



## LM113/LM313 Reference Diode

### General Description

The LM113/LM313 are temperature compensated, low voltage reference diodes. They feature extremely-tight regulation over a wide range of operating currents in addition to an unusually-low breakdown voltage and good temperature stability.

The diodes are synthesized using transistors and resistors in a monolithic integrated circuit. As such, they have the same low noise and long term stability as modern IC op amps. Further, output voltage of the reference depends only on highly-predictable properties of components in the IC; so they can be manufactured and supplied to tight tolerances.

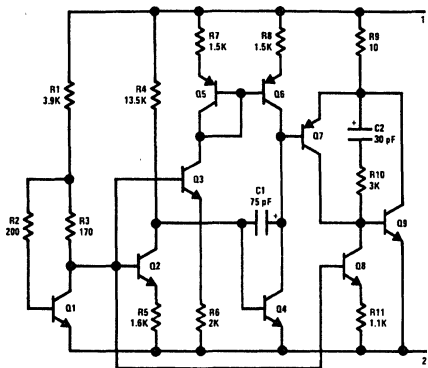
- Dynamic impedance of  $0.3\Omega$  from  $500\ \mu\text{A}$  to  $20\ \text{mA}$
- Temperature stability typically 1% over  $-55^\circ\text{C}$  to  $125^\circ\text{C}$  range (LM113),  $0^\circ\text{C}$  to  $70^\circ\text{C}$  (LM313)
- Tight tolerance:  $\pm 5\%$ ,  $\pm 2\%$  or  $\pm 1\%$

The characteristics of this reference recommend it for use in bias-regulation circuitry, in low-voltage power supplies or in battery powered equipment. The fact that the breakdown voltage is equal to a physical property of silicon—the energy-band gap voltage—makes it useful for many temperature-compensation and temperature-measurement functions.

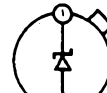
### Features

- Low breakdown voltage: 1.220V

### Schematic and Connection Diagrams



#### Metal Can Package



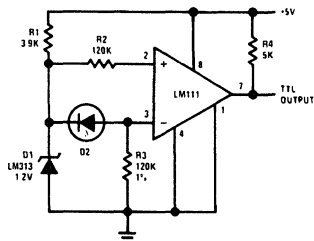
Note: Pin 2 connected to case.  
TOP VIEW

Order Number LM113H or  
LM113-1H or LM113-2H or LM313H  
See NS Package Number H02A

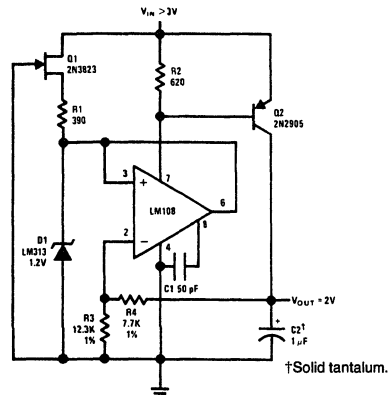
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### Typical Applications

#### Level Detector for Photodiode



#### Low Voltage Regulator



†Solid tantalum.

TL/H/5713-2

## Absolute Maximum Ratings

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

(Note 3)

|                            |        |
|----------------------------|--------|
| Power Dissipation (Note 1) | 100 mW |
| Reverse Current            | 50 mA  |
| Forward Current            | 50 mA  |

|   |                 |
|---|-----------------|
| Storage Temperature Range                   | -65°C to +150°C |
| Lead Temperature<br>(Soldering, 10 seconds) | 300°C           |
| Operating Temperature Range                 | -55°C to +125°C |
| LM113                                       | 0°C to +70°C    |
| LM313                                       |                 |

## Electrical Characteristics (Note 2)

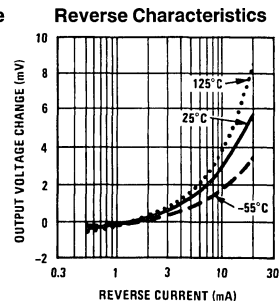
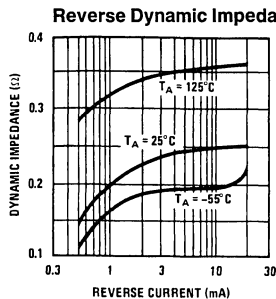
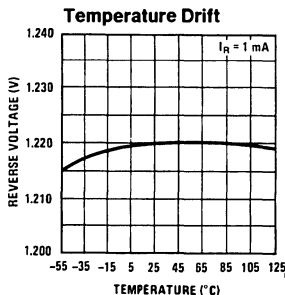
| Parameter  | Conditions  | Min   | Typ   | Max   | Units         |
|--|---|-------|-------|-------|---------------|
| Reverse Breakdown Voltage<br>LM113/LM313<br>LM113-1<br>LM113-2 | $I_R = 1 \text{ mA}$  | 1.160 | 1.220 | 1.280 | V             |
|  |   | 1.210 | 1.22  | 1.232 | V             |
|  |   | 1.195 | 1.22  | 1.245 | V             |
| Reverse Breakdown Voltage<br>Change                            | $0.5 \text{ mA} \leq I_R \leq 20 \text{ mA}$  |       | 6.0   | 15    | mV            |
| Reverse Dynamic Impedance                                      | $I_R = 1 \text{ mA}$<br>$I_R = 10 \text{ mA}$   |       | 0.2   | 1.0   | $\Omega$      |
|  |   |       | 0.25  | 0.8   | $\Omega$      |
| Forward Voltage Drop   | $I_F = 1.0 \text{ mA}$  |       | 0.67  | 1.0   | V             |
| RMS Noise Voltage  | $10 \text{ Hz} \leq f \leq 10 \text{ kHz}$<br>$I_R = 1 \text{ mA}$                            |       | 5     |       | $\mu\text{V}$ |
| Reverse Breakdown Voltage<br>Change with Current               | $0.5 \text{ mA} \leq I_R \leq 10 \text{ mA}$<br>$T_{\text{MIN}} \leq T_A \leq T_{\text{MAX}}$ |       |       | 15    | mV            |
| Breakdown Voltage Temperature<br>Coefficient                   | $1.0 \text{ mA} \leq I_R \leq 10 \text{ mA}$<br>$T_{\text{MIN}} \leq T_A \leq T_{\text{MAX}}$ |       | 0.01  |       | %/°C          |

**Note 1:** For operating at elevated temperatures, the device must be derated based on a 150°C maximum junction and a thermal resistance of 80°C/W junction to case or 440°C/W junction to ambient.

**Note 2:** These specifications apply for  $T_A = 25^\circ\text{C}$ , unless stated otherwise. At high currents, breakdown voltage should be measured with lead lengths less than  $\frac{1}{4}$  inch. Kelvin contact sockets are also recommended. The diode should not be operated with shunt capacitances between 200 pF and 0.1  $\mu\text{F}$ , unless isolated by at least a 100 $\Omega$  resistor, as it may oscillate at some currents.

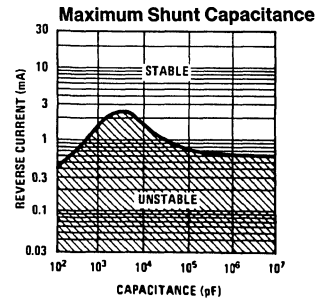
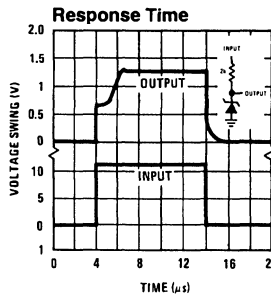
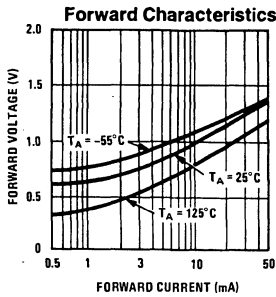
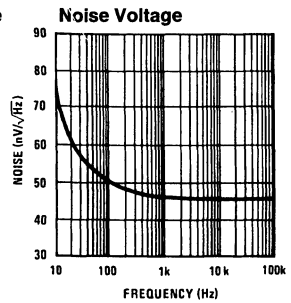
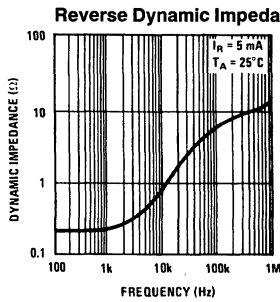
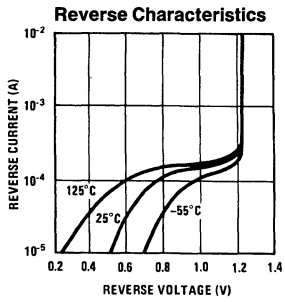
**Note 3:** Refer to the following RETS drawings for military specifications: RETS113-1X for LM113-1, RETS113-2X for LM113-2 or RETS113X for LM113.

## Typical Performance Characteristics



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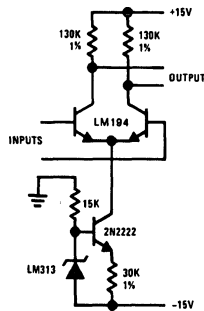
## Typical Performance Characteristics (Continued)



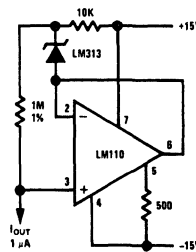
TL/H/5713-4

## Typical Applications (Continued)

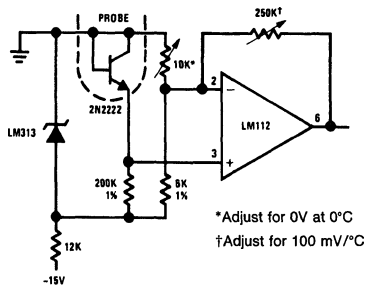
### Amplifier Biasing for Constant Gain with Temperature



### Constant Current Source



### Thermometer



TL/H/5713-5