



# TSH151

## WIDE BANDWIDTH AND MOS INPUTS SINGLE OPERATIONAL AMPLIFIER

- LOW DISTORTION
- GAIN BANDWIDTH PRODUCT : 150MHz
- UNITY GAIN STABLE
- SLEW RATE : 200V/ $\mu$ s
- VERY FAST SETTLING TIME : 70ns (0.1%)
- VERY HIGH INPUT IMPEDANCE

### DESCRIPTION

The TSH151 is a wideband monolithic operational amplifier, internally compensated for unity-gain stability.

The TSH151 features extremely high input impedance (typically greater than  $10^{12}\Omega$ ) allowing direct interfacing with high impedance sources.

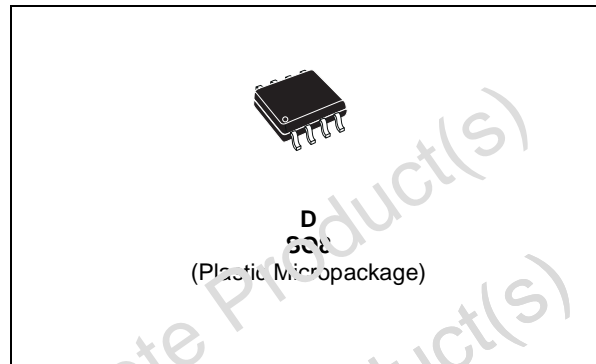
Low distortion, wide bandwidth and high linearity make this amplifier suitable for RF and video applications. Short circuit protection is provided by an internal current-limiting circuit.

The TSH151 has internal electrostatic discharge (ESD) protection circuits and fulfills MILSTD883C-Class2.

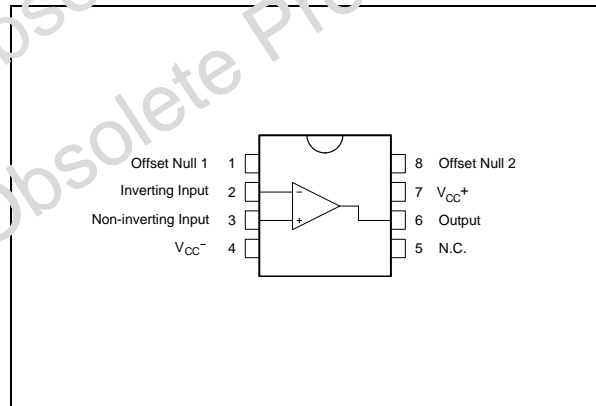
### ORDER CODE

| Part Number | Temperature Range | Package |
|-------------|-------------------|---------|
| TSH151I     | -40°C, +125°C     | •       |

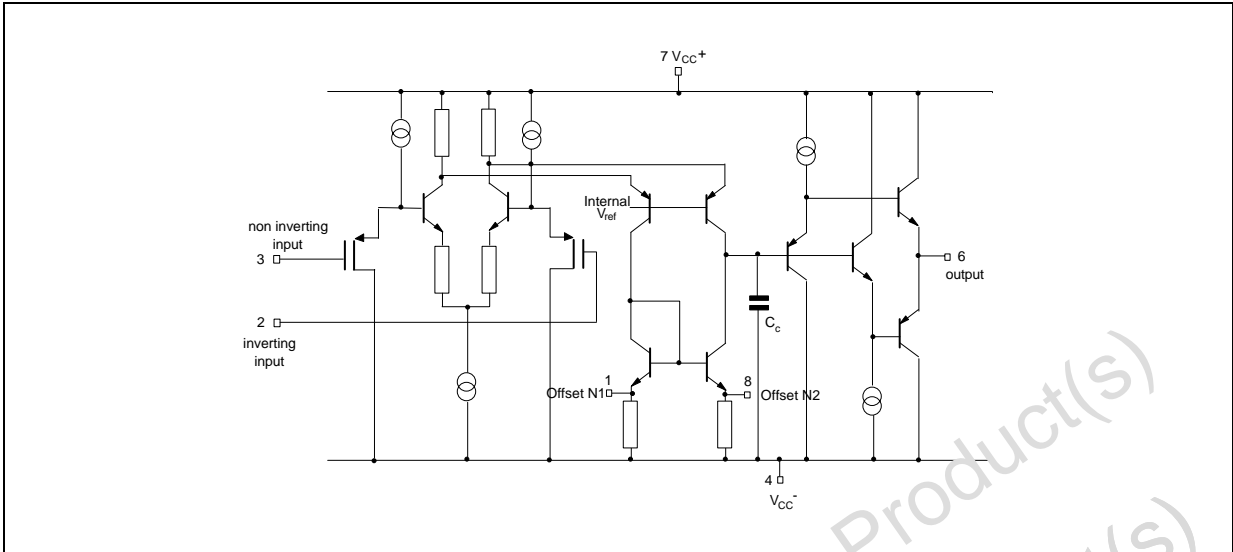
D = Small Outline Package (SO) - also available in Tape & Reel (DT)



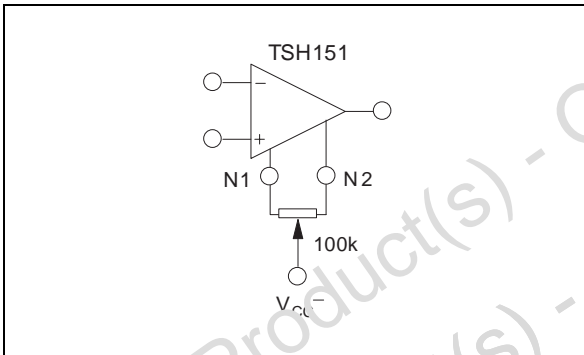
### PIN CONNECTIONS (top view)



**SCHEMATIC DIAGRAM**



**INPUT OFFSET VOLTAGE NULL CIRCUIT**



**MAXIMUM RATINGS**

| Symbol     | Parameter                            | Value       | Unit         |
|------------|--------------------------------------|-------------|--------------|
| $V_{CC}$   | Supply Voltage                       | $\pm 7$     | V            |
| $V_{id}$   | Differential Input Voltage           | $\pm 5$     | V            |
| $V_i$      | Input Voltage                        | $\pm 5$     | V            |
| $I_{in}$   | Current On Offset Null Pins          | $\pm 20$    | $\mu$ A      |
| $T_{oper}$ | Operating Free-Air Temperature range | -40 to +125 | $^{\circ}$ C |

**OPERATING CONDITIONS**

| Symbol   | Parameter                       | Value                        | Unit |
|----------|---------------------------------|------------------------------|------|
| $V_{CC}$ | Supply Voltage                  | $\pm 3$ to $\pm 6$           | V    |
| $V_{ic}$ | Common Mode Input Voltage Range | $V_{CC}^-$ to $V_{CC}^+ - 3$ | V    |

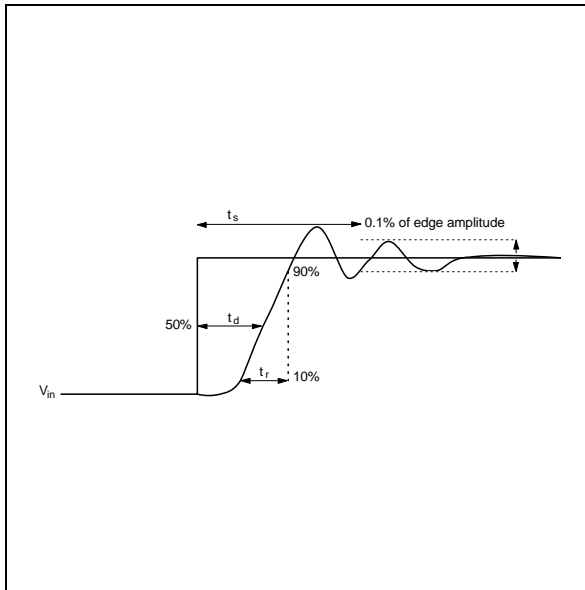
**ELECTRICAL CHARACTERISTICS** $V_{CC} = \pm 5V$ ,  $T_{amb} = 25^{\circ}C$  (unless otherwise specified)

| Symbol        | Parameter  | Min.   | Typ.                         | Max.                 | Unit              |
|---------------|--|--|------------------------------|----------------------|-------------------|
| $V_{io}$      | Input Offset Voltage<br>$T_{min.} \leq T_{amb} \leq T_{max.}$  |  | 0.5                          | 10<br>12             | mV                |
| $DV_{io}$     | Input Offset Voltage Drift<br>$T_{min.} \leq T_{amb} \leq T_{max.}$  |  | 10                           |                      | $\mu V/^{\circ}C$ |
| $I_{ib}$      | Input Bias Current   |  | 2                            | 300                  | pA                |
| $I_{io}$      | Input Offset Current   |  | 2                            | 200                  | pA                |
| $I_{CC}$      | Supply Current, no load<br>$T_{min.} \leq T_{amb} \leq T_{max.}$<br>$V_{CC} = \pm 5V$<br>$V_{CC} = \pm 3V$<br>$V_{CC} = \pm 6V$<br>$V_{CC} = \pm 5V$ |  | 23<br>21<br>25               | 30<br>28<br>40<br>32 | mA                |
| $A_{vd}$      | Large Signal Voltage Gain $V_o = \pm 2.5V$<br>$R_L = \infty$<br>$R_L = 100\Omega$<br>$R_L = 50\Omega$  | 800<br>300<br>200                              | 1300<br>850<br>650           |                      | V/V               |
| $V_{icm}$     | Input Common Mode Voltage Range  | -5 to +2                                       | 5.5 to +2.5                  |                      | V                 |
| CMR           | Common-mode Rejection Ratio $V_{ic} = V_{icm\ min.}$   | 60   | 100                          |                      | dB                |
| SVR           | Supply Voltage Rejection Ratio $V_{CC} = \pm 5V$ to $\pm 3V$   | 50   | 70                           |                      | dB                |
| $V_o$         | Output Voltage<br>$T_{min.} \leq T_{amb} \leq T_{max.}$<br>$R_L = 100\Omega$<br>$R_L = 50\Omega$<br>$R_L = 100\Omega$<br>$R_L = 50\Omega$            | $\pm 3$<br>$\pm 2.8$<br>$\pm 2.9$<br>$\pm 2.7$ | +3.5<br>-3.7<br>+3.3<br>-3.5 |                      | V                 |
| $I_o$         | Output Short Circuit Current $V_{io} = \pm 1V$ , $V_o = 0V$  | $\pm 50$                                       | $\pm 100$                    |                      | mA                |
| GBP           | Gain Bandwidth Product<br>$A_{VCL} = 10$ , $R_L = 100\Omega$ , $C_L = 15pF$ , $f = 7.5MHz$   |  | 150                          |                      | MHz               |
| SR            | Slew Rate $V_{in} = \pm 2V$ , $A_{VCL} = 1$ , $R_L = 100\Omega$ , $C_L = 15pF$   | 100  | 200                          |                      | V/ $\mu s$        |
| $e_n$         | Equivalent Input Voltage Noise<br>$R_s = 50\Omega$<br>$f_o = 1kHz$<br>$f_o = 10kHz$<br>$f_o = 100kHz$<br>$f_o = 1MHz$                                |  | 20<br>18.2<br>18.1<br>18.2   |                      | nV/ $\sqrt{Hz}$   |
| $K_{ov}$      | Overshoot $V_{in} = \pm 2V$ , $A_{VCL} = 1$ , $R_L = 100\Omega$ , $C_L = 15pF$   |  | 10                           |                      | %                 |
| $t_s$         | Settling Time 0.1% <sup>1)</sup><br>$V_{in} = \pm 1V$ , $A_{VCL} = -1$   |  | 70                           |                      | ns                |
| $t_r$ , $t_f$ | Rise and Fall Time (see note 1)<br>$V_{in} = \pm 100mV$ , $A_{VCL} = 2$  |  | 5                            |                      | ns                |
| $t_d$         | Delay Time (see note 1)<br>$V_{in} = \pm 100mV$ , $A_{VCL} = 2$  |  | 4                            |                      | ns                |
| $\phi_m$      | Phase Margin $A_{VM} = 1$ , $R_L = 100\Omega$ , $C_L = 15pF$   |  | 45                           |                      | Degrees           |
| THD           | Total Harmonic Distortion<br>$A_{VCL} = 10$ , $f = 1kHz$ , $V_o = \pm 2.5V$ , no load  |  | 0.02                         |                      | %                 |
| FPB           | Full Power Bandwidth <sup>2)</sup><br>$V_o = 5V_{pp}$ , $R_L = 100\Omega$<br>$V_o = 2V_{pp}$ , $R_L = 100\Omega$                                     |  | 13<br>32                     |                      | MHz               |

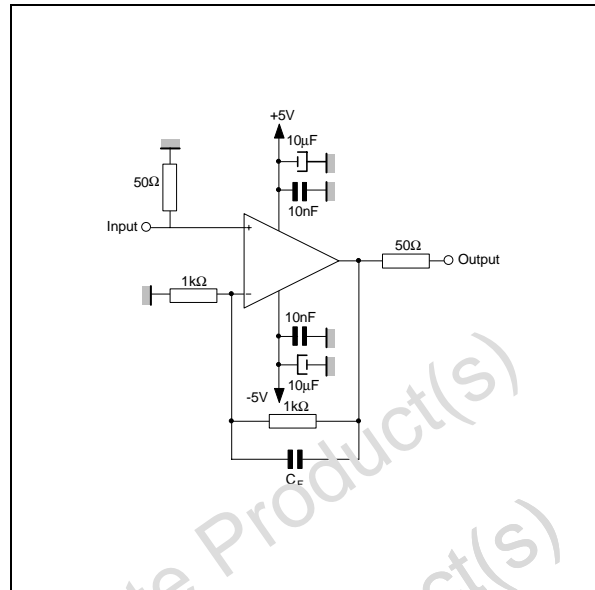
1. See test waveform figure

2. Full power bandwidth =  $\frac{SR}{\pi V_{opp}}$

## TEST WAVEFORM



## EVALUATION CIRCUIT



## PRINTED CIRCUIT LAYOUT

As for any high frequency device, a few rules must be observed when designing the PCB to get the best performances from this high speed op amp.

From the most to the least important points :

- Each power supply lead has to be bypassed to ground with a 10nF ceramic capacitor very close to the device and a 10μF tantalum capacitor.
- To provide low inductance and low resistance common return, use a ground plane or common point return for power and signal.
- All leads must be wide and as short as possible especially for op amp inputs. This is in

order to decrease parasitic capacitance and inductance.

- Use small resistor values to decrease time constant with parasitic capacitance.
- Choose component sizes as small as possible (SMD).
- On output, decrease capacitor load so as to avoid circuit stability being degraded which may cause oscillation. You can also add a serial resistor in order to minimise its influence.
- One can add in parallel with feedback resistor a few pF ceramic capacitor  $C_F$  adjusted to optimize the settling time.

**MACROMODEL****Applies to: TSH151I**

\*\* Standard Linear Ics Macromodels, 1993.

\*\* CONNECTIONS :

\* 1 INVERTING INPUT

\* 2 NON-INVERTING INPUT

\* 3 OUTPUT

\* 4 POSITIVE POWER SUPPLY

\* 5 NEGATIVE POWER SUPPLY

.SUBCKT TSH151 1 3 2 4 5 (analog)

\*\*\*\*\*

.MODEL MDTH D IS=1E-8 KF=3.322525E-14

CJO=10F

\* INPUT STAGE

RESD1 2 202 150

RESD2 1 201 150

CIP 202 5 10.000000E-12

CIN 201 5 10.000000E-12

EIP 10 5 202 5 1

EIN 16 5 201 5 1

RIP 10 11 2.600000E-01

RIN 15 16 2.600000E-01

RIS 11 15 1.683423E-01

DIP 11 12 MDTH 400E-12

DIN 15 14 MDTH 400E-12

VOFP 12 13 DC 0.000000E+00

VOFN 13 14 DC 0

IPOLE 13 5 1.000000E-02

CPS 11 15 8E-09

DINN 17 13 MDTH 400E-12

VIN 17 5 1.500000E+00

DINR 15 18 MDTH 400E-12

VIP 4 18 5.000000E-01

FCP 4 5 VOFP 2.200000E+01

FCN 5 4 VOFN 2.200000E+01

\* AMPLIFYING STAGE

FIP 5 19 VOFP 3.800000E+02

FIN 5 19 VOFN 3.800000E+02

RG1 19 5 1.455096E+03

RG2 19 4 1.455096E+03

CC 19 29 2.000000E-09

HZTP 29 30 VOFP 100

HZTN 30 5 VOFN 100

DOPM 19 22 MDTH 400E-12

DONM 21 19 MDTH 400E-12

HOPM 22 29 VOUT 5.000000E+02

VIPM 29 4 5.000000E+01

ICONM 21 27 VOUT 5.000000E+02

VINM 5 27 5.000000E+01

EOUT 26 23 19 5 1

VOUT 23 5 0

ROUT 26 3 9.978126E+00

COU 3 5 1.000000E-13

DOP 19 25 MDTH 400E-12

VOP 4 25 1.946965E+00

DON 24 19 MDTH 400E-12

VON 24 5 1.946965E+00

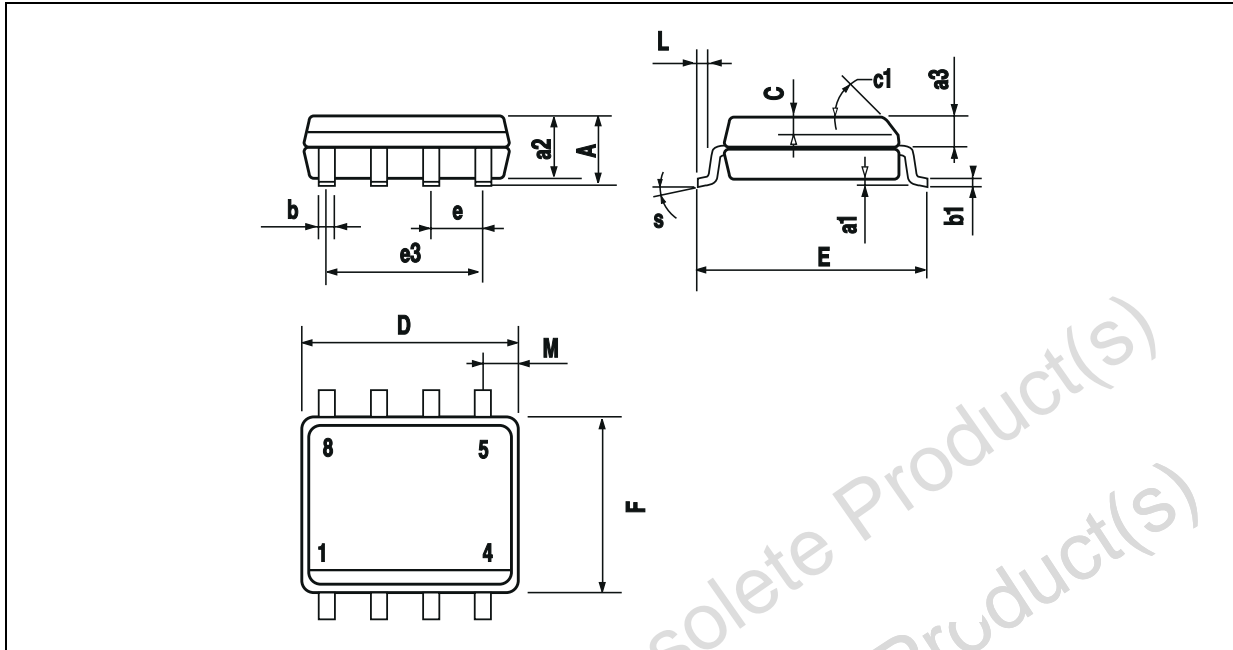
.ENDS

**ELECTRICAL CHARACTERISTICS**

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

| Symbol       | Conditions                       | Value     | Unit       |
|--------------|----------------------------------|-----------|------------|
| $V_{io}$     |                                  | 0         | mV         |
| $A_{vd}$     | $R_L = 100\Omega$                | 1.18      | V/mV       |
| $I_{CC}$     | No load                          | 23        | mA         |
| $V_{icm}$    |                                  | -5 to 2.5 | V          |
| $V_{OH}$     | $R_L = 100\Omega$                | +3.6      | V          |
| $V_{OL}$     | $R_L = 100\Omega$                | -3.6      | V          |
| $I_{sink}$   | $V_o = 0V$                       | 108       | mA         |
| $I_{source}$ | $V_o = 0V$                       | 108       | mA         |
| GBP          | $R_L = 100\Omega$ , $C_L = 15pF$ | 130       | MHz        |
| SR           | $R_L = 100\Omega$ , $C_L = 15pF$ | 172       | V/ $\mu s$ |
| $\phi_m$     | $R_L = 100\Omega$ , $C_L = 15pF$ | 25        | Degrees    |
| $t_s$        | $A_v = -1$ at 0.1%               | 40        | ns         |

**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 |
| c    | 45° (typ.)  |      |      |        |       |       |
| L    | 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° (max.)   |      |      |        |       |       |

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