National Semiconductor

# LM160/LM260/LM360 High Speed Differential Comparator

## General Description

The LM160/LM260/LM360 is a very high speed differential input, complementary TTL output voltage comparator with improved characteristics over the μA760/μA760C, for which it is a pin-for-pin replacement. The device has been optimized for greater speed, input impedance and fan-out, and lower input offset voltage. Typically delay varies only 3 ns for overdrive variations of 5 mV to 400 mV.

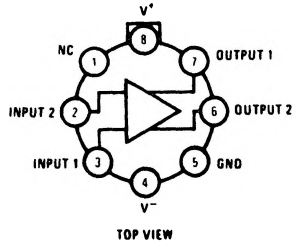
Complementary outputs having minimum skew are provided. Applications involve high speed analog to digital convertors and zero-crossing detectors in disk file systems.

## Features

- Guaranteed high speed — 20 ns max
- Tight delay matching on both outputs
- Complementary TTL outputs
- High input impedance
- Low speed variation with overdrive variation
- Fan-out of 4
- Low input offset voltage
- Series 74 TTL compatible

## Connection Diagrams

**Metal Can Package**

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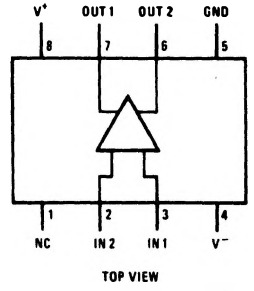
**Order Number LM160H, LM260H or LM360H**
**See NS Package Number H08C**

**Dual-In-Line Package**

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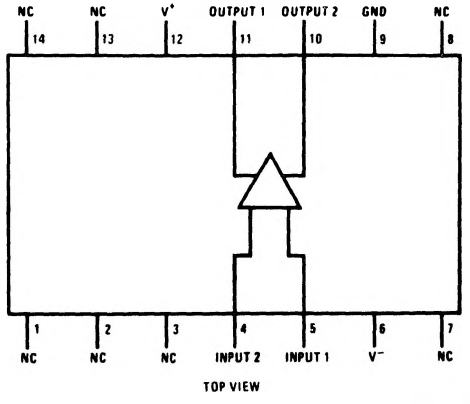
**Order Number LM360M or LM360N**
**See NS Package Number M08A or N08E**

**Dual-In-Package**

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**Order Number LM160J-14, LM360J-14 or LM360N-14**
**See NS Package Number J14A or N14A**

## Absolute Maximum Ratings (Note 5)

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

**(Note 7)**

| | |
|---|---|
| Positive Supply Voltage | +8V |
| Negative Supply Voltage | −8V |
| Peak Output Current | 20 mA |
| Differential Input Voltage | ±5V |
| Input Voltage | $V^+ \geq V_{IN} \geq V^-$ |
| ESD rating is to be determined. | |

| | |
|---|---|
| Operating Temperature Range | |
| LM160 | −55°C to +125°C |
| LM260 | −25°C to +85°C |
| LM360 | 0°C to +70°C |
| Storage Temperature Range | −65°C to +150°C |
| Lead Temperature (Soldering, 10 sec.) | 260°C |
| Soldering Information | |
| Dual-In-Line Package | |
| Soldering (10 seconds) | 260°C |
| Small Outline Package | |
| Vapor Phase (60 seconds) | 215°C |
| Infrared (15 seconds) | 220°C |

See AN-450 "Surface Mounting Methods and Their Effect on Product Reliability" for other methods of soldering surface mount devices.

## Electrical Characteristics ($T_{MIN} \leq T_A \leq T_{MAX}$)

| Parameter | Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|
| Operating Conditions | | | | | |
| Supply Voltage $V_{CC}^+$ | | 4.5 | 5 | 6.5 | V |
| Supply Voltage $V_{CC}^-$ | | −4.5 | −5 | −6.5 | V |
| Input Offset Voltage | $R_S \leq 200\Omega$ | | 2 | 5 | mV |
| Input Offset Current | | | 0.5 | 3 | μA |
| Input Bias Current | | | 5 | 20 | μA |
| Output Resistance (Either Output) | $V_{OUT} = V_{OH}$ | | 100 | | Ω |
| Response Time | $T_A = 25°C$, $V_S = \pm 5V$ (Notes 1, 6) | | 13 | 25 | ns |
| | $T_A = 25°C$, $V_S = \pm 5V$ (Notes 2, 6) | | 12 | 20 | ns |
| | $T_A = 25°C$, $V_S = \pm 5V$ (Notes 3, 6) | | 14 | | ns |
| Response Time Difference between Outputs | | | | | |
| ($t_{pd}$ of $+V_{IN1}$) − ($t_{pd}$ of $-V_{IN2}$) | $T_A = 25°C$ (Notes 1, 6) | | 2 | | ns |
| ($t_{pd}$ of $+V_{IN2}$) − ($t_{pd}$ of $-V_{IN1}$) | $T_A = 25°C$ (Notes 1, 6) | | 2 | | ns |
| ($t_{pd}$ of $+V_{IN1}$) − ($t_{pd}$ of $+V_{IN2}$) | $T_A = 25°C$ (Notes 1, 6) | | 2 | | ns |
| ($t_{pd}$ of $-V_{IN1}$) − ($t_{pd}$ of $-V_{IN2}$) | $T_A = 25°C$ (Notes 1, 6) | | 2 | | ns |
| Input Resistance | f = 1 MHz | | 17 | | kΩ |
| Input Capacitance | f = 1 MHz | | 3 | | pF |
| Average Temperature Coefficient of Input Offset Voltage | $R_S = 50\Omega$ | | 8 | | μV/°C |
| Average Temperature Coefficient of Input Offset Current | | | 7 | | nA/°C |
| Common Mode Input Voltage Range | $V_S = \pm 6.5V$ | ±4 | ±4.5 | | V |
| Differential Input Voltage Range | | ±5 | | | V |
| Output High Voltage (Either Output) | $I_{OUT} = -320\ \mu A$, $V_S = \pm 4.5V$ | 2.4 | 3 | | V |
| Output Low Voltage (Either Output) | $I_{SINK} = 6.4$ mA | | 0.25 | 0.4 | V |
| Positive Supply Current | $V_S = \pm 6.5V$ | | 18 | 32 | mA |
| Negative Supply Current | $V_S = \pm 6.5V$ | | −9 | −16 | mA |

**Note 1:** Response time measured from the 50% point of a 30 mVp-p 10 MHz sinusoidal input to the 50% point of the output.

**Note 2:** Response time measured from the 50% point of a 2 Vp-p 10 MHz sinusoidal input to the 50% point of the output.

**Note 3:** Response time measured from the start of a 100 mV input step with 5 mV overdrive to the time when the output crosses the logic threshold.

**Note 4:** Typical thermal impedances are as follows:

| | | | | | | |
|---|---|---|---|---|---|---|
| Cavity DIP (J): | $\theta_{jA}$ | 135°C/W | Header (H) | $\theta_{jA}$ | 165°C/W | (Still Air) |
| Molded DIP (N): | $\theta_{jA}$ | 130°C/W | | | 67°C/W | (400 LF/min Air Flow) |
| | | | | $\theta_{jC}$ | 25°C/W | |

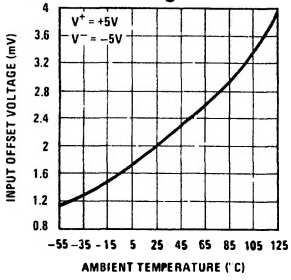
**Note 5:** The device may be damaged if used beyond the maximum ratings.

**Note 6:** Measurements are made in AC Test Circuit, Fanout = 1

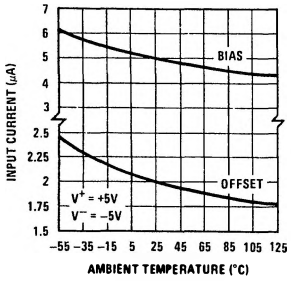
**Note 7:** Refer to RETS 160X for LM160H, LM160J-14 and LM160J military specifications.

## Typical Performance Characteristics

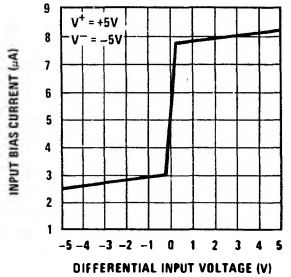
**Offset Voltage**



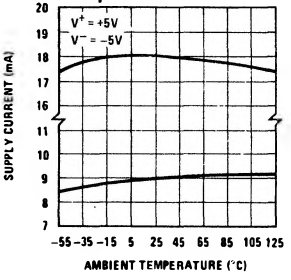

**Input Currents vs Ambient Temperature**



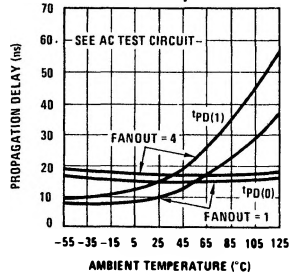

**Input Characteristics**



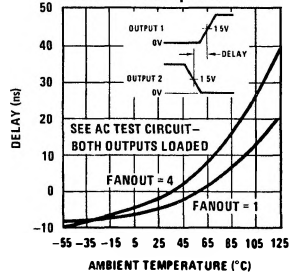

**Supply Current vs Ambient Temperature**



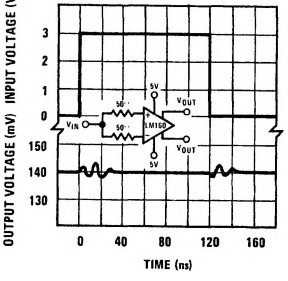

**Propagation Delay vs Ambient Temperature**




**Delay of Output 1 With Respect to Output 2 vs Ambient Temperature**




**Common-Mode Pulse Response**

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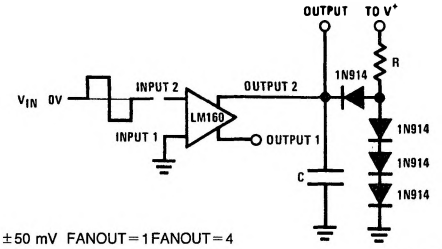
## AC Test Circuit




| | | |
|---|---|---|
| $V_{IN}$ = ±50 mV | FANOUT = 1 | FANOUT = 4 |
| $V^+$ = +5V | R = 2.4k | R = 630Ω |
| $V^-$ = −5V | C = 15 pF | C = 30 pF |

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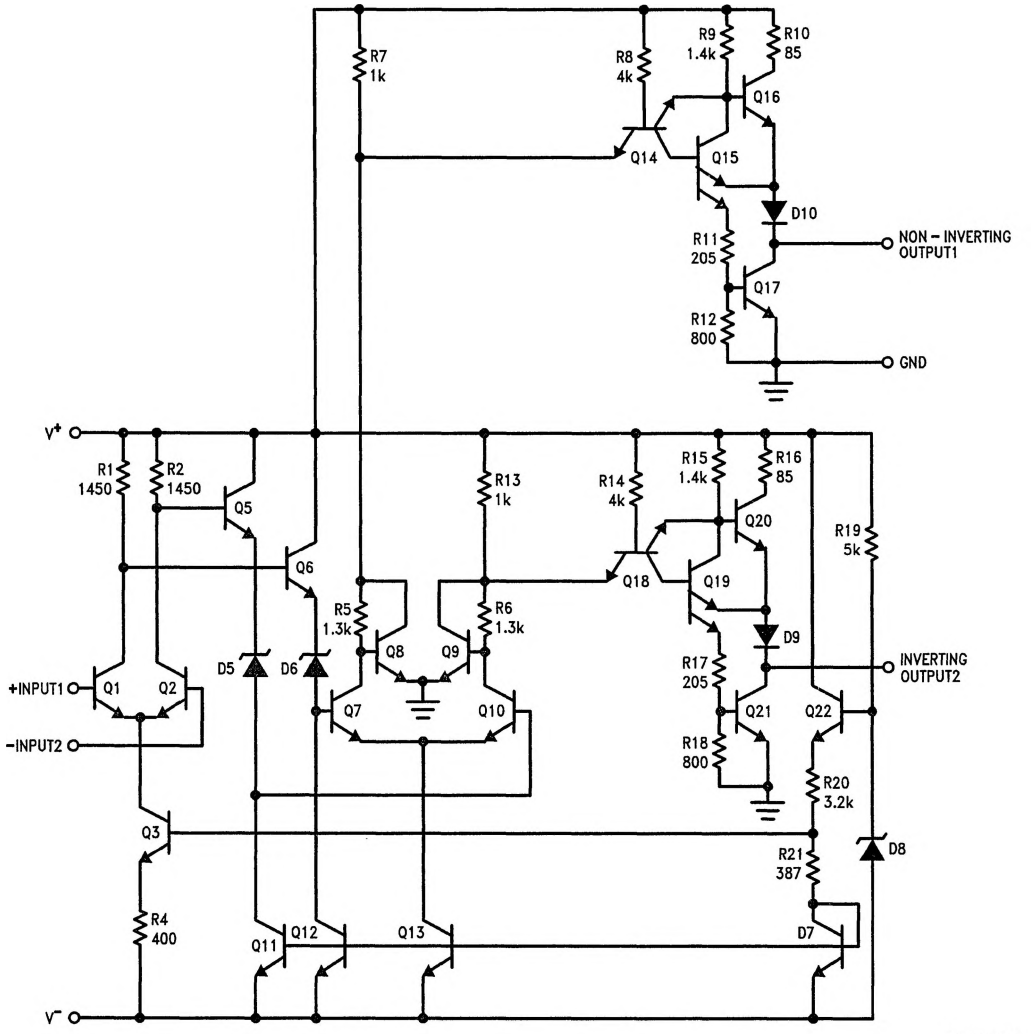
## Schematic Diagram

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