National Semiconductor

July 1987

# LH0070 Series Precision BCD Buffered Reference
# LH0071 Series Precision Binary Buffered Reference

## General Description

The LH0070 and LH0071 are precision, three terminal, voltage references consisting of a temperature compensated zener diode driven by a current regulator and a buffer amplifier. The devices provide an accurate reference that is virtually independent of input voltage, load current, temperature and time. The LH0070 has a 10.000V nominal output to provide equal step sizes in BCD applications. The LH0071 has a 10.240V nominal output to provide equal step sizes in binary applications.

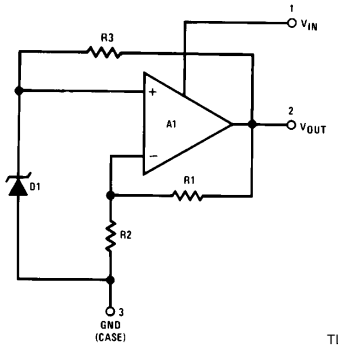
The output voltage is established by trimming ultra-stable, low temperature drift, thin film resistors under actual operating circuit conditions. The devices are shortcircuit proof in both the current sourcing and sinking directions.

The LH0070 and LH0071 series combine excellent long term stability, ease of application, and low cost, making them ideal choices as reference voltages in precision D to A and A to D systems.

## Features

- Accuracy output voltage
  - LH0070 10V ± 0.02%
  - LH0071 10.24V ± 0.02%
- Single supply operation 11.4V to 40V
- Low output impedance 0.2Ω
- Excellent line regulation 0.1 mV/V
- Low zener noise 20 μVp-p
- 3-lead TO-5 (pin compatible with the LM109)
- Short circuit proof
- Low standby current 3 mA

## Equivalent Schematic

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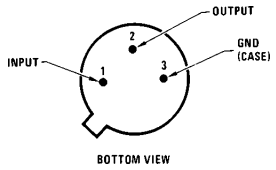
## Connection Diagram

**TO-5 Metal Can Package**

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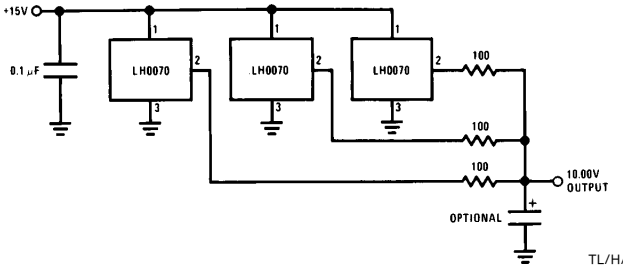
**Order Number LH0070-0H, LH0071-0H, LH0070-1H, LH0071-1H, LH0070-2H or LH0071-2H**
**See NS Package Number H03B**

## Typical Applications

**Statistical Voltage Standard**

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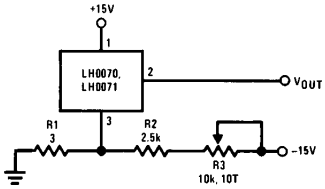
***Output Voltage Fine Adjustment**

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***Note:** The output of the LH0070 and LH0071 may be adjusted to a precise voltage by using the above circuit since the supply current of the devices is relatively small and constant with temperature and input voltage. For the circuit shown, supply sensitivities are degraded slightly to 0.01%/V change in $V_{OUT}$ for changes in $V_{IN}$ and $V^-$.

An additional temperature drift of 0.0001%/°C is added due to the variation of supply current with temperature of the LH0070 and LH0071. Sensitivity to the value of R1, R2 and R3 is less than 0.001%/%.

RRD-B30M115/Printed in U. S. A.

## Absolute Maximum Ratings

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

| | |
|---|---|
| Supply Voltage | 40V |
| Power Dissipation (See Curve) | 600 mW |
| Short Circuit Duration | Continuous |
| Output Current | ± 20 mA |
| Operating Temperature Range | −55°C to +125°C |
| Storage Temperature Range | −65°C to ±150°C |
| Lead Temp. (Soldering, 10 seconds) | 300°C |

## Electrical Characteristics (Note 1)

| Parameter | Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|
| Output Voltage | $T_A = 25°C$ | | | | |
| LH0070 | | | 10.000 | | V |
| LH0071 | | | 10.24 | | V |
| Output Accuracy | $T_A = 25°C$ | | | | |
| −0, −1 | | | ±0.03 | ±0.1 | % |
| −2 | | | ±0.02 | ±0.05 | % |
| Output Accuracy | $T_A = -55°C, 125°C$ | | | | |
| −0, −1 | | | | ±0.3 | % |
| −2 | | | | ±0.2 | % |
| Output Voltage Change With Temperature | (Note 2) | | | | |
| −0 | | | | ±0.2 | % |
| −1 | | | ±0.02 | ±0.1 | % |
| −2 | | | ±0.01 | ±0.04 | % |
| Line Regulation | $13V \le V_{IN} \le 33V$, $T_C = 25°C$ | | | | |
| −0, −1 | | | 0.02 | 0.1 | % |
| −2 | | | 0.01 | 0.03 | % |
| Input Voltage Range | $R_L = 50\ k\Omega$ | 11.4 | | 40 | V |
| Load Regulation | $0\ mA \le I_{OUT} \le 5\ mA$ | | 0.01 | 0.03 | % |
| Quiescent Current | $13V \le V_{IN} \le 33V$, $I_{OUT} = 0\ mA$ | 1 | 3 | 5 | mA |
| Change In Quiescent Current | $\Delta V_{IN} = 20V$ From 23V To 33V | | 0.75 | 1.5 | mA |
| Output Noise Voltage | BW = 0.1 Hz To 10 Hz, $T_A = 25°C$ | | 20 | | μVp-p |
| Ripple Rejection | f = 120 Hz | | 0.01 | | %/Vp-p |
| Output Resistance | | | 0.2 | 0.6 | Ω |
| Long Term Stability | $T_A = 25°C$ (Note 3) | | | | |
| −0, −1 | | | | ±0.2 | %/yr. |
| −2 | | | | ±0.05 | %/yr. |
| Thermal Resistance | $T_j = 150°C$ | | | | |
| $\theta_{ja}$ (Junction to Ambient) | | | 200 | | °C/W |
| $\theta_{jc}$ (Junction to Case) | | | 100 | | °C/W |

**Note 1:** Unless otherwise specified, these specifications apply for $V_{IN} = 15.0V$, $R_L = 10\ k\Omega$, and over the temperature range of $-55°C \le T_A \le +125°C$.

**Note 2:** This specification is the difference in output voltage measured at $T_A = 85°C$ and $T_A = 25°C$ or $T_A = 25°C$ and $T_A = -25°C$ with readings taken after test chamber and device-under-test stabilization at temperature using a suitable precision voltmeter.

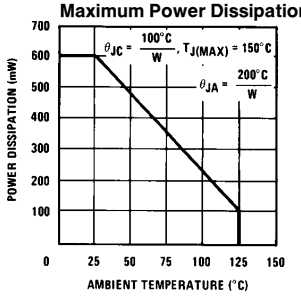
**Note 3:** This parameter is guaranteed by design and not tested.

**Note 4:** Refer to the following RETS drawings for military specifications:

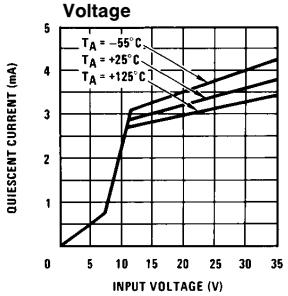
| | |
|---|---|
| RETS0070-0H for LH0070-0H | RETS0071-0H for LH0071-0H |
| RETS0070-1H for LH0070-1H | RETS0071-1H for LH0071-1H |
| RETS0070-2H for LH0070-2H | RETS0071-2H for LH0071-2H |

## Typical Performance Characteristics

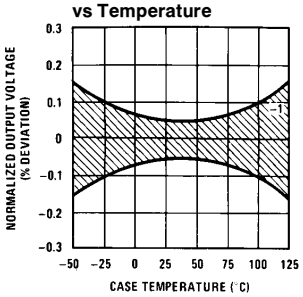
**Maximum Power Dissipation**



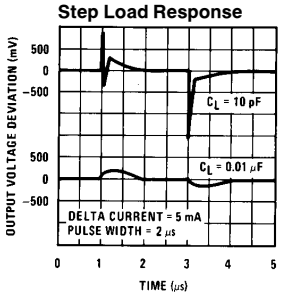

**Quiescent Current vs Input Voltage**



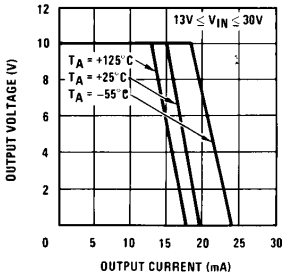

**Normalized Output Voltage vs Temperature**




**Step Load Response**




**Output Short Circuit Characteristics**

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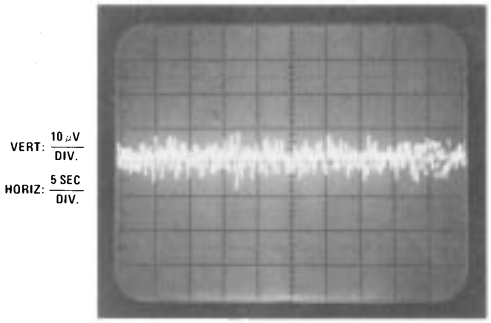
**Noise Voltage**

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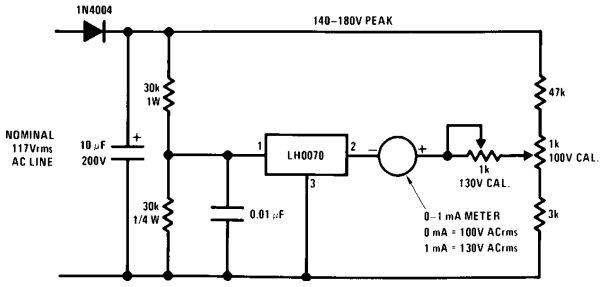
## Typical Applications (Continued)

**Expanded Scale AC Voltmeter**

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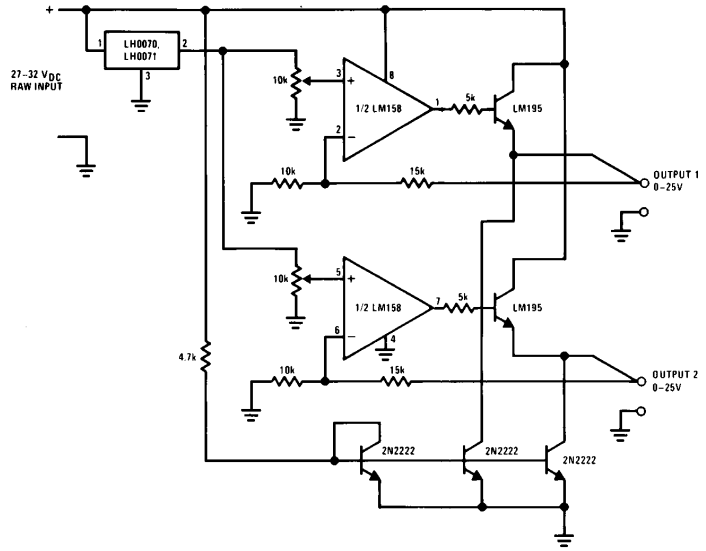
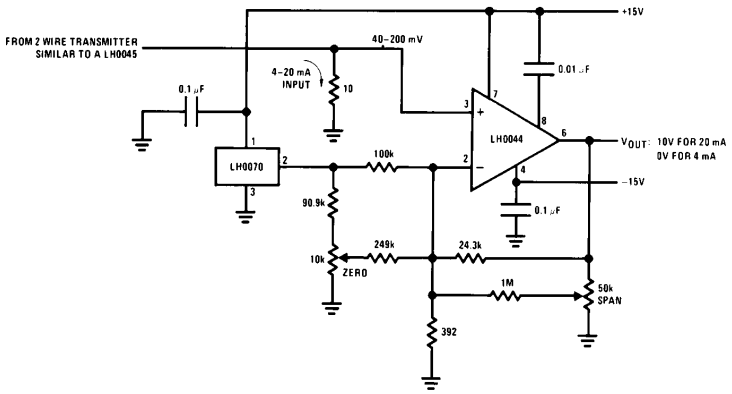
## Typical Applications (Continued)

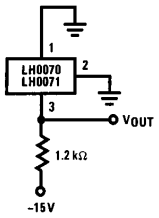
### Dual Output Bench Power Supply



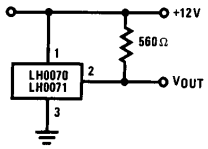

### Precision Process Control Interface




### Negative 10V Reference




### Boosted Reference For Low Input Voltages

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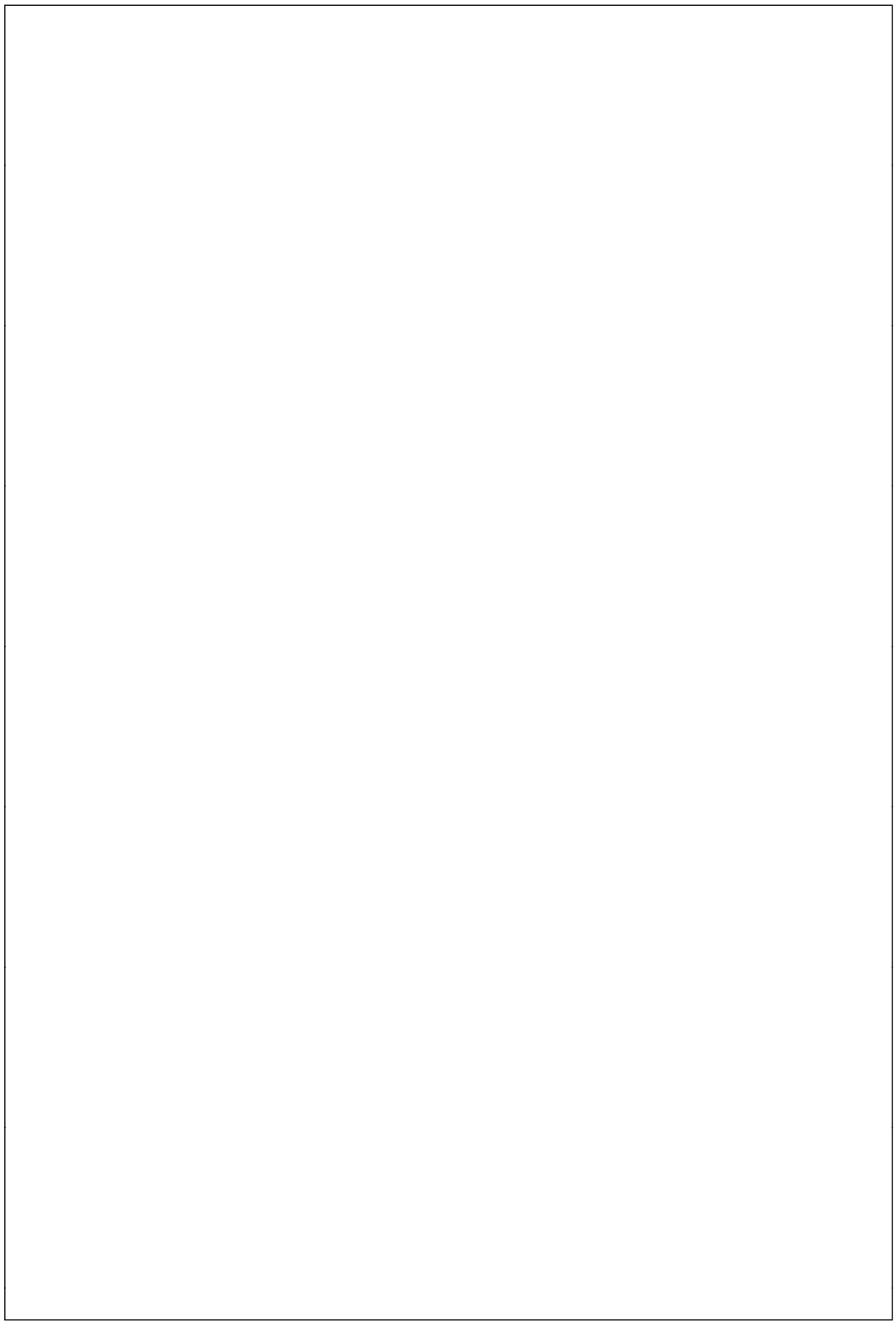
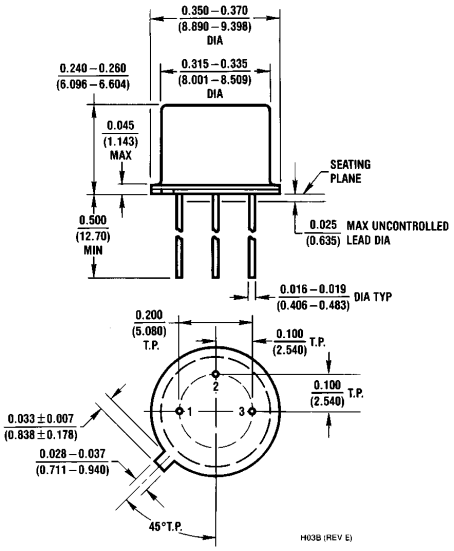


## Physical Dimensions inches (millimeters)




**Metal Can Package (H)**
**Order Number LH0070-0H, LH0071-0H, LH0070-1H, LH0071-1H, LH0070-2H or LH0071-2H**
**NS Package Number H03B**

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