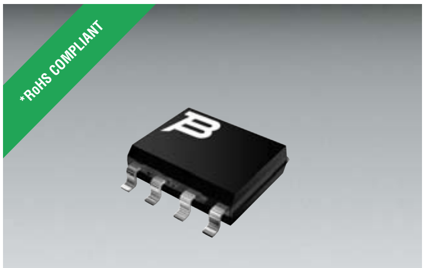


BOURNS®

TISP3125F3, TISP3150F3, TISP3180F3

MEDIUM-VOLTAGE DUAL BIDIRECTIONAL THYRISTOR OVERVOLTAGE PROTECTORS

TISP31xxF3 (MV) Overvoltage Protector Series

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

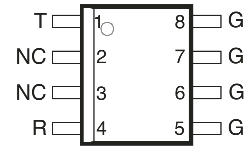
Planar Passivated Junctions
Low Off-State Current <10 µA

Rated for International Surge Wave Shapes

Waveshape	Standard	I_{TSP} A
2/10 µs	GR-1089-CORE	175
8/20 µs	IEC 61000-4-5	120
10/160 µs	FCC Part 68	60
10/700 µs	ITU-T K.20/21 FCC Part 68	50
10/560 µs	FCC Part 68	45
10/1000 µs	GR-1089-CORE	35

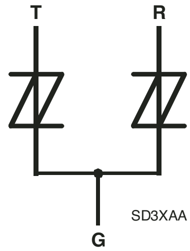
UL .... **UL Recognized Component**

D Package (Top View)



NC - No internal connection

Device Symbol



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

Description

These medium-voltage dual bidirectional thyristor protectors are designed to protect ground backed ringing central office, access and customer premise equipment against overvoltages caused by lightning and a.c. power disturbances. 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. Overvoltages are initially clipped by breakdown clamping until the voltage rises to the breakover level, which causes the device to switch. The high crowbar holding current helps prevent d.c. 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.

How To Order

Device	Package	Carrier	Order As
TISP31xxF3	D, Small-outline	Tape And Reeled	TISP31xxF3DR-S

Insert 1xx value corresponding to protection voltages of 125, 150 and 180

*RoHS Directive 2002/95/EC Jan 27 2003 including Annex

MARCH 1994 - REVISED SEPTEMBER 2008

Absolute Maximum Ratings, T_A = 25 °C (Unless Otherwise Noted)

Rating		Symbol	Value	Unit
Repetitive peak off-state voltage, 0 °C < T_A < 70 °C	'3125F3	V_{DRM}	±100	V
	'3150F3		±120	
	'3180F3		±145	
Non-repetitive peak on-state pulse current (see Notes 1 and 2)		I_{PPSM}		A
1/2 (Gas tube differential transient, 1/2 voltage wave shape)			350	
2/10 (Telcordia GR-1089-CORE, 2/10 voltage wave shape)			175	
1/20 (ITU-T K.22, 1.2/50 voltage wave shape, 25 Ω resistor)			90	
8/20 (IEC 61000-4-5, combination wave generator, 1.2/50 voltage wave shape)			120	
10/160 (FCC Part 68, 10/160 voltage wave shape)			60	
4/250 (ITU-T K.20/21, 10/700 voltage wave shape, simultaneous)			55	
0.2/310 (CNET I 31-24, 0.5/700 voltage wave shape)			38	
5/310 (ITU-T K.20/21, 10/700 voltage wave shape, single)			50	
5/320 (FCC Part 68, 9/720 voltage wave shape, single)			50	
10/560 (FCC Part 68, 10/560 voltage wave shape)			45	
10/1000 (Telcordia GR-1089-CORE, 10/1000 voltage wave shape)			35	
Non-repetitive peak on-state current, 0 °C < T_A < 70 °C (see Notes 1 and 3) 50 Hz, 1 s		I_{TSM}	4.3	A
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	-65 to +150	°C
Storage temperature range		T_{stg}	-65 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 R and T Terminal Pair, T_A = 25 °C (Unless Otherwise Noted)

Parameter		Test Conditions	Min	Typ	Max	Unit
I_{DRM}	Repetitive peak off-state current	V_D = ±2V_{DRM}, 0 °C < T_A < 70 °C			±10	µA
I_D	Off-state current	V_D = ±50 V			±10	µA
C_{off}	Off-state capacitance	f = 100 kHz, V_d = 100 mV , V_D = 0, Third terminal voltage = -50 V to +50 V (see Notes 4 and 5)		0.05	0.15	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 T and G or R and G Terminals, T_A = 25 °C (Unless Otherwise Noted)

Parameter		Test Conditions		Min	Typ	Max	Unit
I_{DRM}	Repetitive peak off-state current	$V_D = \pm V_{DRM}$, 0 °C < T_A < 70 °C				±10	µA
$V_{(BO)}$	Breakover voltage	dv/dt = ±250 V/ms, R_{SOURCE} = 300 Ω	'3125F3 '3150F3 '3180F3			±125 ±150 ±180	V
$V_{(BO)}$	Impulse breakover voltage	dv/dt ≤ ±1000 V/µs, Linear voltage ramp, Maximum ramp value = ±500 V R_{SOURCE} = 50 Ω	'3125F3 '3150F3 '3180F3		±139 ±164 ±194		V
$I_{(BO)}$	Breakover current	dv/dt = ±250 V/ms, R_{SOURCE} = 300 Ω		±0.1		±0.6	A
V_T	On-state voltage	I_T = ±5 A, t_W = 100 µs				±3	V
I_H	Holding current	I_T = ±5 A, di/dt = -/+30 mA/ms		±0.15			A
dv/dt	Critical rate of rise of off-state voltage	Linear voltage ramp, Maximum ramp value < 0.85V_{DRM}		±5			kV/µs
I_D	Off-state current	V_D = ±50 V				±10	µA
C_{off}	Off-state capacitance	f = 1 MHz, V_d = 0.1 V r.m.s., V_D = 0 f = 1 MHz, V_d = 0.1 V r.m.s., V_D = -5 V f = 1 MHz, V_d = 0.1 V r.m.s., V_D = -50 V (see Notes 5 and 6)			55 31 15	95 50 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.

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			160	°C/W

Parameter Measurement Information

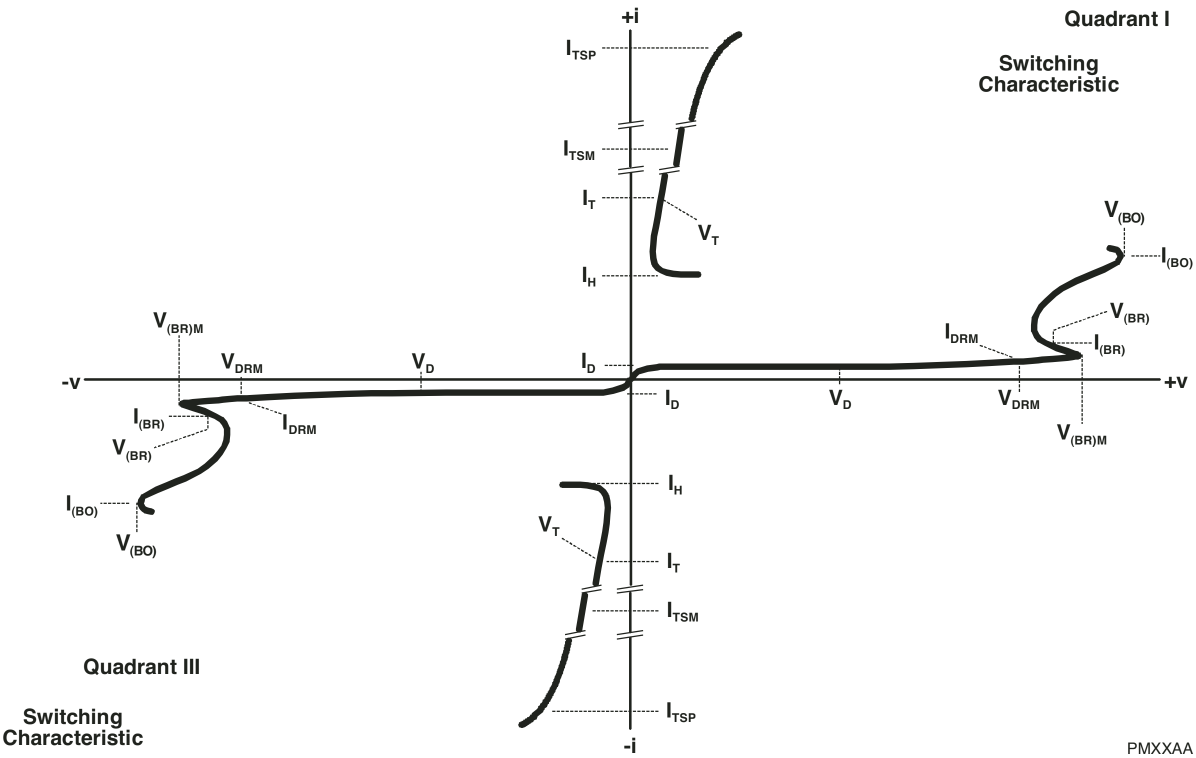


Figure 1. Voltage-Current Characteristics for any Terminal Pair

Typical Characteristics - R and G or T and G Terminals

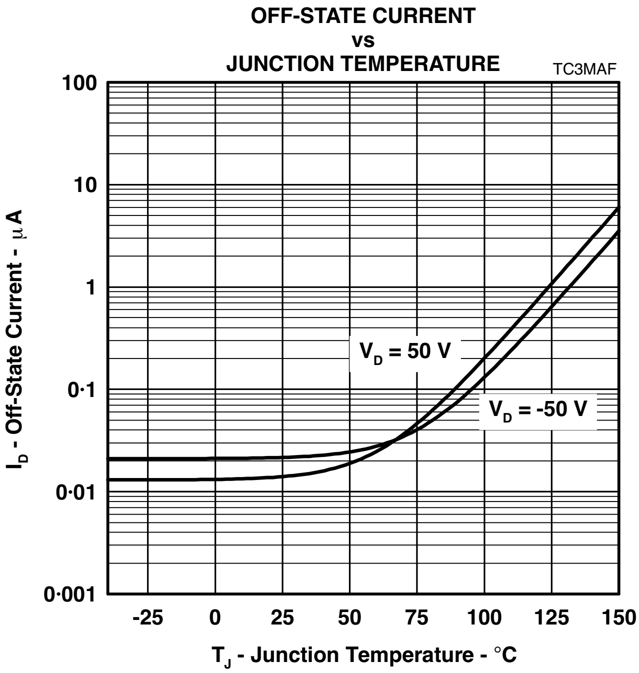


Figure 2.

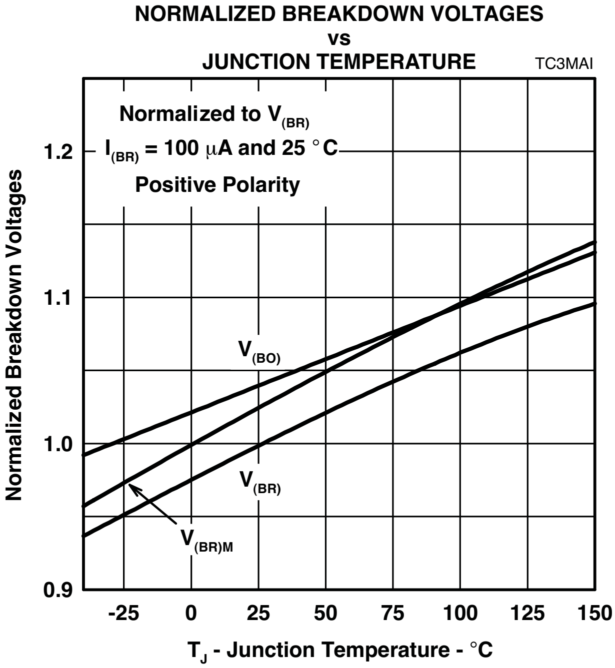


Figure 3.

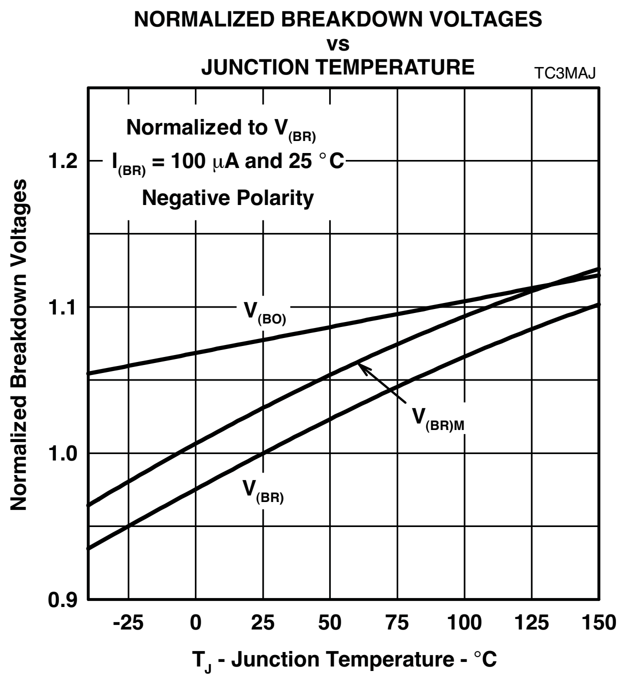


Figure 4.

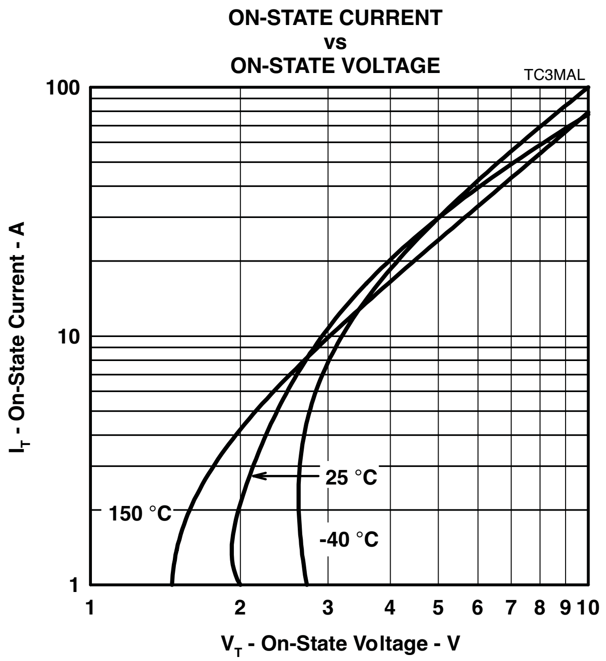


Figure 5.

Typical Characteristics - R and G or T and G Terminals

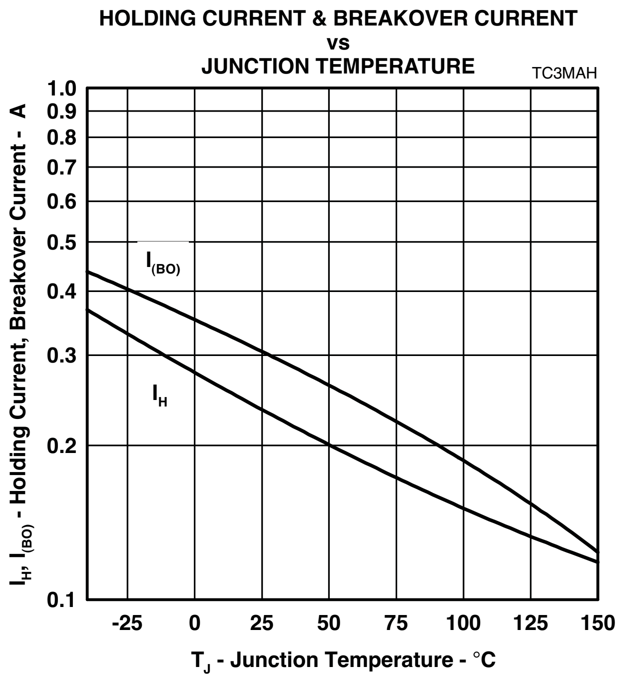


Figure 6.

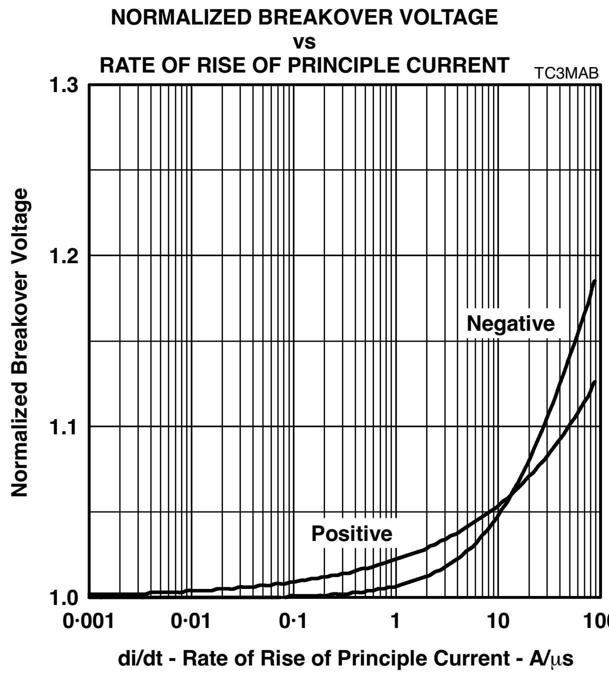


Figure 7.

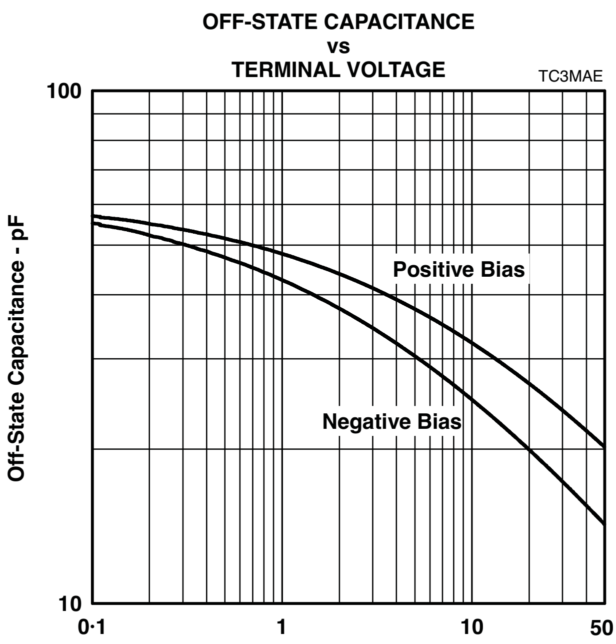


Figure 8.

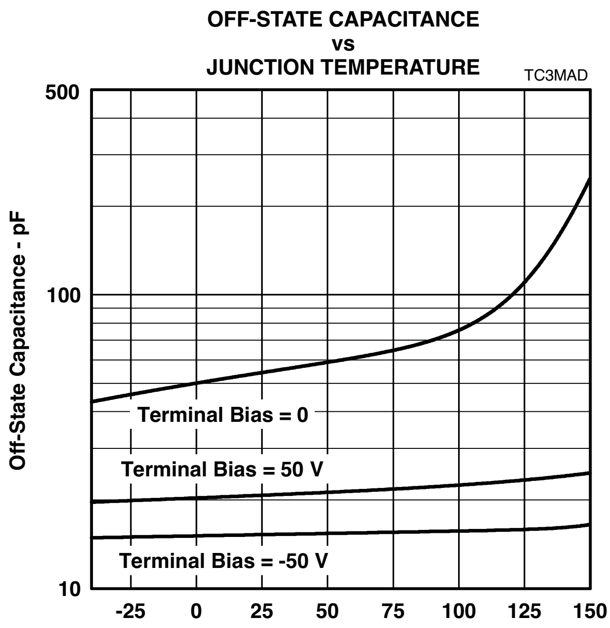


Figure 9.

Typical Characteristics - R and G or T and G Terminals

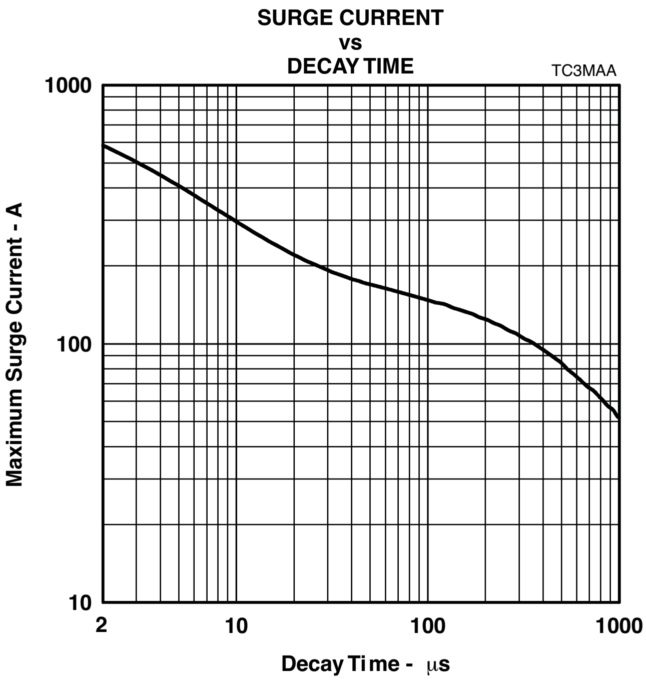


Figure 10.

Typical Characteristics - R and T Terminals

OFF-STATE CURRENT
vs
JUNCTION TEMPERATURE

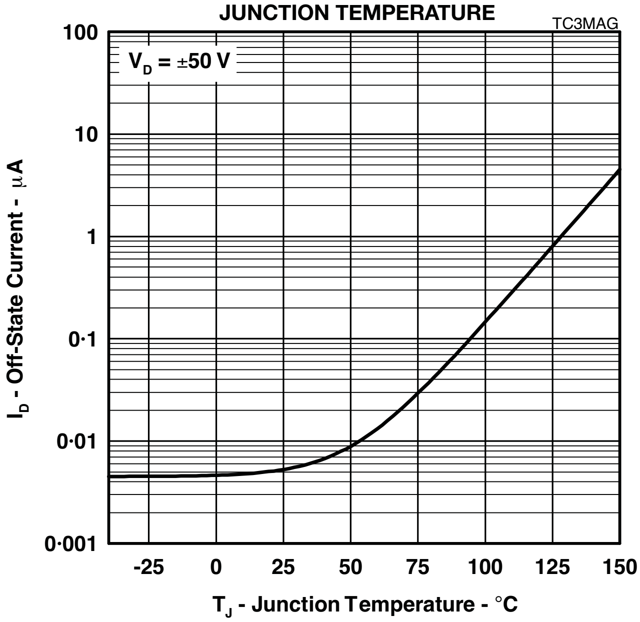


Figure 11.

NORMALIZED BREAKDOWN VOLTAGES
vs
JUNCTION TEMPERATURE

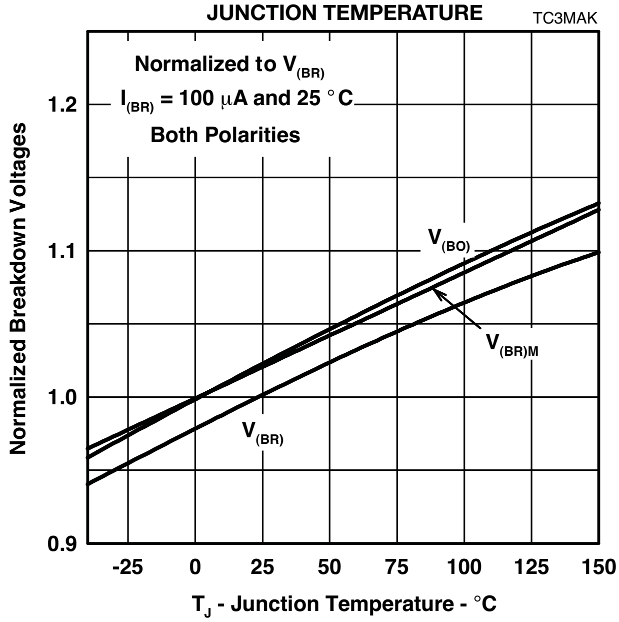


Figure 12.

NORMALIZED BREAKOVER VOLTAGE
vs
RATE OF RISE OF PRINCIPLE CURRENT

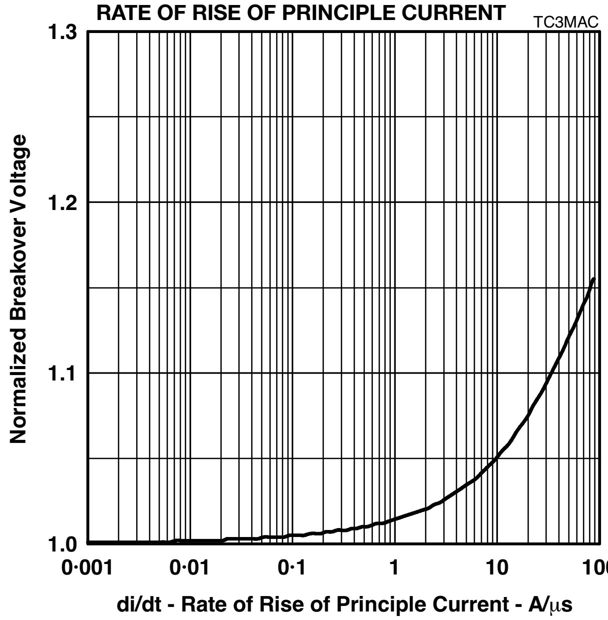


Figure 13.

Thermal Information

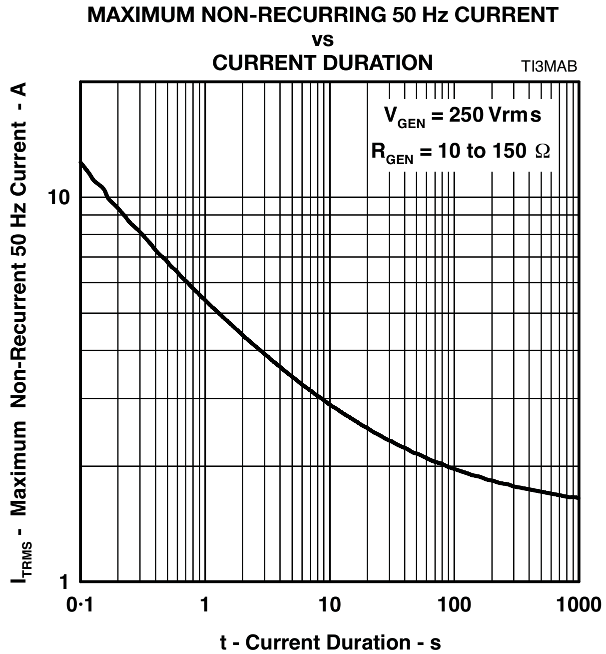


Figure 14.

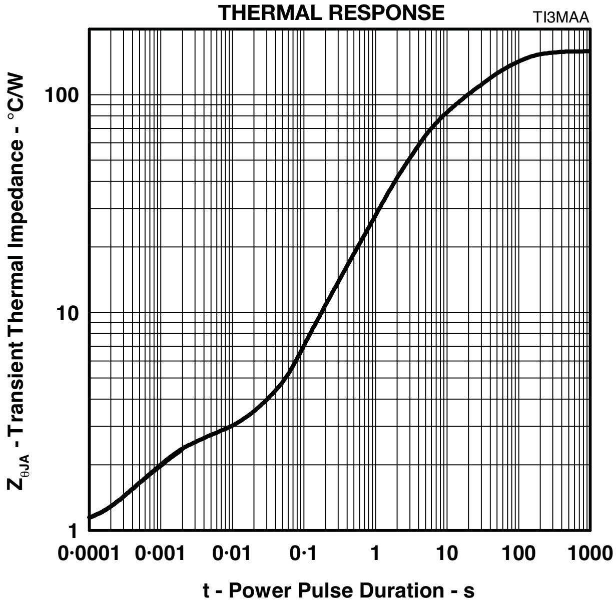


Figure 15.

APPLICATIONS INFORMATION

Electrical Characteristics

The electrical characteristics of a TISP® device 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 minimize 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 50 A, 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® device 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 ITU-T K.21 1.5 kV, 10/700 μs open circuit voltage surge is changed to a 38 A, 5/310 μs current waveshape when driving into a short circuit. Thus, the TISP® surge current capability, when directly connected to the generator, will be found for the ITU-T K.21 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
ITU-T K.21	1.5 kV, 10/700 μs	37.5 A, 5/310 μs
ITU-T K.20	1 kV, 10/700 μs	25 A, 5/310 μs
IEC 61000-4-5, combination wave generator	1.0 kV, 1.2/50 μs	500 A, 8/20 μs
Telcordia GR-1089-CORE	1.0 kV, 10/1000 μs	100 A, 10/1000 μs
Telcordia GR-1089-CORE	2.5 kV, 2/10 μs	500 A, 2/10 μs
FCC Part 68, Type A	1.5 kV, <10/>160 μs	200 A,<10/>160 μs
FCC Part 68, Type A	800 V, <10/>560 μs	100 A,<10/>160 μs
FCC Part 68, Type B	1.5 kV, 9/720 μs	37.5 A, 5/320 μs

Any series resistance in the protected equipment will reduce the peak circuit current to less than the generators' short circuit value. A 1 kV open circuit voltage, 100 A short circuit current generator has an effective output impedance of 10 Ω (1000/100). If the equipment has a series resistance of 25 Ω, then the surge current requirement of the TISP® device becomes 29 A (1000/35) and not 100 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® device 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 normalized 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 ITU-T K.21 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® device is sensitive to junction temperature, T_J, and the bias voltage, comprising of the d.c. voltage, V_D, and the a.c. voltage, V_d. All the capacitance values in this data sheet are measured with an a.c. voltage of 100 mV. The typical 25 °C variation of capacitance value with a.c. bias is shown in Figure 16. 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.

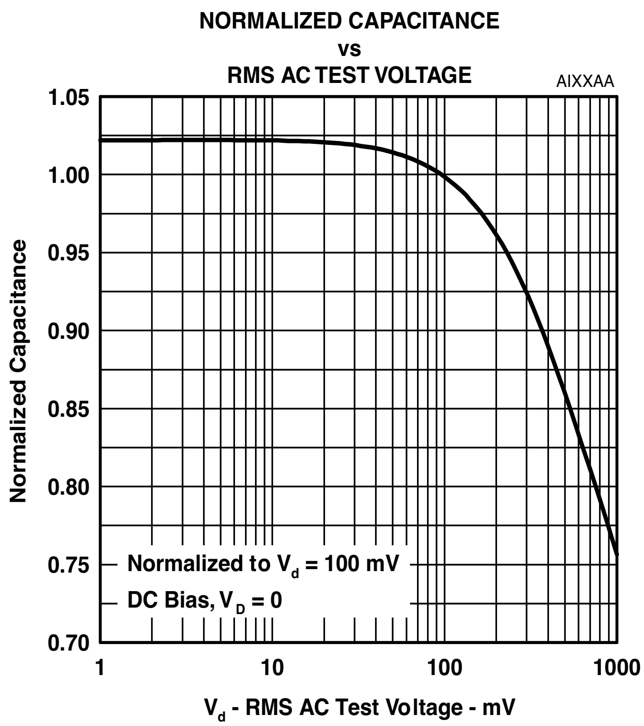


Figure 16.

APPLICATIONS INFORMATION

Longitudinal Balance

Figure 17 shows a three terminal TISP® device 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.

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.

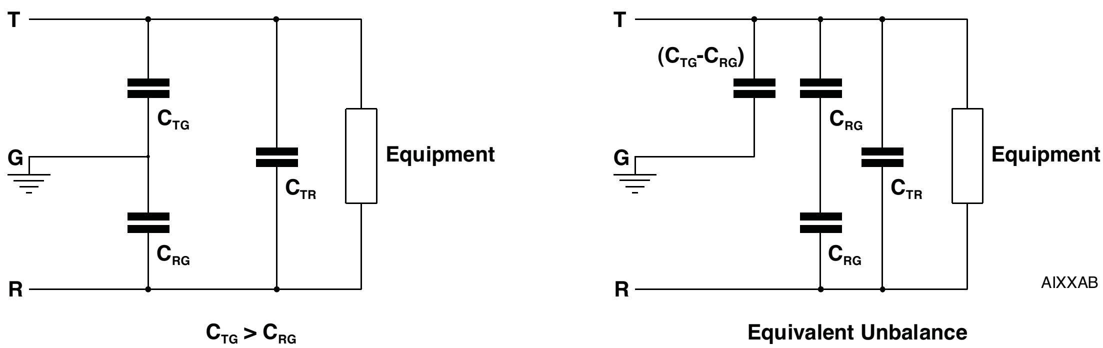


Figure 17.