Full Wave Rectifier Operation - Center Tapped Transformer

The half wave rectifier only uses one of the alternations of an ac cycle, whereas if both alternations could be utilised a greater rectification efficiency could be obtained. One method of achieving this is to use a transformer with a secondary that has a center tap. If this center tap is made the common terminal, then equal amplitude but opposite phase wave forms can be obtained. By using two diodes to alternately rectify each half winding of the secondary, a "full wave rectification' process is obtained. The basic process is shown in figure 1

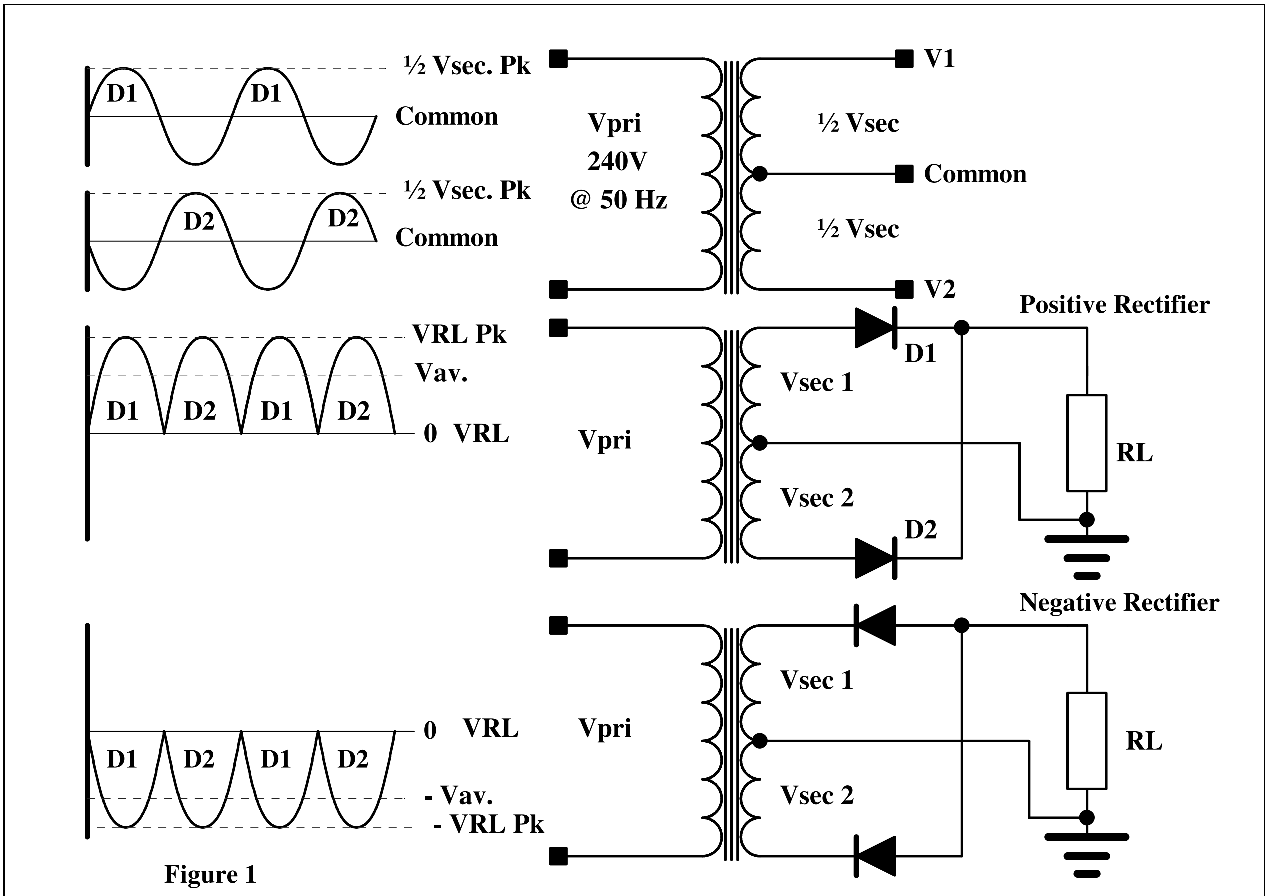

Figure 1

Each half of the secondary winding causes its respective diode to conduct on the appropriate half cycle alternation and hence produce a full wave rectified wave form. Since each diode only conducts for half a cycle it only needs to supply half the total current to the load and also the average voltage (dc) has a higher value. The following equations apply

$$V\sec_{(pk)} = V\sec \times \sqrt{2} \approx V\sec \times 1.414 \text{ \& } V_{RL(pk)} = V\sec_{(pk)} - V_d \approx V\sec_{(pk)} - 0.7V$$

$$Vav = Vdc = \tfrac{2}{\pi} \times V_{RL(pk)} \approx 0.637 \times V_{RL(pk)} \text{ \& } Idc = \tfrac{Vdc}{RL}$$

$$Vac = 0.308 \times V_{RL(pk)} \text{ @ 100Hz ripple frequency \& } V_{(RMS)} = 0.707 \times V_{RL(pk)}$$

The full wave center tapped rectifier has better transformer utilisation than the half wave and also since the current is in opposite directions in each half of the secondary, there is no net magnetic bias to the transformer core. This rectifier is suitable for heavy current applications but because of the double winding for the secondary voltage, the transformer requires more turns that adds to the cost of the transformer. The ripple factor is 48% but this is still too large for electronic device power supplies but again is used for battery charging applications.

Full Wave Bridge Rectifier Operation

By using four diodes in a bridge configuration, a full wave rectifier system can be constructed without the need for a center tapped transformer. In operation, two diodes per half cycle conduct with one supplying the output to the load and the other diode connecting one side of the transformer to common. The other two diodes conduct on the ne

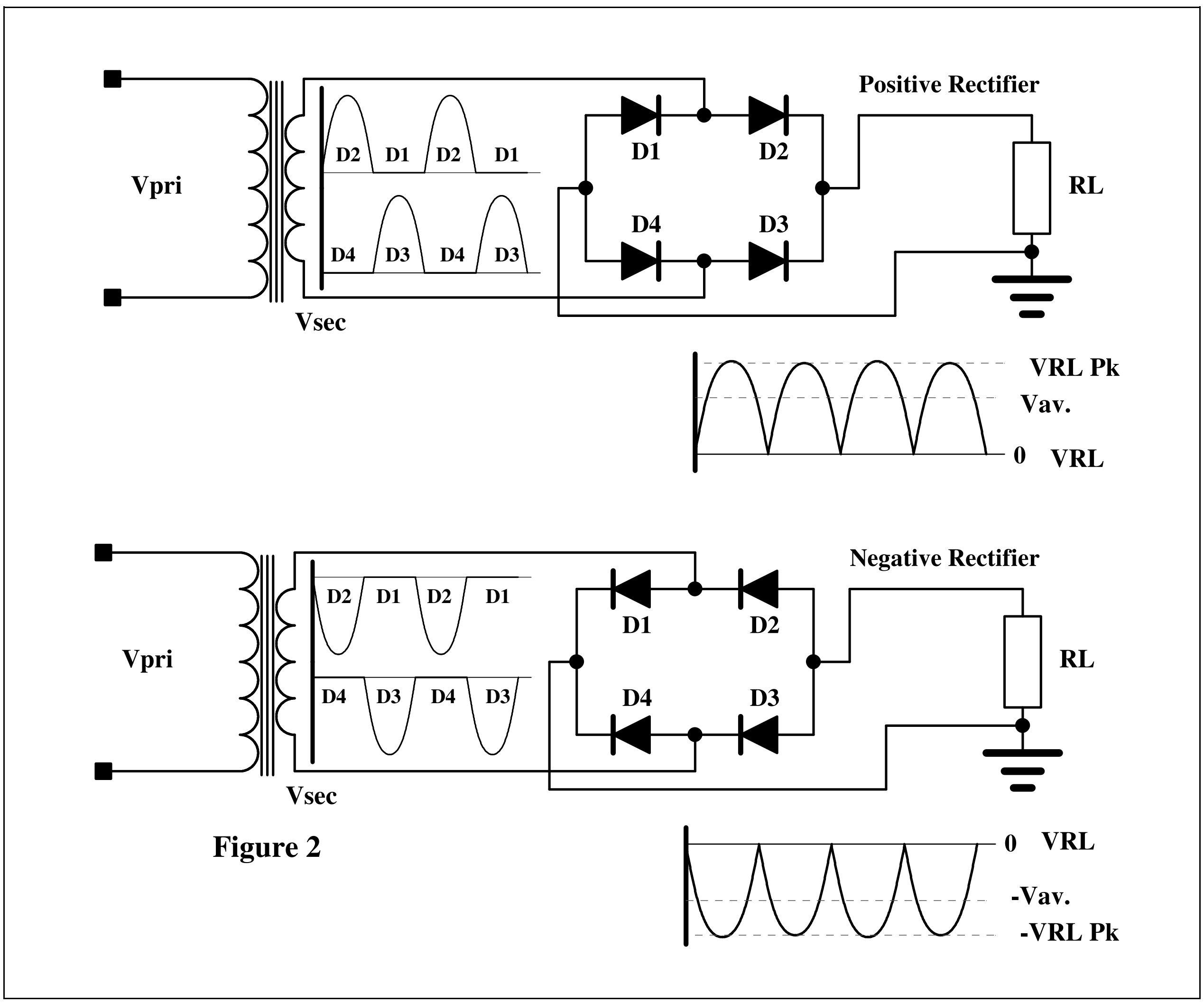

Figure 2

xt half cycle again supplying the load and connecting the opposite side of the transformer to the common point. The basic process is shown in figure 2.

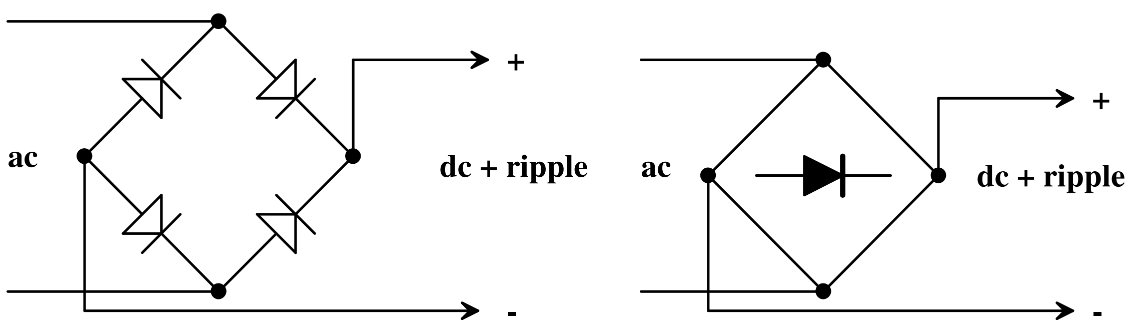

Figure 3

NOTE: The waveforms of the secondary cannot be observed with a conventional oscilloscope since the CRO probe has an 'earthed' common lead and would likely cause a short circuit diode fault.

Since the current is reversed for each half cycle of the secondary voltage, there is no net magnetic offset to the core as in half wave rectification and also for a given dc output power, the bridge circuit requires the smallest physical size of transformer (better transformer utilisation). As it requires two diodes per half cycle, there is a double forward diode voltage drop to be accounted for in the equations. The following equations apply

$$V\sec_{(pk)} = V\sec \times \sqrt{2} \approx V\sec \times 1.414$$
$$V_{RL(pk)} = V\sec_{(pk)} - 2Vd \approx V\sec_{(pk)} - 1.4V$$
$$Vdc = V_{RL(pk)} \times \tfrac{2}{\pi} \approx V_{RL(pk)} \times 0.637 \ \& \ Idc = \tfrac{Vdc}{RL}$$

$$Vac = V_{RL(pk)} \times 0.306 \text{ @ 100 Hz ripple \& } V_{RMS} = 0.707 \times V_{Rl(pk)}$$

The bridge circuit is the most popular rectifier system with the highest rectifier efficiency that can be used with heavy current demands but still has a high ripple factor (48%) and needs to be filtered before it can be used to power electronic devices. The diode bridge symbol as shown may be drawn differently in other circuit diagrams and figure 3 illustrates some of the variations.

Battery chargers and power control circuits (Silicon Controlled Rectifier Systems) may use the rectifier systems illustrated so far as they may operate from a dc with a superimposed ac (ripple) without causing any problems. If amplifiers were operated with these unfiltered rectifier systems, the result in the loudspeaker would be a very loud 50 Hz (half wave) or 100 Hz (full wave) 'hum' which would be intolerable. These low frequency ripple components must be filtered (later lesson) so that the amplitude is very small compared to the dc value.