

# LM433

## Dual Op Amp with On-Chip Fixed 2.5V Reference

### General Description

The LM433 integrates two operational amplifiers and one 2.5V reference. The reference is based on the LMV431 adjustable shunt regulator with the output voltage adjusted to a fixed 2.5V. The Op Amps are similar to the LM358 with a common-mode input range that includes ground. Integrating the reference and Op Amps creates a solution for low cost charging applications.

### Applications

- Low cost charging circuitry
- Power supplies and adapters

### Features

#### Dual Op Amp Circuitry

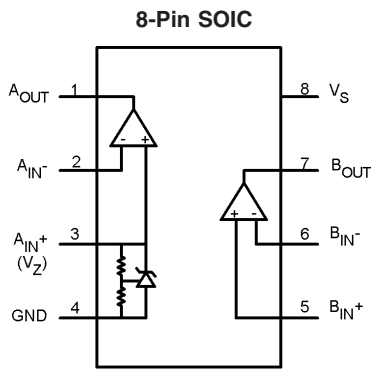
(Typical for  $V_S = 5V$ )

- Input offset voltage 0.6mV
- Input offset current 1nA
- Input bias current 3nA
- Common-mode input voltage range 0V to  $V_S - 1V$
- Power supply current 150 $\mu$ A

#### Reference Circuitry

- Reference voltage 2.5V
- Reference voltage deviation ( $-40^{\circ}C$  to  $85^{\circ}C$ ) 4mV
- Sink Current Capability 0.2mA to 10mA

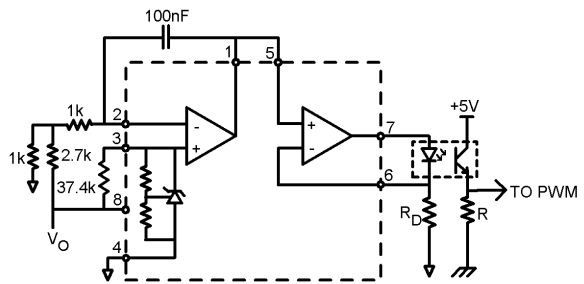
### Connection Diagram



Top View

20003901

### Application Circuit



20003902

Optocoupler Driver Circuit for Power Supply Isolation

### Ordering Information

Package	Part Number	Package Marking	Transport Media	NSC Drawing
8-Pin SOIC	LM433MA	LM433MA	Rails	M08A
	LM433MAX	LM433MA	2.5k Unit Tape and Reel	

**Absolute Maximum Ratings** (Notes 1, 3)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Supply Voltage ( $V_S$ )	20V
Storage Temperature	-65°C to 150°C
Junction Temperature ( $T_J$ )	150°C
ESD Human Body Model	2kV

Input Voltage Range -0.3V to 20V

**Operating Ratings**(Note 2),(Note 3)

Temperature Range	-40°C to 85°C
Supply Voltage (Note 8)	2.5V to 16V
Thermal Resistance( $\theta_{JA}$ )	162°C/W

**Electrical Characteristics**

The following specifications apply for both amplifiers at  $V_S = 5V$ ,  $V_{CM} = 2.5V$ ,  $V_O = 2.5V$ ,  $R_L = \infty$ , and  $T_J = 25^\circ C$ , unless otherwise noted.

Symbol	Parameter	Conditions	Min (Note 5)	Typ (Note 4)	Max (Note 5)	Units
<b>OP Amp Circuitry</b>						
$V_{OS}$	Input Offset Voltage	Amplifier B only	-7	2	7	mV
$I_{OS}$	Input Offset Current	Amplifier B only		1	50	nA
$I_B$	Input Bias Current	Amplifier B only		3	150	nA
$V_{CM}$	Common-Mode Input Voltage Range	Amplifier B only, CMRR > 50dB	0		$V_S - 1$	V
$I_S$	Power Supply Current	Total for both amplifiers		150	500	$\mu A$
$A_V$	Voltage Gain	$V_S = 16V$ , $1V < V_O < 11V$ , $R_L = 10k\Omega$ connected to $V_S/2$	65	100		dB
$V_{OL}$	Output Voltage Low			2	50	mV
$V_{OH}$	Output Voltage High		$V_S - 1.5$	$V_S - 1.3$		V
$I_{SOURCE}$	Output Current Source		20	30		mA
$I_{SINK}$	Output Current Sink		5	11		mA
<b>Reference Circuitry For Op Amp A</b> The following specifications apply for $I_Z = 200\mu A$ and $T_J = 25^\circ C$ , unless otherwise noted.						
$V_Z$	Reference Voltage at $IN^+$ Terminal		2.425	2.5	2.575	V
$V_{ZDEV}$	Reference Voltage Deviation at $IN^+$ Terminal Over Temperature (Note 6),(Note 9)	$-40^\circ C \leq T_J \leq 85^\circ C$		4	65	mV
$I_{Z(MIN)}$	Minimum Cathode Current for Regulation at $IN^+$ ( $V_Z$ ) Terminal			150	200	$\mu A$
$r_z$	Dynamic Output Impedance (Note 7)	$200\mu A < I_Z < 1mA$ , Freq = 0Hz		0.2		$\Omega$

**Note 1:** Absolute Maximum Ratings indicate limits beyond which damage to the device may occur.

**Note 2:** Operating Rating indicate conditions for which the device is functional. These rating 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 3:** All voltages are measured with respect to GND = 0V<sub>DC</sub>, unless otherwise specified.

**Note 4:** Typicals represent the most likely parametric norm.

**Note 5:** Guaranteed to National's Average Outgoing Quality Level (AOQL).

**Note 6:** Reference voltage deviation,  $V_{ZDEV}$ , is defined as the maximum variation of the reference input voltage over the full temperature range.

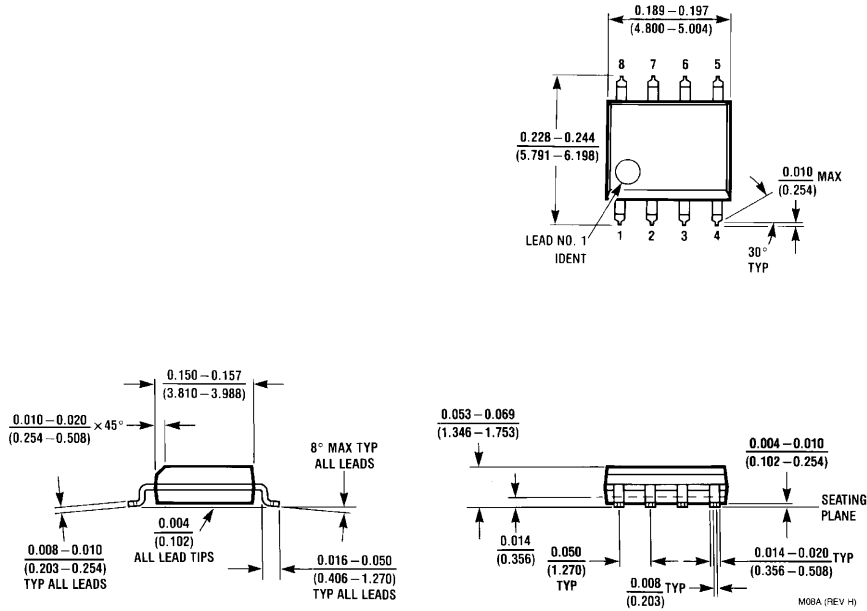
**Note 7:** The Dynamic Output Impedance,  $r_z$ , is defined as  $r_z = \Delta V_Z / \Delta I_Z$

**Note 8:** Minimum value of operating voltage is for Amplifier B only.

**Note 9:** Typical Temperature drift  $\Delta V / \Delta T = 12.8ppm/^\circ C$

## Physical Dimensions inches (millimeters)

unless otherwise noted



**8-Pin SOIC  
NS Package Number M08A**

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