



Dual Operational Amplifier and Voltage Reference

OPERATIONAL AMPLIFIER

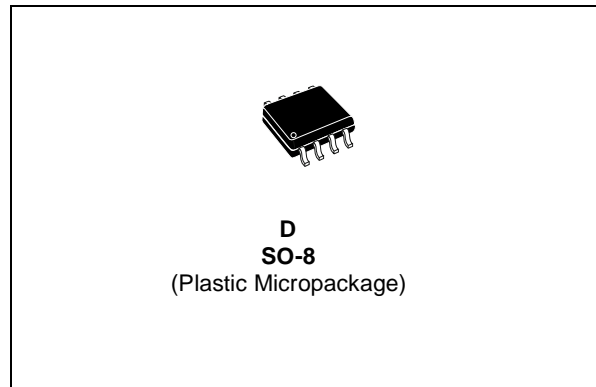
- **LOW INPUT OFFSET VOLTAGE** : 0.5mV typ.
- **LOW SUPPLY CURRENT** : 350 μ A/op. (@ $V_{CC} = 5V$)
- **MEDIUM BANDWIDTH** (unity gain) : 0.9MHz
- **LARGE OUTPUT VOLTAGE SWING** : 0V to ($V_{CC} - 1.5V$)
- **INPUT COMMON MODE VOLTAGE RANGE INCLUDES GROUND**
- **WIDE POWER SUPPLY RANGE** : 3 to 32V ± 1.5 TO $\pm 16V$
- **1.5kV ESD PROTECTION**
- **VOLTAGE REFERENCE**
- **FIXED OUTPUT VOLTAGE REFERENCE 2.5V**
- **$\pm 0.4\%$ OR $\pm 0.7\%$ VOLTAGE PRECISION**
- **SINK CURRENT CAPABILITY** : 1 to 100mA
- **TYPICAL OUTPUT IMPEDANCE** : 0.2 Ω

DESCRIPTION

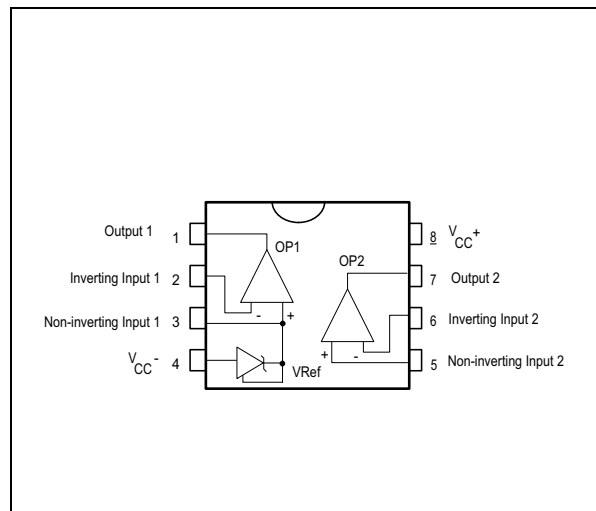
The TSM103W is a monolithic IC that includes one independent op-amp and another op-amp for which the non-inverting input is wired to a 2.5V fixed Voltage Reference. This device offers both space and cost savings in many applications such as power supply management or data acquisition systems.

ORDER CODE

| Part Number | Temperature Range | Package | Packaging |
|-------------|-------------------|---------|-------------|
| TSM103WID | -40, +105°C | SO-8 | Tube |
| TSM103WIDT | | | Tape & Reel |
| TSM103WAID | | | Tube |
| TSM103WAIDT | | | Tape & Reel |



PIN CONNECTIONS (top view)



1 ABSOLUTE MAXIMUM RATINGS

| Symbol | Parameter | Value | Unit |
|------------|---|-------------------------|------|
| V_{CC} | Supply Voltage | 36 | V |
| V_{id} | Differential Input Voltage | $V_{CC} + 0.6$ | V |
| V_i | Input VoltageL | -0.3 to $V_{CC} + 0.3V$ | V |
| T_{stg} | Storage temperature range | -65 to + 150 | °C |
| I_k | Continuous cathode current range | -100 to 150 | mA |
| 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 |

OPERATING CONDITIONS

| Symbol | Parameter | Value | Unit |
|------------|--------------------------------------|---------------|------|
| V_{CC} | DC Supply Conditions | 3 to 32 | V |
| I_k | Vref Cathode Current | 1 to 100 | mA |
| T_{oper} | Operating Free-air Temperature Range | -40°C, +105°C | °C |

2 ELECTRICAL CHARACTERISTICS

| 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.} | | 0.7 | 1.2 2 | mA |

OPERATOR 2 (independent op-amp)V_{CC+} = +5V, V_{CC} = Ground, V_o = 1.4V, T_{amb} = 25°C (unless otherwise specified)

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|------------------|--|----------------------|----------|--|----------|
| V_{io} | Input Offset Voltage V _{icm} = 0V TSM103WA, T _{amb} = 25° T _{min.} ≤ T _{amb} ≤ T _{max.} TSM103W, T _{amb} = 25° T _{min.} ≤ T _{amb} ≤ T _{max.} | | 0.5 1 | 2 3 4 5 | mV |
| DV _{io} | Input Offset Voltage Drift | | 7 | | μV/°C |
| I_{io} | Input Offset Current T _{min.} ≤ T _{amb} ≤ T _{max.} | | 2 | 75 150 | nA |
| I_{ib} | Input Bias Current T _{min.} ≤ T _{amb} ≤ T _{max.} | | 20 | 150 200 | nA |
| Avd | Large Signal Voltage Gain V _{CC} = 15V, R _L = 2k, V _o = 1.4V to 11.4V T _{min.} ≤ T _{amb} ≤ 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.} ≤ T _{amb} ≤ T _{max.} | 0 0 | | (V _{CC+}) -1.5 (V _{CC+}) -2 | V |
| CMR | Common Mode Rejection Ratio T _{min.} ≤ T _{amb} ≤ 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 V _{CC} = +15V, V _o = 0.2V | 10 12 | 20 50 | | mA μA |
| V _{OH} | High Level Output Voltage V _{CC+} = 30V T _{amb} = 25°C, R _L = 2k T _{min.} ≤ T _{amb} ≤ T _{max.} T _{amb} = 25°C, R _L = 10k T _{min.} ≤ T _{amb} ≤ T _{max.} | 26 26 27 27 | 27 28 | | V |
| V _{OL} | Low Level Output Voltage R _L = 10k T _{min.} ≤ T _{amb} ≤ 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 |

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|--------|---|------|------|------|-----------------|
| 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.

OPERATOR 1 (op-amp with non-inverting input connected to the internal Vref)

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

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|--------------|--|----------------------|----------|------------------|------------------|
| V_{io} | Input Offset Voltage $V_{icm} = 0V$ TSM103WA, $T_{amb} = 25^\circ$ $T_{min.} \leq T_{amb} \leq T_{max.}$ TSM103W, $T_{amb} = 25^\circ$ $T_{min.} \leq T_{amb} \leq T_{max.}$ | | 0.5 1 | 2 3 4 5 | mV |
| DV_{io} | Input Offset Voltage Drift | | 7 | | $\mu V/^\circ C$ |
| I_{ib} | Input Bias Current negative input | | 20 | | nA |
| Avd | Large Signal Voltage Gain $V_{CC} = 15V, R_L = 2k, V_o = 1.4V \text{ to } 11.4V$ $T_{min.} \leq T_{amb} \leq T_{max.}$ | | 100 | | V/mV |
| SVR | Supply Voltage Rejection Ratio $V_{icm} = 0V$ $V_{CC}^+ = 5V \text{ to } 30V$ | 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 $V_{id} = -1V,$ $V_{CC} = +15V, V_o = 2V$ $V_{CC} = +15V, V_o = 0.2V$ | 10 12 | 20 50 | | mA μA |
| V_{OH} | High Level Output Voltage $V_{CC}^+ = 30V$ $T_{amb} = 25^\circ C, R_L = 2k$ $T_{min.} \leq T_{amb} \leq T_{max.}$ $T_{amb} = 25^\circ C, R_L = 10k$ $T_{min.} \leq T_{amb} \leq T_{max.}$ | 26 26 27 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 $V_i = 0.5 \text{ to } 2V, V_{CC} = 15V$ $R_L = 2k, C_L = 100pF, \text{ unity gain}$ | 0.2 | 0.4 | | V/ μs |

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|--------|---|------|------|------|------|
| 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 | | % |

VOLTAGE REFERENCE

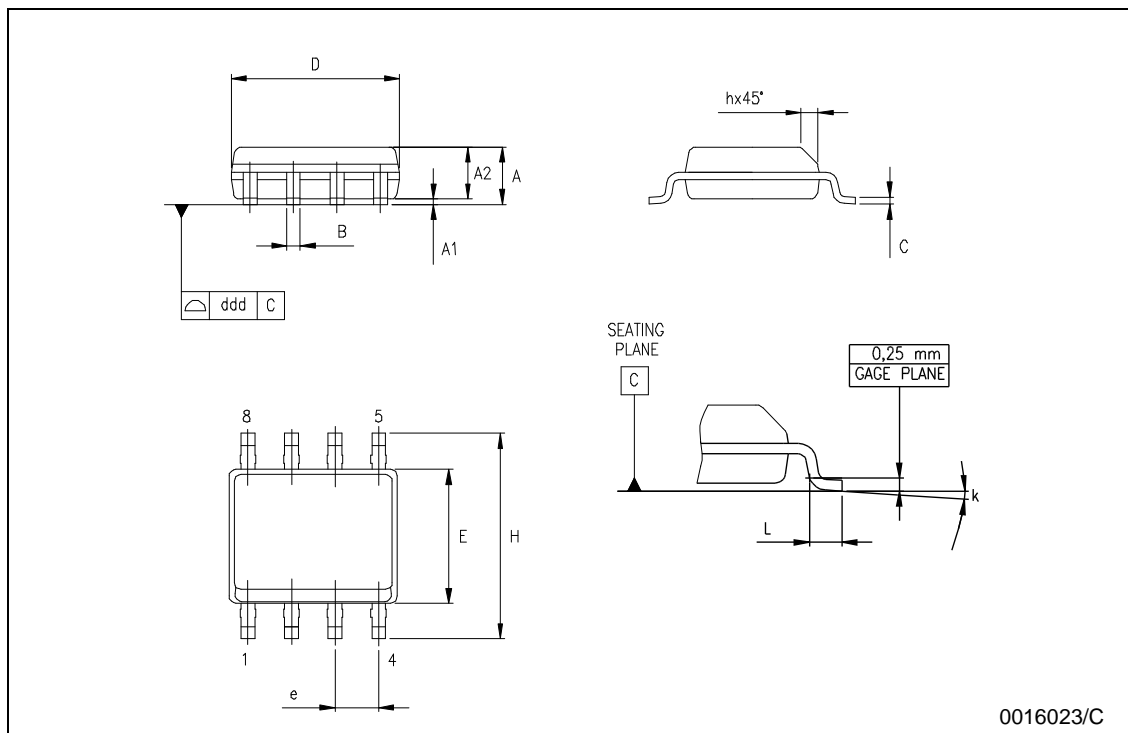
| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|------------------|--|--------------------------------|--------------|--------------------------------|----------|
| V_{ref} | Reference Input Voltage, $I_k = 10mA$ TSM103WA $\pm 0.4\%$ $T_{amb} = 25^\circ C$ $T_{min.} \leq T_{amb} \leq T_{max.}$ TSM103W $\pm 0.7\%$ $T_{amb} = 25^\circ C$ $T_{min.} \leq T_{amb} \leq T_{max.}$ | 2.49 2.48 2.482 2.465 | 2.5 2.500 | 2.51 2.52 2.518 2.535 | V |
| ΔV_{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 $V_{KA} = V_{ref}; \Delta I_K = 1 \text{ to } 100mA, f < 1kHz$ | | 0.2 | 0.5 | Ω |

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

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 |



3 SUMMARY OF CHANGES

| Date | Revision | Description of Changes |
|---------------|----------|---|
| | 1-2 | First Release |
| 02-April-2004 | 3 | 1 - Vid=Vcc+0.6 modified on AMR table - page 2 2 - Add I _k parameter on AMR table - page 2 3 - Avd test condition equal on both tables Operator 1 & Operator 2 - pages 3 & 4 |

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