Fundamentals of Rectifiers

Within the diode family rectifiers are the largest class. One talks about rectifiers, if the specified current is above 0.5 A. Below 0.5 A one normally talks about diodes.

Rectifiers are primarily used, as their name already indicates, for conducting in one direction and blocking in the other.

Within rectifiers there are several groups depending on the reverse recovery characteristic (reverse recovery time t_{rr}):

- Standard rectifiers with a t_{rr} > 500 ns
- Fast rectifiers with a 100 ns < t_{rr} < 500 ns
- Ultrafast rectifiers with a t_{rr} < 100 ns
- Schottky rectifiers with majority carrier effect

Except Schottky rectifiers all these are of p-n junction technology with different processes to optimize the characteristics for different applications. They are placed in different packages, leaded like the Sinterglass, SMD like DO214AC (SMA) or TO220 to fullfill different mounting and power requirements.

Because of their predominant rectifying qualities, rectifiers are primarily used for power or signal conditioning in a variety of applications. This can range from high power output rectifier applications (e.g. power plants, railways,...) to low power switching rectifier requirements (e.g. mobile phone chargers, energy saving lamps,...). They are also used in several other specialized ways like clamping networks for SMPS (e.g. BYT42), damper and modulator diodes for the deflection circuits in CRTs (e.g. BY228), freewheeling diodes for inductive loads etc.

For specialized rectifying applications, silicon controlled rectifiers (SCRs) are used. But these are not simply diodes they have a third terminal, the gate.

The other special group of rectifiers, the Schottky rectifiers, are not use the conventional p-n junction, they have a barrier metal design. These are also non controlled rectifiers with two terminals only. Their big advantage is the excellent switching characteristic compared to even the fastest p-n junction diode. For more details about Schottky rectifiers, please refere to Application Note "Fundamentals of Schottky Rectifiers"

Figure 1. below shows the basic rectifier characteristics with the two regions, the forward conducting region, in which the forward current I_F flows and the reverse blocking region, in which the reverse leakage current I_R flows.
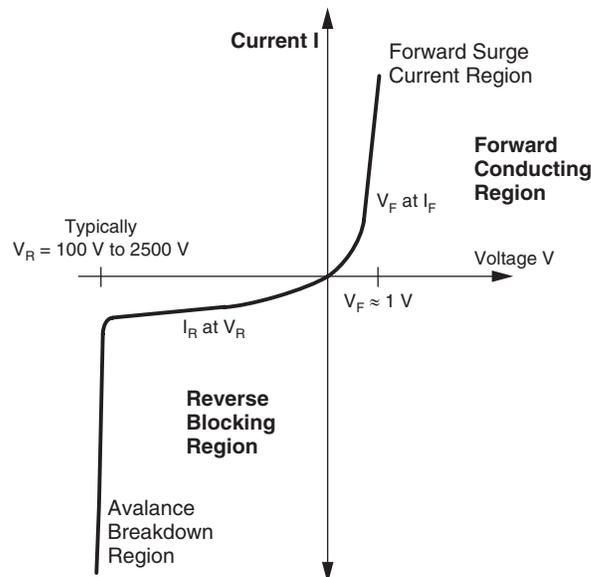

Fig. 1 - Basic Rectifier Characteristics

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The major parameters for the selection of the appropriate rectifier are the maximum reverse voltage (V_{RRM}), the average forward current ($I_{F(AV)}$) and for switching application the reverse recovery characteristic (t_{rr}) too. Additional parameters may be, for example forward, surge capability (I_{FSM}) etc.

BASIC RECTIFIER PARAMETERS

V_R — Reverse voltage

V_{RRM} — Repetitive peak reverse voltage, including all repeated reverse transient voltages

V_{BR} — Reverse breakdown voltage

I_R — Reverse (leakage) current, at a specified reverse voltage V_R and temperature T_J

I_F — Forward current

V_F — Forward voltage drop, at a specified forward current I_F and temperature T_J

$I_{F(AV)}$ — Average forward output current, at a specified current waveform (normally 10 ms/50 Hz half sine wave, sometimes 8.3 ms/60 Hz half sine wave), a specified reverse voltage and a specified mounting condition (e.g. lead-length = 10 mm or PCB mounted with certain pads and distance)

I_{FSM} — Peak forward surge current, with a specified current waveform (normally 10 ms/50 Hz half sine wave, sometimes 8.3 ms/60 Hz half sine wave)

t_{rr} — Reverse recovery time, at a specified forward current (normally 0.5 A), a specified reverse current (normally 1.0 A) and specified measurement conditions (normally from 0 to 0.25 A)

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