

LM285, LM385B

Micropower Voltage Reference Diodes

The LM285/LM385 series are micropower two-terminal bandgap voltage regulator diodes. Designed to operate over a wide current range of 10 μA to 20 mA, these devices feature exceptionally low dynamic impedance, low noise and stable operation over time and temperature. Tight voltage tolerances are achieved by on-chip trimming. The large dynamic operating range enables these devices to be used in applications with widely varying supplies with excellent regulation. Extremely low operating current make these devices ideal for micropower circuitry like portable instrumentation, regulators and other analog circuitry where extended battery life is required.

The LM285/LM385 series are packaged in a low cost TO-226 plastic case and are available in two voltage versions of 1.235 V and 2.500 V as denoted by the device suffix (see Ordering Information table). The LM285 is specified over a -40°C to $+85^{\circ}\text{C}$ temperature range while the LM385 is rated from 0°C to $+70^{\circ}\text{C}$.

The LM385 is also available in a surface mount plastic package in voltages of 1.235 V and 2.500 V.

Features

- Operating Current from 10 μA to 20 mA
- 1.0%, 1.5%, 2.0% and 3.0% Initial Tolerance Grades
- Low Temperature Coefficient
- 1.0 Ω Dynamic Impedance
- Surface Mount Package Available
- These Devices are Pb-Free and are RoHS Compliant

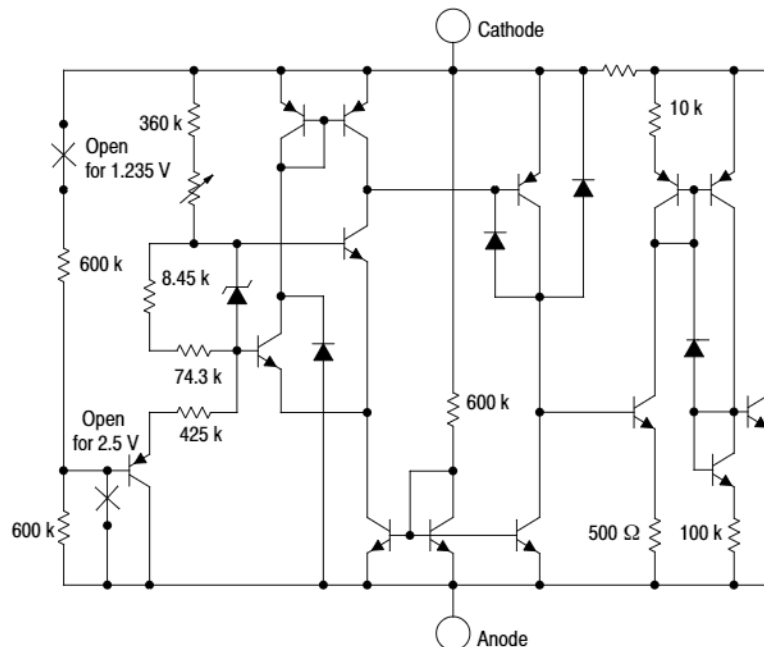


Figure 1. Representative Schematic Diagram



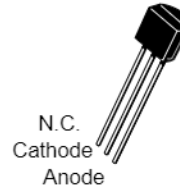
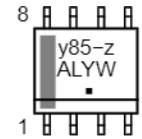
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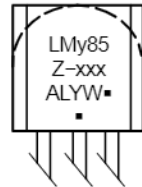
MARKING DIAGRAMS



SOIC-8
D SUFFIX
CASE 751

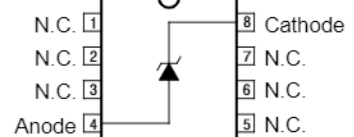
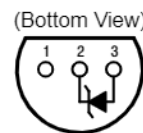


TO-92
(TO-226)
Z SUFFIX
CASE 29

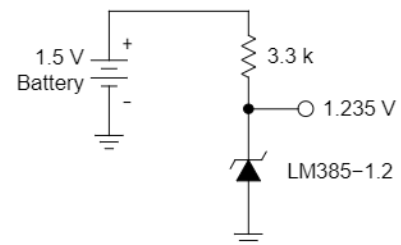


- xxx = 1.2 or 2.5
- y = 2 or 3
- z = 1 or 2
- A = Assembly Location
- L = Wafer Lot
- Y = Year
- W = Work Week
- = Pb-Free Package

(Note: Microdot may be in either location)



Standard Application



ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 6 of this data sheet.

LM285, LM385B

MAXIMUM RATINGS ($T_A = 25^\circ\text{C}$, unless otherwise noted)

Rating	Symbol	Value	Unit
Reverse Current	I_R	30	mA
Forward Current	I_F	10	mA
Operating Ambient Temperature Range	T_A	-40 to +85 0 to +70	$^\circ\text{C}$
Operating Junction Temperature	T_J	+150	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150	$^\circ\text{C}$
Electrostatic Discharge Sensitivity (ESD) Human Body Model (HBM) Machine Model (MM) Charged Device Model (CDM)	ESD	4000 400 2000	V

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$, unless otherwise noted)

Characteristic	Symbol	LM285-1.2			LM385-1.2/LM385B-1.2			Unit
		Min	Typ	Max	Min	Typ	Max	
Reverse Breakdown Voltage ($I_{R\text{min}} \leq I_R \leq 20 \text{ mA}$) LM285-1.2/LM385B-1.2 $T_A = T_{\text{low}}$ to T_{high} (Note 1) LM385-1.2 $T_A = T_{\text{low}}$ to T_{high} (Note 1)	$V_{(\text{BR})R}$	1.223 1.200 - -	1.235 - - -	1.247 1.270 - -	1.223 1.210 1.205 1.192	1.235 - 1.235 -	1.247 1.260 1.260 1.273	V
Minimum Operating Current $T_A = 25^\circ\text{C}$ $T_A = T_{\text{low}}$ to T_{high} (Note 1)	$I_{R\text{min}}$	- -	8.0 -	10 20	- -	8.0 -	15 20	μA
Reverse Breakdown Voltage Change with Current $I_{R\text{min}} \leq I_R \leq 1.0 \text{ mA}$, $T_A = +25^\circ\text{C}$ $T_A = T_{\text{low}}$ to T_{high} (Note 1) $1.0 \text{ mA} \leq I_R \leq 20 \text{ mA}$, $T_A = +25^\circ\text{C}$ $T_A = T_{\text{low}}$ to T_{high} (Note 1)	$\Delta V_{(\text{BR})R}$	- - - -	- - - -	1.0 1.5 10 20	- - - -	- - - -	1.0 1.5 20 25	mV
Reverse Dynamic Impedance $I_R = 100 \mu\text{A}$, $T_A = +25^\circ\text{C}$	Z	-	0.6	-	-	0.6	-	Ω
Average Temperature Coefficient $10 \mu\text{A} \leq I_R \leq 20 \text{ mA}$, $T_A = T_{\text{low}}$ to T_{high} (Note 1)	$\Delta V_{(\text{BR})R}/\Delta T$	-	80	-	-	80	-	ppm/ $^\circ\text{C}$
Wideband Noise (RMS) $I_R = 100 \mu\text{A}$, $10 \text{ Hz} \leq f \leq 10 \text{ kHz}$	n	-	60	-	-	60	-	μV
Long Term Stability $I_R = 100 \mu\text{A}$, $T_A = +25^\circ\text{C} \pm 0.1^\circ\text{C}$	S	-	20	-	-	20	-	ppm/kHR
Reverse Breakdown Voltage ($I_{R\text{min}} \leq I_R \leq 20 \text{ mA}$) LM285-2.5/LM385B-2.5 $T_A = T_{\text{low}}$ to T_{high} (Note 1) LM385-2.5 $T_A = T_{\text{low}}$ to T_{high} (Note 1)	$V_{(\text{BR})R}$	2.462 2.415 - -	2.5 - - -	2.538 2.585 - -	2.462 2.436 2.425 2.400	2.5 - 2.5 -	2.538 2.564 2.575 2.600	V
Minimum Operating Current $T_A = 25^\circ\text{C}$ $T_A = T_{\text{low}}$ to T_{high} (Note 1)	$I_{R\text{min}}$	- -	13 -	20 30	- -	13 -	20 30	μA

1. $T_{\text{low}} = -40^\circ\text{C}$ for LM285-1.2, LM285-2.5
 $T_{\text{high}} = +85^\circ\text{C}$ for LM285-1.2, LM285-2.5
 $T_{\text{low}} = 0^\circ\text{C}$ for LM385-1.2, LM385B-1.2, LM385-2.5, LM385B-2.5
 $T_{\text{high}} = +70^\circ\text{C}$ for LM385-1.2, LM385B-1.2, LM385-2.5, LM385B-2.5

LM285, LM385B

ELECTRICAL CHARACTERISTICS ($T_A = 25^\circ\text{C}$, unless otherwise noted)

Characteristic	Symbol	LM285-1.2			LM385-1.2/LM385B-1.2			Unit
		Min	Typ	Max	Min	Typ	Max	
Reverse Breakdown Voltage Change with Current $I_{Rmin} \leq I_R \leq 1.0 \text{ mA}$, $T_A = +25^\circ\text{C}$ $T_A = T_{low}$ to T_{high} (Note 2) $1.0 \text{ mA} \leq I_R \leq 20 \text{ mA}$, $T_A = +25^\circ\text{C}$ $T_A = T_{low}$ to T_{high} (Note 2)	$\Delta V_{(BR)R}$	-	-	1.0	-	-	2.0	mV
		-	-	1.5	-	-	2.5	
		-	-	10	-	-	20	
		-	-	20	-	-	25	
Reverse Dynamic Impedance $I_R = 100 \mu\text{A}$, $T_A = +25^\circ\text{C}$	Z	-	0.6	-	-	0.6	-	Ω
Average Temperature Coefficient $20 \mu\text{A} \leq I_R \leq 20 \text{ mA}$, $T_A = T_{low}$ to T_{high} (Note 2)	$\Delta V_{(BR)}/\Delta T$	-	80	-	-	80	-	ppm/ $^\circ\text{C}$
Wideband Noise (RMS) $I_R = 100 \mu\text{A}$, $10 \text{ Hz} \leq f \leq 10 \text{ kHz}$	n	-	120	-	-	120	-	μV
Long Term Stability $I_R = 100 \mu\text{A}$, $T_A = +25^\circ\text{C} \pm 0.1^\circ\text{C}$	S	-	20	-	-	20	-	ppm/kHR

2. $T_{low} = -40^\circ\text{C}$ for LM285-1.2, LM285-2.5
 $T_{high} = +85^\circ\text{C}$ for LM285-1.2, LM285-2.5
 $T_{low} = 0^\circ\text{C}$ for LM385-1.2, LM385B-1.2, LM385-2.5, LM385B-2.5
 $T_{high} = +70^\circ\text{C}$ for LM385-1.2, LM385B-1.2, LM385-2.5, LM385B-2.5

LM285, LM385B

TYPICAL PERFORMANCE CURVES FOR LM285-1.2/385-1.2/385B-1.2

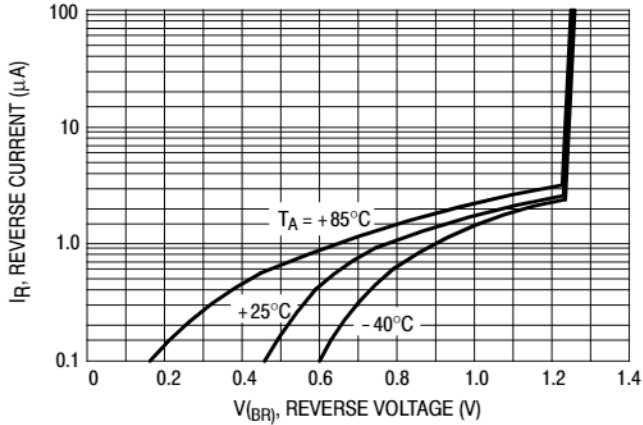


Figure 2. Reverse Characteristics

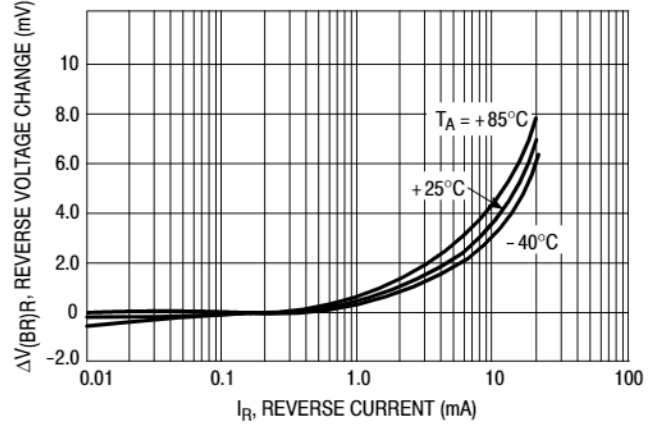


Figure 3. Reverse Characteristics

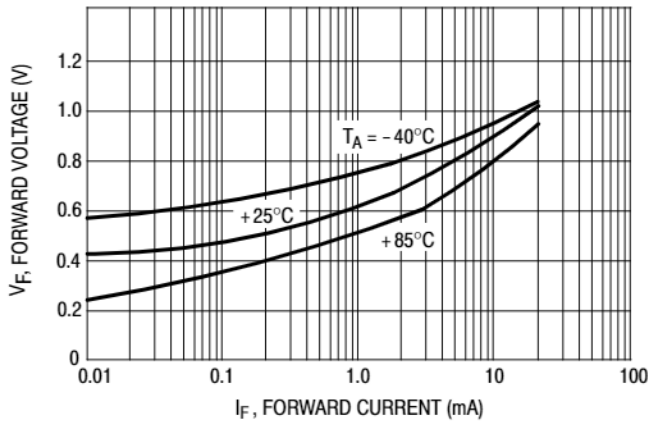


Figure 4. Forward Characteristics

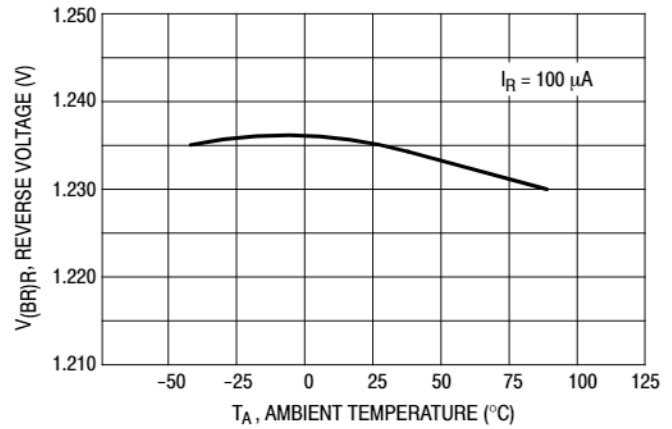


Figure 5. Temperature Drift

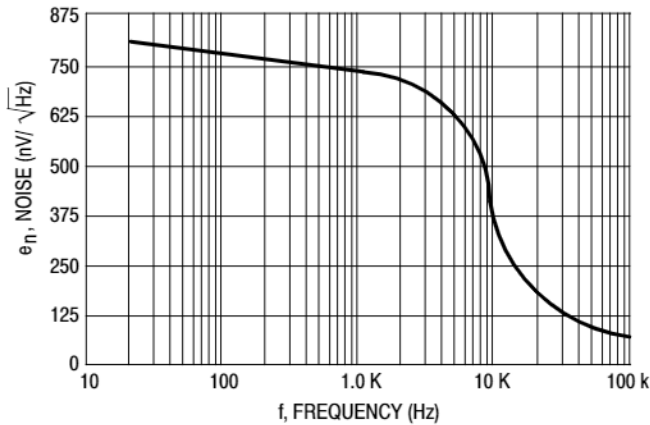


Figure 6. Noise Voltage

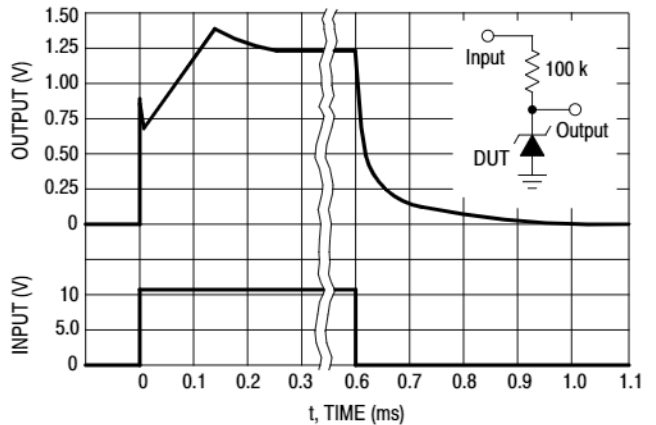


Figure 7. Response Time

LM285, LM385B

TYPICAL PERFORMANCE CURVES FOR LM285-2.5/385-2.5/385B-2.5

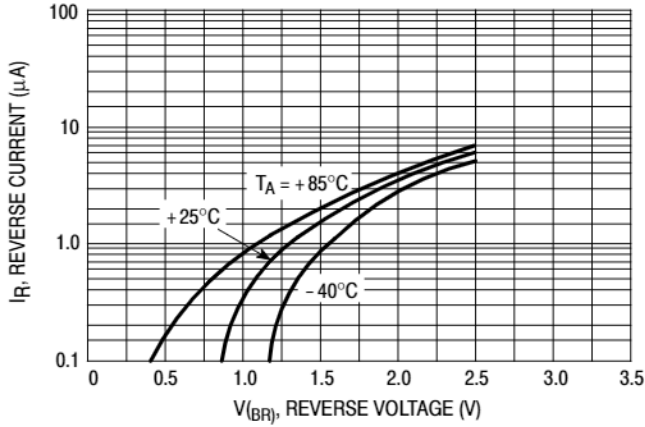


Figure 8. Reverse Characteristics

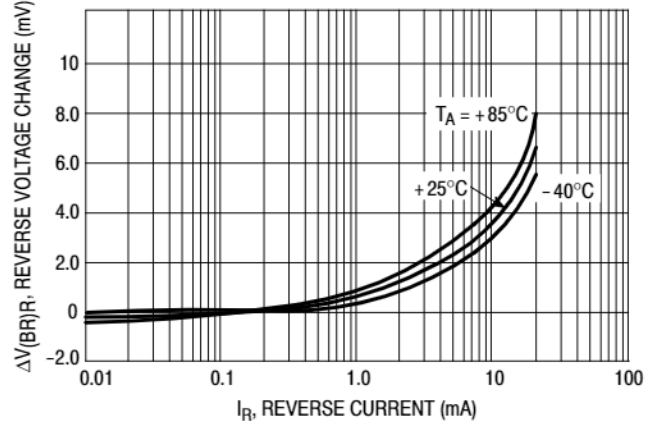


Figure 9. Reverse Characteristics

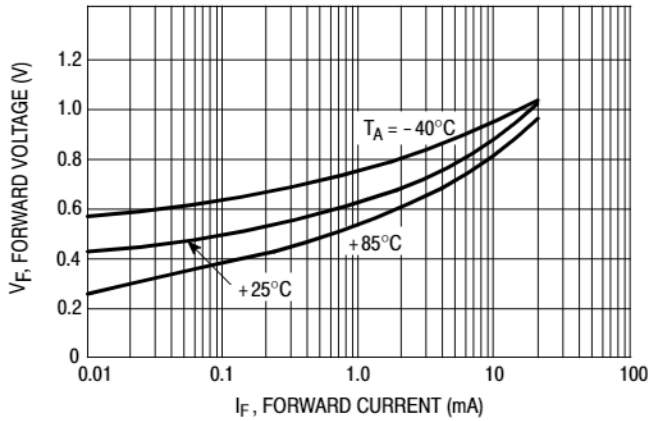


Figure 10. Forward Characteristics

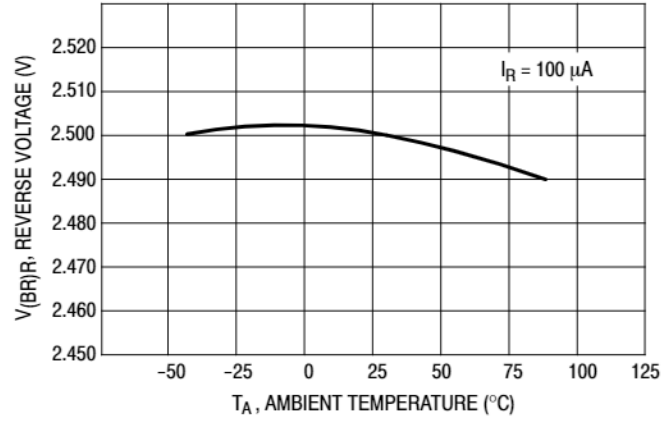


Figure 11. Temperature Drift

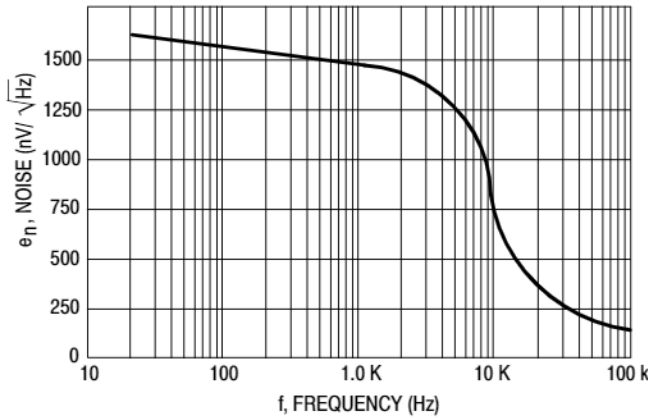


Figure 12. Noise Voltage

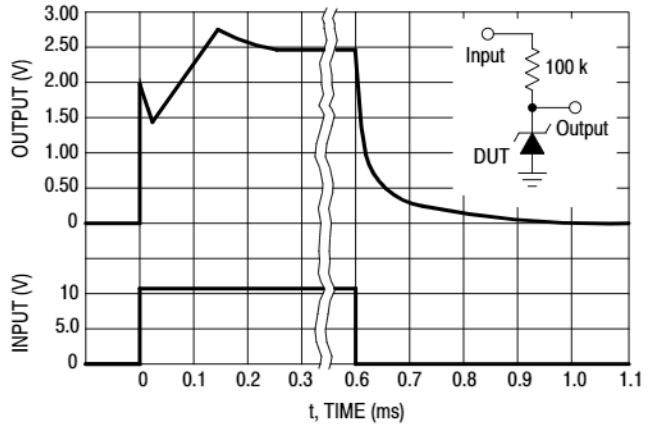


Figure 13. Response Time

LM285, LM385B

ORDERING INFORMATION

Device	Operating Temperature Range	Reverse Break-Down Voltage	Package	Shipping [†]	
LM285D-1.2	T _A = -40°C to +85°C	1.235 V	SOIC-8	98 Units / Rail	
LM285D-1.2G			SOIC-8 (Pb-Free)	98 Units / Rail	
LM285D-1.2R2			SOIC-8	2500 / Tape & Reel	
LM285D-1.2R2G			SOIC-8 (Pb-Free)	2500 / Tape & Reel	
LM285D-2.5		2.500 V	SOIC-8	98 Units / Rail	
LM285D-2.5G			SOIC-8 (Pb-Free)	98 Units / Rail	
LM285D-2.5R2			SOIC-8	2500 / Tape & Reel	
LM285D-2.5R2G			SOIC-8 (Pb-Free)	2500 / Tape & Reel	
LM285Z-1.2		T _A = -40°C to +85°C	1.235 V	TO-92	2000 Units / Bag
LM285Z-1.2G				TO-92 (Pb-Free)	2000 Units / Bag
LM285Z-2.5			2.500 V	TO-92	2000 Units / Bag
LM285Z-2.5G				TO-92 (Pb-Free)	2000 Units / Bag
LM285Z-1.2RA			1.235 V	TO-92	2000 / Tape & Reel
LM285Z-1.2RAG				TO-92 (Pb-Free)	2000 / Tape & Reel
LM285Z-2.5RA			2.500 V	TO-92	2000 / Tape & Reel
LM285Z-2.5RAG				TO-92 (Pb-Free)	2000 / Tape & Reel
LM285Z-2.5RP	TO-92			2000 Units / Fan-Fold	
LM285Z-2.5RPG	TO-92 (Pb-Free)			2000 Units / Fan-Fold	
LM385BD-1.2	T _A = 0°C to +70°C		1.235 V	SOIC-8	98 Units / Rail
LM385BD-1.2G				SOIC-8 (Pb-Free)	98 Units / Rail
LM385BD-1.2R2				SOIC-8	2500 / Tape & Reel
LM385BD-1.2R2G				SOIC-8 (Pb-Free)	2500 / Tape & Reel
LM385BD-2.5			2.500 V	SOIC-8	98 Units / Rail
LM385BD-2.5G				SOIC-8 (Pb-Free)	98 Units / Rail
LM385BD-2.5R2		SOIC-8		2500 / Tape & Reel	
LM385BD-2.5R2G		SOIC-8 (Pb-Free)		2500 / Tape & Reel	
LM385BZ-1.2		1.235 V	TO-92	2000 Units / Bag	
LM385BZ-1.2G			TO-92 (Pb-Free)	2000 Units / Bag	
LM385BZ-1.2RA			TO-92	2000 / Tape & Reel	
LM385BZ-1.2RAG			TO-92 (Pb-Free)	2000 / Tape & Reel	

[†]For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

LM285, LM385B

ORDERING INFORMATION

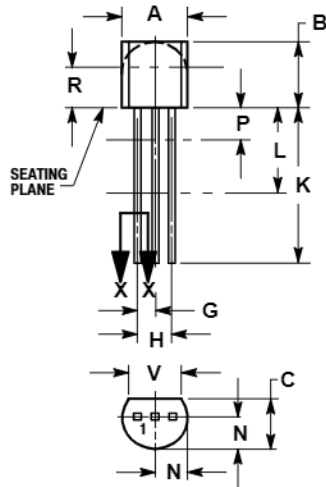
Device	Operating Temperature Range	Reverse Break-Down Voltage	Package	Shipping†			
LM385BZ-2.5	$T_A = 0^{\circ}\text{C}$ to $+70^{\circ}\text{C}$	2.500 V	TO-92	2000 Units / Bag			
LM385BZ-2.5G			TO-92 (Pb-Free)	2000 Units / Bag			
LM385BZ-2.5RA			TO-92	2000 / Tape & Reel			
LM385BZ-2.5RAG			TO-92 (Pb-Free)	2000 / Tape & Reel			
LM385D-1.2		1.235 V	1.235 V	SOIC-8	98 Units / Rail		
LM385D-1.2G				SOIC-8 (Pb-Free)	98 Units / Rail		
LM385D-1.2R2				SOIC-8	2500 / Tape & Reel		
LM385D-1.2R2G				SOIC-8 (Pb-Free)	2500 / Tape & Reel		
LM385D-2.5		2.500 V	2.500 V	SOIC-8	98 Units / Rail		
LM385D-2.5G				SOIC-8 (Pb-Free)	98 Units / Rail		
LM385D-2.5R2				SOIC-8	2500 / Tape & Reel		
LM385D-2.5R2G				SOIC-8 (Pb-Free)	2500 / Tape & Reel		
LM385Z-1.2		1.235 V	1.235 V	TO-92	2000 Units / Bag		
LM385Z-1.2G				TO-92 (Pb-Free)	2000 Units / Bag		
LM385Z-1.2RA				TO-92	2000 / Tape & Reel		
LM385Z-1.2RAG				TO-92 (Pb-Free)	2000 / Tape & Reel		
LM385Z-1.2RP				TO-92	2000 / Ammo Box		
LM385Z-1.2RPG				TO-92 (Pb-Free)	2000 / Ammo Box		
LM385Z-2.5				2.500 V	2.500 V	TO-92	2000 Units / Bag
LM385Z-2.5G						TO-92 (Pb-Free)	2000 Units / Bag
LM385Z-2.5RP	TO-92	2000 / Ammo Box					
LM385Z-2.5RPG	TO-92 (Pb-Free)	2000 / Ammo Box					

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

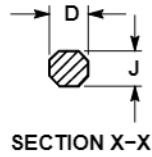
LM285, LM385B

PACKAGE DIMENSIONS

TO-92 (TO-226)
CASE 29-11
ISSUE AM



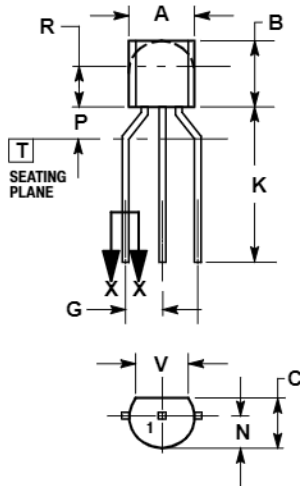
STRAIGHT LEAD
BULK PACK



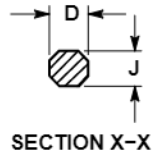
NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
4. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.175	0.205	4.45	5.20
B	0.170	0.210	4.32	5.33
C	0.125	0.165	3.18	4.19
D	0.016	0.021	0.407	0.533
G	0.045	0.055	1.15	1.39
H	0.095	0.105	2.42	2.66
J	0.015	0.020	0.39	0.50
K	0.500	---	12.70	---
L	0.250	---	6.35	---
N	0.080	0.105	2.04	2.66
P	---	0.100	---	2.54
R	0.115	---	2.93	---
V	0.135	---	3.43	---



BENT LEAD
TAPE & REEL
AMMO PACK



NOTES:

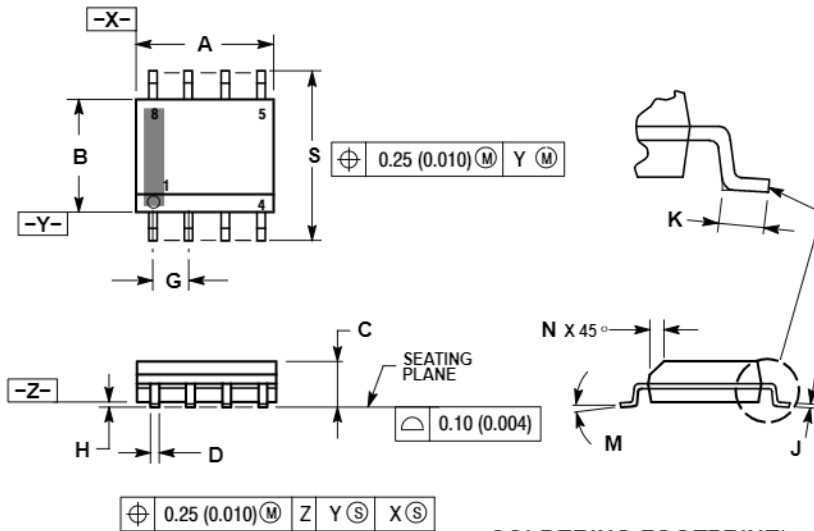
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2. CONTROLLING DIMENSION: MILLIMETERS.
3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
4. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

DIM	MILLIMETERS	
	MIN	MAX
A	4.45	5.20
B	4.32	5.33
C	3.18	4.19
D	0.40	0.54
G	2.40	2.80
J	0.39	0.50
K	12.70	---
N	2.04	2.66
P	1.50	4.00
R	2.93	---
V	3.43	---

LM285, LM385B

PACKAGE DIMENSIONS

SOIC-8 NB
CASE 751-07
ISSUE AK

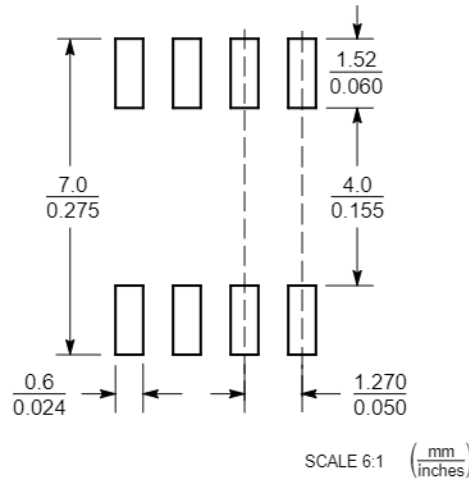


NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. 751-01 THRU 751-06 ARE OBSOLETE. NEW STANDARD IS 751-07.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.80	5.00	0.189	0.197
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.053	0.069
D	0.33	0.51	0.013	0.020
G	1.27 BSC		0.050 BSC	
H	0.10	0.25	0.004	0.010
J	0.19	0.25	0.007	0.010
K	0.40	1.27	0.016	0.050
M	0°	8°	0°	8°
N	0.25	0.50	0.010	0.020
S	5.80	6.20	0.228	0.244

SOLDERING FOOTPRINT*



*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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