National Semiconductor

# MICROCIRCUIT DATA SHEET

## MNLM101-X REV 0A0

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# OPERATION AMPLIFIER

## General Description

The LM101 is a general purpose operational amplifier which features improved performance over industry standards such as the LM709. Advanced processing techniques make possible an order of magnitude reduction in input currents, and a redesign of the biasing circuitry reduces the temperature drift of input current. Improved specifications include:

- Offset voltage 4 mV maximum over temperature
- Input current 1000 nA maximum over temperture
- Offset current 500 nA maximum over temperature
- Offsets guaranteed over entire common mode and supply voltage ranges
- Slew rate of 10V/uS as a summing amplifier

This amplifier offers many features which make its application nearly foolproof: overload protection on the input and output, no latch-up when the common mode range is exceeded, and freedom from oscillations and compensation with a single 30 pF capacitor. It has advantages over internally compensated amplifiers in that the frequency compensation can be tailored to the particular application. For example, in low frequency circuits it can be overcompensated for increased stability margin. Or the compensation can be optimized to give more than a factor of ten improvement in high frequency performance for most applications.

In addition, the device provides better accuracy and lower noise in high impedance circuitry. The low input currents also make it particularly well suited for long interval integrators or timers, sample and hold circuits, and low frequency waveform generators. Further, replacing circuits where matched transistor pairs buffer the inputs of conventional IC op amps, it can give lower offset voltage and a drift at a lower cost.

## Industry Part Number

LM101

## NS Part Numbers

LM101W/883

## Prime Die

LM101

## Processing

MIL-STD-883, Method 5004

## Quality Conformance Inspection

MIL-STD-883, Method 5005

| Subgrp | Description | Temp ($^{O}$C) |
|---|---|---|
| 1 | Static tests at | +25 |
| 2 | Static tests at | +125 |
| 3 | Static tests at | -55 |
| 4 | Dynamic tests at | +25 |
| 5 | Dynamic tests at | +125 |
| 6 | Dynamic tests at | -55 |
| 7 | Functional tests at | +25 |
| 8A | Functional tests at | +125 |
| 8B | Functional tests at | -55 |
| 9 | Switching tests at | +25 |
| 10 | Switching tests at | +125 |
| 11 | Switching tests at | -55 |

## (Absolute Maximum Ratings)
(Note 1)

| | |
|---|---|
| Supply Voltage | ±22V |
| Differential Input Voltage | ± 30V |
| Input Voltage (Note 3) | ±15V |
| Ouput Short Circuit Duration (Note 4) | Continuous |
| Operating Ambient Temperature Range | -55 C to +125 C |
| Maximum Junction Temperature | 150 C |
| Power Dissipation at TA = 25C (Note 2) | |
| W-Package (Still Air) | 500 mW |
| W-Package (500LF/Min Air Flow) | 1200 mW |
| Thermal Resistance (Typical) | |
| ThetaJA | |
| W-Package (Still Air) | 233 C/W |
| (500LF/Min Air flow) | 155 C/W |
| ThetaJC | |
| W-Package | 26 C/W |
| Storage Temperature Range | -65 C to +150 C |
| Lead Temperature (Soldering, 10 seconds) | 300 C |
| ESD Tolerance (Note 5) | 2000V |

Note 1: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not guarantee specific performance limits. For guaranteed specifications and test conditions, see the Electrical Characteristics. The guaranteed specifications apply only for the test conditions listed. Some performance characteristics may degrade when the device is not operated under the listed test conditions.

Note 2: The maximum power dissipation must be derated at elevated temperatures and is dictated by Tjmax (maximum junction temperature), ThetaJA (package junction to ambient thermal resistance), and TA (ambient temperature). The maximum allowable power dissipation at any temperature is Pdmax = (Tjmax - TA)/ThetaJA or the number given in the Absolute Maximum Ratings, whichever is lower.

Note 3: For supply voltages less than ±15V, the absolute maximum input voltage is equal to the supply voltage.

Note 4: Continuous short circuit is allowed for case temperatures to 125C and ambient temperatures to 75 C for LM101A.

Note 5: Human body model, 100 pF discharged through 1.5K Ohms.

# Electrical Characteristics

## DC PARAMETERS

(The following conditions apply to all the following parameters, unless otherwise specified.)
DC: Vcc = ±20V, Vcm = 0

| SYMBOL | PARAMETER | CONDITIONS | NOTES | PIN-NAME | MIN | MAX | UNIT | SUB-GROUPS |
|---|---|---|---|---|---|---|---|---|
| Vio | Input Offset Voltage | Vcm = -15V | | | -3 | 3 | mV | 1 |
| | | | | | -4 | 4 | mV | 2, 3 |
| | | Vcm = +15V | | | -3 | 3 | mV | 1 |
| | | | | | -4 | 4 | mV | 2, 3 |
| | | Vcm = 0 | | | -3 | 3 | mV | 1 |
| | | | | | -4 | 4 | mV | 2, 3 |
| | | Vcc = ±5V, Vcm = 0 | | | -3 | 3 | mV | 1 |
| | | Vcc = ±5V, Vcm = 0 | | | -4 | 4 | mV | 2, 3 |
| Iio | Input Offset Current | Vcm = -15V | | | -200 | 200 | nA | 1, 2 |
| | | | | | -500 | 500 | nA | 3 |
| | | Vcm = +15V | | | -200 | 200 | nA | 1, 2 |
| | | | | | -500 | 500 | nA | 3 |
| | | Vcm = 0 | | | -200 | 200 | nA | 1, 2 |
| | | | | | -500 | 500 | nA | 3 |
| | | Vcc = ± 5V, Vcm = 0 | | | -200 | 200 | nA | 1, 2 |
| | | Vcc = ± 5V, Vcm = 0 | | | -500 | 500 | nA | 3 |
| +Iib | Input Bias Current | Vcm = -15V | | | | 500 | nA | 1, 2 |
| | | | | | | 1000 | nA | 3 |
| | | Vcm = +15V | | | | 500 | nA | 1, 2 |
| | | | | | | 1000 | nA | 3 |
| | | Vcm = 0 | | | | 500 | nA | 1, 2 |
| | | | | | | 1000 | nA | 3 |
| | | Vcc = ± 5V, Vcm = 0 | | | | 500 | nA | 1, 2 |
| | | Vcc = ± 5V, Vcm = 0 | | | | 1000 | nA | 3 |

# Electrical Characteristics

## DC PARAMETERS(Continued)

(The following conditions apply to all the following parameters, unless otherwise specified.)
DC: Vcc = ±20V, Vcm = 0

| SYMBOL | PARAMETER | CONDITIONS | NOTES | PIN-NAME | MIN | MAX | UNIT | SUB-GROUPS |
|---|---|---|---|---|---|---|---|---|
| -Iib | Input Bias Current | Vcm = -15V | | | | 500 | nA | 1, 2 |
| | | | | | | 1000 | nA | 3 |
| | | Vcm = +15V | | | | 500 | nA | 1, 2 |
| | | | | | | 1000 | nA | 3 |
| | | Vcm = 0 | | | | 500 | nA | 1, 2 |
| | | | | | | 1000 | nA | 3 |
| | | Vcc = ± 5V, Vcm = 0 | | | | 500 | nA | 1, 2 |
| | | Vcc = ± 5V, Vcm = 0 | | | | 1000 | nA | 3 |
| +PSRR | Power Supply Rejection Ratio | ±5V ≤ Vcc ≤ ±20V | | | 70 | | dB | 1, 2, 3 |
| -PSRR | Power Supply Rejection Ratio | ±5V ≤ Vcc ≤ ±20V | | | 70 | | dB | 1, 2, 3 |
| CMRR | Common Mode Rejection Ratio | -15V ≤ Vcm ≤ +15V | | | 70 | | dB | 1, 2, 3 |
| Vio(ADJ+) | Input Offset Voltage Adjust | | | | 4 | | mV | 1, 2, 3 |
| Vio(ADJ-) | Input Offset Voltage Adjust | | | | | -4 | mV | 1, 2, 3 |
| +Ios | Short Circuit Current | | | | -45 | -7 | mA | 1 |
| | | | | | -45 | -5 | mA | 2 |
| | | | | | -55 | -7 | mA | 3 |
| -Ios | Short Circuit Current | | | | 7 | 45 | mA | 1 |
| | | | | | 5 | 45 | mA | 2 |
| | | | | | 7 | 55 | mA | 3 |
| Icc | Power Supply Current | | | | | 3 | mA | 1 |
| | | | | | | 2.5 | mA | 2 |
| | | | | | | 3.5 | mA | 3 |
| Vop+ | Output Voltage Swing | Rl = 10K Ohms | | | 16 | | V | 1, 2, 3 |
| | | Rl = 2K Ohms | | | 15 | | V | 1, 2, 3 |
| | | Vcc = ±15V, Rl = 10K Ohms | | | 12 | | V | 1, 2, 3 |
| | | Vcc = ±15V, Rl = 2K Ohms | | | 10 | | V | 1, 2, 3 |

# Electrical Characteristics

## DC PARAMETERS(Continued)

(The following conditions apply to all the following parameters, unless otherwise specified.)
DC: Vcc = ±20V, Vcm = 0

| SYMBOL | PARAMETER | CONDITIONS | NOTES | PIN-NAME | MIN | MAX | UNIT | SUB-GROUPS |
|---|---|---|---|---|---|---|---|---|
| Vop- | Output Voltage Swing | Rl = 10K Ohms | | | | -16 | V | 1, 2, 3 |
| | | Rl = 2K Ohms | | | | -15 | V | 1, 2, 3 |
| | | Vcc = ±15V, Rl = 10K Ohms | | | | -12 | V | 1, 2, 3 |
| | | Vcc = ±15V, Rl = 2K Ohms | | | | -10 | V | 1, 2, 3 |
| Rin | Input Resistance | Iib:Rin= SKT/Q11B | 2, 3 | | 0.3 | | MOhms | 1 |
| Vin | Input Voltage Range | | 1, 3 | | -15 | 15 | V | 1, 2, 3 |
| Avs- | Open Loop Gain | Avs = ±15V, Vo = 0 to -10V, Rl = 2K Ohms | 4 | | 50 | | V/mV | 1 |
| | | Avs = ±15V, Vo = 0 to -10V, Rl = 2K Ohms | 4 | | 25 | | V/mV | 2, 3 |
| Avs+ | Open Loop Gain | Avs = ±15V, Vo = 0 to +10V, Rl = 2K Ohms | 4 | | 50 | | V/mV | 1 |
| | | Avs = ±15V, Vo = 0 to +10V, Rl = 2K Ohms | 4 | | 25 | | V/mV | 2, 3 |

## AC PARAMETERS

(The following conditions apply to all the following parameters, unless otherwise specified.)
AC: Vcc = ±20V, Vcm = 0

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Sr- | Slew Rate | Vin = +5V to -5V, Av = 1 | | | 0.2 | | V/uS | 9 |
| Sr+ | Slew Rate | Vin = -5V to 5V, Av = 1 | | | 0.2 | | V/uS | 9 |
| Gbw | Gain Bandwidth | Vin = 50mVRMS, f = 20KHz, Rl = 2K Ohms | | | 0.25 | | MHz | 9 |

## DC PARAMETERS: DRIFT VALUES

(The following conditions apply to all the following parameters, unless otherwise specified.)
DC: Vcc = ±20V, Vcm = 0. "Deltas not required on B-Level product. Deltas required for S-Level product ONLY as specified on Internal Processing Instructions (IPI)".

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Vio | Input Offset Voltage | Vcm = 0 | | | -1 | 1 | mV | 1 |
| Iio | Input Offset Current | Vcm = 0 | | | -20 | 20 | nA | 1 |
| +Iib | Input Bias Current | Vcm = 0 | | | -50 | 50 | nA | 1 |
| -Iib | Input Bias Current | Vcm = 0 | | | -50 | 50 | nA | 1 |

Note 1: Parameter guaranteed by the input conditions of several DC parameters.

*(Continued)*

Note 2: Guaranteed parameter, not tested.
Note 3: Delta computations for this device can be performed on the Teradyne. The ITP must indicate Data Reduction on the ITP prior to first read and record.
Note 4: Datalog reading in K+V/mV.

## Graphics and Diagrams

| GRAPHICS# | DESCRIPTION |
|---|---|
| 05309HN | (blank) |
| MKT-W10ARE | (blank) |

**See attached graphics following this page.**