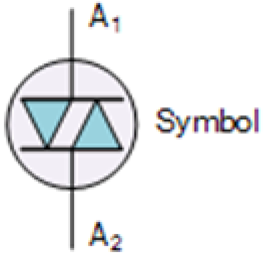
Diac



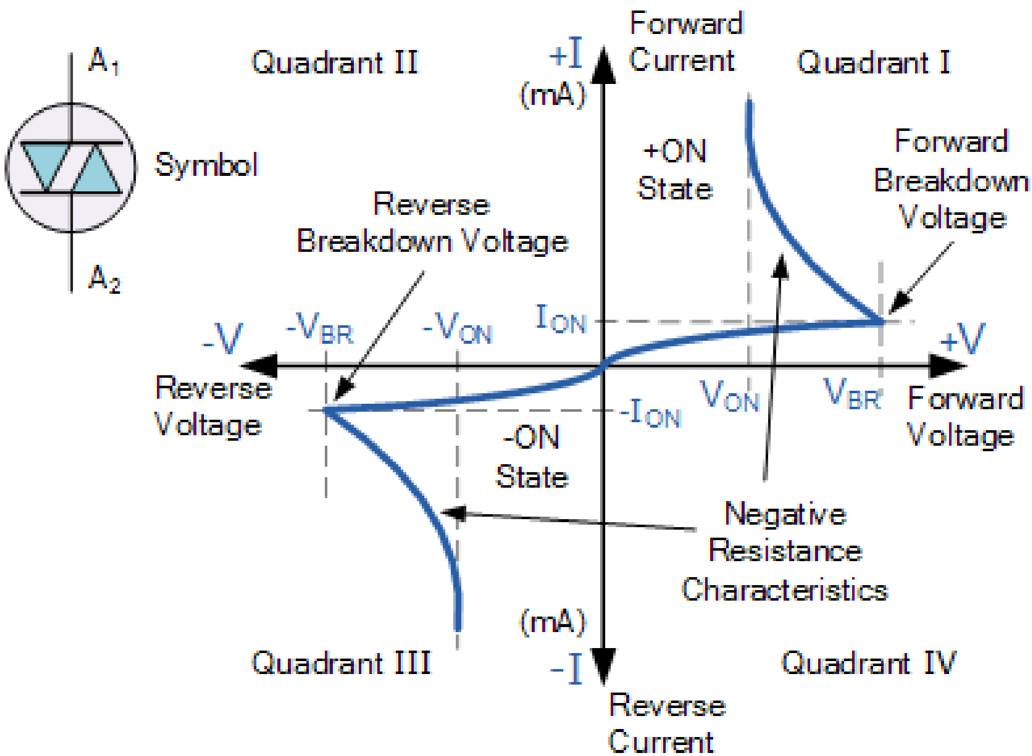
The **DI**ode **AC** switch, or **Diac** for short, is another solid state, three-layer, two-junction semiconductor device but unlike the transistor the *Diac* has no base connection making it a two terminal device, labelled A_1 and A_2.

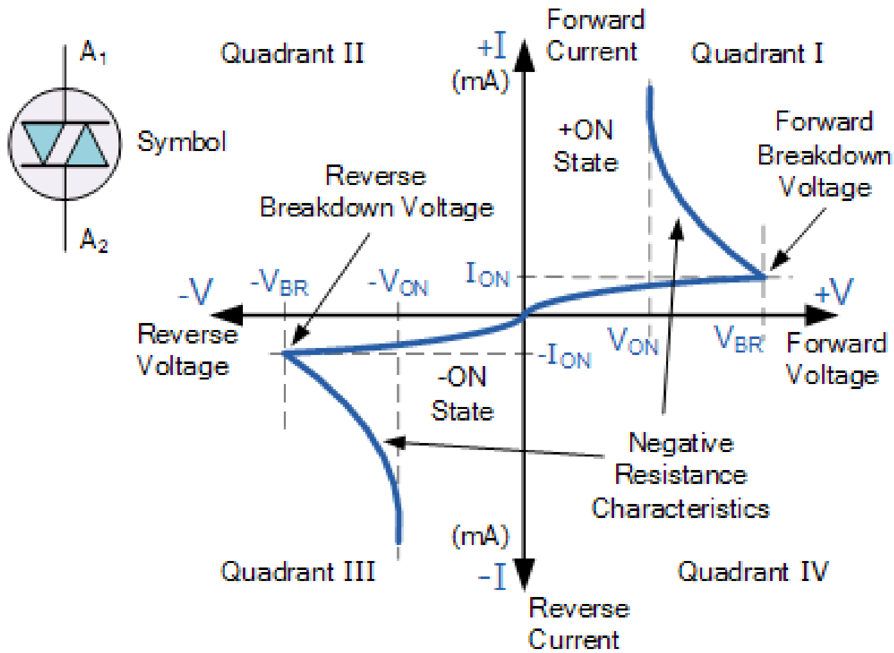
Diac's are an electronic component which offer no control or amplification but act much like a bidirectional switching diode as they can conduct current from either polarity of a suitable AC voltage supply.

Diac

- The diac is constructed like a transistor but has no base connection allowing it to be connected into a circuit in either polarity.
- Diac's are primarily used as trigger devices in phase-triggering and Variable power control applications because a diac helps provide a sharper and more instant trigger pulse (as opposed to a steadily rising ramp voltage) which is used to turn "ON" the main switching device.

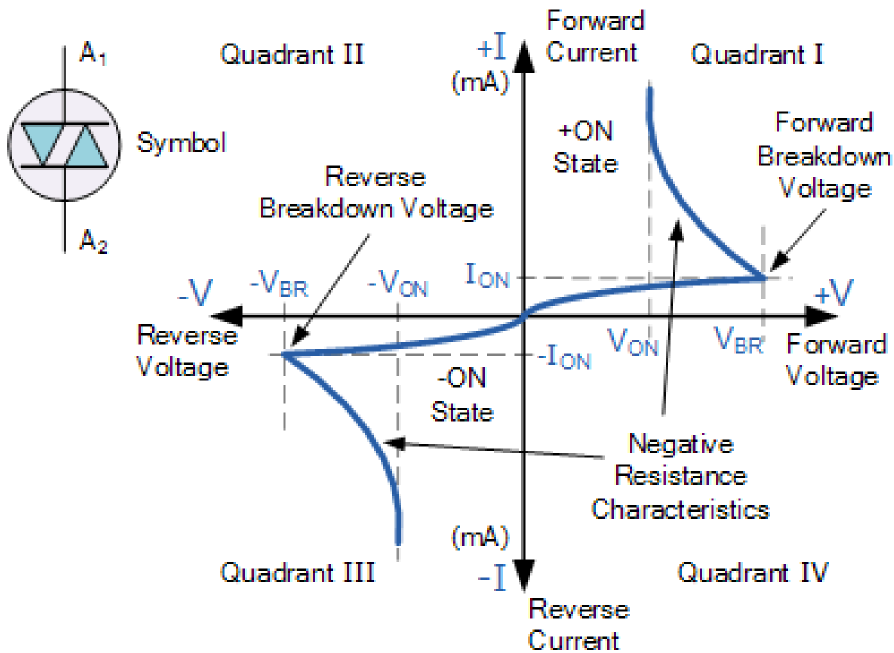
The DIAC symbol and the voltage-current characteristics curves of the DIAC



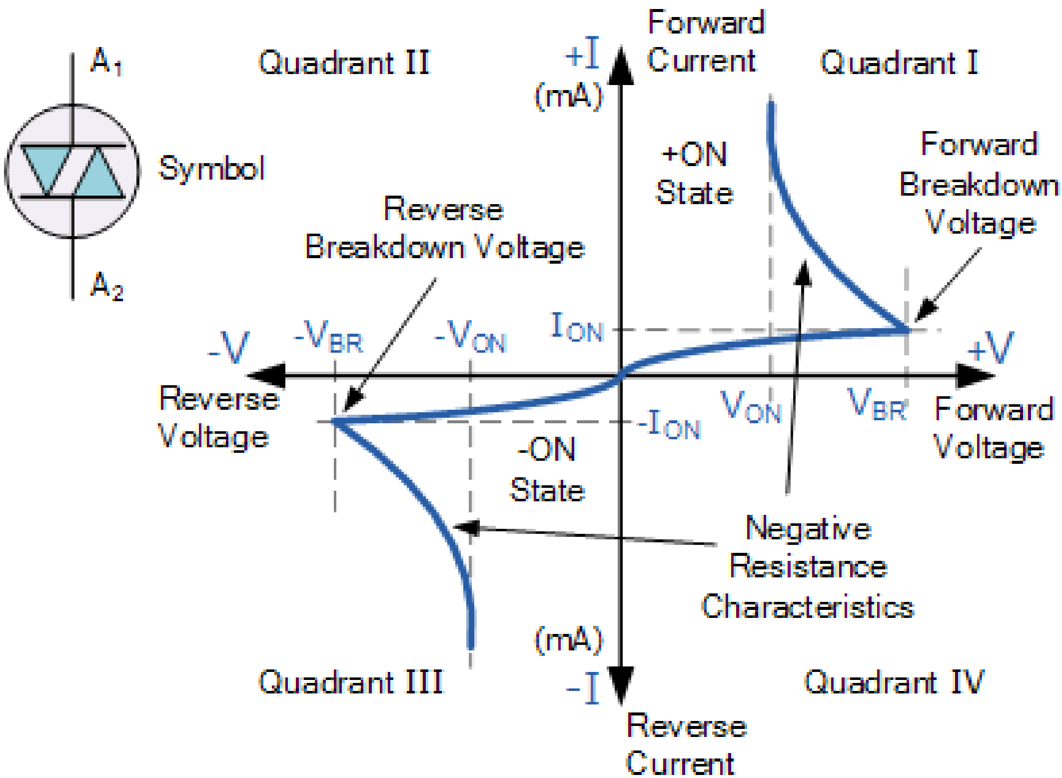


Diac I-V characteristics curves shows that the diac blocks the flow of current in both directions until the applied voltage is greater than V_{BR}, at which point breakdown of the device occurs and the diac conducts heavily in a similar way to the zener diode passing a sudden pulse of voltage. This V_{BR} point is called the Diacs breakdown voltage or breakover voltage.

In an ordinary zener diode the voltage across it would remain constant as the current increased. However, in the diac the transistor action causes the voltage to reduce as the current increases.



Once in the conducting state, the resistance of the diac falls to a very low value allowing a relatively large value of current to flow. For most commonly available diacs such as the ST2 or DB3, their breakdown voltage typically ranges from about ±25 to 35 volts. Higher breakover voltage ratings are available, for example 40 volts for the DB4 diac.



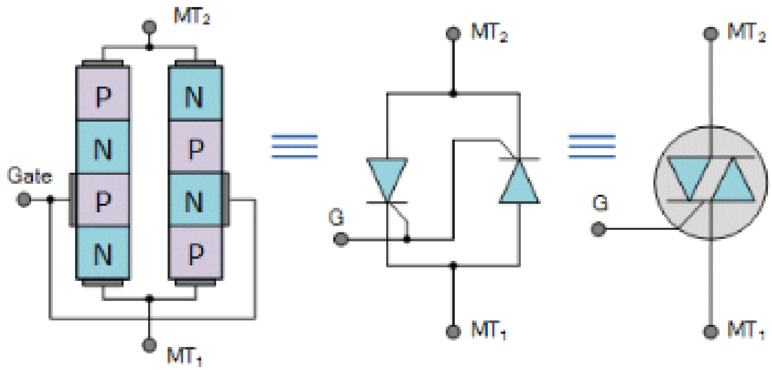
This action gives the diac the characteristic of a negative resistance as shown above. As the diac is a symmetrical device, it therefore has the same characteristic for both positive and negative voltages and it is this negative resistance action that makes the **Diac** suitable as a triggering device for SCR’s or triacs.

Diac Applications

Diac is commonly used as a solid state triggering device for other semiconductor switching devices, mainly SCR’s and triacs. Triacs are widely used in applications such as lamp dimmers and motor speed controllers and as such the diac is used in conjunction with the triac to provide full-wave control of the AC supply as shown.

Triac

A Triac is a high-speed solid-state device that can switch and control AC power in both directions of a sinusoidal waveform



PHYSICAL CONSTRUCTION **2 THYRISTOR ANALOGY** **SYMBOL**

Triac for short which is also a member of the thyristor family that be used as a solid state power switching device but more importantly it is a “bidirectional” device. i.e. *Triac* can be triggered into conduction by both positive and negative voltages applied to its Anode and with both positive and negative trigger pulses applied to its Gate terminal making it a two-quadrant switching Gate controlled device.

A **Triac** behaves just like two conventional thyristors connected together in inverse parallel (back-to-back) with respect to each other and because of this arrangement the two thyristors share a common Gate terminal all within a single three-terminal package.

Since a triac conducts in both directions of a sinusoidal waveform, the concept of an Anode terminal and a Cathode terminal used to identify the main power terminals of a thyristor are replaced with identifications of: MT_1, for *Main Terminal 1* and MT_2 for *Main Terminal 2* with the Gate terminal G referenced the same.

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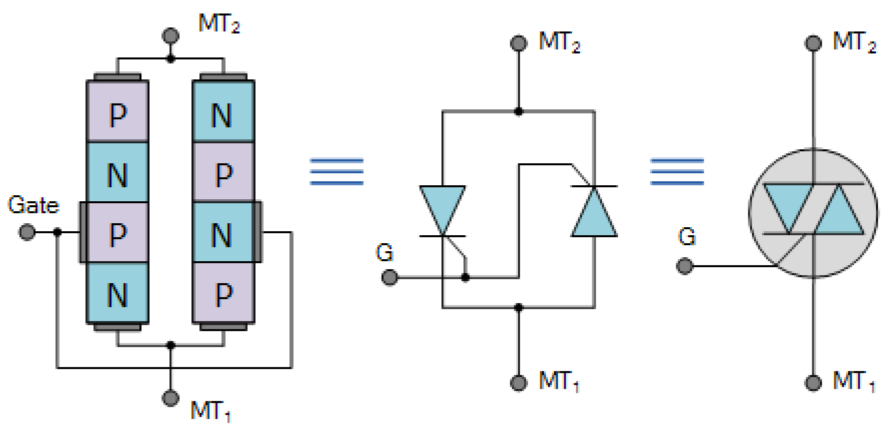
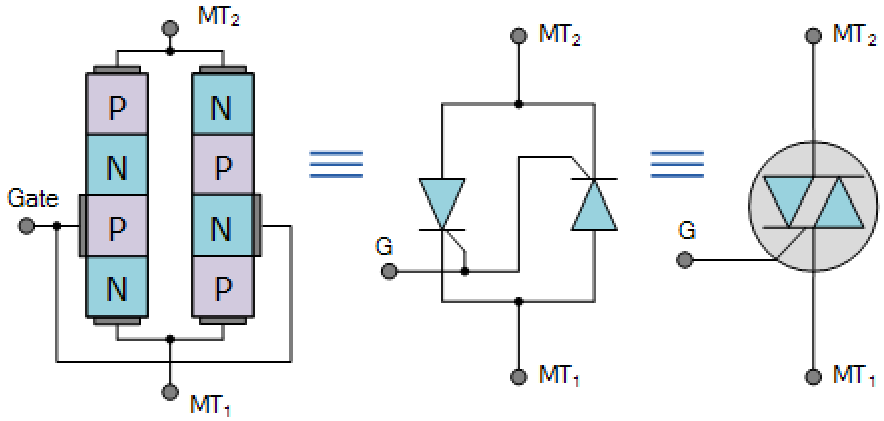


In most AC switching applications, the triac gate terminal is associated with the MT_1 terminal, similar to the gate-cathode relationship of the thyristor or the base-emitter relationship of the transistor. The construction, P-N doping and schematic symbol used to represent a **Triac** is given below



- Tiac” is a 4-layer, PNPN in the positive direction and a NPNP in the negative direction, three-terminal bidirectional device that blocks current in its “OFF” state acting like an open-circuit switch,
- Unlike a conventional thyristor, the triac can conduct current in either direction when triggered by a single gate pulse.
- Then a triac has four possible triggering modes of operation as follows.

- Triac is a 4-layer, PNPN in the positive direction and a NPNP in the negative direction,
- Three-terminal bidirectional device that blocks current in its "OFF" state acting like an open-circuit switch, but unlike a conventional thyristor, the triac can conduct current in either direction when triggered by a single gate pulse.
- Then a triac has four possible triggering modes of operation as follows.

I + Mode = MT_2 current positive (+ve), Gate current positive (+ve)

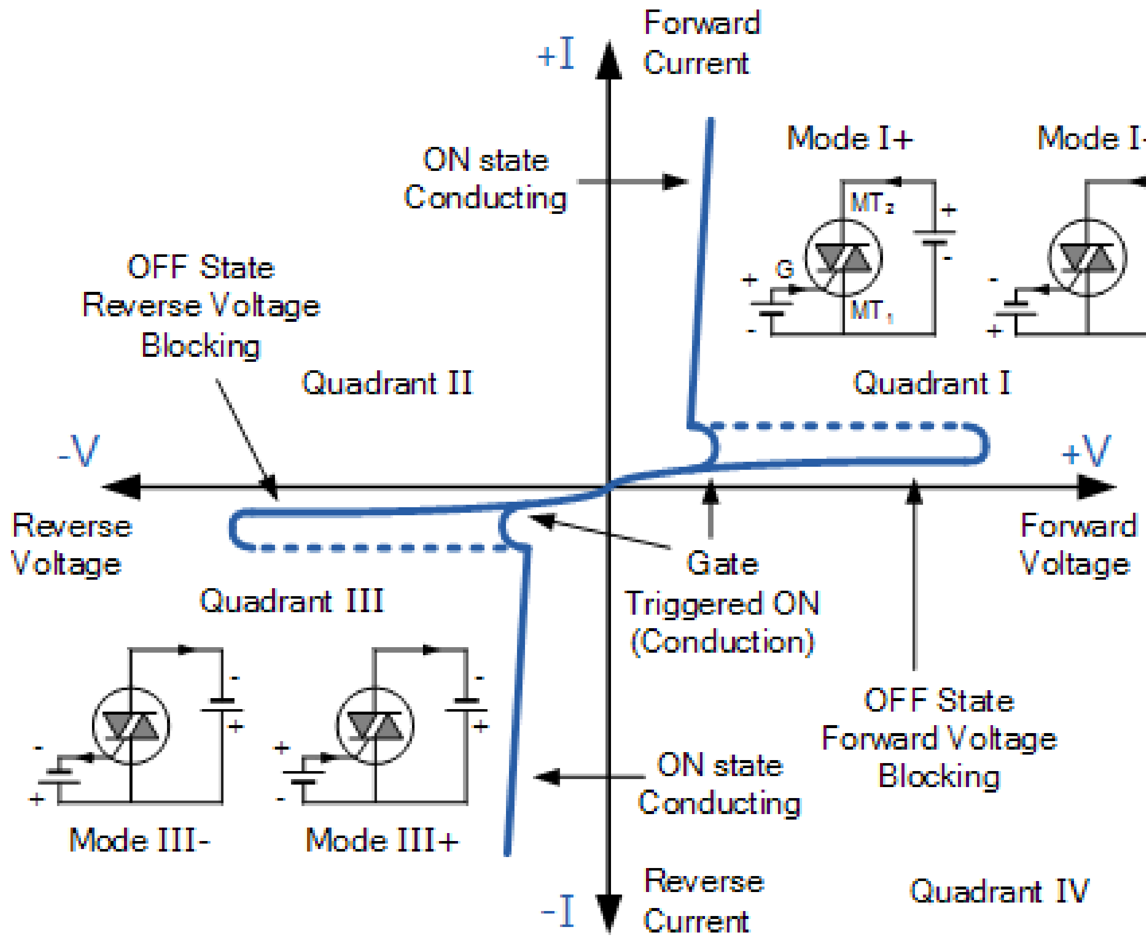
I – Mode = MT_2 current positive (+ve), Gate current negative (-ve)

III + Mode = MT_2 current negative (-ve), Gate current positive (+ve)

III – Mode = MT_2 current negative (-ve), Gate current negative (-ve)

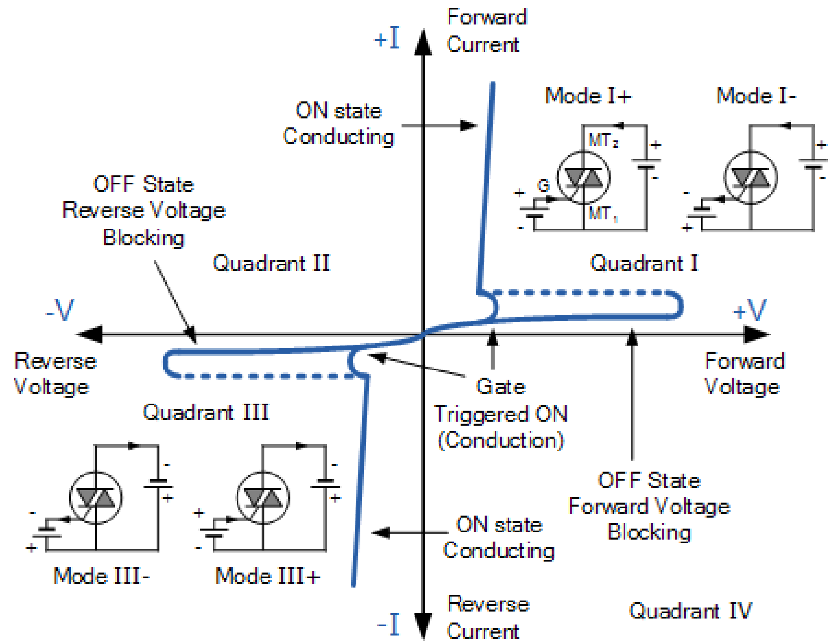
I + Mode = MT_2 current positive (+ve), Gate current positive (+ve)
I – Mode = MT_2 current positive (+ve), Gate current negative (-ve)
III + Mode = MT_2 current negative (-ve), Gate current positive (+ve)
III – Mode = MT_2 current negative (-ve), Gate current negative (-ve)

Triac I-V Characteristics Curves



- In Quadrant I, the triac is usually triggered into conduction by a positive gate current, labelled above as mode I+.
- But it can also be triggered by a negative gate current, mode I–.
- Similarly, in Quadrant <III, triggering with a negative gate current, –I_G is also common, mode III– along with mode III+. Modes I– and III+ are, however, less sensitive configurations requiring a greater gate current to cause triggering than the more common triac triggering modes of I+ and III–.

Triac I-V Characteristics Curves

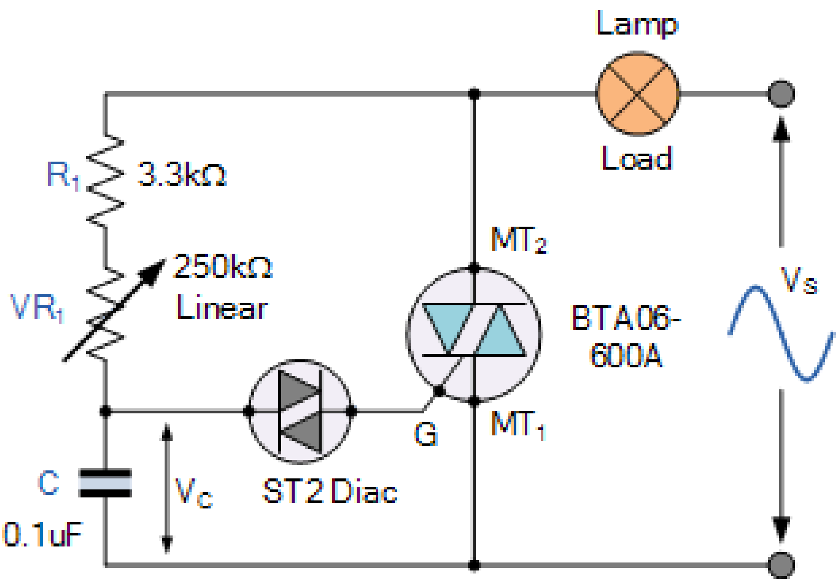


➢Like silicon controlled rectifiers (SCR's), triac's also require a minimum holding current I_H to maintain conduction at the waveforms cross over point. Then even though the two thyristors are combined into one single triac device, they still exhibit individual electrical characteristics such as different breakdown voltages, holding currents and trigger voltage levels exactly the same as we would expect from a single SCR device.

Triac Applications

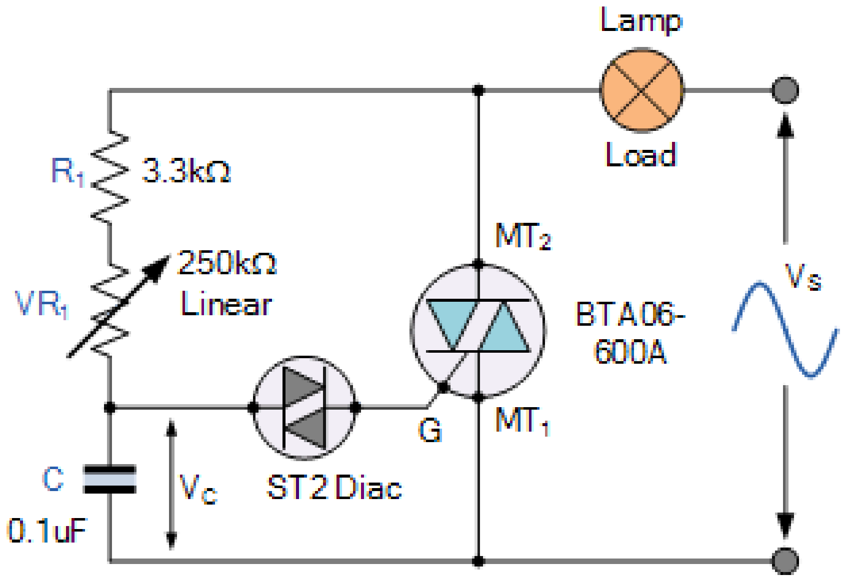
The **Triac** is most commonly used semiconductor device for switching and power control of AC systems as the triac can be switched “ON” by either a positive or negative Gate pulse, regardless of the polarity of the AC supply at that time. This makes the triac ideal to control a lamp or AC motor load with a very basic triac switching circuit .

AC phase control



➢As the AC supply voltage increases at the beginning of the cycle, capacitor, C is charged through the series combination of the fixed resistor, R1 and the potentiometer, VR_1 and the voltage across its plates increases. When the charging voltage reaches the breakover voltage of the diac (about 30 V for the ST2), the diac breaks down and the capacitor discharges through the diac.

➢The discharge produces a sudden pulse of current, which fires the triac into conduction. The phase angle at which the triac is triggered can be varied using VR1, which controls the charging rate of the capacitor. Resistor, R1 limits the gate current to a safe value when VR1 is at its minimum.



- Once the triac has been fired into conduction, it is maintained in its "ON" state by the load current flowing through it, while the voltage across the resistor–capacitor combination is limited by the "ON" voltage of the triac and is maintained until the end of the present half-cycle of the AC supply.
- At the end of the half cycle the supply voltage falls to zero, reducing the current through the triac below its holding current, I_H turning it "OFF" and the diac stops conduction. The supply voltage then enters its next half-cycle, the capacitor voltage again begins to rise (this time in the opposite direction) and the cycle of firing the triac repeats over again.