



## MICROPOWER QUAD CMOS VOLTAGE COMPARATORS

- PUSH-PULL CMOS OUTPUT (NO EXTERNAL PULL-UP RESISTOR REQUIRED)
- EXTREMELY LOW SUPPLY CURRENT : **9µA typ / comparator**
- WIDE SINGLE SUPPLY RANGE **2.7V TO 16V** OR DUAL SUPPLIES ( $\pm 1.35V$  TO  $\pm 8V$ )
- EXTREMELY LOW INPUT BIAS CURRENT : **1pA typ**
- EXTREMELY LOW INPUT OFFSET CURRENTS : **1pA typ**
- INPUT COMMON-MODE VOLTAGE RANGE INCLUDES GND
- HIGH INPUT IMPEDANCE :  $10^{12}\Omega$  typ
- FAST RESPONSE TIME : 2µs typ for 5mV overdrive
- PIN-TO-PIN AND FUNCTIONALLY COMPATIBLE WITH BIPOLAR LM339

### DESCRIPTION

The TS3704 is a micropower CMOS quad voltage comparator with extremely low consumption of 9µA typ / comparator (20 times less than bipolar LM339). The push-pull CMOS output stage allows power and space saving by eliminating the external pull-up resistor required by usual open-collector output comparators.

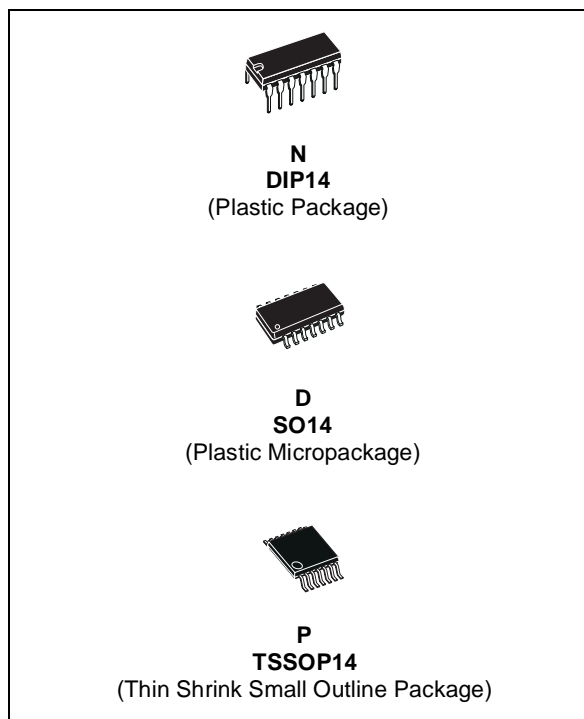
Thus response times remain similar to the LM339.

### ORDER CODE

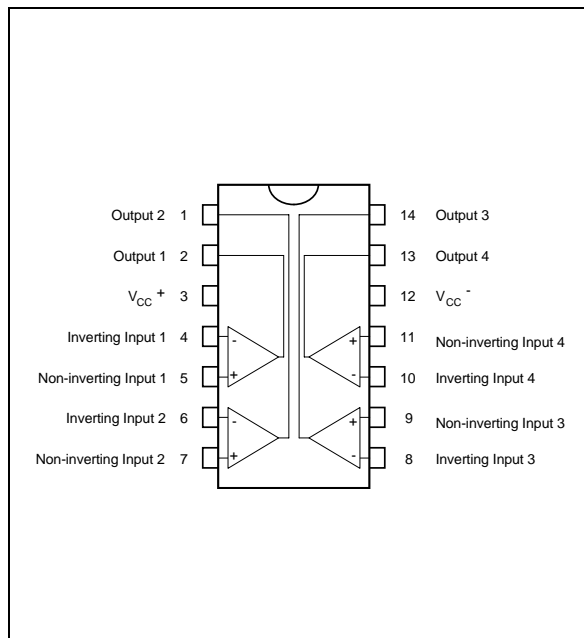
Part Number	Temperature Range	Package		
		N	D	P
TS3704C	0°C, +70°C	•	•	•
TS3704I	-40°C, +125°C	•	•	•
TS3704M	-55°C, +125°C	•	•	•

**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)

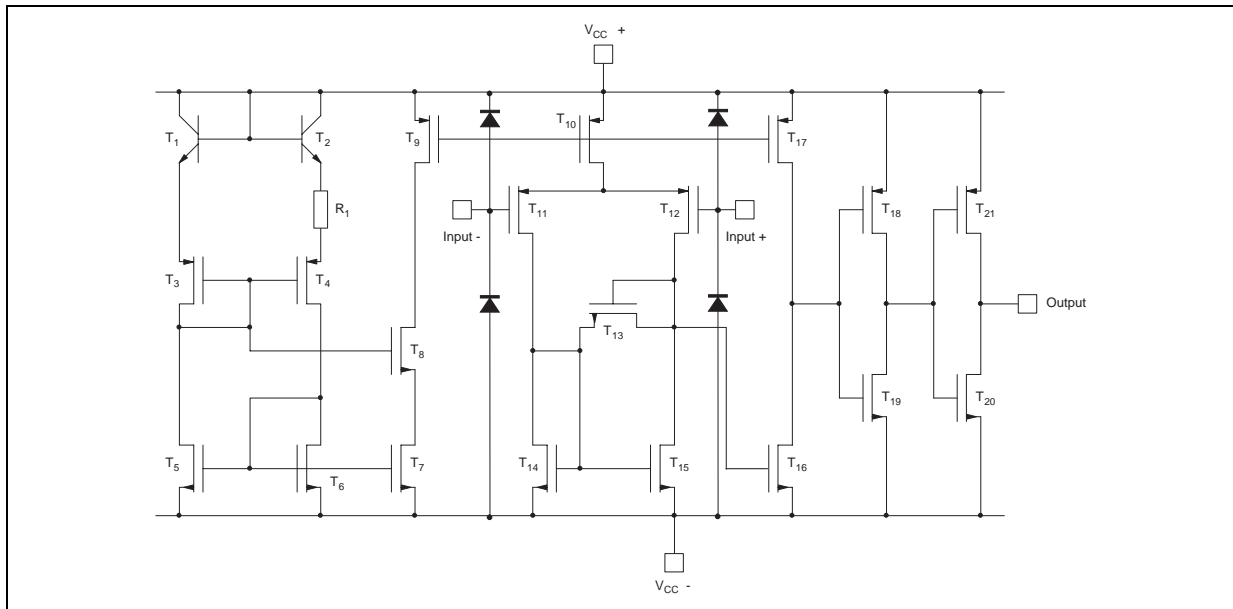
January 2003



### PIN CONNECTIONS (top view)



**SCHEMATIC DIAGRAM** (for 1/4 TS3704)



**ABSOLUTE MAXIMUM RATINGS**

Symbol	Parameter	Value	Unit
$V_{CC}^+$	Supply Voltage <sup>1)</sup>	18	V
$V_{id}$	Differential Input Voltage <sup>2)</sup>	$\pm 18$	V
$V_i$	Input Voltage <sup>3)</sup>	18	V
$V_o$	Output Voltage	18	V
$I_o$	Output Current	20	mA
$I_F$	Forward Current in ESD Protection Diodes on Input <sup>4)</sup>	50	mA
$P_d$	Power Dissipation <sup>5)</sup>	DIP14	1500
		SO14	830
		TSSOP14	710
$T_{stg}$	Storage Temperature Range	-65 to +150	$^{\circ}C$

- All voltage values, except differential voltage, are with respect to network ground terminal.
- Differential voltages are the non-inverting input terminal with respect to the inverting input terminal.
- The magnitude of the input and the output voltages must never exceed the magnitude of the positive supply voltage.
- Guaranteed by design.
- $P_d$  is calculated with  $T_{amb} = +25^{\circ}C$ ,  $T_j = +150^{\circ}C$  and  $R_{thja} = 80^{\circ}C/W$  for DIP14 package  
 $= 150^{\circ}C/W$  for SO14 package  
 $= 175^{\circ}C/W$  for TSSOP14 package

**OPERATING CONDITIONS**

Symbol	Parameter	Value	Unit
$V_{CC}^+$	Supply Voltage	TS3704C,I	2.7 to 16
		TS3704M	4 to 16
$V_{icm}$	Common Mode Input Voltage Range	0 to $V_{CC}^+ - 1.5$	V
$T_{oper}$	Operating Free-Air Temperature range	TS3704C	0 to +70
		TS3704I	-40 to +125
		TS3704M	-55 to +125

**ELECTRICAL CHARACTERISTICS** $V_{CC}^+ = 3V$ ,  $V_{CC}^- = 0V$ ,  $T_{amb} = 25^\circ C$  (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
$V_{io}$	Input Offset Voltage <sup>1)</sup> $V_{ic} = 1.5V$ $T_{min.} \leq T_{amb} \leq T_{max.}$			5 6.5	mV
$I_{io}$	Input Offset Current <sup>2)</sup> $V_{ic} = 1.5V$ $T_{min.} \leq T_{amb} \leq T_{max.}$		1	300	pA
$I_{ib}$	Input Bias Current <sup>2)</sup> $V_{ic} = 1.5V$ $T_{min.} \leq T_{amb} \leq T_{max.}$		1	600	pA
$V_{icm}$	Input Common Mode Voltage Range $T_{min.} \leq T_{amb} \leq T_{max.}$	0 0		$V_{CC}^+ - 1.2$ $V_{CC}^+ - 1.5$	V
CMR	Common-mode Rejection Ratio $V_{ic} = V_{icm \text{ min.}}$		80		dB
SVR	Supply Voltage Rejection Ratio $V_{CC}^+ = 3V \text{ to } 5V$		75		dB
$V_{OH}$	High Level Output Voltage $V_{id} = 1V$ , $I_{OH} = -4mA$ $T_{min.} \leq T_{amb} \leq T_{max.}$	2 1.8	2.4		V
$V_{OL}$	Low Level Output Voltage $V_{id} = -1V$ , $I_{OL} = 4mA$ $T_{min.} \leq T_{amb} \leq T_{max.}$		300	400 450	mV
$I_{CC}$	Supply Current (each comparator) No load - Outputs low $T_{min.} \leq T_{amb} \leq T_{max.}$		7	20 25	$\mu A$
$t_{PLH}$	Response Time Low to High $V_{ic} = 0V$ , $f = 10kHz$ , $C_L = 50pF$ , Overdrive = 5mV TTL Input		1.2 0.7		$\mu s$
$t_{PHL}$	Response Time High to Low $V_{ic} = 0V$ , $f = 10kHz$ , $C_L = 50pF$ , Overdrive = 5mV TTL Input		2 0.15		$\mu s$

1. The specified offset voltage is the maximum value required to drive the output up to 2.5V or down to 0.3V.

2. Maximum values including unavoidable inaccuracies of the industrial test.

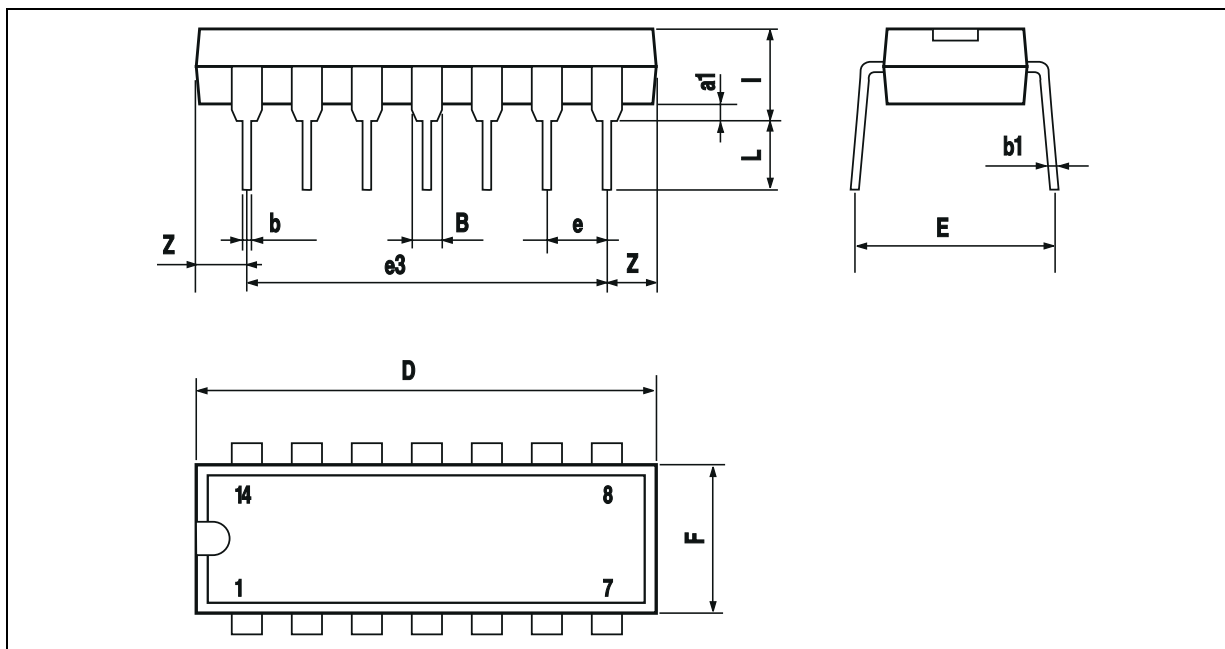
**ELECTRICAL CHARACTERISTICS**

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

Symbol	Parameter	Min.	Typ.	Max.	Unit
$V_{io}$	Input Offset Voltage <sup>1)</sup> $V_{ic} = 2.5V$ , $V_{CC}^+ = 5V$ to $10V$ $T_{min} \leq T_{amb} \leq T_{max}$ .		1.2	5 6.5	mV
$I_{io}$	Input Offset Current <sup>2)</sup> $V_{ic} = 2.5V$ $T_{min} \leq T_{amb} \leq T_{max}$ .		1	300	pA
$I_{ib}$	Input Bias Current <sup>2)</sup> $V_{ic} = 2.5V$ $T_{min} \leq T_{amb} \leq T_{max}$ .		1	600	pA
$V_{icm}$	Input Common Mode Voltage Range $T_{min} \leq T_{amb} \leq T_{max}$	0 0		$V_{CC}^+ - 1.2$ $V_{CC}^+ - 1.5$	V
CMR	Common-mode Rejection Ratio $V_{ic} = V_{icm}$ min.		80		dB
SVR	Supply Voltage Rejection Ratio $V_{CC}^+ = +5V$ to $+10V$		92		dB
$V_{OH}$	High Level Output Voltage $V_{id} = 1V$ , $I_{OH} = -4mA$ $T_{min} \leq T_{amb} \leq T_{max}$ .	4.5 4.3	4.7		V
$V_{OL}$	Low Level Output Voltage $V_{id} = -1V$ , $I_{OL} = 4mA$ $T_{min} \leq T_{amb} \leq T_{max}$ .		200	300 375	mV
$I_{CC}$	Supply Current (each comparator) No load - Outputs low		9	20 25	$\mu A$
$t_{PLH}$	Response Time Low to High $V_{ic} = 0V$ , $f = 10kHz$ , $C_L = 50pF$ , Overdrive = 5mV Overdrive = 10mV Overdrive = 20mV Overdrive = 40mV TTL Input		1.2 1 0.9 0.8 0.7		$\mu s$
$t_{PHL}$	Response Time High to Low $V_{ic} = 0V$ , $f = 10kHz$ , $C_L = 50pF$ , Overdrive = 5mV Overdrive = 10mV Overdrive = 20mV Overdrive = 40mV TTL Input		2 1.5 0.9 0.7 0.15		$\mu s$
$t_f$	Fall time $f = 10kHz$ , $C_L = 50pF$ , Overdrive 50mV		30		ns

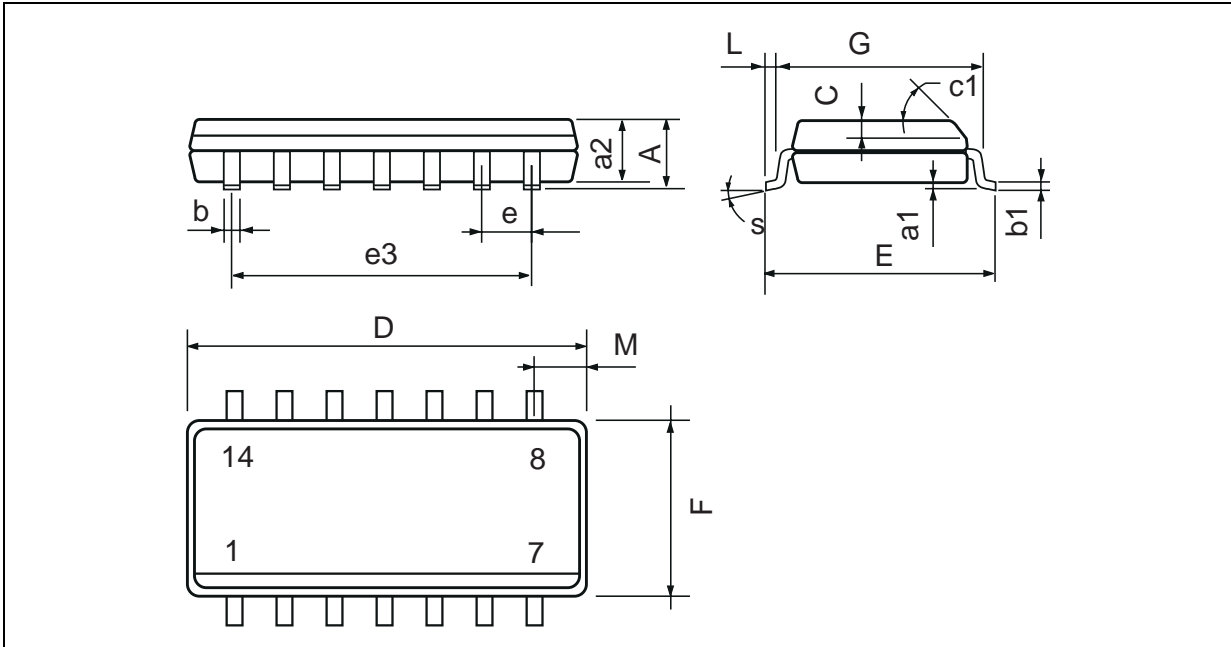
1. The specified offset voltage is the maximum value required to drive the output up to 4.5V or down to 0.3V.
2. Maximum values including unavoidable inaccuracies of the industrial test.

**PACKAGE MECHANICAL DATA**  
14 PINS - PLASTIC DIP



Dimensions	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

**PACKAGE MECHANICAL DATA**  
 14 PINS - PLASTIC MICROPACKAGE (SO)

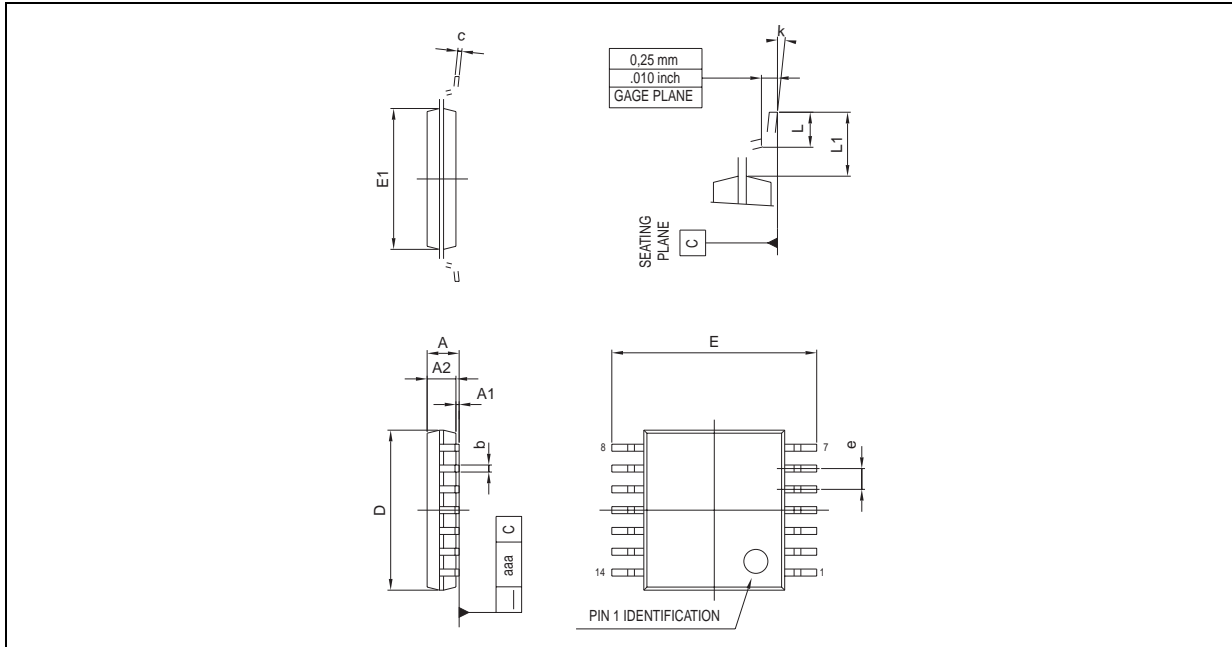


Dimensions	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
a1	0.1		0.2	0.004		0.008
a2			1.6			0.063
b	0.35		0.46	0.014		0.018
b1	0.19		0.25	0.007		0.010
C		0.5			0.020	
c1	45° (typ.)					
D (1)	8.55		8.75	0.336		0.344
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		7.62			0.300	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

**PACKAGE MECHANICAL DATA**

**14 PINS - THIN SHRINK SMALL OUTLINE PACKAGE (TSSOP)**



Dimensions	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	0.450	0.600	0.750	0.018	0.024	0.030
L1		1.00			0.039	
aaa			0.100			0.004

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