



## Dual Comparator and Voltage Reference

### COMPARATOR

- Low supply current (1.1ma) independent of supply voltage
- Low input bias current: 25nA typ
- Low input offset voltage:  $\pm 1\text{mV}$  typ
- Input common-mode voltage range includes ground
- Low output saturation voltage: 250mV typ ( $I_o = 4\text{mA}$ )
- Differential input voltage range equal to the supply voltage
- Wide power supply range:  $\pm 1\text{V}$  to  $\pm 18\text{V}$

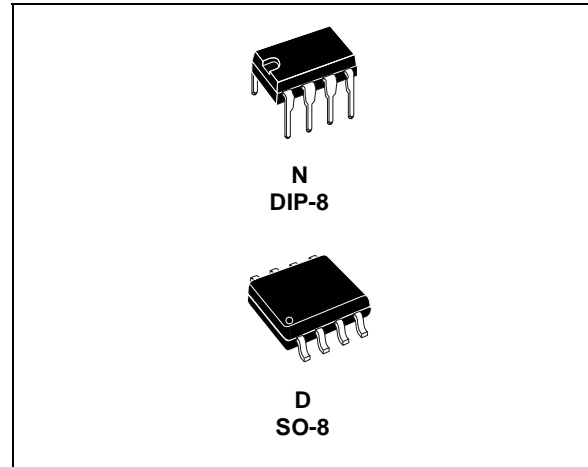
### VOLTAGE REFERENCE

- Fixed  $V_{ref}$  to 2.5V
- 0.4% and 1% voltage precision
- Sink current capability: 1 to 100mA

### DESCRIPTION

The TSM109 is a monolithic IC that includes two comparators and a shunt voltage reference. This device offers space and cost savings in many applications including power supply management or data acquisition systems.

### Package Reference

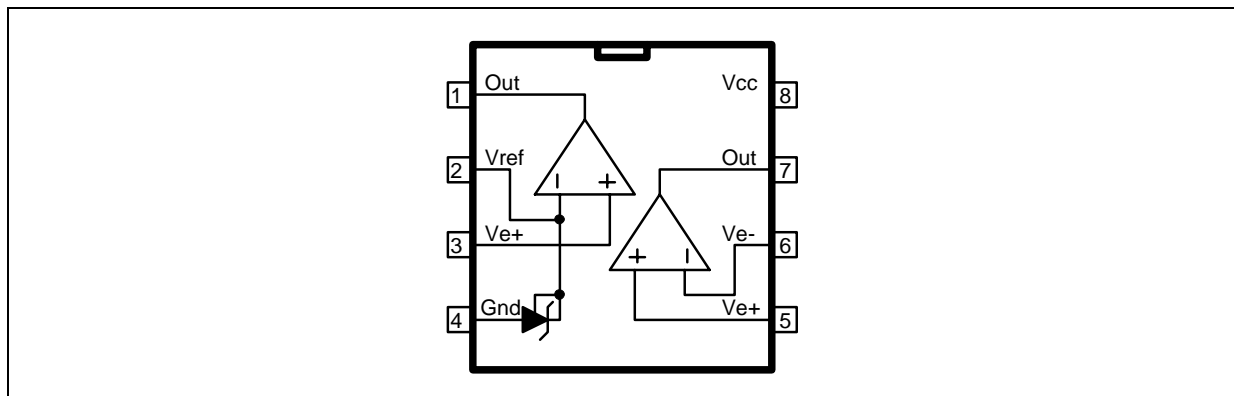


### ORDER CODE

Part Number	Temperature Range	Package	
		N	D
TSM109	-40°C, +105°C	•	•
TSM109A	-40°C, +105°C	•	•

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

### PIN CONNECTIONS (top view)



## 1 ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V <sub>CC</sub>	Supply voltage	36	V
V <sub>in</sub>	Input Voltage	-0.3 to V <sub>CC</sub> +0.3	V
I <sub>k</sub>	Continuous Cathode current range	-100 to 150	mA
T <sub>j</sub>	Maximum Junction Temperature	150	°C
R <sub>thja</sub>	Thermal Resistance Junction to Ambient (SO package)	175	°C/W
ESD	Electrostatic Discharge Protection	1.5	kV

## OPERATING CONDITIONS

Symbol	Parameter	Value	Unit
V <sub>CC</sub>	DC Supply Conditions	2 to 36	V
T <sub>oper</sub>	Operational temperature	-40 to 105	°C

## ELECTRICAL CHARACTERISTICS

V<sub>CC</sub><sup>+</sup> = 5V, V<sub>CC</sub><sup>-</sup> = 0V, T<sub>amb</sub> = 25°C (unless otherwise specified)

Symbol	Parameter	Min	Typ	Max	Unit
I <sub>CC</sub>	Total Supply Current, excluding current in the Voltage Reference V <sub>CC</sub> = +5V, no load V <sub>CC</sub> = +30V, no load		0.4 1	1 2.5	mA

## 2 ELECTRICAL CHARACTERISTICS

### COMPARATOR (independent comparator)

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

Symbol	Parameter	TSM109			Unit
		Min.	Typ.	Max.	
$V_{io}$	Input Offset Voltage - note <sup>1</sup> $T_{amb} = +25^{\circ}C$ $T_{min} \leq T_{amb} \leq T_{max}$		1	5 9	mV
$I_{io}$	Input Offset Current $T_{amb} = +25^{\circ}C$ $T_{min} \leq T_{amb} \leq T_{max}$		3	25 100	nA
$I_{ib}$	Input Bias Current ( $I^+$ or $I^-$ ) - note <sup>2</sup> $T_{amb} = +25^{\circ}C$ $T_{min} \leq T_{amb} \leq T_{max}$		25	250 400	nA
$A_{vd}$	Large Signal Voltage Gain $V_{CC} = 15V$ , $R_L = 15k\Omega$ , $V_o = 1V$ to $11V$	50	200		V/mV
$V_{icm}$	Input Common Mode Voltage Range - note <sup>3</sup> $V_{CC} = 30V$ $T_{amb} = +25^{\circ}C$ $T_{min} \leq T_{amb} \leq T_{max}$	0 0		$V_{CC^+} - 1.5$ $V_{CC^+} - 2$	V
$V_{id}$	Differential Input Voltage - note <sup>4</sup>			$V_{CC^+}$	
$V_{OL}$	Low Level Output Voltage $V_{id} = -1V$ , $I_{sink} = 4mA$ $T_{amb} = +25^{\circ}C$ $T_{min} \leq T_{amb} \leq T_{max}$		250	400 700	mV
$I_{OH}$	High Level Output Current ( $V_{id} = 1V$ ) $V_{CC} = V_o = 30V$ $T_{amb} = +25^{\circ}C$ $T_{min} \leq T_{amb} \leq T_{max}$		30	150 1	nA $\mu A$
$I_{sink}$	Output Sink Current $V_{id} = 1V$ , $V_o = 1.5V$	10	20		mA
$t_{re}$	Response Time - note <sup>5</sup> $R_L = 5.1k\Omega$ connected to $V_{CC^+}$		1.3		$\mu s$
$t_{rel}$	Large Signal Response Time $R_L = 5.1k\Omega$ connected to $V_{CC^+}$ , $e_1 = TTL$ , $V_{(ref)} = +1.4V$		300		ns

- 1) At output switch point,  $V_o \approx 1.4V$ ,  $R_s = 0$  with  $V_{CC^+}$  from  $5V$  to  $30V$ , and over the full common-mode range ( $0V$  to  $V_{CC^+} - 1.5V$ ).
- 2) The direction of the input current is out of the IC due to the PNP input stage. This current is essentially constant, independent of the state of the output, so no loading charge exists on the reference of input lines.
- 3) The input common-mode voltage of either input signal voltage should not be allowed to go negative by more than  $0.3V$ . The upper end of the common-mode voltage range is  $V_{CC^+} - 1.5V$ .
- 4) Positive voltage excursions of one input may exceed the power supply level. As long as the other input voltage remains within the common-mode range, the comparator will provide an appropriate output state. The low input voltage state must not be less than  $-0.3V$  (or  $0.3V$  below the negative power supply, if used).
- 5) The response time specified is for a  $100mV$  input step with  $5mV$  overdrive. For larger overdrive signals,  $300ns$  can be obtained

**COMPARATOR** (comparator with inverting input connected to the internal Vref)) $V_{CC}^+ = +5V$ ,  $V_{CC}^- = GND$ ,  $T_{amb} = +25^\circ C$  (unless otherwise specified)

Symbol	Parameter	TSM109			Unit
		Min.	Typ.	Max.	
$V_{io}$	Input Offset Voltage - note <sup>1</sup> $T_{amb} = +25^\circ C$ $T_{min} \leq T_{amb} \leq T_{max}$		1	5 9	mV
$I_{ib}$	Input Bias Current for positive input note <sup>2</sup> $T_{amb} = +25^\circ C$ $T_{min} \leq T_{amb} \leq T_{max}$		25	250 400	nA
$A_{vd}$	Large Signal Voltage Gain $V_{CC} = 15V$ , $R_L = 15k\Omega$ , $V_o = 1V$ to $11V$	50	200		V/mV
$V_{id}$	Differential Input Voltage -note			$V_{CC}^+$ -2.5V	V
$V_{OL}$	Low Level Output Voltage $V_{id} = -1V$ , $I_{sink} = 4mA$ $T_{amb} = +25^\circ C$ $T_{min} \leq T_{amb} \leq T_{max}$		250	400 700	mV
$I_{OH}$	High Level Output Current ( $V_{id} = 1V$ ) $V_{CC} = V_o = 30V$ $T_{amb} = +25^\circ C$ $T_{min} \leq T_{amb} \leq T_{max}$		30	150 1	nA $\mu A$
$I_{sink}$	Output Sink Current $V_{id} = 1V$ , $V_o = 1.5V$	10	20		mA
$t_{re}$	Response Time - note <sup>3</sup> $R_L = 5.1k\Omega$ connected to $V_{CC}^+$		1.3		$\mu s$
$t_{rel}$	Large Signal Response Time $R_L = 5.1k\Omega$ connected to $V_{CC}^+$ , $e_1 = TTL$ , $V_{(ref)} = +1.4V$		300		ns

- 1) At output switch point,  $V_o \approx 1.4V$ ,  $R_s = 0$  with  $V_{CC}^+$  from  $5V$  to  $30V$ , and over the full common-mode range ( $0V$  to  $V_{CC}^+ - 1.5V$ ).
- 2) The direction of the input current is out of the IC due to the PNP input stage. This current is essentially constant, independent of the state of the output, so no loading charge exists on the reference of input lines.
- 3) The response time specified is for a  $100mV$  input step with  $5mV$  overdrive. For larger overdrive signals,  $300ns$  can be obtained.

## ELECTRICAL CHARACTERISTICS

## VOLTAGE REFERENCE

Symbol	Conditions	Value	Unit
$I_K$	Cathode Current	1 to 100	mA

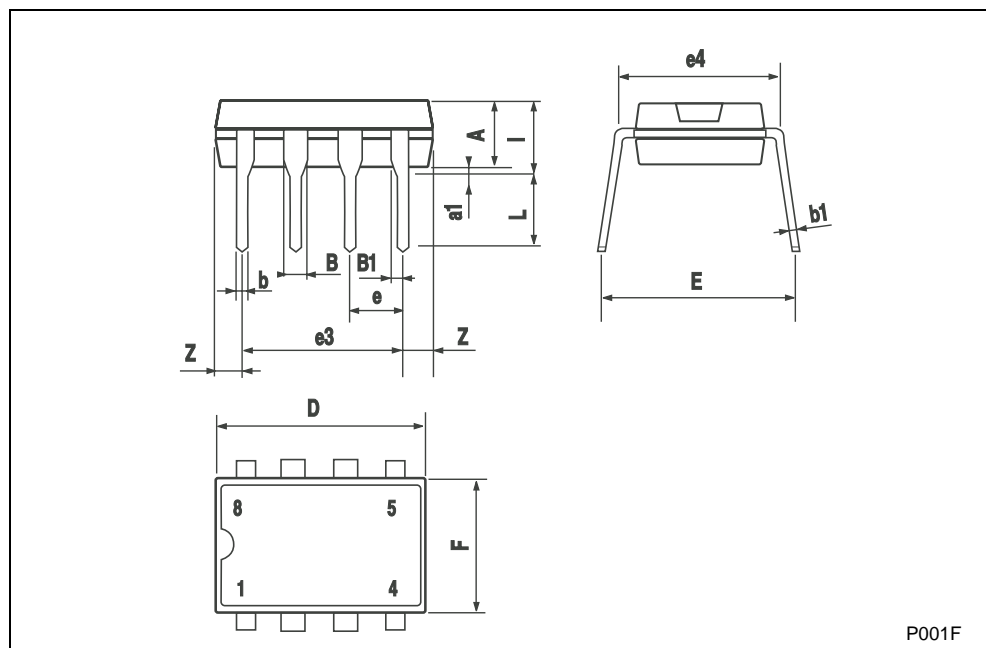
$T_{amb} = 25^{\circ}\text{C}$  (unless otherwise specified)

Symbol	Parameter	TSM109A			TSM109			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
$V_{ref}$	Reference Input Voltage, $I_K = 10\text{ mA}$ $T_{amb} = 25^{\circ}\text{C}$ $T_{min} \leq T_{amb} \leq T_{max}$	2.490 2.48	2.500	2.510 2.52	2.475 2.45	2.500	2.525 2.55	V
$\Delta V_{ref}$	Reference Input Voltage Deviation Over Temperature Range $I_K = 10\text{ mA}$ $T_{min} \leq T_{amb} \leq T_{max}$		7	30		7	30	mV
$\frac{\Delta V_{ref}}{V_{ref} \Delta T}$	Temperature Coefficient of Reference Input Voltage $I_K = 10\text{ mA}$ , $T_{min} \leq T_{amb} \leq T_{max}$		$\pm 13$	$\pm 90$		$\pm 13$	$\pm 90$	ppm/ $^{\circ}\text{C}$
$I_{min}$	Minimum Cathode Current for Regulation		0.5	1		0.5	1	mA
$ Z_{Vref} $	Dynamic Impedance - note <sup>1</sup> $\Delta V_{ref}$ , $\Delta I_K = 1\text{ to }100\text{ mA}$ , $f < 1\text{ KHz}$		0.3	0.65		0.3	0.65	$\Omega$

1) The dynamic impedance is defined as  $|Z_{Vref}| = \Delta V_{Vref} / \Delta I_K$

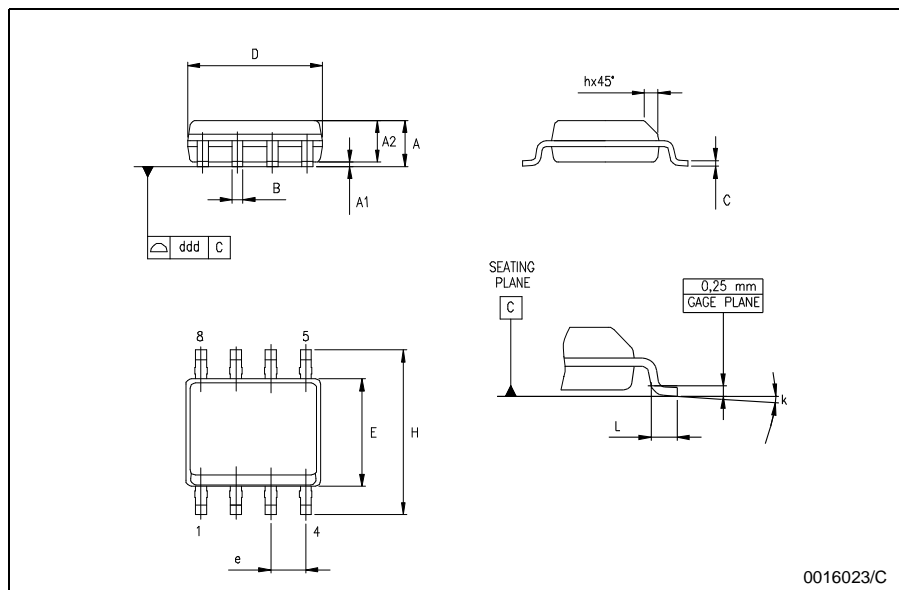
## 3 PACKAGE MECHANICAL DATA

Plastic DIP-8 MECHANICAL DATA						
DIM.	mm.			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A		3.3			0.130	
a1	0.7			0.028		
B	1.39		1.65	0.055		0.065
B1	0.91		1.04	0.036		0.041
b		0.5			0.020	
b1	0.38		0.5	0.015		0.020
D			9.8			0.386
E		8.8			0.346	
e		2.54			0.100	
e3		7.62			0.300	
e4		7.62			0.300	
F			7.1			0.280
l			4.8			0.189
L		3.3			0.130	
Z	0.44		1.6	0.017		0.063



PACKAGE MECHANICAL DATA

SO-8 MECHANICAL DATA						
DIM.	mm.			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	1.35		1.75	0.053		0.069
A1	0.10		0.25	0.04		0.010
A2	1.10		1.65	0.043		0.065
B	0.33		0.51	0.013		0.020
C	0.19		0.25	0.007		0.010
D	4.80		5.00	0.189		0.197
E	3.80		4.00	0.150		0.157
e		1.27			0.050	
H	5.80		6.20	0.228		0.244
h	0.25		0.50	0.010		0.020
L	0.40		1.27	0.016		0.050
k	8° (max.)					
ddd			0.1			0.04



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