

SECTION 4.2.4 DATA SHEETS  
 ZENER VOLTAGE REGULATOR DIODES — continued

Section 4.2.4.2 Surface Mounted — continued

SECTION 4.2.4.2.2 500 mW LEADLESS (DO-34 BODY SIZE)

4

DATA SHEETS

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MLL5221B thru MLL5263B	4-2-75

MULTIPLE PACKAGE QUANTITY (MPQ)  
 REQUIREMENTS

Package Option	Type No. Suffix	MPQ (Units)
Tape and Reel	T1, T2(1)	2K
Tape and Reel	T3, T4(1)	5K

NOTE 1. The numbers on the suffixes indicate the following:  
 1. 7" Reel. Cathode lead toward sprocket hole.  
 2. 7" Reel. Cathode lead away from sprocket hole.  
 3. 13" Reel. Cathode lead toward sprocket hole.  
 4. 13" Reel. Cathode lead away from sprocket hole.

4.2

TRANSIENT VOLTAGE SUPPRESSORS AND ZENER DIODES

4-2-67

\*MOT0SD23\*

**MOTOROLA  
SEMICONDUCTOR  
TECHNICAL DATA**

*500 mW Leadless DO-34 Glass  
Zener Voltage Regulator Diodes*

**GENERAL DATA APPLICABLE TO ALL SERIES IN  
THIS GROUP**

**500 mW Hermetically Sealed  
Glass Silicon Zener Diodes**

**Specification Features:**

- Complete Voltage Range — 1.8 to 56 Volts
- Leadless Package for Surface Mount Technology
- Double Slug Type Construction
- Metallurgically Bonded Construction
- Oxide Passivated Die

**Mechanical Characteristics:**

**CASE:** Double slug type, hermetically sealed glass

**MAXIMUM LEAD TEMPERATURE FOR SOLDERING PURPOSES:** 230°C,  
for 10 seconds

**FINISH:** All external surfaces are corrosion resistant and readily solderable

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

**MOUNTING POSITION:** Any

**GENERAL  
DATA**

**500 mW  
LEADLESS  
DO-34**

**LEADLESS  
GLASS ZENER DIODES  
500 MILLIWATTS  
1.8-56 VOLTS**



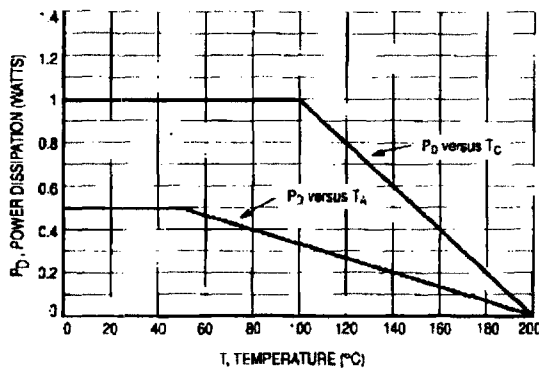
**CASE 362-03  
GLASS**

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MAXIMUM RATINGS			
Rating	Symbol	Value	Unit
DC Power Dissipation @ $T_A \leq 50^\circ\text{C}$ Derate above $T_A = 50^\circ\text{C}$	$P_D$	500 3.3	mW mW/°C
Operating and Storage Junction Temperature Range	$T_J, T_{stg}$	-65 to -200	°C

4.2

**STEADY STATE POWER DERATING**



TRANSIENT VOLTAGE SUPPRESSORS AND ZENER DIODES

4-2-68

**APPLICATION NOTE**

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:

Case Temperature,  $T_C$ , should be determined from:

$$T_C = \theta_{CA} P_D + T_A$$

$\theta_{CA}$  is the case-to-ambient thermal resistance ( $^{\circ}\text{C/W}$ ) and  $P_D$  is the power dissipation. The value for  $\theta_{CA}$  will vary and depends on the device mounting method.  $\theta_{CA}$  is generally  $200^{\circ}\text{C/W}$  for the various clips and tie points in common use and for printed circuit board wiring.

The temperature of the case can also be measured using a thermocouple placed at the case end and 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  $T_C$ , the junction temperature may be determined by:

$$T_J = T_C + \Delta T_{JC}$$

$\Delta T_{JC}$  is the increase in junction temperature above the case temperature and may be found by using:

$$\Delta T_{JC} = \theta_{JC} P_D$$

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:

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

$\theta_{VZ}$ , the zener voltage temperature coefficient, is found from Figures 3 and 4.

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 6. 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 6 be exceeded.

**TYPICAL CHARACTERISTICS**

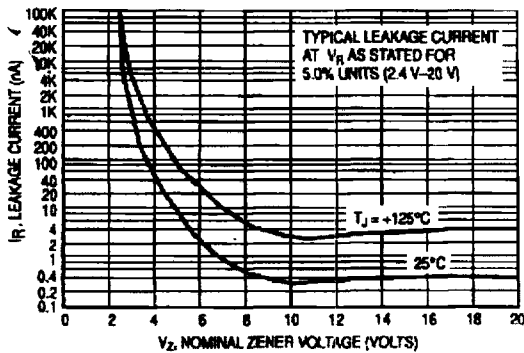


Figure 1. Typical Leakage Current

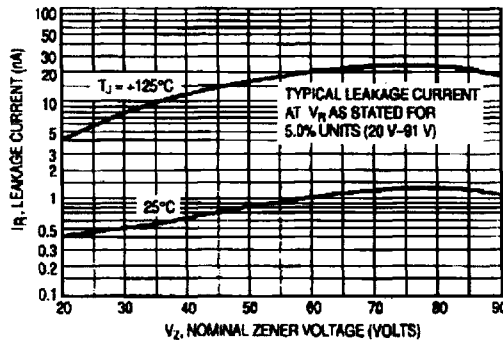
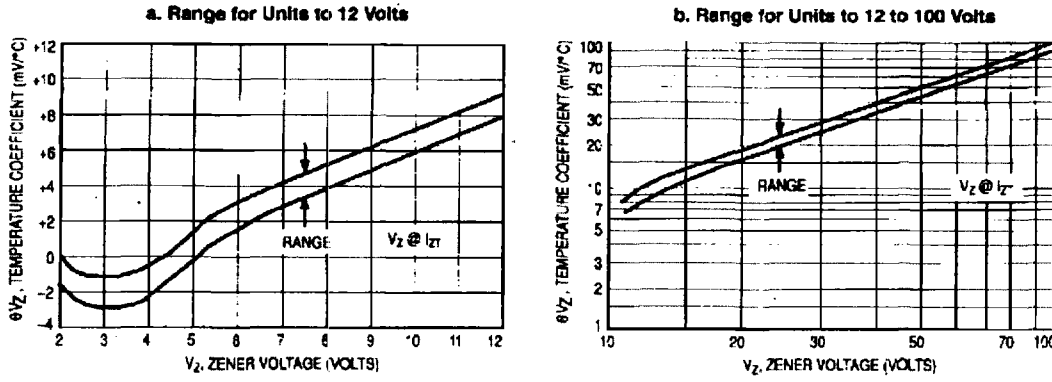
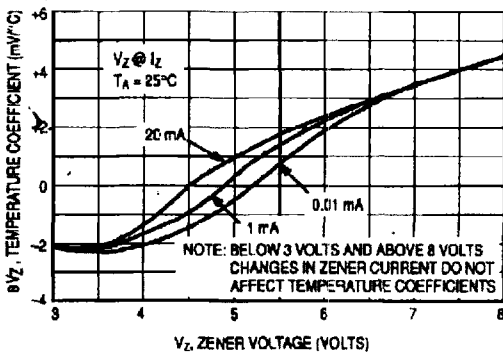


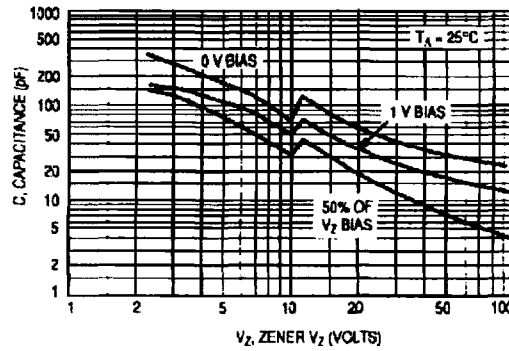
Figure 2. Typical Leakage Current



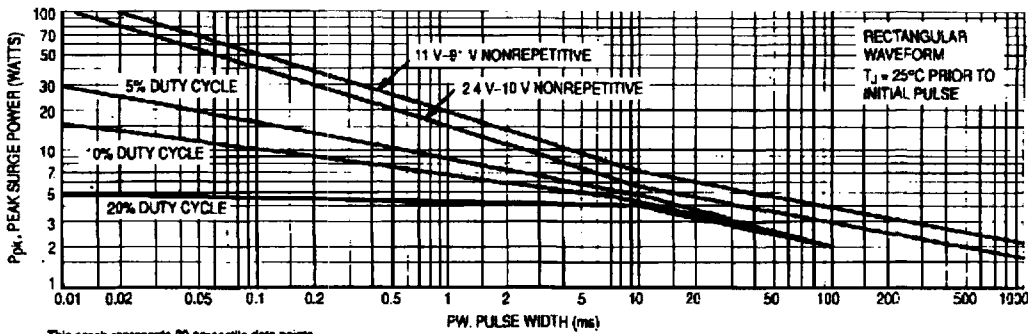
**Figure 3. Temperature Coefficients**  
 (-55°C to +150°C temperature range; 90% of the units are in the ranges indicated.)



**Figure 4. Effect of Zener Current**



**Figure 5. Typical Capacitance**



This graph represents 90 percentile data points.  
 For worst case see gn characteristics. multiply surge power by 2.3.

**Figure 6. Maximum Surge Power**

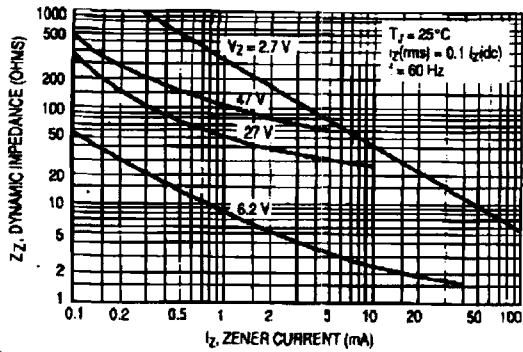


Figure 7. Effect of Zener Current on Zener Impedance

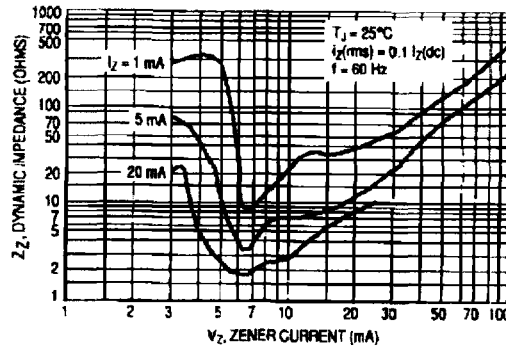


Figure 8. Effect of Zener Voltage on Zener Impedance

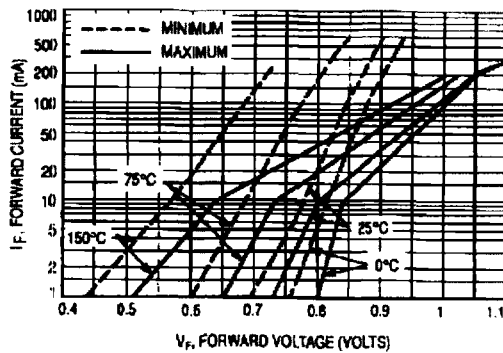


Figure 9. Typical Forward Characteristics

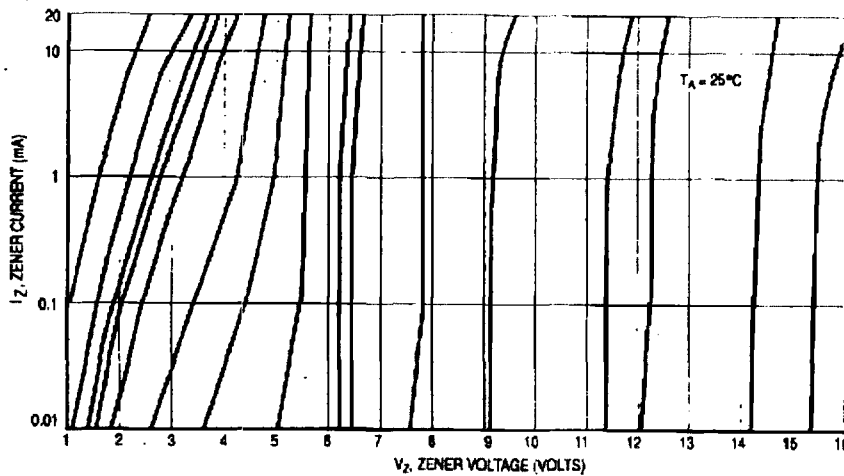


Figure 10. Zener Voltage versus Zener Current —  $V_Z = 1$  thru 16 Volts

GENERAL DATA — 500 mW LEADLESS DO-34

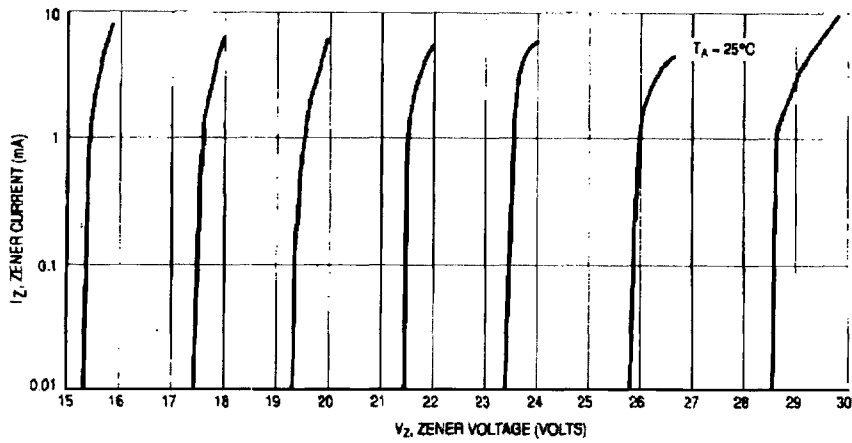


Figure 11. Zener Voltage versus Zener Current —  $V_Z = 15$  thru 30 Volts

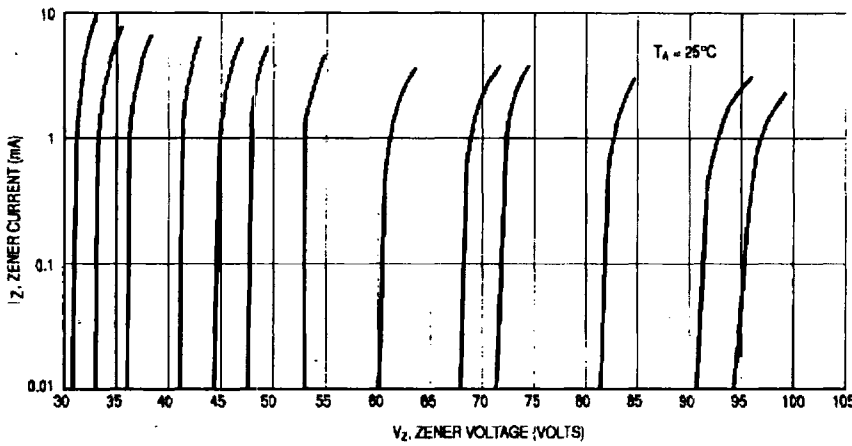


Figure 12. Zener Voltage versus Zener Current —  $V_Z = 30$  thru 105 Volts

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1.2

MOTOROLA SC (DIODES/OPTO) 64E D ■ 6367255 0085443 833 ■ M077  
**BZV55C2V4 thru BZV55C56**

ELECTRICAL CHARACTERISTICS ( $V_F = 0.9$ V Max @ $I_F = 10$ mA for all types)												
Type Number	Zener Voltage $V_Z$ (Volts) @ $I_{ZT} = 5$ mA (Note 1)			Max Zener Impedance $Z_{ZT}$ (Ohms) @ $I_{ZT} = 5$ mA	Max Reverse Leakage Current		Zener Voltage $V_Z$ (Volts) @ $I_{ZT} = 1$ mA (Note 1)		Max Zener Impedance $Z_{ZT}$ (Ohms) @ $I_{ZT} = 1$ mA	Zener Voltage $V_Z$ (Volts) @ $I_{ZT} = 20$ mA (Note 1)		Max Zener Impedance $Z_{ZT}$ (Ohms) @ $I_{ZT} = 20$ mA
	Nom	Min	Max		$I_R$ $\mu$ A	$V_R$ Volts	Min	Max		Min	Max	
BZV55C2V4	2.4	2.2	2.8	100	50	1	1.7	2.1	600	2.6	3.2	50
BZV55C2V7	2.7	2.5	2.9	100	20	1	1.9	2.4	600	3	3.6	50
BZV55C3V0	3	2.8	3.2	95	10	1	2.1	2.7	600	3.3	3.9	50
BZV55C3V3	3.3	3.1	3.5	95	5	1	2.3	2.9	600	3.6	4.2	40
BZV55C3V6	3.6	3.4	3.8	90	5	1	2.7	3.3	600	3.9	4.5	40
BZV55C3V9	3.9	3.7	4.1	90	3	1	2.9	3.5	600	4.1	4.7	30
BZV55C4V3	4.3	4	4.6	90	3	1	3.3	4	600	4.4	5.1	30
BZV55C4V7	4.7	4.4	5	80	3	2	3.7	4.7	500	4.5	5.4	15
BZV55C5V1	5.1	4.8	5.4	80	2	2	4.2	5.3	480	5	5.9	15
BZV55C5V6	5.6	5.2	6	40	1	2	4.6	6	400	5.2	6.3	10
BZV55C6V2	6.2	5.8	6.6	10	3	4	5.6	6.6	150	5.8	6.8	8
BZV55C6V6	6.8	6.4	7.2	15	2	4	6.3	7.2	80	6.4	7.4	6
BZV55C7V6	7.5	7	7.9	15	1	5	6.9	7.9	80	7	8	6
BZV55C8V2	8.2	7.7	8.7	15	0.7	5	7.6	8.7	80	7.7	8.8	6
BZV55C9V1	9.1	8.5	9.6	15	0.5	6	8.4	9.6	100	8.5	9.7	8
BZV55C10	10	9.4	10.6	20	0.2	7	9.3	10.6	150	9.4	10.7	10
BZV55C11	11	10.4	11.6	20	0.1	8	10.2	11.6	150	10.4	11.8	10
BZV55C12	12	11.4	12.7	25	0.1	8	11.2	12.7	150	11.4	12.9	10
BZV55C13	13	12.4	14.1	30	0.1	8	12.3	14	170	12.5	14.2	15
BZV55C16	15	13.8	16.6	30	0.06	10.5	13.7	16.5	200	13.9	16.7	20
BZV55C18	16	15.3	17.1	40	0.05	11.2	15.2	17	200	15.4	17.2	20
BZV55C18	18	16.8	19.1	45	0.05	12.6	16.7	19	225	16.9	19.2	20
BZV55C20	20	18.8	21.2	55	0.05	14	18.7	21.1	225	18.9	21.4	20
BZV55C22	22	20.8	23.3	55	0.05	15.4	20.7	23.2	250	20.9	23.4	25
BZV55C24	24	22.8	25.6	70	0.05	16.8	22.7	25.5	250	22.9	25.7	25
	$V_Z$ Below @ $I_{ZT} = 2$ mA			$Z_{ZT}$ Below @ $I_{ZT} = 2$ mA			$V_Z$ Below @ $I_{ZT} = 0.1$ mA		$Z_{ZT}$ Below @ $I_{ZT} = 0.1$ mA (Note 2)	$V_Z$ Below @ $I_{ZT} = 10$ mA		$Z_{ZT}$ Below @ $I_{ZT} = 10$ mA
BZV55C27	27	25.1	28.9	80	0.05	18.9	25	28.9	300	25.2	29.3	45
BZV55C30	30	28	32	80	0.05	21	27.8	32	300	28.1	32.4	50
BZV55C33	33	31	35	80	0.05	23.1	30.8	35	325	31.1	35.4	55
BZV55C36	36	34	38	80	0.05	25.2	33.8	38	350	34.1	38.4	60
BZV55C39	39	37	41	130	0.05	27.3	36.7	41	350	37.1	41.5	70
BZV55C43	43	40	46	150	0.05	30.1	39.7	46	375	40.1	45.5	80
BZV55C47	47	44	50	170	0.05	32.9	43.7	50	375	44.1	50.5	90
BZV55C51	51	48	54	180	0.05	36.7	47.6	54	400	48.1	54.6	100
BZV55C56	56	52	60	200	0.05	39.2	51.5	60	425	52.1	60.8	110

NOTES: 1. Zener voltage is measured with a pulse test current ( $I_Z$ ) applied at an ambient temperature of 25°C.  
 2. The zener impedances,  $Z_{ZT}$ , for the 27 through 56 volt types is tested at 0.5 mA rather than the test current of 0.1 mA used for  $V_Z$ .

**MLL4678 thru MLL4717**

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

- Complete Voltage Range — 1.8 to 43 Volts
- Zener Voltage Specified @  $I_{ZT} = 50 \mu A$
- Leadless Package for Surface Mount Technology
- Maximum Delta  $V_Z$  Given from 10 to 100  $\mu A$

ELECTRICAL CHARACTERISTICS ( $T_A = 25^\circ C$ , $V_F = 0.9 V$ Max at $I_F = 10 mA$ for all types)							
Type Number (Note 1)	Zener Voltage $V_Z @ I_{ZT} = 50 \mu A$ Volts			Maximum Reverse Current $I_R \mu A$	Test Voltage $V_R$ Volts (Note 3)	Maximum Zener Current $I_{ZM} mA$ (Note 2)	Maximum Voltage Change $\Delta V_Z$ Volts (Note 4)
	Nom (Note 5)	Min	Max				
MLL4678	1.8	1.71	1.89	7.5	1	120	0.7
MLL4679	2	1.9	2.1	6	1	110	0.7
MLL4680	2.2	2.09	2.31	4	1	100	0.75
MLL4681	2.4	2.28	2.52	2	1	95	0.8
MLL4682	2.7	2.585	2.835	1	1	90	0.85
MLL4683	3	2.85	3.15	0.8	1	85	0.9
MLL4684	3.3	3.135	3.465	7.5	1.5	80	0.95
MLL4685	3.6	3.42	3.78	7.5	2	75	0.95
MLL4686	3.9	3.705	4.095	5	2	70	0.97
MLL4687	4.3	4.085	4.515	4	2	65	0.99
MLL4688	4.7	4.465	4.935	10	3	60	0.99
MLL4689	5.1	4.845	5.355	10	3	55	0.97
MLL4690	5.6	5.32	5.88	10	4	50	0.96
MLL4691	6.2	5.89	6.51	10	5	45	0.95
MLL4692	6.8	6.46	7.14	10	5.1	35	0.9
MLL4693	7.5	7.125	7.875	10	5.7	31.8	0.75
MLL4694	8.2	7.79	8.61	1	6.2	29	0.5
MLL4695	8.7	8.265	9.135	1	6.6	27.4	0.1
MLL4696	9.1	8.645	9.555	1	6.9	26.2	0.08
MLL4697	10	9.5	10.5	1	7.6	24.8	0.1
MLL4698	11	10.45	11.55	0.05	8.4	21.6	0.11
MLL4699	12	11.4	12.6	0.05	9.1	20.4	0.12
MLL4700	13	12.35	13.65	0.05	9.8	19	0.13
MLL4701	14	13.3	14.7	0.05	10.6	17.5	0.14
MLL4702	15	14.25	15.75	0.05	11.4	16.3	0.15
MLL4703	16	15.2	16.8	0.05	12.1	15.4	0.16
MLL4704	17	16.15	17.85	0.05	12.9	14.5	0.17
MLL4705	18	17.1	18.9	0.05	13.6	13.2	0.18
MLL4706	18	18.05	19.95	0.05	14.4	12.5	0.19
MLL4707	20	19	21	0.01	15.2	11.9	0.2
MLL4708	22	20.9	23.1	0.01	16.7	10.8	0.22
MLL4709	24	22.8	25.2	0.01	18.2	9.9	0.24
MLL4710	25	23.75	26.25	0.01	19	9.5	0.25
MLL4711	27	25.65	28.35	0.01	20.4	8.8	0.27
MLL4712	28	26.6	29.4	0.01	21.2	8.5	0.28
MLL4713	30	28.5	31.5	0.01	22.8	7.9	0.3
MLL4714	33	31.35	34.65	0.01	25	7.2	0.33
MLL4715	36	34.2	37.8	0.01	27.3	6.6	0.36
MLL4716	39	37.05	40.95	0.01	29.6	6.1	0.39
MLL4717	43	40.85	45.15	0.01	32.6	5.5	0.43

NOTE 1. TOLERANCE AND VOLTAGE DESIGNATION ( $V_Z$ )

The type numbers shown have a standard tolerance of  $\pm 5\%$  on the nominal zener voltage.

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

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

NOTE 3. REVERSE LEAKAGE CURRENT ( $I_R$ )

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

NOTE 4. MAXIMUM VOLTAGE CHANGE ( $\Delta V_Z$ )

Voltage change is equal to the difference between  $V_Z$  at 100  $\mu A$  and  $V_Z$  at 10  $\mu A$ .

NOTE 5. ZENER VOLTAGE ( $V_Z$ ) MEASUREMENT

Nominal zener voltage is measured with the device junction in thermal equilibrium at the case temperature of  $30^\circ C \pm 1^\circ C$ .



MOTOROLA SC (DIODES/OPTO) 64E D ■ 6367255 0085445 606 ■ MOT7  
**MLL5221B thru MLL5263B**

**ELECTRICAL CHARACTERISTICS** ( $T_A = 25^\circ\text{C}$  unless otherwise noted. Based on dc measurements at thermal equilibrium; case temperature maintained at  $30 \pm 2^\circ\text{C}$ .  $V_F = 0.9$  Max @  $I_F = 10$  mA for all types.)

Type No. (Note 1)	Nominal Zener Voltage $V_Z @ I_{ZT}$ (Note 2)	Test Current $I_{ZT}$ mA	Max Zener Impedance		Max Reverse Leakage Current		Max Zener Voltage Temperature Coeff. $\Delta V_Z$ (%/°C) (Note 3)
			$Z_{ZT} @ I_{ZT}$ Ohms	$Z_{ZK} @ I_{ZK} = 0.25$ mA Ohms	$I_R @ V_R$ $\mu\text{A}$ Volts		
MLL5221B	2.4	20	30	1200	100	1	-0.065
MLL5222B	2.5	20	30	1250	100	1	-0.065
MLL5223B	2.7	20	30	1300	75	1	-0.08
MLL5224B	2.8	20	30	1400	75	1	-0.08
MLL5225B	3	20	28	1600	50	1	-0.075
MLL5226B	3.3	20	28	1600	25	1	-0.07
MLL5227B	3.6	20	24	1700	15	1	-0.065
MLL5228B	3.9	20	23	1900	10	1	-0.06
MLL5229B	4.3	20	22	2000	5	1	$\pm 0.055$
MLL5230B	4.7	20	18	1900	5	2	$\pm 0.03$
⇒ MLL5231B	5.1	20	17	1600	5	2	$\pm 0.03$
MLL5232B	5.6	20	11	1600	5	3	+0.038
⇒ MLL5233B	6	20	7	1600	5	3.5	+0.036
MLL5234B	6.2	20	7	1000	5	4	+0.045
MLL5235B	6.8	20	5	750	3	5	+0.05
MLL5236B	7.5	20	6	500	3	6	+0.058
MLL5237B	8.2	20	8	500	3	6.5	+0.062
MLL5238B	8.7	20	8	600	3	6.5	+0.065
MLL5239B	9.1	20	10	600	3	7	+0.068
MLL5240B	10	20	17	600	3	8	+0.075
MLL5241B	11	20	22	600	2	8.4	+0.076
MLL5242B	12	20	30	600	1	9.1	+0.077
MLL5243B	13	9.5	13	600	0.5	9.9	+0.079
⇒ MLL5244B	14	9	15	600	0.1	10	+0.082
MLL5245B	15	8.5	16	600	0.1	11	+0.082
MLL5246B	16	7.8	17	600	0.1	12	+0.083
MLL5247B	17	7.4	19	600	0.1	13	+0.084
MLL5248B	18	7	21	600	0.1	14	+0.085
MLL5249B	19	6.6	23	600	0.1	14	+0.086
MLL5250B	20	6.2	25	600	0.1	15	+0.086
MLL5251B	22	5.6	28	600	0.1	17	+0.087
⇒ MLL5252B	24	5.2	33	600	0.1	18	+0.088
MLL5253B	25	5	35	600	0.1	19	+0.089
MLL5254B	27	4.6	41	600	0.1	21	+0.09
MLL5255B	28	4.5	44	600	0.1	21	+0.091
MLL5256B	30	4.2	49	600	0.1	23	+0.091
MLL5257B	33	3.8	58	700	0.1	25	+0.092
MLL5258B	36	3.4	70	700	0.1	27	+0.093
MLL5259B	39	3.2	80	800	0.1	30	+0.094
MLL5260B	43	3	93	900	0.1	33	+0.095
MLL5261B	47	2.7	105	1000	0.1	36	+0.095
MLL5262B	51	2.5	125	1100	0.1	39	+0.096
MLL5263B	56	2.2	150	1300	0.1	43	+0.096

(continued)

⇒ Preferred part

(See Notes on the following page)

MOTOROLA SC (DIODES/OPTO) 64E D ■ 6367255 0085446 542 ■ MOT7  
MLL5221B thru MLL5263B

**NOTE 1. TOLERANCE**

Units shown indicate a tolerance of ±5%.

**NOTE 2. SPECIAL SELECTIONS AVAILABLE:**

For information on special selections contact your nearest Motorola representative.

**NOTE 3. TEMPERATURE COEFFICIENT ( $\alpha_{Vz}$ )**

Test conditions for temperature coefficient are as follows:

- a.  $I_{ZT} = 7.5 \text{ mA}$ ,  $T_1 = 25^\circ\text{C}$ ,  
 $T_2 = 125^\circ\text{C}$  (MLL5221B through MLL5242B).
- b.  $I_{ZT} = \text{Rated } I_{ZT}$ ,  $T_1 = 25^\circ\text{C}$ ,  
 $T_2 = 125^\circ\text{C}$  (MLL5243B through MLL5263B).

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 case temperature of  $30^\circ\text{C} \pm 1^\circ\text{C}$ .

**NOTE 5. ZENER IMPEDANCE ( $Z_Z$ ) DERIVATION**

$Z_Z$  and  $Z_{0Z}$  are measured by dividing the ac voltage drop across the device by the ac current applied. The specified limits are for  $I_Z(\text{ac}) = 0.1 \times I_Z(\text{dc})$  with the ac frequency = 1 kHz.

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