

## LM113QML Reference Diode

Check for Samples: [LM113QML](#), [LM113QML-SP](#)

### FEATURES

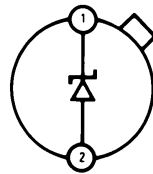
- **Low Breakdown Voltage: 1.220V**
- **Dynamic Impedance of 0.3Ω from 500 μA to 20 mA**
- **Temperature Stability Typically 1% over –55°C to 125°C Range**
- **Tight Tolerance: ±5% or ±1%**
  - **The characteristics of this reference recommend it for use in bias-regulation circuitry, in low-voltage power 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 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.

### Connection Diagrams



Note: Pin 2 connected to case.  
TOP VIEW

Figure 1. 2-Pin TO  
See NDU0002A Package

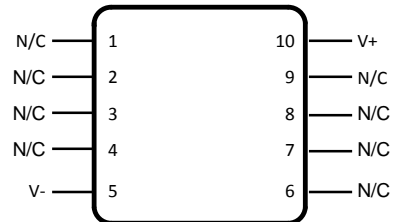


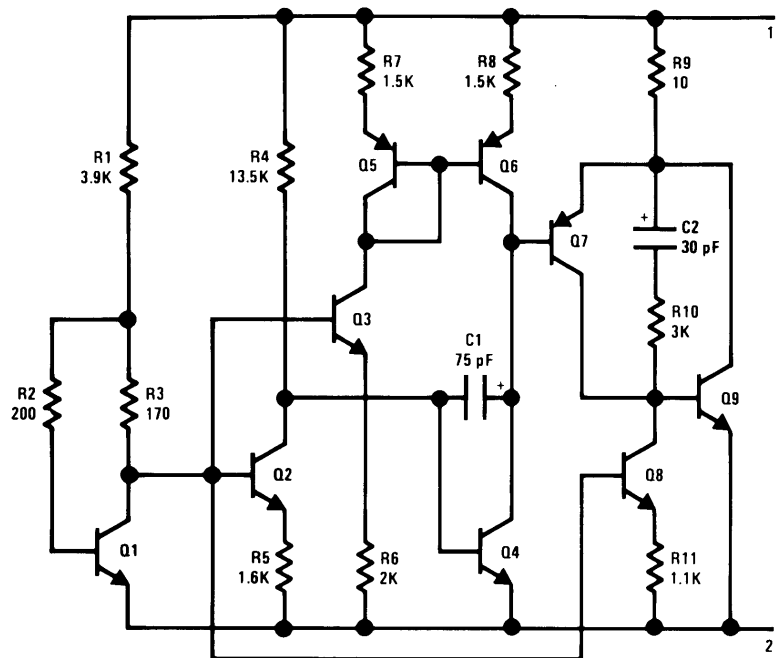
Figure 2. 10-Pin CFP



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

All trademarks are the property of their respective owners.

## Schematic Diagram



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 ≤ T <sub>A</sub> ≤ +150°C	
Lead Temperature (Soldering, 10 seconds)		300°C	
Maximum Junction Temperature (T <sub>Jmax</sub> )		+150°C	
Operating Temperature Range		-55°C ≤ T <sub>A</sub> ≤ +125°C	
Thermal Resistance	θ <sub>JA</sub>	TO (Still Air)	440°C/W
		TO (500LF / Min Air Flow)	TBD
		CFP (Still Air)	218°C/W
		CFP (500LF / Min Air Flow)	140°C/W
	θ <sub>JC</sub>	TO	80°C/W
		CFP	27°C/W
Package Weight	TO	275mg	
	CFP	220mg	
ESD Tolerance <sup>(3)</sup>		4000V	

- (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 ensure specific performance limits. For ensured specifications and test conditions, see the Electrical Characteristics. The ensured specifications apply only for the test conditions listed. Some performance characteristics may degrade when the device is not operated under the listed test conditions.
- (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.
- (3) Human body model, 1.5kΩ in series with 100pF.

**Table 1. 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
$V_{ZR}$	Zener Voltage	$I_R = 1 \text{ mA}$		1.16	1.28	V	1
				1.157	1.283	V	2, 3
$\Delta V_{ZR}$	Delta Zener Voltage	$0.5 \text{ mA} \leq I_R \leq 20 \text{ mA}$			15	mV	1
		$0.5 \text{ mA} \leq I_R \leq 10 \text{ mA}$			15	mV	2, 3
$V_F$	Forward Voltage Drop	$I_F = 1 \text{ mA}$			1.0	V	1, 2, 3
$R_R$	Reverse Dynamic Impedance	$I_R = 1 \text{ mA}$	See <sup>(1)</sup>		1.0	$\Omega$	4
		$I_R = 10 \text{ mA}$			0.8	$\Omega$	4

(1) Specified parameter, not tested.

**LM113 ELECTRICAL CHARACTERISTICS DC DRIFT PARAMETERS**

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

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
$V_{ZR}$	Zener Voltage	$I_R = 1 \text{ mA}$		-0.02	0.02	V	1

**LM113-1 ELECTRICAL CHARACTERISTICS DC PARAMETERS**

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
$V_{ZR}$	Zener Voltage	$I_R = 1 \text{ mA}$		1.210	1.232	V	1
				1.206	1.234	V	2, 3
$\Delta V_{ZR}$	Delta Zener Voltage	$0.5\text{mA} \leq I_R \leq 20\text{mA}$			15	mV	1
		$0.5\text{mA} \leq I_R \leq 10\text{mA}$			15	mV	2, 3
$V_F$	Forward Voltage Drop	$I_F = 1\text{mA}$			1.0	V	1, 2, 3
$R_R$	Reverse Dynamic Impedance	$I_R = 1\text{mA}$	See <sup>(1)</sup>		1.0	$\Omega$	4
		$I_R = 10\text{mA}$			0.8	$\Omega$	4

(1) Specified parameter, not tested.

**LM113-1 Electrical Characteristics DC Drift Parameters**

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

Symbol	Parameter	Conditions	Notes	Min	Max	Unit	Sub-groups
$V_{ZR}$	Zener Voltage	$I_R = 1\text{mA}$		-0.02	0.02	V	1

TYPICAL PERFORMANCE CHARACTERISTICS

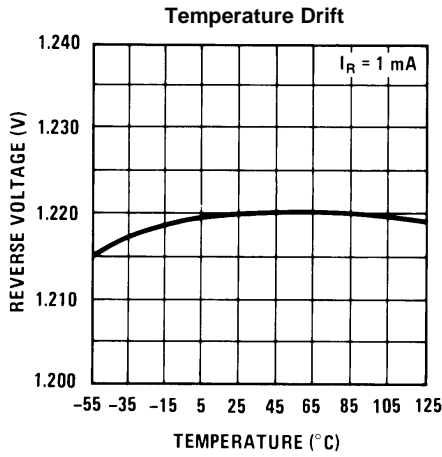


Figure 3.

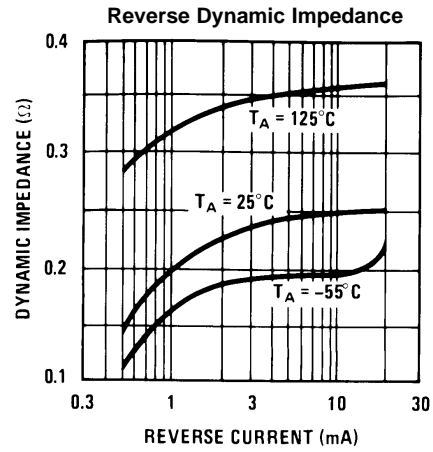


Figure 4.

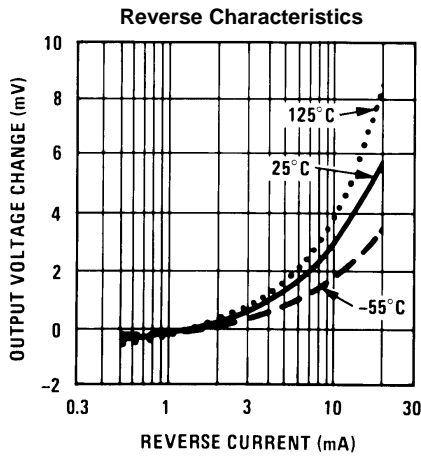


Figure 5.

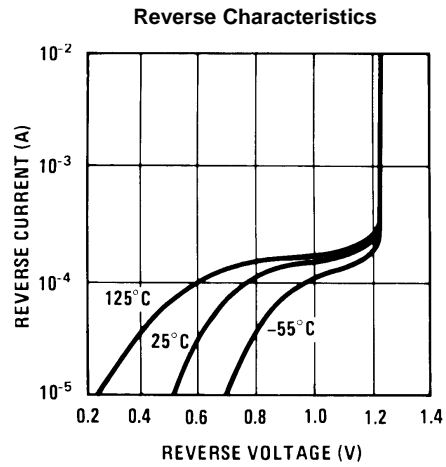


Figure 6.

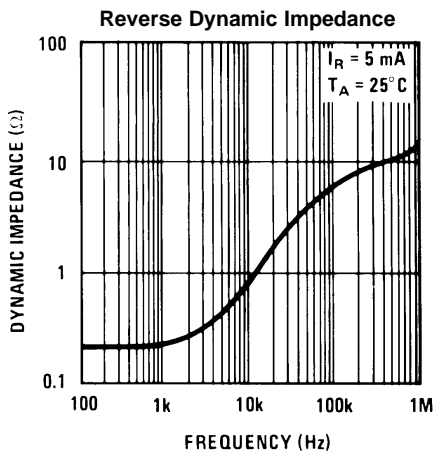


Figure 7.

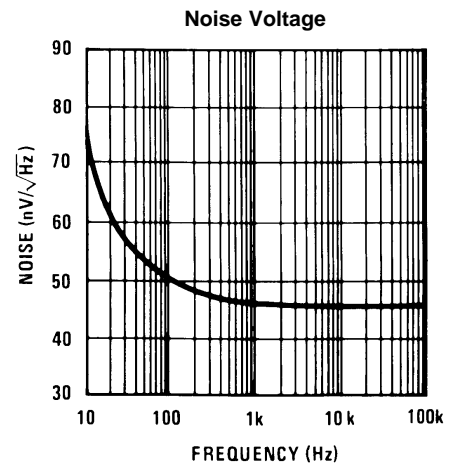
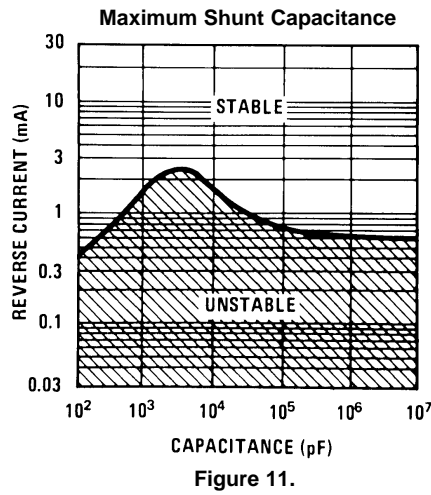
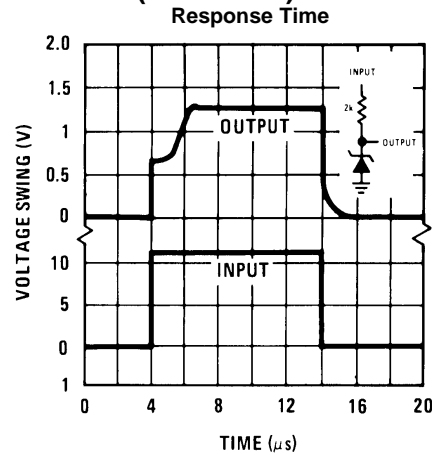
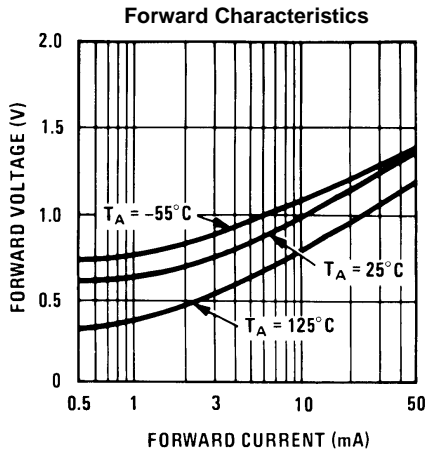


Figure 8.

**TYPICAL PERFORMANCE CHARACTERISTICS (continued)**



TYPICAL APPLICATIONS

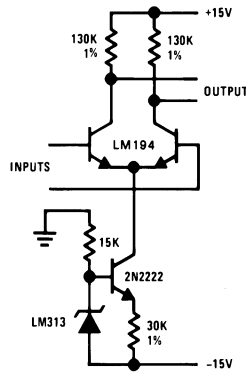


Figure 12. Amplifier Biasing for Constant Gain with Temperature

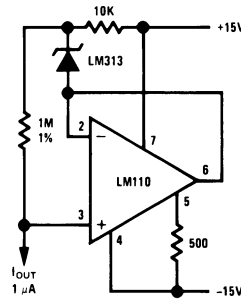
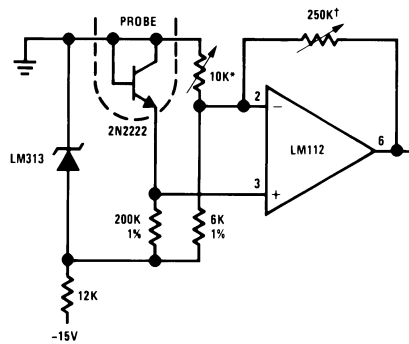


Figure 13. Constant Current Source



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

Figure 14. Thermometer

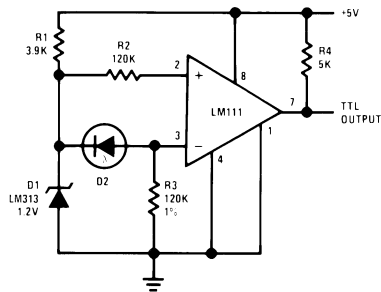
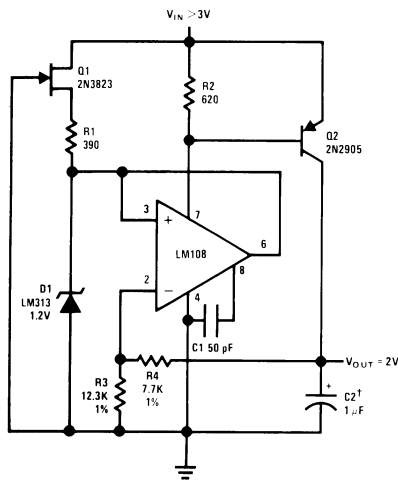


Figure 15. Level Detector for Photodiode



†Solid tantalum.

Figure 16. Low Voltage Regulator

**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.
04/17/2013	A		Changed layout of National Data Sheet to TI format.

## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

### Products

Audio	<a href="http://www.ti.com/audio">www.ti.com/audio</a>
Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>
DLP® Products	<a href="http://www.dlp.com">www.dlp.com</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>
OMAP Applications Processors	<a href="http://www.ti.com/omap">www.ti.com/omap</a>
Wireless Connectivity	<a href="http://www.ti.com/wirelessconnectivity">www.ti.com/wirelessconnectivity</a>

### Applications

Automotive and Transportation	<a href="http://www.ti.com/automotive">www.ti.com/automotive</a>
Communications and Telecom	<a href="http://www.ti.com/communications">www.ti.com/communications</a>
Computers and Peripherals	<a href="http://www.ti.com/computers">www.ti.com/computers</a>
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>
Space, Avionics and Defense	<a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a>
Video and Imaging	<a href="http://www.ti.com/video">www.ti.com/video</a>

### TI E2E Community

[e2e.ti.com](http://e2e.ti.com)