National Semiconductor

# LM161/LM261/LM361
# High Speed Differential Comparators

## General Description

The LM161/LM261/LM361 is a very high speed differential input, complementary TTL output voltage comparator with improved characteristics over the SE529/NE529 for which it is a pin-for-pin replacement. The device has been optimized for greater speed performance and lower input offset voltage. Typically delay varies only 3 ns for over-drive variations of 5 mV to 500 mV. It may be operated from op amp supplies (±15V).

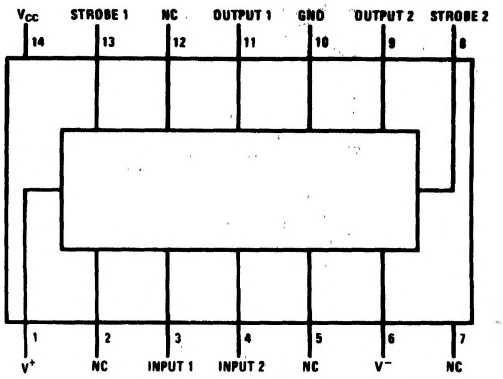
Complementary outputs having maximum skew are provided. Applications involve high speed analog to digital converters and zero-crossing detectors in disk file systems.

## Features

- Independent strobes
- Guaranteed high speed — 20 ns max
- Tight delay matching on both outputs
- Complementary TTL outputs
- Operates from op amp supplies — ±15V
- Low speed variation with overdrive variation
- Low input offset voltage
- Versatile supply voltage range

## Connection Diagrams

**Dual-In-Line Package**

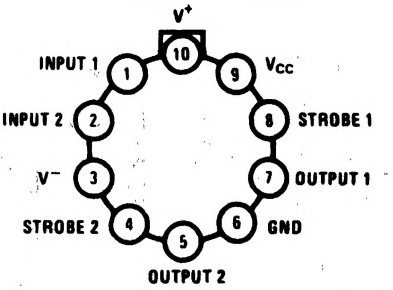



TL/H/5708–2

**Top View**
**Order Number LM161J, LM161J/883*, LM361M or LM361N**
**See NS Package Number J14A, M14A or N14A**

*Also available per SMD #5962-8757203

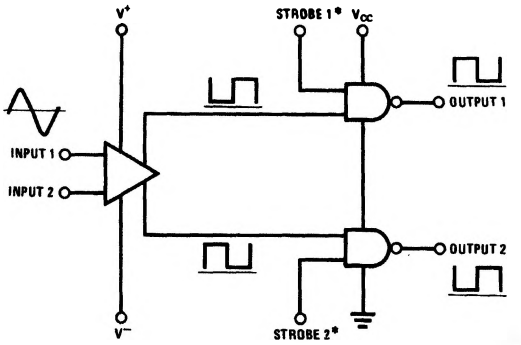
**Metal Can Package**




TL/H/5708–3

**Order Number LM161H/883*, or LM361H**
**See NS Package Number H10C**

## Logic Diagram




*Output is low when current is drawn from strobe pin.

TL/H/5708–4

## Absolute Maximum Ratings (Note 1)

**If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications. (Note 4)**

| | |
|---|---|
| Positive Supply Voltage, $V^+$ | +16V |
| Negative Supply Voltage, $V^-$ | −16V |
| Gate Supply Voltage, $V_{CC}$ | +7V |
| Output Voltage | +7V |
| Differential Input Voltage | ±5V |
| Input Common Mode Voltage | ±6V |
| Power Dissipation | 600 mW |
| Storage Temperature Range | −65°C to +150°C |
| Operating Temperature Range | $T_{MIN}$ $T_{MAX}$ |
| LM161 | −55°C to +125°C |
| LM261 | −25°C to +85°C |
| LM361 | 0°C to +70°C |
| Lead Temp. (Soldering, 10 seconds) | 260°C |
| For Any Device Lead Below $V^-$ | 0.3V |

## Operating Conditions

| | Min | Typ | Max |
|---|---|---|---|
| Supply Voltage $V^+$ | | | |
| LM161/LM261 | 5V | | 15V |
| LM361 | 5V | | 15V |
| Supply Voltage $V^-$ | | | |
| LM161/LM261 | −6V | | −15V |
| LM361 | −6V | | −15V |
| Supply Voltage $V_{CC}$ | | | |
| LM161/LM261 | 4.5V | 5V | 5.5V |
| LM361 | 4.75V | 5V | 5.25V |
| ESD Tolerance (Note 5) | | | 1600V |
| 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 ($V^+ = +10V$, $V_{CC} = +5V$, $V^- = -10V$, $T_{MIN} \le T_A \le T_{MAX}$, unless noted)

| Parameter | Conditions | Limits | | | | | | Units |
|---|---|---|---|---|---|---|---|---|
| | | LM161/LM261 | | | LM361 | | | |
| | | Min | Typ | Max | Min | Typ | Max | |
| Input Offset Voltage | | | 1 | 3 | | 1 | 5 | mV |
| Input Bias Current | $T_A = 25°C$ | | 5 | 20 | | 10 | 30 | μA μA |
| Input Offset Current | $T_A = 25°C$ | | 2 | 3 | | 2 | 5 | μA μA |
| Voltage Gain | $T_A = 25°C$ | | 3 | | | 3 | | V/mV |
| Input Resistance | $T_A = 25°C$, f = 1 kHz | | 20 | | | 20 | | kΩ |
| Logical "1" Output Voltage | $V_{CC} = 4.75V$, $I_{SOURCE} = -0.5$ mA | 2.4 | 3.3 | | 2.4 | 3.3 | | V |
| Logical "0" Output Voltage | $V_{CC} = 4.75V$, $I_{SINK} = 6.4$ mA | | | 0.4 | | | 0.4 | V |
| Strobe Input "1" Current (Output Enabled) | $V_{CC} = 5.25V$, $V_{STROBE} = 2.4V$ | | | 200 | | | 200 | μA |
| Strobe Input "0" Current (Output Disabled) | $V_{CC} = 5.25V$, $V_{STROBE} = 0.4V$ | | | −1.6 | | | −1.6 | mA |
| Strobe Input "0" Voltage | $V_{CC} = 4.75V$ | | | 0.8 | | | 0.8 | V |
| Strobe Input "1" Voltage | $V_{CC} = 4.75V$ | 2 | | | 2 | | | V |
| Output Short Circuit Current | $V_{CC} = 5.25V$, $V_{OUT} = 0V$ | −18 | | −55 | −18 | | −55 | mA |

## Electrical Characteristics (Continued)

($V^+ = +10V$, $V_{CC} = +5V$, $V^- = -10V$, $T_{MIN} \le T_A \le T_{MAX}$, unless noted)

| Parameter | Conditions | Limits | | | | | | Units |
|---|---|---|---|---|---|---|---|---|
| | | LM161/LM261 | | | LM361 | | | |
| | | Min | Typ | Max | Min | Typ | Max | |
| Supply Current $I^+$ | $V^+ = 10V$, $V^- = -10V$, $V_{CC} = 5.25V$, $-55°C \le T_A \le 125°C$ | | | 4.5 | | | | mA |
| Supply Current $I^+$ | $V^+ = 10V$, $V^- = -10V$, $V_{CC} = 5.25V$, $0°C \le T_A \le 70°C$ | | | | | | 5 | mA |
| Supply Current $I^-$ | $V^+ = 10V$, $V^- = -10V$, $V_{CC} = 5.25V$, $-55°C \le T_A \le 125°C$ | | | 10 | | | | mA |
| Supply Current $I^-$ | $V^+ = 10V$, $V^- = -10V$, $V_{CC} = 5.25V$, $0°C \le T_A \le 70°C$ | | | | | | 10 | mA |
| Supply Current $I_{CC}$ | $V^+ = 10V$, $V^- = -10V$, $V_{CC} = 5.25V$, $-55°C \le T_A \le 125°C$ | | | 18 | | | | mA |
| Supply Current $I_{CC}$ | $V^+ = 10V$, $V^- = -10V$, $V_{CC} = 5.25V$, $0°C \le T_A \le 70°C$ | | | | | | 20 | mA |
| Transient Response | $V_{IN}$ = 50 mV overdrive (Note 3) | | | | | | | |
| Propagation Delay Time ($t_{pd(0)}$) | $T_A = 25°C$ | | 14 | 20 | | 14 | 20 | ns |
| Propagation Delay Time ($t_{pd(1)}$) | $T_A = 25°C$ | | 14 | 20 | | 14 | 20 | ns |
| Delay Between Output A and B | $T_A = 25°C$ | | 2 | 5 | | 2 | 5 | ns |
| Strobe Delay Time ($t_{pd(0)}$) | $T_A = 25°C$ | | 8 | | | 8 | | ns |
| Strobe Delay Time ($t_{pd(1)}$) | $T_A = 25°C$ | | 8 | | | 8 | | ns |

**Note 1:** The device may be damaged by use beyond the maximum ratings.

**Note 2:** Typical thermal impedances are as follows:

| | H Package | J Package | N Package |
|---|---|---|---|
| $\theta_{jA}$ | 165°C/W (Still Air)<br>67°C/W (400 LF/Min Air Flow) | 112°C/W | 105°C/W |
| $\theta_{jC}$ | 25°C/W | | |

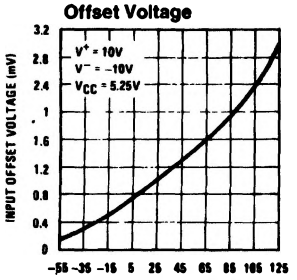
**Note 3:** Measurements using AC Test circuit, Fanout = 1. The devices are faster at low supply voltages.

**Note 4:** Refer to RETS161X for LM161H and LM161J military specifications.

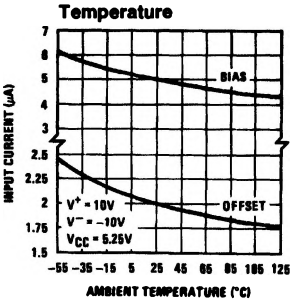
**Note 5:** Human body model, 1.5 kΩ in series with 100 pF.

# Typical Performance Characteristics

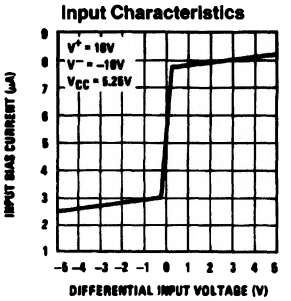
**Offset Voltage**



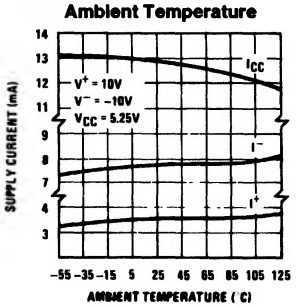

**Input Currents vs Ambient Temperature**



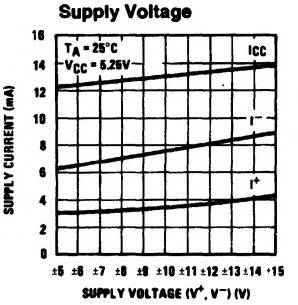

**Input Characteristics**



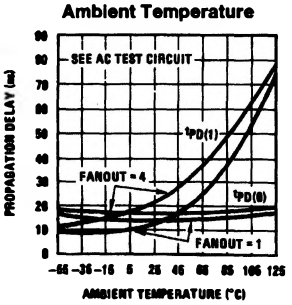

**Supply Current vs Ambient Temperature**



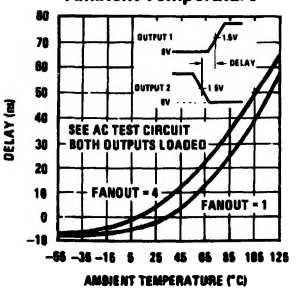

**Supply Current vs Supply Voltage**



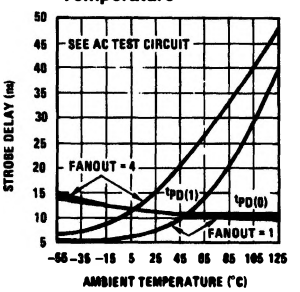

**Propagation Delay vs Ambient Temperature**



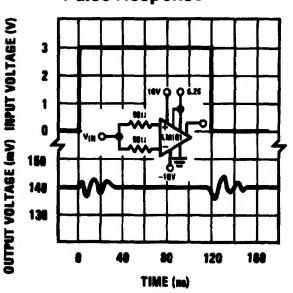

**Delay of Output 1 With Respect to Output 2 vs Ambient Temperature**




**Strobe Delay vs Ambient Temperature**

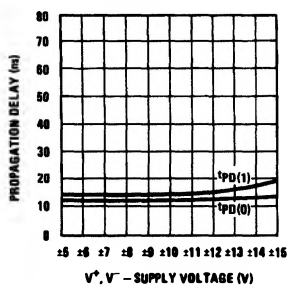



**Common-Mode Pulse Response**



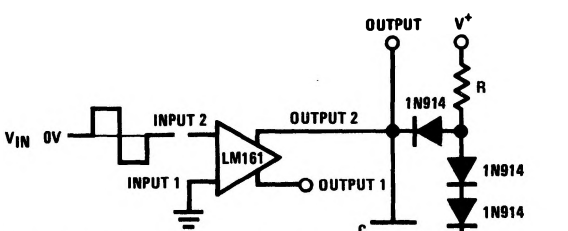

TL/H/5708–5

**Propagation Delay vs Supply Voltage**




TL/H/5708–7

## AC Test Circuit

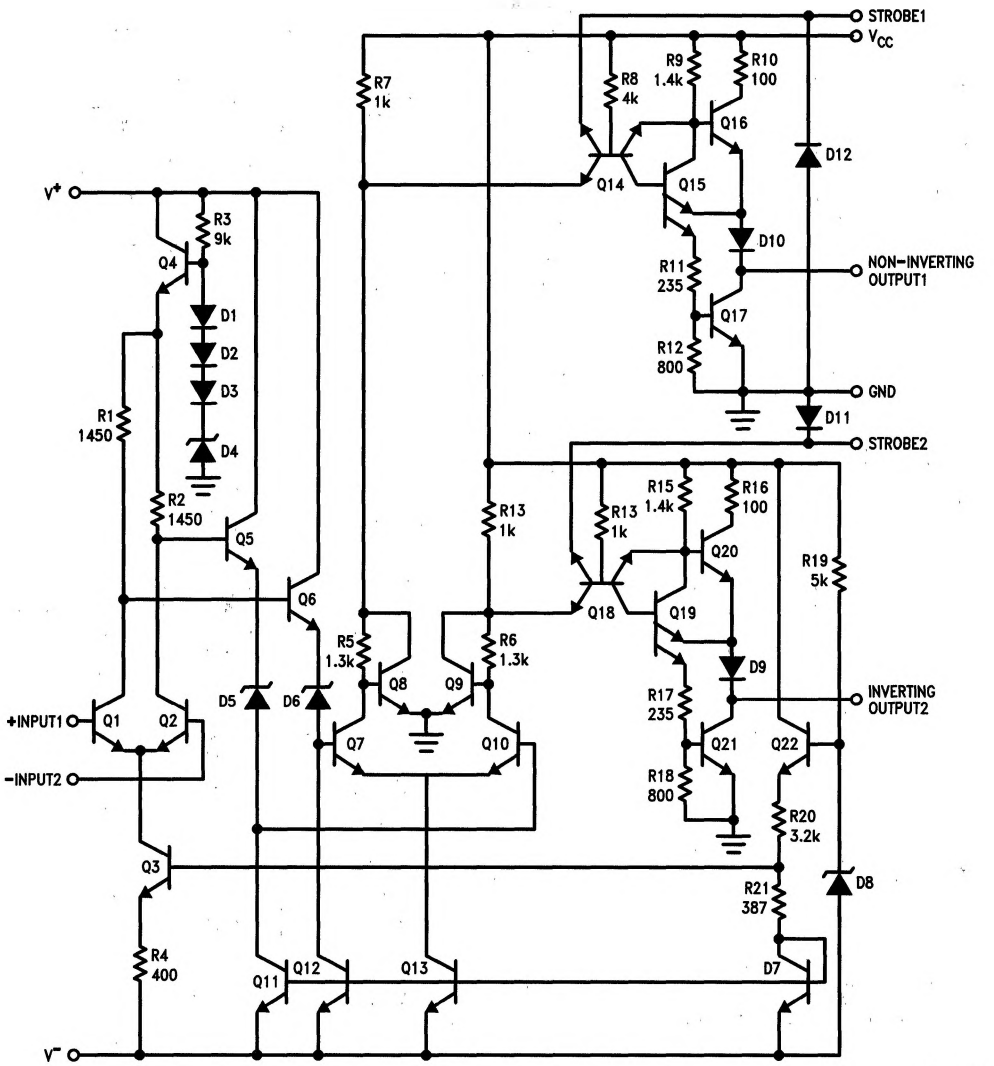



| | | |
|---|---|---|
| $V_{IN}$ = ±50 mV | FANOUT = 1 | FANOUT = 4 |
| $V^+$ = +10V | R = 2.4k | R = 680Ω |
| $V^-$ = −10V | C = 15 pF | C = 30 pF |
| $V_{CC}$ = 5.25V | | |

TL/H/5708–6

## Schematic Diagram

**LM161**




TL/H/5708–1

R10, R16: 85
R11, R17: 205