



# TSM104/A

## QUAD OPERATIONAL AMPLIFIER AND PROGRAMMABLE VOLTAGE REFERENCE

### OPERATIONAL AMPLIFIERS

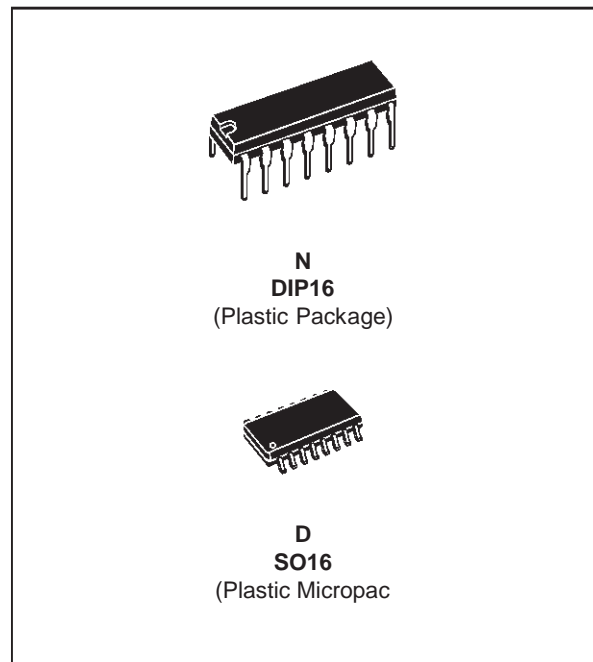
- LOW SUPPLY CURRENT : 375 $\mu$ A/op. (@  $V_{CC} = 5V$ )
- LOW INPUT BIAS CURRENT : 20nA
- MEDIUM SPEED : 0.9MHz
- LOW INPUT OFFSET VOLTAGE : 0.5mV typ for TSM104A
- WIDE POWER SUPPLY RANGE :  $\pm 1.5V$  to  $\pm 15V$

### VOLTAGE REFERENCE

- ADJUSTABLE OUTPUT VOLTAGE :  $V_{ref}$  to 36V
- 0.4% AND 1% VOLTAGE PRECISION
- SINK CURRENT CAPABILITY : 1 to 100mA
- TYPICAL OUTPUT IMPEDANCE : 0.2 $\Omega$

### DESCRIPTION

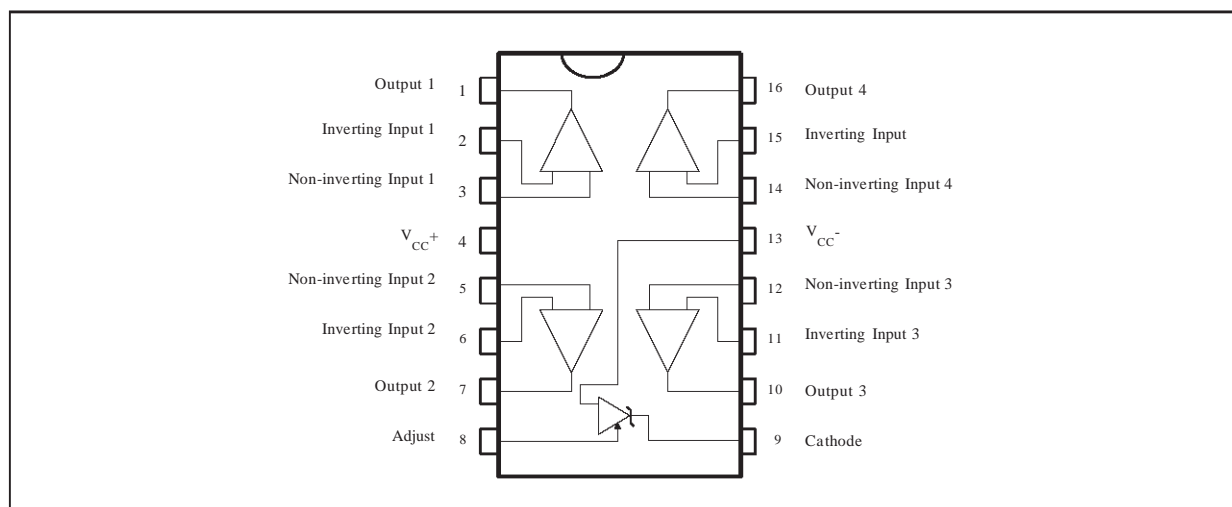
The TSM104 is a monolithic IC that includes four op-amps and an adjustable shunt voltage reference. This device is offering space and cost saving in many applications like power supply management or data acquisition systems.



### ORDER CODES

Part number	Temperature Range	Package	
		N	D
TSM104I/AI	-40°C, +105°C	•	•

### PIN CONNECTIONS



**ABSOLUTE MAXIMUM RATINGS**

Symbol	Parameter	Value	Unit
$V_{CC}$	Supply Voltage	36	V
$V_{id}$	Differential Input Voltage	36	V
$V_i$	Input Voltage	-0.3 to 36	V
$T_{oper}$	Operating Free-air Temperature Range	-55 to +125	°C
$T_j$	Maximum Junction Temperature	150	°C
$R_{thja}$	Thermal Resistance Junction to Ambient (SO package)	150	°C/W

**ELECTRICAL CHARACTERISTICS**

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

Symbol	Parameter	Min	Typ	Max	Unit
$I_{CC}$	Total Supply Current, excluding current in the Voltage Reference $V_{CC}^+ = 5V$ , no load $T_{min.} < T_{amb} < T_{max}$ $V_{CC}^+ = 30V$ , no load $T_{min.} < T_{amb} < T_{max}$		1.4	2.4 4	mA

**OPERATIONAL AMPLIFIERS**

$V_{CC}^+ = 5V$ ,  $V_{CC}^- = \text{Ground}$ ,  $V_O = 1.4V$ ,  $T_{amb} = 25^\circ\text{C}$  (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
$V_{io}$	Input Offset Voltage TSM104, $T_{amb} = 25^\circ\text{C}$ $T_{min.} \leq T_{amb} \leq T_{max.}$ TSM104A, $T_{amb} = 25^\circ\text{C}$ $T_{min.} \leq T_{amb} \leq T_{max.}$		1 0.5	5 6 3 4	mV
$DV_{io}$	Input Offset Voltage Drift		7		$\mu\text{V}/^\circ\text{C}$
$I_{io}$	Input Offset Current $T_{min.} \leq T_{amb} \leq T_{max.}$		2	30 50	nA
$I_{ib}$	Input Bias Current $T_{min.} \leq T_{amb} \leq T_{max.}$		20	150 200	nA
$A_{vd}$	Large Signal Voltage Gain $V_{CC} = 15V$ , $R_L = 2k$ $V_O = 1.4V$ to $11.4V$ $T_{min.} \leq T_{amb} \leq T_{max.}$	50 25	100		V/mV
SVR	Supply Voltage Rejection Ratio $V_{CC} = 5V$ to $30V$	65	100		dB
$V_{icm}$	Input Voltage Mode Voltage Range $V_{CC} = +30V$ - see note 1 $T_{min.} \leq T_{amb} \leq T_{max.}$	0 0		$V_{CC}^+ - 1.5$ $V_{CC}^+ - 2$	V
CMR	Common Mode Rejection Ratio $T_{min.} \leq T_{amb} \leq T_{max.}$	70 60	85		dB
$I_{source}$	Output Current Source $V_O = 2V$ , $V_{CC} = +15V$ , $V_{id} = +1V$	20	40		mA
$I_O$	Short Circuit to Ground $V_{CC} = +15V$		40	60	mA
$I_{sink}$	Output Current Sink $V_{id} = -1V$ , $V_{CC} = +15V$ , $V_O = +2V$	10	20		mA
$V_{OH}$	High Level Output Voltage $R_L = 10k$ , $V_{CC}^+ = 30V$ $T_{amb} = 25^\circ\text{C}$ $T_{min.} \leq T_{amb} \leq T_{max.}$	27 27	28		V
$V_{OL}$	Low Level Output Voltage $R_L = 10k$ $T_{min.} \leq T_{amb} \leq T_{max.}$		5	20 20	mV
SR	Slew Rate at Unity Gain $V_i = 0.5$ to $3V$ , $V_{CC} = 15V$ $R_L = 2k$ , $C_L = 100\text{pF}$ , unity gain	0.1	0.3		V/ $\mu\text{s}$
GBP	Gain Bandwidth Product $V_{CC} = 30V$ , $R_L = 2k$ , $C_L = 100\text{pF}$ $f = 100\text{kHz}$ , $V_{in} = 10\text{mV}$	0.5	0.9		MHz
THD	Total Harmonic Distortion $f = 1\text{kHz}$ $A_V = 20\text{dB}$ , $R_L = 2k$ , $V_{CC} = 30V$ $C_L = 100\text{pF}$ , $V_O = 2V_{pp}$		0.02		%
$e_n$	Equivalent Input Noise Voltage $f = 1\text{kHz}$ , $V_{CC} = 30V$ , $R_S = 100\Omega$		50		$\frac{\text{nV}}{\sqrt{\text{Hz}}}$
cs	Channel Separation $1\text{kHz} < f < 20\text{kHz}$		120		dB
$C_s$	Channel Separation $1\text{kHz} < f < 20\text{kHz}$		120		dB

**Note 1 :** 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  $V_{CC}^+ - 1.5V$ . But either of both inputs can go to +36V without damage.

# TSM104/A

## VOLTAGE REFERENCE

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

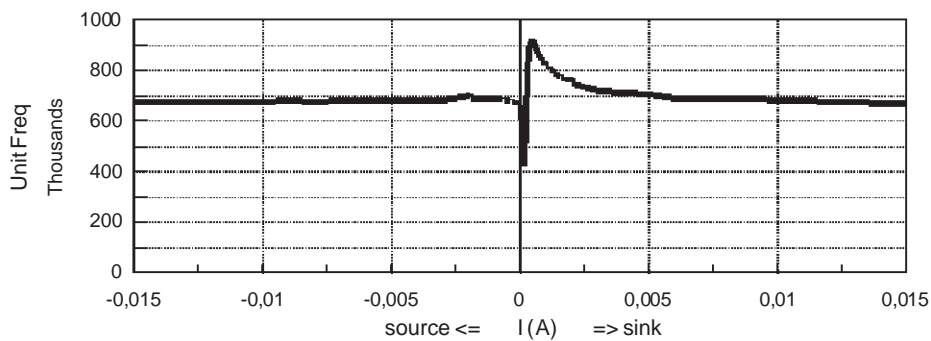
Symbol	Parameter	Min.	Typ.	Max.	Unit
$V_{ref}$	Reference Input Voltage TSM104, $T_{amb} = 25^{\circ}C$ $T_{min.} \leq T_{amb} \leq T_{max.}$ TSM104A, $T_{amb} = 25^{\circ}C$ $T_{min.} \leq T_{amb} \leq T_{max.}$	2.475 2.45 2.49 2.48	2.5 2.5	2.525 2.55 2.51 2.52	V
$\Delta V_{ref}$	Reference Input Voltage Deviation Over Temperature Range $V_{KA} = V_{ref}$ , $I_K = 10mA$ $T_{min.} \leq T_{amb} \leq T_{max.}$		7	30	mV
$\frac{\Delta V_{ref}}{\Delta V_{KA}}$	Ratio of Change in Reference Input Voltage to Change in Cathode to Anode Voltage $I_K = 10mA$ , $\Delta V_{ka} = 36V$ to $3V$	-2	-1.1		mV/V
$I_{ref}$	Reference Input Current $I_K = 10mA$ $T_{min.} \leq T_{amb} \leq T_{max.}$		1.5	2.5 3	$\mu A$
$\Delta I_{ref}$	Reference Input Current Deviation over $T^{\circ}$ Range		0.8	1.2	$\mu A$
$I_{min}$	Minimum Cathode Current for Regulation $V_{KA} = V_{ref}$		0.5	1	mA
$I_{off}$	Off-State Cathode Current		180	500	nA
$ Z_{KA} $	Dynamic Impedance - (note 1) $V_{KA} = V_{ref}$ , $\Delta I_K = 1$ to $100mA$ , $f < 1kHz$		0.2	0.5	$\Omega$

Note 1 : the dynamic impedance is defined as  $|Z_{KA}| = \Delta V_{KA} / \Delta I_K$

## OPERATIONAL AMPLIFIERS

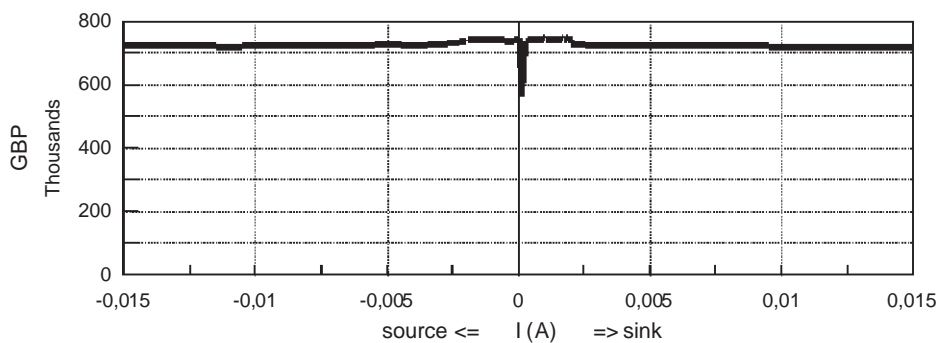
## Unit Frequency = F(I)

Vcc=+/-15V, RL=2k, CL=100pF



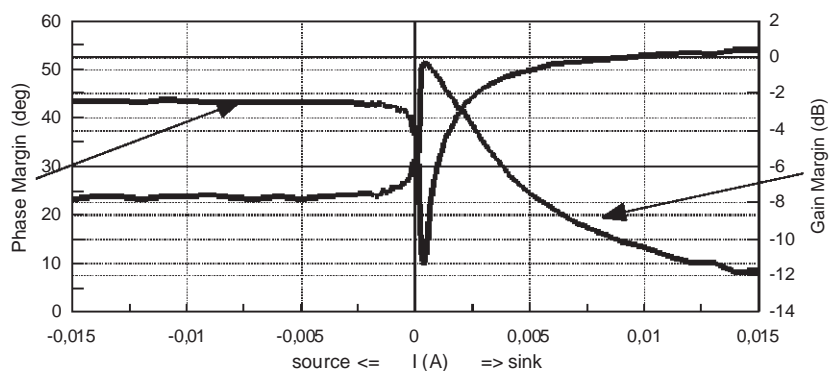
## GBP = F(I)

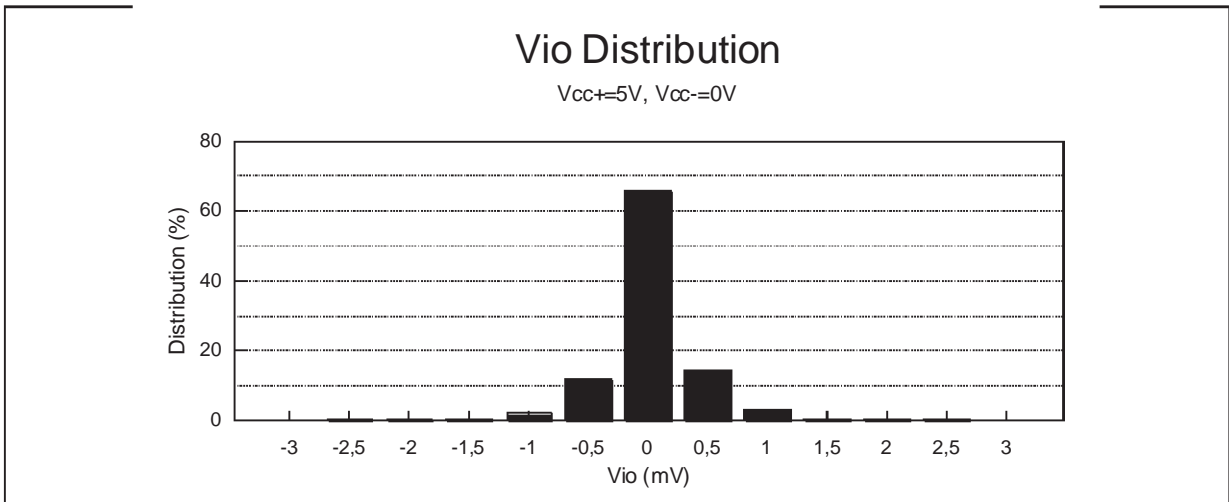
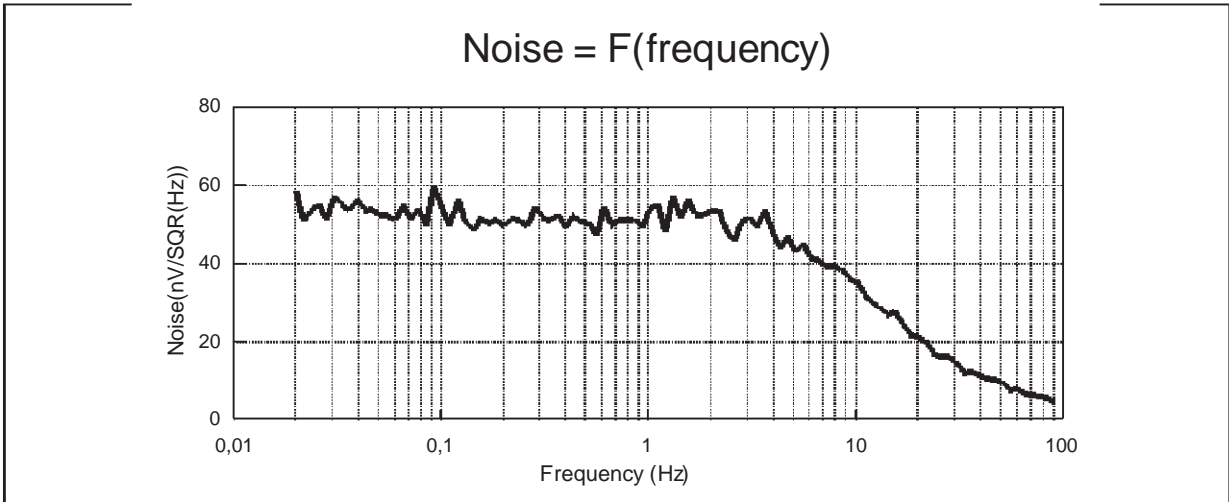
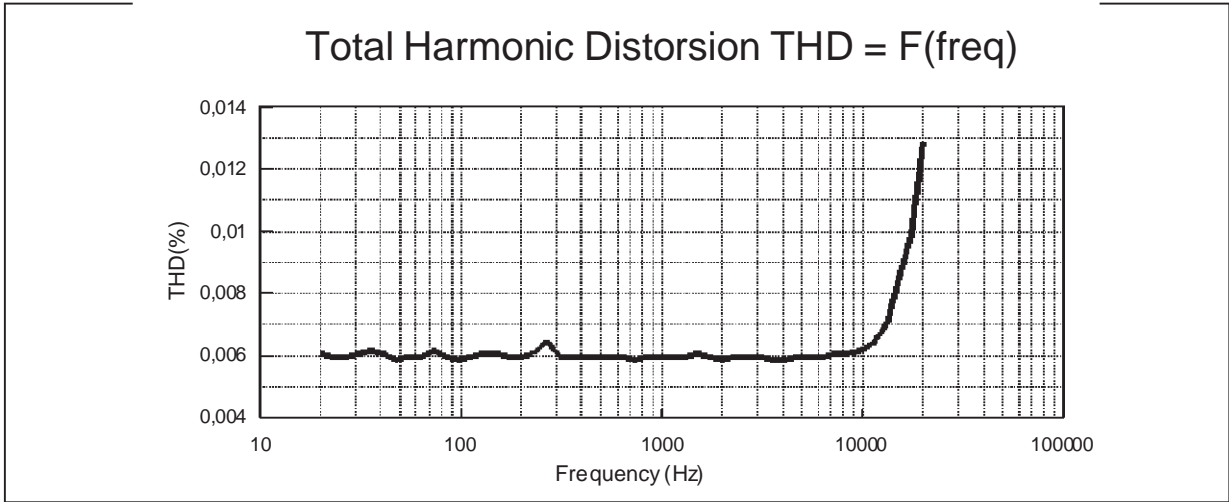
Vcc=+/-15V, RL=2k, CL=100pF



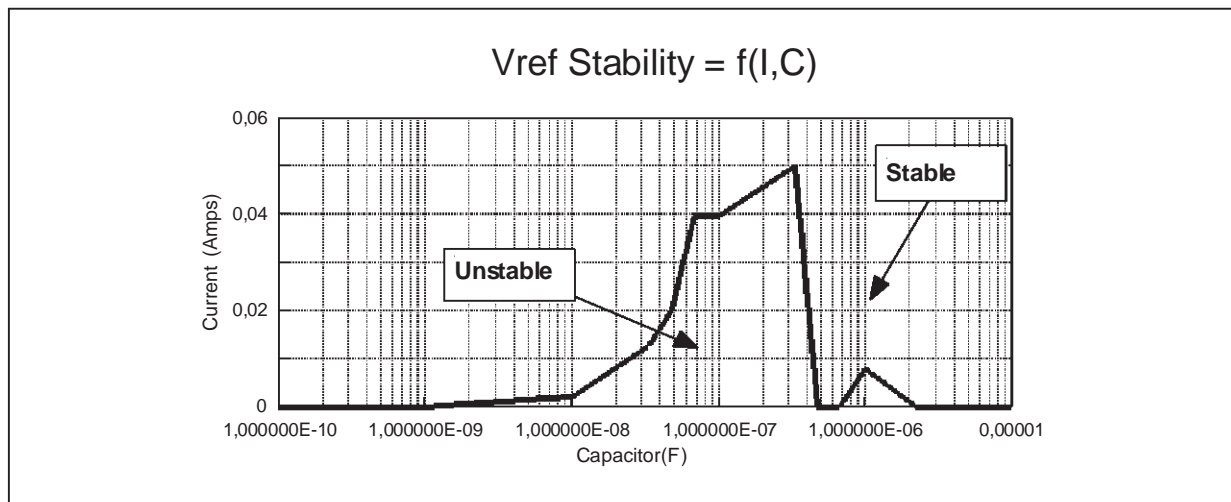
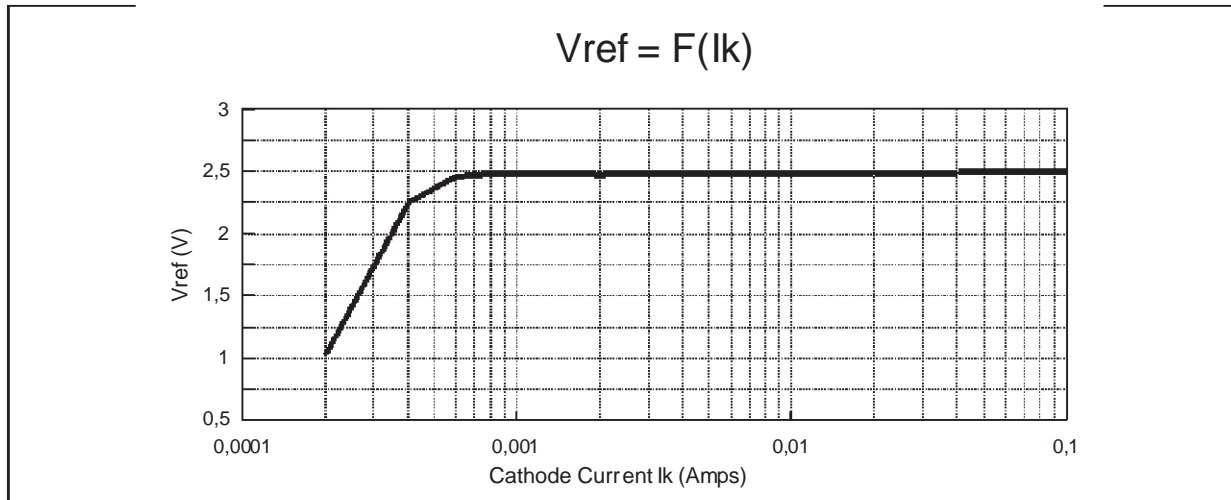
## Phase and Gain Margin = F(I)

Vcc=+/-15V, RL=2k, CL=100pF



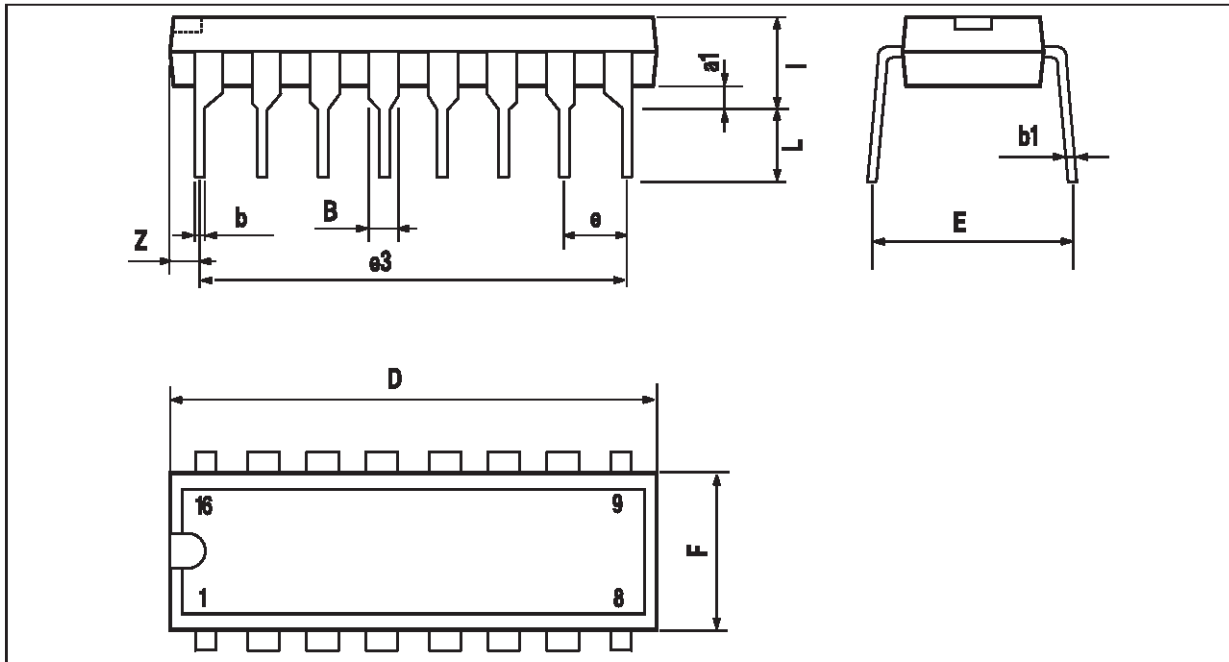


## VOLTAGE REFERENCE



# TSM104/A

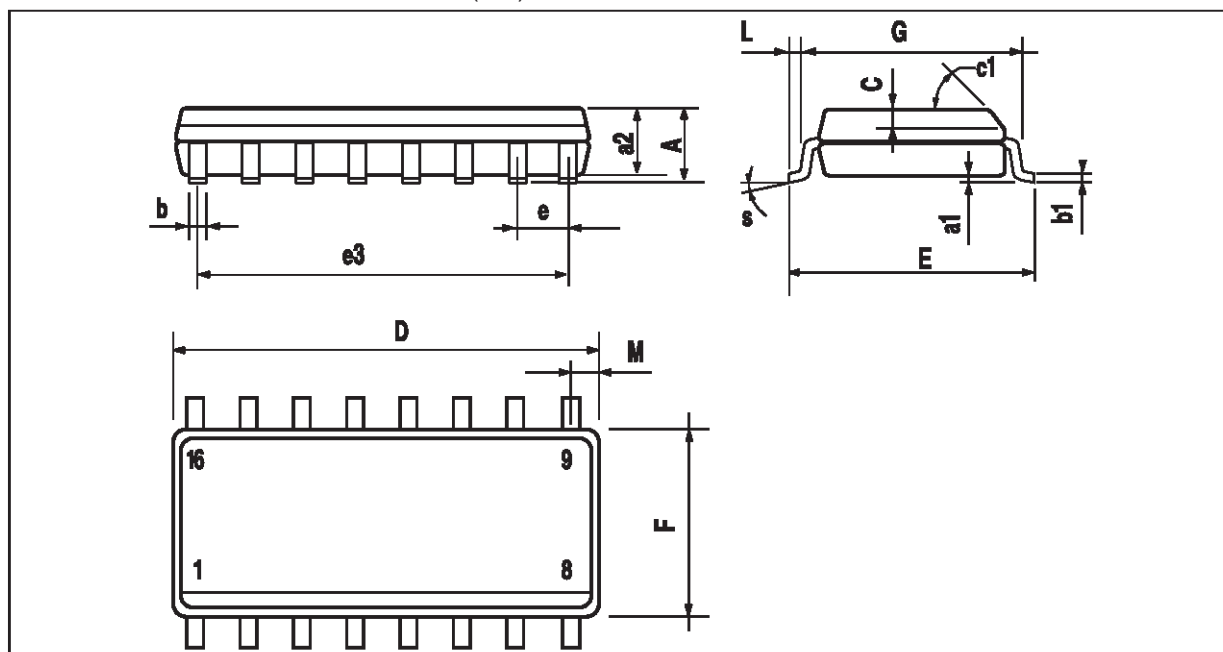
## PACKAGE MECHANICAL DATA 16 PINS - PLASTIC PACKAGE



Dim.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
a1	0.51			0.020		
B	0.77		1.65	0.030		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		17.78			0.700	
F			7.1			0.280
i			5.1			0.201
L		3.3			0.130	
Z			1.27			0.050

## PACKAGE MECHANICAL DATA

16 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	9.8		10	0.386		0.394
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		8.89			0.350	
F	3.8		4.0	0.150		0.157
G	4.6		5.3	0.181		0.209
L	0.5		1.27	0.020		0.050
M			0.62			0.024
S	8° (max.)					

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