

# MC285\_1.2&MC385\_1.2

## Micropower Voltage Reference Diode General Description

The LM185-1.2/MC285-1.2/MC385-1.2 are micropower 2-terminal band-gap voltage regulator diodes. Operating over a 10µA to 20mA current range, they feature exceptionally low dynamic impedance and good temperature stability. On-chip trimming is used to provide tight voltage tolerance. Since the LM185-1.2 band-gap reference uses only transistors and resistors, low noise and good long term stability result.

Careful design of the LM185-1.2 has made the device exceptionally tolerant of capacitive loading, making it easy to use in almost any reference application. The wide dynamic operating range allows its use with widely varying supplies with excellent regulation.

The extremely low power drain of the LM185-1.2 makes it useful for micropower circuitry. This voltage reference can be used to make portable meters, regulators or general purpose analog circuitry with battery life approaching shelf life.

Further, the wide operating current allows it to replace older references with a tighter tolerance part.

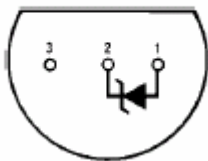
The LM185-1.2 is rated for operation over a -55° C to 125° C temperature range while the MC285-1.2 is rated -40° C to 85° C and the MC385-1.2 0° C to 70° C. The LM185-1.2/MC285-1.2 are available in a hermetic TO-46 package and the MC285-1.2/MC385-1.2 are also available in a low-cost TO-92 molded package, as well as SO and SOT-23. The LM185-1.2 is also available in a hermetic leadless chip carrier package.

### Features

- ±1% and 2% initial tolerance
- Operating current of 10µA to 20mA
- 1 dynamic impedance
- Low temperature coefficient
- Low voltage reference—1.235V
- 2.5V device and adjustable device also available
- LM185-2.5 series and LM185 series, respectively

### Connection Diagrams

**TO-92  
Plastic Package (Z)**



Bottom View

Order Number **MC285Z-1.2,**

**floating.**

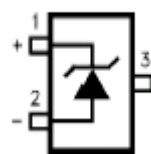
**MC285BXZ-1.2, MC285BYZ-1.2**

MC385Z-1.2, MC385BZ-1.2

**MC385BXZ-1.2 or MC385BYZ-1.2**

See NS Package Number Z03A

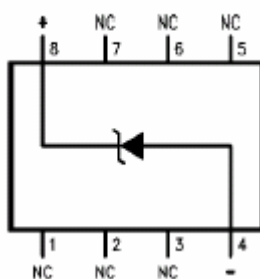
**SOT23**



Order Number MC385M3-1.2

See NS Package Number MF03A

**SO Package**



Order Number **MC285M - 1.2,**

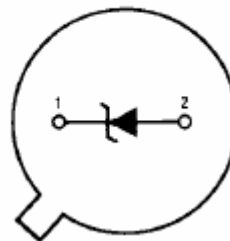
**MC285BXM - 1.2, MC285BYM - 1.2**

MC385M - 1.2, MC385BM - 1.2

MC385BXM - 1.2 or MC385BYM - 1.2

See NS Package Number M08A

**TO-46  
Metal Can Package (H)**



Bottom View

Order Number **LM185H - 1.2, LM185H - 1.2/883,**

**LM185BXH - 1.2, LM185BYH - 1.2**

MC285H - 1.2 or MC285BXH - 1.2

See NS Package Number H02A

## MC285\_1.2&MC385\_1.2

**Absolute Maximum Ratings (Note 1)**

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

(Note 2)

Reverse Current 30mA

Forward Current 10mA

Operating Temperature Range (Note 3)

LM185-1.2 -55° C to +125° C

MC285-1.2 -40° C to +85° C

MC385-1.2 0° C to 70° C

ESD Susceptibility (Note 9) 2kV

Storage Temperature -55° C to +150° C

Soldering Information

TO-92 package: 10 sec. 260° C

TO-46 package: 10 sec. 300° C

SO and SOT Pkg.

Vapor phase (60 sec.) 215° C

Infrared (15 sec.) 220° C

See AN-450 “Surface Mounting Methods and Their Effect on Product Reliability” for other methods of soldering surface mount devices.

**Electrical Characteristics (Note 4)**

Parameter	Conditions	Typ	MC185-1.2 MC 185BX-1.2 MC 185BY-1.2 MC 285-1.2 MC 285BX-1.2 MC.285BY-1.2		MC 385B-1.2 MC385BX-1.2 MC 385BY-1.2		MC 385-1.2		Units (Limit)
			Tested Limit (Notes 5, 8)	Design Limit (Note 6)	Tested Limit (Note 5)	Design Limit (Note 6)	Tested Limit (Note 5)	Design Limit (Note 6)	
Reverse Breakdown Voltage	$T_A = 25^\circ\text{C}$ , $10\mu\text{A} \leq I_R \leq 20\text{mA}$	1.23 5	1.223		1.223		1.205		V(Min)
			1.247		1.247		1.260		V(Max)
Minimum Operating Current	LM385M3-1.2	8	10	20	15	20	15	20	$\mu\text{A}$ (Max)
Reverse Breakdown Voltage Change with Current	$10\mu\text{A} \leq I_R \leq 1\text{mA}$		1	1.5	1	1.5	1	1.5	mV (Max)
	$1\text{mA} \leq I_R \leq 20\text{mA}$		10	20	20	25	20	25	mV (Max)
Reverse Dynamic Impedance	$I_R = 100\mu\text{A}$ , $f = 20\text{Hz}$	1							$\Omega$
Wideband Noise (rms)	$I_R = 100\mu\text{A}$ , $10\text{Hz} \leq f \leq 10\text{kHz}$	60							$\mu\text{V}$
Long Term Stability	$I_R = 100\mu\text{A}$ , $T = 1000\text{Hr}$ , $T_A = 25^\circ\text{C} \pm 0.1^\circ\text{C}$	20							ppm
Average Temperature Coefficient (Note 7)	$I_R = 100\mu\text{A}$ X Suffix Y Suffix All Others		30 50		30 50		150	150	ppm/ $^\circ\text{C}$ ppm/ $^\circ\text{C}$ ppm/ $^\circ\text{C}$ (Max)

# MC285\_1.2&MC385\_1.2

**Note 1:** Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be 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.

**Note 2:** Refer to RETS185H-1.2 for military specifications.

**Note 3:** For elevated temperature operation, Tj max is:

LM185 150° C

MC285 125° C

MC385 100° C

Thermal Resistance	TO-92	TO-46	S0-8	SOT23
$\theta_{JA}$ (junction to ambient)	180°C/W (0.4 leads) 170°C/W (0.125 leads)	440°C/W	165°C/W	283°C/W
$\theta_{JC}$ (junction to case)	N/A	80°C/W	N/A	N/A

**Note 4:** Parameters identified with boldface type apply at temperature extremes. All other numbers apply at TA = TJ = 25° C.

**Note 5:** Guaranteed and 100% production tested.

**Note 6:** Guaranteed, but not 100% production tested. These limits are not used to calculate average outgoing quality levels.

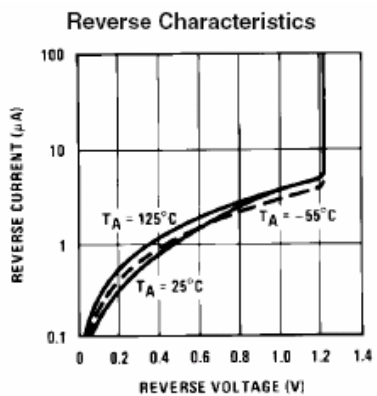
**Note 7:** The average temperature coefficient is defined as the maximum deviation of reference voltage at all measured temperatures between the operating

TMAX and TMIN, divided by TMAX – TMIN. The measured temperatures are -55° C, -40° C, 0° C, 25° C, 70° C, 85° C, 125° C.

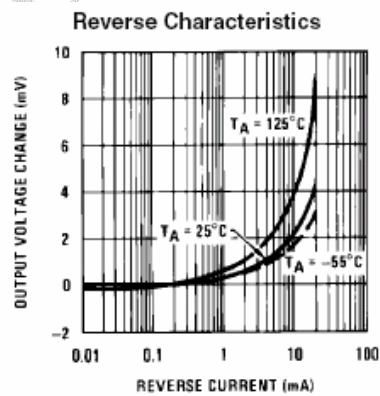
**Note 8:** A military RETS electrical specification is available on request.

**Note 9:** The human body model is a 100 pF capacitor discharged through a 1.5 k resistor into each pin.

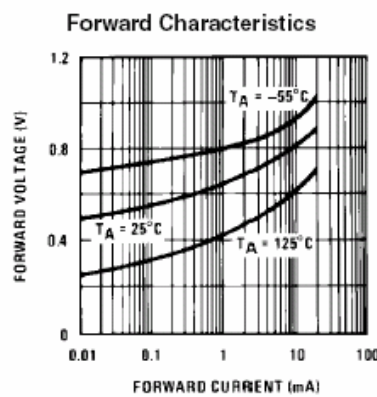
## Typical Performance Characteristics



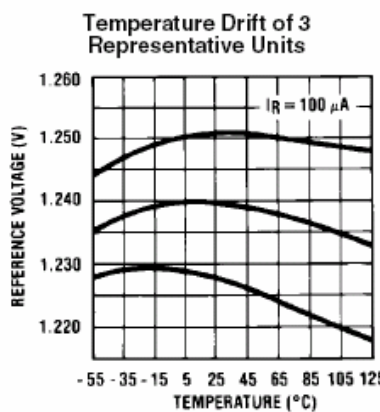
551813



551814



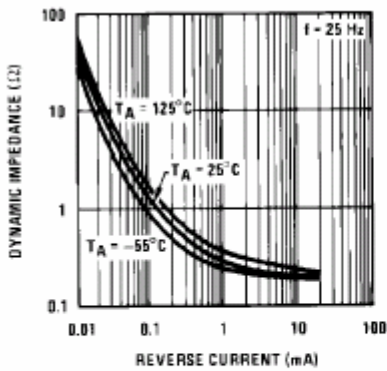
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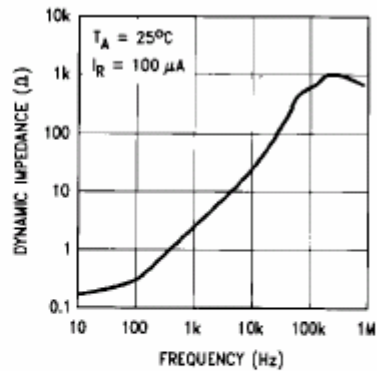
# MC285\_1.2 & MC385\_1.2

Reverse Dynamic Impedance



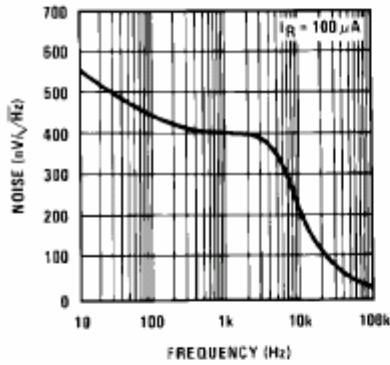
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Reverse Dynamic Impedance



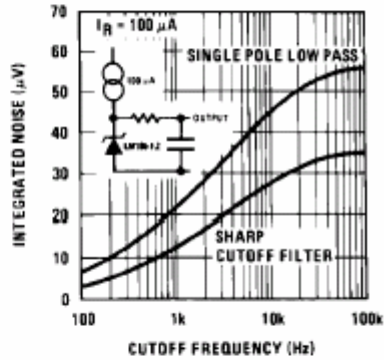
551818

Noise Voltage



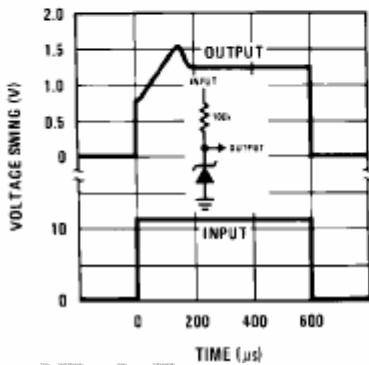
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Filtered Output Noise



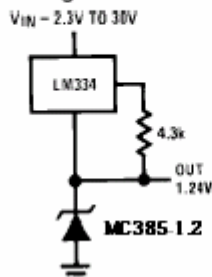
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Response Time

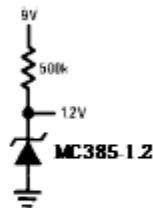


## Typical Applications

Wide Input Range Reference



Micropower Reference from 9V Battery



551822

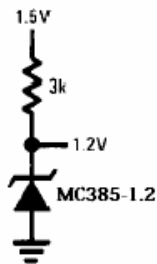
Reference from

# MC285\_1.2 & MC385\_1.2

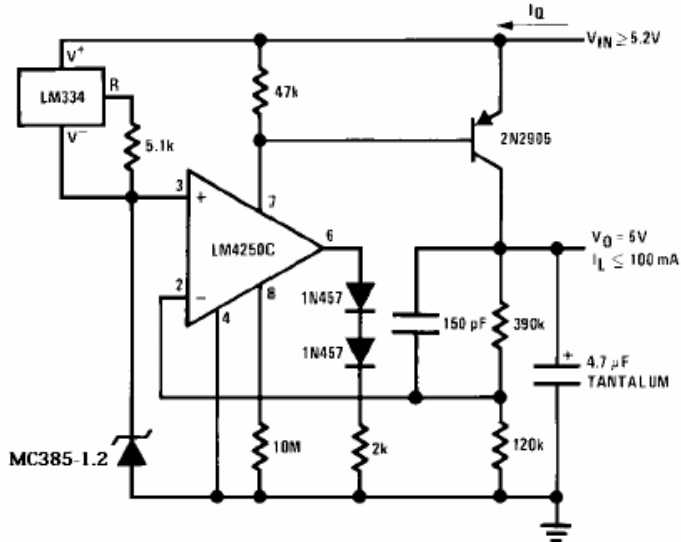
\*I<sub>Q</sub> ≈ 20μA standby current

## Precision 1μA to 1mA Current Sources

### 1.5V Battery

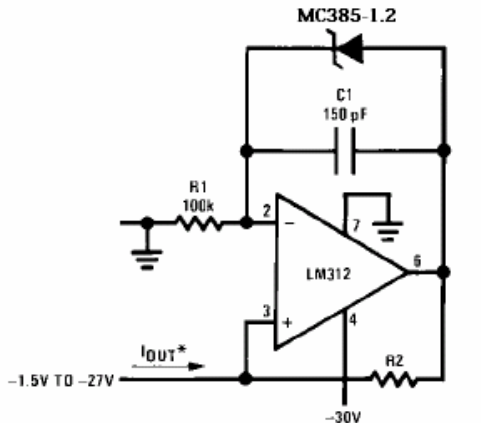
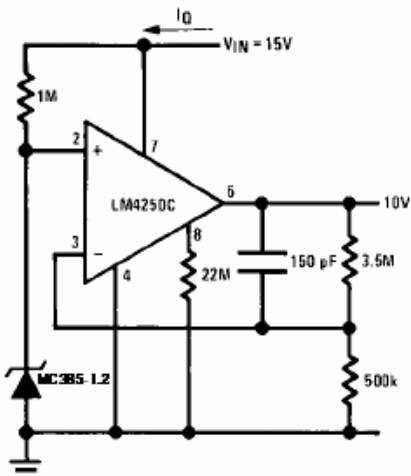


### Micropower\* 5V Regulator

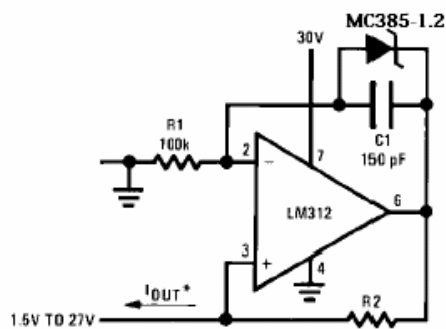


\*I<sub>Q</sub> ≈ 30μA

### Micropower\* 10V Reference



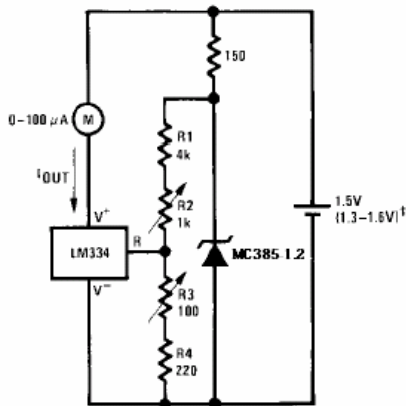
$$*I_{OUT} = \frac{1.23V}{R2}$$



# MC285\_1.2 & MC385\_1.2

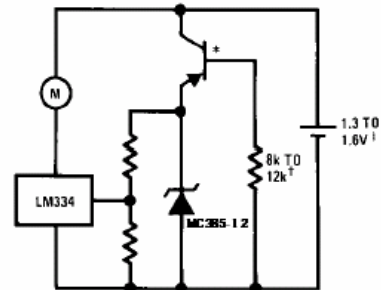
## METER THERMOMETERS

### 0°C–100°C Thermometer



$I_Q$  at 1.3V 500 $\mu$ A  
 $I_Q$  at 1.6V 2.4mA

### Lower Power Thermometer



\*2N3638 or 2N2907 select for inverse  $H_{FE}$  5

†Select for operation at 1.3V

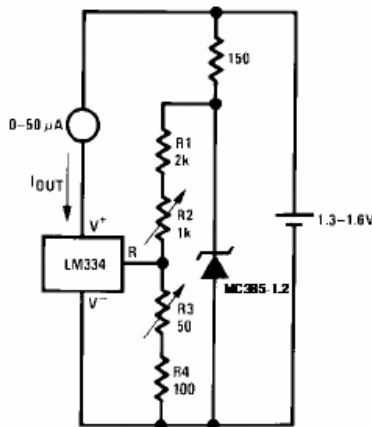
‡ $I_Q$  = 600 $\mu$ A to 900 $\mu$ A

### Calibration

1. Short MC385-1.2, adjust R3 for  $I_{OUT}$  = temp at 1 $\mu$ A/ $^{\circ}$ K
2. Remove short, adjust R2 for correct reading in centigrade

1. Adjust TC ADJ pot until voltage across R1 equals Kelvin temperature multiplied by the thermocouple Seebeck coefficient.
2. Adjust zero ADJ pot until voltage across R2 equals the thermocouple Seebeck coefficient multiplied by 273.2.

### 0°F–50°F Thermometer



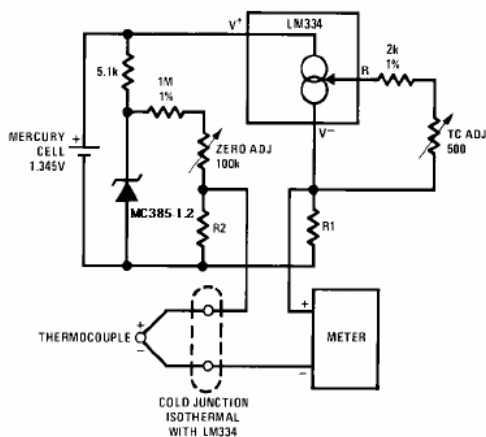
### Calibration

1. Short MC385-1.2, adjust R3 for  $I_{OUT}$  = temp at 1.8  $\mu$  A/ $^{\circ}$  K
2. Remove short, adjust R2 for correct reading in  $^{\circ}$  F

Typical supply current 50 $\mu$ A

Thermocouple Type	Seebeck Coefficient ( $\mu$ V/ $^{\circ}$ C)	R1 ( $\Omega$ )	R2 ( $\Omega$ )	Voltage Across R1 @ 25 $^{\circ}$ C (mV)	Voltage Across R2 (mV)
J	52.3	52	1.2 3 4k	15.60	14.32
T	42.8	43	1k 2	12.77	11.78
K	40.8	41	95 2 3 $\Omega$	12.17	11.17
S	6.4	63.	15 4 0 $\Omega$	1.908	1.766

### Micropower Thermocouple Cold Junction Compensator

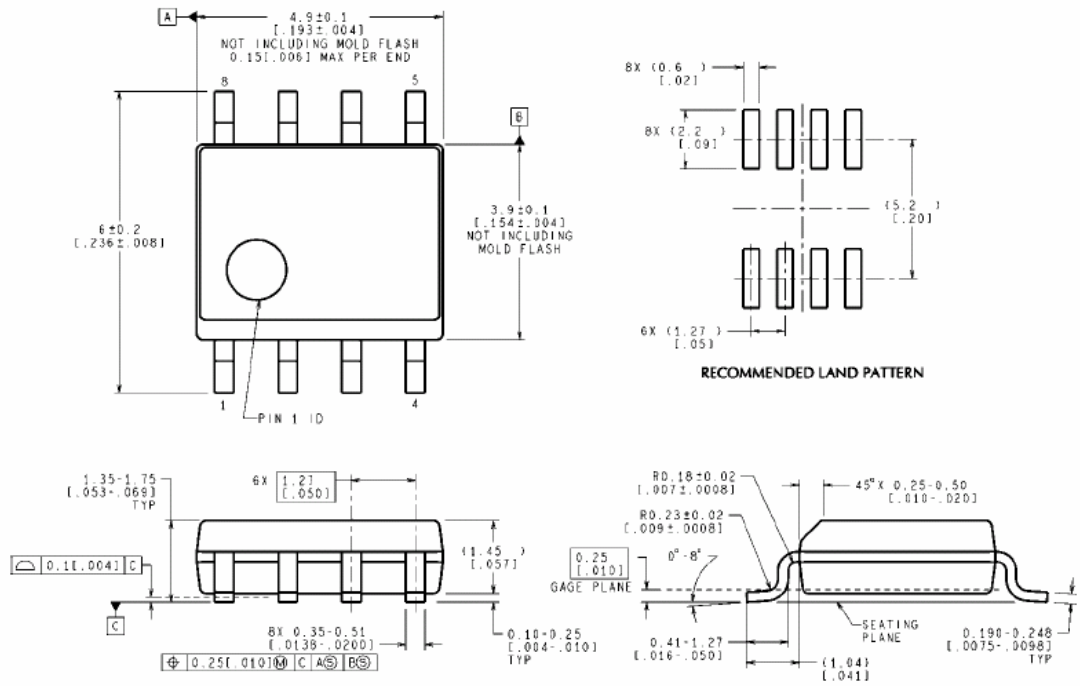








# MC285\_1.2&MC385\_1.2



CONTROLLING DIMENSION IS MILLIMETER  
VALUES IN [ ] ARE INCHES  
DIMENSIONS IN ( ) FOR REFERENCE ONLY

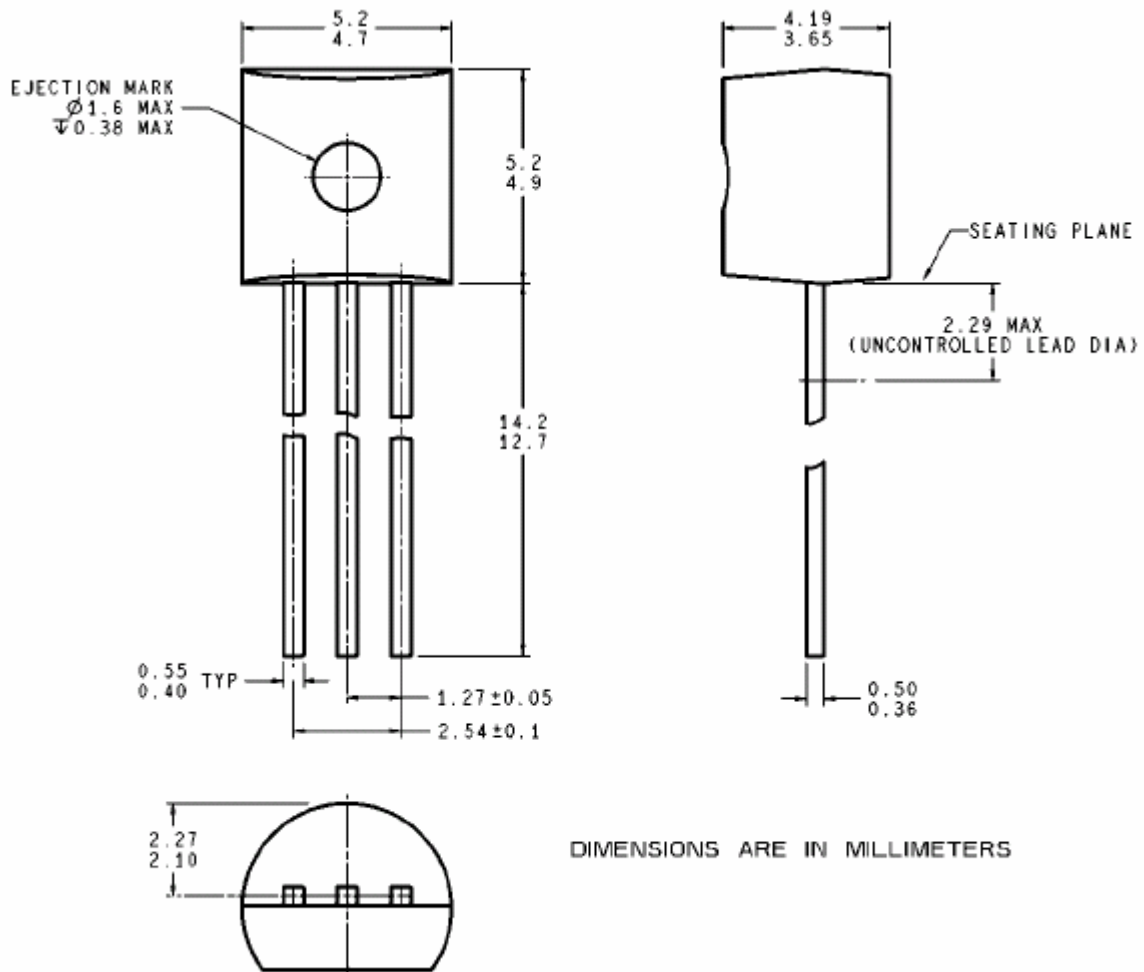
M08A (Rev L)

Small Outline (SO-8) Package

Order Number MC285M -1.2, MC285BXM -1.2, MC285BYM -1.2

MC385M -1.2, MC385BM -1.2, MC385BXM -1.2, MC385BYM -1.2

NS Package Number M08A



DIMENSIONS ARE IN MILLIMETERS

TO - 92 Plastic Package (Z)

Order Number MC285Z - 1.2, MC285BXZ - 1.2

MC285BYZ - 1.2, MC385Z - 1.2, MC385BZ - 1.2

MC385BXZ - 1.2 or MC385BYZ - 1.2

NS Package Number Z03A