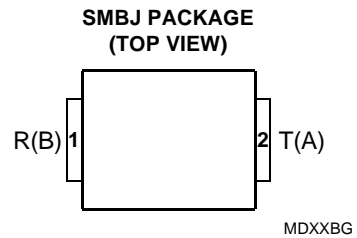


**BIDIRECTIONAL THYRISTOR OVERVOLTAGE PROTECTORS**

**FCC PART 68 AND UL 1950 OVERVOLTAGE PROTECTORS**

- **MODEM Protection against:**
  - FCC Part 68 Type A & B surge
  - UL 1950, Clause 6. power cross
  - CSA 22.2 No. 950, Clause 6. power cross
- **Ring-Tip Protection .....TISP4350L3BJ**
- **Electronics Protection .....TISP4070L3BJ**
- **Ion-Implanted Breakdown Region  
Precise and Stable Voltage  
Low Voltage Overshoot under Surge**



device symbol

DEVICE	V <sub>DRM</sub> V	V <sub>(BO)</sub> V
'4070	58	70
'4350	275	350



Terminals T and R correspond to the alternative line designators of A and B

- **Rated for UL 1950 and Part 68 Wave Shapes**

SURGE TYPE	STANDARD	WAVE SHAPE	I <sub>TSP</sub> A
A	FCC Part 68	10/160 μs	50
		10/560 μs	30
B	FCC Part 68	9/720 μs	40
	UL 1950 / ITU-T K21	10/700 μs	

**description**

These devices are designed to limit overvoltages on the telephone line. Overvoltages are normally caused by a.c. power system or lightning flash disturbances which are induced or conducted on to the telephone line. A single device provides 2-point protection and is typically used for the protection of 2-wire telecommunication equipment (e.g. between the Ring and Tip wires for telephones and modems). Combinations of devices can be used for multi-point protection (e.g. 3-point protection between Ring, Tip and Ground).

The protector consists of a symmetrical voltage-triggered bidirectional thyristor. Overvoltages are initially clipped by breakdown clamping until the voltage rises to the breakover level, which causes the device to crowbar into a low-voltage on state. This low-voltage on state causes the current resulting from the overvoltage to be safely diverted through the device. The high crowbar holding current prevents d.c. latchup as the diverted current subsides. These protectors are guaranteed to voltage limit and withstand the listed lightning surges in both polarities.

After a Type A surge the equipment can be faulty, provided that the fault mode causes the equipment to be unusable. The high current Type A surges (10/160, 200 A and 10/560, 100 A), will cause the TISP4xxxL3BJ to fail short circuit, giving a non-operational equipment pass to Type A surges.

After a Type B surge the equipment must be operational. As the TISP4xxxL3BJ has a current rating of 40 A, will survive both Type B surges, metallic (differential mode 25 A, 9/720) and longitudinal (common mode 37.5 A, 9/720), giving an operational pass to Type B surges.

For metallic protection, the TISP4350L3BJ is connected between the Ring and Tip conductors. For longitudinal protection two TISP4350L3BJ protectors are used; one between the Ring conductor to ground and the other between the Tip conductor to ground. The B type ringer has voltages of 56.5 V d.c. and up to

**PRODUCT INFORMATION**

Information is current as of publication date. Products conform to specifications in accordance with the terms of Power Innovations standard warranty. Production processing does not necessarily include testing of all parameters.



# TISP4070L3BJ, TISP4350L3BJ

## BIDIRECTIONAL THYRISTOR OVERVOLTAGE PROTECTORS

AUGUST 1999 — REVISED NOVEMBER 1999

150 V rms a.c., giving a peak voltage of 269 V. The TISP4350L3BJ will not clip the B type ringing voltage as it has a high impedance up to 275 V.

The TISP4070L3BJ should be connected after the hook switch to protect the following electronics. As the TISP4070L3BJ has a high impedance up to 58 V, it will switch off after a surge and not be triggered by the normal exchange battery voltage

These low (L) current protection devices are in a plastic package SMBJ (JEDEC DO-214AA with J-bend leads) and supplied in embossed tape reel pack. For alternative voltage and holding current values, consult the factory. For higher rated impulse currents in the SMB package, the 100 A 10/1000 TISP4xxxH3BJ series is available.

### absolute maximum ratings, $T_A = 25\text{ }^\circ\text{C}$ (unless otherwise noted)

RATING	SYMBOL	VALUE	UNIT
Repetitive peak off-state voltage,	$V_{DRM}$	$\pm 58$	V
		$\pm 275$	
Non-repetitive peak on-state pulse current (see Notes 1, and 2)	$I_{TSP}$	50	A
10/160 $\mu\text{s}$ (FCC Part 68, 10/160 $\mu\text{s}$ voltage wave shape, Type A)		40	
5/310 $\mu\text{s}$ (ITU-T K21, 10/700 $\mu\text{s}$ voltage wave shape)		40	
5/320 $\mu\text{s}$ (FCC Part 68, 9/720 $\mu\text{s}$ voltage wave shape, Type B)		30	
10/560 $\mu\text{s}$ (FCC Part 68, 10/560 $\mu\text{s}$ voltage wave shape, Type A)			
Non-repetitive peak on-state current (see Notes 1, 2 and 3)	$I_{TSM}$	12	A
20 ms (50 Hz) full sine wave		13	
16.7 ms (60 Hz) full sine wave		2	
1000 s 50 Hz/60 Hz a.c.			
Initial rate of rise of on-state current, Exponential current ramp, Maximum ramp value < 100 A	$di_T/dt$	120	A/ $\mu\text{s}$
Junction temperature	$T_J$	-40 to +150	$^\circ\text{C}$
Storage temperature range	$T_{stg}$	-65 to +150	$^\circ\text{C}$

- NOTES: 1. Initially the TISP4xxxL3BJ must be in thermal equilibrium with  $T_J = 25\text{ }^\circ\text{C}$ .  
 2. The surge may be repeated after the TISP4xxxL3BJ returns to its initial conditions.  
 3. EIA/JESD51-2 environment and EIA/JESD51-3 PCB with standard footprint dimensions connected with 5 A rated printed wiring track widths. Derate current values at -0.61 %/ $^\circ\text{C}$  for ambient temperatures above  $25\text{ }^\circ\text{C}$

### overload ratings, $T_A = 25\text{ }^\circ\text{C}$ (unless otherwise noted)

RATING	SYMBOL	VALUE	UNIT
Peak overload on-state current, Type A impulse (see Note 4)	$I_{T(OV)M}$	300	A
10/160 $\mu\text{s}$		150	
10/560 $\mu\text{s}$			
Peak overload on-state current, a.c. power cross tests UL 1950 (see Note 4)	$I_{T(OV)M}$	See Figure 2 for current versus time	A

- NOTE 4: These electrical stress levels may damage the TIS4xxxL3BJ silicon chip. After test, the pass criterion is either that the device is functional or, if it is faulty, that it has a short circuit fault mode. In the short circuit fault mode, the following equipment is protected as the device is a permanent short across the line. The equipment would be unprotected if an open circuit fault mode developed.

## PRODUCT INFORMATION

## BIDIRECTIONAL THYRISTOR OVERVOLTAGE PROTECTORS

AUGUST 1999 — REVISED NOVEMBER 1999

electrical characteristics for the T and R terminals,  $T_A = 25\text{ °C}$  (unless otherwise noted)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$I_{DRM}$ Repetitive peak off-state current	$V_D = V_{DRM}$ $T_A = 25\text{ °C}$ $T_A = 85\text{ °C}$			$\pm 5$ $\pm 10$	$\mu\text{A}$
$V_{(BO)}$ Breakover voltage	$dv/dt = \pm 250\text{ V/ms}$ , $R_{SOURCE} = 300\ \Omega$			$\pm 70$ $\pm 350$	V
$V_{(BO)}$ Impulse breakover voltage	$dv/dt \leq \pm 1000\text{ V}/\mu\text{s}$ , Linear voltage ramp, Maximum ramp value = $\pm 500\text{ V}$ $di/dt = \pm 20\text{ A}/\mu\text{s}$ , Linear current ramp, Maximum ramp value = $\pm 10\text{ A}$			$\pm 78$ $\pm 359$	V
$I_{(BO)}$ Breakover current	$dv/dt = \pm 250\text{ V/ms}$ , $R_{SOURCE} = 300\ \Omega$	$\pm 40$		$\pm 250$	mA
$V_T$ On-state voltage	$I_T = \pm 5\text{ A}$ , $t_W = 100\ \mu\text{s}$			$\pm 3$	V
$I_H$ Holding current	$I_T = \pm 5\text{ A}$ , $di/dt = \pm 30\text{ mA/ms}$	$\pm 120$		$\pm 350$	mA
$dv/dt$ Critical rate of rise of off-state voltage	Linear voltage ramp, Maximum ramp value $< 0.85V_{DRM}$	$\pm 5$			kV/ $\mu\text{s}$
$I_D$ Off-state current	$V_D = \pm 50\text{ V}$ $T_A = 85\text{ °C}$			$\pm 10$	$\mu\text{A}$
$C_{off}$ Off-state capacitance	$f = 100\text{ kHz}$ , $V_d = 1\text{ V rms}$ , $V_D = 0$ $V_D = 1\text{ V}$ $V_D = 5\text{ V}$ $f = 100\text{ kHz}$ , $V_d = 1\text{ V rms}$ , $V_D = 0$ $V_D = 1\text{ V}$ $V_D = 5\text{ V}$	$\pm 4070$ $\pm 4350$	40 38 31 26 24 20	50 48 39 33 30 25	pF

## thermal characteristics

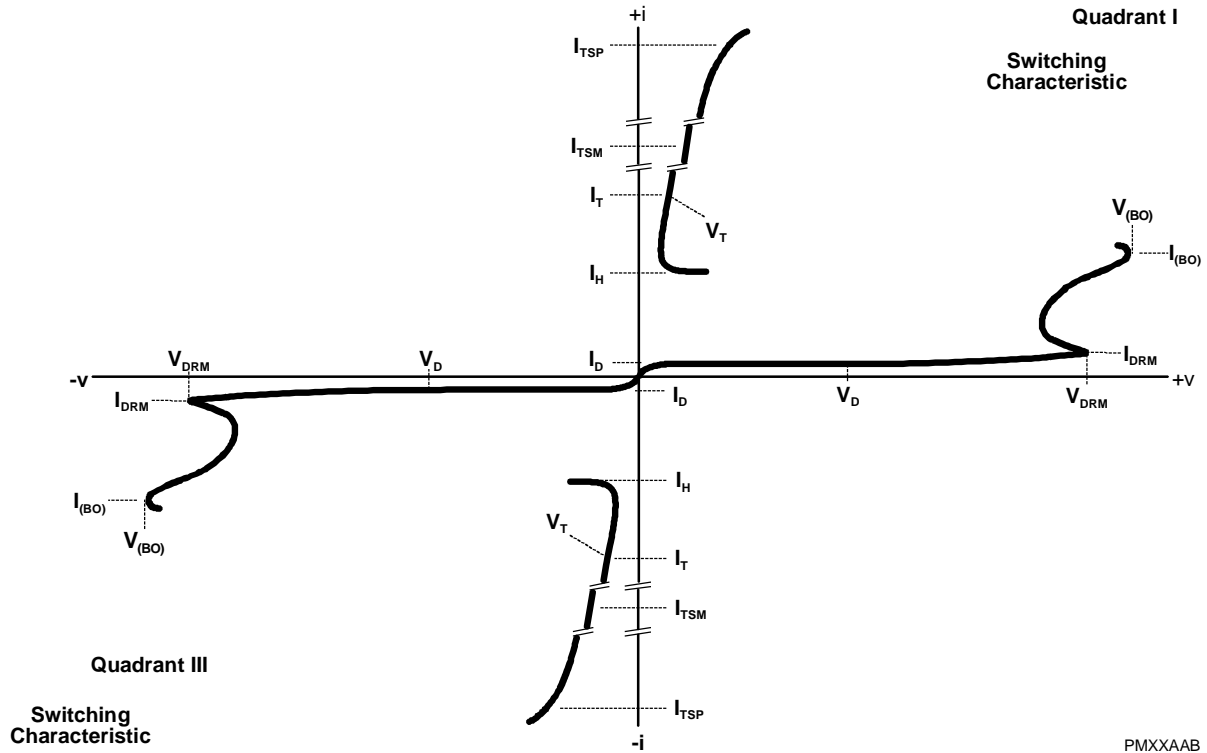
PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$R_{\theta JA}$ Junction to free air thermal resistance	EIA/JESD51-3 PCB, $I_T = I_{TSM(1000)}$ , $T_A = 25\text{ °C}$ , (see Note 5)			115	$^{\circ}\text{C/W}$
	265 mm x 210 mm populated line card, 4-layer PCB, $I_T = I_{TSM(1000)}$ , $T_A = 25\text{ °C}$		52		

NOTE 5: EIA/JESD51-2 environment and PCB has standard footprint dimensions connected with 5 A rated printed wiring track widths.

**BIDIRECTIONAL THYRISTOR OVERVOLTAGE PROTECTORS**

AUGUST 1999 — REVISED NOVEMBER 1999

**PARAMETER MEASUREMENT INFORMATION**



**Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR T AND R TERMINALS  
ALL MEASUREMENTS ARE REFERENCED TO THE R TERMINAL**

PMXXAAB

**PRODUCT INFORMATION**

## BIDIRECTIONAL THYRISTOR OVERVOLTAGE PROTECTORS

AUGUST 1999 — REVISED NOVEMBER 1999

## THERMAL INFORMATION

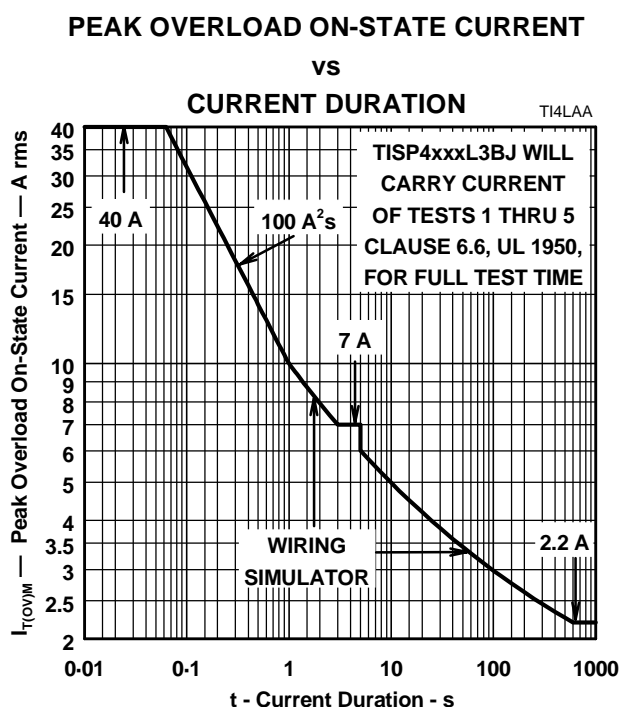


Figure 2. PEAK OVERLOAD ON-STATE CURRENT AGAINST DURATION

## APPLICATIONS INFORMATION

**UL 1950, CSA C22.2 No. 950 and EN 60950**

These electrical safety standards for IT (Information Technology) equipment at the customer premise use the IEC (International Electro-technical Commission) 60950 standard as the core document. The IEC 60950 covers fundamental safety criteria such as creepage and isolation. The connection to a telecommunication network voltage (TNV) is covered in clause 6.

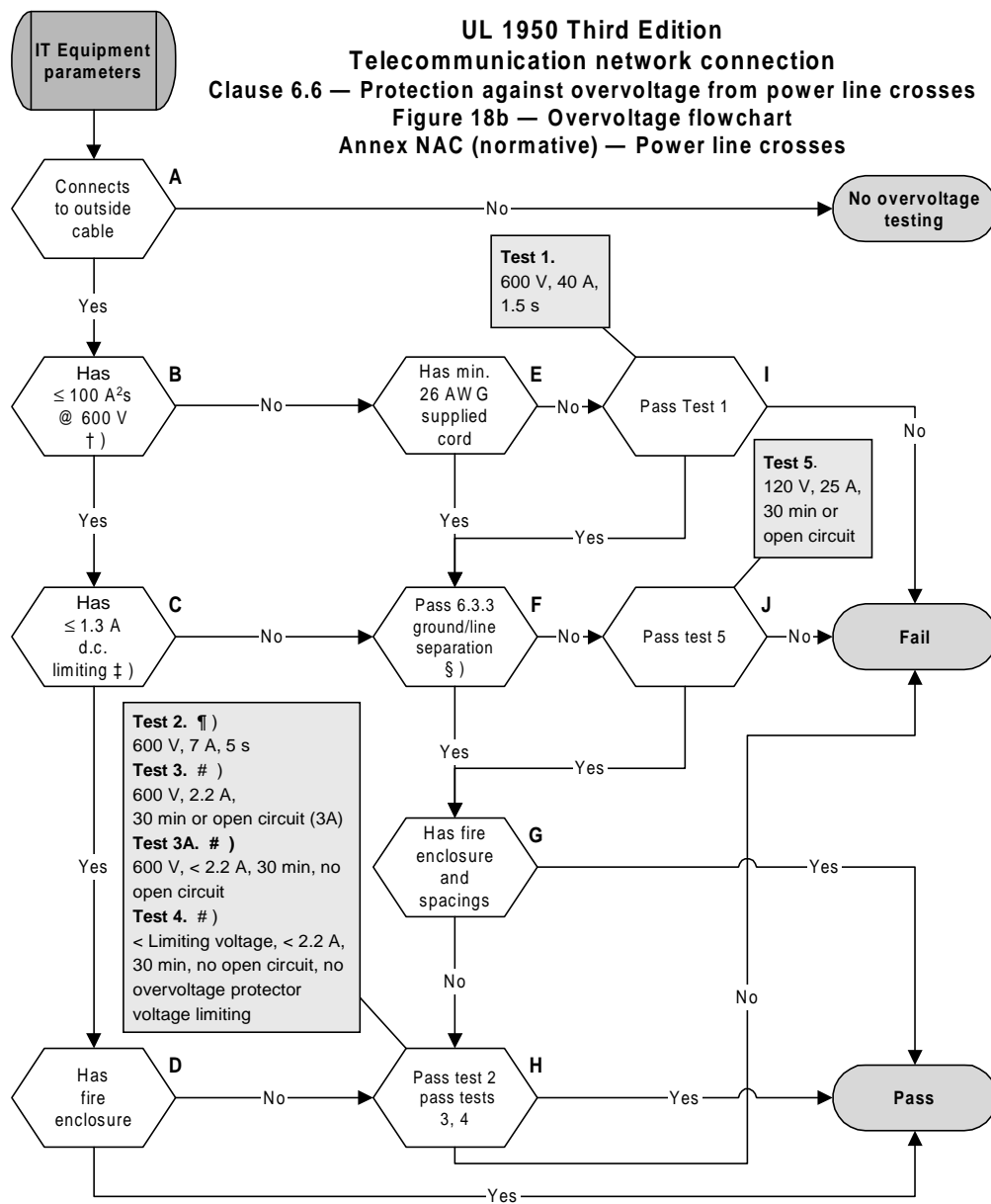
Europe is harmonised by CENELEC (Comité Européen de Normalization Electro-technique) under EN 60950 (included in the Low Voltage Directive, CE mark). US has UL (Underwriters Laboratories) 1950 and Canada CSA (Canadian Standards Authority) C22.2 No. 950. The US and Canadian standards include regional changes and additions to the IEC 60950. A major addition is the inclusion of clause 6.6, power cross withstand and annex NAC covering testing. Remarks made for UL 1950 will generally be true for CSA 22.2 No. 950.

**UL 1950, clause 6.6 — power cross**

Figure 3 shows the criterion flow for UL 1950 power cross. (This is a modified version of UL1950, Figure 18b — Overvoltage flowchart) There are many routes for achieving a pass result. For discussion, each criterion has been given a letter reference. Brief details of any electrical testing is given as a criterion note. Test pass criteria are given in the bottom table of Figure 3.

# BIDIRECTIONAL THYRISTOR OVERVOLTAGE PROTECTORS

AUGUST 1999 — REVISED NOVEMBER 1999



**NOTES**  
 †) Overcurrent protector  $I^2t$  must be lower than any other equipment element which carries the same current.  
 ‡) UL accepts that a fuse with a 1 A or less rating meets the 1.3 A criterion.  
 §) Pass for 120 V a.c. between telecommunication line and ground current < 10 mA.  
 ¶) Test 2 not required if the equipment d.c. breaking is 1.3 A or less, see comment ‡).  
 #) Tests 3 and 4 not required for equipment with less than 1000 m of outside cable.

Pass criteria	Test 1	Test 2	Test 3	Test 3A	Test 4	Test 5
No cheesecloth charring	✓	✓	✓	✓	✓	✓
Insulation OK	✓	✓	✓	✓	✓	✓
wiring simulator (fuse) OK	✓					✓
$I^2t < 100 A^2s @ 600 V a.c.$	✓					

Users must verify requirements against latest issue of UL 1950

August 1999 V2.3

Figure 3. UL 1950 POWER CROSS FLOW CHART

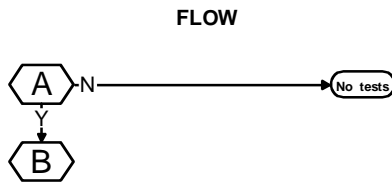
## PRODUCT INFORMATION

## BIDIRECTIONAL THYRISTOR OVERVOLTAGE PROTECTORS

AUGUST 1999 — REVISED NOVEMBER 1999

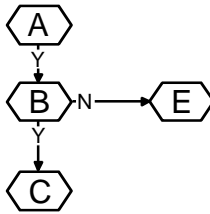
## power cross pass routes

This discussion covers typical modem flows.

**box A**

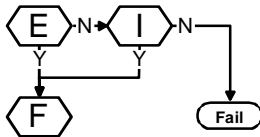
The criterion for box A is if the modem connects to an outside TNV line.

The majority of modems will be connected to an outside line, so the answer is *yes*. The *yes* path goes to box B.

**box B**

The criterion for box B is if the equipment has a limit of  $\leq 100 \text{ A}^2\text{s}$  at 600 V rms for Test 1. Many interpret this as a fuse with  $I^2t \leq 100 \text{ A}^2\text{s}$  and often miss the 600 V a.c. breaking requirement. However, the current loop is completed by the fuse and other equipment components. To ensure that the fuse  $I^2t$  sets the equipment performance, the other current loop components, such as the printed wiring (PW), must have a higher  $I^2t$  values than the fuse. Certainly the fuse  $I^2t$  needs to be lower than 100  $\text{A}^2\text{s}$  but other components, for example IC packaging, may impose a hazard-free limit of 10  $\text{A}^2\text{s}$ . (This conflicts with FCC Part 68 Type A surge pass requirement of 8  $\text{A}^2\text{s}$ .)

A *yes* leads to box C and a *no* to box E.

**boxes E and I**

The criterion for box E is for a minimum telecommunications line cord of No. 26 AWG to be supplied or specified.

A *yes* leads to box F and a *no* to box I.

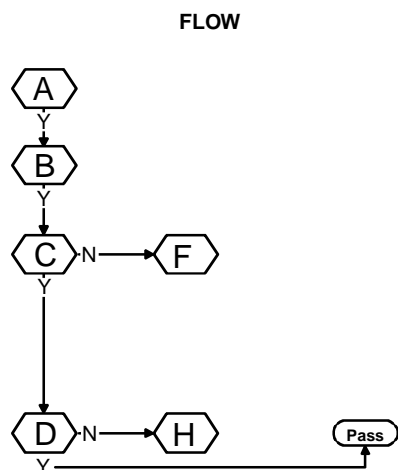
The criterion for box I is to pass Test 1.

If all the four pass criteria of Test 1 are met, this is a *yes* and the flow goes to box F.

A *no* result fails the equipment.

## BIDIRECTIONAL THYRISTOR OVERVOLTAGE PROTECTORS

AUGUST 1999 — REVISED NOVEMBER 1999



### boxes C and D

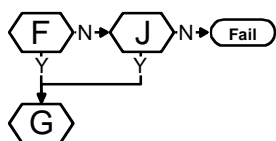
The criterion for box C is overcurrent protection that reduces currents above 1.3 A. This requirement is met by a 1 A fuse (a 1 A current fusing rating, not an IEC 1 A current carrying rating).

Modems which pass FCC Part 68 Type B surges and non-operationally pass Type A surges can use a fuse of 1 A or less, so the *yes* path to box D can be followed. High performance modems which operationally pass both Type A and B surges would need a fuse of greater than 1 A and so follow the *no* path to box F.

The criterion for box D is a fire enclosure.

Few modems can afford fire enclosures. However, for an internal modem in a known computer case, the case may be evaluated as a fire enclosure. A successful case evaluation will give a *yes* and an equipment pass.

More likely the modem will not have a fire enclosure. The *no* flow goes to box H.



### boxes F and J

The criterion for box F is a pass to clause 6.3.3 requirements.

A *yes* goes to box G and a *no* goes to box J.

The criterion for box J is to pass Test 5.

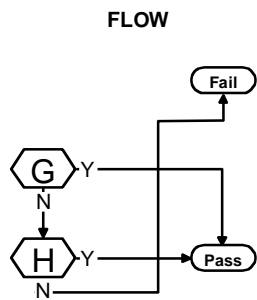
If all the three pass criteria of Test 5 are met, this is a *yes* and the flow goes to box G.

A *no* result fails the equipment.



## BIDIRECTIONAL THYRISTOR OVERVOLTAGE PROTECTORS

AUGUST 1999 — REVISED NOVEMBER 1999

**boxes G and H**

The criterion for box G is a fire enclosure and spacings (See box D comments).

A *yes* result passes the equipment and a *no* result leads to box H.

The criterion for box H is to pass Tests 2, 3 and 4. Test 2 is not required if there is overcurrent protection that reduces currents above 1.3 A (See box C).

High performance modems, using fuses and without fire enclosures, must pass tests 2, 3, possibly 3A if the fuse opens, and 4. For standard modems, using fuses of 1 A or less and without fire enclosures, tests 3, 3A and 4 must be passed.

If the two pass criteria of each of the tests performed are met, this is a *yes* and the equipment passes.

A *no* result fails the equipment.

**fuse values**

There are two areas of fuse criteria; surge capability (FCC Part 68 impulse) and power cross capability (UL1950 clause 6.6 and annex NAC).

To survive an impulse, a fuse must have a melting  $I^2t$  rating greater than the impulse  $I^2t$ . The fuse  $I^2t$  rating should be specified for the impulse waveshape current as the normal d.c. rating may not result in adiabatic conditions. Alternatively, the fuse may be specified for a rated current under the impulse waveshape conditions.

An exponentially decaying impulse with a current amplitude  $I_{PP}$  and 50 % amplitude decay time of  $t_D$  has an  $I^2t$  value of  $0.72I_{PP}^2t_D$ . Test waveforms have tolerances and the formula can be approximated to  $I_{PP}^2t_D$ , giving about a 40 % allowance to cover tolerances e.g. +5 % on  $I_{PP}$  and +30 % on  $t_D$ . Using the approximate formula, the  $I^2t$  values for typical waveforms are shown in the table below.

SPECIFICATION	AMPLITUDE $I_{PP}$ A	CURRENT WAVESHAPES $t_R/t_D$ ( $\mu$ s)	MELTING $I^2t$ $A^2s$
FCC Part 68, Type A	200	10/160	6.4
	100	10/560	5.6
FCC Part 68, Type B	37.5	5/320	0.45
UL 1950 / ITU-T K21	37.5	5/310	0.45
TELCORDIA (FORMALLY BELLCORE) GR-1089	500	2/10	2.5
	100	10/1000	10

Fuse power cross current capability can be determined from its time-current curve. The fuse must be rated to break the current at the applied power cross a.c. voltage level.

**fuse values for FCC Part 68**

Fuses must not blow on the Type B surge. To survive a 37.5 A Type B surge, the fuse needs to have an  $I^2t$  of greater than  $0.45 A^2s$ . Fuses, such as the 1 A surface mount SMTelecom™ 0436001.PR or the 0.5 A axial lead 2AG Surge Withstand 230.500 (both from the Littelfuse) will meet this criteria.

### BIDIRECTIONAL THYRISTOR OVERVOLTAGE PROTECTORS

AUGUST 1999 — REVISED NOVEMBER 1999

---

To survive the Type A surges a fuse  $I^2t$  value of 6.4 A<sup>2</sup>s is needed. Fuses, such as the 1.6 A 043601.6PR will meet this criteria.

#### **fuse values for UL 1950**

Fuses for the UL 1950 power cross need to break the specified currents at 600 V a.c. - ordinary fuses will not do! Fuse specification terms like *short circuit capabilities to UL 1459 and UL 1950, 40 A, 7 A and 2.2 A at 600 V a.c.* ensure that the 600 V breaking is met.

The requirement of Figure 3, box B, limits the fuse  $I^2t$  to less than 100 A<sup>2</sup>s.

Box C, with its 1.3 A limit gives a flow division. Modems passing the FCC Part 68 Type A surge in a non-operational mode, could use a 1 A fuse and satisfy the 1.3 A limit and move to box D. Modems operationally passing the Type A surge will tend to use a 1.6 A fuse a fuse and move to box F. Fuses with ratings of 2 A and above may not operate before the wiring simulator fails.

#### **TISP4xxxL3BJ and UL 1950 power cross**

The TISP4xxxL3BJ conducts current for periods greater than the power cross test times, Figure 2, so the TISP4xxxL3BJ is not a major factor in UL 1950 compliance. The main design task for UL 1950 power cross is about enclosure design and the selection of the other components that are subject to power cross. A UL specified fuse together with a TISP4xxxL3BJ gives a simple design approach to meeting the power cross requirements.

BIDIRECTIONAL THYRISTOR OVERVOLTAGE PROTECTORS

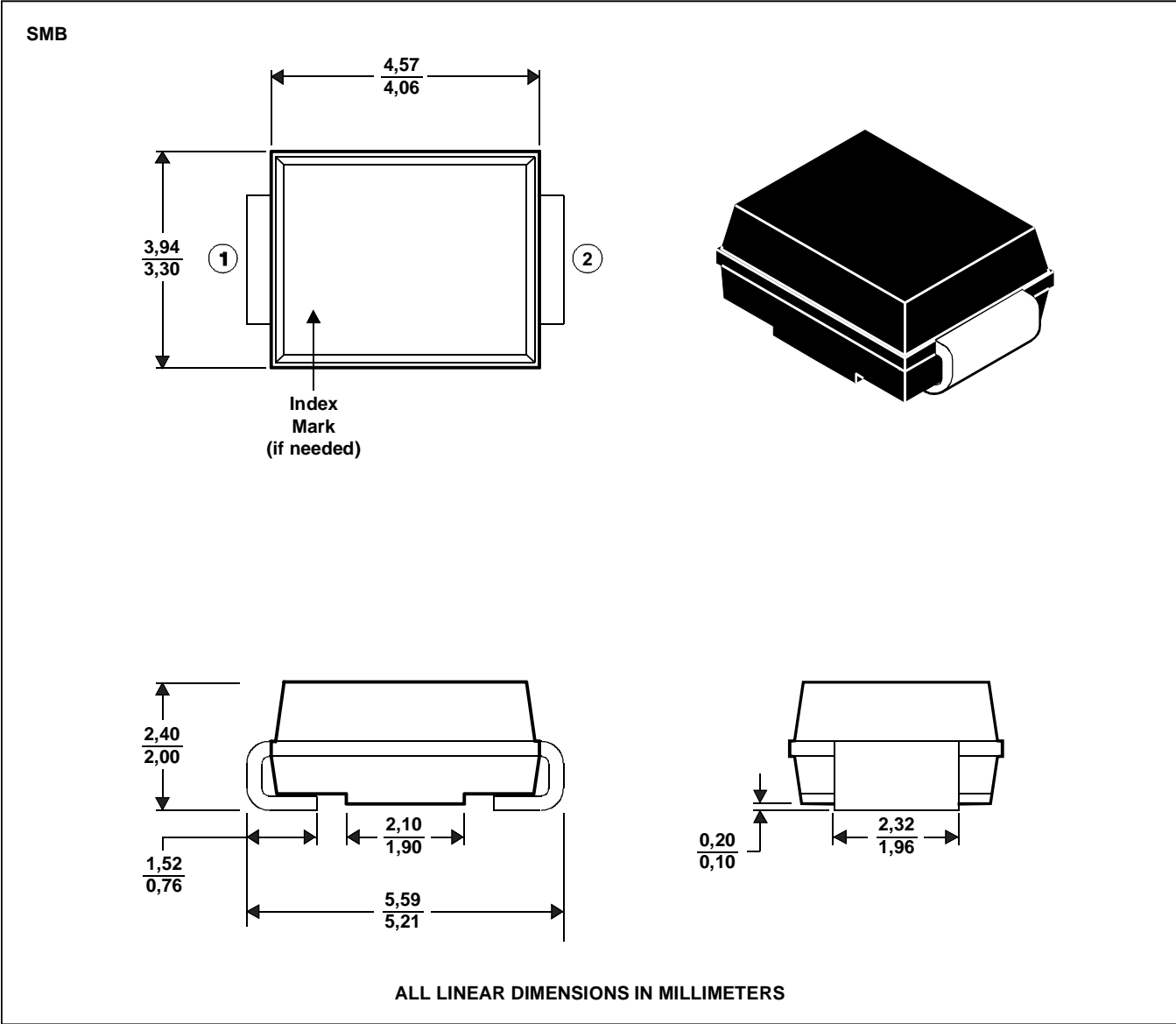
AUGUST 1999 — REVISED NOVEMBER 1999

MECHANICAL DATA

SMBJ (DO-214AA)

plastic surface mount diode package

This surface mount package consists of a circuit mounted on a lead frame and encapsulated within a plastic compound. The compound will withstand soldering temperature with no deformation, and circuit performance characteristics will remain stable when operated in high humidity conditions. Leads require no additional cleaning or processing when used in soldered assembly.



MDXXBHA

PRODUCT INFORMATION

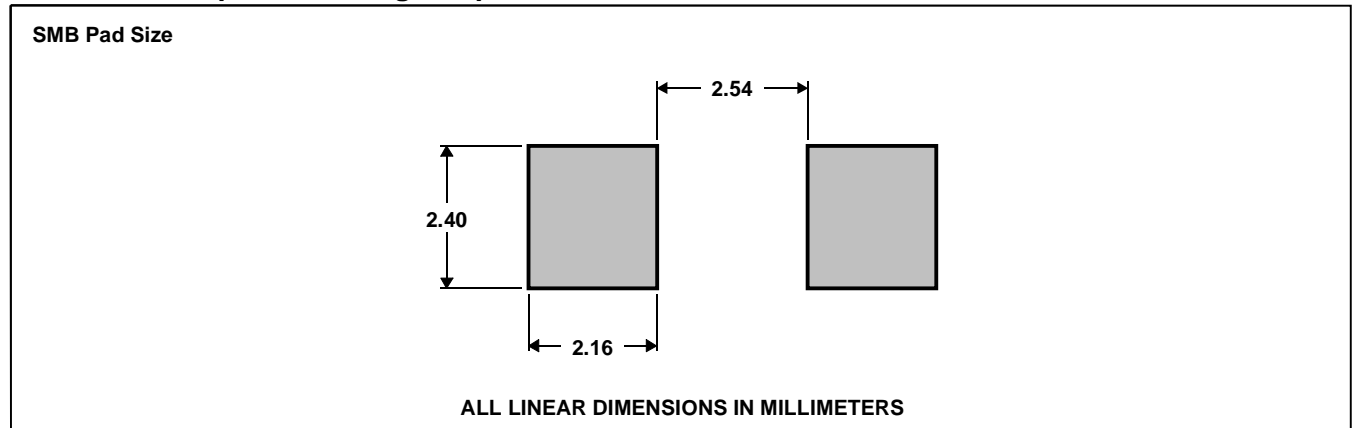


**BIDIRECTIONAL THYRISTOR OVERVOLTAGE PROTECTORS**

AUGUST 1999 — REVISED NOVEMBER 1999

**MECHANICAL DATA**

recommended printed wiring footprint.



MDXXBI

**device symbolization code**

Devices will be coded as below. As the device parameters are symmetrical, terminal 1 is not identified.

DEVICE	PRODUCTION SYMBOLIZATION CODE	DEVELOPMENT SYMBOLIZATION CODE
TISP4070L3BJ	4070L3	TX4070
TISP4350L3BJ	4350L3	TX4350

**carrier information**

Devices are shipped in one of the carriers below. Unless a specific method of shipment is specified by the customer, devices will be shipped in the most practical carrier. For production quantities the carrier will be embossed tape reel pack. Evaluation quantities may be shipped in bulk pack or embossed tape.

**AVAILABLE OPTIONS**

PACKAGE TYPE	CARRIER	
	BULK PACK	TAPE AND REEL
SMBJ (DO-214AA)	TISP4xxxL3BJ	TISP4xxxL3BJR

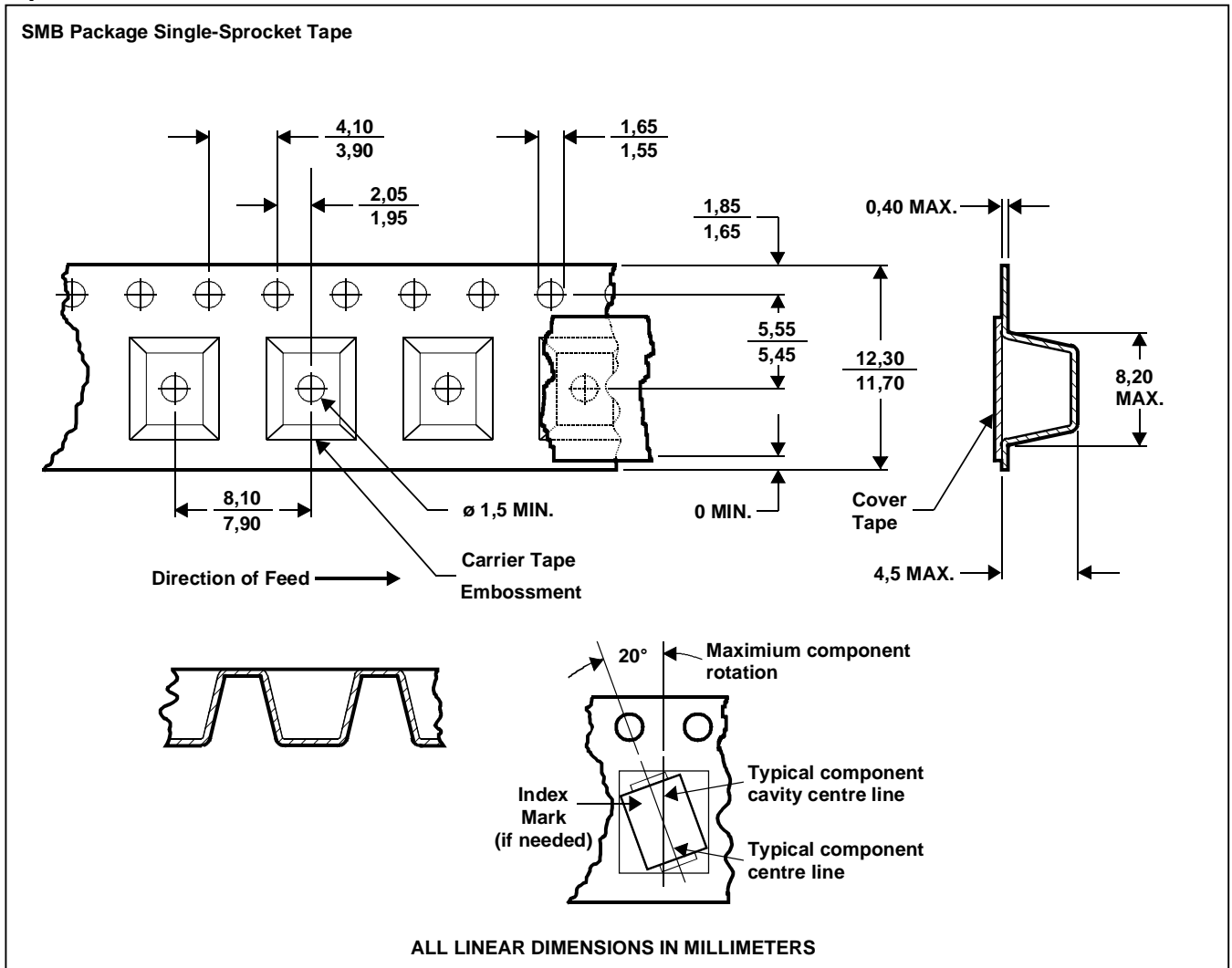
**PRODUCT INFORMATION**

**BIDIRECTIONAL THYRISTOR OVERVOLTAGE PROTECTORS**

AUGUST 1999 — REVISED NOVEMBER 1999

**MECHANICAL DATA**

**tape dimensions**



NOTES: A. The clearance between the component and the cavity must be within 0,05 mm MIN. to 0,65 mm MAX. so that the component cannot rotate more than 20° within the determined cavity. MDXXBJ

B. Taped devices are supplied on a reel of the following dimensions:-

- Reel diameter: 330 ±3,0 mm
- Reel hub diameter 75 mm MIN.
- Reel axial hole: 13,0 ±0,5 mm

C. 3000 devices are on a reel.

**PRODUCT INFORMATION**



## BIDIRECTIONAL THYRISTOR OVERVOLTAGE PROTECTORS

AUGUST 1999 — REVISED NOVEMBER 1999

---

### IMPORTANT NOTICE

Power Innovations Limited (PI) reserves the right to make changes to its products or to discontinue any semiconductor product or service without notice, and advises its customers to verify, before placing orders, that the information being relied on is current.

PI warrants performance of its semiconductor products to the specifications applicable at the time of sale in accordance with PI's standard warranty. Testing and other quality control techniques are utilized to the extent PI deems necessary to support this warranty. Specific testing of all parameters of each device is not necessarily performed, except those mandated by government requirements.

PI assumes no liability for applications assistance, customer product design, software performance, or infringement of patents or services described herein. Nor is any license, either express or implied, granted under any patent right, copyright, design right, or other intellectual property right of PI covering or relating to any combination, machine, or process in which such semiconductor products or services might be or are used.

PI SEMICONDUCTOR PRODUCTS ARE NOT DESIGNED, INTENDED, AUTHORISED, OR WARRANTED TO BE SUITABLE FOR USE IN LIFE-SUPPORT APPLICATIONS, DEVICES OR SYSTEMS.

Copyright © 1999, Power Innovations Limited