

# LM113QML

*LM113QML Reference Diode*



Literature Number: SNVS367

# LM113QML

## Reference Diode

### General Description

The LM113 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.

### Features

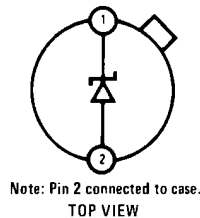
- Low breakdown voltage: 1.220V
  - Dynamic impedance of  $0.3\Omega$  from 500  $\mu\text{A}$  to 20 mA
  - Temperature stability typically 1% over  $-55^\circ\text{C}$  to  $125^\circ\text{C}$  range
  - Tight tolerance:  $\pm 5\%$  or  $\pm 1\%$
- The characteristics of this reference recommend it 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.

### Ordering Information

| NS Part Number | SMD Part Number | NS Package Number | Package Description |
|----------------|-----------------|-------------------|---------------------|
| LM113H-SMD     | 5962-8671101XA  | H02A              | 2LD Metal Can       |
| LM113-1H-SMD   | 5962-8671102XA  | H02A              | 2LD Metal Can       |
| LM113-1H-QMLV  | 5962-9684302VXA | H02A              | 2LD Metal Can       |
| LM113WG-QMLV   | 5962-9684301VZA | WG10A             | 10LD Ceramic SOIC   |
| LM113-1WG-QMLV | 5962-9684302VZA | WG10A             | 10LD Ceramic SOIC   |

### Connection Diagrams

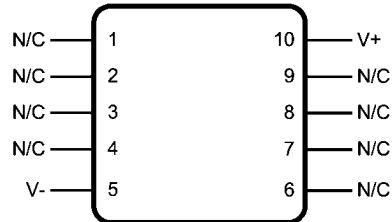
**Metal Can Package (H)**



20150021

See NS Package Number H02A

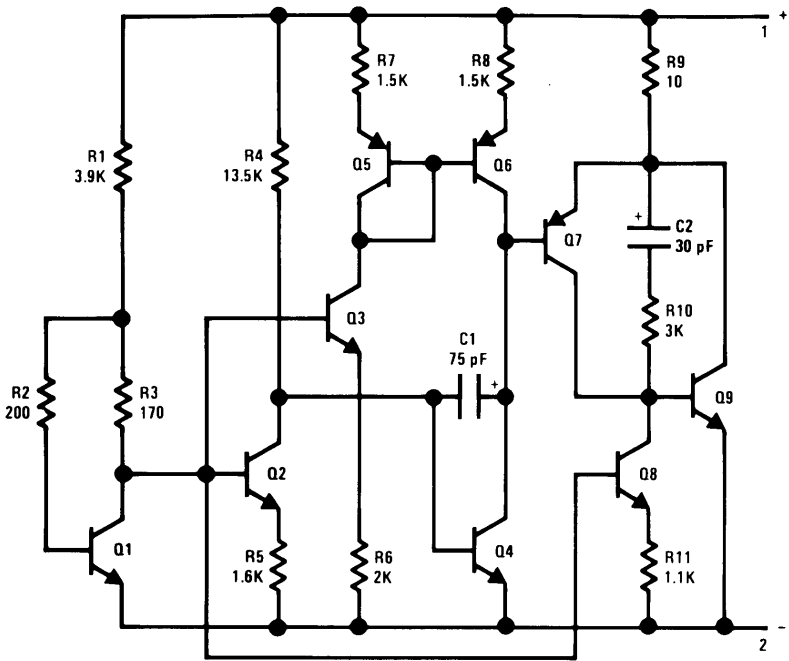
**Ceramic SOIC Package (WG)**



20150001

See NS Package Number WG10A

# Schematic Diagram



20150020

## Absolute Maximum Ratings *(Note 1)*

|   |  |
|---|--|
| Power Dissipation <i>(Note 2)</i>           | 100 mW   |
| Reverse Current                             | 50 mA  |
| Forward Current                             | 50 mA  |
| Storage Temperature Range                   | $-65^{\circ}\text{C} \leq T_A \leq +150^{\circ}\text{C}$ |
| Lead Temperature (Soldering, 10 seconds)    | 300°C  |
| Maximum Junction Temperature ( $T_{Jmax}$ ) | +150°C   |
| Operating Temperature Range                 | $-55^{\circ}\text{C} \leq T_A \leq +125^{\circ}\text{C}$ |
| Thermal Resistance                          |  |
| $\theta_{JA}$                               |  |
| Metal Can (Still Air)                       | 440°C/W  |
| Metal Can (500LF / Min Air Flow)            | TBD  |
| Ceramic SOIC (Still Air)                    | 218°C/W  |
| Ceramic SOIC (500LF / Min Air Flow)         | 140°C/W  |
| $\theta_{JC}$                               |  |
| Metal Can                                   | 80°C/W   |
| Ceramic SOIC                                | 27°C/W   |
| Package Weight                              |  |
| Metal Can                                   | 275mg  |
| Ceramic SOIC                                | 220mg  |
| ESD Tolerance <i>(Note 3)</i>               | 4000V  |

## Quality Conformance

Mil-Std-883, Method 5005 - Group A

| Subgroup | Description         | Temp (°C) |
|----------|---------------------|-----------|
| 1        | Static tests at     | +25       |
| 2        | Static tests at     | +125      |
| 3        | Static tests at     | -55       |
| 4        | Dynamic tests at    | +25       |
| 5        | Dynamic tests at    | +125      |
| 6        | Dynamic tests at    | -55       |
| 7        | Functional tests at | +25       |
| 8A       | Functional tests at | +125      |
| 8B       | Functional tests at | -55       |
| 9        | Switching tests at  | +25       |
| 10       | Switching tests at  | +125      |
| 11       | Switching tests at  | -55       |
| 12       | Settling time at    | +25       |
| 13       | Settling time at    | +125      |
| 14       | Settling time at    | -55       |

## LM113 Electrical Characteristics

### DC Parameters

| Symbol           | Parameter                 | Conditions                    | Notes    | Min   | Max   | Unit | Sub-groups |
|------------------|---------------------------|-------------------------------|----------|-------|-------|------|------------|
| V <sub>ZR</sub>  | Zener Voltage             | I <sub>R</sub> = 1 mA         |          | 1.16  | 1.28  | V    | 1          |
|                  |                           |                               |          | 1.157 | 1.283 | V    | 2, 3       |
| ΔV <sub>ZR</sub> | Delta Zener Voltage       | 0.5mA ≤ I <sub>R</sub> ≤ 20mA |          |       | 15    | mV   | 1          |
|                  |                           | 0.5mA ≤ I <sub>R</sub> ≤ 10mA |          |       | 15    | mV   | 2, 3       |
| V <sub>F</sub>   | Forward Voltage Drop      | I <sub>F</sub> = 1mA          |          |       | 1.0   | V    | 1, 2, 3    |
| R <sub>R</sub>   | Reverse Dynamic Impedance | I <sub>R</sub> = 1mA          | (Note 4) |       | 1.0   | Ω    | 4          |
|                  |                           | I <sub>R</sub> = 10mA         |          |       | 0.8   | Ω    | 4          |

### DC Drift Parameters

Delta Calculations performed on QMLV devices at Group B, Subgroup 5, only.

| Symbol          | Parameter     | Conditions           | Notes | Min   | Max  | Unit | Sub-groups |
|-----------------|---------------|----------------------|-------|-------|------|------|------------|
| V <sub>ZR</sub> | Zener Voltage | I <sub>R</sub> = 1mA |       | -0.02 | 0.02 | V    | 1          |

## LM113-1 Electrical Characteristics

### DC Parameters

| Symbol           | Parameter                 | Conditions                    | Notes    | Min   | Max   | Unit | Sub-groups |
|------------------|---------------------------|-------------------------------|----------|-------|-------|------|------------|
| V <sub>ZR</sub>  | Zener Voltage             | I <sub>R</sub> = 1 mA         |          | 1.210 | 1.232 | V    | 1          |
|                  |                           |                               |          | 1.206 | 1.234 | V    | 2, 3       |
| ΔV <sub>ZR</sub> | Delta Zener Voltage       | 0.5mA ≤ I <sub>R</sub> ≤ 20mA |          |       | 15    | mV   | 1          |
|                  |                           | 0.5mA ≤ I <sub>R</sub> ≤ 10mA |          |       | 15    | mV   | 2, 3       |
| V <sub>F</sub>   | Forward Voltage Drop      | I <sub>F</sub> = 1mA          |          |       | 1.0   | V    | 1, 2, 3    |
| R <sub>R</sub>   | Reverse Dynamic Impedance | I <sub>R</sub> = 1mA          | (Note 4) |       | 1.0   | Ω    | 4          |
|                  |                           | I <sub>R</sub> = 10mA         |          |       | 0.8   | Ω    | 4          |

### DC Drift Parameters

Delta Calculations performed on QMLV devices at Group B, Subgroup 5, only.

| Symbol          | Parameter     | Conditions           | Notes | Min   | Max  | Unit | Sub-groups |
|-----------------|---------------|----------------------|-------|-------|------|------|------------|
| V <sub>ZR</sub> | Zener Voltage | I <sub>R</sub> = 1mA |       | -0.02 | 0.02 | V    | 1          |

**Note 1:** 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. For guaranteed specifications and test conditions, see the Electrical Characteristics. The guaranteed specifications apply only for the test conditions listed. Some performance characteristics may degrade when the device is not operated under the listed test conditions.

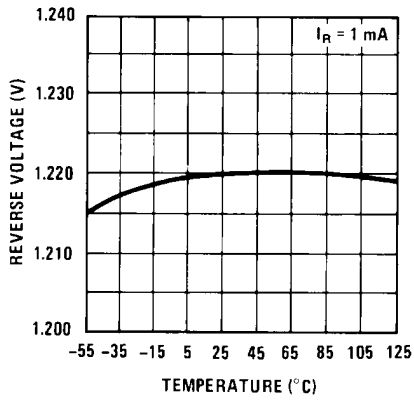
**Note 2:** The maximum power dissipation must be derated at elevated temperatures and is dictated by T<sub>Jmax</sub> (maximum junction temperature), θ<sub>JA</sub> (package junction to ambient thermal resistance), and T<sub>A</sub> (ambient temperature). The maximum allowable power dissipation at any temperature is P<sub>Dmax</sub> = (T<sub>Jmax</sub> - T<sub>A</sub>) / θ<sub>JA</sub> or the number given in the Absolute Maximum Ratings, whichever is lower.

**Note 3:** Human body model, 1.5KΩ in series with 100pF.

**Note 4:** Guaranteed parameter, not tested.

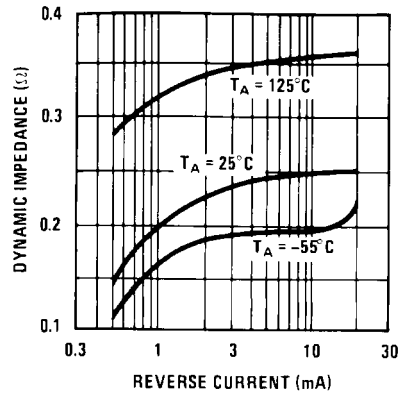
# Typical Performance Characteristics

Temperature Drift



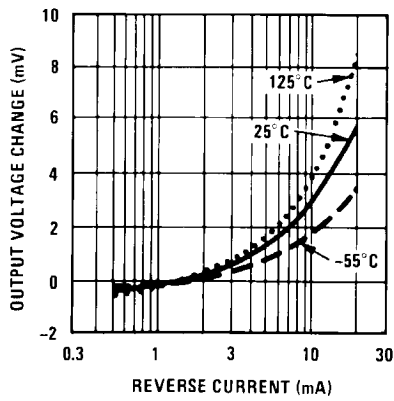
20150006

Reverse Dynamic Impedance



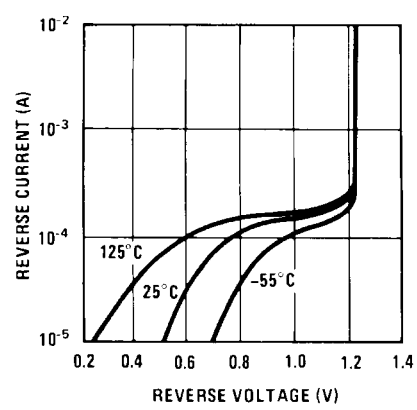
20150007

Reverse Characteristics



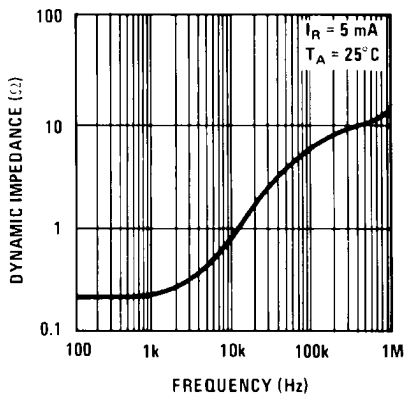
20150008

Reverse Characteristics



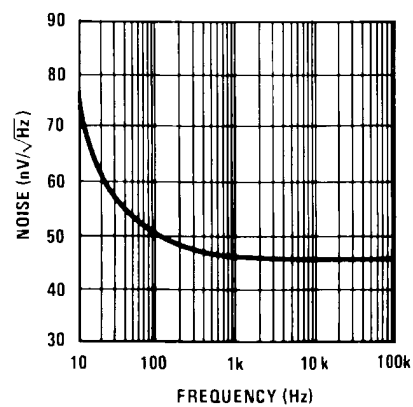
20150009

Reverse Dynamic Impedance



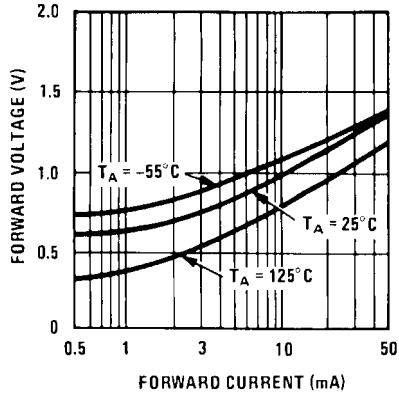
20150010

Noise Voltage



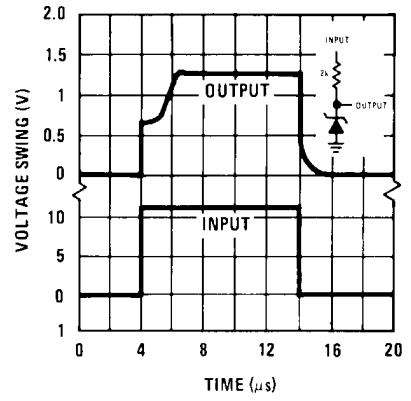
20150011

**Forward Characteristics**



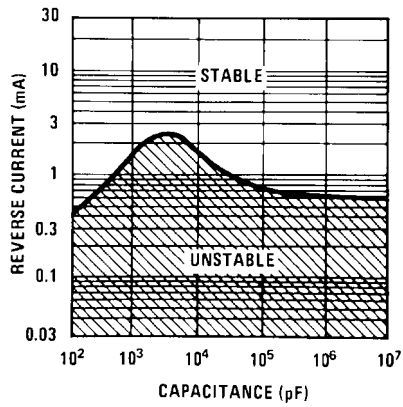
20150012

**Response Time**



20150013

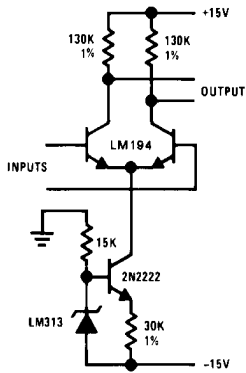
**Maximum Shunt Capacitance**



20150014

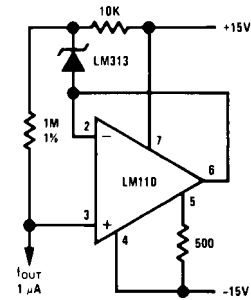
# Typical Applications

## Amplifier Biasing for Constant Gain with Temperature



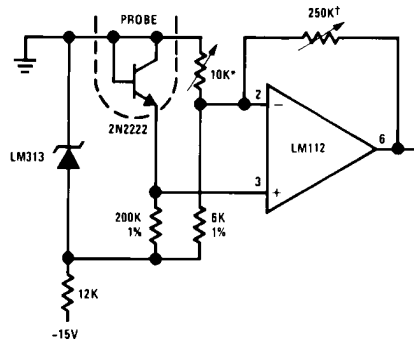
20150017

## Constant Current Source



20150018

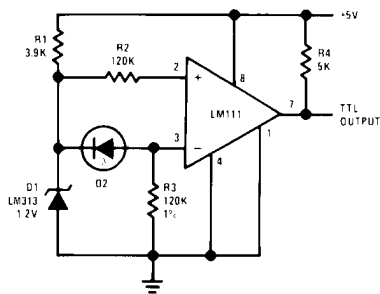
## Thermometer



20150019

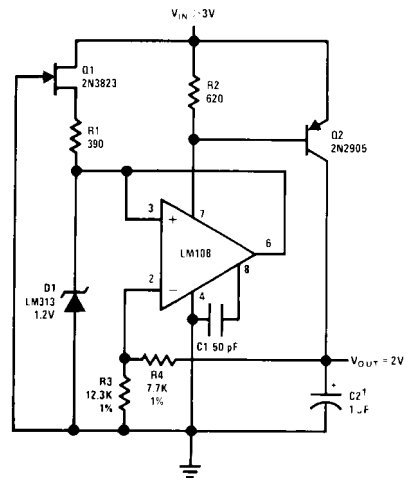
Adjust for 0V at 0°C  
Adjust for 100 mV/°C

## Level Detector for Photodiode



20150015

## Low Voltage Regulator



20150016

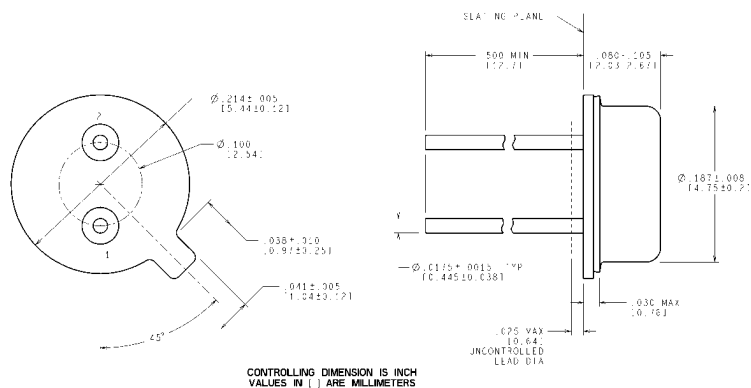
†Solid tantalum.



# Revision History

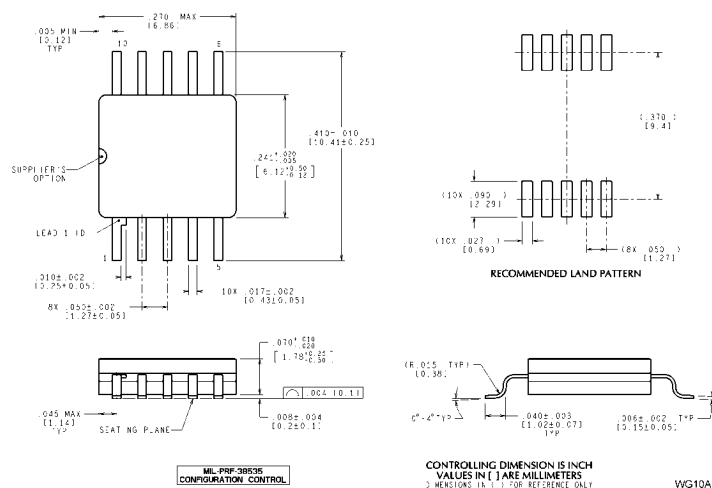
| Released   | Revision | Section                         | Changes   |
|------------|----------|---------------------------------|---|
| 12/16/2010 | A        | New release to corporate format | 2 MDS data sheets converted into one Corp. data sheet format. MDSs MNLM113-X Rev 1C1 and MNLM113-1-X Rev. 2A1 will be archived. |

# Physical Dimensions inches (millimeters) unless otherwise noted



H02A (Rev F)

## NS Package Number H02A



WG10A (Rev F)

## NS Package Number WG10A

## Notes

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| LED Lighting                   | <a href="http://www.national.com/led">www.national.com/led</a>               | Feedback/Support             | <a href="http://www.national.com/feedback">www.national.com/feedback</a>           |
| Voltage References             | <a href="http://www.national.com/vref">www.national.com/vref</a>             | Design Made Easy             | <a href="http://www.national.com/easy">www.national.com/easy</a>                   |
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### Applications

|                               |  |
|-------------------------------|--|
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| Consumer Electronics          | <a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>                   |
| Energy and Lighting           | <a href="http://www.ti.com/energy">www.ti.com/energy</a>                                 |
| Industrial                    | <a href="http://www.ti.com/industrial">www.ti.com/industrial</a>                         |
| Medical                       | <a href="http://www.ti.com/medical">www.ti.com/medical</a>                               |
| Security                      | <a href="http://www.ti.com/security">www.ti.com/security</a>                             |
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