Parameter list for SCRs, Triacs, AC Switches, and Diacs

Introduction

All datasheet parameters are rated as minimum or maximum values, corresponding to the product parameter distribution. In each datasheet, two classes of parameters are available:

1. Absolute ratings, corresponding to critical parameters, not to be exceeded for safe operation. If the absolute rating is exceeded, the component may be damaged.
2. Electrical, thermal, and static characteristics, defining limits on product characteristics.

1 Parameters

Table 1. Absolute ratings parameters

Parameter	Name and description
V_{DRM} / V_{RRM} V_{RM}	**Repetitive peak off-state voltage (50-60 Hz)** This is the maximum peak voltage allowed across the device. This parameter is specified up to the maximum junction temperature and the leakage currents, I_{DRM} / I_{RRM} are specified under this value.
V_{DSM} / V_{RSM}	**Non repetitive peak off-state voltage** This is the maximum peak voltage allowed under pulse conditions across the device. It is specified for pulse durations lower or equal to 10 ms. This parameter guarantees the ruggedness of the Triac in case of fast line transients exceeding the specified V_{DRM} / V_{RRM} value.
$I_{T(RMS)}$	**On-state rms current** This is the maximum rms current allowed in the device for a specified case temperature (T_c), or ambient temperature (T_a) or lead temperature (T_l), depending on the package type.
$I_{T(AV)}$	**Average on-state current (SCR only)** This is the maximum average current allowed in the SCR at a specified case temperature (T_c), or ambient temperature (T_{amb}) or lead temperature (T_l), depending on the type of package.
I_{TRM}	**Repetitive peak on-state current** This is the maximum allowable repetitive peak current for a specified pulse duration at a specified case, ambient or lead temperature and frequency.
I_{TSM}	**Non repetitive surge peak on-state current** This is the maximum peak current allowed in the device under pulse conditions. For Triacs, it is defined for a single full cycle sine wave of 20 ms corresponding to the 50 Hz mains, and 16.6 ms for the 60 Hz mains. If the absolute rating is exceeded, the component may be damaged.
dI/dt	**Critical repetitive rate of rise of on-state current** During turn-on, the maximum rate of rise of current should not exceed this maximum value. Above this limit, the SCR, or Triac may be damaged.
I^2t	**Value for fuse definition** To protect the device, the I^2t rating of the fuse used in series with it must be lower than this specified value. This parameter is linked to the I_{TSM} parameter as described below: $i^2t = \frac{i^2{TSM}}{2} t_p$ with t_p the duration of full-cycle sinewave.
T_{stg}, T_j	**Storage and operating junction temperatures** The storage temperature range is the range in which the device can be stored (shipping, handling, storage...), without working. The operating junction temperature range is the range at which the junction can work without damage.
I_{GM}	**Peak gate current** This is the maximum peak current allowed through gate and cathode, defined for a 20 µs pulse duration. If the absolute rating is exceeded, the component may be damaged.
$P_{G(AV)}$	**Average gate power dissipation** This is the maximum average power that the gate junction can dissipate. If the absolute rating is exceeded, the component may be damaged.
V_{RGM}	**Peak reverse gate voltage** This parameter is only defined for SCRs. It is the maximum reverse voltage than can be applied across gate and cathode terminals, without risk of destruction of the gate to the cathode junction.
V_{GM}	**Peak positive gate voltage (with respect to the pin "COM")** This parameter is only defined for ACSs. It is the maximum voltage than can be applied across gate and COM terminals without risk of destruction of the gate to the COM junction.

Table 2. Electrical characteristics parameters

Parameter	Name and description
P	**Average power dissipation** This is the average power dissipated by current conduction through the device for one full cycle operation.
I_{GT}	**Triggering gate current** This is the current to apply between gate and cathode (or gate and electrode A1 for Triac) to turn-on the device. This parameter defines the sensitivity of the component. For a SCR, the gate current has always to be sunk by the gate. For a TRIAC, I_{GT} is define for 3 or 4 quadrants corresponding to the different polarities of A2, A1 and gate: • Q1: Ig sunk by the gate, VA2-A1 > 0 • Q2: Ig sourced by the gate, VA2-A1 > 0 • Q3: Ig sourced by the gate, VA2-A1 < 0 • Q4: Ig sunk by the gate, VA2-A1 < 0 The I_{GT} value is higher in Q4 quadrant. For ACS types, I_{GT} is defined in two quadrants (Q2 and Q3).
V_{GT}	**Triggering gate voltage** This is the voltage to apply across gate and cathode (or gate and electrode A1 for Triac) to reach the I_{GT} current and then to trigger the device.
V_{GD}	**Non-triggering gate voltage** V_{GD} is the maximum voltage which can be applied across gate and cathode (or gate and electrode A1 for Triac) without causing undesired turn-on. This parameter is specified, for the worst case scenario, at the maximum junction temperature.
I_H	**Holding current** This is the current level circulating through anode and cathode (or A2 and A1 for a Triac) under which the device turns off, without gate current.
I_L	**Latching current** This is the current level circulating through anode and cathode (or A2 and A1 for a Triac) to keep the device conducting after removal of the gate current. If the anode current is under this value after having removed the gate current, the device switches off. For Triacs, the I_L value is higher in Q2 quadrant.
dV/dt	**Critical rate of rise of off-state voltage** This is the maximum value of rate of the rising voltage that can be applied across anode and cathode of the SCR (or across A2 and A1 for a Triac) without risking turning it on spuriously.
(dI/dt)c	**Critical rate of decrease of commutating on-state current** This is the maximum rate of decrease of the anode current allowed to turn the Triac off. Above this value, the Triac can remains ON in next reverse polarity. For standard, logic level Triacs and ACSs, the (dI/dt)c is specified with a limited (dV/dt)c parameter. For Snubberless Triacs, this value is specified without it.
(dV/dt)c	**Critical rate of rise of commutating off-state voltage** This is the maximum rate of rise of the reapplied voltage during turn-off. Above this limit, the Triac may remain ON without any gate current.
V_{CL}	**Clamping voltage** This is the voltage level, applied across OUT and COM terminals, from which the device enters in avalanche mode. It is only defined for ACS and ACST devices which internally feature an overvoltage protection capability.
V_{BO}	**Breakover voltage** This is the voltage measured across the terminals of a Diac or across OUT and COM terminals of an ACS/ ACST, when the device current reaches its I_{BO} level (no gate current). Above this point, the device will turn on in breakover mode.
I_{BO}	**Breakover current** This is current flowing through a Diac or an ACS just before that the device switches on in the breakover mode.

Parameter	Name and description
V_{TM}	**Peak on-state voltage drop** This is the voltage across the device while it is on-state. It is specified at the peak current corresponding to the $I_{T(RMS)}$ current of the device.
V_F	**Peak forward voltage drop** This is the voltage across a diode when the diode is conducting.
V_{to} / R_d	**Threshold voltage** Dynamic on-state resistance. These two parameters are used to calculate the instantaneous voltage drop according to the relation $V_T = V_{to} + R_d \times I_T$. They are also useful to calculate the power dissipation of the device: For SCR: $$P = V_{t0} \times I_{T(AV)} + R_d \times i^2{}_{T(RMS)} \quad (1)$$ For Triacs: $$P = \frac{2\sqrt{2}}{\pi} V_{t0} \times I_{T(RMS)} + R_d \times I^2{}_{T(RMS)} \quad (2)$$
I_{DRM} / I_{RRM} I_{RM} or I_R	**Maximum forward and reverse leakage current (SCRs, Triacs and ACS) / Maximum leakage current for diodes** This is the current flowing through the device when it is in the OFF state, at the specified V_{DRM} or V_{RRM} value for Triacs or SCRs, or V_R for diodes or Diacs. Please refer to Appendix A Testing method for parameters.
t_{gt}	**Turn-on time** This is the time between the beginning of the gate current pulse (10% of its peak value) and when the A-K voltage of the SCR or A2-A1 voltage of the Triac has fallen down to 10% of its previous stand-off value.
t_q	**Turn-off time** This parameter is specific to SCRs. After this time, a positive voltage rate can be applied across Anode and Cathode without causing any spurious firing. This parameter defines the maximum operating frequency of the SCR.
t_d	**Delay time** This is the time between the beginning of the gate current pulse (10% of its peak value) and the beginning of the decrease of the A2-A1 or A-K voltage (90% of its peak value).
t_p	**Rise time** For a Diac, this is the time between 10% and 90% of the peak current generated when the component discharge a specified capacitor into a specified load.
V_{BR}	**Breakdown voltage** This is the voltage across the device, at off-state, measured at a specified current level. This parameter is specific for some ASD and protection devices.
αT	**Temperature coefficient** This is the positive temperature coefficient of the breakover voltage. This parameter is generally specified in percentage, for specific devices.
V_O	**Output voltage** For a Diac, this is the peak voltage across a 20 Ω resistor in series with the device during the discharge of a specified capacitor.
ΔV	**Dynamic breakover voltage** For a Diac, this is the dynamic variation of its voltage at triggering. It is the difference between V_{BO} and the voltage for a 10 mA current. $\Delta V = V_{BO} - V_{Diac}$ (10 mA). Diacs feature a negative-resistance triggered characteristic.
$R_{th(j-a)}$	**Junction to ambient thermal resistance** This is the thermal resistance between junction and ambient, when the device is used without heatsink. For SMD packages, the copper surface under the tab is specified.

Parameter	Name and description
$R_{th(j-c)}$	**Junction to case thermal resistance** This is the thermal resistance between junction to case. For Triacs and SCRs, this value is respectively specified for AC and DC operations.
$R_{th(j-l)}$	**Junction to lead thermal resistance** This is the thermal resistance between junction and leads. It is given for small packages like TO92, with no other metallic case temperature reference.
$Z_{th(j-c)}$ $Z_{th(j-a)}$	**Transient thermal impedance** This is the value of the thermal resistance when the steady state of the device is not reached. Curves provided in the datasheets, $Z_{TH(j-c)}$ and $Z_{TH(j-a)}$, show the relative value of this impedance according the to the time duration of dissipated power pulse.

Appendix A Testing method for parameters

The testing method for I_{DRM} / I_{RRM} parameters is:

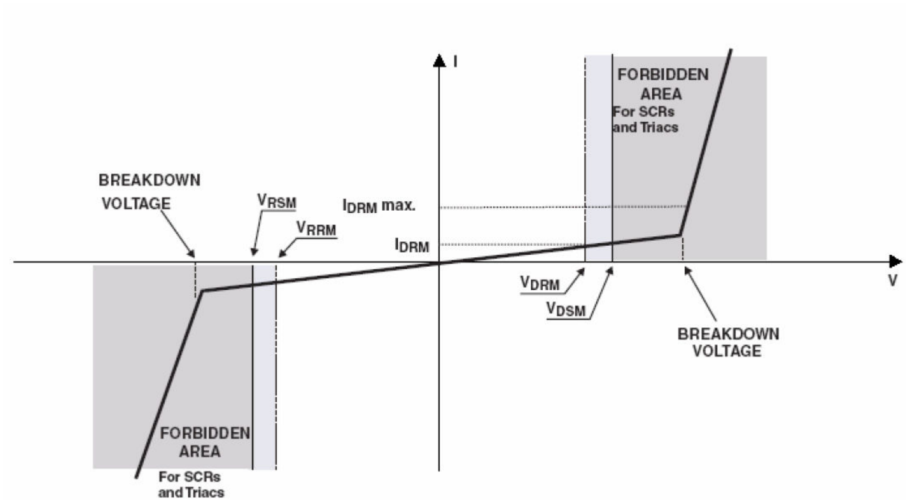
- Apply the specified V_{DRM} or V_{RRM} voltage across the anode and the cathode (or A2 and A1 terminals for Triacs, or OUT and COM terminals for AC Switches)
- Measure the leakage current peak value: it must be less than the maximum specification value (I_{DRM} / I_{RRM} max.).

It is forbidden to use a current supply and apply the I_{DRM} / I_{RRM} max. through the anode and the cathode, and then measure the voltage.

In this case, the Triac or the SCR goes into breakdown voltage and may be damaged.

Note: A voltage higher than the V_{DRM} / V_{RRM} rated values may be applied for less than 10 ms if it does not exceed the V_{DSM} / V_{RSM} parameters specified in the device datasheet.

Figure 1. Relationship between applied and measured values



Revision history

Table 3. **Document revision history**

Date	Revision	Changes
Aug-2005	1	Initial release.
28-Jan-2008	2	Reformatted to current standards.
24-Mar-2022	3	Minor text changes.
02-Mar-2023	4	Updated the power dissipation equation for Triacs.

Contents

List of figures