TEXAS INSTRUMENTS

Over-voltage Protection For Telecommunication Systems

Data Manual & Application Information

1994

Over-voltage Protection For Telecommunication Systems

Data Manual and Application Information

TEXAS INSTRUMENTS

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INTRODUCTION

Texas Instruments supplies a wide range of primary and secondary over-voltage protection devices designed specifically to provide protection in telecommunications equipment. High voltages can occur on the telephone line as a result of exposure to lightning strikes and ac power surges. To ensure an adequate service life international standards define various impulse and ac surge levels that equipment connected to the telephone network must withstand. The use of the over-voltage protectors in this book will protect the equipment to allow standard certification.

The range of products is implemented using Texas Instruments high reliability ion-implanted planar process, which permits precise control of electrical characteristics, extremely stable parameters and the monolithic integration of a complete over-voltage protection solution in a single package.

This publication presents technical information for Texas Instruments range of primary and secondary over-voltage protection devices. Complete device specifications are provided in the form of datasheets which are organised by product and package type for easy reference. A selection guide is provided to enable a quick over-view of the complete family with consideration for the end equipments in which the devices are used. Package outlines are provided with tape and reel specifications where appropriate.

Every datasheet is formatted to the same style. As a minimum the front page will detail quick reference data, description, package, pin out, schematic diagram and product status. A full datasheet will contain the following order of information :

datasheet contents

- **Features**
- **Description**
- **Package**
- **Pin out**
- **Schematic**
- **Absolute Maximum Ratings**
- **Electrical Characteristics**
- **Thermal Characteristics**
- **Parameter Measurement Information**
- **Typical Characteristic Graphs** [1]
- **Thermal Graphs** [2]

NOTES: 1. Details characteristics for the main terminal pair, followed by other terminal pairs. Characteristics are usually ordered as off-state current, breakdown voltage, on-state voltage, breakover and holding current variation with temperature. Following the breakover voltage variation with di/dt and capacitance variation is detailed. Finally typical surge capability with decay time is given.

2. These detail the non-repetitive ac surge current and thermal impedance.

SELECTION GUIDE

primary over-voltage protection devices

IEC Protection Definition CCITT K11 : Primary protection is applied at the location where it may prevent most of the stressful energy from propagating beyond the designated interface.

Description	Device Number	Package	Working Voltage (V)	Protection Voltage (V)
Main Distribution Frame	9EL2 [1]	Cell	265	400
Intermediate Distribution Frame	9EL3 [2]	Cell	200	265
Network Demarcation Interfaces	9EL5	Cell	175	250
Solid state replacement for gas discharge tube				

NOTES: 1. Bellcore TR-NWT-000974 (issue 1) and CCITT K28 (1991) compliant
2. Bellsouth compliant

secondary over-voltage protection devices

IEC Protection Definition CCITT K11 : Secondary protection is applied subsequently to the primary protection. It may be provided by inherent protection.

battery backed ringing systems

Description	VRING RMS	VBAT=50V	VBAT=60V	Package
Transformer coupled SLIC	40	TISP2150	TISP2150	PDIP,SOIC.SIP
Ring generator	50	TISP2180	TISP2180	PDIP,SOIC,SIP,TO-220,SOT-82
Line test equipment	60	TISP2180	TISP2240	PDIP,SOIC,SIP
Repeaters	70	TISP2240	TISP2240	PDIP,SOIC,SIP
Analogue Concentrators	80	TISP2240	TISP2240	PDIP,SOIC.SIP
	90	TISP2240	TISP2260	PDIP,SOIC,SIP
	100	TISP2260	TISP2290	PDIP,SOIC.SIP,TO-220,SOT-82
	110	TISP2290	TISP2290	PDIP,SOIC,SIP,TO-220,SOT-82
	120	TISP2320	TISP2320	PDIP,SOIC,SIP
	130	TISP2320	TISP2380	PDIP,SOIC,SIP
	140	TISP2380	TISP2380	PDIP,SOIC,SIP
	150	TISP2380	TISP2380	PDIP,SOIC,SIP

ground backed ringing and balanced ringing systems

Description	VRING RMS	VBAT=50V	VBAT=60V	Package
Transformer coupled SLIC	40	TISP3125	TISP3125	PDIP,SOIC.SIP
Ring generator	50	TISP3125	TISP3125	PDIP,SOIC,SIP
Line test equipment	60	TISP3125	TISP3215	PDIP,SOIC,SIP
Repeaters	70	TISP3150	TISP3150	PDIP,SOIC,SIP
Analogue Concentrators	80	TISP3150	TISP3150	PDIP,SOIC.SIP
	90	TISP3180	TISP3180	PDIP,SOIC,SIP
	100	TISP3180	TISP3180	PDIP,SOIC.SIP,TO220,SOT-82
	110	TISP3240	TISP3240	PDIP,SOIC,SIP
	120	TISP3240	TISP3240	PDIP,SOIC,SIP
	130	TISP3260	TISP3260	PDIP,SOIC,SIP
	140	TISP3260	TISP3260	PDIP,SOIC,SIP
	150	TISP3290	TISP3290	PDIP,SOIC,SIP,TO220,SOT-82

subscriber line interface circuits

Description	Device Number	Package	Working Voltage (V)	Protection Voltage (V)
Direct Coupled SLIC IC	TISP1072	PDIP, SOIC, SIP	58	72
	TISP1082	PDIP, SOIC, SIP	66	82
		TO-220, SOT-82	58	82
	TISP61CAP3	PDIP		Programmable

integrated services digital network

Description	Device Number	Package	Working Voltage (V)	Protection Voltage (V)
Inter-wire ISDN	TISP4082	SOIC, SIP	66	82
		TO-220, SOT-82	58	82
3 wire ISDN	TISP7082	PDIP, SOIC, SIP	66	82
	TISP2082	TO-220, SOT-82	58	82
	TISP3082	PDIP, SOIC, SIP	66	82
		TO-200, SOT-82	58	82

subscriber equipment - 2 wire

Description	Device Number	Package	Working Voltage (V)	Protection Voltage (V)
Telephone	TISP4082	SOIC, SIP	66	82
Modem		DO-220	58	82
	TISP4180	SOIC, SIP	145	180
		DO-220, TO-92	145	180
	TISP4290	SOIC, SIP	220	290
		DO-220, TO-92	200	290
	TISP4380 [1]	SOIC, SIP	270	380

NOTE 1: Compatible with FCC part 68 requirements

TISP GLOSSARY

Term	Description	Symbol
Off-State Voltage	The dc voltage when the device is in the off-state.	V_D
Off-State Current	The dc value of current that results from the application of the off-state voltage, V_D	I_D
Repetitive Peak Off-State Voltage.	Rated maximum (peak) continuous voltage that may be applied in the off-state conditions including all dc and repetitive alternating voltage components.	V_{DRM}
Repetitive Peak Off-State Current	The maximum (peak) value of off-state current that results from the application of the repetitive peak off-state voltage, V_{DRM}	I_{DRM}
Breakover Voltage	The maximum voltage across the device in or at the breakdown region measured under specified voltage rate of rise and current rate of rise.	$V_{(BO)}$
Breakover Current	The instantaneous current flowing at the breakover voltage, $V_{(BO)}$.	$I_{(BO)}$
On-State Voltage	The voltage across the device in the on-state condition at a specified current I_T	V_T
On-State Current	The current though the device in the on-state condition.	I_T
Repetitive Peak On-State Current	Rated maximum (peak) value of ac power frequency on-state current of specified waveshape and frequency which may be applied continuously.	I_{TRM}
Non-Repetitive Peak On-State Current	Rated maximum (peak) value of ac power frequency on-state surge current of specified waveshape and frequency which may be applied for a specified time or number of ac cycles.	I_{TSM}
Non-Repetative Peak Pulse Current	Rated maximum value of peak impulse pulse current of specified amplitude and waveshape that may be applied.	I_{PPS} (I_{TSP})
Holding Current	The minimum current required to maintain the device in the on-state.	I_H
Off-State Capacitance	The capacitance in the off-state measured at specified frequency, amplitude and dc bias.	C_O (C_{off})
Breakdown Voltage	The voltage across the device in the breakdown region prior to the switching point at a specified breakdown current, $I_{(BR)}$.	$V_{(BR)}$
Zener or Reference Voltage	Alternative name for Breakdown Voltage	V_Z
Breakdown Current	The current through the device in the breakdown condition.	$I_{(BR)}$
Zener or Reference Current	Alternative name for Breakdown Current	I_Z
Switching Voltage	The instantaneous voltage across the device at the final point in the breakdown region prior to switching into the on-state.	V_S

Term	Description	Symbol
Switching Current	The instantaneous current flowing through the device at the switching voltage, V_S.	I_S
Repetitive Peak Reverse Voltage	Rated maximum (peak) continuous voltage that may be applied in the reverse blocking direction including all dc and repetitive alternating voltage components.	V_{RRM}
Repetitive Peak Reverse Current	The maximum (peak) value of reverse current that results from the application of the repetitive peak reverse voltage, V_{RRM}.	I_{RRM}
Forward Voltage	The voltage across the device in the forward conducting state at a specified current I_F	V_F
Forward Current	The current through the device in the forward conducting state.	I_F
Non-Repetitive Peak Forward Current	Rated maximum (peak) value of ac power frequency forward surge current of specified waveshape and frequency which may be applied for a specified time or number of ac cycles.	I_{FSM}
Repetitive Peak Forward Current	Rated maximum (peak) value of ac power frequency forward current of specified waveshape and frequency which may be applied continuously.	I_{FRM}
Peak Forward Recovery Voltage	The maximum value of forward conduction voltage across the device upon the application of a specified voltage rate of rise and current rate of rise following a zero or specified reverse-voltage condition.	V_{FRM}
Switching Resistance	The equivalent slope resistance of the breakdown region. (Used for negative breakdown slope resistance devices)	R_S
Critical Rate of Rise of Off-State Voltage	The maximum rate of rise of voltage (below V_{DRM}) that will not cause switching from the off-state to the on-state.	dv/dt
Critical Rate of Rise of On-State Current	Rated value of the rate of rise of current which the device can withstand without damage.	di/dt
Insulation Resistance	The equivalent insulation resistance of the device.	
Lifetime Rated Pulse Currents	Rated values of the peak impulse current, as a function of the number of pulses and waveshape, which may be applied over the device rated lifetime.	
Impulse Reset Current	The value of direct current that flows when the device is short circuited. Not a device parameter.	$I_{(Reset)}$
Peak Pulse Impulse Current	Rated maximum value of peak impulse pulse current (I_{PP}) applied for 10 pulses with 10 x 1000 µs waveform and maximum duty factor of 0.01% without causing failure	I_{PPM}

Term	Description	Symbol
Temperature Coefficient of Breakdown Voltage	The ratio of the change in breakdown voltage, $V_{(BR)}$, to changes in temperature. Expressed as either millivolts per degree Celsius or percent per degree Celsius with reference to the 25°C value of breakdown voltage (mV/°C or %/°C).	$Alpha_{V(BR)}$ $(dV_{(BR)}/dT_j)$
Variation of Holding Current with Temperature	The change in holding current, I_H, with changes in temperature. It is shown as a graph.	
Temperature Derating	Derating with temperature above a specified base temperature, expressed as a percentage, such as may be applied to peak pulse current	
Thermal Resistance	The effective temperature rise per unit power dissipation of a designated junction, above the temperature of a stated external reference point (lead, case, or ambient) under conditions of thermal equilibrium.	
Transient Thermal Impedance	The change in the difference between the virtual junction temperature and the temperature of a specified reference point or region (lead, case, or ambient) at the end of a time interval divided by the step function change in power dissipation at the begining of the same time interval which causes the change of temperature-difference. *Note:* It is the thermal impedance of the junction under conditions of change and is generally given in the form of a curve as a function of the duration of an applied pulse	

Technical Specifications

8 Pin Dual In Line Package
3 Pin Single In Line Package - (Interchangeable with TO-220 Package)
2 Pin Single In Line Package - (Interchangeable with DO-220 Package)
8 Pin Surface Mount Package

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TELECOMMUNICATION SYSTEM SECONDARY PROTECTION

- **Ion-Implanted Breakdown Region**
  Precise and Stable Voltage
  Low Voltage Overshoot under Surge

DEVICE	V_{DRM} V	$V_{(BO)}$ V
'1072F3	- 58	- 72
'1082F3	- 66	- 82

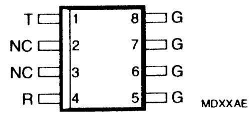
- **Planar Passivated Junctions**
  Low Off-State Current < 10 µA
- **Rated for International Surge Wave Shapes**

WAVE SHAPE	STANDARD	I_{TSP} A
2/10 µs	FCC Part 68	80
8/20 µs	ANSI C62.41	70
10/160 µs	FCC Part 68	60
10/560 µs	FCC Part 68	45
0.5/700 µs	RLM 88	38
10/700 µs	FTZ R12	50
	VDE 0433	50
	CCITT IX K17	38
10/1000 µs	REA PE-60	35

- **Surface Mount and Through-Hole Options**

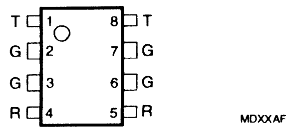
PACKAGE	PART # SUFFIX
Small-outline	D
Small-outline taped and reeled	DR
Plastic DIP	P
Single-in-line	SL

D PACKAGE
(TOP VIEW)



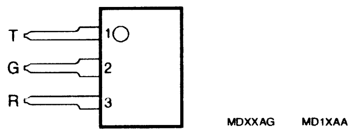
NC - No internal connection

P PACKAGE
(TOP VIEW)

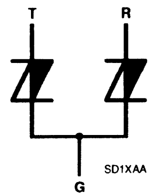


Specified T terminal ratings require connection of pins 1 and 8.
Specified R terminal ratings require connection of pins 4 and 5.

SL PACKAGE
(TOP VIEW)



device symbol



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

description

These dual asymmetrical transient voltage suppressors are designed for the overvoltage protection of ICs used for the SLIC (Subscriber Line Interface Circuit) function. The IC line driver section is typically powered with 0 V and a negative supply. The TISP1xxxF3 limits voltages that exceed these supply rails and is offered in two voltage variants to match typical negative supply voltage values.

High voltages can occur on the line as a result of exposure to lightning strikes and ac power surges. Negative transients are initially limited by breakdown clamping until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the current subsides. Positive transients are limited by diode forward conduction. These protectors are guaranteed to suppress and withstand the listed international lightning surges on any terminal pair

These monolithic protection devices are fabricated in ion-implanted planar structures to

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description (continued)

ensure precise and matched breakover control and are virtually transparent to the system in normal operation

The small-outline 8-pin assignment has been carefully chosen for these devices to maximise the inter-pin clearance and creepage distances which are used by standards (e.g. IEC950) to establish voltage withstand ratings.

absolute maximum ratings

RATING		SYMBOL	VALUE	UNIT
Repetitive peak off-state voltage (0°C < T_J <70°C)	'1072F3	V_{DRM}	-58	V
	'1082F3		-66	
Non-repetitive peak on-state pulse current (see Notes 1, 2 and 3)		I_{TSP}		A
1/2 μs (Gas tube differential transient, open-circuit voltage wave shape 1/2 μs)			120	
2/10 μs (FCC Part 68, open-circuit voltage wave shape 2/10 μs)			80	
8/20 μs (ANSI C62.41, open-circuit voltage wave shape 1.2/50 μs)			70	
10/160 μs (FCC Part 68, open-circuit voltage wave shape 10/160 μs)			60	
5/200 μs (VDE 0433, open-circuit voltage wave shape 2 kV, 10/700 μs)			50	
0.2/310 μs (RLM 88, open-circuit voltage wave shape 1.5 kV, 0.5/700 μs)			38	
5/310 μs (CCITT IX K17, open-circuit voltage wave shape 1.5 kV, 10/700 μs)			38	
5/310 μs (FTZ R12, open-circuit voltage wave shape 2 kV, 10/700 μs)			50	
10/560 μs (FCC Part 68, open-circuit voltage wave shape 10/560 μs)			45	
10/1000 μs (REA PE-60, open-circuit voltage wave shape 10/1000 μs)			35	
Non-repetitive peak on-state current (see Notes 2 and 3)	D Package	I_{TSM}	4	A rms
50 Hz, 1 s	P Package		6	
	SL Package		6	
Initial rate of rise of on-state current, Linear current ramp, Maximum ramp value < 38 A		di_T/dt	250	A/μs
Junction temperature		T_J	-40 to +150	°C
Storage temperature range		T_{stg}	-40 to +150	°C

NOTES: 1. Further details on surge wave shapes are contained in the Applications Information section.
2. Initially the TISP must be in thermal equilibrium with 0°C < T_J <70°C. The surge may be repeated after the TISP returns to its initial conditions.
3. Above 70°C, derate linearly to zero at 150°C lead temperature.

electrical characteristics for the T and R terminals, 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS		TISP1072F3			TISP1082F3			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
I_{DRM}	Repetitive peak off-state current	$V_D = \pm V_{DRM}$, 0°C < T_J <70°C				±10			±10	μA
I_D	Off-state current	$V_D = \pm 50$ V				±10			±10	μA
C_{off}	Off-state capacitance	f = 100 kHz, $V_d = 100$ mV	D Package		0.08	0.5		0.08	0.5	pF
		$V_D = 0$	P Package		0.06	0.4		0.06	0.4	pF
		(see Note 4)	SL Package		0.02	0.3		0.02	0.3	pF

NOTE 4: Further details on capacitance are given in the Applications Information section.

electrical characteristics for the T and G and R and G terminals, 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS	TISP1072F3			TISP1082F3			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
I_{DRM}	Repetitive peak off-state current	$V_D = V_{DRM}$, 0°C < T_J <70°C			-10			-10	μA

electrical characteristics for the T and G and R and G terminals, 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS		TISP1072F3			TISP1082F3			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
$V_{(BO)}$	Breakover voltage	dv/dt = -250 V/ms, R_{SOURCE} = 300 Ω				-72			-82	V
$V_{(BO)}$	Impulse breakover voltage	dv/dt = -1000 V/μs, R_{SOURCE} = 50 Ω, di/dt < -20 A/μs			-78			-92		V
$I_{(BO)}$	Breakover current	dv/dt = -250 V/ms, R_{SOURCE} = 300 Ω		-0.1		-0.6	-0.1		-0.6	A
V_{FRM}	Peak forward recovery voltage	dv/dt = 1000 V/μs, R_{SOURCE} = 50 Ω, di_F/dt < 20 A/μs			3.3			3.3		V
V_F	Forward voltage	I_T = 5 A, t_W = 100 μs				3			3	V
V_T	On-state voltage	I_T = -5 A, t_W = 100 μs				-3			-3	V
I_H	Holding current	di/dt = +30 mA/ms		-0.15			-0.15			A
dv/dt	Critical rate of rise of off-state voltage	Linear voltage ramp Maximum ramp value < $0.85V_{DRM}$		-5			-5			kV/μs
I_D	Off-state current	V_D = -50 V				-10			-10	μA
C_{off}	Off-state capacitance	f = 100 kHz, V_d = 100 mV	V_D = 0,		150	240		130	240	pF
		Third terminal voltage = 0	V_D = -5 V		65	104		55	104	pF
		(see Note 5)	V_D = -50 V		30	48		25	48	pF

NOTE 5: Further details on capacitance are given in the Applications Information section.

thermal characteristics

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance	P_{tot} = 0.8 W, T_A = 25°C 5 cm^2, FR4 PCB	D Package			160	°C/W
			P Package			100	
			SL Package			105	

PARAMETER MEASUREMENT INFORMATION

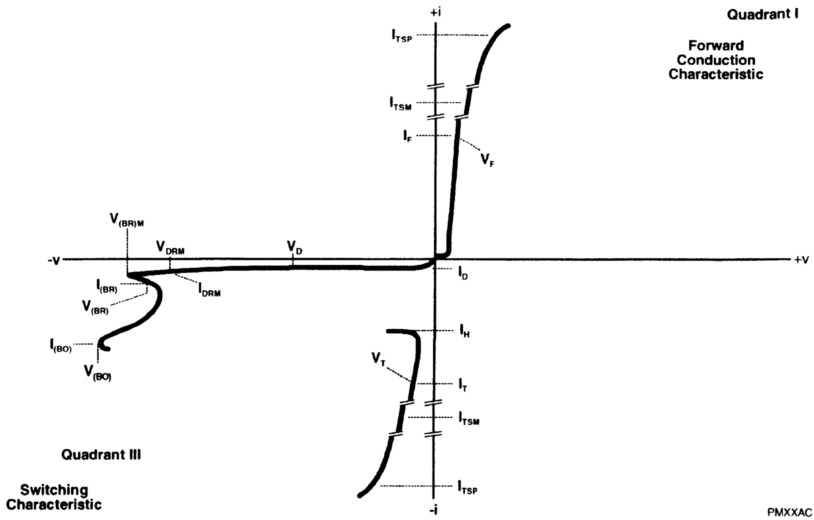


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR TERMINALS R AND G OR T AND G

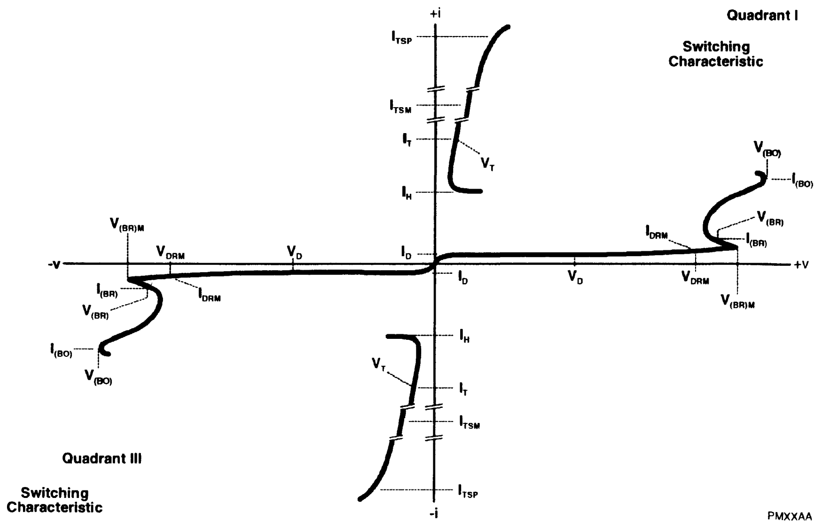


Figure 2. VOLTAGE-CURRENT CHARACTERISTIC FOR TERMINALS R AND T

TYPICAL CHARACTERISTICS
R and G, or T and G terminals

OFF-STATE CURRENT vs JUNCTION TEMPERATURE

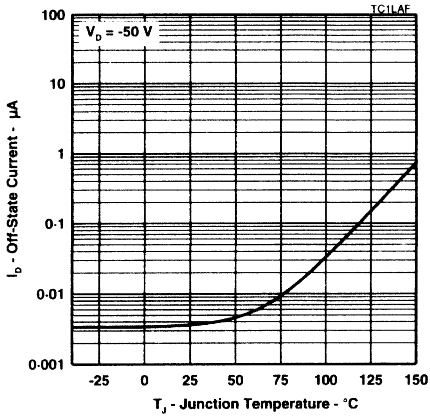


Figure 3.

BREAKDOWN VOLTAGES vs JUNCTION TEMPERATURE

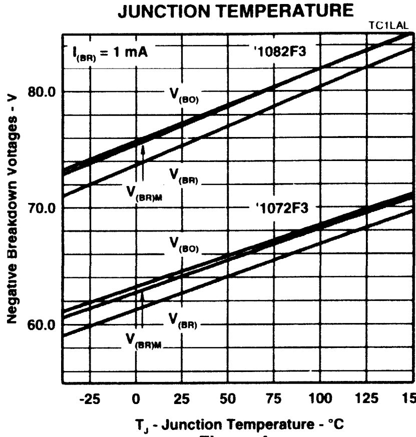


Figure 4.

ON-STATE CURRENT vs ON-STATE VOLTAGE

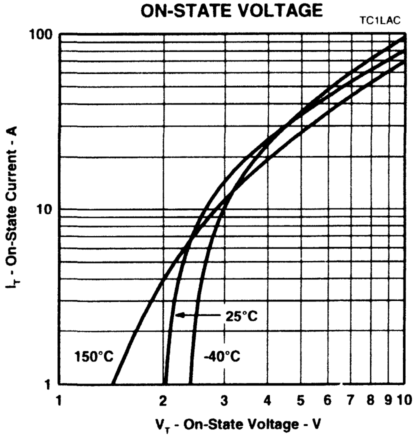


Figure 5.

FORWARD CURRENT vs FORWARD VOLTAGE

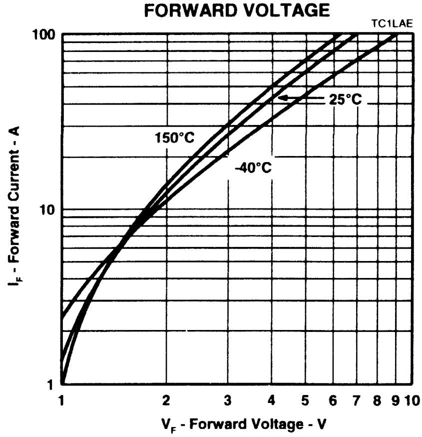


Figure 6.

TYPICAL CHARACTERISTICS
R and G, or T and G terminals

HOLDING CURRENT & BREAKOVER CURRENT vs JUNCTION TEMPERATURE

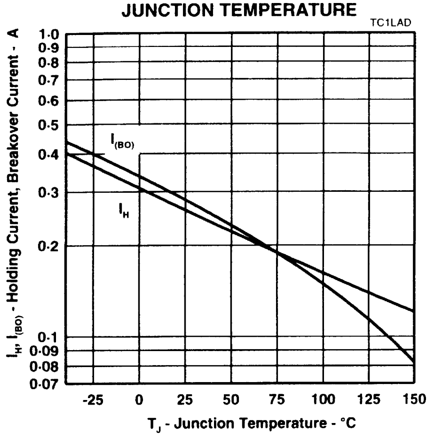


Figure 7.

NORMALISED BREAKOVER VOLTAGE vs RATE OF RISE OF PRINCIPLE CURRENT

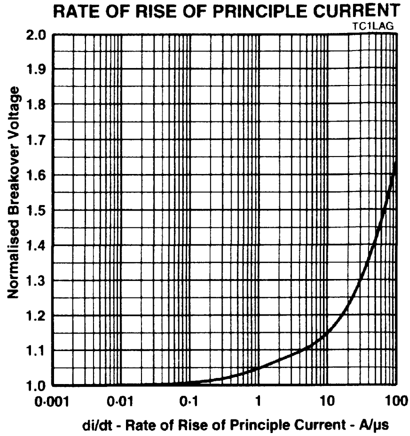


Figure 8.

PEAK FORWARD RECOVERY VOLTAGE vs RATE OF RISE OF PRINCIPLE CURRENT

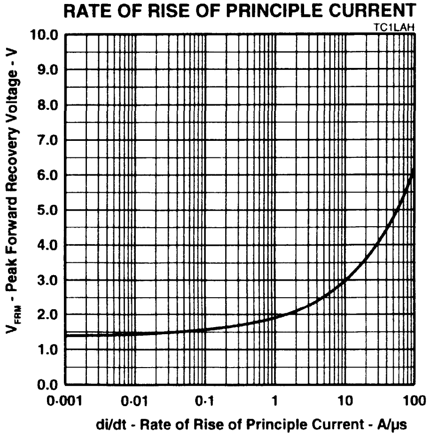


Figure 9.

OFF-STATE CAPACITANCE vs R or T TERMINAL VOLTAGE (NEGATIVE)

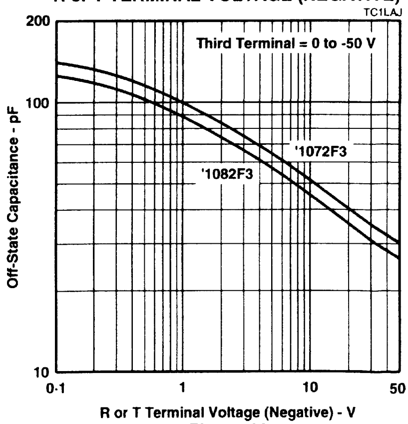


Figure 10.

TYPICAL CHARACTERISTICS
R and G, or T and G terminals

OFF-STATE CAPACITANCE vs R or T TERMINAL VOLTAGE (POSITIVE)

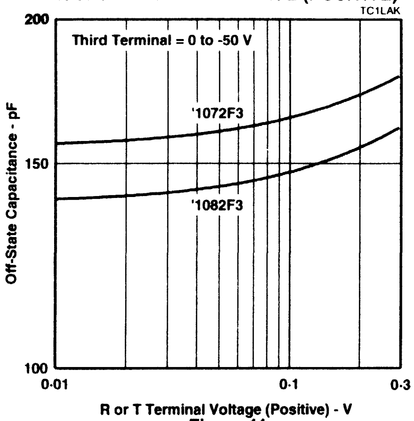


Figure 11.

OFF-STATE CAPACITANCE vs JUNCTION TEMPERATURE

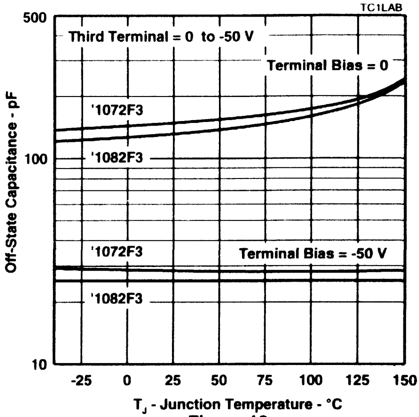


Figure 12.

SURGE CURRENT vs DECAY TIME

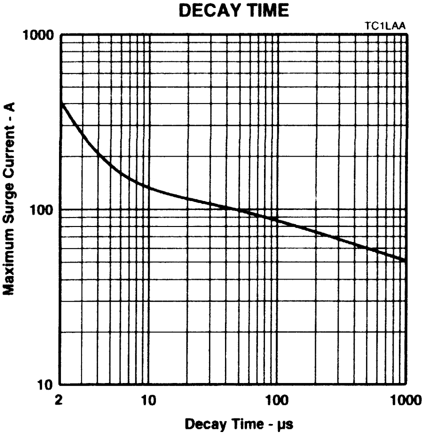


Figure 13.

TYPICAL CHARACTERISTICS
R and T terminals

OFF-STATE CURRENT vs JUNCTION TEMPERATURE

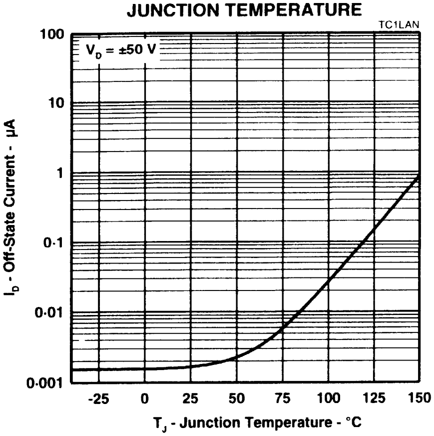


Figure 14.

BREAKDOWN VOLTAGES vs JUNCTION TEMPERATURE

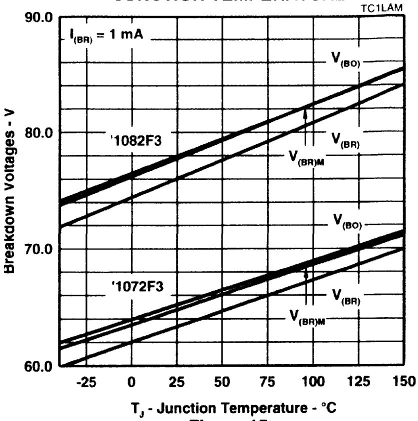


Figure 15.

HOLDING CURRENT & BREAKOVER CURRENT vs JUNCTION TEMPERATURE

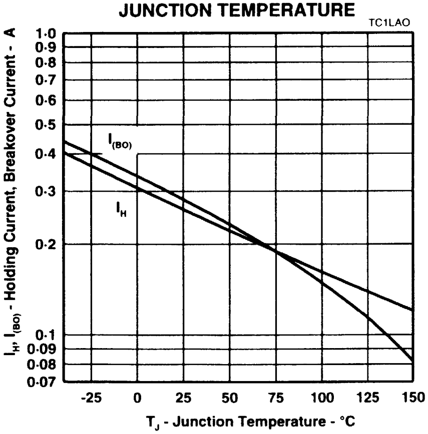


Figure 16.

NORMALISED BREAKOVER VOLTAGE vs RATE OF RISE OF PRINCIPLE CURRENT

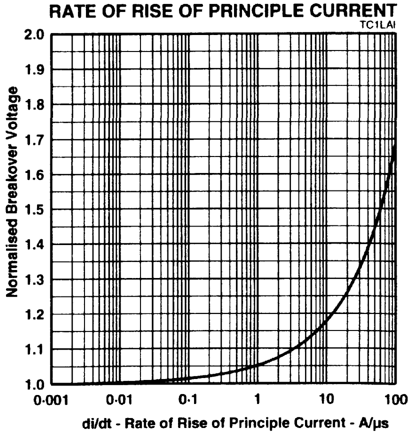


Figure 17.

TYPICAL CHARACTERISTICS
R and T terminals

OFF-STATE CAPACITANCE
vs
TERMINAL VOLTAGE

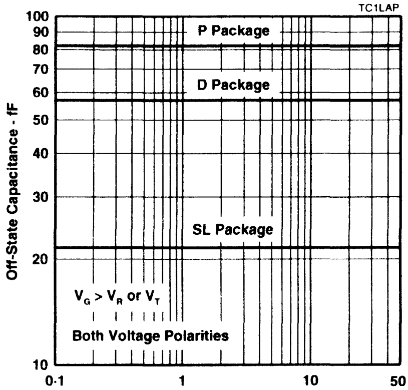


Figure 18.

THERMAL INFORMATION

MAXIMUM NON-RECURRING 50 Hz CURRENT
vs
CURRENT DURATION

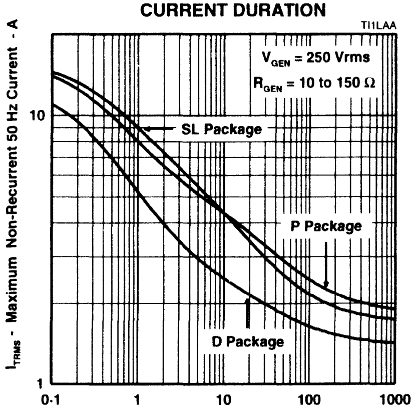


Figure 19.

THERMAL RESPONSE

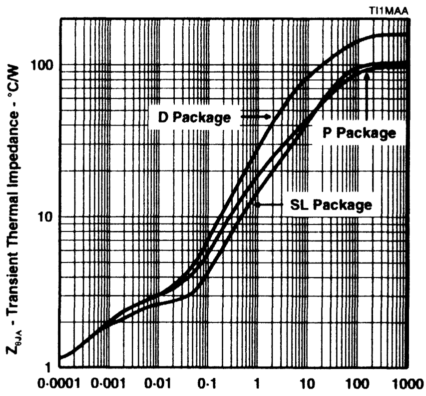


Figure 20.

APPLICATIONS INFORMATION

electrical characteristics

The electrical characteristics of a TISP are strongly dependent on junction temperature, T_J. Hence a characteristic value will depend on the junction temperature at the instant of measurement. The values given in this data sheet were measured on commercial testers, which generally minimise the temperature rise caused by testing. Application values may be calculated from the parameters' temperature coefficient, the power dissipated and the thermal response curve ,Z_θ (see M. J. Maytum, "Transient Suppressor Dynamic Parameters."TI Technical Journal, vol. 6, No. 4, pp.63-70, July-August 1989).

lightning surge

wave shape notation

Most lightning tests, used for equipment verification, specify a unidirectional sawtooth waveform which has an exponential rise and an exponential decay. Wave shapes are classified in terms of peak amplitude (voltage or current), rise time and a decay time to 50% of the maximum amplitude. The notation used for the wave shape is *amplitude, rise time/decay time.* A 50A, 5/310 µs wave shape would have a peak current value of 50 A, a rise time of 5 µs and a decay time of 310 µs. The TISP surge current graph comprehends the wave shapes of commonly used surges.

generators

There are three categories of surge generator type, single wave shape, combination wave shape and circuit defined. Single wave shape generators have essentially the same wave shape for the open circuit voltage and short circuit current (e.g. 10/1000 µs open circuit voltage and short circuit current). Combination generators have two wave shapes, one for the open circuit voltage and the other for the short circuit current (e.g. 1.2/50 µs open circuit voltage and 8/20 µs short circuit current) Circuit specified generators usually equate to a combination generator, although typically only the open circuit voltage waveshape is referenced (e.g. a 10/700 µs open circuit voltage generator typically produces a 5/310 µs short circuit current). If the combination or circuit defined generators operate into a finite resistance the wave shape produced is intermediate between the open circuit and short circuit values.

current rating

When the TISP switches into the on-state it has a very low impedance. As a result, although the surge wave shape may be defined in terms of open circuit voltage, it is the current wave shape that must be used to assess the required TISP surge capability. As an example, the CCITT IX K17 1.5 kV, 10/700 µs surge is changed to a 38 A, 5/310 µs waveshape when driving into a short circuit. Thus the TISP surge current capability, when directly connected to the generator, will be found for the CCITT IX K17 waveform at 310 µs on the surge graph and not 700 µs. Some common short circuit equivalents are tabulated below:

STANDARD	OPEN CIRCUIT VOLTAGE	SHORT CIRCUIT CURRENT
CCITT IX K17	1.5 kV, 10/700 µs	38 A, 5/310 µs
CCITT IX K20	1 kV, 10/700 µs	25 A, 5/310 µs
RLM88	1.5 kV, 0.5/700 µs	38 A, 0.2/310 µs
VDE 0433	2.0 kV, 10/700 µs	50 A, 5/200 µs
FTZ R12	2.0 kV, 10/700 µs	50 A, 5/310 µs

Any series resistance in the protected equipment will reduce the peak circuit current to less than the generators' short circuit value. A 2 kV open circuit voltage, 50 A short circuit current generator has an effective output impedance of 40 Ω (2000/50). If the equipment has a series resistance of 25 Ω then the surge current requirement of the TISP becomes 31 A (2000/65) and not 50 A.

APPLICATIONS INFORMATION

protection voltage

The protection voltage, ($V_{(BO)}$), increases under lightning surge conditions due to thyristor regeneration. This increase is dependent on the rate of current rise, di/dt, when the TISP is clamping the voltage in its breakdown region. The $V_{(BO)}$ value under surge conditions can be estimated by multiplying the 50 Hz rate $V_{(BO)}$ (250 V/ms) value by the normalised increase at the surge's di/dt (Figure 2.) . An estimate of the di/dt can be made from the surge generator voltage rate of rise, dv/dt, and the circuit resistance.

As an example, the CCITT IX K17 1.5 kV, 10/700 µs surge has an average dv/dt of 150 V/µs, but, as the rise is exponential, the initial dv/dt is higher, being in the region of 450 V/µs. The instantaneous generator output resistance is 25 Ω. If the equipment has an additional series resistance of 20 Ω, the total series resistance becomes 45 Ω. The maximum di/dt then can be estimated as 450/45 = 10 A/µs. In practice the measured di/dt and protection voltage increase will be lower due to inductive effects and the finite slope resistance of the TISP breakdown region.

capacitance

off-state capacitance

The off-state capacitance of a TISP is sensitive to junction temperature, T_J , and the bias voltage, comprising of the dc voltage, V_D , and the ac voltage, V_d . All the capacitance values in this data sheet are measured with an ac voltage of 100 mV. The typical 25°C variation of capacitance value with ac bias is shown in Figure 6 When $V_D >> V_d$ the capacitance value is independent on the value of V_d . The capacitance is essentially constant over the range of normal telecommunication frequencies.

**NORMALISED CAPACITANCE
vs
RMS AC TEST VOLTAGE**

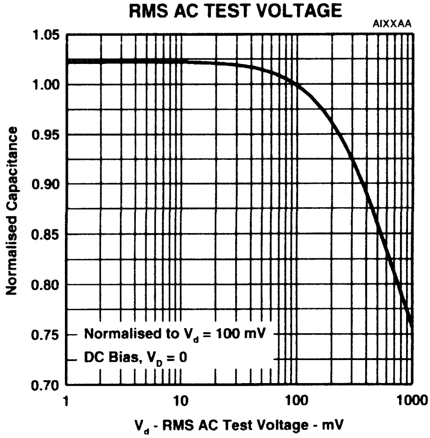


Figure 21.

APPLICATIONS INFORMATION

longitudinal balance

Figure 7 shows a three terminal TISP with its equivalent "delta" capacitance Each capacitance, C_{TG} , C_{RG} and C_{TR} , is the true terminal pair capacitance measured with a three terminal or guarded capacitance bridge. If wire R is biased at a larger potential than wire T then $C_{TG} > C_{RG}$. Capacitance C_{TG} is equivalent to a capacitance of C_{RG} in parallel with the capacitive difference of ($C_{TG} - C_{RG}$). The line capacitive unbalance is due to ($C_{TG} - C_{RG}$) and the capacitance shunting the line is $C_{TR} + C_{RG}/2$.

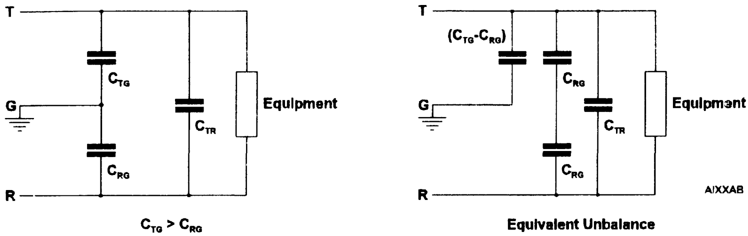


Figure 22.

All capacitance measurements in this data sheet are three terminal guarded to allow the designer to accurately assess capacitive unbalance effects. Simple two terminal capacitance meters (unguarded third terminal) give false readings as the shunt capacitance via the third terminal is included.

TISP2072F3, TISP2082F3
DUAL SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

SLPSE05 - MARCH 1994 - REVISED SEPTEMBER 1994

TELECOMMUNICATION SYSTEM SECONDARY PROTECTION

- **Ion-Implanted Breakdown Region**
  Precise and Stable Voltage
  Low Voltage Overshoot under Surge

DEVICE	V_{DRM} V	$V_{(BO)}$ V
'2072F3	58	72
'2082F3	66	82

- **Planar Passivated Junctions**
  Low Off-State Current < 10 μA

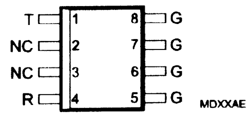
- **Rated for International Surge Wave Shapes**

WAVE SHAPE	STANDARD	I_{TSP} A
2/10 μs	FCC Part 68	80
8/20 μs	ANSI C62.41	70
10/160 μs	FCC Part 68	60
10/560 μs	FCC Part 68	45
0.5/700 μs	RLM 88	38
10/700 μs	FTZ R12	50
	VDE 0433	50
	CCITT IX K17	38
10/1000 μs	REA PE-60	35

- **Surface Mount and Through-Hole Options**

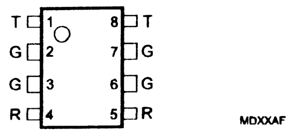
PACKAGE	PART # SUFFIX
Small-outline	D
Small-outline taped and reeled	DR
Plastic DIP	P
Single-in-line	SL

D PACKAGE
(TOP VIEW)



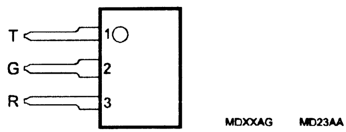
NC - No internal connection

P PACKAGE
(TOP VIEW)

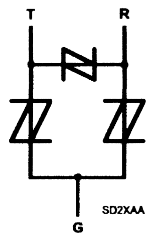


Specified T terminal ratings require connection of pins 1 and 8.
Specified R terminal ratings require connection of pins 4 and 5.

SL PACKAGE
(TOP VIEW)



device symbol



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

description

These low voltage dual symmetrical transient voltage suppressor devices are designed to protect ISDN applications against transients caused by lightning strikes and ac power lines. Offered in two voltage variants to meet battery and protection requirements they are guaranteed to suppress and withstand the listed international lightning surges in both polarities. Transients are initially clipped by breakdown clamping until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the current subsides.

These monolithic protection devices are fabricated in ion-implanted planar structures to ensure precise and matched breakover control and are virtually transparent to the system in normal operation

description (Continued)

The small-outline 8-pin assignment has been carefully chosen for the TISP series to maximise the inter-pin clearance and creepage distances which are used by standards (e.g. IEC950) to establish voltage withstand ratings.

absolute maximum ratings

RATING		SYMBOL	VALUE	UNIT
Repetitive peak off-state voltage (0°C < T_J < 70°C)	'2072F3	V_{DRM}	± 58	V
	'2082F3		± 66	
Non-repetitive peak on-state pulse current (see Notes 1, 2 and 3)		I_{TSP}		A
1/2 μs (Gas tube differential transient, open-circuit voltage wave shape 1/2 μs)			120	
2/10 μs (FCC Part 68, open-circuit voltage wave shape 2/10 μs)			80	
8/20 μs (ANSI C62.41, open-circuit voltage wave shape 1.2/50 μs)			70	
10/160 μs (FCC Part 68, open-circuit voltage wave shape 10/160 μs)			60	
5/200 μs (VDE 0433, open-circuit voltage wave shape 2 kV, 10/700 μs)			50	
0.5/310 μs (RLM 88, open-circuit voltage wave shape 1.5 kV, 0.5/700 μs)			38	
5/310 μs (CCITT IX K17, open-circuit voltage wave shape 1.5 kV, 10/700 μs)			38	
5/310 μs (FTZ R12, open-circuit voltage wave shape 2 kV, 10/700 μs)			50	
10/560 μs (FCC Part 68, open-circuit voltage wave shape 10/560 μs)			45	
10/1000 μs (REA PE-60, open-circuit voltage wave shape 10/1000 μs)			35	
Non-repetitive peak on-state current (see Notes 2 and 3)	D Package	I_{TSM}	4	A rms
50 Hz, 1 s	P Package		6	
	SL Package		6	
Initial rate of rise of on-state current, Linear current ramp, Maximum ramp value < 38 A		di_F/dt	250	A/μs
Junction temperature		T_J	-40 to +150	°C
Storage temperature range		T_{stg}	-40 to +150	°C

NOTES: 1. Further details on surge wave shapes are contained in the Applications Information section.
2. Initially the TISP must be in thermal equilibrium with 0°C < T_J <70°C. The surge may be repeated after the TISP returns to its initial conditions.
3. Above 70°C, derate linearly to zero at 150°C lead temperature.

electrical characteristics for the T and R terminals, T_J = 25°C

PARAMETER		TEST CONDITIONS	TISP2072F3		TISP2082F3		UNIT
			MIN	MAX	MIN	MAX	
I_{DRM}	Repetitive peak off-state current	$V_D = \pm V_{DRM}$, 0°C < T_J < 70°C		±10		±10	μA
I_D	Off-state current	V_D = ±50 V		±10		±10	μA
C_{off}	Off-state capacitance	f = 100 kHz, V_d = 100 mV V_D = 0, Third terminal voltage = 0 (see Notes 4 and 5)	32†	55	32†	55	pF

NOTES: 4. These capacitance measurements employ a three terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.
5. Further details on capacitance are given in the Applications Information section.

† Typical value of the parameter, not a limit value.

electrical characteristics for the T and G or the R and G terminals, T_J = 25°C

PARAMETER		TEST CONDITIONS	TISP2072F3		TISP2082F3		UNIT
			MIN	MAX	MIN	MAX	
I_{DRM}	Repetitive peak off-state current	$V_D = \pm V_{DRM}$, 0°C < T_J < 70°C		±10		±10	μA

electrical characteristics for the T and G or the R and G terminals, T_J = 25°C (Continued)

PARAMETER		TEST CONDITIONS	TISP2072F3		TISP2082F3		UNIT
			MIN	MAX	MIN	MAX	
$V_{(BO)}$	Breakover voltage	dv/dt = ±250 V/ms, Source Resistance = 300 Ω		±72		±82	V
$V_{(BO)}$	Impulse breakover voltage	dv/dt = ±1000 V/μs, di/dt < 20 A/μs Source Resistance = 50 Ω		±84†		±94†	V
$I_{(BO)}$	Breakover current	dv/dt = ±250 V/ms, Source Resistance = 300 Ω	±0.15	±0.6	±0.15	±0.6	A
V_T	On-state voltage	I_T = ±5 A, t_W = 100 μs		±3		±3	V
I_H	Holding current	di/dt = -/+30 mA/ms	±0.15		±0.15		A
dv/dt	Critical rate of rise of off-state voltage	Linear voltage ramp, Maximum ramp value < $0.85V_{(BR)MIN}$	±5		±5		kV/μs
I_D	Off-state current	V_D = ±50 V		±10		±10	μA
C_{off}	Off-state capacitance	f = 100 kHz, V_d = 100 mV V_D = 0,	77†	130	77†	130	pF
		Third terminal voltage = 0 V_D = -5 V	42†	70	42†	70	pF
		(see Notes 6 and 7) V_D = -50 V	19†	30	19†	30	pF

NOTES: 6 These capacitance measurements employ a three terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.

7. Further details on capacitance are given in the Applications Information section.

† Typical value of the parameter, not a limit value.

PARAMETER MEASUREMENT INFORMATION

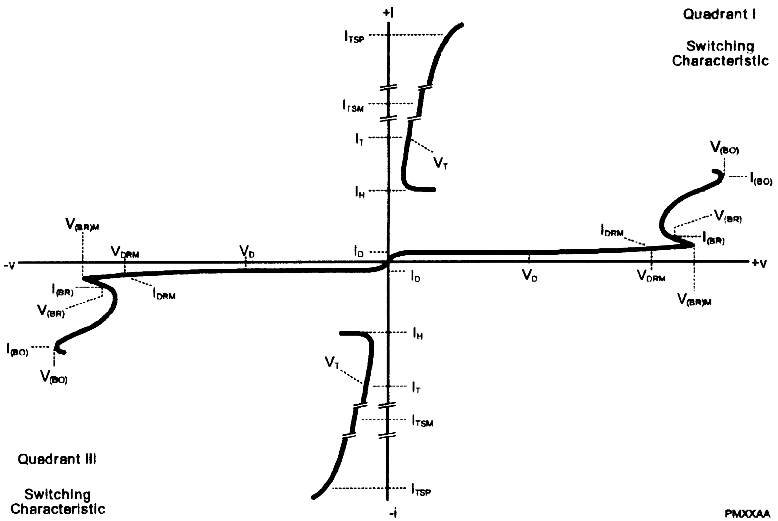


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR ANY PAIR OF TERMINALS

The high level characteristics for terminals R and T are not guaranteed.

thermal characteristics

PARAMETER			MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance	D Package			160	°C/W
		P Package			100	
		SL Package			105	

TYPICAL CHARACTERISTICS
T and G, or R and G terminals

OFF-STATE CURRENT
vs
JUNCTION TEMPERATURE

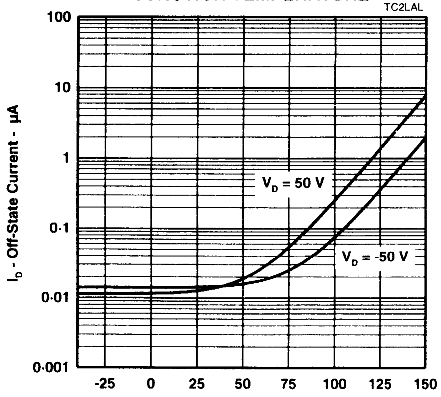


Figure 2.

NORMALISED BREAKDOWN VOLTAGES
vs
JUNCTION TEMPERATURE

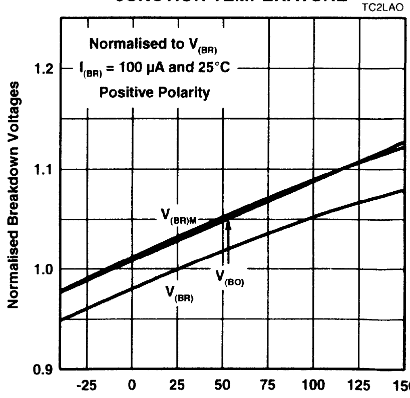


Figure 3.

TYPICAL CHARACTERISTICS
T and G, or R and G terminals

NORMALISED BREAKDOWN VOLTAGES vs JUNCTION TEMPERATURE

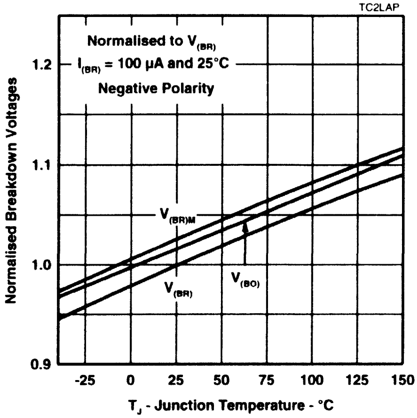


Figure 4.

ON-STATE CURRENT vs ON-STATE VOLTAGE

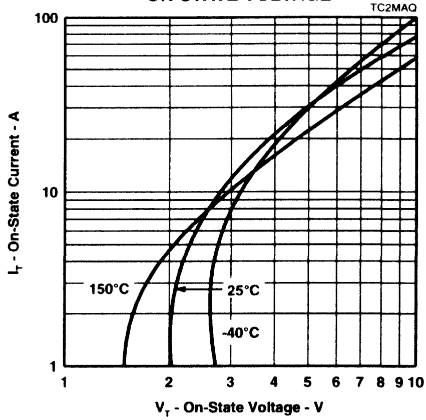


Figure 5.

HOLDING CURRENT & BREAKOVER CURRENT vs JUNCTION TEMPERATURE

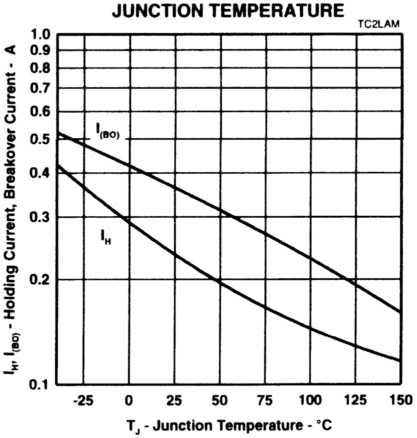


Figure 6.

NORMALISED BREAKOVER VOLTAGE vs RATE OF RISE OF PRINCIPLE CURRENT

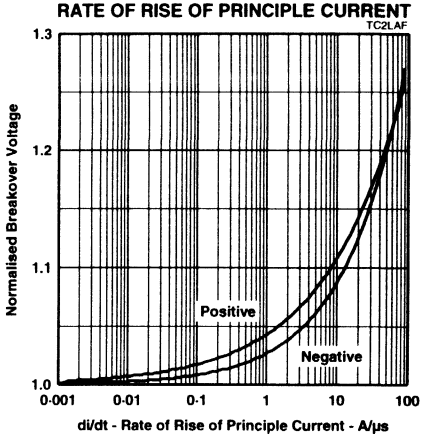


Figure 7.

TYPICAL CHARACTERISTICS
T and G, or R and G terminals

OFF-STATE CAPACITANCE vs TERMINAL VOLTAGE (POSITIVE)

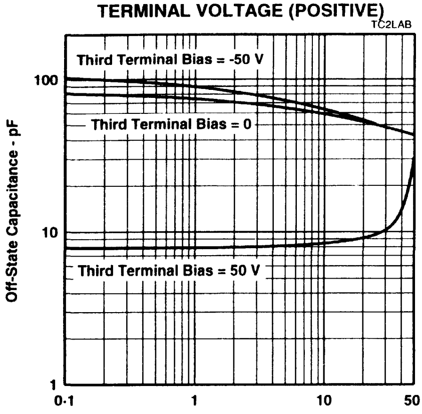


Figure 8.

OFF-STATE CAPACITANCE vs TERMINAL VOLTAGE (NEGATIVE)

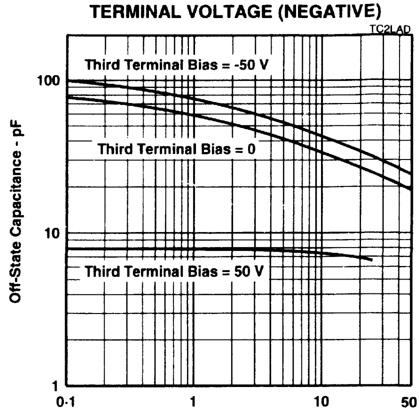


Figure 9.

OFF-STATE CAPACITANCE vs JUNCTION TEMPERATURE

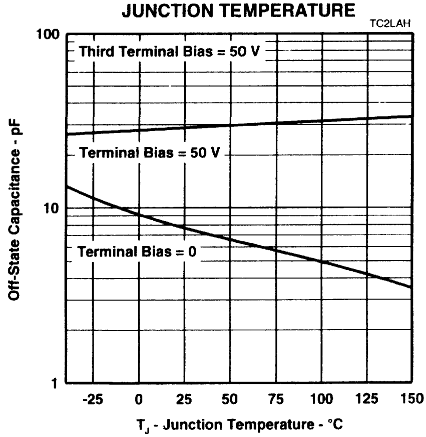


Figure 10.

TYPICAL CHARACTERISTICS
T and G, or R and G terminals

OFF-STATE CAPACITANCE
vs
JUNCTION TEMPERATURE

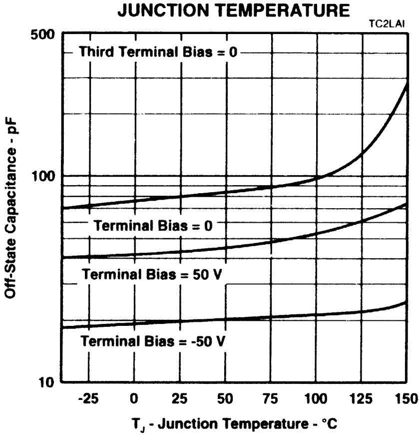


Figure 11.

OFF-STATE CAPACITANCE
vs
JUNCTION TEMPERATURE

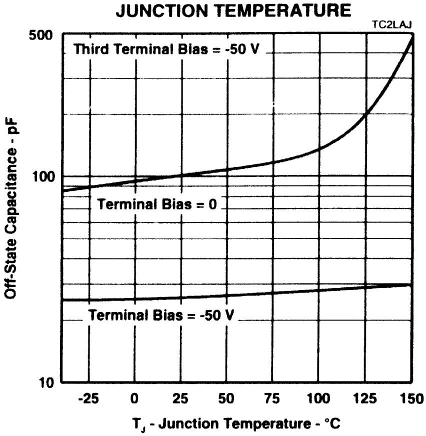


Figure 12.

SURGE CURRENT
vs
DECAY TIME

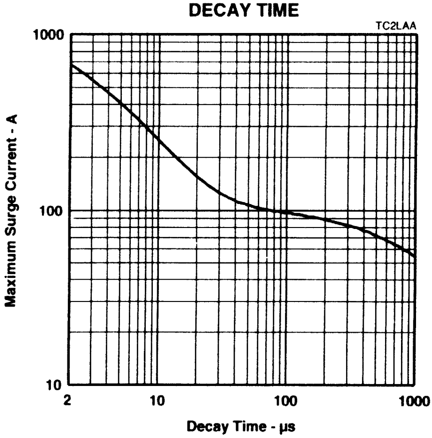


Figure 13.

TYPICAL CHARACTERISTICS
T and R terminals

OFF-STATE CURRENT vs JUNCTION TEMPERATURE

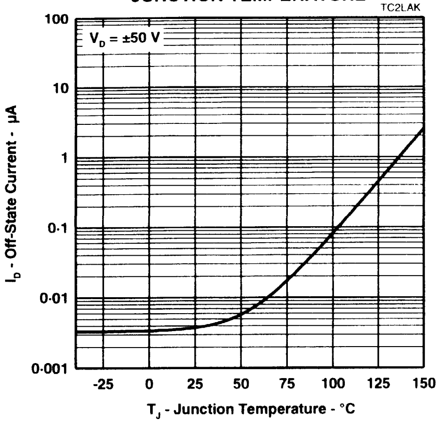


Figure 14.

NORMALISED BREAKDOWN VOLTAGES vs JUNCTION TEMPERATURE

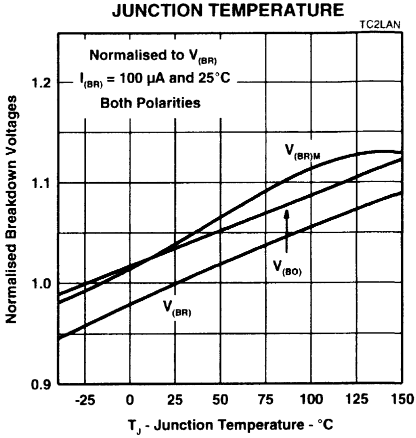


Figure 15.

NORMALISED BREAKOVER VOLTAGE vs RATE OF RISE OF PRINCIPLE CURRENT

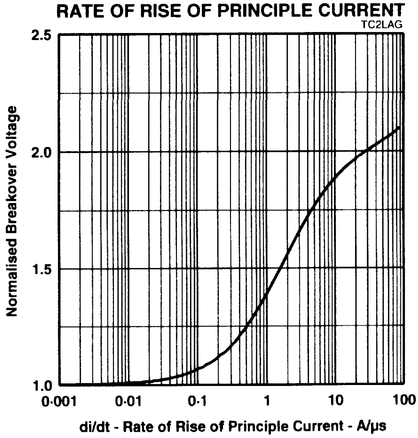


Figure 16.

TYPICAL CHARACTERISTICS
T and R terminals

OFF-STATE CAPACITANCE
vs
TERMINAL VOLTAGE (POSITIVE)

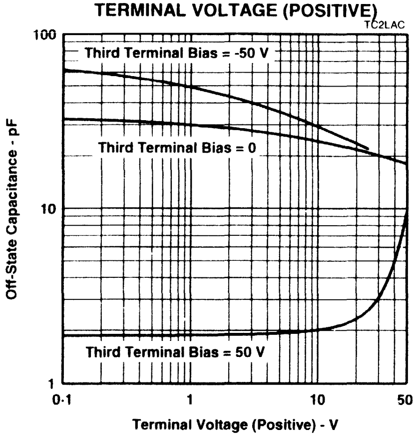


Figure 17.

OFF-STATE CAPACITANCE
vs
TERMINAL VOLTAGE (NEGATIVE)

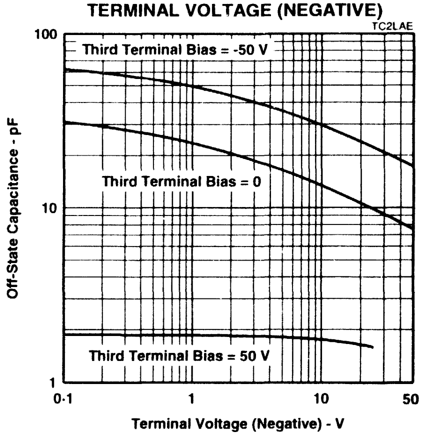


Figure 18.

THERMAL INFORMATION

MAXIMUM NON-RECURRING 50 Hz CURRENT
vs
CURRENT DURATION

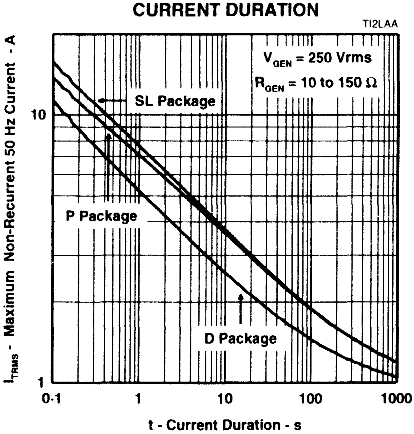


Figure 19.

THERMAL RESPONSE

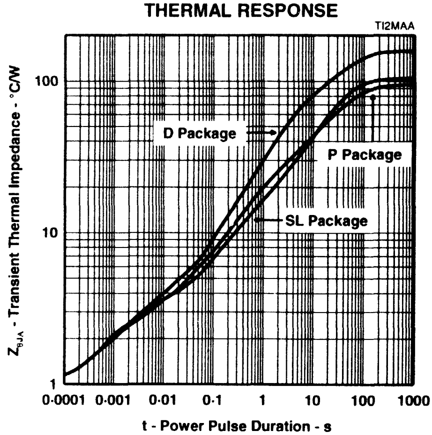


Figure 20.

APPLICATIONS INFORMATION

electrical characteristics

The electrical characteristics of a TISP are strongly dependent on junction temperature, T_J. Hence a characteristic value will depend on the junction temperature at the instant of measurement. The values given in this data sheet were measured on commercial testers, which generally minimise the temperature rise caused by testing. Application values may be calculated from the parameters' temperature curves, the power dissipated and the thermal response curve (Z_θ).

lightning surge

wave shape notation

Most lightning tests, used for equipment verification, specify a unidirectional sawtooth waveform which has an exponential rise and an exponential decay. Wave shapes are classified in terms of peak amplitude (voltage or current), rise time and a decay time to 50% of the maximum amplitude. The notation used for the wave shape is *amplitude, rise time/decay time*. A 50A, 5/310 µs wave shape would have a peak current value of 50 A, a rise time of 5 µs and a decay time of 310 µs. The TISP surge current graph comprehends the wave shapes of commonly used surges.

generators

There are three categories of surge generator type, single wave shape, combination wave shape and circuit defined. Single wave shape generators have essentially the same wave shape for the open circuit voltage and short circuit current (e.g. 10/1000 µs open circuit voltage and short circuit current). Combination generators have two wave shapes, one for the open circuit voltage and the other for the short circuit current (e.g. 1.2/50 µs open circuit voltage and 8/20 µs short circuit current) Circuit specified generators usually equate to a combination generator, although typically only the open circuit voltage waveshape is referenced (e.g. a 10/700 µs open circuit voltage generator typically produces a 5/310 µs short circuit current). If the combination or circuit defined generators operate into a finite resistance the wave shape produced is intermediate between the open circuit and short circuit values.

current rating

When the TISP switches into the on-state it has a very low impedance. As a result, although the surge wave shape may be defined in terms of open circuit voltage, it is the current wave shape that must be used to assess the required TISP surge capability. As an example, the CCITT IX K17 1.5 kV, 10/700 µs surge is changed to a 38 A, 5/310 µs waveshape when driving into a short circuit. Thus the TISP surge current capability, when directly connected to the generator, will be found for the CCITT IX K17 waveform at 310 µs on the surge graph and not 700 µs. Some common short circuit equivalents are tabulated below:

STANDARD	OPEN CIRCUIT VOLTAGE	SHORT CIRCUIT CURRENT
CCITT IX K17	1.5 kV, 10/700 µs	38 A, 5/310 µs
CCITT IX K20	1 kV, 10/700 µs	25 A, 5/310 µs
RLM88	1.5 kV, 0.5/700 µs	38 A, 0.2/310 µs
VDE 0433	2.0 kV, 10/700 µs	50 A, 5/200 µs
FTZ R12	2.0 kV, 10/700 µs	50 A, 5/310 µs

Any series resistance in the protected equipment will reduce the peak circuit current to less than the generators' short circuit value. A 2 kV open circuit voltage, 50 A short circuit current generator has an effective output impedance of 40 Ω (2000/50). If the equipment has a series resistance of 25 Ω then the surge current requirement of the TISP becomes 31 A (2000/65) and not 50 A.

APPLICATIONS INFORMATION

protection voltage

The protection voltage, ($V_{(BO)}$), increases under lightning surge conditions due to thyristor regeneration. This increase is dependent on the rate of current rise, di/dt, when the TISP is clamping the voltage in its breakdown region. The $V_{(BO)}$ value under surge conditions can be estimated by multiplying the 50 Hz rate $V_{(BO)}$ (250 V/ms) value by the normalised increase at the surge's di/dt (Figure 7.) . An estimate of the di/dt can be made from the surge generator voltage rate of rise, dv/dt, and the circuit resistance.

As an example, the CCITT IX K17 1.5 kV, 10/700 µs surge has an average dv/dt of 150 V/µs, but, as the rise is exponential, the initial dv/dt is higher, being in the region of 450 V/µs. The instantaneous generator output resistance is 25 Ω. If the equipment has an additional series resistance of 20 Ω, the total series resistance becomes 45 Ω. The maximum di/dt then can be estimated as 450/45 = 10 A/µs. In practice the measured di/dt and protection voltage increase will be lower due to inductive effects and the finite slope resistance of the TISP breakdown region.

capacitance

off-state capacitance

The off-state capacitance of a TISP is sensitive to junction temperature, T_J, and the bias voltage, comprising of the dc voltage, V_D, and the ac voltage, V_d. All the capacitance values in this data sheet are measured with an ac voltage of 100 mV. The typical 25°C variation of capacitance value with ac bias is shown in Figure 21. When $V_D >> V_d$ the capacitance value is independent on the value of V_d. The capacitance is essentially constant over the range of normal telecommunication frequencies.

NORMALISED CAPACITANCE
vs
RMS AC TEST VOLTAGE

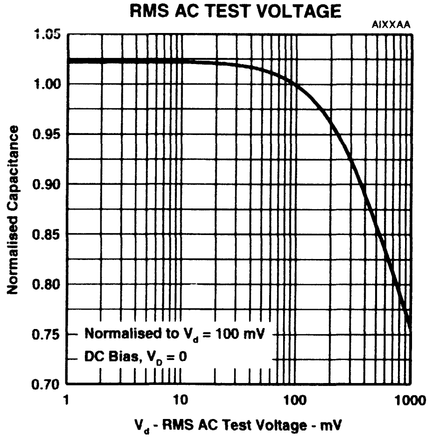


Figure 21.

APPLICATIONS INFORMATION

longitudinal balance

Figure 22 shows a three terminal TISP with its equivalent "delta" capacitance Each capacitance, C_{TG} , C_{RG} and C_{TR} , is the true terminal pair capacitance measured with a three terminal or guarded capacitance bridge. If wire R is biased at a larger potential than wire T then $C_{TG} > C_{RG}$. Capacitance C_{TG} is equivalent to a capacitance of C_{RG} in parallel with the capacitive difference of (C_{TG} - C_{RG}). The line capacitive unbalance is due to (C_{TG} - C_{RG}) and the capacitance shunting the line is $C_{TR} + C_{RG}/2$.

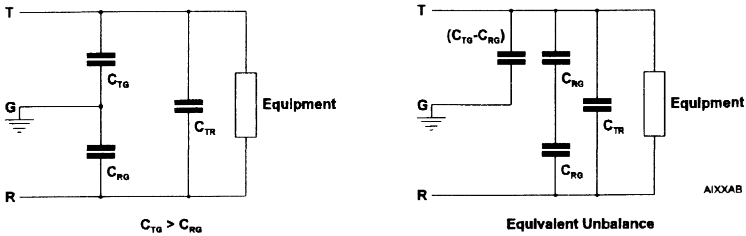


Figure 22.

All capacitance measurements in this data sheet are three terminal guarded to allow the designer to accurately assess capacitive unbalance effects. Simple two terminal capacitance meters (unguarded third terminal) give false readings as the shunt capacitance via the third terminal is included.

TELECOMMUNICATION SYSTEM SECONDARY PROTECTION

- **Ion-Implanted Breakdown Region**
  Precise and Stable Voltage
  Low Voltage Overshoot under Surge

DEVICE	V_{DRM} V	$V_{(BO)}$ V
'2125F3	100	125
'2150F3	120	150
'2180F3	145	180

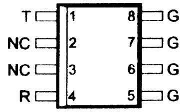
- **Planar Passivated Junctions**
  Low Off-State Current < 10 μA
- **Rated for International Surge Wave Shapes**

WAVE SHAPE	STANDARD	I_{TSP} A
2/10 μs	FCC Part 68	175
8/20 μs	ANSI C62.41	120
10/160 μs	FCC Part 68	60
10/560 μs	FCC Part 68	45
0.5/700 μs	RLM 88	38
10/700 μs	FTZ R12	50
	VDE 0433	50
	CCITT IX K17	38
10/1000 μs	REA PE-60	35

- **Surface Mount and Through-Hole Options**

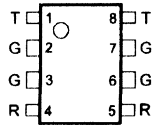
PACKAGE	PART # SUFFIX
Small-outline	D
Small-outline taped and reeled	DR
Plastic DIP	P
Single-in-line	SL

D PACKAGE
(TOP VIEW)



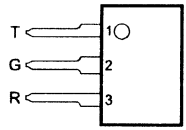
NC - No internal connection

P PACKAGE
(TOP VIEW)

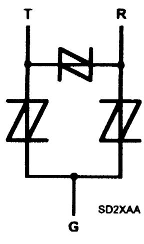


Specified T terminal ratings require connection of pins 1 and 8.
Specified R terminal ratings require connection of pins 4 and 5.

SL PACKAGE
(TOP VIEW)



device symbol



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

description

These medium voltage dual symmetrical transient voltage suppressor devices are designed to protect ISDN and telecommunication applications with battery backed ringing against transients caused by lightning strikes and ac power lines. Offered in three voltage variants to meet battery and protection requirements they are guaranteed to suppress and withstand the listed international lightning surges in both polarities. Transients are initially clipped by breakdown clamping until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the current subsides.

These monolithic protection devices are fabricated in ion-implanted planar structures to ensure precise and matched breakover control and are virtually transparent to the system in normal operation

TEXAS INSTRUMENTS

description (Continued)

The small-outline 8-pin assignment has been carefully chosen for the TISP series to maximise the inter-pin clearance and creepage distances which are used by standards (e.g. IEC950) to establish voltage withstand ratings.

absolute maximum ratings

RATING		SYMBOL	VALUE	UNIT
Repetitive peak off-state voltage (0°C < T_J < 70°C)	'2125F3	V_{DRM}	± 100	V
	'2125F3		± 120	
	'2180F3		± 145	
Non-repetitive peak on-state pulse current (see Notes 1, 2 and 3)		I_{TSP}		A
1/2 µs (Gas tube differential transient, open-circuit voltage wave shape 1/2 µs)			350	
2/10 µs (FCC Part 68, open-circuit voltage wave shape 2/10 µs)			175	
8/20 µs (ANSI C62.41, open-circuit voltage wave shape 1.2/50 µs)			120	
10/160 µs (FCC Part 68, open-circuit voltage wave shape 10/160 µs)			60	
5/200 µs (VDE 0433, open-circuit voltage wave shape 2 kV, 10/700 µs)			50	
0.5/310 µs (RLM 88, open-circuit voltage wave shape 1.5 kV, 0.5/700 µs)			38	
5/310 µs (CCITT IX K17, open-circuit voltage wave shape 1.5 kV, 10/700 µs)			38	
5/310 µs (FTZ R12, open-circuit voltage wave shape 2 kV, 10/700 µs)			50	
10/560 µs (FCC Part 68, open-circuit voltage wave shape 10/560 µs)			45	
10/1000 µs (REA PE-60, open-circuit voltage wave shape 10/1000 µs)			35	
Non-repetitive peak on-state current (see Notes 2 and 3)	D Package	I_{TSM}	4	A rms
50 Hz, 1 s	P Package		6	
	SL Package		6	
Initial rate of rise of on-state current, Linear current ramp, Maximum ramp value < 38 A		di_F/dt	250	A/µs
Junction temperature		T_J	-40 to +150	°C
Storage temperature range		T_{stg}	-40 to +150	°C

NOTES: 1. Further details on surge wave shapes are contained in the Applications Information section.
2. Initially the TISP must be in thermal equilibrium with 0°C < T_J <70°C. The surge may be repeated after the TISP returns to its initial conditions.
3. Above 70°C, derate linearly to zero at 150°C lead temperature.

electrical characteristics for the T and R terminals, T_J = 25°C

PARAMETER		TEST CONDITIONS	TISP2125F3		TISP2150F3		TISP2180F3		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	
I_{DRM}	Repetitive peak off-state current	$V_D = \pm V_{DRM}$, 0°C < T_J < 70°C		±10		±10		±10	µA
I_D	Off-state current	V_D = ±50 V		±10		±10		±10	µA
C_{off}	Off-state capacitance	f = 100 kHz, V_d = 100 mV V_D = 0, Third terminal voltage = 0 (see Notes 4 and 5)	20†	35	20†	35	20†	35	pF

NOTES: 4. These capacitance measurements employ a three terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.
5. Further details on capacitance are given in the Applications Information section.

† Typical value of the parameter, not a limit value.

electrical characteristics for the T and G or the R and G terminals, T_J = 25°C

PARAMETER		TEST CONDITIONS	TISP2125F3		TISP2150F3		TISP2180F3		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	
I_{DRM}	Repetitive peak off-state current	$V_D = \pm V_{DRM}$, 0°C < T_J < 70°C		±10		±10		±10	μA
$V_{(BO)}$	Breakover voltage	dv/dt = ±250 V/ms, Source Resistance = 300 Ω		±125		±150		±180	V
$V_{(BO)}$	Impulse breakover voltage	dv/dt = ±1000 V/μs, di/dt < 20 A/μs Source Resistance = 50 Ω		±143†		±168†		±198†	V
$I_{(BO)}$	Breakover current	dv/dt = ±250 V/ms, Source Resistance = 300 Ω	±0.15	±0.6	±0.15	±0.6	±0.15	±0.6	A
V_T	On-state voltage	I_T = ±5 A, t_W = 100 μs		±3		±3		±3	V
I_H	Holding current	di/dt = -/+30 mA/ms	±0.15		±0.15		±0.15		A
dv/dt	Critical rate of rise of off-state voltage	Linear voltage ramp, Maximum ramp value < $0.85V_{(BR)MIN}$	±5		±5		±5		kV/μs
I_D	Off-state current	V_D = ±50 V		±10		±10		±10	μA
C_{off}	Off-state capacitance	f = 100 kHz, V_d = 100 mV V_D = 0,	52†	90	52†	90	52†	90	pF
		Third terminal voltage = 0 V_D = -5 V	26†	45	26†	45	26†	45	pF
		(see Notes 6 and 7) V_D = -50 V	11†	20	11†	20	11†	20	pF

NOTES: 6 These capacitance measurements employ a three terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.
7. Further details on capacitance are given in the Applications Information section.

† Typical value of the parameter, not a limit value.

thermal characteristics

PARAMETER			MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance	D Package			160	°C/W
		P Package			100	
		SL Package			105	

PARAMETER MEASUREMENT INFORMATION

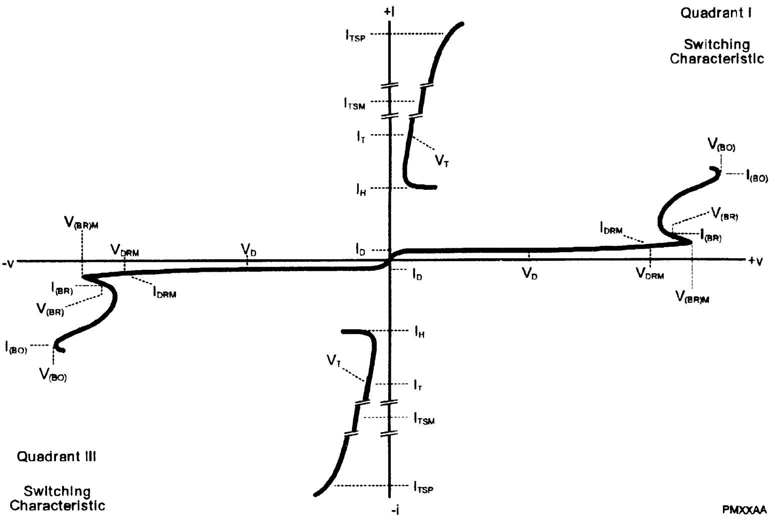


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR ANY PAIR OF TERMINALS

The high level characteristics for terminals R and T are not guaranteed.

TYPICAL CHARACTERISTICS
T and G, or R and G terminals

OFF-STATE CURRENT vs JUNCTION TEMPERATURE

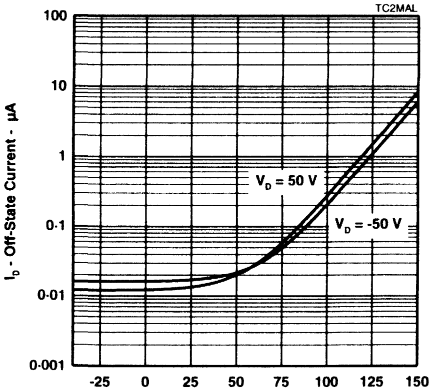


Figure 2.

NORMALISED BREAKDOWN VOLTAGES vs JUNCTION TEMPERATURE

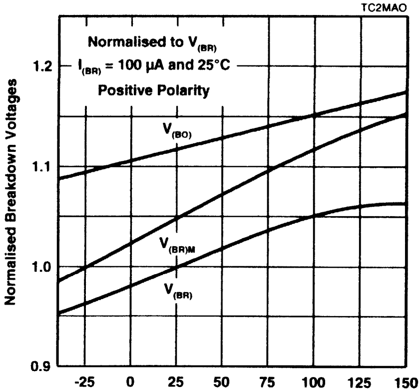


Figure 3.

TYPICAL CHARACTERISTICS
T and G, or R and G terminals

NORMALISED BREAKDOWN VOLTAGES vs JUNCTION TEMPERATURE

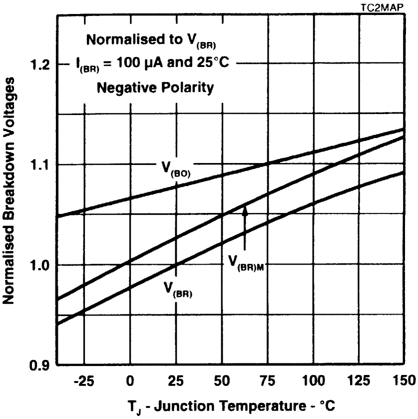


Figure 4.

ON-STATE CURRENT vs ON-STATE VOLTAGE

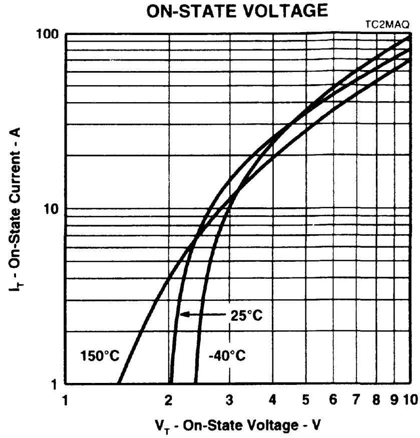


Figure 5.

HOLDING CURRENT & BREAKOVER CURRENT vs JUNCTION TEMPERATURE

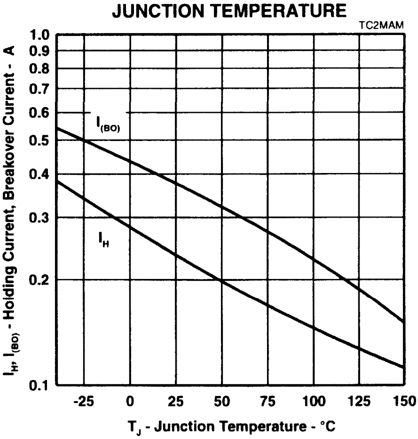


Figure 6.

NORMALISED BREAKOVER VOLTAGE vs RATE OF RISE OF PRINCIPLE CURRENT

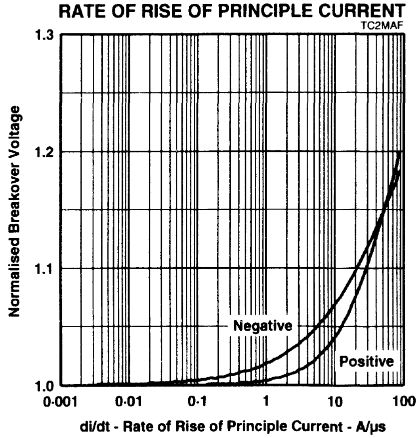


Figure 7.

TEXAS INSTRUMENTS

TYPICAL CHARACTERISTICS
T and G, or R and G terminals

OFF-STATE CAPACITANCE vs TERMINAL VOLTAGE (POSITIVE)

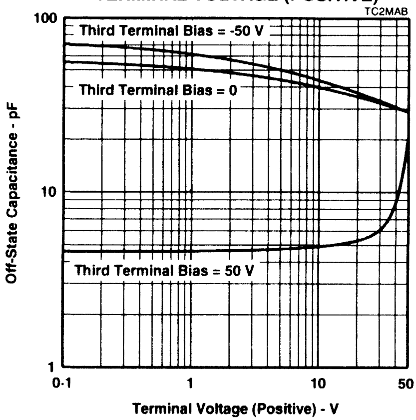


Figure 8.

OFF-STATE CAPACITANCE vs TERMINAL VOLTAGE (NEGATIVE)

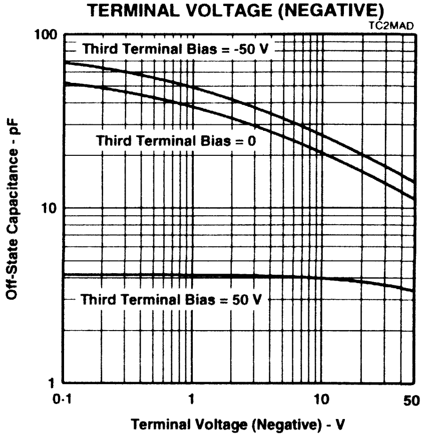


Figure 9.

OFF-STATE CAPACITANCE vs JUNCTION TEMPERATURE

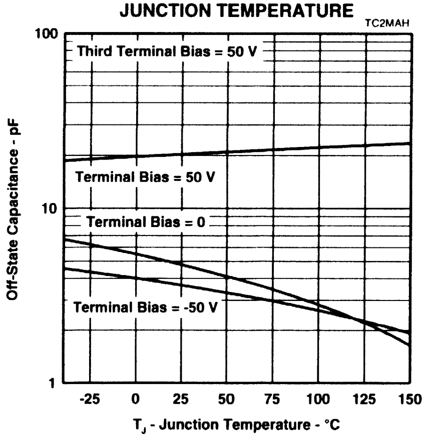


Figure 10.

TYPICAL CHARACTERISTICS
T and G, or R and G terminals

OFF-STATE CAPACITANCE vs JUNCTION TEMPERATURE

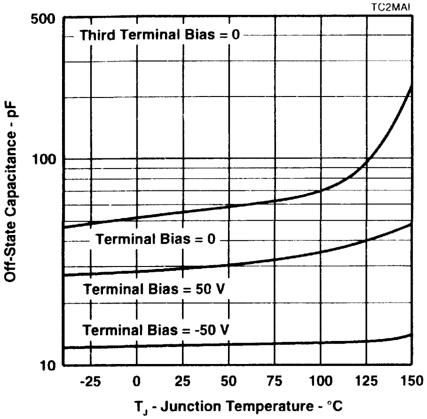


Figure 11.

OFF-STATE CAPACITANCE vs JUNCTION TEMPERATURE

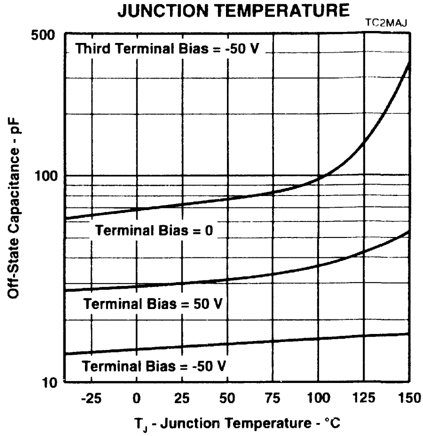


Figure 12.

SURGE CURRENT vs DECAY TIME

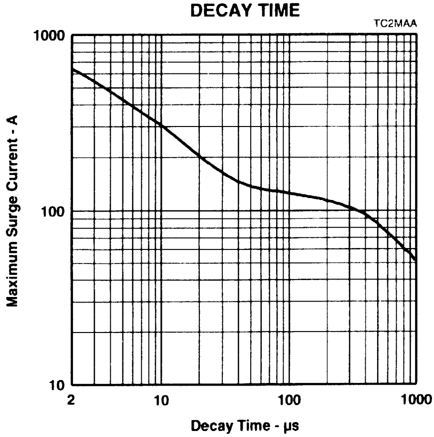


Figure 13.

TYPICAL CHARACTERISTICS
T and R terminals

OFF-STATE CURRENT vs JUNCTION TEMPERATURE

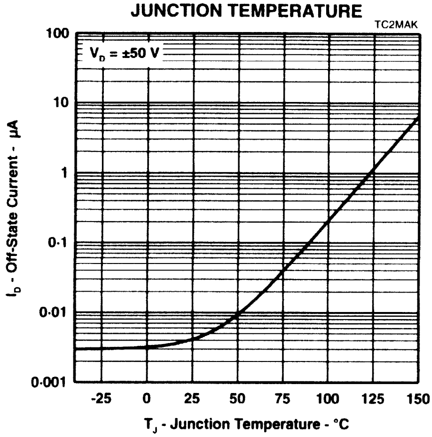


Figure 14.

NORMALISED BREAKDOWN VOLTAGES vs JUNCTION TEMPERATURE

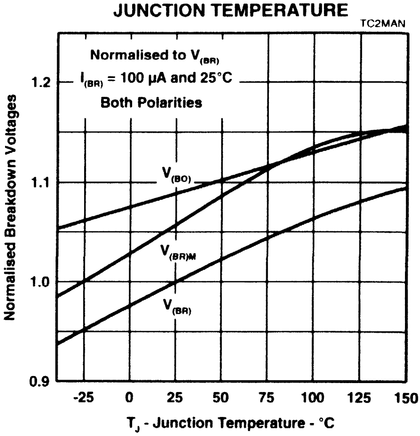


Figure 15.

NORMALISED BREAKOVER VOLTAGE vs RATE OF RISE OF PRINCIPLE CURRENT

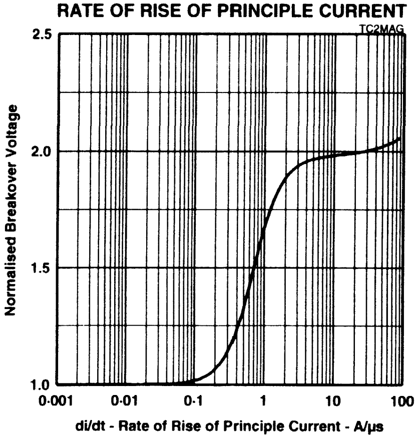


Figure 16.

TYPICAL CHARACTERISTICS
T and R terminals

OFF-STATE CAPACITANCE vs TERMINAL VOLTAGE (POSITIVE)

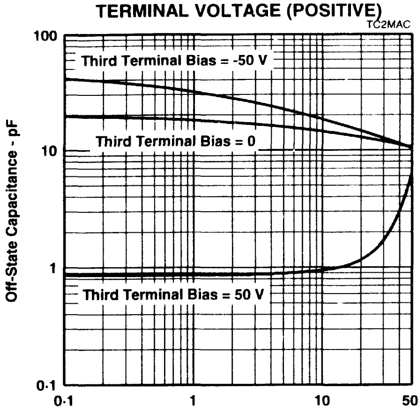


Figure 17.

OFF-STATE CAPACITANCE vs TERMINAL VOLTAGE (NEGATIVE)

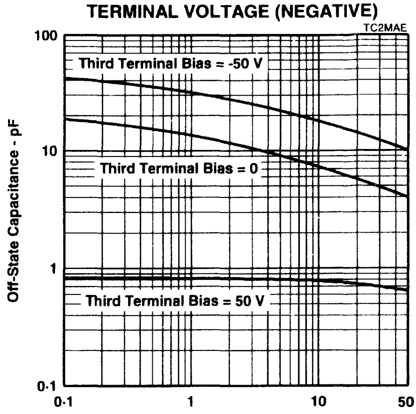


Figure 18.

THERMAL INFORMATION

MAXIMUM NON-RECURRING 50 Hz CURRENT vs CURRENT DURATION

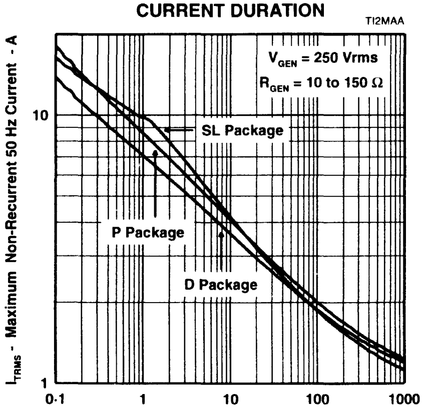


Figure 19.

THERMAL RESPONSE

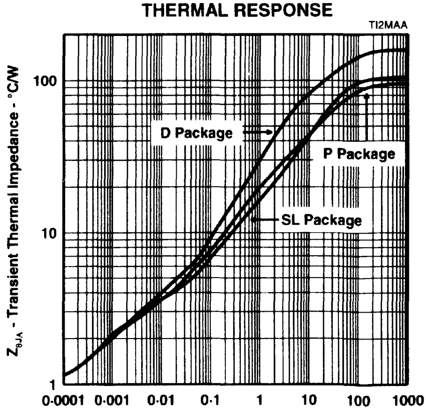


Figure 20.

TEXAS INSTRUMENTS

APPLICATIONS INFORMATION

electrical characteristics

The electrical characteristics of a TISP are strongly dependent on junction temperature, T_J. Hence a characteristic value will depend on the junction temperature at the instant of measurement. The values given in this data sheet were measured on commercial testers, which generally minimise the temperature rise caused by testing. Application values may be calculated from the parameters' temperature curves, the power dissipated and the thermal response curve (Z_θ).

lightning surge

wave shape notation

Most lightning tests, used for equipment verification, specify a unidirectional sawtooth waveform which has an exponential rise and an exponential decay. Wave shapes are classified in terms of peak amplitude (voltage or current), rise time and a decay time to 50% of the maximum amplitude. The notation used for the wave shape is *amplitude, rise time/decay time*. A 50A, 5/310 µs wave shape would have a peak current value of 50 A, a rise time of 5 µs and a decay time of 310 µs. The TISP surge current graph comprehends the wave shapes of commonly used surges.

generators

There are three categories of surge generator type, single wave shape, combination wave shape and circuit defined. Single wave shape generators have essentially the same wave shape for the open circuit voltage and short circuit current (e.g. 10/1000 µs open circuit voltage and short circuit current). Combination generators have two wave shapes, one for the open circuit voltage and the other for the short circuit current (e.g. 1.2/50 µs open circuit voltage and 8/20 µs short circuit current) Circuit specified generators usually equate to a combination generator, although typically only the open circuit voltage waveshape is referenced (e.g. a 10/700 µs open circuit voltage generator typically produces a 5/310 µs short circuit current). If the combination or circuit defined generators operate into a finite resistance the wave shape produced is intermediate between the open circuit and short circuit values.

current rating

When the TISP switches into the on-state it has a very low impedance. As a result, although the surge wave shape may be defined in terms of open circuit voltage, it is the current wave shape that must be used to assess the required TISP surge capability. As an example, the CCITT IX K17 1.5 kV, 10/700 µs surge is changed to a 38 A, 5/310 µs waveshape when driving into a short circuit. Thus the TISP surge current capability, when directly connected to the generator, will be found for the CCITT IX K17 waveform at 310 µs on the surge graph and not 700 µs. Some common short circuit equivalents are tabulated below:

STANDARD	OPEN CIRCUIT VOLTAGE	SHORT CIRCUIT CURRENT
CCITT IX K17	1.5 kV, 10/700 µs	38 A, 5/310 µs
CCITT IX K20	1 kV, 10/700 µs	25 A, 5/310 µs
RLM88	1.5 kV, 0.5/700 µs	38 A, 0.2/310 µs
VDE 0433	2.0 kV, 10/700 µs	50 A, 5/200 µs
FTZ R12	2.0 kV, 10/700 µs	50 A, 5/310 µs

Any series resistance in the protected equipment will reduce the peak circuit current to less than the generators' short circuit value. A 2 kV open circuit voltage, 50 A short circuit current generator has an effective output impedance of 40 Ω (2000/50). If the equipment has a series resistance of 25 Ω then the surge current requirement of the TISP becomes 31 A (2000/65) and not 50 A.

APPLICATIONS INFORMATION

protection voltage

The protection voltage, ($V_{(BO)}$), increases under lightning surge conditions due to thyristor regeneration. This increase is dependent on the rate of current rise, di/dt, when the TISP is clamping the voltage in its breakdown region. The $V_{(BO)}$ value under surge conditions can be estimated by multiplying the 50 Hz rate $V_{(BO)}$ (250 V/ms) value by the normalised increase at the surge's di/dt (Figure 7.) . An estimate of the di/dt can be made from the surge generator voltage rate of rise, dv/dt, and the circuit resistance.

As an example, the CCITT IX K17 1.5 kV, 10/700 µs surge has an average dv/dt of 150 V/µs, but, as the rise is exponential, the initial dv/dt is higher, being in the region of 450 V/µs. The instantaneous generator output resistance is 25 Ω. If the equipment has an additional series resistance of 20 Ω, the total series resistance becomes 45 Ω. The maximum di/dt then can be estimated as 450/45 = 10 A/µs. In practice the measured di/dt and protection voltage increase will be lower due to inductive effects and the finite slope resistance of the TISP breakdown region.

capacitance

off-state capacitance

The off-state capacitance of a TISP is sensitive to junction temperature, T_J, and the bias voltage, comprising of the dc voltage, V_D, and the ac voltage, V_d. All the capacitance values in this data sheet are measured with an ac voltage of 100 mV. The typical 25°C variation of capacitance value with ac bias is shown in Figure 21. When $V_D >> V_d$ the capacitance value is independent on the value of V_d. The capacitance is essentially constant over the range of normal telecommunication frequencies.

NORMALISED CAPACITANCE
vs
RMS AC TEST VOLTAGE

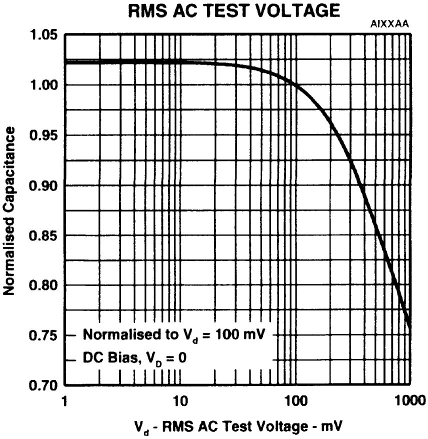


Figure 21.

APPLICATIONS INFORMATION

longitudinal balance

Figure 22 shows a three terminal TISP with its equivalent "delta" capacitance Each capacitance, C_{TG} , C_{RG} and C_{TR} , is the true terminal pair capacitance measured with a three terminal or guarded capacitance bridge. If wire R is biased at a larger potential than wire T then $C_{TG} > C_{RG}$. Capacitance C_{TG} is equivalent to a capacitance of C_{RG} in parallel with the capacitive difference of (C_{TG} - C_{RG}). The line capacitive unbalance is due to (C_{TG} - C_{RG}) and the capacitance shunting the line is C_{TR} + C_{RG}/2 .

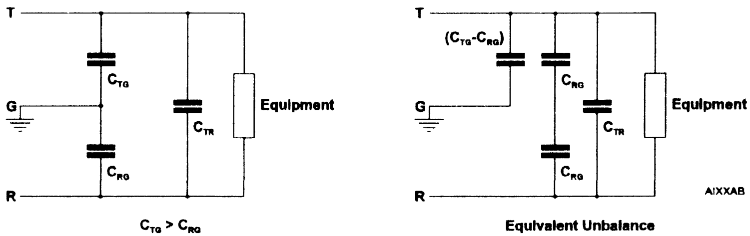


Figure 22.

All capacitance measurements in this data sheet are three terminal guarded to allow the designer to accurately assess capacitive unbalance effects. Simple two terminal capacitance meters (unguarded third terminal) give false readings as the shunt capacitance via the third terminal is included.

TELECOMMUNICATION SYSTEM SECONDARY PROTECTION

- **Ion-Implanted Breakdown Region**
  Precise and Stable Voltage
  Low Voltage Overshoot under Surge

DEVICE	V_{DRM} V	$V_{(BO)}$ V
'2240F3	180	240
'2260F3	200	260
'2290F3	220	290
'2320F3	240	320
'2380F3	270	380

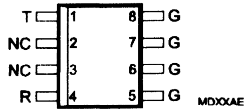
- **Planar Passivated Junctions**
  Low Off-State Current < 10 µA
- **Rated for International Surge Wave Shapes**

WAVE SHAPE	STANDARD	I_{TSP} A
2/10 µs	FCC Part 68	175
8/20 µs	ANSI C62.41	120
10/160 µs	FCC Part 68	60
10/560 µs	FCC Part 68	45
0.5/700 µs	RLM 88	38
10/700 µs	FTZ R12	50
	VDE 0433	50
	CCITT IX K17	38
10/1000 µs	REA PE-60	35

- **Surface Mount and Through-Hole Options**

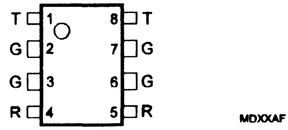
PACKAGE	PART # SUFFIX
Small-outline	D
Small-outline taped and reeled	DR
Plastic DIP	P
Single-in-line	SL

D PACKAGE
(TOP VIEW)



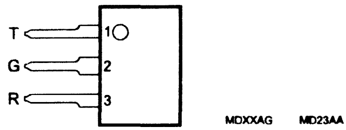
NC - No internal connection

P PACKAGE
(TOP VIEW)

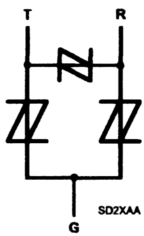


Specified T terminal ratings require connection of pins 1 and 8.
Specified R terminal ratings require connection of pins 4 and 5.

SL PACKAGE
(TOP VIEW)



device symbol



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

description

These high voltage dual symmetrical transient voltage suppressor devices are designed to protect telecommunication applications with battery backed ringing against transients caused by lightning strikes and ac power lines. Offered in five voltage variants to meet battery and protection requirements they are guaranteed to suppress and withstand the listed international lightning surges in both polarities. Transients are initially clipped by breakdown clamping until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the current subsides.

These monolithic protection devices are fabricated in ion-implanted planar structures to

TEXAS INSTRUMENTS

description (Continued)

ensure precise and matched breakover control and are virtually transparent to the system in normal operation

The small-outline 8 pin assignment has been carefully chosen for the TISP series to maximise the inter-pin clearance and creepage distances which are used by standards (e.g. IEC950) to establish voltage withstand ratings.

absolute maximum ratings

RATING		SYMBOL	VALUE	UNIT
Repetitive peak off-state voltage (0°C < T_J < 70°C)	'2240F3	V_{DRM}	± 180	V
	'2260F3		± 200	
	'2290F3		± 220	
	'2320F3		± 240	
	'2380F3		± 270	
Non-repetitive peak on-state pulse current (see Notes 1, 2 and 3)		I_{TSP}		A
1/2 μs (Gas tube differential transient, open-circuit voltage wave shape 1/2 μs)			350	
2/10 μs (FCC Part 68, open-circuit voltage wave shape 2/10 μs)			175	
8/20 μs (ANSI C62.41, open-circuit voltage wave shape 1.2/50 μs)			120	
10/160 μs (FCC Part 68, open-circuit voltage wave shape 10/160 μs)			60	
5/200 μs (VDE 0433, open-circuit voltage wave shape 2 kV, 10/700 μs)			50	
0.5/310 μs (RLM 88, open-circuit voltage wave shape 1.5 kV, 0.5/700 μs)			38	
5/310 μs (CCITT IX K17, open-circuit voltage wave shape 1.5 kV, 10/700 μs)			38	
5/310 μs (FTZ R12, open-circuit voltage wave shape 2 kV, 10/700 μs)			50	
10/560 μs (FCC Part 68, open-circuit voltage wave shape 10/560 μs)			45	
10/1000 μs (REA PE-60, open-circuit voltage wave shape 10/1000 μs)			35	
Non-repetitive peak on-state current (see Notes 2 and 3)	D Package	I_{TSM}	4	A rms
50 Hz, 1 s	P Package		6	
	SL Package		6	
Initial rate of rise of on-state current, Linear current ramp, Maximum ramp value < 38 A		di_F/dt	250	A/μs
Junction temperature		T_J	-40 to +150	°C
Storage temperature range		T_{stg}	-40 to +150	°C

NOTES: 1. Further details on surge wave shapes are contained in the Applications Information section.
2. Initially the TISP must be in thermal equilibrium with 0°C < T_J <70°C. The surge may be repeated after the TISP returns to its initial conditions.
3. Above 70°C, derate linearly to zero at 150°C lead temperature.

electrical characteristics for the T and R terminals, T_J = 25°C

PARAMETER		TEST CONDITIONS	TISP2240F3		TISP2260F3		TISP2290F3		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	
I_{DRM}	Repetitive peak off-state current	$V_D = \pm V_{DRM}$, 0°C < T_J < 70°C		±10		±10		±10	μA
I_D	Off-state current	V_D = ±50 V		±10		±10		±10	μA
C_{off}	Off-state capacitance	f = 100 kHz, V_d = 100 mV V_D = 0, Third terminal voltage = 0 (see Notes 4 and 5)	22†	40	22†	40	22†	40	pF

NOTES: 4. These capacitance measurements employ a three terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.
5. Further details on capacitance are given in the Applications Information section.

† Typical value of the parameter, not a limit value.

electrical characteristics for the T and G or the R and G terminals, T_J = 25°C

PARAMETER		TEST CONDITIONS	TISP2240F3		TISP2260F3		TISP2290F3		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	
I_{DRM}	Repetitive peak off-state current	$V_D = \pm V_{DRM}$, 0°C < T_J < 70°C		±10		±10		±10	μA
$V_{(BO)}$	Breakover voltage	dv/dt = ±250 V/ms, Source Resistance = 300 Ω		±240		±260		±290	V
$V_{(BO)}$	Impulse breakover voltage	dv/dt = ±1000 V/μs, di/dt < 20 A/μs Source Resistance = 50 Ω		±267†		±287†		±317†	V
$I_{(BO)}$	Breakover current	dv/dt = ±250 V/ms, Source Resistance = 300 Ω	±0.15	±0.6	±0.15	±0.6	±0.15	±0.6	A
V_T	On-state voltage	I_T = ±5 A, t_W = 100 μs		±3		±3		±3	V
I_H	Holding current	di/dt = -/+30 mA/ms	±0.15		±0.15		±0.15		A
dv/dt	Critical rate of rise of off-state voltage	Linear voltage ramp, Maximum ramp value < $0.85V_{(BR)MIN}$	±5		±5		±5		kV/μs
I_D	Off-state current	V_D = ±50 V		±10		±10		±10	μA
C_{off}	Off-state capacitance	f = 100 kHz, V_d = 100 mV V_D = 0,	52†	90	52†	90	52†	90	pF
		Third terminal voltage = 0 V_D = -5 V	20†	35	20†	35	20†	35	pF
		(see Notes 6 and 7) V_D = -50 V	8†	15	8†	15	8†	15	pF

NOTES: 6 These capacitance measurements employ a three terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.
7. Further details on capacitance are given in the Applications Information section

† Typical value of the parameter, not a limit value.

electrical characteristics for the T and R terminals, T_J = 25°C

PARAMETER		TEST CONDITIONS	TISP2320F3		TISP2380F3		UNIT
			MIN	MAX	MIN	MAX	
I_{DRM}	Repetitive peak off-state current	$V_D = \pm V_{DRM}$, 0°C < T_J < 70°C		±10		±10	μA
I_D	Off-state current	V_D = ±50 V		±10		±10	μA
C_{off}	Off-state capacitance	f = 100 kHz, V_d = 100 mV V_D = 0, Third terminal voltage = 0 (see Notes 4 and 5)	22†	40	22†	40	pF

NOTES: 4. These capacitance measurements employ a three terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.
5. Further details on capacitance are given in the Applications Information section.

electrical characteristics for the T and G or the R and G terminals, T_J = 25°C

PARAMETER		TEST CONDITIONS	TISP2320F3		TISP2380F3		UNIT
			MIN	MAX	MIN	MAX	
I_{DRM}	Repetitive peak off-state current	$V_D = \pm V_{DRM}$, 0°C < T_J < 70°C		±10		±10	μA
$V_{(BO)}$	Breakover voltage	dv/dt = ±250 V/ms, Source Resistance = 300 Ω		±320		±380	V
$V_{(BO)}$	Impulse breakover voltage	dv/dt = ±1000 V/μs, di/dt < 20 A/μs Source Resistance = 50 Ω		±347†		±407†	V

electrical characteristics for the T and G or the R and G terminals, T_J = 25°C (Continued)

PARAMETER		TEST CONDITIONS		TISP2320F3		TISP2380F3		UNIT
				MIN	MAX	MIN	MAX	
$I_{(BO)}$	Breakover current	dv/dt = ±250 V/ms, Source Resistance = 300 Ω		±0.15	±0.6	±0.15	±0.6	A
V_T	On-state voltage	I_T = ±5 A, t_W = 100 µs			±3		±3	V
I_H	Holding current	di/dt = -/+30 mA/ms		±0.15		±0.15		A
dv/dt	Critical rate of rise of off-state voltage	Linear voltage ramp, Maximum ramp value < $0.85V_{(BR)MIN}$		±5		±5		kV/µs
I_D	Off-state current	V_D = ±50 V			±10		±10	µA
C_{off}	Off-state capacitance	f = 100 kHz, V_d = 100 mV	V_D = 0,	77†	130	77†	130	pF
		Third terminal voltage = 0	V_D = -5 V	42†	70	42†	70	pF
		(see Notes 6 and 7)	V_D = -50 V	19†	30	19†	30	pF

NOTES: 6 These capacitance measurements employ a three terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.
7. Further details on capacitance are given in the Applications Information section.

† Typical value of the parameter, not a limit value.

PARAMETER MEASUREMENT INFORMATION

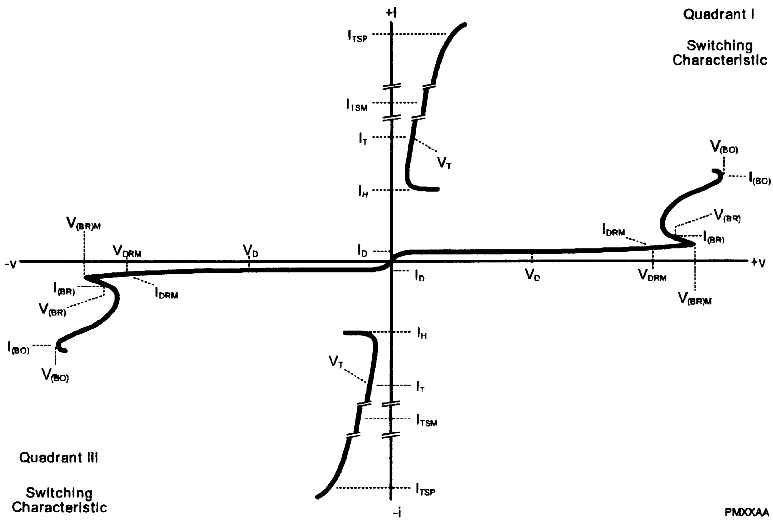


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR ANY PAIR OF TERMINALS

The high level characteristics for terminals R and T are not guaranteed.

thermal characteristics

PARAMETER			MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance	D Package			160	°C/W
		P Package			100	
		SL Package			105	

TYPICAL CHARACTERISTICS
T and G, or R and G terminals

OFF-STATE CURRENT vs JUNCTION TEMPERATURE

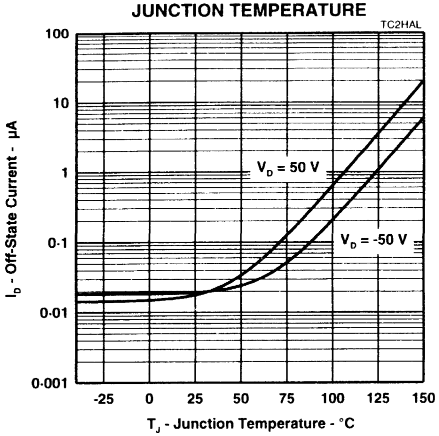


Figure 2.

NORMALISED BREAKDOWN VOLTAGES vs JUNCTION TEMPERATURE

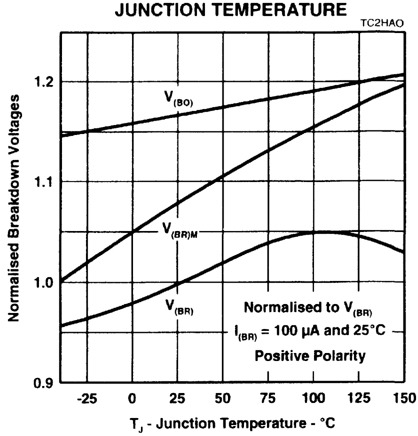


Figure 3.

NORMALISED BREAKDOWN VOLTAGES vs JUNCTION TEMPERATURE

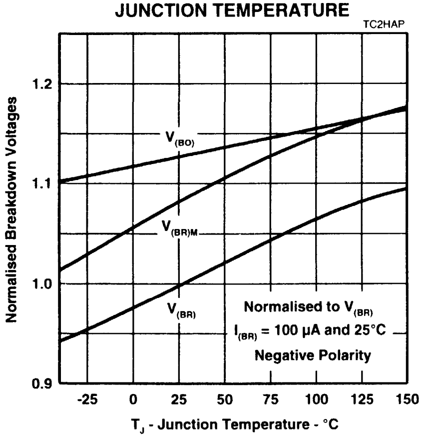


Figure 4.

ON-STATE CURRENT vs ON-STATE VOLTAGE

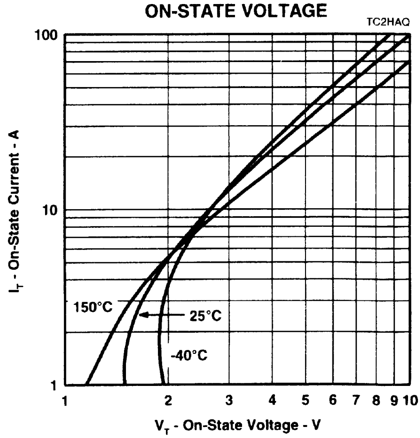


Figure 5.

TYPICAL CHARACTERISTICS
T and G, or R and G terminals

HOLDING CURRENT & BREAKOVER CURRENT vs JUNCTION TEMPERATURE

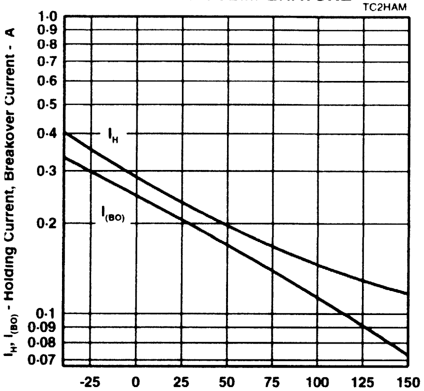


Figure 6.

NORMALISED BREAKOVER VOLTAGE vs RATE OF RISE OF PRINCIPLE CURRENT

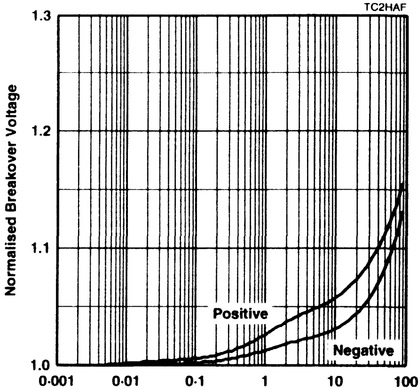


Figure 7.

OFF-STATE CAPACITANCE vs TERMINAL VOLTAGE (POSITIVE)

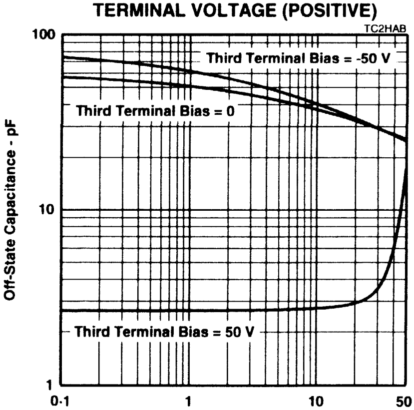


Figure 8.

OFF-STATE CAPACITANCE vs TERMINAL VOLTAGE (NEGATIVE)

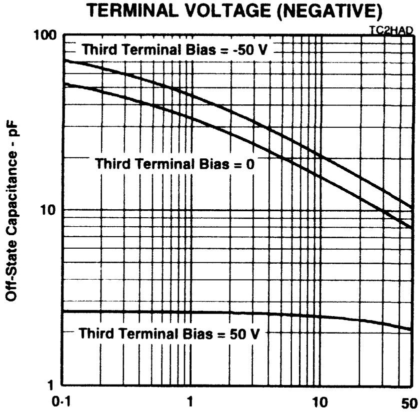


Figure 9.

TYPICAL CHARACTERISTICS
T and G, or R and G terminals

OFF-STATE CAPACITANCE vs JUNCTION TEMPERATURE

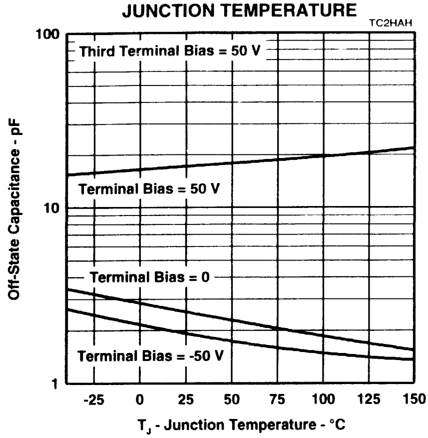


Figure 10.

OFF-STATE CAPACITANCE vs JUNCTION TEMPERATURE

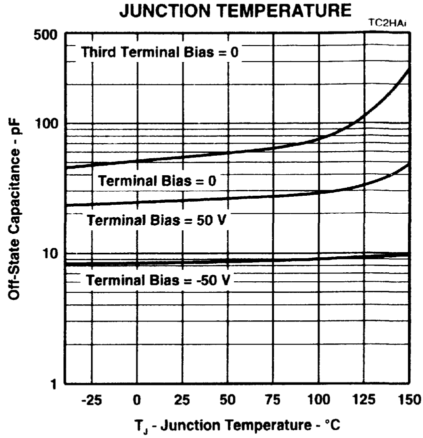


Figure 11.

OFF-STATE CAPACITANCE vs JUNCTION TEMPERATURE

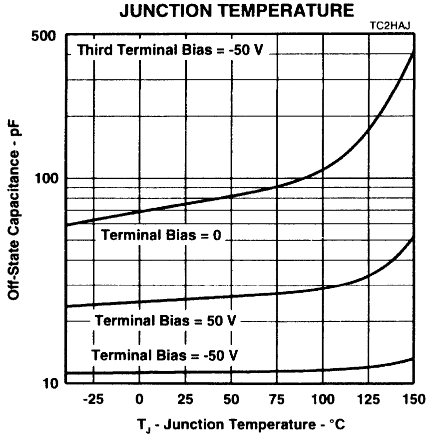


Figure 12.

SURGE CURRENT vs DECAY TIME

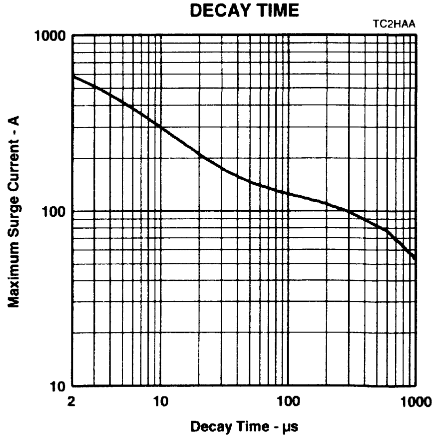


Figure 13.

TYPICAL CHARACTERISTICS
T and R terminals

OFF-STATE CURRENT vs JUNCTION TEMPERATURE

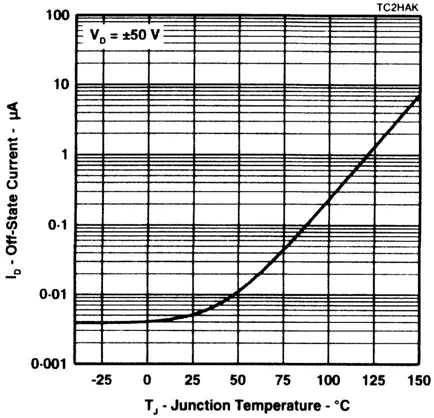


Figure 14.

NORMALISED BREAKDOWN VOLTAGES vs JUNCTION TEMPERATURE

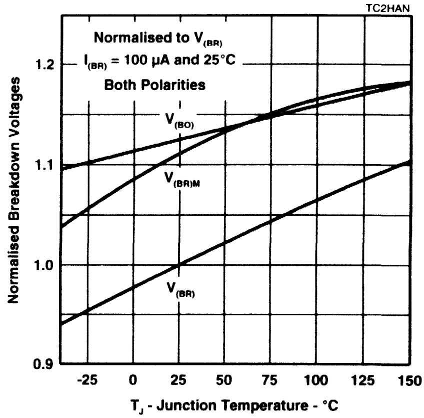


Figure 15.

NORMALISED BREAKOVER VOLTAGE vs RATE OF RISE OF PRINCIPLE CURRENT

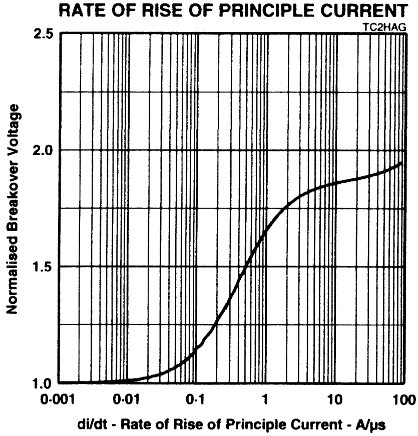


Figure 16.

TYPICAL CHARACTERISTICS
T and R terminals

OFF-STATE CAPACITANCE vs TERMINAL VOLTAGE (POSITIVE)

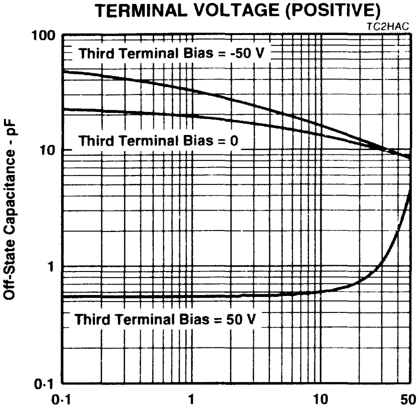


Figure 17.

OFF-STATE CAPACITANCE vs TERMINAL VOLTAGE (NEGATIVE)

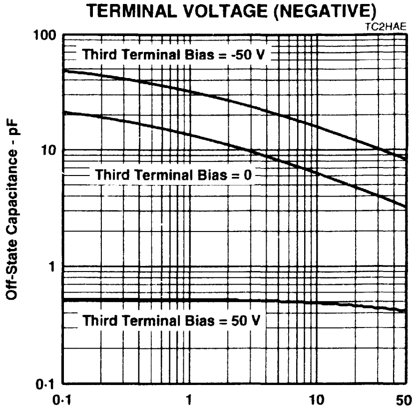


Figure 18.

THERMAL INFORMATION

MAXIMUM NON-RECURRING 50 Hz CURRENT vs CURRENT DURATION

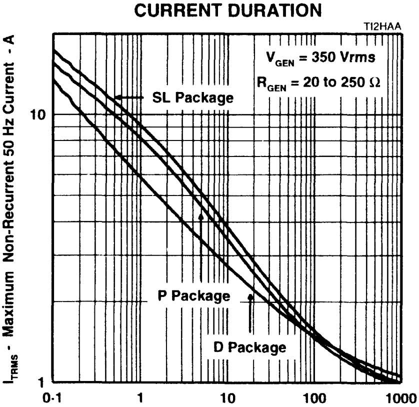


Figure 19.

THERMAL RESPONSE

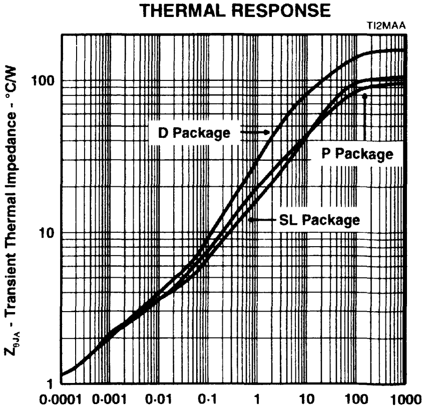


Figure 20.

APPLICATIONS INFORMATION

electrical characteristics

The electrical characteristics of a TISP are strongly dependent on junction temperature, T_J. Hence a characteristic value will depend on the junction temperature at the instant of measurement. The values given in this data sheet were measured on commercial testers, which generally minimise the temperature rise caused by testing. Application values may be calculated from the parameters' temperature curves, the power dissipated and the thermal response curve (Z_θ).

lightning surge

wave shape notation

Most lightning tests, used for equipment verification, specify a unidirectional sawtooth waveform which has an exponential rise and an exponential decay. Wave shapes are classified in terms of peak amplitude (voltage or current), rise time and a decay time to 50% of the maximum amplitude. The notation used for the wave shape is *amplitude, rise time/decay time*. A 50A, 5/310 µs wave shape would have a peak current value of 50 A, a rise time of 5 µs and a decay time of 310 µs. The TISP surge current graph comprehends the wave shapes of commonly used surges.

generators

There are three categories of surge generator type, single wave shape, combination wave shape and circuit defined. Single wave shape generators have essentially the same wave shape for the open circuit voltage and short circuit current (e.g. 10/1000 µs open circuit voltage and short circuit current). Combination generators have two wave shapes, one for the open circuit voltage and the other for the short circuit current (e.g. 1.2/50 µs open circuit voltage and 8/20 µs short circuit current) Circuit specified generators usually equate to a combination generator, although typically only the open circuit voltage waveshape is referenced (e.g. a 10/700 µs open circuit voltage generator typically produces a 5/310 µs short circuit current). If the combination or circuit defined generators operate into a finite resistance the wave shape produced is intermediate between the open circuit and short circuit values.

current rating

When the TISP switches into the on-state it has a very low impedance. As a result, although the surge wave shape may be defined in terms of open circuit voltage, it is the current wave shape that must be used to assess the required TISP surge capability. As an example, the CCITT IX K17 1.5 kV, 10/700 µs surge is changed to a 38 A, 5/310 µs waveshape when driving into a short circuit. Thus the TISP surge current capability, when directly connected to the generator, will be found for the CCITT IX K17 waveform at 310 µs on the surge graph and not 700 µs. Some common short circuit equivalents are tabulated below:

STANDARD	OPEN CIRCUIT VOLTAGE	SHORT CIRCUIT CURRENT
CCITT IX K17	1.5 kV, 10/700 µs	38 A, 5/310 µs
CCITT IX K20	1 kV, 10/700 µs	25 A, 5/310 µs
RLM88	1.5 kV, 0.5/700 µs	38 A, 0.2/310 µs
VDE 0433	2.0 kV, 10/700 µs	50 A, 5/200 µs
FTZ R12	2.0 kV, 10/700 µs	50 A, 5/310 µs

Any series resistance in the protected equipment will reduce the peak circuit current to less than the generators' short circuit value. A 2 kV open circuit voltage, 50 A short circuit current generator has an effective output impedance of 40 Ω (2000/50). If the equipment has a series resistance of 25 Ω then the surge current requirement of the TISP becomes 31 A (2000/65) and not 50 A.

APPLICATIONS INFORMATION

protection voltage

The protection voltage, ($V_{(BO)}$), increases under lightning surge conditions due to thyristor regeneration. This increase is dependent on the rate of current rise, di/dt, when the TISP is clamping the voltage in its breakdown region. The $V_{(BO)}$ value under surge conditions can be estimated by multiplying the 50 Hz rate $V_{(BO)}$ (250 V/ms) value by the normalised increase at the surge's di/dt (Figure 7.) . An estimate of the di/dt can be made from the surge generator voltage rate of rise, dv/dt, and the circuit resistance.

As an example, the CCITT IX K17 1.5 kV, 10/700 μs surge has an average dv/dt of 150 V/μs, but, as the rise is exponential, the initial dv/dt is higher, being in the region of 450 V/μs. The instantaneous generator output resistance is 25 Ω. If the equipment has an additional series resistance of 20 Ω, the total series resistance becomes 45 Ω. The maximum di/dt then can be estimated as 450/45 = 10 A/μs. In practice the measured di/dt and protection voltage increase will be lower due to inductive effects and the finite slope resistance of the TISP breakdown region.

capacitance

off-state capacitance

The off-state capacitance of a TISP is sensitive to junction temperature, T_J, and the bias voltage, comprising of the dc voltage, V_D, and the ac voltage, V_d. All the capacitance values in this data sheet are measured with an ac voltage of 100 mV. The typical 25°C variation of capacitance value with ac bias is shown in Figure 21. When $V_D >> V_d$ the capacitance value is independent on the value of V_d. The capacitance is essentially constant over the range of normal telecommunication frequencies.

NORMALISED CAPACITANCE vs RMS AC TEST VOLTAGE

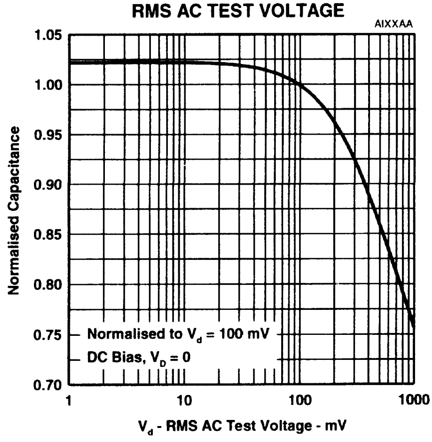


Figure 21.

APPLICATIONS INFORMATION

longitudinal balance

Figure 22 shows a three terminal TISP with its equivalent "delta" capacitance Each capacitance, C_{TG} , C_{RG} and C_{TR} , is the true terminal pair capacitance measured with a three terminal or guarded capacitance bridge. If wire R is biased at a larger potential than wire T then $C_{TG} > C_{RG}$. Capacitance C_{TG} is equivalent to a capacitance of C_{RG} in parallel with the capacitive difference of (C_{TG} - C_{RG}). The line capacitive unbalance is due to (C_{TG} - C_{RG}) and the capacitance shunting the line is $C_{TR} + C_{RG}/2$.

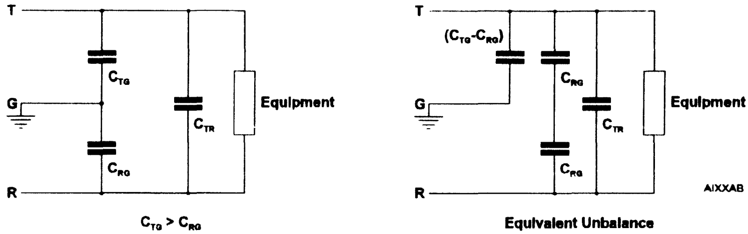


Figure 22.

All capacitance measurements in this data sheet are three terminal guarded to allow the designer to accurately assess capacitive unbalance effects. Simple two terminal capacitance meters (unguarded third terminal) give false readings as the shunt capacitance via the third terminal is included.

TISP3072F3, TISP3082F3
DUAL SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

SLPSE08 - MARCH 1994 - REVISED SEPTEMBER 1994

TELECOMMUNICATION SYSTEM SECONDARY PROTECTION

- **Ion-Implanted Breakdown Region**
  Precise and Stable Voltage
  Low Voltage Overshoot under Surge

DEVICE	V_{DRM} V	$V_{(BO)}$ V
'3072F3	58	72
'3082F3	66	82

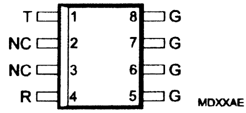
- **Planar Passivated Junctions**
  Low Off-State Current < 10 µA
- **Rated for International Surge Wave Shapes**

WAVE SHAPE	STANDARD	I_{TSP} A
2/10 µs	FCC Part 68	80
8/20 µs	ANSI C62.41	70
10/160 µs	FCC Part 68	60
10/560 µs	FCC Part 68	45
0.5/700 µs	RLM 88	38
10/700 µs	FTZ R12	50
	VDE 0433	50
	CCITT IX K17	38
10/1000 µs	REA PE-60	35

- **Surface Mount and Through-Hole Options**

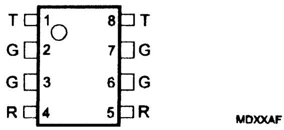
PACKAGE	PART # SUFFIX
Small-outline	D
Small-outline taped and reeled	DR
Plastic DIP	P
Single-in-line	SL

D PACKAGE (TOP VIEW)



NC - No internal connection

P PACKAGE (TOP VIEW)



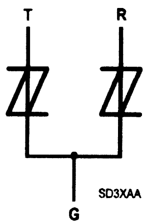
Specified T terminal ratings require connection of pins 1 and 8.
Specified R terminal ratings require connection of pins 4 and 5.

SL PACKAGE (TOP VIEW)

description

These low voltage dual symmetrical transient voltage suppressor devices are designed to protect ISDN applications against transients caused by lightning strikes and ac power lines. Offered in two voltage variants to meet battery and protection requirements they are guaranteed to suppress and withstand the listed international lightning surges in both polarities. Transients are initially clipped by breakdown clamping until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the current subsides.

device symbol



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

These monolithic protection devices are fabricated in ion-implanted planar structures to ensure precise and matched breakover control and are virtually transparent to the system in normal operation

TEXAS INSTRUMENTS

description (Continued)

The small-outline 8-pin assignment has been carefully chosen for the TISP series to maximise the inter-pin clearance and creepage distances which are used by standards (e.g. IEC950) to establish voltage withstand ratings.

absolute maximum ratings

RATING		SYMBOL	VALUE	UNIT
Repetitive peak off-state voltage (0°C < T_J < 70°C)	'3072F3	V_{DRM}	± 58	V
	'3082F3		± 66	
Non-repetitive peak on-state pulse current (see Notes 1, 2 and 3)				
1/2 µs (Gas tube differential transient, open-circuit voltage wave shape 1/2 µs)			120	
2/10 µs (FCC Part 68, open-circuit voltage wave shape 2/10 µs)			80	
8/20 µs (ANSI C62.41, open-circuit voltage wave shape 1.2/50 µs)			70	
10/160 µs (FCC Part 68, open-circuit voltage wave shape 10/160 µs)			60	
5/200 µs (VDE 0433, open-circuit voltage wave shape 2 kV, 10/700 µs)		I_{TSP}	50	A
0.5/310 µs (RLM 88, open-circuit voltage wave shape 1.5 kV, 0.5/700 µs)			38	
5/310 µs (CCITT IX K17, open-circuit voltage wave shape 1.5 kV, 10/700 µs)			38	
5/310 µs (FTZ R12, open-circuit voltage wave shape 2 kV, 10/700 µs)			50	
10/560 µs (FCC Part 68, open-circuit voltage wave shape 10/560 µs)			45	
10/1000 µs (REA PE-60, open-circuit voltage wave shape 10/1000 µs)			35	
Non-repetitive peak on-state current (see Notes 2 and 3)	D Package		4	
50 Hz, 1 s	P Package	I_{TSM}	6	A rms
	SL Package		6	
Initial rate of rise of on-state current, Linear current ramp, Maximum ramp value < 38 A		di_F/dt	250	A/µs
Junction temperature		T_J	-40 to +150	°C
Storage temperature range		T_{stg}	-40 to +150	°C

NOTES: 1. Further details on surge wave shapes are contained in the Applications Information section.
2. Initially the TISP must be in thermal equilibrium with 0°C < T_J <70°C. The surge may be repeated after the TISP returns to its initial conditions.
3. Above 70°C, derate linearly to zero at 150°C lead temperature.

electrical characteristics for the T and R terminals, T_J = 25°C

PARAMETER		TEST CONDITIONS		TISP3072F3		TISP3082F3		UNIT
				MIN	MAX	MIN	MAX	
I_{DRM}	Repetitive peak off-state current	V_D = ±V_{DRM}, 0°C < T_J < 70°C			±10		±10	µA
I_D	Off-state current	V_D = ±50 V			±10		±10	µA
C_{off}	Off-state capacitance	f = 100 kHz, V_d = 100 mV V_D = 0,	D Package	50†	150	50†	150	fF
		Third terminal voltage = -50 V to +50 V	P Package	65†	200	65†	200	
		(see Notes 4 and 5)	SL Package	30†	100	30†	100	

NOTES: 4. These capacitance measurements employ a three terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.
5. Further details on capacitance are given in the Applications Information section.

† Typical value of the parameter, not a limit value.

electrical characteristics for the T and G or the R and G terminals, T_J = 25°C

PARAMETER		TEST CONDITIONS	TISP3072F3		TISP3082F3		UNIT
			MIN	MAX	MIN	MAX	
I_{DRM}	Repetitive peak off-state current	V_D = ±V_{DRM}, 0°C < T_J < 70°C		±10		±10	µA

electrical characteristics for the T and G or the R and G terminals, T_J = 25°C (Continued)

PARAMETER		TEST CONDITIONS		TISP3072F3 MIN	TISP3072F3 MAX	TISP3082F3 MIN	TISP3082F3 MAX	UNIT
$V_{(BO)}$	Breakover voltage	dv/dt = ±250 V/ms, Source Resistance = 300 Ω			±72		±82	V
$V_{(BO)}$	Impulse breakover voltage	dv/dt = ±1000 V/μs, di/dt < 20 A/μs Source Resistance = 50 Ω			±86†		±96†	V
$I_{(BO)}$	Breakover current	dv/dt = ±250 V/ms, Source Resistance = 300 Ω		±0.15	±0.6	±0.15	±0.6	A
V_T	On-state voltage	I_T = ±5 A, t_W = 100 μs			±3		±3	V
I_H	Holding current	di/dt = -/+30 mA/ms		±0.15		±0.15		A
dv/dt	Critical rate of rise of off-state voltage	Linear voltage ramp, Maximum ramp value < 0.85$V_{(BR)MIN}$		±5		±5		kV/μs
I_D	Off-state current	V_D = ±50 V			±10		±10	μA
C_{off}	Off-state capacitance	f = 100 kHz, V_d = 100 mV	V_D = 0,	82†	140	82†	140	pF
		Third terminal voltage = -50 V to +50 V	V_D = -5 V	49†	85	49†	85	pF
		(see Notes 6 and 7)	V_D = -50 V	25†	40	25†	40	pF

NOTES: 6 These capacitance measurements employ a three terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.

7. Further details on capacitance are given in the Applications Information section.

† Typical value of the parameter, not a limit value.

PARAMETER MEASUREMENT INFORMATION

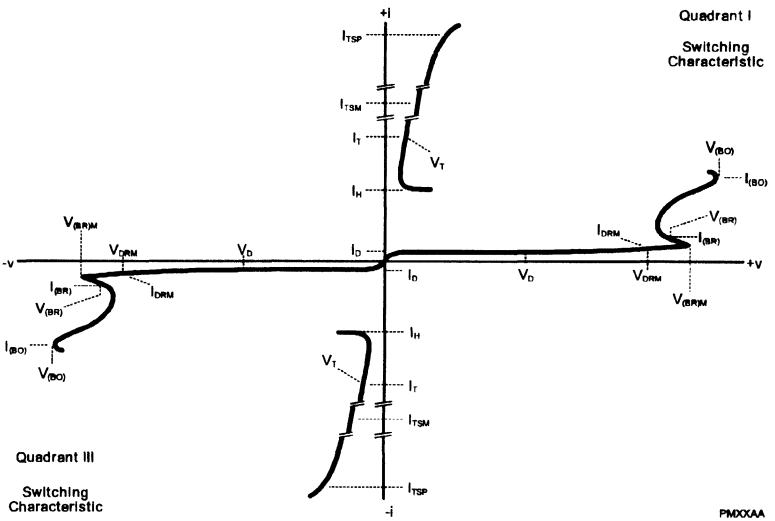


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR ANY PAIR OF TERMINALS

thermal characteristics

PARAMETER			MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance	D Package			160	°C/W
		P Package			100	
		SL Package			105	

TYPICAL CHARACTERISTICS
T and G, or R and G terminals

OFF-STATE CURRENT vs JUNCTION TEMPERATURE

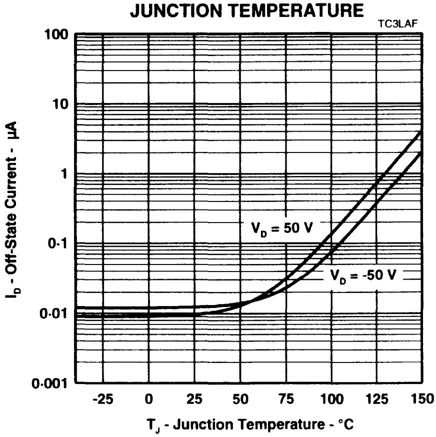


Figure 2.

NORMALISED BREAKDOWN VOLTAGES vs JUNCTION TEMPERATURE

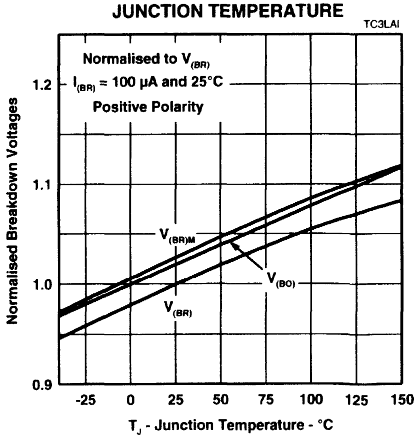


Figure 3.

TYPICAL CHARACTERISTICS
T and G, or R and G terminals

NORMALISED BREAKDOWN VOLTAGES vs JUNCTION TEMPERATURE

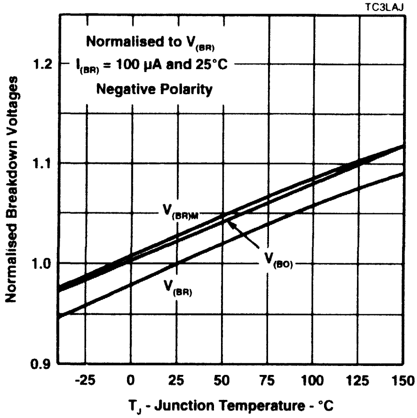


Figure 4.

ON-STATE CURRENT vs ON-STATE VOLTAGE

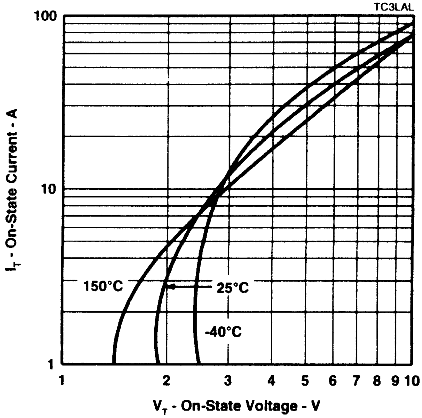


Figure 5.

HOLDING CURRENT & BREAKOVER CURRENT vs JUNCTION TEMPERATURE

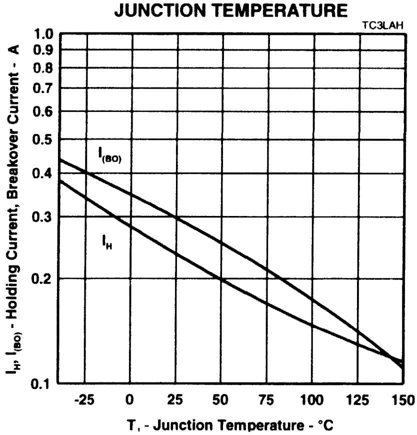


Figure 6.

TEXAS INSTRUMENTS

TYPICAL CHARACTERISTICS
T and G, or R and G terminals

NORMALISED BREAKOVER VOLTAGE
vs
RATE OF RISE OF PRINCIPLE CURRENT

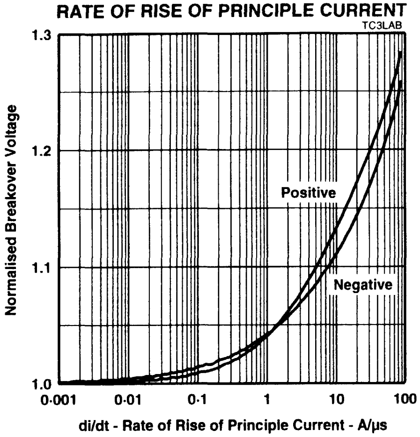


Figure 7.

OFF-STATE CAPACITANCE
vs
TERMINAL VOLTAGE

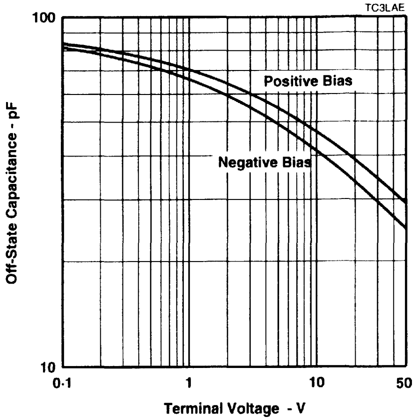


Figure 8.

OFF-STATE CAPACITANCE
vs
JUNCTION TEMPERATURE

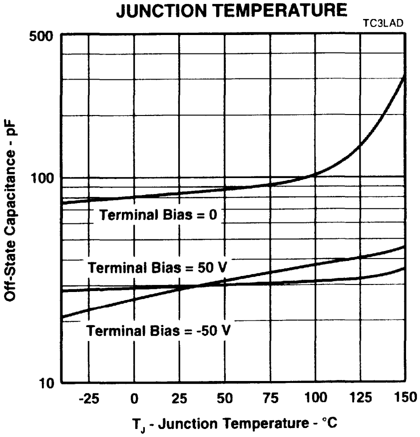


Figure 9.

TYPICAL CHARACTERISTICS
T and G, or R and G terminals

SURGE CURRENT
vs
DECAY TIME

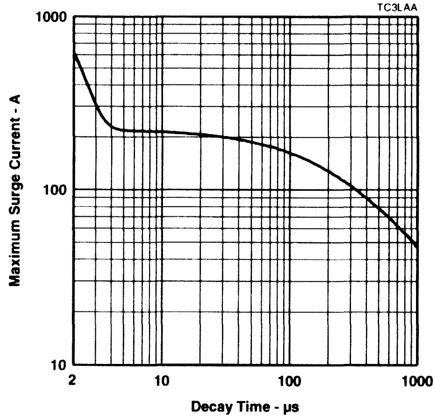


Figure 10.

TYPICAL CHARACTERISTICS
T and R terminals

OFF-STATE CURRENT
vs
JUNCTION TEMPERATURE

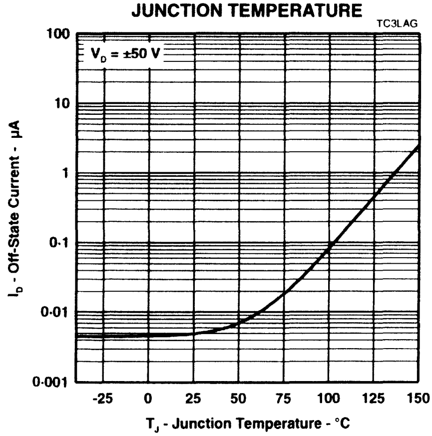


Figure 11.

NORMALISED BREAKDOWN VOLTAGES
vs
JUNCTION TEMPERATURE

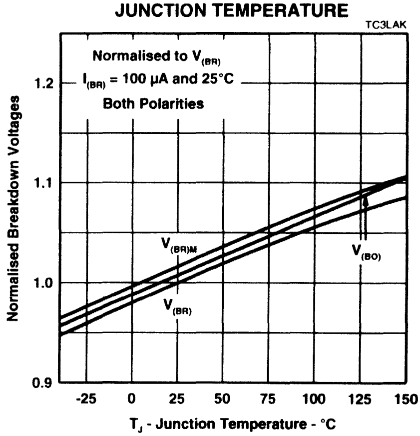


Figure 12.

TYPICAL CHARACTERISTICS
T and R terminals

NORMALISED BREAKOVER VOLTAGE vs RATE OF RISE OF PRINCIPLE CURRENT

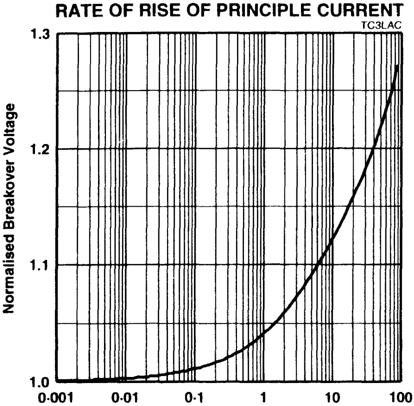


Figure 13.

OFF-STATE CAPACITANCE vs TERMINAL VOLTAGE

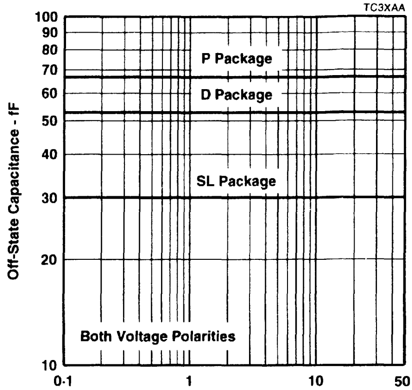


Figure 14.

THERMAL INFORMATION

MAXIMUM NON-RECURRING 50 Hz CURRENT vs CURRENT DURATION

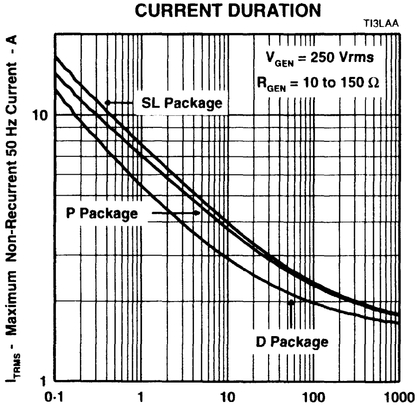


Figure 15.

THERMAL RESPONSE

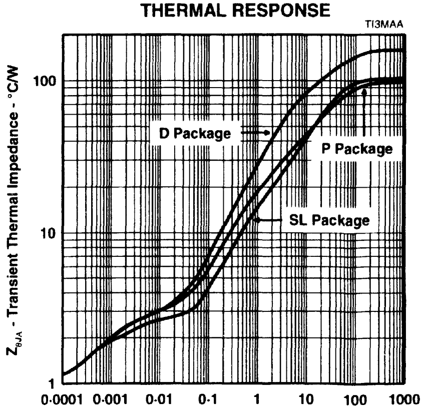


Figure 16.

APPLICATIONS INFORMATION

electrical characteristics

The electrical characteristics of a TISP are strongly dependent on junction temperature, T_J. Hence a characteristic value will depend on the junction temperature at the instant of measurement. The values given in this data sheet were measured on commercial testers, which generally minimise the temperature rise caused by testing. Application values may be calculated from the parameters' temperature curves, the power dissipated and the thermal response curve (Z_θ).

lightning surge

wave shape notation

Most lightning tests, used for equipment verification, specify a unidirectional sawtooth waveform which has an exponential rise and an exponential decay. Wave shapes are classified in terms of peak amplitude (voltage or current), rise time and a decay time to 50% of the maximum amplitude. The notation used for the wave shape is *amplitude, rise time/decay time.* A 50A, 5/310 μs wave shape would have a peak current value of 50 A, a rise time of 5 μs and a decay time of 310 μs. The TISP surge current graph comprehends the wave shapes of commonly used surges.

generators

There are three categories of surge generator type, single wave shape, combination wave shape and circuit defined. Single wave shape generators have essentially the same wave shape for the open circuit voltage and short circuit current (e.g. 10/1000 μs open circuit voltage and short circuit current). Combination generators have two wave shapes, one for the open circuit voltage and the other for the short circuit current (e.g. 1.2/50 μs open circuit voltage and 8/20 μs short circuit current) Circuit specified generators usually equate to a combination generator, although typically only the open circuit voltage waveshape is referenced (e.g. a 10/700 μs open circuit voltage generator typically produces a 5/310 μs short circuit current). If the combination or circuit defined generators operate into a finite resistance the wave shape produced is intermediate between the open circuit and short circuit values.

current rating

When the TISP switches into the on-state it has a very low impedance. As a result, although the surge wave shape may be defined in terms of open circuit voltage, it is the current wave shape that must be used to assess the required TISP surge capability. As an example, the CCITT IX K17 1.5 kV, 10/700 μs surge is changed to a 38 A, 5/310 μs waveshape when driving into a short circuit. Thus the TISP surge current capability, when directly connected to the generator, will be found for the CCITT IX K17 waveform at 310 μs on the surge graph and not 700 μs. Some common short circuit equivalents are tabulated below:

STANDARD	OPEN CIRCUIT VOLTAGE	SHORT CIRCUIT CURRENT
CCITT IX K17	1.5 kV, 10/700 μs	38 A, 5/310 μs
CCITT IX K20	1 kV, 10/700 μs	25 A, 5/310 μs
RLM88	1.5 kV, 0.5/700 μs	38 A, 0.2/310 μs
VDE 0433	2.0 kV, 10/700 μs	50 A, 5/200 μs
FTZ R12	2.0 kV, 10/700 μs	50 A, 5/310 μs

Any series resistance in the protected equipment will reduce the peak circuit current to less than the generators' short circuit value. A 2 kV open circuit voltage, 50 A short circuit current generator has an effective output impedance of 40 Ω (2000/50). If the equipment has a series resistance of 25 Ω then the surge current requirement of the TISP becomes 31 A (2000/65) and not 50 A.

APPLICATIONS INFORMATION

protection voltage

The protection voltage, ($V_{(BO)}$), increases under lightning surge conditions due to thyristor regeneration. This increase is dependent on the rate of current rise, di/dt, when the TISP is clamping the voltage in its breakdown region. The $V_{(BO)}$ value under surge conditions can be estimated by multiplying the 50 Hz rate $V_{(BO)}$ (250 V/ms) value by the normalised increase at the surge's di/dt (Figure 7.) . An estimate of the di/dt can be made from the surge generator voltage rate of rise, dv/dt, and the circuit resistance.

As an example, the CCITT IX K17 1.5 kV, 10/700 μs surge has an average dv/dt of 150 V/μs, but, as the rise is exponential, the initial dv/dt is higher, being in the region of 450 V/μs. The instantaneous generator output resistance is 25 Ω. If the equipment has an additional series resistance of 20 Ω, the total series resistance becomes 45 Ω. The maximum di/dt then can be estimated as 450/45 = 10 A/μs. In practice the measured di/dt and protection voltage increase will be lower due to inductive effects and the finite slope resistance of the TISP breakdown region.

capacitance

off-state capacitance

The off-state capacitance of a TISP is sensitive to junction temperature, T_J, and the bias voltage, comprising of the dc voltage, V_D, and the ac voltage, V_d. All the capacitance values in this data sheet are measured with an ac voltage of 100 mV. The typical 25°C variation of capacitance value with ac bias is shown in Figure 17 When $V_D >> V_d$ the capacitance value is independent on the value of V_d. The capacitance is essentially constant over the range of normal telecommunication frequencies.

NORMALISED CAPACITANCE
vs
RMS AC TEST VOLTAGE

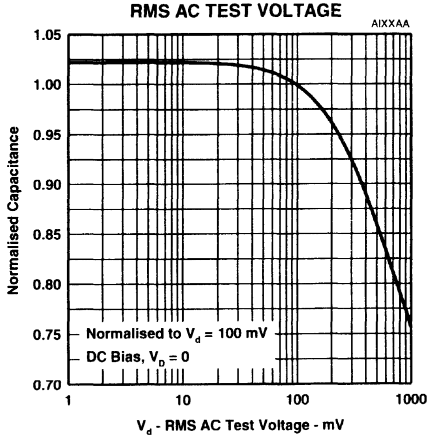


Figure 17.

APPLICATIONS INFORMATION

longitudinal balance

Figure 18 shows a three terminal TISP with its equivalent "delta" capacitance Each capacitance, C_{TG} , C_{RG} and C_{TR} , is the true terminal pair capacitance measured with a three terminal or guarded capacitance bridge. If wire R is biased at a larger potential than wire T then $C_{TG} > C_{RG}$. Capacitance C_{TG} is equivalent to a capacitance of C_{RG} in parallel with the capacitive difference of (C_{TG} - C_{RG}). The line capacitive unbalance is due to (C_{TG} - C_{RG}) and the capacitance shunting the line is C_{TR} + $C_{RG}/2$.

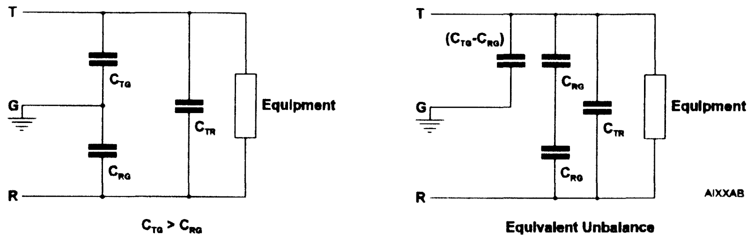


Figure 18.

All capacitance measurements in this data sheet are three terminal guarded to allow the designer to accurately assess capacitive unbalance effects. Simple two terminal capacitance meters (unguarded third terminal) give false readings as the shunt capacitance via the third terminal is included.

TELECOMMUNICATION SYSTEM SECONDARY PROTECTION

- **Ion-Implanted Breakdown Region**
  Precise and Stable Voltage
  Low Voltage Overshoot under Surge

DEVICE	V_{DRM} V	$V_{(BO)}$ V
'3125F3	100	125
'3150F3	120	150
'3180F3	145	180

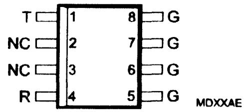
- **Planar Passivated Junctions**
  Low Off-State Current < 10 µA
- **Rated for International Surge Wave Shapes**

WAVE SHAPE	STANDARD	I_{TSP} A
2/10 µs	FCC Part 68	175
8/20 µs	ANSI C62.41	120
10/160 µs	FCC Part 68	60
10/560 µs	FCC Part 68	45
0.5/700 µs	RLM 88	38
10/700 µs	FTZ R12	50
	VDE 0433	50
	CCITT IX K17	38
10/1000 µs	REA PE-60	35

- **Surface Mount and Through-Hole Options**

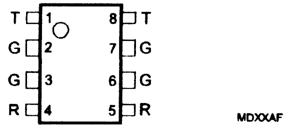
PACKAGE	PART # SUFFIX
Small-outline	D
Small-outline taped and reeled	DR
Plastic DIP	P
Single-in-line	SL

D PACKAGE
(TOP VIEW)



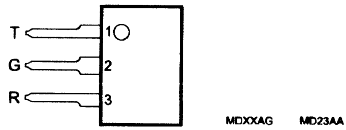
NC - No internal connection

P PACKAGE
(TOP VIEW)

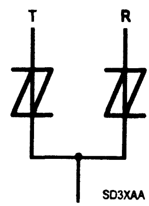


Specified T terminal ratings require connection of pins 1 and 8.
Specified R terminal ratings require connection of pins 4 and 5.

SL PACKAGE
(TOP VIEW)



device symbol



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

description

These medium voltage dual symmetrical transient voltage suppressor devices are designed to protect ISDN and telecommunication applications with ground backed ringing against transients caused by lightning strikes and ac power lines. Offered in three voltage variants to meet battery and protection requirements they are guaranteed to suppress and withstand the listed international lightning surges in both polarities. Transients are initially clipped by breakdown clamping until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the current subsides.

These monolithic protection devices are fabricated in ion-implanted planar structures to ensure precise and matched breakover control and are virtually transparent to the system in normal operation

description (Continued)

The small-outline 8-pin assignment has been carefully chosen for the TISP series to maximise the inter-pin clearance and creepage distances which are used by standards (e.g. IEC950) to establish voltage withstand ratings.

absolute maximum ratings

RATING		SYMBOL	VALUE	UNIT
Repetitive peak off-state voltage (0°C < T_J < 70°C)	'3125F3	V_{DRM}	± 100	V
	'3150F3		± 120	
	'3180F3		± 145	
Non-repetitive peak on-state pulse current (see Notes 1, 2 and 3)		I_{TSP}		A
1/2 µs (Gas tube differential transient, open-circuit voltage wave shape 1/2 µs)			350	
2/10 µs (FCC Part 68, open-circuit voltage wave shape 2/10 µs)			175	
8/20 µs (ANSI C62.41, open-circuit voltage wave shape 1.2/50 µs)			120	
10/160 µs (FCC Part 68, open-circuit voltage wave shape 10/160 µs)			60	
5/200 µs (VDE 0433, open-circuit voltage wave shape 2 kV, 10/700 µs)			50	
0.5/310 µs (RLM 88, open-circuit voltage wave shape 1.5 kV, 0.5/700 µs)			38	
5/310 µs (CCITT IX K17, open-circuit voltage wave shape 1.5 kV, 10/700 µs)			38	
5/310 µs (FTZ R12, open-circuit voltage wave shape 2 kV, 10/700 µs)			50	
10/560 µs (FCC Part 68, open-circuit voltage wave shape 10/560 µs)			45	
10/1000 µs (REA PE-60, open-circuit voltage wave shape 10/1000 µs)			35	
Non-repetitive peak on-state current (see Notes 2 and 3)	D Package	I_{TSM}	4	A rms
50 Hz, 1 s	P Package		6	
	SL Package		6	
Initial rate of rise of on-state current, Linear current ramp, Maximum ramp value < 38 A		di_F/dt	250	A/µs
Junction temperature		T_J	-40 to +150	°C
Storage temperature range		T_{stg}	-40 to +150	°C

NOTES: 1. Further details on surge wave shapes are contained in the Applications Information section.
2. Initially the TISP must be in thermal equilibrium with 0°C < T_J <70°C. The surge may be repeated after the TISP returns to its initial conditions.
3. Above 70°C, derate linearly to zero at 150°C lead temperature.

electrical characteristics for the T and R terminals, T_J = 25°C

PARAMETER		TEST CONDITIONS		TISP3125F3		TISP3150F3		TISP3180F3		UNIT
				MIN	MAX	MIN	MAX	MIN	MAX	
I_{DRM}	Repetitive peak off-state current	$V_D = \pm V_{DRM}$, 0°C < T_J < 70°C			±10		±10		±10	µA
I_D	Off-state current	V_D = ±50 V			±10		±10		±10	µA
C_{off}	Off-state capacitance	f = 100 kHz, V_d = 100 mV	D Package	50†	150	50†	150	50†	150	fF
		V_D = 0, (see Notes 4 and 5)	P Package	65†	200	65†	200	65†	200	
		Third terminal = -50 to +50 V	SL Package	30†	100	30†	100	30†	100	

NOTES: 4. These capacitance measurements employ a three terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.
5. Further details on capacitance are given in the Applications Information section.

† Typical value of the parameter, not a limit value.

electrical characteristics for the T and G or the R and G terminals, T_J = 25°C

PARAMETER		TEST CONDITIONS	TISP3125F3		TISP3150F3		TISP3180F3		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	
I_{DRM}	Repetitive peak off-state current	$V_D = \pm V_{DRM}$, 0°C < T_J < 70°C		±10		±10		±10	µA
$V_{(BO)}$	Breakover voltage	dv/dt = ±250 V/ms, Source Resistance = 300 Ω		±125		±150		±180	V
$V_{(BO)}$	Impulse breakover voltage	dv/dt = ±1000 V/µs, di/dt < 20 A/µs Source Resistance = 50 Ω		±139†		±164†		±194†	V
$I_{(BO)}$	Breakover current	dv/dt = ±250 V/ms, Source Resistance = 300 Ω	±0.15	±0.6	±0.15	±0.6	±0.15	±0.6	A
V_T	On-state voltage	I_T = ±5 A, t_W = 100 µs		±3		±3		±3	V
I_H	Holding current	di/dt = -/+30 mA/ms	±0.15		±0.15		±0.15		A
dv/dt	Critical rate of rise of off-state voltage	Linear voltage ramp, Maximum ramp value < $0.85V_{(BR)MIN}$	±5		±5		±5		kV/µs
I_D	Off-state current	V_D = ±50 V		±10		±10		±10	µA
C_{off}	Off-state capacitance	f = 100 kHz, V_d = 100 mV V_D = 0,	55†	95	55†	95	55†	95	pF
		Third terminal = -50 to +50 V V_D = -5 V	31†	50	31†	50	31†	50	pF
		(see Notes 6 and 7) V_D = -50 V	15†	25	15†	25	15†	25	pF

NOTES: 6 These capacitance measurements employ a three terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.
7. Further details on capacitance are given in the Applications Information section.

† Typical value of the parameter, not a limit value.

thermal characteristics

PARAMETER			MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance	D Package			160	°C/W
		P Package			100	
		SL Package			105	

PARAMETER MEASUREMENT INFORMATION

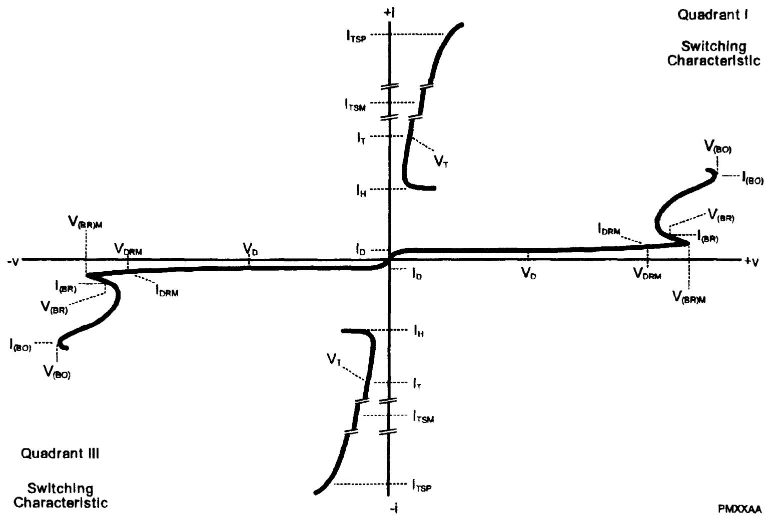


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR ANY PAIR OF TERMINALS

TYPICAL CHARACTERISTICS
T and G, or R and G terminals

OFF-STATE CURRENT vs JUNCTION TEMPERATURE

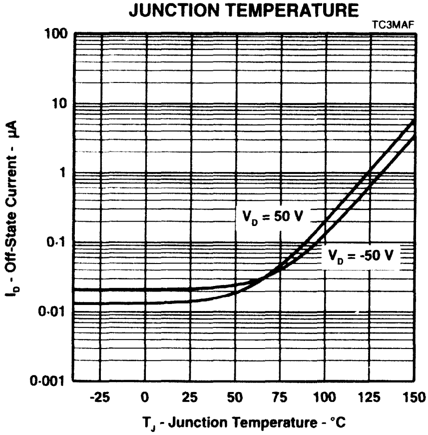


Figure 2.

NORMALISED BREAKDOWN VOLTAGES vs JUNCTION TEMPERATURE

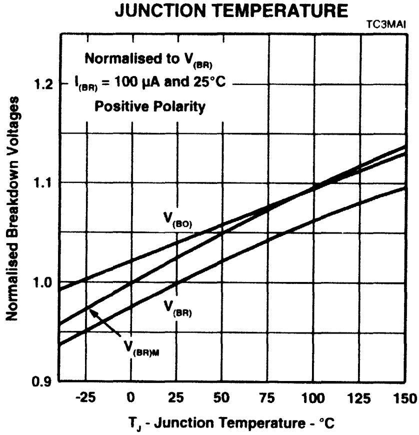


Figure 3.

TYPICAL CHARACTERISTICS
T and G, or R and G terminals

NORMALISED BREAKDOWN VOLTAGES vs JUNCTION TEMPERATURE

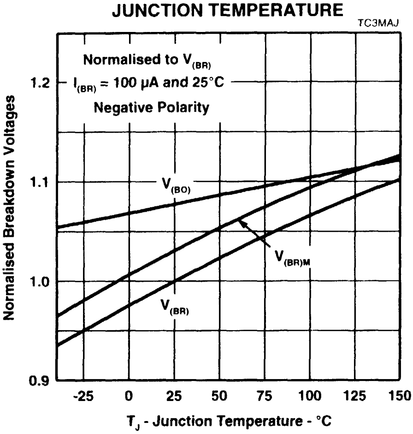


Figure 4.

ON-STATE CURRENT vs ON-STATE VOLTAGE

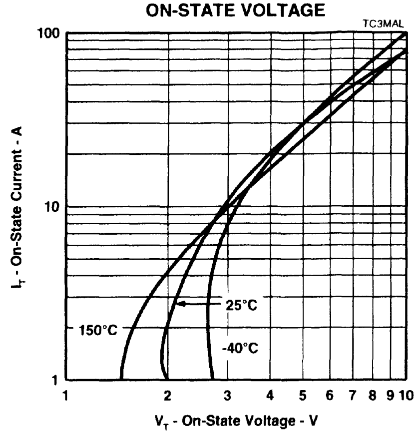


Figure 5.

HOLDING CURRENT & BREAKOVER CURRENT vs JUNCTION TEMPERATURE

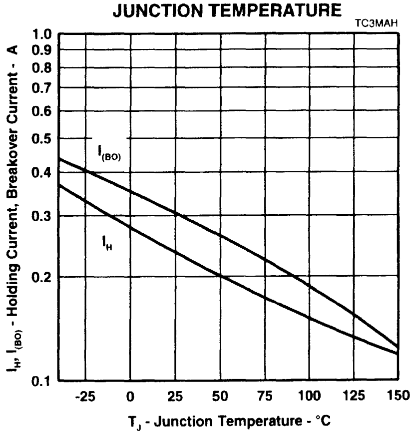


Figure 6.

TYPICAL CHARACTERISTICS
T and G, or R and G terminals

NORMALISED BREAKOVER VOLTAGE vs RATE OF RISE OF PRINCIPLE CURRENT

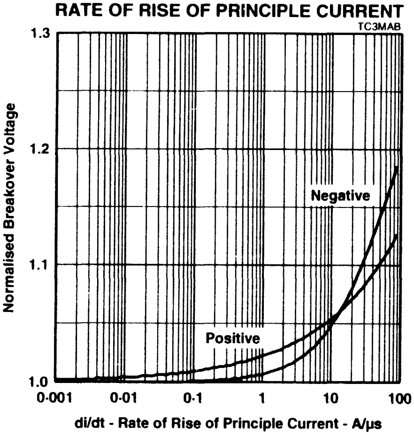


Figure 7.

OFF-STATE CAPACITANCE vs TERMINAL VOLTAGE

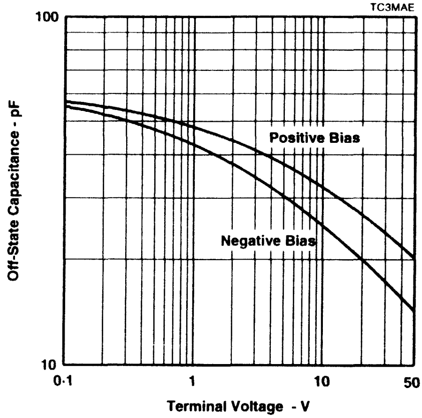


Figure 8.

OFF-STATE CAPACITANCE vs JUNCTION TEMPERATURE

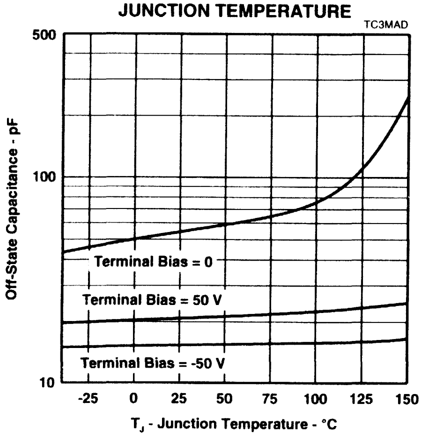


Figure 9.

TYPICAL CHARACTERISTICS
T and G, or R and G terminals

SURGE CURRENT
vs
DECAY TIME

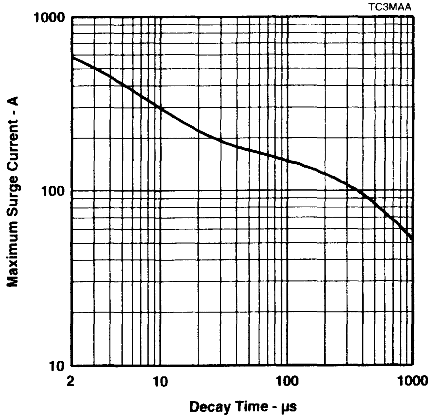


Figure 10.

TYPICAL CHARACTERISTICS
T and R terminals

OFF-STATE CURRENT
vs
JUNCTION TEMPERATURE

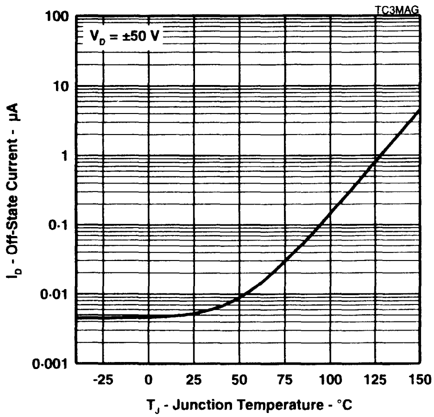


Figure 11.

NORMALISED BREAKDOWN VOLTAGES
vs
JUNCTION TEMPERATURE

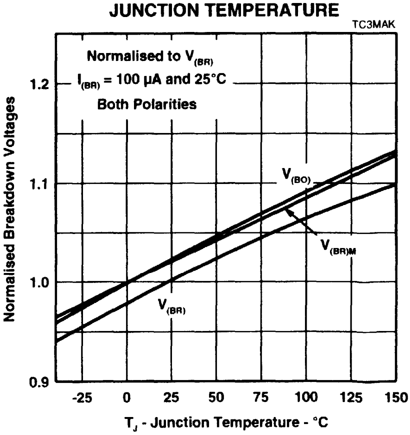


Figure 12.

TYPICAL CHARACTERISTICS
T and R terminals

NORMALISED BREAKOVER VOLTAGE vs RATE OF RISE OF PRINCIPLE CURRENT

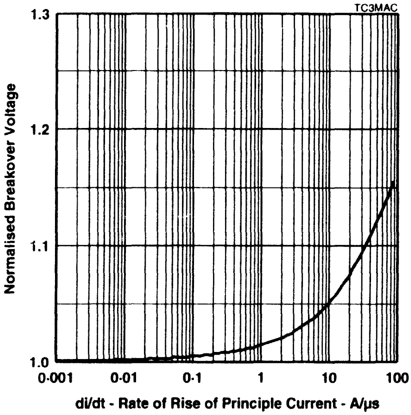


Figure 13.

OFF-STATE CAPACITANCE vs TERMINAL VOLTAGE

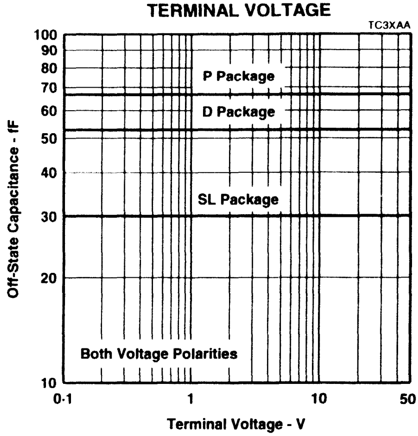


Figure 14.

THERMAL INFORMATION

MAXIMUM NON-RECURRING 50 Hz CURRENT vs CURRENT DURATION

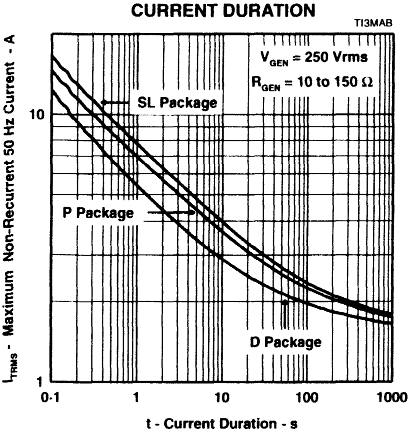


Figure 15.

THERMAL RESPONSE

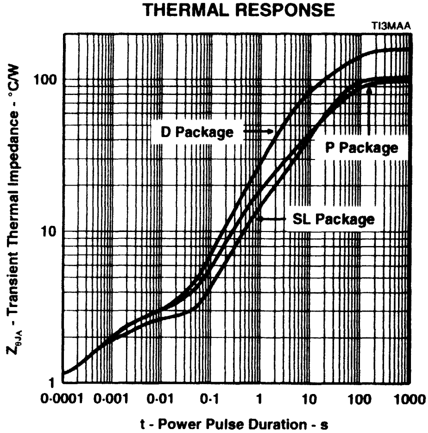


Figure 16.

APPLICATIONS INFORMATION

electrical characteristics

The electrical characteristics of a TISP are strongly dependent on junction temperature, T_J. Hence a characteristic value will depend on the junction temperature at the instant of measurement. The values given in this data sheet were measured on commercial testers, which generally minimise the temperature rise caused by testing. Application values may be calculated from the parameters' temperature curves, the power dissipated and the thermal response curve (Z_θ).

lightning surge

wave shape notation

Most lightning tests, used for equipment verification, specify a unidirectional sawtooth waveform which has an exponential rise and an exponential decay. Wave shapes are classified in terms of peak amplitude (voltage or current), rise time and a decay time to 50% of the maximum amplitude. The notation used for the wave shape is *amplitude, rise time/decay time.* A 50A, 5/310 µs wave shape would have a peak current value of 50 A, a rise time of 5 µs and a decay time of 310 µs. The TISP surge current graph comprehends the wave shapes of commonly used surges.

generators

There are three categories of surge generator type, single wave shape, combination wave shape and circuit defined. Single wave shape generators have essentially the same wave shape for the open circuit voltage and short circuit current (e.g. 10/1000 µs open circuit voltage and short circuit current). Combination generators have two wave shapes, one for the open circuit voltage and the other for the short circuit current (e.g. 1.2/50 µs open circuit voltage and 8/20 µs short circuit current) Circuit specified generators usually equate to a combination generator, although typically only the open circuit voltage waveshape is referenced (e.g. a 10/700 µs open circuit voltage generator typically produces a 5/310 µs short circuit current). If the combination or circuit defined generators operate into a finite resistance the wave shape produced is intermediate between the open circuit and short circuit values.

current rating

When the TISP switches into the on-state it has a very low impedance. As a result, although the surge wave shape may be defined in terms of open circuit voltage, it is the current wave shape that must be used to assess the required TISP surge capability. As an example, the CCITT IX K17 1.5 kV, 10/700 µs surge is changed to a 38 A, 5/310 µs waveshape when driving into a short circuit. Thus the TISP surge current capability, when directly connected to the generator, will be found for the CCITT IX K17 waveform at 310 µs on the surge graph and not 700 µs. Some common short circuit equivalents are tabulated below:

STANDARD	OPEN CIRCUIT VOLTAGE	SHORT CIRCUIT CURRENT
CCITT IX K17	1.5 kV, 10/700 µs	38 A, 5/310 µs
CCITT IX K20	1 kV, 10/700 µs	25 A, 5/310 µs
RLM88	1.5 kV, 0.5/700 µs	38 A, 0.2/310 µs
VDE 0433	2.0 kV, 10/700 µs	50 A, 5/200 µs
FTZ R12	2.0 kV, 10/700 µs	50 A, 5/310 µs

Any series resistance in the protected equipment will reduce the peak circuit current to less than the generators' short circuit value. A 2 kV open circuit voltage, 50 A short circuit current generator has an effective output impedance of 40 Ω (2000/50). If the equipment has a series resistance of 25 Ω then the surge current requirement of the TISP becomes 31 A (2000/65) and not 50 A.

APPLICATIONS INFORMATION

protection voltage

The protection voltage, ($V_{(BO)}$), increases under lightning surge conditions due to thyristor regeneration. This increase is dependent on the rate of current rise, di/dt, when the TISP is clamping the voltage in its breakdown region. The $V_{(BO)}$ value under surge conditions can be estimated by multiplying the 50 Hz rate $V_{(BO)}$ (250 V/ms) value by the normalised increase at the surge's di/dt (Figure 7.) . An estimate of the di/dt can be made from the surge generator voltage rate of rise, dv/dt, and the circuit resistance.

As an example, the CCITT IX K17 1.5 kV, 10/700 µs surge has an average dv/dt of 150 V/µs, but, as the rise is exponential, the initial dv/dt is higher, being in the region of 450 V/µs. The instantaneous generator output resistance is 25 Ω. If the equipment has an additional series resistance of 20 Ω, the total series resistance becomes 45 Ω. The maximum di/dt then can be estimated as 450/45 = 10 A/µs. In practice the measured di/dt and protection voltage increase will be lower due to inductive effects and the finite slope resistance of the TISP breakdown region.

capacitance

off-state capacitance

The off-state capacitance of a TISP is sensitive to junction temperature, T_J, and the bias voltage, comprising of the dc voltage, V_D, and the ac voltage, V_d. All the capacitance values in this data sheet are measured with an ac voltage of 100 mV. The typical 25°C variation of capacitance value with ac bias is shown in Figure 21. When $V_D >> V_d$ the capacitance value is independent on the value of V_d. The capacitance is essentially constant over the range of normal telecommunication frequencies.

NORMALISED CAPACITANCE
vs
RMS AC TEST VOLTAGE

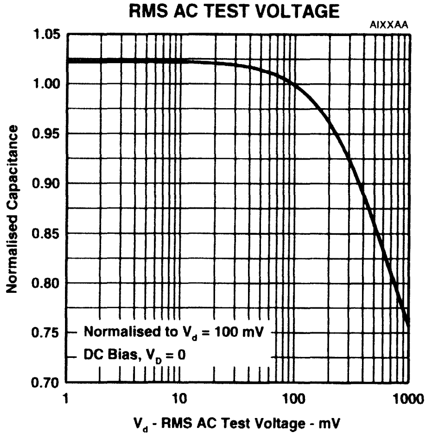


Figure 17.

APPLICATIONS INFORMATION

longitudinal balance

Figure 22 shows a three terminal TISP with its equivalent "delta" capacitance Each capacitance, C_{TG} , C_{RG} and C_{TR} , is the true terminal pair capacitance measured with a three terminal or guarded capacitance bridge. If wire R is biased at a larger potential than wire T then $C_{TG} > C_{RG}$. Capacitance C_{TG} is equivalent to a capacitance of C_{RG} in parallel with the capacitive difference of (C_{TG} - C_{RG}). The line capacitive unbalance is due to (C_{TG} - C_{RG}) and the capacitance shunting the line is $C_{TR} + C_{RG}/2$.

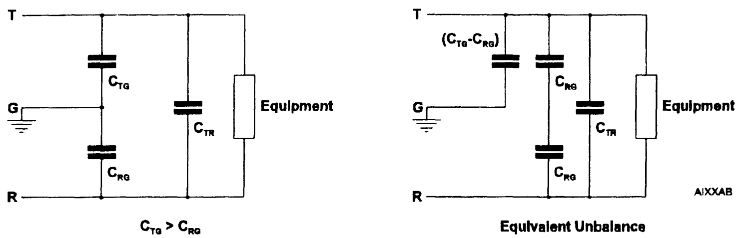


Figure 18.

All capacitance measurements in this data sheet are three terminal guarded to allow the designer to accurately assess capacitive unbalance effects. Simple two terminal capacitance meters (unguarded third terminal) give false readings as the shunt capacitance via the third terminal is included.

TELECOMMUNICATION SYSTEM SECONDARY PROTECTION

- **Ion-Implanted Breakdown Region**
  Precise and Stable Voltage
  Low Voltage Overshoot under Surge

DEVICE	V_{DRM} V	$V_{(BO)}$ V
'3240F3	180	240
'3260F3	200	260
'3290F3	220	290
'3320F3	240	320
'3380F3	270	380

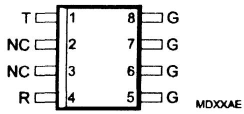
- **Planar Passivated Junctions**
  Low Off-State Current < 10 μA
- **Rated for International Surge Wave Shapes**

WAVE SHAPE	STANDARD	I_{TSP} A
2/10 μs	FCC Part 68	175
8/20 μs	ANSI C62.41	120
10/160 μs	FCC Part 68	60
10/560 μs	FCC Part 68	45
0.5/700 μs	RLM 88	38
10/700 μs	FTZ R12	50
	VDE 0433	50
	CCITT IX K17	38
10/1000 μs	REA PE-60	35

- **Surface Mount and Through-Hole Options**

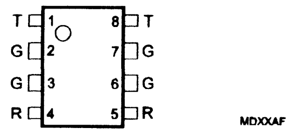
PACKAGE	PART # SUFFIX
Small-outline	D
Small-outline taped and reeled	DR
Plastic DIP	P
Single-in-line	SL

D PACKAGE
(TOP VIEW)



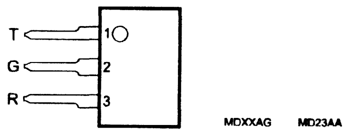
NC - No internal connection

P PACKAGE
(TOP VIEW)

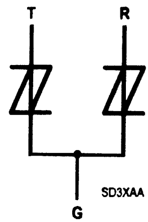


Specified T terminal ratings require connection of pins 1 and 8.
Specified R terminal ratings require connection of pins 4 and 5.

SL PACKAGE
(TOP VIEW)



device symbol



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

description

These high voltage dual symmetrical transient voltage suppressor devices are designed to protect telecommunication applications with ground backed ringing against transients caused by lightning strikes and ac power lines. Offered in five voltage variants to meet battery and protection requirements they are guaranteed to suppress and withstand the listed international lightning surges in both polarities. Transients are initially clipped by breakdown clamping until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the current subsides.

These monolithic protection devices are fabricated in ion-implanted planar structures to

TEXAS INSTRUMENTS

description (Continued)

ensure precise and matched breakover control and are virtually transparent to the system in normal operation

The small-outline 8 pin assignment has been carefully chosen for the TISP series to maximise the inter-pin clearance and creepage distances which are used by standards (e.g. IEC950) to establish voltage withstand ratings.

absolute maximum ratings

RATING		SYMBOL	VALUE	UNIT
Repetitive peak off-state voltage (0°C < T_J < 70°C)	'3240F3	V_{DRM}	± 180	V
	'3260F3		± 200	
	'3290F3		± 220	
	'3320F3		± 240	
	'3380F3		± 270	
Non-repetitive peak on-state pulse current (see Notes 1, 2 and 3)		I_{TSP}		A
1/2 µs (Gas tube differential transient, open-circuit voltage wave shape 1/2 µs)			350	
2/10 µs (FCC Part 68, open-circuit voltage wave shape 2/10 µs)			175	
8/20 µs (ANSI C62.41, open-circuit voltage wave shape 1.2/50 µs)			120	
10/160 µs (FCC Part 68, open-circuit voltage wave shape 10/160 µs)			60	
5/200 µs (VDE 0433, open-circuit voltage wave shape 2 kV, 10/700 µs)			50	
0.5/310 µs (RLM 88, open-circuit voltage wave shape 1.5 kV, 0.5/700 µs)			38	
5/310 µs (CCITT IX K17, open-circuit voltage wave shape 1.5 kV, 10/700 µs)			38	
5/310 µs (FTZ R12, open-circuit voltage wave shape 2 kV, 10/700 µs)			50	
10/560 µs (FCC Part 68, open-circuit voltage wave shape 10/560 µs)			45	
10/1000 µs (REA PE-60, open-circuit voltage wave shape 10/1000 µs)			35	
Non-repetitive peak on-state current (see Notes 2 and 3)	D Package	I_{TSM}	4	A rms
50 Hz, 1 s	P Package		6	
	SL Package		6	
Initial rate of rise of on-state current, Linear current ramp, Maximum ramp value < 38 A		di_F/dt	250	A/µs
Junction temperature		T_J	-40 to +150	°C
Storage temperature range		T_{stg}	-40 to +150	°C

NOTES: 1. Further details on surge wave shapes are contained in the Applications Information section.
2. Initially the TISP must be in thermal equilibrium with 0°C < T_J <70°C. The surge may be repeated after the TISP returns to its initial conditions.
3. Above 70°C, derate linearly to zero at 150°C lead temperature.

electrical characteristics for the T and R terminals, T_J = 25°C

PARAMETER		TEST CONDITIONS		TISP3240F3 MIN	TISP3240F3 MAX	TISP3260F3 MIN	TISP3260F3 MAX	TISP3290F3 MIN	TISP3290F3 MAX	UNIT
I_{DRM}	Repetitive peak off-state current	$V_D = \pm V_{DRM}$, 0°C < T_J < 70°C			±10		±10		±10	µA
I_D	Off-state current	V_D = ±50 V			±10		±10		±10	µA
C_{off}	Off-state capacitance	f = 100 kHz, V_d = 100 mV	D Package	50†	150	50†	150	50†	150	fF
		V_D = 0, (see Notes 4 and 5)	P Package	65†	200	65†	200	65†	200	
		Third terminal = -50 to +50 V	SL Package	30†	100	30†	100	30†	100	

NOTES: 4. These capacitance measurements employ a three terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.
5. Further details on capacitance are given in the Applications Information section.

† Typical value of the parameter, not a limit value.

electrical characteristics for the T and G or the R and G terminals, T_J = 25°C

PARAMETER		TEST CONDITIONS	TISP3240F3		TISP3260F3		TISP3290F3		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	
I_{DRM}	Repetitive peak off-state current	$V_D = \pm V_{DRM}$, 0°C < T_J < 70°C		±10		±10		±10	μA
$V_{(BO)}$	Breakover voltage	dv/dt = ±250 V/ms, Source Resistance = 300 Ω		±240		±260		±290	V
$V_{(BO)}$	Impulse breakover voltage	dv/dt = ±1000 V/μs, di/dt < 20 A/μs Source Resistance = 50 Ω		±267†		±287†		±317†	V
$I_{(BO)}$	Breakover current	dv/dt = ±250 V/ms, Source Resistance = 300 Ω	±0.15	±0.6	±0.15	±0.6	±0.15	±0.6	A
V_T	On-state voltage	I_T = ±5 A, t_W = 100 μs		±3		±3		±3	V
I_H	Holding current	di/dt = -/+30 mA/ms	±0.15		±0.15		±0.15		A
dv/dt	Critical rate of rise of off-state voltage	Linear voltage ramp, Maximum ramp value < $0.85V_{(BR)MIN}$	±5		±5		±5		kV/μs
I_D	Off-state current	V_D = ±50 V		±10		±10		±10	μA
C_{off}	Off-state capacitance	f = 100 kHz, V_d = 100 mV V_D = 0,	57†	95	57†	95	57†	95	pF
		Third terminal = -50 to +50 V V_D = -5 V	26†	45	26†	45	26†	45	pF
		(see Notes 6 and 7) V_D = -50 V	11†	20	11†	20	11†	20	pF

NOTES: 6 These capacitance measurements employ a three terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.
7. Further details on capacitance are given in the Applications Information section

† Typical value of the parameter, not a limit value.

electrical characteristics for the T and R terminals, T_J = 25°C

PARAMETER		TEST CONDITIONS		TISP3320F3		TISP3380F3		UNIT
				MIN	MAX	MIN	MAX	
I_{DRM}	Repetitive peak off-state current	$V_D = \pm V_{DRM}$, 0°C < T_J < 70°C			±10		±10	μA
I_D	Off-state current	V_D = ±50 V			±10		±10	μA
C_{off}	Off-state capacitance	f = 100 kHz, V_d = 100 mV	D Package	50†	150	50†	150	fF
		V_D = 0, (see Notes 4 and 5)	P Package	65†	200	65†	200	
		Third terminal = -50 to +50 V	SL Package	30†	100	30†	100	

NOTES: 4. These capacitance measurements employ a three terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.
5. Further details on capacitance are given in the Applications Information section.

electrical characteristics for the T and G or the R and G terminals, T_J = 25°C

PARAMETER		TEST CONDITIONS	TISP3320F3		TISP3380F3		UNIT
			MIN	MAX	MIN	MAX	
I_{DRM}	Repetitive peak off-state current	$V_D = \pm V_{DRM}$, 0°C < T_J < 70°C		±10		±10	μA
$V_{(BO)}$	Breakover voltage	dv/dt = ±250 V/ms, Source Resistance = 300 Ω		±320		±380	V
$V_{(BO)}$	Impulse breakover voltage	dv/dt = ±1000 V/μs, di/dt < 20 A/μs Source Resistance = 50 Ω		±347†		±407†	V

electrical characteristics for the T and G or the R and G terminals, T_J = 25°C (Continued)

PARAMETER		TEST CONDITIONS		TISP3320F3		TISP3380F3		UNIT
				MIN	MAX	MIN	MAX	
$I_{(BO)}$	Breakover current	dv/dt = ±250 V/ms, Source Resistance = 300 Ω		±0.15	±0.6	±0.15	±0.6	A
V_T	On-state voltage	I_T = ±5 A, t_W = 100 µs			±3		±3	V
I_H	Holding current	di/dt = -/+30 mA/ms		±0.15		±0.15		A
dv/dt	Critical rate of rise of off-state voltage	Linear voltage ramp, Maximum ramp value < 0.85$V_{(BR)MIN}$		±5		±5		kV/µs
I_D	Off-state current	V_D = ±50 V			±10		±10	µA
C_{off}	Off-state capacitance	f = 100 kHz, V_d = 100 mV	V_D = 0,	57†	95	57†	95	pF
		Third voltage = -50 to +50 V	V_D = -5 V	26†	45	26†	45	pF
		(see Notes 6 and 7)	V_D = -50 V	11†	20	11†	20	pF

NOTES: 6 These capacitance measurements employ a three terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.
7. Further details on capacitance are given in the Applications Information section.

† Typical value of the parameter, not a limit value.

PARAMETER MEASUREMENT INFORMATION

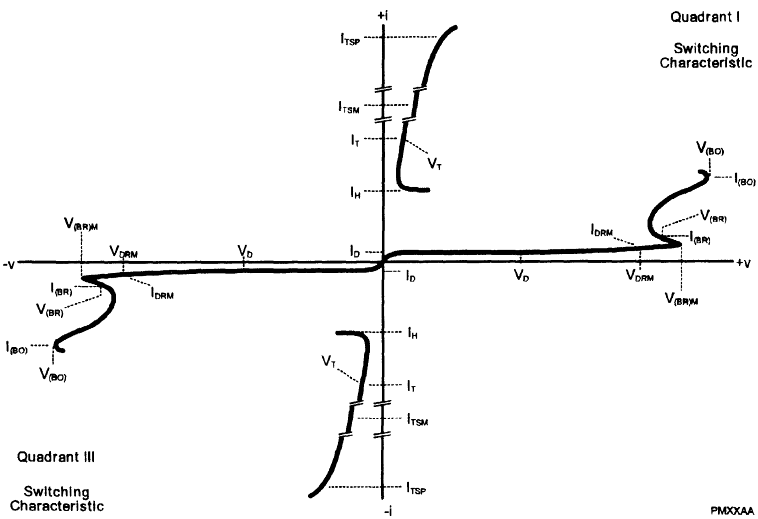


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR ANY PAIR OF TERMINALS

thermal characteristics

PARAMETER			MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance	D Package			160	°C/W
		P Package			100	
		SL Package			105	

TYPICAL CHARACTERISTICS
T and G, or R and G terminals

OFF-STATE CURRENT
vs
JUNCTION TEMPERATURE

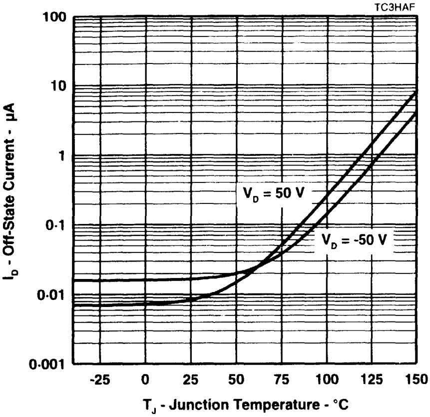


Figure 2.

NORMALISED BREAKDOWN VOLTAGES
vs
JUNCTION TEMPERATURE

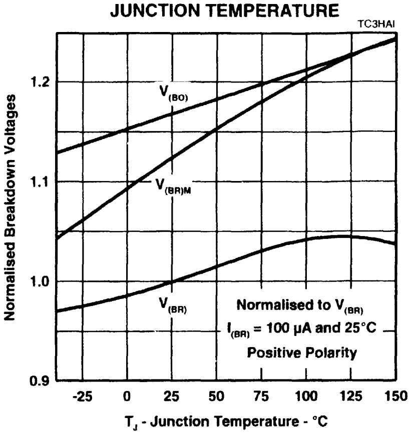


Figure 3.

NORMALISED BREAKDOWN VOLTAGES
vs
JUNCTION TEMPERATURE

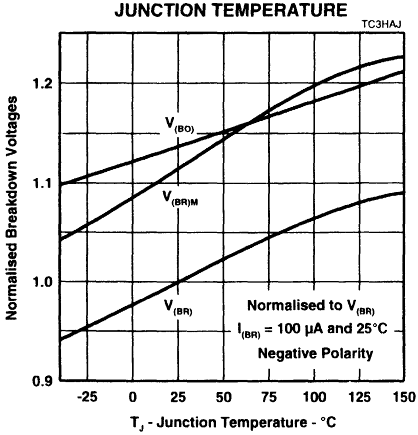


Figure 4.

ON-STATE CURRENT
vs
ON-STATE VOLTAGE

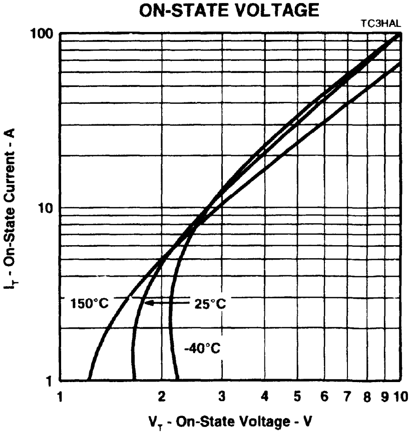


Figure 5.

TYPICAL CHARACTERISTICS
T and G, or R and G terminals

HOLDING CURRENT & BREAKOVER CURRENT vs JUNCTION TEMPERATURE

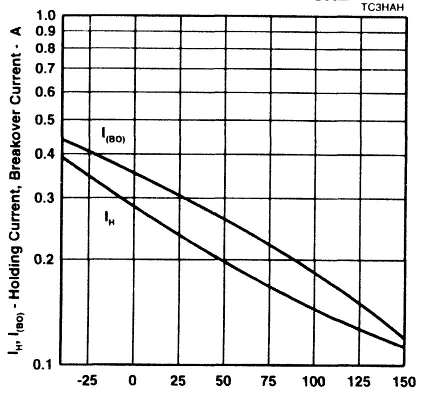


Figure 6.

NORMALISED BREAKOVER VOLTAGE vs RATE OF RISE OF PRINCIPLE CURRENT

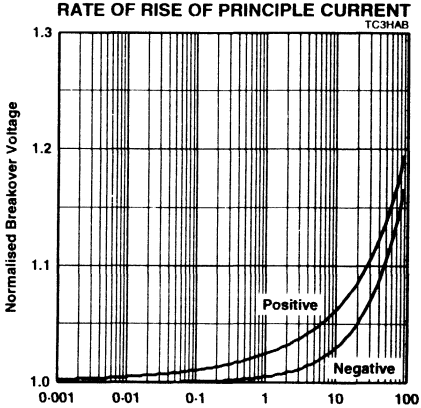


Figure 7.

OFF-STATE CAPACITANCE vs TERMINAL VOLTAGE

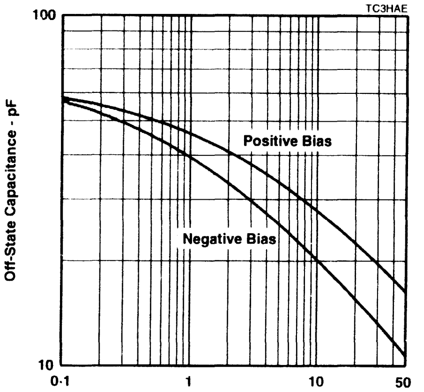


Figure 8.

OFF-STATE CAPACITANCE vs JUNCTION TEMPERATURE

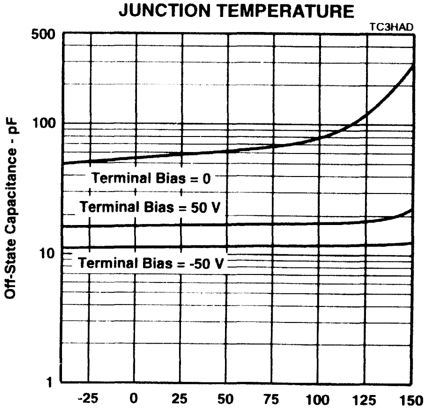


Figure 9.

TYPICAL CHARACTERISTICS
T and G, or R and G terminals

SURGE CURRENT vs DECAY TIME

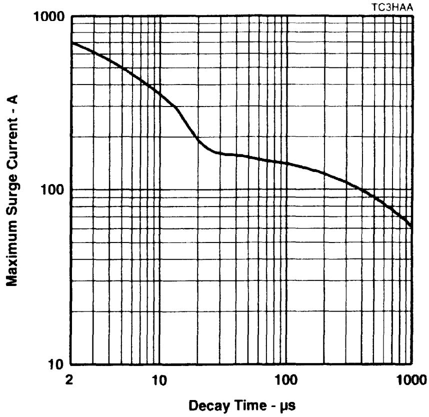


Figure 10.

TYPICAL CHARACTERISTICS
T and R terminals

OFF-STATE CURRENT vs JUNCTION TEMPERATURE

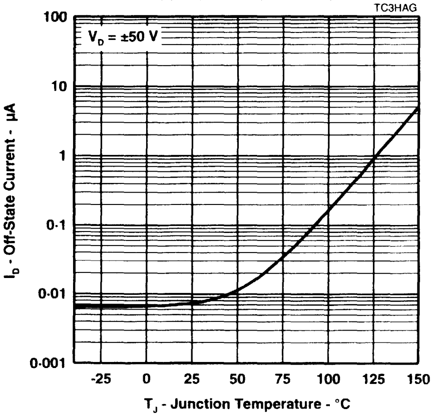


Figure 11.

NORMALISED BREAKDOWN VOLTAGES vs JUNCTION TEMPERATURE

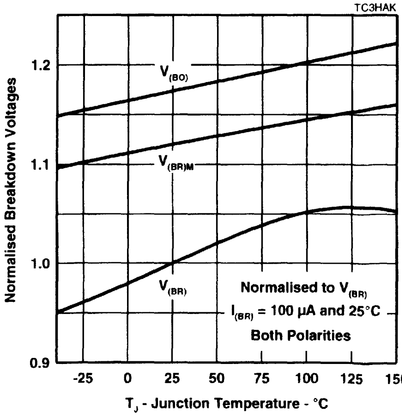


Figure 12.

TYPICAL CHARACTERISTICS
T and R terminals

NORMALISED BREAKOVER VOLTAGE vs RATE OF RISE OF PRINCIPLE CURRENT

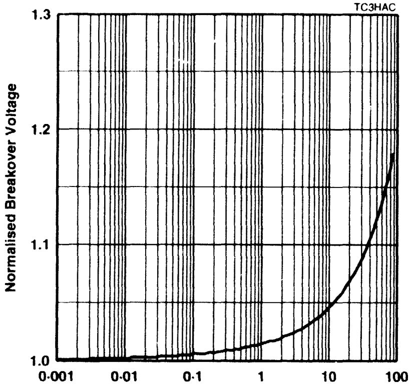


Figure 13.

OFF-STATE CAPACITANCE vs TERMINAL VOLTAGE

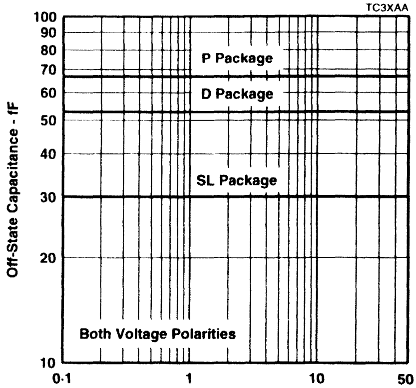


Figure 14.

THERMAL INFORMATION

MAXIMUM NON-RECURRING 50 Hz CURRENT vs CURRENT DURATION

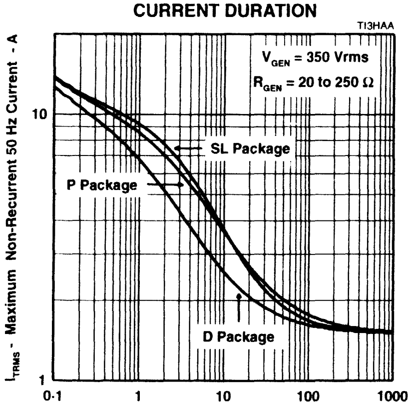


Figure 15.

THERMAL RESPONSE

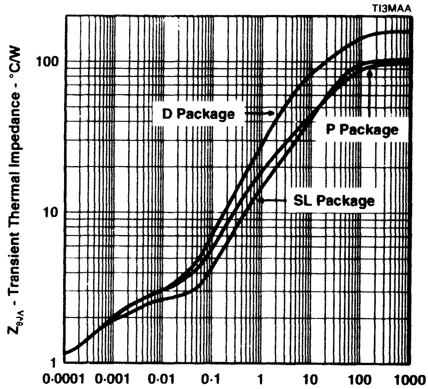


Figure 16.

APPLICATIONS INFORMATION

electrical characteristics

The electrical characteristics of a TISP are strongly dependent on junction temperature, T_J. Hence a characteristic value will depend on the junction temperature at the instant of measurement. The values given in this data sheet were measured on commercial testers, which generally minimise the temperature rise caused by testing. Application values may be calculated from the parameters' temperature curves, the power dissipated and the thermal response curve (Z_θ).

lightning surge

wave shape notation

Most lightning tests, used for equipment verification, specify a unidirectional sawtooth waveform which has an exponential rise and an exponential decay. Wave shapes are classified in terms of peak amplitude (voltage or current), rise time and a decay time to 50% of the maximum amplitude. The notation used for the wave shape is *amplitude, rise time/decay time*. A 50A, 5/310 µs wave shape would have a peak current value of 50 A, a rise time of 5 µs and a decay time of 310 µs. The TISP surge current graph comprehends the wave shapes of commonly used surges.

generators

There are three categories of surge generator type, single wave shape, combination wave shape and circuit defined. Single wave shape generators have essentially the same wave shape for the open circuit voltage and short circuit current (e.g. 10/1000 µs open circuit voltage and short circuit current). Combination generators have two wave shapes, one for the open circuit voltage and the other for the short circuit current (e.g. 1.2/50 µs open circuit voltage and 8/20 µs short circuit current) Circuit specified generators usually equate to a combination generator, although typically only the open circuit voltage waveshape is referenced (e.g. a 10/700 µs open circuit voltage generator typically produces a 5/310 µs short circuit current). If the combination or circuit defined generators operate into a finite resistance the wave shape produced is intermediate between the open circuit and short circuit values.

current rating

When the TISP switches into the on-state it has a very low impedance. As a result, although the surge wave shape may be defined in terms of open circuit voltage, it is the current wave shape that must be used to assess the required TISP surge capability. As an example, the CCITT IX K17 1.5 kV, 10/700 µs surge is changed to a 38 A, 5/310 µs waveshape when driving into a short circuit. Thus the TISP surge current capability, when directly connected to the generator, will be found for the CCITT IX K17 waveform at 310 µs on the surge graph and not 700 µs. Some common short circuit equivalents are tabulated below:

STANDARD	OPEN CIRCUIT VOLTAGE	SHORT CIRCUIT CURRENT
CCITT IX K17	1.5 kV, 10/700 µs	38 A, 5/310 µs
CCITT IX K20	1 kV, 10/700 µs	25 A, 5/310 µs
RLM88	1.5 kV, 0.5/700 µs	38 A, 0.2/310 µs
VDE 0433	2.0 kV, 10/700 µs	50 A, 5/200 µs
FTZ R12	2.0 kV, 10/700 µs	50 A, 5/310 µs

Any series resistance in the protected equipment will reduce the peak circuit current to less than the generators' short circuit value. A 2 kV open circuit voltage, 50 A short circuit current generator has an effective output impedance of 40 Ω (2000/50). If the equipment has a series resistance of 25 Ω then the surge current requirement of the TISP becomes 31 A (2000/65) and not 50 A.

APPLICATIONS INFORMATION

protection voltage

The protection voltage, ($V_{(BO)}$), increases under lightning surge conditions due to thyristor regeneration. This increase is dependent on the rate of current rise, di/dt, when the TISP is clamping the voltage in its breakdown region. The $V_{(BO)}$ value under surge conditions can be estimated by multiplying the 50 Hz rate $V_{(BO)}$ (250 V/ms) value by the normalised increase at the surge's di/dt (Figure 7.) . An estimate of the di/dt can be made from the surge generator voltage rate of rise, dv/dt, and the circuit resistance.

As an example, the CCITT IX K17 1.5 kV, 10/700 µs surge has an average dv/dt of 150 V/µs, but, as the rise is exponential, the initial dv/dt is higher, being in the region of 450 V/µs. The instantaneous generator output resistance is 25 Ω. If the equipment has an additional series resistance of 20 Ω, the total series resistance becomes 45 Ω. The maximum di/dt then can be estimated as 450/45 = 10 A/µs. In practice the measured di/dt and protection voltage increase will be lower due to inductive effects and the finite slope resistance of the TISP breakdown region.

capacitance

off-state capacitance

The off-state capacitance of a TISP is sensitive to junction temperature, T_J, and the bias voltage, comprising of the dc voltage, V_D, and the ac voltage, V_d. All the capacitance values in this data sheet are measured with an ac voltage of 100 mV. The typical 25°C variation of capacitance value with ac bias is shown in Figure17. When $V_D >> V_d$ the capacitance value is independent on the value of V_d. The capacitance is essentially constant over the range of normal telecommunication frequencies.

NORMALISED CAPACITANCE
vs
RMS AC TEST VOLTAGE

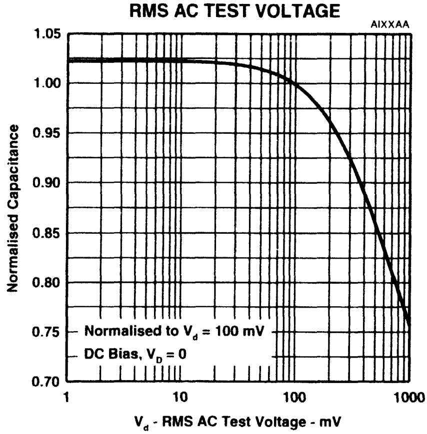


Figure 17.

APPLICATIONS INFORMATION

longitudinal balance

Figure 18 shows a three terminal TISP with its equivalent "delta" capacitance Each capacitance, C_{TG} , C_{RG} and C_{TR} , is the true terminal pair capacitance measured with a three terminal or guarded capacitance bridge. If wire R is biased at a larger potential than wire T then $C_{TG} > C_{RG}$. Capacitance C_{TG} is equivalent to a capacitance of C_{RG} in parallel with the capacitive difference of (C_{TG} - C_{RG}). The line capacitive unbalance is due to (C_{TG} - C_{RG}) and the capacitance shunting the line is C_{TR} + C_{RG}/2 .

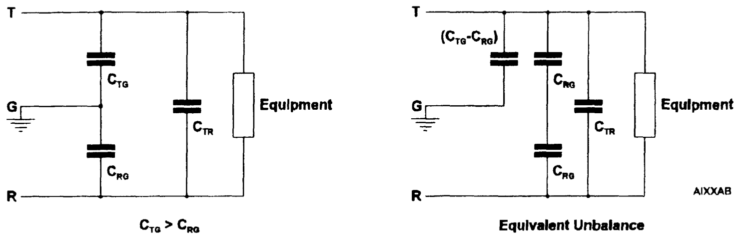


Figure 18.

All capacitance measurements in this data sheet are three terminal guarded to allow the designer to accurately assess capacitive unbalance effects. Simple two terminal capacitance meters (unguarded third terminal) give false readings as the shunt capacitance via the third terminal is included.

TELECOMMUNICATION SYSTEM SECONDARY PROTECTION

- **Ion-Implanted Breakdown Region**
  Precise and Stable Voltage
  Low Voltage Overshoot under Surge

DEVICE	V_{DRM} V	$V_{(BO)}$ V
'4072F3	58	72
'4082F3	66	82

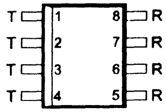
- **Planar Passivated Junctions**
  Low Off-State Current < 10 µA
- **Rated for International Surge Wave Shapes**

WAVE SHAPE	STANDARD	I_{TSP} A
2/10 µs	FCC Part 68	80
8/20 µs	ANSI C62.41	70
10/160 µs	FCC Part 68	60
10/560 µs	FCC Part 68	45
0.5/700 µs	RLM 88	38
10/700 µs	FTZ R12	50
	VDE 0433	50
	CCITT IX K17	38
10/1000 µs	REA PE-60	35

- **Surface Mount and Through-Hole Options**

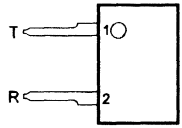
PACKAGE	PART # SUFFIX
Small-outline	D
Small-outline taped and reeled	DR
Single-in-line	SL

D PACKAGE
(TOP VIEW)



Specified ratings require the connection of pins 1, 2, 3 and 4 for the T terminal.

SL PACKAGE
(TOP VIEW)



MD4XAA

device symbol

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

description

These low voltage symmetrical transient voltage suppressor devices are designed to protect two wire telecommunication applications against transients caused by lightning strikes and ac power lines. Offered in two voltage variants to meet battery and protection requirements they are guaranteed to suppress and withstand the listed international lightning surges in both polarities.

Transients are initially clipped by breakdown clamping until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the current subsides.

These monolithic protection devices are fabricated in ion-implanted planar structures to ensure precise and matched breakover control and are virtually transparent to the system in normal operation

The small-outline 8-pin assignment has been carefully chosen for the TISP series to maximise the inter-pin clearance and creepage distances which are used by standards (e.g. IEC950) to establish voltage withstand ratings.

absolute maximum ratings

RATING		SYMBOL	VALUE	UNIT
Repetitive peak off-state voltage (0°C < T_J < 70°C)	'4072F3	V_{DRM}	± 58	V
	'4082F3		± 66	
Non-repetitive peak on-state pulse current (see Notes 1, 2 and 3)		I_{TSP}		A
1/2 µs (Gas tube differential transient, open-circuit voltage wave shape 1/2 µs)			120	
2/10 µs (FCC Part 68, open-circuit voltage wave shape 2/10 µs)			80	
8/20 µs (ANSI C62.41, open-circuit voltage wave shape 1.2/50 µs)			70	
10/160 µs (FCC Part 68, open-circuit voltage wave shape 10/160 µs)			60	
5/200 µs (VDE 0433, open-circuit voltage wave shape 2 kV, 10/700 µs)			50	
0.2/310 µs (RLM 88, open-circuit voltage wave shape 1.5 kV, 0.5/700 µs)			38	
5/310 µs (CCITT IX K17, open-circuit voltage wave shape 1.5 kV, 10/700 µs)			38	
5/310 µs (FTZ R12, open-circuit voltage wave shape 2 kV, 10/700 µs)			50	
10/560 µs (FCC Part 68, open-circuit voltage wave shape 10/560 µs)			45	
10/1000 µs (REA PE-60, open-circuit voltage wave shape 10/1000 µs)			35	
Non-repetitive peak on-state current (see Notes 2 and 3) 50 Hz, 1 s	D Package	I_{TSM}	4	A rms
	SL Package		6	
Initial rate of rise of on-state current, Linear current ramp, Maximum ramp value < 38 A		di_T/dt	250	A/µs
Junction temperature		T_J	-40 to +150	°C
Storage temperature range		T_{stg}	-40 to +150	°C

NOTES: 1. Further details on surge wave shapes are contained in the Applications Information section.
2. Initially the TISP must be in thermal equilibrium with 0°C < T_J <70°C. The surge may be repeated after the TISP returns to its initial conditions.
3. Above 70°C, derate linearly to zero at 150°C lead temperature.

electrical characteristics for the T and R terminals, T_J = 25°C

PARAMETER		TEST CONDITIONS		TISP4072F3			TISP4082F3			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
I_{DRM}	Repetitive peak off-state current	$V_D = \pm V_{DRM}$, 0°C < T_J < 70°C				±10			±10	µA
$V_{(BO)}$	Breakover voltage	dv/dt = ±250 V/ms, R_{SOURCE} = 300 Ω				±72			±82	V
$V_{(BO)}$	Impulse breakover voltage	dv/dt = ±1000 V/µs, R_{SOURCE} = 50 Ω, di/dt < 20 A/µs			±86			±96		V
$I_{(BO)}$	Breakover current	dv/dt = ±250 V/ms, R_{SOURCE} = 300 Ω		±0.15		±0.6	±0.15		±0.6	A
V_T	On-state voltage	I_T = ±5 A, t_W = 100 µs				±3			±3	V
I_H	Holding current	di/dt = +/-30 mA/ms		±0.15			±0.15			
dv/dt	Critical rate of rise of off-state voltage	Linear voltage ramp Maximum ramp value < $0.85V_{(BR)MIN}$		±5			±5			kV/µs
I_D	Off-state current	V_D = ±50 V				±10			±10	µA
C_{off}	Off-state capacitance	f = 100 kHz, V_d = 100 mV (see Note 4)	V_D = 0,		82	140		82	140	pF
			V_D = -5 V		49	85		49	85	pF
			V_D = -50 V		25	40		25	40	pF

NOTE 4: Further details on capacitance are given in the Applications Information section.

thermal characteristics

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance	P_{tot} = 0.8 W, T_A = 25°C 5 cm², FR4 PCB	D Package			160	°C/W
			SL Package			105	

PARAMETER MEASUREMENT INFORMATION

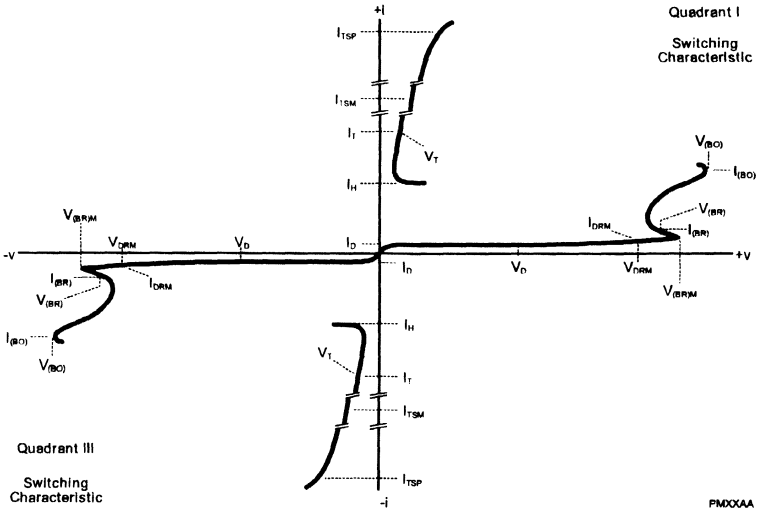


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR T AND R TERMINALS
ALL MEASUREMENTS ARE REFERENCED TO THE R TERMINAL

TYPICAL CHARACTERISTICS
R and T terminals

OFF-STATE CURRENT vs JUNCTION TEMPERATURE

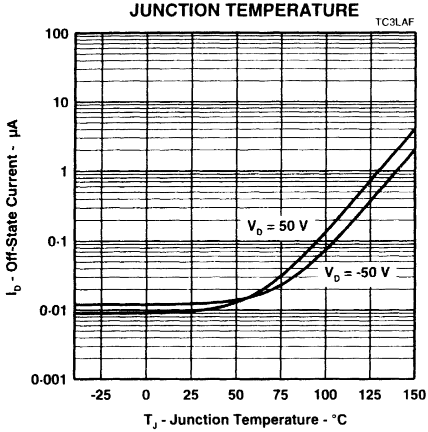


Figure 2.

NORMALISED BREAKDOWN VOLTAGES vs JUNCTION TEMPERATURE

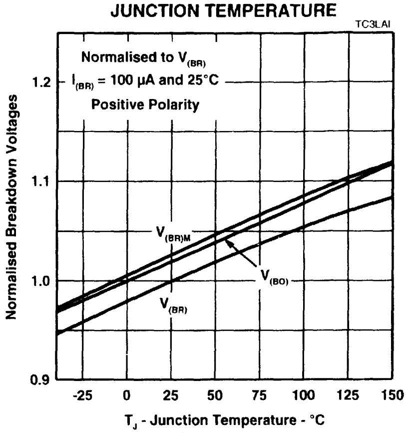


Figure 3.

NORMALISED BREAKDOWN VOLTAGES vs JUNCTION TEMPERATURE

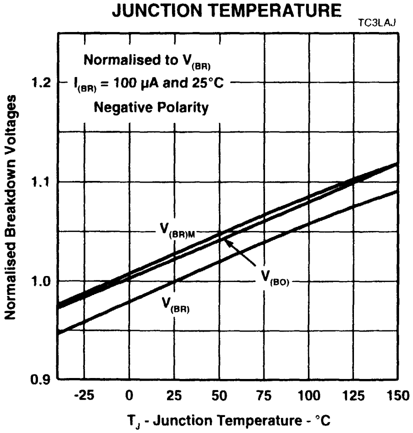


Figure 4.

ON-STATE CURRENT vs ON-STATE VOLTAGE

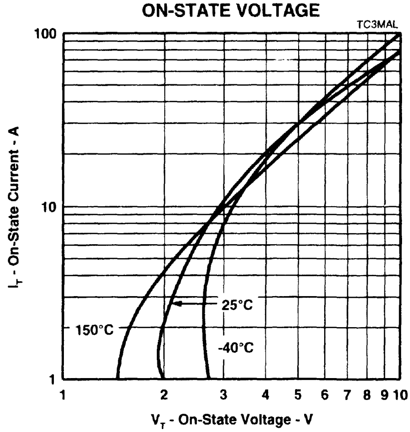


Figure 5.

TYPICAL CHARACTERISTICS
R and T terminals

HOLDING CURRENT & BREAKOVER CURRENT vs JUNCTION TEMPERATURE

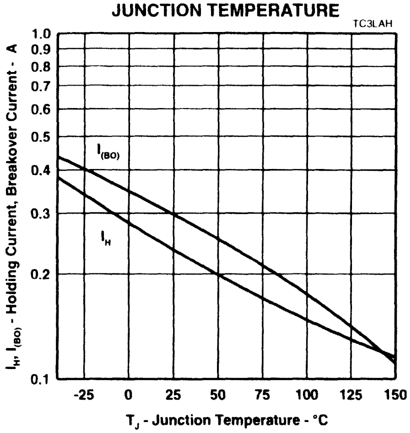


Figure 6.

NORMALISED BREAKOVER VOLTAGE vs RATE OF RISE OF PRINCIPLE CURRENT

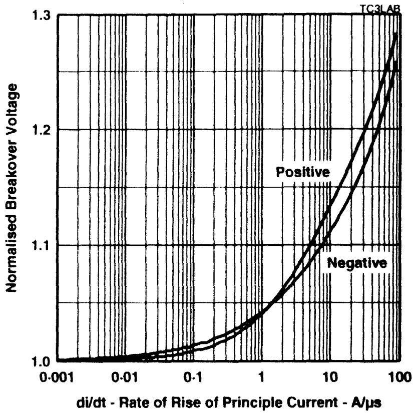


Figure 7.

OFF-STATE CAPACITANCE vs TERMINAL VOLTAGE

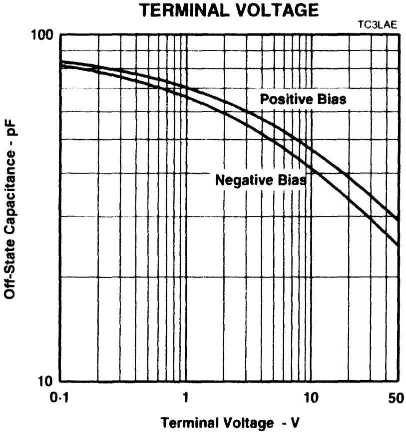


Figure 8.

OFF-STATE CAPACITANCE vs JUNCTION TEMPERATURE

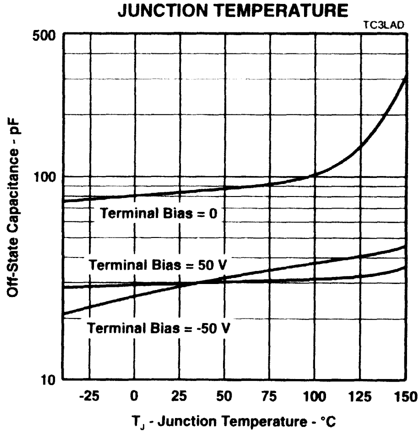


Figure 9.

TYPICAL CHARACTERISTICS
R and T terminals

SURGE CURRENT
vs
DECAY TIME

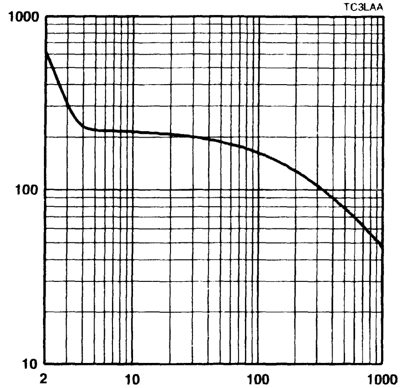


Figure 10.

THERMAL INFORMATION

MAXIMUM NON-RECURRING 50 Hz CURRENT
vs
CURRENT DURATION

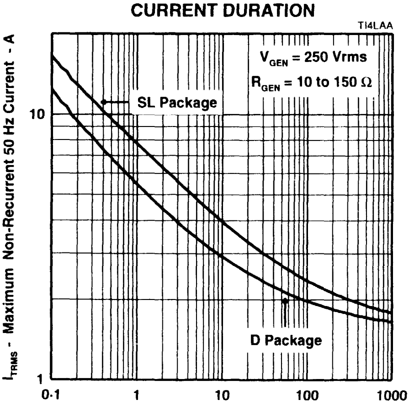


Figure 11.

THERMAL RESPONSE

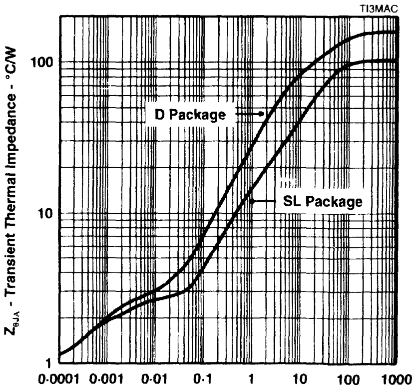


Figure 12.

TEXAS INSTRUMENTS

APPLICATIONS INFORMATION

electrical characteristics

The electrical characteristics of a TISP are strongly dependent on junction temperature, T_J. Hence a characteristic value will depend on the junction temperature at the instant of measurement. The values given in this data sheet were measured on commercial testers, which generally minimise the temperature rise caused by testing. Application values may be calculated from the parameters' temperature curves, the power dissipated and the thermal response curve (Z_θ).

lightning surge

wave shape notation

Most lightning tests, used for equipment verification, specify a unidirectional sawtooth waveform which has an exponential rise and an exponential decay. Wave shapes are classified in terms of peak amplitude (voltage or current), rise time and a decay time to 50% of the maximum amplitude. The notation used for the wave shape is *amplitude, rise time/decay time.* A 50A, 5/310 µs wave shape would have a peak current value of 50 A, a rise time of 5 µs and a decay time of 310 µs. The TISP surge current graph comprehends the wave shapes of commonly used surges.

generators

There are three categories of surge generator type, single wave shape, combination wave shape and circuit defined. Single wave shape generators have essentially the same wave shape for the open circuit voltage and short circuit current (e.g. 10/1000 µs open circuit voltage and short circuit current). Combination generators have two wave shapes, one for the open circuit voltage and the other for the short circuit current (e.g. 1.2/50 µs open circuit voltage and 8/20 µs short circuit current) Circuit specified generators usually equate to a combination generator, although typically only the open circuit voltage waveshape is referenced (e.g. a 10/700 µs open circuit voltage generator typically produces a 5/310 µs short circuit current). If the combination or circuit defined generators operate into a finite resistance the wave shape produced is intermediate between the open circuit and short circuit values.

current rating

When the TISP switches into the on-state it has a very low impedance. As a result, although the surge wave shape may be defined in terms of open circuit voltage, it is the current wave shape that must be used to assess the required TISP surge capability. As an example, the CCITT IX K17 1.5 kV, 10/700 µs surge is changed to a 38 A, 5/310 µs waveshape when driving into a short circuit. Thus the TISP surge current capability, when directly connected to the generator, will be found for the CCITT IX K17 waveform at 310 µs on the surge graph and not 700 µs. Some common short circuit equivalents are tabulated below:

STANDARD	OPEN CIRCUIT VOLTAGE	SHORT CIRCUIT CURRENT
CCITT IX K17	1.5 kV, 10/700 µs	38 A, 5/310 µs
CCITT IX K20	1 kV, 10/700 µs	25 A, 5/310 µs
RLM88	1.5 kV, 0.5/700 µs	38 A, 0.2/310 µs
VDE 0433	2.0 kV, 10/700 µs	50 A, 5/200 µs
FTZ R12	2.0 kV, 10/700 µs	50 A, 5/310 µs

Any series resistance in the protected equipment will reduce the peak circuit current to less than the generators' short circuit value. A 2 kV open circuit voltage, 50 A short circuit current generator has an effective output impedance of 40 Ω (2000/50). If the equipment has a series resistance of 25 Ω then the surge current requirement of the TISP becomes 31 A (2000/65) and not 50 A.

APPLICATIONS INFORMATION

protection voltage

The protection voltage, ($V_{(BO)}$), increases under lightning surge conditions due to thyristor regeneration. This increase is dependent on the rate of current rise, di/dt, when the TISP is clamping the voltage in its breakdown region. The $V_{(BO)}$ value under surge conditions can be estimated by multiplying the 50 Hz rate $V_{(BO)}$ (250 V/ms) value by the normalised increase at the surge's di/dt (Figure 7.) . An estimate of the di/dt can be made from the surge generator voltage rate of rise, dv/dt, and the circuit resistance.

As an example, the CCITT IX K17 1.5 kV, 10/700 µs surge has an average dv/dt of 150 V/µs, but, as the rise is exponential, the initial dv/dt is higher, being in the region of 450 V/µs. The instantaneous generator output resistance is 25 Ω. If the equipment has an additional series resistance of 20 Ω, the total series resistance becomes 45 Ω. The maximum di/dt then can be estimated as 450/45 = 10 A/µs. In practice the measured di/dt and protection voltage increase will be lower due to inductive effects and the finite slope resistance of the TISP breakdown region.

capacitance

off-state capacitance

The off-state capacitance of a TISP is sensitive to junction temperature, T_J, and the bias voltage, comprising of the dc voltage, V_D, and the ac voltage, V_d. All the capacitance values in this data sheet are measured with an ac voltage of 100 mV. The typical 25°C variation of capacitance value with ac bias is shown in Figure 13 When $V_D >> V_d$ the capacitance value is independent on the value of V_d. The capacitance is essentially constant over the range of normal telecommunication frequencies.

NORMALISED CAPACITANCE
vs
RMS AC TEST VOLTAGE

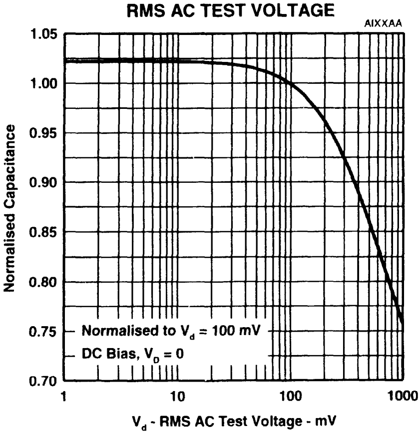


Figure 13.

TISP4125F3, TISP4150F3, TISP4180F3
SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

SLPS013 - MARCH 1994 - REVISED SEPTEMBER 1994

TELECOMMUNICATION SYSTEM SECONDARY PROTECTION

- **Ion-Implanted Breakdown Region**
  Precise and Stable Voltage
  Low Voltage Overshoot under Surge

DEVICE	V_{DRM} V	$V_{(BO)}$ V
'4125F3	100	125
'4150F3	120	150
'4180F3	145	180

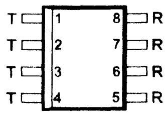
- **Planar Passivated Junctions**
  Low Off-State Current < 10 μA
- **Rated for International Surge Wave Shapes**

WAVE SHAPE	STANDARD	I_{TSP} A
2/10 μs	FCC Part 68	175
8/20 μs	ANSI C62.41	120
10/160 μs	FCC Part 68	60
10/560 μs	FCC Part 68	45
0.5/700 μs	RLM 88	38
10/700 μs	FTZ R12	50
	VDE 0433	50
	CCITT IX K17	38
10/1000 μs	REA PE-60	35

- **Surface Mount and Through-Hole Options**

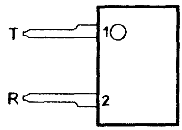
PACKAGE	PART # SUFFIX
Small-outline	D
Small-outline taped and reeled	DR
Single-in-line	SL

D PACKAGE (TOP VIEW)



Specified ratings require the connection of pins 1, 2, 3 and 4 for the T terminal.

SL PACKAGE (TOP VIEW)



device symbol

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

description

These medium voltage symmetrical transient voltage suppressor devices are designed to protect two wire telecommunication applications against transients caused by lightning strikes and ac power lines. Offered in three voltage variants to meet battery and protection requirements they are guaranteed to suppress and withstand the listed international lightning surges in both polarities.

Transients are initially clipped by breakdown clamping until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the current subsides.

These monolithic protection devices are fabricated in ion-implanted planar structures to ensure precise and matched breakover control and are virtually transparent to the system in normal operation

The small-outline 8-pin assignment has been carefully chosen for the TISP series to maximise the inter-pin clearance and creepage distances which are used by standards (e.g. IEC950) to establish voltage withstand ratings.

absolute maximum ratings

RATING		SYMBOL	VALUE	UNIT
Repetitive peak off-state voltage (0°C < T_J < 70°C)	'4125F3	V_{DRM}	± 100	V
	'4150F3		± 120	
	'4180F3		± 145	
Non-repetitive peak on-state pulse current (see Notes 1, 2 and 3)		I_{TSP}		A
1/2 µs (Gas tube differential transient, open-circuit voltage wave shape 1/2 µs)			350	
2/10 µs (FCC Part 68, open-circuit voltage wave shape 2/10 µs)			175	
8/20 µs (ANSI C62.41, open-circuit voltage wave shape 1.2/50 µs)			120	
10/160 µs (FCC Part 68, open-circuit voltage wave shape 10/160 µs)			60	
5/200 µs (VDE 0433, open-circuit voltage wave shape 2 kV, 10/700 µs)			50	
0.2/310 µs (RLM 88, open-circuit voltage wave shape 1.5 kV, 0.5/700 µs)			38	
5/310 µs (CCITT IX K17, open-circuit voltage wave shape 1.5 kV, 10/700 µs)			38	
5/310 µs (FTZ R12, open-circuit voltage wave shape 2 kV, 10/700 µs)			50	
10/560 µs (FCC Part 68, open-circuit voltage wave shape 10/560 µs)			45	
10/1000 µs (REA PE-60, open-circuit voltage wave shape 10/1000 µs)			35	
Non-repetitive peak on-state current (see Notes 2 and 3) 50 Hz, 1 s	D Package	I_{TSM}	4	A rms
	SL Package		6	
Initial rate of rise of on-state current, Linear current ramp, Maximum ramp value < 38 A		di_T/dt	250	A/µs
Junction temperature		T_J	-40 to +150	°C
Storage temperature range		T_{stg}	-40 to +150	°C

NOTES: 1. Further details on surge wave shapes are contained in the Applications Information section.
2. Initially the TISP must be in thermal equilibrium with 0°C < T_J <70°C. The surge may be repeated after the TISP returns to its initial conditions.
3. Above 70°C, derate linearly to zero at 150°C lead temperature.

electrical characteristics for the T and R terminals, 25°C

PARAMETER		TEST CONDITIONS		TISP4125F3			TISP4150F3			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
I_{DRM}	Repetitive peak off-state current	$V_D = \pm V_{DRM}$, 0°C < T_J < 70°C				±10			±10	µA
$V_{(BO)}$	Breakover voltage	dv/dt = ±250 V/ms, R_{SOURCE} = 300 Ω				±125			±150	V
$V_{(BO)}$	Impulse breakover voltage	dv/dt = ±1000 V/µs, R_{SOURCE} = 50 Ω, di/dt < 20 A/µs			±143			±168		V
$I_{(BO)}$	Breakover current	dv/dt = ±250 V/ms, R_{SOURCE} = 300 Ω		±0.15		±0.6	±0.15		±0.6	A
V_T	On-state voltage	I_T = ±5 A, t_W = 100 µs				±3			±3	V
I_H	Holding current	di/dt = +/-30 mA/ms		±0.15			±0.15			
dv/dt	Critical rate of rise of off-state voltage	Linear voltage ramp Maximum ramp value < $0.85V_{(BR)MIN}$		±5			±5			kV/µs
I_D	Off-state current	V_D = ±50 V				±10			±10	µA
C_{off}	Off-state capacitance	f = 100 kHz, V_d = 100 mV (see Note 4)	V_D = 0,		55	95		55	95	pF
			V_D = -5 V		30	50		30	50	pF
			V_D = -50 V		15	25		15	25	pF

NOTE 4: Further details on capacitance are given in the Applications Information section.

electrical characteristics for the T and R terminals, 25°C

PARAMETER		TEST CONDITIONS	TISP4180F3			UNIT
			MIN	TYP	MAX	
I_{DRM}	Repetitive peak off-state current	$V_D = \pm V_{DRM}$, 0°C < T_J < 70°C			±10	µA
$V_{(BO)}$	Breakover voltage	dv/dt = ±250 V/ms, R_{SOURCE} = 300 Ω			±180	V

electrical characteristics for the T and R terminals, 25°C (continued)

PARAMETER		TEST CONDITIONS		TISP4180F3 MIN	TISP4180F3 TYP	TISP4180F3 MAX	UNIT
$V_{(BO)}$	Impulse breakover voltage	dv/dt = ±1000 V/μs, R_{SOURCE} = 50 Ω, di/dt < 20 A/μs			±198		V
$I_{(BO)}$	Breakover current	dv/dt = ±250 V/ms, R_{SOURCE} = 300 Ω		±0.15		±0.6	A
V_T	On-state voltage	I_T = ±5 A, t_W = 100 μs				±3	V
I_H	Holding current	di/dt = +/-30 mA/ms		±0.15			
dv/dt	Critical rate of rise of off-state voltage	Linear voltage ramp Maximum ramp value < $0.85V_{(BR)MIN}$		±5			kV/μs
I_D	Off-state current	V_D = ±50 V				±10	μA
C_{off}	Off-state capacitance	f = 100 kHz, V_d = 100 mV (see Note 5)	V_D = 0,		55	95	pF
			V_D = -5 V		30	50	pF
			V_D = -50 V		15	25	pF

NOTE 5: Further details on capacitance are given in the Applications Information section.

thermal characteristics

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance	P_{tot} = 0.8 W, T_A = 25°C 5 cm², FR4 PCB	D Package			160	°C/W
			SL Package			105	

PARAMETER MEASUREMENT INFORMATION

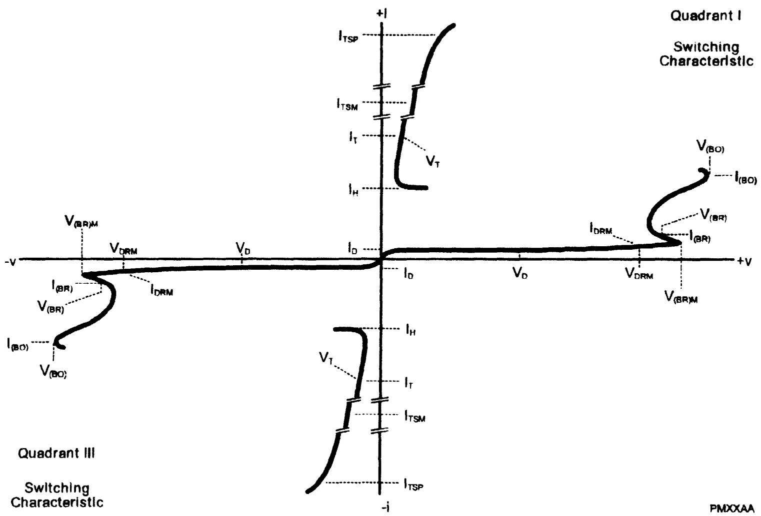


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR T AND R TERMINALS ALL MEASUREMENTS ARE REFERENCED TO THE R TERMINAL

TYPICAL CHARACTERISTICS
R and T terminals

OFF-STATE CURRENT
vs
JUNCTION TEMPERATURE

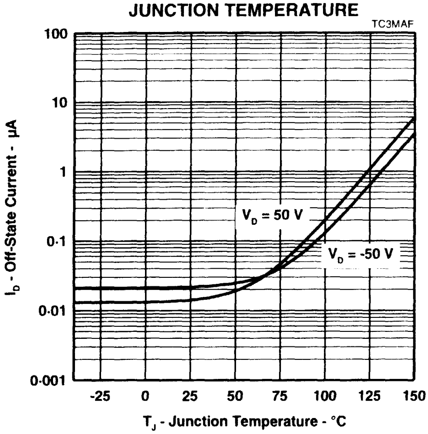


Figure 2.

NORMALISED BREAKDOWN VOLTAGES
vs
JUNCTION TEMPERATURE

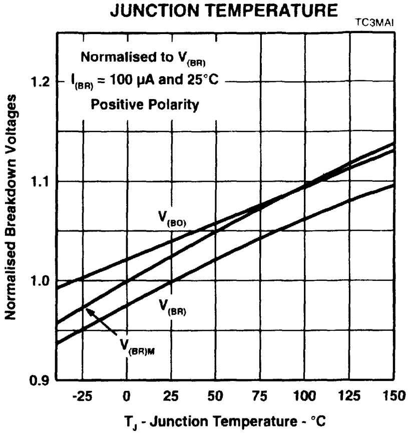


Figure 3.

NORMALISED BREAKDOWN VOLTAGES
vs
JUNCTION TEMPERATURE

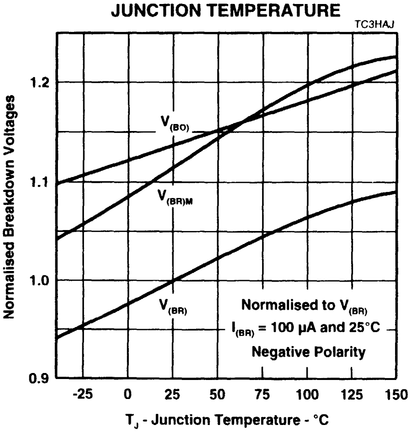


Figure 4.

ON-STATE CURRENT
vs
ON-STATE VOLTAGE

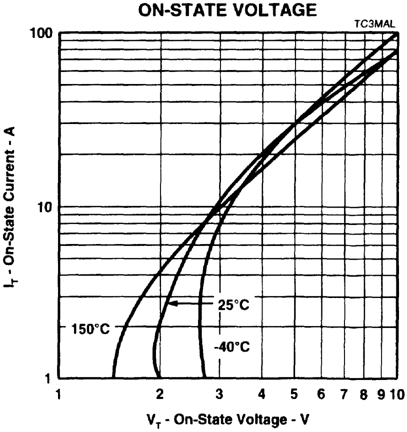


Figure 5.

TEXAS INSTRUMENTS

TYPICAL CHARACTERISTICS
R and T terminals

HOLDING CURRENT & BREAKOVER CURRENT vs JUNCTION TEMPERATURE

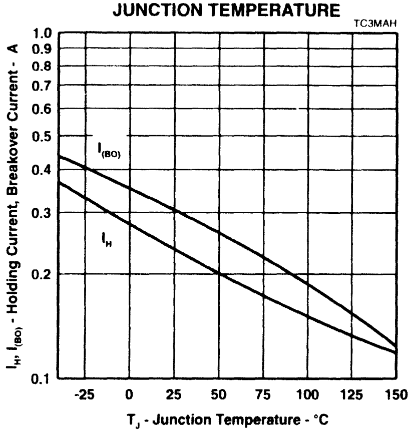


Figure 6.

NORMALISED BREAKOVER VOLTAGE vs RATE OF RISE OF PRINCIPLE CURRENT

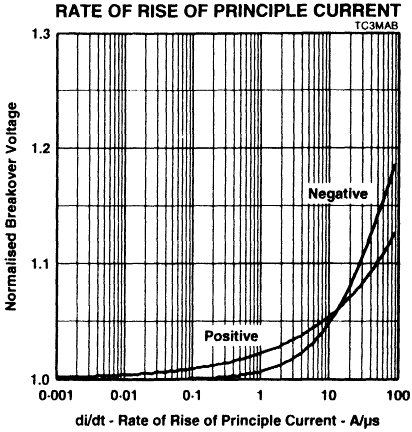


Figure 7.

OFF-STATE CAPACITANCE vs TERMINAL VOLTAGE

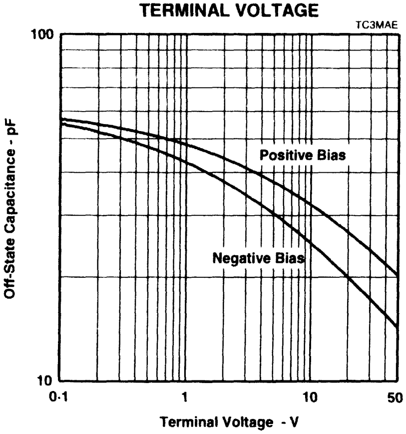


Figure 8.

OFF-STATE CAPACITANCE vs JUNCTION TEMPERATURE

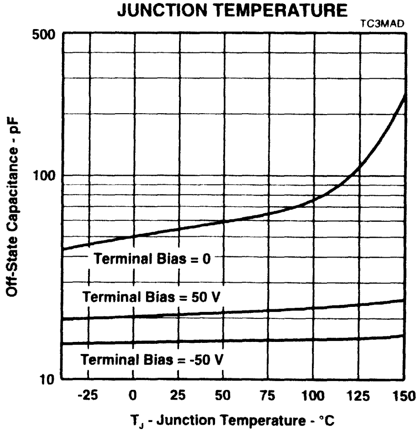


Figure 9.

TYPICAL CHARACTERISTICS
R and T terminals

SURGE CURRENT vs DECAY TIME

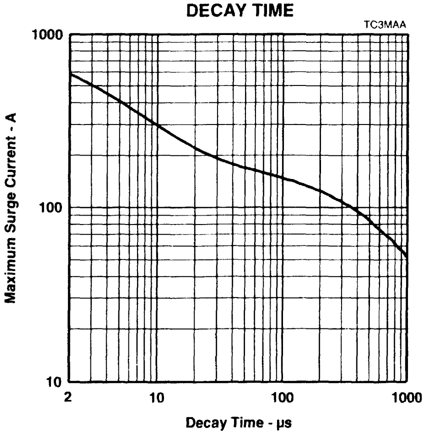


Figure 10.

THERMAL INFORMATION

MAXIMUM NON-RECURRING 50 Hz CURRENT vs CURRENT DURATION

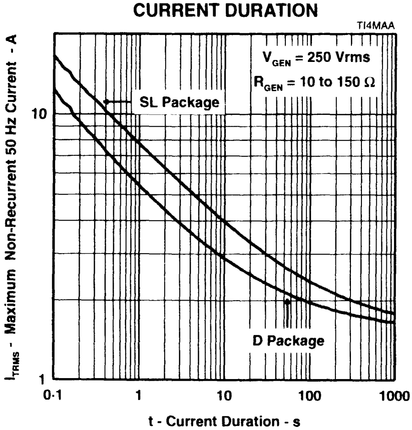


Figure 11.

THERMAL RESPONSE

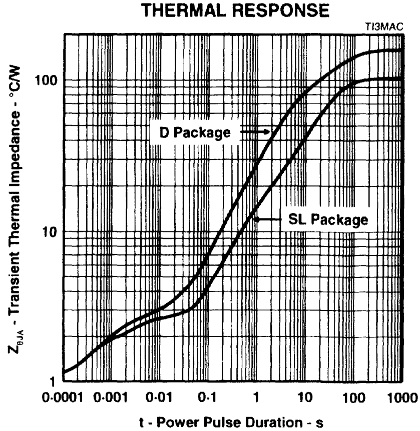


Figure 12.

APPLICATIONS INFORMATION

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The electrical characteristics of a TISP are strongly dependent on junction temperature, T_J. Hence a characteristic value will depend on the junction temperature at the instant of measurement. The values given in this data sheet were measured on commercial testers, which generally minimise the temperature rise caused by testing. Application values may be calculated from the parameters' temperature curves, the power dissipated and the thermal response curve (Z_θ).

lightning surge

wave shape notation

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When the TISP switches into the on-state it has a very low impedance. As a result, although the surge wave shape may be defined in terms of open circuit voltage, it is the current wave shape that must be used to assess the required TISP surge capability. As an example, the CCITT IX K17 1.5 kV, 10/700 µs surge is changed to a 38 A, 5/310 µs waveshape when driving into a short circuit. Thus the TISP surge current capability, when directly connected to the generator, will be found for the CCITT IX K17 waveform at 310 µs on the surge graph and not 700 µs. Some common short circuit equivalents are tabulated below:

STANDARD	OPEN CIRCUIT VOLTAGE	SHORT CIRCUIT CURRENT
CCITT IX K17	1.5 kV, 10/700 µs	38 A, 5/310 µs
CCITT IX K20	1 kV, 10/700 µs	25 A, 5/310 µs
RLM88	1.5 kV, 0.5/700 µs	38 A, 0.2/310 µs
VDE 0433	2.0 kV, 10/700 µs	50 A, 5/200 µs
FTZ R12	2.0 kV, 10/700 µs	50 A, 5/310 µs

Any series resistance in the protected equipment will reduce the peak circuit current to less than the generators' short circuit value. A 2 kV open circuit voltage, 50 A short circuit current generator has an effective output impedance of 40 Ω (2000/50). If the equipment has a series resistance of 25 Ω then the surge current requirement of the TISP becomes 31 A (2000/65) and not 50 A.

APPLICATIONS INFORMATION

protection voltage

The protection voltage, ($V_{(BO)}$), increases under lightning surge conditions due to thyristor regeneration. This increase is dependent on the rate of current rise, di/dt, when the TISP is clamping the voltage in its breakdown region. The $V_{(BO)}$ value under surge conditions can be estimated by multiplying the 50 Hz rate $V_{(BO)}$ (250 V/ms) value by the normalised increase at the surge's di/dt (Figure 7.) . An estimate of the di/dt can be made from the surge generator voltage rate of rise, dv/dt, and the circuit resistance.

As an example, the CCITT IX K17 1.5 kV, 10/700 µs surge has an average dv/dt of 150 V/µs, but, as the rise is exponential, the initial dv/dt is higher, being in the region of 450 V/µs. The instantaneous generator output resistance is 25 Ω. If the equipment has an additional series resistance of 20 Ω, the total series resistance becomes 45 Ω. The maximum di/dt then can be estimated as 450/45 = 10 A/µs. In practice the measured di/dt and protection voltage increase will be lower due to inductive effects and the finite slope resistance of the TISP breakdown region.

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The off-state capacitance of a TISP is sensitive to junction temperature, T_J, and the bias voltage, comprising of the dc voltage, V_D, and the ac voltage, V_d. All the capacitance values in this data sheet are measured with an ac voltage of 100 mV. The typical 25°C variation of capacitance value with ac bias is shown in Figure 13 When $V_D >> V_d$ the capacitance value is independent on the value of V_d. The capacitance is essentially constant over the range of normal telecommunication frequencies.

NORMALISED CAPACITANCE
vs
RMS AC TEST VOLTAGE

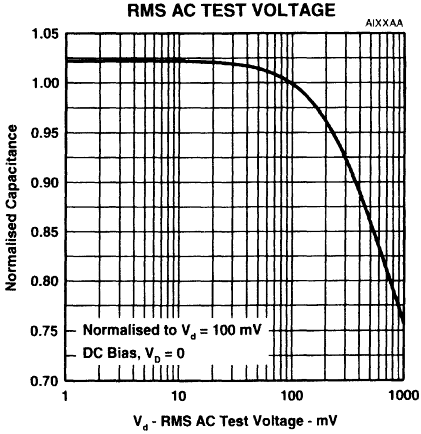


Figure 13.

TELECOMMUNICATION SYSTEM SECONDARY PROTECTION

- **Ion-Implanted Breakdown Region**
  Precise and Stable Voltage
  Low Voltage Overshoot under Surge

DEVICE	V_{DRM} V	$V_{(BO)}$ V
'4240F3	180	240
'4260F3	200	260
'4290F3	220	290
'4320F3	240	320
'4380F3	270	380

- **Planar Passivated Junctions**
  Low Off-State Current < 10 μA

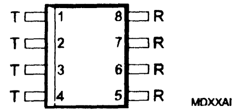
- **Rated for International Surge Wave Shapes**

WAVE SHAPE	STANDARD	I_{TSP} A
2/10 μs	FCC Part 68	175
8/20 μs	ANSI C62.41	120
10/160 μs	FCC Part 68	60
10/560 μs	FCC Part 68	45
0.5/700 μs	RLM 88	38
10/700 μs	FTZ R12	50
	VDE 0433	50
	CCITT IX K17	38
10/1000 μs	REA PE-60	35

- **Surface Mount and Through-Hole Options**

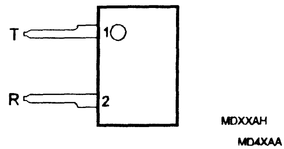
PACKAGE	PART # SUFFIX
Small-outline	D
Small-outline taped and reeled	DR
Single-in-line	SL

D PACKAGE
(TOP VIEW)



Specified ratings require the connection of pins 1, 2, 3 and 4 for the T terminal.

SL PACKAGE
(TOP VIEW)



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

description

These high voltage symmetrical transient voltage suppressor devices are designed to protect two wire telecommunication applications against transients caused by lightning strikes and ac power lines. Offered in five voltage variants to meet battery and protection requirements they are guaranteed to suppress and withstand the listed international lightning surges in both polarities.

Transients are initially clipped by breakdown clamping until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the current subsides.

These monolithic protection devices are fabricated in ion-implanted planar structures to ensure precise and matched breakover control and are virtually transparent to the system in normal operation

The small-outline 8-pin assignment has been carefully chosen for the TISP series to maximise the inter-pin clearance and creepage distances which are used by standards (e.g. IEC950) to establish voltage withstand ratings.

absolute maximum ratings

RATING		SYMBOL	VALUE	UNIT
Repetitive peak off-state voltage (0°C < T_J < 70°C)	'4240F3	V_{DRM}	± 180	V
	'4260F3		± 200	
	'4290F3		± 220	
	'4320F3		± 240	
	'4380F3		± 270	
Non-repetitive peak on-state pulse current (see Notes 1, 2 and 3)		I_{TSP}		A
1/2 μs (Gas tube differential transient, open-circuit voltage wave shape 1/2 μs)			350	
2/10 μs (FCC Part 68, open-circuit voltage wave shape 2/10 μs)			175	
8/20 μs (ANSI C62.41, open-circuit voltage wave shape 1.2/50 μs)			120	
10/160 μs (FCC Part 68, open-circuit voltage wave shape 10/160 μs)			60	
5/200 μs (VDE 0433, open-circuit voltage wave shape 2 kV, 10/700 μs)			50	
0.2/310 μs (RLM 88, open-circuit voltage wave shape 1.5 kV, 0.5/700 μs)			38	
5/310 μs (CCITT IX K17, open-circuit voltage wave shape 1.5 kV, 10/700 μs)			38	
5/310 μs (FTZ R12, open-circuit voltage wave shape 2 kV, 10/700 μs)			50	
10/560 μs (FCC Part 68, open-circuit voltage wave shape 10/560 μs)			45	
10/1000 μs (REA PE-60, open-circuit voltage wave shape 10/1000 μs)			35	
Non-repetitive peak on-state current (see Notes 2 and 3) 50 Hz, 1 s	D Package	I_{TSM}	4	A rms
	SL Package		6	
Initial rate of rise of on-state current, Linear current ramp, Maximum ramp value < 38 A		di_T/dt	250	A/μs
Junction temperature		T_J	-40 to +150	°C
Storage temperature range		T_{stg}	-40 to +150	°C

NOTES: 1. Further details on surge wave shapes are contained in the Applications Information section.
2. Initially the TISP must be in thermal equilibrium with 0°C < T_J <70°C. The surge may be repeated after the TISP returns to its initial conditions.
3. Above 70°C, derate linearly to zero at 150°C lead temperature.

electrical characteristics for the T and R terminals, 25°C

PARAMETER		TEST CONDITIONS		TISP4240F3 MIN	TISP4240F3 TYP	TISP4240F3 MAX	TISP4260F3 MIN	TISP4260F3 TYP	TISP4260F3 MAX	UNIT
I_{DRM}	Repetitive peak off-state current	$V_D = \pm V_{DRM}$, 0°C < T_J < 70°C				±10			±10	μA
$V_{(BO)}$	Breakover voltage	dv/dt = ±250 V/ms, R_{SOURCE} = 300 Ω				±240			±260	V
$V_{(BO)}$	Impulse breakover voltage	dv/dt = ±1000 V/μs, R_{SOURCE} = 50 Ω, di/dt < 20 A/μs			±267			±287		V
$I_{(BO)}$	Breakover current	dv/dt = ±250 V/ms, R_{SOURCE} = 300 Ω		±0.15		±0.6	±0.15		±0.6	A
V_T	On-state voltage	I_T = ±5 A, t_W = 100 μs				±3			±3	V
I_H	Holding current	di/dt = +/-30 mA/ms		±0.15			±0.15			
dv/dt	Critical rate of rise of off-state voltage	Linear voltage ramp Maximum ramp value < $0.85V_{(BR)MIN}$		±5			±5			kV/μs
I_D	Off-state current	V_D = ±50 V				±10			±10	μA
C_{off}	Off-state capacitance	f = 100 kHz, V_d = 100 mV (see Note 4)	V_D = 0,		57	95		57	95	pF
			V_D = -5 V		26	45		26	45	pF
			V_D = -50 V		11	20		11	20	pF

NOTE 4: Further details on capacitance are given in the Applications Information section.

electrical characteristics for the T and R terminals, 25°C

PARAMETER		TEST CONDITIONS		TISP4290F3			TISP4320F3			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
I_{DRM}	Repetitive peak off-state current	$V_D = \pm V_{DRM}$, $0°C < T_J < 70°C$				±10			±10	μA
$V_{(BO)}$	Breakover voltage	dv/dt = ±250 V/ms, R_{SOURCE} = 300 Ω				±290			±320	V
$V_{(BO)}$	Impulse breakover voltage	dv/dt = ±1000 V/μs, R_{SOURCE} = 50 Ω, di/dt < 20 A/μs			±317			±347		V
$I_{(BO)}$	Breakover current	dv/dt = ±250 V/ms, R_{SOURCE} = 300 Ω		±0.15		±0.6	±0.15		±0.6	A
V_T	On-state voltage	I_T = ±5 A, t_W = 100 μs				±3			±3	V
I_H	Holding current	di/dt = +/-30 mA/ms		±0.15			±0.15			
dv/dt	Critical rate of rise of off-state voltage	Linear voltage ramp Maximum ramp value < $0.85V_{(BR)MIN}$		±5			±5			kV/μs
I_D	Off-state current	V_D = ±50 V				±10			±10	μA
C_{off}	Off-state capacitance	f = 100 kHz, V_d = 100 mV (see Note 5)	V_D = 0,		57	95		57	95	pF
			V_D = -5 V		26	45		26	45	pF
			V_D = -50 V		11	20		11	20	pF

NOTE 5: Further details on capacitance are given in the Applications Information section.

electrical characteristics for the T and R terminals, 25°C

PARAMETER		TEST CONDITIONS		TISP4380F3			UNIT
				MIN	TYP	MAX	
I_{DRM}	Repetitive peak off-state current	$V_D = \pm V_{DRM}$, $0°C < T_J < 70°C$				±10	μA
$V_{(BO)}$	Breakover voltage	dv/dt = ±250 V/ms, R_{SOURCE} = 300 Ω				±380	V
$V_{(BO)}$	Impulse breakover voltage	dv/dt = ±1000 V/μs, R_{SOURCE} = 50 Ω, di/dt < 20 A/μs			±407		V
$I_{(BO)}$	Breakover current	dv/dt = ±250 V/ms, R_{SOURCE} = 300 Ω		±0.15		±0.6	A
V_T	On-state voltage	I_T = ±5 A, t_W = 100 μs				±3	V
I_H	Holding current	di/dt = +/-30 mA/ms		±0.15			
dv/dt	Critical rate of rise of off-state voltage	Linear voltage ramp Maximum ramp value < $0.85V_{(BR)MIN}$		±5			kV/μs
I_D	Off-state current	V_D = ±50 V				±10	μA
C_{off}	Off-state capacitance	f = 100 kHz, V_d = 100 mV (see Note 6)	V_D = 0,		57	95	pF
			V_D = -5 V		26	45	pF
			V_D = -50 V		11	20	pF

NOTE 6: Further details on capacitance are given in the Applications Information section.

thermal characteristics

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance	P_{tot} = 0.8 W, T_A = 25°C 5 cm², FR4 PCB	D Package			160	°C/W
			SL Package			105	

PARAMETER MEASUREMENT INFORMATION

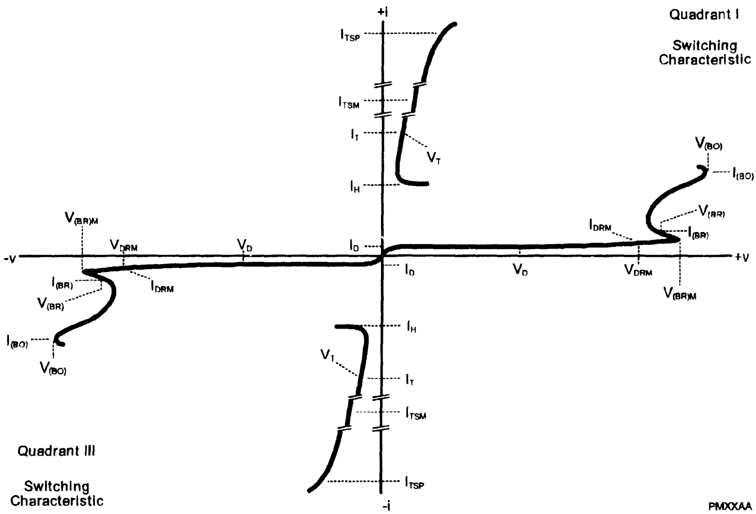


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR T AND R TERMINALS
ALL MEASUREMENTS ARE REFERENCED TO THE R TERMINAL

TYPICAL CHARACTERISTICS
R and T terminals

OFF-STATE CURRENT vs JUNCTION TEMPERATURE

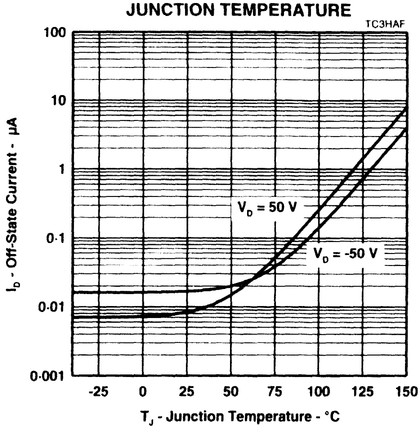


Figure 2.

NORMALISED BREAKDOWN VOLTAGES vs JUNCTION TEMPERATURE

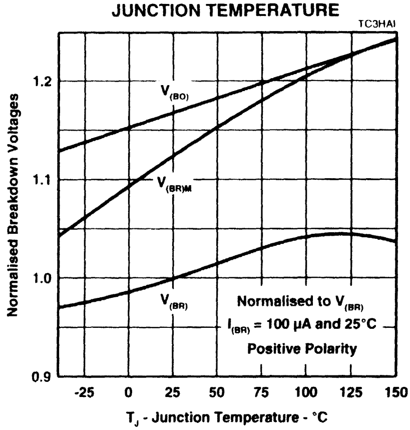


Figure 3.

NORMALISED BREAKDOWN VOLTAGES vs JUNCTION TEMPERATURE

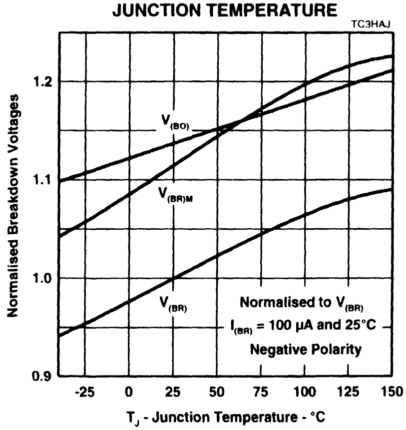


Figure 4.

ON-STATE CURRENT vs ON-STATE VOLTAGE

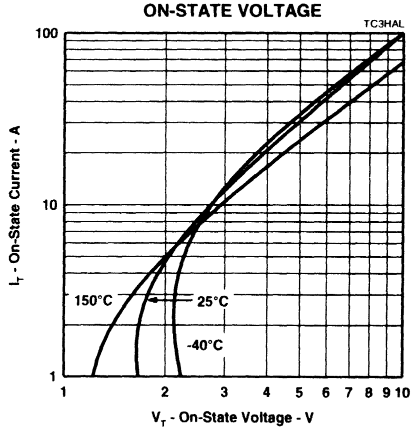


Figure 5.

TEXAS INSTRUMENTS

TYPICAL CHARACTERISTICS
R and T terminals

HOLDING CURRENT & BREAKOVER CURRENT vs JUNCTION TEMPERATURE

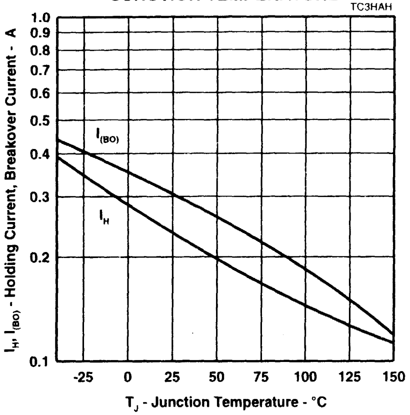


Figure 6.

NORMALISED BREAKOVER VOLTAGE vs RATE OF RISE OF PRINCIPLE CURRENT

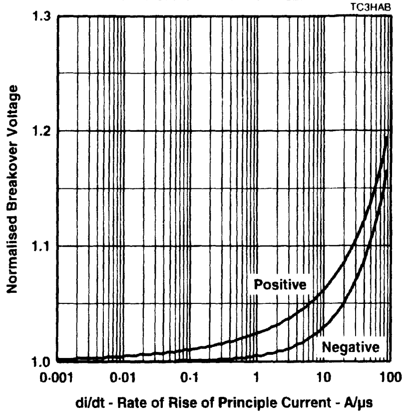


Figure 7.

OFF-STATE CAPACITANCE vs TERMINAL VOLTAGE

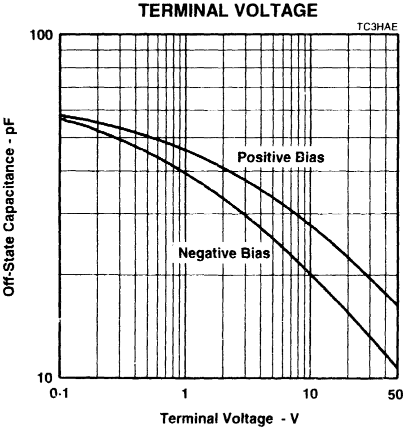


Figure 8.

OFF-STATE CAPACITANCE vs JUNCTION TEMPERATURE

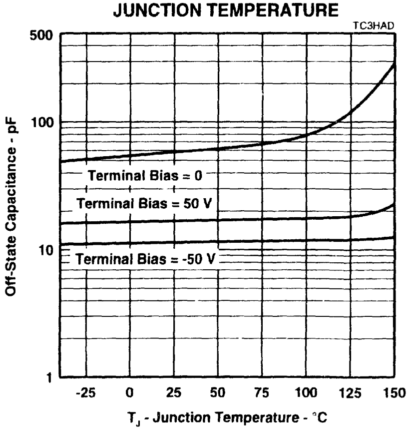


Figure 9.

TEXAS INSTRUMENTS

TYPICAL CHARACTERISTICS
R and T terminals

SURGE CURRENT
vs
DECAY TIME

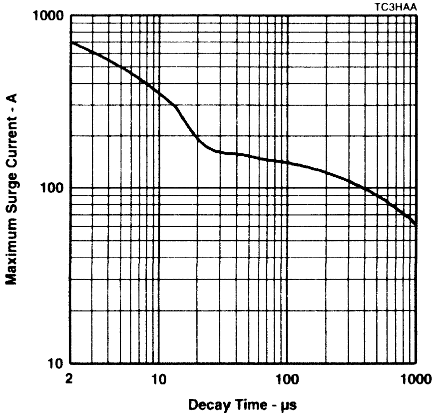


Figure 10.

THERMAL INFORMATION

MAXIMUM NON-RECURRING 50 Hz CURRENT
vs
CURRENT DURATION

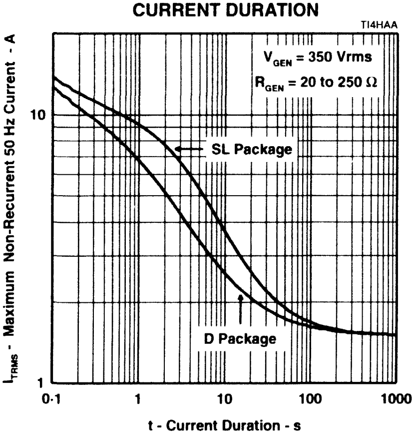


Figure 11.

THERMAL RESPONSE

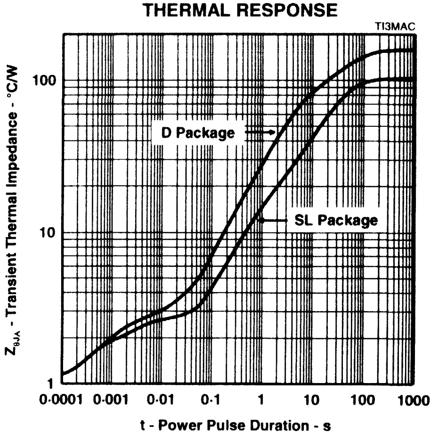


Figure 12.

APPLICATIONS INFORMATION

electrical characteristics

The electrical characteristics of a TISP are strongly dependent on junction temperature, T_J. Hence a characteristic value will depend on the junction temperature at the instant of measurement. The values given in this data sheet were measured on commercial testers, which generally minimise the temperature rise caused by testing. Application values may be calculated from the parameters' temperature curves, the power dissipated and the thermal response curve (Z_θ).

lightning surge

wave shape notation

Most lightning tests, used for equipment verification, specify a unidirectional sawtooth waveform which has an exponential rise and an exponential decay. Wave shapes are classified in terms of peak amplitude (voltage or current), rise time and a decay time to 50% of the maximum amplitude. The notation used for the wave shape is *amplitude, rise time/decay time*. A 50A, 5/310 µs wave shape would have a peak current value of 50 A, a rise time of 5 µs and a decay time of 310 µs. The TISP surge current graph comprehends the wave shapes of commonly used surges.

generators

There are three categories of surge generator type, single wave shape, combination wave shape and circuit defined. Single wave shape generators have essentially the same wave shape for the open circuit voltage and short circuit current (e.g. 10/1000 µs open circuit voltage and short circuit current). Combination generators have two wave shapes, one for the open circuit voltage and the other for the short circuit current (e.g. 1.2/50 µs open circuit voltage and 8/20 µs short circuit current) Circuit specified generators usually equate to a combination generator, although typically only the open circuit voltage waveshape is referenced (e.g. a 10/700 µs open circuit voltage generator typically produces a 5/310 µs short circuit current). If the combination or circuit defined generators operate into a finite resistance the wave shape produced is intermediate between the open circuit and short circuit values.

current rating

When the TISP switches into the on-state it has a very low impedance. As a result, although the surge wave shape may be defined in terms of open circuit voltage, it is the current wave shape that must be used to assess the required TISP surge capability. As an example, the CCITT IX K17 1.5 kV, 10/700 µs surge is changed to a 38 A, 5/310 µs waveshape when driving into a short circuit. Thus the TISP surge current capability, when directly connected to the generator, will be found for the CCITT IX K17 waveform at 310 µs on the surge graph and not 700 µs. Some common short circuit equivalents are tabulated below:

STANDARD	OPEN CIRCUIT VOLTAGE	SHORT CIRCUIT CURRENT
CCITT IX K17	1.5 kV, 10/700 µs	38 A, 5/310 µs
CCITT IX K20	1 kV, 10/700 µs	25 A, 5/310 µs
RLM88	1.5 kV, 0.5/700 µs	38 A, 0.2/310 µs
VDE 0433	2.0 kV, 10/700 µs	50 A, 5/200 µs
FTZ R12	2.0 kV, 10/700 µs	50 A, 5/310 µs

Any series resistance in the protected equipment will reduce the peak circuit current to less than the generators' short circuit value. A 2 kV open circuit voltage, 50 A short circuit current generator has an effective output impedance of 40 Ω (2000/50). If the equipment has a series resistance of 25 Ω then the surge current requirement of the TISP becomes 31 A (2000/65) and not 50 A.

APPLICATIONS INFORMATION

protection voltage

The protection voltage, ($V_{(BO)}$), increases under lightning surge conditions due to thyristor regeneration. This increase is dependent on the rate of current rise, di/dt, when the TISP is clamping the voltage in its breakdown region. The $V_{(BO)}$ value under surge conditions can be estimated by multiplying the 50 Hz rate $V_{(BO)}$ (250 V/ms) value by the normalised increase at the surge's di/dt (Figure 7.) . An estimate of the di/dt can be made from the surge generator voltage rate of rise, dv/dt, and the circuit resistance.

As an example, the CCITT IX K17 1.5 kV, 10/700 μs surge has an average dv/dt of 150 V/μs, but, as the rise is exponential, the initial dv/dt is higher, being in the region of 450 V/μs. The instantaneous generator output resistance is 25 Ω. If the equipment has an additional series resistance of 20 Ω, the total series resistance becomes 45 Ω. The maximum di/dt then can be estimated as 450/45 = 10 A/μs. In practice the measured di/dt and protection voltage increase will be lower due to inductive effects and the finite slope resistance of the TISP breakdown region.

capacitance

off-state capacitance

The off-state capacitance of a TISP is sensitive to junction temperature, T_J, and the bias voltage, comprising of the dc voltage, V_D, and the ac voltage, V_d. All the capacitance values in this data sheet are measured with an ac voltage of 100 mV. The typical 25°C variation of capacitance value with ac bias is shown in Figure 13 When $V_D >> V_d$ the capacitance value is independent on the value of V_d. The capacitance is essentially constant over the range of normal telecommunication frequencies.

NORMALISED CAPACITANCE
vs
RMS AC TEST VOLTAGE

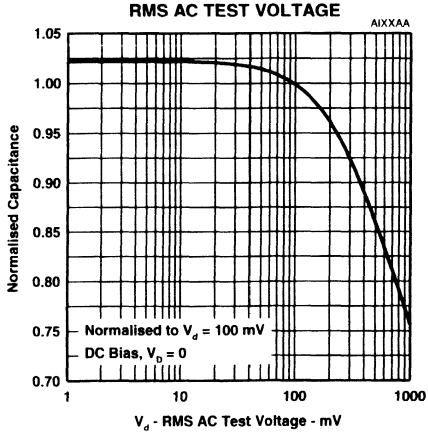


Figure 13.

TELECOMMUNICATION SYSTEM SECONDARY PROTECTION

- **Ion-Implanted Breakdown Region**
  Precise and Stable Voltage
  Low Voltage Overshoot under Surge

DEVICE	V_{DRM} V	$V_{(BO)}$ V
'7072F3	58	72
'7082F3	66	82

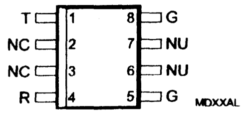
- **Planar Passivated Junctions**
  Low Off-State Current < 10 µA
- **Rated for International Surge Wave Shapes**

WAVE SHAPE	STANDARD	I_{TSP} A
2/10 µs	FCC Part 68	80
8/20 µs	ANSI C62.41	70
10/160 µs	FCC Part 68	60
10/560 µs	FCC Part 68	45
0.5/700 µs	RLM 88	38
10/700 µs	FTZ R12	50
	VDE 0433	50
	CCITT IX K17	38
10/1000 µs	REA PE-60	35

- **Surface Mount and Through-Hole Options**

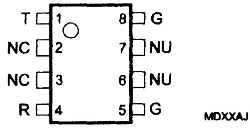
PACKAGE	PART # SUFFIX
Small-outline	D
Small-outline taped and reeled	DR
Plastic DIP	P
Single-in-line	SL

D PACKAGE
(TOP VIEW)



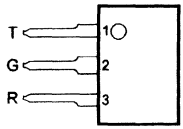
NC - No internal connection
NU - Nonusable; no external electrical connection should be made to these pins.
Specified ratings require connection of pin 5 and pin 8.

P PACKAGE
(TOP VIEW)



NC - No internal connection
NU - Nonusable; no external electrical connection should be made to these pins.
Specified ratings require connection of pin 5 and pin 8.

SL PACKAGE
(TOP VIEW)



MDXXAK

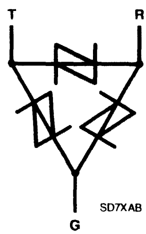
MD7XAA

description

These low voltage symmetrical transient voltage suppressor devices are designed to protect against metallic and simultaneous longitudinal surges. These balanced devices are suitable for the protection of ISDN applications against transients caused by lightning strikes and ac power lines. Offered in two voltage variants to meet battery and protection requirements they are guaranteed to suppress and withstand the listed international lightning surges on any terminal pair.

Transients are initially clipped by breakdown clamping until the voltage rises to the breakover level, which causes the device to crowbar.

device symbol



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

description (continued)

The high crowbar holding current prevents dc latchup as the current subsides

These monolithic protection devices are fabricated in ion-implanted planar structures to ensure precise and matched breakover control and are virtually transparent to the system in normal operation

The small-outline 8-pin assignment has been carefully chosen for the TISP series to maximise the inter-pin clearance and creepage distances which are used by standards (e.g. IEC950) to establish voltage withstand ratings.

absolute maximum ratings

RATING		SYMBOL	VALUE	UNIT
Repetitive peak off-state voltage (0°C < T_J < 70°C)	'7072F3	V_{DRM}	58	V
	'7082F3		66	
Non-repetitive peak on-state pulse current (see Notes 1, 2 and 3)				
1/2 μs (Gas tube differential transient, open-circuit voltage wave shape 1/2 μs)		I_{TSP}	120	A
2/10 μs (FCC Part 68, open-circuit voltage wave shape 2/10 μs)			80	
8/20 μs (ANSI C62.41, open-circuit voltage wave shape 1.2/50 μs)			70	
10/160 μs (FCC Part 68, open-circuit voltage wave shape 10/160 μs)			60	
5/200 μs (VDE 0433, open-circuit voltage wave shape 2 kV, 10/700 μs)			50	
0.2/310 μs (RLM 88, open-circuit voltage wave shape 1.5 kV, 0.5/700 μs)			38	
5/310 μs (CCITT IX K17, open-circuit voltage wave shape 1.5 kV, 10/700 μs)			38	
5/310 μs (FTZ R12, open-circuit voltage wave shape 2 kV, 10/700 μs)			50	
10/560 μs (FCC Part 68, open-circuit voltage wave shape 10/560 μs)			45	
10/1000 μs (REA PE-60, open-circuit voltage wave shape 10/1000 μs)			35	
Non-repetitive peak on-state current (see Notes 2 and 3)	D Package	I_{TSM}	3	A rms
50 Hz, 1 s	P Package		4	
	SL Package		5	
Initial rate of rise of on-state current, Linear current ramp, Maximum ramp value < 38 A		di_T/dt	250	A/μs
Junction temperature		T_J	-40 to +150	°C
Storage temperature range		T_{stg}	-40 to +150	°C

NOTES: 1. Further details on surge wave shapes are contained in the Applications Information section.
2. Initially the TISP must be in thermal equilibrium with 0°C < T_J <70°C. The surge may be repeated after the TISP returns to its initial conditions.
3. Above 70°C, derate linearly to zero at 150°C lead temperature.

electrical characteristics for the T and G, R and G and T and R terminals, 25°C

PARAMETER		TEST CONDITIONS	TISP7072F3			TISP7082F3			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
I_{DRM}	Repetitive peak off-state current	V_D = ±V_{DRM}, 0°C < T_J < 70°C			±10			±10	μA
$V_{(BO)}$	Breakover voltage	dv/dt = ±250 V/ms, R_{SOURCE} = 300 Ω			±72			±82	V
$V_{(BO)}$	Impulse breakover voltage	dv/dt = ±1000 V/μs, R_{SOURCE} = 50 Ω, di/dt < 20 A/μs		±90			±100		V
$I_{(BO)}$	Breakover current	dv/dt = ±250 V/ms, R_{SOURCE} = 300 Ω	±0.1		±0.8	±0.1		±0.8	A
V_T	On-state voltage	I_T = ±5 A, t_W = 100 μs			±5			±5	V
I_H	Holding current	di/dt = +/-30 mA/ms	±0.15			±0.15			
dv/dt	Critical rate of rise of off-state voltage	Linear voltage ramp Maximum ramp value < 0.85V_{DRM}	±5			±5			kV/μs
I_D	Off-state current	V_D = ±50 V			±10			±10	μA

electrical characteristics for the T and G, R and G and T and R terminals, 25°C (continued)

PARAMETER		TEST CONDITIONS		TISP7072F3 MIN	TISP7072F3 TYP	TISP7072F3 MAX	TISP7082F3 MIN	TISP7082F3 TYP	TISP7082F3 MAX	UNIT
C_{off}	Off-state capacitance	f = 100 kHz, V_d = 100 mV Third terminal voltage = 0 (see Notes 4 and 5)	V_D = 0,		66	135		66	135	pF
			V_D = -5 V		34	70		34	70	pF
			V_D = -50 V		18	40		18	40	pF
			V_{DTR} = 0		37	75		37	75	pF

NOTES: 4 Further details on capacitance are given in the Applications Information section.
5 First three capacitance values, with bias V_D, are for the T and G and T and G terminals only. The forth capacitance value, with bias V_{DTR}, is for T and R terminals only.

thermal characteristics

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance	P_{tot} = 0.8 W, T_A = 25°C 5 cm^2, FR4 PCB	D Package			160	°C/W
			P Package			100	
			SL Package			135	

PARAMETER MEASUREMENT INFORMATION

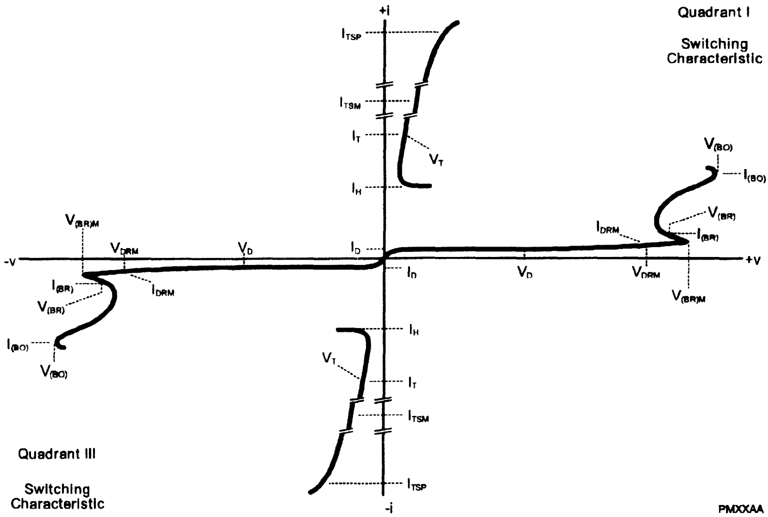


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR T AND R TERMINALS
T and G and R and G measurements are referenced to the G terminal
T and R measurements are referenced to the R terminal

TYPICAL CHARACTERISTICS
R and G, or T and G terminals

OFF-STATE CURRENT vs JUNCTION TEMPERATURE

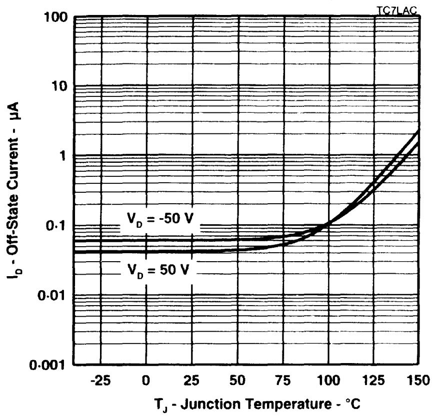


Figure 2.

NORMALISED BREAKDOWN VOLTAGES vs JUNCTION TEMPERATURE

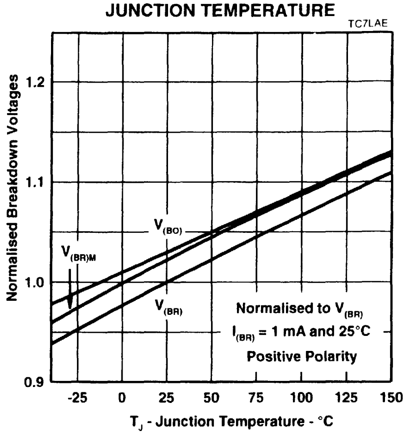


Figure 3.

NORMALISED BREAKDOWN VOLTAGES vs JUNCTION TEMPERATURE

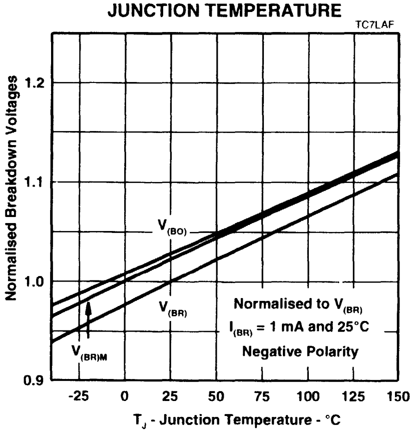


Figure 4.

ON-STATE CURRENT vs ON-STATE VOLTAGE

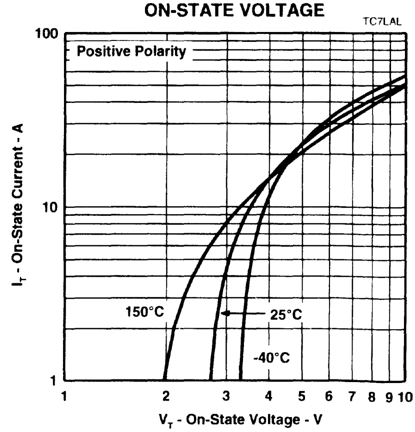


Figure 5.

TYPICAL CHARACTERISTICS
R and G, or T and G terminals

ON-STATE CURRENT vs ON-STATE VOLTAGE

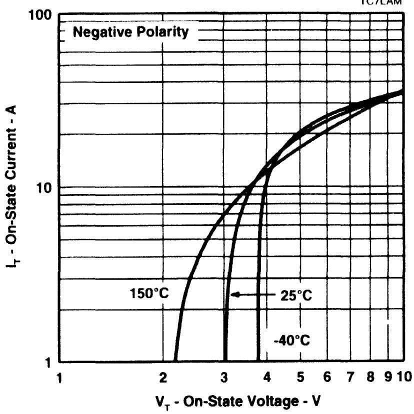


Figure 6.

HOLDING CURRENT & BREAKOVER CURRENT vs JUNCTION TEMPERATURE

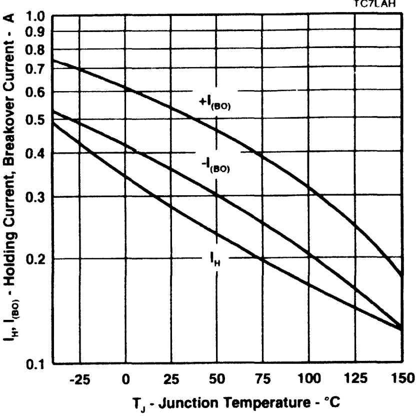


Figure 7.

NORMALISED BREAKOVER VOLTAGE vs RATE OF RISE OF PRINCIPLE CURRENT

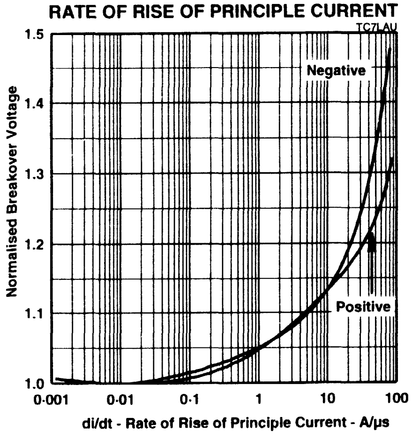


Figure 8.

OFF-STATE CAPACITANCE vs TERMINAL VOLTAGE (POSITIVE)

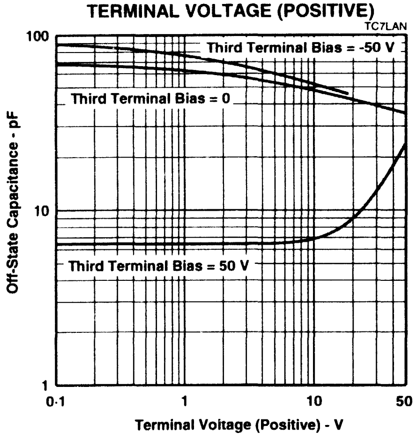


Figure 9.

TYPICAL CHARACTERISTICS
R and G, or T and G terminals

OFF-STATE CAPACITANCE vs TERMINAL VOLTAGE (NEGATIVE)

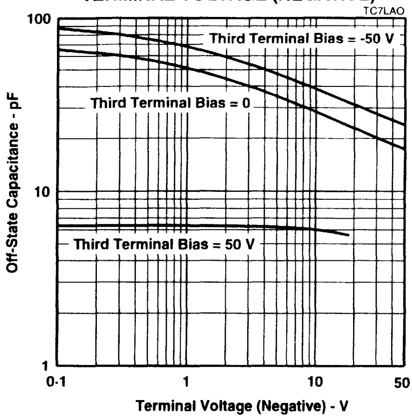


Figure 10.

OFF-STATE CAPACITANCE vs JUNCTION TEMPERATURE

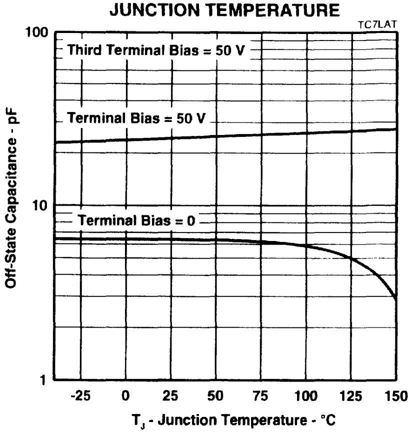


Figure 11.

OFF-STATE CAPACITANCE vs JUNCTION TEMPERATURE

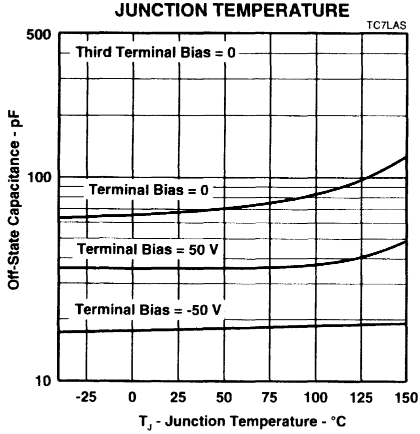


Figure 12.

OFF-STATE CAPACITANCE vs JUNCTION TEMPERATURE

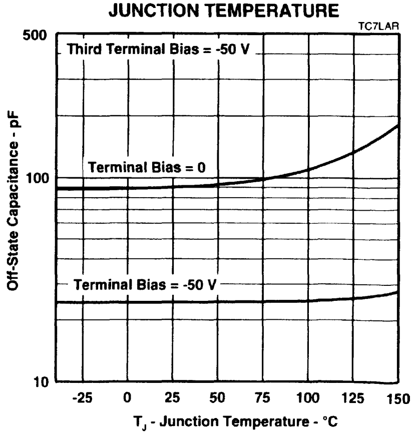


Figure 13.

TYPICAL CHARACTERISTICS
R and G, or T and G terminals

SURGE CURRENT vs DECAY TIME

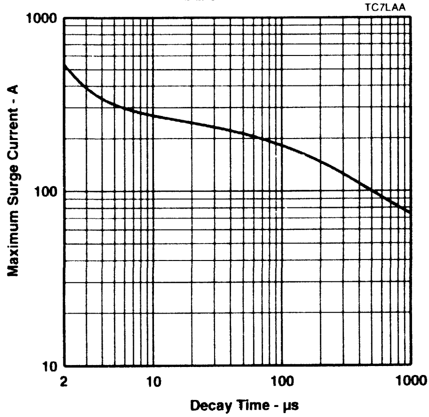


Figure 14.

TYPICAL CHARACTERISTICS
R and T terminals

OFF-STATE CURRENT vs JUNCTION TEMPERATURE

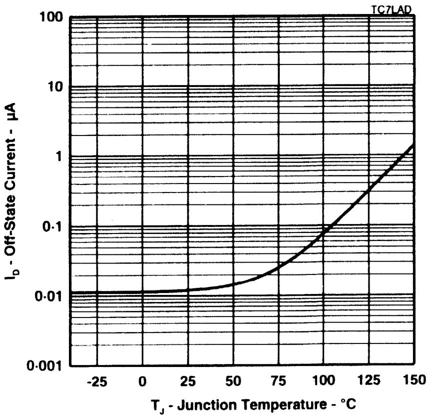


Figure 15.

NORMALISED BREAKDOWN VOLTAGES vs JUNCTION TEMPERATURE

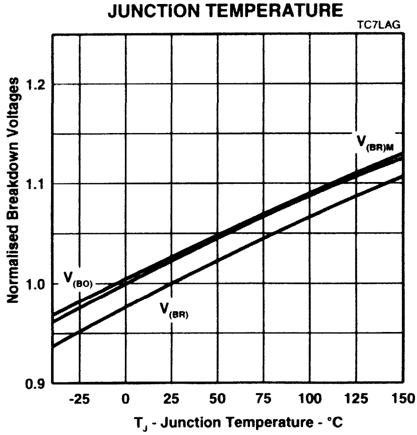


Figure 16.

TYPICAL CHARACTERISTICS
R and T terminals

ON-STATE CURRENT
vs
ON-STATE VOLTAGE

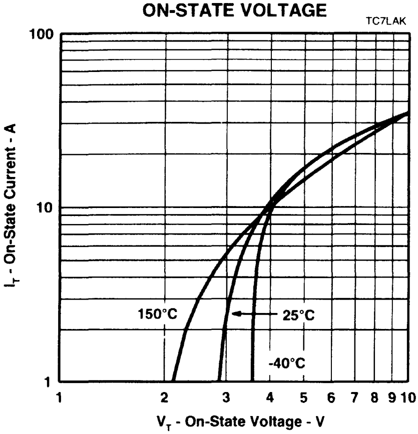


Figure 17.

HOLDING CURRENT & BREAKOVER CURRENT
vs
JUNCTION TEMPERATURE

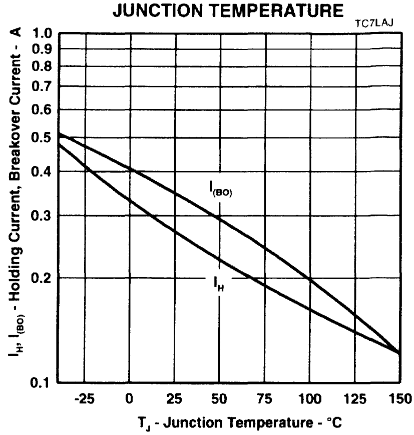


Figure 18.

NORMALISED BREAKOVER VOLTAGE
vs
RATE OF RISE OF PRINCIPLE CURRENT

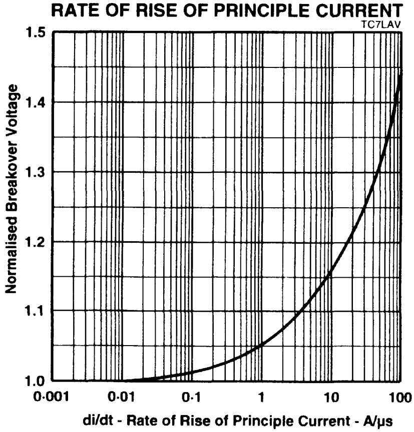


Figure 19.

OFF-STATE CAPACITANCE
vs
TERMINAL VOLTAGE (POSITIVE)

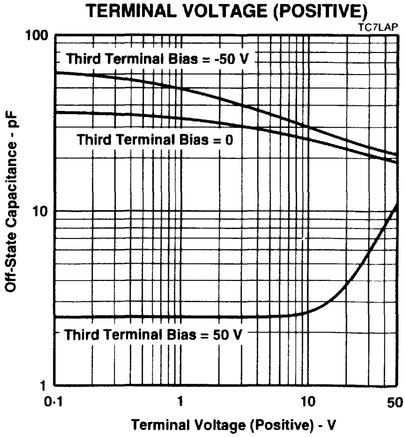


Figure 20.

TYPICAL CHARACTERISTICS

R and T terminals

OFF-STATE CAPACITANCE
vs
TERMINAL VOLTAGE (NEGATIVE)

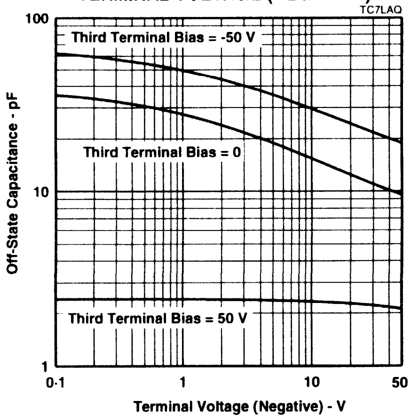


Figure 21.

THERMAL INFORMATION

MAXIMUM NON-RECURRING 50 Hz CURRENT
vs
CURRENT DURATION

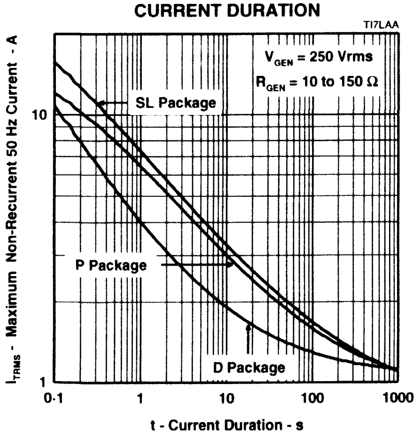


Figure 22.

THERMAL RESPONSE

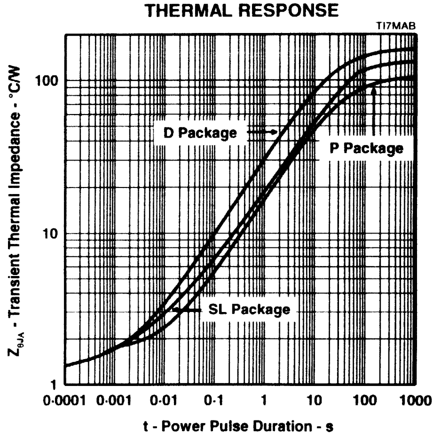


Figure 23.

APPLICATIONS INFORMATION

electrical characteristics

The electrical characteristics of a TISP are strongly dependent on junction temperature, T_J. Hence a characteristic value will depend on the junction temperature at the instant of measurement. The values given in this data sheet were measured on commercial testers, which generally minimise the temperature rise caused by testing. Application values may be calculated from the parameters' temperature coefficient, the power dissipated and the thermal response curve ,Z_θ (see M. J. Maytum, "Transient Suppressor Dynamic Parameters."TI Technical Journal, vol. 6, No. 4, pp.63-70, July-August 1989).

lightning surge

wave shape notation

Most lightning tests, used for equipment verification, specify a unidirectional sawtooth waveform which has an exponential rise and an exponential decay. Wave shapes are classified in terms of peak amplitude (voltage or current), rise time and a decay time to 50% of the maximum amplitude. The notation used for the wave shape is *amplitude, rise time/decay time*. A 50A, 5/310 µs wave shape would have a peak current value of 50 A, a rise time of 5 µs and a decay time of 310 µs. The TISP surge current graph comprehends the wave shapes of commonly used surges.

generators

There are three categories of surge generator type, single wave shape, combination wave shape and circuit defined. Single wave shape generators have essentially the same wave shape for the open circuit voltage and short circuit current (e.g. 10/1000 µs open circuit voltage and short circuit current). Combination generators have two wave shapes, one for the open circuit voltage and the other for the short circuit current (e.g. 1.2/50 µs open circuit voltage and 8/20 µs short circuit current) Circuit specified generators usually equate to a combination generator, although typically only the open circuit voltage waveshape is referenced (e.g. a 10/700 µs open circuit voltage generator typically produces a 5/310 µs short circuit current). If the combination or circuit defined generators operate into a finite resistance the wave shape produced is intermediate between the open circuit and short circuit values.

current rating

When the TISP switches into the on-state it has a very low impedance. As a result, although the surge wave shape may be defined in terms of open circuit voltage, it is the current wave shape that must be used to assess the required TISP surge capability. As an example, the CCITT IX K17 1.5 kV, 10/700 µs surge is changed to a 38 A, 5/310 µs waveshape when driving into a short circuit. Thus the TISP surge current capability, when directly connected to the generator, will be found for the CCITT IX K17 waveform at 310 µs on the surge graph and not 700 µs. Some common short circuit equivalents are tabulated below:

STANDARD	OPEN CIRCUIT VOLTAGE	SHORT CIRCUIT CURRENT
CCITT IX K17	1.5 kV, 10/700 µs	38 A, 5/310 µs
CCITT IX K20	1 kV, 10/700 µs	25 A, 5/310 µs
RLM88	1.5 kV, 0.5/700 µs	38 A, 0.2/310 µs
VDE 0433	2.0 kV, 10/700 µs	50 A, 5/200 µs
FTZ R12	2.0 kV, 10/700 µs	50 A, 5/310 µs

Any series resistance in the protected equipment will reduce the peak circuit current to less than the generators' short circuit value. A 2 kV open circuit voltage, 50 A short circuit current generator has an effective output impedance of 40 Ω (2000/50). If the equipment has a series resistance of 25 Ω then the surge current requirement of the TISP becomes 31 A (2000/65) and not 50 A.

APPLICATIONS INFORMATION

protection voltage

The protection voltage, ($V_{(BO)}$), increases under lightning surge conditions due to thyristor regeneration. This increase is dependent on the rate of current rise, di/dt, when the TISP is clamping the voltage in its breakdown region. The $V_{(BO)}$ value under surge conditions can be estimated by multiplying the 50 Hz rate $V_{(BO)}$ (250 V/ms) value by the normalised increase at the surge's di/dt (Figure 2.) . An estimate of the di/dt can be made from the surge generator voltage rate of rise, dv/dt, and the circuit resistance.

As an example, the CCITT IX K17 1.5 kV, 10/700 µs surge has an average dv/dt of 150 V/µs, but, as the rise is exponential, the initial dv/dt is higher, being in the region of 450 V/µs. The instantaneous generator output resistance is 25 Ω. If the equipment has an additional series resistance of 20 Ω, the total series resistance becomes 45 Ω. The maximum di/dt then can be estimated as 450/45 = 10 A/µs. In practice the measured di/dt and protection voltage increase will be lower due to inductive effects and the finite slope resistance of the TISP breakdown region.

capacitance

off-state capacitance

The off-state capacitance of a TISP is sensitive to junction temperature, T_J, and the bias voltage, comprising of the dc voltage, V_D, and the ac voltage, V_d. All the capacitance values in this data sheet are measured with an ac voltage of 100 mV. The typical 25°C variation of capacitance value with ac bias is shown in Figure 6 When $V_D >> V_d$ the capacitance value is independent on the value of V_d. The capacitance is essentially constant over the range of normal telecommunication frequencies.

NORMALISED CAPACITANCE vs RMS AC TEST VOLTAGE

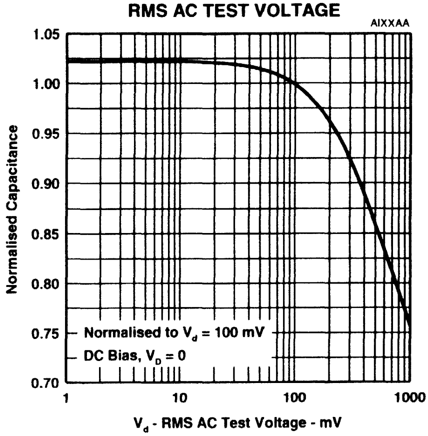


Figure 24.

APPLICATIONS INFORMATION

longitudinal balance

Figure 7 shows a three terminal TISP with its equivalent "delta" capacitance Each capacitance, C_{TG} , C_{RG} and C_{TR} , is the true terminal pair capacitance measured with a three terminal or guarded capacitance bridge. If wire R is biased at a larger potential than wire T then $C_{TG} > C_{RG}$. Capacitance C_{TG} is equivalent to a capacitance of C_{RG} in parallel with the capacitive difference of (C_{TG} - C_{RG}). The line capacitive unbalance is due to (C_{TG} - C_{RG}) and the capacitance shunting the line is $C_{TR} + C_{RG}/2$.

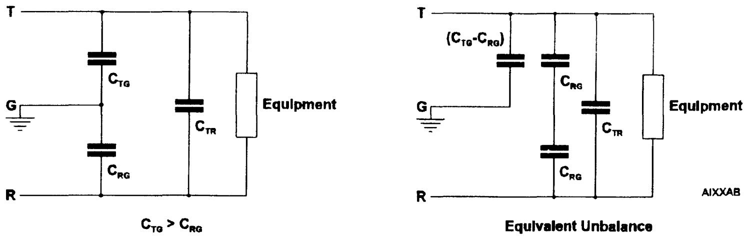


Figure 25.

All capacitance measurements in this data sheet are three terminal guarded to allow the designer to accurately assess capacitive unbalance effects. Simple two terminal capacitance meters (unguarded third terminal) give false readings as the shunt capacitance via the third terminal is included.

TELECOMMUNICATION SYSTEM SECONDARY PROTECTION

- **Ion-Implanted Breakdown Region**
  Precise and Stable Voltage
  Low Voltage Overshoot under Surge

DEVICE	V_{DRM} V	$V_{(BO)}$ V
'7125F3	100	125
'7150F3	120	150
'7180F3	145	180

- **Planar Passivated Junctions**
  Low Off-State Current < 10 μA

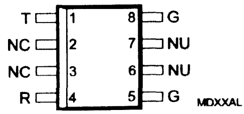
- **Rated for International Surge Wave Shapes**

WAVE SHAPE	STANDARD	I_{TSP} A
2/10 μs	FCC Part 68	175
8/20 μs	ANSI C62.41	120
10/160 μs	FCC Part 68	60
10/560 μs	FCC Part 68	45
0.5/700 μs	RLM 88	38
10/700 μs	FTZ R12	50
	VDE 0433	50
	CCITT IX K17	38
10/1000 μs	REA PE-60	35

- **Surface Mount and Through-Hole Options**

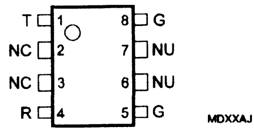
PACKAGE	PART # SUFFIX
Small-outline	D
Small-outline taped and reeled	DR
Plastic DIP	P
Single-in-line	SL

D PACKAGE
(TOP VIEW)



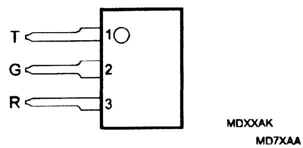
NC - No internal connection
NU - Nonusable; no external electrical connection should be made to these pins.
Specified ratings require connection of pin 5 and pin 8.

P PACKAGE
(TOP VIEW)



NC - No internal connection
NU - Nonusable; no external electrical connection should be made to these pins.
Specified ratings require connection of pin 5 and pin 8.

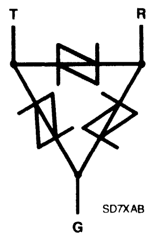
SL PACKAGE
(TOP VIEW)



description

These medium voltage symmetrical transient voltage suppressor devices are designed to protect against metallic and simultaneous longitudinal surges. These balanced devices are suitable for the protection of ISDN and telecommunication applications with battery backed ringing against transients caused by lightning strikes and ac power lines. Offered in three voltage variants to meet battery and protection requirements they are guaranteed to suppress and withstand the listed international lightning surges on any terminal pair.

device symbol



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

description (continued)

Transients are initially clipped by breakdown clamping until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the current subsides

These monolithic protection devices are fabricated in ion-implanted planar structures to ensure precise and matched breakover control and are virtually transparent to the system in normal operation

The small-outline 8-pin assignment has been carefully chosen for the TISP series to maximise the inter-pin clearance and creepage distances which are used by standards (e.g. IEC950) to establish voltage withstand ratings.

absolute maximum ratings

RATING		SYMBOL	VALUE	UNIT
Repetitive peak off-state voltage (0°C < T_J < 70°C)	'7125F3	V_{DRM}	100	V
	'7150F3		120	
	'7180F3		145	
Non-repetitive peak on-state pulse current (see Notes 1, 2 and 3)		I_{TSP}		A
1/2 µs (Gas tube differential transient, open-circuit voltage wave shape 1/2 µs)			350	
2/10 µs (FCC Part 68, open-circuit voltage wave shape 2/10 µs)			175	
8/20 µs (ANSI C62.41, open-circuit voltage wave shape 1.2/50 µs)			120	
10/160 µs (FCC Part 68, open-circuit voltage wave shape 10/160 µs)			60	
5/200 µs (VDE 0433, open-circuit voltage wave shape 2 kV, 10/700 µs)			50	
0.2/310 µs (RLM 88, open-circuit voltage wave shape 1.5 kV, 0.5/700 µs)			38	
5/310 µs (CCITT IX K17, open-circuit voltage wave shape 1.5 kV, 10/700 µs)			38	
5/310 µs (FTZ R12, open-circuit voltage wave shape 2 kV, 10/700 µs)			50	
10/560 µs (FCC Part 68, open-circuit voltage wave shape 10/560 µs)			45	
10/1000 µs (REA PE-60, open-circuit voltage wave shape 10/1000 µs)			35	
Non-repetitive peak on-state current (see Notes 2 and 3)	D Package	I_{TSM}	3	A rms
50 Hz, 1 s	P Package		4	
	SL Package		5	
Initial rate of rise of on-state current, Linear current ramp, Maximum ramp value < 38 A		di_T/dt	250	A/µs
Junction temperature		T_J	-40 to +150	°C
Storage temperature range		T_{stg}	-40 to +150	°C

NOTES: 1. Further details on surge wave shapes are contained in the Applications Information section.
2. Initially the TISP must be in thermal equilibrium with 0°C < T_J <70°C. The surge may be repeated after the TISP returns to its initial conditions.
3. Above 70°C, derate linearly to zero at 150°C lead temperature.

electrical characteristics for the T and G, R and G and T and R terminals, 25°C

PARAMETER		TEST CONDITIONS	TISP7125F3			TISP7150F3			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
I_{DRM}	Repetitive peak off-state current	V_D = ±V_{DRM}, 0°C < T_J < 70°C			±10			±10	µA
$V_{(BO)}$	Breakover voltage	dv/dt = ±250 V/ms, R_{SOURCE} = 300 Ω			±125			±150	V
$V_{(BO)}$	Impulse breakover voltage	dv/dt = ±1000 V/µs, R_{SOURCE} = 50 Ω, di/dt < 20 A/µs		±143			±168		V
$I_{(BO)}$	Breakover current	dv/dt = ±250 V/ms, R_{SOURCE} = 300 Ω	±0.1		±0.8	±0.1		±0.8	A
V_T	On-state voltage	I_T = ±5 A, t_W = 100 µs			±5			±5	V
I_H	Holding current	di/dt = +/-30 mA/ms	±0.15			±0.15			
dv/dt	Critical rate of rise of off-state voltage	Linear voltage ramp Maximum ramp value < 0.85$V_{(BR)MIN}$	±5			±5			kV/µs

electrical characteristics for the T and G, R and G and T and R terminals, 25°C (continued)

PARAMETER		TEST CONDITIONS		TISP7125F3 MIN	TISP7125F3 TYP	TISP7125F3 MAX	TISP7150F3 MIN	TISP7150F3 TYP	TISP7150F3 MAX	UNIT
I_D	Off-state current	V_D = ±50 V				±10			±10	µA
C_{off}	Off-state capacitance	f = 100 kHz, V_d = 100 mV Third terminal voltage = 0 (see Notes 4 and 5)	V_D = 0,		41	85		41	85	pF
			V_D = -5 V		21	45		21	45	pF
			V_D = -50 V		10	20		10	20	pF
			V_{DTR} = 0		23	50		23	50	pF

NOTES: 4 Further details on capacitance are given in the Applications Information section.
5 First three capacitance values, with bias V_D, are for the T and G and T and G terminals only. The forth capacitance value, with bias V_{DTR}, is for T and R terminals only.

electrical characteristics for the T and G, R and G and T and R terminals, 25°C

PARAMETER		TEST CONDITIONS		TISP7180F3 MIN	TISP7180F3 TYP	TISP7180F3 MAX	UNIT
I_{DRM}	Repetitive peak off-state current	$V_D = \pm V_{DRM}$, 0°C < T_J < 70°C				±10	µA
$\alpha_{V(BR)}$	Temperature coefficient of breakdown voltage	$I_{(BR)}$ = ±100 µA, 0°C < T_J < 70°C			±0.1		%/°C
$V_{(BO)}$	Breakover voltage	dv/dt = ±250 V/ms, R_{SOURCE} = 300 Ω				±180	V
$V_{(BO)}$	Impulse breakover voltage	dv/dt = ±1000 V/µs, R_{SOURCE} = 50 Ω, di/dt < 20 A/µs			±198		V
$I_{(BO)}$	Breakover current	dv/dt = ±250 V/ms, R_{SOURCE} = 300 Ω		±0.1		±0.8	A
V_T	On-state voltage	I_T = ±5 A, t_W = 100 µs				±5	V
I_H	Holding current	di/dt = +/-30 mA/ms		±0.15			
dv/dt	Critical rate of rise of off-state voltage	Linear voltage ramp Maximum ramp value < $0.85V_{(BR)MIN}$		±5			kV/µs
I_D	Off-state current	V_D = ±50 V				±10	µA
C_{off}	Off-state capacitance	f = 100 kHz, V_d = 100 mV Third terminal voltage = 0 (see Notes 6 and 7)	V_D = 0,		41	85	pF
			V_D = -5 V		21	45	pF
			V_D = -50 V		10	20	pF
			V_{DTR} = 0		23	50	pF

NOTES: 6 Further details on capacitance are given in the Applications Information section.
7 First three capacitance values, with bias V_D, are for the T and G and T and G terminals only. The forth capacitance value, with bias V_{DTR}, is for T and R terminals only.

thermal characteristics

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance	P_{tot} = 0.8 W, T_A = 25°C 5 cm², FR4 PCB	D Package			160	°C/W
			P Package			100	
			SL Package			135	

PARAMETER MEASUREMENT INFORMATION

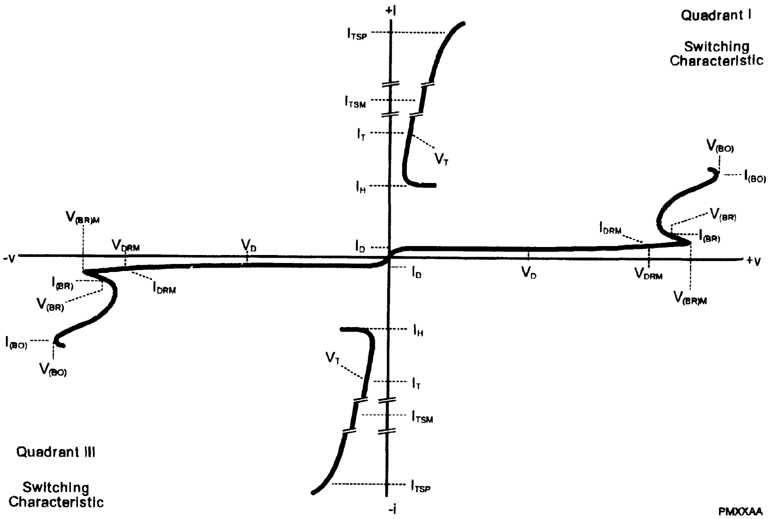


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR T AND R TERMINALS
T and G and R and G measurements are referenced to the G terminal
T and R measurements are referenced to the R terminal

TYPICAL CHARACTERISTICS
R and G, or T and G terminals

OFF-STATE CURRENT vs JUNCTION TEMPERATURE

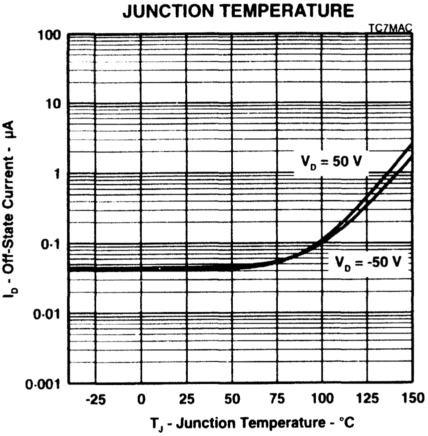


Figure 2.

NORMALISED BREAKDOWN VOLTAGES vs JUNCTION TEMPERATURE

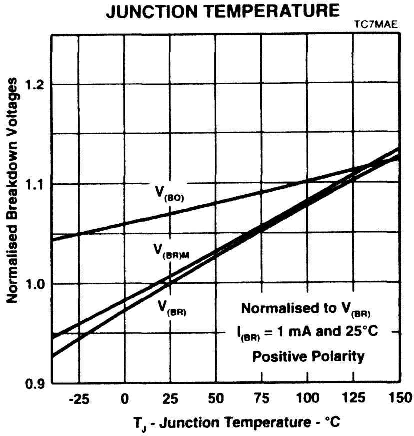


Figure 3.

NORMALISED BREAKDOWN VOLTAGES vs JUNCTION TEMPERATURE

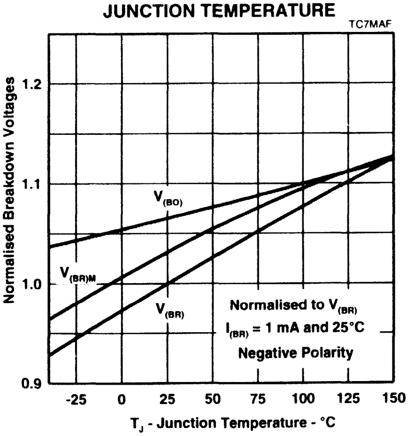


Figure 4.

ON-STATE CURRENT vs ON-STATE VOLTAGE

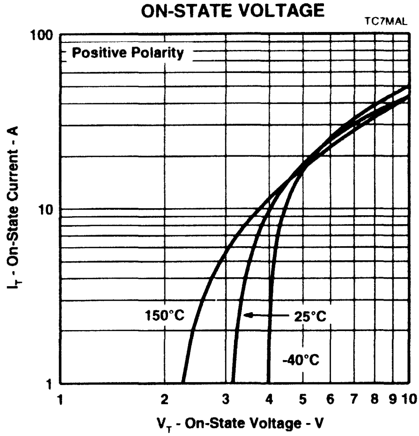


Figure 5.

TYPICAL CHARACTERISTICS
R and G, or T and G terminals

ON-STATE CURRENT vs ON-STATE VOLTAGE

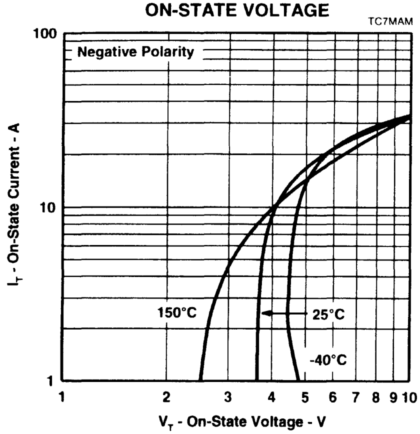


Figure 6.

HOLDING CURRENT & BREAKOVER CURRENT

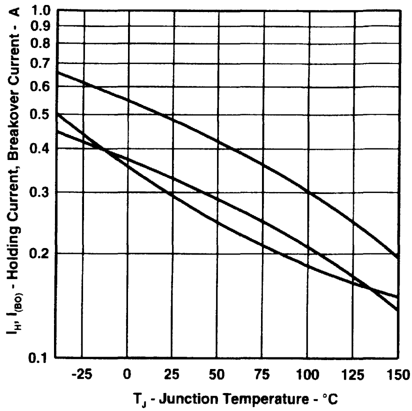


Figure 7.

NORMALISED BREAKOVER VOLTAGE vs RATE OF RISE OF PRINCIPLE CURRENT

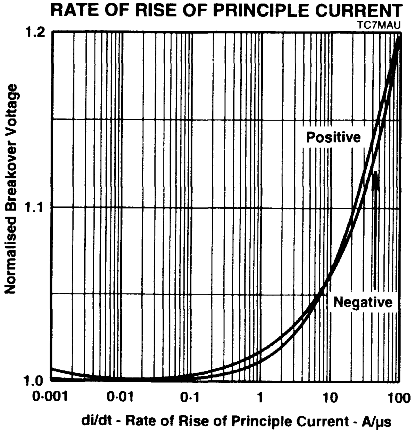


Figure 8.

OFF-STATE CAPACITANCE vs TERMINAL VOLTAGE (POSITIVE)

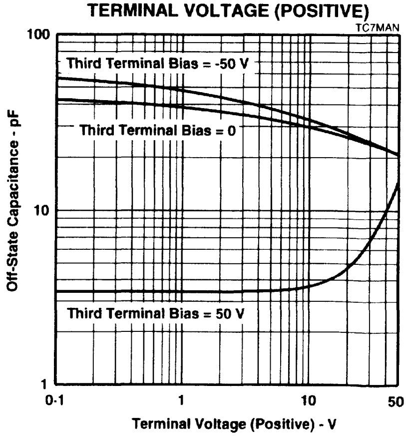


Figure 9.

TYPICAL CHARACTERISTICS
R and G, or T and G terminals

OFF-STATE CAPACITANCE vs TERMINAL VOLTAGE (NEGATIVE)

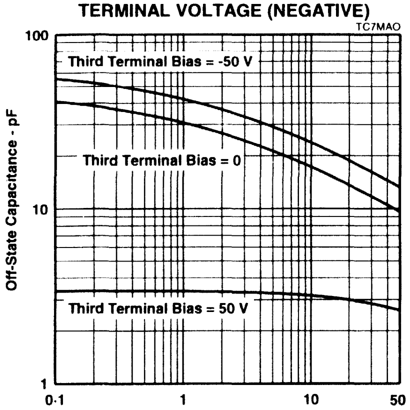


Figure 10.

OFF-STATE CAPACITANCE vs JUNCTION TEMPERATURE

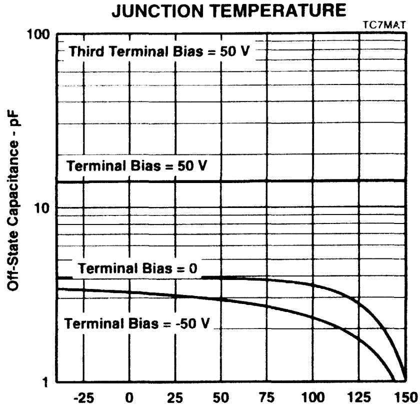


Figure 11.

OFF-STATE CAPACITANCE vs JUNCTION TEMPERATURE

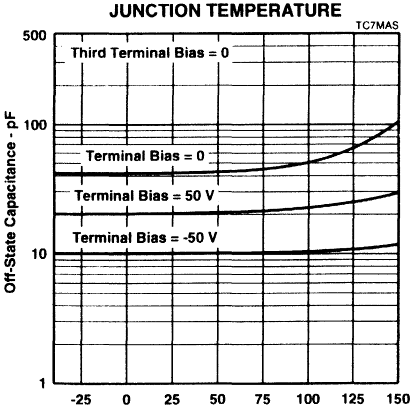


Figure 12.

OFF-STATE CAPACITANCE vs JUNCTION TEMPERATURE

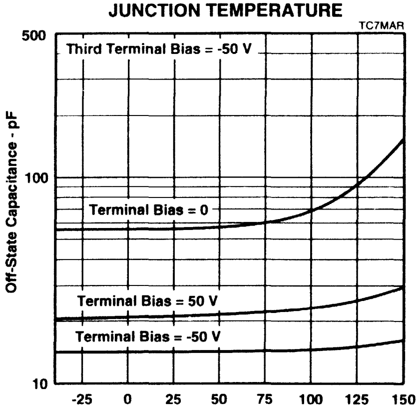


Figure 13.

TYPICAL CHARACTERISTICS
R and G, or T and G terminals

SURGE CURRENT
vs
DECAY TIME

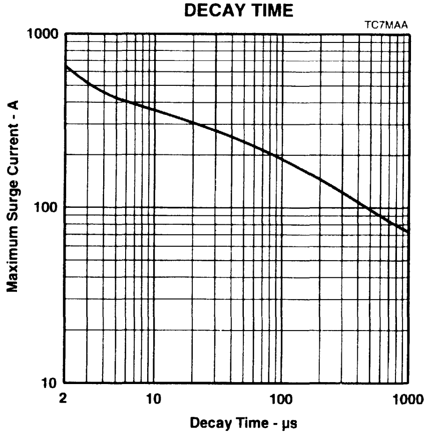


Figure 14.

TYPICAL CHARACTERISTICS
R and T terminals

OFF-STATE CURRENT
vs
JUNCTION TEMPERATURE

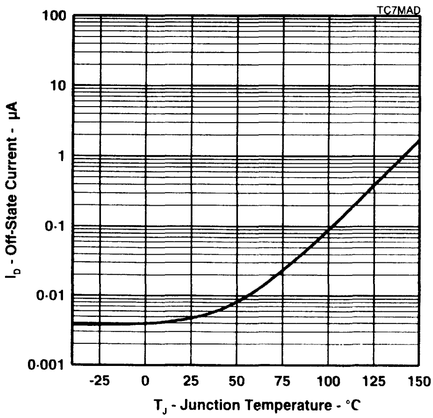


Figure 15.

NORMALISED BREAKDOWN VOLTAGES
vs
JUNCTION TEMPERATURE

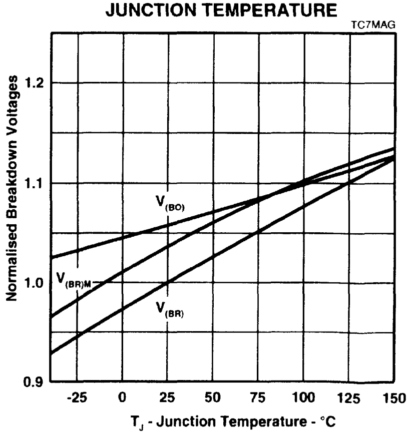


Figure 16.

TYPICAL CHARACTERISTICS
R and T terminals

ON-STATE CURRENT vs ON-STATE VOLTAGE

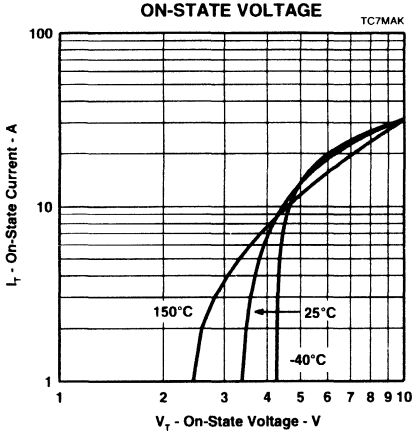


Figure 17.

HOLDING CURRENT & BREAKOVER CURRENT vs JUNCTION TEMPERATURE

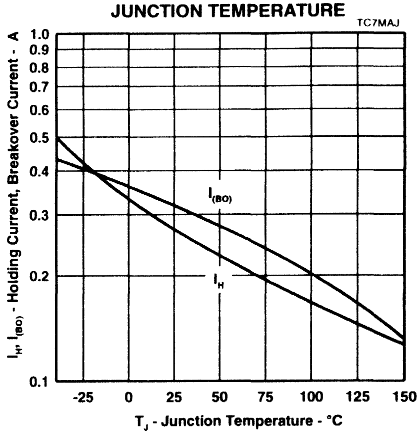


Figure 18.

NORMALISED BREAKOVER VOLTAGE vs RATE OF RISE OF PRINCIPLE CURRENT

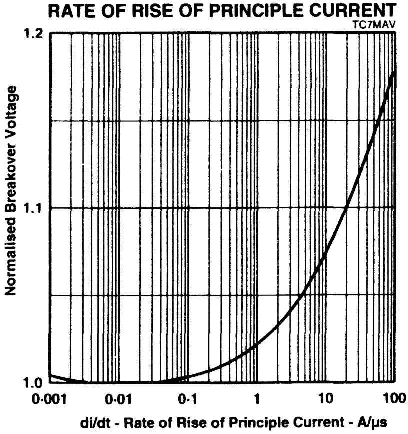


Figure 19.

OFF-STATE CAPACITANCE vs TERMINAL VOLTAGE (POSITIVE)

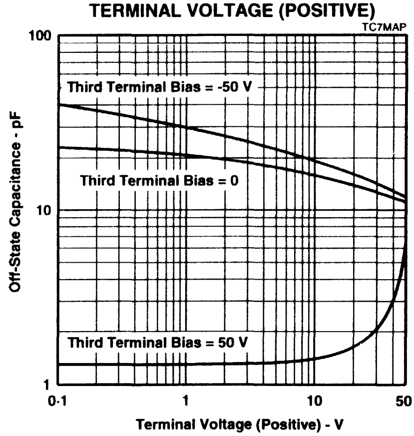


Figure 20.

TYPICAL CHARACTERISTICS

R and T terminals

OFF-STATE CAPACITANCE vs TERMINAL VOLTAGE (NEGATIVE)

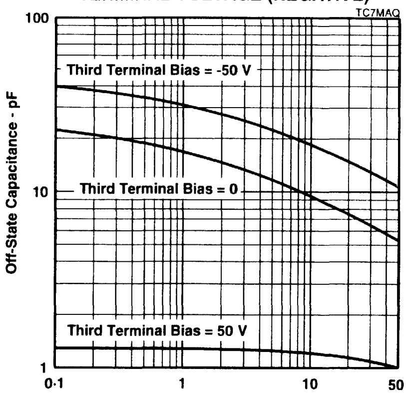


Figure 21.

THERMAL INFORMATION

MAXIMUM NON-RECURRING 50 Hz CURRENT vs CURRENT DURATION

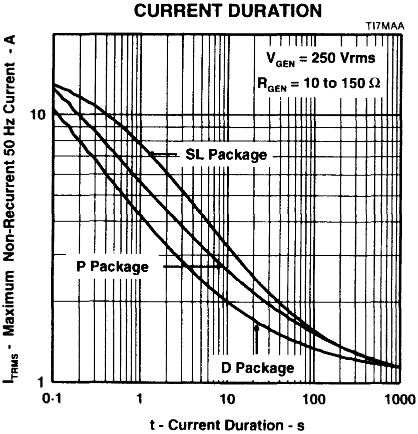


Figure 22.

THERMAL RESPONSE

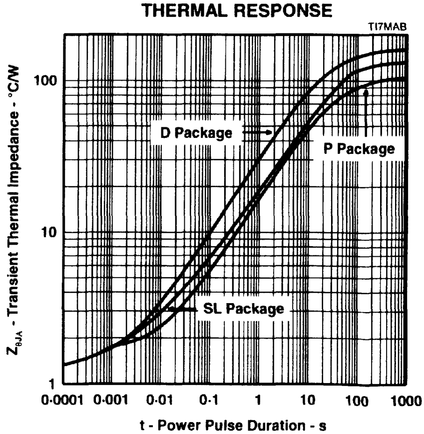


Figure 23.

APPLICATIONS INFORMATION

electrical characteristics

The electrical characteristics of a TISP are strongly dependent on junction temperature, T_J. Hence a characteristic value will depend on the junction temperature at the instant of measurement. The values given in this data sheet were measured on commercial testers, which generally minimise the temperature rise caused by testing. Application values may be calculated from the parameters' temperature coefficient, the power dissipated and the thermal response curve ,Z_θ (see M. J. Maytum, "Transient Suppressor Dynamic Parameters."TI Technical Journal, vol. 6, No. 4, pp.63-70, July-August 1989).

lightning surge

wave shape notation

Most lightning tests, used for equipment verification, specify a unidirectional sawtooth waveform which has an exponential rise and an exponential decay. Wave shapes are classified in terms of peak amplitude (voltage or current), rise time and a decay time to 50% of the maximum amplitude. The notation used for the wave shape is *amplitude, rise time/decay time*. A 50A, 5/310 µs wave shape would have a peak current value of 50 A, a rise time of 5 µs and a decay time of 310 µs. The TISP surge current graph comprehends the wave shapes of commonly used surges.

generators

There are three categories of surge generator type, single wave shape, combination wave shape and circuit defined. Single wave shape generators have essentially the same wave shape for the open circuit voltage and short circuit current (e.g. 10/1000 µs open circuit voltage and short circuit current). Combination generators have two wave shapes, one for the open circuit voltage and the other for the short circuit current (e.g. 1.2/50 µs open circuit voltage and 8/20 µs short circuit current) Circuit specified generators usually equate to a combination generator, although typically only the open circuit voltage waveshape is referenced (e.g. a 10/700 µs open circuit voltage generator typically produces a 5/310 µs short circuit current). If the combination or circuit defined generators operate into a finite resistance the wave shape produced is intermediate between the open circuit and short circuit values.

current rating

When the TISP switches into the on-state it has a very low impedance. As a result, although the surge wave shape may be defined in terms of open circuit voltage, it is the current wave shape that must be used to assess the required TISP surge capability. As an example, the CCITT IX K17 1.5 kV, 10/700 µs surge is changed to a 38 A, 5/310 µs waveshape when driving into a short circuit. Thus the TISP surge current capability, when directly connected to the generator, will be found for the CCITT IX K17 waveform at 310 µs on the surge graph and not 700 µs. Some common short circuit equivalents are tabulated below:

STANDARD	OPEN CIRCUIT VOLTAGE	SHORT CIRCUIT CURRENT
CCITT IX K17	1.5 kV, 10/700 µs	38 A, 5/310 µs
CCITT IX K20	1 kV, 10/700 µs	25 A, 5/310 µs
RLM88	1.5 kV, 0.5/700 µs	38 A, 0.2/310 µs
VDE 0433	2.0 kV, 10/700 µs	50 A, 5/200 µs
FTZ R12	2.0 kV, 10/700 µs	50 A, 5/310 µs

Any series resistance in the protected equipment will reduce the peak circuit current to less than the generators' short circuit value. A 2 kV open circuit voltage, 50 A short circuit current generator has an effective output impedance of 40 Ω (2000/50). If the equipment has a series resistance of 25 Ω then the surge current requirement of the TISP becomes 31 A (2000/65) and not 50 A.

APPLICATIONS INFORMATION

protection voltage

The protection voltage, ($V_{(BO)}$), increases under lightning surge conditions due to thyristor regeneration. This increase is dependent on the rate of current rise, di/dt, when the TISP is clamping the voltage in its breakdown region. The $V_{(BO)}$ value under surge conditions can be estimated by multiplying the 50 Hz rate $V_{(BO)}$ (250 V/ms) value by the normalised increase at the surge's di/dt (Figure 2.) . An estimate of the di/dt can be made from the surge generator voltage rate of rise, dv/dt, and the circuit resistance.

As an example, the CCITT IX K17 1.5 kV, 10/700 µs surge has an average dv/dt of 150 V/µs, but, as the rise is exponential, the initial dv/dt is higher, being in the region of 450 V/µs. The instantaneous generator output resistance is 25 Ω. If the equipment has an additional series resistance of 20 Ω, the total series resistance becomes 45 Ω. The maximum di/dt then can be estimated as 450/45 = 10 A/µs. In practice the measured di/dt and protection voltage increase will be lower due to inductive effects and the finite slope resistance of the TISP breakdown region.

capacitance

off-state capacitance

The off-state capacitance of a TISP is sensitive to junction temperature, T_J, and the bias voltage, comprising of the dc voltage, V_D, and the ac voltage, V_d. All the capacitance values in this data sheet are measured with an ac voltage of 100 mV. The typical 25°C variation of capacitance value with ac bias is shown in Figure 6 When $V_D >> V_d$ the capacitance value is independent on the value of V_d. The capacitance is essentially constant over the range of normal telecommunication frequencies.

NORMALISED CAPACITANCE
vs
RMS AC TEST VOLTAGE

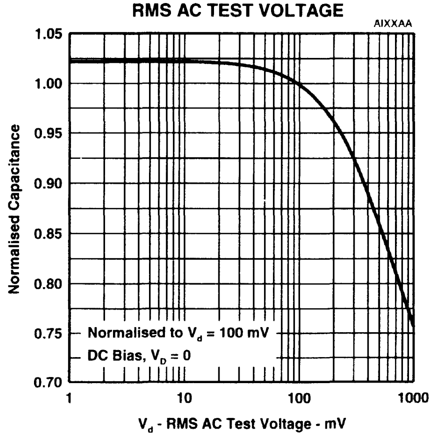


Figure 24.

APPLICATIONS INFORMATION

longitudinal balance

Figure 7 shows a three terminal TISP with its equivalent "delta" capacitance Each capacitance, C_{TG} , C_{RG} and C_{TR} , is the true terminal pair capacitance measured with a three terminal or guarded capacitance bridge. If wire R is biased at a larger potential than wire T then $C_{TG} > C_{RG}$. Capacitance C_{TG} is equivalent to a capacitance of C_{RG} in parallel with the capacitive difference of (C_{TG} - C_{RG}). The line capacitive unbalance is due to (C_{TG} - C_{RG}) and the capacitance shunting the line is $C_{TR} + C_{RG}/2$.

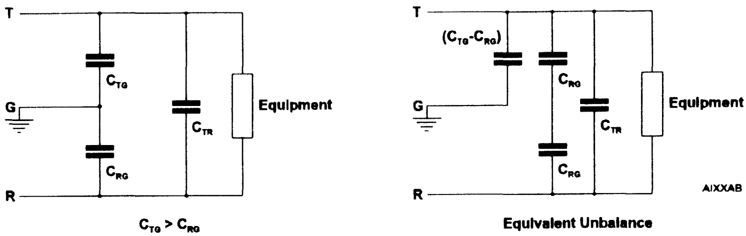


Figure 25.

All capacitance measurements in this data sheet are three terminal guarded to allow the designer to accurately assess capacitive unbalance effects. Simple two terminal capacitance meters (unguarded third terminal) give false readings as the shunt capacitance via the third terminal is included.

TELECOMMUNICATION SYSTEM SECONDARY PROTECTION

- **Ion-Implanted Breakdown Region**
  Precise and Stable Voltage
  Low Voltage Overshoot under Surge

DEVICE	V_{DRM} V	$V_{(BO)}$ V
'7240F3	180	240
'7260F3	200	260
'7290F3	220	290
'7320F3	240	320
'7380F3	270	380

- **Planar Passivated Junctions**
  Low Off-State Current < 10 μA

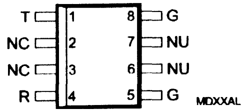
- **Rated for International Surge Wave Shapes**

WAVE SHAPE	STANDARD	I_{TSP} A
2/10 μs	FCC Part 68	175
8/20 μs	ANSI C62.41	120
10/160 μs	FCC Part 68	60
10/560 μs	FCC Part 68	45
0.5/700 μs	RLM 88	38
10/700 μs	FTZ R12	50
	VDE 0433	50
	CCITT IX K17	38
10/1000 μs	REA PE-60	35

- **Surface Mount and Through-Hole Options**

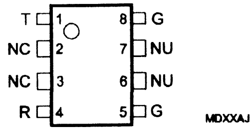
PACKAGE	PART # SUFFIX
Small-outline	D
Small-outline taped and reeled	DR
Plastic DIP	P
Single-in-line	SL

D PACKAGE
(TOP VIEW)



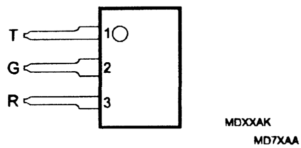
NC - No internal connection
NU - Nonusable; no external electrical connection should be made to these pins.
Specified ratings require connection of pin 5 and pin 8.

P PACKAGE
(TOP VIEW)

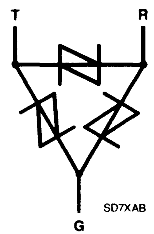


NC - No internal connection
NU - Nonusable; no external electrical connection should be made to these pins.
Specified ratings require connection of pin 5 and pin 8.

SL PACKAGE
(TOP VIEW)



device symbol



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

description

These high voltage symmetrical transient voltage suppressor devices are designed to protect against metallic and simultaneous longitudinal surges. These balanced devices are suitable for the protection of telecommunication applications with battery backed ringing against transients caused by lightning strikes and ac power lines. Offered in five voltage variants to meet battery and protection requirements they are guaranteed to suppress and withstand the listed international lightning surges on any terminal pair.

TEXAS INSTRUMENTS

description (continued)

Transients are initially clipped by breakdown clamping until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the current subsides

These monolithic protection devices are fabricated in ion-implanted planar structures to ensure precise and matched breakover control and are virtually transparent to the system in normal operation

The small-outline 8-pin assignment has been carefully chosen for the TISP series to maximise the inter-pin clearance and creepage distances which are used by standards (e.g. IEC950) to establish voltage withstand ratings.

absolute maximum ratings

RATING		SYMBOL	VALUE	UNIT
Repetitive peak off-state voltage (0°C < T_J < 70°C)	'7240F3	V_{DRM}	180	V
	'7260F3		200	
	'7290F3		220	
	'7320F3		240	
	'7380F3		270	
Non-repetitive peak on-state pulse current (see Notes 1, 2 and 3)		I_{TSP}		A
1/2 µs (Gas tube differential transient, open-circuit voltage wave shape 1/2 µs)			350	
2/10 µs (FCC Part 68, open-circuit voltage wave shape 2/10 µs)			175	
8/20 µs (ANSI C62.41, open-circuit voltage wave shape 1.2/50 µs)			120	
10/160 µs (FCC Part 68, open-circuit voltage wave shape 10/160 µs)			60	
5/200 µs (VDE 0433, open-circuit voltage wave shape 2 kV, 10/700 µs)			50	
0.2/310 µs (RLM 88, open-circuit voltage wave shape 1.5 kV, 0.5/700 µs)			38	
5/310 µs (CCITT IX K17, open-circuit voltage wave shape 1.5 kV, 10/700 µs)			38	
5/310 µs (FTZ R12, open-circuit voltage wave shape 2 kV, 10/700 µs)			50	
10/560 µs (FCC Part 68, open-circuit voltage wave shape 10/560 µs)			45	
10/1000 µs (REA PE-60, open-circuit voltage wave shape 10/1000 µs)			35	
Non-repetitive peak on-state current (see Notes 2 and 3) 50 Hz, 1 s	D Package	I_{TSM}	3	A rms
	P Package		4	
	SL Package		5	
Initial rate of rise of on-state current, Linear current ramp, Maximum ramp value < 38 A		di_T/dt	250	A/µs
Junction temperature		T_J	-40 to +150	°C
Storage temperature range		T_{stg}	-40 to +150	°C

NOTES: 1. Further details on surge wave shapes are contained in the Applications Information section.
2. Initially the TISP must be in thermal equilibrium with 0°C < T_J <70°C. The surge may be repeated after the TISP returns to its initial conditions.
3. Above 70°C, derate linearly to zero at 150°C lead temperature.

electrical characteristics for the T and G, R and G and T and R terminals, 25°C

PARAMETER		TEST CONDITIONS	TISP7240F3			TISP7260F3			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
I_{DRM}	Repetitive peak off-state current	$V_D = \pm V_{DRM}$, 0°C < T_J < 70°C			±10			±10	µA
$V_{(BO)}$	Breakover voltage	dv/dt = ±250 V/ms, R_{SOURCE} = 300 Ω			±240			±260	V
$V_{(BO)}$	Impulse breakover voltage	dv/dt = ±1000 V/µs, R_{SOURCE} = 50 Ω. di/dt < 20 A/µs		±269			±289		V
$I_{(BO)}$	Breakover current	dv/dt = ±250 V/ms, R_{SOURCE} = 300 Ω	±0.1		±0.8	±0.1		±0.8	A
V_T	On-state voltage	I_T = ±5 A, t_W = 100 µs			±5			±5	V
I_H	Holding current	di/dt = +/-30 mA/ms	±0.15			±0.15			

electrical characteristics for the T and G, R and G and T and R terminals, 25°C (continued)

PARAMETER		TEST CONDITIONS		TISP7240F3 MIN	TYP	MAX	TISP7260F3 MIN	TYP	MAX	UNIT
dv/dt	Critical rate of rise of off-state voltage	Linear voltage ramp Maximum ramp value < $0.85V_{(BR)MIN}$		±5			±5			kV/µs
I_D	Off-state current	V_D = ±50 V				±10			±10	µA
C_{off}	Off-state capacitance	f = 100 kHz, V_d = 100 mV Third terminal voltage = 0 (see Notes 4 and 5)	V_D = 0,		44	90		44	90	pF
			V_D = -5 V		18	40		18	40	pF
			V_D = -50 V		7	15		7	15	pF
			V_{DTR} = 0		26	50		26	50	pF

NOTES: 4 Further details on capacitance are given in the Applications Information section.
5 First three capacitance values, with bias V_D, are for the T and G and T and G terminals only. The forth capacitance value, with bias V_{DTR}, is for T and R terminals only.

electrical characteristics for the T and G, R and G and T and R terminals, 25°C

PARAMETER		TEST CONDITIONS		TISP7290F3 MIN	TYP	MAX	TISP7320F3 MIN	TYP	MAX	UNIT
I_{DRM}	Repetitive peak off-state current	$V_D = \pm V_{DRM}$, 0°C < T_J < 70°C				±10			±10	µA
$V_{(BO)}$	Breakover voltage	dv/dt = ±250 V/ms, R_{SOURCE} = 300 Ω				±290			±320	V
$V_{(BO)}$	Impulse breakover voltage	dv/dt = ±1000 V/µs, R_{SOURCE} = 50 Ω, di/dt < 20 A/µs			±319			±349		V
$I_{(BO)}$	Breakover current	dv/dt = ±250 V/ms, R_{SOURCE} = 300 Ω		±0.1		±0.8	±0.1		±0.8	A
V_T	On-state voltage	I_T = ±5 A, t_W = 100 µs				±5			±5	V
I_H	Holding current	di/dt = +/-30 mA/ms		±0.15			±0.15			
dv/dt	Critical rate of rise of off-state voltage	Linear voltage ramp Maximum ramp value < $0.85V_{(BR)MIN}$		±5			±5			kV/µs
I_D	Off-state current	V_D = ±50 V				±10			±10	µA
C_{off}	Off-state capacitance	f = 100 kHz, V_d = 100 mV Third terminal voltage = 0 (see Notes 4 and 5)	V_D = 0,		44	90		44	90	pF
			V_D = -5 V		18	40		18	40	pF
			V_D = -50 V		7	15		7	15	pF
			V_{DTR} = 0		26	50		26	50	pF

electrical characteristics for the T and G, R and G and T and R terminals, 25°C

PARAMETER		TEST CONDITIONS	TISP7380F3 MIN	TYP	MAX	UNIT
I_{DRM}	Repetitive peak off-state current	$V_D = \pm V_{DRM}$, 0°C < T_J < 70°C			±10	µA
$V_{(BO)}$	Breakover voltage	dv/dt = ±250 V/ms, R_{SOURCE} = 300 Ω			±380	V
$V_{(BO)}$	Impulse breakover voltage	dv/dt = ±1000 V/µs, R_{SOURCE} = 50 Ω, di/dt < 20 A/µs		±409		V
$I_{(BO)}$	Breakover current	dv/dt = ±250 V/ms, R_{SOURCE} = 300 Ω	±0.1		±0.8	A
V_T	On-state voltage	I_T = ±5 A, t_W = 100 µs			±5	V
I_H	Holding current	di/dt = +/-30 mA/ms	±0.15			
dv/dt	Critical rate of rise of off-state voltage	Linear voltage ramp Maximum ramp value < $0.85V_{(BR)MIN}$	±5			kV/µs
I_D	Off-state current	V_D = ±50 V			±10	µA

electrical characteristics for the T and G, R and G and T and R terminals, 25°C (continued)

PARAMETER		TEST CONDITIONS		TISP7380F3 MIN	TYP	MAX	UNIT
C_{off}	Off-state capacitance	f = 100 kHz, V_d = 100 mV Third terminal voltage = 0 (see Notes 6 and 7)	V_D = 0,		44	90	pF
			V_D = -5 V		18	40	pF
			V_D = -50 V		7	15	pF
			V_{DTR} = 0		26	50	pF

NOTES: 6 Further details on capacitance are given in the Applications Information section.
7 First three capacitance values, with bias V_D, are for the T and G and T and G terminals only. The forth capacitance value, with bias V_{DTR}, is for T and R terminals only.

thermal characteristics

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance	P_{tot} = 0.8 W, T_A = 25°C 5 cm², FR4 PCB	D Package			160	°C/W
			P Package			100	
			SL Package			135	

PARAMETER MEASUREMENT INFORMATION

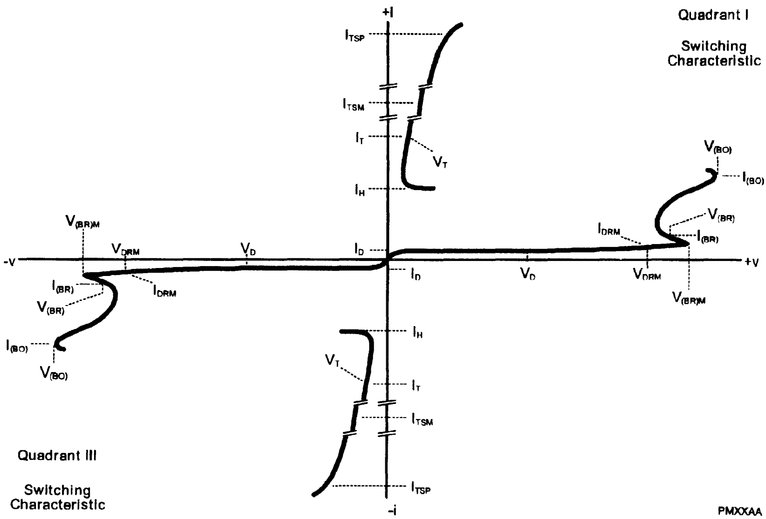


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR T AND R TERMINALS
T and G and R and G measurements are referenced to the G terminal
T and R measurements are referenced to the R terminal

TYPICAL CHARACTERISTICS
R and G, or T and G terminals

OFF-STATE CURRENT vs JUNCTION TEMPERATURE

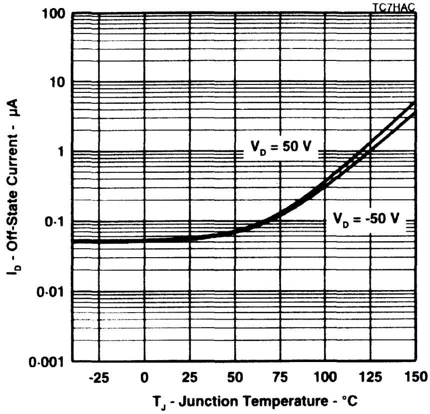


Figure 2.

NORMALISED BREAKDOWN VOLTAGES vs JUNCTION TEMPERATURE

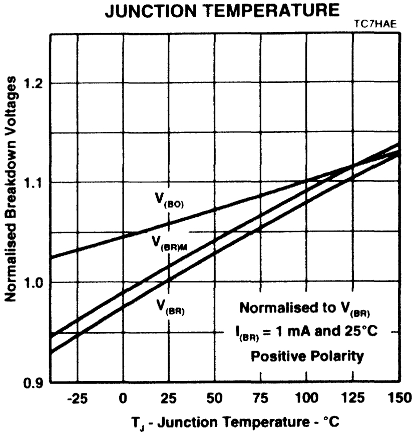


Figure 3.

NORMALISED BREAKDOWN VOLTAGES vs JUNCTION TEMPERATURE

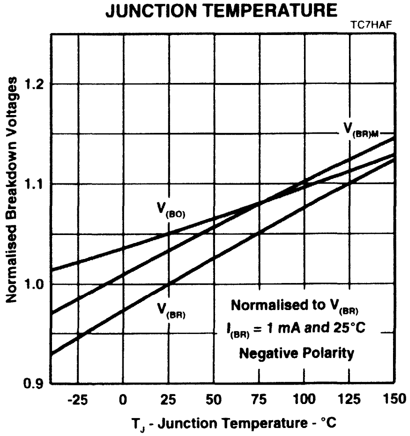


Figure 4.

ON-STATE CURRENT vs ON-STATE VOLTAGE

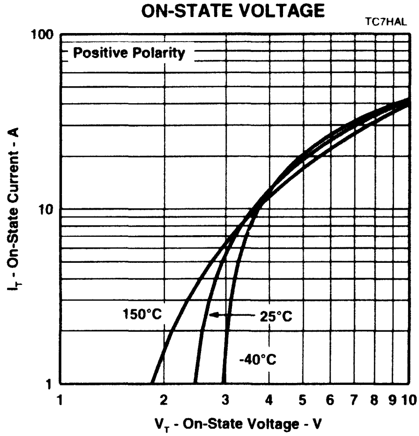


Figure 5.

TEXAS INSTRUMENTS

TYPICAL CHARACTERISTICS
R and G, or T and G terminals

ON-STATE CURRENT vs ON-STATE VOLTAGE

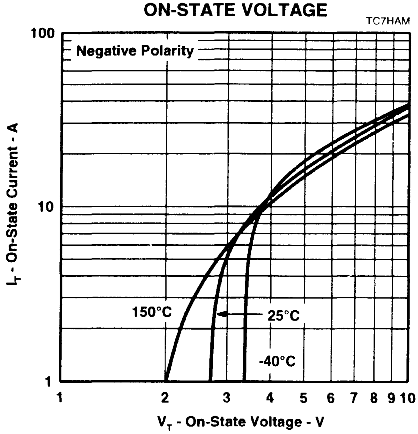


Figure 6.

HOLDING CURRENT & BREAKOVER CURRENT vs JUNCTION TEMPERATURE

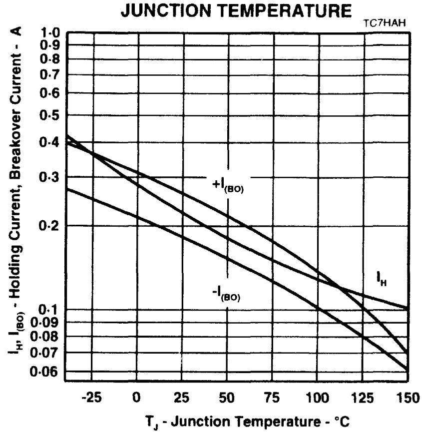


Figure 7.

NORMALISED BREAKOVER VOLTAGE vs RATE OF RISE OF PRINCIPLE CURRENT

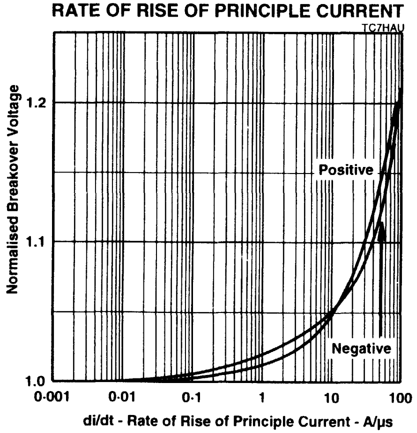


Figure 8.

OFF-STATE CAPACITANCE vs TERMINAL VOLTAGE (POSITIVE)

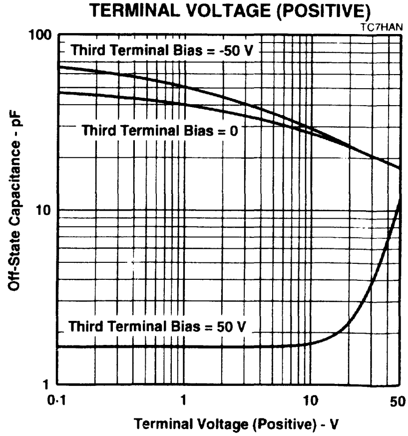


Figure 9.

TYPICAL CHARACTERISTICS
R and G, or T and G terminals

OFF-STATE CAPACITANCE vs TERMINAL VOLTAGE (NEGATIVE)

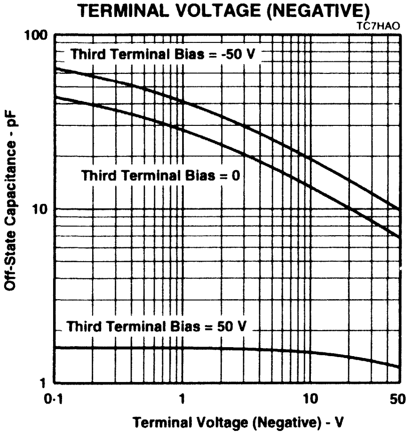


Figure 10.

OFF-STATE CAPACITANCE vs JUNCTION TEMPERATURE

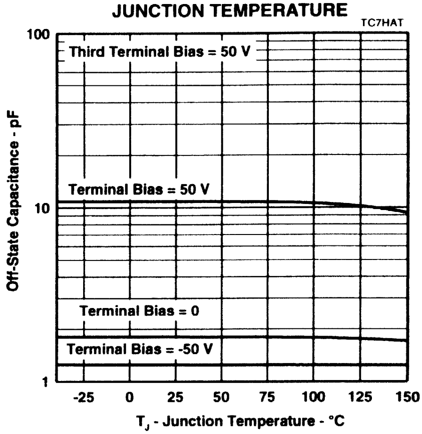


Figure 11.

OFF-STATE CAPACITANCE vs JUNCTION TEMPERATURE

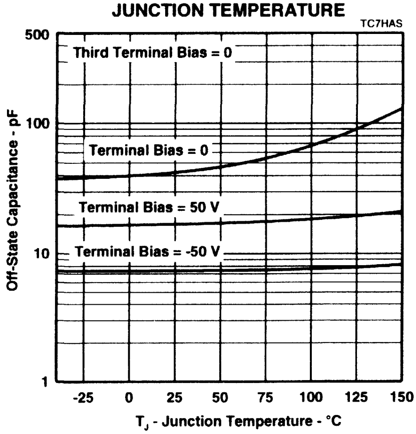


Figure 12.

OFF-STATE CAPACITANCE vs JUNCTION TEMPERATURE

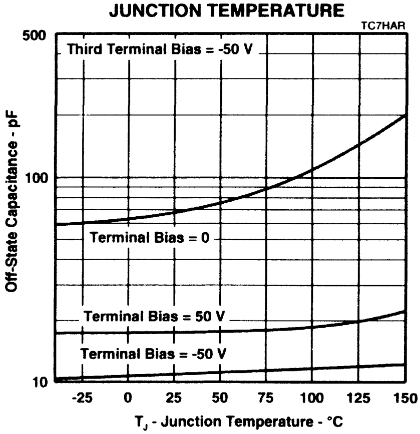


Figure 13.

TYPICAL CHARACTERISTICS
R and G, or T and G terminals

SURGE CURRENT
vs
DECAY TIME

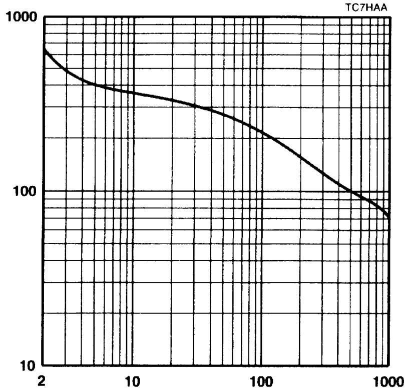


Figure 14.

TYPICAL CHARACTERISTICS
R and T terminals

OFF-STATE CURRENT
vs
JUNCTION TEMPERATURE

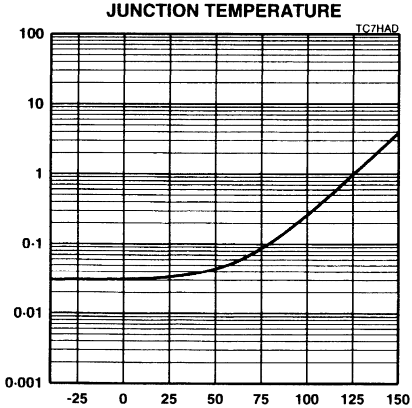


Figure 15.

NORMALISED BREAKDOWN VOLTAGES
vs
JUNCTION TEMPERATURE

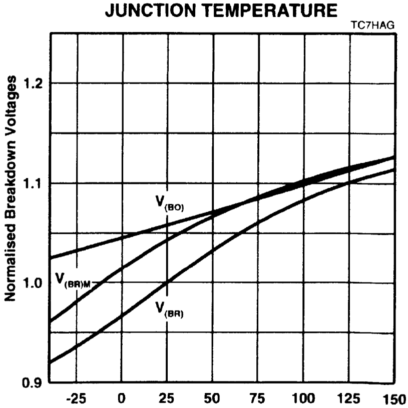


Figure 16.

TEXAS INSTRUMENTS

TYPICAL CHARACTERISTICS
R and T terminals

ON-STATE CURRENT vs ON-STATE VOLTAGE

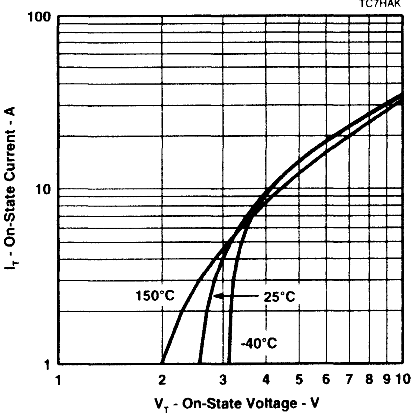


Figure 17.

HOLDING CURRENT & BREAKOVER CURRENT vs JUNCTION TEMPERATURE

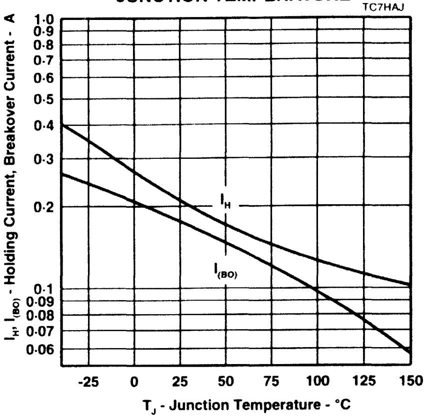


Figure 18.

NORMALISED BREAKOVER VOLTAGE vs RATE OF RISE OF PRINCIPLE CURRENT

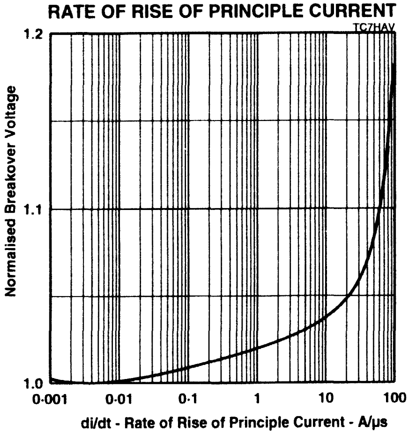


Figure 19.

OFF-STATE CAPACITANCE vs TERMINAL VOLTAGE (POSITIVE)

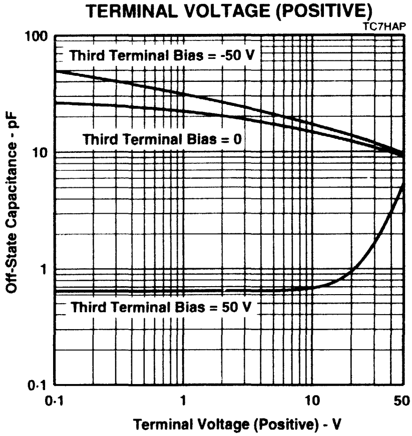


Figure 20.

TYPICAL CHARACTERISTICS

R and G, T and G and R and T terminals

OFF-STATE CAPACITANCE

vs

TERMINAL VOLTAGE (NEGATIVE)

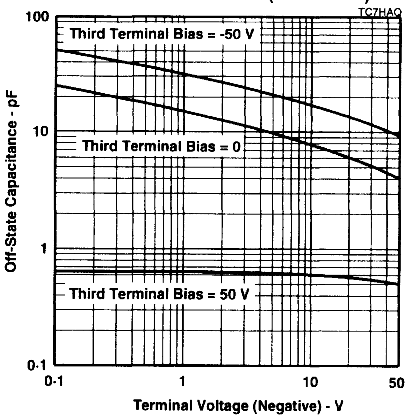


Figure 21.

THERMAL INFORMATION

MAXIMUM NON-RECURRING 50 Hz CURRENT

vs

CURRENT DURATION

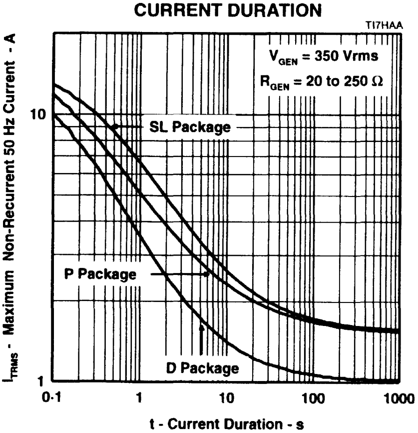


Figure 22.

THERMAL RESPONSE

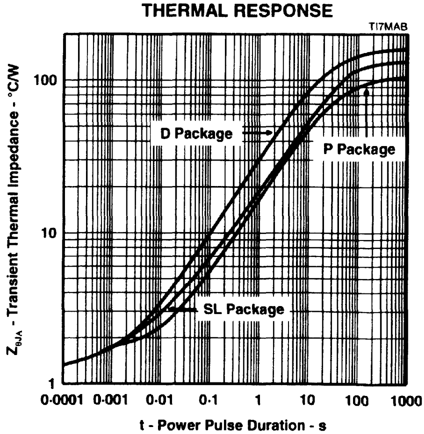


Figure 23.

APPLICATIONS INFORMATION

electrical characteristics

The electrical characteristics of a TISP are strongly dependent on junction temperature, T_J. Hence a characteristic value will depend on the junction temperature at the instant of measurement. The values given in this data sheet were measured on commercial testers, which generally minimise the temperature rise caused by testing. Application values may be calculated from the parameters' temperature coefficient, the power dissipated and the thermal response curve ,Z_θ (see M. J. Maytum, "Transient Suppressor Dynamic Parameters."TI Technical Journal, vol. 6, No. 4, pp.63-70, July-August 1989).

lightning surge

wave shape notation

Most lightning tests, used for equipment verification, specify a unidirectional sawtooth waveform which has an exponential rise and an exponential decay. Wave shapes are classified in terms of peak amplitude (voltage or current), rise time and a decay time to 50% of the maximum amplitude. The notation used for the wave shape is *amplitude, rise time/decay time*. A 50A, 5/310 µs wave shape would have a peak current value of 50 A, a rise time of 5 µs and a decay time of 310 µs. The TISP surge current graph comprehends the wave shapes of commonly used surges.

generators

There are three categories of surge generator type, single wave shape, combination wave shape and circuit defined. Single wave shape generators have essentially the same wave shape for the open circuit voltage and short circuit current (e.g. 10/1000 µs open circuit voltage and short circuit current). Combination generators have two wave shapes, one for the open circuit voltage and the other for the short circuit current (e.g. 1.2/50 µs open circuit voltage and 8/20 µs short circuit current) Circuit specified generators usually equate to a combination generator, although typically only the open circuit voltage waveshape is referenced (e.g. a 10/700 µs open circuit voltage generator typically produces a 5/310 µs short circuit current). If the combination or circuit defined generators operate into a finite resistance the wave shape produced is intermediate between the open circuit and short circuit values.

current rating

When the TISP switches into the on-state it has a very low impedance. As a result, although the surge wave shape may be defined in terms of open circuit voltage, it is the current wave shape that must be used to assess the required TISP surge capability. As an example, the CCITT IX K17 1.5 kV, 10/700 µs surge is changed to a 38 A, 5/310 µs waveshape when driving into a short circuit. Thus the TISP surge current capability, when directly connected to the generator, will be found for the CCITT IX K17 waveform at 310 µs on the surge graph and not 700 µs. Some common short circuit equivalents are tabulated below:

STANDARD	OPEN CIRCUIT VOLTAGE	SHORT CIRCUIT CURRENT
CCITT IX K17	1.5 kV, 10/700 µs	38 A, 5/310 µs
CCITT IX K20	1 kV, 10/700 µs	25 A, 5/310 µs
RLM88	1.5 kV, 0.5/700 µs	38 A, 0.2/310 µs
VDE 0433	2.0 kV, 10/700 µs	50 A, 5/200 µs
FTZ R12	2.0 kV, 10/700 µs	50 A, 5/310 µs

Any series resistance in the protected equipment will reduce the peak circuit current to less than the generators' short circuit value. A 2 kV open circuit voltage, 50 A short circuit current generator has an effective output impedance of 40 Ω (2000/50). If the equipment has a series resistance of 25 Ω then the surge current requirement of the TISP becomes 31 A (2000/65) and not 50 A.

APPLICATIONS INFORMATION

protection voltage

The protection voltage, ($V_{(BO)}$), increases under lightning surge conditions due to thyristor regeneration. This increase is dependent on the rate of current rise, di/dt, when the TISP is clamping the voltage in its breakdown region. The $V_{(BO)}$ value under surge conditions can be estimated by multiplying the 50 Hz rate $V_{(BO)}$ (250 V/ms) value by the normalised increase at the surge's di/dt (Figure 2.) . An estimate of the di/dt can be made from the surge generator voltage rate of rise, dv/dt, and the circuit resistance.

As an example, the CCITT IX K17 1.5 kV, 10/700 µs surge has an average dv/dt of 150 V/µs, but, as the rise is exponential, the initial dv/dt is higher, being in the region of 450 V/µs. The instantaneous generator output resistance is 25 Ω. If the equipment has an additional series resistance of 20 Ω, the total series resistance becomes 45 Ω. The maximum di/dt then can be estimated as 450/45 = 10 A/µs. In practice the measured di/dt and protection voltage increase will be lower due to inductive effects and the finite slope resistance of the TISP breakdown region.

capacitance

off-state capacitance

The off-state capacitance of a TISP is sensitive to junction temperature, T_J, and the bias voltage, comprising of the dc voltage, V_D, and the ac voltage, V_d. All the capacitance values in this data sheet are measured with an ac voltage of 100 mV. The typical 25°C variation of capacitance value with ac bias is shown in Figure 6 When $V_D >> V_d$ the capacitance value is independent on the value of V_d. The capacitance is essentially constant over the range of normal telecommunication frequencies.

NORMALISED CAPACITANCE
vs
RMS AC TEST VOLTAGE

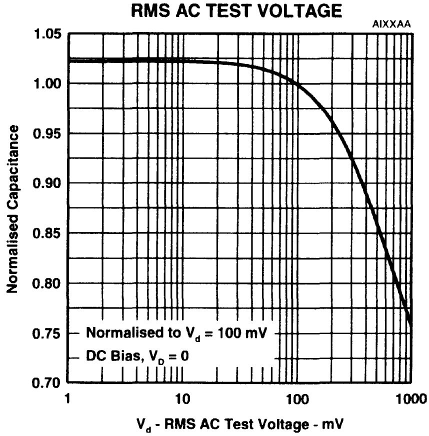


Figure 24.

APPLICATIONS INFORMATION

longitudinal balance

Figure 7 shows a three terminal TISP with its equivalent "delta" capacitance Each capacitance, C_{TG} , C_{RG} and C_{TR} , is the true terminal pair capacitance measured with a three terminal or guarded capacitance bridge. If wire R is biased at a larger potential than wire T then $C_{TG} > C_{RG}$. Capacitance C_{TG} is equivalent to a capacitance of C_{RG} in parallel with the capacitive difference of (C_{TG} - C_{RG}). The line capacitive unbalance is due to (C_{TG} - C_{RG}) and the capacitance shunting the line is $C_{TR} + C_{RG}/2$.

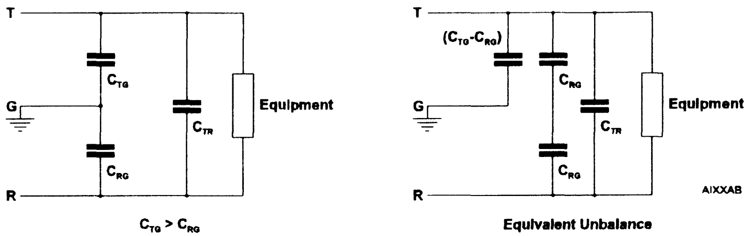


Figure 25.

All capacitance measurements in this data sheet are three terminal guarded to allow the designer to accurately assess capacitive unbalance effects. Simple two terminal capacitance meters (unguarded third terminal) give false readings as the shunt capacitance via the third terminal is included.

TISP61CAP3
PROGRAMMABLE TRANSIENT VOLTAGE SUPPRESSORS

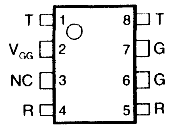
SLPSE45 - SEPTEMBER 1994

TELECOMMUNICATION SYSTEM SECONDARY PROTECTION

- **Programmable Voltage Triggered SCR with high Holding Current**
- **Transistor Buffered Inputs for Low V_{GG} current**
- **Rated for International Surge Wave Shapes**

WAVE SHAPE	STANDARD	I_{TSP} A
10/700 µs	CCITT IX K17	38
10/1000 µs	REA PE-60	30

P PACKAGE (TOP VIEW)



MD6XAC

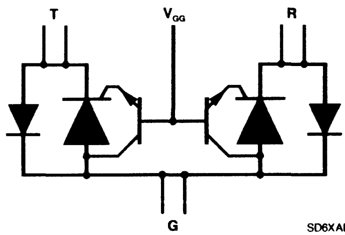
NC - No internal connection

description

The TISP61CAP3 is a programmable overvoltage protector designed to protect SLIC applications against lightning and transients induced by ac power lines. Normally the V_{GG} (Gate) terminal will be connected to the negative supply rail of the SLIC

When a negative transient exceeds the negative supply rail voltage of the SLIC it will cause the thyristor to crowbar, shunting the surge to ground. The high crowbar holding current prevents dc latchup as the transient subsides. Positive transients are clipped by diode action.

device symbol



SD6XAB

Terminals T, R and G correspond to the alternative line designators of A, B and C. The negative protection voltage is controlled by the voltage applied to the V_{GG} terminal.

absolute maximum ratings

RATING	SYMBOL	VALUE	UNIT
Non-repetitive peak on-state pulse current (see Notes 1, 2 and 3)			
5/310 µs (CCITT IX K17, open-circuit voltage wave shape 1.5 kV, 10/700 µs)	I_{TSP}	38	A
10/1000 µs (REA PE-60, open-circuit voltage wave shape 10/1000 µs)		30	
Non-repetitive peak on-state current, 50 Hz, 1 s (see Notes 1 and 2)	I_{TSM}	2.5	A rms
Maximum gate current	I_{GM}	2	A
Repetitive peak off-state voltage	V_{DRM}	- 80	V
Maximum gate supply voltage	$V_{GG(max)}$	- 80	V

NOTES: 1. Above 70°C, derate linearly to zero at 150°C case temperature

2. This value applies when the initial case temperature is at (or below) 70°C. The surge may be repeated after the device has returned to thermal equilibrium.
3. Most PTT's quote an unloaded voltage waveform. In operation the TISP essentially shorts the generator output. The resulting loaded current waveform is specified.

electrical characteristics, T_J = 25°C

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
V_F	Forward voltage	I_F = 5 A					3	V
V_{FR}	Forward recovery voltage	dv/dt = 300 V/µs	di/dt < 10 A/µs	R_{SOURCE} = 30 Ω			7	V
$V_{GK(BO)}$	Gate cathode voltage at breakover ($V_{(BO)}$ - V_{GG})	dv/dt = -250 V/ms	-72 < V_{GG} < -10 V	R_{SOURCE} = 300 Ω			-3	V
$V_{GK(BO)}$	Impulse gate cathode voltage at breakover ($V_{(BO)}$ - V_{GG})	dv/dt = -300 V/µs di/dt < -10 A/µs	-72 < V_{GG} < -10 V	R_{SOURCE} = 30 Ω			-15	V
V_T	On-state voltage	I_T = -4 A	-72 < V_{GG} < -10 V				-3	V
I_D	Off-state current	V_D = -80 V	V_{GG} = -80 V				-10	µA
I_S	Switching current	dv/dt = -250 V/ms	-72 < V_{GG} < -10 V	R_{SOURCE} = 300 Ω	-0.15			A
I_H	Holding current	di/dt = 30 mA/µs	-72 < V_{GG} < -10 V		-0.15			A
I_{GAO}	Gate reverse current with cathode open	V_{GG} = -72 V					-10	µA
I_{GAT}	Gate reverse current in the on-state	V_{GG} = -72 V	I_T = -0.5 A				-1	mA
I_{GAF}	Gate reverse current in the forward conducting state	V_{GG} = -72 V	I_T = 1 A I_T = 5 A			-10 -30		mA
I_{GSM}	Peak gate switching current	dv/dt = -250 V/ms	-72 < V_{GG} < -10 V	R_{SOURCE} = 300 Ω			5	mA
C_{off}	Off-state capacitance	-72 < V_{GG} < -10 V	V_D = -3 V V_D = -48 V	(see Note 4)			150 80	pF
dv/dt	Critical rate of rise of off-state voltage	V_{GG} = -72 V, linear ramp, Maximum ramp value > 0.85 V_{GG}			-50			V/µs

NOTE 4: These capacitance measurements employ a three terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.

PARAMETER MEASUREMENT INFORMATION

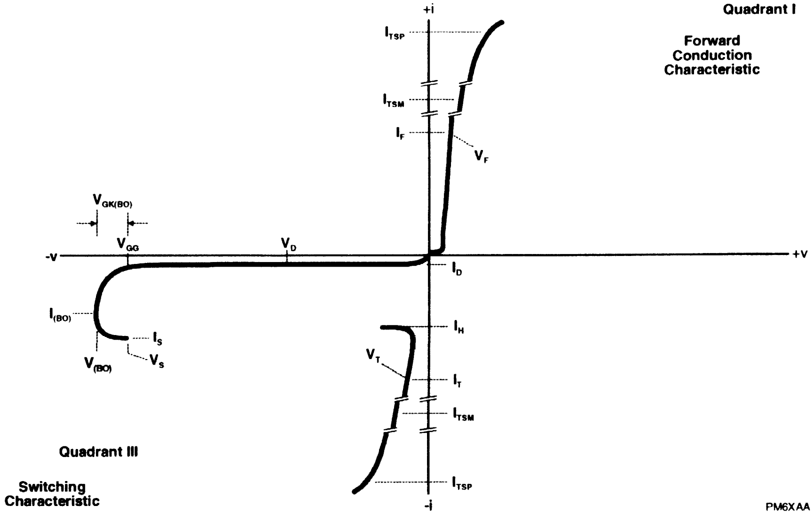


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC

Technical Specifications

DO-220 Package
SOT-82 Package
TO-220 Package
TO-92 Package

TEXAS INSTRUMENTS

TELECOMMUNICATION SYSTEM SECONDARY PROTECTION

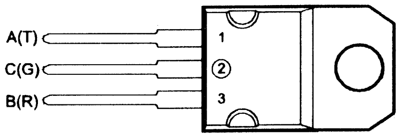
- **Ion-Implanted Breakdown Region**
  Precise and Stable Voltage
  Low Voltage Overshoot under Surge

DEVICE	$V_{(Z)}$ V	$V_{(BO)}$ V
'1082	- 58	- 82

- **Planar Passivated Junctions**
  Low Off-State Current < 10 µA
- **Rated for International Surge Wave Shapes**

WAVE SHAPE	STANDARD	I_{TSP} A
8/20 µs	ANSI C62.41	150
10/160 µs	FCC Part 68	60
10/560 µs	FCC Part 68	45
0.5/700 µs	RLM 88	38
10/700 µs	FTZ R12	50
	VDE 0433	50
	CCITT IX K17	50
10/1000 µs	REA PE-60	50

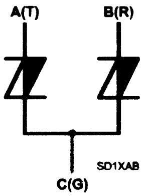
TO-220 PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDXXAN

device symbol



description

The TISP1082 is designed specifically for telephone line card protection against lightning and transients induced by ac power lines. These devices will supress voltage transients between terminals A and C, B and C, and A and B.

Negative transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides. Positive transients are clipped by diode action.

These monolithic protection devices are fabricated in ion-implanted planar structures to ensure precise and matched breakover control and are virtually transparent to the system in normal operation

TEXAS INSTRUMENTS

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING	SYMBOL	VALUE	UNIT
Non-repetitive peak on-state pulse current (see Notes 1, 2 and 3)			
8/20 µs (ANSI C62.41, open-circuit voltage wave shape 1.2/50 µs)		150	
10/160 µs (FCC Part 68, open-circuit voltage wave shape 10/160 µs)		60	
5/200 µs (VDE 0433, open-circuit voltage wave shape 2 kV, 10/700 µs)		50	
0.5/310 µs (RLM 88, open-circuit voltage wave shape 1.5 kV, 0.5/700 µs)	I_{TSP}	38	A
5/310 µs (CCITT IX K17, open-circuit voltage wave shape 1.5 kV, 10/700 µs)		50	
5/310 µs (FTZ R12, open-circuit voltage wave shape 2 kV, 10/700 µs)		50	
10/560 µs (FCC Part 68, open-circuit voltage wave shape 10/560 µs)		45	
10/1000 µs (REA PE-60, open-circuit voltage wave shape 10/1000 µs)		50	
Non-repetitive peak on-state current, 50 Hz, 2.5 s (see Notes 1 and 2)	I_{TSM}	10	A rms
Initial rate of rise of on-state current, Linear current ramp, Maximum ramp value < 38 A	di_T/dt	250	A/µs
Junction temperature	T_J	150	°C
Operating free - air temperature range		0 to 70	°C
Storage temperature range	T_{stg}	-40 to +150	°C
Lead temperature 1.5 mm from case for 10 s	T_{lead}	260	°C

NOTES: 1. Above 70°C, derate linearly to zero at 150°C case temperature
2. This value applies when the initial case temperature is at (or below) 70°C. The surge may be repeated after the device has returned to thermal equilibrium.
3. Most PTT's quote an unloaded voltage waveform. In operation the TISP essentially shorts the generator output. The resulting loaded current waveform is specified.

electrical characteristics for the A and B terminals, T_J = 25°C

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA			± 58			V
I_D	Off-state leakage current	V_D = ± 50 V					± 10	µA
C_{off}	Off-state capacitance	V_D = 0	f = 1 kHz	(see Note 4)		1	5	pF

NOTE 4: These capacitance measurements employ a three terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.

electrical characteristics for the A and C or the B and C terminals, T_J = 25°C

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = - 1mA			- 58			V
αV_Z	Temperature coefficient of reference voltage					0.1		%/°C
$V_{(BO)}$	Breakover voltage	(see Notes 5 and 6)					- 82	V
$I_{(BO)}$	Breakover current	(see Note 5)			- 0.15		- 0.6	A
V_F	Forward voltage	I_F = 5 A	(see Notes 5 and 6)				3	V
V_{TM}	Peak on-state voltage	I_T = - 5 A	(see Notes 5 and 6)			- 2.2	- 3	V
I_H	Holding current	(see Note 5)			- 150			mA
dv/dt	Critical rate of rise of off-state voltage	(see Note 7)					- 5	kV/µs
I_D	Off-state leakage current	V_D = - 50 V					- 10	µA
C_{off}	Off-state capacitance	V_D = 0	f = 1 kHz	(see Note 4)		300	500	pF

NOTES: 5. These parameters must be measured using pulse techniques, t_w = 100 µs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts seperate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.

NOTE 7: Linear rate of rise, maximum voltage limited to 80 % V_Z (minimum).

PARAMETER MEASUREMENT INFORMATION

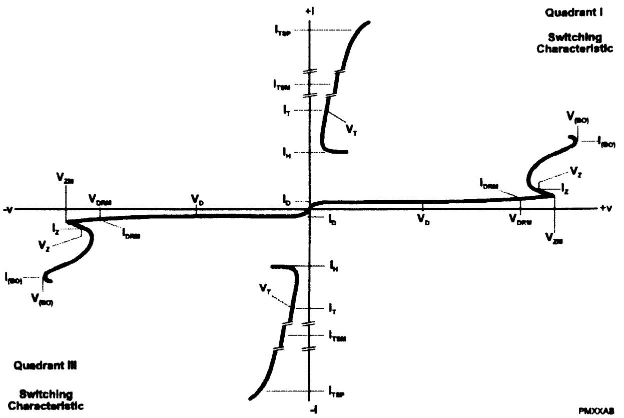


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR TERMINALS A AND B

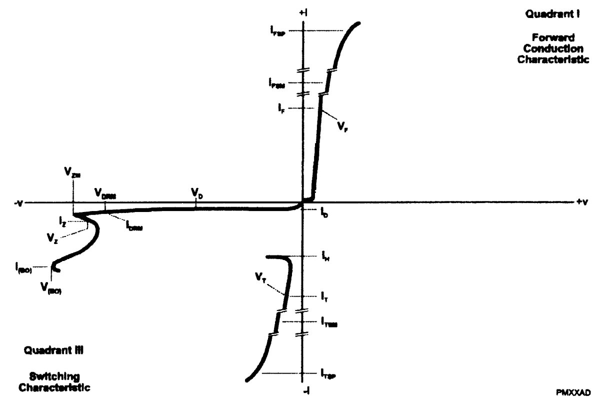


Figure 2. VOLTAGE-CURRENT CHARACTERISTIC FOR TERMINALS A AND C OR B AND C†

†Polarity is determined at terminal A or B with respect to C

thermal characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance			62.5	°C/W

TYPICAL CHARACTERISTICS
A and C, or B and C terminals

ON-STATE AND FORWARD CURRENTS
vs
ON-STATE AND FORWARD VOLTAGES

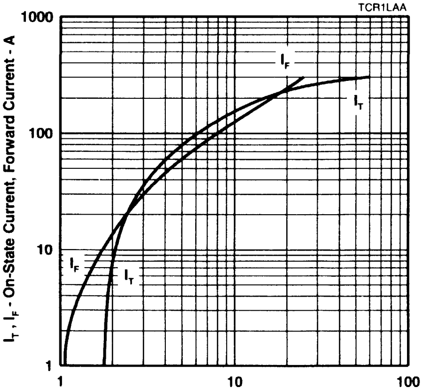


Figure 3.

ZENER AND BREAKOVER VOLTAGE
vs
JUNCTION TEMPERATURE

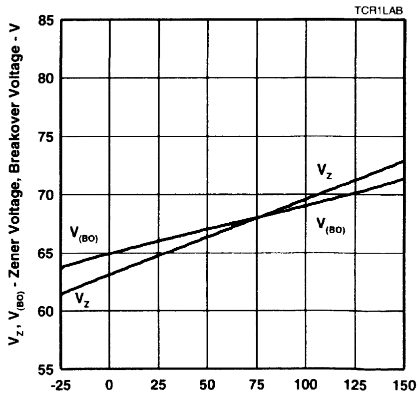


Figure 4.

TYPICAL CHARACTERISTICS
A and C, or B and C terminals

HOLDING CURRENT & BREAKOVER CURRENT vs JUNCTION TEMPERATURE

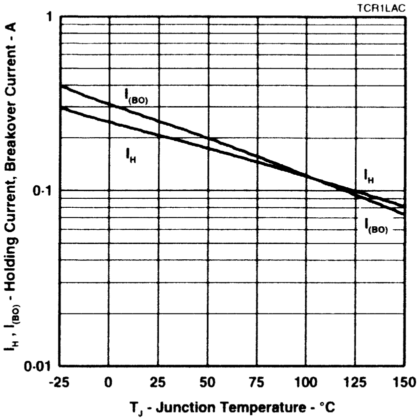


Figure 5.

OFF-STATE CURRENT vs JUNCTION TEMPERATURE

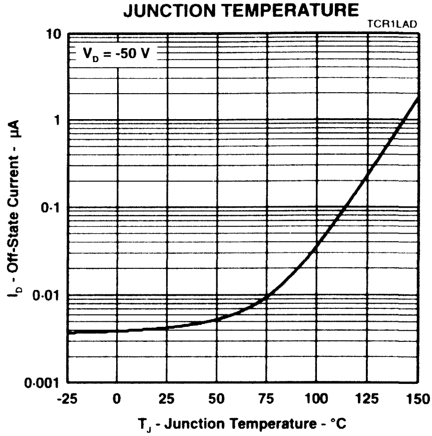


Figure 6.

ON-STATE VOLTAGE & FORWARD VOLTAGE vs JUNCTION TEMPERATURE

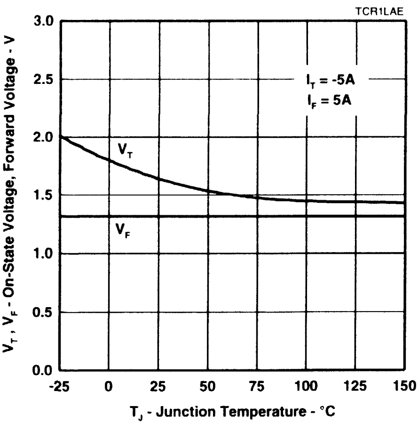


Figure 7.

NORMALISED BREAKOVER VOLTAGE vs RATE OF RISE OF PRINCIPLE CURRENT

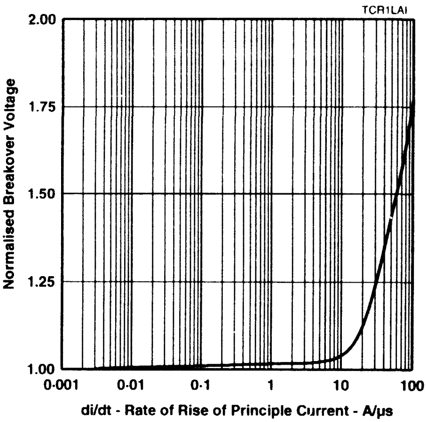


Figure 8.

TYPICAL CHARACTERISTICS
A and C, or B and C terminals

PEAK DIODE FORWARD VOLTAGE vs RATE OF RISE OF PRINCIPLE CURRENT

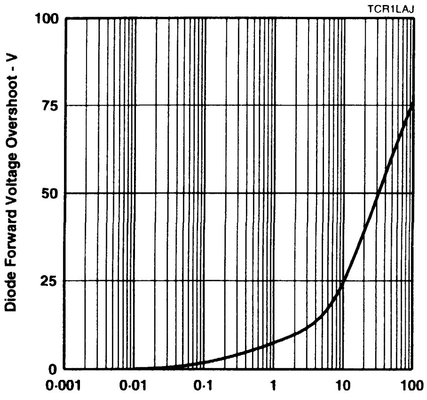


Figure 9.

OFF-STATE CAPACITANCE vs A OR B TERMINAL VOLTAGE (POSITIVE)

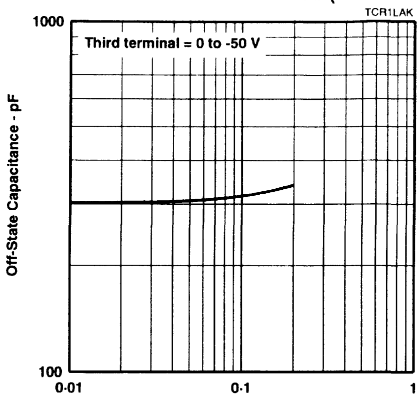


Figure 10.

OFF-STATE CAPACITANCE vs A OR B TERMINAL VOLTAGE (NEGATIVE)

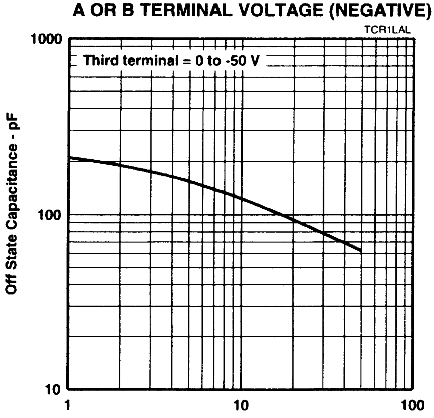


Figure 11.

TYPICAL CHARACTERISTICS
A and B terminals

ZENER VOLTAGE & BREAKOVER VOLTAGE vs JUNCTION TEMPERATURE

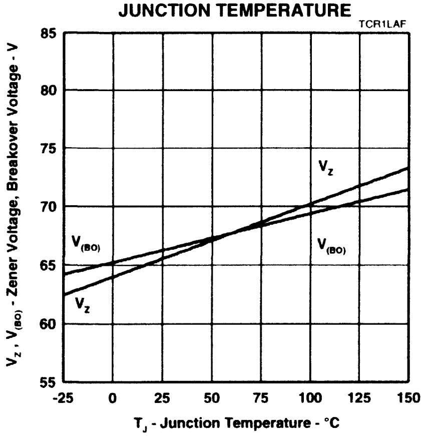


Figure 12.

HOLDING CURRENT & BREAKOVER CURRENT vs JUNCTION TEMPERATURE

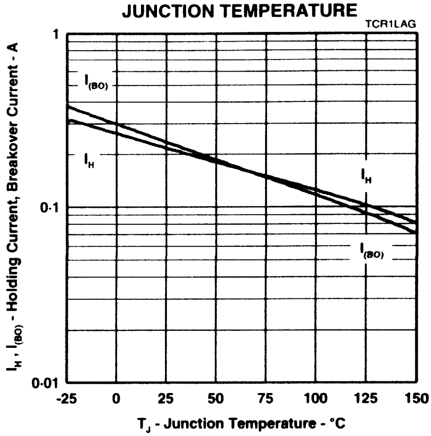


Figure 13.

OFF-STATE CURRENT vs JUNCTION TEMPERATURE

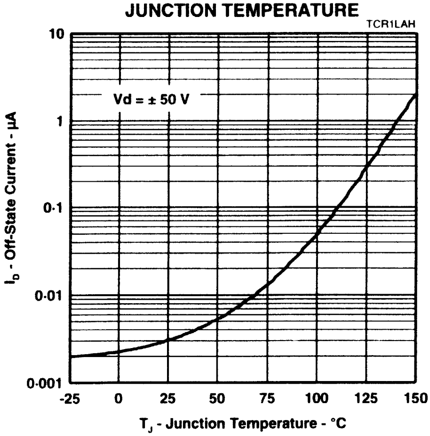


Figure 14.

TYPICAL CHARACTERISTICS
A and B terminals

OFF-STATE CAPACITANCE vs A OR B TERMINAL VOLTAGE (POSITIVE)

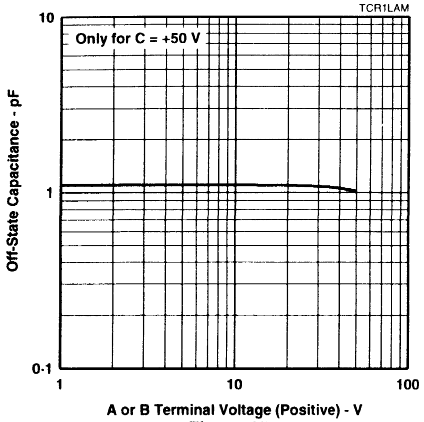


Figure 15.

OFF-STATE CAPACITANCE vs A OR B TERMINAL VOLTAGE (NEGATIVE)

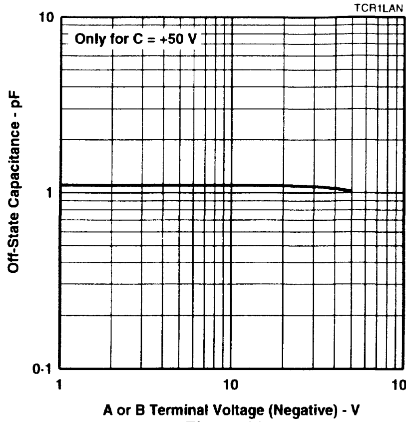


Figure 16.

SURGE CURRENT vs DECAY TIME

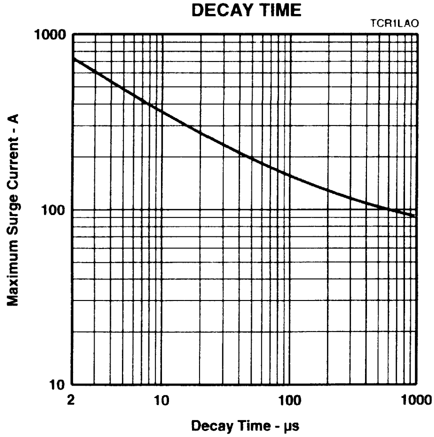


Figure 17.

THERMAL INFORMATION

THERMAL RESPONSE

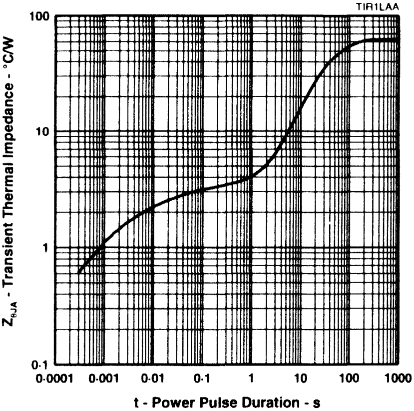


Figure 18.

MAXIMUM NON-RECURRENT 50Hz CURRENT vs CURRENT DURATION

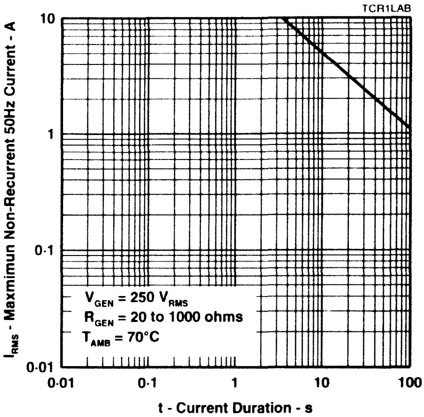


Figure 19.

FREE AIR TEMPERATURE DERATING CURVE

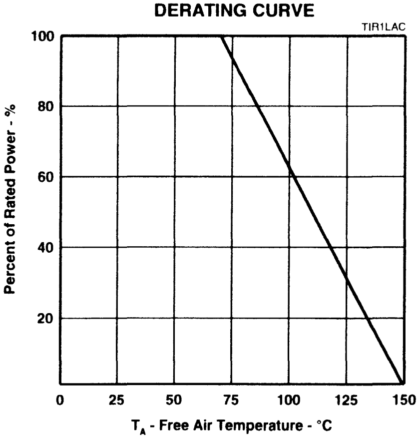


Figure 20.

TISP1082L
DUAL ASYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

SLPSE23 - FEBRUARY 1990 - REVISED SEPTEMBER 1994

TELECOMMUNICATION SYSTEM SECONDARY PROTECTION

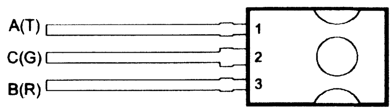
- **Ion-Implanted Breakdown Region**
  Precise and Stable Voltage
  Low Voltage Overshoot under Surge

DEVICE	$V_{(Z)}$ V	$V_{(BO)}$ V
'1082L	- 58	- 82

- **Planar Passivated Junctions**
  Low Off-State Current < 10 μA
- **Rated for International Surge Wave Shapes**

WAVE SHAPE	STANDARD	I_{TSP} A
8/20 μs	ANSI C62.41	150
10/160 μs	FCC Part 68	60
10/560 μs	FCC Part 68	45
0.5/700 μs	RLM 88	38
10/700 μs	FTZ R12	50
	VDE 0433	50
	CCITT IX K17	50
10/1000 μs	REA PE-60	50

L PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

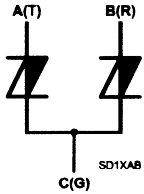
MDXXAC

description

The TISP1082L is designed specifically for telephone line card protection against lightning and transients induced by ac power lines. These devices will supress voltage transients between terminals A and C, B and C, and A and B.

Negative transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides. Positive transients are clipped by diode action.

device symbol



These monolithic protection devices are fabricated in ion-implanted planar structures to ensure precise and matched breakover control and are virtually transparent to the system in normal operation

TEXAS INSTRUMENTS

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING	SYMBOL	VALUE	UNIT
Non-repetitive peak on-state pulse current (see Notes 1, 2 and 3)			
8/20 µs (ANSI C62.41, open-circuit voltage wave shape 1.2/50 µs)	I_{TSP}	150	A
10/160 µs (FCC Part 68, open-circuit voltage wave shape 10/160 µs)		60	
5/200 µs (VDE 0433, open-circuit voltage wave shape 2 kV, 10/700 µs)		50	
0.5/310 µs (RLM 88, open-circuit voltage wave shape 1.5 kV, 0.5/700 µs)		38	
5/310 µs (CCITT IX K17, open-circuit voltage wave shape 1.5 kV, 10/700 µs)		50	
5/310 µs (FTZ R12, open-circuit voltage wave shape 2 kV, 10/700 µs)		50	
10/560 µs (FCC Part 68, open-circuit voltage wave shape 10/560 µs)		45	
10/1000 µs (REA PE-60, open-circuit voltage wave shape 10/1000 µs)		50	
Non-repetitive peak on-state current, 50 Hz, 0.7 s (see Notes 1 and 2)	I_{TSM}	10	A rms
Initial rate of rise of on-state current, Linear current ramp, Maximum ramp value < 38 A	di_T/dt	250	A/µs
Junction temperature	T_J	150	°C
Operating free - air temperature range		0 to 70	°C
Storage temperature range	T_{stg}	-40 to +150	°C
Lead temperature 1.5 mm from case for 10 s	T_{lead}	260	°C

NOTES: 1. Above 70°C, derate linearly to zero at 150°C case temperature
2. This value applies when the initial case temperature is at (or below) 70°C. The surge may be repeated after the device has returned to thermal equilibrium.
3. Most PTT's quote an unloaded voltage waveform. In operation the TISP essentially shorts the generator output. The resulting loaded current waveform is specified.

electrical characteristics for the A and B terminals, T_J = 25°C

	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 58			V
I_D	Off-state leakage current	V_D = ± 50 V			± 10	µA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz (see Note 4)		1	5	pF

NOTE 4: These capacitance measurements employ a three terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.

electrical characteristics for the A and C or the B and C terminals, T_J = 25°C

	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = - 1mA	- 58			V
αV_Z	Temperature coefficient of reference voltage			0.1		%/°C
$V_{(BO)}$	Breakover voltage	(see Notes 5 and 6)			- 82	V
$I_{(BO)}$	Breakover current	(see Note 5)	- 0.15		- 0.6	A
V_F	Forward voltage	I_F = 5 A (see Notes 5 and 6)			3	V
V_{TM}	Peak on-state voltage	I_T = - 5 A (see Notes 5 and 6)		- 2.2	- 3	V
I_H	Holding current	(see Note 5)	- 150			mA
dv/dt	Critical rate of rise of off-state voltage	(see Note 7)			- 5	kV/µs
I_D	Off-state leakage current	V_D = - 50 V			- 10	µA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz (see Note 4)		300	500	pF

NOTES: 5. These parameters must be measured using pulse techniques, t_w = 100 µs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts seperate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.

NOTE 7: Linear rate of rise, maximum voltage limited to 80 % V_Z (minimum).

PARAMETER MEASUREMENT INFORMATION

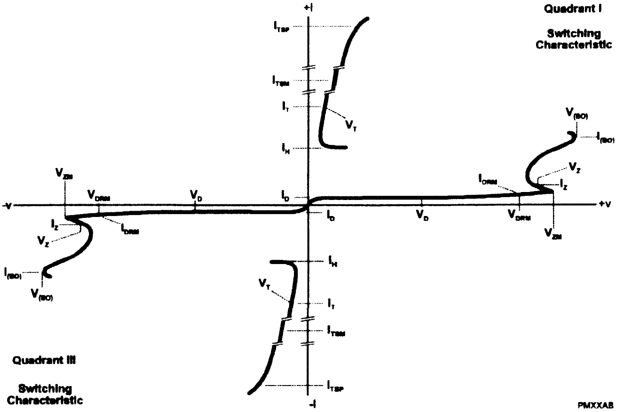


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR TERMINALS A AND B

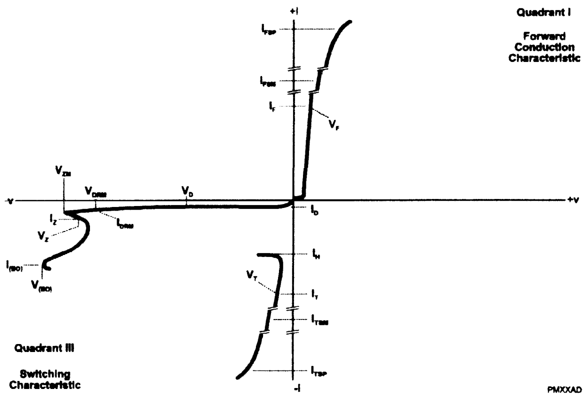


Figure 2. VOLTAGE-CURRENT CHARACTERISTIC FOR TERMINALS A AND C OR B AND C†

†Polarity is determined at terminal A or B with respect to C

thermal characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance			100	°C/W

TISP2082
DUAL SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

SLPSE24 - NOVEMBER 1986 - REVISED SEPTEMBER 1994

TELECOMMUNICATION SYSTEM SECONDARY PROTECTION

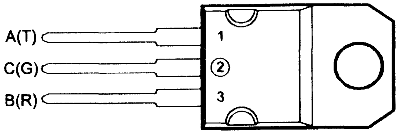
- **Ion-Implanted Breakdown Region**
  Precise and Stable Voltage
  Low Voltage Overshoot under Surge

DEVICE	$V_{(Z)}$ V	$V_{(BO)}$ V
'2082	58	82

- **Planar Passivated Junctions**
  Low Off-State Current < 10 µA
- **Rated for International Surge Wave Shapes**

WAVE SHAPE	STANDARD	I_{TSP} A
8/20 µs	ANSI C62.41	150
10/160 µs	FCC Part 68	60
10/560 µs	FCC Part 68	45
0.5/700 µs	RLM 88	38
10/700 µs	FTZ R12	50
	VDE 0433	50
	CCITT IX K17	50
10/1000 µs	REA PE-60	40

TO-220 PACKAGE (TOP VIEW)



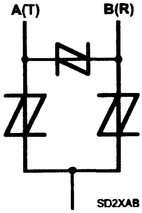
Pin 2 is in electrical contact with the mounting base.
MDXXAN

description

The TISP2082 is designed specifically for telephone equipment protection against lightning and transients induced by ac power lines. These devices will supress voltage transients between terminals A and C, B and C, and A and B.

Transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides.

device symbol



SD2XAB

These monolithic protection devices are fabricated in ion-implanted planar structures to ensure precise and matched breakover control and are virtually transparent to the system in normal operation

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING	SYMBOL	VALUE	UNIT
Non-repetitive peak on-state pulse current (see Notes 1, 2 and 3)			
8/20 μs (ANSI C62.41, open-circuit voltage wave shape 1.2/50 μs)		150	
10/160 μs (FCC Part 68, open-circuit voltage wave shape 10/160 μs)		60	
5/200 μs (VDE 0433, open-circuit voltage wave shape 2 kV, 10/700 μs)		50	
0.5/310 μs (RLM 88, open-circuit voltage wave shape 1.5 kV, 0.5/700 μs)	I_{TSP}	38	A
5/310 μs (CCITT IX K17, open-circuit voltage wave shape 1.5 kV, 10/700 μs)		50	
5/310 μs (FTZ R12, open-circuit voltage wave shape 2 kV, 10/700 μs)		50	
10/560 μs (FCC Part 68, open-circuit voltage wave shape 10/560 μs)		45	
10/1000 μs (REA PE-60, open-circuit voltage wave shape 10/1000 μs)		40	
Non-repetitive peak on-state current, 50 Hz, 2.5 s (see Notes 1 and 2)	I_{TSM}	10	A rms
Initial rate of rise of on-state current, Linear current ramp, Maximum ramp value < 38 A	di_T/dt	250	A/μs
Junction temperature	T_J	150	°C
Operating free - air temperature range		0 to 70	°C
Storage temperature range	T_{stg}	-40 to +150	°C
Lead temperature 1.5 mm from case for 10 s	T_{lead}	260	°C

NOTES: 1. Above 70°C, derate linearly to zero at 150°C case temperature
2. This value applies when the initial case temperature is at (or below) 70°C. The surge may be repeated after the device has returned to thermal equilibrium.
3. Most PTT's quote an unloaded voltage waveform. In operation the TISP essentially shorts the generator output. The resulting loaded current waveform is specified.

electrical characteristics for the A and B terminals, T_J = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 58			V
I_D	Off-state leakage current	V_D = ± 50 V			± 10	μA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz (see Note 4)		70	150	pF

NOTE 4: These capacitance measurements employ a three terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.

electrical characteristics for the A and C or the B and C terminals, T_J = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 58			V
αV_Z	Temperature coefficient of reference voltage			0.1		%/°C
$V_{(BO)}$	Breakover voltage	(see Notes 5 and 6)			± 82	V
$I_{(BO)}$	Breakover current	(see Note 5)	± 0.15		± 0.6	A
V_{TM}	Peak on-state voltage	I_T = ± 5 A (see Notes 5 and 6)		± 2.2	± 3	V
I_H	Holding current	(see Note 5)	± 150			mA
dv/dt	Critical rate of rise of off-state voltage	(see Note 7)			± 5	kV/μs
I_D	Off-state leakage current	V_D = ± 50 V			± 10	μA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz (see Note 4)		110	200	pF

NOTES: 5. These parameters must be measured using pulse techniques, t_w = 100 μs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts seperate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.
7. Linear rate of rise, maximum voltage limited to 80 % V_Z (minimum).

PARAMETER MEASUREMENT INFORMATION

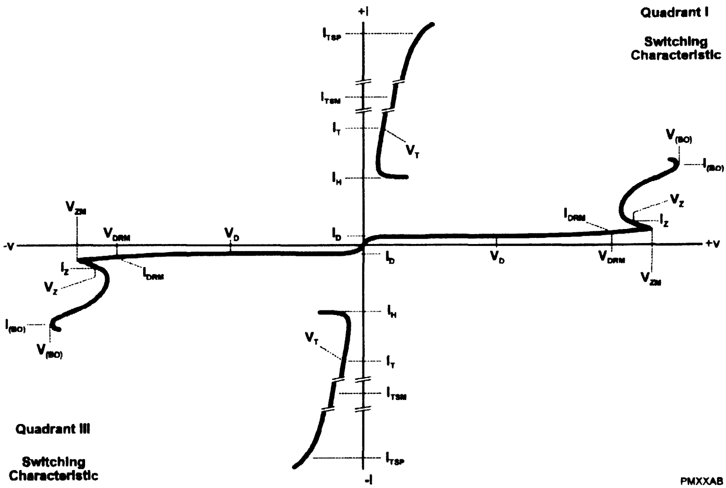


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR ANY PAIR OF TERMINALS

The high level characteristics for terminals A and B are not guaranteed.

thermal characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance			62.5	°C/W

TYPICAL CHARACTERISTICS
A and C, or B and C terminals

SURGE CURRENT vs DECAY TIME

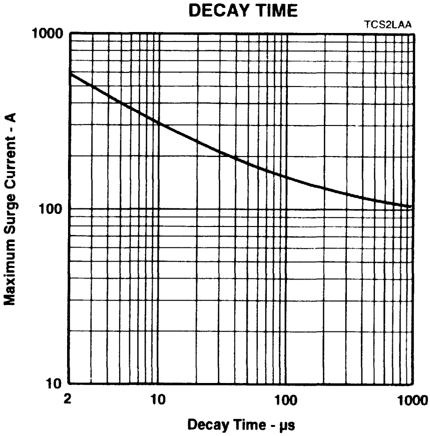


Figure 2.

TELECOMMUNICATION SYSTEM SECONDARY PROTECTION

- **Ion-Implanted Breakdown Region**
  Precise and Stable Voltage
  Low Voltage Overshoot under Surge

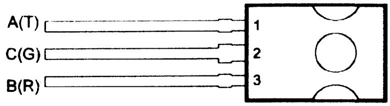
DEVICE	$V_{(Z)}$ V	$V_{(BO)}$ V
'2082L	58	82

- **Planar Passivated Junctions**
  Low Off-State Current < 10 µA

- **Rated for International Surge Wave Shapes**

WAVE SHAPE	STANDARD	I_{TSP} A
8/20 µs	ANSI C62.41	150
10/160 µs	FCC Part 68	60
10/560 µs	FCC Part 68	45
0.5/700 µs	RLM 88	38
10/700 µs	FTZ R12	50
	VDE 0433	50
	CCITT IX K17	50
10/1000 µs	REA PE-60	40

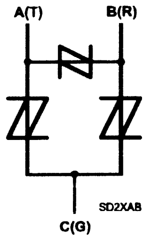
L PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDXXAO

device symbol



description

The TISP2082L is designed specifically for telephone equipment protection against lightning and transients induced by ac power lines. These devices will supress voltage transients between terminals A and C, B and C, and A and B.

Transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides.

These monolithic protection devices are fabricated in ion-implanted planar structures to ensure precise and matched breakover control and are virtually transparent to the system in normal operation

TEXAS INSTRUMENTS

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING	SYMBOL	VALUE	UNIT
Non-repetitive peak on-state pulse current (see Notes 1, 2 and 3)			
8/20 μs (ANSI C62.41, open-circuit voltage wave shape 1.2/50 μs)	I_{TSP}	150	A
10/160 μs (FCC Part 68, open-circuit voltage wave shape 10/160 μs)		60	
5/200 μs (VDE 0433, open-circuit voltage wave shape 2 kV, 10/700 μs)		50	
0.5/310 μs (RLM 88, open-circuit voltage wave shape 1.5 kV, 0.5/700 μs)		38	
5/310 μs (CCITT IX K17, open-circuit voltage wave shape 1.5 kV, 10/700 μs)		50	
5/310 μs (FTZ R12, open-circuit voltage wave shape 2 kV, 10/700 μs)		50	
10/560 μs (FCC Part 68, open-circuit voltage wave shape 10/560 μs)		45	
10/1000 μs (REA PE-60, open-circuit voltage wave shape 10/1000 μs)		40	
Non-repetitive peak on-state current, 50 Hz, 0.7 s (see Notes 1 and 2)	I_{TSM}	10	A rms
Initial rate of rise of on-state current, Linear current ramp, Maximum ramp value < 38 A	di_T/dt	250	A/μs
Junction temperature	T_J	150	°C
Operating free - air temperature range		0 to 70	°C
Storage temperature range	T_{stg}	-40 to +150	°C
Lead temperature 1.5 mm from case for 10 s	T_{lead}	260	°C

NOTES: 1. Above 70°C, derate linearly to zero at 150°C case temperature
2. This value applies when the initial case temperature is at (or below) 70°C. The surge may be repeated after the device has returned to thermal equilibrium.
3. Most PTT's quote an unloaded voltage waveform. In operation the TISP essentially shorts the generator output. The resulting loaded current waveform is specified.

electrical characteristics for the A and B terminals, T_J = 25°C

	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 58			V
I_D	Off-state leakage current	V_D = ± 50 V			± 10	μA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz (see Note 4)		70	150	pF

NOTE 4: These capacitance measurements employ a three terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.

electrical characteristics for the A and C or the B and C terminals, T_J = 25°C

	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 58			V
αV_Z	Temperature coefficient of reference voltage			0.1		%/°C
$V_{(BO)}$	Breakover voltage	(see Notes 5 and 6)			± 82	V
$I_{(BO)}$	Breakover current	(see Note 5)	± 0.15		± 0.6	A
V_{TM}	Peak on-state voltage	I_T = ± 5 A (see Notes 5 and 6)		± 2.2	± 3	V
I_H	Holding current	(see Note 5)	± 150			mA
dv/dt	Critical rate of rise of off-state voltage	(see Note 7)			± 5	kV/μs
I_D	Off-state leakage current	V_D = ± 50 V			± 10	μA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz (see Note 4)		110	200	pF

NOTES: 5. These parameters must be measured using pulse techniques, t_w = 100 μs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts seperate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.
7. Linear rate of rise, maximum voltage limited to 80 % V_Z (minimum).

PARAMETER MEASUREMENT INFORMATION

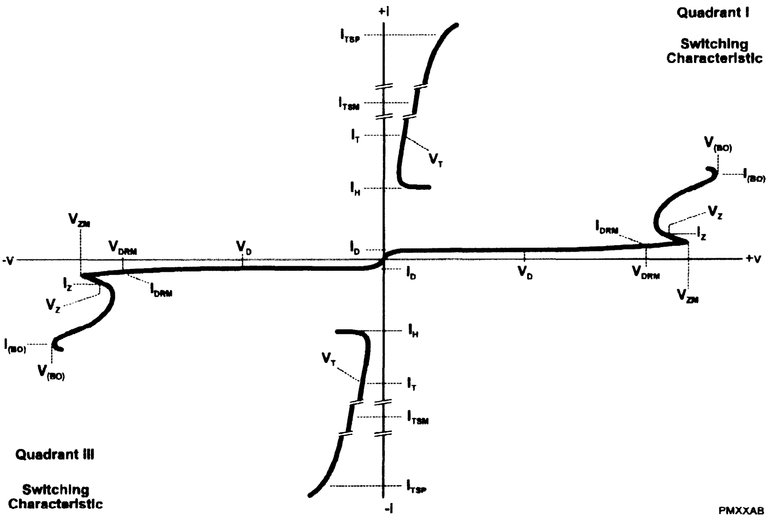


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR ANY PAIR OF TERMINALS

The high level characteristics for terminals A and B are not guaranteed.

thermal characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance			100	°C/W

TELECOMMUNICATION SYSTEM SECONDARY PROTECTION

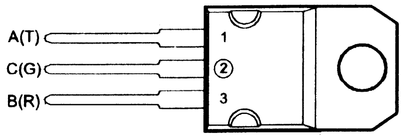
- **Ion-Implanted Breakdown Region**
  Precise and Stable Voltage
  Low Voltage Overshoot under Surge

DEVICE	$V_{(Z)}$ V	$V_{(BO)}$ V
'2180	145	180

- **Planar Passivated Junctions**
  Low Off-State Current < 10 μA
- **Rated for International Surge Wave Shapes**

WAVE SHAPE	STANDARD	I_{TSP} A
8/20 μs	ANSI C62.41	150
10/160 μs	FCC Part 68	60
10/560 μs	FCC Part 68	45
0.5/700 μs	RLM 88	38
10/700 μs	FTZ R12	50
	VDE 0433	50
	CCITT IX K17	50
10/1000 μs	REA PE-60	50

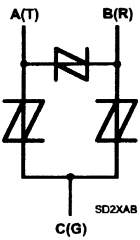
TO-220 PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDXXAN

device symbol



description

The TISP2180 is designed specifically for telephone equipment protection against lightning and transients induced by ac power lines. These devices will supress voltage transients between terminals A and C, B and C, and A and B.

Transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides.

These monolithic protection devices are fabricated in ion-implanted planar structures to ensure precise and matched breakover control and are virtually transparent to the system in normal operation

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING	SYMBOL	VALUE	UNIT
Non-repetitive peak on-state pulse current (see Notes 1, 2 and 3)			
8/20 μs (ANSI C62.41, open-circuit voltage wave shape 1.2/50 μs)		150	
10/160 μs (FCC Part 68, open-circuit voltage wave shape 10/160 μs)		60	
5/200 μs (VDE 0433, open-circuit voltage wave shape 2 kV, 10/700 μs)		50	
0.5/310 μs (RLM 88, open-circuit voltage wave shape 1.5 kV, 0.5/700 μs)	I_{TSP}	38	A
5/310 μs (CCITT IX K17, open-circuit voltage wave shape 1.5 kV, 10/700 μs)		50	
5/310 μs (FTZ R12, open-circuit voltage wave shape 2 kV, 10/700 μs)		50	
10/560 μs (FCC Part 68, open-circuit voltage wave shape 10/560 μs)		45	
10/1000 μs (REA PE-60, open-circuit voltage wave shape 10/1000 μs)		50	
Non-repetitive peak on-state current, 50 Hz, 2.5 s (see Notes 1 and 2)	I_{TSM}	10	A rms
Initial rate of rise of on-state current, Linear current ramp, Maximum ramp value < 38 A	di_T/dt	250	A/μs
Junction temperature	T_J	150	°C
Operating free - air temperature range		0 to 70	°C
Storage temperature range	T_{stg}	-40 to +150	°C
Lead temperature 1.5 mm from case for 10 s	T_{lead}	260	°C

NOTES: 1. Above 70°C, derate linearly to zero at 150°C case temperature
2. This value applies when the initial case temperature is at (or below) 70°C. The surge may be repeated after the device has returned to thermal equilibrium.
3. Most PTT's quote an unloaded voltage waveform. In operation the TISP essentially shorts the generator output. The resulting loaded current waveform is specified.

electrical characteristics for the A and B terminals, T_J = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	$I_Z = \pm 1mA$	± 145			V
I_D	Off-state leakage current	$V_D = \pm 50$ V			± 10	μA
C_{off}	Off-state capacitance	$V_D = 0$ f = 1 kHz (see Note 4)		40	100	pF

NOTE 4: These capacitance measurements employ a three terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.

electrical characteristics for the A and C or the B and C terminals, T_J = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	$I_Z = \pm 1mA$	± 145			V
αV_Z	Temperature coefficient of reference voltage			0.1		%/°C
$V_{(BO)}$	Breakover voltage	(see Notes 5 and 6)			± 180	V
$I_{(BO)}$	Breakover current	(see Note 5)	± 0.15		± 0.6	A
V_{TM}	Peak on-state voltage	$I_T = \pm 5$ A (see Notes 5 and 6)		± 2.2	± 3	V
I_H	Holding current	(see Note 5)	± 150			mA
dv/dt	Critical rate of rise of off-state voltage	(see Note 7)			± 5	kV/μs
I_D	Off-state leakage current	$V_D = \pm 50$ V			± 10	μA
C_{off}	Off-state capacitance	$V_D = 0$ f = 1 kHz (see Note 4)		110	200	pF

NOTES: 5. These parameters must be measured using pulse techniques, t_w = 100 μs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts seperate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.
7. Linear rate of rise, maximum voltage limited to 80 % V_Z (minimum).

PARAMETER MEASUREMENT INFORMATION

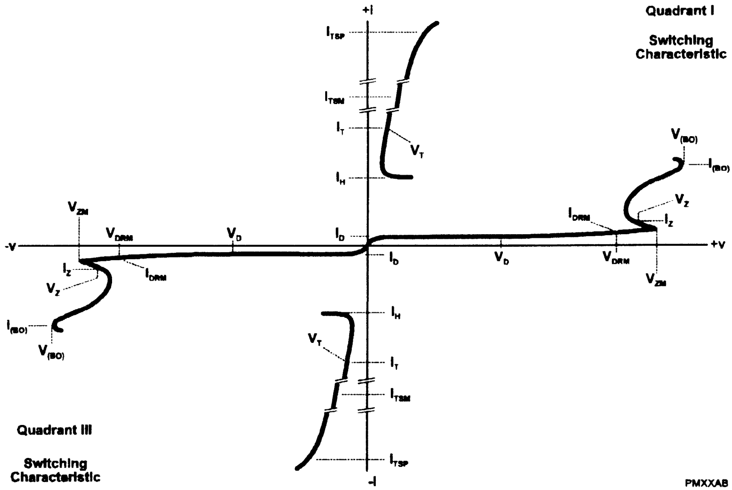


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR ANY PAIR OF TERMINALS

The high level characteristics for terminals A and B are not guaranteed.

thermal characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance			62.5	°C/W

TEXAS INSTRUMENTS

TYPICAL CHARACTERISTICS
A and C, or B and C terminals

ON-STATE CURRENT vs ON-STATE VOLTAGE

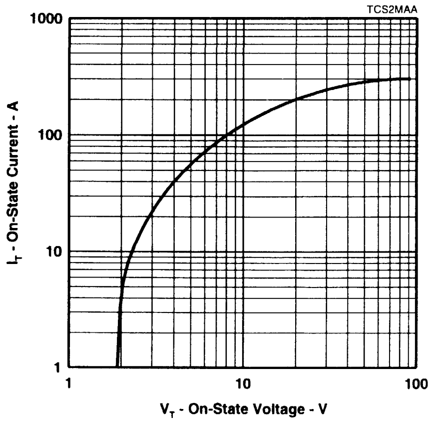


Figure 2.

ZENER VOLTAGE & BREAKOVER VOLTAGE vs JUNCTION TEMPERATURE

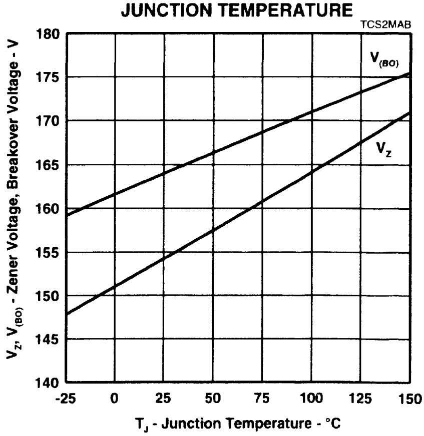


Figure 3.

TEXAS INSTRUMENTS

TYPICAL CHARACTERISTICS
A and C, or B and C terminals

HOLDING CURRENT & BREAKOVER CURRENT vs JUNCTION TEMPERATURE

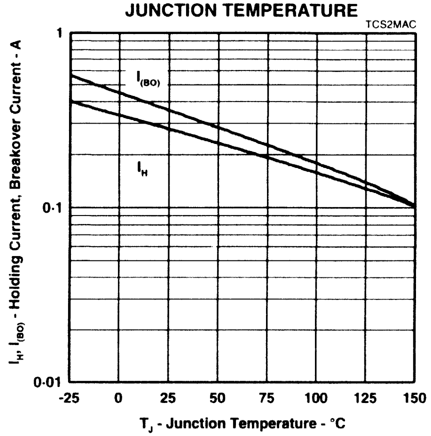


Figure 4.

OFF-STATE CURRENT vs JUNCTION TEMPERATURE

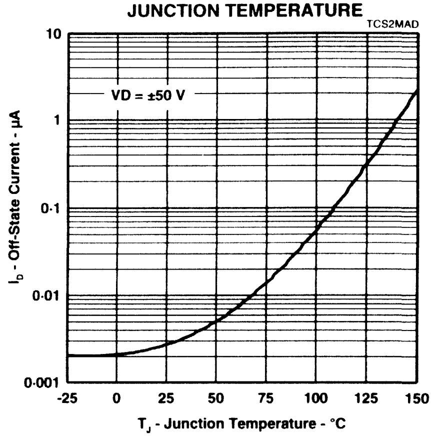


Figure 5.

ON-STATE VOLTAGE vs JUNCTION TEMPLATE

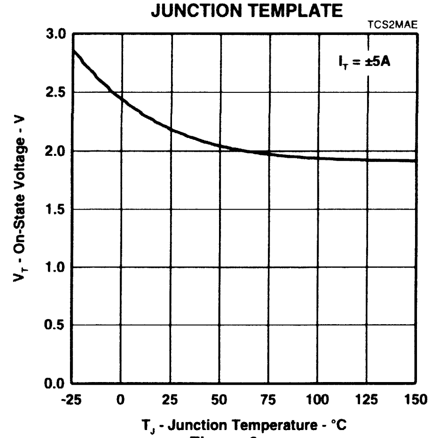


Figure 6.

NORMALISED BREAKOVER VOLTAGE vs RATE OF RISE OF PRINCIPLE CURRENT

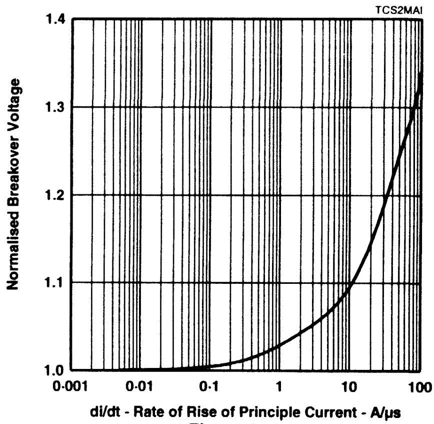


Figure 7.

TYPICAL CHARACTERISTICS
A and C, or B and C terminals

OFF-STATE CAPACITANCE vs TERMINAL VOLTAGE (POSITIVE)

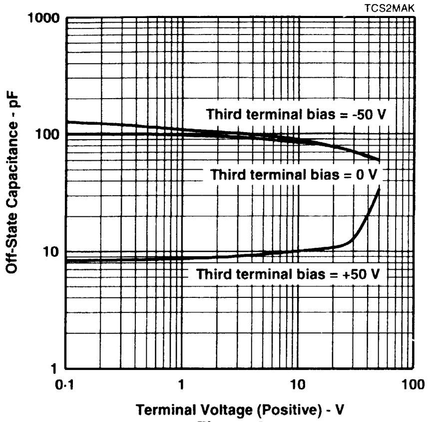


Figure 8.

OFF-STATE CAPACITANCE vs TERMINAL VOLTAGE (NEGATIVE)

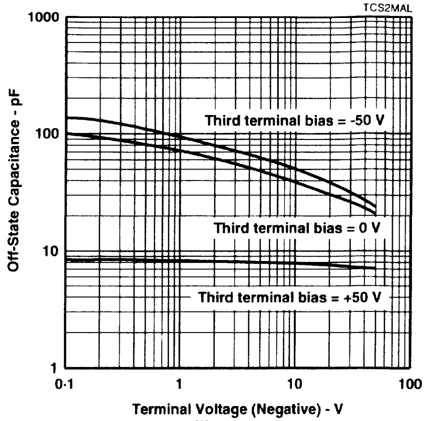


Figure 9.

SURGE CURRENT vs DECAY TIME

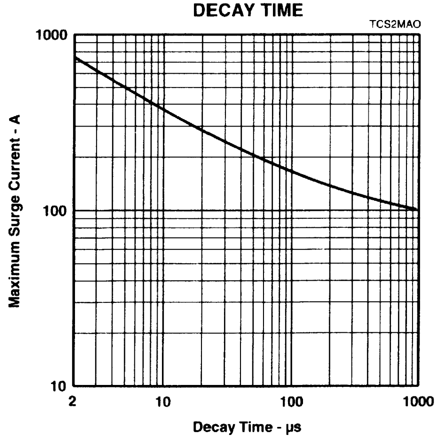


Figure 10.

TYPICAL CHARACTERISTICS
A and B terminals

ZENER VOLTAGE & BREAKOVER VOLTAGE vs JUNCTION TEMPERATURE

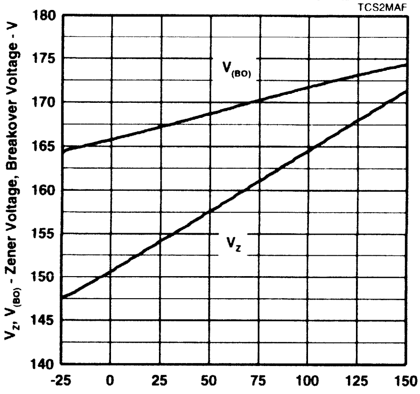


Figure 11.

HOLDING CURRENT & BREAKOVER CURRENT vs JUNCTION TEMPERATURE

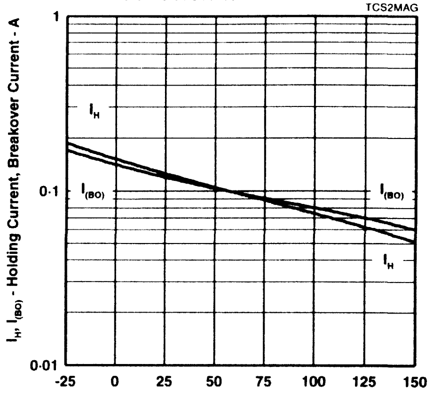


Figure 12.

OFF-STATE CURRENT vs JUNCTION TEMPERATURE

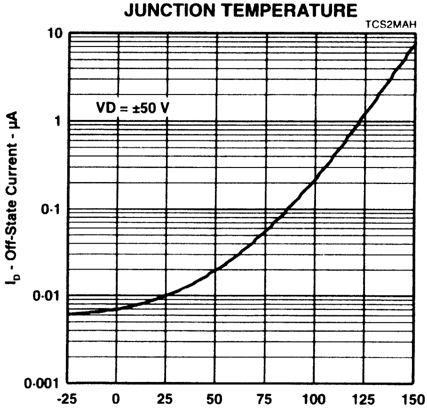


Figure 13.

TYPICAL CHARACTERISTICS
A and B terminals

NORMALISED BREAKOVER VOLTAGE vs RATE OF RISE OF PRINCIPLE CURRENT

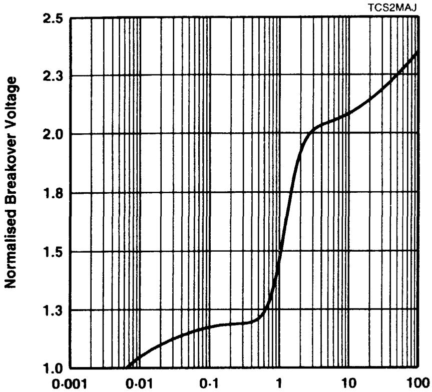


Figure 14.

OFF-STATE CAPACITANCE vs TERMINAL VOLTAGE (POSITIVE)

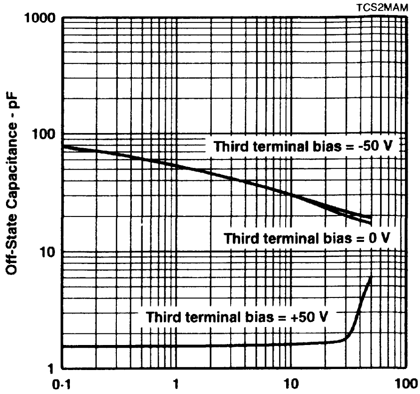


Figure 15.

OFF-STATE CAPACITANCE vs TERMINAL VOLTAGE (NEGATIVE)

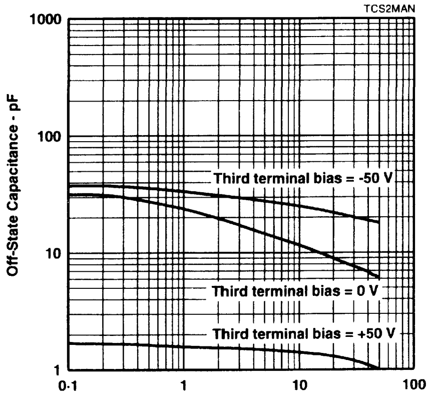


Figure 16.

THERMAL INFORMATION

THERMAL RESPONSE

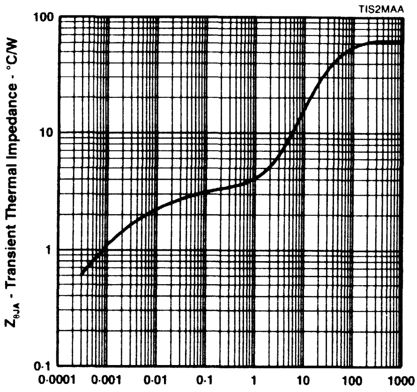


Figure 17.

MAXIMUM NON-RECURRENT 50Hz CURRENT vs CURRENT DURATION

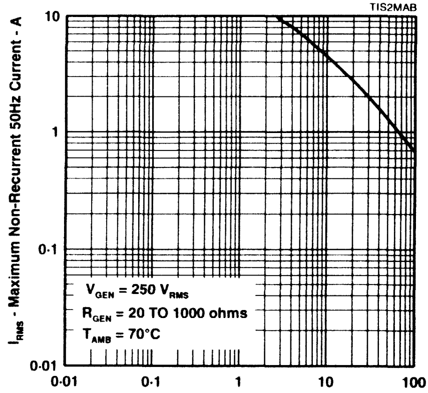


Figure 18.

FREE AIR TEMPERATURE

DERATING CURVE

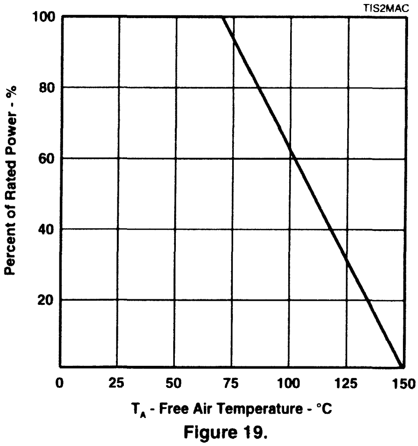


Figure 19.

TISP2180L
DUAL SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

SLPSE27 - FEBRUARY 1990 - REVISED SEPTEMBER 1994

TELECOMMUNICATION SYSTEM SECONDARY PROTECTION

- **Ion-Implanted Breakdown Region**
  Precise and Stable Voltage
  Low Voltage Overshoot under Surge

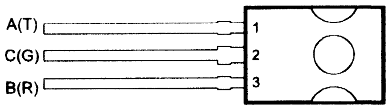
DEVICE	$V_{(Z)}$ V	$V_{(BO)}$ V
'2180L	145	180

- **Planar Passivated Junctions**
  Low Off-State Current < 10 µA

- **Rated for International Surge Wave Shapes**

WAVE SHAPE	STANDARD	I_{TSP} A
8/20 µs	ANSI C62.41	150
10/160 µs	FCC Part 68	60
10/560 µs	FCC Part 68	45
0.5/700 µs	RLM 88	38
10/700 µs	FTZ R12	50
	VDE 0433	50
	CCITT IX K17	50
10/1000 µs	REA PE-60	50

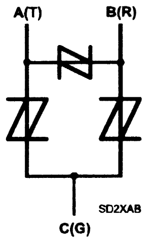
L PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDXXAO

device symbol



description

The TISP2180L is designed specifically for telephone equipment protection against lightning and transients induced by ac power lines. These devices will supress voltage transients between terminals A and C, B and C, and A and B.

Transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides.

These monolithic protection devices are fabricated in ion-implanted planar structures to ensure precise and matched breakover control and are virtually transparent to the system in normal operation

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING	SYMBOL	VALUE	UNIT
Non-repetitive peak on-state pulse current (see Notes 1, 2 and 3)			
8/20 μs (ANSI C62.41, open-circuit voltage wave shape 1.2/50 μs)		150	
10/160 μs (FCC Part 68, open-circuit voltage wave shape 10/160 μs)		60	
5/200 μs (VDE 0433, open-circuit voltage wave shape 2 kV, 10/700 μs)		50	
0.5/310 μs (RLM 88, open-circuit voltage wave shape 1.5 kV, 0.5/700 μs)	I_{TSP}	38	A
5/310 μs (CCITT IX K17, open-circuit voltage wave shape 1.5 kV, 10/700 μs)		50	
5/310 μs (FTZ R12, open-circuit voltage wave shape 2 kV, 10/700 μs)		50	
10/560 μs (FCC Part 68, open-circuit voltage wave shape 10/560 μs)		45	
10/1000 μs (REA PE-60, open-circuit voltage wave shape 10/1000 μs)		50	
Non-repetitive peak on-state current, 50 Hz, 0.7 s (see Notes 1 and 2)	I_{TSM}	10	A rms
Initial rate of rise of on-state current, Linear current ramp, Maximum ramp value < 38 A	di_T/dt	250	A/μs
Junction temperature	T_J	150	°C
Operating free - air temperature range		0 to 70	°C
Storage temperature range	T_{stg}	-40 to +150	°C
Lead temperature 1.5 mm from case for 10 s	T_{lead}	260	°C

NOTES: 1. Above 70°C, derate linearly to zero at 150°C case temperature
2. This value applies when the initial case temperature is at (or below) 70°C. The surge may be repeated after the device has returned to thermal equilibrium.
3. Most PTT's quote an unloaded voltage waveform. In operation the TISP essentially shorts the generator output. The resulting loaded current waveform is specified.

electrical characteristics for the A and B terminals, T_J = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 145			V
I_D	Off-state leakage current	V_D = ± 50 V			± 10	μA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz (see Note 4)		40	100	pF

NOTE 4: These capacitance measurements employ a three terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.

electrical characteristics for the A and C or the B and C terminals, T_J = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 145			V
$\propto V_Z$	Temperature coefficient of reference voltage			0.1		%/°C
$V_{(BO)}$	Breakover voltage	(see Notes 5 and 6)			± 180	V
$I_{(BO)}$	Breakover current	(see Note 5)	± 0.15		± 0.6	A
V_{TM}	Peak on-state voltage	I_T = ± 5 A (see Notes 5 and 6)		± 2.2	± 3	V
I_H	Holding current	(see Note 5)	± 150			mA
dv/dt	Critical rate of rise of off-state voltage	(see Note 7)			± 5	kV/μs
I_D	Off-state leakage current	V_D = ± 50 V			± 10	μA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz (see Note 4)		110	200	pF

NOTES: 5. These parameters must be measured using pulse techniques, t_w = 100 μs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts seperate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.
7. Linear rate of rise, maximum voltage limited to 80 % V_Z (minimum).

PARAMETER MEASUREMENT INFORMATION

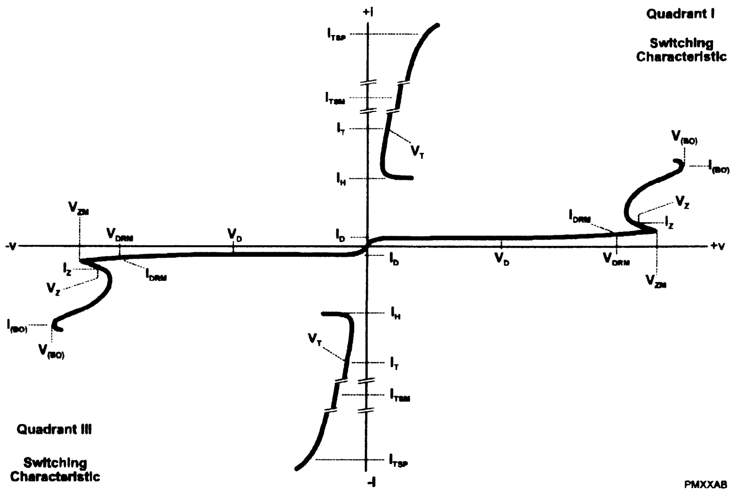


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR ANY PAIR OF TERMINALS

The high level characteristics for terminals A and B are not guaranteed.

thermal characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance			100	°C/W

TYPICAL CHARACTERISTICS
A and C, or B and C terminals

SURGE CURRENT
vs
DECAY TIME

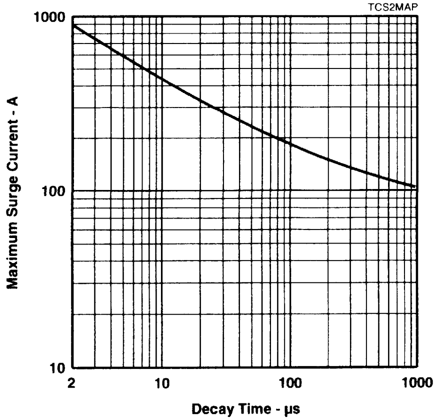


Figure 2.

TELECOMMUNICATION SYSTEM SECONDARY PROTECTION

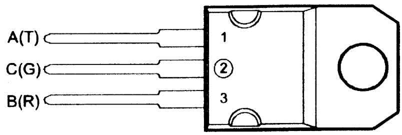
- **Ion-Implanted Breakdown Region**
  Precise and Stable Voltage
  Low Voltage Overshoot under Surge

DEVICE	$V_{(Z)}$ V	$V_{(BO)}$ V
'2290	200	290

- **Planar Passivated Junctions**
  Low Off-State Current < 10 μA
- **Rated for International Surge Wave Shapes**

WAVE SHAPE	STANDARD	I_{TSP} A
8/20 μs	ANSI C62.41	150
10/160 μs	FCC Part 68	60
10/560 μs	FCC Part 68	45
0.5/700 μs	RLM 88	38
10/700 μs	FTZ R12	50
	VDE 0433	50
	CCITT IX K17	50
10/1000 μs	REA PE-60	50

TO-220 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

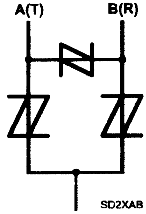
MDXXAN

description

The TISP2290 is designed specifically for telephone equipment protection against lightning and transients induced by ac power lines. These devices will supress voltage transients between terminals A and C, B and C, and A and B.

Transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides.

device symbol



These monolithic protection devices are fabricated in ion-implanted planar structures to ensure precise and matched breakover control and are virtually transparent to the system in normal operation

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING	SYMBOL	VALUE	UNIT
Non-repetitive peak on-state pulse current (see Notes 1, 2 and 3)			
8/20 µs (ANSI C62.41, open-circuit voltage wave shape 1.2/50 µs)	I_{TSP}	150	A
10/160 µs (FCC Part 68, open-circuit voltage wave shape 10/160 µs)		60	
5/200 µs (VDE 0433, open-circuit voltage wave shape 2 kV, 10/700 µs)		50	
0.5/310 µs (RLM 88, open-circuit voltage wave shape 1.5 kV, 0.5/700 µs)		38	
5/310 µs (CCITT IX K17, open-circuit voltage wave shape 1.5 kV, 10/700 µs)		50	
5/310 µs (FTZ R12, open-circuit voltage wave shape 2 kV, 10/700 µs)		50	
10/560 µs (FCC Part 68, open-circuit voltage wave shape 10/560 µs)		45	
10/1000 µs (REA PE-60, open-circuit voltage wave shape 10/1000 µs)		50	
Non-repetitive peak on-state current, 50 Hz, 2.5 s (see Notes 1 and 2)	I_{TSM}	10	A rms
Initial rate of rise of on-state current, Linear current ramp, Maximum ramp value < 38 A	di_T/dt	250	A/µs
Junction temperature	T_J	150	°C
Operating free - air temperature range		0 to 70	°C
Storage temperature range	T_{stg}	-40 to +150	°C
Lead temperature 1.5 mm from case for 10 s	T_{lead}	260	°C

NOTES: 1. Above 70°C, derate linearly to zero at 150°C case temperature
2. This value applies when the initial case temperature is at (or below) 70°C. The surge may be repeated after the device has returned to thermal equilibrium.
3. Most PTT's quote an unloaded voltage waveform. In operation the TISP essentially shorts the generator output. The resulting loaded current waveform is specified.

electrical characteristics for the A and B terminals, T_J = 25°C

	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	$I_Z = \pm$ 1mA	± 200			V
I_D	Off-state leakage current	$V_D = \pm$ 50 V			± 10	µA
C_{off}	Off-state capacitance	$V_D = 0$ f = 1 kHz (see Note 4)		40	100	pF

NOTE 4: These capacitance measurements employ a three terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.

electrical characteristics for the A and C or the B and C terminals, T_J = 25°C

	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	$I_Z = \pm$ 1mA	± 200			V
αV_Z	Temperature coefficient of reference voltage			0.1		%/°C
$V_{(BO)}$	Breakover voltage	(see Notes 5 and 6)			± 290	V
$I_{(BO)}$	Breakover current	(see Note 5)	± 0.15		± 0.6	A
V_{TM}	Peak on-state voltage	$I_T = \pm$ 5 A (see Notes 5 and 6)		± 1.9	± 3	V
I_H	Holding current	(see Note 5)	± 150			mA
dv/dt	Critical rate of rise of off-state voltage	(see Note 7)			± 5	kV/µs
I_D	Off-state leakage current	$V_D = \pm$ 50 V			± 10	µA
C_{off}	Off-state capacitance	$V_D = 0$ f = 1 kHz (see Note 4)		110	200	pF

NOTES: 5. These parameters must be measured using pulse techniques, t_w = 100 µs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts seperate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.
7. Linear rate of rise, maximum voltage limited to 80 % V_Z (minimum).

PARAMETER MEASUREMENT INFORMATION

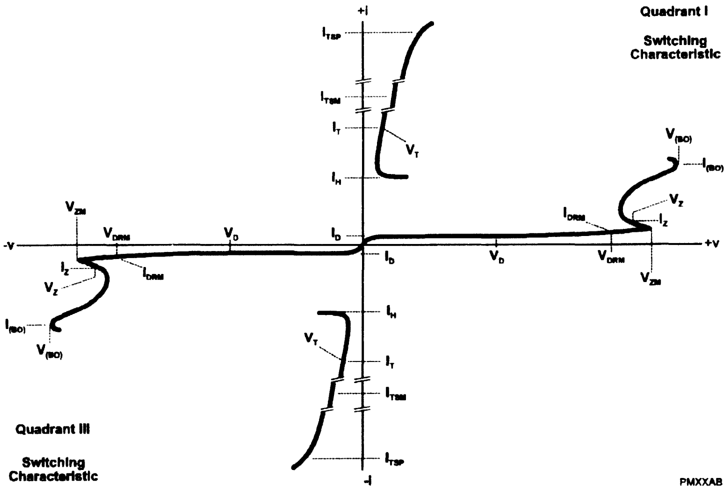


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR ANY PAIR OF TERMINALS

The high level characteristics for terminals A and B are not guaranteed.

thermal characteristics

PARAMETER	MIN	TYP	MAX	UNIT
$R_{\theta JA}$ Junction to free air thermal resistance			62.5	°C/W

TYPICAL CHARACTERISTICS
A and C, or B and C terminals

ON-STATE CURRENT vs ON-STATE VOLTAGE

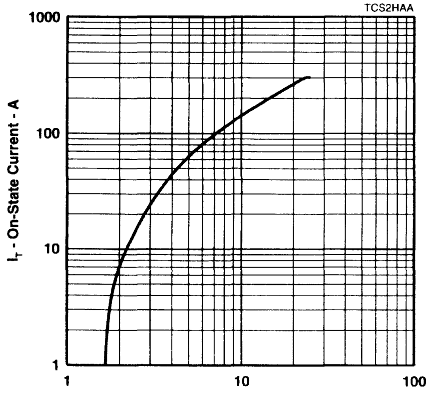


Figure 2.

ZENER VOLTAGE & BREAKOVER VOLTAGE vs JUNCTION TEMPERATURE

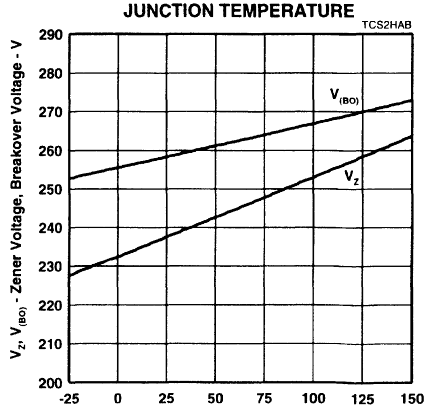


Figure 3.

TYPICAL CHARACTERISTICS
A and C, or B and C terminals

HOLDING CURRENT & BREAKOVER CURRENT vs JUNCTION TEMPERATURE

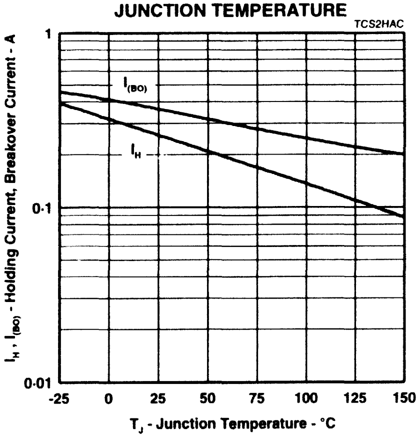


Figure 4.

OFF-STATE CURRENT vs JUNCTION TEMPERATURE

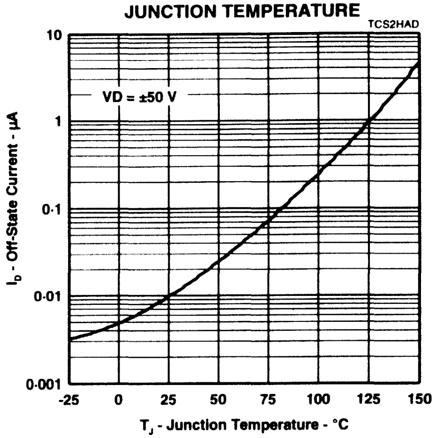


Figure 5.

ON-STATE VOLTAGE vs JUNCTION TEMPERATURE

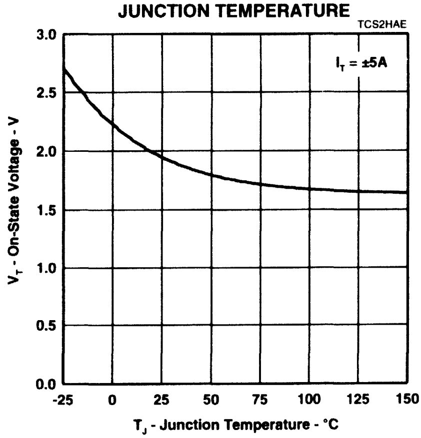


Figure 6.

NORMALISED BREAKOVER VOLTAGE vs RATE OF RISE OF PRINCIPLE CURRENT

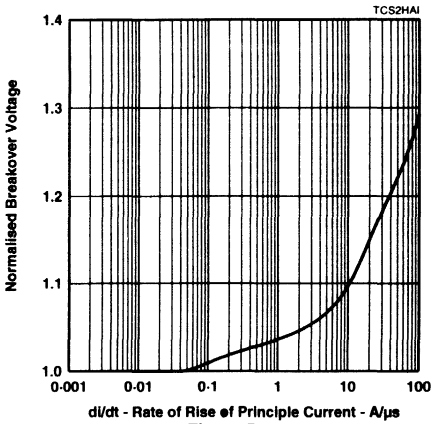


Figure 7.

TYPICAL CHARACTERISTICS
A and C, or B and C terminals

OFF-STATE CAPACITANCE vs TERMINAL VOLTAGE (POSITIVE)

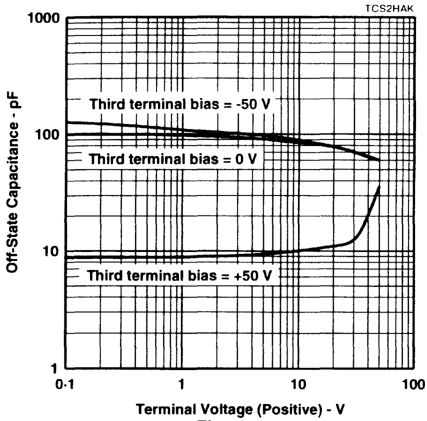


Figure 8.

OFF-STATE CAPACITANCE vs TERMINAL VOLTAGE (NEGATIVE)

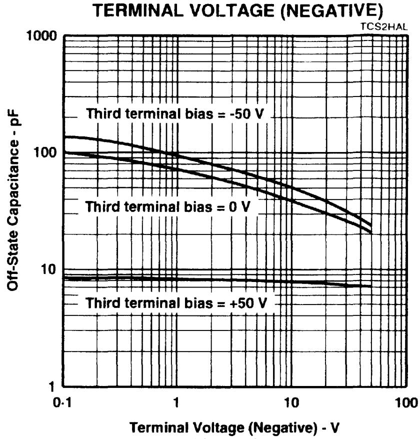


Figure 9.

SURGE CURRENT vs DECAY TIME

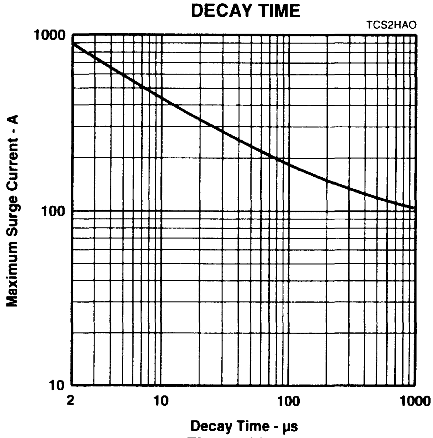


Figure 10.

TEXAS INSTRUMENTS

TYPICAL CHARACTERISTICS
A and B terminals

ZENER VOLTAGE & BREAKOVER VOLTAGE vs JUNCTION TEMPERATURE

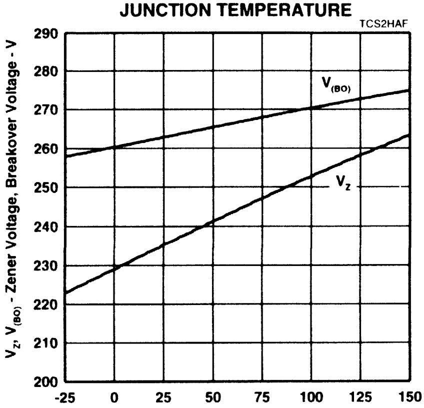


Figure 11.

HOLDING CURRENT & BREAKOVER CURRENT vs JUNCTION TEMPERATURE

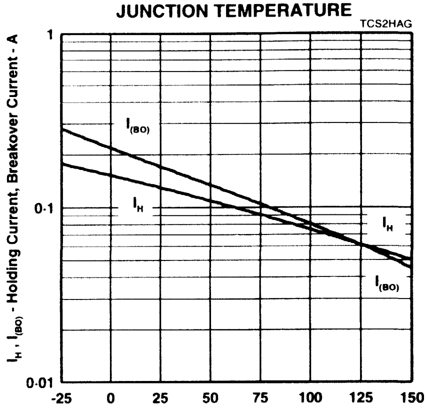


Figure 12.

OFF-STATE CURRENT vs JUNCTION TEMPERATURE

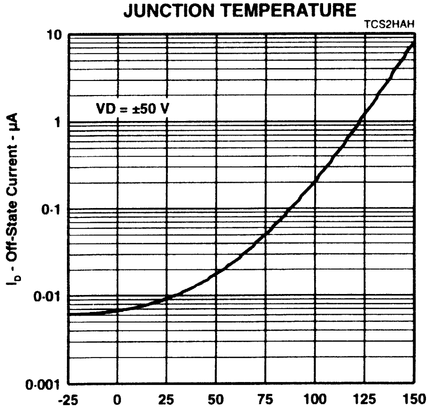


Figure 13.

TYPICAL CHARACTERISTICS
A and B terminals

NORMALISED BREAKOVER VOLTAGE vs RATE OF RISE OF PRINCIPLE CURRENT

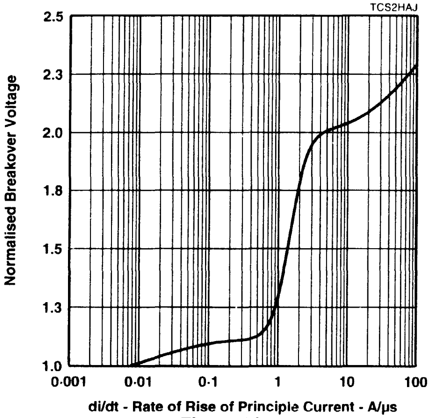


Figure 14.

OFF-STATE CAPACITANCE vs TERMINAL VOLTAGE (POSITIVE)

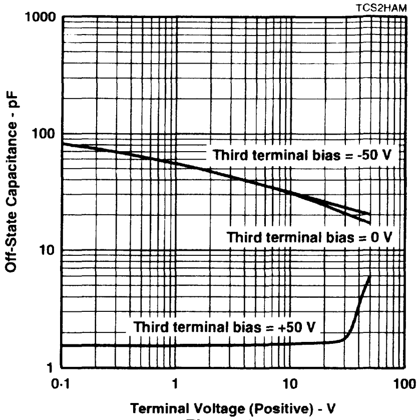


Figure 15.

OFF-STATE CAPACITANCE vs TERMINAL VOLTAGE (NEGATIVE)

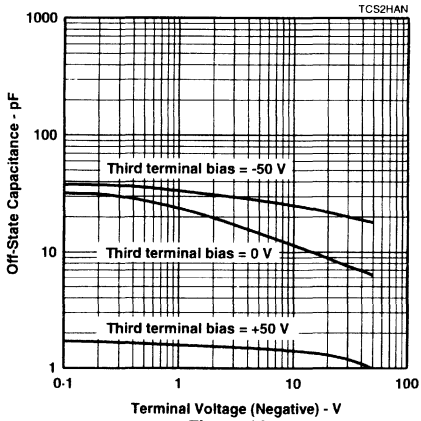


Figure 16.

THERMAL INFORMATION

THERMAL RESPONSE

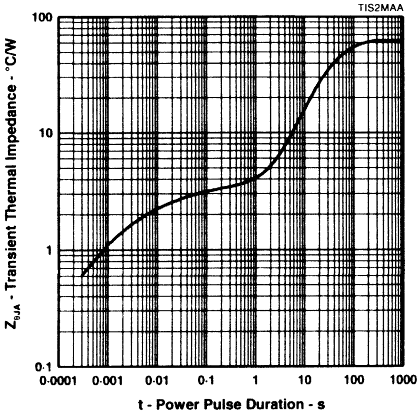


Figure 17.

MAXIMUM NON-RECURRENT 50Hz CURRENT vs CURRENT DURATION

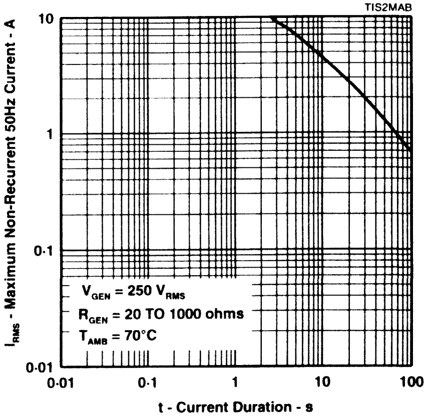


Figure 18.

FREE AIR TEMPERATURE

DERATING CURVE

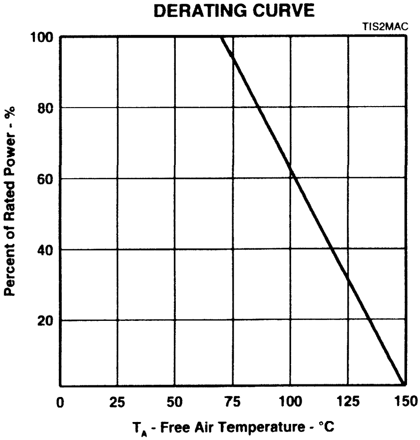


Figure 19.

TELECOMMUNICATION SYSTEM SECONDARY PROTECTION

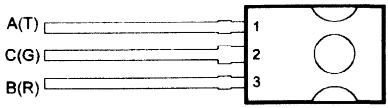
- **Ion-Implanted Breakdown Region**
  Precise and Stable Voltage
  Low Voltage Overshoot under Surge

DEVICE	$V_{(Z)}$ V	$V_{(BO)}$ V
'2290L	200	290

- **Planar Passivated Junctions**
  Low Off-State Current < 10 μA
- **Rated for International Surge Wave Shapes**

WAVE SHAPE	STANDARD	I_{TSP} A
8/20 μs	ANSI C62.41	150
10/160 μs	FCC Part 68	60
10/560 μs	FCC Part 68	45
0.5/700 μs	RLM 88	38
10/700 μs	FTZ R12	50
	VDE 0433	50
	CCITT IX K17	50
10/1000 μs	REA PE-60	50

L PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

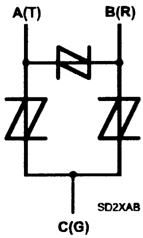
MDXXAO

description

The TISP2290L is designed specifically for telephone equipment protection against lightning and transients induced by ac power lines. These devices will supress voltage transients between terminals A and C, B and C, and A and B.

Transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides.

device symbol



These monolithic protection devices are fabricated in ion-implanted planar structures to ensure precise and matched breakover control and are virtually transparent to the system in normal operation

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING	SYMBOL	VALUE	UNIT
Non-repetitive peak on-state pulse current (see Notes 1, 2 and 3)			
8/20 μs (ANSI C62.41, open-circuit voltage wave shape 1.2/50 μs)	I_{TSP}	150	A
10/160 μs (FCC Part 68, open-circuit voltage wave shape 10/160 μs)		60	
5/200 μs (VDE 0433, open-circuit voltage wave shape 2 kV, 10/700 μs)		50	
0.5/310 μs (RLM 88, open-circuit voltage wave shape 1.5 kV, 0.5/700 μs)		38	
5/310 μs (CCITT IX K17, open-circuit voltage wave shape 1.5 kV, 10/700 μs)		50	
5/310 μs (FTZ R12, open-circuit voltage wave shape 2 kV, 10/700 μs)		50	
10/560 μs (FCC Part 68, open-circuit voltage wave shape 10/560 μs)		45	
10/1000 μs (REA PE-60, open-circuit voltage wave shape 10/1000 μs)		50	
Non-repetitive peak on-state current, 50 Hz, 0.7 s (see Notes 1 and 2)	I_{TSM}	10	A rms
Initial rate of rise of on-state current, Linear current ramp, Maximum ramp value < 38 A	di_T/dt	250	A/μs
Junction temperature	T_J	150	°C
Operating free - air temperature range		0 to 70	°C
Storage temperature range	T_{stg}	-40 to +150	°C
Lead temperature 1.5 mm from case for 10 s	T_{lead}	260	°C

NOTES: 1. Above 70°C, derate linearly to zero at 150°C case temperature
2. This value applies when the initial case temperature is at (or below) 70°C. The surge may be repeated after the device has returned to thermal equilibrium.
3. Most PTT's quote an unloaded voltage waveform. In operation the TISP essentially shorts the generator output. The resulting loaded current waveform is specified.

electrical characteristics for the A and B terminals, T_J = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 200			V
I_D	Off-state leakage current	V_D = ± 50 V			± 10	μA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz (see Note 4)		40	100	pF

NOTE 4: These capacitance measurements employ a three terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.

electrical characteristics for the A and C or the B and C terminals, T_J = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 200			V
αV_Z	Temperature coefficient of reference voltage			0.1		%/°C
$V_{(BO)}$	Breakover voltage	(see Notes 5 and 6)			± 290	V
$I_{(BO)}$	Breakover current	(see Note 5)	± 0.15		± 0.6	A
V_{TM}	Peak on-state voltage	I_T = ± 5 A (see Notes 5 and 6)		± 1.9	± 3	V
I_H	Holding current	(see Note 5)	± 150			mA
dv/dt	Critical rate of rise of off-state voltage	(see Note 7)			± 5	kV/μs
I_D	Off-state leakage current	V_D = ± 50 V			± 10	μA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz (see Note 4)		110	200	pF

NOTES: 5. These parameters must be measured using pulse techniques, t_w = 100 μs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts seperate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.
7. Linear rate of rise, maximum voltage limited to 80 % V_Z (minimum).

PARAMETER MEASUREMENT INFORMATION

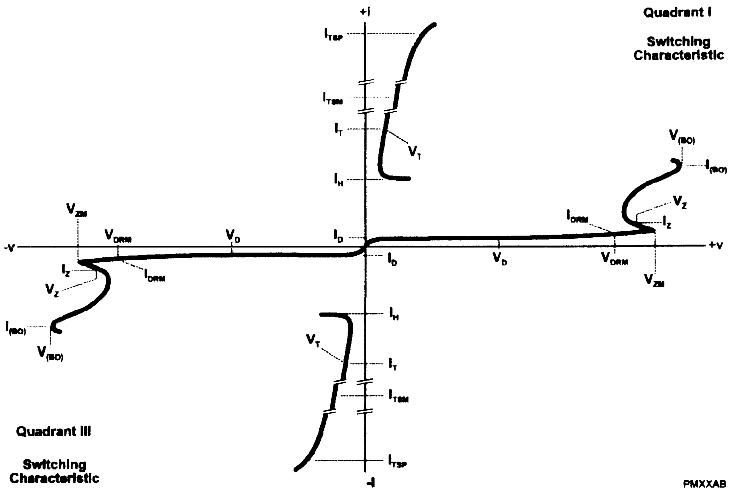


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR ANY PAIR OF TERMINALS

The high level characteristics for terminals A and B are not guaranteed.

thermal characteristics

PARAMETER	MIN	TYP	MAX	UNIT
$R_{\theta JA}$ Junction to free air thermal resistance			100	°C/W

TYPICAL CHARACTERISTICS
A and C, or B and C terminals

SURGE CURRENT vs DECAY TIME

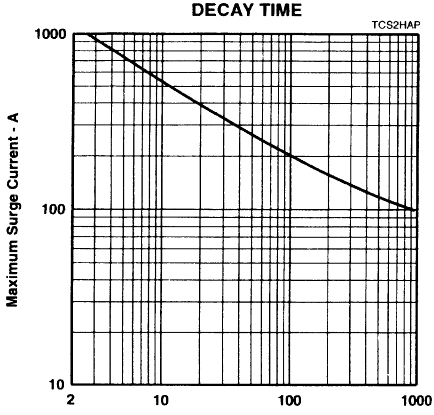


Figure 2.

TELECOMMUNICATION SYSTEM SECONDARY PROTECTION

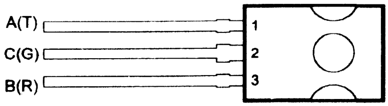
- **Ion-Implanted Breakdown Region**
  Precise and Stable Voltage
  Low Voltage Overshoot under Surge

DEVICE	$V_{(Z)}$ V	$V_{(BO)}$ V
'2310L	250	310

- **Planar Passivated Junctions**
  Low Off-State Current < 10 µA
- **Rated for International Surge Wave Shapes**

WAVE SHAPE	STANDARD	I_{TSP} A
8/20 µs	ANSI C62.41	150
10/160 µs	FCC Part 68	60
10/560 µs	FCC Part 68	45
0.5/700 µs	RLM 88	38
10/700 µs	FTZ R12	50
	VDE 0433	50
	CCITT IX K17	50
10/1000 µs	REA PE-60	50

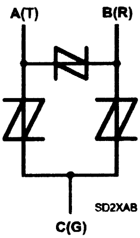
L PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDXXAO

device symbol



description

The TISP2310L is designed specifically for telephone equipment protection against lightning and transients induced by ac power lines. These devices will supress voltage transients between terminals A and C, B and C, and A and B.

Transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides.

These monolithic protection devices are fabricated in ion-implanted planar structures to ensure precise and matched breakover control and are virtually transparent to the system in normal operation

TEXAS INSTRUMENTS

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING	SYMBOL	VALUE	UNIT
Non-repetitive peak on-state pulse current (see Notes 1, 2 and 3)			
8/20 μs (ANSI C62.41, open-circuit voltage wave shape 1.2/50 μs)	I_{TSP}	150	A
10/160 μs (FCC Part 68, open-circuit voltage wave shape 10/160 μs)		60	
5/200 μs (VDE 0433, open-circuit voltage wave shape 2 kV, 10/700 μs)		50	
0.5/310 μs (RLM 88, open-circuit voltage wave shape 1.5 kV, 0.5/700 μs)		38	
5/310 μs (CCITT IX K17, open-circuit voltage wave shape 1.5 kV, 10/700 μs)		50	
5/310 μs (FTZ R12, open-circuit voltage wave shape 2 kV, 10/700 μs)		50	
10/560 μs (FCC Part 68, open-circuit voltage wave shape 10/560 μs)		45	
10/1000 μs (REA PE-60, open-circuit voltage wave shape 10/1000 μs)		50	
Non-repetitive peak on-state current, 50 Hz, 0.7 s (see Notes 1 and 2)	I_{TSM}	10	A rms
Initial rate of rise of on-state current, Linear current ramp, Maximum ramp value < 38 A	di_T/dt	250	A/μs
Junction temperature	T_J	150	°C
Operating free - air temperature range		0 to 70	°C
Storage temperature range	T_{stg}	-40 to +150	°C
Lead temperature 1.5 mm from case for 10 s	T_{lead}	260	°C

NOTES: 1. Above 70°C, derate linearly to zero at 150°C case temperature
2. This value applies when the initial case temperature is at (or below) 70°C. The surge may be repeated after the device has returned to thermal equilibrium.
3. Most PTT's quote an unloaded voltage waveform. In operation the TISP essentially shorts the generator output. The resulting loaded current waveform is specified.

electrical characteristics for the A and B terminals, T_J = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	$I_Z = \pm$ 1mA	± 250			V
I_D	Off-state leakage current	$V_D = \pm$ 50 V			± 10	μA
C_{off}	Off-state capacitance	$V_D = 0$ f = 1 kHz (see Note 4)		40	100	pF

NOTE 4: These capacitance measurements employ a three terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.

electrical characteristics for the A and C or the B and C terminals, T_J = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	$I_Z = \pm$ 1mA	± 250			V
αV_Z	Temperature coefficient of reference voltage			0.1		%/°C
$V_{(BO)}$	Breakover voltage	(see Notes 5 and 6)			± 310	V
$I_{(BO)}$	Breakover current	(see Note 5)	± 0.15		± 0.6	A
V_{TM}	Peak on-state voltage	$I_T = \pm$ 5 A (see Notes 5 and 6)		± 2.2	± 3	V
I_H	Holding current	(see Note 5)	± 150			mA
dv/dt	Critical rate of rise of off-state voltage	(see Note 7)			± 5	kV/μs
I_D	Off-state leakage current	$V_D = \pm$ 50 V			± 10	μA
C_{off}	Off-state capacitance	$V_D = 0$ f = 1 kHz (see Note 4)		110	200	pF

NOTES: 5. These parameters must be measured using pulse techniques, t_w = 100 μs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts seperate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.
7. Linear rate of rise, maximum voltage limited to 80 % V_Z (minimum).

PARAMETER MEASUREMENT INFORMATION

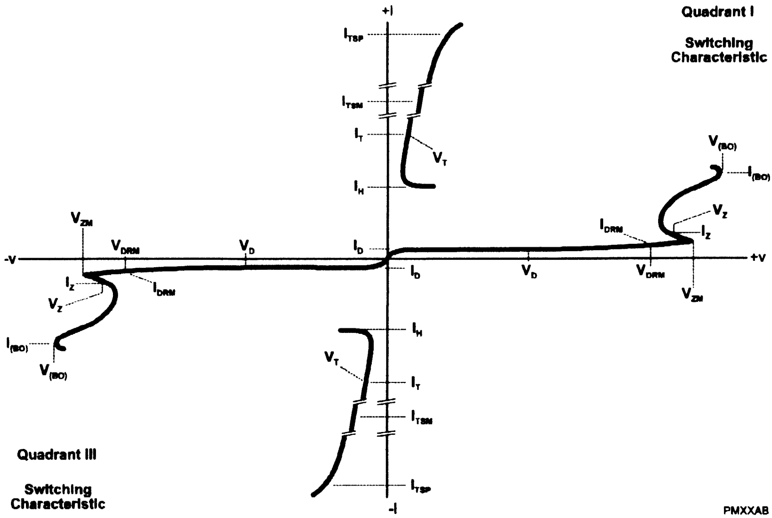


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR ANY PAIR OF TERMINALS

The high level characteristics for terminals A and B are not guaranteed.

thermal characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance			100	°C/W

TEXAS INSTRUMENTS

TISP3082
DUAL SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

SLPSE30 - NOVEMBER 1986 - REVISED SEPTEMBER 1994

TELECOMMUNICATION SYSTEM SECONDARY PROTECTION

- **Ion-Implanted Breakdown Region**
  Precise and Stable Voltage
  Low Voltage Overshoot under Surge

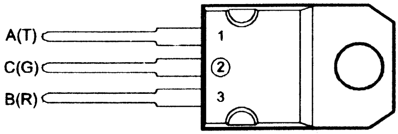
DEVICE	$V_{(Z)}$ V	$V_{(BO)}$ V
'3082	58	82

- **Planar Passivated Junctions**
  Low Off-State Current < 10 µA

- **Rated for International Surge Wave Shapes**

WAVE SHAPE	STANDARD	I_{TSP} A
8/20 µs	ANSI C62.41	150
10/160 µs	FCC Part 68	60
10/560 µs	FCC Part 68	45
0.5/700 µs	RLM 88	38
10/700 µs	FTZ R12	50
	VDE 0433	50
	CCITT IX K17	50
10/1000 µs	REA PE-60	40

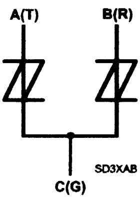
TO-220 PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDXXAN

device symbol



description

The TISP3082 is designed specifically for telephone equipment protection against lightning and transients induced by ac power lines. These devices consist of two bidirectional suppressor elements connected to a Common (C) terminal. These devices will supress voltage transients between terminals A and C, B and C, and A and B.

Transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides.

These monolithic protection devices are fabricated in ion-implanted planar structures to ensure precise and matched breakover control and are virtually transparent to the system in normal operation

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING	SYMBOL	VALUE	UNIT
Non-repetitive peak on-state pulse current (see Notes 1, 2 and 3)	I_{TSP}		A
8/20 μs (ANSI C62.41, open-circuit voltage wave shape 1.2/50 μs)		150	
10/160 μs (FCC Part 68, open-circuit voltage wave shape 10/160 μs)		60	
5/200 μs (VDE 0433, open-circuit voltage wave shape 2 kV, 10/700 μs)		50	
0.5/310 μs (RLM 88, open-circuit voltage wave shape 1.5 kV, 0.5/700 μs)		38	
5/310 μs (CCITT IX K17, open-circuit voltage wave shape 1.5 kV, 10/700 μs)		50	
5/310 μs (FTZ R12, open-circuit voltage wave shape 2 kV, 10/700 μs)		50	
10/560 μs (FCC Part 68, open-circuit voltage wave shape 10/560 μs)		45	
10/1000 μs (REA PE-60, open-circuit voltage wave shape 10/1000 μs)		40	
Non-repetitive peak on-state current, 50 Hz, 2.5 s (see Notes 1 and 2)	I_{TSM}	10	A rms
Initial rate of rise of on-state current, Linear current ramp, Maximum ramp value < 38 A	di_T/dt	250	A/μs
Junction temperature	T_J	150	°C
Operating free - air temperature range		0 to 70	°C
Storage temperature range	T_{stg}	-40 to +150	°C
Lead temperature 1.5 mm from case for 10 s	T_{lead}	260	°C

NOTES: 1. Above 70°C, derate linearly to zero at 150°C case temperature
2. This value applies when the initial case temperature is at (or below) 70°C. The surge may be repeated after the device has returned to thermal equilibrium.
3. Most PTT's quote an unloaded voltage waveform. In operation the TISP essentially shorts the generator output. The resulting loaded current waveform is specified.

electrical characteristics for the A and B terminals, T_J = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 116			V
I_D	Off-state leakage current	V_D = ± 50 V			± 10	μA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz (see Note 4)		0.5	5	pF

NOTE 4: These capacitance measurements employ a three terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.

electrical characteristics for the A and C or the B and C terminals, T_J = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 58			V
αV_Z	Temperature coefficient of reference voltage			0.1		%/°C
$V_{(BO)}$	Breakover voltage	(see Notes 5 and 6)			± 82	V
$I_{(BO)}$	Breakover current	(see Note 5)	± 0.15		± 0.6	A
V_{TM}	Peak on-state voltage	I_T = ± 5 A (see Notes 5 and 6)		± 2.2	± 3	V
I_H	Holding current	(see Note 5)	± 150			mA
dv/dt	Critical rate of rise of off-state voltage	(see Note 7)			± 5	kV/μs
I_D	Off-state leakage current	V_D = ± 50 V			± 10	μA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz (see Note 4)		110	200	pF

NOTES: 5. These parameters must be measured using pulse techniques, t_w = 100 μs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts seperate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.
7. Linear rate of rise, maximum voltage limited to 80 % V_Z (minimum).

PARAMETER MEASUREMENT INFORMATION

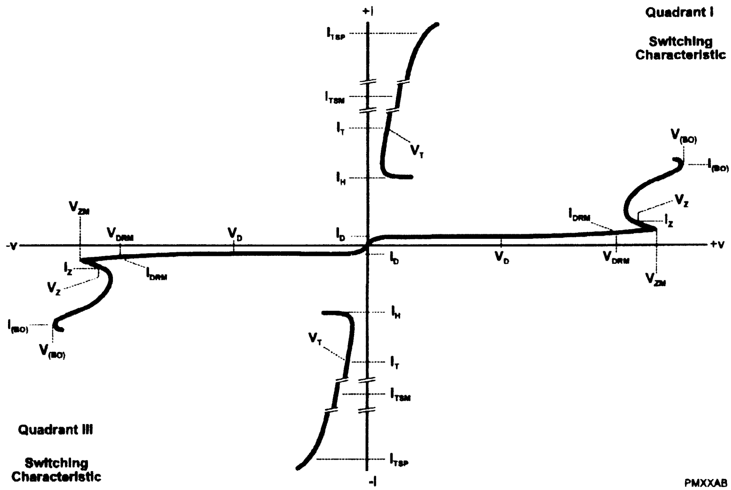


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR ANY PAIR TERMINALS

thermal characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance			62.5	°C/W

TYPICAL CHARACTERISTICS
A and C, or B and C terminals

SURGE CURRENT vs DECAY TIME

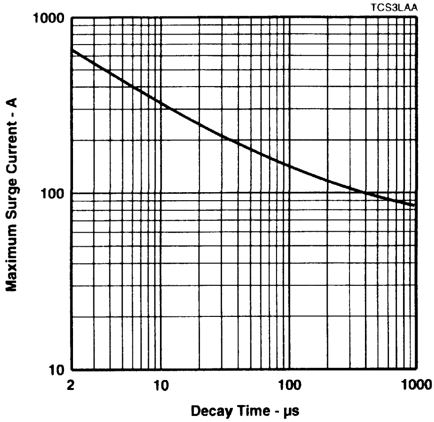


Figure 2.

TELECOMMUNICATION SYSTEM SECONDARY PROTECTION

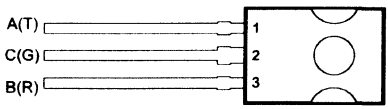
- **Ion-Implanted Breakdown Region**
  Precise and Stable Voltage
  Low Voltage Overshoot under Surge

DEVICE	$V_{(Z)}$ V	$V_{(BO)}$ V
'3082L	58	82

- **Planar Passivated Junctions**
  Low Off-State Current < 10 µA
- **Rated for International Surge Wave Shapes**

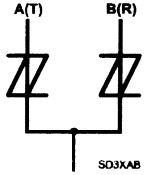
WAVE SHAPE	STANDARD	I_{TSP} A
8/20 µs	ANSI C62.41	100
10/160 µs	FCC Part 68	60
10/560 µs	FCC Part 68	45
0.5/700 µs	RLM 88	38
10/700 µs	FTZ R12	50
	VDE 0433	50
	CCITT IX K17	50
10/1000 µs	REA PE-60	35

L PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.
MDXXAO

device symbol



description

The TISP3082L is designed specifically for telephone equipment protection against lightning and transients induced by ac power lines. These devices consist of two bidirectional suppressor elements connected to a Common (C) terminal. These devices will supress voltage transients between terminals A and C, B and C, and A and B.

Transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides.

These monolithic protection devices are fabricated in ion-implanted planar structures to ensure precise and matched breakover control and are virtually transparent to the system in normal operation

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING	SYMBOL	VALUE	UNIT
Non-repetitive peak on-state pulse current (see Notes 1, 2 and 3)			
8/20 μs (ANSI C62.41, open-circuit voltage wave shape 1.2/50 μs)	I_{TSP}	100	A
10/160 μs (FCC Part 68, open-circuit voltage wave shape 10/160 μs)		60	
5/200 μs (VDE 0433, open-circuit voltage wave shape 2 kV, 10/700 μs)		50	
0.5/310 μs (RLM 88, open-circuit voltage wave shape 1.5 kV, 0.5/700 μs)		38	
5/310 μs (CCITT IX K17, open-circuit voltage wave shape 1.5 kV, 10/700 μs)		50	
5/310 μs (FTZ R12, open-circuit voltage wave shape 2 kV, 10/700 μs)		50	
10/560 μs (FCC Part 68, open-circuit voltage wave shape 10/560 μs)		45	
10/1000 μs (REA PE-60, open-circuit voltage wave shape 10/1000 μs)		35	
Non-repetitive peak on-state current, 50 Hz, 0.7 s (see Notes 1 and 2)	I_{TSM}	10	A rms
Initial rate of rise of on-state current, Linear current ramp, Maximum ramp value < 38 A	di_T/dt	250	A/μs
Junction temperature	T_J	150	°C
Operating free - air temperature range		0 to 70	°C
Storage temperature range	T_{stg}	-40 to +150	°C
Lead temperature 1.5 mm from case for 10 s	T_{lead}	260	°C

NOTES: 1. Above 70°C, derate linearly to zero at 150°C case temperature
2. This value applies when the initial case temperature is at (or below) 70°C. The surge may be repeated after the device has returned to thermal equilibrium.
3. Most PTT's quote an unloaded voltage waveform. In operation the TISP essentially shorts the generator output. The resulting loaded current waveform is specified.

electrical characteristics for the A and B terminals, T_J = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 116			V
I_D	Off-state leakage current	V_D = ± 50 V			± 10	μA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz (see Note 4)		0.5	5	pF

NOTE 4: These capacitance measurements employ a three terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.

electrical characteristics for the A and C or the B and C terminals, T_J = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 58			V
αV_Z	Temperature coefficient of reference voltage			0.1		%/°C
$V_{(BO)}$	Breakover voltage	(see Notes 5 and 6)			± 82	V
$I_{(BO)}$	Breakover current	(see Note 5)	± 0.15		± 0.6	A
V_{TM}	Peak on-state voltage	I_T = ± 5 A (see Notes 5 and 6)		± 2.2	± 3	V
I_H	Holding current	(see Note 5)	± 150			mA
dv/dt	Critical rate of rise of off-state voltage	(see Note 7)			± 5	kV/μs
I_D	Off-state leakage current	V_D = ± 50 V			± 10	μA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz (see Note 4)		110	200	pF

NOTES: 5. These parameters must be measured using pulse techniques, t_w = 100 μs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts seperate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.
7. Linear rate of rise, maximum voltage limited to 80 % V_Z (minimum).

PARAMETER MEASUREMENT INFORMATION

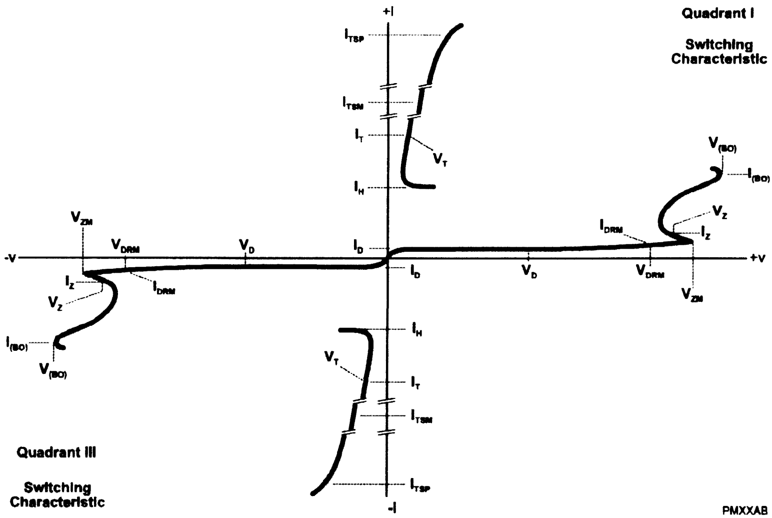


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR ANY PAIR OF TERMINALS

thermal characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance			100	°C/W

TELECOMMUNICATION SYSTEM SECONDARY PROTECTION

- **Ion-Implanted Breakdown Region**
  Precise and Stable Voltage
  Low Voltage Overshoot under Surge

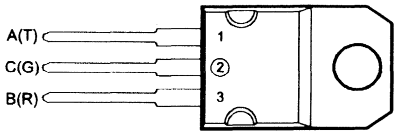
DEVICE	$V_{(Z)}$ V	$V_{(BO)}$ V
'3180	145	180

- **Planar Passivated Junctions**
  Low Off-State Current < 10 µA

- **Rated for International Surge Wave Shapes**

WAVE SHAPE	STANDARD	I_{TSP} A
8/20 µs	ANSI C62.41	150
10/160 µs	FCC Part 68	60
10/560 µs	FCC Part 68	45
0.5/700 µs	RLM 88	38
10/700 µs	FTZ R12	50
	VDE 0433	50
	CCITT IX K17	50
10/1000 µs	REA PE-60	50

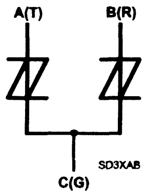
TO-220 PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDXXAN

device symbol



description

The TISP3180 is designed specifically for telephone equipment protection against lightning and transients induced by ac power lines. These devices consist of two bidirectional suppressor elements connected to a Common (C) terminal. They will supress voltage transients between terminals A and C, B and C, and A and B.

Transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides.

These monolithic protection devices are fabricated in ion-implanted planar structures to ensure precise and matched breakover control and are virtually transparent to the system in normal operation

absolute maximum ratings

RATING	SYMBOL	VALUE	UNIT
Non-repetitive peak on-state pulse current (see Notes 1, 2 and 3)			
8/20 μs (ANSI C62.41, open-circuit voltage wave shape 1.2/50 μs)		150	
10/160 μs (FCC Part 68, open-circuit voltage wave shape 10/160 μs)		60	
5/200 μs (VDE 0433, open-circuit voltage wave shape 2 kV, 10/700 μs)		50	
0.5/310 μs (RLM 88, open-circuit voltage wave shape 1.5 kV, 0.5/700 μs)	I_{TSP}	38	A
5/310 μs (CCITT IX K17, open-circuit voltage wave shape 1.5 kV, 10/700 μs)		50	
5/310 μs (FTZ R12, open-circuit voltage wave shape 2 kV, 10/700 μs)		50	
10/560 μs (FCC Part 68, open-circuit voltage wave shape 10/560 μs)		45	
10/1000 μs (REA PE-60, open-circuit voltage wave shape 10/1000 μs)		50	
Non-repetitive peak on-state current, 50 Hz, 2.5 s (see Notes 1 and 2)	I_{TSM}	10	A rms
Initial rate of rise of on-state current, Linear current ramp, Maximum ramp value < 38 A	di_T/dt	250	A/μs
Junction temperature	T_J	150	°C
Operating free - air temperature range		0 to 70	°C
Storage temperature range	T_{stg}	-40 to +150	°C
Lead temperature 1.5 mm from case for 10 s	T_{lead}	260	°C

NOTES: 1. Above 70°C, derate linearly to zero at 150°C case temperature
2. This value applies when the initial case temperature is at (or below) 70°C. The surge may be repeated after the device has returned to thermal equilibrium.
3. Most PTT's quote an unloaded voltage waveform. In operation the TISP essentially shorts the generator output. The resulting loaded current waveform is specified.

electrical characteristics for the A and B terminals, T_J = 25°C

	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 290			V
I_D	Off-state leakage current	V_D = ± 50 V			± 10	μA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz (see Note 4)		0.5	5	pF

NOTE 4: These capacitance measurements employ a three terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.

electrical characteristics for the A and C or the B and C terminals, T_J = 25°C

	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 145			V
αV_Z	Temperature coefficient of reference voltage			0.1		%/°C
$V_{(BO)}$	Breakover voltage	(see Notes 5 and 6)			± 180	V
$I_{(BO)}$	Breakover current	(see Note 5)	± 0.15		± 0.6	A
V_{TM}	Peak on-state voltage	I_T = ± 5 A (see Notes 5 and 6)		± 2.2	± 3	V
I_H	Holding current	(see Note 5)	± 150			mA
dv/dt	Critical rate of rise of off-state voltage	(see Note 7)			± 5	kV/μs
I_D	Off-state leakage current	V_D = ± 50 V			± 10	μA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz (see Note 4)		110	200	pF

NOTES: 5. These parameters must be measured using pulse techniques, t_w = 100 μs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts seperate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.
7. Linear rate of rise, maximum voltage limited to 80 % V_Z (minimum).

PARAMETER MEASUREMENT INFORMATION

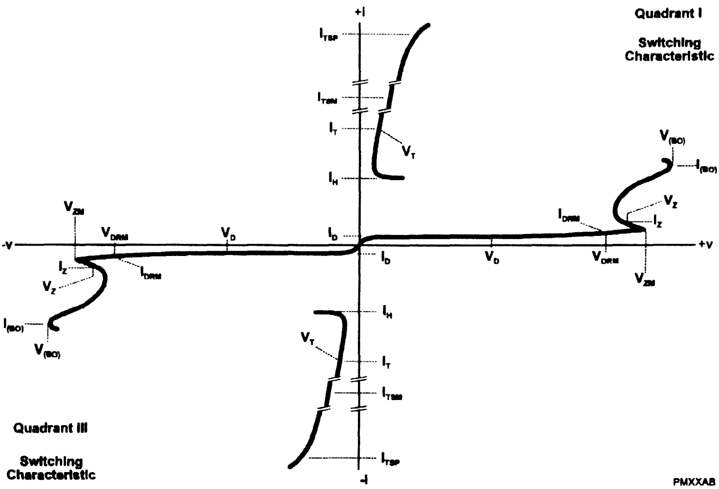


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR ANY PAIR OF TERMINALS

thermal characteristics

PARAMETER	MIN	TYP	MAX	UNIT
$R_{\theta JA}$ Junction to free air thermal resistance			62.5	°C/W

TYPICAL CHARACTERISTICS
A and C, or B and C terminals

ON-STATE CURRENT vs ON-STATE VOLTAGE

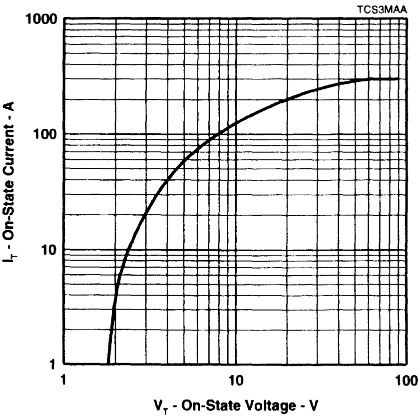


Figure 2.

ZENER VOLTAGE & BREAKOVER VOLTAGE vs JUNCTION TEMPERATURE

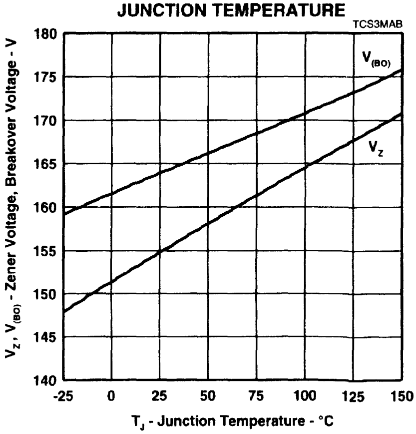


Figure 3.

TYPICAL CHARACTERISTICS
A and C, or B and C terminals

HOLDING CURRENT & BREAKOVER CURRENT vs JUNCTION TEMPERATURE

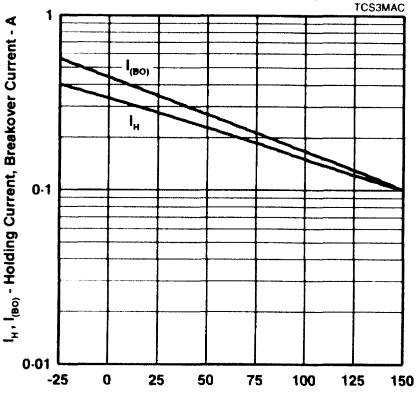


Figure 4.

OFF-STATE CURRENT vs JUNCTION TEMPERATURE

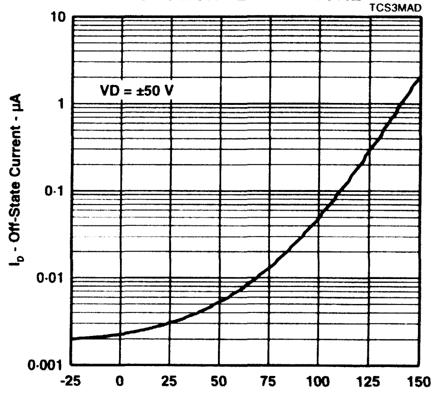


Figure 5.

ON-STATE VOLTAGE vs JUNCTION TEMPERATURE

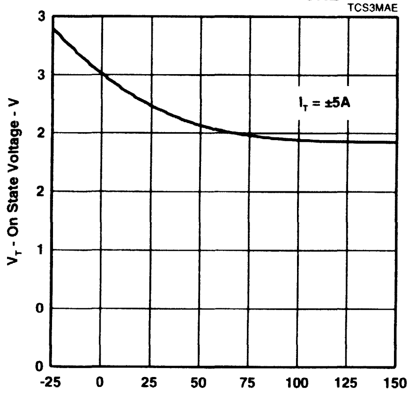


Figure 6.

NORMALISED BREAKOVER VOLTAGE vs RATE OF RISE OF PRINCIPLE CURRENT

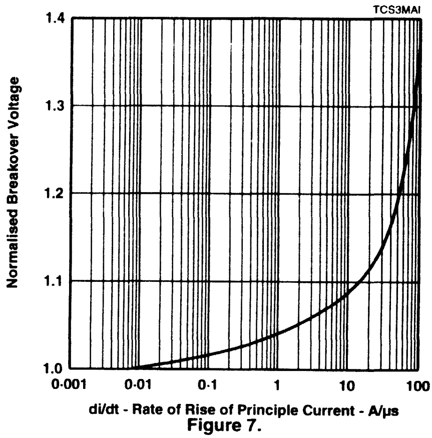


Figure 7.

TYPICAL CHARACTERISTICS
A and C, or B and C terminals

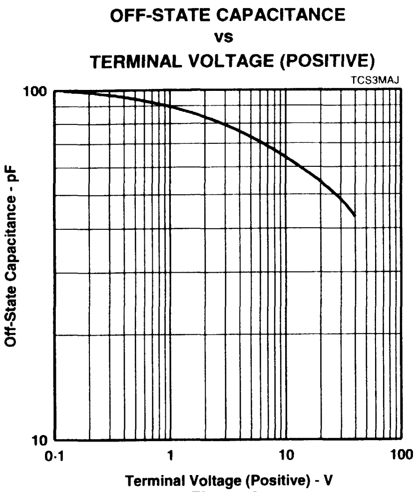


Figure 8.

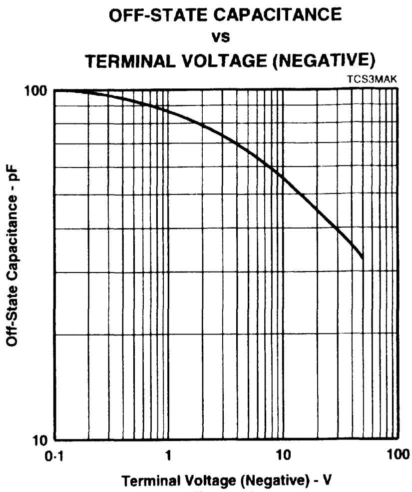


Figure 9.

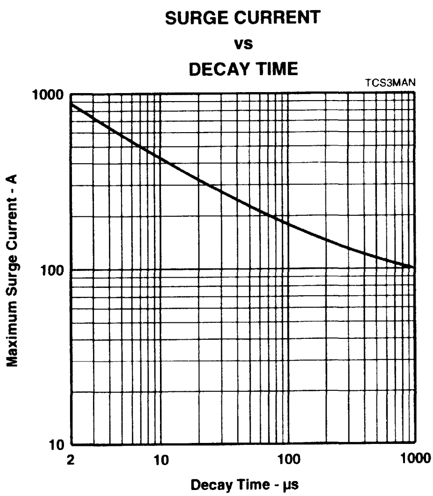


Figure 10.

TYPICAL CHARACTERISTICS
A and B terminals

ZENER VOLTAGE & BREAKOVER VOLTAGE vs JUNCTION TEMPERATURE

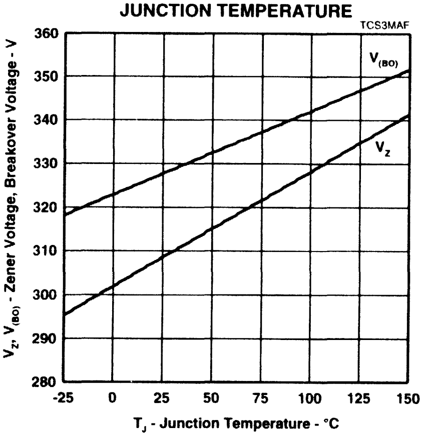


Figure 11.

HOLDING CURRENT & BREAKOVER CURRENT vs JUNCTION TEMPERATURE

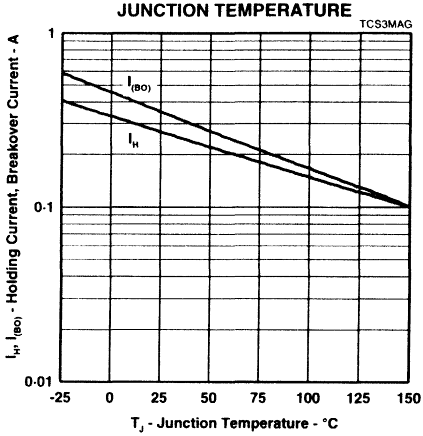


Figure 12.

OFF-STATE CURRENT vs JUNCTION TEMPERATURE

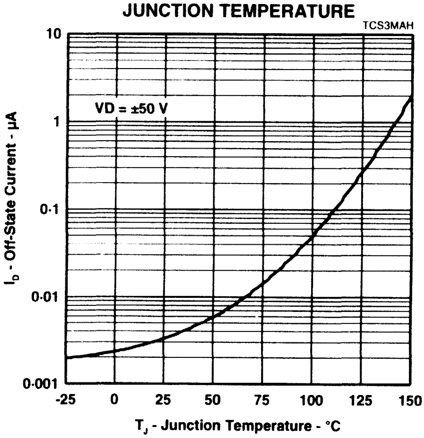


Figure 13.

TYPICAL CHARACTERISTICS
A and B terminals

OFF-STATE CAPACITANCE
vs
TERMINAL VOLTAGE (POSITIVE)

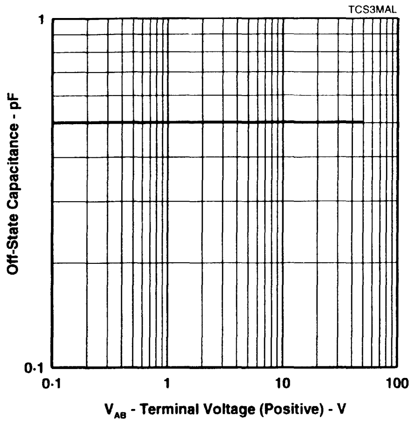


Figure 14.

OFF-STATE CAPACITANCE
vs
TERMINAL VOLTAGE (NEGATIVE)

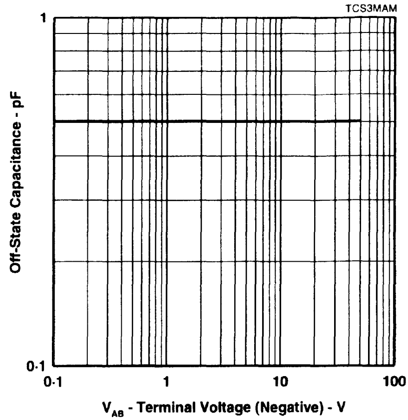


Figure 15.

THERMAL INFORMATION

THERMAL RESPONSE

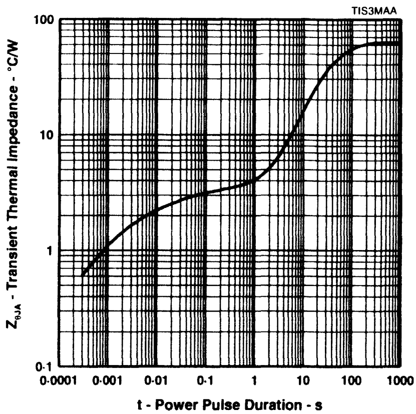


Figure 16.

MAXIMUM NON-RECURRENT 50 Hz CURRENT vs CURRENT DURATION

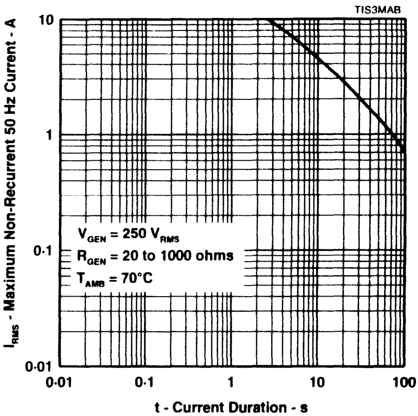


Figure 17.

FREE AIR TEMPERATURE DERATING CURVE

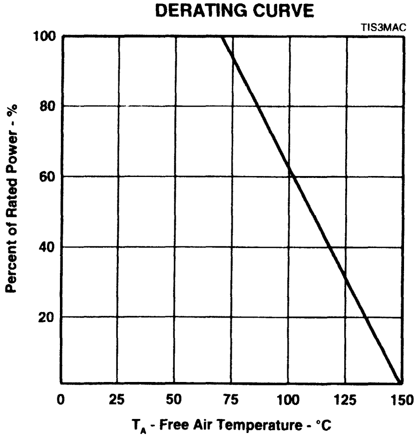


Figure 18.

TISP3180L
DUAL SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

SLPSE33 - FEBRUARY 1990 - REVISED SEPTEMBER 1994

TELECOMMUNICATION SYSTEM SECONDARY PROTECTION

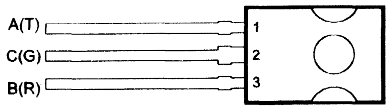
- **Ion-Implanted Breakdown Region**
  Precise and Stable Voltage
  Low Voltage Overshoot under Surge

DEVICE	$V_{(Z)}$ V	$V_{(BO)}$ V
'3180L	145	180

- **Planar Passivated Junctions**
  Low Off-State Current < 10 µA
- **Rated for International Surge Wave Shapes**

WAVE SHAPE	STANDARD	I_{TSP} A
8/20 µs	ANSI C62.41	100
10/160 µs	FCC Part 68	60
10/560 µs	FCC Part 68	45
0.5/700 µs	RLM 88	38
10/700 µs	FTZ R12	50
	VDE 0433	50
	CCITT IX K17	50
10/1000 µs	REA PE-60	35

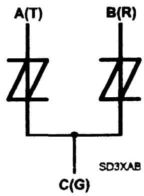
L PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDXXAO

device symbol



description

The TISP3180L is designed specifically for telephone equipment protection against lightning and transients induced by ac power lines. These devices consist of two bidirectional suppressor elements connected to a Common (C) terminal. They will supress voltage transients between terminals A and C, B and C, and A and B.

Transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides.

These monolithic protection devices are fabricated in ion-implanted planar structures to ensure precise and matched breakover control and are virtually transparent to the system in normal operation

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING	SYMBOL	VALUE	UNIT
Non-repetitive peak on-state pulse current (see Notes 1, 2 and 3)			
8/20 μs (ANSI C62.41, open-circuit voltage wave shape 1.2/50 μs)	I_{TSP}	100	A
10/160 μs (FCC Part 68, open-circuit voltage wave shape 10/160 μs)		60	
5/200 μs (VDE 0433, open-circuit voltage wave shape 2 kV, 10/700 μs)		50	
0.5/310 μs (RLM 88, open-circuit voltage wave shape 1.5 kV, 0.5/700 μs)		38	
5/310 μs (CCITT IX K17, open-circuit voltage wave shape 1.5 kV, 10/700 μs)		50	
5/310 μs (FTZ R12, open-circuit voltage wave shape 2 kV, 10/700 μs)		50	
10/560 μs (FCC Part 68, open-circuit voltage wave shape 10/560 μs)		45	
10/1000 μs (REA PE-60, open-circuit voltage wave shape 10/1000 μs)		35	
Non-repetitive peak on-state current, 50 Hz, 0.7 s (see Notes 1 and 2)	I_{TSM}	10	A rms
Initial rate of rise of on-state current, Linear current ramp, Maximum ramp value < 38 A	di_T/dt	250	A/μs
Junction temperature	T_J	150	°C
Operating free - air temperature range		0 to 70	°C
Storage temperature range	T_{stg}	-40 to +150	°C
Lead temperature 1.5 mm from case for 10 s	T_{lead}	260	°C

NOTES: 1. Above 70°C, derate linearly to zero at 150°C case temperature
2. This value applies when the initial case temperature is at (or below) 70°C. The surge may be repeated after the device has returned to thermal equilibrium.
3. Most PTT's quote an unloaded voltage waveform. In operation the TISP essentially shorts the generator output. The resulting loaded current waveform is specified.

electrical characteristics for the A and B terminals, T_J = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 290			V
I_D	Off-state leakage current	V_D = ± 50 V			± 10	μA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz (see Note 4)		0.5	5	pF

NOTE 4: These capacitance measurements employ a three terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.

electrical characteristics for the A and C or the B and C terminals, T_J = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 145			V
αV_Z	Temperature coefficient of reference voltage			0.1		%/°C
$V_{(BO)}$	Breakover voltage	(see Notes 5 and 6)			± 180	V
$I_{(BO)}$	Breakover current	(see Note 5)	± 0.15		± 0.6	A
V_{TM}	Peak on-state voltage	I_T = ± 5 A (see Notes 5 and 6)		± 2.2	± 3	V
I_H	Holding current	(see Note 5)	± 150			mA
dv/dt	Critical rate of rise of off-state voltage	(see Note 7)			± 5	kV/μs
I_D	Off-state leakage current	V_D = ± 50 V			± 10	μA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz (see Note 4)		70	150	pF

NOTES: 5. These parameters must be measured using pulse techniques, t_w = 100 μs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts seperate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.
7. Linear rate of rise, maximum voltage limited to 80 % V_Z (minimum).

PARAMETER MEASUREMENT INFORMATION

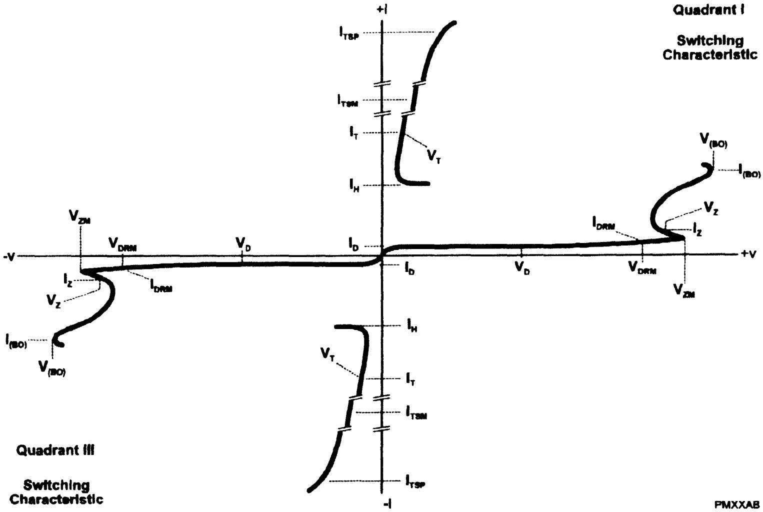


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR ANY PAIR OF TERMINALS

thermal characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance			100	°C/W

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TELECOMMUNICATION SYSTEM SECONDARY PROTECTION

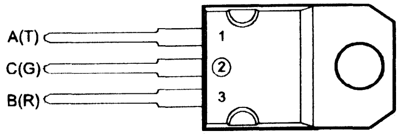
- **Ion-Implanted Breakdown Region**
  Precise and Stable Voltage
  Low Voltage Overshoot under Surge

DEVICE	$V_{(Z)}$ V	$V_{(BO)}$ V
'3290	200	290

- **Planar Passivated Junctions**
  Low Off-State Current < 10 µA
- **Rated for International Surge Wave Shapes**

WAVE SHAPE	STANDARD	I_{TSP} A
8/20 µs	ANSI C62.41	150
10/160 µs	FCC Part 68	60
10/560 µs	FCC Part 68	45
0.5/700 µs	RLM 88	38
10/700 µs	FTZ R12	50
	VDE 0433	50
	CCITT IX K17	50
10/1000 µs	REA PE-60	35

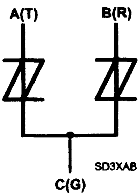
TO-220 PACKAGE
(TOP VIEW)



Pin 2 is in electrical contact with the mounting base.

MDXXAN

device symbol



description

The TISP3290 is designed specifically for telephone equipment protection against lightning and transients induced by ac power lines. These devices consist of two bidirectional suppressor elements connected to a Common (C) terminal. They will supress voltage transients between terminals A and C, B and C, and A and B.

Transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides.

These monolithic protection devices are fabricated in ion-implanted planar structures to ensure precise and matched breakover control and are virtually transparent to the system in normal operation

TEXAS INSTRUMENTS

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING	SYMBOL	VALUE	UNIT
Non-repetitive peak on-state pulse current (see Notes 1, 2 and 3)			
8/20 µs (ANSI C62.41, open-circuit voltage wave shape 1.2/50 µs)	I_{TSP}	150	A
10/160 µs (FCC Part 68, open-circuit voltage wave shape 10/160 µs)		60	
5/200 µs (VDE 0433, open-circuit voltage wave shape 2 kV, 10/700 µs)		50	
0.5/310 µs (RLM 88, open-circuit voltage wave shape 1.5 kV, 0.5/700 µs)		38	
5/310 µs (CCITT IX K17, open-circuit voltage wave shape 1.5 kV, 10/700 µs)		50	
5/310 µs (FTZ R12, open-circuit voltage wave shape 2 kV, 10/700 µs)		50	
10/560 µs (FCC Part 68, open-circuit voltage wave shape 10/560 µs)		45	
10/1000 µs (REA PE-60, open-circuit voltage wave shape 10/1000 µs)		35	
Non-repetitive peak on-state current, 50 Hz, 2.5 s (see Notes 1 and 2)	I_{TSM}	10	A rms
Initial rate of rise of on-state current, Linear current ramp, Maximum ramp value < 38 A	di_T/dt	250	A/µs
Junction temperature	T_J	150	°C
Operating free - air temperature range		0 to 70	°C
Storage temperature range	T_{stg}	-40 to +150	°C
Lead temperature 1.5 mm from case for 10 s	T_{lead}	260	°C

NOTES: 1. Above 70°C, derate linearly to zero at 150°C case temperature
2. This value applies when the initial case temperature is at (or below) 70°C. The surge may be repeated after the device has returned to thermal equilibrium.
3. Most PTT's quote an unloaded voltage waveform. In operation the TISP essentially shorts the generator output. The resulting loaded current waveform is specified.

electrical characteristics for the A and B terminals, T_J = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 400			V
I_D	Off-state leakage current	V_D = ± 50 V			± 10	µA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz (see Note 4)		0.5	5	pF

NOTE 4: These capacitance measurements employ a three terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.

electrical characteristics for the A and C or the B and C terminals, T_J = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 200			V
αV_Z	Temperature coefficient of reference voltage			0.1		%/°C
$V_{(BO)}$	Breakover voltage	(see Notes 5 and 6)			± 290	V
$I_{(BO)}$	Breakover current	(see Note 5)	± 0.15		± 0.6	A
V_{TM}	Peak on-state voltage	I_T = ± 5 A (see Notes 5 and 6)		± 1.9	± 3	V
I_H	Holding current	(see Note 5)	± 150			mA
dv/dt	Critical rate of rise of off-state voltage	(see Note 7)			± 5	kV/µs
I_D	Off-state leakage current	V_D = ± 50 V			± 10	µA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz (see Note 4)		70	150	pF

NOTES: 5. These parameters must be measured using pulse techniques, t_w = 100 µs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts seperate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.
7. Linear rate of rise, maximum voltage limited to 80 % V_Z (minimum).

PARAMETER MEASUREMENT INFORMATION

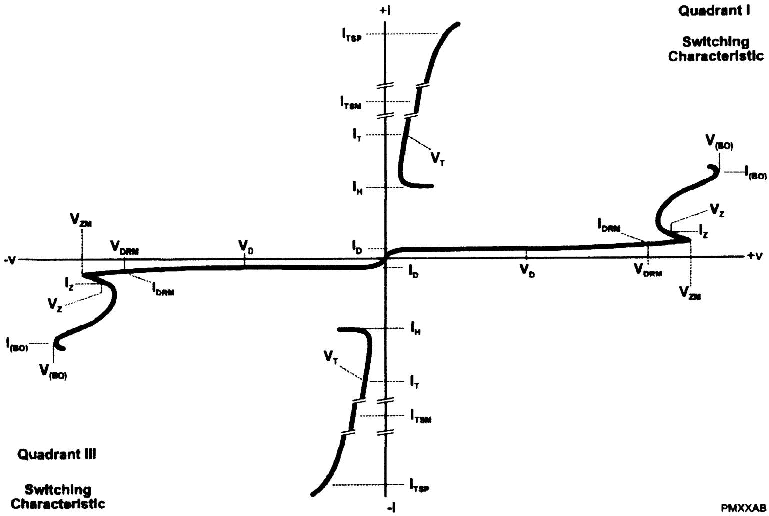


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR ANY PAIR OF TERMINALS

thermal characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance			62.5	°C/W

TELECOMMUNICATION SYSTEM SECONDARY PROTECTION

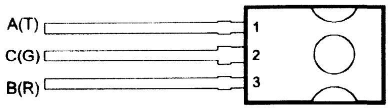
- **Ion-Implanted Breakdown Region**
  Precise and Stable Voltage
  Low Voltage Overshoot under Surge

DEVICE	$V_{(Z)}$ V	$V_{(BO)}$ V
'3290L	200	290

- **Planar Passivated Junctions**
  Low Off-State Current < 10 µA
- **Rated for International Surge Wave Shapes**

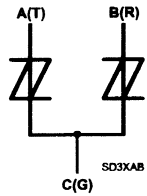
WAVE SHAPE	STANDARD	I_{TSP} A
8/20 µs	ANSI C62.41	150
10/160 µs	FCC Part 68	60
10/560 µs	FCC Part 68	45
0.5/700 µs	RLM 88	38
10/700 µs	FTZ R12	50
	VDE 0433	50
	CCITT IX K17	50
10/1000 µs	REA PE-60	35

L PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base.
MDXXAO

device symbol



description

The TISP3290L is designed specifically for telephone equipment protection against lightning and transients induced by ac power lines. These devices consist of two bidirectional suppressor elements connected to a Common (C) terminal. They will supress voltage transients between terminals A and C, B and C, and A and B.

Transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides.

These monolithic protection devices are fabricated in ion-implanted planar structures to ensure precise and matched breakover control and are virtually transparent to the system in normal operation

TEXAS INSTRUMENTS

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING	SYMBOL	VALUE	UNIT
Non-repetitive peak on-state pulse current (see Notes 1, 2 and 3)			
8/20 μs (ANSI C62.41, open-circuit voltage wave shape 1.2/50 μs)	I_{TSP}	150	A
10/160 μs (FCC Part 68, open-circuit voltage wave shape 10/160 μs)		60	
5/200 μs (VDE 0433, open-circuit voltage wave shape 2 kV, 10/700 μs)		50	
0.5/310 μs (RLM 88, open-circuit voltage wave shape 1.5 kV, 0.5/700 μs)		38	
5/310 μs (CCITT IX K17, open-circuit voltage wave shape 1.5 kV, 10/700 μs)		50	
5/310 μs (FTZ R12, open-circuit voltage wave shape 2 kV, 10/700 μs)		50	
10/560 μs (FCC Part 68, open-circuit voltage wave shape 10/560 μs)		45	
10/1000 μs (REA PE-60, open-circuit voltage wave shape 10/1000 μs)		35	
Non-repetitive peak on-state current, 50 Hz, 0.7 s (see Notes 1 and 2)	I_{TSM}	10	A rms
Initial rate of rise of on-state current, Linear current ramp, Maximum ramp value < 38 A	di_T/dt	250	A/μs
Junction temperature	T_J	150	°C
Operating free - air temperature range		0 to 70	°C
Storage temperature range	T_{stg}	-40 to +150	°C
Lead temperature 1.5 mm from case for 10 s	T_{lead}	260	°C

NOTES: 1. Above 70°C, derate linearly to zero at 150°C case temperature
2. This value applies when the initial case temperature is at (or below) 70°C. The surge may be repeated after the device has returned to thermal equilibrium.
3. Most PTT's quote an unloaded voltage waveform. In operation the TISP essentially shorts the generator output. The resulting loaded current waveform is specified.

electrical characteristics for the A and B terminals, T_J = 25°C

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA			± 400			V
I_D	Off-state leakage current	V_D = ± 50 V					± 10	μA
C_{off}	Off-state capacitance	V_D = 0	f = 1 kHz	(see Note 4)		0.5	5	pF

NOTE 4: These capacitance measurements employ a three terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.

electrical characteristics for the A and C or the B and C terminals, T_J = 25°C

PARAMETER		TEST CONDITIONS			MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA			± 200			V
αV_Z	Temperature coefficient of reference voltage					0.1		%/°C
$V_{(BO)}$	Breakover voltage	(see Notes 5 and 6)					± 290	V
$I_{(BO)}$	Breakover current	(see Note 5)			± 0.15		± 0.6	A
V_{TM}	Peak on-state voltage	I_T = ± 5 A	(see Notes 5 and 6)			± 1.9	± 3	V
I_H	Holding current	(see Note 5)			± 150			mA
dv/dt	Critical rate of rise of off-state voltage	(see Note 7)					± 5	kV/μs
I_D	Off-state leakage current	V_D = ± 50 V					± 10	μA
C_{off}	Off-state capacitance	V_D = 0	f = 1 kHz	(see Note 4)		70	150	pF

NOTES: 5. These parameters must be measured using pulse techniques, t_w = 100 μs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts seperate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.
7. Linear rate of rise, maximum voltage limited to 80 % V_Z (minimum).

PARAMETER MEASUREMENT INFORMATION

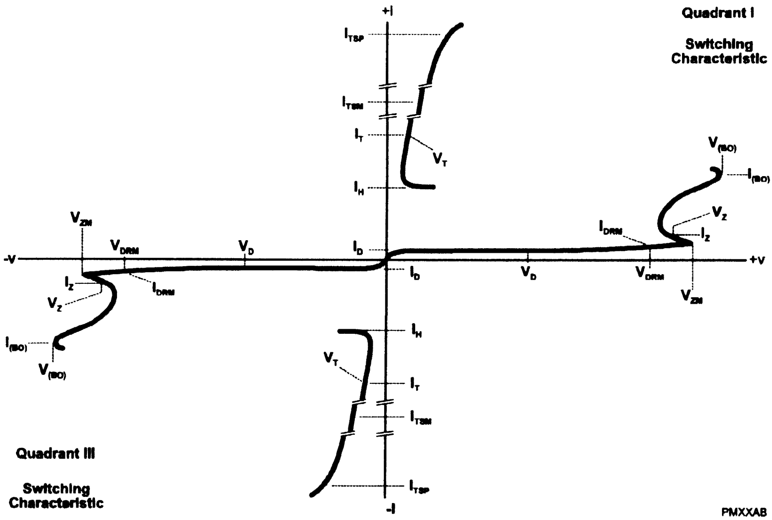


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR ANY PAIR OF TERMINALS

thermal characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance			100	°C/W

TELECOMMUNICATION SYSTEM SECONDARY PROTECTION

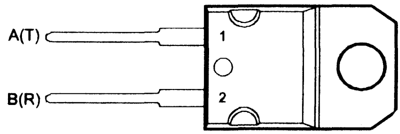
- **Ion-Implanted Breakdown Region**
  Precise and Stable Voltage
  Low Voltage Overshoot under Surge

DEVICE	$V_{(Z)}$ V	$V_{(BO)}$ V
'4082	58	82

- **Planar Passivated Junctions**
  Low Off-State Current < 10 µA
- **Rated for International Surge Wave Shapes**

WAVE SHAPE	STANDARD	I_{TSP} A
8/20 µs	ANSI C62.41	150
10/160 µs	FCC Part 68	60
10/560 µs	FCC Part 68	45
0.5/700 µs	RLM 88	38
10/700 µs	FTZ R12	50
	VDE 0433	50
	CCITT IX K17	50
10/1000 µs	REA PE-60	40

DO-220 PACKAGE
(TOP VIEW)



Pin 1 is in electrical contact with the mounting base.
MD4XAB

description

The TISP4082 is designed specifically for telephone equipment protection against lightning and transients induced by ac power lines. These devices consist of a bidirectional suppressor element connecting the A and B terminals. They will suppress inter-wire voltage transients.

Transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides.

device symbol

These monolithic protection devices are fabricated in ion-implanted planar structures to ensure precise and matched breakover control and are virtually transparent to the system in normal operation

TEXAS INSTRUMENTS

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING	SYMBOL	VALUE	UNIT
Non-repetitive peak on-state pulse current (see Notes 1, 2 and 3)			
8/20 μs (ANSI C62.41, open-circuit voltage wave shape 1.2/50 μs)	I_{TSP}	150	A
10/160 μs (FCC Part 68, open-circuit voltage wave shape 10/160 μs)		60	
5/200 μs (VDE 0433, open-circuit voltage wave shape 2 kV, 10/700 μs)		50	
0.5/310 μs (RLM 88, open-circuit voltage wave shape 1.5 kV, 0.5/700 μs)		38	
5/310 μs (CCITT IX K17, open-circuit voltage wave shape 1.5 kV, 10/700 μs)		50	
5/310 μs (FTZ R12, open-circuit voltage wave shape 2 kV, 10/700 μs)		50	
10/560 μs (FCC Part 68, open-circuit voltage wave shape 10/560 μs)		45	
10/1000 μs (REA PE-60, open-circuit voltage wave shape 10/1000 μs)		50	
Non-repetitive peak on-state current, 50 Hz, 2.5 s (see Notes 1 and 2)	I_{TSM}	10	A rms
Initial rate of rise of on-state current, Linear current ramp, Maximum ramp value < 38 A	di_T/dt	250	A/μs
Junction temperature	T_J	150	°C
Operating free - air temperature range		0 to 70	°C
Storage temperature range	T_{stg}	-40 to +150	°C
Lead temperature 1.5 mm from case for 10 s	T_{lead}	260	°C

NOTES: 1. Above 70°C, derate linearly to zero at 150°C case temperature
2. This value applies when the initial case temperature is at (or below) 70°C. The surge may be repeated after the device has returned to thermal equilibrium.
3. Most PTT's quote an unloaded voltage waveform. In operation the TISP essentially shorts the generator output. The resulting loaded current waveform is specified.

electrical characteristics, T_J = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 58			V
$\propto V_Z$	Temperature coefficient of reference voltage			0.1		%/°C
$V_{(BO)}$	Breakover voltage	(see Notes 5 and 6)			± 82	V
$I_{(BO)}$	Breakover current	(see Note 5)	± 0.15		± 0.6	A
V_{TM}	Peak on-state voltage	I_T = ± 5 A (see Notes 5 and 6)		± 2.2	± 3	V
I_H	Holding current	(see Note 5)	± 150			mA
dv/dt	Critical rate of rise of off-state voltage	(see Note 7)			± 5	kV/μs
I_D	Off-state leakage current	V_D = ± 50 V			± 10	μA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz (see Note 4)		110	200	pF

NOTES: 4. These capacitance measurements employ a three terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.
5. These parameters must be measured using pulse techniques, t_w = 100 μs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts seperate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.
7. Linear rate of rise, maximum voltage limited to 80 % V_Z (minimum).

thermal characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance			62.5	°C/W

PARAMETER MEASUREMENT INFORMATION

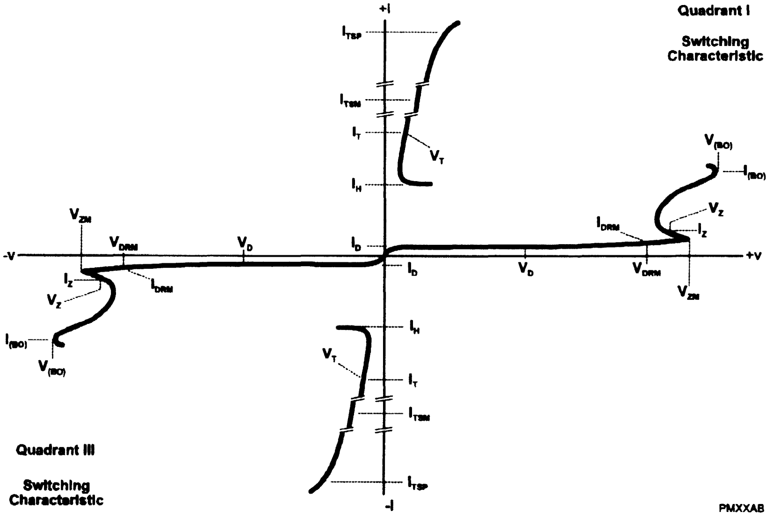


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC TERMINALS A AND B

TELECOMMUNICATION SYSTEM SECONDARY PROTECTION

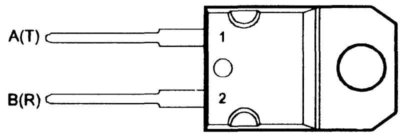
- **Ion-Implanted Breakdown Region**
  Precise and Stable Voltage
  Low Voltage Overshoot under Surge

DEVICE	$V_{(Z)}$ V	$V_{(BO)}$ V
'4180	145	180

- **Planar Passivated Junctions**
  Low Off-State Current < 10 μA
- **Rated for International Surge Wave Shapes**

WAVE SHAPE	STANDARD	I_{TSP} A
8/20 μs	ANSI C62.41	150
10/160 μs	FCC Part 68	60
10/560 μs	FCC Part 68	45
0.5/700 μs	RLM 88	38
10/700 μs	FTZ R12	50
	VDE 0433	50
	CCITT IX K17	50
10/1000 μs	REA PE-60	50

DO-220 PACKAGE (TOP VIEW)



Pin 1 is in electrical contact with the mounting base.
MD4XAB

device symbol

description

The TISP4180 is designed specifically for telephone equipment protection against lightning and transients induced by ac power lines. These devices consist of a bidirectional suppressor element connecting the A and B terminals. They will suppress inter-wire voltage transients.

Transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides.

These monolithic protection devices are fabricated in ion-implanted planar structures to ensure precise and matched breakover control and are virtually transparent to the system in normal operation

TEXAS INSTRUMENTS

absolute maximum ratings

RATING	SYMBOL	VALUE	UNIT
Non-repetitive peak on-state pulse current (see Notes 1, 2 and 3)			
8/20 μs (ANSI C62.41, open-circuit voltage wave shape 1.2/50 μs)		150	
10/160 μs (FCC Part 68, open-circuit voltage wave shape 10/160 μs)		60	
5/200 μs (VDE 0433, open-circuit voltage wave shape 2 kV, 10/700 μs)		50	
0.5/310 μs (RLM 88, open-circuit voltage wave shape 1.5 kV, 0.5/700 μs)	I_{TSP}	38	A
5/310 μs (CCITT IX K17, open-circuit voltage wave shape 1.5 kV, 10/700 μs)		50	
5/310 μs (FTZ R12, open-circuit voltage wave shape 2 kV, 10/700 μs)		50	
10/560 μs (FCC Part 68, open-circuit voltage wave shape 10/560 μs)		45	
10/1000 μs (REA PE-60, open-circuit voltage wave shape 10/1000 μs)		50	
Non-repetitive peak on-state current, 50 Hz, 2.5 s (see Notes 1 and 2)	I_{TSM}	10	A rms
Initial rate of rise of on-state current, Linear current ramp, Maximum ramp value < 38 A	di_T/dt	250	A/μs
Junction temperature	T_J	150	°C
Operating free - air temperature range		0 to 70	°C
Storage temperature range	T_{stg}	-40 to +150	°C
Lead temperature 1.5 mm from case for 10 s	T_{lead}	260	°C

NOTES: 1. Above 70°C, derate linearly to zero at 150°C case temperature
2. This value applies when the initial case temperature is at (or below) 70°C. The surge may be repeated after the device has returned to thermal equilibrium.
3. Most PTT's quote an unloaded voltage waveform. In operation the TISP essentially shorts the generator output. The resulting loaded current waveform is specified.

electrical characteristics, T_J = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 145			V
$\propto V_Z$	Temperature coefficient of reference voltage			0.1		%/°C
$V_{(BO)}$	Breakover voltage	(see Notes 5 and 6)			± 180	V
$I_{(BO)}$	Breakover current	(see Note 5)	± 0.15		± 0.6	A
V_{TM}	Peak on-state voltage	I_T = ± 5 A (see Notes 5 and 6)		± 2.2	± 3	V
I_H	Holding current	(see Note 5)	± 150			mA
dv/dt	Critical rate of rise of off-state voltage	(see Note 7)			± 5	kV/μs
I_D	Off-state leakage current	V_D = ± 50 V			± 10	μA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz (see Note 4)		110	200	pF

NOTES: 4. These capacitance measurements employ a three terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.
5. These parameters must be measured using pulse techniques, t_w = 100 μs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts seperate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.
7. Linear rate of rise, maximum voltage limited to 80 % V_Z (minimum).

thermal characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance			62.5	°C/W

PARAMETER MEASUREMENT INFORMATION

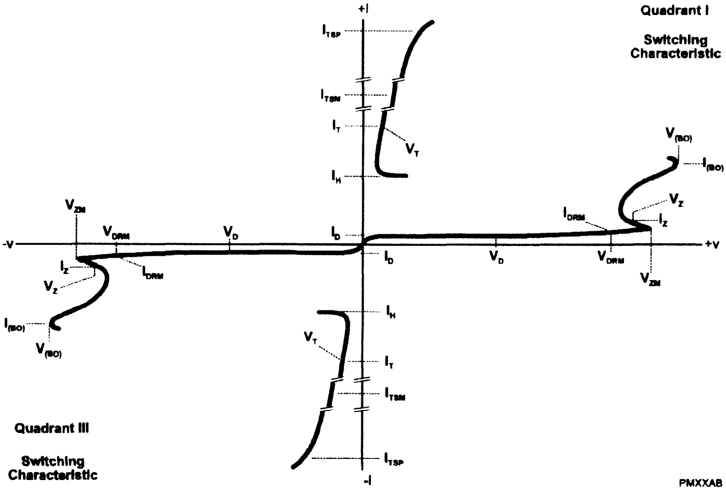


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR TERMINALS A and B

TYPICAL CHARACTERISTICS
A and B terminals

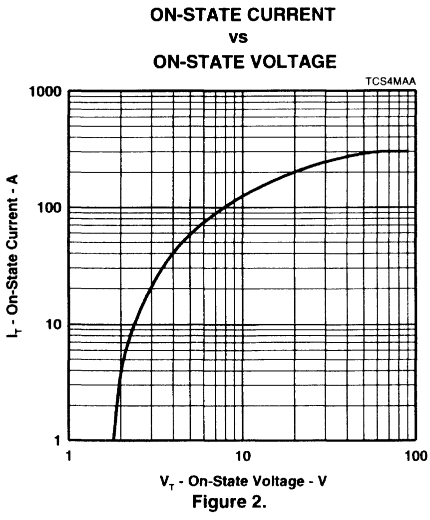


Figure 2.

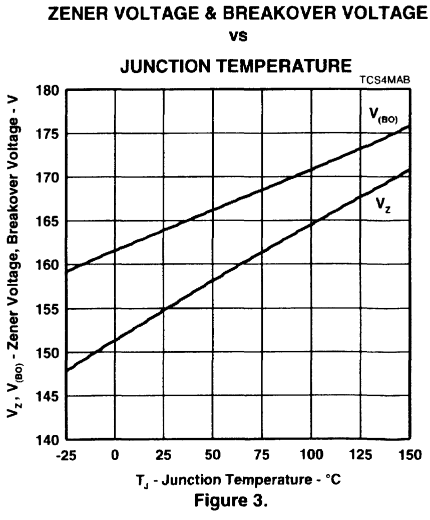


Figure 3.

TYPICAL CHARACTERISTICS
A and B terminals

HOLDING CURRENT & BREAKOVER CURRENT vs JUNCTION TEMPERATURE

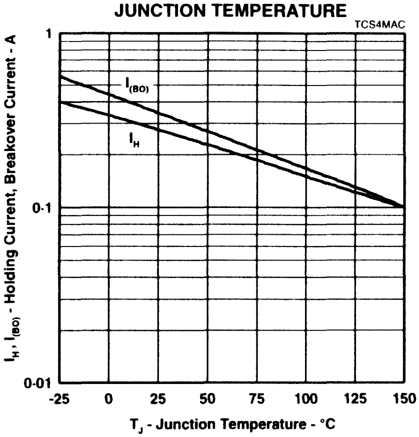


Figure 4.

OFF-STATE CURRENT vs JUNCTION TEMPERATURE

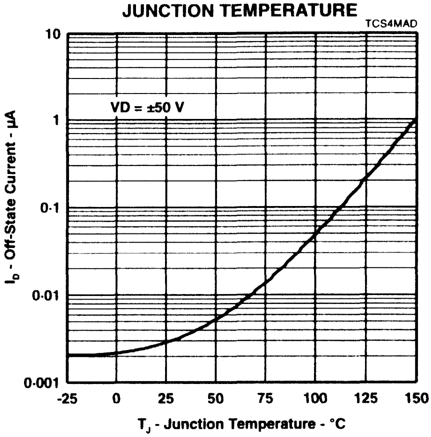


Figure 5.

ON-STATE VOLTAGE vs JUNCTION TEMPERATURE

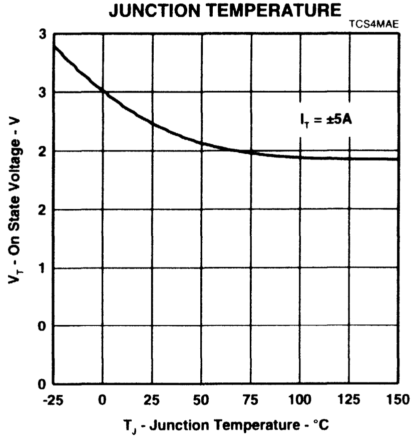


Figure 6.

NORMALISED BREAKOVER VOLTAGE vs RATE OF RISE OF PRINCIPLE CURRENT

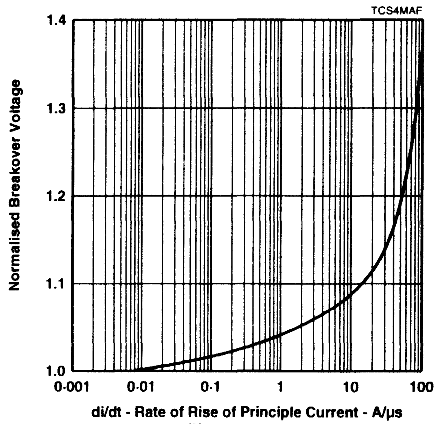


Figure 7.

TYPICAL CHARACTERISTICS
A and B terminals

OFF-STATE CAPACITANCE vs A TERMINAL VOLTAGE (POSITIVE)

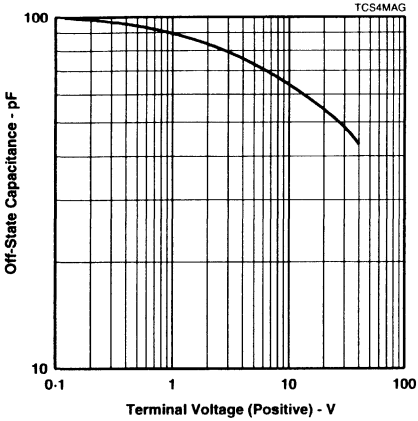


Figure 8.

OFF-STATE CAPACITANCE vs TERMINAL VOLTAGE (NEGATIVE)

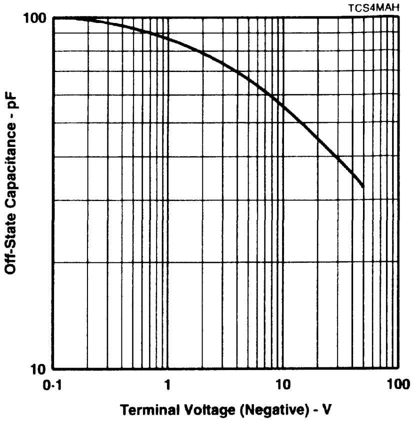


Figure 9.

SURGE CURRENT vs DECAY TIME

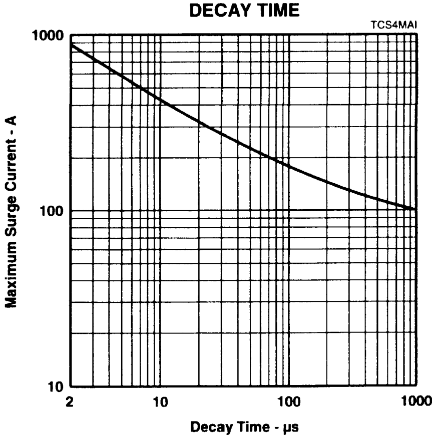


Figure 10.

THERMAL INFORMATION

THERMAL RESPONSE

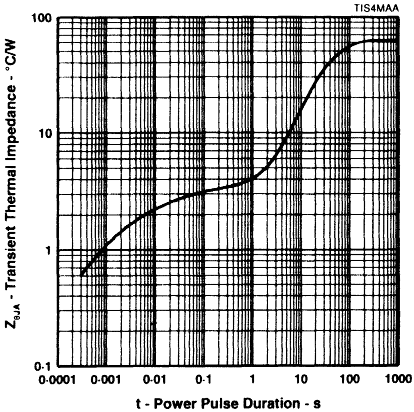


Figure 11.

MAXIMUM NON-RECURRENT 50 Hz CURRENT vs CURRENT DURATION

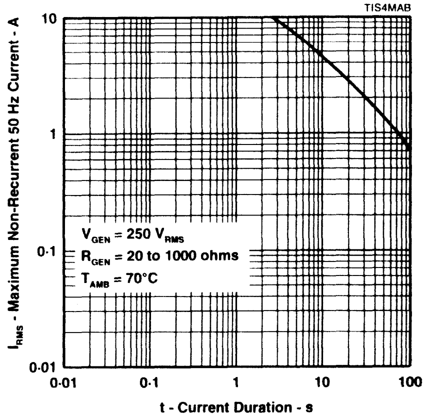


Figure 12.

FREE AIR TEMPERATURE

DERATING CURVE

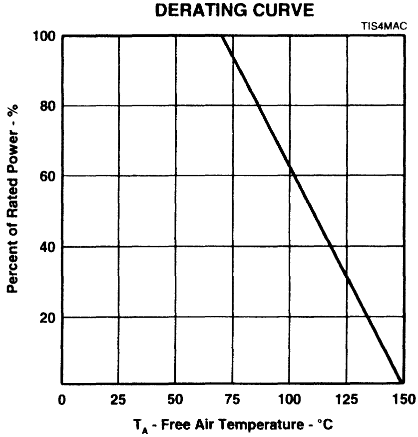


Figure 13.

TISP4290
SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

SLPSE38 - APRIL 1987 - REVISED SEPTEMBER 1994

TELECOMMUNICATION SYSTEM SECONDARY PROTECTION

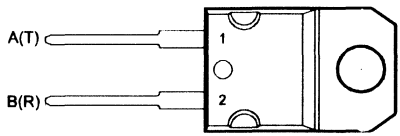
- **Ion-Implanted Breakdown Region**
  Precise and Stable Voltage
  Low Voltage Overshoot under Surge

DEVICE	$V_{(Z)}$ V	$V_{(BO)}$ V
'4290	200	290

- **Planar Passivated Junctions**
  Low Off-State Current < 10 µA
- **Rated for International Surge Wave Shapes**

WAVE SHAPE	STANDARD	I_{TSP} A
8/20 µs	ANSI C62.41	150
10/160 µs	FCC Part 68	60
10/560 µs	FCC Part 68	45
0.5/700 µs	RLM 88	38
10/700 µs	FTZ R12	50
	VDE 0433	50
	CCITT IX K17	50
10/1000 µs	REA PE-60	35

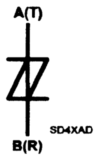
DO-220 PACKAGE (TOP VIEW)



Pin 1 is in electrical contact with the mounting base.

MD4XAB

device symbol



description

The TISP4290 is designed specifically for telephone equipment protection against lightning and transients induced by ac power lines. These devices consist of a bidirectional suppressor element connecting the A and B terminals. They will suppress inter-wire voltage transients.

Transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides.

These monolithic protection devices are fabricated in ion-implanted planar structures to ensure precise and matched breakover control and are virtually transparent to the system in normal operation

TEXAS INSTRUMENTS

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING	SYMBOL	VALUE	UNIT
Non-repetitive peak on-state pulse current (see Notes 1, 2 and 3)			
8/20 µs (ANSI C62.41, open-circuit voltage wave shape 1.2/50 µs)	I_{TSP}	150	A
10/160 µs (FCC Part 68, open-circuit voltage wave shape 10/160 µs)		60	
5/200 µs (VDE 0433, open-circuit voltage wave shape 2 kV, 10/700 µs)		50	
0.5/310 µs (RLM 88, open-circuit voltage wave shape 1.5 kV, 0.5/700 µs)		38	
5/310 µs (CCITT IX K17, open-circuit voltage wave shape 1.5 kV, 10/700 µs)		50	
5/310 µs (FTZ R12, open-circuit voltage wave shape 2 kV, 10/700 µs)		50	
10/560 µs (FCC Part 68, open-circuit voltage wave shape 10/560 µs)		45	
10/1000 µs (REA PE-60, open-circuit voltage wave shape 10/1000 µs)		35	
Non-repetitive peak on-state current, 50 Hz, 2.5 s (see Notes 1 and 2)	I_{TSM}	10	A rms
Initial rate of rise of on-state current, Linear current ramp, Maximum ramp value < 38 A	di_T/dt	250	A/µs
Junction temperature	T_J	150	°C
Operating free - air temperature range		0 to 70	°C
Storage temperature range	T_{stg}	-40 to +150	°C
Lead temperature 1.5 mm from case for 10 s	T_{lead}	260	°C

NOTES: 1. Above 70°C, derate linearly to zero at 150°C case temperature
2. This value applies when the initial case temperature is at (or below) 70°C. The surge may be repeated after the device has returned to thermal equilibrium.
3. Most PTT's quote an unloaded voltage waveform. In operation the TISP essentially shorts the generator output. The resulting loaded current waveform is specified.

electrical characteristics, T_J = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	I_Z = ± 1mA	± 200			V
αV_Z	Temperature coefficient of reference voltage			0.1		%/°C
$V_{(BO)}$	Breakover voltage	(see Notes 5 and 6)			± 290	V
$I_{(BO)}$	Breakover current	(see Note 5)	± 0.15		± 0.6	A
V_{TM}	Peak on-state voltage	I_T = ± 5 A (see Notes 5 and 6)		± 1.9	± 3	V
I_H	Holding current	(see Note 5)	± 150			mA
dv/dt	Critical rate of rise of off-state voltage	(see Note 7)			± 5	kV/µs
I_D	Off-state leakage current	V_D = ± 50 V			± 10	µA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz (see Note 4)		110	200	pF

NOTES: 4. These capacitance measurements employ a three terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.
5. These parameters must be measured using pulse techniques, t_w = 100 µs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts seperate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.
7. Linear rate of rise, maximum voltage limited to 80 % V_Z (minimum).

thermal characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance			62.5	°C/W

PARAMETER MEASUREMENT INFORMATION

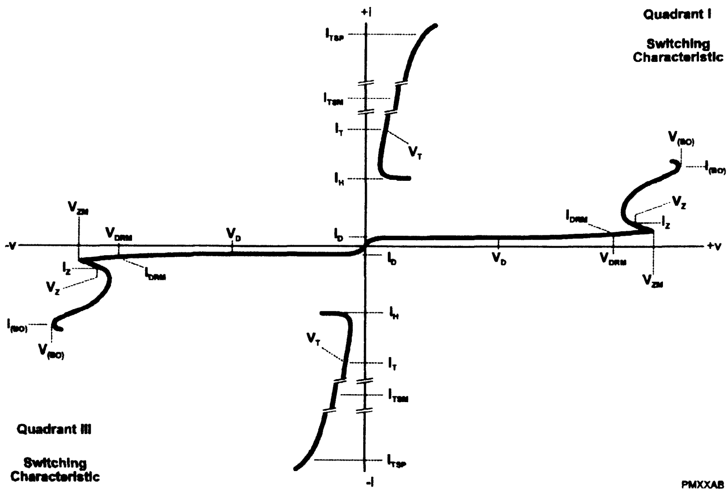


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR TERMINALS A AND B

TYPICAL CHARACTERISTICS
A and B terminals

SURGE CURRENT vs DECAY TIME

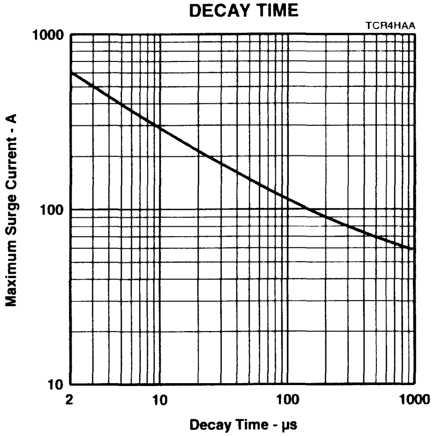


Figure 2.

TELECOMMUNICATION SYSTEM SECONDARY PROTECTION

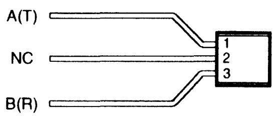
- **Ion-Implanted Breakdown Region**
  Precise and Stable Voltage
  Low Voltage Overshoot under Surge

DEVICE	$V_{(Z)}$ V	$V_{(BO)}$ V
'4160LPR	120	160
'4180LPR	145	180

- **Planar Passivated Junctions**
  Low Off-State Current < 10 μA
- **Rated for International Surge Wave Shapes**

WAVE SHAPE	STANDARD	I_{TSP} A
8/20 μs	ANSI C62.41	100
0.5/700 μs	RLM 88	38
10/700 μs	VDE 0433	50
	CCITT IX K17	38

LP PACKAGE WITH FORMED LEADS (TOP VIEW)



NC - No internal connection

MD4XAF

device symbol

description

The TISP4xxxLPR series is designed specifically for telephone equipment protection against lightning and transients induced by ac power lines. These devices consist of a bidirectional suppressor element connecting the A and B terminals. They will suppress inter-wire voltage transients.

Transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides.

These monolithic protection devices are fabricated in ion-implanted planar structures to ensure precise and matched breakover control and are virtually transparent to the system in normal operation

absolute maximum ratings at 25°C case temperature (unless otherwise noted)

RATING	SYMBOL	VALUE	UNIT
Non-repetitive peak on-state pulse current (see Notes 1, 2 and 3)			
8/20 µs (ANSI C62.41, open-circuit voltage wave shape 1.2/50 µs)	I_{TSP}	100	A
5/200 µs (VDE 0433, open-circuit voltage wave shape 2 kV, 10/700 µs)		50	
0.5/310 µs (RLM 88, open-circuit voltage wave shape 1.5 kV, 0.5/700 µs)		38	
5/310 µs (CCITT IX K17, open-circuit voltage wave shape 1.5 kV, 10/700 µs)		38	
Non-repetitive peak on-state current, 50 Hz, 1 s (see Notes 1 and 2)	I_{TSM}	2.5	A rms
Initial rate of rise of on-state current, Linear current ramp, Maximum ramp value < 38 A	di_T/dt	250	A/µs
Junction temperature	T_J	150	°C
Operating free - air temperature range		0 to 70	°C
Storage temperature range	T_{stg}	-40 to +150	°C
Lead temperature 1.5 mm from case for 10 s	T_{lead}	260	°C

NOTES: 1. Above 70°C, derate linearly to zero at 150°C case temperature
2. This value applies when the initial case temperature is at (or below) 70°C. The surge may be repeated after the device has returned to thermal equilibrium.
3. Most PTT's quote an unloaded voltage waveform. In operation the TISP essentially shorts the generator output. The resulting loaded current waveform is specified.

electrical characteristics, T_J = 25°C

PARAMETER		TEST CONDITIONS	TISP4160LP			TISP4180LP			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
V_Z	Reference zener voltage	I_Z = ± 1mA	± 120			± 145			V
αV_Z	Temperature coefficient of reference voltage			0.1			0.1		%/°C
$V_{(BO)}$	Breakover voltage	(see Notes 5 and 6)			± 160			± 180	V
$I_{(BO)}$	Breakover current	(see Note 5)	± 0.15		± 0.6	± 0.15		± 0.6	A
V_{TM}	Peak on-state voltage	I_T = ± 5 A (see Notes 5 and 6)		± 2.2	± 3		± 2.2	± 3	V
I_H	Holding current	(see Note 5)	± 150			± 150			mA
dv/dt	Critical rate of rise of off-state voltage	(see Note 7)			± 5			± 5	kV/µs
I_D	Off-state leakage current	V_D = ± 50 V			± 10			± 10	µA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz (see Note 4)		70	150		70	150	pF

NOTES: 4. These capacitance measurements employ a three terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.
5. These parameters must be measured using pulse techniques, t_w = 100 µs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts seperate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.
7. Linear rate of rise, maximum voltage limited to 80 % V_Z (minimum).

thermal characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance			156	°C/W

PARAMETER MEASUREMENT INFORMATION

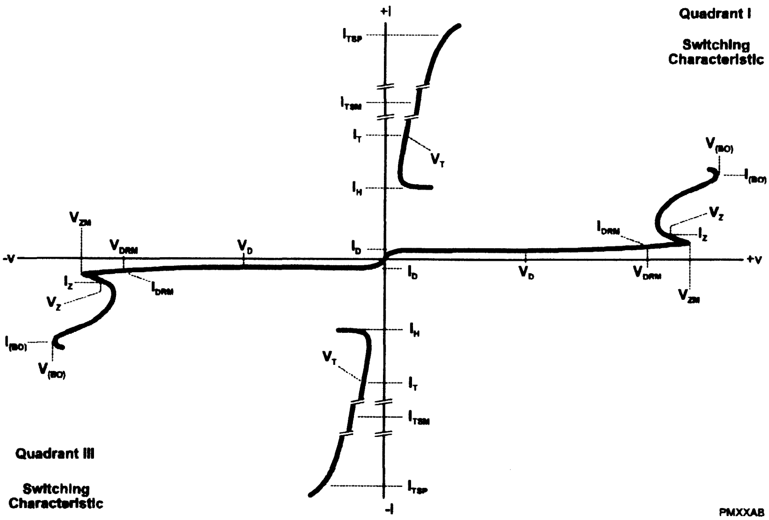


Figure 1. VOLTAGE-CURRENT CHARACTERISTICS FOR TERMINALS A AND B

TISP4290LPR
SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

SLPSE40 - APRIL 1987 - REVISED SEPTEMBER 1994

TELECOMMUNICATION SYSTEM SECONDARY PROTECTION

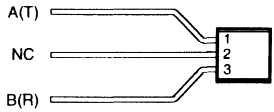
- **Ion-Implanted Breakdown Region**
  Precise and Stable Voltage
  Low Voltage Overshoot under Surge

DEVICE	$V_{(Z)}$ V	$V_{(BO)}$ V
'4290LP	200	290

- **Planar Passivated Junctions**
  Low Off-State Current < 10 µA
- **Rated for International Surge Wave Shapes**

WAVE SHAPE	STANDARD	I_{TSP} A
8/20 µs	ANSI C62.41	150
0.5/700 µs	RLM 88	38
10/700 µs	VDE 0433	50
	CCITT IX K17	50

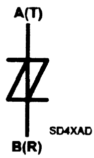
LP PACKAGE WITH FORMED LEADS (TOP VIEW)



NC - No internal connection

MD4XAF

device symbol



description

The TISP4290LPR is designed specifically for telephone equipment protection against lightning and transients induced by ac power lines. These devices consist of a bidirectional suppressor element connecting the A and B terminals. They will suppress inter-wire voltage transients.

Transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides.

These monolithic protection devices are fabricated in ion-implanted planar structures to ensure precise and matched breakover control and are virtually transparent to the system in normal operation

TEXAS INSTRUMENTS

absolute maximum ratings at 25°C case temperature (unless otherwise noted))

RATING	SYMBOL	VALUE	UNIT
Non-repetitive peak on-state pulse current (see Notes 1, 2 and 3)			
8/20 µs (ANSI C62.41, open-circuit voltage wave shape 1.2/50 µs)	I_{TSP}	100	A
5/200 µs (VDE 0433, open-circuit voltage wave shape 2 kV, 10/700 µs)		50	
0.5/310 µs (RLM 88, open-circuit voltage wave shape 1.5 kV, 0.5/700 µs)		38	
5/310 µs (CCITT IX K17, open-circuit voltage wave shape 1.5 kV, 10/700 µs)		38	
Non-repetitive peak on-state current, 50 Hz, 1 s (see Notes 1 and 2)	I_{TSM}	2.5	A rms
Initial rate of rise of on-state current, Linear current ramp, Maximum ramp value < 38 A	di_T/dt	250	A/µs
Junction temperature	T_J	150	°C
Operating free - air temperature range		0 to 70	°C
Storage temperature range	T_{stg}	-40 to +150	°C
Lead temperature 1.5 mm from case for 10 s	T_{lead}	260	°C

NOTES: 1. Above 70°C, derate linearly to zero at 150°C case temperature
2. This value applies when the initial case temperature is at (or below) 70°C. The surge may be repeated after the device has returned to thermal equilibrium.
3. Most PTT's quote an unloaded voltage waveform. In operation the TISP essentially shorts the generator output. The resulting loaded current waveform is specified.

electrical characteristics, T_J = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_Z	Reference zener voltage	$I_Z = \pm$ 1mA	± 200			V
$\propto V_Z$	Temperature coefficient of reference voltage			0.1		%/°C
$V_{(BO)}$	Breakover voltage	(see Notes 5 and 6)			± 290	V
$I_{(BO)}$	Breakover current	(see Note 5)	± 0.15		± 0.6	A
V_{TM}	Peak on-state voltage	$I_T = \pm$ 5 A (see Notes 5 and 6)		± 2.2	± 3	V
I_H	Holding current	(see Note 5)	± 150			mA
dv/dt	Critical rate of rise of off-state voltage	(see Note 7)			± 5	kV/µs
I_D	Off-state leakage current	$V_D = \pm$ 50 V			± 10	µA
C_{off}	Off-state capacitance	V_D = 0 f = 1 kHz (see Note 4)		70	150	pF

NOTES: 4. These capacitance measurements employ a three terminal capacitance bridge incorporating a guard circuit. The third terminal is connected to the guard terminal of the bridge.
5. These parameters must be measured using pulse techniques, t_w = 100 µs, duty cycle ≤ 2%.
6. These parameters are measured with voltage sensing contacts seperate from the current carrying contacts located within 3.2 mm (0.125 inch) from the device body.
7. Linear rate of rise, maximum voltage limited to 80 % V_Z (minimum).

thermal characteristics

PARAMETER		MIN	TYP	MAX	UNIT
$R_{\theta JA}$	Junction to free air thermal resistance			156	°C/W

PARAMETER MEASUREMENT INFORMATION

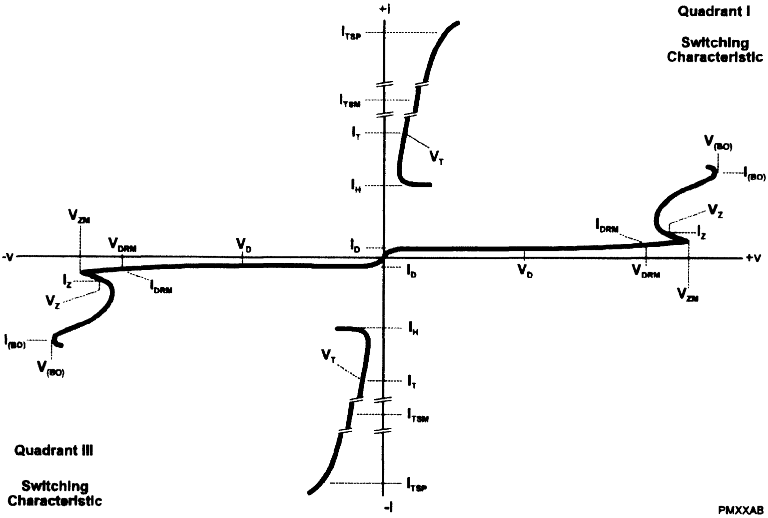


Figure 1. VOLTAGE-CURRENT CHARACTERISTICS FOR TERMINALS A AND B

Advance Information

Cell Package

TEXAS INSTRUMENTS

9EL2
SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

SLPSE42 - JANUARY 1994 - REVISED SEPTEMBER 1994

SOLID STATE REPLACEMENT FOR GAS DISCHARGE TUBES

- **Ion-Implanted Breakdown Region**
  Precise and Stable Voltage
  Low Voltage Overshoot under Surge

$V_{(BO)}$ min	265 V @ 250 V/ms
$V_{(BO)}$ max	400 V @ 250 V/ms

- **Planar Passivated Junctions**
  Low Off-State Current < 0.5 μA
  Extended Service Life

- **Rated for International Surge Wave Shapes**

WAVE SHAPE	STANDARD	I_{TSP}
10/700 μs	CCITT IX K17	5 kV
10/1000 μs	Bellcore	100 A

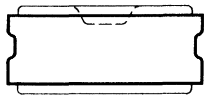
- **Fast Response to Transients Gives**
  Low Let Through Voltage
  < 400 V @ 1000 V/μs

- **Sealed Cell Construction**
  High Current Capability

- **Soldered Copper Electrodes for**
  High Strength

- **Fails Short Circuit Under Excessive**
  Current Conditions

CELL PACKAGE
(SIDE VIEW)



device symbol

description

The 9EL2 Primary Protector is designed specifically for applications that require adherance to Bellcore TR-NWT-000974 (Issue 1). This device consists of a bidirectional suppressor element connecting the A and B terminals. Typically, the 9EL2 is used as a replacement for conventional gas discharge tubes (GDT's) which are utilized to protect telephone exchange equipment from lightning and transients induced by ac power lines.

High level transients are initially clipped by breakdown clamping until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides.

These monolithic protection devices are constructed using two nickel plated 4.95 mm (0.195") diameter copper electrodes soldered to each side of the silicon chip. This packaging approach allows heat to be removed from both sides of the silicon, resulting in the doubling of the devices thermal capacity. This improves the power line cross current capability enabling conformance to international requirements such as 10 A for 1 second. One of the 9EL2's copper electrodes is specially shaped to promote a progressive shorting action (@ 50/60 Hz currents greater than 60 A) when mounted under compression inside a protection module. Under excessive power line cross conditions the 9EL2 will fail short circuit, providing maximum protection to the equipment.

For added environmental and physical protection, the 9EL2 utilizes a green plastic sleeve which shrouds the entire silicon chip.

ADVANCE INFORMATION

absolute maximum ratings at specified temperature

RATING	SYMBOL	TEMPERATURE T_J INITIAL	VALUE	UNIT
Non-repetitive peak on-state pulse current (see Notes 1 and 2)				
5/310 μs (CCITT IX K17, open-circuit voltage wave shape 8 kV, 10/700 μs)	I_{TSP}	-20 to +65°C	200	A
10/1000 μs (Bellcore, open-circuit voltage wave shape 1.5 kV, 10/1000 μs)		-20 to +65°C	150	
50/60 Hz rms on-state current 1 s, (see Note 1)	I_{TSM}	-40 to +65°C	10	A rms
Junction temperature	T_J		150	°C
Storage temperature range	T_{stg}		-40 to +150	°C

NOTES: 1. The surge may be repeated after the device has returned to thermal equilibrium.
2. Most PTT's quote an unloaded voltage waveform. In operation the 9EL essentially shorts the generator output. The resulting loaded current waveform is specified.

electrical characteristics at specified temperature

PARAMETER		TEST CONDITIONS	TEMPERATURE T_J INITIAL	MIN	TYP	MAX	UNIT
$V_{(BR)}$	Breakdown voltage	$I_{(BR)}$ = 20 mA (see Note 3)	-40 to +65°C	± 245			V
$V_{(BO)}$	Breakover voltage	≤ 250 V/ms, ≤ 1 A/ms	+15 to +25°C	± 265			V
		≤ 250 V/ms, ≤ 1 A/ms	-40 to +65°C			± 400	V
		≤ 100 V/μs, ≤ 10 A/μs	-40 to +65°C			± 400	V
		≤ 1 kV/μs, ≤ 10 A/μs	-40 to +65°C			± 400	V
	Impulse reset	52.5 V, 260 mA S.C., dc 135 V, 200 mA S.C., dc 1000 V, 25 A S.C., 10/1000 μs	-40 to +65°C			20	ms
I_D	Off-state current	V_D = ± 50 V (see Note 4)	-40 to +65°C			± 0.5	μA
		V_D = ± 200 V	-40 to +65°C			± 10	μA
C_{off}	Off-state capacitance	1 Vrms, 1 MHz, V_D = 0 Vdc bias	-40 to +65°C			150	pF

NOTES: 3. Meets Bellcore TR-NWT-000974 Issue 1 - DC Limiting Voltage Test (4.4).
4. This device can be sensitive to light. Suggest this parameter be measured in a dark environment.

PARAMETER MEASUREMENT INFORMATION

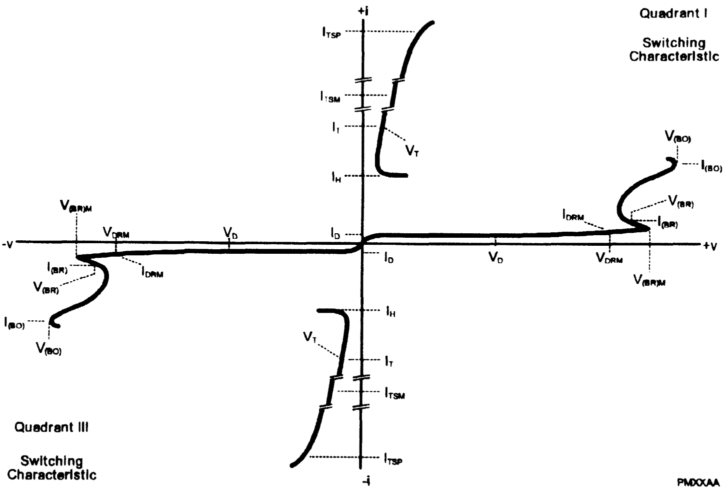


Figure 1. VOLTAGE-CURRENT CHARACTERISTICS

SLPSE43 - JANUARY 1994 - REVISED SEPTEMBER 1994

SOLID STATE REPLACEMENT FOR GAS DISCHARGE TUBES

- **Ion-Implanted Breakdown Region**
  Precise and Stable Voltage
  Low Voltage Overshoot under Surge

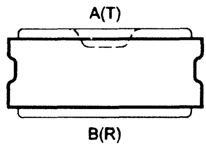
$V_{(BO)}$ min	200 V @ 250 V/ms
$V_{(BO)}$ max	265 V @ 250 V/ms

- **Planar Passivated Junctions**
  Low Off-State Current < 0.5 µA
  Extended Service Life
- **Rated for International Surge Wave Shapes**

WAVE SHAPE	STANDARD	I_{TSP}
10/700 µs	CCITT IX K17	5 kV
10/1000 µs	Bellcore	100 A

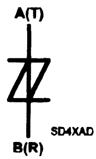
- **Fast Response to Transients Gives**
  Low Let Through Voltage
  < 350 V @ 1000 V/µs
- **Sealed Cell Construction**
  High Current Capability
- **Soldered Copper Electrodes for**
  High Strength
- **Fails Short Circuit Under Excessive**
  Current Conditions

CELL PACKAGE
(SIDE VIEW)



MD4XAC

device symbol



SD4XAD

ADVANCE INFORMATION

description

The 9EL3 Primary Protector is designed specifically for applications required to be Bellsouth complient. This device consists of a bidirectional suppressor element connecting the A and B terminals. Typically, the 9EL3 is used as a replacement for conventional gas discharge tubes (GDT's) which are utilized to protect telephone exchange equipment from lightning and transients induced by ac power lines.

High level transients are initially clipped by breakdown clamping until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides.

These monolithic protection devices are constructed using two nickel plated 4.95 mm (0.195") diameter copper electrodes soldered to each side of the silicon chip. This packaging approach allows heat to be removed from both sides of the silicon, resulting in the doubling of the devices thermal capacity. This improves the power line cross current capability enabling conformance to international requirements such as 10 A for 1 second. One of the 9EL3's copper electrodes is specially shaped to promote a progressive shorting action (@ 50/60 Hz currents greater than 60 A) when mounted under compression inside a protection module. Under excessive power line cross conditions the 9EL3 will fail short circuit, providing maximum protection to the equipment.

For added environmental and physical protection, the 9EL3 utilizes a black plastic sleeve which shrouds the entire silicon chip.

absolute maximum ratings at specified temperature

RATING	SYMBOL	TEMPERATURE T_J INITIAL	VALUE	UNIT
Non-repetitive peak on-state pulse current (see Notes 1 and 2)				
5/310 μs (CCITT IX K17, open-circuit voltage wave shape 5 kV, 10/700 μs)	I_{TSP}	0 to +65°C	125	A
10/1000 μs (Bellcore, open-circuit voltage wave shape 1 kV, 10/1000 μs)		0 to +65°C	100	
50/60 Hz rms on-state current 1 s, (see Note 1)	I_{TSM}	0 to +65°C	10	A rms
Junction temperature	T_J		150	°C
Storage temperature range	T_{stg}		-40 to +150	°C

NOTES: 1. The surge may be repeated after the device has returned to thermal equilibrium.
2. Most PTT's quote an unloaded voltage waveform. In operation the 9EL essentially shorts the generator output. The resulting loaded current waveform is specified.

electrical characteristics at specified temperature

PARAMETER		TEST CONDITIONS	TEMPERATURE T_J INITIAL	MIN	TYP	MAX	UNIT
$V_{(BO)}$	Breakover voltage	≤ 250 V/ms, ≤ 1 A/ms	+15 to +25°C	± 200			V
		≤ 250 V/ms, ≤ 1 A/ms	0 to +65°C			± 265	V
		≤ 100 V/μs, ≤ 10 A/μs	0 to +65°C			± 350	V
		≤ 1 kV/μs, ≤ 10 A/μs	0 to +65°C			± 350	V
	Impulse reset	52.5 V, 260 mA S.C., dc 135 V, 200 mA S.C., dc 1000 V, 25 A S.C., 10/1000 μs	0 to +50°C			20	ms
I_D	Off-state current	V_D = ± 50 V (see Note 3)	0 to +65°C			± 0.5	μA
		V_D = ± 200 V (see Note 3)	0 to +65°C			± 1	μA
C_{off}	Off-state capacitance	1 Vrms, 1 MHz, V_D = 0 Vdc bias	0 to +65°C			150	pF

NOTE 3: This device can be sensitive to light. Suggest this parameter be measured in a dark environment.

PARAMETER MEASUREMENT INFORMATION

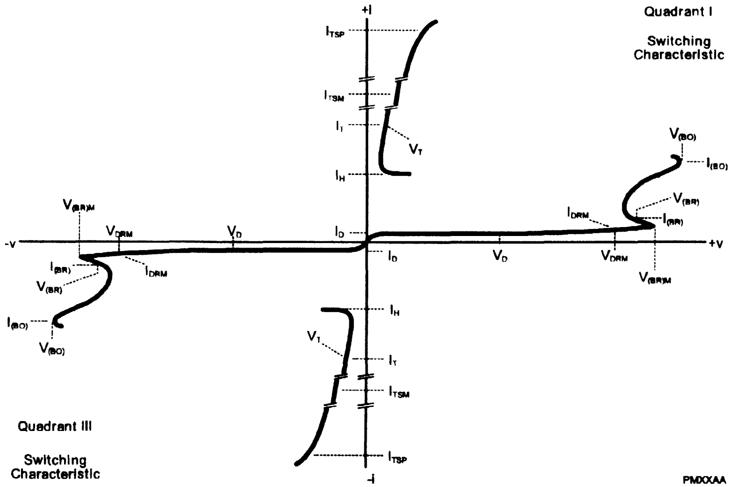


Figure 1. VOLTAGE-CURRENT CHARACTERISTICS

SOLID STATE REPLACEMENT FOR GAS DISCHARGE TUBES

- **Ion-Implanted Breakdown Region**
  Precise and Stable Voltage
  Low Voltage Overshoot under Surge

$V_{(BO)}$ max	250 V @ 250 V/ms

- **Planar Passivated Junctions**
  Low Leakage
  Extended Service Life

- **Rated for International Surge Wave Shapes**

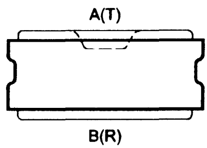
WAVE SHAPE	STANDARD	I_{TSP}
10/700 µs	CCITT IX K17	5 kV
10/1000 µs	Bellcore	100 A

- **Sealed Cell Construction**
  High Current Capability

- **Soldered Copper Electrodes for**
  High Strength

- **Fails Short Circuit Under Excessive**
  Current Conditions

CELL PACKAGE
(SIDE VIEW)



MD4XAC

device symbol

SD4XAD

description

This device consists of a bidirectional suppressor element connecting the A and B terminals. Typically, the 9EL5 is used as a replacement for conventional gas discharge tubes (GDT's) which are utilized to protect telephone exchange equipment from lightning and transients induced by ac power lines.

High level transients are initially clipped by breakdown clamping until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides.

These monolithic protection devices are constructed using two nickel plated 4.95 mm (0.195") diameter copper electrodes soldered to each side of the silicon chip. This packaging approach allows heat to be removed from both sides of the silicon, resulting in the doubling of the devices thermal capacity. This improves the power line cross current capability enabling conformance to international requirements such as 10 A for 1 second. One of the 9EL5's copper electrodes is specially shaped to promote a progressive shorting action (@ 50/60 Hz currents greater than 60 A) when mounted under compression inside a protection module. Under excessive power line cross conditions the 9EL5 will fail short circuit, providing maximum protection to the equipment.

For added environmental and physical protection, the 9EL5 utilizes a plastic sleeve which shrouds the entire silicon chip.

ADVANCE INFORMATION

absolute maximum ratings at specified temperature

RATING	SYMBOL	TEMPERATURE T_J INITIAL	VALUE	UNIT
Non-repetitive peak on-state pulse current (see Notes 1 and 2)				
5/310 μs (CCITT IX K17, open-circuit voltage wave shape 8 kV, 10/700 μs)	I_{TSP}	0 to +70°C	125	A
10/1000 μs (Bellcore, open-circuit voltage wave shape 1.5 kV, 10/1000 μs)		0 to +70°C	100	
50/60 Hz rms on-state current 1 s, (see Note 1)	I_{TSM}	0 to +70°C	10	A rms
Junction temperature	T_J		150	°C
Storage temperature range	T_{stg}		-20 to +85	°C

NOTES: 1. The surge may be repeated after the device has returned to thermal equilibrium.
2. Most PTT's quote an unloaded voltage waveform. In operation the 9EL essentially shorts the generator output. The resulting loaded current waveform is specified.

electrical characteristics at specified temperature

PARAMETER		TEST CONDITIONS	TEMPERATURE T_J INITIAL	MIN	TYP	MAX	UNIT
$V_{(BR)}$	Breakdown voltage	$I_{(BR)}$ = 20 mA (see Note 3)	0 to +70°C	± 175			V
$V_{(BO)}$	Breakover voltage	≤ 250 V/ms, ≤ 1 A/ms	0 to +70°C			± 250	V
		≤ 100 V/μs, ≤ 10 A/μs	0 to +70°C			± 250	V
I_H	Holding current	di/dt = ± 30 mA/ms	0 to +70°C	± 0.15			A
I_D	Off-state current	V_D = ± 50 V (see Note 4)	0 to +70°C			± 10	μA
C_{off}	Off-state capacitance	1 Vrms, 1 MHz, V_D = 0 Vdc bias	0 to +70°C			200	pF

NOTES: 3. Meets Bellcore TR-NWT-000974 Issue 1 - DC Limiting Voltage Test (4.4).
4. This device can be sensitive to light. Suggest this parameter be measured in a dark environment.

PARAMETER MEASUREMENT INFORMATION

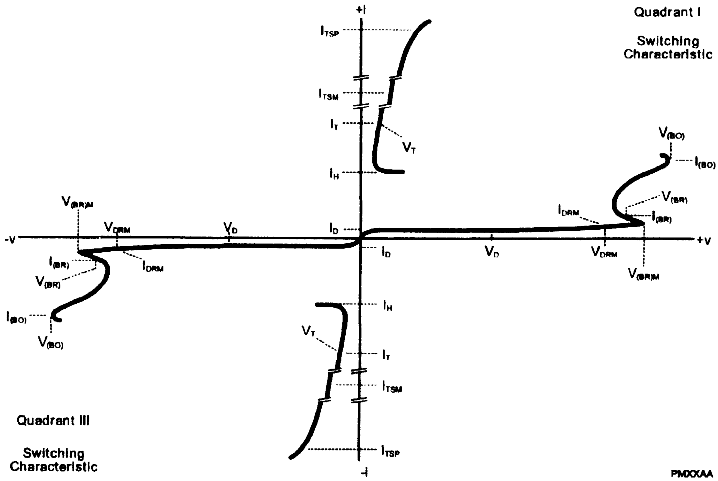


Figure 1. VOLTAGE-CURRENT CHARACTERISTICS

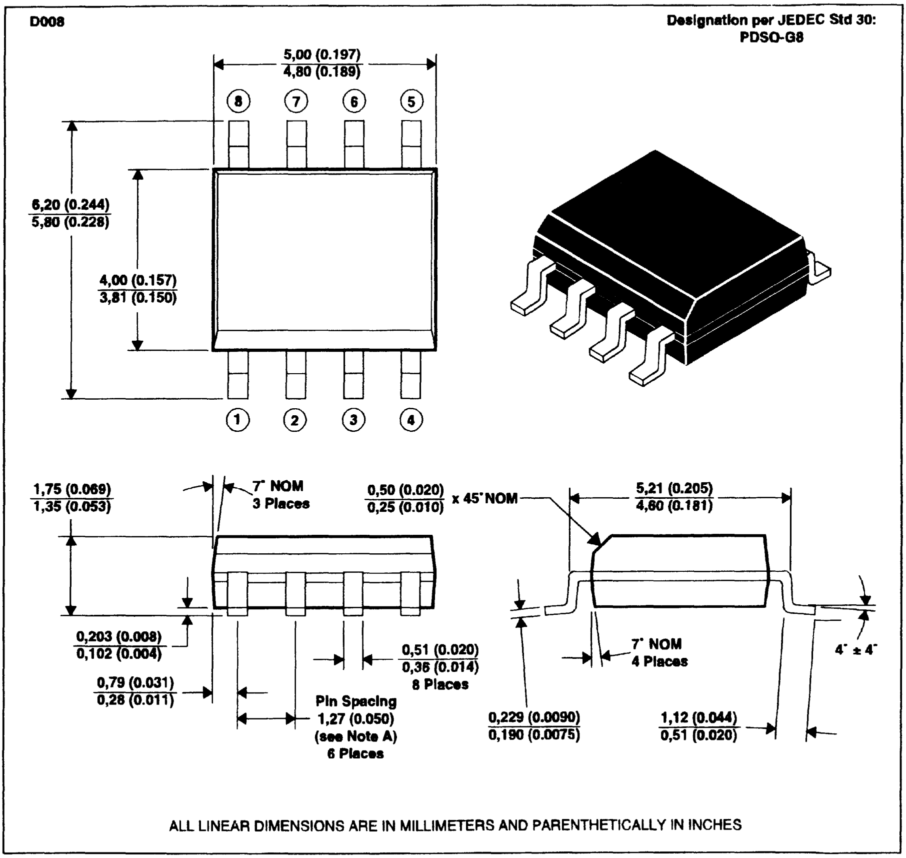
Mechanical Data

TEXAS INSTRUMENTS

D008

plastic small-outline package

This small-outline 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.



MDXXAA

NOTES: A. Leads are within 0,25 (0.010) radius of true position at maximum material condition.
B. Body dimensions do not include mold flash or protrusion.
C. Mold flash or protrusion shall not exceed 0,15 (0.006).
D. Lead tips to be planar within ±0,051 (0.002).

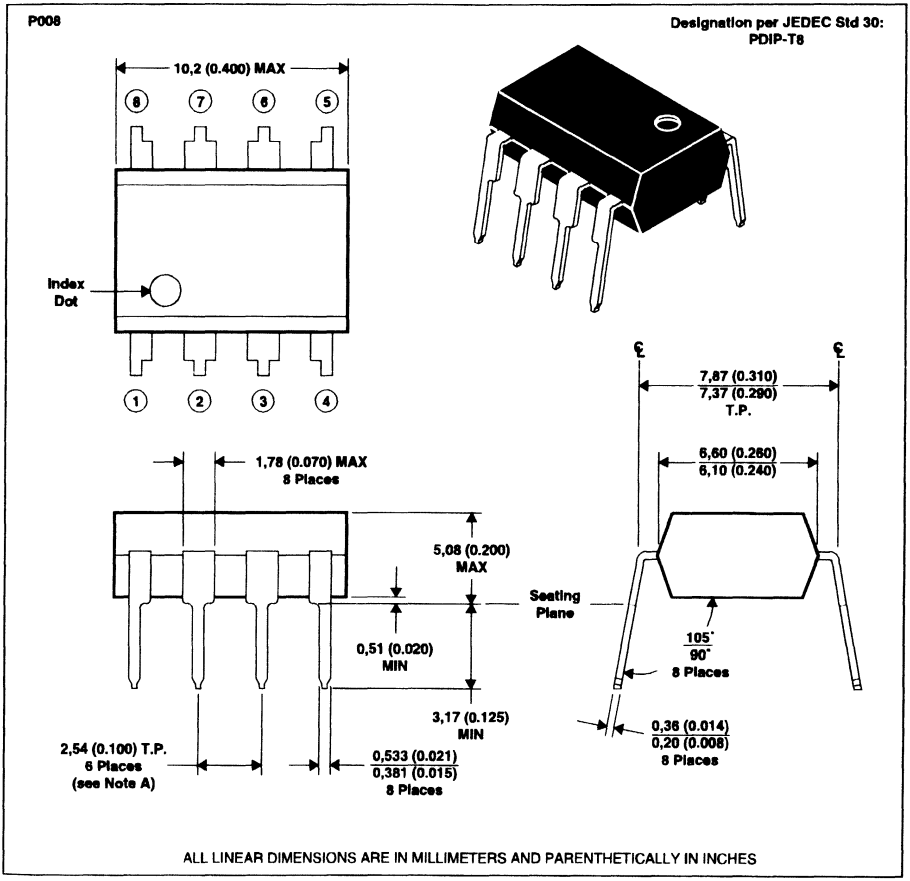
TEXAS INSTRUMENTS

MECHANICAL DATA

P008

plastic dual-in-line package

This dual-in-line 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 The package is intended for insertion in mounting-hole rows on 7,62 (0.300) centers. Once the leads are compressed and inserted, sufficient tension is provided to secure the package in the board during soldering. Leads require no additional cleaning or processing when used in soldered assembly.



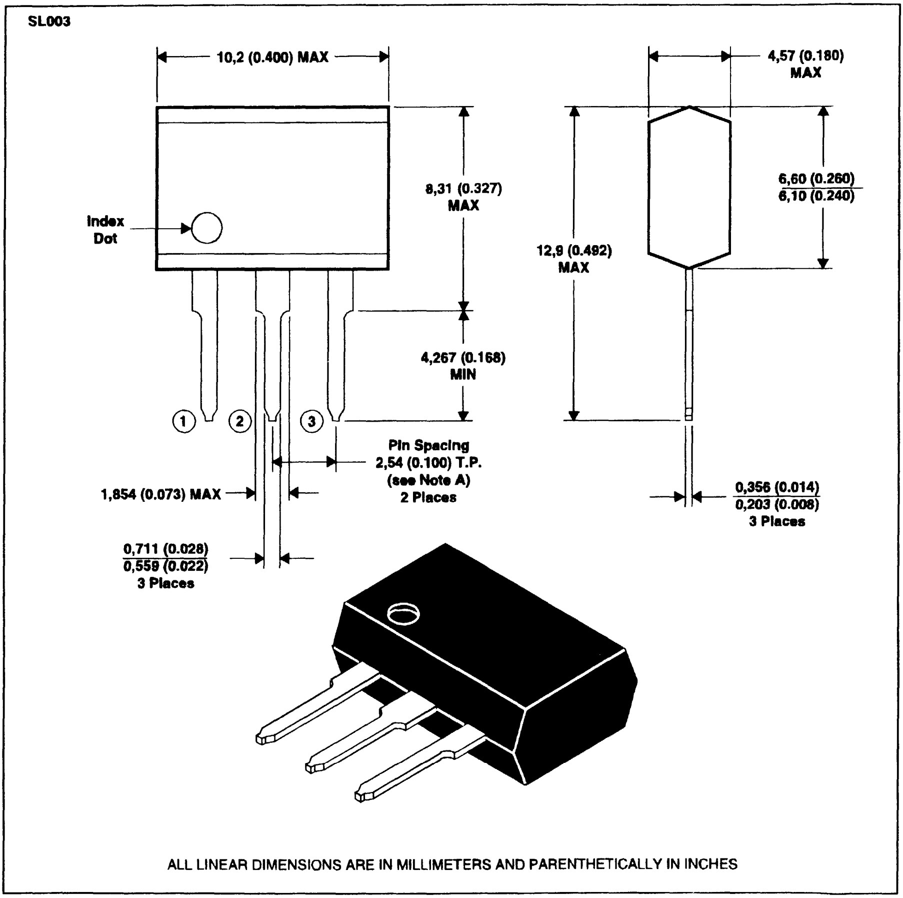
NOTE A: Each pin centerline is located within 0,25 (0.010) of its true longitudinal position

MDXXAB

SL003

3-pin plastic single-in-line package

This single-in-line 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.



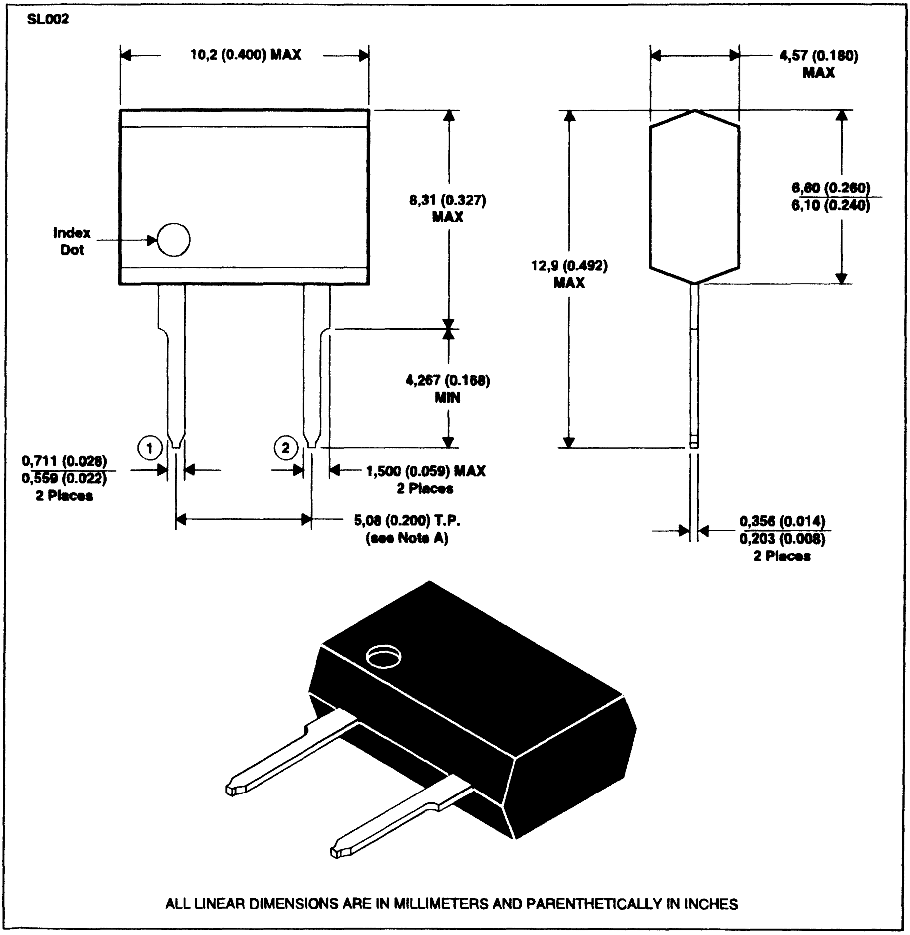
NOTES: A. Each pin centerline is located within 0,25 (0.010) of its true longitudinal position.
B. Body molding flash of up to 0,15 (0.006) may occur in the package lead plane.

MDXXAD

SL002

2-pin plastic single-in-line package

This single-in-line 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



NOTES: A. Each pin centerline is located within 0,25 (0.010) of its true longitudinal position.
B. Body molding flash of up to 0,15 (0.006) may occur in the package lead plane.

MDXXAC

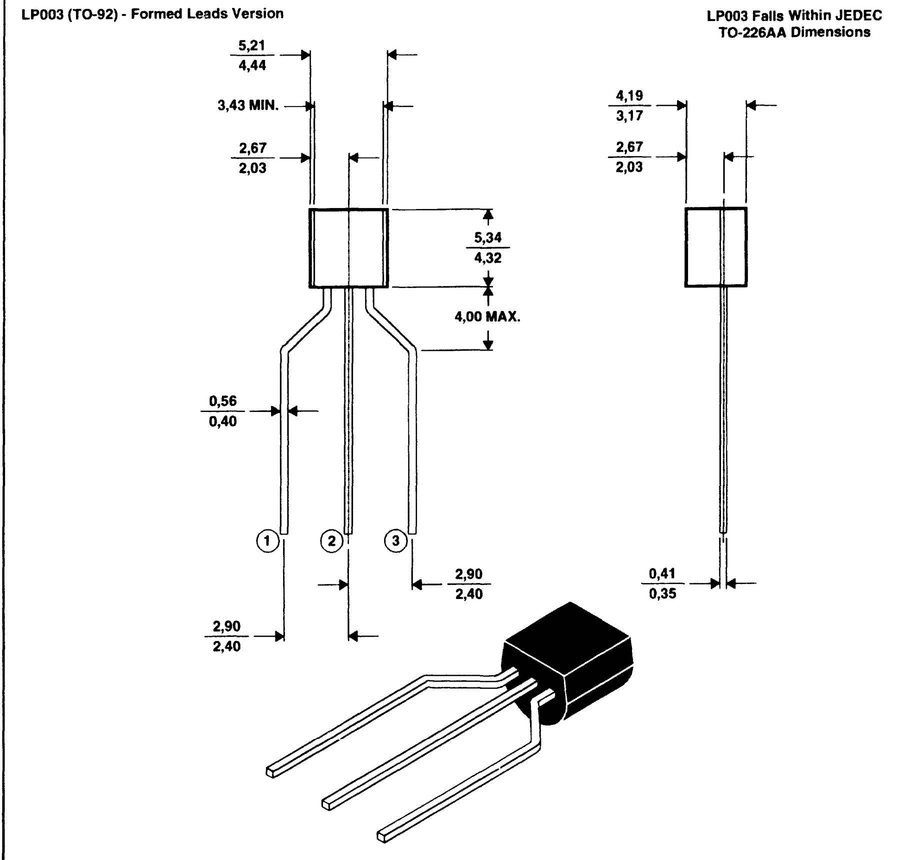
TEXAS INSTRUMENTS

MECHANICAL DATA

LP003 (TO-92)

3-pin cylindical plastic package

This single-in-line 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.



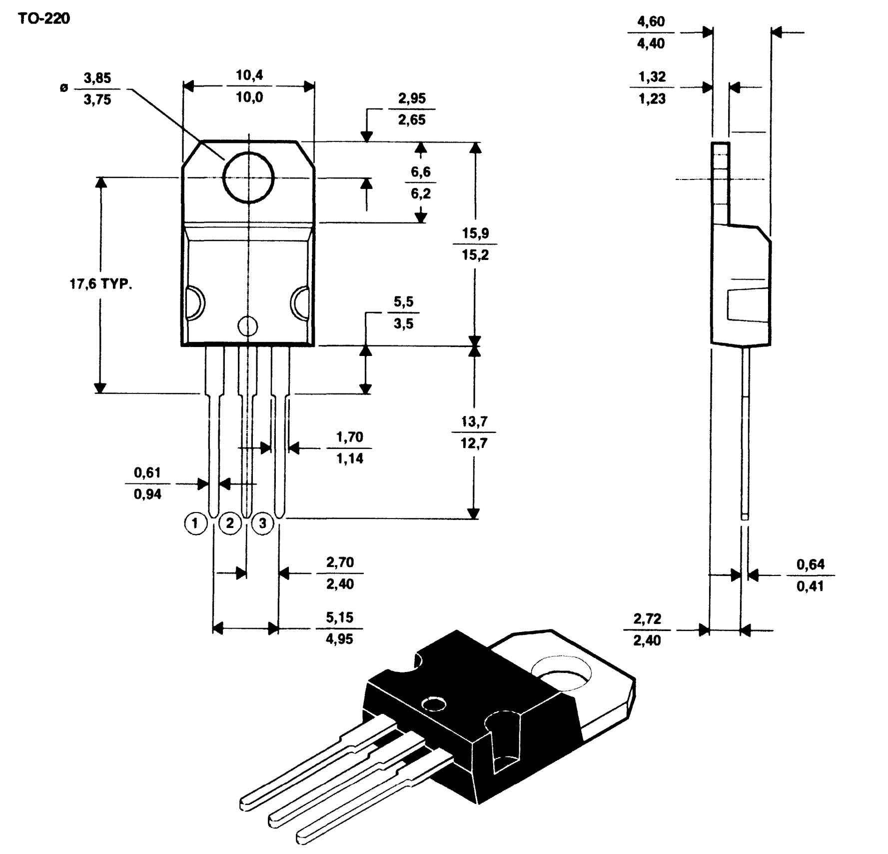
MDXXAR

MECHANICAL DATA

TO-220

3-pin plastic flange-mount package

This single-in-line 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.



ALL LINEAR DIMENSIONS IN MILLIMETERS

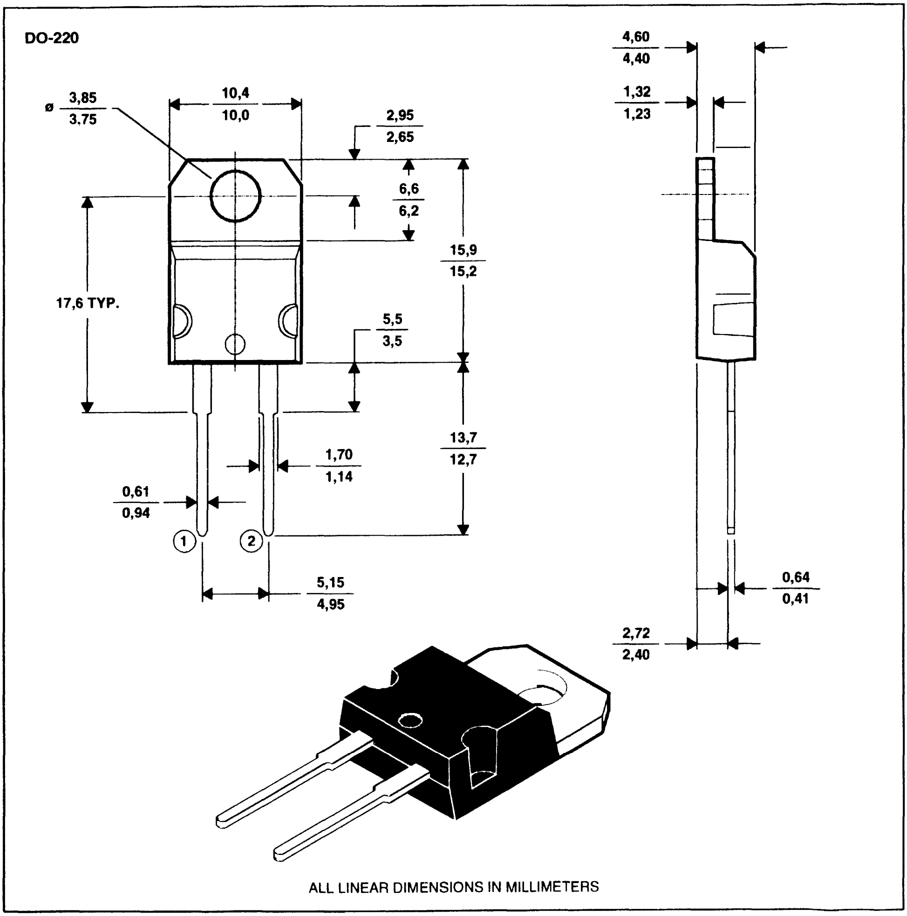
NOTE A: The centre pin is in electrical contact with the mounting tab.

MDXXAP

DO-220

2-pin plastic flange-mount package

This single-in-line 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.



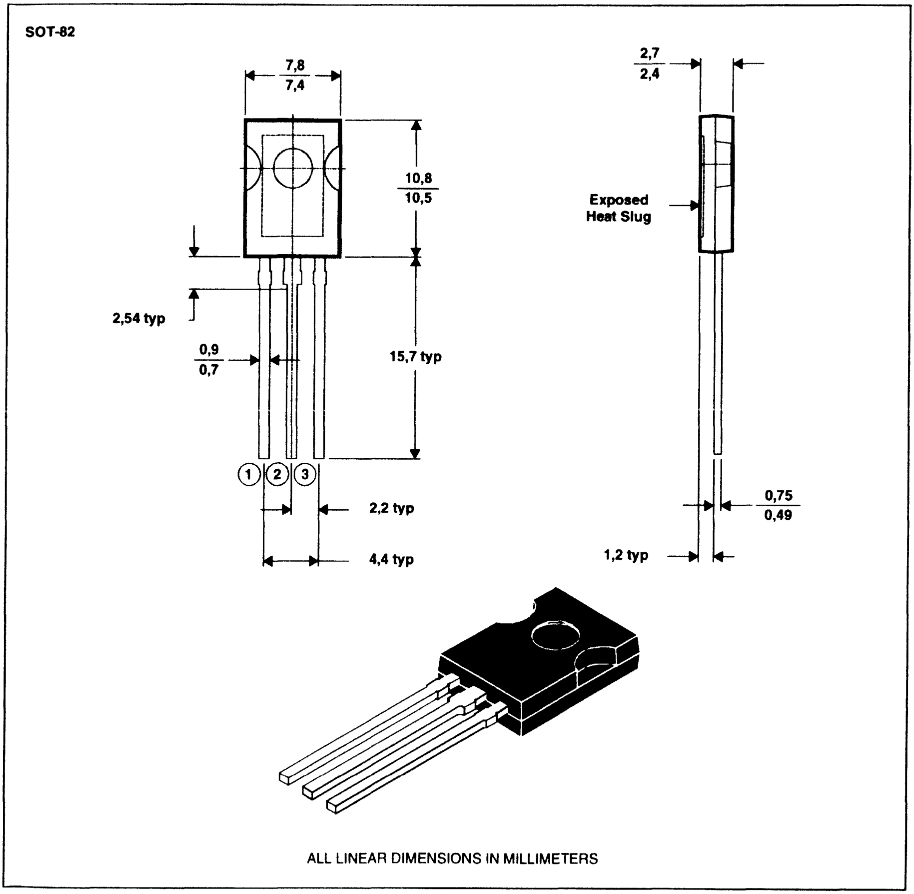
NOTE A: Pin 1 is in electrical contact with the mounting tab.

MDXXAU

SOT-82

3-pin plastic single-in-line package

This single-in-line 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.

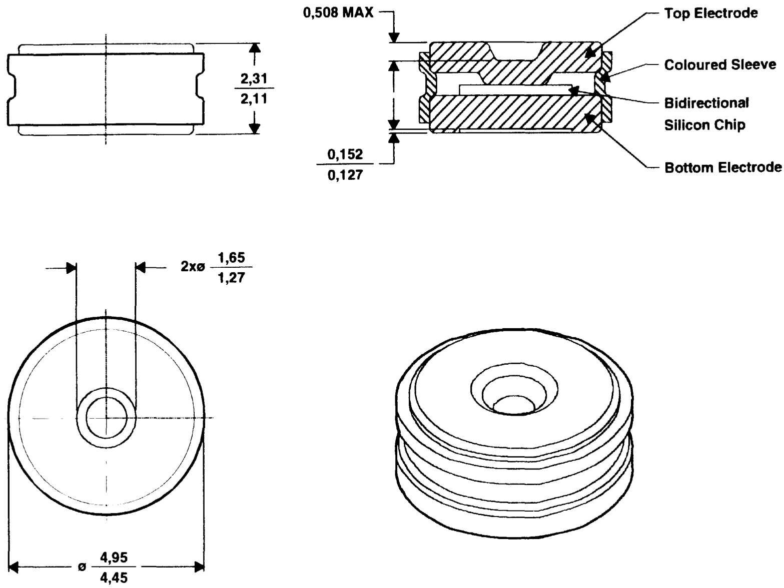


NOTE A: The centre pin is in electrical contact with the heat slug.

MDXXAQ

Cell Package

BUTTON CELL 9ELx



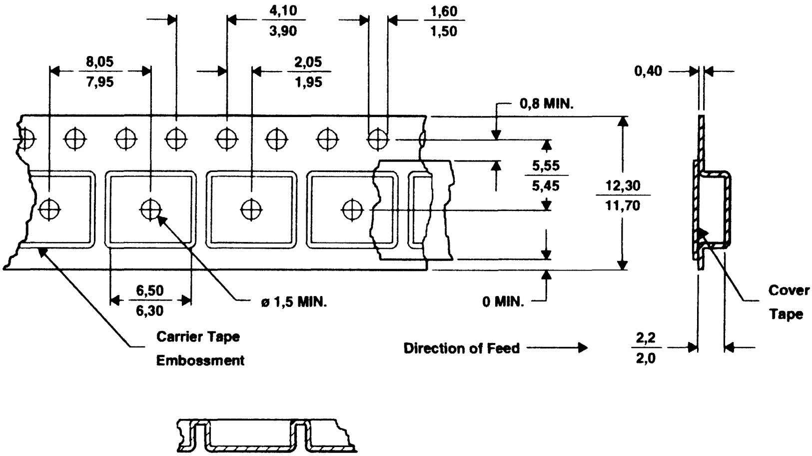
ALL LINEAR DIMENSIONS IN MILLIMETERS

MDXXAV

D008

tape dimensions

D008 Package (8 pin SOIC) Single-Sprocket Tape



ALL LINEAR DIMENSIONS IN MILLIMETERS

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

MDXXAT

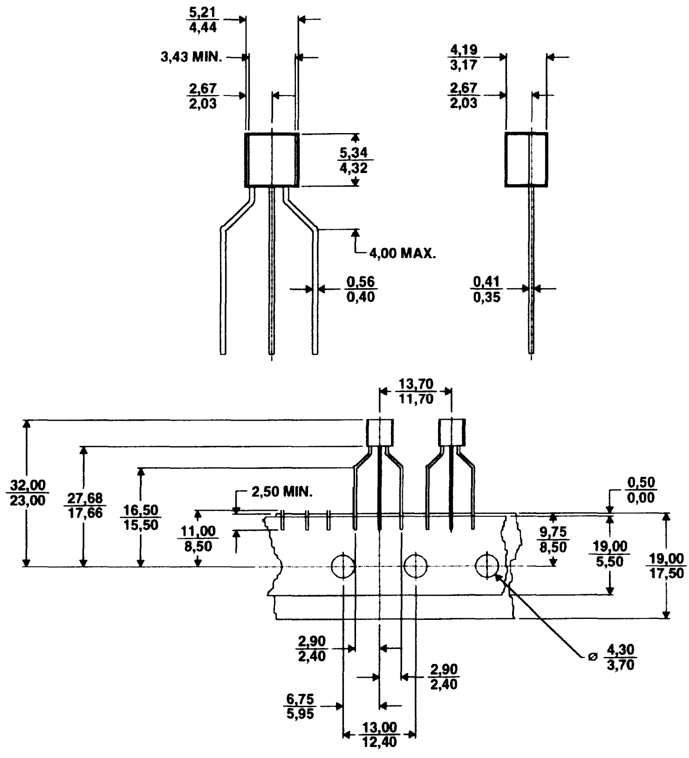
Reel diameter:	330 +0,0/-4,0 mm
Reel hub diameter:	100 ±2,0 mm
Reel axial hole:	13,0 ±0,2 mm

B. 2500 devices are on a reel.

LPR

tape dimensions

LP Package (TO-92) Tape (Formed Lead Version)



ALL LINEAR DIMENSIONS IN MILLIMETERS

MDXXAS

ORDERING INSTRUCTIONS

new IC packages (Introduced 1994)

TISP	1	072 082	F3	D DR P SL
TISP	2 3 4 7	072 082 125 150 180 240 290 320 380	F3	D DR P SL
	Device Configuration	Protection Voltage	$I_{(BO)}$ = 150mA $I_{(H)}$ = 150mA	Package D = 8 pin surface mount DR = tape and reel P = 8 pin dual in line (not TISP4xxx) SL = single in line

e.g.

TISP7290F3DR 7xxx series configuration, 290V protection voltage, 8 pin surface mount tape and reel

TISP4180F3SL 4xxx series configuration, 180V protection voltage, single in line package

note : SL package interchangeable with TO-220/DO-220

existing packages

TISP	1	082	L
	2	160	LPR
	3	180	None
	4	290	
	Device Configuration	Protection Voltage	Package L = SOT-82 LPR= TO-92 tape and reel None = TO-220 None = DO-220 (TISP4xxx only)

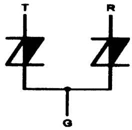
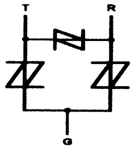
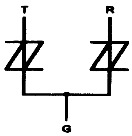
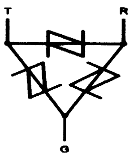
e.g.

TISP2180L	2xxx series configuration, 180V protection voltage, SOT-82 package
TISP3082	3xxx series configuration, 82V protection voltage, TO-220 package

Note : changes made to the part numbering system October 1994 :

TISP5160-R	renamed as TISP4160LPR	TISP8180	renamed as TISP3180
TISP5180-R	renamed as TISP4180LPR	TISP8290	renamed as TISP3290
TISP5290-R	renamed as TISP4290LPR	TISP8180L	renamed as TISP3180L
TISP7180	renamed as TISP2180	TISP8290L	renamed as TISP3290L
TISP7290	renamed as TISP2290	TISP9180	renamed as TISP4180
TISP7180L	renamed as TISP2180L	TISP9290	renamed as TISP4290
TISP7290L	renamed as TISP2290L		

DEVICE CONFIGURATION

End Equipment	Family	Configuration	Working Voltage (V)	Protection Voltage (V)	Working Voltage (V)	Protection Voltage (V)
			Existing	Packages	**NEW IC**	**Packages**
SLIC linecard	TISP1xxx		58	82	58 66	72 82
3 wire battery backed ringing	TISP2xxx		58 145 200	82 180 290	58 66	72 82
3 wire ground backed ringing	TISP3xxx		58 145 200	82 180 290	100 120 145	125 150 180
2 wire system	TISP4xxx		58 120 145 200	82 160 180 290	180 200 220	240 260 290
ISDN / Interwire	TISP7xxx				240 270	320 380

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