Section 4.2.4 Data Sheets Zener Voltage Regulator Diodes

Section 4.2.4.1 Axial Leaded

SECTION 4.2.4.1.1 500 mW DO-35 GLASS

DATA SHEETS

MULTIPLE PACKAGE QUANTITY (MPQ) REQUIREMENTS

Package Option	Type No. Suffix	MPQ (Units)
Tape and Reel	RL, RL2(1)	5K
Tape and Ammo	TA, TA2(1)	5K
Radial Tape and Reel	RR1, RR2(2)	3K
Radial Tape and Ammo	RA1, RA2(2)	3K

NOTES 1 The "2" suffix refers to 26 mm tape spacing
2 The "1" suffix designates the cathode band is up and the cathode lead comes off first
The "2" suffix indicates the cathode band is down and the anode lead comes off first

MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

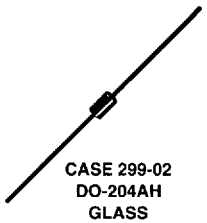
500 mW DO-35 Glass Zener Voltage Regulator Diodes

GENERAL DATA APPLICABLE TO ALL SERIES IN THIS GROUP

500 Milliwatt Hermetically Sealed Glass Silicon Zener Diodes

GENERAL DATA
500 mW
DO-35 GLASS

GLASS ZENER DIODES
500 MILLIWATTS
1.8–200 VOLTS



CASE 299-02
DO-204AH
GLASS

Specification Features:

- Complete Voltage Range — 1.8 to 200 Volts
- DO-204AH Package — Smaller than Conventional DO-204AA Package
- Double Slug Type Construction
- Metallurgically Bonded Construction

Mechanical Characteristics:

CASE: Double slug type, hermetically sealed glass

MAXIMUM LEAD TEMPERATURE FOR SOLDERING PURPOSES: 230°C, 1/16″ from case for 10 seconds

FINISH: All external surfaces are corrosion resistant with readily solderable leads

POLARITY: Cathode indicated by color band. When operated in zener mode, cathode will be positive with respect to anode

MOUNTING POSITION: Any

4

MAXIMUM RATINGS (Motorola Devices)*

Rating	Symbol	Value	Unit
DC Power Dissipation and $T_L \leq 75°C$ Lead Length = 3/8″ Derate above $T_L = 75°C$	P_D	500 4	mW mW/°C
Operating and Storage Temperature Range	T_J, T_{stg}	– 65 to +200	°C

4.2

* Some part number series have lower JEDEC registered ratings

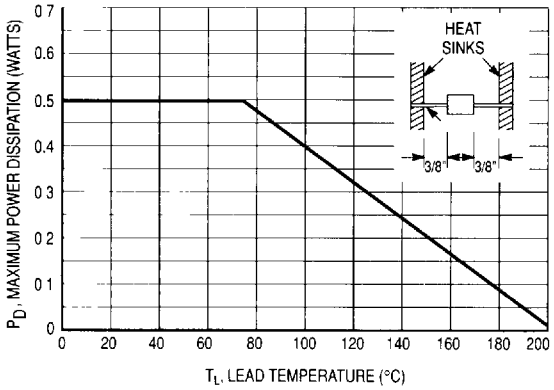


Figure 1. Steady State Power Derating

GENERAL DATA — 500 mW DO-35 GLASS

NOTE 1. SPECIAL SELECTIONS † AVAILABLE INCLUDE:

a Nominal zener voltages between those shown
b Nominal voltages at non-standard test currents

NOTE 2. TEMPERATURE COEFFICIENT (θ_{VZ})

Test conditions for temperature coefficient are as follows

Figure 4a I_{ZT} = 7 5 mA, T_1 = 25°C,
T_2 = 125°C
Figure 4b, 4c I_{ZT} = Rated I_{ZT} (125 mW/V_Z nom.)
T_1 = 25°C, T_2 = 125°C

Device to be temperature stabilized with current applied prior to reading breakdown voltage at the specified ambient temperature

NOTE 3. ZENER VOLTAGE (V_Z) MEASUREMENT

Nominal zener voltage is measured with the device junction in thermal equilibrium at the lead temperature of 30°C ±1°C and 3/8" lead length Part number series that are pulse tested are so noted

NOTE 4. ZENER IMPEDANCE (Z_Z) DERIVATION

Z_{ZT} and Z_{ZK} are measured by dividing the ac voltage drop across the device by the ac current applied The specified limits are for I_Z(ac) = 0 1 I_Z(dc) with the ac frequency = 60 Hz

† For more information on special selections contact your nearest Motorola representative

APPLICATION NOTE — ZENER VOLTAGE

Since the actual voltage available from a given zener diode is temperature dependent, it is necessary to determine junction temperature under any set of operating conditions in order to calculate its value. The following procedure is recommended:

Lead Temperature, T_L, should be determined from:

$$T_L = \theta_{LA}P_D + T_A.$$

θ_{LA} is the lead-to-ambient thermal resistance (°C/W) and P_D is the power dissipation. The value for θ_{LA} will vary and depends on the device mounting method. θ_{LA} is generally 30 to 40°C/W for the various clips and tie points in common use and for printed circuit board wiring.

The temperature of the lead can also be measured using a thermocouple placed on the lead as close as possible to the tie point. The thermal mass connected to the tie point is normally large enough so that it will not significantly respond to heat surges generated in the diode as a result of pulsed operation once steady-state conditions are achieved. Using the measured value of T_L, the junction temperature may be determined by:

$$T_J = T_L + \Delta T_{JL}.$$

ΔT_{JL} is the increase in junction temperature above the lead temperature and may be found from Figure 2 for dc power:

$$\Delta T_{JL} = \theta_{JL}P_D.$$

For worst-case design, using expected limits of I_Z, limits of P_D and the extremes of $T_J(\Delta T_J)$ may be estimated. Changes in voltage, V_Z, can then be found from:

$$\Delta V = \theta_{VZ}T_J.$$

θ_{VZ}, the zener voltage temperature coefficient, is found from Figures 4 and 5.

Under high power-pulse operation, the zener voltage will vary with time and may also be affected significantly by the zener resistance. For best regulation, keep current excursions as low as possible.

Surge limitations are given in Figure 7. They are lower than would be expected by considering only junction temperature, as current crowding effects cause temperatures to be extremely high in small spots, resulting in device degradation should the limits of Figure 7 be exceeded.

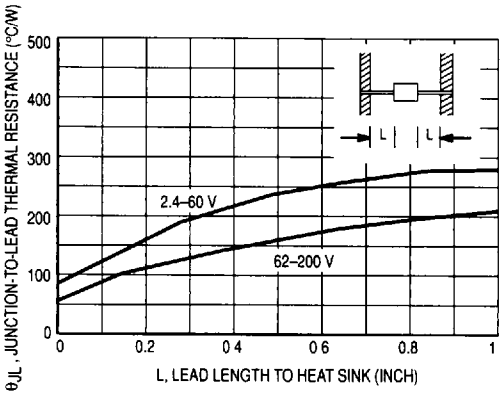


Figure 2. Typical Thermal Resistance

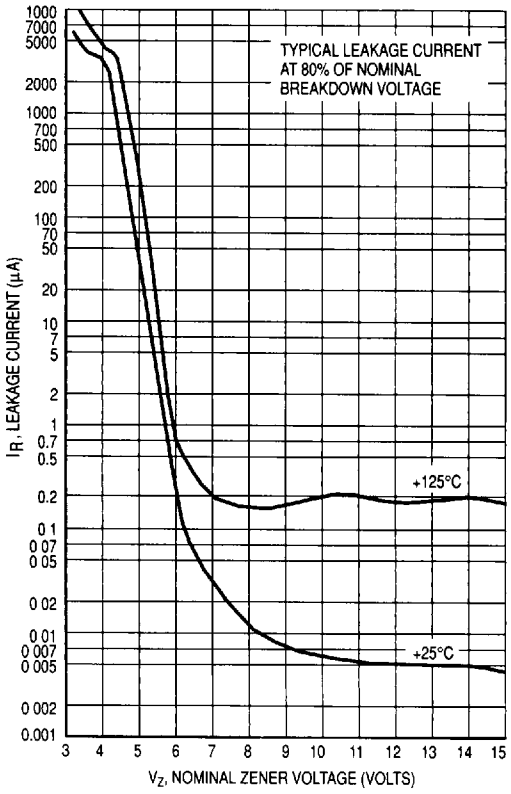


Figure 3. Typical Leakage Current

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4.2

GENERAL DATA — 500 mW DO-35 GLASS

TEMPERATURE COEFFICIENTS

(–55°C to +150°C temperature range; 90% of the units are in the ranges indicated.)

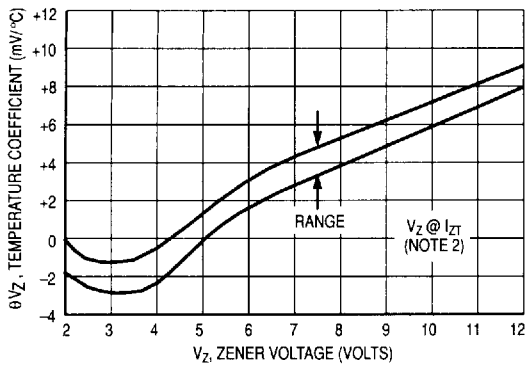

Figure 4a. Range for Units to 12 Volts

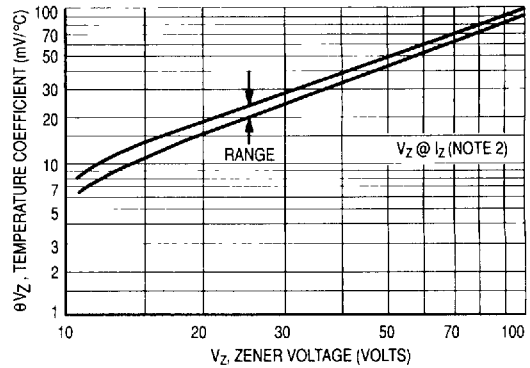

Figure 4b. Range for Units 12 to 100 Volts

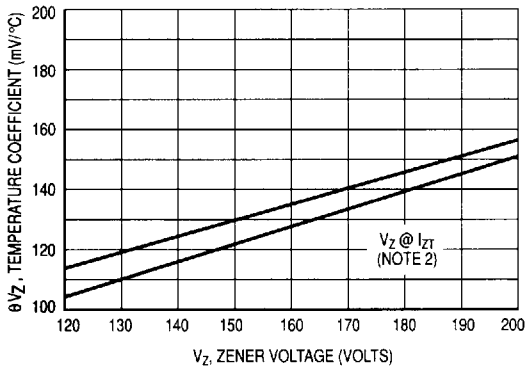

Figure 4c. Range for Units 120 to 200 Volts

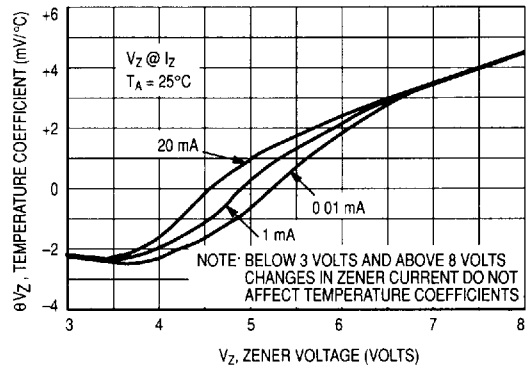

Figure 5. Effect of Zener Current

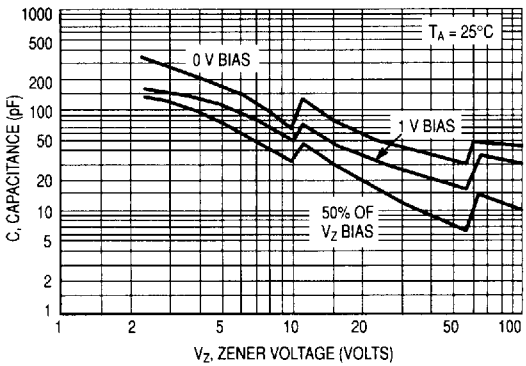

Figure 6a. Typical Capacitance 2.4–100 Volts

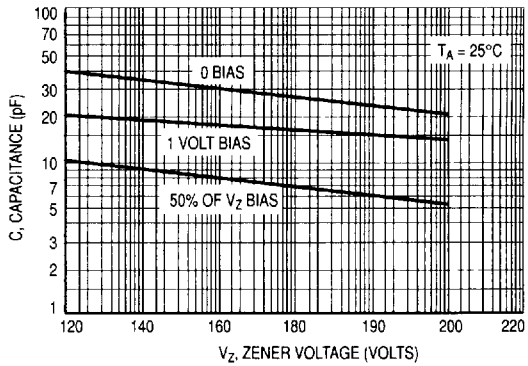

Figure 6b. Typical Capacitance 120–200 Volts

GENERAL DATA — 500 mW DO-35 GLASS

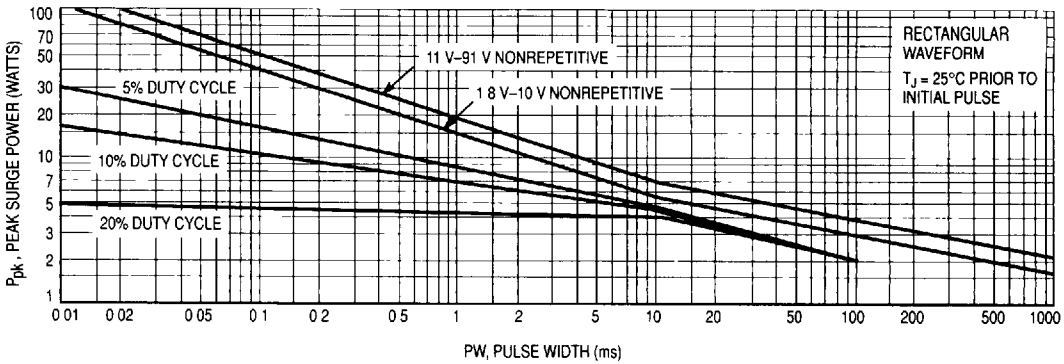

Figure 7a. Maximum Surge Power 1.8–91 Volts

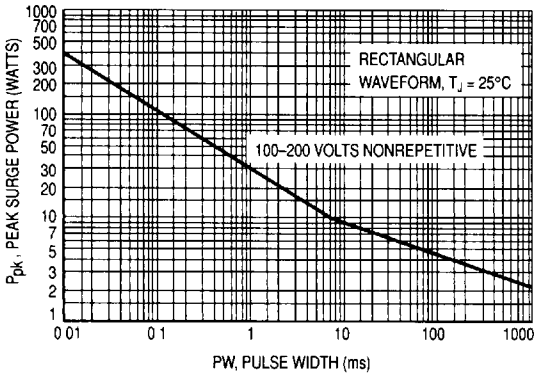

Figure 7b. Maximum Surge Power DO-204AH 100–200 Volts

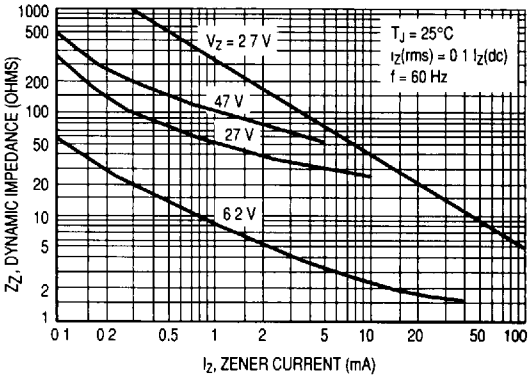

Figure 8. Effect of Zener Current on Zener Impedance

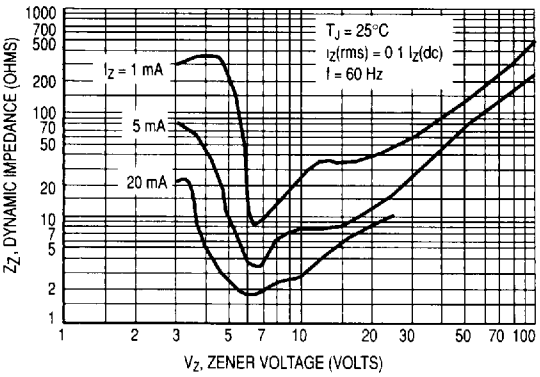

Figure 9. Effect of Zener Voltage on Zener Impedance

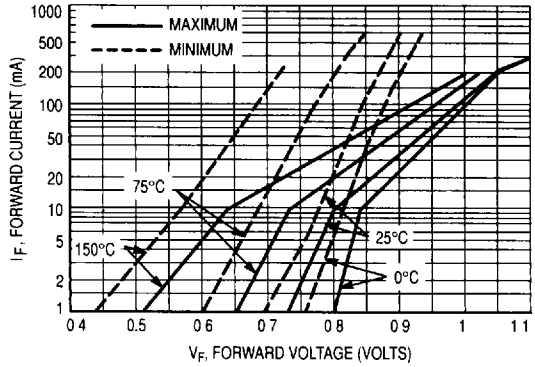

Figure 10. Typical Forward Characteristics

GENERAL DATA — 500 mW DO-35 GLASS

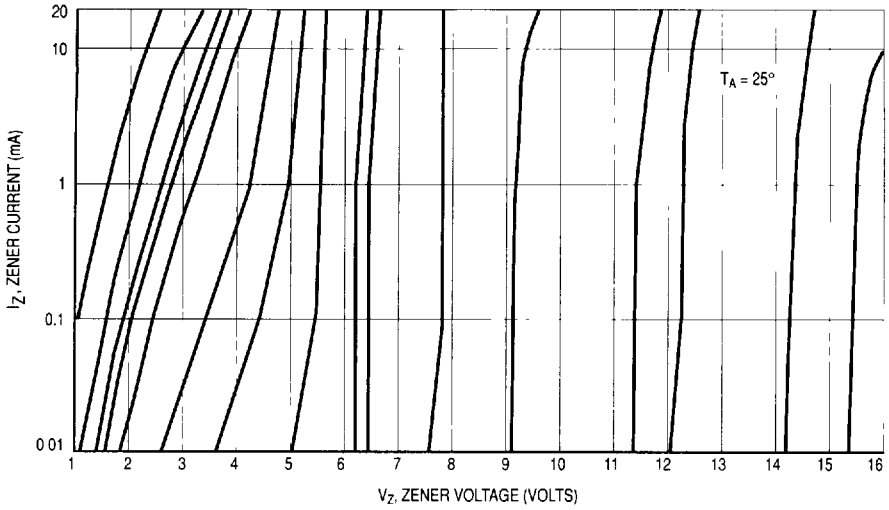

Figure 11. Zener Voltage versus Zener Current — V_Z = 1 thru 16 Volts

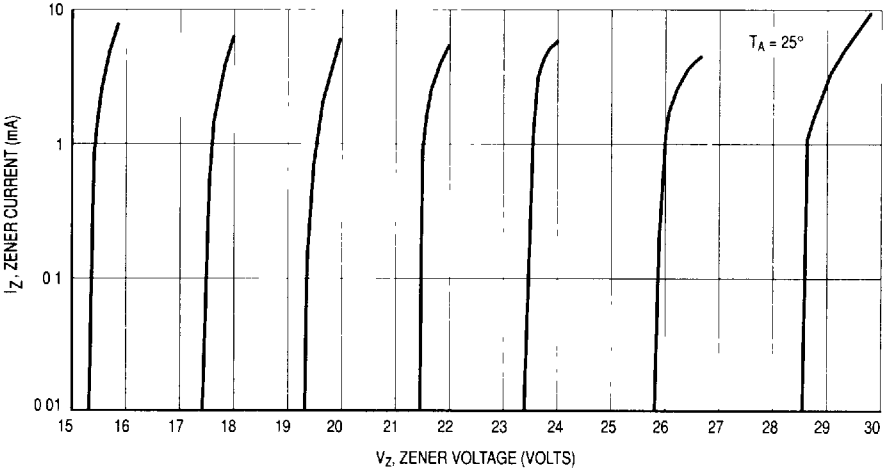

Figure 12. Zener Voltage versus Zener Current — V_Z = 15 thru 30 Volts

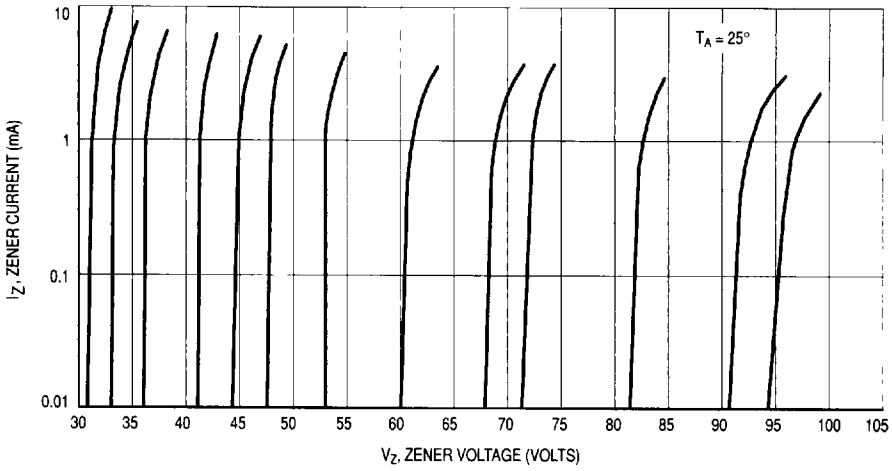

Figure 13. Zener Voltage versus Zener Current — V_Z = 30 thru 105 Volts

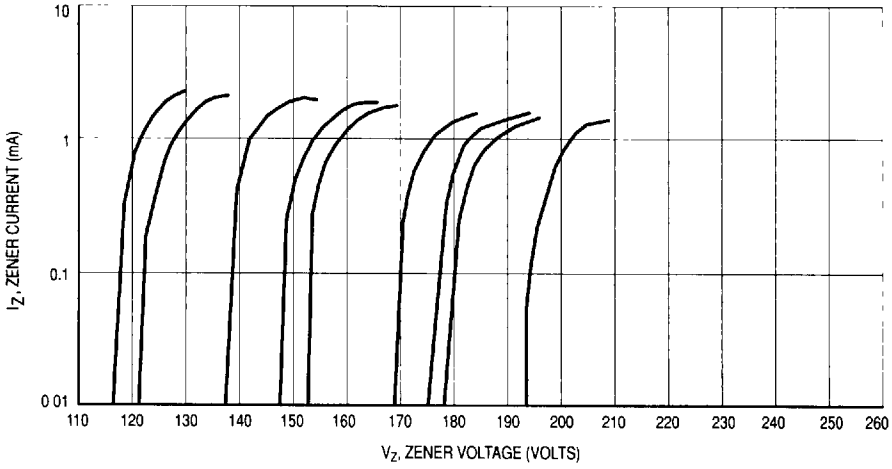

Figure 14. Zener Voltage versus Zener Current — V_Z = 110 thru 220 Volts

1N746A thru 1N759A, 1N957B thru 1N992B, 1N4370A thru 1N4372A

ELECTRICAL CHARACTERISTICS (T_A = 25°C, V_F = 1.5 V Max at 200 mA for all types)

Type Number (Note 1)	Nominal Zener Voltage V_Z @ I_{ZT} (Note 2) Volts	Test Current I_{ZT} mA	Maximum Zener Impedance Z_{ZT} @ I_{ZT} (Note 3) Ohms	Maximum DC Zener Current I_{ZM} (Note 4) mA	Maximum Reverse Leakage Current	
					T_A = 25°C I_R @ V_R = 1 V µA	T_A = 150°C I_R @ V_R = 1 V µA
1N4370A	2.4	20	30	150	100	200
1N4371A	2.7	20	30	135	75	150
1N4372A	3	20	29	120	50	100
1N746A	3.3	20	28	110	10	30
1N747A	3.6	20	24	100	10	30
1N748A	3.9	20	23	95	10	30
1N749A	4.3	20	22	85	2	30
1N750A	4.7	20	19	75	2	30
1N751A	5.1	20	17	70	1	20
1N752A	5.6	20	11	65	1	20
1N753A	6.2	20	7	60	0.1	20
1N754A	6.8	20	5	55	0 1	20
1N755A	7.5	20	6	50	0.1	20
1N756A	8.2	20	8	45	0 1	20
1N757A	9.1	20	10	40	0.1	20
1N758A	10	20	17	35	0 1	20
1N759A	12	20	30	30	0 1	20

Type Number (Note 1)	Nominal Zener Voltage V_Z (Note 2) Volts	Test Current I_{ZT} mA	Maximum Zener Impedance (Note 3)			Maximum DC Zener Current I_{ZM} (Note 4) mA	Maximum Reverse Current	
			Z_{ZT} @ I_{ZT} Ohms	Z_{ZK} @ I_{ZK} Ohms	I_{ZK} mA		I_R Maximum µA	Test Voltage Vdc V_R
1N957B	6 8	18.5	4.5	700	1	47	150	5 2
1N958B	7 5	16.5	5 5	700	0 5	42	75	5.7
1N959B	8.2	15	6 5	700	0.5	38	50	6.2
1N960B	9.1	14	7 5	700	0 5	35	25	6.9
1N961B	10	12 5	8.5	700	0.25	32	10	7 6
1N962B	11	11.5	9.5	700	0 25	28	5	8.4
1N963B	12	10.5	11.5	700	0.25	26	5	9.1
1N964B	13	9.5	13	700	0.25	24	5	9.9
1N965B	15	8.5	16	700	0 25	21	5	11.4
1N966B	16	7.8	17	700	0 25	19	5	12.2
1N967B	18	7	21	750	0 25	17	5	13.7
1N968B	20	6 2	25	750	0 25	15	5	15 2
1N969B	22	5.6	29	750	0 25	14	5	16.7
1N970B	24	5.2	33	750	0.25	13	5	18.2
1N971B	27	4.6	41	750	0.25	11	5	20 6
1N972B	30	4.2	49	1000	0 25	10	5	22.8
1N973B	33	3 8	58	1000	0 25	9 2	5	25.1
1N974B	36	3 4	70	1000	0.25	8 5	5	27.4
1N975B	39	3 2	80	1000	0.25	7.8	5	29.7
1N976B	43	3	93	1500	0 25	7	5	32.7
1N977B	47	2 7	105	1500	0.25	6 4	5	35 8
1N978B	51	2 5	125	1500	0 25	5.9	5	38.8
1N979B	56	2.2	150	2000	0 25	5.4	5	42.6
1N980B	62	2	185	2000	0 25	4 9	5	47.1

Type Number (Note 1)	Nominal Zener Voltage V_Z (Note 2) Volts	Test Current I_{ZT} mA	Maximum Zener Impedance (Note 3) Z_{ZT} @ I_{ZT} Ohms	Z_{ZK} @ I_{ZK} Ohms	I_{ZK} mA	Maximum DC Zener Current I_{ZM} (Note 4) mA	Maximum Reverse Leakage Current I_R Maximum µA	Test Voltage Vdc V_R
1N981B	68	1.8	230	2000	0.25	4.5	5	51.7
1N982B	75	1.7	270	2000	0.25	4.1	5	56
1N983B	82	1.5	330	3000	0.25	3.7	5	62.2
1N984B	91	1.4	400	3000	0.25	3.3	5	69.2
1N985B	100	1.3	500	3000	0.25	3	5	76
1N986B	110	1.1	750	4000	0.25	2.7	5	83.6
1N987B	120	1	900	4500	0.25	2.5	5	91.2
1N988B	130	0.95	1100	5000	0.25	2.3	5	98.8
1N989B	150	0.85	1500	6000	0.25	2	5	114
1N990B	160	0.8	1700	6500	0.25	1.9	5	121.6
1N991B	180	0.68	2200	7100	0.25	1.7	5	136.8
1N992B	200	0.65	2500	8000	0.25	1.5	5	152

NOTE 1. TOLERANCE AND VOLTAGE DESIGNATION

Tolerance Designation

The type numbers shown have tolerance designations as follows

1N4370A series ±5% units, C for ±2%, D for ±1%

1N746A series· ±5% units, C for ±2%, D for ±1%

1N957B series. ±5% units, C for ±2%, D for ±1%

NOTE 2. ZENER VOLTAGE (V_Z) MEASUREMENT

Nominal zener voltage is measured with the device junction in thermal equilibrium at the lead temperature of 30°C ±1°C and 3/8" lead length

NOTE 3. ZENER IMPEDANCE (Z_Z) DERIVATION

Z_{ZT} and Z_{ZK} are measured by dividing the ac voltage drop across the device by the ac current applied The specified limits are for $I_Z(ac) = 0.1\ I_Z(dc)$ with the ac frequency = 60 Hz

NOTE 4. MAXIMUM ZENER CURRENT RATINGS (I_{ZM})

Values shown are based on the JEDEC rating of 400 mW Where the actual zener voltage (V_Z) is known at the operating point, the maximum zener current may be increased and is limited by the derating curve.

1N4678 thru 1N4717

Low level oxide passivated zener diodes for applications requiring extremely low operating currents, low leakage, and sharp breakdown voltage.

- Zener Voltage Specified @ I_{ZT} = 50 μA
- Maximum Delta V_Z Given from 10 to 100 μA

ELECTRICAL CHARACTERISTICS (T_A = 25°C, V_F = 1.5 V Max at I_F = 100 mA for all types)

Type Number (Note 1)	Zener Voltage V_Z @ I_{ZT} = 50 μA Volts			Maximum Reverse Current I_R μA (Note 3)	Test Voltage V_R Volts	Maximum Zener Current I_{ZM} mA (Note 2)	Maximum Voltage Change ΔV_Z Volts (Note 4)
	Nom (Note 1)	Min	Max				
1N4678	1.8	1 71	1 89	7 5	1	120	0 7
1N4679	2	1 9	2 1	5	1	110	0 7
1N4680	2 2	2.09	2 31	4	1	100	0 75
1N4681	2 4	2 28	2 52	2	1	95	0 8
1N4682	2 7	2.565	2 835	1	1	90	0 85
1N4683	3	2 85	3 15	0 8	1	85	0 9
1N4684	3.3	3 135	3.465	7 5	1.5	80	0.95
1N4685	3.6	3 42	3.78	7 5	2	75	0.95
1N4686	3.9	3.705	4 095	5	2	70	0.97
1N4687	4.3	4 085	4 515	4	2	65	0 99
1N4688	4 7	4 465	4 935	10	3	60	0 99
⇒ **1N4689**	**5.1**	**4.845**	**5.355**	**10**	**3**	**55**	**0.97**
1N4690	5 6	5.32	5 88	10	4	50	0 96
1N4691	6 2	5.89	6 51	10	5	45	0 95
1N4692	6 8	6 46	7 14	10	5 1	35	0.9
1N4693	7 5	7 125	7 875	10	5.7	31 8	0 75
1N4694	8 2	7 79	8 61	1	6.2	29	0.5
1N4695	8.7	8.265	9 135	1	6 6	27 4	0.1
1N4696	9 1	8 645	9 555	1	6.9	26.2	0.08
1N4697	10	9.5	10 5	1	7 6	24 8	0 1
1N4698	11	10.45	11.55	0 05	8 4	21.6	0 11
1N4699	12	11.4	12 6	0 05	9 1	20.4	0 12
1N4700	13	12 35	13.65	0 05	9 8	19	0.13
1N4701	14	13.3	14.7	0 05	10 6	17 5	0 14
1N4702	15	14.25	15.75	0.05	11 4	16 3	0.15
1N4703	16	15.2	16 8	0.05	12.1	15.4	0.16
1N4704	17	16.15	17 85	0.05	12.9	14.5	0.17
1N4705	18	17.1	18.9	0.05	13.6	13 2	0 18
1N4706	19	18.05	19 95	0.05	14 4	12.5	0 19
1N4707	20	19	21	0 01	15 2	11.9	0.2
1N4708	22	20 9	23.1	0 01	16.7	10.8	0 22
1N4709	24	22 8	25 2	0 01	18 2	9 9	0.24
1N4710	25	23 75	26 25	0 01	19	9 5	0.25
1N4711	27	25 65	28 35	0 01	20.4	8.8	0.27
1N4712	28	26.6	29.4	0 01	21.2	8 5	0 28
1N4713	30	28.5	31 5	0 01	22 8	7 9	0.3
1N4714	33	31.35	34.65	0.01	25	7 2	0.33
1N4715	36	34.2	37 8	0.01	27 3	6 6	0 36
1N4716	39	37.05	40 95	0 01	29 6	6 1	0 39
1N4717	43	40 85	45 15	0.01	32 6	5.5	0.43

⇒ **Preferred part**

NOTE 1. TOLERANCE AND VOLTAGE DESIGNATION (V_Z)

The type numbers shown have a standard tolerance of ±5% on the nominal Zener voltage

C for ±2%, D for ±1%

NOTE 2. MAXIMUM ZENER CURRENT RATINGS (I_{ZM})

Maximum Zener current ratings are based on maximum Zener voltage of the individual units and JEDEC 250 mW rating

NOTE 3. REVERSE LEAKAGE CURRENT (I_R)

Reverse leakage currents are guaranteed and measured at V_R as shown on the table

NOTE 4 MAXIMUM VOLTAGE CHANGE (ΔV_Z)

Voltage change is equal to the difference between V_Z at 100 μA and V_Z at 10 μA.

NOTE 5. ZENER VOLTAGE (V_Z) MEASUREMENT

Nominal Zener voltage is measured with the device junction in thermal equilibrium at the lead temperature at 30°C +1°C and 3/8 lead length

1N5221B thru 1N5281B

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted. Based on dc measurements at thermal equilibrium; lead length = 3/8″; thermal resistance of heat sink = 30°C/W) V_F = 1.1 Max @ I_F = 200 mA for all types.

JEDEC Type No. (Note 1)	Nominal Zener Voltage V_Z @ I_{ZT} Volts (Note 2)	Test Current I_{ZT} mA	Max Zener Impedance		Max Reverse Leakage Current		Max Zener Voltage Temperature Coeff.
			Z_{ZT} @ I_{ZT} Ohms	Z_{ZK} @ I_{ZK} = 0.25 mA Ohms	I_R µA	V_R Volts	θ_{VZ} (%/°C) (Note 3)
⇒ **1N5221B**	**2.4**	**20**	**30**	**1200**	**100**	**1**	**–0.085**
1N5222B	2.5	20	30	1250	100	1	–0.085
⇒ **1N5223B**	**2.7**	**20**	**30**	**1300**	**75**	**1**	**–0.08**
1N5224B	2.8	20	30	1400	75	1	–0.08
1N5225B	3	20	29	1600	50	1	–0.075
⇒ **1N5226B**	**3.3**	**20**	**28**	**1600**	**25**	**1**	**–0.07**
1N5227B	3.6	20	24	1700	15	1	–0.065
⇒ **1N5228B**	**3.9**	**20**	**23**	**1900**	**10**	**1**	**–0.06**
⇒ **1N5229B**	**4.3**	**20**	**22**	**2000**	**5**	**1**	**±0.055**
⇒ **1N5230B**	**4.7**	**20**	**19**	**1900**	**5**	**2**	**± 0.03**
⇒ **1N5231B**	**5.1**	**20**	**17**	**1600**	**5**	**2**	**± 0.03**
⇒ **1N5232B**	**5.6**	**20**	**11**	**1600**	**5**	**3**	**+0.038**
⇒ **1N5233B**	**6**	**20**	**7**	**1600**	**5**	**3.5**	**+0.038**
⇒ **1N5234B**	**6.2**	**20**	**7**	**1000**	**5**	**4**	**+0.045**
⇒ **1N5235B**	**6.8**	**20**	**5**	**750**	**3**	**5**	**+0.05**
⇒ **1N5236B**	**7.5**	**20**	**6**	**500**	**3**	**6**	**+0.058**
⇒ **1N5237B**	**8.2**	**20**	**8**	**500**	**3**	**6.5**	**+0.062**
1N5238B	8.7	20	8	600	3	6.5	+0.065
⇒ **1N5239B**	**9.1**	**20**	**10**	**600**	**3**	**7**	**+0.068**
⇒ **1N5240B**	**10**	**20**	**17**	**600**	**3**	**8**	**+0.075**
1N5241B	11	20	22	600	2	8.4	+0.076
⇒ **1N5242B**	**12**	**20**	**30**	**600**	**1**	**9.1**	**+0.077**
⇒ **1N5243B**	**13**	**9.5**	**13**	**600**	**0.5**	**9.9**	**+0.079**
⇒ **1N5244B**	**14**	**9**	**15**	**600**	**0.1**	**10**	**+0.082**
⇒ **1N5245B**	**15**	**8.5**	**16**	**600**	**0.1**	**11**	**+0.082**
⇒ **1N5246B**	**16**	**7.8**	**17**	**600**	**0.1**	**12**	**+0.083**
1N5247B	17	7.4	19	600	0.1	13	+0.084
⇒ **1N5248B**	**18**	**7**	**21**	**600**	**0.1**	**14**	**+0.085**
1N5249B	19	6.6	23	600	0.1	14	+0.086
⇒ **1N5250B**	**20**	**6.2**	**25**	**600**	**0.1**	**15**	**+0.086**
1N5251B	22	5.6	29	600	0.1	17	+0.087
⇒ **1N5252B**	**24**	**5.2**	**33**	**600**	**0.1**	**18**	**+0.088**
1N5253B	25	5	35	600	0.1	19	+0.089
⇒ **1N5254B**	**27**	**4.6**	**41**	**600**	**0.1**	**21**	**+0.09**
1N5255B	28	4.5	44	600	0.1	21	+0.091
⇒ **1N5256B**	**30**	**4.2**	**49**	**600**	**0.1**	**23**	**+0.091**
⇒ **1N5257B**	**33**	**3.8**	**58**	**700**	**0.1**	**25**	**+0.092**
⇒ **1N5258B**	**36**	**3.4**	**70**	**700**	**0.1**	**27**	**+0.093**
1N5259B	39	3.2	80	800	0.1	30	+0.094
1N5260B	43	3	93	900	0.1	33	+0.095
1N5261B	47	2.7	105	1000	0 1	36	+0.095
1N5262B	51	2.5	125	1100	0.1	39	+0.096
1N5263B	56	2.2	150	1300	0.1	43	+0.096
1N5264B	60	2.1	170	1400	0.1	46	+0.097
1N5265B	62	2	185	1400	0.1	47	+0.097

(continued)

⇒ **Preferred part**

1N5221B thru 1N5281B

ELECTRICAL CHARACTERISTICS — continued (T_A = 25°C unless otherwise noted Based on dc measurements at thermal equilibrium, lead length = 3/8″; thermal resistance of heat sink = 30°C/W) V_F = 1 1 Max @ I_F = 200 mA for all types

JEDEC Type No. (Note 1)	Nominal Zener Voltage V_Z @ I_{ZT} Volts (Note 2)	Test Current I_{ZT} mA	Max Zener Impedance		Max Reverse Leakage Current		Max Zener Voltage Temperature Coeff.
			Z_{ZT} @ I_{ZT} Ohms	Z_{ZK} @ I_{ZK} = 0.25 mA Ohms	I_R µA	V_R Volts	θ_{VZ} (%/°C) (Note 3)
1N5266B	68	1 8	230	1600	0 1	52	+0 097
1N5267B	75	1 7	270	1700	0 1	56	+0 098
1N5268B	82	1 5	330	2000	0 1	62	+0 098
1N5269B	87	1.4	370	2200	0 1	68	+0 099
1N5270B	91	1 4	400	2300	0 1	69	+0 099
1N5271B	100	1 3	500	2600	0 1	76	+0 11
1N5272B	110	1.1	750	3000	0 1	84	+0 11
1N5273B	120	1	900	4000	0 1	91	+0 11
1N5274B	130	0 95	1100	4500	0 1	99	+0 11
1N5275B	140	0 9	1300	4500	0.1	106	+0 11
1N5276B	150	0 85	1500	5000	0 1	114	+0 11
1N5277B	160	0.8	1700	5500	0 1	122	+0 11
1N5278B	170	0 74	1900	5500	0 1	129	+0 11
1N5279B	180	0 68	2200	6000	0 1	137	+0.11
1N5280B	190	0 66	2400	6500	0 1	144	+0.11
1N5281B	200	0 65	2500	7000	0 1	152	+0 11

NOTE 1. TOLERANCE

The JEDEC type numbers shown indicate a tolerance of ±5% For tighter tolerance devices use suffixes "C" for ±2% and "D" for ±1%

NOTE 2. SPECIAL SELECTIONS † AVAILABLE INCLUDE·

1 Nominal zener voltages between those shown
2 Nominal voltages at non-standard test currents

NOTE 3. TEMPERATURE COEFFICIENT (θ_{VZ})

Test conditions for temperature coefficient are as follows

a I_{ZT} = 7 5 mA, T_1 = 25°C,
T_2 = 125°C (1N5221B through 1N5242B)

b I_{ZT} = Rated I_{ZT}, T_1 = 25°C
T_2 = 125°C (1N5243B through 1N5281B)

Device to be temperature stabilized with current applied prior to reading breakdown voltage at the specified ambient temperature

NOTE 4 ZENER VOLTAGE (V_Z) MEASUREMENT

Nominal zener voltage is measured with the device junction in thermal equilibrium at the lead temperature of 30°C +1°C and 3/8″ lead length

NOTE 5 ZENER IMPEDANCE (Z_Z) DERIVATION

Z_{Z1} and Z_{ZK} are measured by dividing the ac voltage drop across the device by the ac current applied The specified limits are for I_Z(ac) = 0 1 I_Z(dc) with the ac frequency = 60 Hz

† For more information on special selections contact your nearest Motorola representative

1N5985B thru 1N6025B

***ELECTRICAL CHARACTERISTICS** (T_L = 30°C unless otherwise noted.) (V_F = 1.5 Volts Max @ I_F = 100 mAdc for all types.)

Motorola Type Number (Note 1)	Nominal Zener Voltage V_Z @ I_{ZT} Volts (Notes 2 & 5)	Test Current I_{ZT} mA	Max Zener Impedance (Note 4)		Max Reverse Leakage Current		Max DC Zener Current I_{ZM} (Note 3)
			Z_{ZT} @ I_{ZT} Ohms	Z_{ZK} @ I_{ZK} = Ohms 0.25 mA	I_R μA	@ V_R Volts	
1N5985B	2.4	5	100	1800	100	1	208
1N5986B	2.7	5	100	1900	75	1	185
1N5987B	3	5	95	2000	50	1	167
⇒ **1N5988B**	**3.3**	**5**	**95**	**2200**	**25**	**1**	**152**
1N5989B	3.6	5	90	2300	15	1	139
1N5990B	3.9	5	90	2400	10	1	128
1N5991B	4.3	5	88	2500	5	1	116
1N5992B	4 7	5	70	2200	3	1.5	106
⇒ **1N5993B**	**5.1**	**5**	**50**	**2050**	**2**	**2**	**98**
⇒ **1N5994B**	**5.6**	**5**	**25**	**1800**	**2**	**3**	**89**
1N5995B	6.2	5	10	1300	1	4	81
1N5996B	6.8	5	8	750	1	5.2	74
1N5997B	7.5	5	7	600	0.5	6	67
⇒ **1N5998B**	**8.2**	**5**	**7**	**600**	**0.5**	**6.5**	**61**
1N5999B	9.1	5	10	600	0.1	7	55
1N6000B	10	5	15	600	0.1	8	50
1N6001B	11	5	18	600	0.1	8.4	45
1N6002B	12	5	22	600	0.1	9.1	42
1N6003B	13	5	25	600	0.1	9.9	38
1N6004B	15	5	32	600	0.1	11	33
1N6005B	16	5	36	600	0.1	12	31
1N6006B	18	5	42	600	0.1	14	28
⇒ **1N6007B**	**20**	**5**	**48**	**600**	**0.1**	**15**	**25**
1N6008B	22	5	55	600	0.1	17	23
1N6009B	24	5	62	600	0.1	18	21
1N6010B	27	5	70	600	0.1	21	19
1N6011B	30	5	78	600	0.1	23	17
1N6012B	33	5	88	700	0.1	25	15
1N6013B	36	5	95	700	0.1	27	14
1N6014B	39	2	130	800	0.1	30	13
1N6015B	43	2	150	900	0.1	33	12
1N6016B	47	2	170	1000	0.1	36	11
1N6017B	51	2	180	1300	0.1	39	9.8
1N6018B	56	2	200	1400	0.1	43	8.9
1N6019B	62	2	225	1400	0.1	47	8
1N6020B	68	2	240	1600	0.1	52	7.4
1N6021B	75	2	265	1700	0.1	56	6.7
1N6022B	82	2	280	2000	0.1	62	6.1
1N6023B	91	2	300	2300	0.1	69	5.5
1N6024B	100	1	500	2600	0.1	76	5
1N6025B	110	1	650	3000	0.1	84	4.5

⇒ Preferred part

*Indicates JEDEC Registered Data

NOTE 1. TOLERANCE AND VOLTAGE DESIGNATION

Tolerance designation — Device tolerances of ±5% are indicated by a "B" suffix, ±2% by a "C" suffix, ±1% by a "D" suffix

NOTE 2. SPECIAL SELECTIONS AVAILABLE INCLUDE:

(a) Nominal Zener voltages between those shown Contact your nearest Motorola representative

NOTE 3.

This data was calculated using nominal voltages The maximum current handling capability on a worst case basis is limited by the actual zener voltage at the operating point and the power derating curve

NOTE 4.

Z_{ZT} and Z_{ZK} are measured by dividing the ac voltage drop across the device by the ac current applied The specified limits are for I_Z(ac) = 0 1 I_Z(dc) with the ac frequency = 1 0 kHz

NOTE 5.

Nominal Zener Voltage (V_Z) is measured with the device junction in thermal equilibrium at the lead temperature of 30°C ±1°C and 3/8" lead length

BZX55C2V4 thru BZX55C91

ELECTRICAL CHARACTERISTICS (T_L = 30°C unless otherwise noted.) (V_F = 1 3 Volts Max, I_F = 100 mAdc for all types)

Motorola Type Number	V_{ZT} at I_{ZT} (V) Min (Note 1)	V_{ZT} at I_{ZT} (V) Max (Note 1)	Max Zener Impedance (Note 3) Z_{ZT} @ I_{ZT} (Ohms) Max	I_{ZT} (mA)	Max Reverse Leakage Current I_R at V_R (μA) T_{amb} 25°C Max	Max Reverse Leakage Current I_R at V_R (μA) T_{amb} 125°C Max	V_R (V)	I_{ZM} (mA) (Note 2)
BZX55C2V4	2 28	2 56	85	5	50	100	1	155
BZX55C2V7	2 5	2 9	85	5	10	50	1	135
BZX55C3V0	2 8	3 2	85	5	4	40	1	125
BZX55C3V3	3 1	3 5	85	5	2	40	1	115
BZX55C3V6	3 4	3 8	85	5	2	40	1	105
BZX55C3V9	3 7	4 1	85	5	2	40	1	95
BZX55C4V3	4	4 6	75	5	1	20	1	90
BZX55C4V7	4 4	5	60	5	0 5	10	1	85
BZX55C5V1	4.8	5.4	35	5	0.1	2	1	80
BZX55C5V6	5 2	6	25	5	0 1	2	1	70
BZX55C6V2	5 8	6.6	10	5	0 1	2	2	64
BZX55C6V8	6 4	7.2	8	5	0 1	2	3	58
BZX55C7V5	7	7.9	7	5	0 1	2	5	53
BZX55C8V2	7 7	8.7	7	5	0 1	2	6	47
BZX55C9V1	8.5	9.6	10	5	0.1	2	7	43
BZX55C10	9.4	10.6	15	5	0 1	2	7 5	40
BZX55C11	10 4	11.6	20	5	0.1	2	8 5	36
BZX55C12	11 4	12 7	20	5	0.1	2	9	32
BZX55C13	12 4	14 1	26	5	0.1	2	10	29
BZX55C15	13 8	15.6	30	5	0.1	2	11	27
BZX55C16	15.3	17.1	40	5	0 1	2	12	24
BZX55C18	16.8	19.1	50	5	0.1	2	14	21
BZX55C20	18 8	21 1	55	5	0.1	2	15	20
BZX55C22	20 8	23.3	55	5	0.1	2	17	18
BZX55C24	22 8	25.6	80	5	0 1	2	18	16
BZX55C27	25 1	28.9	80	5	0.1	2	20	14
BZX55C30	28	32	80	5	0.1	2	22	13
BZX55C33	31	35	80	5	0.1	2	24	12
BZX55C36	34	38	80	5	0 1	2	27	11
BZX55C39	37	41	90	2 5	0 1	5	28	10
BZX55C43	40	46	90	2 5	0 1	5	32	9.2
BZX55C47	44	50	110	2.5	0 1	5	35	8 5
BZX55C51	48	54	125	2 5	0 1	10	38	7 8
BZX55C56	52	60	135	2 5	0.1	10	42	7
BZX55C62	58	66	150	2 5	0 1	10	47	6.4
BZX55C68	64	72	160	2.5	0.1	10	51	5 9
BZX55C75	70	80	170	2.5	0.1	10	56	5 3
BZX55C82	77	87	200	2.5	0.1	10	62	4.8
BZX55C91	85	96	250	1	0.1	10	69	4 3

NOTE 1 TOLERANCE AND VOLTAGE DESIGNATION

Tolerance designation — The type numbers listed have zener voltage min/max limits as shown Device tolerance of ±2% are indicated by a "B" instead of a "C" Zener voltage is measured with the device junction in thermal equilibrium at the lead temperature of 30°C ±1°C and 3/8" lead length

NOTE 2.

This data was calculated using nominal voltages The maximum current handling capability on a worst case basis is limited by the actual zener voltage at the operating point and the power derating curve

NOTE 3.

Z_{ZT} and Z_{ZK} are measured by dividing the ac voltage drop across the device by the ac current applied The specified limits are for I_Z(ac) = 0 1 I_Z(dc) with the ac frequency = 1 0 kHz

BZX79C2V4 thru BZX79C200

***ELECTRICAL CHARACTERISTICS** (T_L = 30°C unless otherwise noted) (V_F = 1 5 Volts Max @ I_F = 100 mAdc for all types.)

Device Type (Note 2)	Zener Voltage (Note 1) (Note 4) Min	Max	I_{ZT} = (mA)	Impedance (Ohm) @ I_{ZT} f = 1000 Hz Max (Note 3)	Leakage Current (μA) Max	@ V_R = (Volt)	Temp. Coefficient (Typical) (mV/°C) Min	Max	Capacitance (Typical) (pF) V_R = 0, f = 1.0 MHz
BZX79C2V4	2 2	2.6	5	100	100	1	−3.5	0	255
BZX79C2V7	2.5	2.9	5	100	75	1	−3.5	0	230
BZX79C3V0	2 8	3.2	5	95	50	1	−3.5	0	215
BZX79C3V3	3.1	3.5	5	95	25	1	−3.5	0	200
BZX79C3V6	3 4	3.8	5	90	15	1	−3.5	0	185
BZX79C3V9	3.7	4.1	5	90	10	1	−3 5	+0 3	175
BZX79C4V3	4	4.6	5	90	5	1	−3.5	+1	160
BZX79C4V7	4.4	5	5	80	3	2	−3.5	+0 2	130
BZX79C5V1	4.8	5.4	5	60	2	2	−2 7	+1 2	110
BZX79C5V6	5.2	6	5	40	1	2	−2	+2.5	95
BZX79C6V2	5.8	6 6	5	10	3	4	0 4	3.7	90
BZX79C6V8	6.4	7.2	5	15	2	4	1.2	4.5	85
BZX79C7V5	7	7.9	5	15	1	5	2.5	5.3	80
BZX79C8V2	7 7	8 7	5	15	0.7	5	3.2	6.2	75
BZX79C9V1	8.5	9.6	5	15	0.5	6	3.8	7	70
BZX79C10	9.4	10.6	5	20	0.2	7	4 5	8	70
BZX79C11	10.4	11.6	5	20	0.1	8	5.4	9	65
BZX79C12	11.4	12 7	5	25	0.1	8	6	10	65
BZX79C13	12.4	14.1	5	30	0.1	8	7	11	60
BZX79C15	13.8	15.6	5	30	0.05	10.5	9.2	13	55
BZX79C16	15.3	17.1	5	40	0.05	11.2	10.4	14	52
BZX79C18	16.8	19.1	5	45	0.05	12.6	12.9	16	47
BZX79C20	18.8	21.2	5	55	0.05	14	14.4	18	36
BZX79C22	20.8	23.3	5	55	0.05	15.4	16.4	20	34
BZX79C24	22.8	25.6	5	70	0.05	16.8	18.4	22	33
BZX79C27	25.1	28.9	2	80	0.05	18.9		23.5	30
BZX79C30	28	32	2	80	0.05	21		26	27
BZX79C33	31	35	2	80	0.05	23.1		29	25
BZX79C36	34	38	2	90	0.05	25.2		31	23
BZX79C39	37	41	2	130	0.05	27.3		34	21
BZX79C43	40	46	2	150	0.05	30.1		37	21
BZX79C47	44	50	2	170	0.05	32.9		40	19
BZX79C51	48	54	2	180	0.05	35.7		44	19
BZX79C56	52	60	2	200	0.05	39 2		47	18
BZX79C62	58	66	2	215	0.05	43.4		51	17
BZX79C68	64	72	2	240	0.05	47.6		56	17
BZX79C75	70	79	2	255	0 05	52.5		60	16 5
BZX79C82	77	87	2	280	0.1	62	46	95	29
BZX79C91	85	96	2	300	0 1	69	51	107	28
BZX79C100	94	106	1	500	0 1	76	57	119	27
BZX79C110	104	116	1	650	0 1	84	63	131	26
BZX79C120	114	127	1	800	0 1	91	69	144	24
BZX79C130	124	141	1	950	0 1	99	75	158	23
BZX79C150	138	156	1	1250	0 1	114	87	185	21
BZX79C160	153	171	1	1400	0 1	122	93	200	20
BZX79C180	168	191	1	1700	0 1	137	105	228	18
BZX79C200	188	212	1	2000	0 1	152	120	255	17

NOTE 1. Zener voltage is measured under pulse conditions such that T_J is no more than 2°C above T_A

NOTE 2. TOLERANCE AND VOLTAGE DESIGNATION

Tolerance designation — The type numbers listed have zener voltage min/max limits as shown Device tolerances of ±2% are indicated by a "B" instead of a "C," and ±1% by "A."

NOTE 3. Z_{ZT} is measured by dividing the ac voltage drop across the device by the ac current applied The specified limits are for I_Z(ac) = 0 1 I_Z(dc) with the ac frequency = 1 0 kHz.

BZX83C2V7 thru BZX83C33, M-ZPD2.7 thru M-ZPD33

ELECTRICAL CHARACTERISTICS (at T_A = 25°C)
Motorola ZPD and BZX83C series. Forward Voltage V_F = 1 Volt Max at I_F = 50 mA

Device Type		Zener Voltage (Note 1) at I_{ZT} = 5.0 mA			Impedance (Ω) Max (Note 2)			Typ. Temp. Coeff. at I_{ZT}	V_R Min V		
						at I_Z = 1 mA					
		Nominal	Min	Max	at I_{ZT}	BZX83	ZPD	% per °C	BZX83	ZPD	at I_R
BZX83C2V7	ZPD2.7	2.7	2.5	2.9	85	600	500	–0 09 –0.04	1	—	100 μA
BZX83C3V0	ZPD3.0	3	2.8	3.2	90	600	500	–0.09. –0.03	1	—	60 μA
BZX83C3V3	ZPD3 3	3 3	3.1	3.5	90	600	500	–0 08. .–0.03	1	—	30 μA
BZX83C3V6	ZPD3.6	3.6	3.4	3.8	90	600	500	–0.08...–0 03	1	—	20 μA
BZX83C3V9	ZPD3.9	3.9	3.7	4.1	85	600	500	–0.07...–0 03	1	—	10 μA
BZX83C4V3	ZPD4 3	4 3	4	4.6	80	600	500	–0 06 –0 01	1	—	5 μA
BZX83C4V7	ZPD4 7	4.7	4.4	5	78	600	500	–0.05 . +0 02	1	—	2 μA
BZX83C5V1	ZPD5 1	5.1	4.8	5.4	60	550	480	–0.03 ..+0 04	0.8		100 nA
BZX83C5V6	ZPD5 6	5.6	5.2	6	40	450	400	–0.02 . +0.06	1		100 nA
BZX83C6V2	ZPD6 2	6.2	5.8	6.6	10	200		–0.01 .+0.07	2		100 nA
BZX83C6V8	ZPD6 8	6 8	6 4	7.2	8	150		+0.02 +0 07	3		100 nA
BZX83C7V5	ZPD7 5	7.5	7	7 9	7	50		+0.03 +0 07	5		100 nA
BZX83C8V2	ZPD8 2	8.2	7 7	8 7	7	50		+0.04 +0 07	6		100 nA
BZX83C9V1	ZPD9 1	9.1	8.5	9 6	10	50		+0.05 +0 08	7		100 nA
BZX83C10	ZPD10	10	9.4	10 6	15	70		+0 05 +0.08	7 5		100 nA
BZX83C11	ZPD11	11	10 4	11.6	20	70		+0 05 +0 09	8.5		100 nA
BZX83C12	ZPD12	12	11.4	12 7	20	90		+0.06 +0 09	9		100 nA
BZX83C13	ZPD13	13	12 4	14 1	25	110		+0 07 +0 09	10		100 nA
BZX83C15	ZPD15	15	13.8	15.6	30	110		+0.07...+0.09	11		100 nA
BZX83C16	ZPD16	16	15.3	17.1	40	170		+0.08...+0.095	12		100 nA
BZX83C18	ZPD18	18	16.8	19 1	50	170		+0 08 ..+0 10	14		100 nA
BZX83C20	ZPD20	20	18.8	21 2	55	220		+0 08. +0 10	15		100 nA
BZX83C22	ZPD22	22	20 8	23.3	55	220		+0.08 ..+0.10	17		100 nA
BZX83C24	ZPD24	24	22.8	25.6	80	220		+0.08...+0.10	18		100 nA
BZX83C27	ZPD27	27	25.1	28.9	80	250		+0.08...+0.10	20		100 nA
BZX83C30	ZPD30	30	28	32	80	250		+0.08...+0.10	22		100 nA
BZX83C33	ZPD33	33	31	35	80	250		+0 08...+0 10	24		100 nA

NOTE 1. Pulse test
NOTE 2. f = 1 0 kHz, I_Z(ac) = 0 1 I_Z(dc)

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4.2

MZ4099 thru MZ4104, MZ4614 thru MZ4627

. . . designed for 250 mW applications requiring low leakage, low impedance. Same as 1N4099 through 1N4104 and 1N4614 through 1N4627 except low noise test omitted.

- Voltage Range from 1.8 to 10 Volts
- Zener Impedance and Zener Voltage Specified for Low-Level Operation at I_{ZT} = 250 μA

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise specified. I_{ZT} = 250 μA and V_F = 1 V Max @ I_F = 200 mA for all types)

Type Number (Note 1)	Nominal Zener Voltage V_Z (Note 2) (Volts)	Max Zener Impedance Z_{ZT} (Note 3) (Ohms)	Max Reverse Current I_R (μA)	@ (Note 5) Test Voltage V_R (Volts)	Max Zener Current I_{ZM} (Note 4) (mA)
MZ4614	1 8	1200	7.5	1	120
MZ4615	2	1250	5	1	110
MZ4616	2.2	1300	4	1	100
MZ4617	2.4	1400	2	1	95
MZ4618	2.7	1500	1	1	90
MZ4619	3	1600	0.8	1	85
MZ4620	3.3	1650	7.5	1.5	80
MZ4621	3.6	1700	7.5	2	75
MZ4622	3.9	1650	5	2	70
MZ4623	4.3	1600	4	2	65
MZ4624	4 7	1550	10	3	60
MZ4625	5.1	1500	10	3	55
MZ4626	5 6	1400	10	4	50
MZ4627	6.2	1200	10	5	45
MZ4099	6 8	200	10	5.2	35
MZ4100	7 5	200	10	5.7	31.8
MZ4101	8.2	200	1	6.3	29
MZ4102	8.7	200	1	6.7	27 4
MZ4103	9.1	200	1	7	26.2
MZ4104	10	200	1	7.6	24.8

NOTE 1. TOLERANCE AND VOLTAGE DESIGNATION

The type numbers shown have a standard tolerance of ±5% on the nominal zener voltage

NOTE 2. ZENER VOLTAGE (V_Z) MEASUREMENT

Nominal Zener Voltage is measured with the device junction in the thermal equilibrium with ambient temperature of 25°C

NOTE 3. ZENER IMPEDANCE (Z_{ZT}) DERIVATION

The zener impedance is derived from the 60 cycle ac voltage, which results when an ac current having an rms value equal to 10% of the dc zener current (I_{ZT}) is superimposed on I_{ZT}

NOTE 4. MAXIMUM ZENER CURRENT RATINGS (I_{ZM})

Maximum zener current ratings are based on maximum zener voltage of the individual units

NOTE 5. REVERSE LEAKAGE CURRENT I_R

Reverse leakage currents are guaranteed and are measured at V_R as shown on the table

NOTE 6. SPECIAL SELECTORS AVAILABLE INCLUDE:

a) Nominal Zener voltages between those shown

b) Tighter voltage tolerances. Contact your nearest Motorola representative for more information

Low Voltage Avalanche Passivated Silicon Oxide Zener Regulator Diodes

. . . Same as 1N5520B through 1N5530B except low noise test spec ommitted.

- Low Maximum Regulation Factor
- Low Zener Impedance
- Low Leakage Current

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise specified Based on dc measurements at thermal equilibrium, V_F = 1 1 Max @ I_F = 200 mA for all types)

Motorola Type No. (Note 1)	Nominal Zener Voltage V_Z @ I_{ZT} Volts (Note 2)	Test Current I_{ZT} mAdc	Max Zener Impedance Z_{ZT} @ I_{ZT} Ohms (Note 3)	Max Reverse Leakage Current I_R µAdc (Note 4)	Max Reverse Leakage Current V_R – Volts	Maximum DC Zener Current I_{ZM} mAdc (Note 5)	Regulation Factor ΔV_Z Volts (Note 6)	Low V_Z Current I_{ZL} mAdc
MZ5520B	3.9	20	22	1	1	98	0.85	2.0
MZ5521B	4.3	20	18	3	1 5	88	0 75	2.0
MZ5522B	4.7	10	22	2	2	81	0.6	1.0
MZ5523B	5.1	5	26	2	2.5	75	0 65	0 25
MZ5524B	5.6	3	30	2	3.5	68	0.3	0.25
MZ5525B	6.2	1	30	1	5	61	0.2	0.01
MZ5526B	6.8	1	30	1	6.2	56	0.1	0.01
MZ5527B	7.5	1	35	0 5	6.8	51	0.05	0.01
MZ5528B	8.2	1	40	0 5	7.5	46	0.05	0 01
MZ5529B	9.1	1	45	0 1	8.2	42	0.05	0 01
MZ5530B	10	1	60	0.05	9.1	38	0 1	0.01

NOTE 1. TOLERANCE AND VOLTAGE DESIGNATION

The "B" suffix type numbers listed are ±5% tolerance of nominal V_Z

NOTE 2. ZENER VOLTAGE (V_Z) MEASUREMENT

Nominal zener voltage is measured with the device junction in thermal equilibrium with ambient temperature of 25°C

NOTE 3. ZENER IMPEDANCE (Z_Z) DERIVATION

The zener impedance is derived from the 60 Hz ac voltage, which results when an ac current having an rms value equal to 10% of the dc zener current (I_{ZT}) is superimposed on I_{ZT}

NOTE 4. REVERSE LEAKAGE CURRENT I_R

Reverse leakage currents are guaranteed and are measured at V_R as shown on the table

NOTE 5. MAXIMUM REGULATOR CURRENT (I_{ZM})

The maximum current shown is based on the maximum voltage of a ±5% type unit, therefore, it applies only to the "B" suffix device The actual I_{ZM} for any device may not exceed the value of 400 milliwatts divided by the actual V_Z of the device

NOTE 6. MAXIMUM REGULATION FACTOR (ΔV_Z)

ΔV_Z is the maximum difference between V_Z at I_{ZT} and V_Z at I_{ZL} measured with the device junction in thermal equilibrium

NOTE 7. SPECIAL SELECTORS AVAILABLE INCLUDE:

a) Nominal Zener voltages between those shown

b) Tighter voltage tolerances Contact your nearest Motorola representative for more information