

Over-voltage Protection For Telecommunication Systems

Data Manual & Application Information

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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 overvoltage 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 | 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, \mathbf{V}_{D} | ID |
| 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 | Iz |
| 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 . | Is |
| 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 _{RBM} . | 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 offstate 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 |
|---|---|
| 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). |
| 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. |

Symbol

Alpha_{V(BR)}

 $(dV_{(BR)}/dT_i)$

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



TELECOMMUNICATION SYSTEM SECONDARY PROTECTION

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

| DEVICE | V _{DRM} | V _(BO) |
|---------|------------------|-------------------|
| DEVICE | v | ٧ |
| '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} |
|------------|--------------|------------------|
| 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 |
| | FTZ R12 | 50 |
| 10/700 µs | VDE 0433 | 50 |
| | CCITT IX K17 | 38 |
| 10/1000 µs | REA PE-60 | 35 |

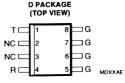
Surface Mount and Through-Hole Options

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

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



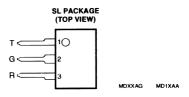
NC - No internal connection

P PACKAGE (TOP VIEW)

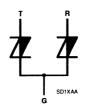


MDXXAF

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



device symbol

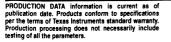


Terminals T, R and G correspond to the alternative line designators of A, B and C

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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TISP1072F3, TISP1082F3 DUAL ASYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

SLPSE04 - SEPTEMBER 1993 - REVISED SEPTEMBER 1994

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) | o peak off-state voltage (0°C < T _J <70°C) '1072F3 '1082F3 | | | |
| 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 μ | is) | | 70 | |
| 10/160 µs (FCC Part 68, open-circuit voltage wave shape 10/160 | 0 μs) | | 60 | |
| 5/200 µs (VDE 0433, open-circuit voltage wave shape 2 kV, 10/7 | '00 μs) | I _{TSP} | 50 | Α |
| 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 | i |
| 5/310 µs (FTZ R12, open-circuit voltage wave shape 2 kV, 10/70 | 0 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 10/100 | 00 μs) | | 35 | |
| Non-repetitive peak on-state current (see Notes 2 and 3) | D Package | | 4 | |
| 50 Hz, 1 s | P Package | ITSM | 6 | A rms |
| 50 Hz, 1 S | SL Package | | 6 | 1 |
| Initial rate of rise of on-state current, Linear current ramp, Maximum ramp value < 38 A | | | 250 | A/µs |
| Junction temperature | | | -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.
 - 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)

| | | TEST CONDITIONS | | TISP1072F3 | | TISP1082F3 | | | | |
|------------------|---------------------------------------|---|------------|------------|------|------------|-----|------|-----|------|
| | PARAMETER | | | MIN | TYP | MAX | MIN | TYP | MAX | UNIT |
| I _{DRM} | Repetitive peak off- state current | $V_D = \pm V_{DRM}, 0^{\circ}C < T_J < 70^{\circ}C$ | | | | ±10 | | L | ±10 | μA |
| ID | Off-state current | V _D = ±50 V | | | | ±10 | | | ±10 | μÁ |
| | | f = 100 kHz, V _d = 100 mV | D Package | | 0.08 | 0.5 | | 0.08 | 0.5 | pF |
| Coff | Off-state capacitance | 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)

| | | TEST CONDITIONS | | TISP1072F3 | | TISP1082F3 | | | l |
|------|---------------------------------------|--|--|------------|-----|------------|-----|-----|------|
| | PARAMETER | | | TYP | MAX | MIN | TYP | MAX | UNIT |
| IDRM | Repetitive peak off- state current | V _D = V _{DRM} , 0°C < T _J <70°C | | | -10 | | | -10 | μА |



TISP1072F3, TISP1082F3 **DUAL ASYMMETRICAL TRANSIENT** VOLTAGE SUPPRESSORS SLPSE04 - SEPTEMBER 1993 - REVISED SEPTEMBER 1994

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

| | | | | TISP1072F3 | | TISP1082F3 | | | | | |
|-------------------|--|--|------------------------|------------|-----|-----------------|-------|-----|------|-------|--|
| | PARAMETER | TEST CONDITIONS | | MIN | TYP | MAX | MIN | TYP | MAX | UNIT | |
| V _(BO) | Breakover voltage | dv/dt = -250 V/ms, R _{SOURCE} = | = 300 Ω | | | -72 | | | -82 | v | |
| V _(BO) | Impulse breakover volt- age | dv/dt = -1000 V/μs, R _{SOURCE} di/dt < -20 A/μs | = 50 Ω. | | -78 | will #10 -22-10 | | -92 | | ٧ | |
| I _(BO) | Breakover current | dv/dt = -250 V/ms, R _{SOURCE} = | = 300 Ω | -0.1 | | -0.6 | -0.1 | | -0.6 | Α | |
| V _{FRM} | Peak forward recovery voltage | $dv/dt = 1000 V/\mu s$, $R_{SOURCE} = di_F/dt < 20 A/\mu s$ | = 50 Ω. | | 3.3 | | | 3.3 | | ٧ | |
| 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 | | | Α | |
| dv/dt | Critical rate of rise of off-state voltage | Linear voltage ramp Maximum ramp value < 0.85V _D | RM | -5 | | | -5 | | | kV/μs | |
| ID | Off-state current | V _D = -50 V | | | | -10 | | | -10 | μA | |
| | | f = 100 kHz, V _d = 100 mV | $V_D = 0$, | | 150 | 240 | | 130 | 240 | pF | |
| Coff | Off-state capacitance | 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 | | | TYP | MAX | UNIT |
|------------------|---|--|------------|--|-----|-----|------|
| | | B -0.8 W T - 25°C | D Package | | | 160 | |
| R _{BJA} | Junction to free air thermal resistance | P _{tot} = 0.8 W, T _A = 25°C 5 cm ² , FR4 PCB | P Package | | | 100 | °C/W |
| | | SCIII, FR4 FOB | SL Package | | | 105 | |



2-5

PARAMETER MEASUREMENT INFORMATION

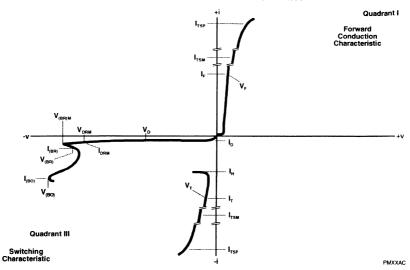


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR TERMINALS R AND G OR T AND G

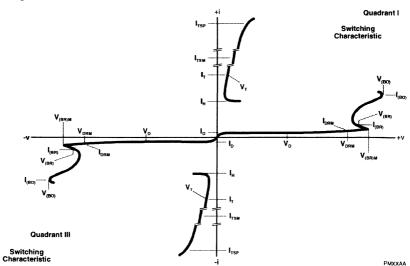
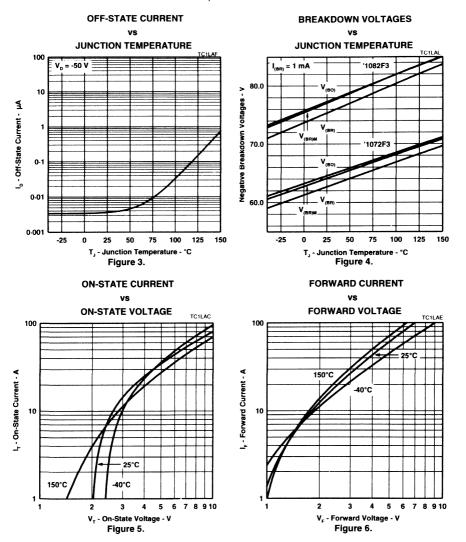


Figure 2. VOLTAGE-CURRENT CHARACTERISTIC FOR TERMINALS R AND T



2-6

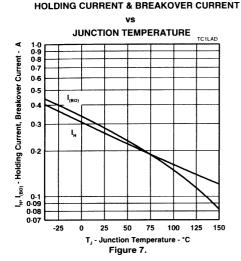
TYPICAL CHARACTERISTICS R and G, or T and G terminals

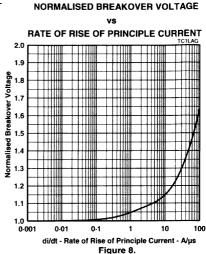




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TYPICAL CHARACTERISTICS R and G, or T and G terminals





VS RATE OF RISE OF PRINCIPLE CURRENT 10.0 V_{FRW} - Peak Forward Recovery Voltage - V 9.0 8.0 7.0 Ш 6.0 5.0 4.0 Ш ₹₩ 3.0

0.1

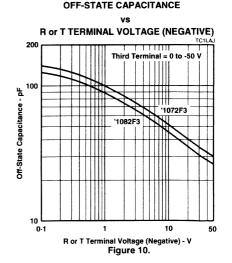
11111

di/dt - Rate of Rise of Principle Current - A/µs

Figure 9.

10

PEAK FORWARD RECOVERY VOLTAGE



TEXAS

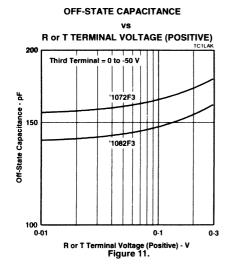
2.0

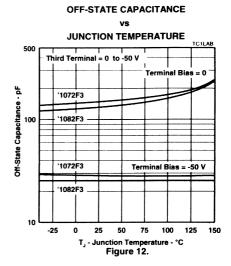
1.0 0.0

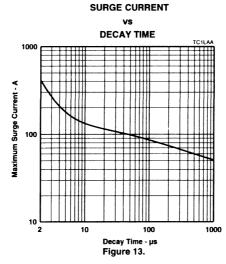
0.001

0.01

TYPICAL CHARACTERISTICS R and G, or T and G terminals

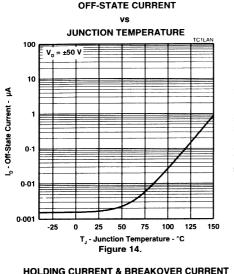


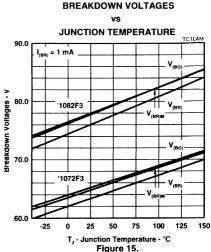




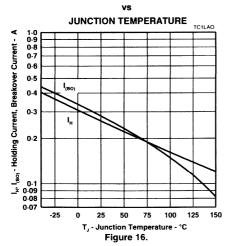


TYPICAL CHARACTERISTICS R and T terminals

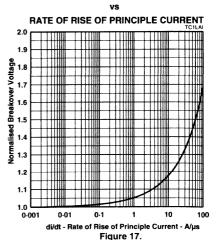




HOLDING CURRENT & BREAKOVER CURRENT



NORMALISED BREAKOVER VOLTAGE





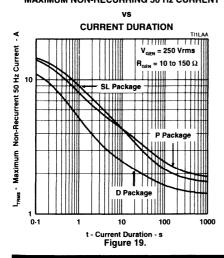
TYPICAL CHARACTERISTICS R and T terminals **OFF-STATE CAPACITANCE**

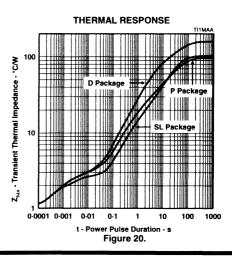
vs **TERMINAL VOLTAGE** 100 90 P Package 80 70 D Package 60 Off-State Capacitance - fF 50 40 30 SL Package 20 $V_{\rm G} > V_{\rm R}$ or $V_{\rm T}$ 1 1 1 1 1 1 **Both Voltage Polarities** 10 0.1 10 50

THERMAL INFORMATION

Terminal Voltage - V Figure 18.

MAXIMUM NON-RECURRING 50 Hz CURRENT







TISP1072F3, TISP1082F3 DUAL ASYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

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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, $10/700~\mu s$ surge is changed to a 38 A, $5/310~\mu s$ 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 $310~\mu s$ on the surge graph and not $700~\mu s$. 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.



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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, $10/700~\mu s$ surge has an average dv/dt of $150~V/\mu s$, but, as the rise is exponential, the initial dv/dt is higher, being in the region of $450~V/\mu s$. The instantaneous generator output resistance is $25~\Omega$. If the equipment has an additional series resistance of $20~\Omega$, the total series resistance becomes $45~\Omega$. The maximum di/dt then can be estimated as $450/45 = 10~A/\mu s$. 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

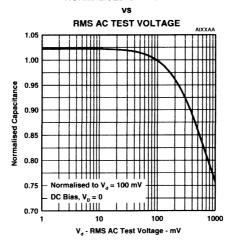


Figure 21.



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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 $C_{TR} + C_{RG}/2$.

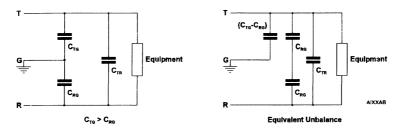


Figure 22.

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.



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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 _(BO) |
|---------|------------------|-------------------|
| DEVICE | v | v |
| '2072F3 | 58 | 72 |
| '2082F3 | 66 | 82 |

Planar Passivated Junctions Low Off-State Current < 10 µA

Rated for International Surge Wave Shapes

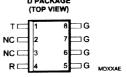
| WAVE SHAPE | WAVE SHAPE STANDARD | |
|------------|---------------------|----|
| 2/10 µs | FCC Part 68 | 80 |
| 8/20 µs | ANSI C62.41 | 70 |
| 10/160 µs | FCC Part 68 | 60 |
| 10/560 µs | FCC Part 68 | 45 |
| 0.5/700 µs | RLM 88 | 38 |
| | FTZ R12 | 50 |
| 10/700 μs | VDE 0433 | 50 |
| | CCITT IX K17 | 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 | Р | | | | |
| Single-in-line | SL | | | | |

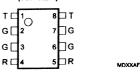
description

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.

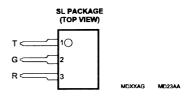


NC - No internal connection

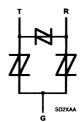
P PACKAGE (TOP VIEW)



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



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

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all the parameters.



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TISP2072F3, TISP2082F3 DUAL SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

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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) | V _{DRM} | ± 58 ± 66 | V | |
| Non-repetitive peak on-state pulse current (see Notes 1, 2 and 3) | | | | |
| 1/2 µs (Gas tube differential transient, open-circuit voltage way | re shape 1/2 µs) | | 120 | |
| 2/10 μs (FCC Part 68, open-circuit voltage wave shape 2/10 μs | s) | | 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 10/1 | 60 µs) | | 60 | |
| 5/200 µs (VDE 0433, open-circuit voltage wave shape 2 kV, 10 | I _{TSP} | 50 | Α | |
| 0.5/310 µs (RLM 88, open-circuit voltage wave shape 1.5 kV, 0 | | 38 | | |
| 5/310 µs (CCITT IX K17, open-circuit voltage wave shape 1.5 | | 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 10/1 | 000 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 ra | di _F /dt | 250 | A/µs | |
| Junction temperature | | | -40 to +150 | °C |
| Storage temperature range | Storage temperature range | | | °C |

- NOTES: 1. Further details on surge wave shapes are contained in the Applications Information section.
 - 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 |
|------------------|---------------------------------------|---|------------|-----|------------|-----|------|
| | PANAMETEN | TEST CONDITIONS | | MAX | MIN | MAX | UNII |
| I _{DRM} | Repetitive peak off- state current | V _D = ±V _{DRM} , 0°C < T _J < 70°C | | ±10 | | ±10 | μА |
| ID | Off-state current | V _D = ±50 V | | ±10 | | ±10 | μA |
| C _{off} | Off-state capacitance | $ f = 100 \text{ kHz}, V_d = 100 \text{ mV} \qquad 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.

electrical characteristics for the T and G or the R and G terminals, $T_J = 25^{\circ}C$

| PARAMETER | | TEST CONDITIONS | | TISP2072F3 | | TISP2082F3 | |
|------------------|----------------------|---|--|------------|-----|------------|------|
| 1 | PARAMETER | TEST CONDITIONS | | MAX | MIN | MAX | UNIT |
| I _{DRM} | Repetitive peak off- | $V_D = \pm V_{DRM}, 0^{\circ}C < T_J < 70^{\circ}C$ | | ±10 | | ±10 | |
| | state current | | | 110 | | ±10 | μА |



^{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 (Continued)

| | PARAMETER | TEST CONDITIONS | TISP2072F3 | | TISP2082F3 | | UNIT |
|-------------------|--|---|------------|------|------------|------|-------|
| | FANAMEIEN | | MIN | MAX | MIN | MAX | 0 |
| V _(BO) | Breakover voltage | $dv/dt = \pm 250 \text{ V/ms},$ Source Resistance = 300 Ω | | ±72 | | ±82 | v |
| V _(BO) | Impulse breakover volt- age | dv/dt = ±1000 V/μs, di/dt < 20 A/μs Source Resistance = 50 Ω | | ±84† | | ±94† | v |
| I _(BO) | Breakover current | $dv/dt = \pm 250 \text{ V/ms},$ Source Resistance = 300 Ω | ±0.15 | ±0.6 | ±0.15 | ±0.6 | Α |
| V _T | On-state voltage | $I_T = \pm 5 \text{ A}, t_W = 100 \mu\text{s}$ | | ±3 | | ±3 | ٧ |
| I _H | Holding current | di/dt = -/+30 mA/ms | ±0.15 | | ±0.15 | | Α |
| 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 | $V_D = \pm 50 \text{ V}$ | | ±10 | | ±10 | μA |
| | | $f = 100 \text{ kHz}, V_d = 100 \text{ mV} \qquad V_D = 0,$ | 77† | 130 | 77† | 130 | pF |
| Coff | Off-state capacitance | Third terminal voltage = 0 V _D = -5 V | 42† | 70 | 42† | 70 | pF |
| | | (see Notes 6 and 7) $V_D = -50 \text{ V}$ | 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.

PARAMETER MEASUREMENT INFORMATION

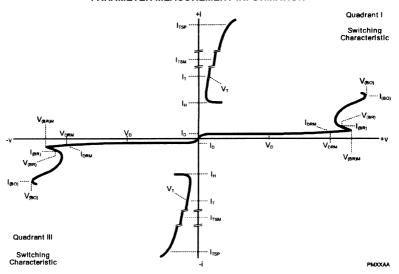


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR ANY PAIR OF TERMINALS

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



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

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

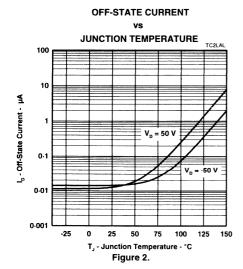
TISP2072F3, TISP2082F3 DUAL SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

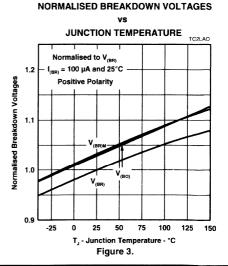
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thermal characteristics

| | PARAMETER | | MIN | TYP | MAX | UNIT |
|------------------|--|------------|-----|-----|-----|------|
| | The second secon | D Package | | | 160 | |
| R _{BJA} | Junction to free air thermal resistance | P Package | | | 100 | °C/W |
| | | SL Package | | | 105 | |

TYPICAL CHARACTERISTICS T and G, or R and G terminals

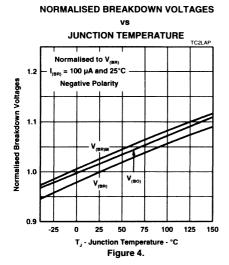


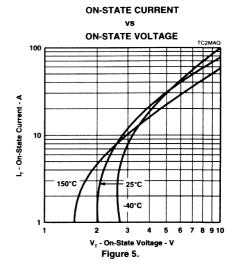




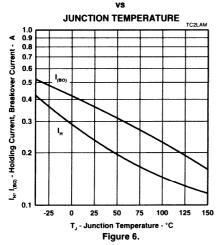
CLUCKOS MARCH 1004 DEVISED SEPTEMBER 100.

TYPICAL CHARACTERISTICS T and G, or R and G terminals

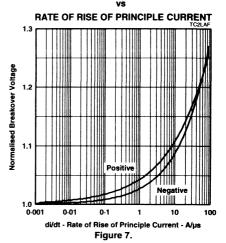




HOLDING CURRENT & BREAKOVER CURRENT

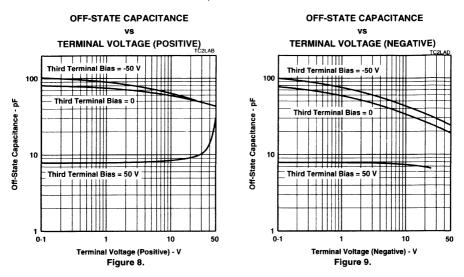


NORMALISED BREAKOVER VOLTAGE

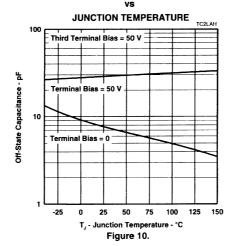




TYPICAL CHARACTERISTICS T and G, or R and G terminals

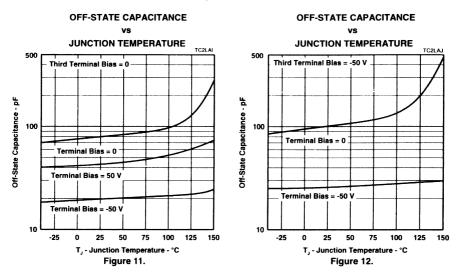


OFF-STATE CAPACITANCE

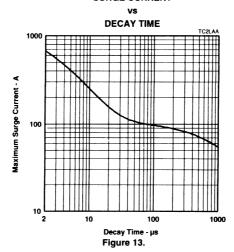




TYPICAL CHARACTERISTICS T and G, or R and G terminals

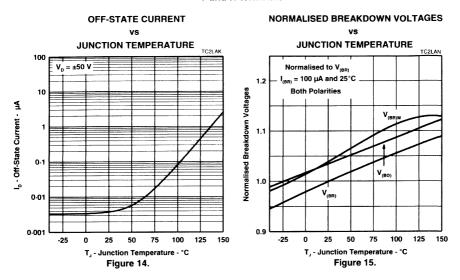


SURGE CURRENT





TYPICAL CHARACTERISTICS T and R terminals

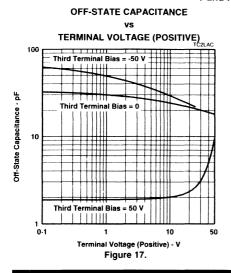


NORMALISED BREAKOVER VOLTAGE



2-22

TYPICAL CHARACTERISTICS T and R terminals



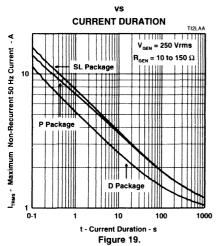
OFF-STATE CAPACITANCE VS TERMINAL VOLTAGE (NEGATIVE) TOULAGE Third Terminal Bias = -50 V Third Terminal Bias = 50 V Third Terminal Bias = 50 V

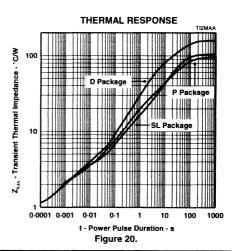
Terminal Voltage (Negative) - V

Figure 18.

THERMAL INFORMATION

MAXIMUM NON-RECURRING 50 Hz CURRENT







TISP2072F3, TISP2082F3 DUAL SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

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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.



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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, $10/700~\mu s$ surge has an average dv/dt of $150~V/\mu s$, but, as the rise is exponential, the initial dv/dt is higher, being in the region of $450~V/\mu s$. The instantaneous generator output resistance is $25~\Omega$. If the equipment has an additional series resistance of $20~\Omega$, the total series resistance becomes $45~\Omega$. The maximum di/dt then can be estimated as $450/45 = 10~A/\mu s$. 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

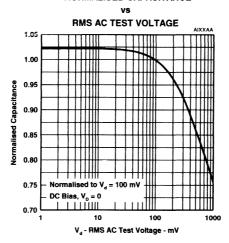


Figure 21.



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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 $C_{TR} + C_{RG}/2$.

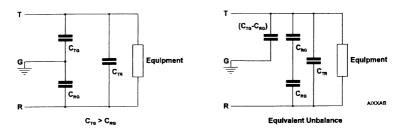


Figure 22.

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.



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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 _(BO) |
|---------|------------------|-------------------|
| DEVICE | v | ٧ |
| '2125F3 | 100 | 125 |
| '2150F3 | 120 | 150 |
| '2180F3 | 145 | 180 |

Planar Passivated Junctions
 Low Off-State Current < 10 μA

Rated for International Surge Wave Shapes

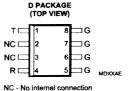
| WAVE SHAPE | STANDARD | I _{TSP} |
|------------|--------------|------------------|
| 2/10 µs | FCC Part 68 | 175 |
| 8/20 µs | ANSI C62.41 | 120 |
| 10/160 µs | FCC Part 68 | 60 |
| 10/560 µs | FCC Part 68 | 45 |
| 0.5/700 μs | RLM 88 | 38 |
| | FTZ R12 | 50 |
| 10/700 µs | VDE 0433 | 50 |
| | CCITT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

Surface Mount and Through-Hole Options

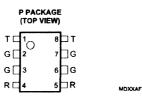
| PACKAGE | PART # SUFFIX |
|---------------------|---------------|
| Small-outline | D |
| Small-outline taped | DB |
| and reeled | DIT |
| Plastic DIP | Р |
| Single-in-line | SL |

description

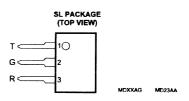
These medium voltage dual symmetrical transient voltage suppressor devices are designed to protect ISDN and telecommunication applications with battery backed ringing against transients caused by lightning strikes and ac power lines. Offered in three voltage variants to meet battery and protection requirements 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 de latchup as the current subsides.



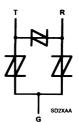
to the interner compact



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



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

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all the parameters.



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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 |
|---|------------------|---|-------------|-------|
| A. A. (140) | '2125F3 | *************************************** | ± 100 | |
| Repetitive peak off-state voltage (0°C < T _J < 70°C) | '2125F3 | V_{DRM} | ± 120 | V |
| | '2180F3 | | ± 145 | |
| Non-repetitive peak on-state pulse current (see Notes 1, 2 and 3) | | | | |
| 1/2 µs (Gas tube differential transient, open-circuit voltage wav | re shape 1/2 µs) | | 350 | 1 |
| 2/10 µs (FCC Part 68, open-circuit voltage wave shape 2/10 µs | s) | | 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 10/1 | 60 µs) | | 60 | |
| 5/200 µs (VDE 0433, open-circuit voltage wave shape 2 kV, 10/700 µs) | | | 50 | A |
| 0.5/310 μs (RLM 88, open-circuit voltage wave shape 1.5 kV, 0.5/700 μs) | | | 38 | 1 |
| 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 10/1 | (8μ 000 | | 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 ra | amp value < 38 A | di _F /dt | 250 | A/µs |
| Junction temperature | | Tj | -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.

- 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

| DADAMETED | | TISP: | | TISP2125F3 TISP2 | | 2150F3 TISF | | 180F3 | UNIT |
|------------------|---------------------------------------|---|-----|------------------|-----|-------------|-----|-------|------|
| | PARAMETER | TEST CONDITIONS | | MAX | MIN | MAX | MIN | MAX | UNIT |
| I _{DRM} | Repetitive peak off- state current | $V_D = \pm V_{DRM}, 0^{\circ}C < T_J < 70^{\circ}C$ | | ±10 | | ±10 | | ±10 | μА |
| I _D | Off-state current | V _D = ±50 V | | ±10 | | ±10 | | ±10 | μA |
| C _{off} | Off-state capacitance | $f = 100 \text{ kHz}, V_d = 100 \text{ mV} V_D = 0,$ 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.

TISP2125F3, TISP2150F3, TISP2180F3 DUAL SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS SLPSE06 - MARCH 1994 - REVISED SEPTEMBER 1994

electrical characteristics for the T and G or the R and G terminals, $T_J = 25^{\circ}C$

| | PARAMETER | TEST CONDITIONS TISP2 | | 2125F3 | TISP2 | 2150F3 TISP2180F3 | | UNIT | | |
|-------------------|--|--|------------------------|--------|-------|-------------------|-------|-------|-------|-------|
| | TANAMETEN | 1231 CONDING | 7113 | MIN | MAX | MIN | MAX | MIN | MAX | UNII |
| I _{DRM} | Repetitive peak off- state current | V _D = ±V _{DRM} , 0°C < T _J < 70°C | ; | | ±10 | | ±10 | | ±10 | μА |
| V _(BO) | Breakover voltage | $dv/dt = \pm 250 \text{ V/ms},$ Source Resistance = 300 Ω | | | ±125 | | ±150 | | ±180 | ٧ |
| V _(BO) | Impulse breakover volt- age | $dv/dt = \pm 1000 V/\mu s$, $di/dt < 2$ Source Resistance = 50 Ω | 20 A /μs | | ±143† | | ±168† | | ±198† | ٧ |
| 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 | Α |
| V _T | On-state voltage | I _T = ±5 A, t _W = 100 μs | | | ±3 | | ±3 | | ±3 | V |
| 1 _H | Holding current | di/dt = -/+30 mA/ms | | ±0.15 | | ±0.15 | | ±0.15 | | Α |
| 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 | μА |
| | | $f = 100 \text{ kHz}, V_d = 100 \text{ mV}$ | $V_D = 0$, | 52† | 90 | 52† | 90 | 52† | 90 | pF |
| Coff | Off-state capacitance | 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.

thermal characteristics

| PARAMETER | MIN | TYP | MAX | UNIT |
|--|-----|-----|-----|------|
| D Package | | | 160 | |
| R _{BJA} Junction to free air thermal resistance P Package | | | 100 | °C/W |
| SL Package | | | 105 | |



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

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

PARAMETER MEASUREMENT INFORMATION

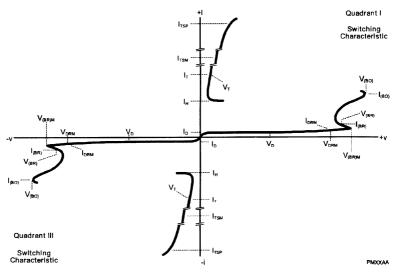


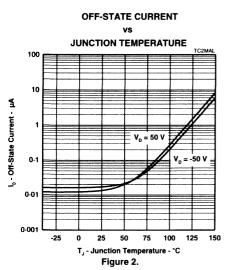
Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR ANY PAIR OF TERMINALS

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



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TYPICAL CHARACTERISTICS T and G, or R and G terminals



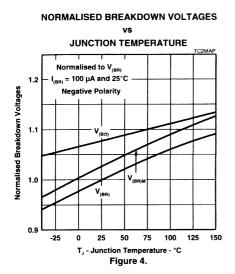
vs **JUNCTION TEMPERATURE** Normalised to V_(BR) _m = 100 μA and 25°C 1.2 Normalised Breakdown Voltages Positive Polarity 1.1 1.0 0.9 -25 100 125 150 T, - Junction Temperature - °C Figure 3.

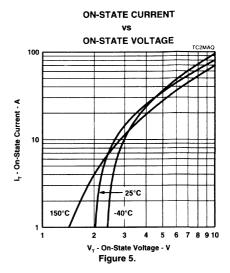
NORMALISED BREAKDOWN VOLTAGES



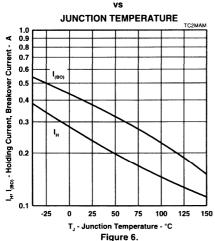
SLPSE06 - MARCH 1994 - REVISED SEPTEMBER 1994

TYPICAL CHARACTERISTICS T and G, or R and G terminals

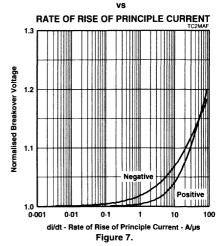




HOLDING CURRENT & BREAKOVER CURRENT



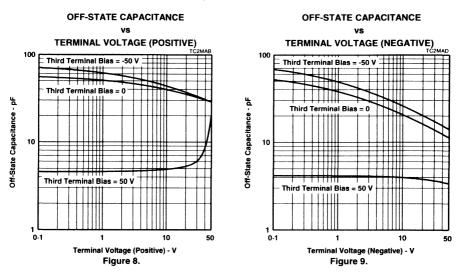
NORMALISED BREAKOVER VOLTAGE



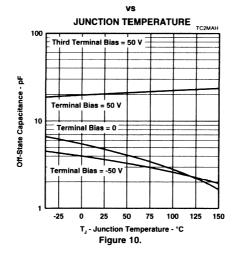


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TYPICAL CHARACTERISTICS T and G, or R and G terminals



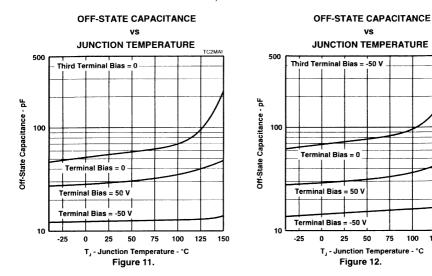
OFF-STATE CAPACITANCE

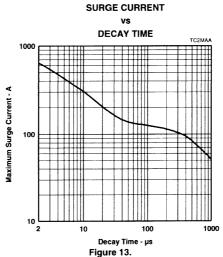




SLPSE06 - MARCH 1994 - REVISED SEPTEMBER 1994

TYPICAL CHARACTERISTICS T and G, or R and G terminals



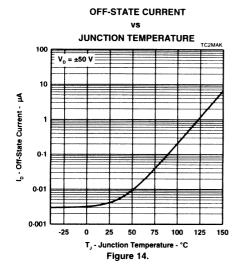


75 100 150



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TYPICAL CHARACTERISTICS T and R terminals



NORMALISED BREAKDOWN VOLTAGES JUNCTION TEMPERATURE Normalised to V_(BR) I_(BR) = 100 μA and 25°C 1.2 **Both Polarities** Normalised Breakdown Voltages 1.0 0.9 -25 0 25 50 75 100 125 150 T, - Junction Temperature - °C

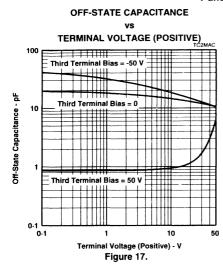
Figure 15.

NORMALISED BREAKOVER VOLTAGE



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TYPICAL CHARACTERISTICS T and R terminals

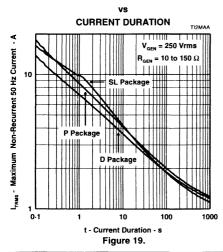


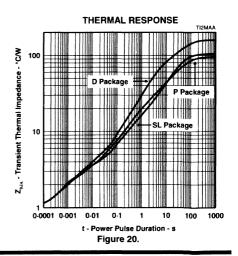
OFF-STATE CAPACITANCE VS TERMINAL VOLTAGE (NEGATIVE) Third Terminal Blas = -50 V Third Terminal Blas = 0 Third Terminal Blas = 50 V Third Terminal Blas = 50 V Third Terminal Blas = 50 V

Figure 18.

THERMAL INFORMATION

MAXIMUM NON-RECURRING 50 Hz CURRENT







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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_A).

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 μ s surge is changed to a 38 A, 5/310 μ s 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 μ s on the surge graph and not 700 μ s. 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 B12 | 2.0 kV. 10/700 us | 50 A. 5/310 us |

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.



SLPSE06 - MARC'H 1994 - REVISED SEPTEMBER 1994

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

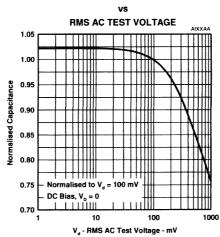


Figure 21.



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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 $C_{TG} > C_{RG}$ 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 $C_{TR} + C_{RG}/2$.

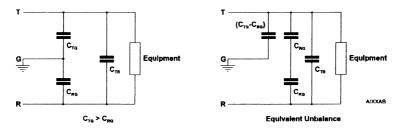


Figure 22.

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.



SLPSE07 - MARCH 1994 - REVISED SEPTEMBER 1994

TELECOMMUNICATION SYSTEM SECONDARY PROTECTION

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

| DEVICE | VDRM | V _(BO) |
|---------|------|-------------------|
| DEVICE | v | ٧ |
| '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

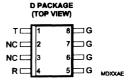
| WAVE SHAPE | STANDARD | I _{TSP} |
|------------|--------------|------------------|
| 2/10 µs | FCC Part 68 | 175 |
| 8/20 µs | ANSI C62.41 | 120 |
| 10/160 µs | FCC Part 68 | 60 |
| 10/560 µs | FCC Part 68 | 45 |
| 0.5/700 μs | RLM 88 | 38 |
| | FTZ R12 | 50 |
| 10/700 µs | VDE 0433 | 50 |
| | CCITT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

Surface Mount and Through-Hole Options

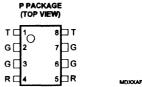
| PACKAGE | PART # SUFFIX |
|---------------------|---------------|
| Small-outline | D |
| Small-outline taped | DB |
| and reeled | Un |
| Plastic DIP | Р |
| Single-in-line | SL |

description

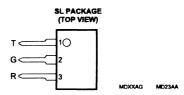
These high voltage dual symmetrical transient voltage suppressor devices are designed to protect telecommunication applications with battery backed ringing against transients caused by lightning strikes and ac power lines. Offered in five voltage variants to meet battery and protection requirements they 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



NC - No internal connection



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



device symbol



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

holding current prevents dc latchup as the current subsides.

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

tions anty. clude

Texas

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PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all the parameters.

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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 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 '2260F3 '2290F3 '2320F3 '2380F3 | V _{DRM} | ± 180 ± 200 ± 220 ± 240 | v |
| Non-repetitive peak on-state pulse current (see Notes 1, 2 and 3) | 2380F3 | | ± 2/0 | |
| 1/2 µs (Gas tube differential transient, open-circuit voltage way | re shape 1/2 µs) | | 350 | |
| 2/10 μs (FCC Part 68, open-circuit voltage wave shape 2/10 μs | s) | | 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 10/1 | 60 µs) | | 60 | |
| 5/200 µs (VDE 0433, open-circuit voltage wave shape 2 kV, 10 | /700 μs) | ITSP | ± 180 ± 200 ± 220 ± 240 ± 270 350 175 120 | A |
| 0.5/310 µs (RLM 88, open-circuit voltage wave shape 1.5 kV, 0 |).5/700 µs) | | | ĺ |
| 5/310 µs (CCITT IX K17, open-circuit voltage wave shape 1.5 | kV, 10/700 µs) | | | i |
| 5/310 µs (FTZ R12, open-circuit voltage wave shape 2 kV, 10/7 | 700 µs) | | 50 | |
| 10/560 µs (FCC Part 68, open-circuit voltage wave shape 10/5 | 60 µs) | | 45 | |
| 10/1000 µs (REA PE-60, open-circuit voltage wave shape 10/1 | 000 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 ra | amp value < 38 A | di _F /dt | 250 | A/µs |
| Junction temperature | | Tj | -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.
 - 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, $T_J = 25^{\circ}C$

| | PARAMETER | TEST CONDITIONS | | TISP2240F3 | | TISP2260F3 | | TISP2290F3 | |
|------------------|---------------------------------------|---|-----|------------|-----|------------|-----|------------|------|
| TANAMETEN | | TEST CONDITIONS | | MIN MAX | | MAX | MIN | MAX | UNIT |
| I _{DRM} | Repetitive peak off- state current | $V_D = \pm V_{DRM}, 0^{\circ}C < T_J < 70^{\circ}C$ | | ±10 | | ±10 | | ±10 | μА |
| I _D | Off-state current | V _D = ±50 V | | ±10 | | ±10 | | ±10 | μA |
| C _{off} | Off-state capacitance | $f = 100 \text{ kHz}, V_d = 100 \text{ mV} \qquad V_D = 0,$ 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.



TISP2240F3, TISP2260F3, TISP2290F3, TISP2320F3, TISP2380F3 **DUAL SYMMETRICAL TRANSIENT** VOLTAGE SUPPRESSORS SLPSE07 - MARCH 1994 - REVISED SEPTEMBER 1994

electrical characteristics for the T and G or the R and G terminals, $T_J = 25^{\circ}C$

| | PARAMETER | TEST CONDITIONS | TISP | 2240F3 | TISP2 | 2260F3 | TISP2 | 2290F3 | UNIT |
|-------------------|--|---|-------|--------|-------|--------|-------|--------|-------|
| | PANAMETER | TEST CONDITIONS | MIN | MAX | MIN | MAX | MIN | MAX | UNIT |
| IDRM | Repetitive peak off- state current | $V_D = \pm V_{DRM}, 0^{\circ}C < T_J < 70^{\circ}C$ | | ±10 | | ±10 | | ±10 | μA |
| V _(BO) | Breakover voltage | dv/dt = ±250 V/ms, Source Resistance = 300 Ω | | ±240 | | ±260 | | ±290 | ٧ |
| V _(BO) | Impulse breakover volt- age | $dv/dt = \pm 1000 \text{ V/μs}, di/dt < 20 \text{ A/μs}$ Source Resistance = 50 Ω | | ±267† | | ±287† | | ±317† | ٧ |
| 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 | Α |
| V _T | On-state voltage | $i_T = \pm 5 \text{ A}, t_W = 100 \mu\text{s}$ | | ±3 | | ±3 | | ±3 | ٧ |
| I _H | Holding current | di/dt = -/+30 mA/ms | ±0.15 | | ±0.15 | | ±0.15 | | Α |
| 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 |
| ID | Off-state current | $V_D = \pm 50 \text{ V}$ | | ±10 | | ±10 | | ±10 | μA |
| | | $f = 100 \text{ kHz}, V_d = 100 \text{ mV} V_D = 0,$ | 52† | 90 | 52† | 90 | 52† | 90 | pF |
| Coff | Off-state capacitance | Third terminal voltage = 0 V _D = -5 V | 20† | 35 | 20† | 35 | 20† | 35 | pF |
| | | (see Notes 6 and 7) $V_D = -50 \text{ V}$ | / 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.

electrical characteristics for the T and R terminals, $T_J = 25^{\circ}C$

| | PARAMETER TEST CONDITIONS | | TISP2320F3 | | TISP2380F3 | | UNIT |
|------|---------------------------------------|---|------------|-----|------------|-----|------|
| | FANAMETEN | TEST CONDITIONS | MIN | MAX | #10 #1 | MAX | UNIT |
| IDRM | Repetitive peak off- state current | $V_D = \pm V_{DRM}, 0^{\circ}C < T_J < 70^{\circ}C$ | | ±10 | | ±10 | μА |
| ID | Off-state current | V _D = ±50 V | | ±10 | | ±10 | μA |
| Coff | Off-state capacitance | | 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.

electrical characteristics for the T and G or the R and G terminals, $T_J = 25^{\circ}C$

| | PARAMETER | TEST CONDITIONS | TISP2320F3 | | TISP2380F3 | | UNIT |
|-------------------|---------------------------------------|---|------------|-------|------------|-------|------|
| | FARAMETER | TEST CONDITIONS | | MAX | MIN | MAX | ONII |
| I _{DRM} | Repetitive peak off- state current | $V_D = \pm V_{DRM}$, $0^{\circ}C < T_J < 70^{\circ}C$ | | ±10 | | ±10 | μА |
| V _(BO) | Breakover voltage | $dv/dt = \pm 250 \text{ V/ms},$ Source Resistance = 300 Ω | | ±320 | | ±380 | ٧ |
| V _(BO) | Impulse breakover volt- age | $dv/dt = \pm 1000 V/μs$, $di/dt < 20 A/μs$ Source Resistance = 50 Ω | | ±347† | | ±407† | V |



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

[†] Typical value of the parameter, not a limit value

^{5.} Further details on capacitance are given in the Applications Information section.

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

| | PARAMETER | TEST CONDITIONS | TISP2320F3 | | TISP2380F3 | | UNIT |
|-------------------|--|---|------------|------|------------|------|-------|
| | PAHAMETER | TEST CONDITIONS | | MAX | MIN | MAX | ONII |
| I _(BO) | Breakover current | $dv/dt = \pm 250 \text{ V/ms},$ Source Resistance = 300 Ω | ±0.15 | ±0.6 | ±0.15 | ±0.6 | Α |
| V _T | On-state voltage | I _T = ±5 A, t _W = 100 μs | | ±3 | | ±3 | ٧ |
| 1н | Holding current | di/dt = -/+30 mA/ms | ±0.15 | | ±0.15 | | Α |
| 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 |
| | | $f = 100 \text{ kHz}, V_d = 100 \text{ mV} V_D = 0,$ | 77† | 130 | 77† | 130 | рF |
| Coff | Off-state capacitance | Third terminal voltage = 0 V _D = -5 V | 42† | 70 | 42† | 70 | pF |
| | | (see Notes 6 and 7) $V_D = -50 \text{ V}$ | 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.

PARAMETER MEASUREMENT INFORMATION

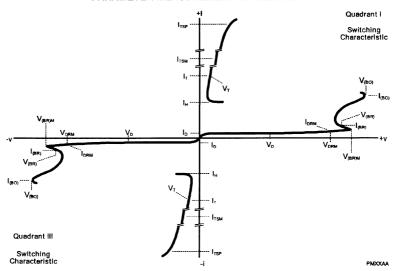


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR ANY PAIR OF TERMINALS

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



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

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

TISP2240F3, TISP2260F3, TISP2290F3, TISP2320F3, TISP2380F3 DUAL SYMMETRICAL TRANSIENT

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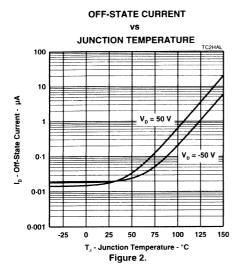
thermal characteristics

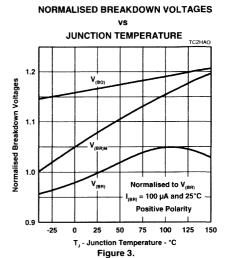
| | PARAMETER | | MIN | TYP | MAX | UNIT |
|------------------|---|------------|-----|-----|-----|------|
| | | D Package | | | 160 | |
| R _{eJA} | Junction to free air thermal resistance | P Package | | | 100 | °C/W |
| | | SL Package | | | 105 | ĺ |



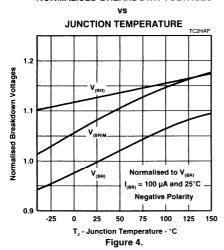
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TYPICAL CHARACTERISTICS T and G, or R and G terminals

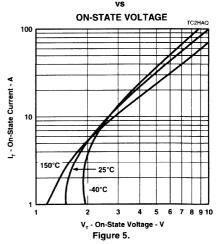




NORMALISED BREAKDOWN VOLTAGES



ON-STATE CURRENT

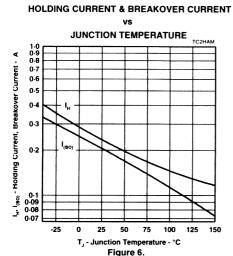




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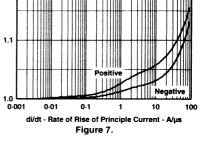
TYPICAL CHARACTERISTICS T and G, or R and G terminals

Normalised Breakover Voltage

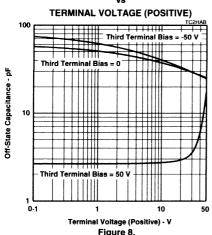


RATE OF RISE OF PRINCIPLE CURRENT 1.3 1.2

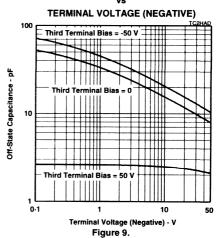
NORMALISED BREAKOVER VOLTAGE



OFF-STATE CAPACITANCE



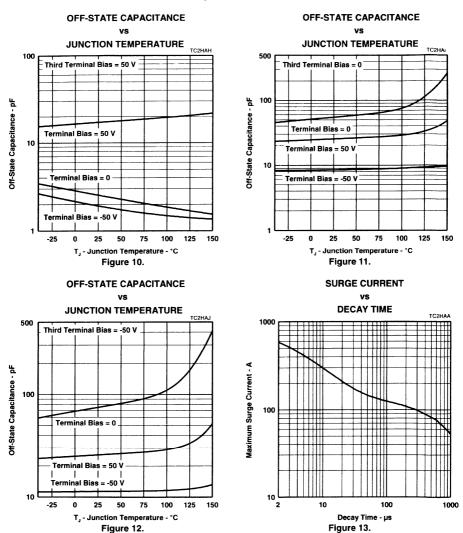
OFF-STATE CAPACITANCE





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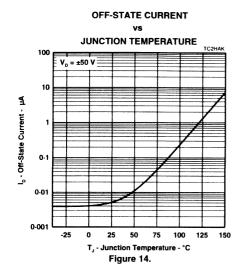
TYPICAL CHARACTERISTICS T and G, or R and G terminals





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TYPICAL CHARACTERISTICS T and R terminals



NORMALISED BREAKDOWN VOLTAGES **JUNCTION TEMPERATURE** Normalised to V_(BR) _(BR) = 100 μA and 25°C 1.2 Normalised Breakdown Voltages **Both Polarities** 1.0 0.9 -25 0 75 100 125 150 T, - Junction Temperature - °C

Figure 15.

NORMALISED BREAKOVER VOLTAGE

RATE OF RISE OF PRINCIPLE CURRENT
TC2HAG

2.5

2.0

2.0

2.0

1.0

0.001

0.01

0.01

0.1

1.0

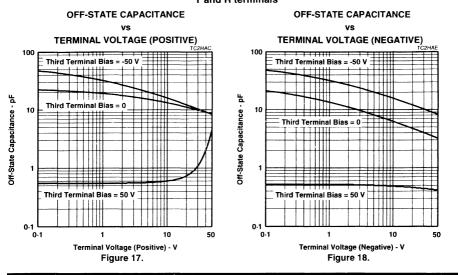
di/dt - Rate of Rise of Principle Current - A/ys



Figure 16.

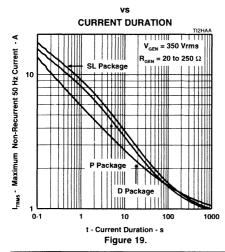
SLPSE07 - MARCH 1994 - REVISED SEPTEMBER 1994

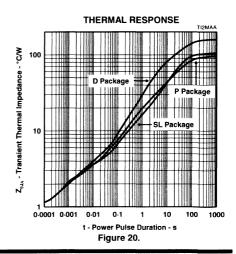
TYPICAL CHARACTERISTICS T and R terminals



THERMAL INFORMATION

MAXIMUM NON-RECURRING 50 Hz CURRENT







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APPLICATIONS INFORMATION

electrical characteristics

The electrical characteristics of a TISP are strongly dependent on junction temperature, $T_{\rm J}$. 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 ($Z_{\rm D}$).

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, $10/700 \, \mu s$ surge is changed to a 38 A, $5/310 \, \mu s$ 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:

| OPEN CIRCUIT VOLTAGE | SHORT CIRCUIT CURRENT |
|---|--|
| 1.5 kV, 10/700 µs 1 kV, 10/700 µs 1.5 kV, 0.5/700 µs 2.0 kV, 10/700 µs | 38 A, 5/310 µs 25 A, 5/310 µs 38 A, 0.2/310 µs 50 A, 5/200 µs 50 A, 5/310 µs |
| | VOLTAGE 1.5 kV, 10/700 μs 1 kV, 10/700 μs 1.5 kV, 0.5/700 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.



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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 μ s surge has an average dv/dt of 150 V/ μ s, but, as the rise is exponential, the initial dv/dt is higher, being in the region of 450 V/ μ s. 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/ μ s. 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

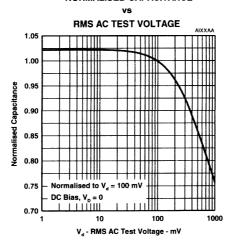


Figure 21.



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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 $C_{TR} + C_{RG}/2$.

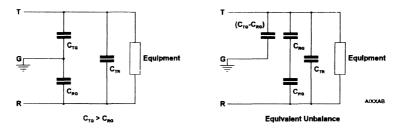


Figure 22.

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.



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G MOYAE

MOYYAE

TELECOMMUNICATION SYSTEM SECONDARY PROTECTION

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

| DEVICE | V _{DRM} | V _(BO) |
|---------|------------------|-------------------|
| DEVICE | v | v |
| '3072F3 | 58 | 72 |
| '3082F3 | 66 | 82 |

Planar Passivated Junctions
 Low Off-State Current < 10 μA

Rated for International Surge Wave Shapes

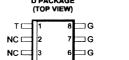
| WAVE SHAPE | STANDARD | I _{TSP} A |
|------------|--------------|-----------------------|
| 2/10 µs | FCC Part 68 | 80 |
| 8/20 µs | ANSI C62.41 | 70 |
| 10/160 µs | FCC Part 68 | 60 |
| 10/560 μs | FCC Part 68 | 45 |
| 0.5/700 µs | RLM 88 | 38 |
| | FTZ R12 | 50 |
| 10/700 μs | VDE 0433 | 50 |
| | 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 | Р |
| Single-in-line | SL |

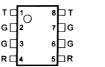
description

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.

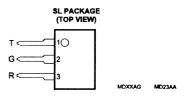


NC - No internal connection

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.



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

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all the parameters.



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TISP3072F3, TISP3082F3 DUAL SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

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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 < $T_{\rm J}$ < 70°C) | '3072F3 '3082F3 | V _{DRM} | ± 58 ± 66 | V |
| 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) | 1 | | ± 58 ± 66 | |
| 8/20 μs (ANSI C62.41, open-circuit voltage wave shape 1.2/50 μ | s) | | | |
| 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, 10/7 | 00 μs) | 1 _{TSP} | ± 58 ± 66 120 80 70 60 50 38 38 50 45 35 4 6 6 250 | Α |
| 0.5/310 μs (RLM 88, open-circuit voltage wave shape 1.5 kV, 0.5 | /700 µs) | ĺ | | l |
| 5/310 µs (CCITT IX K17, open-circuit voltage wave shape 1.5 kV | , 10/700 µs) | | | 1 |
| 5/310 µs (FTZ R12, open-circuit voltage wave shape 2 kV, 10/700 |) µs) | | 50 | ĺ |
| 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 10/100 | 00 µs) | | 35 | |
| Non-repetitive peak on-state current (see Notes 2 and 3) | D Package | | 4 | |
| 50 Hz, 1 s | P Package | ITSM | 120 80 70 60 50 38 38 50 45 35 4 6 6 250 | A rms |
| | SL Package | } | 6 | , |
| Initial rate of rise of on-state current, Linear current ramp, Maximum ram | p value < 38 A | di _F /dt | 250 | A/µs |
| Junction temperature | | TJ | -40 to +150 | °C |
| Storage temperature range | | T _{stq} | -40 to +150 | °C |

NOTES: 1. Further details on surge wave shapes are contained in the Applications Information section.

- 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_{.1} = 25°C

| | PARAMETER | TEST CONDITIONS | | | TISP3072F3 | | TISP3082F3 | |
|------------------|---------------------------------------|--|------------|-----|------------|-----|------------|------|
| FARAMEIER | | TEST CONDITIONS | | MIN | MAX | MIN | MAX | UNIT |
| I _{DRM} | Repetitive peak off- state current | $V_D = \pm V_{DRM}, 0^{\circ}C < T_J < 70^{\circ}C$ | | | ±10 | | ±10 | μА |
| ID | Off-state current | V _D = ±50 V | | | ±10 | | ±10 | μA |
| | | $f = 100 \text{ kHz}, V_d = 100 \text{ mV} V_D = 0,$ | D Package | 50† | 150 | 50† | 150 | |
| C _{off} | Off-state capacitance | Third terminal voltage = -50 V to +50 V | P Package | 65† | 200 | 65† | 200 | fF |
| | | (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.

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

| | | PARAMETER | TEST CONDITIONS | | TISP3072F3 | | TISP3082F3 | |
|------|-------------|----------------------|--|--|------------|-----|------------|------|
| | TANAMETER . | | 1231 CONDITIONS | | MAX | MIN | MAX | UNIT |
| IDRM | i | Repetitive peak off- | $V_D = \pm V_{DRM}$, 0°C < T_J < 70°C | | ±10 | | ±10 | 4 |
| | DRM | state current | | | ±10 | | ±10 | μА |



^{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 (Continued)

| | PARAMETER | TEST CONDITIONS | | TISP3072F3 | | TISP3082F3 | | UNIT |
|-------------------|--|---|-----------------------|------------|------|------------|------|-------|
| | TANAME I EN | | | MIN | MAX | MIN | MAX | UNIT |
| V _(BO) | Breakover voltage | dv/dt = ±250 V/ms, Source Resistance = 300 Ω | | | ±72 | | ±82 | ٧ |
| V _(BO) | Impulse breakover volt- age | $dv/dt = \pm 1000 V/\mu s$, $di/dt < 20 A/\mu s$ Source Resistance = 50 Ω | | | ±86† | | ±96† | ٧ |
| I _(BO) | Breakover current | dv/dt = ±250 V/ms, Source Resistance = 300 Ω | | ±0.15 | ±0.6 | ±0.15 | ±0.6 | Α |
| V _T | On-state voltage | $I_T = \pm 5 \text{ A}, t_W = 100 \mu\text{s}$ | | | ±3 | | ±3 | V |
| l _H | Holding current | di/dt = -/+30 mA/ms | | ±0.15 | | ±0.15 | | Α |
| dv/dt | Critical rate of rise of off-state voltage | Linear voltage ramp, Maximum ramp value < 0.85V _{(BR)MIN} | | ±5 | | ±5 | | kV/μs |
| ID | Off-state current | $V_D = \pm 50 \text{ V}$ | | | ±10 | | ±10 | μA |
| | | f = 100 kHz, V _d = 100 mV | $V_D = 0$, | 82† | 140 | 82† | 140 | pF |
| Coff | Off-state capacitance | Third terminal voltage = -50 V to +50 V | $V_D = -5 V$ | 49† | 85 | 49† | 85 | pF |
| | | (see Notes 6 and 7) | $V_D = -50 \text{ V}$ | 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

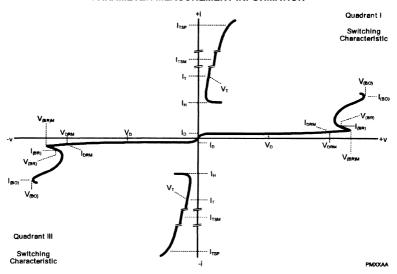


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR ANY PAIR OF TERMINALS



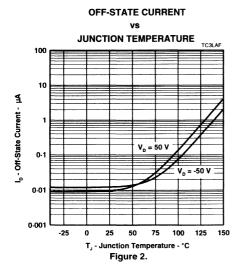
TISP3072F3, TISP3082F3 DUAL SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

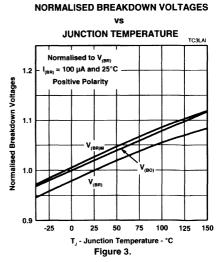
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thermal characteristics

| | PARAMETER | | | TYP | MAX | UNIT |
|---|------------------|---|--|-----|-----|------|
| r | | D Package | | | 160 | |
| | R _{eJA} | Junction to free air thermal resistance P Package | | | 100 | °C/W |
| | | SL Package | | | 105 | |

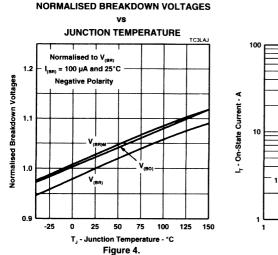
TYPICAL CHARACTERISTICS T and G, or R and G terminals

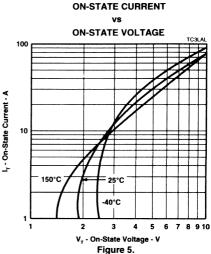




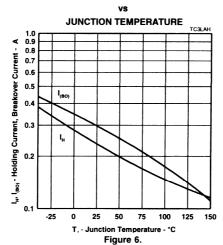


TYPICAL CHARACTERISTICS T and G, or R and G terminals





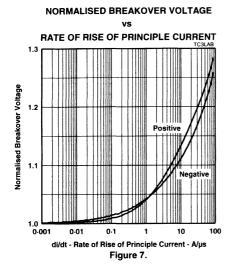
HOLDING CURRENT & BREAKOVER CURRENT

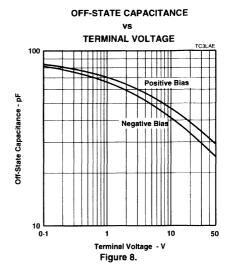




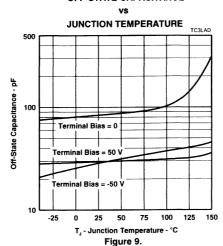
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TYPICAL CHARACTERISTICS T and G, or R and G terminals





OFF-STATE CAPACITANCE





TYPICAL CHARACTERISTICS T and G, or R and G terminals SURGE CURRENT

٧S **DECAY TIME** TC3LAA 1000 Maximum Surge Current - A 100 2 10 1000 Decay Time - µs Figure 10.

TYPICAL CHARACTERISTICS T and R terminals

OFF-STATE CURRENT

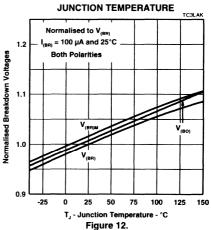
JUNCTION TEMPERATURE V₀ = ±50 V 10 l_o - Off-State Current - μΑ 0.1 0.01

T, - Junction Temperature - °C

Figure 11.

0.001

NORMALISED BREAKDOWN VOLTAGES

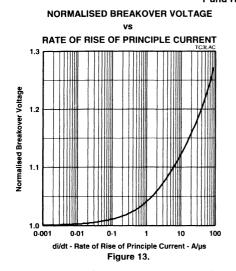




150

TISP3072F3, TISP3082F3 **DUAL SYMMETRICAL TRANSIENT** VOLTAGE SUPPRESSORS SLPSE08 - MARCH 1994 - REVISED SEPTEMBER 1994

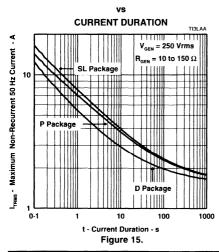
TYPICAL CHARACTERISTICS T and R terminals

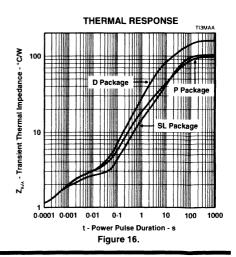


OFF-STATE CAPACITANCE **TERMINAL VOLTAGE ТСЗХАА** 100 90 80 70 60 D Package Off-State Capacitance - fF 50 40 SL Package 30 20 **Both Voltage Polarities** 10 0.1 50 Terminal Voltage - V Figure 14.

THERMAL INFORMATION

MAXIMUM NON-RECURRING 50 Hz CURRENT







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 $(Z_{\bf A})$.

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 | SHORT CIRCUIT |
|--------------|--------------------|------------------|
| | VOLTAGE | 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 us |
| 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.



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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 $V_{(BO)}$ 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 μ s surge has an average dv/dt of 150 V/ μ s, but, as the rise is exponential, the initial dv/dt is higher, being in the region of 450 V/ μ s. 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/ μ s. 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, $T_{\rm J}$, and the bias voltage, comprising of the dc voltage, $V_{\rm D}$, and the ac voltage, $V_{\rm d}$. 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 $V_{\rm D}>>V_{\rm d}$ the capacitance value is independent on the value of $V_{\rm d}$. The capacitance is essentially constant over the range of normal telecommunication frequencies.

NORMALISED CAPACITANCE

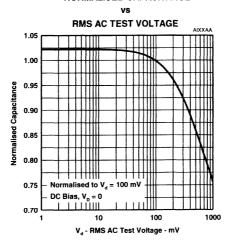


Figure 17.



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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 $C_{TR} + C_{RG}/2$.

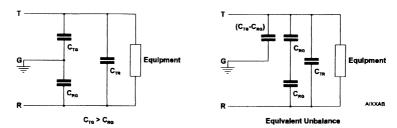


Figure 18.

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.



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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 _(BO) |
|---------|------------------|-------------------|
| DEVICE | v | ν |
| '3125F3 | 100 | 125 |
| '3150F3 | 120 | 150 |
| '3180F3 | 145 | 180 |

Planar Passivated Junctions Low Off-State Current < 10 µA

Rated for International Surge Wave Shapes

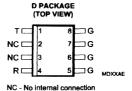
| WAVE SHAPE | STANDARD | I _{TSP} |
|------------|--------------|------------------|
| 2/10 µs | FCC Part 68 | 175 |
| 8/20 µs | ANSI C62.41 | 120 |
| 10/160 µs | FCC Part 68 | 60 |
| 10/560 µs | FCC Part 68 | 45 |
| 0.5/700 µs | RLM 88 | 38 |
| | FTZ R12 | 50 |
| 10/700 µs | VDE 0433 | 50 |
| | CCITT 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 | Р |
| Single-in-line | SL |

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.

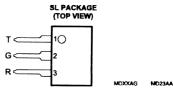




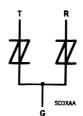


MOXXAE

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



device symbol



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

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

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all the parameters.



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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 |
|--|------------------|---------------------|-------------|-------|
| | '3125F3 | | ± 100 | |
| Repetitive peak off-state voltage (0°C < T _J < 70°C) | '3150F3 | V _{DRM} | ± 120 | V |
| | '3180F3 | | ± 145 | [|
| Non-repetitive peak on-state pulse current (see Notes 1, 2 and 3) | | | | |
| 1/2 µs (Gas tube differential transient, open-circuit voltage way | /e shape 1/2 μs) | | 350 |) |
| 2/10 µs (FCC Part 68, open-circuit voltage wave shape 2/10 µs | s) | | 175 | 1 |
| 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 10/1 | 60 µs) | | 60 | 1 |
| 5/200 µs (VDE 0433, open-circuit voltage wave shape 2 kV, 10/700 µs) | | | 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, 10/7 | 700 µs) | | 50 | |
| 10/560 µs (FCC Part 68, open-circuit voltage wave shape 10/5 | 660 μs) | | 45 | |
| 10/1000 µs (REA PE-60, open-circuit voltage wave shape 10/1 | 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 | | TJ | -40 to +150 | °C |
| Storage temperature range | | T _{stq} | -40 to +150 | °C |

NOTES: 1. Further details on surge wave shapes are contained in the Applications Information section.

- 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 | | TISP3 | 3125F3 | TISPS | 150F3 | TISPS | 3180F3 | UNIT | |
|------|---------------------------------------|--|--------------------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|------|
| | PANAMETER | lesi condition | NS | MIN | MAX | MIN | MAX | MIN | MAX | UNIT |
| IDRM | Repetitive peak off- state current | $V_D = \pm V_{DRM}, 0^{\circ}C < T_J < 70^{\circ}C$ | | | ±10 | | ±10 | | ±10 | μA |
| ID | Off-state current | V _D = ±50 V | | | ±10 | | ±10 | | ±10 | μA |
| Coff | Off-state capacitance | f = 100 kHz, V _d = 100 mV V _D = 0, (see Notes 4 and 5) Third terminal = -50 to +50 V | D Package P Package SL Package | 50† 65† 30† | 150 200 100 | 50† 65† 30† | 150 200 100 | 50† 65† 30† | 150 200 100 | fF |

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.

TISP3125F3, TISP3150F3, TISP3180F3 DUAL SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS SLPSE09 - MARCH 1994 - REVISED SEPTEMBER 1994

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

| | PARAMETER | TEST CONDITIONS | TISPS | 3125F3 | TISPS | 150F3 | TISPS | 180F3 | UNIT |
|-------------------|--|---|-------|--------|-------|-------|-------|-------|-------|
| | PARAMETER | TEST CONDITIONS | MIN | MAX | MIN | MAX | MIN | MAX | ONII |
| I _{DRM} | Repetitive peak off- state current | $V_D = \pm V_{DRM}, 0^{\circ}C < T_J < 70^{\circ}C$ | | ±10 | | ±10 | | ±10 | μА |
| V _(BO) | Breakover voltage | dv/dt = ±250 V/ms, Source Resistance = 300 Ω | | ±125 | | ±150 | | ±180 | ٧ |
| V _(BO) | Impulse breakover volt- age | 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 | Α |
| V _T | On-state voltage | $I_T = \pm 5 \text{ A}, t_W = 100 \mu\text{s}$ | T | ±3 | | ±3 | | ±3 | V |
| I _H | Holding current | di/dt = -/+30 mA/ms | ±0.15 | | ±0.15 | | ±0.15 | | Α |
| 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 | 1 | ±10 | | ±10 | | ±10 | μΑ |
| | | $f = 100 \text{ kHz}, V_d = 100 \text{ mV} V_D = 0,$ | 55† | 95 | 55† | 95 | 55† | 95 | pF |
| C_{off} | Off-state capacitance | 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.

thermal characteristics

| PARAMETER | | TYP | MAX | UNIT |
|--|--|-----|-----|------|
| D Package | | | 160 | |
| R _{BJA} Junction to free air thermal resistance P Package | | | 100 | ∘c/w |
| SL Package | | | 105 | |



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

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

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PARAMETER MEASUREMENT INFORMATION

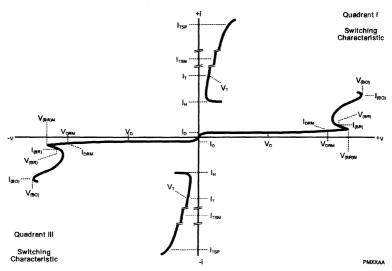
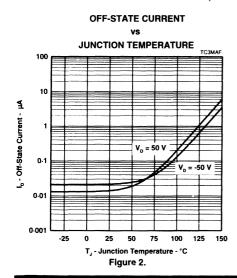


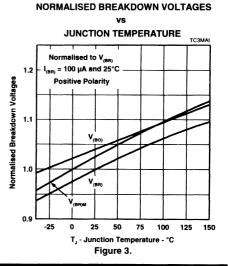
Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR ANY PAIR OF TERMINALS



SLPSE09 - MARCH 1994 - REVISED SEPTEMBER 1994

TYPICAL CHARACTERISTICS T and G, or R and G terminals

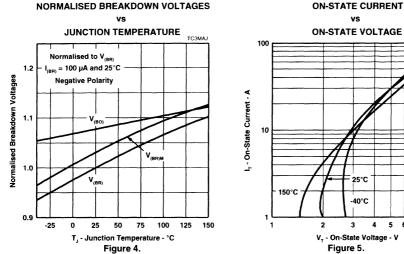


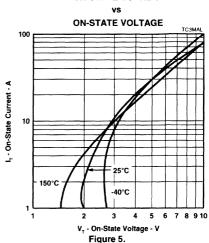




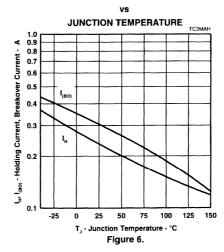
SLPSE09 - MARCH 1994 - REVISED SEPTEMBER 1994

TYPICAL CHARACTERISTICS T and G, or R and G terminals





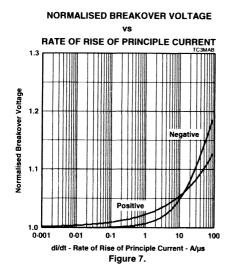
HOLDING CURRENT & BREAKOVER CURRENT

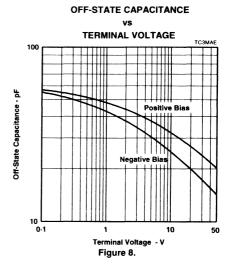




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TYPICAL CHARACTERISTICS T and G, or R and G terminals





OFF-STATE CAPACITANCE

JUNCTION TEMPERATURE

500

Terminal Bias = 0

Terminal Bias = 50 V

10

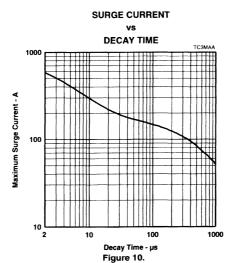
-25 0 25 50 75 100 125 150

T, - Junction Temperature - °C

Figure 9.



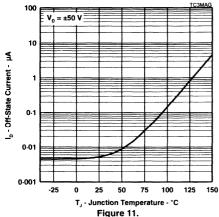
TYPICAL CHARACTERISTICS T and G, or R and G terminals



TYPICAL CHARACTERISTICS T and R terminals

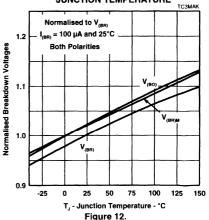
OFF-STATE CURRENT

vs **JUNCTION TEMPERATURE**



NORMALISED BREAKDOWN VOLTAGES

JUNCTION TEMPERATURE

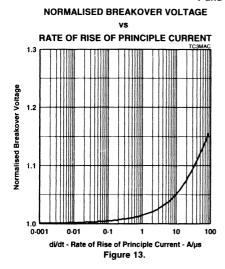




OFF-STATE CAPACITANCE

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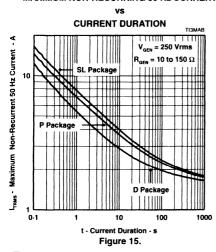
TYPICAL CHARACTERISTICS T and R terminals

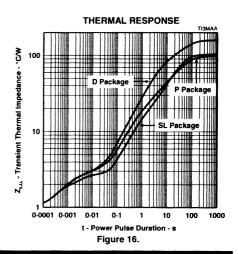


TERMINAL VOLTAGE TC3XAA 100 90 80 P Package 70 60 D Package Off-State Capacitance - fF 50 40 SL Package 30 20 **Both Voltage Polarities** 10 0.1 50 Terminal Voltage - V Figure 14.

THERMAL INFORMATION

MAXIMUM NON-RECURRING 50 Hz CURRENT







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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.



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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 $V_{(BO)}$ 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 μ s surge has an average dv/dt of 150 V/ μ s, but, as the rise is exponential, the initial dv/dt is higher, being in the region of 450 V/ μ s. 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/ μ s. 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

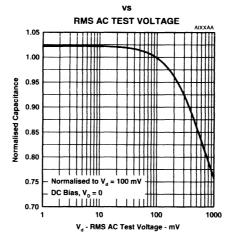


Figure 17.



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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 $C_{TR} + C_{RG}/2$.

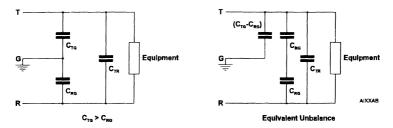


Figure 18.

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.



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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 _(BO) |
|---------|------------------|-------------------|
| DEVICE | V | ٧ |
| '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

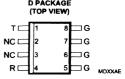
| WAVE SHAPE | STANDARD | I _{TSP} |
|------------|--------------|------------------|
| 2/10 µs | FCC Part 68 | 175 |
| 8/20 µs | ANSI C62.41 | 120 |
| 10/160 µs | FCC Part 68 | 60 |
| 10/560 µs | FCC Part 68 | 45 |
| 0.5/700 µs | RLM 88 | 38 |
| | FTZ R12 | 50 |
| 10/700 μs | VDE 0433 | 50 |
| | CCITT 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 | Р |
| Single-in-line | SL |

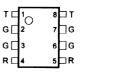
description

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



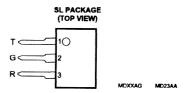
NC - No internal connection

P PACKAGE (TOP VIEW)

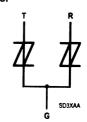


MOXXAE

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



device symbol



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

holding current prevents dc latchup as the current subsides.

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

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all the parameters.



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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 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 |
|---|--------------------|---------------------|----------------|-------|
| | '3240F3 '3260F3 | | ± 180 ± 200 | |
| Repetitive peak off-state voltage ($0^{\circ}C < T_J < 70^{\circ}C$) | '3290F3 | V _{DRM} | ± 220 | V |
| | '3320F3 | | ± 240 | ļ |
| | '3380F3 | | ± 270 | ł |
| Non-repetitive peak on-state pulse current (see Notes 1, 2 and 3) | | | | |
| 1/2 µs (Gas tube differential transient, open-circuit voltage way | /e shape 1/2 μs) | | 350 | |
| 2/10 µs (FCC Part 68, open-circuit voltage wave shape 2/10 µs | s) | | 175 | ļ |
| 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 10/1 | 60 µs) | | 60 | |
| 5/200 µs (VDE 0433, open-circuit voltage wave shape 2 kV, 10 |)/700 µs) | ITSP | 50 |) A |
| 0.5/310 µs (RLM 88, open-circuit voltage wave shape 1.5 kV, 0 |).5/700 µs) | | 38 | i |
| 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, 10/7 | 700 µs) | | 50 | [|
| 10/560 μs (FCC Part 68, open-circuit voltage wave shape 10/5 | i60 μs) | | 45 | |
| 10/1000 μs (REA PE-60, open-circuit voltage wave shape 10/1 | 000 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 ra | amp value < 38 A | di _F /dt | 250 | A/µs |
| Junction temperature | | TJ | -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.

- 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_{.i} = 25°C

| | PARAMETER | TEST CONDITION | NC | TISP3240F3 | | TISP3260F3 | | TISP3290F3 | | LIMIT |
|------------------|---------------------------------------|--|------------|------------|------------|------------|------------|------------|------------|-------|
| | PARAMETER | TEST CONDITION | NS | MIN | MAX | MIN | MAX | MIN | MAX | UNIT |
| I _{DRM} | Repetitive peak off- state current | $V_D = \pm V_{DRM}$, 0°C < T _J < 70°C | | | ±10 | | ±10 | | ±10 | μА |
| ID | Off-state current | V _D = ±50 V | | | ±10 | | ±10 | | ±10 | μA |
| Coff | Off-state capacitance | $f = 100 \text{ kHz}, V_d = 100 \text{ mV}$ $V_D = 0$, (see Notes 4 and 5) | D Package | 50† 65† | 150 200 | 50† 65† | 150 200 | 50† 65† | 150 200 | fF |
| off | on orace sapacitance | 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.

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



^{5.} Further details on capacitance are given in the Applications Information section.

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electrical characteristics for the T and G or the R and G terminals, $T_J = 25^{\circ}C$

| | PARAMETER | TEST CONDITIONS | TISPS | 3240F3 | TISPS | 260F3 | TISP3290F3 | | UNIT |
|-------------------|--|---|-------|--------|-------|-------|------------|-------|-------|
| | | TEST CONDITIONS | MIN | MAX | MIN | MAX | MIN | MAX | UNIT |
| I _{DRM} | Repetitive peak off- state current | $V_D = \pm V_{DRM}, 0^{\circ}C < T_J < 70^{\circ}C$ | | ±10 | | ±10 | | ±10 | μA |
| V _(BO) | Breakover voltage | dv/dt = ±250 V/ms, Source Resistance = 300 Ω | | ±240 | | ±260 | | ±290 | ٧ |
| V _(BO) | Impulse breakover volt- age | $dv/dt = \pm 1000 \text{ V/μs}, di/dt < 20 \text{ A/μs}$ Source Resistance = 50 Ω | | ±267† | | ±287† | | ±317† | V |
| I _(BO) | Breakover current | $dv/dt = \pm 250 \text{ V/ms},$ Source Resistance = 300 Ω | ±0.15 | ±0.6 | ±0.15 | ±0.6 | ±0.15 | ±0.6 | Α |
| V _T | On-state voltage | $I_T = \pm 5 \text{ A}, t_W = 100 \mu\text{s}$ | 1 | ±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 |
| ID | Off-state current | $V_D = \pm 50 \text{ V}$ | | ±10 | | ±10 | | ±10 | μА |
| | | $f = 100 \text{ kHz}, V_d = 100 \text{ mV} V_D = 0,$ | 57† | 95 | 57† | 95 | 57† | 95 | pF |
| Coff | Off-state capacitance | Third terminal = -50 to +50 V $V_D = -5 V$ | 26† | 45 | 26† | 45 | 26† | 45 | pF |
| | | (see Notes 6 and 7) $V_D = -50 \text{ V}$ | 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.

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

| | PARAMETER | TEST CONDITIONS | | TISP3320F | | F3 TISP3380F3 | | UNIT |
|------------------|---------------------------------------|---|------------|-----------|-----|---------------|-----|------|
| | PANAMETER | TEST CONDITIONS | | MIN | MAX | MIN | MAX | UNIT |
| I _{DRM} | Repetitive peak off- state current | $V_D = \pm V_{DRM}, 0^{\circ}C < T_J < 70^{\circ}C$ | | | ±10 | | ±10 | μА |
| ID | Off-state current | V _D = ±50 V | | | ±10 | | ±10 | μA |
| | | f = 100 kHz, V _d = 100 mV | D Package | 50† | 150 | 50† | 150 | |
| Coff | Off-state capacitance | V _D = 0, (see Notes 4 and 5) | P Package | 65† | 200 | 65† | 200 | fF |
| | | 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.

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

| | PARAMETER | TEST CONDITIONS | TISP | 3320F3 | TISP3380F3 | | UNIT |
|-------------------|---------------------------------------|---|------|--------|------------|-------|--------|
| | PANAMEIEN | TEST CONDITIONS | MIN | MAX | MIN | MAX | Olviii |
| 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 | $dv/dt = \pm 250$ V/ms, Source Resistance = 300 Ω | | ±320 | | ±380 | ٧ |
| V _(BO) | Impulse breakover volt- age | dv/dt = ±1000 V/μs, di/dt < 20 A/μs Source Resistance = 50 Ω | | ±347† | | ±407† | ٧ |



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

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

^{5.} Further details on capacitance are given in the Applications Information section.

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

| | PARAMETER | TEST CONDITIONS | | TISP3320F3 | | TISP3 | 380F3 | UNIT |
|-------------------|--|---|------------------------|------------|------|-------|-------|-------|
| PAHAMETER | | TEST CONDITIONS | | MIN | MAX | MIN | MAX | ONT |
| I _(BO) | Breakover current | dv/dt = ±250 V/ms, Source Resistance = 300 Ω | | ±0.15 | ±0.6 | ±0.15 | ±0.6 | Α |
| V _T | On-state voltage | I _T = ±5 A, t _W = 100 μs | | | ±3 | | ±3 | V |
| Н | Holding current | di/dt = -/+30 mA/ms | | ±0.15 | | ±0.15 | | Α |
| dv/dt | Critical rate of rise of off-state voltage | Linear voltage ramp, Maximum ramp value < 0.85V _{(BR)MIN} | | ±5 | | ±5 | | kV/μs |
| ID | Off-state current | V _D = ±50 V | | | ±10 | | ±10 | μA |
| | | f = 100 kHz, V _d = 100 mV | V _D = 0, | 57† | 95 | 57† | 95 | pF |
| Coff | Off-state capacitance | 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.

PARAMETER MEASUREMENT INFORMATION

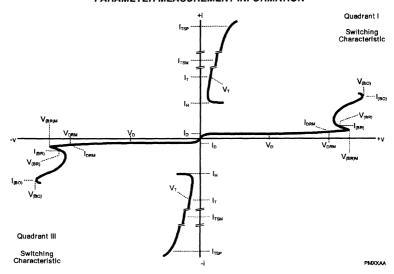


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR ANY PAIR OF TERMINALS



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

TISP3240F3, TISP3260F3, TISP3290F3, TISP3320F3, TISP3380F3 DUAL SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS SLPSE10 - MARCH 1994 - REVISED SEPTEMBER 1994

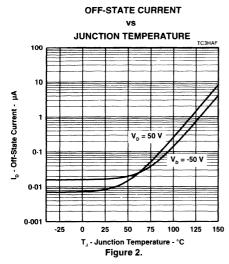
thermal characteristics

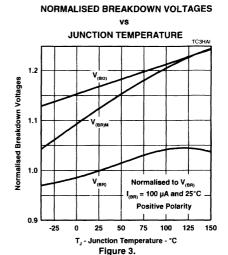
| | PARAMETER | | MIN | TYP | MAX | UNIT |
|------------------|---|------------|-----|-----|-----|------|
| | | D Package | | | 160 | |
| R _{eJA} | Junction to free air thermal resistance | P Package | | | 100 | °C/W |
| | | SL Package | | | 105 | |



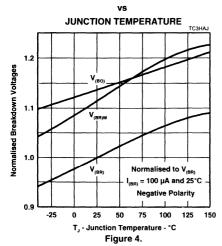
SLPSE 10 - MARCH 1994 - REVISED SEPTEMBER 199-

TYPICAL CHARACTERISTICS T and G, or R and G terminals

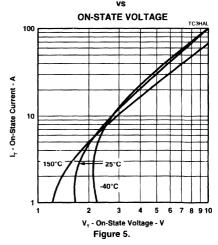




NORMALISED BREAKDOWN VOLTAGES



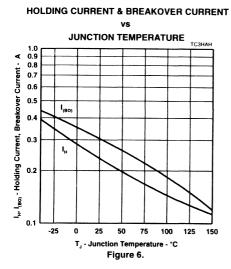
ON-STATE CURRENT

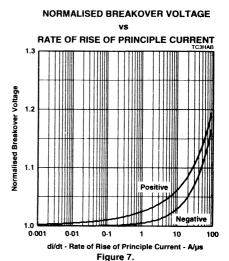




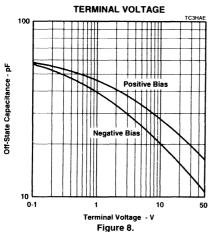
SLPSE10 - MARCH 1994 - REVISED SEPTEMBER 1994

TYPICAL CHARACTERISTICS T and G, or R and G terminals

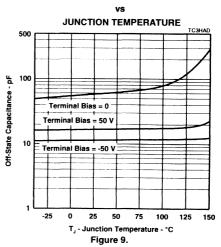




OFF-STATE CAPACITANCE vs



OFF-STATE CAPACITANCE





TISP3240F3, TISP3260F3, TISP3290F3, TISP3320F3, TISP3380F3 **DUAL SYMMETRICAL TRANSIENT** VOLTAGE SUPPRESSORS SLPSE10 - MARCH 1994 - REVISED SEPTEMBER 1994

TYPICAL CHARACTERISTICS T and G, or R and G terminals

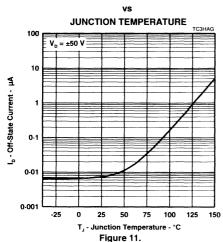


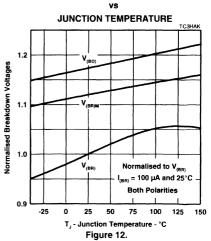
vs **DECAY TIME** 1000 Maximum Surge Current - A 100 10 10 1000 Decay Time - µs Figure 10.

TYPICAL CHARACTERISTICS T and R terminals

OFF-STATE CURRENT

NORMALISED BREAKDOWN VOLTAGES

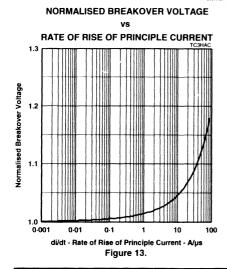


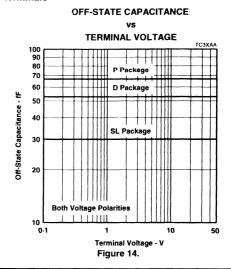




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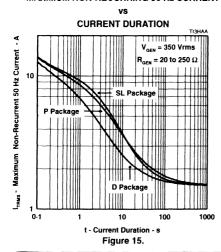
TYPICAL CHARACTERISTICS T and R terminals

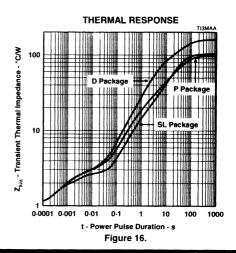




THERMAL INFORMATION

MAXIMUM NON-RECURRING 50 Hz CURRENT







SLPSE10 - MARCH 1994 - REVISED SEPTEMBER 1994

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_0).

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.



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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 μ s surge has an average dv/dt of 150 V/ μ s, but, as the rise is exponential, the initial dv/dt is higher, being in the region of 450 V/ μ s. 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/ μ s. 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

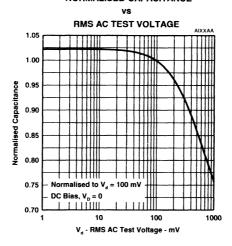


Figure 17.



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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 $C_{TR} + C_{RG}/2$.

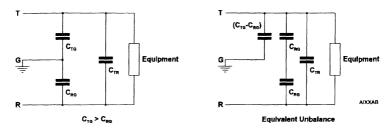


Figure 18.

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) |
|---------|-----------------------|-------------------|
| '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} |
|------------|--------------|------------------|
| 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 |
| | FTZ R12 | 50 |
| 10/700 µs | VDE 0433 | 50 |
| | CCITT IX K17 | 38 |
| 10/1000 μs | REA PE-60 | 35 |

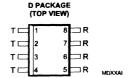
Surface Mount and Through-Hole Options

| PACKAGE | PART # SUFFIX |
|---------------------|---------------|
| Small-outline | D |
| Small-outline taped | DB |
| and reeled | Un |
| Single-in-line | SL |

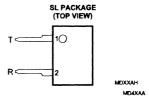
description

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.



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



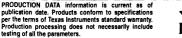
device symbol



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

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.



TISP4072F3, TISP4082F3 SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS SLPSE12 - MARCH 1994 - REVISED SEPTEMBER 1994

absolute maximum ratings

| RATING | | SYMBOL | VALUE | UNIT |
|---|---------------------|------------------|-------------|--------|
| D = 112 1 - # -tot 100C - T - 700C) | '4072F3 | V | ± 58 | v |
| Repetitive peak off-state voltage (0°C < T _J < 70°C) | '4082F3 | V _{DRM} | ± 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 | e 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 |
| 0.2/310 µs (RLM 88, open-circuit voltage wave shape 1.5 kV, 0.5/700 µ | μs) | | 38 | İ |
| 5/310 µs (CCITT IX K17, open-circuit voltage wave shape 1.5 kV, 10/7 | '00 μs) | | 38 | |
| 5/310 µs (FTZ R12, open-circuit voltage wave shape 2 kV, 10/700 µs) | | | 50 | ı |
| 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 | 1 |
| Non-repetitive peak on-state current (see Notes 2 and 3) | D Package | 1 | 4 | A rms |
| 50 Hz, 1 s | SL Package | ^I TSM | 6 | Aillis |
| Initial rate of rise of on-state current, Linear current ramp, Maximum ramp value | di _T /dt | 250 | A/µs | |
| Junction temperature | | | -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 $0^{\circ}C < T_{J} < 70^{\circ}C$. 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

| | | | | TISP4072F3 | | | TISP4082F3 | | | |
|-------------------|--|---|-----------------------|------------|-----|------|------------|-----|------|-------|
| PARAMETER | | TEST CONDITIONS | | MIN | TYP | MAX | MIN | TYP | MAX | UNIT |
| IDRM | Repetitive peak off- state current | $V_D = \pm V_{DRM}, 0^{\circ}C < T_J < 70^{\circ}C$ | | | | ±10 | | | ±10 | μA |
| V _(BO) | Breakover voltage | $dv/dt = \pm 250 \text{ V/ms}, R_{SOURCE} = 300 \Omega$ | | | | ±72 | | | ±82 | V |
| V _(BO) | Impulse breakover volt- age | $dv/dt = \pm 1000 \text{ V/μs}, R_{SOURCE} = 50 \Omega.$ di/dt < 20 A/μs | | | ±86 | | | ±96 | | ٧ |
| I _(BO) | Breakover current | dv/dt = ±250 V/ms, R _{SOURCE} = 300 Ω | | ±0.15 | | ±0.6 | ±0.15 | | ±0.6 | Α |
| V _T | On-state voltage | I _T = ±5 A, t _W = 100 μs | | | | ±3 | | | ±3 | V |
| l _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 |
| ID | Off-state current | V _D = ±50 V | | | | ±10 | | | ±10 | μA |
| C _{off} | Off-state capacitance | $f = 100 \text{ kHz}, V_d = 100 \text{ mV}$ (see Note 4) | $V_D = 0$, | | 82 | 140 | | 82 | 140 | pF |
| | | | $V_D = -5 V$ | | 49 | 85 | | 49 | 85 | pF |
| | | | $V_D = -50 \text{ V}$ | | 25 | 40 | | 25 | 40 | pF |

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

thermal characteristics

| | PARAMETER | TEST CONDITION | MIN | TYP | MAX | UNIT | |
|------------------|---|---|------------|-----|-----|------|------|
| R _{eJA} | Junction to free air thermal resistance | P _{tot} = 0.8 W, T _A = 25°C | D Package | | | 160 | °C/W |
| | | 5 cm ² , FR4 PCB | SL Package | 105 | | 105 | C/VV |



PARAMETER MEASUREMENT INFORMATION

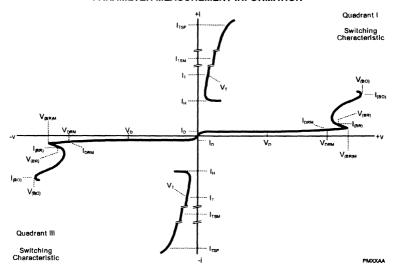
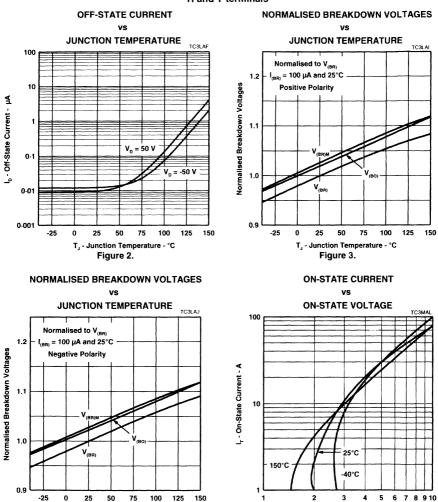


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR T AND R TERMINALS ALL MEASUREMENTS ARE REFERENCED TO THE R TERMINAL



TYPICAL CHARACTERISTICS R and T terminals





V, - On-State Voltage - V

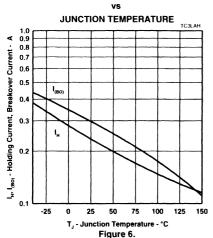
Figure 5.

T, - Junction Temperature - °C

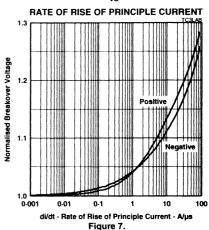
Figure 4.

TYPICAL CHARACTERISTICS R and T terminals

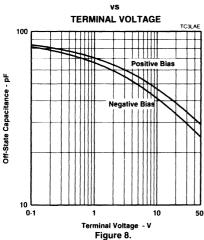
HOLDING CURRENT & BREAKOVER CURRENT



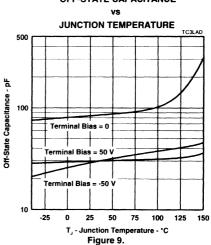
NORMALISED BREAKOVER VOLTAGE vs



OFF-STATE CAPACITANCE

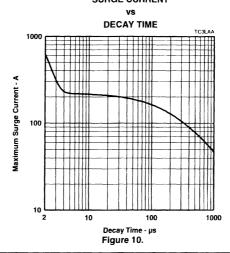


OFF-STATE CAPACITANCE



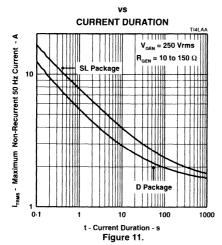


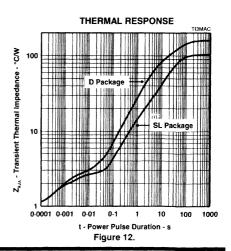
TYPICAL CHARACTERISTICS R and T terminals SURGE CURRENT



THERMAL INFORMATION

MAXIMUM NON-RECURRING 50 Hz CURRENT







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_0).

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. $10/1000~\mu s$ 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. $1.2/50~\mu s$ open circuit voltage and $8/20~\mu s$ 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 $10/700~\mu s$ open circuit voltage generator typically produces a $5/310~\mu s$ 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 us | 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.



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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 $V_{(BO)}$ 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

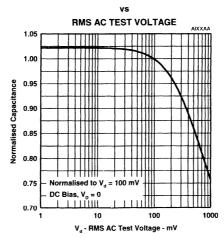


Figure 13.



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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 _(BO) |
|---------|------------------|-------------------|
| DEVICE | v | ٧ |
| '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} |
|------------|--------------|------------------|
| 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 |
| | FTZ R12 | 50 |
| 10/700 μs | VDE 0433 | 50 |
| | CCITT IX K17 | 38 |
| 10/1000 µs | REA PE-60 | 35 |

Surface Mount and Through-Hole Options

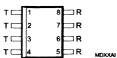
| PACKAGE | PART # SUFFIX |
|---------------------|---------------|
| Small-outline | D |
| Small-outline taped | DB |
| and reeled | Un |
| Single-in-line | SL |

description

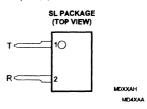
These medium voltage symmetrical transient voltage suppressor devices are designed to protect two wire telecommunication applications against transients caused by lightning strikes and ac power lines. Offered in three voltage variants to meet battery and protection requirements they are guaranteed to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





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



device symbol



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

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.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all the parameters.



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TISP4125F3, TISP4150F3, TISP4180F3 SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS SLPSE13 - MARCH 1994 - REVISED SEPTEMBER 1994

absolute maximum ratings

| RATING | | SYMBOL | VALUE | UNIT |
|--|-----------------------|---------------------|-------------|-------|
| | '4125F3 | | ± 100 | |
| Repetitive peak off-state voltage (0°C < T _J < 70°C) | '4150F3 | V _{DRM} | ± 120 | V |
| | '4180F3 | | ± 145 | |
| Non-repetitive peak on-state pulse current (see Notes 1, 2 and 3) | | | | |
| 1/2 µs (Gas tube differential transient, open-circuit voltage wave shap | e 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 | A |
| 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 | 1 | 4 | A rms |
| 50 Hz, 1 s | 50 Hz, 1 s SL Package | | 6 | Aims |
| Initial rate of rise of on-state current, Linear current ramp, Maximum ramp value < 38 A | | di _T /dt | 250 | A/µs |
| Junction temperature | | TJ | -40 to +150 | °C |
| Storage temperature range | | T _{stq} | -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
 - 3. Above 70°C, derate linearly to zero at 150°C lead temperature.

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

| | | | | T | SP4125 | F3 | TISP4150F3 | | | | |
|-------------------|--|---|---|-----------------------|--------|------|------------|-------|------|------|-------|
| | PARAMETER | Ti | EST CONDIT | TIONS | MIN | ТҮР | MAX | 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 | dt = ±250 V/ms, R _{SOURCE} = 300 Ω | | | | ±125 | | | ±150 | ٧ |
| V _(BO) | Impulse breakover volt- age | dv/dt = ±1000 ' di/dt < 20 A/μs | | RCE = 50 Ω, | | ±143 | | | ±168 | | ٧ |
| I _(BO) | Breakover current | dv/dt = ±250 V | ms, R _{SOUP} | ace = 300 Ω | ±0.15 | | ±0.6 | ±0.15 | | ±0.6 | Α |
| V _T | On-state voltage | $I_T = \pm 5 \text{ A}, t_W$ | = 100 µs | | | | ±3 | | | ±3 | ٧ |
| I _H | Holding current | di/dt = +/-30 m | A/ms | | ±0.15 | | | ±0.15 | | | |
| dv/dt | Critical rate of rise of off-state voltage | Linear voltage Maximum ram | | 5V _{(BR)MIN} | ±5 | | | ±5 | | | kV/µs |
| ID | Off-state current | $V_D = \pm 50 \text{ V}$ | | | | | ±10 | | | ±10 | μА |
| | | f = 100 kHz | / - 100 m\/ | $V_D = 0$, | | 55 | 95 | | 55 | 95 | pF |
| Coff | Off-state capacitance | Off-state capacitance $f = 100 \text{ kHz}, V_d = 100 \text{ mV}$ | $V_D = -5 \text{ V}$ | | 30 | 50 | | 30 | 50 | pF | |
| | | (see Note 4) | | $V_D = -50 \text{ V}$ | | 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

| DARAMETER | TEST CONDITIONS | TI | SP4180 | F3 | UNIT |
|----------------------|--|--|--|---|---|
| TATIONICICI | TEST CONDITIONS | MIN | TYP | MAX | O.W. |
| Repetitive peak off- | V V 0°C - T - 70°C | | | .10 | |
| state current | VD = ±VDRM, O C × 1J < 70 C | | | ±10 | μΑ |
| Breakover voltage | dv/dt = ±250 V/ms, R _{SOURCE} = 300 Ω | | | ±180 | V |
| | state current | Repetitive peak off- state current $V_D = \pm V_{DRM}$, $0^{\circ}C < T_J < 70^{\circ}C$ | PARAMETER TEST CONDITIONS MIN Repetitive peak off-state current V _D = ±V _{DRM} , 0°C < T _J < 70°C | PARAMETER TEST CONDITIONS MIN TYP Repetitive peak off- state current $V_D = \pm V_{DRM}$, 0°C < T _J < 70°C | Repetitive peak off-state current $V_D = \pm V_{DRM}$, $0^{\circ}C < T_J < 70^{\circ}C$ ± 10 |



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

| | PARAMETER TEST CONDITIONS | | TI | SP4180 | F3 | UNIT | |
|-------------------|--|--|------------------------|--------|------|------|-------|
| ĺ | PANAMETEN | TEST CONDITIONS | | MIN | TYP | MAX | UNIT |
| V _(BO) | Impulse breakover volt- age | $dv/dt = \pm 1000 V/μs$, $R_{SOURCE} = 50 Ω$, $di/dt < 20 A/μs$ | | | ±198 | | ٧ |
| I _(BC) | Breakover current | $dv/dt = \pm 250 \text{ V/ms}, R_{SOURCE} = 300 \Omega$ | | ±0.15 | | ±0.6 | Α |
| VT | On-state voltage | l _T = ±5 A, t _W = 100 μs | | | | ±3 | V |
| 1 _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} | VA | ±5 | | | kV/μs |
| ID | Off-state current | V _D = ±50 V | | | | ±10 | μA |
| | A STATE OF THE PARTY OF THE PAR | 6 100 kHz V 100 mV | $V_D = 0$, | | 55 | 95 | pF |
| Coff | Off-state capacitance | f = 100 kHz, V _d = 100 mV (see Note 5) | $V_D = -5 V$ | | 30 | 50 | pF |
| | | (See Note 3) | 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 | |
|--|---|------------|-----|-----|------|------|
| Rela Junction to free air thermal resistance | P _{tot} = 0.8 W, T _A = 25°C | D Package | | | 160 | ∘c/w |
| H _{eJA} Junction to free air thermal resistance | 5 cm ² , FR4 PCB | SL Package | | | 105 | O, |

PARAMETER MEASUREMENT INFORMATION

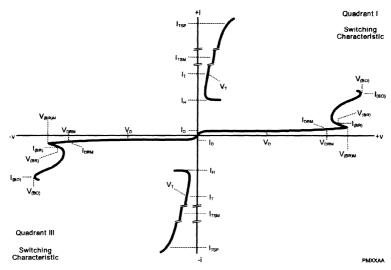


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR T AND R TERMINALS ALL MEASUREMENTS ARE REFERENCED TO THE R TERMINAL



TYPICAL CHARACTERISTICS R and T terminals

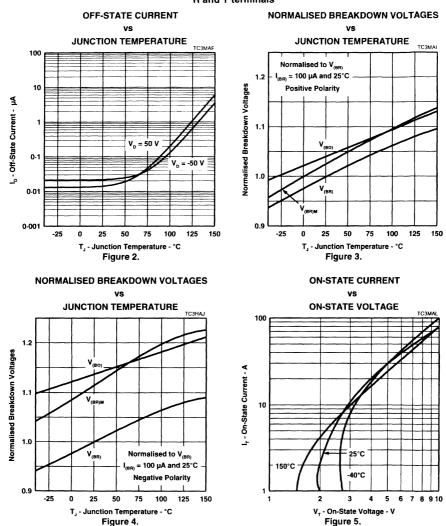
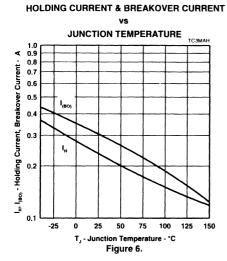




Figure 4.

TYPICAL CHARACTERISTICS R and T terminals



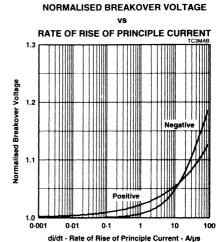
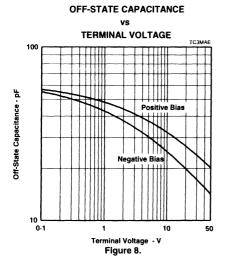
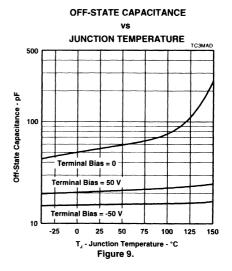


Figure 7.

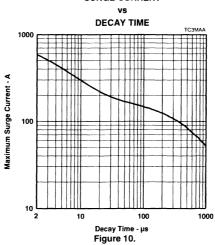






TYPICAL CHARACTERISTICS R and T terminals

SURGE CURRENT

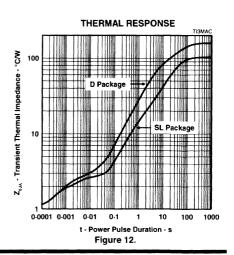


THERMAL INFORMATION

MAXIMUM NON-RECURRING 50 Hz CURRENT

CURRENT DURATION TIMMA V_{GEN} = 250 Vrms R_{GEN} = 10 to 150 Ω SL Package D Package D Package

t - Current Duration - s Figure 11.





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 ($Z_{\rm A}$).

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. $10/1000 \, \mu s$ 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. $1.2/50 \, \mu s$ open circuit voltage and $8/20 \, \mu s$ 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 $10/700 \, \mu s$ open circuit voltage generator typically produces a $5/310 \, \mu s$ 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 us | 50 A. 5/310 us |

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 $V_{(BO)}$ 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, $10/700~\mu s$ 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

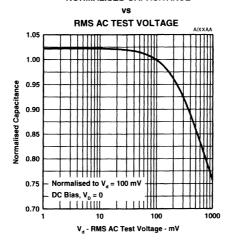


Figure 13.



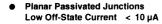
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TELECOMMUNICATION SYSTEM SECONDARY PROTECTION

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

| DEVICE | V _{DRM} | V _(BO) |
|---------|------------------|-------------------|
| BEVICE | v | ٧ |
| '4240F3 | 180 | 240 |
| '4260F3 | 200 | 260 |
| '4290F3 | 220 | 290 |
| '4320F3 | 240 | 320 |
| '4380F3 | 270 | 380 |



Rated for International Surge Wave Shapes

| WAVE SHAPE | STANDARD | I _{TSP} |
|------------|--------------|------------------|
| 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 |
| | FTZ R12 | 50 |
| 10/700 µs | VDE 0433 | 50 |
| | CCITT IX K17 | 38 |
| 10/1000 µs | REA PE-60 | 35 |

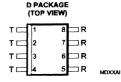
Surface Mount and Through-Hole Options

| PACKAGE | PART # SUFFIX |
|---------------------|---------------|
| Small-outline | D |
| Small-outline taped | 00 |
| and reeled | DR |
| Single-in-line | SL |

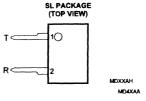
description

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



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



device symbol



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

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.



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absolute maximum ratings

| RATING | | SYMBOL | VALUE | UNIT |
|--|--------------|---------------------|-------------|-------|
| | '4240F3 | | ± 180 | |
| | '4260F3 | | ± 200 | |
| Repetitive peak off-state voltage (0°C < T _J < 70°C) | '4290F3 | V _{DRM} | ± 220 | V |
| | '4320F3 | | ± 240 | ĺ |
| | '4380F3 | | ± 270 | 1 |
| Non-repetitive peak on-state pulse current (see Notes 1, 2 and 3) | | | | |
| 1/2 µs (Gas tube differential transient, open-circuit voltage wave s | hape 1/2 μs) | | 350 | |
| 2/10 µs (FCC Part 68, open-circuit voltage wave shape 2/10 µs) | | | 175 | 1 |
| 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, 10/70 | 0 µs) | ITSP | 50 | А |
| 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 | ł |
| 5/310 µs (FTZ R12, open-circuit voltage wave shape 2 kV, 10/700 | μs) | | 50 | ł |
| 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 10/100 |) µs) | | 35 | |
| Non-repetitive peak on-state current (see Notes 2 and 3) | D Package | ITSM | 4 | A rms |
| 50 Hz, 1 s SL Package | | | 6 | 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 | | TJ | -40 to +150 | °C |
| Storage temperature range | , | T _{stq} | -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

| | | | | | | T | SP4240 | F3 | TI | SP4260 | F3 | |
|-------------------|--|--------------------------------------|--|-----------------------|------------------------|-------|--------|------|-------|--------|------|-------|
| | PARAMETER | TEST CONDITIONS | | MIN | ТУР | мах | MIN | TYP | MAX | UNIT | | |
| I _{DRM} | Repetitive peak off- state current | V _D = ±V _{DRM} , | 0°C < T _J < 7 | 70°C | | | | ±10 | | | ±10 | μA |
| V _(BO) | Breakover voltage | dv/dt = ±250 \ | $dv/dt = \pm 250 \text{ V/ms}, R_{SOURCE} = 300 \Omega$ | | | | | ±240 | | | ±260 | ٧ |
| V _(BO) | Impulse breakover volt- age | dv/dt = ±1000 di/dt < 20 A/μs | $dv/dt = \pm 1000 V/\mu s$, $R_{SOURCE} = 50 Ω$. $di/dt < 20 A/\mu s$ | | | | ±267 | | | ±287 | | ٧ |
| I _(BO) | Breakover current | dv/dt = ±250 \ | //ms, R _{SOL} | URCE = 3 | Ω 00 | ±0.15 | | ±0.6 | ±0.15 | | ±0.6 | Α |
| V _T | On-state voltage | $I_T = \pm 5 A$, t_W | / = 100 μs | | | | | ±3 | | | ±3 | ٧ |
| I _H | Holding current | di/dt = +/-30 m | nA/ms | | | ±0.15 | | | ±0.15 | | | |
| dv/dt | Critical rate of rise of off-state voltage | Linear voltage Maximum ram | | .85V _{(BR)N} | 1IN | ±5 | | | ±5 | | | kV/μs |
| I _D | Off-state current | V _D = ±50 V | | | | | | ±10 | | | ±10 | μΑ |
| | | f = 100 kHz, | V = 100 m) | , 1 | $I_D = 0$, | | 57 | 95 | | 57 | 95 | pF |
| C_{off} | Off-state capacitance | (see Note 4) | v _d = 100 m | " | _D = -5 V | | 26 | 45 | | 26 | 45 | pF |
| | | (See Note 4) | | 1 | / _D = -50 V | | 11 | 20 | | 11 | 20 | pF |

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



TISP4240F3, TISP4260F3, TISP4290F3, TISP4320F3, TISP4380F3 SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS SLPSE14 - MARCH 1994 - REVISED SEPTEMBER 1994

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

| | | | | TISP4290F3 | | | TI | SP4320 | F3 | |
|-------------------|--|---|------------------------|------------|------|------|-------|--------|------|-------|
| | PARAMETER | TEST CONDITION | S | MIN | TYP | MAX | MIN | TYP | MAX | UNIT |
| I _{DRM} | Repetitive peak off- state current | $V_D = \pm V_{DRM}, 0^{\circ}C < T_J < 70^{\circ}C$ | | | | ±10 | | | ±10 | μΑ |
| V _(BO) | Breakover voltage | dv/dt = ±250 V/ms, R _{SOURCE} : | = 300 Ω | | | ±290 | | | ±320 | V |
| V _(BO) | Impulse breakover volt- age | $dv/dt = \pm 1000 \text{ V/}\mu\text{s}$, R_{SOURCE} $di/dt < 20 \text{ A/}\mu\text{s}$ | = 50 Ω, | | ±317 | | | ±347 | | ٧ |
| I _(BO) | Breakover current | dv/dt = ±250 V/ms, R _{SOURCE} = | = 300 Ω | ±0.15 | | ±0.6 | ±0.15 | | ±0.6 | Α |
| V _T | On-state voltage | I _T = ±5 A, t _W = 100 μs | | 1 | | ±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 _{(B} | R)MIN | ±5 | | | ±5 | | | kV/μs |
| 1 _D | Off-state current | V _D = ±50 V | | | | ±10 | | | ±10 | μA |
| | | f = 100 kHz, V _d = 100 mV | $V_D = 0$, | | 57 | 95 | | 57 | 95 | pF |
| Coff | Off-state capacitance $(see Note 5)$ | ١ ٠ | V _D = -5 V | | 26 | 45 | | 26 | 45 | pF |
| | | (see Note 5) | 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 | | | SP4380 | F3 | 11017 |
|-------------------|---|---|-----------------------------|-------|--------|------|-------|
| | PAHAMETER | TEST CONDITIONS | | MIN | TYP | MAX | UNIT |
| I _{DRM} | Repetitive peak off- state current | $V_D = \pm V_{DRM}$, 0°C < T _J < 70°C | | | | ±10 | μΑ |
| V _(BO) | Breakover voltage | $dv/dt = \pm 250 \text{ V/ms}, R_{SOURCE} = 300 \Omega$ | | 1 | | ±380 | V |
| V _(BO) | Impulse breakover volt- age | $dv/dt = \pm 1000 \text{ V/μs}, R_{SOURCE} = 50 \Omega,$ di/dt < 20 A/μs | | | ±407 | | ٧ |
| I _(BO) | Breakover current | $dv/dt = \pm 250 \text{ V/ms}, R_{SOURCE} = 300 \Omega$ | | ±0.15 | | ±0.6 | Α |
| ν _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 |
| ID | Off-state current | $V_{D} = \pm 50 \text{ V}$ | | | | ±10 | μА |
| | | f = 100 kHz, V _d = 100 mV | V _D = 0, | | 57 | 95 | pF |
| Coff | Off-state capacitance | (see Note 6) | $V_D = -5 \text{ V}$ | | 26 | 45 | pF |
| | | (300 11016 0) | $V_{\rm D} = -50 \text{ V}$ | | 11 | 20 | pF |

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

thermal characteristics

| ſ | PARAMETER | TEST CONDITIONS | | MIN | TYP | MAX | UNIT |
|----|--|---|------------|-----|-----|-----|-------|
| 1 | R _{BJA} Junction to free air thermal resistance | P _{tot} = 0.8 W, T _A = 25°C | D Package | | | 160 | °C/W |
| ľ. | AND STATE OF THE S | 5 cm ² , FR4 PCB | SL Package | | | 105 | C/ VV |



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PARAMETER MEASUREMENT INFORMATION

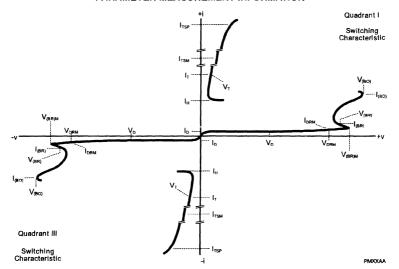
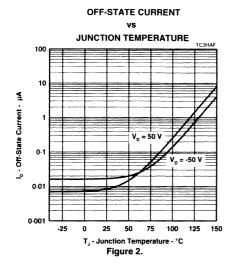


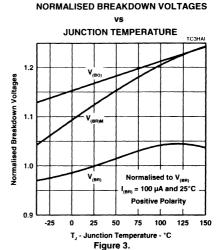
Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR T AND R TERMINALS ALL MEASUREMENTS ARE REFERENCED TO THE R TERMINAL



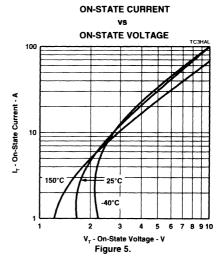
TISP4240F3, TISP4260F3, TISP4290F3, TISP4320F3, TISP4380F3 SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS SLPSE14 - MARCH 1994 - REVISED SEPTEMBER 1994

TYPICAL CHARACTERISTICS R and T terminals





NORMALISED BREAKDOWN VOLTAGES JUNCTION TEMPERATURE Normalised Breakdown Voltages 1.0 Normalised to V(BR) = 100 µA and 25°C Negative Polarity 0.9 -25 100 125 150 T_J - Junction Temperature - °C Figure 4.

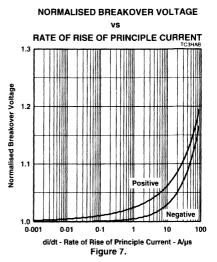


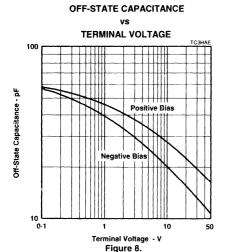


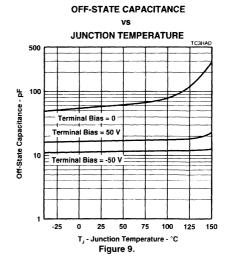
SLPSE14 - MARCH 1994 - REVISED SEPTEMBER 1994

TYPICAL CHARACTERISTICS R and T terminals

HOLDING CURRENT & BREAKOVER CURRENT JUNCTION TEMPERATURE 1.0 0.9 I,, I₍₈₀₎ - Holding Current, Breakover Current - A 0.8 0.7 0.6 0.5 (BO) 0.4 0.3 0.2 -25 0 25 50 75 100 150 T, - Junction Temperature - °C Figure 6.





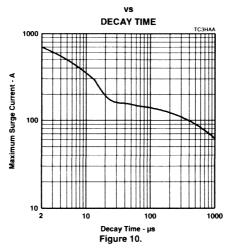




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TYPICAL CHARACTERISTICS R and T terminals

SURGE CURRENT



THERMAL INFORMATION

MAXIMUM NON-RECURRING 50 Hz CURRENT

CURRENT DURATION

THAMA

VOER = 350 Vrms

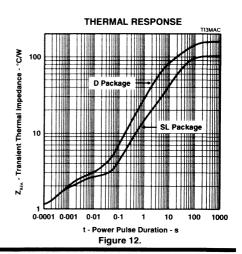
Roen = 20 to 250 Ω SL Package

D Package

10-1 1 10 100 1000

t - Current Duration - s

Figure 11.





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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_{Φ}).

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, $10/700~\mu s$ surge is changed to a 38 A, $5/310~\mu s$ 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 $310~\mu s$ on the surge graph and not $700~\mu s$. 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 us | 50 A 5/310 us |

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, $10/700~\mu s$ surge has an average dv/dt of $150~V/\mu s$, but, as the rise is exponential, the initial dv/dt is higher, being in the region of $450~V/\mu s$. The instantaneous generator output resistance is $25~\Omega$. If the equipment has an additional series resistance of $20~\Omega$, the total series resistance becomes $45~\Omega$. The maximum di/dt then can be estimated as $450/45 = 10~A/\mu s$. 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

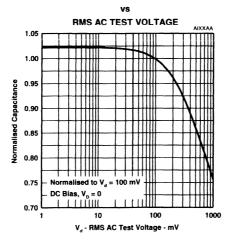


Figure 13.

TEXAS INSTRUMENTS

2-115

lon-Implanted Breakdown Region Precise and Stable Voltage

Low Voltage Overshoot under Surge

| DEVICE | V _{DRM} | V _(BO) |
|---------|------------------|-------------------|
| DEVIGE | v | v |
| '7072F3 | 58 | 72 |
| '7082F3 | 66 | 82 |

Planar Passivated Junctions Low Off-State Current < 10 μA

Rated for International Surge Wave Shapes

| WAVE SHAPE | WAVE SHAPE STANDARD | | | | |
|------------|---------------------|----|--|--|--|
| 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 | | | |
| | FTZ R12 | 50 | | | |
| 10/700 µs | VDE 0433 | 50 | | | |
| | CCITT IX K17 | 38 | | | |
| 10/1000 µs | REA PE-60 | 35 | | | |

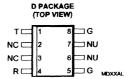
Surface Mount and Through-Hole Options

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

description

These low voltage symmetrical transient voltage suppressor devices are designed to protect against metallic and simultaneous longitudinal surges. These baianced 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.

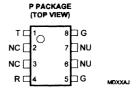
Transients are initially clipped by breakdown clamping until the voltage rises to the breakover level, which causes the device to crowbar.



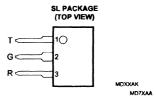
NC - No internal connection

TELECOMMUNICATION SYSTEM SECONDARY PROTECTION

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



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



device symbol



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

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all the parameters.



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TISP7072F3, TISP7082F3 TRIPLE SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

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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) | V _{DRM} | 58 66 | V | |
| Non-repetitive peak on-state pulse current (see Notes 1, 2 and 3) | | | | |
| 1/2 µs (Gas tube differential transient, open-circuit voltage wave sha | ape 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 | Α |
| 0.2/310 µs (RLM 88, open-circuit voltage wave shape 1.5 kV, 0.5/70 | | 38 | | |
| 5/310 µs (CCITT IX K17, open-circuit voltage wave shape 1.5 kV, 19 | ITT 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 μ | s) | | 50 | |
| 10/560 μs (FCC Part 68, open-circuit voltage wave shape 10/560 μs | s) | | 45 | |
| 10/1000 μs (REA PE-60, open-circuit voltage wave shape 10/1000 | us) | | 35 | |
| Non-repetitive peak on-state current (see Notes 2 and 3) | D Package | | 3 | |
| E0.H= 1 a | P Package | I _{TSM} | 4 | A rms |
| 50 Hz, 1 s | | | 5 | |
| Initial rate of rise of on-state current, Linear current ramp, Maximum ramp v | alue < 38 A | di _T /dt | 250 | A/µs |
| Junction temperature | | TJ | -40 to +150 | °C |
| Storage temperature range | | T _{stq} | -40 to +150 | °C |

NOTES: 1. Further details on surge wave shapes are contained in the Applications Information section.

- 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

| | | | T | ISP7072 | F3 | TI | SP7082 | F3 | |
|-------------------|--|---|-------|---------|------|-------|--------|------|-------|
| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | MIN | TYP | MAX | UNIT |
| I _{DRM} | Repetitive peak off- state current | V _D = ±V _{DRM} , 0°C < T _J < 70°C | | 1 | ±10 | | | ±10 | μА |
| V _(BO) | Breakover voltage | $dv/dt = \pm 250 \text{ V/ms}, R_{SOURCE} = 300 \Omega$ | | | ±72 | | | ±82 | V |
| V _(BO) | Impulse breakover volt- age | $dv/dt = \pm 1000 \text{ V/μs}, R_{SOURCE} = 50 \Omega,$ 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 | $V_D = \pm 50 \text{ V}$ | | | ±10 | | | ±10 | μA |



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

| | | | | TISP7072F3 | | | TISP7082F3 | | | |
|------------------|-----------------------|-----------------------------|------------------------|------------|-----|-----|------------|-----|-----|------|
| | PARAMETER | TEST CONDITIO | NS | MIN | TYP | MAX | MIN | TYP | MAX | UNIT |
| C _{off} | Off-state capacitance | I bird terminal voltage = 0 | $V_D = 0$. | | 66 | 135 | | 66 | 135 | pF |
| | | | $V_{D} = -5 \text{ V}$ | | 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.

thermal characteristics

| PARAMETER | TEST CONDITIONS | | | TYP | MAX | UNIT |
|-----------|--|------------|--|-----|-----|------|
| | B -0.8W T -35°C | D Package | | | 160 | |
| | P _{tot} = 0.8 W, T _A = 25°C 5 cm ² , FR4 PCB | P Package | | | 100 | °C/W |
| | S CIII , FN4 FOB | SL Package | | | 135 | |

Quadrant II Switching Characteristic Quadrant III Switching Characteristic Quadrant III Switching Characteristic

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

T and G and R and G measurements are referenced to the G terminal

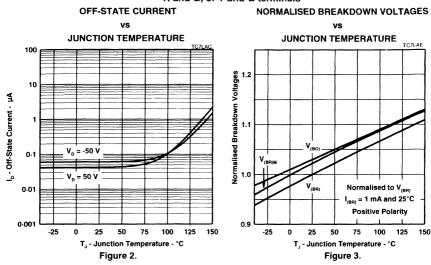
T and R measurements are referenced to the R terminal



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.

TISP7072F3, TISP7082F3 TRIPLE SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS SLPSE15 - MARCH 1994 - REVISED SEPTEMBER 1994

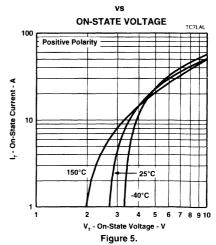
TYPICAL CHARACTERISTICS R and G, or T and G terminals



NORMALISED BREAKDOWN VOLTAGES

JUNCTION TEMPERATURE TC7LAF Normalised Breakdown Voltages 1.1 Normalised to V(BR) I_(BD) = 1 mA and 25°C 0.9 T, - Junction Temperature - °C Figure 4.

ON-STATE CURRENT

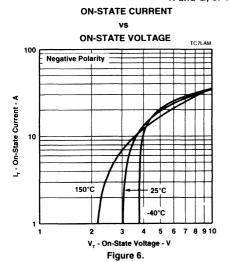




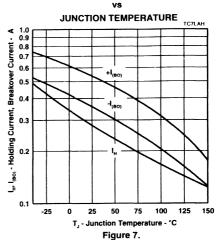
TISP7072F3, TISP7082F3 TRIPLE SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

SLPSE15 - MARCH 1994 - REVISED SEPTEMBER 1994

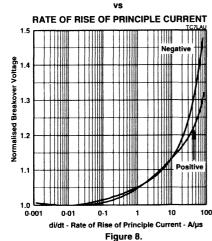
TYPICAL CHARACTERISTICS R and G, or T and G terminals



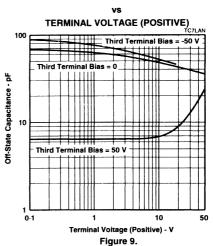
HOLDING CURRENT & BREAKOVER CURRENT



NORMALISED BREAKOVER VOLTAGE



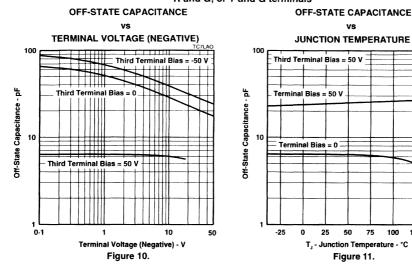
OFF-STATE CAPACITANCE



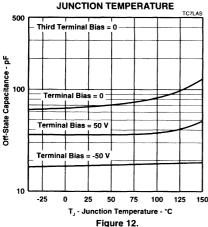


TISP7072F3, TISP7082F3 TRIPLE SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS SLPSE15 - MARCH 1994 - REVISED SEPTEMBER 1994

TYPICAL CHARACTERISTICS R and G, or T and G terminals



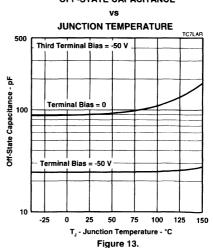




OFF-STATE CAPACITANCE

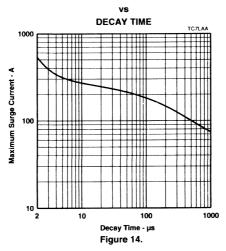
Figure 11.

75 100 125 150





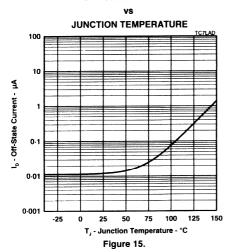
TYPICAL CHARACTERISTICS R and G, or T and G terminals SURGE CURRENT

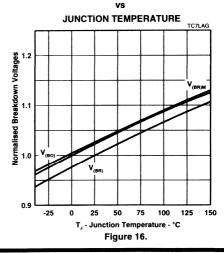


TYPICAL CHARACTERISTICS R and T terminals

OFF-STATE CURRENT

NORMALISED BREAKDOWN VOLTAGES



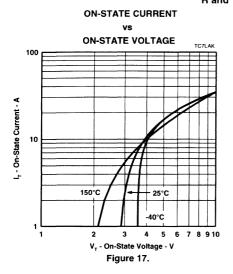


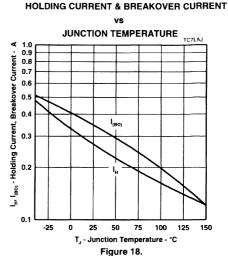


TISP7072F3, TISP7082F3 TRIPLE SYMMETRICAL TRANSIENT **VOLTAGE SUPPRESSORS**

SLPSE15 - MARCH 1994 - REVISED SEPTEMBER 1994

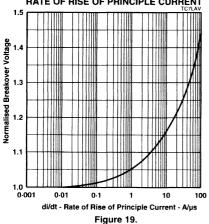
TYPICAL CHARACTERISTICS R and T terminals

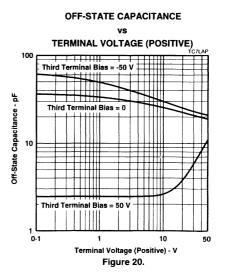




RATE OF RISE OF PRINCIPLE CURRENT 1.5 1.3

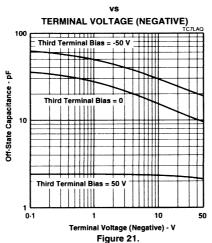
NORMALISED BREAKOVER VOLTAGE





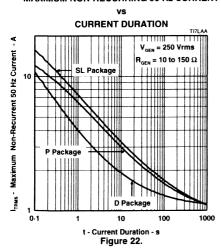


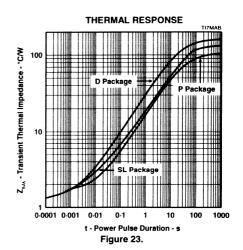
TYPICAL CHARACTERISTICS R and T terminals OFF-STATE CAPACITANCE



THERMAL INFORMATION

MAXIMUM NON-RECURRING 50 Hz CURRENT







TISP7072F3, TISP7082F3 TRIPLE SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

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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 μ s surge is changed to a 88 A, 5/310 μ s 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 μ s on the surge graph and not 700 μ s. 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, $10/700~\mu s$ surge has an average dv/dt of $150~V/\mu s$, but, as the rise is exponential, the initial dv/dt is higher, being in the region of $450~V/\mu s$. The instantaneous generator output resistance is $25~\Omega$. If the equipment has an additional series resistance of $20~\Omega$, the total series resistance becomes $45~\Omega$. The maximum di/dt then can be estimated as $450/45 = 10~A/\mu s$. 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, $T_{\rm J}$, and the bias voltage, comprising of the dc voltage, $V_{\rm D}$, and the ac voltage, $V_{\rm d}$. 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 $V_{\rm D}>>V_{\rm d}$ the capacitance value is independent on the value of $V_{\rm d}$. The capacitance is essentially constant over the range of normal telecommunication frequencies.

NORMALISED CAPACITANCE

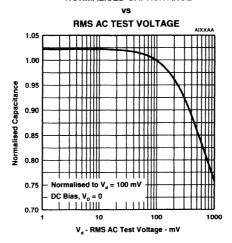


Figure 24.



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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 $(C_{TG} \cdot C_{RG})$. The line capacitive unbalance is due to $(C_{TG} \cdot C_{RG})$ and the capacitance shunting the line is $C_{TR} + C_{RG}/2$.

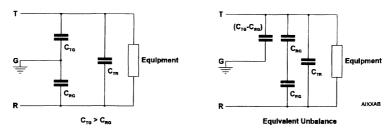


Figure 25.

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.



TISP7125F3, TISP7150F3, TISP7180F3 TRIPLE SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

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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 _(BO) | | |
|---------|------------------|-------------------|--|--|
| | v | ٧ | | |
| '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} |
|------------|--------------|------------------|
| 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 |
| | FTZ R12 | 50 |
| 10/700 µs | VDE 0433 | 50 |
| | CCITT IX K17 | 38 |
| 10/1000 μs | REA PE-60 | 35 |

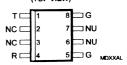
Surface Mount and Through-Hole Options

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

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.

D PACKAGE (TOP VIEW)

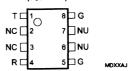


NC - No internal connection

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

device symbol



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

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all the parameters.



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TISP7125F3, TISP7150F3, TISP7180F3 TRIPLE SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

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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 | | | VALUE | UNIT |
|---|---------------------|------------------|-------------|-------|
| | '7125F3 | | 100 | |
| Repetitive peak off-state voltage (0°C < T _J < 70°C) | '7150F3 | V _{DRM} | 120 | V |
| | '7180F3 | | 145 | |
| 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) | | 350 | 1 |
| 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 |) | 1 _{TSP} | 50 | A |
| 0.2/310 µs (RLM 88, open-circuit voltage wave shape 1.5 kV, 0.5/700 µ | ıs) | | 38 | |
| 5/310 µs (CCITT IX K17, open-circuit voltage wave shape 1.5 kV, 10/7 | 00 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 | | 3 | |
| 50 Hz, 1 s | P Package | I _{TSM} | 4 | A rms |
| 50 Hz, 1 S | SL Package | | 5 | |
| Initial rate of rise of on-state current, Linear current ramp, Maximum ramp value | di _T /dt | 250 | A/µs | |
| Junction temperature | | TJ | -40 to +150 | °C |
| Storage temperature range | T _{stq} | -40 to +150 | °C | |

- NOTES: 1. Further details on surge wave shapes are contained in the Applications Information section.
 - 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

| | | | TISP7125F3 | | | TISP7150F3 | | | |
|-------------------|--|---|------------|------|------|------------|------|------|-------|
| | PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | MIN | TYP | MAX | UNIT |
| I _{DRM} | Repetitive peak off- state current | $V_D = \pm V_{DRM}, 0^{\circ}C < T_J < 70^{\circ}C$ | | l | ±10 | | | ±10 | μА |
| V _(BO) | Breakover voltage | $dv/dt = \pm 250 \text{ V/ms}, R_{SOURCE} = 300 \Omega$ | 1 | | ±125 | | | ±150 | ٧ |
| V _(BO) | Impulse breakover volt- age | $dv/dt = \pm 1000 V/\mu s$, R _{SOURCE} = 50 Ω. di/dt < 20 A/μs | | ±143 | | | ±168 | | ٧ |
| I _(BO) | Breakover current | $dv/dt = \pm 250 \text{ V/ms}, R_{SOURCE} = 300 \Omega$ | ±0.1 | | ±0.8 | ±0.1 | | ±0.8 | Α |
| 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 |



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

| | | ETER TEST CONDITIONS | | TISP7125F3 | | | TISP7150F3 | | | |
|-----------|---|----------------------|-----------------------|------------|-----|-----|------------|-----|--------|------|
| | PARAMETER Off-state current Off-state capacitance | | | MIN | TYP | MAX | MIN | TYP | MAX UN | UNIT |
| ID | Off-state current V _D = ±50 V | | | | | ±10 | | | ±10 | μА |
| | Off-state capacitance | | $V_{D} = 0$, | | 41 | 85 | | 41 | 85 | ρF |
| | | | $V_D = -5 V$ | | 21 | 45 | | 21 | 45 | pF |
| C_{off} | | | $V_D = -50 \text{ V}$ | | 10 | 20 | | 10 | 20 | pF |
| | | | | 23 | 50 | | 23 | 50 | pF | |

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

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

| | | | | TI | SP7180 | F3 | UNIT |
|--------------------|--|--|--|-----------|--------|------|-------|
| | PARAMETER | TEST CONDITIONS | | #198 ±0.1 | MAX | UNIT | |
| I _{DRM} | Repetitive peak off- state current | $V_{D} = \pm V_{DRM}, 0^{\circ}C < T_{J} < 70^{\circ}C$ | | | | ±10 | μА |
| α _{V(BR)} | Temperature coefficient of breakdown voltage | I _(BR) = ±100 μA, 0°C < T _J < 70°C | | | ±0.1 | | %/°C |
| V _(BO) | Breakover voltage | $dv/dt = \pm 250 \text{ V/ms}, R_{SOURCE} = 300 \Omega$ | | | | ±180 | ٧ |
| V _(BO) | Impulse breakover volt- age | $dv/dt = \pm 1000 \text{ V/μs}$. $R_{SOURCE} = 50 \Omega$. $di/dt < 20 \text{ A/μs}$ | | | ±198 | | V |
| I _(BO) | Breakover current | $dv/dt = \pm 250 \text{ V/ms}, R_{SOURCE} = 300 \Omega$ | AND ALL TO A STATE OF THE STATE | ±0.1 | | ±0.8 | Α |
| V _T | On-state voltage | I _T = ±5 A, t _W = 100 μs | | | | ±5 | ٧ |
| 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 |
| | | 4 100 kH= V = 100 mV | $V_D = 0$, | | 41 | 85 | pF |
| c | Off state consultance | f = 100 kHz, V _d = 100 mV | $V_D = -5 V$ | | 21 | 45 | pF |
| Coff | Off-state capacitance | Third terminal voltage = 0 (see Notes 6 and 7) | $V_D = -50 \text{ V}$ | | 10 | 20 | pF |
| | | (see Notes o and 7) | $V_{DTR} = 0$ | | 23 | 50 | pF |

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

thermal characteristics

| | PARAMETER | TEST CONDITION | ıs | MIN | TYP | MAX | UNIT |
|---|-----------|--|------------|-----|-----|-----|------|
| Γ | | B -0.9 W T - 25°C | D Package | | | 160 | |
| | | P _{tot} = 0.8 W, T _A = 25°C 5 cm ² . FR4 PCB | P Package | | | 100 | °C/W |
| ١ | | S CIII , FN4 FOB | SL Package | | | 135 | |



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.

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_{DTB}, is for T and R terminals only.

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PARAMETER MEASUREMENT INFORMATION

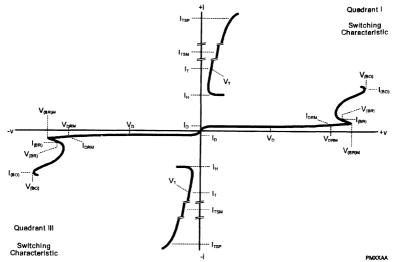


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR T AND R TERMINALS

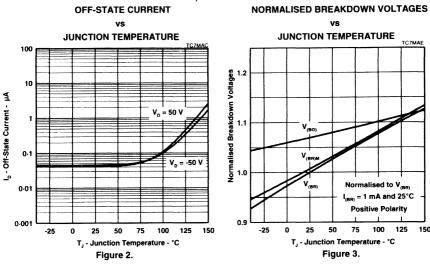
T and G and R and G measurements are referenced to the G terminal

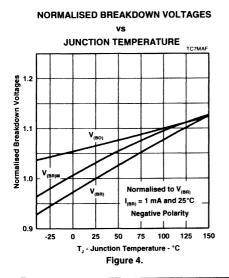
T and R measurements are referenced to the R terminal

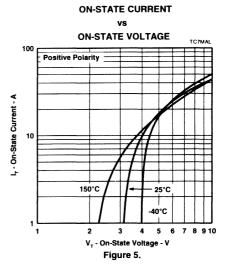


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TYPICAL CHARACTERISTICS R and G, or T and G terminals







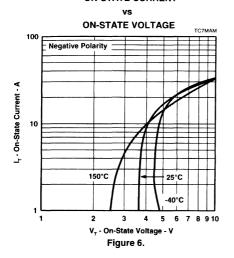


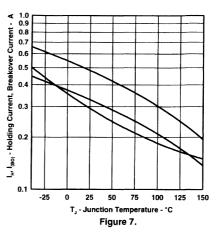
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TYPICAL CHARACTERISTICS R and G, or T and G terminals

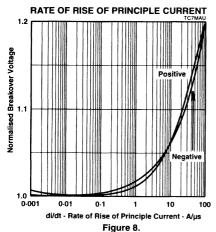
ON-STATE CURRENT

HOLDING CURRENT & BREAKOVER CURRENT

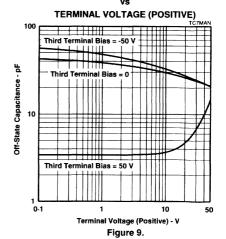




NORMALISED BREAKOVER VOLTAGE



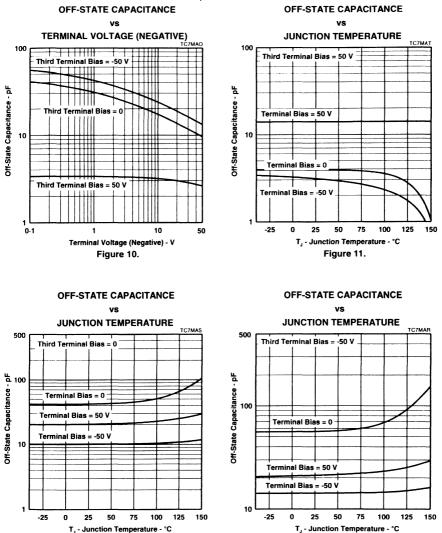
OFF-STATE CAPACITANCE





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TYPICAL CHARACTERISTICS R and G. or T and G terminals





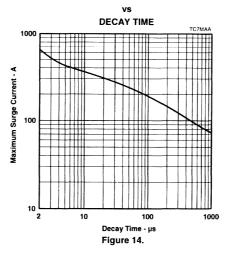
T, - Junction Temperature - °C

Figure 12.

Figure 13.

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TYPICAL CHARACTERISTICS R and G, or T and G terminals SURGE CURRENT



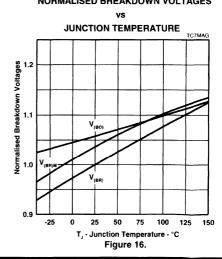
TYPICAL CHARACTERISTICS R and T terminals

OFF-STATE CURRENT vs

T, - Junction Temperature - °C

Figure 15.

NORMALISED BREAKDOWN VOLTAGES

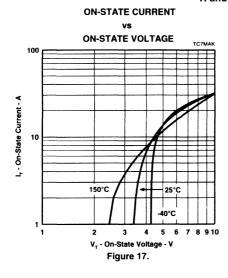


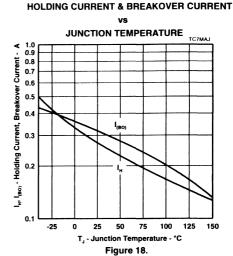


0.001

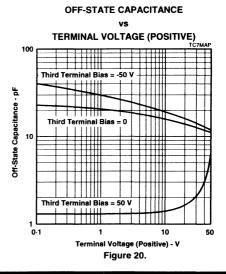
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TYPICAL CHARACTERISTICS R and T terminals





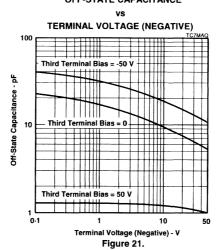
RATE OF RISE OF PRINCIPLE CURRENT 1.2 Begin 1.1 O-001 O-01 O-01 O-01 O-01 O-01 Figure 19.





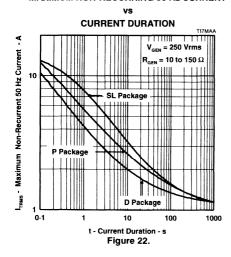
TISP7125F3, TISP7150F3, TISP7180F3 TRIPLE SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS SLPSE16 - MARCH 1994 - REVISED SEPTEMBER 1994

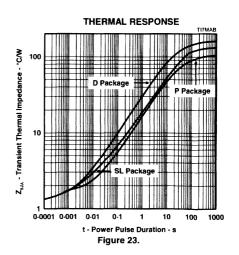
TYPICAL CHARACTERISTICS R and T terminals **OFF-STATE CAPACITANCE**



THERMAL INFORMATION

MAXIMUM NON-RECURRING 50 Hz CURRENT







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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 .Z₀ (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.



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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

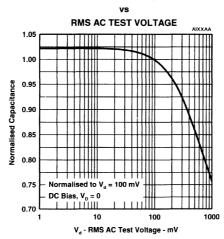


Figure 24.



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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 $C_{TR} + C_{RG}/2$.

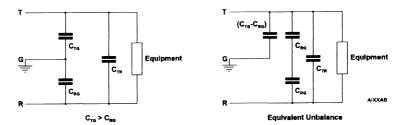


Figure 25.

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.



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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 _(BO) |
|---------|------------------|-------------------|
| DEVICE | v | 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

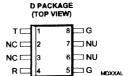
| WAVE SHAPE | STANDARD | I _{TSP} |
|------------|--------------|------------------|
| 2/10 µs | FCC Part 68 | 175 |
| 8/20 µs | ANSI C62.41 | 120 |
| 10/160 µs | FCC Part 68 | 60 |
| 10/560 µs | FCC Part 68 | 45 |
| 0.5/700 µs | RLM 88 | 38 |
| | FTZ R12 | 50 |
| 10/700 µs | VDE 0433 | 50 |
| | CCITT 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 | Р |
| Single-in-line | SL |

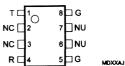
description

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.



- 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

device symbol



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

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all the parameters.



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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 |
|---|------------|---------------------|-------------|-------|
| | '7240F3 | | 180 | |
| | '7260F3 | | 200 | |
| Repetitive peak off-state voltage (0°C < T _J < 70°C) | '7290F3 | V _{DRM} | 220 | V |
| | '7320F3 | i | 240 | |
| | '7380F3 | | 270 | |
| 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) | | 350 | į i |
| 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) | | I _{TSP} | 50 | A |
| 0.2/310 μs (RLM 88, open-circuit voltage wave shape 1.5 kV, 0.5/700 μ | ıs) | | 38 | |
| 5/310 µs (CCITT IX K17, open-circuit voltage wave shape 1.5 kV, 10/76 | 00 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 | | 3 | |
| 50 Hz, 1 s | P Package | I _{TSM} | 4 | A rms |
| 50 nz, 1 s | SL Package | | 5 | |
| Initial rate of rise of on-state current, Linear current ramp, Maximum ramp value | e < 38 A | di _⊤ /dt | 250 | A/µs |
| Junction temperature | | TJ | -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.
 - 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.
 - 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

| | | | | TISP7240F3 | | | TISP7260F3 | | |
|-------------------|---------------------------------------|--|-------|------------|------|-------|------------|------|------|
| | PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | MIN | TYP | MAX | UNIT |
| I _{DRM} | Repetitive peak off- state current | $V_D = \pm V_{DRM}, 0^{\circ}C < T_J < 70^{\circ}C$ | | L | ±10 | | | ±10 | μА |
| V _(BO) | Breakover voltage | $dv/dt = \pm 250 \text{ V/ms}, R_{SOURCE} = 300 \Omega$ | | | ±240 | | | ±260 | V |
| V _(BO) | Impulse breakover volt- age | $dv/dt = \pm 1000 V/\mu s$, $R_{SOURCE} = 50 Ω$. $di/dt < 20 A/\mu s$ | | ±269 | | | ±289 | | ٧ |
| I _(BO) | Breakover current | $dv/dt = \pm 250 \text{ V/ms}, R_{SOURCE} = 300 \Omega$ | ±0.1 | | ±0.8 | ±0.1 | | ±0.8 | Α |
| 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 | | | |



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

| | | | | T | TISP7240F3 | | TISP7260F3 | | | |
|-------|--|--|------------------------|-----|------------|-----|------------|-----|-----------------|-------|
| | PARAMETER | TEST CONDITIO | NS | MIN | TYP | MAX | MIN | ТҮР | MAX | UNIT |
| dv/dt | Critical rate of rise of off-state voltage | Linear voltage ramp Maximum ramp value < 0.85V | (BR)MIN | ±5 | L | | ±5 | | | kV/μs |
| ID | Off-state current | V _D = ±50 V | | | | ±10 | | | ±10 | μA |
| | | 4 400111- 1/4 400 1/4 | $V_D = 0$, | | 44 | 90 | | 44 | 90 | pF |
| | Off-state capacitance | f = 100 kHz, V _d = 100 mV Third terminal voltage = 0 | $V_{D} = -5 \text{ V}$ | | 18 | 40 | | 18 | 40 | pF |
| Coff | On-state capacitance | (see Notes 4 and 5) | V _D = -50 V | | 7 | 15 | | 7 | 15 | pF |
| | | (see Notes 4 and 5) | V _{DTR} = 0 | | 26 | 50 | | 26 | ±10 90 40 | pF |

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

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

| | | | | TI | SP7290 | F3 | T | SP7320 | F3 | |
|-------------------------|--|---|-----------------------------|-------|--------|------|-------|--------|------|-------|
| | age Breakover current On-state voltage | TEST CONDITIONS | | MIN | TYP | MAX | MIN | TYP | MAX | UNIT |
| I _{DRM} | | $V_D = \pm V_{DRM}, 0^{\circ}C < T_J < 70^{\circ}C$ | AMERICAN STREET | | L | ±10 | | | ±10 | μА |
| V _(BO) | Breakover voltage | dv/dt = ±250 V/ms, R _{SOURCE} | = 300 Ω | | | ±290 | | | ±320 | ٧ |
| V _(BO) | Impulse breakover volt- age | $dv/dt = \pm 1000 \text{ V/}\mu\text{s}, R_{SOURCE}$ $di/dt < 20 \text{ A/}\mu\text{s}$ | = 50 Ω, | | ±319 | | | ±349 | | ٧ |
| 1 _(BO) | Breakover current | dv/dt = ±250 V/ms, R _{SOURCE} | = 300 Ω | ±0.1 | | ±0.8 | ±0.1 | | ±0.8 | Α |
| ν _τ | 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 _{(E} | BR)MIN | ±5 | | | ±5 | | | kV/μs |
| I _D | Off-state current | V _D = ±50 V | | | | ±10 | | | ±10 | μΑ |
| | | 6 100 kHz V - 100 mV | $V_D = 0$, | | 44 | 90 | | 44 | 90 | pF |
| C | Off-state capacitance | f = 100 kHz, V _d = 100 mV | V _D = -5 V | | 18 | 40 | | 18 | 40 | pF |
| Coff | | Third terminal voltage = 0 (see Notes 4 and 5) | $V_{\rm D} = -50 \text{ V}$ | | 7 | 15 | | 7 | 15 | pF |
| dv/dt I _D | | (see Notes 4 and 5) | $V_{DTR} = 0$ | | 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 | | TI | TISP7380F3 | | |
|-------------------|--|---|---------|------------|------|-------|
| | PARAMETER | TEST CONDITIONS | MIN TYP | TYP | MAX | UNIT |
| I _{DRM} | Repetitive peak off- state current | V _D = ±V _{DRM} , 0°C < T _J < 70°C | | | ±10 | μA |
| V _(BO) | Breakover voltage | $dv/dt = \pm 250 \text{ V/ms}, R_{SOURCE} = 300 \Omega$ | | | ±380 | V |
| V _(BO) | Impulse breakover volt- age | $dv/dt = \pm 1000 \text{ V/μs}, R_{SOURCE} = 50 \Omega,$ di/dt < 20 A/μs | | ±409 | | ٧ |
| I _(BO) | Breakover current | $dv/dt = \pm 250 \text{ V/ms}, R_{SOURCE} = 300 \Omega$ | ±0.1 | | ±0.8 | Α |
| V _T | On-state voltage | $I_T = \pm 5 \text{ A}, I_W = 100 \mu\text{s}$ | | | ±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 |
| ID | Off-state current | $V_D = \pm 50 \text{ V}$ | | | ±10 | μA |



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.

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

| PARAMETER | | TEST CONDITIONS | | | TISP7380F3 | | |
|-----------|-----------------------|--|-----------------------|--|------------|-----|------|
| | | | | | TYP | MAX | UNIT |
| Coff | Off-state capacitance | t = 100 kHz, V _d = 100 mV Third terminal voltage = 0 | V _D = 0, | | 44 | 90 | pF |
| | | | $V_D = -5 V$ | | 18 | 40 | pF |
| | | | $V_D = -50 \text{ V}$ | | 7 | 15 | pF |
| | | | $V_{DTR} = 0$ | | 26 | 50 | pF |

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

thermal characteristics

| PARAMETER | | TEST CONDITIONS | | MIN | TYP | MAX | UNIT |
|------------------|--|---|------------|-----|-----|-----|------|
| | | P _{tot} = 0.8 W, T _A = 25°C | D Package | | | 160 | |
| R _{eJA} | R _{BJA} Junction to free air thermal resistance | 5 cm ² , FR4 PCB | P Package | 100 | | 100 | ∘c/w |
| | | 3 CIII , FN4 FCB | SL Package | | | 135 | |

PARAMETER MEASUREMENT INFORMATION Quadrant I Switching Characteristic Quadrant II Switching Characteristic Quadrant III Switching Characteristic

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

T and G and R and G measurements are referenced to the G terminal

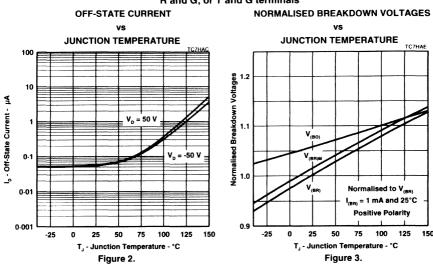
T and R measurements are referenced to the R terminal



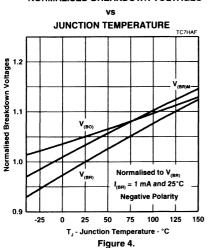
⁷ First three capacitance values, with bias V_D, are for the T and G and T and G terminals only. The forth capacitance value, with bias V_{DTR}, is for T and R terminals only.

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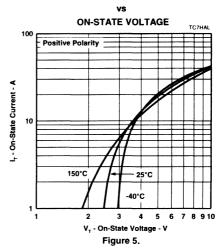
TYPICAL CHARACTERISTICS R and G, or T and G terminals



NORMALISED BREAKDOWN VOLTAGES



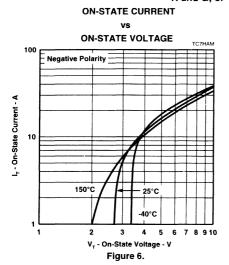
ON-STATE CURRENT

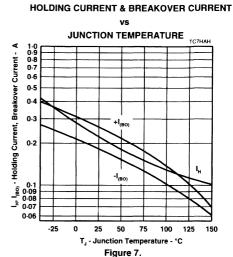




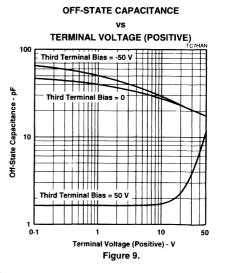
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TYPICAL CHARACTERISTICS R and G, or T and G terminals





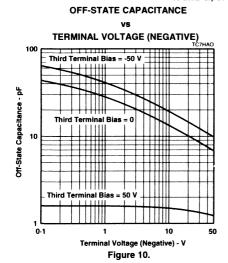
RATE OF RISE OF PRINCIPLE CURRENT 1.0 Positive Positive Negative 1.0 O-001 O-001 O-01 O-01 O-01 Figure 8.



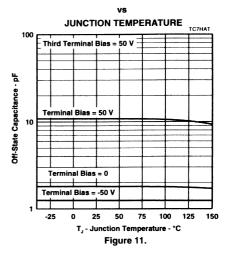


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TYPICAL CHARACTERISTICS R and G, or T and G terminals



OFF-STATE CAPACITANCE



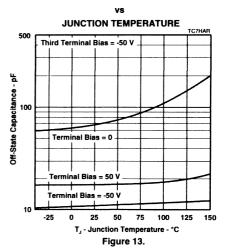
OFF-STATE CAPACITANCE

Third Terminal Bias = 0

Terminal Bias = 50 V

Figure 12.

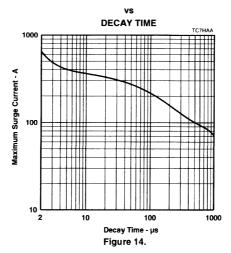
OFF-STATE CAPACITANCE





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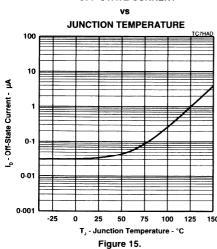
TYPICAL CHARACTERISTICS R and G, or T and G terminals SURGE CURRENT

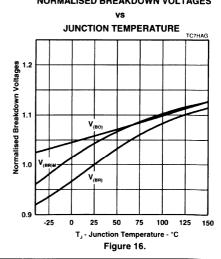


TYPICAL CHARACTERISTICS R and T terminals

OFF-STATE CURRENT

NORMALISED BREAKDOWN VOLTAGES

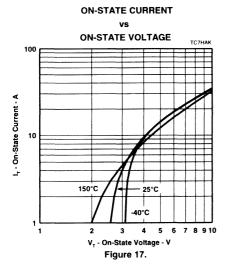


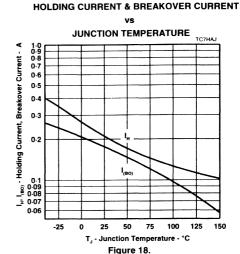




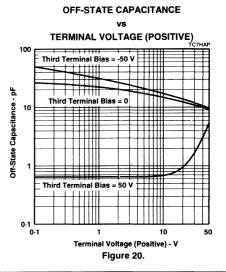
TISP7240F3, TISP7260F3, TISP7290F3, TISP7320F3, TISP7380F3 TRIPLE SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS SLPSE17 - MARCH 1994 - REVISED SEPTEMBER 1994

TYPICAL CHARACTERISTICS R and T terminals





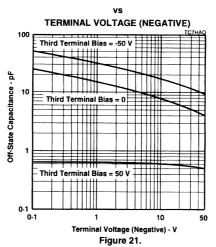
NORMALISED BREAKOVER VOLTAGE RATE OF RISE OF PRINCIPLE CURRENT 1.2 **Breakover Voltage** Normalised 0.001 0.01 10 100 di/dt - Rate of Rise of Principle Current - A/µs Figure 19.





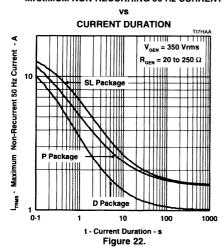
SLPSE17 - MARCH 1994 - REVISED SEPTEMBER 1994

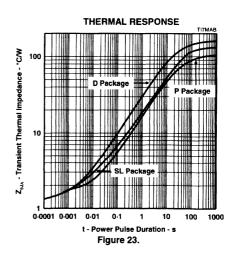
TYPICAL CHARACTERISTICS R and G, T and G and R and T terminals OFF-STATE CAPACITANCE



THERMAL INFORMATION

MAXIMUM NON-RECURRING 50 Hz CURRENT







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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 .Z₀ (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 |
| FT7 B12 | 2.0 kV 10/700 us | 50 A. 5/310 us |

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.



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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 μ s surge has an average dv/dt of 150 V/ μ s, but, as the rise is exponential, the initial dv/dt is higher, being in the region of 450 V/ μ s. 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/ μ s. 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

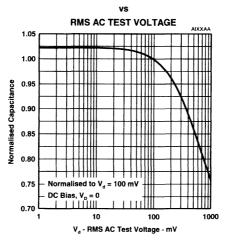


Figure 24.



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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 $C_{TR} + C_{RG}/2$.

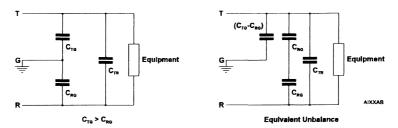


Figure 25.

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

- 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} |
|------------|--------------|------------------|
| 10/700 μs | CCITT IX K17 | 38 |
| 10/1000 µs | REA PE-60 | 30 |

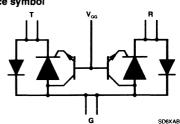
NC - No internal connection

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



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) | 1 | 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
 - 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.
 - Most PTT's quote an unloaded voltage waveform. In operation the TISP essentially shorts the generator output. The resulting loaded current waveform is specified.

TEXAS INSTRUMENTS

TISP61CAP3 PROGRAMMABLE TRANSIENT VOLTAGE SUPPRESSORS SLPSE45 - SEPTEMBER 1994

electrical characteristics, $T_J = 25^{\circ}C$

| | PARAMETER | | TEST CONDITION | NS | 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 | ٧ |
| 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 | ٧ |
| 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 |
| ID | Off-state current | V _D = -80 V | V _{GG} = -80 V | | | | -10 | μА |
| Is | Switching current | dv/dt = -250 V/ms | -72 < V _{GG} < -10 V | R _{SOURCE} = 300 Ω | -0.15 | | | Α |
| l _H | Holding current | di/dt = 30 mA/μs | -72 < V _{GG} < -10 V | | -0.15 | | | Α |
| I _{GAO} | Gate reverse current with cathode open | V _{GG} = -72 V | | | | | -10 | μА |
| 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 |
| Coff | 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.



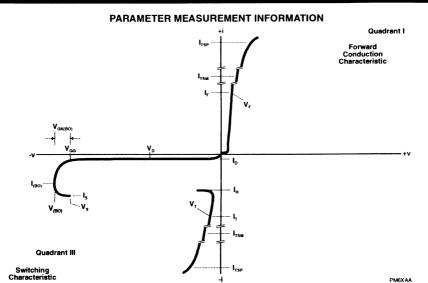


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC



Technical Specifications

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



SLPSE22 - 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 _(BO) |
|--------|------------------|-------------------|
| DEVICE | ٧ | ٧ |
| '1082 | - 58 | - 82 |

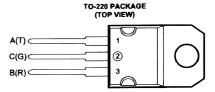
- Planar Passivated Junctions Low Off-State Current < 10 μA
- Rated for International Surge Wave Shapes

| WAVE SHAPE | STANDARD | I _{TSP} |
|------------|--------------|------------------|
| 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 |
| | FTZ R12 | 50 |
| 10/700 μs | VDE 0433 | 50 |
| | CCITT IX K17 | 50 |
| 10/1000 μs | REA PE-60 | 50 |

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.

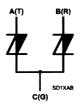
Negative transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides. Positive transients are clipped by diode action.



Pin 2 is in electrical contact with the mounting base.

MDXXAN

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



TISP1082 DUAL ASYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

SLPSE22 - NOVEMBER 1986 - REVISED SEPTEMBER 1994

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 | TJ | 150 | °C |
| Operating free - air temperature range | | 0 to 70 | °C |
| Storage temperature range | T _{stq} | -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

- 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.
- 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, $T_J = 25^{\circ}C$

| | PARAMETER | | TEST CONDITI | ONS | MIN | TYP | MAX | UNIT |
|----------------|-----------------------|-------------------------|--------------------------|--------------|------|-----|------|------|
| V ₇ | Reference zener | l _z = ± 1mA | | | ± 58 | | | V |
| \ vz | voltage | 1Z = ± 1111A | Z = ± 1111A | | | | | ľ |
| | Off-state leakage | V 150 V | | | | | | |
| 'D | current | V _D = ± 50 V | $V_D = \pm 50 \text{ V}$ | | | | ± 10 | μА |
| Coff | 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, = 25°C

| | | / G | | | | | | | |
|-------------------|--|---|---------------------|--------------|--------|-------|-------|-------|--|
| | PARAMETER | *************************************** | TEST CONDITIONS | | MIN | TYP | MAX | UNIT | |
| Vz | Reference zener voltage | I _Z = - 1mA | | | - 58 | | | ٧ | |
| ∝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 | Α | |
| 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 | |
| 1 _D | Off-state leakage current | V _D = - 50 V | | | | | - 10 | μА | |
| Coff | 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 μ s, duty cycle \leq 2%.

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

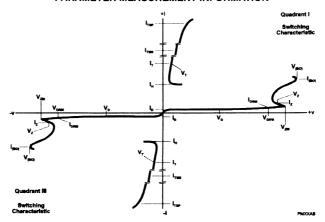


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR TERMINALS A AND B

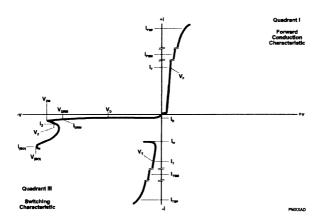


Figure 2. VOLTAGE-CURRENT CHARACTERISTIC FOR TERMINALS A AND C OR B AND C† †Polarity is determined at terminal A or B with respect to C



TISP1082 DUAL ASYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

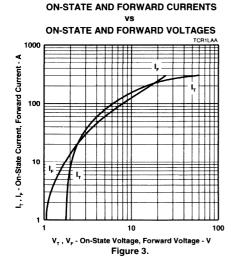
SLPSE22 - NOVEMBER 1986 - REVISED SEPTEMBER 1994

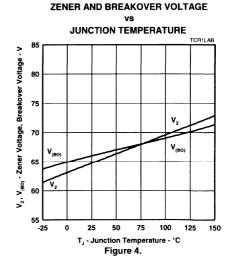
thermal characteristics

| PARAMETER | MIN | TYP | MAX | UNIT |
|--|-----|-----|------|------|
| R _{BJA} Junction to free air thermal resistance | | | 62.5 | °C/W |

TYPICAL CHARACTERISTICS A and C, or B and C terminals

A and C, or B and C terminal





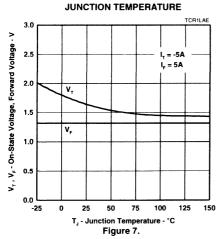


TYPICAL CHARACTERISTICS A and C, or B and C terminals

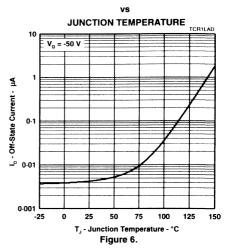
JUNCTION TEMPERATURE I_H, I_(BO) - Holding Current, Breakover Current - A 0.1 0.01 . -25 0 75 150 25 50 100 125 T, - Junction Temperature - °C Figure 5.

HOLDING CURRENT & BREAKOVER CURRENT

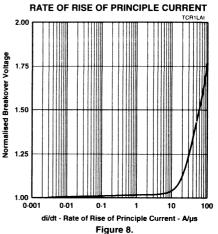
ON-STATE VOLTAGE & FORWARD VOLTAGE



OFF-STATE CURRENT

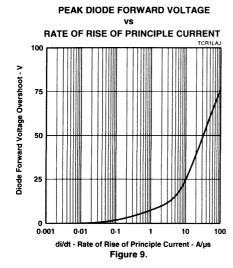


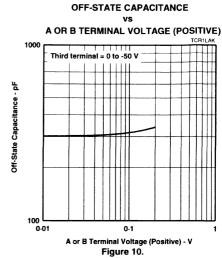
NORMALISED BREAKOVER VOLTAGE





TYPICAL CHARACTERISTICS A and C, or B and C terminals





OFF-STATE CAPACITANCE

A OR B TERMINAL VOLTAGE (NEGATIVE)

TOTALLAL

Third terminal = 0 to -50 V

Third terminal = 0 to -50 V

A or B Terminal Voltage (Negative) - V

Figure 11.

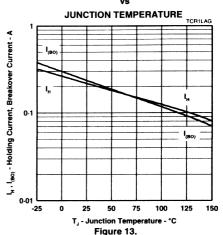


TYPICAL CHARACTERISTICS A and B terminals

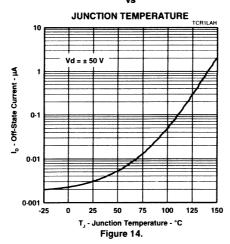
ZENER VOLTAGE & BREAKOVER VOLTAGE JUNCTION TEMPERATURE 85 V₂ , V₍₈₀₎ - Zener Voltage, Breakover Voltage - V 80 75 V_(BO) V_(BO) 65 ٧, 60 55 -25 100 125 150 T, - Junction Temperature - °C

Figure 12.

HOLDING CURRENT & BREAKOVER CURRENT

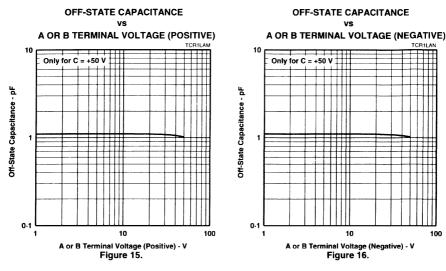


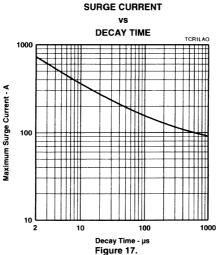
OFF-STATE CURRENT vs





TYPICAL CHARACTERISTICS A and B terminals







THERMAL INFORMATION

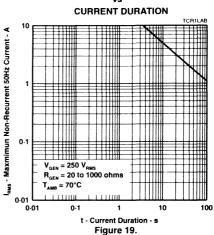
THERMAL RESPONSE TIRILAA Z_{eJA} - Transient Thermal Impedance - °C/W

t - Power Pulse Duration - s

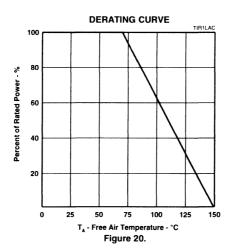
Figure 18.

0.0001 0.001

MAXIMUM NON-RECURRENT 50Hz CURRENT vs



FREE AIR TEMPERATURE





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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 _(BO) |
|--------|------------------|-------------------|
| | v | v |
| '1082L | - 58 | - 82 |

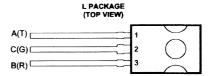
- **Planar Passivated Junctions** Low Off-State Current < 10 µA
- **Rated for International Surge Wave Shapes**

| WAVE SHAPE | STANDARD | I _{TSP} |
|------------|--------------|------------------|
| 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 |
| | FTZ R12 | 50 |
| 10/700 µs | VDE 0433 | 50 |
| | CCITT IX K17 | 50 |
| 10/1000 µs | REA PE-60 | 50 |

description

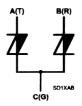
The TISP1082L is designed specifically for telephone line card protection against lightning and transients induced by ac power lines. These devices will supress voltage transients between terminals A and C, B and C, and A and B.

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.



Pin 2 is in electrical contact with the mounting base

device symbol



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



TISP1082L DUAL ASYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

SLPSE23 - FEBRUARY 1990 - REVISED SEPTEMBER 1994

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) | | 38 | Α |
| 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 | TJ | 150 | °C |
| Operating free - air temperature range | | 0 to 70 | °C |
| Storage temperature range | T _{stq} | -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
 - 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.
 - 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_{.1} = 25°C

| | PARAMETER | TEST CONDITIONS | | MIN | TYP | MAX | UNIT | |
|----------------|-----------------------|-------------------------|-----------|--------------|------|-----|------|----|
| V ₇ | Reference zener | l _z = ± 1mA | | | ± 58 | | | V |
| \ vz | voltage | 12 = 1 IIIIA | | | ± 36 | | | V |
| | Off-state leakage | V _D = ± 50 V | | | | | ± 10 | |
| l '0 | current | νD = ± 20 Λ | | | | | ± 10 | μА |
| Coff | 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 = 25°C

| | PARAMETER | | TEST CONDITIONS | 3 | MIN | TYP | MAX | UNIT |
|-------------------|---|-------------------------|---------------------|--------------|--------|-------|-------|-------|
| ٧ _z | Reference zener voltage | I _Z = - 1mA | | | - 58 | | | ٧ |
| ∝vz | Temperature coefficient of reference voltage | | | | | 0.1 | | %/°C |
| V _(BO) | Breakover voltage | (see Notes 5 and 6) | | | | | - 82 | ٧ |
| 1(80) | Breakover current | (see Note 5) | | | - 0.15 | | - 0.6 | Α |
| 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 | μА |
| Coff | 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 μ s, duty cycle \leq 2%.

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).

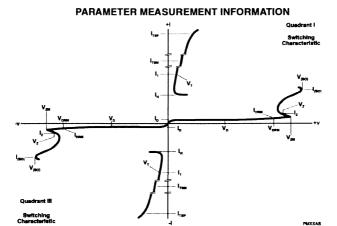


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR TERMINALS A AND B

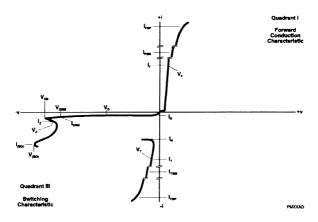


Figure 2. VOLTAGE-CURRENT CHARACTERISTIC FOR TERMINALS A AND C OR B AND C† †Polarity is determined at terminal A or B with respect to C

TISP1082L **DUAL ASYMMETRICAL TRANSIENT** VOLTAGE SUPPRESSORS SLPSE23 - FEBRUARY 1990 - REVISED SEPTEMBER 1994

thermal characteristics

| PARAMETER | | | MAX | UNIT |
|--|--|--|-----|------|
| R _{BJA} 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 _(BO) |
|--------|------------------|-------------------|
| DEVICE | V | ٧ |
| '2082 | 58 | 82 |

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

| WAVE SHAPE | STANDARD | I _{TSP} |
|------------|--------------|------------------|
| 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 |
| | FTZ R12 | 50 |
| 10/700 µs | VDE 0433 | 50 |
| | CCITT IX K17 | 50 |
| 10/1000 µs | REA PE-60 | 40 |

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.

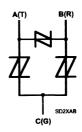
Transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides.

A(T) C(G) B(R) TO-220 PACKAGE (TOP VIEW) 1 (2) 3

Pin 2 is in electrical contact with the mounting base.

MDXXAN

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



TISP2082 DUAL SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

SLPSE24 - NOVEMBER 1986 - REVISED SEPTEMBER 1994

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) | 1 | 60 | l |
| 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) | 1 _{TSP} | 38 | Α |
| 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 | ļ |
| 10/1000 μs (REA PE-60, open-circuit voltage wave shape 10/1000 μs) | | 40 | ĺ |
| Non-repetitive peak on-state current, 50 Hz, 2.5 s (see Notes 1 and 2) | l _{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 | TJ | 150 | °C |
| Operating free - air temperature range | | 0 to 70 | °C |
| Storage temperature range | T _{stq} | -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
 - 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.
 - 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, $T_J = 25^{\circ}C$

| | PARAMETER | TEST CONDITIONS | | MIN | TYP | MAX | UNIT | |
|------|------------------------------|-------------------------|-----------|--------------|------|-----|------|----|
| Vz | Reference zener voltage | I _Z = ± 1mA | | | ± 58 | | | ٧ |
| 1D | Off-state leakage current | V _D = ± 50 V | | | | | ± 10 | μА |
| Coff | 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_{.I} = 25°C

| | PARAMETER | | TEST CONDITIONS | 3 | MIN | TYP | MAX | UNIT |
|-----------------------------|--|-------------------------|---------------------|--------------|--------|-------|-------|-------|
| VZ | Reference zener voltage | I _Z = ± 1mA | | | ± 58 | | | ٧ |
| [∞] V _Z | Temperature coefficient of reference voltage | | | | | 0.1 | | %₽C |
| ν _(BO) | Breakover voltage | (see Notes 5 and 6) | | | | | ± 82 | ٧ |
| I _(BO) | Breakover current | (see Note 5) | | | ± 0.15 | | ± 0.6 | Α |
| 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 |
| ι _D | Off-state leakage current | V _D = ± 50 V | | | | | ± 10 | μА |
| Coff | 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%.
 - 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 % Vz (minimum).



PARAMETER MEASUREMENT INFORMATION

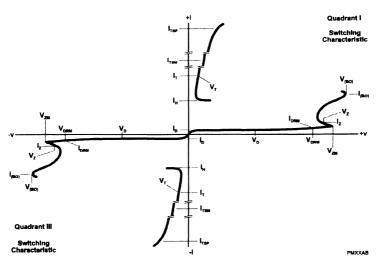


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR ANY PAIR OF TERMINALS

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

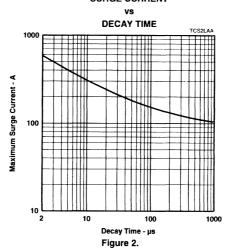
thermal characteristics

| PARAMETER | | | MAX | UNIT | |
|--|--|--|------|------|--|
| R _{BJA} Junction to free air thermal resistance | | | 62.5 | °C/W | |



TYPICAL CHARACTERISTICS A and C, or B and C terminals

SURGE CURRENT





SLPSE25 - FEBRUARY 1990 - REVISED SEPTEMBER 1994

Ion-Implanted Breakdown Region Precise and Stable Voltage

Low Voltage Overshoot under Surge

| DEVICE | V _(Z) | V _(BO) |
|--------|------------------|-------------------|
| | V | V |
| '2082L | 58 | 82 |

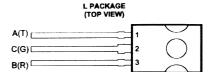
- **Planar Passivated Junctions** Low Off-State Current < 10 µA
- **Rated for International Surge Wave Shapes**

| WAVE SHAPE | STANDARD | I _{TSP} |
|------------|--------------|------------------|
| 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 |
| | FTZ R12 | 50 |
| 10/700 µs | VDE 0433 | 50 |
| | CCITT IX K17 | 50 |
| 10/1000 μs | REA PE-60 | 40 |

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.

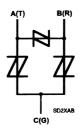
Transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides.



Pin 2 is in electrical contact with the mounting base MDXXAO

device symbol

TELECOMMUNICATION SYSTEM SECONDARY PROTECTION



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

TISP2082L **DUAL SYMMETRICAL TRANSIENT** VOLTAGE SUPPRESSORS SLPSE25 - FEBRUARY 1990 - REVISED SEPTEMBER 1994

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) | | 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, 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 | TJ | 150 | °C |
| Operating free - air temperature range | | 0 to 70 | °C |
| Storage temperature range | T _{stq} | -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, $T_J = 25^{\circ}C$

| | PARAMETER | | TEST CONDIT | IONS | MIN | TYP | MAX | UNIT |
|------|-----------------------|-------------------------|-------------|--------------|------|-----|------|------|
| V-7 | Reference zener | I _z = ± 1mA | | | ± 58 | | | V |
| Vz | voltage | IZ = I IIIIA | | | 1 36 | 1 | | ٧ |
| | Off-state leakage | V - + 50 V | | | | | . 10 | |
| ۵' ا | current | V _D = ± 50 V | | | | | ± 10 | μΑ |
| Coff | 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 |
|-------------------|---|-------------------------|---------------------|--------------|--------|-------|-------|-------|
| Vz | Reference zener voltage | I _Z = ± 1mA | | | ± 58 | | | ٧ |
| ∝v _z | Temperature coefficient of reference voltage | | | | | 0.1 | | %/°C |
| V _(BO) | Breakover voltage | (see Notes 5 and 6) | | | | | ± 82 | ٧ |
| I _(BO) | Breakover current | (see Note 5) | | | ± 0.15 | | ± 0.6 | Α |
| 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 | μА |
| Coff | 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 μ s, duty cycle \leq 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

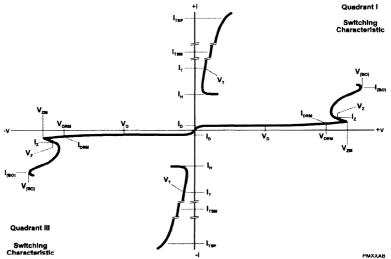


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR ANY PAIR OF TERMINALS

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

thermal characteristics

| PARAMETER | | TYP | MAX | UNIT |
|--|--|-----|-----|------|
| R _{BJA} 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 _(BO) |
|--------|------------------|-------------------|
| DEVICE | V | v |
| '2180 | 145 | 180 |

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

| WAVE SHAPE | STANDARD | I _{TSP} |
|------------|--------------|------------------|
| 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 |
| | FTZ R12 | 50 |
| 10/700 µs | VDE 0433 | 50 |
| | CCITT IX K17 | 50 |
| 10/1000 µs | REA PE-60 | 50 |

description

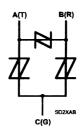
The TISP2180 is designed specifically for telephone equipment protection against lightning and transients induced by ac power lines. These devices will supress voltage transients between terminals A and C, B and C, and A and B.

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.

Pin 2 is in electrical contact with the mounting base

MDXXAN

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



TISP2180 DUAL SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

SLPSE26 - NOVEMBER 1986 - REVISED SEPTEMBER 1994

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) | 1 | 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 | 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 | TJ | 150 | °C |
| Operating free - air temperature range | | 0 to 70 | °C |
| Storage temperature range | T _{stg} | -40 to +150 | °Ĉ |
| 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

- 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.
- 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, $T_J = 25^{\circ}C$

| PARAMETER | | TEST CONDITIONS | | | MIN | TYP | MAX | UNIT |
|----------------|-----------------------|-------------------------|-----------|--------------|-------|-----|------|------|
| | Reference zener | l _z = ± 1mA | | | + 145 | | | V |
| V _Z | voltage | IZ = I IIIA | | | 1 145 | | | ľ |
| | Off-state leakage | V _D = ± 50 V | | | | | ± 10 | uА |
| םי | current | V _D = ± 50 V | | | | | ± 10 | μΑ |
| Coff | 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 |
|-------------------|--|-------------------------|---------------------|--------------|--------|-------|-------|-------|
| VZ | Reference zener voltage | I _Z = ± 1mA | | | ± 145 | | | ٧ |
| ~v _z | Temperature coefficient of reference voltage | | | | | 0.1 | | %/°C |
| V _(BO) | Breakover voltage | (see Notes 5 and 6) | | | | | ± 180 | ٧ |
| I _(BO) | Breakover current | (see Note 5) | | | ± 0.15 | | ± 0.6 | Α |
| V _{TM} | Peak on-state voltage | I _T = ± 5 A | (see Notes 5 and 6) | | | ± 2.2 | ± 3 | ٧ |
| 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 |
| ID | Off-state leakage current | V _D = ± 50 V | | | | | ± 10 | μА |
| Coff | 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 μ s, duty cycle $\leq 2\%$

- 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 % VZ (minimum).



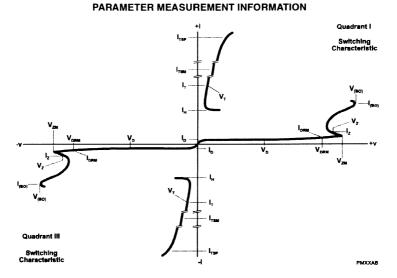


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR ANY PAIR OF TERMINALS

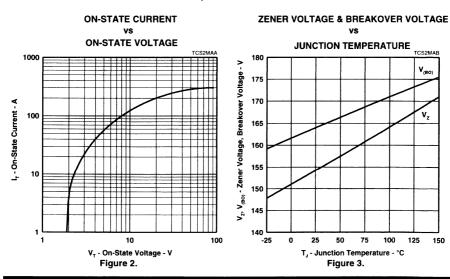
The high level characteristics for terminals A and B are not guaranteed.

thermal characteristics

| į | PARAMETER | | | TYP | MAX | UNIT | 1 |
|---|------------------|---|--|-----|------|------|---|
| | R _{eJA} | Junction to free air thermal resistance | | | 62.5 | °C/W | |

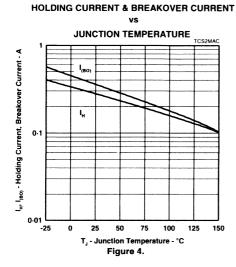


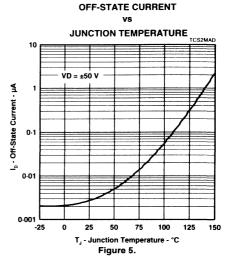
TYPICAL CHARACTERISTICS A and C, or B and C terminals

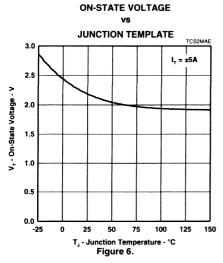


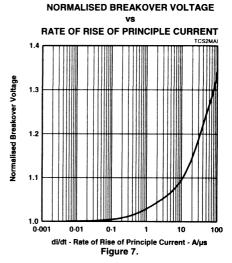


TYPICAL CHARACTERISTICS A and C, or B and C terminals



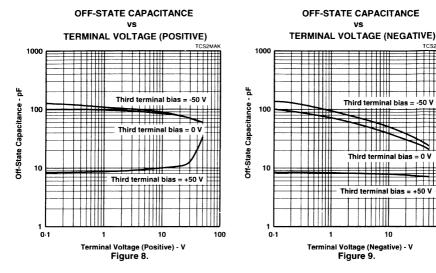


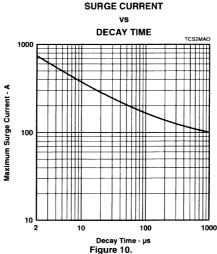






TYPICAL CHARACTERISTICS A and C, or B and C terminals





100



TYPICAL CHARACTERISTICS A and B terminals

ZENER VOLTAGE & BREAKOVER VOLTAGE

JUNCTION TEMPERATURE TCS2MAF 180 V2, V(BO) - Zener Voltage, Breakover Voltage - V 175 170 165 160 155 150

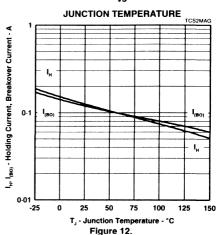
T, - Junction Temperature - °C

Figure 11.

145

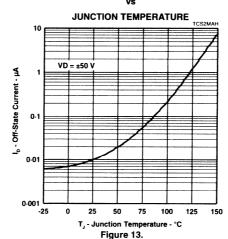
-25

HOLDING CURRENT & BREAKOVER CURRENT



OFF-STATE CURRENT

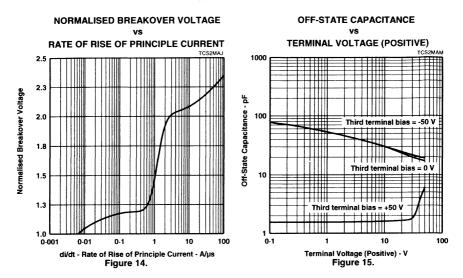
150



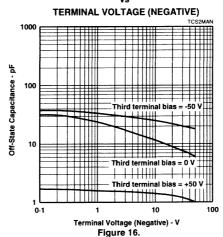


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TYPICAL CHARACTERISTICS A and B terminals



OFF-STATE CAPACITANCE

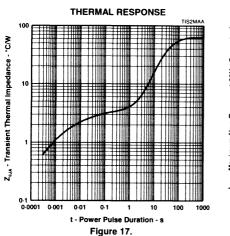


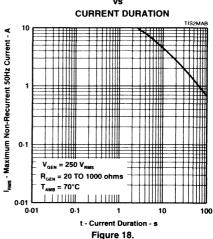


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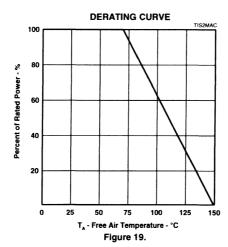
THERMAL INFORMATION

MAXIMUM NON-RECURRENT 50Hz CURRENT





FREE AIR TEMPERATURE





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 _(BO) |
|--------|------------------|-------------------|
| DEVICE | v | v |
| '2180L | 145 | 180 |

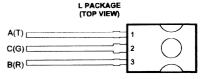
- Planar Passivated Junctions
 Low Off-State Current < 10 μA
- Rated for International Surge Wave Shapes

| WAVE SHAPE | STANDARD | I _{TSP} |
|------------|--------------|------------------|
| 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 |
| | FTZ R12 | 50 |
| 10/700 µs | VDE 0433 | 50 |
| | CCITT IX K17 | 50 |
| 10/1000 μs | REA PE-60 | 50 |

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.

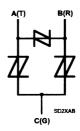
Transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides.



Pln 2 is in electrical contact with the mounting base.

MDXXAO

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



TISP2180L DUAL SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

SLPSE27 - FEBRUARY 1990 - REVISED SEPTEMBER 1994

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 | Α |
| 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 | TJ | 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
 - 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.
 - 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 CONDIT | ONS | MIN | TYP | MAX | UNIT |
|------|-----------------------|-------------------------|-------------|--------------|-------|-----|------|------|
| V-2 | Reference zener | l _z = ± 1mA | | | ± 145 | | | V |
| ٧Z | voltage | IZ = I IMA | | | ± 145 | | | \ \ |
| | Off-state leakage | V + 50 V | | | | | ± 10 | |
| 'D | current | V _D = ± 50 V | | | | | ± 10 | μA |
| Coff | 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 | 3 | MIN | TYP | MAX | UNIT |
|-------------------|---|-------------------------|---------------------|--------------|--------|-------|-------|-------|
| Vz | Reference zener voltage | I _Z = ± 1mA | | | ± 145 | | | ٧ |
| ∝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 | Α |
| V _{TM} | Peak on-state voltage | I _T = ± 5 A | (see Notes 5 and 6) | | | ± 2.2 | ± 3 | V |
| IH | 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 | μА |
| Coff | 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 $\leq 2\%$.

- 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 % V₇ (minimum).



PARAMETER MEASUREMENT INFORMATION

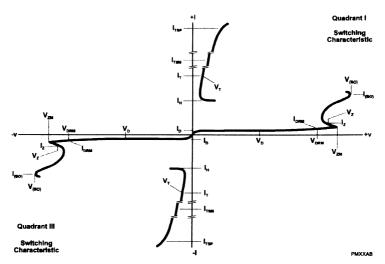


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR ANY PAIR OF TERMINALS

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

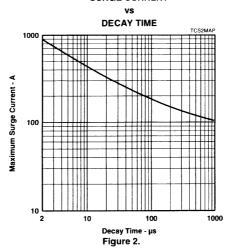
thermal characteristics

| PARAMETER | MIN | TYP | MAX | UNIT |
|--|-----|-----|-----|------|
| R _{BJA} Junction to free air thermal resistance | | | 100 | °C/W |



TYPICAL CHARACTERISTICS A and C, or B and C terminals

SURGE CURRENT





TELECOMMUNICATION SYSTEM SECONDARY PROTECTION

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

| DEVICE | V _(Z) | V _(BO) |
|--------|------------------|-------------------|
| DEVICE | v | v |
| '2290 | 200 | 290 |

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

| WAVE SHAPE | STANDARD | I _{TSP} |
|------------|--------------|------------------|
| 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 |
| | FTZ R12 | 50 |
| 10/700 μs | VDE 0433 | 50 |
| | CCITT IX K17 | 50 |
| 10/1000 µs | REA PE-60 | 50 |

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.

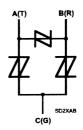
TO-220 PACKAGE (TOP VIEW) A(T) 1 C(G) 2

Pin 2 is in electrical contact with the mounting base.

MDXXAN

device symbol

B(R) <



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



TISP2290 DUAL SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

SLPSE28 - NOVEMBER 1986 - REVISED SEPTEMBER 1994

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 | Α |
| 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) | İ | 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 | Tj | 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

- 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.
- 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, $T_J = 25^{\circ}C$

| | PARAMETER | | TEST CONDITI | ONS | MIN | TYP | MAX | UNIT |
|----------------|-----------------------|-------------------------|--------------|--------------|-------|-----|------|------|
| V ₇ | Reference zener | l _z = ± 1mA | | | ± 200 | | | ., |
| ٧z | voltage | IZ = I IIIA | | | ± 200 | | | v |
| | Off-state leakage | V . 50.V | | | | | | |
| ο, | current | V _D = ± 50 V | | | 1 | | ± 10 | μА |
| Coff | 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 |
|-------------------|--|-------------------------|---------------------|--------------|--------|-------|-------|-------|
| Vz | Reference zener voltage | I _Z = ± 1mA | | | ± 200 | | | ٧ |
| ~v _z | Temperature coefficient of reference voltage | | 10.5533000 | | | 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 | Α |
| V _{TM} | Peak on-state voltage | I _T = ± 5 A | (see Notes 5 and 6) | | | ± 1.9 | ± 3 | ٧ |
| Ι _Η | 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 | μА |
| Coff | 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, $t_w = 100 \mu s$, duty cycle $\leq 2\%$.

- 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 % Vz (minimum).



PARAMETER MEASUREMENT INFORMATION

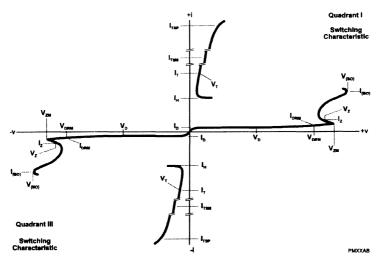


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR ANY PAIR OF TERMINALS

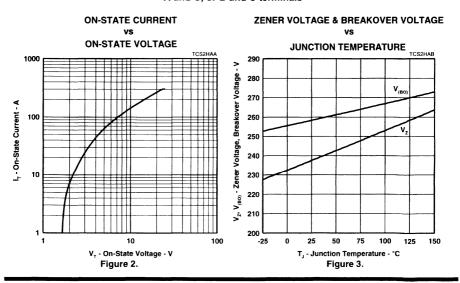
The high level characteristics for terminals A and B are not guaranteed.

thermal characteristics

| PARAMETER | MIN | TYP | MAX | UNIT |
|--|-----|-----|------|------|
| R _{BJA} Junction to free air thermal resistance | | | 62.5 | °C/W |



TYPICAL CHARACTERISTICS A and C, or B and C terminals





TYPICAL CHARACTERISTICS A and C, or B and C terminals

OFF-STATE CURRENT HOLDING CURRENT & BREAKOVER CURRENT JUNCTION TEMPERATURE JUNCTION TEMPERATURE TCS2HAC 10 In . I (BO) - Holding Current, Breakover Current - A (BO) VD = ±50 V I_o - Off-State Current - µA 0.1 0.1 0.01 0.001 0.01 -25 75 100 125 150 . -25 25 50 75 100 125 150 T, - Junction Temperature - °C T_J - Junction Temperature - °C Figure 5. Figure 4. **ON-STATE VOLTAGE** NORMALISED BREAKOVER VOLTAGE VS RATE OF RISE OF PRINCIPLE CURRENT **JUNCTION TEMPERATURE** TCS2HAE 3.0 $I_T = \pm 5A$ 2.5 Normalised Breakover Voltage V. - On-State Voltage - V 1.3 1.5 1.2 1.0 1.1 0.5 0.0 1.0



0.001

0.01

0.1

di/dt - Rate of Rise of Principle Current - A/µs Figure 7.

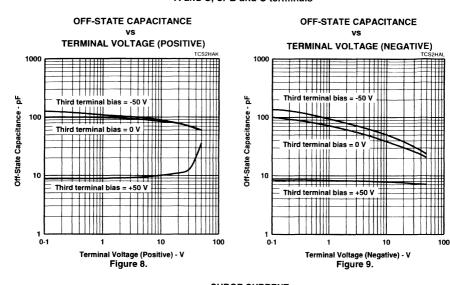
150

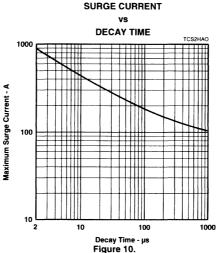
100

T, - Junction Temperature - °C

Figure 6.

TYPICAL CHARACTERISTICS A and C, or B and C terminals





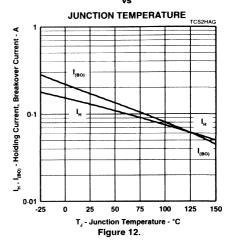


TYPICAL CHARACTERISTICS A and B terminals

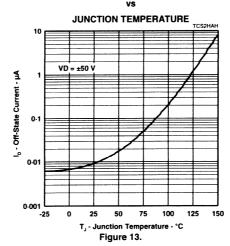
ZENER VOLTAGE & BREAKOVER VOLTAGE

JUNCTION TEMPERATURE TCS2HAF 290 Vz, V(BO) - Zener Voltage, Breakover Voltage - V 280 V_(BO) 270 260 250 240 230 220 210 200 150 -25 0 75 100 125 T_J - Junction Temperature - °C Figure 11.

HOLDING CURRENT & BREAKOVER CURRENT

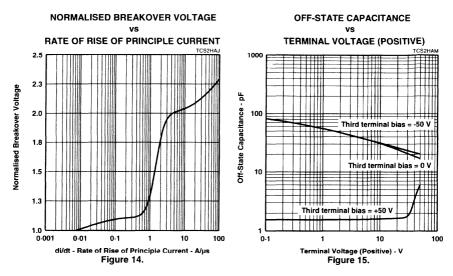


OFF-STATE CURRENT

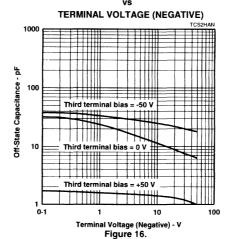




TYPICAL CHARACTERISTICS A and B terminals



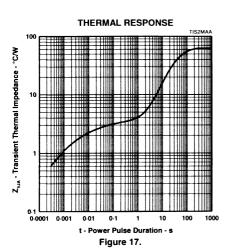
OFF-STATE CAPACITANCE

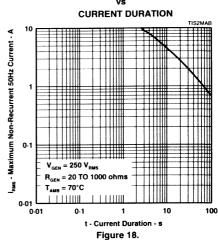




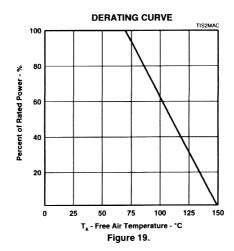
THERMAL INFORMATION

MAXIMUM NON-RECURRENT 50Hz CURRENT





FREE AIR TEMPERATURE





TELECOMMUNICATION SYSTEM SECONDARY PROTECTION

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

| DEVICE | V _(Z) | V _(BO) |
|--------|------------------|-------------------|
| DEVICE | ٧ | ٧ |
| '2290L | 200 | 290 |

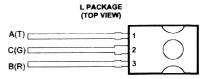
- Planar Passivated Junctions
 Low Off-State Current < 10 μA
- Rated for International Surge Wave Shapes

| WAVE SHAPE | STANDARD | I _{TSP} |
|------------|--------------|------------------|
| 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 |
| | FTZ R12 | 50 |
| 10/700 µs | VDE 0433 | 50 |
| | CCITT IX K17 | 50 |
| 10/1000 µs | REA PE-60 | 50 |

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.

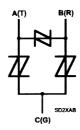
Transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides.



Pin 2 is in electrical contact with the mounting base.

MDXXAO

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



TISP2290L DUAL SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

SLPSE29 - FEBRUARY 1990 - REVISED SEPTEMBER 1994

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) | ITSP | 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 | TJ | 150 | °C |
| Operating free - air temperature range | | 0 to 70 | °C |
| Storage temperature range | T _{stq} | -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

- 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.
- 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_{.1} = 25°C

| | PARAMETER | | TEST CONDIT | ONS | MIN | TYP | MAX | UNIT |
|----------------|-----------------------|-------------------------|-------------|--------------|-------|-----|------|------|
| V ₂ | Reference zener | 1 ₂ = ± 1mA | | | ± 200 | | | V |
| l *z | voltage | IZ = I IIIIA | | | 1 200 | İ | | ľ |
| | Off-state leakage | V + 50 V | | | | | . 10 | |
| ם' | current | V _D = ± 50 V | | | | | ± 10 | μА |
| Coff | 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 |
|-------------------|---|-------------------------|---------------------|--------------|--------|-------|-------|-------|
| Vz | Reference zener voltage | I _Z = ± 1mA | | | ± 200 | | | ٧ |
| ~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 = ± 5 A | (see Notes 5 and 6) | | | ± 1.9 | ± 3 | V |
| IH | Holding current | (see Note 5) | | | ± 150 | | | mA |
| dv/dt | Critical rate of rise of off-state voltage | (see Note 7) | | | | | ± 5 | kV/μs |
| ID | Off-state leakage current | V _D = ± 50 V | | | | | ± 10 | μА |
| Coff | 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 \leq 2%.

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



PARAMETER MEASUREMENT INFORMATION

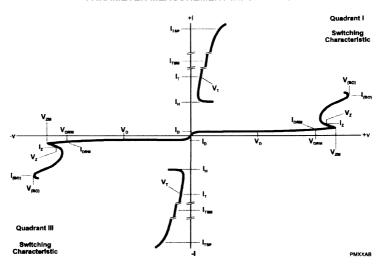


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR ANY PAIR OF TERMINALS

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

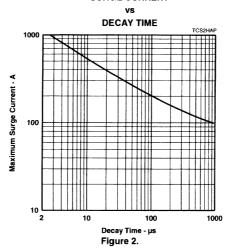
thermal characteristics

| PARAMETER | MIN | TYP | MAX | UNIT | |
|--|-----|-----|-----|------|--|
| R _{BJA} Junction to free air thermal resistance | | | 100 | °C/W | |



TYPICAL CHARACTERISTICS A and C, or B and C terminals

SURGE CURRENT





SLPSE41 - 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 _(BO) |
|--------|------------------|-------------------|
| DEVICE | v | v |
| '2310L | 250 | 310 |

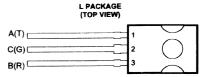
- **Planar Passivated Junctions** Low Off-State Current < 10 µA
- **Rated for International Surge Wave Shapes**

| WAVE SHAPE | VAVE SHAPE STANDARD | | |
|------------|---------------------|-----|--|
| 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 | |
| | FTZ R12 | 50 | |
| 10/700 µs | VDE 0433 | 50 | |
| | CCITT IX K17 | 50 | |
| 10/1000 µs | REA PE-60 | 50 | |

description

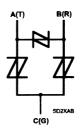
The TISP2310L is designed specifically for telephone equipment protection against lightning and transients induced by ac power lines. These devices will supress voltage transients between terminals A and C, B and C, and A and B.

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.



Pin 2 is in electrical contact with the mounting base MDXXAO

device symbol



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



TISP2310L DUAL SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

SLPSE41 - FEBRUARY 1990 - REVISED SEPTEMBER 1994

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 | Α |
| 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 | TJ | 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
 - 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.
 - 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_{.1} = 25°C

| | PARAMETER | | TEST CONDITI | ONS | MiN | TYP | MAX | UNIT |
|----------------|-----------------------|-------------------------|--------------|--------------|-------|-----|------|------|
| V ₇ | Reference zener | I ₂ = ± 1mA | | | ± 250 | | | V |
| ٧Z | voltage | IZ = I IIIA | | | 1 230 | | | • |
| | Off-state leakage | V _D = ± 50 V | | | | | ± 10 | μА |
| ¹D | current | VD = ± 30 V | | | | | 10 | μΛ |
| Coff | 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 |
|-------------------|--|-------------------------|---------------------|--------------|--------|-------|-------|-------|
| Vz | Reference zener voltage | I _Z = ± 1mA | | | ± 250 | | | ٧ |
| ~v _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 | Α |
| V _{TM} | Peak on-state voltage | I _T = ± 5 A | (see Notes 5 and 6) | | | ± 2.2 | ± 3 | V |
| IH | Holding current | (see Note 5) | | | ± 150 | | | mA |
| dv/dt | Critical rate of rise of off-state voltage | (see Note 7) | | | | | ± 5 | kV/μs |
| ID | Off-state leakage current | V _D = ± 50 V | | | | | ± 10 | μА |
| Coff | 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 μ s, duty cycle \leq 2%.
 - 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

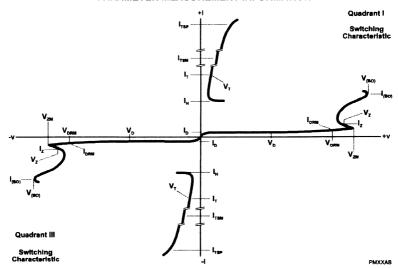


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR ANY PAIR OF TERMINALS

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

thermal characteristics

| PARAMETER | MIN | TYP | MAX | UNIT |
|--|-----|-----|-----|------|
| R _{BJA} Junction to free air thermal resistance | | | 100 | °C/W |



SLPSE 30 - 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 _(BO) |
|--------|------------------|-------------------|
| DEVICE | V | v |
| '3082 | 58 | 82 |

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

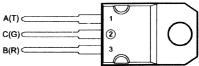
| WAVE SHAPE | STANDARD | I _{TSP} |
|------------|--------------|------------------|
| 8/20 µs | ANSI C62.41 | 150 |
| 10/160 µs | FCC Part 68 | 60 |
| 10/560 µs | FCC Part 68 | 45 |
| 0.5/700 µs | RLM 88 | 38 |
| | FTZ R12 | 50 |
| 10/700 μs | VDE 0433 | 50 |
| | CCITT IX K17 | 50 |
| 10/1000 µs |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

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 R

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.

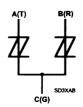
TO-220 PACKAGE (TOP VIEW)



Pin 2 is in electrical contact with the mounting base

MOXXAN

device symbol



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

TISP3082 DUAL SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

SLPSE30 - NOVEMBER 1986 - REVISED SEPTEMBER 1994

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 | Α |
| 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 | ĺ |
| 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 | TJ | 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
 - 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.
 - 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, $T_J = 25^{\circ}C$

| | PARAMETER | | TEST CONDITI | ONS | MIN | TYP | MAX | UNIT |
|------|-----------------------|--------------------------|--------------|--------------|-------|-----|------|------|
| V-7 | Reference zener | l _z = ± 1mA | | | ± 116 | | | V |
| Vz | voltage | IZ= IIIIA | | | 1 110 | | | |
| | Off-state leakage | V + 50 V | | | | | ± 10 | μА |
| ם' ו | current | $V_D = \pm 50 \text{ V}$ | | | | | 110 | μА |
| Coff | 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 |
|-------------------|--|-------------------------|---------------------|--------------|--------|-------|-------|-------|
| Vz | Reference zener voltage | I _Z = ± 1mA | | | ± 58 | | | ٧ |
| ∝vz | Temperature coefficient of reference voltage | | | | | 0.1 | | %/°C |
| V _(BO) | Breakover voltage | (see Notes 5 and 6) | | | | | ± 82 | ٧ |
| I _(BO) | Breakover current | (see Note 5) | | | ± 0.15 | | ± 0.6 | Α |
| 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 |
| ID | Off-state leakage current | V _D = ± 50 V | | | | | ± 10 | μА |
| 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 μ s, duty cycle \leq 2%.
 - 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 % V₇ (minimum).



PARAMETER MEASUREMENT INFORMATION

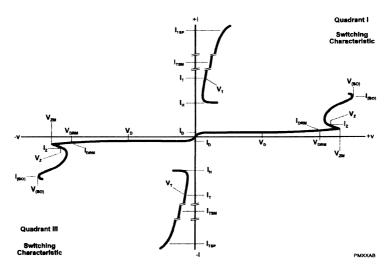


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR ANY PAIR TERMINALS

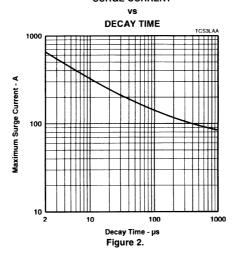
thermal characteristics

| PARAMETER | MIN | TYP | MAX | UNIT |
|--|-----|-----|------|------|
| R _{BJA} Junction to free air thermal resistance | | | 62.5 | °C/W |



TYPICAL CHARACTERISTICS A and C, or B and C terminals

SURGE CURRENT





SLPSE31 - 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 _(BO) |
|--------|------------------|-------------------|
| '3082L | 58 | 82 |

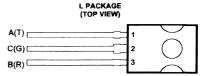
- Planar Passivated Junctions Low Off-State Current < 10 μA
- Rated for International Surge Wave Shapes

| WAVE SHAPE | STANDARD | I _{TSP} |
|------------|--------------|------------------|
| 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 |
| | FTZ R12 | 50 |
| 10/700 μs | VDE 0433 | 50 |
| | CCITT IX K17 | 50 |
| 10/1000 µs | REA PE-60 | 35 |

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

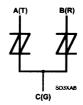
Transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides.



Pin 2 is in electrical contact with the mounting base.

MDXXAO

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



TISP3082L DUAL SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

SLPSE 31 - FERRUARY 1990 - REVISED SEPTEMBER 1994

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) | | 100 | |
| 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) | | 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 | TJ | 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

- 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.
- 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_{.1} = 25°C

| | PARAMETER | | TEST CONDIT | IONS | MIN | TYP | MAX | UNIT |
|----------------|-----------------------|-------------------------|-------------|--------------|-------|-----|------|------|
| V ₇ | Reference zener | I ₇ = ± 1mA | | | ± 116 | | | V |
| ٧z | voltage | 12 = 1 11110 | | | 1 110 | | | • |
| | Off-state leakage | V _D = ± 50 V | | | | | ± 10 | μА |
| ΙD | current | VD = ± 30 V | | | | | 110 | μΛ |
| Coff | 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 |
|-------------------|--|-------------------------|---------------------|--------------|--------|-------|-------|-------|
| Vz | Reference zener voltage | I _Z = ± 1mA | | | ± 58 | | | V |
| ∝vz | 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 | Α |
| V _{TM} | Peak on-state voltage | I _T = ± 5 A | (see Notes 5 and 6) | | | ± 2.2 | ± 3 | ٧ |
| 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 |
| ID | Off-state leakage current | V _D = ± 50 V | | | | | ± 10 | μА |
| Coff | 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 μ s, duty cycle \leq 2%.

- 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).



PMXXAB

PARAMETER MEASUREMENT INFORMATION Quadrant I Switching Characteristic Quadrant III Switching Characteristic

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

thermal characteristics

| PARAMETER | MIN | TYP | MAX | UNIT |
|--|-----|-----|-----|------|
| R _{BJA} Junction to free air thermal resistance | | | 100 | °C/W |



SLPSE32 - NOVEMBER 1986 - REVISED SEPTEMBER 199

TELECOMMUNICATION SYSTEM SECONDARY PROTECTION

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

| DEVICE | V _(Z) | V _(BO) |
|--------|------------------|-------------------|
| DEVICE | V | v |
| '3180 | 145 | 180 |

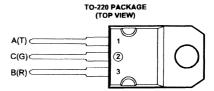
- Planar Passivated Junctions Low Off-State Current < 10 μA
- Rated for International Surge Wave Shapes

| WAVE SHAPE | STANDARD | I _{TSP} |
|------------|--------------|------------------|
| 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 |
| | FTZ R12 | 50 |
| 10/700 µs | VDE 0433 | 50 |
| | CCITT IX K17 | 50 |
| 10/1000 µs | REA PE-60 | 50 |

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.

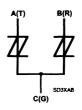
Transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides.



Pin 2 is in electrical contact with the mounting base.

MDXXAN

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



TISP3180 DUAL SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

SLPSE32 - NOVEMBER 1986 - REVISED SEPTEMBER 1994

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 | 1 |
| 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 | 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) | 1 | 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) | ITSM | 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 | TJ | 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

- 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.
- 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 | | ONS | MIN | TYP | MAX | UNIT | |
|----------------|---------------------------|-------------------------|-----------|--------------|-------|-----|------|----|
| VZ | Reference zener | I _Z = ± 1mA | | | ± 290 | | | ٧ |
| I _D | Off-state leakage | V _D = ± 50 V | | | | | ± 10 | μΑ |
| Coff | 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 |
|-------------------|---|-------------------------|---------------------|--------------|--------|-------|-------|-------|
| Vz | Reference zener voltage | I _Z = ± 1mA | | | ± 145 | | | ٧ |
| ∝v _z | Temperature coefficient of reference voltage | | | | | 0.1 | | %/°C |
| V _(BO) | Breakover voltage | (see Notes 5 and 6) | | | | | ± 180 | ٧ |
| I _(BO) | Breakover current | (see Note 5) | | | ± 0.15 | | ± 0.6 | Α |
| V _{TM} | Peak on-state voltage | I _T = ± 5 A | (see Notes 5 and 6) | | | ± 2.2 | ± 3 | ٧ |
| 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 |
| Ι _D | Off-state leakage current | V _D = ± 50 V | | | | | ± 10 | μА |
| Coff | 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, $t_w = 100 \ \mu s$, duty cycle $\leq 2\%$.

- 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 % V₇ (minimum).



PARAMETER MEASUREMENT INFORMATION

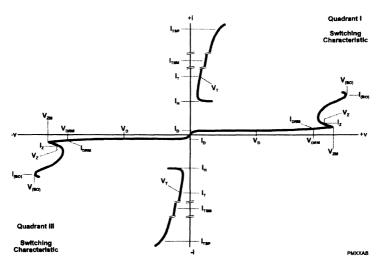


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR ANY PAIR OF TERMINALS

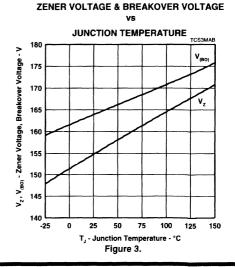
thermal characteristics

| PARAMETER | | | MAX | UNIT |
|--|--|--|------|------|
| R _{BJA} Junction to free air thermal resistance | | | 62.5 | °C/W |



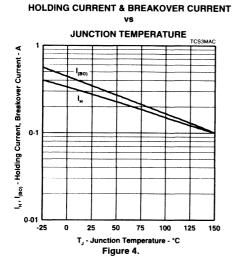
TYPICAL CHARACTERISTICS A and C, or B and C terminals

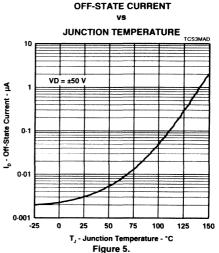
ON-STATE CURRENT VS ON-STATE VOLTAGE TCS3MAA



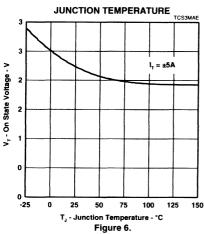


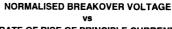
TYPICAL CHARACTERISTICS A and C, or B and C terminals

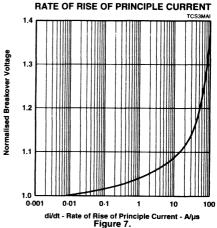




ON-STATE VOLTAGE vs

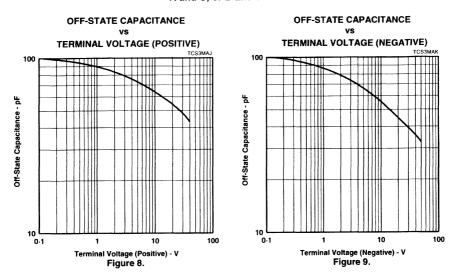




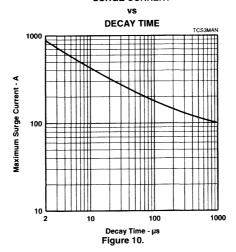




TYPICAL CHARACTERISTICS A and C, or B and C terminals



SURGE CURRENT





TYPICAL CHARACTERISTICS A and B terminals

ZENER VOLTAGE & BREAKOVER VOLTAGE

JUNCTION TEMPERATURE TCS3MAF 360 Vz. V(80) - Zener Voltage, Breakover Voltage - V 350 340 330 320 310 300 290

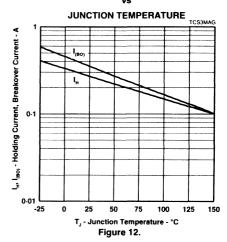
T_J - Junction Temperature - °C

Figure 11.

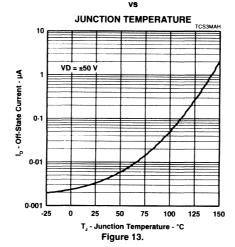
280

-25 0 25 50 75 100 125 150

HOLDING CURRENT & BREAKOVER CURRENT

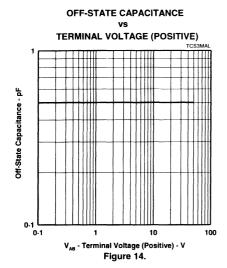


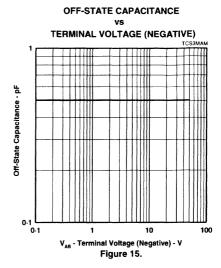
OFF-STATE CURRENT





TYPICAL CHARACTERISTICS A and B terminals



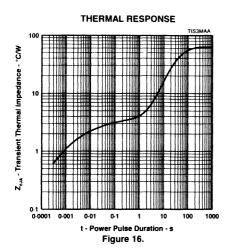


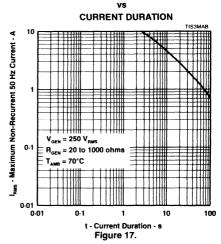


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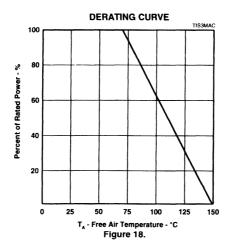
THERMAL INFORMATION

MAXIMUM NON-RECURRENT 50 Hz CURRENT





FREE AIR TEMPERATURE





TELECOMMUNICATION SYSTEM SECONDARY PROTECTION

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

| DEVICE | V _(Z) | V _(BO) |
|--------|------------------|-------------------|
| DEVICE | v | v |
| '3180L | 145 | 180 |

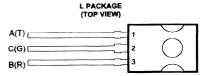
- Planar Passivated Junctions
 Low Off-State Current < 10 μA
- Rated for International Surge Wave Shapes

| WAVE SHAPE | STANDARD | I _{TSP} |
|------------|--------------|------------------|
| 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 |
| | FTZ R12 | 50 |
| 10/700 μs | VDE 0433 | 50 |
| | CCITT IX K17 | 50 |
| 10/1000 µs | REA PE-60 | 35 |

description

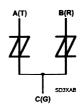
The TISP3180L is designed specifically for telephone equipment protection against lightning and transients induced by ac power lines. These devices consist of two bidirectional suppressor elements connected to a Common (C) terminal. They will supress voltage transients between terminals A and C. B and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



Pin 2 is in electrical contact with the mounting base.

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



TISP3180L DUAL SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

SLPSE33 - FEBRUARY 1990 - REVISED SEPTEMBER 1994

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) | | 100 | Ì |
| 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) 0.5/310 µs (RLM 88, open-circuit voltage wave shape 1.5 kV, 0.5/700 µs) | | 50 | |
| | | 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 | İ |
| 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 | TJ | 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

- 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.
- 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, $T_J = 25^{\circ}C$

| | PARAMETER | TEST CONDITIONS | | | MIN | TYP | MAX | UNIT |
|----------------|------------------------------|-------------------------|-----------|--------------|-------|-----|------|------|
| Vz | Reference zener voltage | I _Z = ± 1mA | | | ± 290 | | | ٧ |
| I _D | Off-state leakage current | V _D = ± 50 V | | | | | ± 10 | μА |
| Coff | 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, $T_J = 25^{\circ}C$

| | PARAMETER | | TEST CONDITIONS | | MIN | TYP | MAX | UNIT |
|-------------------|---|-------------------------|---------------------|--------------|--------|-------|-------|-------|
| ٧z | Reference zener voltage | I _Z = ± 1mA | | | ± 145 | | | ٧ |
| ∝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 | Α |
| 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 |
| ID | Off-state leakage current | V _D = ± 50 V | | | | | ± 10 | μА |
| Coff | 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%.

- 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

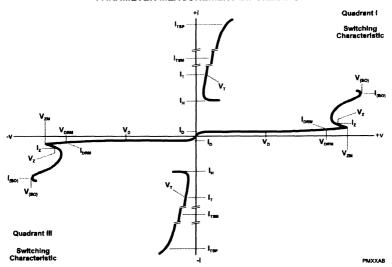


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR ANY PAIR OF TERMINALS

thermal characteristics

| PARAMETER | MIN | TYP | MAX | UNIT | |
|--|-----|-----|-----|------|--|
| R _{BJA} Junction to free air thermal resistance | | | 100 | °C/W | |



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

| DEVICE | V _(Z) | V _(BO) |
|--------|------------------|-------------------|
| DEVICE | V | V |
| '3290 | 200 | 290 |

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

| WAVE SHAPE | STANDARD | I _{TSP} |
|------------|--------------|------------------|
| 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 |
| | FTZ R12 | 50 |
| 10/700 µs | VDE 0433 | 50 |
| | CCITT IX K17 | 50 |
| 10/1000 µs | REA PE-60 | 35 |

description

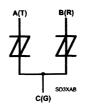
The TISP3290 is designed specifically for telephone equipment protection against lightning and transients induced by ac power lines. These devices consist of two bidirectional suppressor elements connected to a Common (C) terminal. They will supress voltage transients between terminals A and C, B and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

Pin 2 is in electrical contact with the mounting base.

MDXXAN

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



STRUMENTS

TISP3290 DUAL SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

SLPSE34 - NOVEMBER 1986 - REVISED SEPTEMBER 1994

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 | ĺ |
| 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) | | 35 | |
| Non-repetitive peak on-state current, 50 Hz, 2.5 s (see Notes 1 and 2) | 1TSP 38 50 45 35 1TSM 10 dit/dt 250 TJ 150 0 to 70 Tstg -40 to +150 | | A rms |
| Initial rate of rise of on-state current, Linear current ramp, Maximum ramp value < 38 A | 15M | | A/µs |
| Junction temperature | TJ | 150 | °C |
| Operating free - air temperature range | | 0 to 70 | °C |
| Storage temperature range | T _{stq} | -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

- 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.
- 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_{.1} = 25°C

| PARAMETER | | TEST CONDITIONS | | | MIN | TYP | MAX | UNIT |
|-----------|------------------------------|-------------------------|-----------|--------------|-------|-----|------|------|
| VZ | Reference zener voltage | I _Z = ± 1mA | | | ± 400 | | | v |
| ID | Off-state leakage current | V _D = ± 50 V | | | | | ± 10 | μА |
| Coff | 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_{.I} = 25°C

| | PARAMETER | | TEST CONDITION | 15 | MIN | TYP | MAX | UNIT |
|-------------------|---|-------------------------|--------------------|--------------|--------|-------|-------|-------|
| ٧z | Reference zener voltage | I _Z = ± 1mA | | | ± 200 | | | ٧ |
| ∝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 | Α |
| V _{TM} | Peak on-state voltage | I _T = ± 5 A | (see Notes 5 and 6 |) | | ± 1.9 | ± 3 | V |
| 1 _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 | μА |
| Coff | 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, $t_w = 100 \mu s$, duty cycle $\leq 2\%$.

- 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

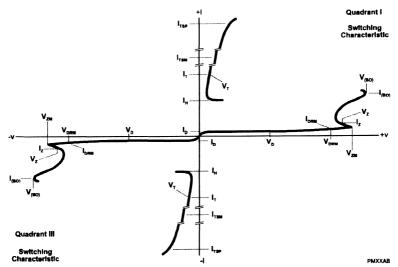


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR ANY PAIR OF TERMINALS

thermal characteristics

| ١ | PARAMETER | | | MAX | UNIT | |
|---|--|--|--|------|------|--|
| Ì | R _{BJA} Junction to free air thermal resistance | | | 62.5 | °C/W | |



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

| DEVICE | V _(Z) | V _(BO) |
|--------|------------------|-------------------|
| DEVICE | v | v |
| '3290L | 200 | 290 |

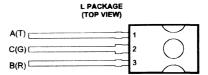
- Planar Passivated Junctions Low Off-State Current < 10 μΑ
- Rated for International Surge Wave Shapes

| WAVE SHAPE | STANDARD | I _{TSP} |
|------------|--------------|------------------|
| 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 |
| | FTZ R12 | 50 |
| 10/700 µs | VDE 0433 | 50 |
| | CCITT IX K17 | 50 |
| 10/1000 µs | REA PE-60 | 35 |

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.

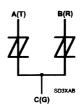
Transients are initially clipped by zener action until the voltage rises to the breakover level, which causes the device to crowbar. The high crowbar holding current prevents dc latchup as the transient subsides.



Pin 2 is in electrical contact with the mounting base.

MDXXAO

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



TISP3290L DUAL SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

SLPSE35 - FEBRUARY 1990 - REVISED SEPTEMBER 1994

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) 5/310 µs (CCITT IX K17, open-circuit voltage wave shape 1.5 kV, 10/700 µs) | | 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) | | 35 | |
| Non-repetitive peak on-state current, 50 Hz, 0.7 s (see Notes 1 and 2) | I _{TSM} | 10 | A rms |
| on-repetitive peak on-state current, 50 Hz, 0.7 s (see Notes 1 and 2) ITSM 10 Itial rate of rise of on-state current, Linear current ramp, Maximum ramp value < 38 A | | 250 | A/µs |
| Junction temperature | TJ | 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

- 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.
- 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 |
|------|------------------------------|-------------------------|-----------|--------------|-------|-----|------|------|
| Vz | Reference zener voltage | i _Z = ± 1mA | | | ± 400 | | | ٧ |
| ID | Off-state leakage current | V _D = ± 50 V | | | | | ± 10 | μА |
| Coff | 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 |
|-------------------|--|-------------------------|---------------------|--------------|--------|-------|-------|-------|
| Vz | Reference zener voltage | I _Z = ± 1mA | | | ± 200 | | | ٧ |
| ∝vz | Temperature coefficient of reference voltage | | | | | 0.1 | | %/°C |
| V _(BO) | Breakover voltage | (see Notes 5 and 6) | | | | | ± 290 | ٧ |
| I _(BO) | Breakover current | (see Note 5) | | | ± 0.15 | | ± 0.6 | Α |
| V _{TM} | Peak on-state voltage | I _T = ± 5 A | (see Notes 5 and 6) | | | ± 1.9 | ± 3 | ٧ |
| l _H | Holding current | (see Note 5) | | | ± 150 | | | mA |
| dv/dt | Critical rate of rise of off-state voltage | (see Note 7) | | | | | ± 5 | kV/μs |
| ID | Off-state leakage current | V _D = ± 50 V | | | | | ± 10 | μА |
| Coff | 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, $t_w = 100 \mu s$, duty cycle $\leq 2\%$.

- 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 % V₇ (minimum).



SLPSE35 - FEBRUARY 1990 - REVISED SEPTEMBER 1994

PARAMETER MEASUREMENT INFORMATION

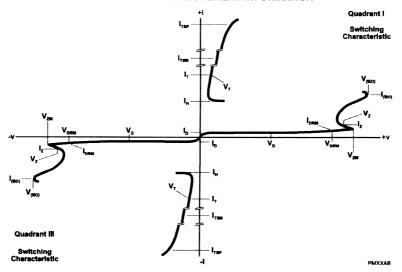


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR ANY PAIR OF TERMINALS

thermal characteristics

| PARAMETER | | | MAX | UNIT | ı |
|--|--|--|-----|------|---|
| R _{BJA} Junction to free air thermal resistance | | | 100 | °C/W | |



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

| | DEVICE | | V _(BO) |
|---|--------|----|-------------------|
| ' | DEVICE | v | v |
| | '4082 | 58 | 82 |

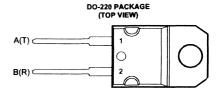
- Planar Passivated Junctions Low Off-State Current < 10 µA
- Rated for International Surge Wave Shapes

| WAVE SHAPE | STANDARD | I _{TSP} |
|------------|--------------|------------------|
| 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 |
| | FTZ R12 | 50 |
| 10/700 μs | VDE 0433 | 50 |
| | CCITT IX K17 | 50 |
| 10/1000 µs | REA PE-60 | 40 |

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.



Pin 1 is in electrical contact with the mounting base

MD4XAB

device symbol



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



TEXAS

TISP4082 SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

SLPSE36 - APRIL 1987 - REVISED SEPTEMBER 1994

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

| SYMBOL | VALUE | UNIT |
|---------------------|---|-------|
| | | |
| | 150 | |
| | 60 | 1 |
| | 50 | |
| ITSP | 38 | A |
| | 50 | |
| 1 | 50 | |
| | 45 | |
| | 50 | |
| I _{TSM} | 10 | A rms |
| di _T /dt | 250 | A/µs |
| TJ | 150 | °C |
| | 0 to 70 | °C |
| T _{stg} | -40 to +150 | °C |
| T _{lead} | 260 | °C |
| | I _{TSM} di _T /dt T _J | 17SP |

- NOTES: 1. Above 70°C, derate linearly to zero at 150°C case temperature
 - 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.
 - 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 |
|-------------------|--|-------------------------|---------------------|--------------|--------|-------|-------|-------|
| VZ | Reference zener voltage | I _Z = ± 1mA | | - | ± 58 | | | ٧ |
| ∝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 | Α |
| V _{TM} | Peak on-state voltage | $I_T = \pm 5 A$ | (see Notes 5 and 6) | | | ± 2.2 | ± 3 | ٧ |
| 1 _H | Holding current | (see Note 5) | | | ± 150 | | | mA |
| dv/dt | Critical rate of rise of off-state voltage | (see Note 7) | | | | | ± 5 | kV/μs |
| ID | Off-state leakage current | V _D = ± 50 V | | | | | ± 10 | μА |
| Coff | Off-state capacitance | V _D = 0 | f = 1 kHz | (see Note 4) | | 110 | 200 | ρF |

- 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 μ s, duty cycle \leq 2%.
 - 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 % Vz (minimum).

thermal characteristics

| PARAMETER | | TYP | MAX | UNIT |
|--|--|-----|------|------|
| R _{BJA} Junction to free air thermal resistance | | | 62.5 | °C/W |



PARAMETER MEASUREMENT INFORMATION

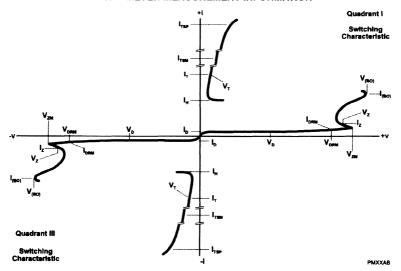


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC TERMINALS A AND B



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

| DEVICE | V _(Z) | V _(BO) |
|--------|------------------|-------------------|
| DEVICE | v | v |
| '4180 | 145 | 180 |

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

| WAVE SHAPE | STANDARD | I _{TSP} |
|------------|--------------|------------------|
| 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 |
| | FTZ R12 | 50 |
| 10/700 µs | VDE 0433 | 50 |
| | CCITT IX K17 | 50 |
| 10/1000 µs | REA PE-60 | 50 |

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.

DO-220 PACKAGE (TOP VIEW) A(T) 1 B(R) 2

Pin 1 is in electrical contact with the mounting base.

MD4XAB

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



TISP4180 SYMMETRICAL TRANSIENT **VOLTAGE SUPPRESSORS**

SLPSE37 - APRIL 1987 - REVISED SEPTEMBER 1994

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) | ITSM | 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 | TJ | 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 |
|-------------------|--|-------------------------|--|--|--------|-------|-------|-------|
| Vz | Reference zener voltage | I _Z = ± 1mA | | | ± 145 | | | ٧ |
| ∝v _z | Temperature coefficient of reference voltage | | and the state of t | | | 0.1 | | %/°C |
| V _(BO) | Breakover voltage | (see Notes 5 and 6) | | | | | ± 180 | ٧ |
| (BO) | Breakover current | (see Note 5) | | | ± 0.15 | | ± 0.6 | Α |
| V _{TM} | Peak on-state voltage | I _T = ± 5 A | (see Notes 5 and 6) | | | ± 2.2 | ± 3 | V |
| IH | Holding current | (see Note 5) | | | ± 150 | | | mA |
| dv/dt | Critical rate of rise of off-state voltage | (see Note 7) | | | | | ± 5 | kV/μs |
| ID | Off-state leakage current | V _D = ± 50 V | | ALL STATES OF THE STATES OF TH | | | ± 10 | μА |
| Coff | 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 % VZ (minimum).

thermal characteristics

| PARAMETER | | TYP | MAX | UNIT |
|--|--|-----|------|------|
| R _{BJA} Junction to free air thermal resistance | | | 62.5 | °C/W |



PARAMETER MEASUREMENT INFORMATION

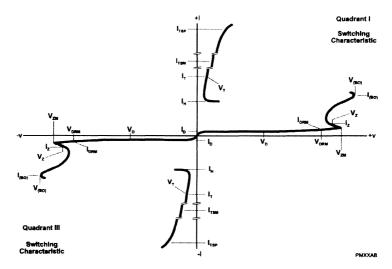
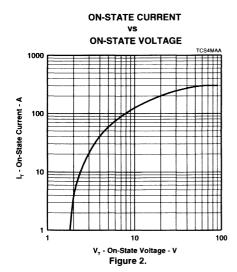


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR TERMINALS A and B

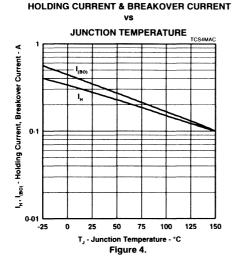


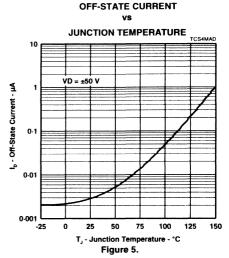


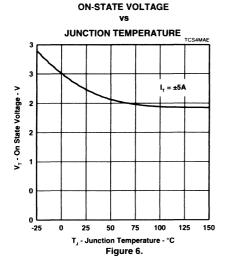
JUNCTION TEMPERATURE TCS4MAB V(80) 170 V(80) 170 V(80) 170 140 140 140 150 T, - Junction Temperature - °C Figure 3.

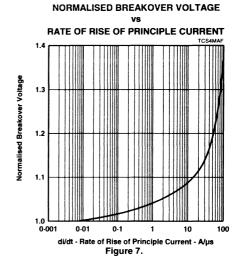
ZENER VOLTAGE & BREAKOVER VOLTAGE



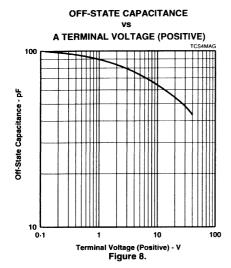


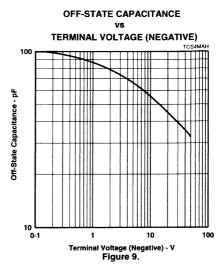




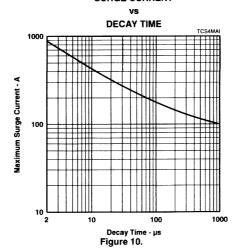








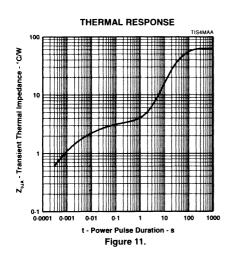
SURGE CURRENT

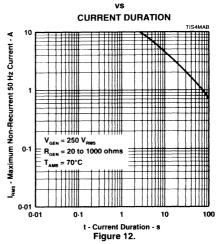




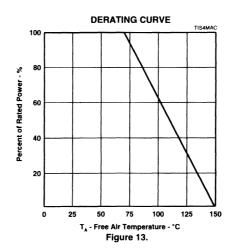
THERMAL INFORMATION

MAXIMUM NON-RECURRENT 50 Hz CURRENT





FREE AIR TEMPERATURE





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

| DEVICE | V _(Z) | V _(BO) |
|--------|------------------|-------------------|
| DEVICE | V | v |
| '4290 | 200 | 290 |

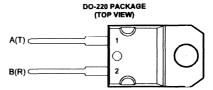
- Planar Passivated Junctions Low Off-State Current < 10 µA
- Rated for International Surge Wave Shapes

| WAVE SHAPE | STANDARD | I _{TSP} |
|------------|--------------|------------------|
| 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 |
| | FTZ R12 | 50 |
| 10/700 µs | VDE 0433 | 50 |
| | CCITT IX K17 | 50 |
| 10/1000 µs | REA PE-60 | 35 |

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.



Pin 1 is in electrical contact with the mounting base.

MD4XAB

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

ISTRUMENTS

TISP4290 SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

SLPSE38 - APRIL 1987 - REVISED SEPTEMBER 1994

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 | Ì |
| 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) | | 35 | ł |
| Non-repetitive peak on-state current, 50 Hz, 2.5 s (see Notes 1 and 2) | ITSM | 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 | TJ | 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

- 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.
- 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 |
|-------------------|--|-------------------------|---------------------|--------------|--------|-------|-------|-------|
| Vz | Reference zener voltage | I _Z = ± 1mA | | | ± 200 | | | ٧ |
| ∝v _z | Temperature coefficient of reference voltage | | | | | 0.1 | | %/°C |
| V _(BO) | Breakover voltage | (see Notes 5 and 6) | | 100 | | | ± 290 | ٧ |
| I _(BO) | Breakover current | (see Note 5) | | | ± 0.15 | | ± 0.6 | Α |
| V _{TM} | Peak on-state voltage | I _T = ± 5 A | (see Notes 5 and 6) | | | ± 1.9 | ± 3 | ٧ |
| 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 |
| ID | Off-state leakage current | V _D = ± 50 V | | | | | ± 10 | μА |
| Coff | 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, $t_w = 100 \mu s$, duty cycle $\leq 2\%$.
 - 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 _{BJA} Junction to free air thermal resistance | | | 62.5 | °C/W |



PARAMETER MEASUREMENT INFORMATION

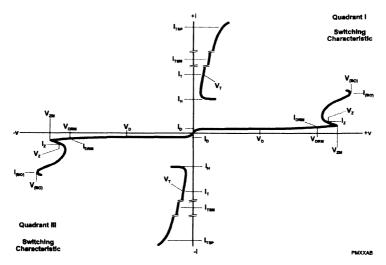


Figure 1. VOLTAGE-CURRENT CHARACTERISTIC FOR TERMINALS A AND B



SURGE CURRENT

DECAY TIME

TORHHAA

1000

1000

1000

Decay Time - µs

Figure 2.



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

| DEVICE | V _(Z) | V _(BO) |
|----------|------------------|-------------------|
| DEVICE | v | v |
| '4160LPR | 120 | 160 |
| '4180LPR | 145 | 180 |

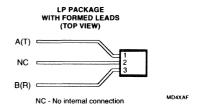
- **Planar Passivated Junctions** Low Off-State Current < 10 µA
- Rated for International Surge Wave Shapes

| WAVE SHAPE | STANDARD | I _{TSP} |
|------------|--------------|------------------|
| 8/20 µs | ANSI C62.41 | 100 |
| 0.5/700 μs | RLM 88 | 38 |
| 10/700 µs | VDE 0433 | 50 |
| 10//00 μs | CCITT IX K17 | 38 |

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.



device symbol



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



Texas

TISP4160LPR, TISP4180LPR SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

SLPSE39 - APRIL 1987 - REVISED SEPTEMBER 1994

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) | | 100 | |
| 5/200 µs (VDE 0433, open-circuit voltage wave shape 2 kV, 10/700 µs) | ITSP | 50 | Α |
| 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) | 1 | 38 | |
| Non-repetitive peak on-state current, 50 Hz, 1 s (see Notes 1 and 2) | I _{TSM} | 2.5 | À 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 | TJ | 150 | °C |
| Operating free - air temperature range | | 0 to 70 | °C |
| Storage temperature range | T _{stq} | -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
 - 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.
 - 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

| | 0.0.00 | TISP4160LP | | LP | TI | SP4180 | LP | UNIT | | | |
|-------------------|--|-------------------------|------------|--------------|-------------|--------|---------|--------|-------|-------|-------|
| PARAMETER | | TEST CONDITIONS | | MIN | MIN TYP MAX | | MIN TYP | | MAX | Oilli | |
| Vz | Reference zener voltage | I _Z = ± 1mA | | | ± 120 | | | ± 145 | | | ٧ |
| ~v _z | Temperature coefficient of reference voltage | | | | | 0.1 | | | 0.1 | | %/°C |
| V _(BO) | Breakover voltage | (see Notes 5 | and 6) | | | | ± 160 | | | ± 180 | ٧ |
| I _(BO) | Breakover current | (see Note 5) | | | ± 0.15 | | ± 0.6 | ± 0.15 | | ± 0.6 | Α |
| 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 |
| ID | Off-state leakage current | V _D = ± 50 V | | | | | ± 10 | | | ± 10 | μА |
| Coff | 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.
 - 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 % Vz (minimum).

thermal characteristics

| 1 | PARAMETER | MIN | TYP | MAX | UNIT |
|---|--|-----|-----|-----|------|
| | R _{eJA} Junction to free air thermal resistance | | | 156 | °C/W |



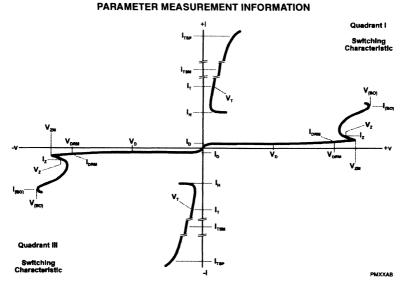


Figure 1. VOLTAGE-CURRENT CHARACTERISTICS FOR TERMINALS A AND B



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

| DEVICE | V _(Z) | V _(BO) |
|---------|------------------|-------------------|
| | ٧ | ٧ |
| '4290LP | 200 | 290 |

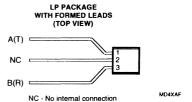
- Planar Passivated Junctions
 Low Off-State Current < 10 μA
- Rated for International Surge Wave Shapes

| WAVE SHAPE | STANDARD | I _{TSP} |
|------------|--------------|------------------|
| 8/20 µs | ANSI C62.41 | 150 |
| 0.5/700 µs | RLM 88 | 38 |
| 10/700 μs | VDE 0433 | 50 |
| | CCITT IX K17 | 50 |

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.



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



TISP4290LPR SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

SLPSE40 - APRIL 1987 - REVISED SEPTEMBER 1994

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) | | 100 | |
| 5/200 µs (VDE 0433, open-circuit voltage wave shape 2 kV, 10/700 µs) | ITSP | 50 | Α |
| 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 | Ťj | 150 | °C |
| Operating free - air temperature range | | 0 to 70 | °C |
| Storage temperature range | T _{stq} | -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
 - 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.
 - 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 CONDIT | IONS | MIN | TYP | MAX | UNIT |
|-------------------|---|-------------------------|------------------|--|--------|-------|-------|-------|
| Vz | Reference zener voltage | I _Z = ± 1mA | | 450 | ± 200 | | | V |
| ~v _z | Temperature coefficient of reference voltage | | | | | 0.1 | | %/°C |
| V _(BO) | Breakover voltage | (see Notes 5 and 6) | | | | | ± 290 | ٧ |
| 1 _(BO) | Breakover current | (see Note 5) | | | ± 0.15 | | ± 0.6 | Α |
| 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) | | A CONTRACTOR OF THE CONTRACTOR | ± 150 | | | mA |
| dv/dt | Critical rate of rise of off-state voltage | (see Note 7) | | | | | ± 5 | kV/μs |
| ID | Off-state leakage current | V _D = ± 50 V | | | | | ± 10 | μА |
| Coff | 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 μ s, duty cycle \leq 2%.
 - 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 | | TYP | MAX | UNIT | ١ |
|--|--|-----|-----|------|---|
| R _{BJA} Junction to free air thermal resistance | | | 156 | °C/W | ĺ |



PARAMETER MEASUREMENT INFORMATION

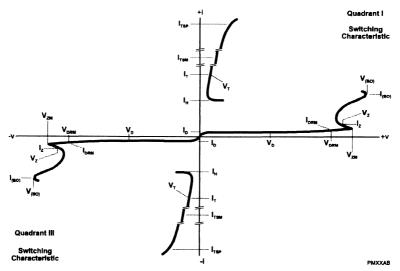


Figure 1. VOLTAGE-CURRENT CHARACTERISTICS FOR TERMINALS A AND B



Advance Information

Cell Package



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

description

The 9EL2 Primary Protector is designed specifically applications that for 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.





MD4YAC

device symbol



monolithic protection devices 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.

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9EL2 SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

SLPSE42 - JANUARY 1994 - REVISED SEPTEMBER 1994

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 | Α |
| 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) | ITSM | -40 to +65°C | 10 | A rms |
| Junction temperature | Tj | | 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 | | | ٧ |
| | | ≤ 250 V/ms, ≤ 1 A/ms | +15 to +25°C | ± 265 | | | ٧ |
| | | ≤ 250 V/ms, ≤ 1 A/ms | -40 to +65°C | | | ± 400 | ٧ |
| $V_{(BO)}$ | | ≤ 100 V/μs, ≤ 10 A/μs | -40 to +65°C | | | ± 400 | V |
| | | ≤ 1 kV/μs, ≤ 10 A/μs | -40 to +65°C | J | | ± 400 | V |
| | Impulse reset | 52.5 V, 260 mA S.C., dc | | | | | |
| | | 135 V, 200 mA S.C., dc | -40 to +65°C | | | 20 | ms |
| | | 1000 V, 25 A S.C., 10/1000 μs | | 1 | | | |
| | 0" | $V_D = \pm 50 \text{ V}$ | -40 to +65°C | | | ± 0.5 | μА |
| D | Off-state current | $V_D = \pm 200 \text{ V}$ (see Note 4) | -40 to +65°C | | | ± 10 | μА |
| Coff | Off-state capacitance | 1 Vrms, 1 MHz, V _D = 0 Vdc bias | -40 to +65°C | | | 150 | ρF |

- 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

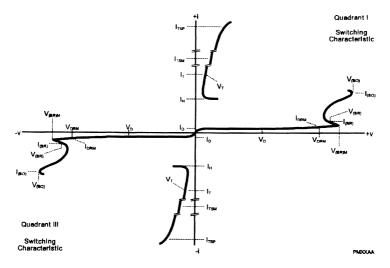


Figure 1. VOLTAGE-CURRENT CHARACTERISTICS



4-5

MD4XAC

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

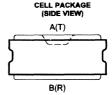
| WAVE SHAPE | STANDARD | ITSP |
|------------|--------------|-------|
| 10/700 µs | CCITT IX K17 | 5 kV |
| 10/1000 µs | Bellcore | 100 A |

- **Fast Response to Transients Gives** Low Let Through Voltage < 350 V @ 1000 V/us
- **Sealed Cell Construction High Current Capability**
- Soldered Copper Electrodes for **High Strength**
- Fails Short Circuit Under Excessive **Current Conditions**

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.





SOLID STATE REPLACEMENT FOR GAS DISCHARGE TUBES



These monolithic protection devices 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.

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9EL3 SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

SLPSE43 - JANUARY 1994 - REVISED SEPTEMBER 1994

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 | Α |
| 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 | Tj | | 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.

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 |
|------------|-----------------------|--|---------------------------------------|-------|-----|-------|------|
| | | ≤ 250 V/ms, ≤ 1 A/ms | +15 to +25°C | ± 200 | | | V |
| ., | Decelor | ≤ 250 V/ms, ≤ 1 A/ms | 0 to +65°C | | | ± 265 | ٧ |
| $V_{(BO)}$ | Breakover voltage | ≤ 100 V/μs, ≤ 10 A/μs | 0 to +65°C | | | ± 350 | ٧ |
| | | ≤ 1 kV/μs, ≤ 10 A/μs | 0 to +65°C | | | ± 350 | ٧ |
| | | 52.5 V, 260 mA S.C., dc | | | | | |
| | Impulse reset | 135 V, 200 mA S.C., dc | 0 to +50°C | | | 20 | ms |
| | | 1000 V, 25 A S.C., 10/1000 μs | | | | | |
| | Off-state current | V _D = ± 50 V (see Note 3) | 0 to +65°C | | | ± 0.5 | μА |
| ΙD | On-state current | V _D = ± 200 V (See Note 3) | 0 to +65°C | | | ±1 | μА |
| Coff | 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

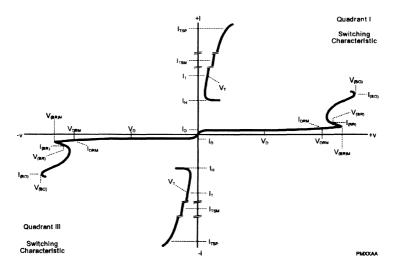


Figure 1. VOLTAGE-CURRENT CHARACTERISTICS



4-9

| V _(BO) max | 250 V | 0 | 250 | V/ms |
|-----------------------|-------|---|-----|------|

- Planar Passivated Junctions Low Leakage
 Extended Service Life
- Rated for International Surge Wave Shapes

| WAVE SHAPE | STANDARD | ITSP |
|------------|--------------|-------|
| 10/700 µs | CCITT IX K17 | 5 kV |
| 10/1000 µs | Bellcore | 100 A |

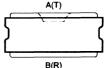
- Sealed Cell Construction High Current Capability
- Soldered Copper Electrodes for High Strength
- Fails Short Circuit Under Excessive Current Conditions

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.

CELL PACKAGE (SIDE VIEW)



MD4XAC

device symbol



These monolithic protection devices 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.

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9EL5 SYMMETRICAL TRANSIENT VOLTAGE SUPPRESSORS

SLPSE44 - JANUARY 1994 - REVISED SEPTEMBER 1994

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) | ITSP | 0 to +70°C | 125 | Α |
| 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 | Tj | | 150 | °C |
| Storage temperature range | T _{stq} | | -20 to +85 | °C |

- NOTES: 1. The surge may be repeated after the device has returned to thermal equilibrium.
 - 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 | ТҮР | MAX | UNIT |
|-------------------|-----------------------|--|---------------------------------------|--------|-----|-------|------|
| V _(BR) | Breakdown voltage | I _(BR) = 20 mA (see Note 3) | 0 to +70°C | ± 175 | | | ٧ |
| | | ≤ 250 V/ms, ≤ 1 A/ms | 0 to +70°C | | | ± 250 | V |
| $V_{(BO)}$ | Breakover voltage | ≤ 100 V/μs, ≤ 10 A/μs | 0 to +70°C | | | ± 250 | ν |
| I _H | Holding current | di/dt = ± 30 mA/ms | 0 to +70°C | ± 0.15 | | | Α |
| ID | Off-state current | V _D = ± 50 V (see Note 4) | 0 to +70°C | | | ± 10 | μA |
| Coff | 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

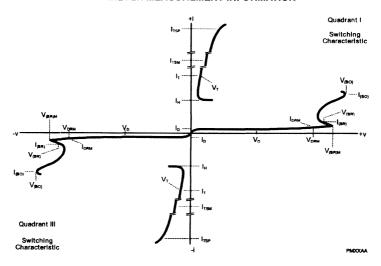


Figure 1. VOLTAGE-CURRENT CHARACTERISTICS



4-13

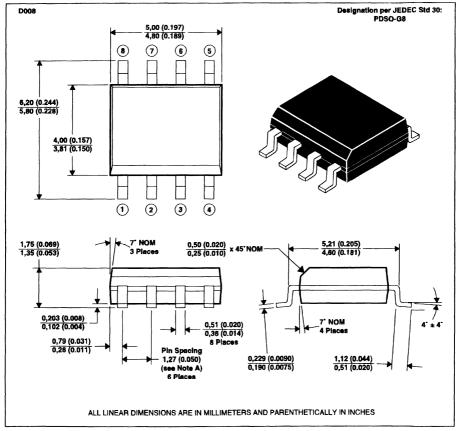
Mechanical Data



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.



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).

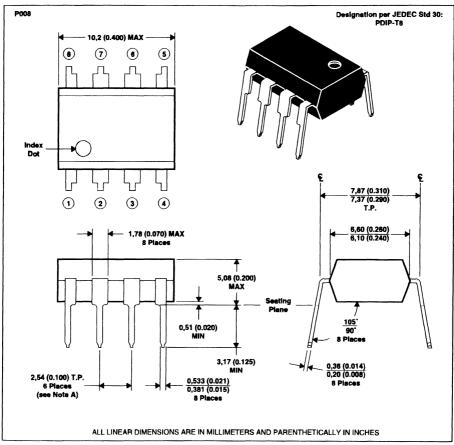
MDXXAA



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

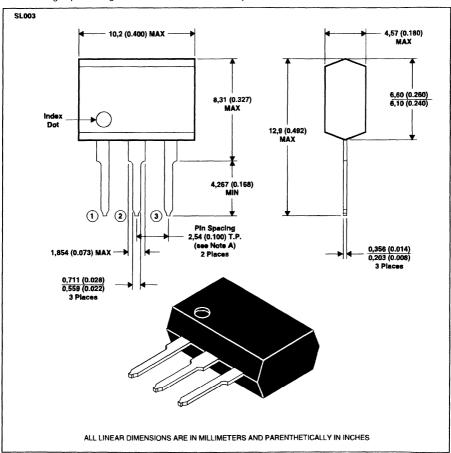
MDXXAB



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.

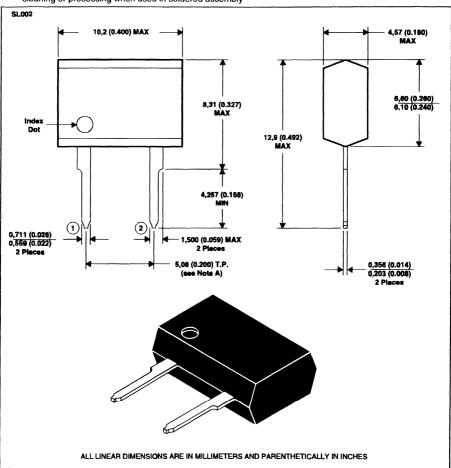
MDXXAD



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.

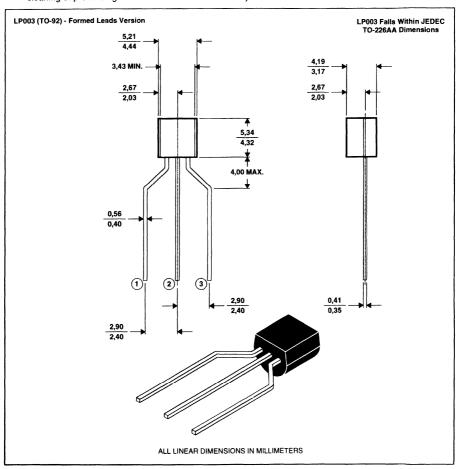
MDXXAC



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.



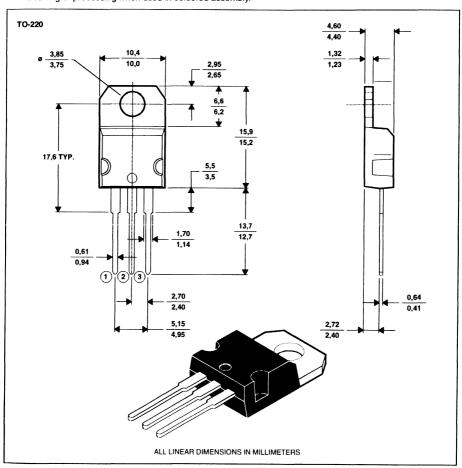
MDXXAR



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.



NOTE A: The centre pin is in electrical contact with the mounting tab.

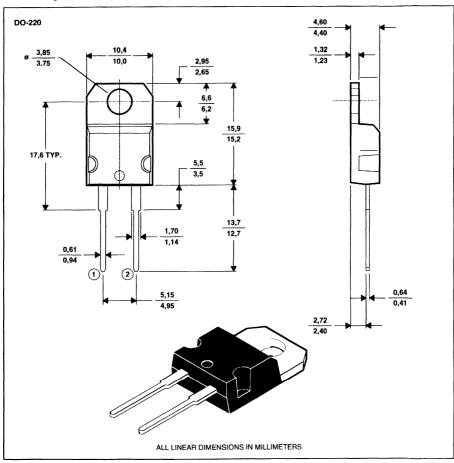
MDXXAP



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.

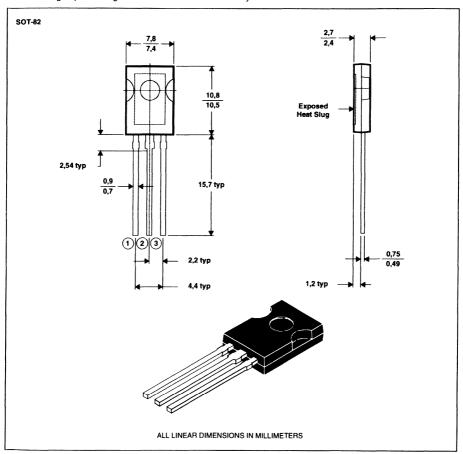
MDXXAU



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.

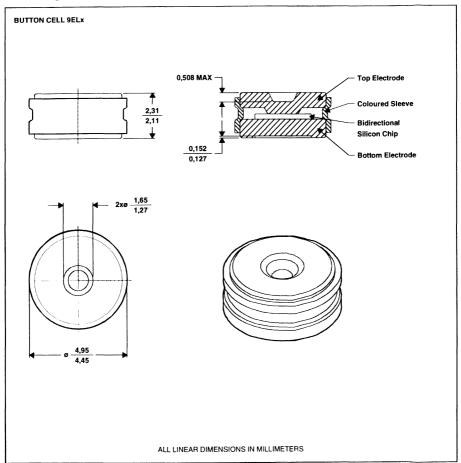


NOTE A: The centre pin is in electrical contact with the heat slug.

MDXXAQ



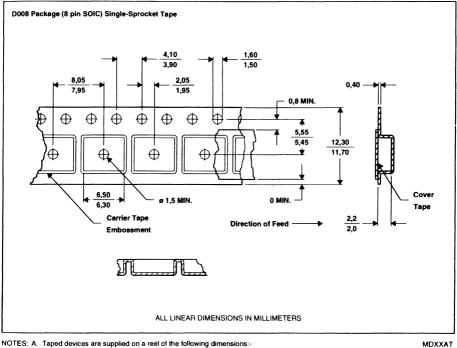
Cell Package



MDXXAV



D008 tape dimensions



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

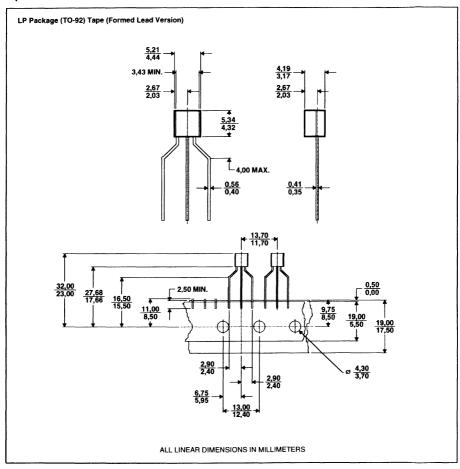
Reel diameter: Reel hub diameter: 330 +0,0/-4,0 mm 100 ±2,0 mm Reel axial hole: 13,0 ±0,2 mm

B. 2500 devices are on a reel.



5-11

LPR tape dimensions



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 | Protection | I _(BO) = 150mA | Package |

Configuration Voltage $I_{(H)} = 150 mA$

D = 8 pin surface mount

DR = tape and reel P = 8 pin dual in line (not TISP4xxx) SL = single in line

e.g.

TIŠP7290F3DR 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 | |

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 | Protection | Working | Protection |
|------------------|----------|---|-------------|-------------|-------------|-------------|
| | | | Voltage (V) | Voltage (V) | Voltage (V) | Voltage (V) |
| | | | Existing | Packages | NEW IC | Packages |
| SLIC linecard | TISP1xxx | İi | 58 | 82 | 58 | 72 |
| | | 7 7 | | | 66 | 82 |
| 3 wire battery | TISP2xxx | | | | | |
| backed ringing | | | 58 145 | 82 180 | 58 | 72 |
| | | 本本 | 200 | 290 | 66 | 82 |
| 3 wire ground | TISP3xxx | Ġ | | | 100 | 125 |
| backed ringing | THE GAM | T R | 58 | 82 | 100 | 123 |
| 0 0 | | 1 to 1 | 145 | 180 | 120 | 150 |
| | | 4 4 | 200 | 290 | | |
| | | | i | | 145 | 180 |
| 2 wire system | TISP4xxx | _ | 58 | 82 | 180 | 240 |
| | | | 120 | 160 | | |
| | | | 145 | 180 | 200 | 260 |
| | | 44 | 200 | 290 | 000 | 200 |
| | | l l | | | 220 | 290 |
| ISDN / Interwire | TISP7xxx | T R | 237 | | 240 | 320 |
| | | N. A. | | | 270 | 380 |
| | | | | | | |



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