



# TSM103/A

## DUAL OPERATIONAL AMPLIFIER AND VOLTAGE REFERENCE

### OPERATIONAL AMPLIFIER

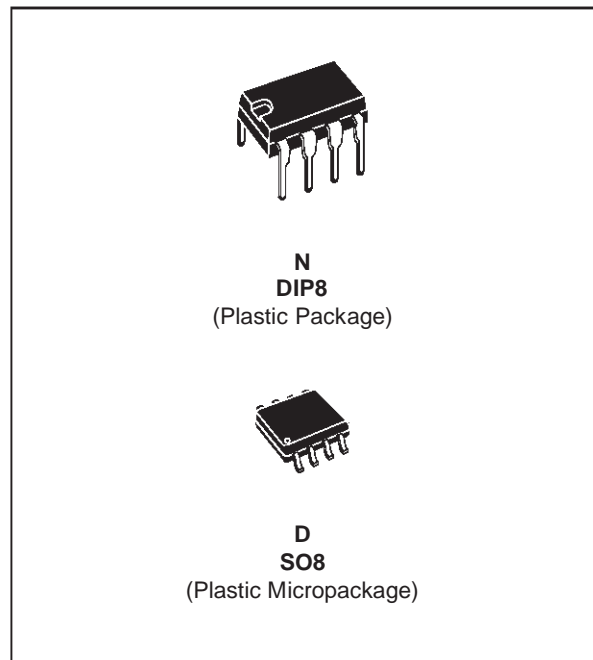
- LOW INPUT OFFSET VOLTAGE : 0.5mV  
typ. for TSM103A
- LOW SUPPLY CURRENT : 350 $\mu$ A/op.  
(@  $V_{CC} = 5V$ )
- MEDIUM BANDWIDTH (unity gain) : 0.9MHz
- LARGE OUTPUT VOLTAGE SWING : 0V to  
( $V_{CC} - 1.5V$ )
- INPUT COMMON MODE VOLTAGE RANGE  
INCLUDES GROUND
- WIDE POWER SUPPLY RANGE : 3 to 32V  
 $\pm 1.5$  to  $\approx 16V$

### VOLTAGE REFERENCE

- FIXED OUTPUT VOLTAGE REFERENCE  
2.5V
- 0.4% AND 1% VOLTAGE PRECISION
- SINK CURRENT CAPABILITY : 1 to 100mA
- TYPICAL OUTPUT IMPEDANCE : 0.2 $\Omega$

### DESCRIPTION

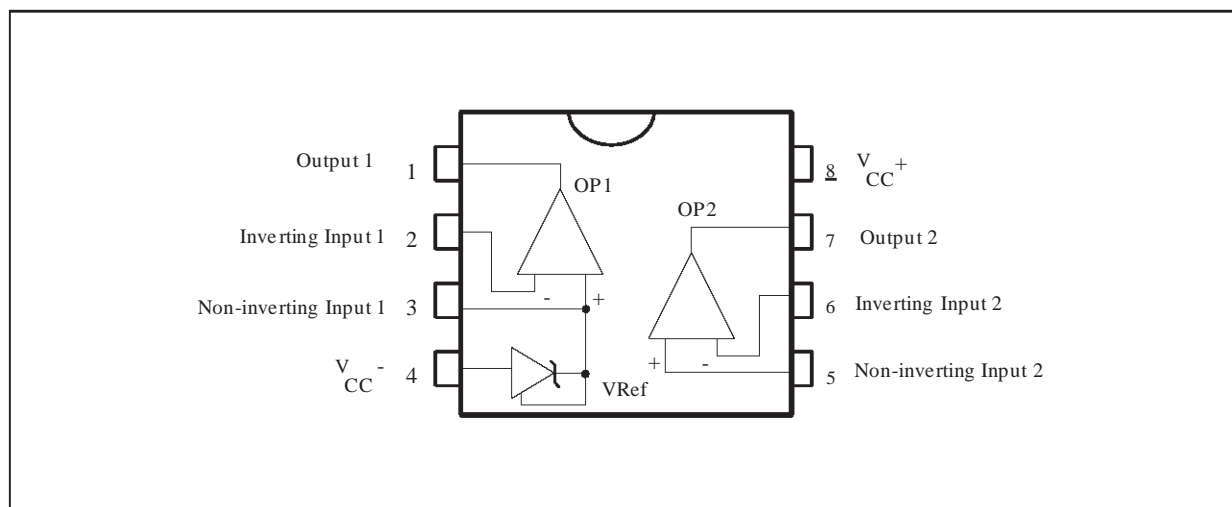
The TSM103 is a monolithic IC that includes one independent op-amp and another op-amp for which the non inverting input is wired to a 2.5V fixed Voltage Reference. This device is offering space and cost saving in many applications like power supply management or data acquisition systems.



### ORDER CODES

Part number	Temperature Range	Package	
		N	D
TSM103I/AI	-40 $^{\circ}$ C, +105 $^{\circ}$ C	•	•

### PIN CONNECTIONS



**ABSOLUTE MAXIMUM RATINGS**

Symbol	Parameter	Value	Unit
V <sub>CC</sub>	Supply Voltage	36	V
V <sub>id</sub>	Differential Input Voltage	36	V
V <sub>i</sub>	Input Voltage	-0.3 to +36	V
T <sub>oper</sub>	Operating Free-air Temperature Range	-55 to +125	°C
T <sub>j</sub>	Maximum Junction Temperature	150	°C
R <sub>thja</sub>	Thermal Resistance Junction to Ambient (SO package)	175	°C/W

**ELECTRICAL CHARACTERISTICS**

Symbol	Parameter	Min	Typ	Max	Unit
I <sub>CC</sub>	Total Supply Current, excluding Current in the Voltage Reference V <sub>CC</sub> <sup>+</sup> = 5V, no load T <sub>min.</sub> < T <sub>amb</sub> < T <sub>max.</sub> V <sub>CC</sub> <sup>+</sup> = 30V, no load T <sub>min.</sub> < T <sub>amb</sub> < T <sub>max.</sub>		0.7	1.2 2	mA

**OPERATOR 2** (independent op-amp)
 $V_{CC}^+ = +5V$ ,  $V_{CC} = \text{Ground}$ ,  $V_O = 1.4V$ ,  $T_{amb} = 25^\circ\text{C}$  (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
$V_{io}$	Input Offset Voltage TSM103, $T_{amb} = 25^\circ\text{C}$ $T_{min.} \leq T_{amb} \leq T_{max.}$ TSM103A, $T_{amb} = 25^\circ\text{C}$ $T_{min.} \leq T_{amb} \leq T_{max.}$		1 0.5	4 5 2 3	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 Common 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 $V_{CC} = +15V$ , $V_O = 2V$ , $V_{id} = +1V$	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 $V_{CC}^+ = 30V$ $T_{amb} = 25^\circ\text{C}$ , $R_L = 10k$ $T_{min.} \leq T_{amb} \leq T_{max.}$	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	0.2	0.4		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		%

**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.

## TSM103/A

**OPERATOR 1** (op-amp with non-inverting input connected to the internal Vref)  
 $V_{CC}^+ = +5V$ ,  $V_{CC}^- = \text{Ground}$ ,  $T_{amb} = 25^\circ\text{C}$  (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
$V_{io}$	Input Offset Voltage $V_{icm} = 0V$ TSM103, $T_{amb} = 25^\circ\text{C}$ $T_{min.} \leq T_{amb} \leq T_{max.}$ TSM103A, $T_{amb} = 25^\circ\text{C}$ $T_{min.} \leq T_{amb} \leq T_{max.}$		1 0.5	4 5 2 3	mV
$DV_{io}$	Input Offset Voltage Drift		7		$\mu\text{V}/^\circ\text{C}$
$I_{ib}$	Input Bias Current negative input		20		nA
$A_{vd}$	Large Signal Voltage Gain $V_{icm} = 0V$ $V_{CC} = 15V$ , $R_L = 2k$		100		V/mV
SVR	Supply Voltage Rejection Ratio $V_{icm} = 0V$ $V_{CC}^+ = 5V$ to $30V$	65	100		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 $V_{CC}^+ = 30V$ $T_{amb} = 25^\circ\text{C}$ , $R_L = 10k$ $T_{min.} \leq T_{amb} \leq T_{max.}$	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 $2V$ , $V_{CC} = 15V$ $R_L = 2k$ , $C_L = 100\text{pF}$ , unity gain	0.2	0.4		$\text{V}/\mu\text{s}$
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		%

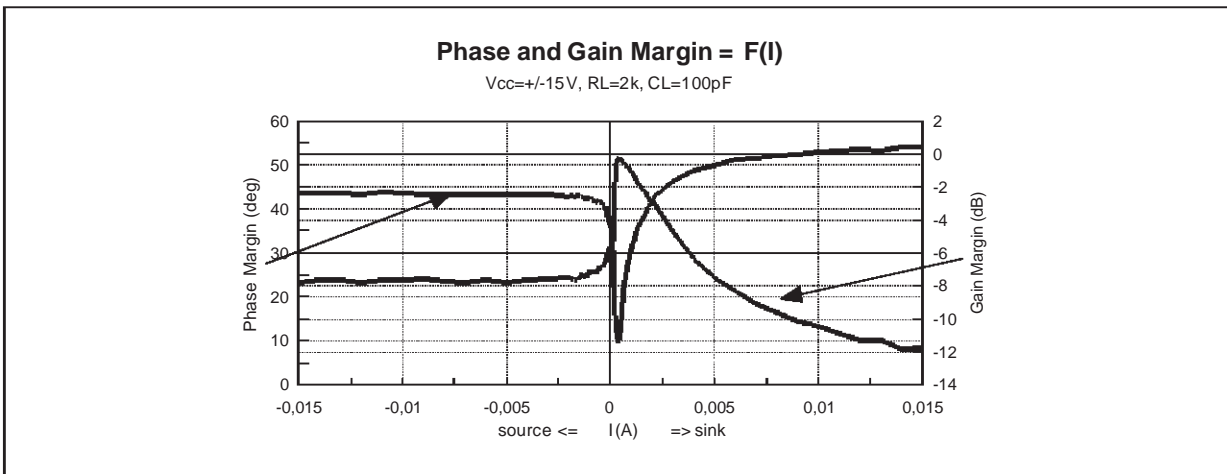
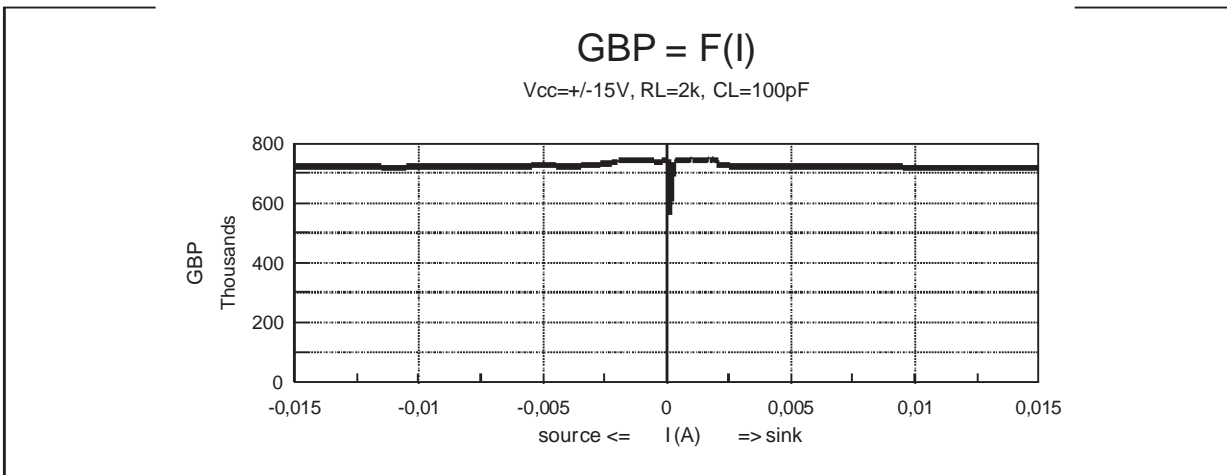
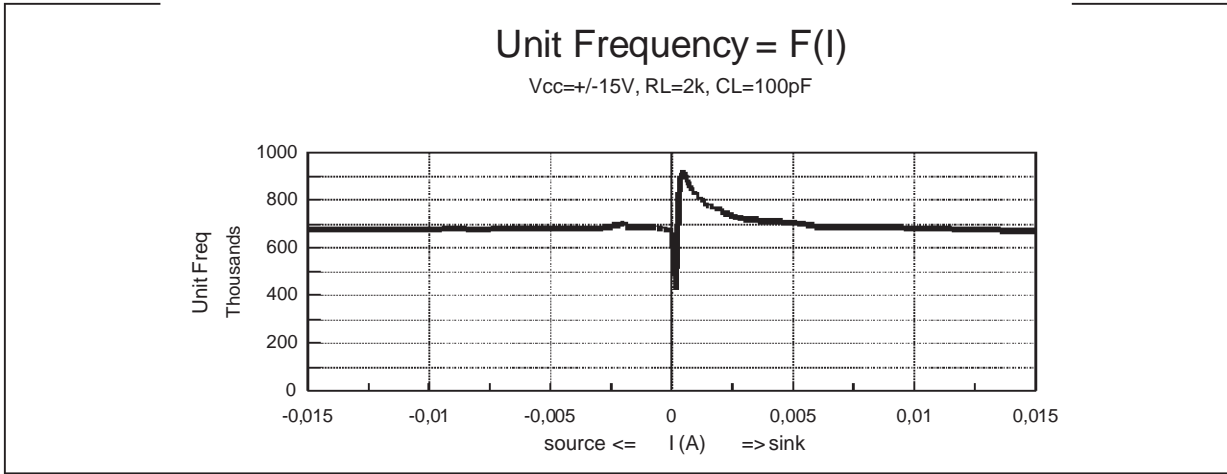
**VOLTAGE REFERENCE**

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

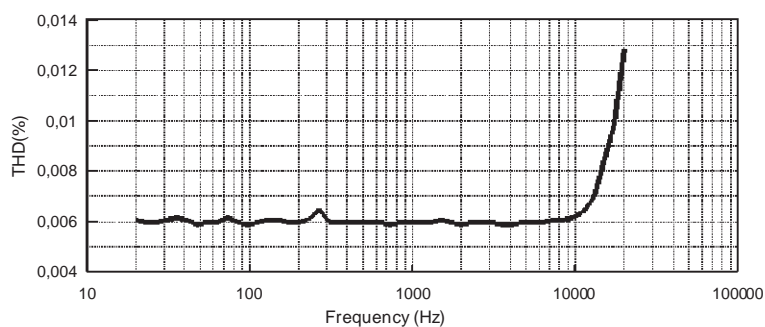
Symbol	Parameter	Min.	Typ.	Max.	Unit
$V_{ref}$	Reference Input Voltage TSM103, $T_{amb} = 25^{\circ}C$ $T_{min.} \leq T_{amb} \leq T_{max.}$ TSM103A, $T_{amb} = 25^{\circ}C$ $T_{min.} \leq T_{amb} \leq T_{max.}$	2.475 2.45 2.49 2.48	2.5 2.5	2.525 2.55 2.51 2.52	V
$\Delta V_{ref}$	Reference Input Voltage Deviation Over Temperature Range $V_{KA} = V_{ref}$ , $I_K = 10mA$ $T_{min.} \leq T_{amb} \leq T_{max.}$		7	30	mV
$I_{min}$	Minimum Cathode Current for Regulation $V_{KA} = V_{ref}$		0.5	1	mA
$ 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  $|Z_{KA}| = \Delta V_{KA} / \Delta I_K$

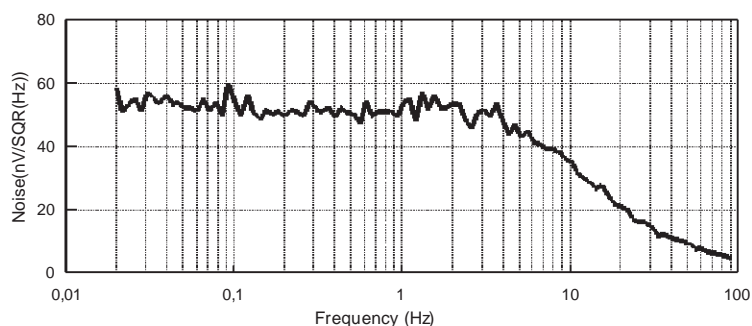
OPERATIONAL AMPLIFIERS



Total Harmonic Distorsion THD = F(freq)

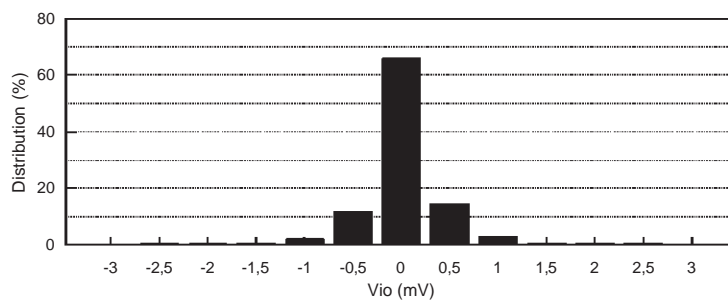


Noise = F(frequency)



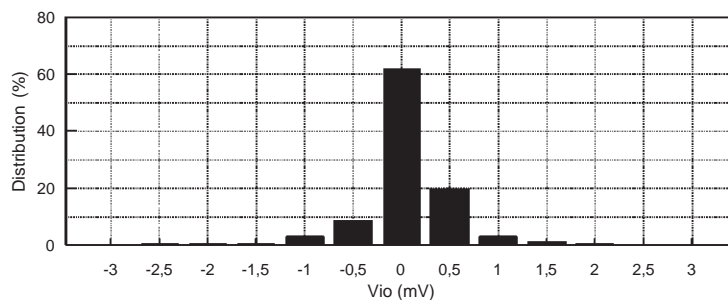
Vio Distribution - Operator 1

Vcc+=5V, Vcc=0V

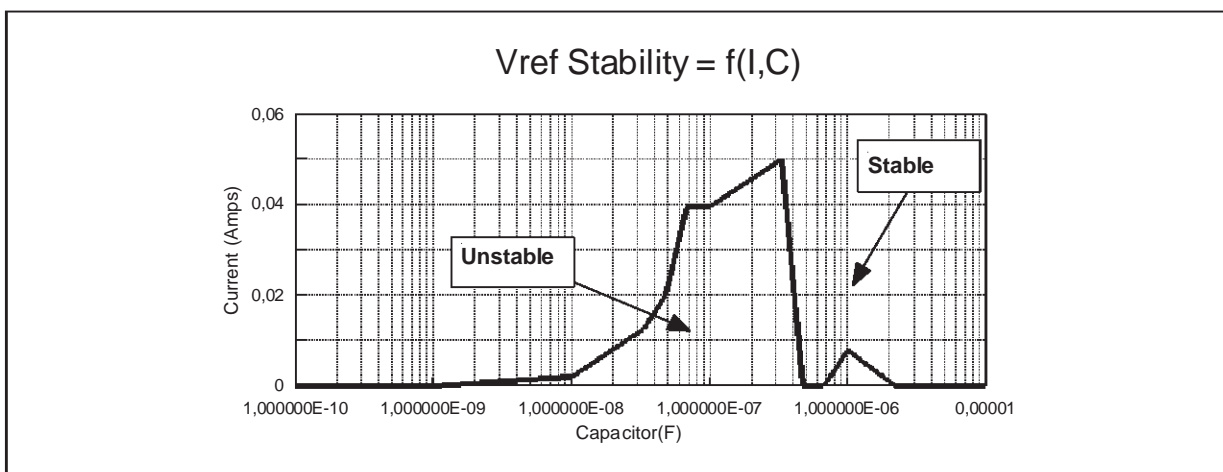
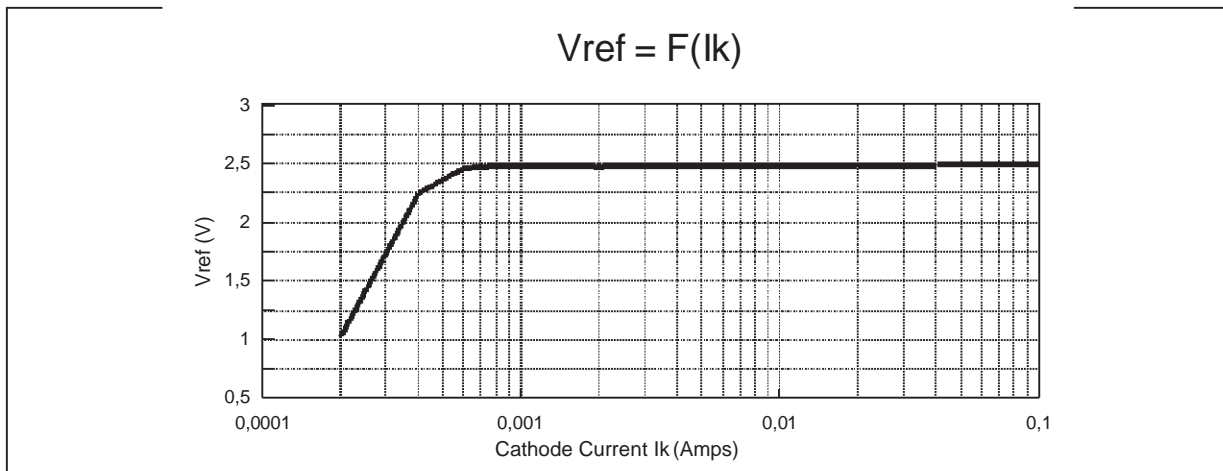


Vio Distribution - Operator 2

Vcc+=5V, Vcc=0V

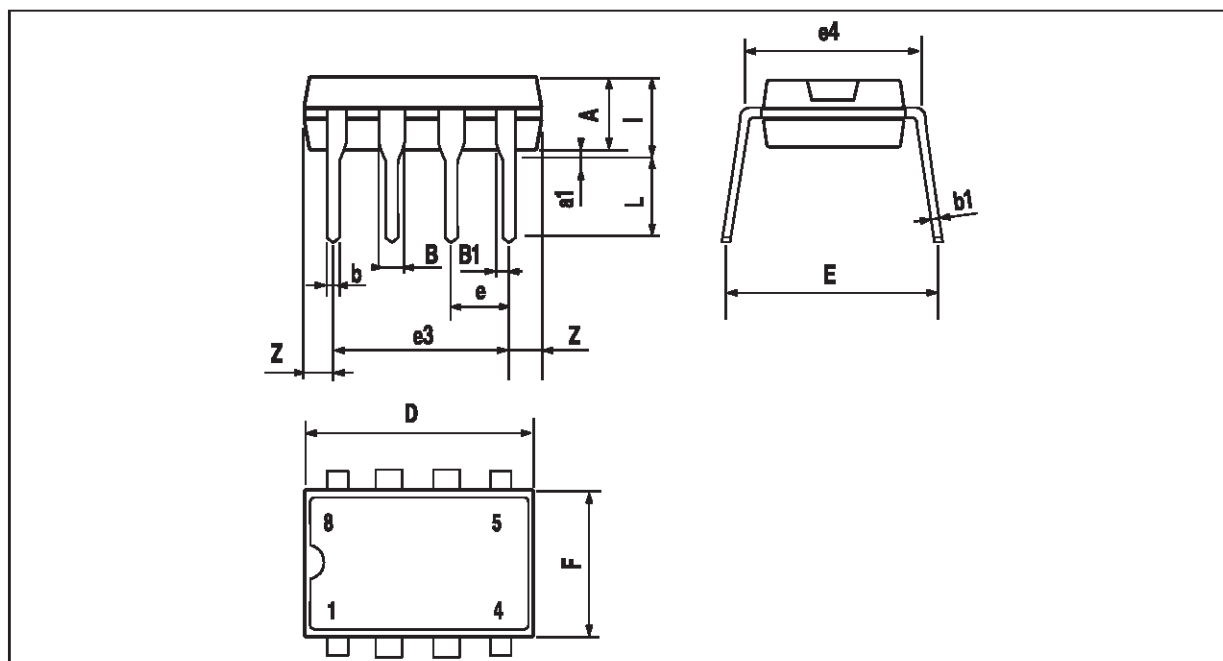


VOLTAGE REFERENCE



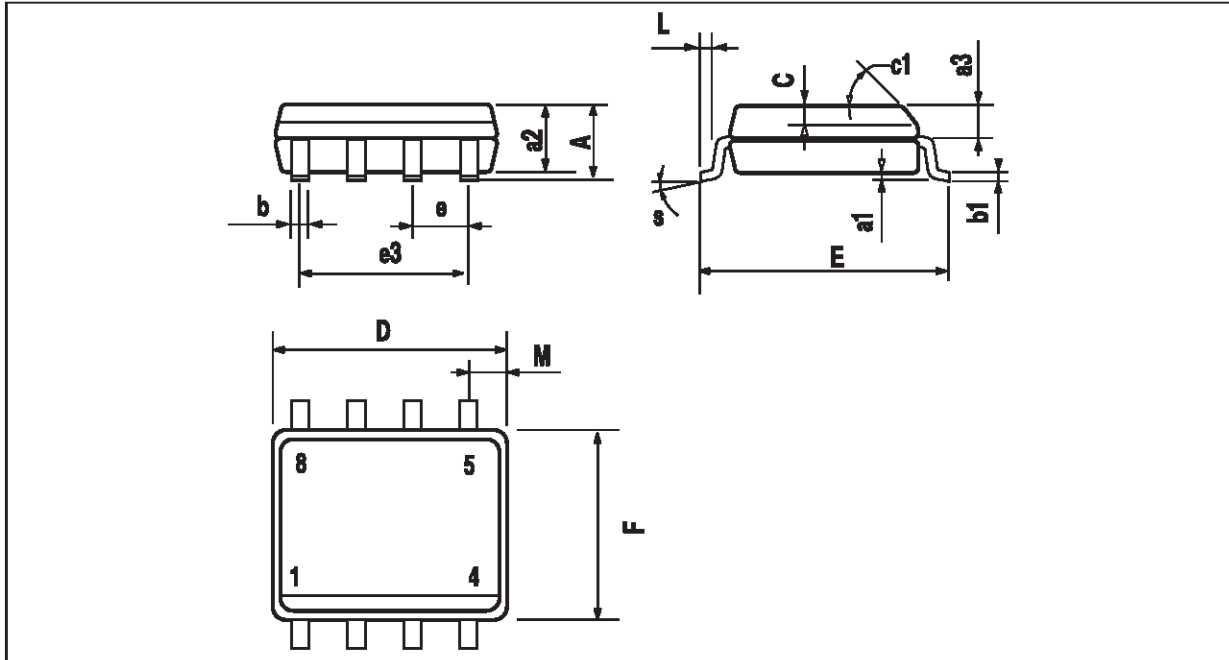


**PACKAGE MECHANICAL DATA**  
8 PINS - PLASTIC PACKAGE



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			0.260
i			5.08			0.200
L	3.18		3.81	0.125		0.150
Z			1.52			0.060

**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	$45^\circ$ (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	$8^\circ$ (max.)					

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