



# TSM106

## Dual Operational Amplifier and Voltage Reference

### Operational Amplifier:

- Low input offset voltage: 1mV typ.
- 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: 4 to 32V  $\pm 2$  TO  $\pm 16V$
- 1.5kV ESD protection (HBM)

### Voltage Reference:

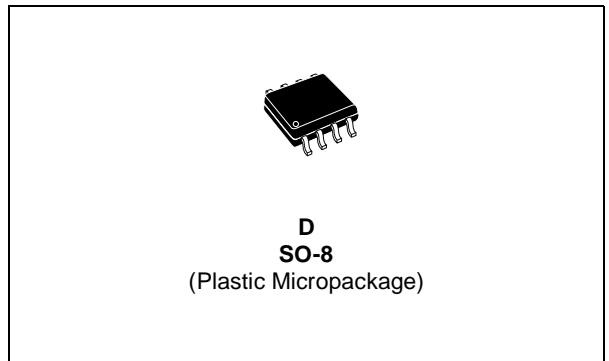
- Fixed output voltage reference 0.83V
- $\pm 1\%$  Voltage precision

### DESCRIPTION

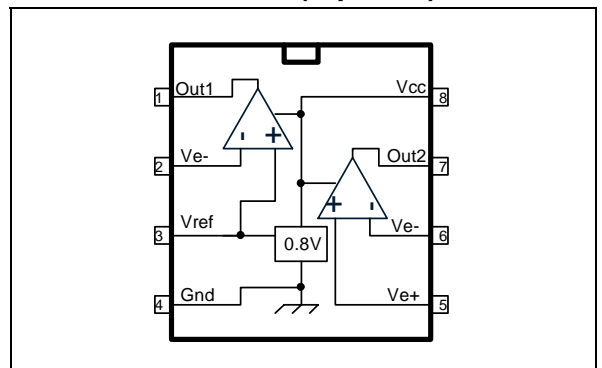
The TSM106 is a monolithic IC that includes one independent op-amp and another op-amp for which the non-inverting input is wired to a 0.83V fixed voltage reference. This device offers both space and cost savings in many applications such as power supply management or data acquisition systems.

### ORDER CODES

Part Number	Temperature Range	Package	Packaging	Marking
TSM106ID	-40°C, +105°C	SO	Tube	M106
TSM106IDT		SO	Tape & Reel	



### PIN CONNECTIONS (top view)



## 1 Absolute Maximum Ratings

Table 1: Key parameters and their 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 $V_{CC} + 0.3V$	V
$T_{oper}$	Operating Free-air Temperature Range	-40 to +105	°C
$T_j$	Maximum Junction Temperature	150	°C
$R_{thja}$	Thermal Resistance Junction to Ambient (SO package)	175	°C/W
$T_l$	Maximum Lead Temperature (10 seconds maximum)	260	°C
ESD	Electrostatic Discharge Protection	1.5	kV

## 2 Electrical Characteristics

Table 2: General electrical characteristics

Symbol	Parameter	Min.	Typ.	Max.	Unit
$I_{CC}$	Total Supply Current $V_{CC+} = 5V$ , no load $T_{min.} < T_{amb} < T_{max.}$		2.5	4.5	mA
	$V_{CC+} = 30V$ , no load $T_{min.} < T_{amb} < T_{max.}$		5.5	8.5 10	

Table 3: Electrical characteristics for operator 2 (independent op-amp):  $V_{CC+} = +5V$ ,  $V_{CC} =$  Ground,  $V_o = 1.4V$ ,  $T_{amb} = 25^\circ C$  (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
$V_{io}$	Input Offset Voltage $V_{icm} = 0V$ $T_{amb} = 25^\circ$ $T_{min.} \leq T_{amb} \leq T_{max.}$		1	4 5	mV
	$DV_{io}$	Input Offset Voltage Drift		7	
$I_{io}$	Input Offset Current $T_{min.} \leq T_{amb} \leq T_{max.}$		2	75 150	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 <sup>1</sup> $T_{min.} \leq T_{amb} \leq T_{max.}$	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

**Table 3: Electrical characteristics for operator 2 (independent op-amp): VCC+ = +5V, VCC = Ground, Vo = 1.4V, Tamb = 25°C (unless otherwise specified)**

Symbol	Parameter	Min.	Typ.	Max.	Unit
$I_{sink}$	Output Current Sink $V_{id} = -1V$ , $V_{CC} = +15V$ , $V_o = 2V$	10	20		mA
$V_{OH}$	High Level Output Voltage $T_{min.} \leq T_{amb} \leq T_{max}$ $T_{amb} = 25^\circ C$ , $R_L = 10k$ $T_{min.} \leq T_{amb} \leq T_{max.}$	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 $3V$ , $V_{CC} = 15V$ $R_L = 2k$ , $C_L = 100pF$ , unity gain	0.2	0.4		V/ $\mu s$
GBP	Gain Bandwidth Product $V_{CC} = 30V$ , $R_L = 2k$ , $C_L = 100pF$ $f = 100kHz$ , $V_{in} = 10mV$	0.5	0.9		MHz
THD	Total Harmonic Distortion $f = 1kHz$ $A_V = 20dB$ , $R_L = 2k$ , $V_{CC} = 30V$ $C_L = 100pF$ , $V_o = 2V_{pp}$		0.02		%
$e_n$	Equivalent Input Noise Voltage $f = 1kHz$ , $R_s = 100\Omega$ $V_{CC} = 30V$		50		nV/ $\sqrt{Hz}$

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  $V_{CC}^+ - 1.5V$ . Both inputs can go to  $V_{CC} + 0.3V$  without damage.

**Table 4: Electrical characteristics for operator 1 (op-amp with non-inverting input connected to the internal Vref): VCC+ = +5V, VCC- = Ground, Tamb = 25°C (unless otherwise specified)**

Symbol	Parameter	Min.	Typ.	Max.	Unit
$V_{io}$	Input Offset Voltage $V_{icm} = 0.83V$ $V_{CC} = 5V$ or $30V$ $T_{amb} = 25^\circ$ $T_{min.} \leq T_{amb} \leq T_{max.}$		1	4 5	mV
$DV_{io}$	Input Offset Voltage Drift		7		$\mu V/^\circ C$
$I_{ib}$	Input Bias Current negative input		20		nA
SVR	Supply Voltage Rejection Ratio $V_{icm} = 0.83V$ $V_{CC}^+ = 5V$ 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

**Table 4: Electrical characteristics for operator 1 (op-amp with non-inverting input connected to the internal Vref): VCC+ = +5V, VCC- = Ground, Tamb = 25°C (unless otherwise specified)**

Symbol	Parameter	Min.	Typ.	Max.	Unit
$V_{OH}$	High Level Output Voltage $V_{CC+} = 30V$ $T_{amb} = 25^{\circ}C, R_L = 10k$ $T_{min.} \leq T_{amb} \leq T_{max.}$	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
THD	Total Harmonic Distortion $f = 1kHz$ $A_V = 20dB, R_L = 2k, V_{CC} = 30V$ $C_L = 100pF, V_o = 2V_{pp}$		0.02		%

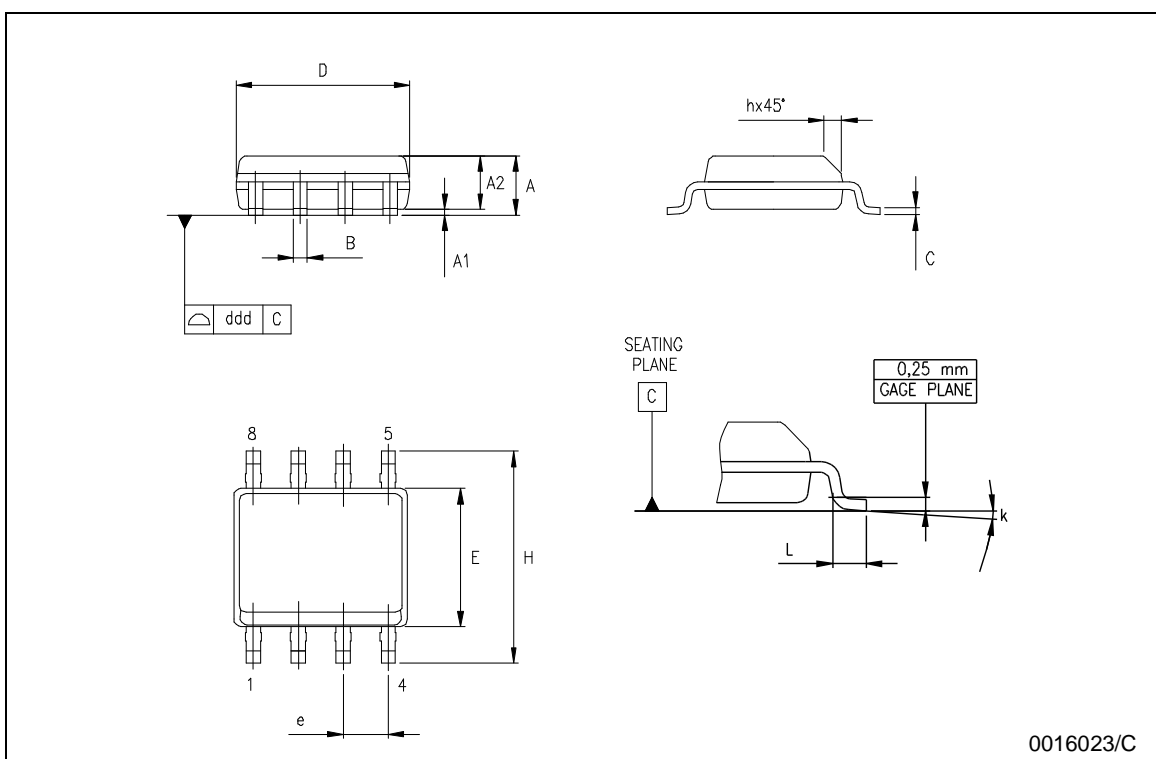
**Table 5: Electrical characteristics for voltage reference**

Symbol	Parameter	Min.	Typ.	Max.	Unit
$V_{ref}$	Reference Input Voltage $T_{amb} = 25^{\circ}C$ $T_{min.} \leq T_{amb} \leq T_{max.}$	0.822	0.83V	0.838	V
Regline	Reference Input Voltage over Vcc range $V_{icm} = 3.7V \text{ to } 30V, T_{amb} = 25^{\circ}C$ $T_{min.} \leq T_{amb} \leq T_{max.}$		3	6 10	mV
Regload	Reference Input Voltage over Ioutref current $I_{outref} = 1mA \text{ to } 10mA, T_{amb} = 25^{\circ}C$ $T_{min.} \leq T_{amb} \leq T_{max.}$		10	20 25	mV
$\Delta V_{ref}$	Reference Input Voltage Deviation Over Temperature Range $T_{min.} \leq T_{amb} \leq T_{max.}$		7	30	mV

### 3 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



0016023/C

## 4 Revision History

Date	Revision	Description of Changes
July 2004	1	First Release
September 2004	2	Modifications on first page: $V_{io} = 1\text{mV}$ Curves will be added in the future

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