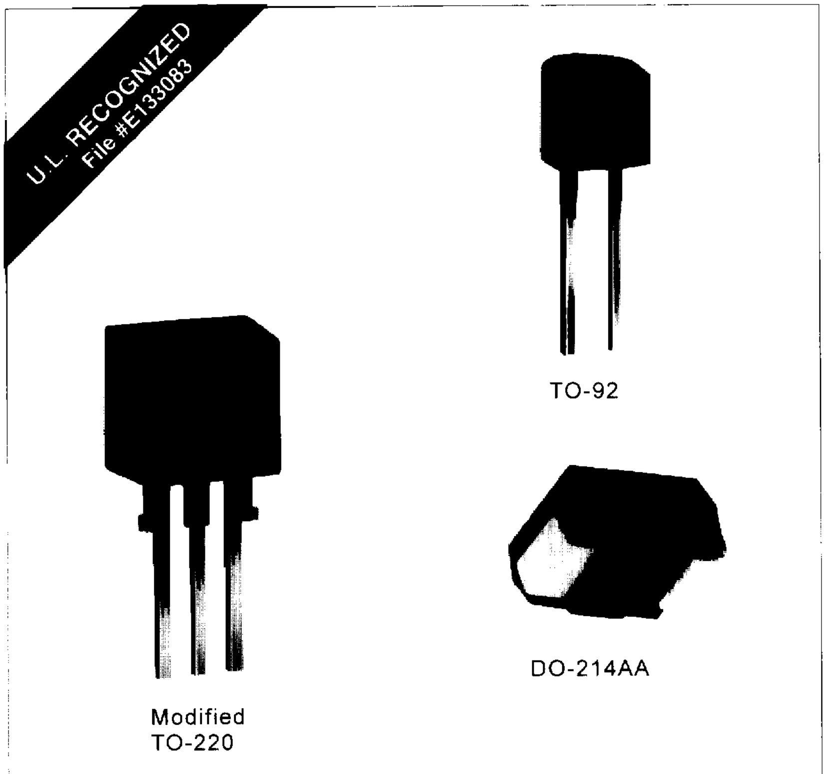

TECCOR
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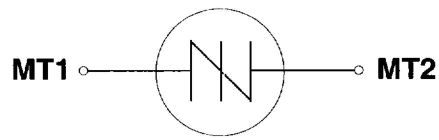


SIDACtor®

(27 - 540 volts)

General Information

The Teccor SIDACtor is a transient overvoltage protector with clamping voltage ranges of 27 to 540 volts. The SIDACtor can also be supplied in multiple-chip packages. Surge current ratings are from 50 amps to 100 amps (10X1000μs).

Upon application of a voltage exceeding the SIDACtor breakover voltage point, the SIDACtor switches on through a negative or positive resistance region to a low on-state voltage. Conduction will continue until the current is interrupted or drops below the minimum holding current of the device.

If your electronic equipment is being protected by zener diodes, gas discharge tubes, MOV's or other types of protectors, you are taking unnecessary risks. The Teccor SIDACtor offers longer life and faster response than other types of protection.

The bidirectional SIDACtor is ideal for protecting electronic equipment (telecommunications, computers, instrumentation, etc.) from lightning, line transients, and other damaging high voltage spikes. The SIDACtor can be tailored to meet specific application requirements.

The SIDACtor is faster than other currently-used devices or methods and is able to respond without voltage overshoot. Conventional gas discharge tubes, carbon arrestors, and MOV's are all slow to respond and allow significant voltage spikes above the clamping voltage before they begin to conduct. The SIDACtor is as fast as a zener diode, while offering a much lower impedance during conduction. SIDACtors can handle much more current and they are bidirectional.

Teccor's unique multi-chip packaging also offers complete protection of all circuit legs with a single package.

The SIDACtor is normally connected between the high side of the circuit to be protected and common. As long as the voltage being monitored remains below the specified level, the SIDACtor presents a high off-state impedance (leakage current ≤ 5μA). When the monitored voltage exceeds the specified level (clamping voltage), the SIDACtor starts clamping in nanoseconds. The SIDACtor will continue to conduct until the current is interrupted or drops below the minimum holding current of the device.

SIDACtors do not degrade with time, bias, operations or surges within the device ratings. SIDACtors fails short circuit when the surge current exceeds the devices rated I_{PP} or I_{TSM}.

Tape-and-reel packaging is available for both TO-92 and TO-220 packages; embossed carrier reel packing for DO-214AA. Please consult the factory for more information.

Features

- **Bidirectional Transient Voltage Protection**
- **Breakover Voltages from 27 to 540 volts**
- **Clamping speed of nanoseconds**
- **Patented Multiple Chip Packages**
- **Electrically Isolated Packages**
- **Robust Surge Current Capabilities**
- **Glass-Passivated Junctions**

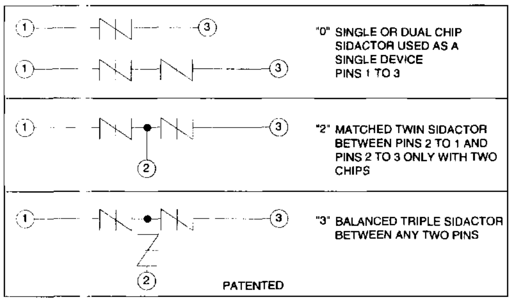
Part Number Definition

P 210 3 A X XX XX

DEVICE TYPE
P = SIDACtors

VOLTAGE RATING
030 = 27 - 36V
060 = 54 - 72V
064 = 58 - 70V
072 = 65 - 80V
080 = 60 - 95V
110 = 90 - 125V
130 = 120 - 145V
150 = 135 - 165V
155 = 140 - 170V
160 = 120 - 190V
200 = 190 - 215V
210 = 180 - 240V
220 = 190 - 250V
220 = 205 - 230V
230 = 190 - 265V
235 = 210 - 265V
240 = 220 - 250V
250 = 240 - 280V
260 = 220 - 300V
270 = 240 - 300V
300 = 270 - 330V
300 = 280 - 320V
310 = 275 - 350V
320 = 280 - 350V
330 = 300 - 360V
340 = 300 - 380V
350 = 300 - 400V
480 = 440 - 580V
600 = 540 - 720V

CONSTRUCTION VARIABLE



PACKAGE TYPE
A = MODIFIED TO-220
B = TO-92
E = TO-92
S = DO-214AA

IPP MAXIMUM (10x1000μs)
A = 50 amp or 75 amp
(Except PXXX0BA70 is 100 amp)
B = 100 amp

LEAD FORM OPTIONS
TO-220 Modified ..... (See Page 108)
TO-92 .... (See Page 104)

PACKING OPTIONS
See table below

Device Packing Options					
Package Type	**Description**	**Packing Quantity**	**Added Suffix**	**Optional**	**Industry Standard**
TO-92	Bulk Pack	2000		Standard	None
	Tape and Reel Pack	2000	RD	Option	EIA RS-468-A
	Tape and Ammo Pack	2000	RC	Option	EIA RS-468-A
TO-220	Bulk Pack	500		Standard	None
	Clear Plastic Magazine or Tube Pack	50	TA	Option	None
	Tape and Reel Pack	700	RB	Option	EIA RS-468-A
	Tape and Reel Pack for Type 61 Leadform	700	RC	Option	EIA RS-468-A
DO-214AA	Embossed Carrier Reel Pack	2500	FA	Standard	EIA-481-1
	Bulk Pack	5000		Option	None
Detailed packing drawings are available from the factory, upon request.					

100% Testing is a constant monitor for Quality Assurance

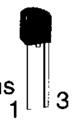
Test Description	Condition	Comments
1. Surge (I_{PP})	10 x 1000 μSec. Rated Current	Repeated four times in the normal sequence of testing, except TO-92 which is repeated twice.
2. Breakover Voltage (V_{BO})	V_{BO} and absolute peak in forward and reverse directions	All devices fully characterized on voltage to ensure proper operation and reliability.
3. Holding Current (I_H)	Measured for a minimum value as rated	This ensures proper delatch (turn-off) after surge current condition.
4. Peak On-State Voltage (V_{TM})	Measured with 1 Amp RMS or DC current	
5. Leakage Current (I_{DRM})	Breakover leakage and off-state leakage	These tests ensure long term reliability.

Environmental and life tests are constantly being performed on the Sidactor to confirm long-term reliability. Listed below are some of these tests.

Test Description	Conditions	Comments
1. High Temperature Storage	+ 150°C for 250 hrs., no bias, post tested to confirm 25°C electrical specifications.	The epoxy encapsulated Sidactors are transfer molded, making them extremely tough and durable.
2. Temperature Cycling	- 40°C to + 125°C, 30 minute dwell at all extremes with 40 minute transfer time, for 500 cycles, no bias, post tested to confirm initial 25°C electrical specifications.	Exceeds normal telecommunication's temperature requirements.
3. Thermal Shock (Liquid to Liquid)	0°C to + 100°C, 15 seconds dwell time at extremes.	
4. Blocking (Off-State) Voltage Test	+ 125°C for 500 hours minimum with 80% of rated V_{BO} minimum supplied as bias then post tested to confirm initial 25°C electrical specifications.	Teccor's glass passivated junctions ensure long term blocking capability.
5. Flammability	The epoxy encapsulated body passes UL 94V0 requirements.	The epoxy used in the molded Sidactor is UL recognized.
6. High Voltage, High Current Life Testing (Power Burn-in)	Repeated surging of devices at rated V_{BO} discharging capacitors (I_{PP}) for ≥ 10K surge cycles.	This is a repetitive surge current and voltage life test where often devices are tested for ≥ 50K surges.
7. Humidity Life Test	85% RH, + 85°C for 100 hrs. minimum post tested to confirm initial 25°C electrical specifications.	Industry standard test for molded epoxy package devices.
8. Highly Accelerated Stress Testing (HAST)	Autoclave for 24 hours at + 121°C at 2ATMs. Post tested to confirm initial 25°C electrical specifications.	This is a pressure cooker or "steam-bomb" test to further show integrity of the epoxy packages.
9. I_{PP} Surge Life Test	Surged 100 times simultaneously at rated I_{PP} 10x1000 μSec.	This is to test the I_{PP} surge life capabilities of the device.

Electrical Specifications

Bidirectional

Package TYPE	Package	Part Number	V_{BO} Breakover Voltage (Instantaneous Clamping Voltage) (1)(5)(16)(19) Volts, PINS 1 to 3		I_{BO} Breakover Current µAmps	V_{DRM} Blocking Voltage (2) (4) Volts, PINS 1 to 3	I_{DRM} Peak Off-State Current at V_{DRM} (2) µAmps	I_{PP} Peak Pulse Current $T_J \le 150°C$ (7) (12) Amps			I_{TSM} Peak One Cycle (Sinusoidal) Surge Current (17) Amps	
								10x160µs	10x560µs	10x1000µs		
			MIN	MAX	MAX	MIN	MAX	MAX	MAX	MAX	60Hz	50Hz
E TYPE 70	 Pins 1 3 TO-92 (Isolated)	P0300EA70	27	36	10	20	5	100	50	50	30	25
		P0640EA70	58	70	10	50	5	150	75	75	30	25
		P0720EA70	65	80	10	50	5	150	75	75	30	25
		P0800EA70	60	95	10	50	5	150	75	75	30	25
		P1100EA70	90	125	10	75	5	100	50	50	30	25
		P1300EA70	120	145	10	95	5	100	50	50	30	25
		P1500EA70	135	165	10	110	5	100	50	50	30	25
		P2300EA70 (13)	190	265	10	160	5	100	50	50	30	25
		P2600EA70 (13)	220	300	10	180	5	100	50	50	30	25
		P3100EA70 (13)	275	350	10	220	5	100	50	50	30	25
		P3500EA70 (13)	300	400	10	240	5	100	50	50	30	25
B TYPE 70	 Pins 1 3 TO-92 (Isolated)	P2300BA70 (13)	190	265	10	160	5	150	100	100	60	50
		P2600BA70 (13)	220	300	10	180	5	150	100	100	60	50
		P3100BA70 (13)	275	350	10	220	5	150	100	100	60	50
		P3500BA70 (13)	300	400	10	240	5	150	100	100	60	50

GENERAL NOTES

- All measurements are made at 60Hz with a resistive load at an ambient temperature of +25°C unless otherwise specified.
- Storage temperature range (T_S) is -65°C to +150°C.
- The case temperature (T_C) is measured as shown on the dimensional outline drawings. See "Package Dimensions" section.
- Junction temperature range (T_J) is -40°C to +150°C on all devices except for P0300EA70, P0300SA and P0602AA where T_J is -40°C to +125°C.
- Lead solder temperature is a maximum of +230°C for 10 seconds maximum; ≥ 1/16" (1.59mm) from case.
- All SIDACtors are Bidirectional and all Electrical Parameters apply to both the forward and reverse polarities.
- All SIDACtors are recognized under UL 497B "Protectors for Data Communications and Fire Alarm Circuits", UL File #E133083.
- All SIDACtor Leads are Tin/Lead plated with no less than 5% lead content.
- All SIDACtors meet the surge requirements of the following standards:

CCITT K17 - K20	10/700 µs	1.5 kV
	5/310 µs	38 A
VDE 0433	10/700 µs	2 kV
	5/200 µs	50 A
CNET	0.5/700 µs	1.5 kV
	0.2/310 µs	38 A

ELECTRICAL ISOLATION

Teccor's electrically isolated TO-92 and modified TO-220 SIDACtor will withstand a high potential test of 1600 VAC RMS from leads to case over the operating temperature range.

I^2t	I_T	I_H	V_{TM}	C_O		di/dt
RMS Surge (Non-Repetitive) On-State Current For a Period of 8.3 ms for Fusing	Continuous On-State DC or RMS Current (8)(18)	Holding Current (3)	Peak On-State Voltage I_T = 1 Amp	Off-State Capacitance at 1kHz 1VAC with 50VDC Bias (6) (20)	Off-State Capacitance at 1MHz 15mVAC with 50VDC Bias (6) (20)	Critical Rate of Rise of On-State Current
			Volts	pF	pF	
Amps^2 Sec	Amps	mAmps	PINS 1 to 3	PINS 1 to 3	PINS 1 to 3	Amps/µs
	MAX	MIN	MAX	TYP	TYP	MAX
3.7	1.0	50	4.0	90 (20)	90 (20)	100
3.7	1.0	150	3.0	70	70	100
3.7	1.0	150	3.0	70	70	100
3.7	1.0	150	3.0	70	70	100
3.7	1.0	150	3.0	50	50	100
3.7	1.0	150	3.0	45	45	100
3.7	1.0	150	3.0	35	35	100
3.7	1.0	150	4.0	50	50	100
3.7	1.0	150	4.0	40	40	100
3.7	1.0	150	4.0	40	40	100
3.7	1.0	150	4.0	40	40	100
15.0	1.0	150	4.0	50	50	100
15.0	1.0	150	4.0	40	40	100
15.0	1.0	150	4.0	40	40	100
15.0	1.0	150	4.0	40	40	100

FOR NOTES TO ELECTRICAL SPECIFICATIONS

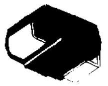
See Pages 80 and 81.

APPLICATIONS GUIDE
See Referenced Device Application Notes for Device Recommendations

Application	Description	Application Note
FCC Part 68	Connection of Terminal Equipment to the Telephone Network	AN1010 AN1011
UL 1459	Telephone Equipment Safety	AN1010 AN1011
Bellcore TR-NWT-001089	Compatibility and Safety for Network Telecommunications Equipment	AN1012
Bellcore TR-NWT-000974	Telecommunications Primary Line Protector Units for Central Office and Station	Call factory for assistance.
SLIC	Subscriber Line Interface Circuit	AN1013
PTC's	Using PTCs to Pass FCC Part 68 and UL1459	AN1020

Electrical Specifications

Bidirectional

Package TYPE	Package	Part Number	V_{BO} Breakover Voltage (Instantaneous Clamping Voltage) (1)(5)(16)(19) Volts		IBO Breakover Current µAmps	V_{DRM} Blocking Voltage (2) (4) Volts	I_{DRM} Peak Off-State Current at V_{DRM} (2) Amps	I_{PP} Peak Pulse Current $T_J \leq 150°C$ (7) (12) Amps			I_{TSM} Peak One Cycle (Sinusoidal) Surge Current (17) Amps	
								10x160µs	10x560µs	10x1000µs		
			MIN	MAX	MAX	MIN	MAX	MAX	MAX	MAX	60Hz	50Hz
S	 DO-214AA (Isolated)	P0300SA	27	36	10	20	5	100	50	50	30	25
		P0640SA	58	70	10	50	5	150	75	75	30	25
		P0720SA	65	80	10	50	5	150	75	75	30	25
		P0800SA	60	95	10	50	5	150	75	75	30	25
		P1100SA	90	125	10	75	5	100	50	50	30	25
		P1300SA	120	145	10	95	5	100	50	50	30	25
		P1500SA	135	165	10	110	5	100	50	50	30	25
		P2300SA (13)	190	265	10	160	5	100	50	50	30	25
		P2600SA (13)	220	300	10	180	5	100	50	50	30	25
		P3100SA (13)	275	350	10	220	5	100	50	50	30	25
		P3500SA (13)	300	400	10	240	5	100	50	50	30	25
S	 DO-214AA (Isolated)	P2300SB (13)	190	265	10	160	5	150	100	100	60	50
		P2600SB (13)	220	300	10	180	5	150	100	100	60	50
		P3100SB (13)	275	350	10	220	5	150	100	100	60	50
		P3500SB (13)	300	400	10	240	5	150	100	100	60	50

All DO-214AA are embossed carrier reel packed for shipping.
The suffix "FA" will automatically be inserted when ordering.
Bulk pack is available upon special request.

FOR GENERAL NOTES

See Page 78.

NOTES TO ELECTRICAL SPECIFICATIONS

1. See Figure 4 for V_{BO} change vs junction temperature.
2. See Figure 5 for I_{DRM} vs junction temperature.
3. See Figure 2 for I_H vs case temperature.
4. Repetitive Peak Off-State Voltage can also be referred to as "Stand-Off Voltage" or "Blocking Voltage".
5. All devices have a negative resistance slope unless otherwise noted. Negative resistance slope devices V_{BO} is measured at an applied rate-of-rise of voltage ≤ 1 kV/Sec. See Figure 3A for V-I characteristics.
6. Capacitance Imbalance between forward and reverse polarities is typically ≤ 15 pF.
7. See Figure 1 (A, B, C) for Pulse Wave Form.
8. Maximum T_C is 110°C for TO-92 and 115°C for modified TO-220, except maximum T_C is 75°C for P0300SA, P0300EA70 and 95°C for P0602AA.
9. Surge rating is 2X with respect to Pin 2 during a simultaneous surge operation.
10. Between Pins 2 to 1 and Pins 2 to 3.

I^2t	I_T	I_H	V_{TM}	C_O		di/dt
RMS Surge (Non-Repetitive) On-State Current For a Period of 8.3 ms for Fusing	Continuous On-State DC or RMS Current (8)(18)	Holding Current (3)	Peak On-State Voltage I_T = 1 Amp (14)	Off-State Capacitance at 1kHz 1VAC with 50VDC Bias (6) (20)	Off-State Capacitance at 1MHz 15mVAC with 50VDC Bias (6) (20)	Critical Rate of Rise of On-State Current
Amps² Sec	Amps	mAmps	Volts	pF	pF	Amps/µs
	MAX	MIN	MAX	TYP	TYP	MAX
3.7	**1.0**	**50**	**4.0**	**90 (20)**	**90 (20)**	**100**
3.7	**1.0**	**150**	**3.0**	**70**	**70**	**100**
3.7	**1.0**	**150**	**3.0**	**70**	**70**	**100**
3.7	**1.0**	**150**	**3.0**	**70**	**70**	**100**
3.7	**1.0**	**150**	**3.0**	**50**	**50**	**100**
3.7	**1.0**	**150**	**3.0**	**45**	**45**	**100**
3.7	**1.0**	**150**	**3.0**	**35**	**35**	**100**
3.7	**1.0**	**150**	**4.0**	**50**	**50**	**100**
3.7	**1.0**	**150**	**4.0**	**40**	**40**	**100**
3.7	**1.0**	**150**	**4.0**	**40**	**40**	**100**
3.7	**1.0**	**150**	**4.0**	**40**	**40**	**100**
15.0	1.0	150	4.0	50	50	100
15.0	1.0	150	4.0	40	40	100
15.0	1.0	150	4.0	40	40	100
15.0	1.0	150	4.0	40	40	100

NOTES TO ELECTRICAL SPECIFICATIONS (Continued)

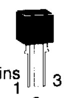
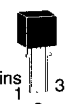
11. Between any two pins.
12. The current wave virtual front duration is 1.25X rise time from 10% to 90% of crest. Virtual zero is defined as the intersection with zero axis of a straight line drawn through points on the front of the current wave of 10% and 90% crest. Waveforms defined per IEEE/ANSI C62.1
13. These devices have a positive resistance slope prior to switching. The initial breakdown voltage V_{BO} (MIN) is a DC measurement made at I_{BO} and V_{BO} (MAX) or peak breakover voltage (V_{PEAK}) is measured at 850 Volts/mSec. rate-of-rise voltage. See Figure 3B for V-I characteristics.
14. Minimum switching resistance is 100Ω. For best SIDACtor operation, the load impedance should be near or less than switching resistance.
15. 260mA minimum I_H is available from the factory on special request
16. The UL497B rate-of-rise of voltage requirements for V_{BO} testing is 100V/s, 100V/µs, 500V/µs, and 1kV/µs. All SIDACtors V_{BO}'s to be ±10% of ratings.
17. For more than one full cycle rating, see Figure 8.
18. Thermal Resistance

PxxxSA	DO214-AA	$R_{\theta JC}$ = 28°C/Watt and $R_{\theta JA}$ = 90°C/Watt.
PxxxSB	DO214-AA	$R_{\theta JC}$ = 26°C/Watt and $R_{\theta JA}$ = 85°C/Watt.
PxxxEA70	TO-92	$R_{\theta JC}$ = 28°C/Watt and $R_{\theta JA}$ = 90°C/Watt.
PxxxBA70	TO-92	$R_{\theta JC}$ = 26°C/Watt and $R_{\theta JA}$ = 85°C/Watt.
PxxxAA	TO-220	$R_{\theta JC}$ = 12°C/Watt and $R_{\theta JA}$ = 50°C/Watt.
PxxxAB	TO-220	$R_{\theta JC}$ = 12°C/Watt and $R_{\theta JA}$ = 50°C/Watt.

19. All SIDACtors have a Critical rate-of-rise of Off-State voltage at Rated V_{DRM}, $T_J \leq$ 150°C, of 10kV/µSec. minimum, except P0300SA, P0300EA70 and P0602AA have a $T_J \leq$125°C.
20. C_O is measured at 20VDC bias on P0300SA, P0300EA70, and P0602AA.

Electrical Specifications

Bidirectional

Package TYPE	Package	Part Number	V_{BO} Breakover Voltage (Instantaneous Clamping Voltage) (1)(5)(16)(19) Volts, PINS 1 to 3		PINS 3 to 2, 1 to 2		I_{BO} Breakover Current µAmps	V_{DRM} Blocking Voltage (2) (4) Volts, PINS 1 to 3	I_{DRM} Peak Off-State Current at V_{DRM} (2) µAmps	I_{PP} Peak Pulse Current $T_J \le 150°C$ (7) (12) Amps, 10x160µs	10x560µs	10x1000µs	I_{TSM} Peak One Cycle (Sinusoidal) Surge Current (17) Amps	
			MIN	MAX	MIN	MAX	MAX	MIN	MAX	MAX	MAX	MAX	60Hz	50Hz
A TYPE 61	 Pins 1 3 Modified TO-220 (Isolated)	P2000AA61	190	215			10	150	5	100	50	50	30	25
		P2200AA61	205	230			10	165	5	100	50	50	30	25
		P2400AA61	220	250			10	175	5	100	50	50	30	25
		P2500AA61	240	280			10	190	5	100	50	50	30	25
		P3000AA61	270	330			10	215	5	100	50	50	30	25
		P3300AA61	300	360			10	240	5	100	50	50	30	25
A	 Pins 1 3 2 Modified TO-220 (Isolated)	P0602AA	54	72	27	36	10	20 (10)	5	100 (9)	50 (9)	50 (9)	30	25
		P1602AA	120	190	60	95	10	50 (10)	5	100 (9)	50 (9)	50 (9)	30	25
		P2202AA	190	250	95	125	10	75 (10)	5	100 (9)	50 (9)	50 (9)	30	25
		P2702AA	240	300	120	150	10	95 (10)	5	100 (9)	50 (9)	50 (9)	30	25
		P3002AA	280	320	140	160	10	110 (10)	5	100 (9)	50 (9)	50 (9)	30	25
A	 Pins 1 3 2 Modified TO-220 (Isolated)	P1602AB	120	190	60	95	10	50 (10)	5	150 (9)	100 (9)	100 (9)	60	50
		P2202AB	190	250	95	125	10	75 (10)	5	150 (9)	100 (9)	100 (9)	60	50
		P2702AB	240	300	120	150	10	95 (10)	5	150 (9)	100 (9)	100 (9)	60	50
		P3002AB	280	320	140	160	10	110 (10)	5	150 (9)	100 (9)	100 (9)	60	50
		P4802AB (13)	440	580	220	290	10	175 (10)	5	150 (9)	100 (9)	100 (9)	60	50
		P6002AB (13)	540	720	270	360	10	215 (10)	5	150 (9)	100 (9)	100 (9)	60	50
A	 Pins 1 3 2 Modified TO-220 (Isolated)	P1553AA	140	170	140	170	10	110 (11)	5	100 (9)	50 (9)	50 (9)	30	25
		P2103AA	180	240	180	240	10	145 (11)	5	100 (9)	50 (9)	50 (9)	30	25
		P2353AA	210	265	210	265	10	170 (11)	5	100 (9)	50 (9)	50 (9)	30	25
		P2703AA	240	300	240	300	10	190 (11)	5	100 (9)	50 (9)	50 (9)	30	25
		P3203AA	280	350	280	350	10	225 (11)	5	100 (9)	50 (9)	50 (9)	30	25
		P3403AA	300	380	300	380	10	240 (11)	5	100 (9)	50 (9)	50 (9)	30	25
A	 Pins 1 3 2 Modified TO-220 (Isolated)	P1553AB	140	170	140	170	10	110 (11)	5	150 (9)	100 (9)	100 (9)	60	50
		P2103AB	180	240	180	240	10	145 (11)	5	150 (9)	100 (9)	100 (9)	60	50
		P2353AB	210	265	210	265	10	170 (11)	5	150 (9)	100 (9)	100 (9)	60	50
		P2703AB	240	300	240	300	10	190 (11)	5	150 (9)	100 (9)	100 (9)	60	50
		P3203AB	280	350	280	350	10	225 (11)	5	150 (9)	100 (9)	100 (9)	60	50
		P3403AB	300	380	300	380	10	240 (11)	5	150 (9)	100 (9)	100 (9)	60	50

FOR GENERAL NOTES

See Page 78.

I^2t	I_T	I_H	V_{TM}		C_O				di/dt
RMS Surge (Non-Repetitive) On-State Current For a Period of 8.3 ms for Fusing	Continuous On-State DC or RMS Current (8)	Holding Current (3) (11)	Peak On-State Voltage I_T = 1 Amp (14) Volts		Off-State Capacitance at 1kHz 1VAC with 50 VDC Bias (6) (20) pF		Off-State Capacitance at 1MHz 15mVAC with 50 VDC Bias (6) (20) pF		Critical Rate of Rise of On-State Current
			PINS 3 to 2 1 to 2	PINS 1 to 3	PINS 3 to 2 1 to 2	PINS 1 to 3	PINS 3 to 2 1 to 2	PINS 1 to 3	
Amps^2 Sec	Amps	mAmps							Amps/µS
	MAX	MIN	MAX	MAX	TYP	TYP	TYP	TYP	MAX
3.7	**1.0**	**150**		**6.0**		**30**		**30**	**100**
3.7	**1.0**	**150**		**6.0**		**30**		**30**	**100**
3.7	**1.0**	**150**		**6.0**		**30**		**30**	**100**
3.7	**1.0**	**150**		**6.0**		**30**		**30**	**100**
3.7	**1.0**	**150**		**6.0**		**25**		**25**	**100**
3.7	**1.0**	**150**		**6.0**		**25**		**25**	**100**
3.7	1.0	50	4.0	8.0	90 (20)	45 (20)	90 (20)	45 (20)	100
3.7	1.0	150	3.0	6.0	140	85	140	85	100
3.7	1.0	150	3.0	6.0	50	30	50	30	100
3.7	1.0	150	3.0	6.0	45	30	45	30	100
3.7	1.0	150	3.0	6.0	40	25	40	25	100
15.0	**1.0**	**200 (15)**	**3.0**	**6.0**	**140**	**85**	**140**	**85**	**100**
15.0	**1.0**	**200 (15)**	**3.0**	**6.0**	**90**	**60**	**90**	**60**	**100**
15.0	**1.0**	**200 (15)**	**3.0**	**6.0**	**80**	**50**	**80**	**50**	**100**
15.0	**1.0**	**200 (15)**	**3.0**	**6.0**	**75**	**45**	**75**	**45**	**100**
15.0	**1.0**	**200 (15)**	**4.0**	**8.0**	**50**	**35**	**50**	**35**	**100**
15.0	**1.0**	**200 (15)**	**4.0**	**8.0**	**50**	**30**	**50**	**30**	**100**
3.7	1.0	150	6.0	6.0	50	40	50	40	100
3.7	1.0	150	6.0	6.0	45	35	45	35	100
3.7	1.0	150	6.0	6.0	40	30	40	30	100
3.7	1.0	150	6.0	6.0	35	25	35	25	100
3.7	1.0	150	6.0	6.0	50	40	50	40	100
3.7	1.0	150	6.0	6.0	50	40	50	40	100
15.0	**1.0**	**200 (15)**	**6.0**	**6.0**	**100**	**80**	**100**	**80**	**100**
15.0	**1.0**	**200 (15)**	**6.0**	**6.0**	**80**	**60**	**80**	**60**	**100**
15.0	**1.0**	**200 (15)**	**6.0**	**6.0**	**70**	**55**	**70**	**55**	**100**
15.0	**1.0**	**200 (15)**	**6.0**	**6.0**	**60**	**50**	**60**	**50**	**100**
15.0	**1.0**	**200 (15)**	**6.0**	**6.0**	**50**	**40**	**50**	**40**	**100**
15.0	**1.0**	**200 (15)**	**6.0**	**6.0**	**50**	**40**	**50**	**40**	**100**

FOR NOTES TO ELECTRICAL SPECIFICATIONS

See Pages 80 and 81.

Electrical Specifications

Figure 1A — Pulse Wave Form (10x1000µs)

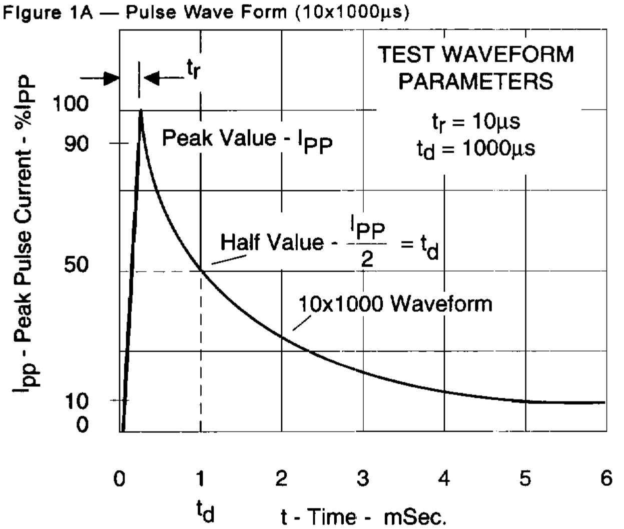


Figure 1B — Pulse Wave Form (10x560µs)

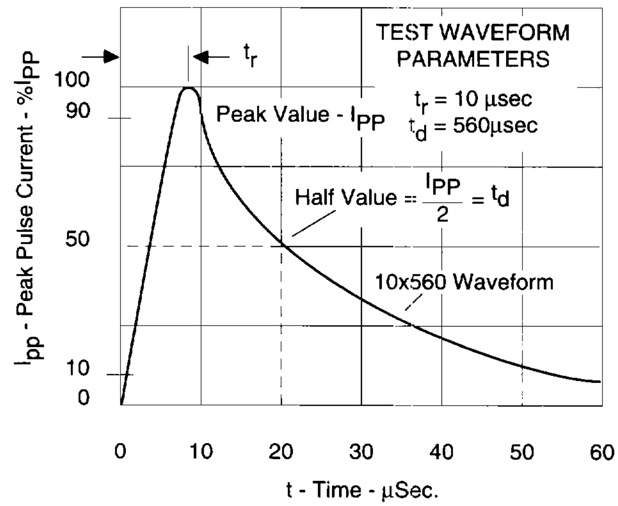


Figure 1C — Pulse Wave Form (10x160µs)

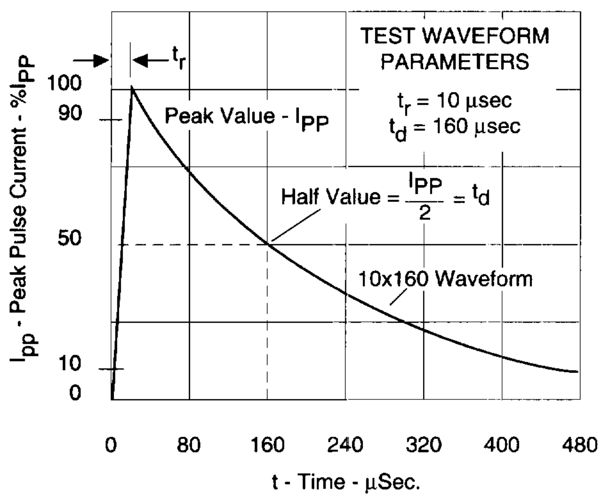


Figure 2 — Normalized DC Holding Current vs Case Temperature

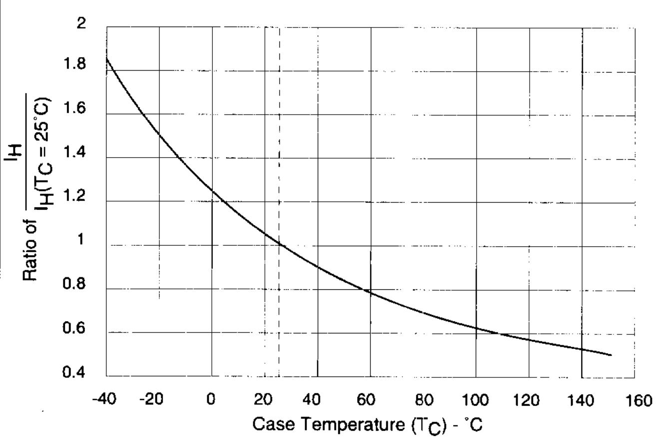


Figure 3A — V-I Characteristics of Devices with Negative Resistance

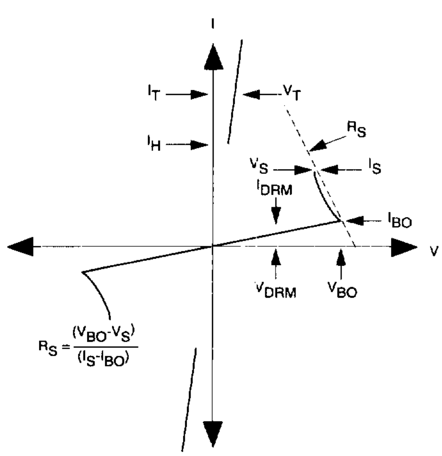


Figure 3B — V-I Characteristics of Devices with Positive Switching Slope

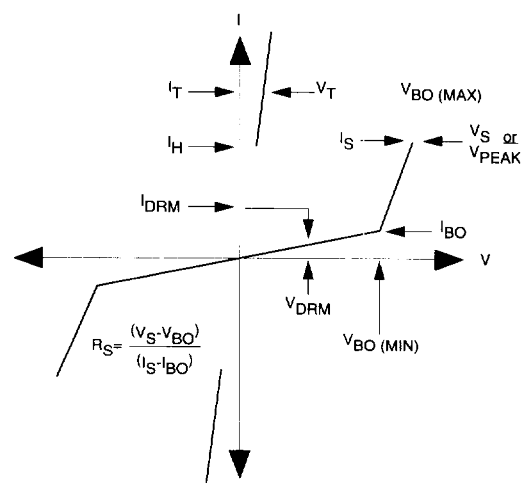


Figure 4 — Normalized V_{BO} Change vs Junction Temperature

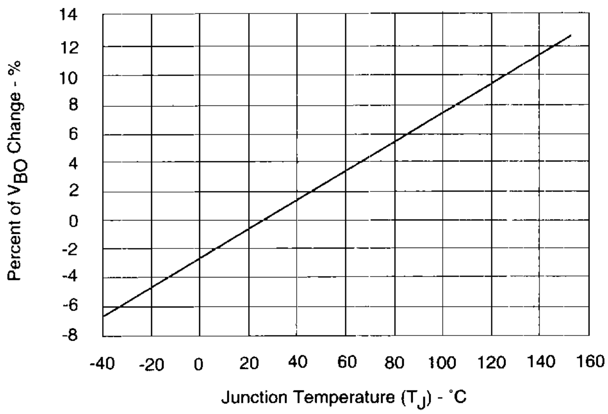


Figure 5 — Normalized Repetitive Peak Off-State (Leakage) Current vs Junction Temperature

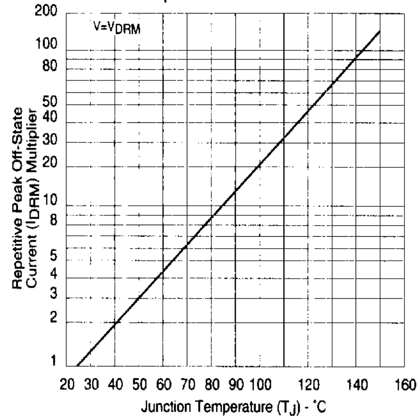


Figure 6 — Peak On-State Voltage vs Peak On-State Current for DO-214AA and TO-92 (Typical)

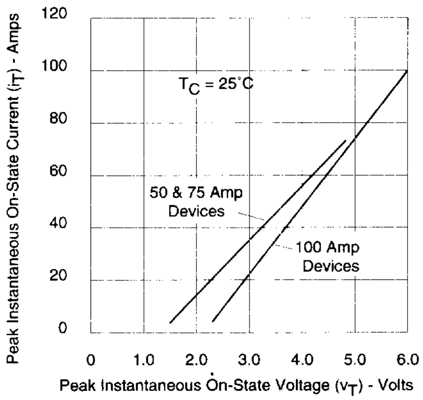


Figure 7 — Peak On-State Voltage vs Peak On-State Current for Modified TO-220, Pins 1 to 3 (Typical)

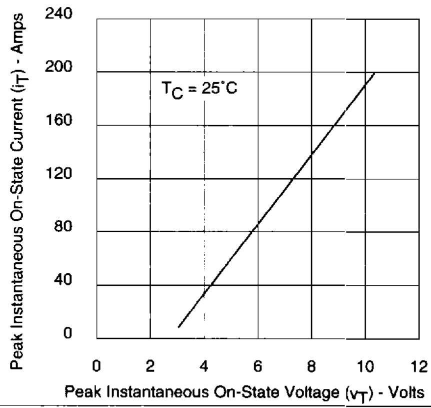
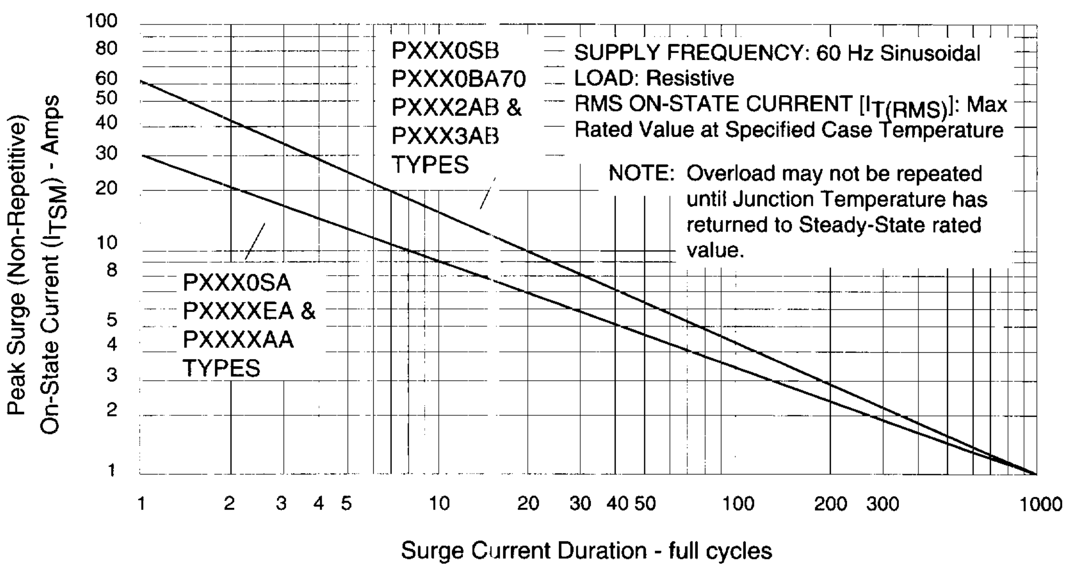
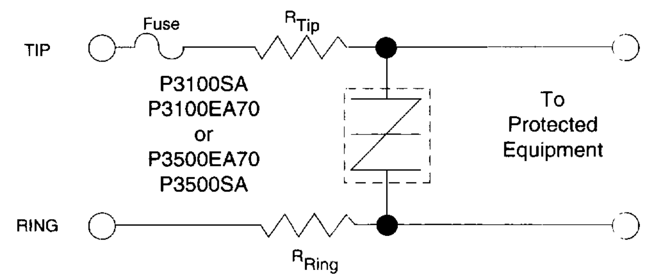


Figure 8 — Peak Surge On-State Current vs Surge Current Duration



AN1010 — FCC Part 68 and UL 1459 Metallic Protection

Figure A – UL1459 Metallic



Consideration for Metallic Surge 800V, 100A, 10x560µs				
Selected Fuse mA	Fuse 10x560µs Rating Amps	R_{TOT} MIN Ω	R_T & R_R MIN Ω	Required 10x560µs Ipp of SIDACtor Amps
350	25	32.0	12	50
400	28	28.6	10	50
500	35	23.0	7	50
600	43	18.6	5	50
700	50	16.0	4	50
1000	78	10.3	1.15	100

$R_{TOT} = R_S + R_T + R_R$

(R_S = Source Impedance of Surge Generator)

$$R_{TOT} = \frac{V_{PK}(\text{Surge})}{I_{PP}(\text{Fuse})}$$

1. To meet UL1459, a current-limiting device (e.g. PTC, fuse) must be used. If using a fuse, Teccor recommends that the fuse rating be no greater than 1.0A. The 10x560µs I_{PP} rating listed above is the maximum I_{PP} surge limitation of the selected Bel fuse (type MJS) without R_T and R_R.

2. R_T and R_R are optional with the SIDACtor. They are used to limit the 100A, 10x560µs surge within the rating of the selected fuse. I.E., for a 500mA fuse an additional 15Ω (R_T=7.5Ω, R_R=7.5Ω) is necessary to prevent the fuse from opening during FCC Part 68 surge. Hence, R_T and R_R allow the circuit to pass Part 68 operationally.

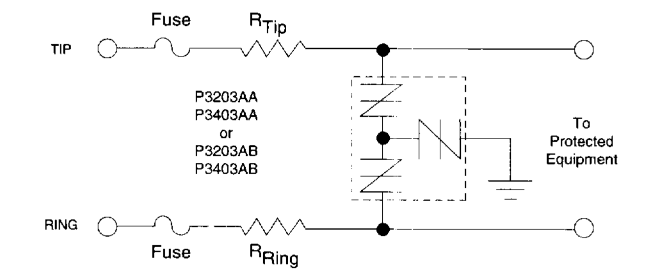
3. If desired, R_T and R_R may be eliminated. This will allow the circuit still to pass Part 68 and UL1459; however, it will pass FCC Part 68 non-operationally since the fuse will open.

4. The robustness of a circuit designed to pass FCC Part 68 non-operationally is dependent on the size of fuse used. The SIDACtor allows the engineer to use up to a full 1A fuse without any series resistance. See required 10x560µs I_{PP} of SIDACtor to determine the proper value of the SIDACtor for the selected fuse.

5. See application notes AN1017, AN1018, and AN1019 for detailed description of FCC Part 68, UL1459, and circuit component value calculations.

AN1011 — FCC Part 68 and UL 1459 Longitudinal Protection

Figure B – UL1459 Longitudinal



Consideration for Longitudinal Surge 1500V, 200A, 10x160µs				
Selected Fuse mA	Fuse 10x160µs Rating Amps	R_{TOT} MIN Ω	R_T & R_R MIN Ω	Required 10x160µs Ipp of SIDACtor Amps
350	45	33.3	25.3	100
400	52	28.9	20.9	100
500	65	23.1	15.1	100
600	78	19.3	11.3	100
700	91	16.5	8.5	100
1000	130	11.6	4.1	150

$R_{TOT} = R_S + R_T$ (or) $R_S + R_R$

$$R_{TOT} = \frac{V_{PK}(\text{Surge})}{I_{PP}(\text{Fuse})}$$

1. To meet UL1459, a current-limiting device (e.g. PTC, fuse) must be used. If using a fuse, Teccor recommends that the fuse rating be no greater than 1.0A. The 10x160µs I_{PP} rating listed above is the maximum I_{PP} surge limitation of the selected Bel fuse (type MJS) without R_T and R_R.

2. R_T and R_R are optional with the SIDACtor. They are used to limit the 200A, 10x160µs surge within the rating of the selected fuse. I.E., for a 500mA fusean additional15.1Ω on R_T and R_R is necessary to prevent the fuse from opening during FCC Part 68 surge. Hence, R_T and R_R allow the circuit to pass Part 68 operationally.

3. If desired, R_T and R_R may be eliminated. This will allow the circuit still to pass Part 68 and UL1459; however, it will pass FCC Part 68 non-operationally since the fuse will open.

4. The robustness of a circuit designed to pass FCC Part 68 non-operationally is dependent on the size of fuse used. The SIDACtor allows the engineer to use up to a full 1A fuse without any series resistance. See required 10x160µs I_{PP} of SIDACtor to determine the proper value of the SDIACtor for the selected fuse.

5. See application notes AN1017, AN1018, and AN1019 for detailed description of FCC Part 68, UL1459, and circuit component value calculations.

Bellcore TR-NWT-001089, Table 4-2 First Level Lightning Surge Test (Telecommunications Port).					
Surge Test Number	Peak voltage Volts	Peak Current Amps	Waveform time µSec	P265 P3203AB P282 P3002AB P272 P1500SA P283 P1500EA70	Required R_{Tip} & R_{Ring} Ω
1	±600	100	10 x 1000	Withstand	None
2	±1000	100	10 x 360	Withstand	None
3	±1000	100	10 x 1000	Withstand	None
4	±2500	500	2 x 10	Withstand	None (1)
5	±1000	25	10 x 360	Withstand	None

AN1012 — Bellcore TR-NWT-001089

"Electromagnetic Compatiblity and Electrical Safety Generic Criteria for Network Telecommunications Equipment". Table 4-2, First Level Lightning Surge tests (Telecommunications Port). There are designs and designers that prefer or require overvoltage protection devices that can withstand all 5 surges of Table 4-2 without the use of any series resistance (0Ω). Meeting the challange, Teccor has developed devices specifically to pass operationally all 5 surges of Table 4-2. Teccor recommends the following Special Devices: P265 P3203AB, P282 P3002AB, P272 P1500SA or P283 P1500EA70. These devices are rated with an I_{PP} surge of 100 amp 10x1000µs and 500 amp 2x10µs (Surge #4).

Note:

(1)A standard SIDACtor with a 100 amp 10x1000µs surge rating may be used, but an R_{Tip} = 12Ω and R_{Ring} = 12Ω minimum is required to pass Surge #4 operationally. The 12Ω limits Surge #4 rise time to within the devices di/dt rating.

AN1013 — SLIC (Subscriber Line Interface Circuit)

SLICs (Subscriber Line Interface Circuits) are normally operated from a nominal -50VDC supply (with respect to ground), located behind the ring generator or ring detection circuit and do not see ring voltages. Protection of the SLIC from a positive overvoltage is easily accomplished with a diode and in the negative polarity with a SIDACtor with its minimum V_{BO} greater than the -50VDC supply maximum voltage (typically 56.6VDC).

Figure C shows how to protect a SLIC with a single SIDACtor and a diode bridge. The P0640EA70 or P0640SA SIDACtors offer V_{BO} 58 volts minimum & 70 volts maximum with the ability to hold fast rising transients up to 1kV/µsec to 70 volts maximum, thus protecting sensitive SLICs. The bridge may be a 4 pin DIP (surface mount package if preferred) or discrete components. The cost of this protection scheme is approximately one half that of single SLIC protection components other manufacturers offer.

Figures D & E show how to protect a SLIC with either a single P1602AA and two diodes or two discrete P295 P0640SA (DO-214AA, surface mount packages). The P295 P0640SA contains one $58V_{MIN}$ – $70V_{MAX}$ SIDACtor chip and a diode.

Figure C -SLIC Protection

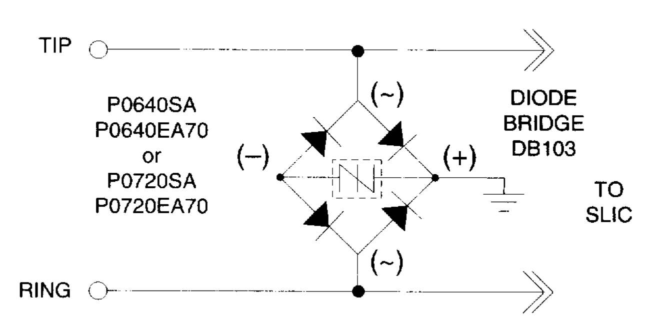


Figure D - SLIC Protection

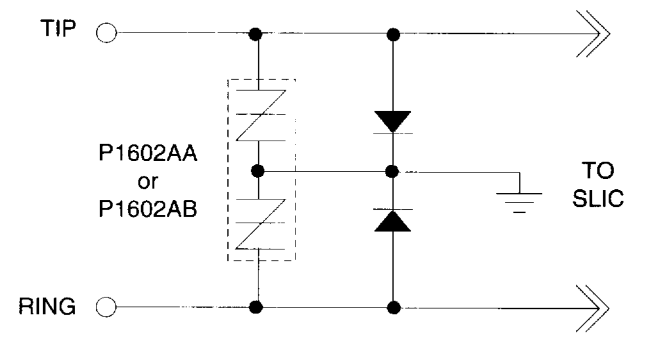
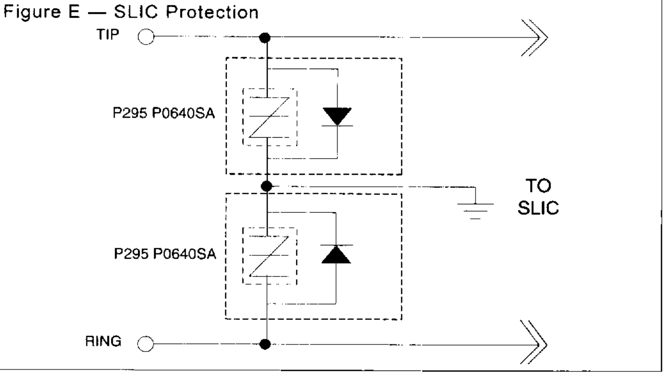


Figure E — SLIC Protection



AN1014 — Low Voltage Data Line Protection with the New 27 volt SIDACtor

The Bidirectional Teccor 27 volt SIDACtor (P0300SA, P0300EA70 or P0602AA) is an ideal replacement for applications using 30 volt, 600 & 1500 watt avalanche diodes and zener diodes. The 27 volt SIDACtor's 50 amp 10x1000μs surge rating is greater than the 36 amp 10x1000μs surge current rating of the 1500 watt 30 volt avalanche diode or zener diode. The SIDACtor's 90pF capacitance at 1MHz, 20VDC bias is much lower than the 30 volt 1.5kW avalanche and zener diode devices at 550pF.

Induced AC surges occurring on data lines are a problem encountered with data transmission systems due to unforeseen paralleled AC lines inducing voltages onto the data lines. The Teccor SIDACtor has a rating of 30 amps AC one cycle and 1 amps RMS continuous. A 1kVAC$_{RMS}$ at 1A$_{RMS}$ for 30 seconds test was conducted with P0300EA70 SIDACtors and 30 volt 1.5kW avalanche diodes. The SIDACtor survived the test easily with typical T_C (Case Temperature) ≤ 95°C, where all the avalanche diodes tested failed electrically, achieved T_L's (lead temperatures) great enough to possibly cause 60/40 Sn/Pb solder to reflow, and cracked their epoxy cases. (See Figures A and B.)

Figure A - Data Line Protection

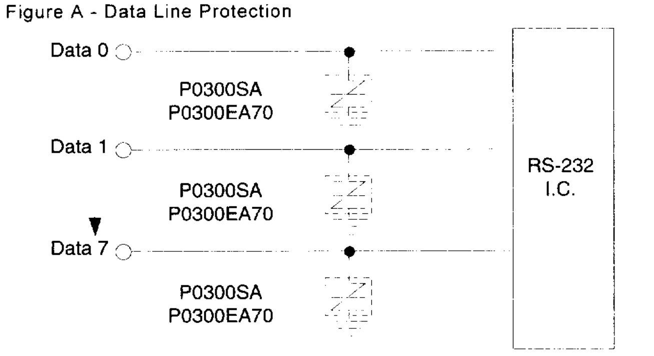
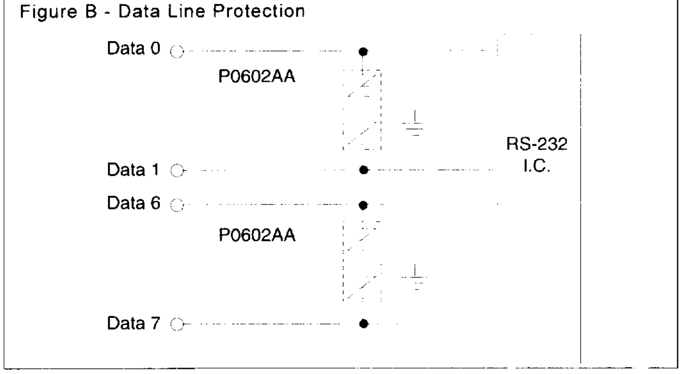


Figure B - Data Line Protection



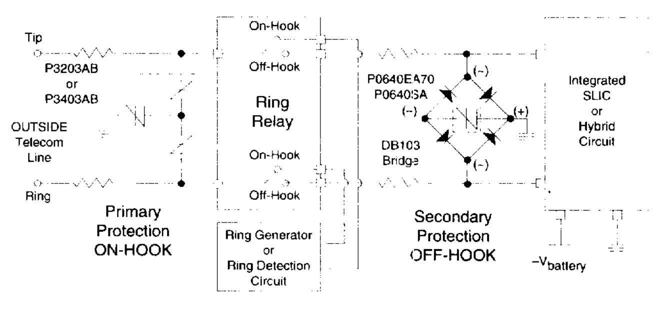
AN1015 — Teccor Patented 3-Chip "Y" Configuration

The patented TECCOR 3-chip "Y" configuration (using two SIDACtor chips in series between any terminal pair) offers additional protection in its operation. Example: When an overvoltage surge occurs on a typical telecommunication twisted pair line, a simultaneous longitudinal surge occurs (between Tip to ground and Ring to ground). The Tip or Ring terminal SIDACtor chip with the lowest V_{BO} and the center (or Ground) SIDACtor chip will turn-on first (to the device's V_{TM}). This leaves the opposite side of the 3-chip SIDACtor protector at the V_{BO} of only one SIDACtor chip to ground, or approximately 1/2 V_{BO} rating of the device. The simultaneous voltage surge on the opposite side will also be at least at a voltage equal to V_{BO} so the opposite side SIDACtor chip (at 1/2 V_{BO}) will turn-on also. The low I_H of the center (or ground) SIDACtor chip allows it to be the first SIDACtor chip to turn-on and the last to turn-off, to force and maintain the connection or path to ground. This patented 3-chip SIDACtor offers differential voltages between Tip and Ring terminals limited to approximately 1/2 V_{BO} maximum rating of the device occurring typically within a few hundred nanoseconds during a simultaneous longitudinal voltage surge.

AN1016 — On-Hook & Off-Hook Protection Requirements

FCC, UL, Bellcore, etc. require telecommunications equipment to be surged in all its operating states. This refers to the two commonly referred to states as "On-Hook" state (ring generator or ring detection monitoring) and the "Off-Hook" state (operational state). The On-Hook state must allow operation of the normal battery voltage (DC bias) plus ring voltage without interference. The Off-Hook state should only allow operation of the battery voltage (DC bias) plus operation signals and has a typical maximum of 70 to 80 volts (FCC Part 68 has a 70 volt maximum). Telecommunications equipment needs **primary** protection for the On-Hook surge and **secondary** protection for the Off-Hook surge (see AN1013, SLIC protection schemes). The two applications have different voltage protection requirements and therefore two overvoltage protectors are required. See **Figure F** below for circuit protection scheme.

Figure F — Complete PC Board Operation Protection



AN1017 — FCC Rules Part 68, Subpart D Metallic Voltage Surge, Detailed

The FCC Part 68 telecom Metallic Voltage Surge is an 800 volt, 100 amp 10x560μs surge applied metallically (Line to Line) between tip and ring of a 2-wire connection. To select the proper SIDACtor V_{BO} and calculate the Tip and Ring impedances required to limit the surge current within the surge current ratings of the SIDACtor, see Telecom Application Notes section on circuit calculations. To survive operational and against a metallic voltage surge, see **Figures G, H, & I**.

Figure G shows how to protect against an on-hook metallic surge without utilizing any circuit impedance using a P3100SB, P3100BA70, P3500SB or P3500BA70. This is because the surge current rating of the overvoltage protection device (100 amp 10x1000µs) is greater than the surge requirement.

Figure G — FCC Part 68 Metallic

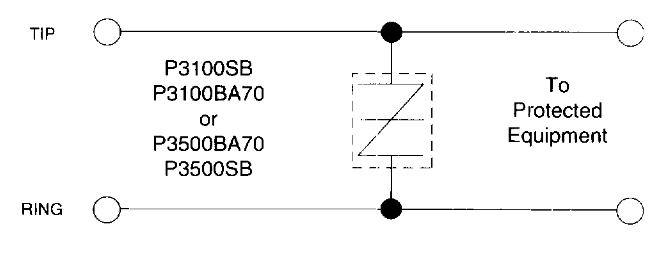


Figure H shows how to protect against an on-hook metallic surge utilizing circuit impedances to reduce the 100 amp metallic surge to less than the 50 amp 10x1000µs surge capability of the P3100SA, P3100EA70, P3500SA or P3500EA70.

Figure H — FCC Part 68 Metallic

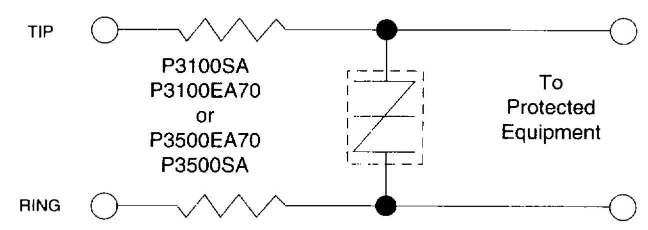
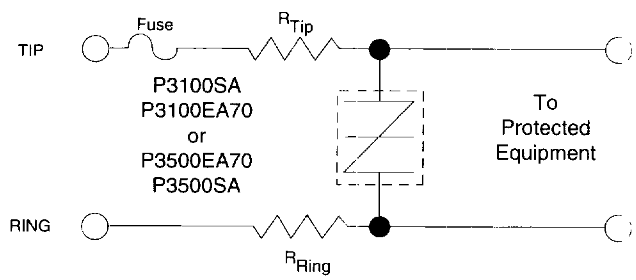


Figure I is the same as Figure H except it utilizes one fuse. The National Electric Code (NEC) article 800 states that telecommunication lines with no connections or paths to ground are only required to incorporate one overcurrent protection device (fuse) in series with either Tip or Ring.

Figure I — FCC Part 68 Metallic



Longitudinal Voltage Surge

The FCC Part 68 telecom Longitudinal Voltage Surge is a 1500 volt, 200 amp 10x160µs. surge applied longitudinally (Line to Ground), between tip to ground, ring to ground and tip tied to ring to ground. This surge has the highest peak current of the two FCC Part 68 telecom voltage surges. A circuit designed to withstand the Longitudinal voltage Surge should also survive the Metallic voltage Surge. The tip and ring impedances should be selected to reduce the applied surge current to within the selected SIDACtor's surge rating. To calculate the Tip and Ring impedances, see Telecom Application Notes section on circuit calculations. To survive operational against an on-hook longitudinal voltage surge, see **Figures J, K, L & M**.

Figures J & K show how to protect against a longitudinal surge with a single SIDACtor or two individual devices. A design consideration should be to know that during a Metallic voltage Surge, the protected circuit will see a voltage equal to two times the V_{BO} (breakover voltage) of the selected device.

Figure J - FCC Part 68 Longitudinal

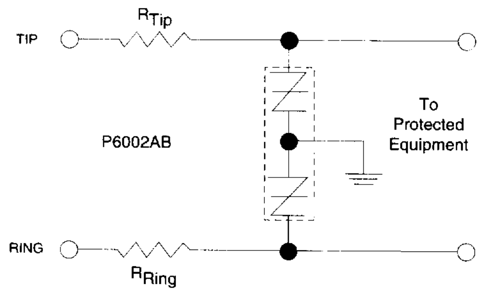


Figure K - FCC Part 68 Longitudinal

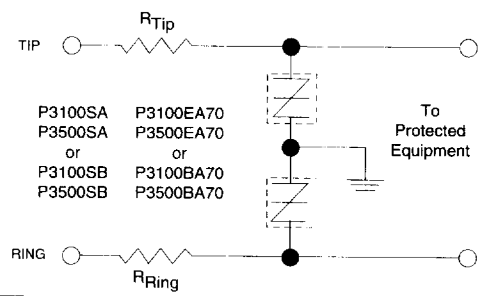


Figure L shows a "Delta" configuration protection solution. It is the same as Figures J & K, except it has a third SIDACtor added between Tip and Ring that will limit the Metallic voltage Surge to its breakover voltage (V_{BO}) level.

Figure L - FCC Part 68 Longitudinal

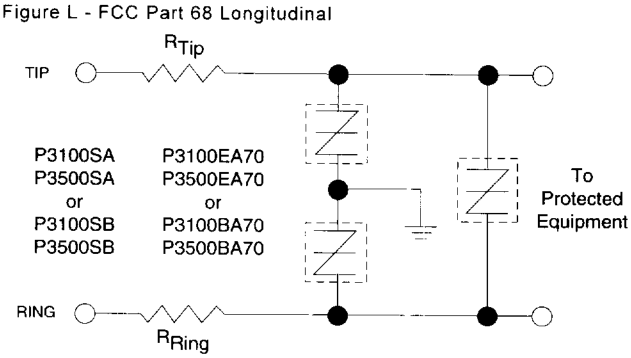


Figure M shows a Balanced "Y" configuration protection solution. This unique Teccor patented 3 chip "Y" configuration (using 2 SIDACtor chips in series between any two terminals) offers additional protection in its operation. See Telecom Applications Note explaining the patented 3 chip "Y" configuration operation.

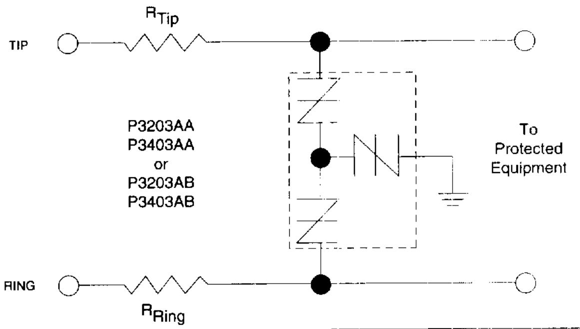


Figure M - FCC Part 68 Longitudinal

AN1018 — UL 1459 (Standard for Telephone Equipment) and CSA-C22.2 No. 225 (Telecommunications Equipment), Detailed

The UL 1459 and CSA-C22.2 No. 225 Metallic (M), differential mode (Line to Line) and Longitudinal (L), common mode (Line to Ground), AC open circuit voltage and short circuit current test levels at 50 or 60 Hz are as follows:

Test M-1 or L-1: 600 V_{RMS}, 40 A_{RMS}, applied for 1.5 seconds.

Test M-2 or L-2: 600 V_{RMS}, 7A_{RMS}, applied for 5.0 seconds.

Test M-3 or L-3:

A. 600 V_{RMS}, 2.2 A_{RMS} and
B. This test is conducted at less than 2.2 A_{RMS}, 600 V_{RMS}, with the short circuit current set just below the current interrupting device's (fuse or PTC) activation level.

Test M-4 or L-4: 200 V_{RMS}, 2.2A_{RMS};This test is conducted with the voltage set just below the breakdown voltage (V_{BO}) of the overvoltage protection device (SIDACtor) and short circuit current just below the current interrupting device's (fuse or PTC) activation level.

Test L-5: 120 V_{RMS}, 25A_{RMS}

Test M-3, L-3, M-4, L-4 and L-5: are conducted for 30 minutes or until an open circuit condition occurs.
Note: Longitudinal surges are conducted simultaneously (Tip to Ground and Ring to Ground).

Compliance with the testing is determined by the following: Telecom equipment shall not present a risk of fire (no ignition or charring of the cheese cloth indicator), no electrical shock and it shall not interrupt the current during the test (open the UL circuit wiring simulator, a fuse, Bussman Mfg. Co. type MDQ 1.6 amp).

Using SIDACtors (overvoltage surge protectors) in circuits to comply with UL 1459 and CSA-C22.2 No. 225 requirements:
Note: U.L. requires components used to be U.L. recognized. CSA-C22.2 No. 225 does not require the components used to be CSA certified. Only the final product meets the CSA requirements.

SIDACtors are recognized under UL 497B (Standard for Secondary protectors for data communications and fire alarm circuits).

SIDACtor epoxy used is UL recognized and the encapsulated body passes UL 94V0 requirements for flammability.

SIDACtors have 1600VAC$_{RMS}$ electrical isolation between the leads and the case.

SIDACtors are offered with V_{BO}'s (breakover voltages) greater than the normal operating voltages.

SIDACtors will withstand the UL surges for the duration required for the UL circuit 1.6A fuse to clear (open). If the SIDACtors surge current rating is exceeded, the SIDACtor will fail shorted and not open.

UL 1459 Solution: Use a SIDACtor (overvoltage surge protector) and add a fuse or a resettable device, PTC (Positive Temperature Coefficient). The minimum value of the fuse required is determined by the maximum normal operating circuit currents (to allow normal circuit operation). The maximum fuse value is the UL circuit wiring simulator, the Bussman Mfg. type MDQ 1.6 amp fuse. Typical fuse values are between 250 mA and 1.0 amp. See Telecom Application Notes on circuit impedance calculations. Telecom equipment that must comply with UL 1459 must also comply with FCC Rules Part 68 Subpart D. To comply with UL 1459 and CSA-C22.2 No. 225 surge testing (by interrupting overcurrent, open) and remain operational after FCC Rules Part 68 Subpart D on-hook Metallic and Longitudinal voltage Surges, see the following examples:

Figure N shows a single SIDACtor and a fuse to protect against the on-hook UL Metallic surges. Note that FCC Part 68 does not require the circuit to be operational after the FCC surges.

Figure O shows a single SIDACtor, resistor, and a fuse to protect against the on-hook UL Metallic surges. The resistor values are selected in conjunction with the fuse to pass FCC Metallic voltage Surge. A substitue for the fuse would be a PTC (Positive Temperature Coefficient) resettable current limiting device, such as is manufactured by Raychem.

See Application Note AN1020.

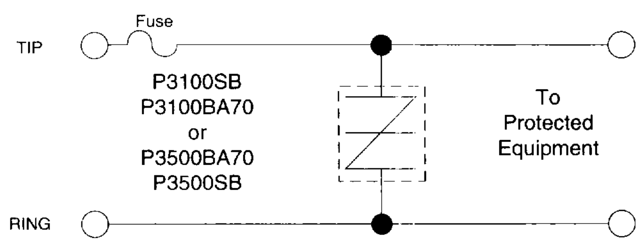


Figure N - UL1459 Metallic

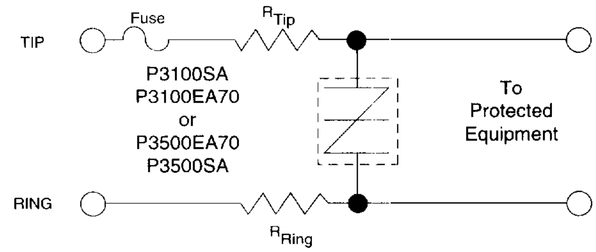


Figure O - UL1459 Metalic

Figures P & Q show a common scheme to protect against the on-hook UL surges using SIDACtor(s) and fuses. A design consideration should be to know that during a Metallic voltage Surge, the protected circuit will see a voltage equal to two times the V_{BO} (breakover voltage) of the selected overvoltage protection device.

Figure P - UL1459 Longitudinal

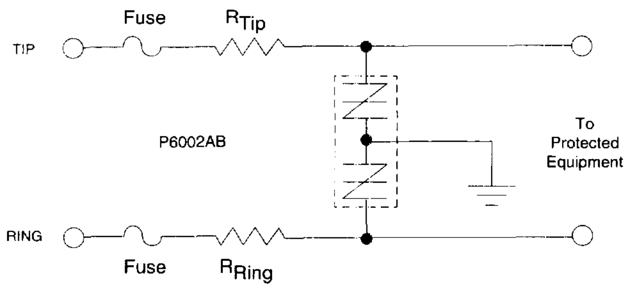


Figure Q - UL1459 Longitudinal

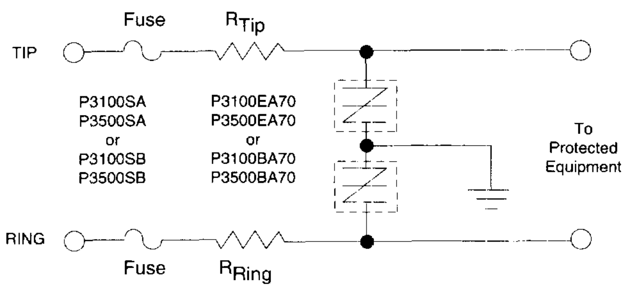


Figure R shows a "Delta" configuration protection solution. It is the same as Figures P and Q except it has a third SIDACtor added between Tip and Ring that will limit the Metallic voltage Surge to its V_{BO} (breakover voltage) level.

Figure R - UL1459 Longitudinal

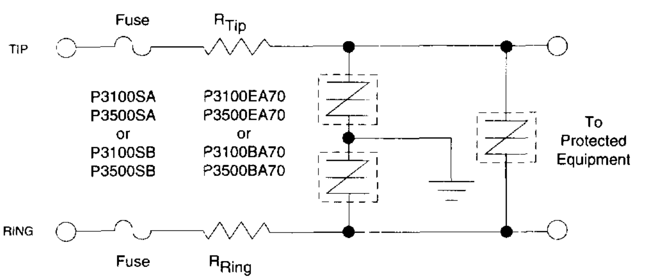
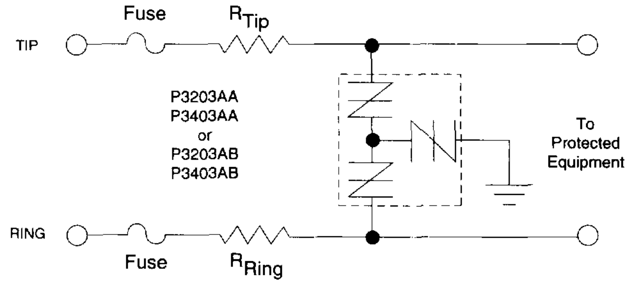


Figure S shows a Balanced "Y" configuration protection solution using a Teccor patented 3 chip "Y" configuration P3203AB or P3403AB (with 150 amp 10x160µS surge capability) or the P3203AA or P3403AA (100 amp 10x160µS surge capability).

Figure S - UL1459 Longitudinal



AN1019 — Circuit Calculations for FCC Part 68 and UL 1459

Selecting the proper SIDACtor V_{BO} (Breakover voltage): take the circuit maximum operating Ring RMS voltage, convert this to a peak voltage and add the maximum operating dc bias.

V_{BO} (minimum) = √2[RMS ring voltage maximum] + [DC bias maximum]

EXAMPLE:

V_{BO} (minimum) = √2[150 V_{RMS} maximum] + [56.6VDC maximum]

V_{BO} (minimum) = [212V_{Peak}] + [56.6V dc] = 268.6V_{Peak}

The SIDACtor V_{BO} (minimum) should be greater than your maximum circuit operating voltages and the V_{BO} (maximum) should be the protected components maximum voltage withstanding rating. A device with a V_{BO} (minimum) = 275 volts will work for this example.

The following equations are necessary for calculating the surge path impedances. Impedances can then be added to the circuit's series surge path to reduce the applied peak surge current to a value within the current carrying capabilities of the components used (SIDACtor and the fuse).

(Rs) Surge Generator Internal Source Impedance: Open Circuit voltage divided by the Short Circuit Current.

$$\text{Source Impedance } R_S = \frac{V_{Peak}}{I_{Peak}}$$

($\Sigma R_{(long)}$) Longitudinal Total Loop Impedance: Sum of all Loop Impedances in <u>either</u> Tip <u>or</u> Ring line to ground (but not both) including the Source Impedance.

$$\text{Longitudinal} \sum R_{Tip\,(long)} = R_S + R_{Tip}$$

Note: $R_{Tip} = R_{Ring}$

— Or —

$$\text{Longitudinal} \sum R_{Ring\,(long)} = R_S + R_{Ring}$$

Note: $R_{Tip(long)} = R_{Ring(long)}$

($I_{Peak(long)}$) Longitudinal Peak Surge Current: Open Circuit voltage divided by the Sum of all Longitudinal Loop impedances.

$$\text{Longitudinal Tip } I_{Peak(long)} = \frac{V_{Peak}}{\sum R_{Tip(long)}}$$

— Or —

$$\text{Longitudinal Ring } I_{Peak(long)} = \frac{V_{Peak}}{\sum R_{Ring(long)}}$$

($\Sigma R_{(metal)}$) Metallic Total Loop Impedance: Sum of all Loop Impedances in Tip and Ring including the Source Impedance.

Metallic $\Sigma R_{(metal)} = R_S + R_{Tip} + R_{Ring}$ If $R_{Tip} = R_{Ring}$ then Metallic $\Sigma R_{(metal)} = R_S + [\,2R_{Tip}\,]$

($I_{Peak(metal)}$) Metallic Peak Surge Current: Open Circuit voltage divided by the Sum of all Metallic Loop Impedances.

$$\text{Metallic } I_{Peak(meta)} = \frac{V_{Peak}}{\sum R_{metal}}$$

The following examples show how to calculate the values of R_{Tip} and R_{Ring} to reduce the applied surge current to within the surge ratings of the components used and to remain operational after the surges.

Fuse Selection: Calculate the value of R_{Tip} & R_{Ring} by first selecting a fuse using its applicable waveform surge withstanding rating, calculate $\Sigma R_{(metal)}$ or $\Sigma R_{(long)}$ then R_{Tip} & R_{Ring}. Then select a SIDACtor with an Ipp 10x1000µSec. or 10x160µSec. greater than or equal to the fuse I_{Peak} 10x560µSec. or 10x160µSec.

EXAMPLE 1: FCC Part 68 Metallic Surge (Line to Line), 800 volt, 100 amp 10x560µSec.

$$\text{Metallic } R_S = \frac{800\text{Volts}}{100\text{Amps}} = 8.0\Omega$$

$$\text{Metallic } \sum R_{(metal)} = \frac{800\text{Volts}}{I_{Peak\,(Fuse\ 10x560)}}$$

$$\text{Metallic } R_{Tip} = \frac{[\sum R_{(metal)} - R_S]}{2}$$

Note: $R_{TIP} = R_{RING}$

Metallic

Selected BEL FUSE Type MJS Value mA	Fuse 10x560 µSec. Withstanding Rating (1) Amps	Calculated $\Sigma R_{(metal)}$ Ohms	Calculated (2) R_{Tip} & R_{Ring} Ohms	SIDACtor (4) Required Ipp 10x1000µS Amps
		MIN	MIN	
250	15	53.3	22.7	50
350	25	32.0	12.0	50
400	28	28.6	10.3	50
500	35	23.0	7.5	50
600	43	18.6	5.3	50
700	50	16.0	4.0	50
800	62	12.9	2.5	100 (3)
1.00A	78	10.3	1.2	100 (3)
1.25A	100	8.0	0.0	100 (3)

Notes:

(1) The Fuse Type and Waveform withstanding rating are BEL FUSE INC. type MJS.

(2) R_{Tip} & R_{Ring} values are minimum and should be chosen from the next higher standard ohm value.

(3) If a 50 amp 10x1000µSec. rated SIDACtor is preferred, use a 4.0Ω or greater resistor for R_{Tip} & R_{Ring}.

(4) The SIDACtor should be selected with an Ipp 10x1000µSec. equal to or greater than the applied 10x560µSec. surge current.

EXAMPLE 2: FCC Part 68 Longitudinal Surge (Line to Ground), 1500 volt, 200 amp 10x160µSec.

$$\text{Longitudinal } R_S = \frac{1500\text{V}}{200\text{Amps}} = 7.5\,\Omega$$

$$\text{Longitudinal } \sum R\,(\text{long}) = \frac{1500\text{V}}{I_{Peak}\,(\text{Fuse}10\text{x}160)}$$

Longitudinal $R_{Tip} = [\,\sum R_{(long)} - R_S\,]$ Note: $R_{Tip} = R_{Ring}$

Longitudinal

Selected BEL FUSE Type MJS Value mA	Fuse 10x160µs Withstanding Rating (1) Amps	Calculated $\Sigma R_{(long)}$ Ohms	Calculated (2) R_{Tip} & R_{Ring} Ohms	SIDACtor (4) Required Ipp 10x160µs Amps
		MIN	MIN	
250	32	46.9	39.4	100
350	45	33.3	25.3	100
400	52	28.9	20.9	100
500	65	23.1	15.1	100
600	78	19.3	11.3	100
700	91	16.5	8.5	100
800	104	14.3	7.0	100
1000	130	11.6	4.1	150
1250	162	9.3	2.5 (3)	150

Notes:

(1) The Fuse Type and Waveform withstanding rating are BEL FUSE INC. type MJS.

(2) R_{Tip} & R_{Ring} values are minimum and should be chosen from the next higher standard ohm value.

(3) A 2.5Ω resistor was chosen (as opposed to the actual 1.8Ω) to limit the peak current to within the rated value of the SIDACtor 10x160µSec. and not the fuse.

(4) The SIDACtor should be selected with an Ipp 10x160µSec. equal to or greater than the applied 10x160µSec. surge current.

AN1020 — Using PTCs

Figures Y & Z are suggested methods of passing FCC Part 68 metallic and longitudinal surges operationally, as well as complying with UL1459 using PTC's. The Raychem Polyswitch PTC resettable fuse circuit protector is a UL recognized Positive Temperature Coefficient (PTC) resistor. When an overcurrent condition occurs, the PTC dramatically increases in resistance from its base resistance. The surge current is reduced typically to a few milliamps, that is, no significant current flow. After the over current condition subsides, the PTC resets to its base resistance allowing normal circuit operation to continue. For further information, call Raychem Polyswitch Division (1-800-227-4856).

Figure Y - FCC Part 68 and UL1459 Metallic

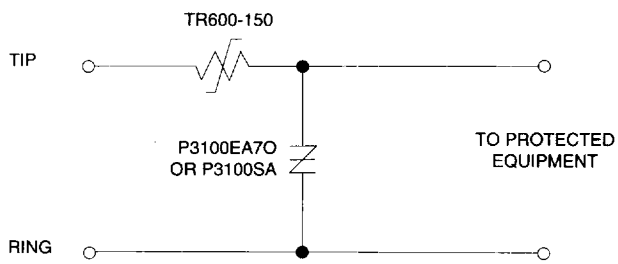
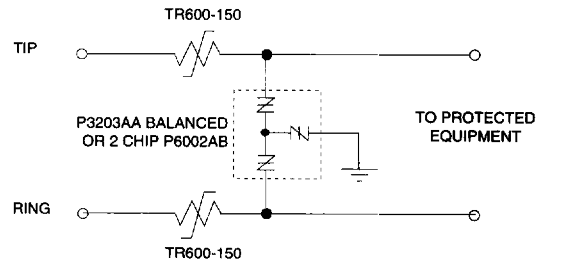


Figure Z - FCC Part 68 and UL1459 Longitudinal



AN1021- SIDACtors Used In AC Circuits

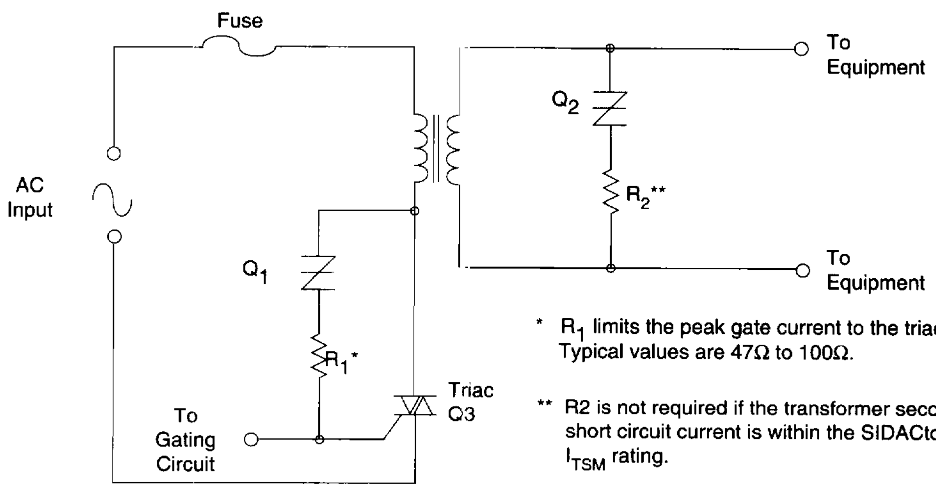
SIDACtors can be used in any number of applications where the normal operating current of the line being protected is limited to less than the I_H (Holding current) or the I_{TSM} (AC surge capability) of the SIDACtor. Excellent examples are security system sensors, zoning lines, the secondary side of transformers, the input side of a solid state relay and etc. .

Figure U shows a typical AC circuit application using a SIDACtor (Q1) to protect a TRIAC (Q3) from an overvoltage surge. The V_{DRM} rating of the TRIAC should be greater than the V_{BO} maximum of the SIDACtor (Q1) and the V_{BO} minimum of the SIDACtor should be greater than the expected high AC line peak voltage.

{VDRM (TRIAC)} > {VBO max)SIDACtor Q1) VBO min} > {AC line VPeak}

SIDACtors may also be used on the secondary side of transformers to protect sensitive circuitry from overvoltages. SIDACtor (Q2) must be designed to handle both the transient peak current & waveshape plus the short circuit follow on current from the AC transformer secondary. The design should withstand a few cycles of AC current to avoid nuisance fuse blowing.

Figure U - Typical AC Applications Using SIDACtors as Transient Overvoltage Protectors



* R_1 limits the peak gate current to the triac. Typical values are 47Ω to 100Ω.

** R2 is not required if the transformer secondary short circuit current is within the SIDACtor I_{TSM} rating.