

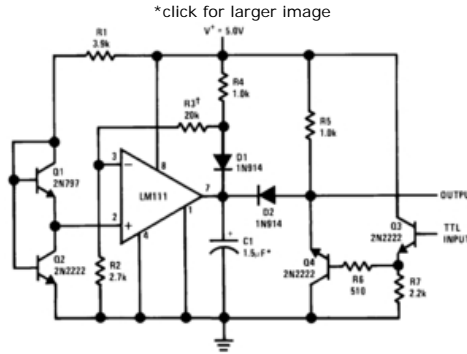


LM311 - Voltage Comparator

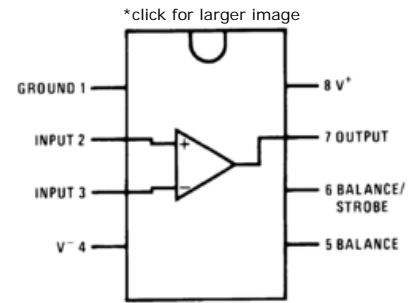
Features

- Operates from single 5V supply
- Input current: 150 nA max. over temperature
- Offset current: 20 nA max. over temperature
- Differential input voltage range: $\pm 30V$
- Power consumption: 135 mW at $\pm 15V$

Typical Application



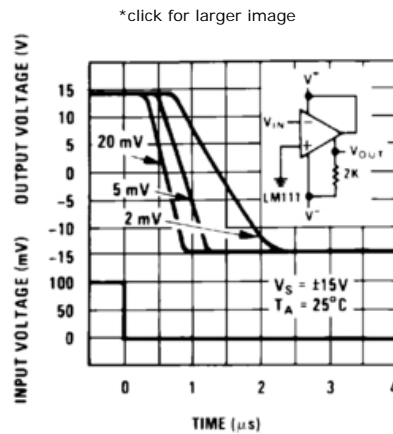
Connection Diagram



Parametric Table

| | |
|----------------------------|--------------------------|
| Response Time | 0.1 μs |
| Output Bus | Open Drain |
| Supply Min | 5 Volt |
| Supply Max | 36 Volt |
| Channels | 1 Channels |
| Offset Voltage max, 25C | 7.5 mV |
| Output Current | 50 mA |
| Input Range | Not R-R |
| Supply Current Per Channel | 5.1 mA |
| PowerWise Rating 3 | 510 $\mu A \times \mu s$ |
| Max Input Bias Current | 300 nA |
| Special Features | Offset Adjust, Strobe |
| Temperature Min | 0 deg C |
| Temperature Max | 70 deg C |
| Function | Comparator |

Typical Performance





RoHS Compliance Information

LM111/LM211/LM311 Voltage Comparator

Package Availability, Models

| Part Number | Package | | | | | | Factory Lead Time | | Models | Std Pack Size | Package Marking Format |
|-------------|----------------|------|-------|------------|-------------|-------------|-------------------|--------|--------|------------------|------------------------|
| | Type | Pins | Spec. | MSL Rating | Peak Reflow | RoHS Report | Weeks | Qty | | | |
| LM311M | SOIC NARROW | 8 | STD | 1 | 235 | RoHS | Full production | | N/A | rail of 95 | NSZXTT LM 311M |
| | | | NOPB | 1 | 260 | | 6 weeks | 3000 | | | |
| LM311MX | SOIC NARROW | 8 | STD | 1 | 235 | RoHS | Full production | | N/A | reel of 2500 | NSZXTT LM 311M |
| | | | NOPB | 1 | 260 | | 6 weeks | 5000 | | | |
| LM311N | MDIP | 8 | STD | 1 | NA | RoHS | Full production | | N/A | rail of 40 | NSUZYTT LM 311N |
| | | | NOPB | 1 | NA | | 6 weeks | 2000 | | | |
| LM311H | TO-99 | 8 | STD | 1 | NA | RoHS | Full production | | N/A | box of 500 | NSZXYTTE# LM311H |
| | | | NOPB | 1 | NA | | 10 weeks | 1000 | | | |
| LM311 MDA | Unpackaged Die | | | | | | Lifetime buy | | N/A | tray of N/A | - |
| | | | | | | | N/A | 150000 | | | |
| LM311 MWA | Wafer | | | | | | Obsolete | | N/A | wafer jar of N/A | - |
| | | | | | | | N/A | N/A | | | |

Obsolete Versions

| Obsolete Part | Alternate Part or Supplier | Source | Last Time Buy Date |
|---------------|----------------------------|------------------------|--------------------|
| LM311J | LM311N | NATIONAL SEMICONDUCTOR | 12/07/93 |
| LM311J-8 | LM311N | NATIONAL SEMICONDUCTOR | 04/04/95 |
| LM311N-14 | NONE | NATIONAL SEMICONDUCTOR | 12/07/93 |

General Description

The LM111, LM211 and LM311 are voltage comparators that have input currents nearly a thousand times lower than devices like the LM106 or LM710. They are also designed to operate over a wider range of supply voltages: from standard $\pm 15V$ op amp supplies down to the single 5V supply used for IC logic. Their output is compatible with RTL, DTL and TTL as well as MOS circuits. Further, they can drive lamps or relays, switching voltages up to 50V at currents as high as 50 mA.

Both the inputs and the outputs of the LM111, LM211 or the LM311 can be isolated from system ground, and the output can drive loads referred to ground, the positive supply or the negative supply. Offset balancing and strobe capability are provided and outputs can be wire OR'ed. Although slower than the LM106 and LM710 (200 ns response time vs 40 ns) the devices are also much less prone to spurious oscillations. The LM111 has the same pin configuration as the LM106 and LM710.

The LM211 is identical to the LM111, except that its performance is specified over a $-25^{\circ}C$ to $+85^{\circ}C$ temperature range instead of $-55^{\circ}C$ to $+125^{\circ}C$. The LM311 has a temperature range of $0^{\circ}C$ to $+70^{\circ}C$.

Reliability Metrics

| Part Number | Process | EFR Reject | EFR Sample Size | PPM * | LTA Rejects | LTA Device Hours | FITS | MTTF (Hours) |
|-------------|---------|------------|-----------------|-------|-------------|------------------|------|--------------|
| LM311M | SLM | 0 | 42786 | 0 | 0 | 3352500 | 2 | 951281028 |
| LM311MX | SLM | 0 | 42786 | 0 | 0 | 3352500 | 2 | 951281028 |
| LM311N | SLM | 0 | 42786 | 0 | 0 | 3352500 | 2 | 951281028 |

Note: The Early Failure Rates were calculated as point estimates. The Long Term Failure Rates were calculated at 60% confidence using the Arrhenius equation at 0.7eV activation energy and derating the assumed stress temperature of 150°C to an application temperature of 55°C.

LM111/LM211/LM311 Voltage Comparator

1.0 General Description

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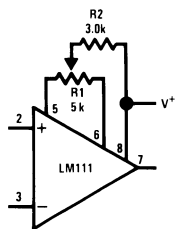
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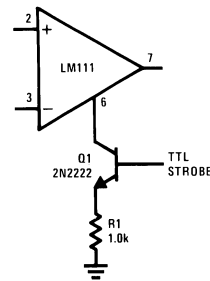
3.0 Typical Applications (Note 3)

Offset Balancing



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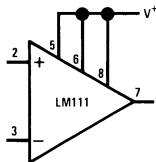
Strobing



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Note: Do Not Ground Strobe Pin. Output is turned off when current is pulled from Strobe Pin.

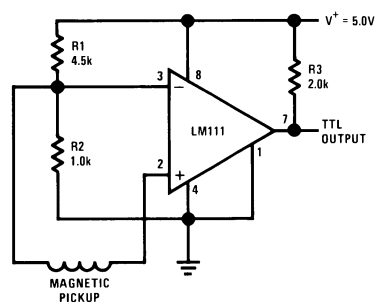
Increasing Input Stage Current (Note 1)



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Note 1: Increases typical common mode slew from $7.0V/\mu s$ to $18V/\mu s$.

Detector for Magnetic Transducer



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5.0 Absolute Maximum Ratings for the LM311 (Note 12)

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

| | |
|--|-----------|
| Total Supply Voltage (V_{S4}) | 36V |
| Output to Negative Supply Voltage (V_{74}) | 40V |
| Ground to Negative Supply Voltage (V_{14}) | 30V |
| Differential Input Voltage | $\pm 30V$ |
| Input Voltage (Note 13) | $\pm 15V$ |
| Power Dissipation (Note 14) | 500 mW |
| ESD Rating (Note 19) | 300V |

| | |
|---|----------------|
| Output Short Circuit Duration | 10 sec |
| Operating Temperature Range | 0° to 70°C |
| Storage Temperature Range | -65°C to 150°C |
| Lead Temperature (soldering, 10 sec) | 260°C |
| Voltage at Strobe Pin | $V^+ - 5V$ |
| 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 (Note 15) for the LM311

| Parameter | Conditions | Min | Typ | Max | Units |
|--------------------------------|--|-------|-------------|------|-------|
| Input Offset Voltage (Note 16) | $T_A = 25^\circ C, R_S \leq 50k$ | | 2.0 | 7.5 | mV |
| Input Offset Current (Note 16) | $T_A = 25^\circ C$ | | 6.0 | 50 | nA |
| Input Bias Current | $T_A = 25^\circ C$ | | 100 | 250 | nA |
| Voltage Gain | $T_A = 25^\circ C$ | 40 | 200 | | V/mV |
| Response Time (Note 17) | $T_A = 25^\circ C$ | | 200 | | ns |
| Saturation Voltage | $V_{IN} \leq -10$ mV, $I_{OUT} = 50$ mA $T_A = 25^\circ C$ | | 0.75 | 1.5 | V |
| Strobe ON Current (Note 18) | $T_A = 25^\circ C$ | | 2.0 | 5.0 | mA |
| Output Leakage Current | $V_{IN} \geq 10$ mV, $V_{OUT} = 35V$ $T_A = 25^\circ C, I_{STROBE} = 3$ mA $V^- = \text{Pin } 1 = -5V$ | | 0.2 | 50 | nA |
| Input Offset Voltage (Note 16) | $R_S \leq 50K$ | | | 10 | mV |
| Input Offset Current (Note 16) | | | | 70 | nA |
| Input Bias Current | | | | 300 | nA |
| Input Voltage Range | | -14.5 | 13.8, -14.7 | 13.0 | V |
| Saturation Voltage | $V^+ \geq 4.5V, V^- = 0$ $V_{IN} \leq -10$ mV, $I_{OUT} \leq 8$ mA | | 0.23 | 0.4 | V |
| Positive Supply Current | $T_A = 25^\circ C$ | | 5.1 | 7.5 | mA |
| Negative Supply Current | $T_A = 25^\circ C$ | | 4.1 | 5.0 | mA |

Note 12: "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."

Note 13: This rating applies for $\pm 15V$ supplies. The positive input voltage limit is 30V above the negative supply. The negative input voltage limit is equal to the negative supply voltage or 30V below the positive supply, whichever is less.

Note 14: The maximum junction temperature of the LM311 is 110°C. For operating at elevated temperature, devices in the H08 package must be derated based on a thermal resistance of 165°C/W, junction to ambient, or 20°C/W, junction to case. The thermal resistance of the dual-in-line package is 100°C/W, junction to ambient.

Note 15: These specifications apply for $V_S = \pm 15V$ and Pin 1 at ground, and $0^\circ C < T_A < +70^\circ C$, unless otherwise specified. The offset voltage, offset current and bias current specifications apply for any supply voltage from a single 5V supply up to $\pm 15V$ supplies.

Note 16: The offset voltages and offset currents given are the maximum values required to drive the output within a volt of either supply with 1 mA load. Thus, these parameters define an error band and take into account the worst-case effects of voltage gain and R_S .

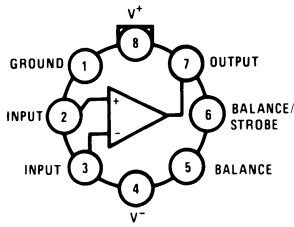
Note 17: The response time specified (see definitions) is for a 100 mV input step with 5 mV overdrive.

Note 18: This specification gives the range of current which must be drawn from the strobe pin to ensure the output is properly disabled. Do not short the strobe pin to ground; it should be current driven at 3 to 5 mA.

Note 19: Human body model, 1.5 k Ω in series with 100 pF.

11.0 Connection Diagrams

Metal Can Package



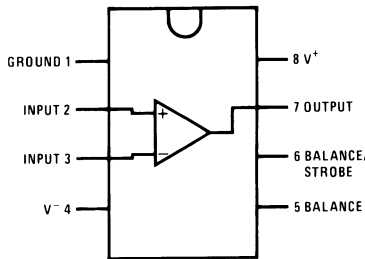
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Note: Pin 4 connected to case

Top View

Order Number LM111H, LM111H/883(Note 21) , LM211H or LM311H
See NS Package Number H08C

Dual-In-Line Package

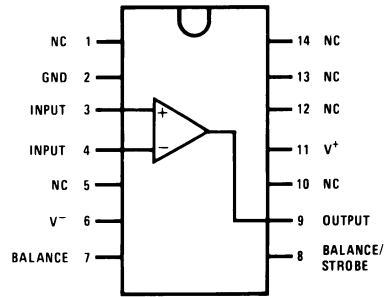


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Top View

Order Number LM111J-8, LM111J-8/883(Note 21),
LM311M, LM311MX or LM311N
See NS Package Number J08A, M08A or N08E

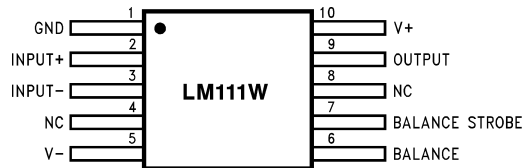
Dual-In-Line Package



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Top View

Order Number LM111J/883(Note 21)
See NS Package Number J14A or N14A

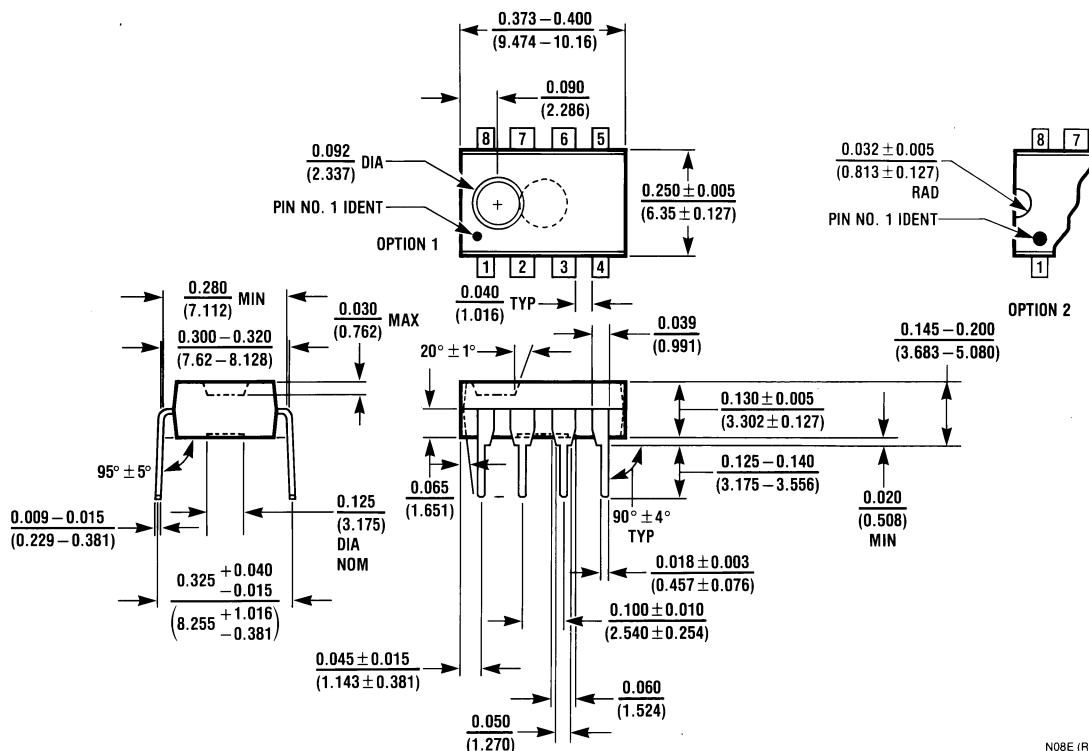


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Order Number LM111W/883(Note 21), LM111WG/883
See NS Package Number W10A, WG10A

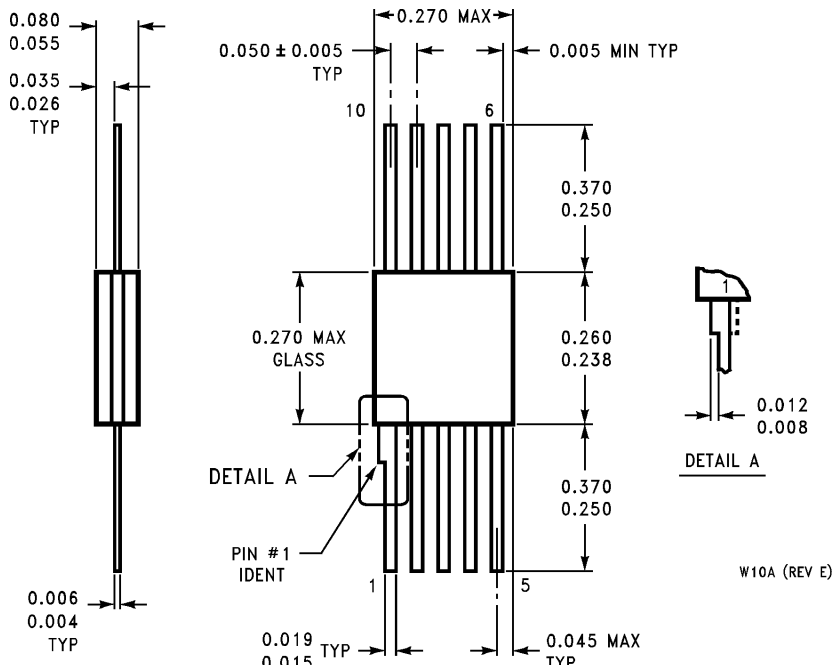
Note 21: Also available per JM38510/10304

12.0 Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



Dual-In-Line Package (N)
Order Number LM311N
NS Package Number N08E

N08E (REV F)



Order Number LM111W/883, LM111WG/883
NS Package Number W10A, WG10A

W10A (REV E)