

## 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.

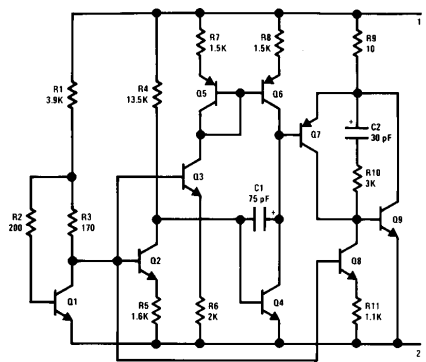
- Dynamic impedance of  $0.3\Omega$  from  $500\ \mu\text{A}$  to  $20\ \text{mA}$
- Temperature stability typically 1% over  $-55^\circ\text{C}$  to  $125^\circ\text{C}$  range (LM113),  $0^\circ\text{C}$  to  $70^\circ\text{C}$  (LM313)
- Tight tolerance:  $\pm 5\%$ ,  $\pm 2\%$  or  $\pm 1\%$

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.

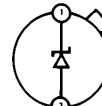
### Features

- Low breakdown voltage: 1.220V

### Schematic and Connection Diagrams



Metal Can Package



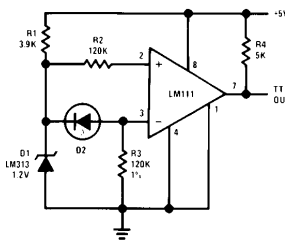
Note: Pin 2 connected to case.  
TOP VIEW

**Order Number**  
LM113H, LM113H/883,  
LM113-1H, LM113-1H/883,  
LM113-2H, LM113-2H/883,  
or LM313H  
See NS Package Number H02A

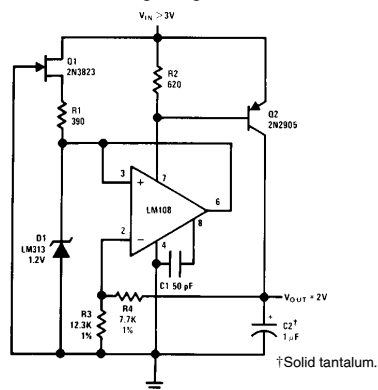
TL/H/5713-1

### Typical Applications

Level Detector for Photodiode



Low Voltage Regulator



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 (Soldering, 10 seconds)	300°C
Operating Temperature Range	
LM113	-55°C to +125°C
LM313	0°C to +70°C

## Electrical Characteristics (Note 2)

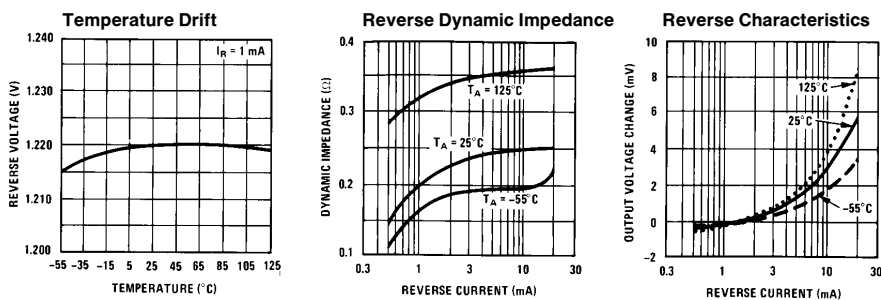
Parameter	Conditions	Min	Typ	Max	Units
Reverse Breakdown Voltage LM113/LM313 LM113-1 LM113-2	$I_R = 1 \text{ mA}$	1.160	1.220	1.280	V
		1.210	1.22	1.232	V
		1.195	1.22	1.245	V
Reverse Breakdown Voltage Change	$0.5 \text{ mA} \leq I_R \leq 20 \text{ mA}$		6.0	15	mV
Reverse Dynamic Impedance	$I_R = 1 \text{ mA}$ $I_R = 10 \text{ mA}$		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	$10 \text{ Hz} \leq f \leq 10 \text{ kHz}$ $I_R = 1 \text{ mA}$		5		$\mu\text{V}$
Reverse Breakdown Voltage Change with Current	$0.5 \text{ mA} \leq I_R \leq 10 \text{ mA}$ $T_{\text{MIN}} \leq T_A \leq T_{\text{MAX}}$			15	mV
Breakdown Voltage Temperature Coefficient	$1.0 \text{ mA} \leq I_R \leq 10 \text{ mA}$ $T_{\text{MIN}} \leq T_A \leq T_{\text{MAX}}$		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.

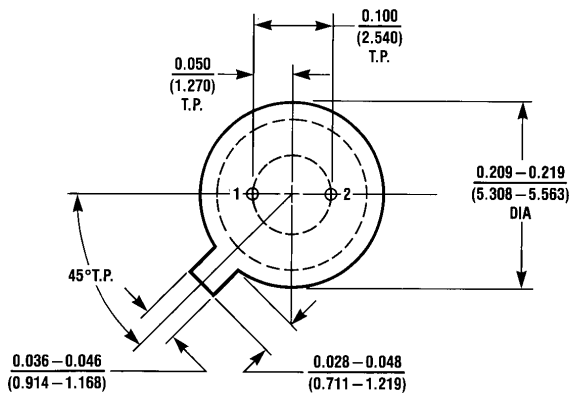
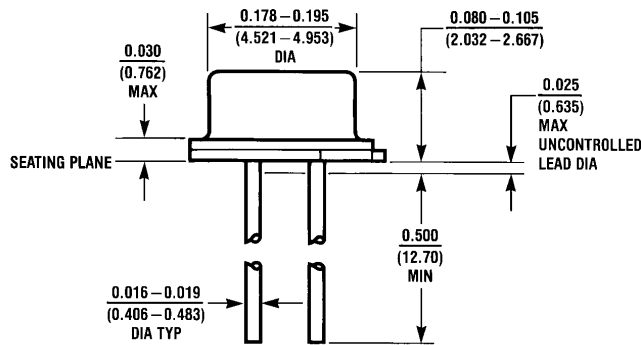
## Typical Performance Characteristics



TL/H/5713-3



**Physical Dimensions** inches (millimeters)



H02A (REV C)

Order Number LM113H, LM113H/883, LM113-1H, LM113-1H/883,  
LM113-2H, LM113-2H/883 or LM313H  
NS Package Number H02A

**LIFE SUPPORT POLICY**

NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT OF NATIONAL SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform, when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.



**National Semiconductor Corporation**  
1111 West Bardin Road  
Arlington, TX 76017  
Tel: 1(800) 272-9959  
Fax: 1(800) 737-7018

**National Semiconductor Europe**  
Fax: (+49) 0-180-530 85 86  
Email: cnjwge@tevm2.nsc.com  
Deutsch Tel: (+49) 0-180-530 85 85  
English Tel: (+49) 0-180-532 78 32  
Français Tel: (+49) 0-180-532 93 58  
Italiano Tel: (+49) 0-180-534 16 80

**National Semiconductor Hong Kong Ltd.**  
13th Floor, Straight Block,  
Ocean Centre, 5 Canton Rd.  
Tsimshatsui, Kowloon  
Hong Kong  
Tel: (852) 2737-1600  
Fax: (852) 2736-9960

**National Semiconductor Japan Ltd.**  
Tel: 81-043-299-2309  
Fax: 81-043-299-2408

National does not assume any responsibility for use of any circuitry described, no circuit patent licenses are implied and National reserves the right at any time without notice to change said circuitry and specifications.