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 μ A 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 $+85^{\circ}$ C temperature range while the LM385 is rated from 0° C to $+70^{\circ}$ 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

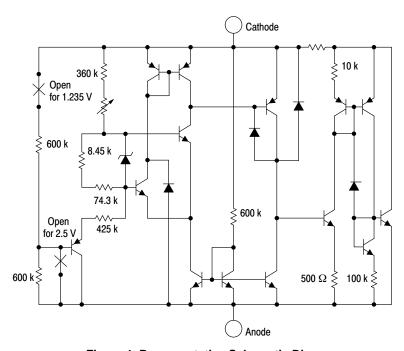


Figure 1. Representative Schematic Diagram



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MARKING DIAGRAMS

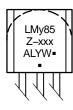


SOIC-8 D SUFFIX CASE 751





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



xxx = 1.2 or 2.5

y = 2 or 3z = 1 or 2

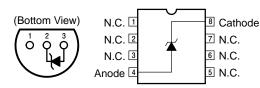
A = Assembly Location

L = Wafer Lot Y = Year

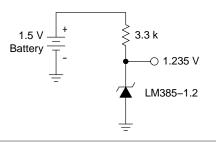
W = Work Week

■ = 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.

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

Rating	Symbol	Value	Unit
Reverse Current	I _R	30	mA
Forward Current	I _F	10	mA
Operating Ambient Temperature Range LM285 LM385	T _A	-40 to +85 0 to +70	°C
Operating Junction Temperature	TJ	+150	°C
Storage Temperature Range	T _{stg}	-65 to + 150	°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°C, unless otherwise noted)

		LM285-1.2		LM385-1.2/LM385B-1.2				
Characteristic	Symbol	Min	Тур	Max	Min	Тур	Max	Unit
$\label{eq:Reverse Breakdown Voltage} \begin{split} \text{Reverse Breakdown Voltage} & (I_{Rmin} \leq I_{R} \leq 20 \text{ mA}) \\ \text{LM2851.2/LM385B1.2} \\ \text{T}_{A} = \text{T}_{low} \text{ to T}_{high} \text{ (Note 1)} \\ \text{LM3851.2} \\ \text{T}_{A} = \text{T}_{low} \text{ to T}_{high} \text{ (Note 1)} \end{split}$	V _{(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 $T_A = 25^{\circ}C$ $T_A = T_{low}$ to T_{high} (Note 1)	I _{Rmin}	- -	8.0 –	10 20	-	8.0 -	15 20	μΑ
Reverse Breakdown Voltage Change with Current $I_{Rmin} \leq I_R \leq 1.0$ mA, $T_A = +25^{\circ}C$ $T_A = T_{low}$ to T_{high} (Note 1) 1.0 mA $\leq I_R \leq 20$ mA, $T_A = +25^{\circ}C$ $T_A = T_{low}$ to T_{high} (Note 1)	$\Delta V_{(BR)R}$	- - - -	- - - -	1.0 1.5 10 20	- - - -	- - - -	1.0 1.5 20 25	mV
Reverse Dynamic Impedance $I_R = 100 \mu A, T_A = +25 ^{\circ} C$	Z	-	0.6	-	-	0.6	-	Ω
Average Temperature Coefficient 10 μ A \leq I _R \leq 20 mA, T _A = T _{low} to T _{high} (Note 1)	$\Delta V_{(BR)}/\Delta T$	-	80	-	-	80	-	ppm/°C
Wideband Noise (RMS) $I_R = 100 \mu A$, $10 \ Hz \le f \le 10 \ kHz$	n	-	60	-	-	60	-	μV
Long Term Stability I_R = 100 μ A, T_A = +25°C \pm 0.1°C	S	-	20	-	-	20	-	ppm/kHR
$\label{eq:Reverse Breakdown Voltage} \begin{aligned} \text{Reverse Breakdown Voltage} & (I_{Rmin} \leq I_{R} \leq 20 \text{ mA}) \\ \text{LM285-2.5/LM385B-2.5} \\ T_{A} &= T_{low} \text{ to } T_{high} \text{ (Note 1)} \\ \text{LM385-2.5} \\ T_{A} &= T_{low} \text{ to } T_{high} \text{ (Note 1)} \end{aligned}$	V _{(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 $T_A = 25^{\circ}C$ $T_A = T_{low}$ to T_{high} (Note 1)	I _{Rmin}	- -	13 -	20 30	- -	13 -	20 30	μΑ

 $[\]begin{array}{ll} T_{low} & = -40^{\circ}\text{C for LM285} - 1.2, \, \text{LM285} - 2.5 \\ T_{high} & = +85^{\circ}\text{C for LM285} - 1.2, \, \text{LM285} - 2.5 \\ T_{low} & = 0^{\circ}\text{C for LM385} - 1.2, \, \text{LM385} - 2.5, \, \text{LM385B} - 2.5 \\ T_{high} & = +70^{\circ}\text{C for LM385} - 1.2, \, \text{LM385B} - 1.2, \, \text{LM385} - 2.5, \, \text{LM385B} - 2.5 \end{array}$

ELECTRICAL CHARACTERISTICS ($T_A = 25$ °C, unless otherwise noted)

		LM285-1.2		LM385-1.2/LM385B-1.2		35B-1.2		
Characteristic	Symbol	Min	Тур	Max	Min	Тур	Max	Unit
Reverse Breakdown Voltage Change with Current $I_{Rmin} \leq I_R \leq 1.0$ mA, $T_A = +25^{\circ}C$ $T_A = T_{low}$ to T_{high} (Note 2) 1.0 mA $\leq I_R \leq 20$ mA, $T_A = +25^{\circ}C$ $T_A = T_{low}$ to T_{high} (Note 2)	$\Delta V_{(BR)R}$	- - -	- - -	1.0 1.5 10 20		- - -	2.0 2.5 20 25	mV
Reverse Dynamic Impedance $I_R = 100 \mu A, T_A = +25^{\circ}C$	Z	-	0.6	-	-	0.6	-	Ω
Average Temperature Coefficient 20 μ A \leq I _R \leq 20 mA, T _A = T _{low} to T _{high} (Note 2)	$\Delta V_{(BR)}/\Delta T$	-	80	-	1	80	-	ppm/°C
Wideband Noise (RMS) $I_R = 100 \mu A$, $10 \ Hz \le f \le 10 \ kHz$	n	- 1	120	- 1	1	120	-	μV
Long Term Stability $I_R = 100 \ \mu A, \ T_A = +25^{\circ}C \pm 0.1^{\circ}C$	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

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

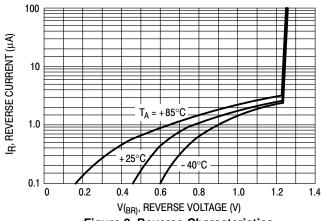


Figure 2. Reverse Characteristics

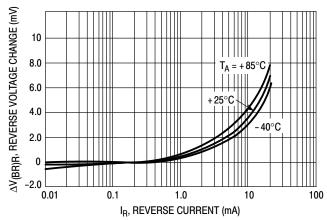


Figure 3. Reverse Characteristics

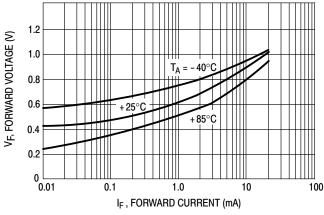


Figure 4. Forward Characteristics

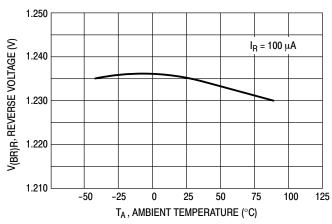


Figure 5. Temperature Drift

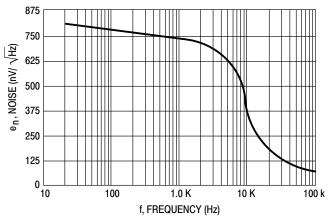


Figure 6. Noise Voltage

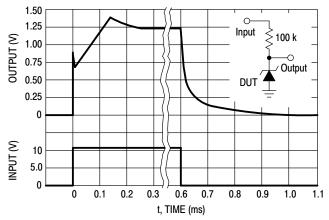


Figure 7. Response Time

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

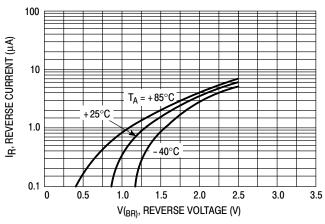
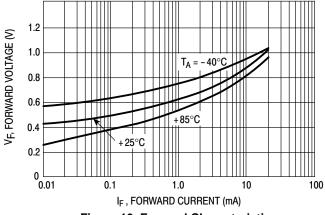


Figure 8. Reverse Characteristics

Figure 9. Reverse Characteristics



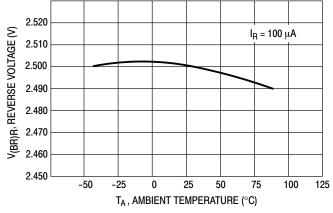
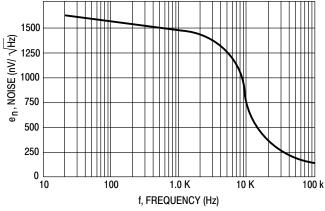


Figure 10. Forward Characteristics

Figure 11. Temperature Drift



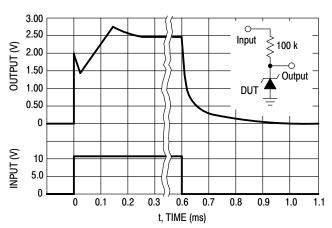


Figure 12. Noise Voltage

Figure 13. Response Time

ORDERING INFORMATION

Device	Operating Temperature Range	Reverse Break-Down Voltage	Package	Shipping [†]
LM285D-1.2			SOIC-8	98 Units / Rail
LM285D-1.2G]	4.005.1/	SOIC-8 (Pb-Free)	98 Units / Rail
LM285D-1.2R2		1.235 V	SOIC-8	2500 / Tape & Reel
LM285D-1.2R2G			SOIC-8 (Pb-Free)	2500 / Tape & Reel
LM285D-2.5			SOIC-8	98 Units / Rail
LM285D-2.5G		2 500 1/	SOIC-8 (Pb-Free)	98 Units / Rail
LM285D-2.5R2		2.500 V	SOIC-8	2500 / Tape & Reel
LM285D-2.5R2G			SOIC-8 (Pb-Free)	2500 / Tape & Reel
LM285Z-1.2			TO-92	2000 Units / Bag
LM285Z-1.2G	$T_A = -40^{\circ}\text{C to } +85^{\circ}\text{C}$	1.235 V	TO-92 (Pb-Free)	2000 Units / Bag
LM285Z-2.5			TO-92	2000 Units / Bag
LM285Z-2.5G		2.500 V	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			SOIC-8	98 Units / Rail
LM385BD-1.2G		4 005 1/	SOIC-8 (Pb-Free)	98 Units / Rail
LM385BD-1.2R2		1.235 V	SOIC-8	2500 / Tape & Reel
LM385BD-1.2R2G			SOIC-8 (Pb-Free)	2500 / Tape & Reel
LM385BD-2.5			SOIC-8	98 Units / Rail
LM385BD-2.5G	T. = 0°C to 170°C	3 500 V	SOIC-8 (Pb-Free)	98 Units / Rail
LM385BD-2.5R2	$T_A = 0^{\circ}C \text{ to } +70^{\circ}C$	2.500 V	SOIC-8	2500 / Tape & Reel
LM385BD-2.5R2G			SOIC-8 (Pb-Free)	2500 / Tape & Reel
LM385BZ-1.2			TO-92	2000 Units / Bag
LM385BZ-1.2G		1.235 V	TO-92 (Pb-Free)	2000 Units / Bag
LM385BZ-1.2RA		1.200 V	TO-92	2000 / Tape & Reel
LM385BZ-1.2RAG			TO-92 (Pb-Free)	2000 / Tape & Reel

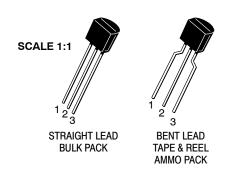
[†]For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

ORDERING INFORMATION

Device	Operating Temperature Range	Reverse Break-Down Voltage	Package	Shipping [†]
LM385BZ-2.5			TO-92	2000 Units / Bag
LM385BZ-2.5G		0.500 V	TO-92 (Pb-Free)	2000 Units / Bag
LM385BZ-2.5RA		2.500 V	TO-92	2000 / Tape & Reel
LM385BZ-2.5RAG]		TO-92 (Pb-Free)	2000 / Tape & Reel
LM385D-1.2			SOIC-8	98 Units / Rail
LM385D-1.2G]	4.005.1/	SOIC-8 (Pb-Free)	98 Units / Rail
LM385D-1.2R2		1.235 V	SOIC-8	2500 / Tape & Reel
LM385D-1.2R2G]		SOIC-8 (Pb-Free)	2500 / Tape & Reel
LM385D-2.5		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	$T_A = 0$ °C to +70°C		SOIC-8 (Pb-Free)	2500 / Tape & Reel
LM385Z-1.2		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			TO-92	2000 Units / Bag
LM385Z-2.5G		0.500.V	TO-92 (Pb-Free)	2000 Units / Bag
LM385Z-2.5RP		2.500 V	TO-92	2000 / Ammo Box
LM385Z-2.5RPG	1		TO-92 (Pb-Free)	2000 / Ammo Box

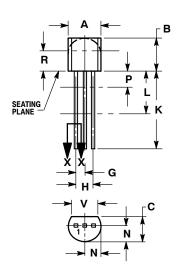
[†]For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.





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

DATE 09 MAR 2007

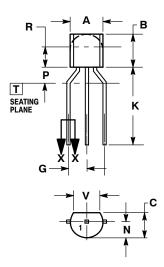


STRAIGHT LEAD **BULK PACK**



- 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.

	INC	HES	MILLIN	METERS		
DIM	MIN	MAX	MIN	MAX		
Α	0.175	0.205	4.45	5.20		
В	0.170	0.210	4.32	5.33		
С	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		
Н	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			
٧	0.135		3.43			



BENT LEAD TAPE & REEL AMMO PACK



- NOTES:
 1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
 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.

	MILLIMETERS						
DIM	MIN	MAX					
Α	4.45	5.20					
В	4.32	5.33					
С	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						

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

ISSUE AM

DATE 09 MAR 2007

STYLE 1: PIN 1. 2. 3.	EMITTER BASE COLLECTOR	STYLE 2: PIN 1. 2. 3.	BASE EMITTER COLLECTOR	STYLE 3: PIN 1. 2. 3.	ANODE ANODE CATHODE	STYLE 4: PIN 1. 2. 3.	CATHODE CATHODE ANODE	STYLE 5: PIN 1. 2. 3.	DRAIN
2.	GATE SOURCE & SUBSTRATE DRAIN	STYLE 7: PIN 1. 2. 3.	SOURCE DRAIN GATE	STYLE 8: PIN 1. 2. 3.	DRAIN GATE SOURCE & SUBSTRATE	PIN 1.	BASE 1		CATHODE
2.	ANODE CATHODE & ANODE CATHODE	STYLE 12: PIN 1. 2. 3.	MAIN TERMINAL 1 GATE MAIN TERMINAL 2	PIN 1.	ANODE 1	PIN 1.	EMITTER COLLECTOR BASE	PIN 1. 2.	
2.	ANODE GATE	PIN 1. 2.	COLLECTOR BASE	PIN 1. 2.	ANODE CATHODE	PIN 1. 2.	GATE	2.	NOT CONNECTED
2.	COLLECTOR	PIN 1. 2.	SOURCE GATE DRAIN	STYLE 23: PIN 1. 2. 3.	GATE SOURCE DRAIN	STYLE 24: PIN 1. 2. 3.	EMITTER COLLECTOR/ANODE CATHODE	STYLE 25: PIN 1. 2. 3.	MT 1 GATE
	V _{CC}	PIN 1. 2.	MT	STYLE 28: PIN 1. 2.	CATHODE ANODE GATE	STYLE 29: PIN 1. 2.		PIN 1. 2.	DRAIN
	GATE	PIN 1. 2.		STYLE 33: PIN 1. 2. 3.	RETURN	2.			

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08 A S R / 2022	R

PAGE 3 OF 3

ISSUE	REVISION	DATE
AM	ADDED BENT-LEAD TAPE & REEL VERSION. REQ. BY J. SUPINA.	09 MAR 2007

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SOIC-8 NB CASE 751-07 **ISSUE AK**

DATE 16 FEB 2011



- NOTES:
 1. DIMENSIONING AND TOLERANCING PER
- ANSI Y14.5M, 1982.
 CONTROLLING DIMENSION: MILLIMETER.
- DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
- MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE
- 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.
- 751-01 THRU 751-06 ARE OBSOLETE. NEW STANDARD IS 751-07.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
Α	4.80	5.00	0.189	0.197
В	3.80	4.00	0.150	0.157
С	1.35	1.75	0.053	0.069
D	0.33	0.51	0.013	0.020
G	1.27 BSC		0.050 BSC	
Н	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
М	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.

GENERIC MARKING DIAGRAM*



XXXXX = Specific Device Code = Assembly Location

= Wafer Lot = Year = Work Week

= Pb-Free Package



XXXXXX = Specific Device Code = Assembly Location Α

= Year ww = Work Week

= Pb-Free Package

*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "•", may or may not be present. Some products may not follow the Generic Marking.

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STYLE 4: PIN 1. ANODE 1 2. ANODE 2 3. ANODE 2 4. ANODE 5. ANODE #2 6. ANODE #2 7. ANODE #1 8. COMMON CATHODE
STYLE 8: PIN 1. COLLECTOR, DIE #1 2. BASE, #1 3. BASE, #2 4. COLLECTOR, #2 5. COLLECTOR, #2 6. EMITTER, #2 STAGE Vd 7. EMITTER, #1 AGE Vd 8. COLLECTOR, #1
STYLE 12: 1 PIN 1. SOURCE 2 SOURCE 2 3. SOURCE 4. GATE 5. DRAIN 6. DRAIN 7. DRAIN 8. DRAIN
STYLE 16: PIN 1. EMITTER, DIE #1 2. BASE, DIE #1 3. EMITTER, DIE #2 4. BASE, DIE #2 5. COLLECTOR, DIE #2 6. COMMON 6. COLLECTOR, DIE #2 6. COMMON 7. COLLECTOR, DIE #1 6. COMMON 8. COLLECTOR, DIE #1
STYLE 20: 1 PIN 1. SOURCE (N) 2. GATE (N) 2 3. SOURCE (P) 4. GATE (P) 5. DRAIN 2 6. DRAIN 7. DRAIN 1 8. DRAIN
STYLE 24: PIN 1. BASE N ANODE/GND 2. EMITTER N ANODE/GND 3. COLLECTOR/ANODE UT 5. CATHODE N ANODE/GND 6. CATHODE N ANODE/GND 7. COLLECTOR/ANODE UT 8. COLLECTOR/ANODE
STYLE 28: PIN 1. SW_TO_GND 2. DASIC_OFF 3. DASIC_SW_DET 4. GND E 5. V_MON E 6. VBULK E 7. VBULK 8. VIN

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