

## LM113/LM313 Reference Diode

Check for Samples: [LM113](#), [LM313](#)

### FEATURES

- Low breakdown voltage: 1.220V
- Dynamic impedance of 0.3Ω from 500 μA to 20 mA
- Temperature stability typically 1% over -55°C to 125°C range (LM113), 0°C to 70°C (LM313)
- Tight tolerance: ±5%, ±2% or ±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.

### 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.

### Schematic and Connection Diagrams

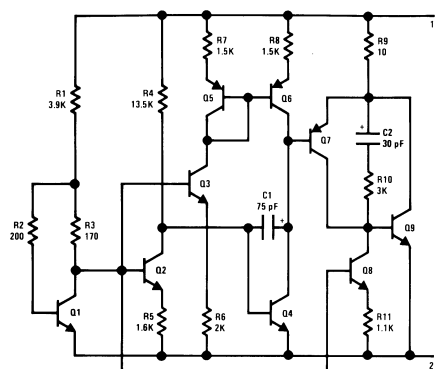
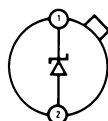


Figure 1. Schematic



Note: Pin 2 connected to case.  
TOP VIEW

Figure 2. Metal Can Package



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## Typical Applications

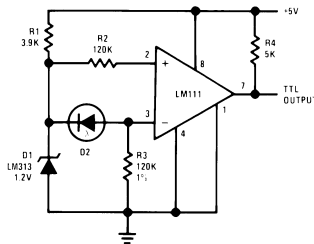
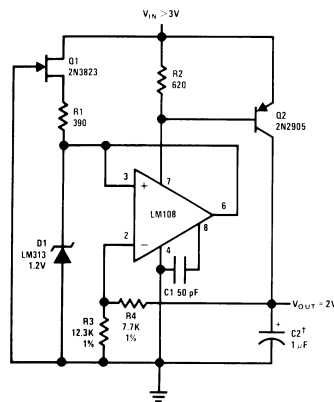


Figure 3. Level Detector for Photodiode



†Solid tantalum.

Figure 4. Low Voltage Regulator



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

### Absolute Maximum Ratings <sup>(1)</sup>

Power Dissipation <sup>(2)</sup>	100 mW
Reverse Current	50 mA
Forward Current	50 mA
Storage Temperature Range	-65°C to +150°C
Lead Temperature	
(Soldering, 10 seconds)	300°C
Operating Temperature Range	
LM113	-55°C to +125°C
LM313	0°C to +70°C

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

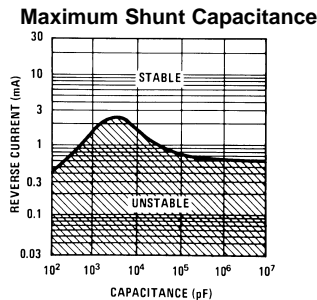
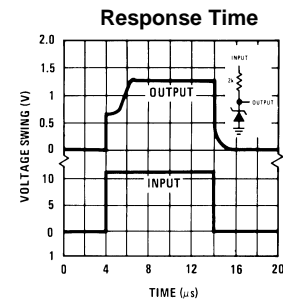
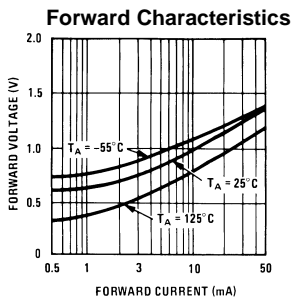
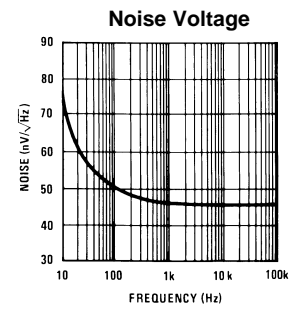
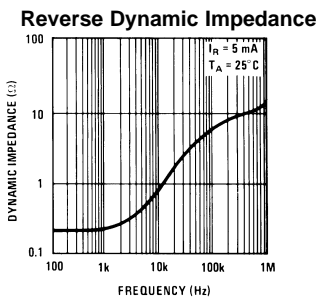
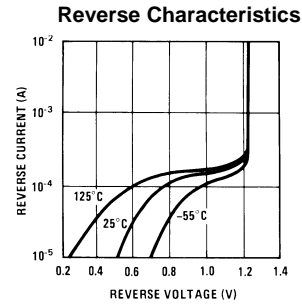
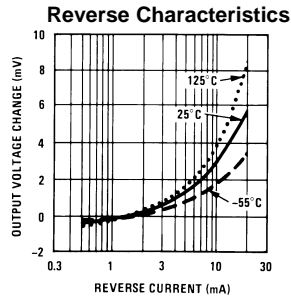
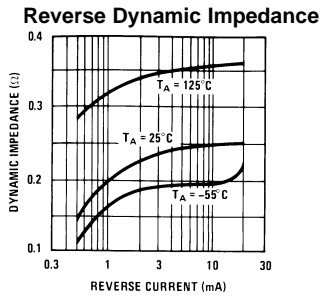
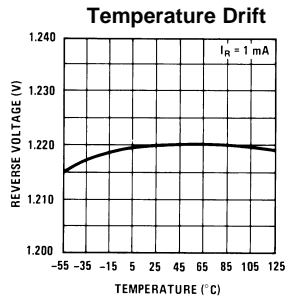
(2) For operating at elevated temperatures, the device must be derated based on a 150°C maximum junction and a thermal resistance of 80°C/W junction to case or 440°C/W junction to ambient.

**Electrical Characteristics <sup>(1)</sup>**

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

- (1) 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.

### Typical Performance Characteristics



Typical Applications

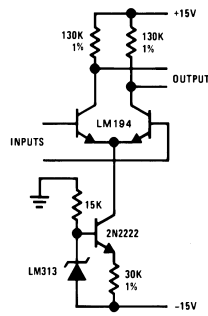


Figure 5. Amplifier Biasing for Constant Gain with Temperature

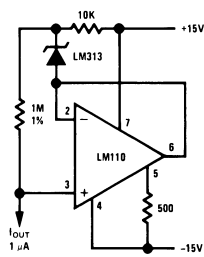
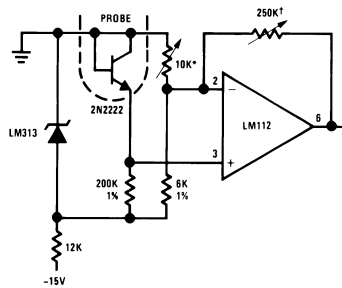


Figure 6. Constant Current Source



Adjust for 0V at 0°C  
Adjust for 100 mV/°C

Figure 7. Thermometer

**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Samples (Requires Login)
LM113H	NRND	TO	NDU	2	1000	TBD	POST-PLATE	Level-1-NA-UNLIM	
LM113H/NOPB	NRND	TO	NDU	2	1000	Green (RoHS & no Sb/Br)	POST-PLATE	Level-1-NA-UNLIM	

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSELETE:** TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

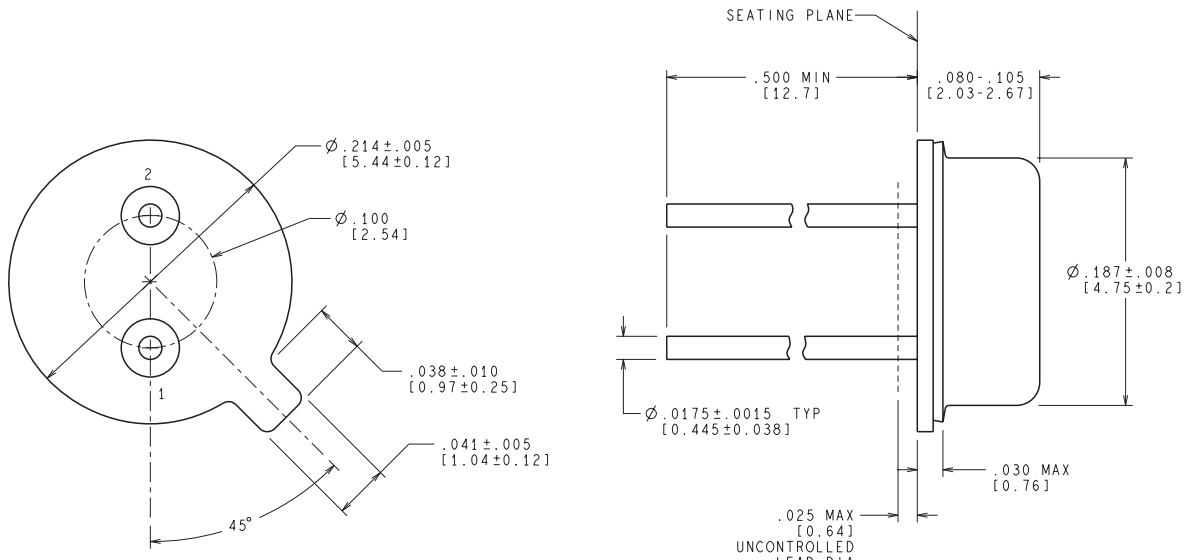
**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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