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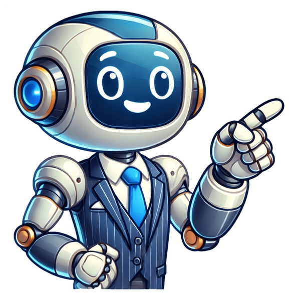

The ability of the diode to conduct current in one direction and block it in another direction. A diode can also be used as a rectifier. Rectifiers are the electrical circuit that converts the AC voltage to DC voltage. All electronic appliances work on DC voltage rather than AC, so rectifiers are an essential part of all electronic appliances. The simplest rectifier is a half-wave rectifier with a capacitor filter.The following diagram shows the half-wave rectifier circuit where the diode, load, and sinusoidal AC source are connected.For the positive half cycle of the input sinusoidal voltage, the anode of the diode is connected with the positive side of the source, the cathode is connected with the negative side of the source and the diode becomes forward biased. So, for the positive half cycle, the output is the same as the input ideally. The current will pass through the load resistor during the positive half cycle. 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(Please note: The 1N914 is NOT typically used in power rectifier circuits. It is, however, more than capable of handling the currents and voltages used in this demonstration (vide infra).) The top trace of the oscilloscope shows the voltage at the output of the signal generator (at the anode of the diode), and the bottom trace shows the voltage across the resistor. As is visible in the photograph above, the diode conducts during one half cycle, and during the other half cycle, the voltage across the resistor is zero. The diode does not begin to conduct, however, until the applied voltage exceeds the junction potential, so the half cycles in the bottom trace are slightly narrower than the distance between zero crossings in the top trace. The amplitude measurements in the enlarged photograph below make this clear: The peak-to-peak voltage of the input signal is 23.8 volts. Half this would be 11.9 volts, but the measured amplitude of the bottom trace is 11.6 volts, about 0.3 volts lower. In order to change the rectified voltage from a pulsating DC voltage to a steady one, we can place a capacitor across the load. The capacitor charges during the positive-going side of each positive half cycle, and it discharges through the load during the rest of the cycle. Depending on the RC time constant (see demonstrations 64.51 -- RC circuit to galvanometer and 64.54 -- RC circuit to oscilloscope), the discharge takes more or less of the time between the peaks, and the filtering action flattens the output voltage to a greater or lesser extent. The circuit board has three capacitors, one end of each connected to ground and the other end free, and a jumper with which you can select one of them to put in parallel with the load resistor. The three photographs below show the result of adding each of these capacitors: 0.01 µf 0.1 µf 10 µf We see that the filtering afforded by the 0.01-µf capacitor raises the tail of the half cycle, the 0.1-µf capacitor smooths the waveform even more, leaving a large ripple, and the 10-µf capacitor takes out enough of the ripple to make the DC voltage essentially flat. For a given rectifier circuit, the size of the ripple can be expressed as the "ripple factor," r = Iac/Idc = Vac/Vdc. r also equals 1/(2√3fCRL), where f is the frequency of the ac component. As we can see from the traces above, for the half-wave rectifier the frequency equals that of the input voltage. This expression holds only for wave forms that are approximately sinusoidal, and for loads that do not cause the output voltage to drop more than about 20% from the peak voltage. Alternatively, we can derive a simple expression for the ripple voltage. If the ripple is small, we can assume that the current through the load is constant, and from I = C(dV/dt) we have ΔV = (I/C)Δt. Δt is just the period of the ripple, so it equals 1/f, making the expression ΔV = (Iload/fC). In doing this, we have assumed a linear discharge of the capacitor, instead of an exponential, but for constant load current, the discharge is linear. We can see from both of these expressions that for a given frequency, increasing the capacitance reduces the magnitude of the ripple, and whatever the capacitance, increasing the frequency of oscillation of the input voltage also decreases the size of the ripple. We can also see from the first two traces above that as the ripple becomes smaller, the discharge gets closer to being linear. In this demonstration, not only can you change the value of the capacitor, as shown above, but you can also vary the frequency of the function generator to show its effect on the ripple. In building a rectifier circuit, one must choose a diode that can safely withstand the current the circuit will have to provide, and also the reverse bias voltage that will be applied to it. Diodes are rated for maximum average forward current, which, since the diode conducts only half the time (positive-going half-cycles only), is roughly 1/2(Vav/RL), where Vav is the average voltage and RL is the load resistance. The peak inverse voltage (PIV), or maximum repetitive reverse voltage (VRRM) is the maximum reverse bias that the diode can withstand. For the unfiltered rectifier, this is just the peak voltage, which in the example shown above is about 12 volts. If one adds a capacitor to filter the output, the PIV doubles to 24 volts, because the capacitor now holds the output at +12 volts while the voltage on the anode of the diode swings to -12 volts. The 1N914 diode used in this demonstration is rated for a VRRM of 100 volts and an average rectified forward current of 200 mA. While these values, especially the average forward current, make this diode unsuitable for use in most power supply applications, this component can easily handle the PIV of 24 volts and average forward current of 0.12 mA present in this demonstration. References: 1) Howard V. Malmstadt, Christie G. Enke and Stanley R. Crouch. Electronics and Instrumentation for Scientists (Menlo Park, California: The Benjamin/Cummings Publishing Company, Inc., 1981), pp.57-58, 61-62. 2) Paul Horowitz and Winfield Hill. The Art of Electronics, Second Edition (New York: Cambridge University Press, 1994), pp. 45-46, 329-330. 3) Fairchild Semiconductor Corporation. Data Sheet for 1N/FDLL 914/A/B / 916/A/B / 4148 / 4448 Small Signal Diode (2002). -> Railway Recruitment Board activated the RRB ALP application form 2025 correction link, candidates can make the correction in the application form till 31st May 2025. -> The Railway Recruitment Board (RRB) has released the official RRB ALP Notification 2025 to fill 9,970 Assistant Loco Pilot posts. -> The Railway Recruitment Board (RRB) has released the official RRB ALP Notification 2025 to fill 9,970 Assistant Loco Pilot posts. -> The official RRB ALP Recruitment 2025 provides an overview of the vacancy, exam date, selection process, eligibility criteria and many more. ->The candidates must have passed 10th with ITI or Diploma to be eligible for this post. ->The RRB Assistant Loco Pilot selection process comprises CBT I, CBT II, Computer Based Aptitude Test (CBAT), Document Verification, and Medical Examination. -> This year, lakhs of aspiring candidates will take part in the recruitment process for this opportunity in Indian Railways. -> Serious aspirants should prepare for the exam with RRB ALP Previous Year Papers. -> Attempt RRB ALP GK & Reasoning Free Mock Tests and RRB ALP Current Affairs Free Mock Tests here The ability of the diode to conduct current in one direction and block it in another direction. 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A halfwave rectifier circuit consists of three main components as follows: A diode A transformer A resistive load Given below is the half-wave rectifier diagram: In this section, let us understand how a half-wave rectifier transforms AC into DC. A high AC voltage is applied to the primary side of the step-down transformer. The obtained secondary low voltage is applied to the diode. The diode is forward biased during the positive half cycle of the AC voltage and reverse biased during the negative half cycle. The final output voltage waveform is as shown in the figure below: For better understanding, let us simplify the half-wave circuit by replacing the secondary transformer coils with a voltage source as shown below: For the positive half cycle of the AC source voltage, the circuit effectively becomes as shown below in the diagram: When the diode is forward biased, it acts as a closed switch. But, during the negative half cycle of the AC source voltage, the equivalent circuit becomes as shown in the figure below When a diode is reverse biased, it acts as an open switch. Since no current can flow to the load, the output voltage is equal to zero. The halfwave rectifier waveform before and after rectification is shown below in the figure. The output waveform of a halfwave rectifier is a pulsating DC waveform. Filters in halfwave rectifiers are used to transform the pulsating waveform into constant DC waveforms. A capacitor or an inductor can be used as a filter. The circuit diagram below shows how a capacitive filter is used with halfwave rectifier to smoothen out a pulsating DC waveform into a constant DC waveform. Similar Articles Full Wave Rectifiers Bridge Rectifiers Ripple factor determines how well a halfwave rectifier can convert AC voltage to DC voltage. Ripple factor can be quantified using the following formula: \(\begin{array}{l} \gamma = \sqrt{ (\frac{ V _ { r m s } }{ V _ { d c } }) ^ { 2 } – 1 } \end{array} \) The ripple factor of a halfwave rectifier is 1.21. The efficiency of a halfwave rectifier is the ratio of output DC power to the input AC power. The efficiency formula for halfwave rectifier is given as follows; \(\begin{array}{l}\eta = \frac{ P _ { D C } }{ P _ { A C } } \end{array} \) The RMS value of the load current for a half-wave rectifier is given by the formula: \(\begin{array}{l} I _ { r m s } = \frac{ I _ { m } }{ 2 } \end{array} \) The form factor is the ratio between RMS value and average value and is given by the formula: \(\begin{array}{l} \textup{Form Factor } = \frac{ \textup{ RMS Value } }{ \textup{ Average Value } } \end{array} \) Here are a few common applications of half wave rectifiers: They are used for signal demodulation purpose They are used for rectification applications They are used for signal peak applications Power loss Low output voltage The output contains a lot of ripples The rectifier circuit that converts alternating current into the direct current is known as a halfwave rectifier circuit. The half-wave rectifier passes only one half of the input sine wave and rejects the other half.A half-wave rectifier is used in firing circuits and pulse generating circuits. Halfwave rectifiers are used along with step up and step down transformers to achieve the desired voltage.Half wave rectifier circuit uses a PN junction to convert the supplied AC into DC. In a half-wave rectifier circuit, the load resistance is connected in series with the PN junction diode.Full-wave rectifiers are more efficient than half-wave rectifiers. A full-wave rectifier passes twice as many waves as a half-wave rectifier. Hence, more of the input is transferred to the load.The filter in a half-wave rectifier is used to smoothen the pulsating fluctuating DC component. This article discussed the Halfwave rectifiers and their nuances. Stay tuned to BYJU'S and Fall in Love with Learning to learn more concepts like this! The ability of the diode to conduct current in one direction and block it in another direction. A diode can also be used as a rectifier. Rectifiers are the electrical circuit that converts the AC voltage to DC voltage. All electronic appliances work on DC voltage rather than AC, so rectifiers are an essential part of all electronic appliances. The simplest rectifier is a half-wave rectifier with a capacitor filter.The following diagram shows the half-wave rectifier circuit where the diode, load, and sinusoidal AC source are connected.For the positive half cycle of the input sinusoidal voltage, the anode of the diode is connected with the positive side of the source, the cathode is connected with the negative side of the source and the diode becomes forward biased. So, for the positive half cycle, the output is the same as the input ideally. The current will pass through the load resistor during the positive half cycle. 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This occurs at Vpi as shown in Fig. 3-7(b), giving a peak capacitor voltage, When the instantaneous level of input (at the diode anode) falls below Vpi the diode becomes reverse biased, because the capacitor voltage (VC) (at the diode cathode) remains close to (Vpi – VF), [see Fig. 3-7(c)]. With the diode reverse biased, the capacitor begins to discharge through the load resistor (RL). So, VC falls slowly, as shown by the capacitor voltage waveform in Fig. 3-7(a). The diode remains reverse biased through the remainder of the input positive half-cycle, the negative half-cycle, and the first part of the positive half-cycle again until the instantaneous level of V1 becomes greater than VC once more. At this point current flows through the diode to recharge the capacitor, causing the capacitor voltage to return to (Vpi – VF). The charge and discharge of the capacitor causes the small increase and decrease in the capacitor voltage, which is also the circuit output voltage. It is seen that the circuit output is a .direct voltage with a small ripple voltage waveform superimposed, Wig. 3-7(a)]. Capacitance Calculation: The amplitude of the ripple voltage is affected by the load current, the reservoir capacitor value, and the capacitor discharge time. The discharge time depends upon the frequency of the ripple waveform, which is the same as the ac input frequency in the case of a Half Wave Rectifier with Capacitor Filter. With a constant load current, the ripple amplitude is inversely proportional to the capacitance; the largest capacitance produces the smallest ripple. The capacitance for the reservoir capacitor can be calculated from the load current, the acceptable ripple amplitude, and the capacitor discharge time. Consider the circuit output voltage waveform illustrated in Fig. 3-8(a). The waveform quantities are: Eave – average dc output voltage Eo(max) – maximum output voltage level Eo(min) – minimum output voltage Vr – ripple voltage peak-to-peak amplitude T – time period of the ac input waveform t1 – capacitor discharge time t2 – capacitor charge time θ1 – phase angle of the input wave from zero to Eo(min) θ2 – phase angle of the input wave from Eo(min) to Eo(max) Figure 3-8(b) shows that, because the input wave is sinusoidal, which gives, Also from Fig. 3-8(b), The time period is, where f is the frequency of the ac input waveform. During T, the input waveform goes through a 360° phase angle, which gives the time per degree as, Taking the current as a constant quantity, Capacitor Selection: When a capacitance value is calculated, an appropriate capacitor has to be selected from a manufacturer's list of available standard values. With a reservoir capacitor, the calculated capacitance is always the minimum value required to give a specified maximum ripple voltage amplitude. If a larger-than-calculated capacitance is used, the ripple voltage will be lower than the specified maximum. So, a larger standard value capacitor is always selected in the case of a reservoir capacitor. The standard-value capacitors are typically available with +20% tolerance. In the case of capacitors greater than 10 pF, the tolerance is often listed as -10% +50%. This means that a 100 µF capacitor might have a capacitance as low as 90 µF, or as high as 150 µF. In most circuit situations, a minimum capacitance value is calculated, and a larger value is quite acceptable. The voltage that a capacitor will be subjected to must be taken into consideration. The maximum voltage that may be safely applied to a capacitor is stated in terms of its dc working voltage. The dc working voltages can be quite small for large-value capacitors. For example, some 10 µF capacitors have 6.3 V working voltages. The capacitor dielectric may break down if the specified voltage is exceeded. Capacitor Polarity: It is very important that polarized capacitors be correctly connected. Sometimes polarized capacitors explode when they are incorrectly connected, and this could have tragic consequences for the eyes of an experimenter. The positive terminal is represented by the straight bar on the component graphic symbol, or identified by the plus sign on the alternative symbol, (see Fig. 3-9). This should be connected to the most positive point in the circuit where the capacitor is to be installed. Non-polarized capacitors should be used in situations where the voltage polarity might be reversed. Approximate Calculations: The capacitance calculation shows that the load current is a constant quantity. This is an approximation, because the load current changes by a small amount as the output voltage increases and decreases. Normally, the load current change is so small that it has no significant effect on the calculation. Another approximation that can be made to simplify the capacitance calculation is to take the discharge time (t1) as equal to the input waveform time period (T), [see Fig. 3-8(a)]. Equation 3-12 assumes that the capacitor charging time (t2) is so much smaller than t1 that it can be neglected. This is a reasonable assumption where the ripple voltage is small. Also, use of Eq. 3-12 gives a larger capacitance value than the more precise calculation, and this is acceptable because a larger-than-calculated standard value capacitor is normally selected. Diode Specification: Rectifier diodes must be specified in terms of the currents and voltages that they are subjected to. The calculated levels are normally minimum quantities, and the selected diodes must be able to survive higher levels. Consider Fig. 3-10 which illustrates the situation when the ac input wave is at its negative peak voltage (-Vp). The capacitor has already been charged up to approximately the positive peak level of the input (+Vp). Consequently, the diode has -Vp at its, anode and +Vp at its cathode, so the diode peak reverse voltage is, The average forward rectified current (IF(av)) that the diode must pass is equal to the dc output current. The diode in a half-wave rectifier circuit with a reservoir capacitor does not conduct continuously, but repeatedly passes pulses of current to recharge the capacitor each time the diode becomes forward biased. This is illustrated in Fig. 3-8 and again in Fig. 3-11. The current pulse is known as the repetitive surge current, and is designated (IFRM). The average input current to the rectifier circuit must equal the average load current (IL), so IFRM averaged over time period T equals IL . (see Fig. 3-11) Figure 3-12 shows a half-wave rectifier circuit with a resistor (RS) connected in series with the diode. This is a low-resistance component known as a surge limiting resistor. As its name suggests, the purpose of RS is to limit the level of any surge current that might pass through the diode. The highest surge current occurs when the ac supply is first switched on to the rectifier circuit. Before switch-on, the reservoir capacitor normally contains no charge, so it behaves as a short-circuit at the instant of switch-on. If switch-on occurs when the ac input is at its peak level, the surge current is, For a diode with a specified maximum non-repetitive surge current (IFSM), the surge limiting resistor is calculated as, Ripple Voltage As you have seen, the capacitor quickly charges at the beginning of a cycle and slowly discharges through RL after the positive peak of the input voltage (when the diode is reverse-biased). The variation in the capacitor voltage due to the charging and discharging is called the ripple voltage. Generally, ripple is undesirable; thus, the smaller the ripple, the better the filtering action, as illustrated in Below Figure. Fig : Half-wave ripple voltage (blue line). For a given input frequency, the output frequency of a full-wave rectifier is twice that of a half-wave rectifier, as illustrated in Figure 1. This makes a full-wave rectifier easier to filter because of the shorter time between peaks. When filtered, the full-wave rectified voltage has a smaller ripple than does a half-wave voltage for the same load resistance and capacitor values. The capacitor discharges less during the shorter interval between full-wave pulses, as shown in Figure 2. Fig 1 : The period of a full-wave rectified voltage is half that of a half-wave rectified voltage. The output frequency of a full-wave rectifier is twice that of a half-wave rectifier. Fig 2 : Comparison of ripple voltages for half-wave and full-wave rectified voltages with the same filter capacitor and load and derived from the same sinusoidal input voltage. Ripple Factor The ripple factor (r) is an indication of the effectiveness of the filter and is defined as where Vr(pp) is the peak-to-peak ripple voltage and VDC is the dc (average) value of the filter's output voltage, as illustrated in Below Figure. The lower the ripple factor, the better the filter. The ripple factor can be lowered by increasing the value of the filter capacitor or increasing the load resistance. For a full-wave rectifier with a capacitor-input filter, approximations for the peak-to-peak ripple voltage, Vr(pp), and the dc value of the filter output voltage, VDC, are given in the following equations. The variable Vp(rect) is the unfiltered peak rectified voltage. Notice that if RL or C increases, the ripple voltage decreases and the dc voltage increases. Engineering Tutorial Keywords:ripple voltagehalf wave rectifier ripple voltage When the fluctuation occurs within the output of the rectifier then it is known as ripple. So this factor is essential to measure the rate of fluctuation within the resolved output. The ripple within output voltage can be reduced by using filters like capacitive or another kind of filter. In most of the circuits like rectifiers utilizes a capacitor within parallel of thyristor otherwise diodes to work as a filter within the circuit. This capacitor helps to decrease the ripple within the rectifier output. This article discusses an overview of the ripple factor (R.F) which includes its definition, calculation, its significance, and R.F using half-wave, full-wave, and bridge rectifier. What is Ripple Factor? The rectifier output mainly includes the AC component as well as the DC component. The ripple can be defined as the AC component within the resolved output. The A.C component within the output is unwanted as well as estimates the pulsations within the output of the rectifier. Here the ripple voltage is nothing but the AC component within o/p of the rectifier. Similarly, the ripple current is an AC component within o/p current. The definition of the ripple factor is the ratio of the AC component's RMS value and the DC component's RMS value within the output of the rectifier. The symbol is denoted with "γ" and the formula of R.F is mentioned below. ripple-factor (R.F) = AC component's RMS value / DC component's RMS value Thus the R.F = I (AC) / I (DC) This is extremely significant while deciding the efficiency of rectifier output. The efficiency of the rectifier can be explained by the lesser R.F. The extra ripple factor is nothing but fluctuating of additional ac components that are there within the resolved output. Basically, the calculation of the ripple indicates the clarity of the resolved output. Therefore each effort can be made for diminishing the R.F. Here we will not discuss the ways to reduce the R.F. Here we are discussing why ripples occur within the output of the rectifier. Why Ripple Occurs? Whenever the rectification occurs through the rectifier circuit then there is no chance of getting accurate DC output. Some variable AC components are frequently happening within the rectifier's output. The circuit of a rectifier can be built with diodes otherwise thyristor. The ripple mainly depends on the elements which are used within the circuit. The best example of the full-wave rectifier with a single phase is shown below. Here the circuit uses four diodes so the output gets like the following waveform. Here we estimated the accurate DC o/p waveform but we cannot get like that due to some ripple within the output and it is also called pulsating AC waveform. By employing a filter within the circuit, we can get almost DC waveform which can diminish ripple within the output. Derivation According to the definition of R.F, the whole load current RMS value can be given by IRMS = √I2dc + I2ac (or) Iac = √I2rms + I2dc When the above equation is divided by using Idc then we can get the following equation. Iac / Idc = 1/ Idc √I2rms + I2dc However, here Iac / Idc is the ripple factor formula R.F = 1/ Idc √I2rms + I2dc = √ (Irms / Idc)2 -1 Ripple Factor of Half Wave Rectifier For half-wave rectifier, Irms = Im/2 Idc = Im/ π We know the formula of R.F = √ (Irms / Idc)2 -1 Substitute the above Irms & Idc in the above equation so we can get the following. R.F = √ (Im/2 / Im/ π)2 -1 = 1.21 Here, from the above derivation, we can get the ripple factor of a half-wave rectifier is 1.21. Therefore it is very clear that AC. component surpasses the DC component within the half-wave rectifier output. It results in extra pulsation within the output. Consequently, this type of rectifier is ineffectively intended for changing AC to DC. ripple-factor-for-half-wave and full-wave-rectifiers Ripple Factor of Full Wave Rectifier For full-wave rectifier, Irms = Im/√ 2 Idc = 2Im / π We know the formula of R.F = √ (Irms / Idc)2 -1 Substitute the above Irms & Idc in the above equation so we can get the following. R.F = √ (Im/√ 2/ 2Im / π)2 -1 = 0.48 Here, from the above derivation, we can get the ripple factor of a full-wave rectifier is 0.48. Therefore it is very clear that in the o/p of this rectifier, the DC component is above the AC component. As a result, the pulsations within the o/p will be less than within half-wave rectifier. Because of this reason, this rectification can be always employed while converting AC into DC. Ripple Factor of Bridge Rectifier The factor value of the bridge rectifier is 0.482. Actually, the R.F value mainly depends on the waveform of load otherwise o/p current. It doesn't rely on the circuit design. Therefore its worth will be similar for rectifiers like a bridge as well as center-tapped when their o/p waveform is equal. Ripple Effects Some equipment can work by ripples but some of the sensitive types of equipment like audio as well as the test cannot work properly due to the effects of high-ripple within the supplies. Some of the ripple effects of equipment mainly occur due to the following reasons. For sensitive instrumentation, it affects negatively Ripple effects can cause errors within digital circuits, inaccurate outputs in data corruption & logic circuits. Ripple effects can cause heating so capacitors can be damaged. These effects initiate noise to audio circuits Thus, this is all about the ripple factor. From the above information finally, we can conclude that generally a rectifier is used to convert the signal from AC to the electrical signal. There are various types of rectifiers available in the market which can be used for rectification such as full-wave rectifier, half-wave rectifier and bridge rectifier. All these have dissimilar efficiency intended for applied i/p AC signal. The rectifier's ripple factor and efficiency can be measured based on the output. Here is a question for you, what is the ripple factor of full wave rectifier with capacitor filter? The ability of the diode to conduct current in one direction and block it in another direction. A diode can also be used as a rectifier. Rectifiers are the electrical circuit that converts the AC voltage to DC voltage. All electronic appliances work on DC voltage rather than AC, so rectifiers are an essential part of all electronic appliances. The simplest rectifier is a half-wave rectifier with a capacitor filter.The following diagram shows the half-wave rectifier circuit where the diode, load, and sinusoidal AC source are connected.For the positive half cycle of the input sinusoidal voltage, the anode of the diode is connected with the positive side of the source, the cathode is connected with the negative side of the source and the diode becomes forward biased. So, for the positive half cycle, the output is the same as the input ideally. The current will pass through the load resistor during the positive half cycle. For practical purposes, the output voltage will be less than 0.7 volts. Before the diode becomes forward bias the input must overcome the barrier potential of the PN junction, that's why the output in the practical diode will be less by 0.7 volts.For the negative half cycle, the anode of the diode will connect with the negative side of the source and the cathode will connect with the positive side of the source, and the diode becomes reverse biased. Ideally, the diode will act as an open switch and no current will pass through the load resistor. But practically there will be a small leakage current. Another thing is that the diode can withstand up to breakdown voltage. So the reverse blocking voltage must be in the range of the withstanding voltage. For safer operation, the maximum input voltage must be 20% less than that of the PIV (Peak Inverse Voltage) rating of the diode.The output of the half-wave rectifier does not change the direction of current in the load resistor, that's why it is called DC voltage. But the magnitude of the voltage varies with time so it is called pulsating DC voltage. A steady-state DC can be achieved by using a filter circuit.The average value of the input sinusoidal voltage is zero because of the same area above and below the axis line. Where the average value of the output can be calculated as followsThe DC voltmeter will measure the average value of the half-wave rectifier.The output of the Half Wave rectifier is pulsating DC instead of steady-state. Where the electronic devices work on steady-state DC and some devices may respond unexpectedly to such type of pulsating DC. A filter circuit may be required to convert the pulsating DC to steady-state DC, whereas a simple filter circuit can be a capacitor input filter. In the capacitor input filter circuit, the output of the half-wave rectifier is passed through a capacitor as the following circuit shows.For the first quarter of the positive cycle of the input voltage, the capacitor will charge up to the supply maximum voltage Vp. For the second quarter of the positive cycle, the diode will become reverse-biased because the cathode is at a higher potential than the anode. So, for the rest of the cycle, the capacitor will provide current to the load and discharge until the supply voltage becomes more than that of the capacitor voltage. As the input voltage increases from the capacitor voltage the capacitor will again start charging and the chain will remain. The discharging time of the capacitor depends upon the RC time constant.In the filtering action, the capacitor charges quickly and discharges slowly because of load resistance. That causes a change in voltage across the capacitor, which is undesirable and called ripple voltage.A measure of the effectiveness of the filter can be judged by the parameter called ripple factor. The formula of the ripple factor is the ratio between ripple voltage (peak to peak) and DC voltage.Half-wave rectifiers are NOT commonly used for rectification purposes as their efficiency is too small. A half-wave rectifier may still be used for rectification, signal demodulation application, and signal peak detection application.Half-wave rectifier's benefit is its simplicity as it requires fewer components so it is comparatively cheap upfront.The half-wave rectifier loses the negative half-wave of the input sinusoidal which leads to power loss. Its output is not pure DC as it contains ripples. It produces comparatively low output voltage.A rectifier converts AC voltage to DC voltage.Half wave Rectifier with a capacitor filter only passes current through load during the positive half cycle of sinusoidal.The output of the half-wave rectifier is pulsating DC voltage, to convert it to a steady state, a filter is used.The effectiveness of the filter can be measured by the ripple factor. As already known the purpose of the rectifier is to convert alternating current (AC) into direct current (DC). It is the basic unit of any DC supply. The designing of the rectifier and its suitability for practical applications is dependent on the characteristics of that particular rectifier. Its characteristics include RMS value, average output value, ripple factor, peak inverse value and so on. After the completion of the process of rectification, the output DC generated consists of some AC components in it. This indicates that output is not in the pure form. This is measured in terms of ripple factor. So here the important topic of concern is the ripple factor of the rectifiers. What is Ripple Factor? After the process of rectification if the output generated consists of some AC components in it are referred to as ripples. These ripples are measured in terms of Ripple Factor. The ratio in between the RMS value of the particular AC components present in the output to the presence of DC in that particular output generated is referred to as ripple factor denoted by 'r'. r=Irms/IDC For any rectifier to measure its effectiveness ripple factor is utilized. Let us discuss the information regarding the ripple factor with the two basic rectifier's half-wave and full-wave. Introduction to the Basic Model of Half Wave Rectifier It is a basic model of the rectifier. In this, only a single diode is used for the purpose of rectification. Here only a single cycle of the input is utilized during rectification other cycle gets blocked. Hence there is a loss of power in the circuitry. The basic model consists of a semiconductor diode connected in series with the supply and the load resistor. The functionality and the output obtained depend on the type of cycle chosen either positive or negative. half wave rectifier If the cycle considered is positive then in that case as per the basic functionality of the diode it will be in forward bias and it allows the path for the flow of current in the circuit. It blocks the negative cycle. This is referred to as a positive half-wave rectifier. The only change made if the negative cycle is to be considered is that change in the direction of the diode-connected. Then the remaining process remains the same. Now it is referred to as negative half-wave rectifier. However, the output generated consists of ripples. This can be eliminated by connecting a capacitor across the load. This capacitor functions as the filter and smoothens the output obtained from the rectifier. half wave rectifier with capacitor filter Once the circuit is connected to the supply if the positive cycle is supplied then capacitor gets enough charged and it holds the voltage of the diode at its peak value and after that capacitor tends to degrade at the load slowly because of reverse bias condition in the diode. Ripple Factor for the Basic Model of Half Wave Rectifier Generally, the ripple factor for the basic half-wave rectifier is r=Irms/IDC The RMS value of the AC component in the output is defined as Irms=Im/2 The DC value of the output wave is IDC= Im/π The I_rrms value can be obtained by Irrms=√(Irms)2-IDC)2 After substituting the values and the further simplification results in obtaining the final value of the ripple factor as r=1.21 Ripple Factor of Half Wave Rectifier with Capacitor Filter After the rectification, the capacitor is connected across the load for further smoothening. This capacitor has the phenomenon of charging and discharging. This results in the induction of ripple voltage. As the capacitor filter is connected the ripple factor gets reduced. Hence the ripple factor for the half-wave rectifier with capacitor filter is given by r=1/(2√3 f RLC) Here the 'f' stands for the frequency of the DC wave that obtained after rectification in the form of pulses. It is the same as that of the applied AC frequency. Based on the output voltage the value of the ripple factor can be estimated as r=(Vrpp/2√3)/(Vp – 0.5Vrpp) The peak value for the output voltage is denoted as Vp and peak to peak ripple voltage value can be referred to as Vrpp. Introduction to the Full Wave Rectifier Circuit The main drawback of a half-wave rectifier is that it utilizes only one cycle during rectification resulting in the loss of power. This can be overcome by the full-wave rectifier. In the full-wave, both the cycles are utilized for rectification. Hence the circuit minimizes the loss in power. Full-wave is classified into two types. (1) Center-Tapped Transformer In this, the basic transformer with a wire at the center of the secondary winding is tapped. Hence it is known as a center-Tapped transformer. The two diodes are connected in parallel to the resistive load. If the positive half of the cycle is applied as the input in that case diode D1 will be in forward bias whereas D2 remains in reverse bias. Full Wave Rectifier (Center-Tapped) If the negative cycle is considered in that case one diode acts in forward and the other in reverse. But the transformer utilized here is costly. Hence the other model of full-wave rectifier has been designed. (2) Full Wave Rectifier (Bridge) The positive and the negative halves of the input are utilized here for rectification. In this type rather than considering a transformer that is center-tapped a rectifier is designed by connecting four diodes in a bridge topology. The diodes that are connected in a diagonally opposite facing follows the same bias and the rest of the two will remain oppositely biased. Hence this is referred to as Bridge rectifier. full wave rectifier (bridge) However, the output generated will consist of some ripples in the output. This can be made more effective by connecting a capacitor across the load for the filtering of the rectified output. Ripple Factor of Full Wave Rectifier (Similar for Both Centres- Tapped as Well As Bridge) Here the ripple factor is given by r=Vrrms/VDC The Vrrms is the ripple factor of the peak to peak is Vrrms=√Vrms2– VDC2 Vrms is the RMS value of the voltage it is given by Vrms=Vm/√2 The output DC value can be given as VDC= (2Vm)/π On substituting and solving results in the value of the ripple factor of the full-wave rectifier as r= 0.483 Ripple Factor of Full Wave Rectifier with Capacitor Filter Derivation Here the output waveform generated as per the characteristics of capacitor involved with the rectifier circuit is considered in order to analyze the ripple factor of the full-wave rectifier. output waveforms of full-wave rectifier with capacitor filter The charge of the capacitor acquired is referred to as Vrrms*C Charge lost on it is given as Idc*T2 However, both the equations of acquired and lost are equated Vrrms*C = Idc*T2 If the considered capacitor or the resistor of the filter is large enough then T2 = T/2 = 1/2f Then, Vrrms = Idc/2fC As per the assumptions based consider that ripple factor waveform in the shape of a triangle Vr rms=Vrrms/(2√3) On substituting the known value of Vrrms the above equation can be rewritten as Vrrms=Idc/(4√3 fC) Therefore by the concept of ohms law; Idc=Vdc/RL Then, Vrrms=Vdc/(4√3 fCRL) (Vrrms)/Vdc =1/(4√3 fCRL) Know more about Rectifiers MCQs. From the above equation, it is clearly evident that the value of the ripple factor in the output signal is inversely related to the value of the capacitor and the resistor. Hence from the above analysis, the necessity of the filtering circuit after the rectification of the output is clearly evident. The importance of the capacitor filter is analyzed here. Similarly, can you compare the capacitor filter with the inductor filter and decide which one is well suited?