



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 ± 2 TO $\pm 16V$
- 1.5kV ESD protection (HBM)

Voltage Reference:

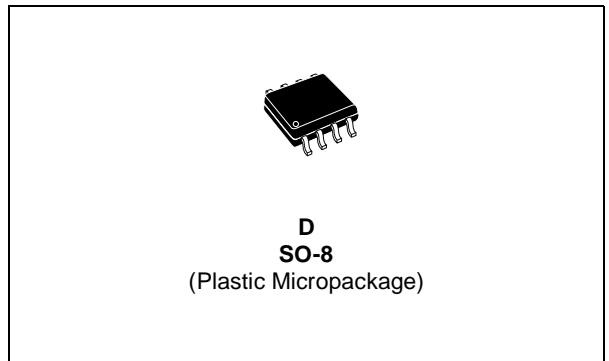
- Fixed output voltage reference 0.83V
- $\pm 1\%$ Voltage precision

DESCRIPTION

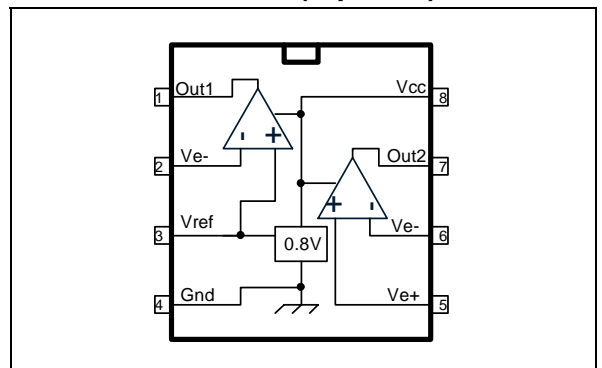
The TSM106 is a monolithic IC that includes one independent op-amp and another op-amp for which the non-inverting input is wired to a 0.83V fixed voltage reference. This device offers both space and cost savings in many applications such as power supply management or data acquisition systems.

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 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 |

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/ μs |
| 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 | | % |

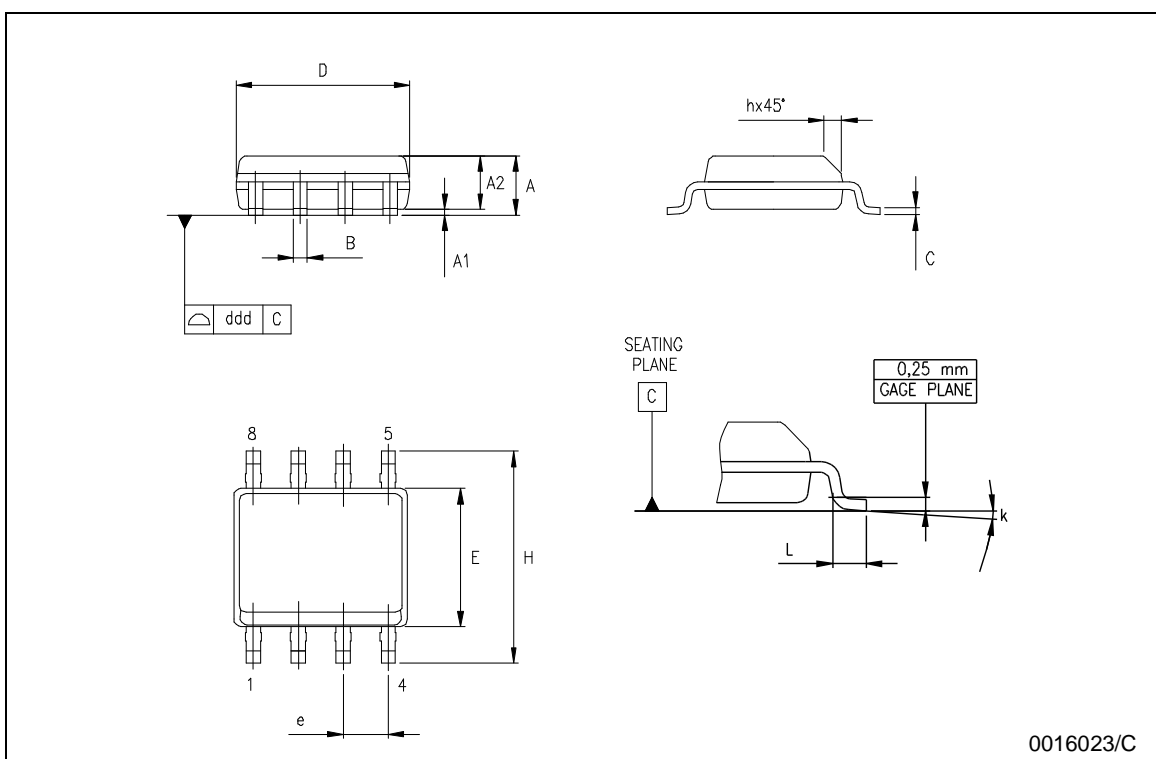
Table 5: Electrical characteristics for voltage reference

| 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 |
| ΔV_{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 |



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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