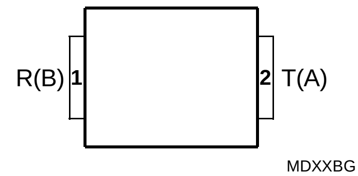
FCC PART 68 AND UL 1950 OVERVOLTAGE PROTECTORS

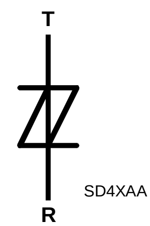
- **MODEM Protection against:**
  — FCC Part 68 Type A & B surge
  — UL 1950, Clause 6. power cross
  — CSA 22.2 No. 950, Clause 6. power cross
- **Ring-Tip Protection TISP4350L3BJ**
- **Electronics Protection TISP4070L3BJ**
- **Ion-Implanted Breakdown Region**
  Precise and Stable Voltage
  Low Voltage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

SMBJ PACKAGE (TOP VIEW)



DEVICE	V_{DRM} V	$V_{(BO)}$ V
‘4070	58	70
‘4350	275	350

device symbol



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

SURGE TYPE	STANDARD	WAVE SHAPE	I_{TSP} A
A	FCC Part 68	10/160 µs	50
		10/560 µs	30
B	FCC Part 68 ITU-T K21	9/720 µs 10/700 µs	40

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 and 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

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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 °C (unless otherwise noted)

RATING		SYMBOL	VALUE	UNIT
Repetitive peak off-state voltage,	‘4070	V_{DRM}	± 58	V
	‘4350		±275	
Non-repetitive peak on-state pulse current (see Notes 1, and 2)		I_{TSP}		A
10/160 µs (FCC Part 68, 10/160 µs voltage wave shape, Type A)			50	
5/310 µs (ITU-T K21, 10/700 µs voltage wave shape)			40	
5/320 µs (FCC Part 68, 9/720 µs voltage wave shape, Type B)			40	
10/560 µs (FCC Part 68, 10/560 µs voltage wave shape, Type A)			30	
Non-repetitive peak on-state current (see Notes 1, 2 and 3)		I_{TSM}		A
20 ms (50 Hz) full sine wave			12	
16.7 ms (60 Hz) full sine wave			13	
1000 s 50 Hz/60 Hz a.c.			2	
Initial rate of rise of on-state current,	Exponential current ramp, Maximum ramp value < 100 A	di_T/dt	120	A/µs
Junction temperature		T_J	-40 to +150	°C
Storage temperature range		T_{stg}	-65 to +150	°C

NOTES: 1. Initially the TISP4xxxL3BJ must be in thermal equilibrium with T_J = 25 °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 %/°C for ambient temperatures above 25 °C

overload ratings, T_A = 25 °C (unless otherwise noted)

RATING	SYMBOL	VALUE	UNIT
Peak overload on-state current, Type A impulse (see Note 4)	$I_{T(OV)M}$		A
10/160 µs		200	
10/560 µs		100	
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.

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electrical characteristics for the T and R terminals, T_A = 25 °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 °C T_A = 85 °C			±5 ±10	µA
$V_{(BO)}$	Breakover voltage	dv/dt = ±750 V/ms, R_{SOURCE} = 300 Ω	‘4070 ‘4350			±70 ±350	V
$V_{(BO)}$	Impulse breakover voltage	dv/dt ≤ ±1000 V/µs, Linear voltage ramp, Maximum ramp value = ±500 V di/dt = ±20 A/µs, Linear current ramp, Maximum ramp value = ±10 A	‘4070 ‘4350			±78 ±359	V
$I_{(BO)}$	Breakover current	dv/dt = ±750 V/ms, R_{SOURCE} = 300 Ω		±0.10		±0.4	A
V_T	On-state voltage	I_T = ±5 A, t_W = 100 µs				±3	V
I_H	Holding current	I_T = ±5 A, di/dt = +/-30 mA/ms		±0.12		±0.35	A
dv/dt	Critical rate of rise of off-state voltage	Linear voltage ramp, Maximum ramp value < $0.85V_{DRM}$		±5			kV/µs
I_D	Off-state current	V_D = ±50 V	T_A = 85 °C			±10	µA
C_{off}	Off-state capacitance	f = 100 kHz, V_d = 1 V rms, V_D = 0 V_D = 1 V V_D = 5 V f = 100 kHz, V_d = 1 V rms, V_D = 0 V_D = 1 V V_D = 5 V	‘4070 ‘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 °C, (see Note 5)			115	°C/W
		265 mm x 210 mm populated line card, 4-layer PCB, $I_T = I_{TSM(1000)}$, T_A = 25 °C		52		

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

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PARAMETER MEASUREMENT INFORMATION

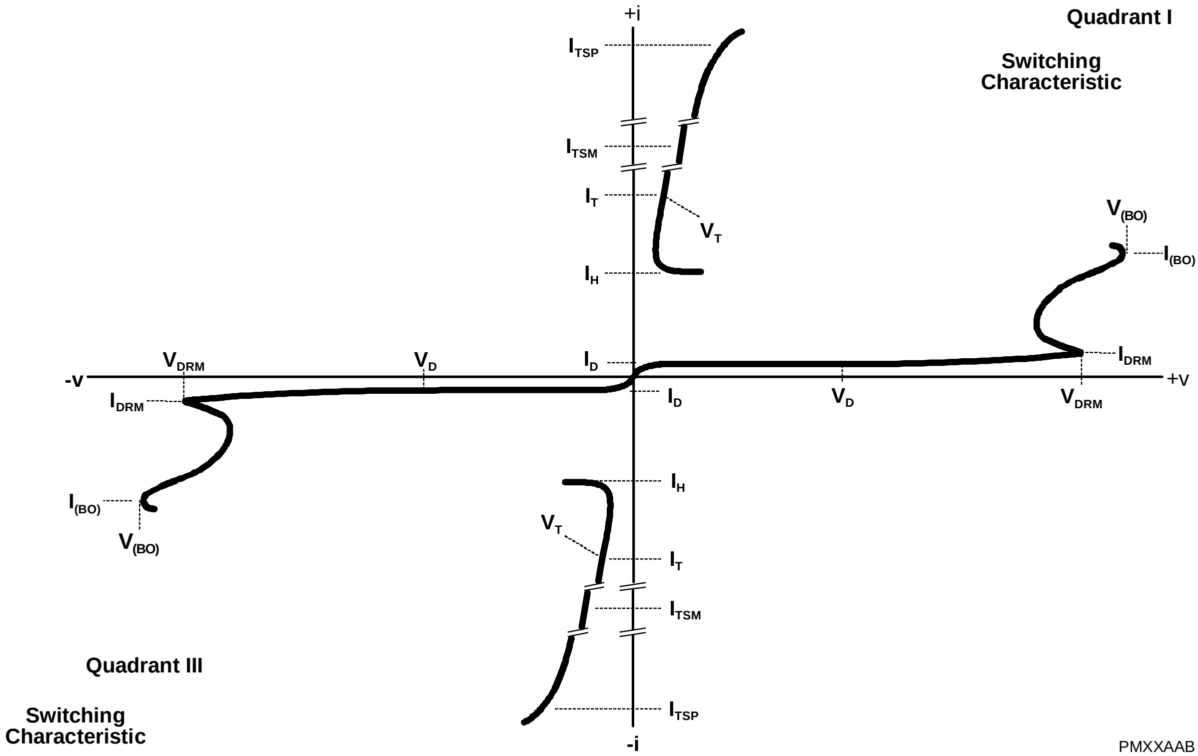

Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR T AND R TERMINALS
ALL MEASUREMENTS ARE REFERENCED TO THE R TERMINAL

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THERMAL INFORMATION

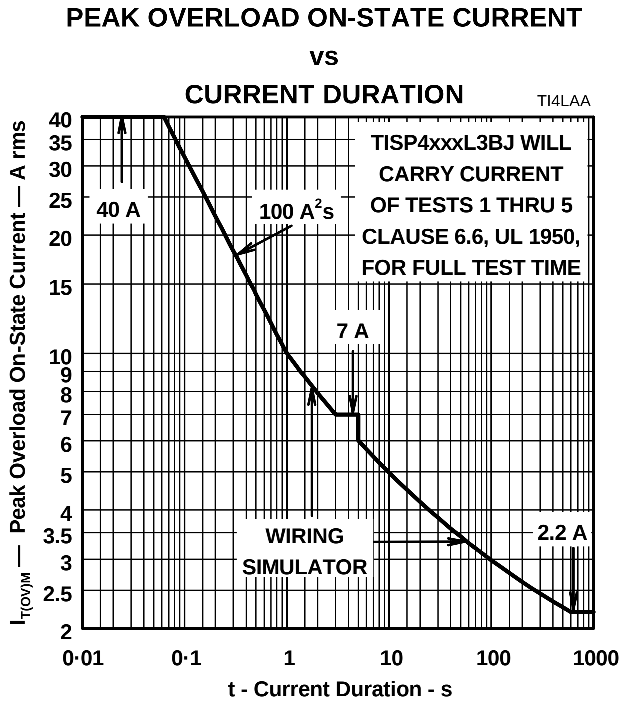

Figure 2. PEAK OVERLOAD ON-STATE CURRENT AGAINST DURATION

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.

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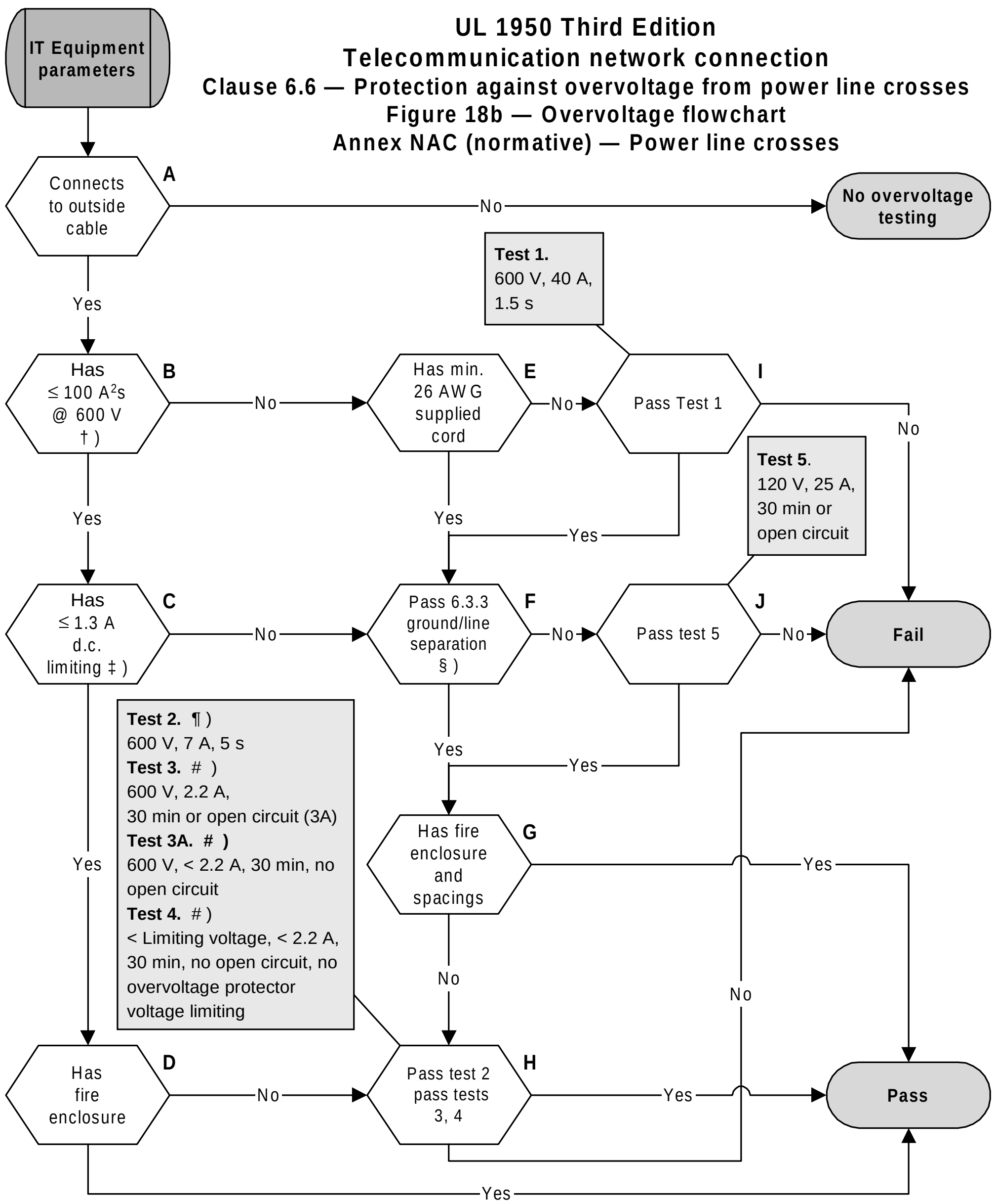


NOTES

†) Overcurrent protector I^2t must 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.

August 1999 V2.3

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

Figure 3. UL 1950 POWER CROSS FLOW CHART

power cross pass routes

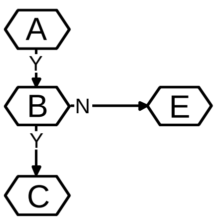
This discussion covers typical modem flows.

FLOW	COMMENT

box A

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

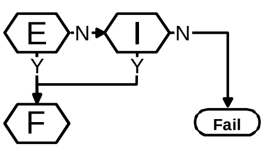
The majority of modems will be connected to an outside line, so the answer is *yes*. The *yes* path goes to box B.



box B

The criterion for box B is if the equipment has a limit of ≤ 100 A^2s at 600 V rms for Test 1. Many interpret this as a fuse with I^2t ≤ 100 A^2s 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 A^2s but other components, for example IC packaging, may impose a hazard-free limit of 10 A^2s. (This conflicts with FCC Part 68 Type A surge pass requirement of 8 A^2s.)

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.

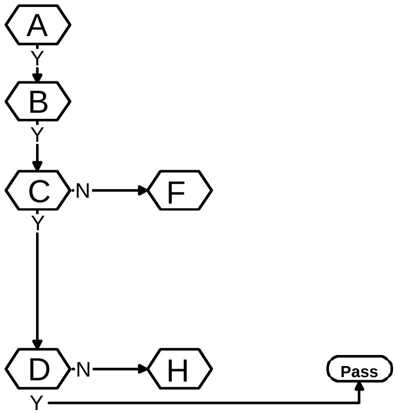
The criterion for box I is to pass Test 1.

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.

ADVANCE INFORMATION

FLOW | **COMMENT**



boxes C and D

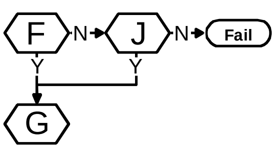
The criterion for box C is overcurrent protection that reduces currents above 1.3 A. This requirement is met by a 1 A fuse (a 1 A current fusing rating, not an IEC 1 A current carrying rating).

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.

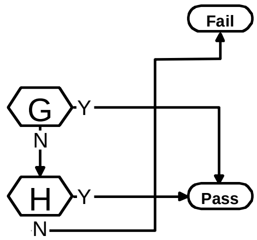
A *yes* goes to box G and a *no* goes to box J.

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.

FLOW | **COMMENT**



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).

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 0.6 A^2s. Typically a 1 A fuse, such as the 0436001.PR (from the Littelfuse SMTelecom™ Fuse 436 Series) will meet this criteria.

To survive the Type A surges a fuse I^2t value of 8 A^2s is needed. Typically a 1.6 A fuse, such as the 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! Fuses with UL references 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^2s.

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.

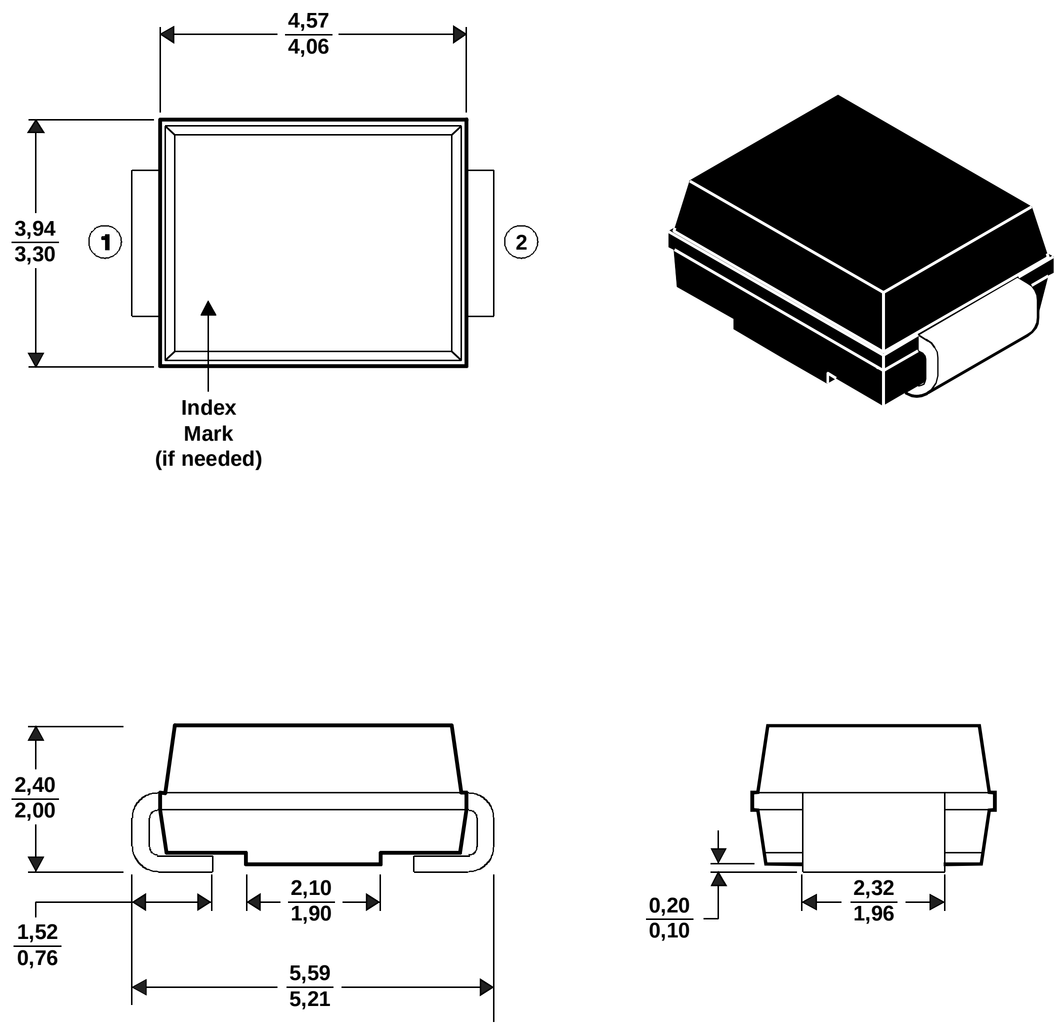
MECHANICAL DATA

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.

SMB



ALL LINEAR DIMENSIONS IN MILLIMETERS

MDXXBHA

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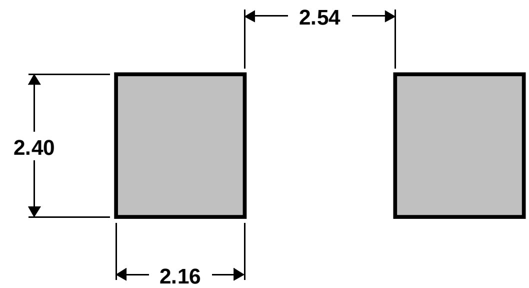
TEXAS INSTRUMENTS

MECHANICAL DATA

recommended printed wiring footprint.

SMB Pad Size



ALL LINEAR DIMENSIONS IN MILLIMETERS

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.

CARRIER	ORDER #
Embossed Tape Reel Pack	TISP4xxxL3BJR
Bulk Pack	TISP4xxxL3BJ

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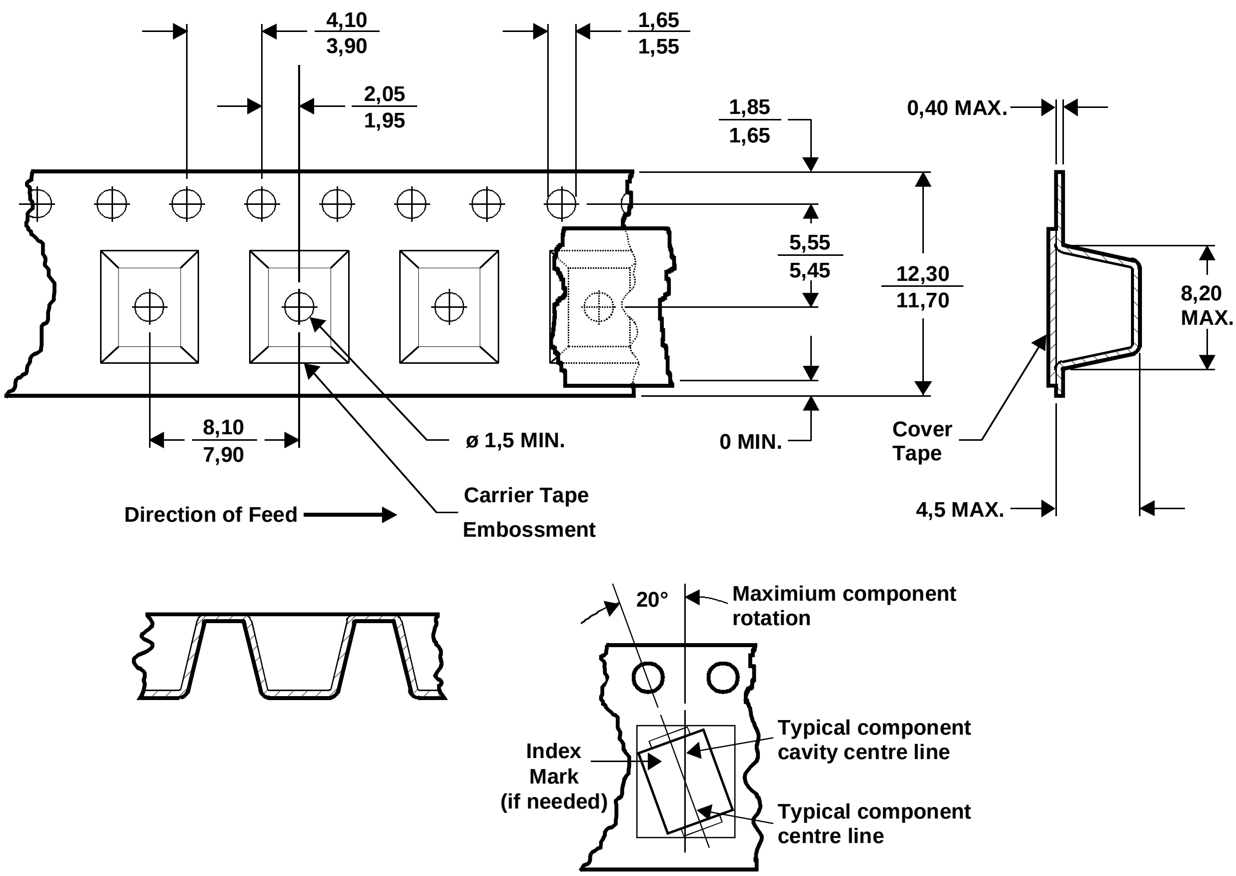
MECHANICAL DATA

tape dimensions

SMB Package Single-Sprocket Tape



ALL LINEAR DIMENSIONS IN MILLIMETERS

MDXXBJ

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.

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.

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