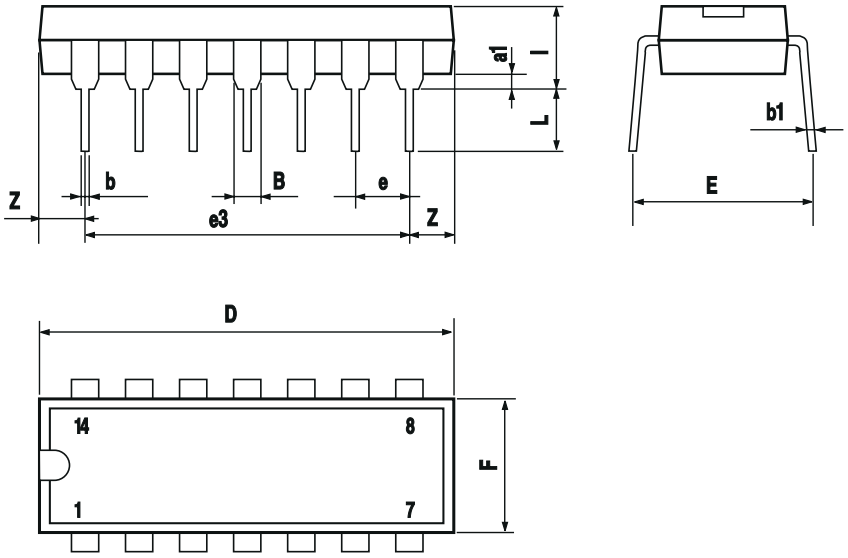
TS934IN



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

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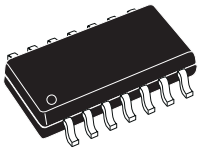
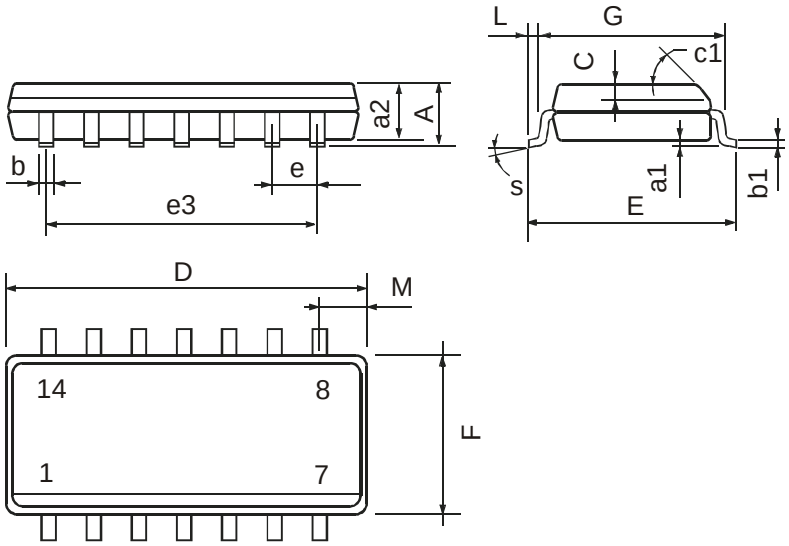
TS934ID



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.

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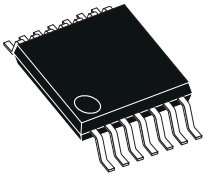
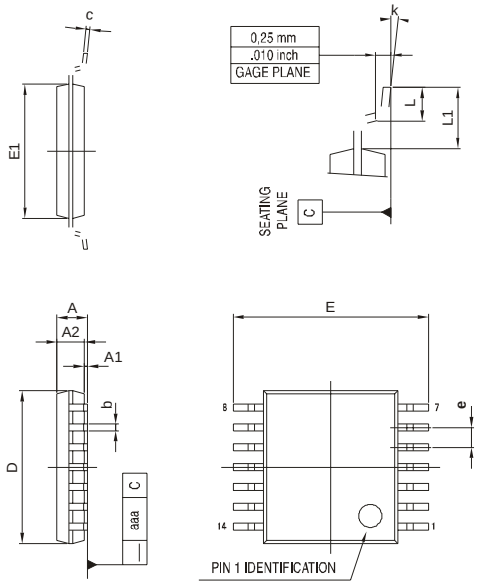
TS934IPT



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

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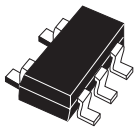
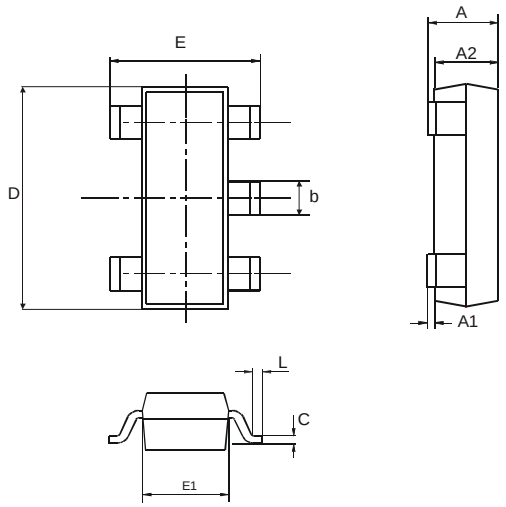
TS931ILT



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	0.0118
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

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