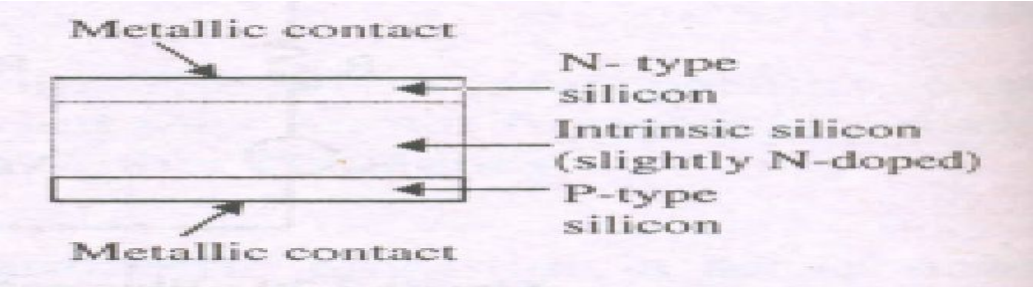
PIN DIODE AND ITS APPLICATION:

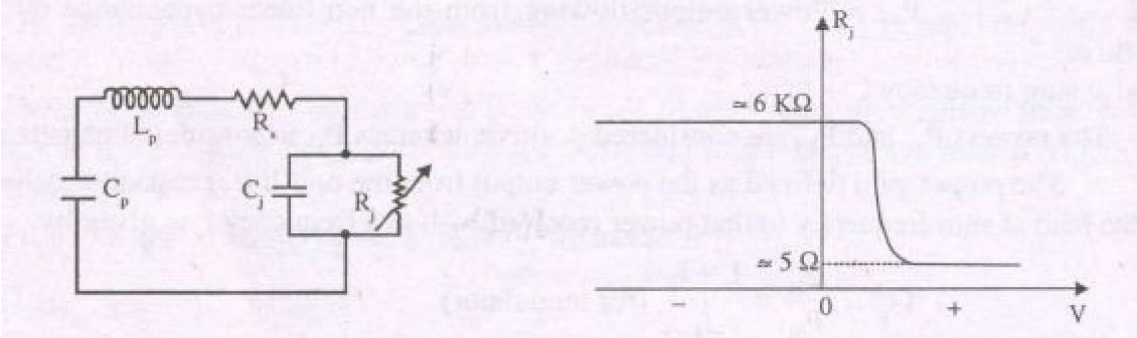
The PIN diode is a p-type, intrinsic, n-type diode consisting of a narrow layer of p-type semiconductor and a narrow layer of n-type semiconductor, with a thicker region of intrinsic or very lightly n-doped semiconductor material sandwiched between them.

Silicon is the semiconductor normally used because of its power handling capability and it offers high resistively for the intrinsic region. But, now-a-days Gallium Arsenide (GaAs) is also being used. Metal layers are attached for contact purposes. Its main applications are in microwave switching and modulation.



PIN diode acts as a more or less ordinary diode at frequencies upto about 100 MHz. At high frequencies, it ceases to rectify and then acts as a variable resistance with an equivalent circuit and a resistance-voltage characteristics .In 'the equivalent circuit, Land C represent the package inductance and capacitance p p respectively. R is the bulk semiconductor layer and contact resistance. R. and C. represent the respective junction resistance and capacitance of the intrinsic layer. When the bias is varied on the PIN diode, its microwave resistance R. changes from a typical value of 6 K under J

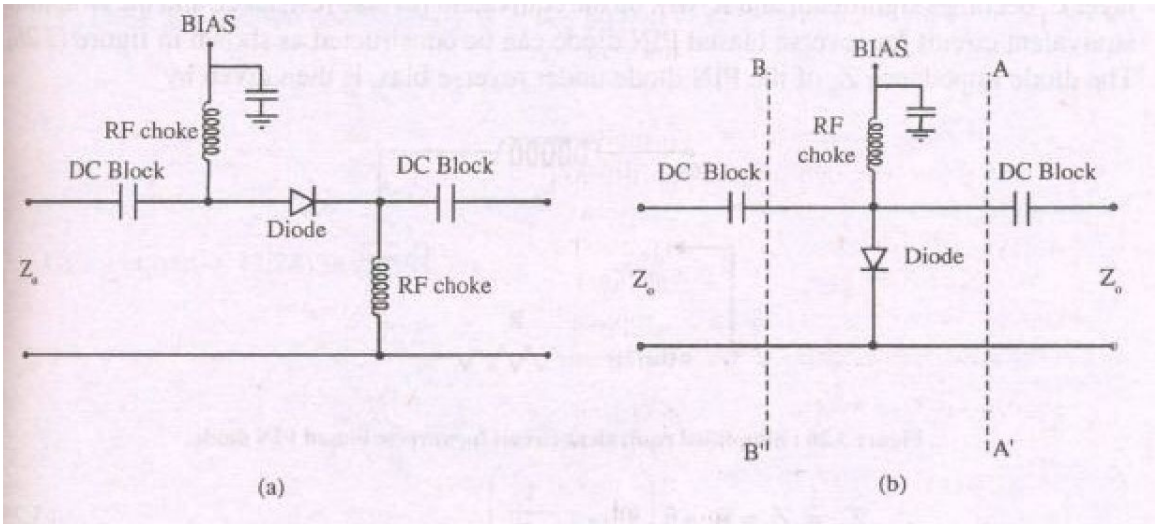
negative bias to perhaps 5 Q when the bias is positive .Thus, if the diode is mounted across a 50 Q co-axial line, it will not significantly load this line when it is back-biased, so that the power flow will not be interfered with. However, if the diode is now forward biased, its resistance drops significantly to 5Q, so that most of the power is reflected and hardly any is transmitted; the diode is acting as a switch.



APPLICATION OF PIN DIODE AS SINGLE POLE SWITCH:

A PIN diode can be used in either a series or a shunt configuration to form a single-pole, single-throw RF switch. These circuits are shown with bias networks below.

In the series configuration the switch is ON when thel diode is forward Biased and OFF when it is reverse biased. But, in shunt configuration of forward biasing the diode *"cuts-off"* the transmission and reverse biasing the diode ensures transmission from input to output. The DC blocks should have a very low impedance at RF operating frequency and RF choke inductors should have very high RF impedance.

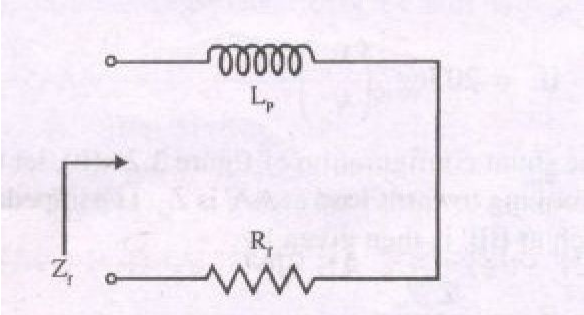


(a) Series configuration **(b) Shunt configuration.**

Ideally, a switch should have zero insertion loss in the ON state and infinite attenuation in the OFF state. Realistic switching elements, of course, result in some insertion loss for the ON state and finite attenuation for the OFF state due to non-zero forward bias resistance.

Similarly, for reverse bias shunt capacitor is not infinite & non-zero insertion loss results. Because of the large breakdown voltage (=500 volts) compared to an ordinary diode, PIN diode can be biased at high negative region so that large a.c. signal, superimposed on d.c. cannot make the device forward biased.

Forward Bias: When the PIN diode is forward biased, the capacitors C and C. almost behave as open circuits so that the equivalent circuit can now be simplified where Rf is the total forward resistance of the PIN diode given by



$$R_f = R_s + R_j$$

.. The diode impedance Zd of the PIN diode is given by

$$Z_d = Z_f = R_f + j\omega L_p$$

Reverse bias: When the PIN diode is reverse biased, the capacitance of the intrinsic layer C. becomes significant and Rr will be the equivalent reverse resistance and the simplified equivalent circuit for reverse biased PIN diode can be constructed as shown.

The diode impedance Zd of the PIN diode under reverse bias, is then given by

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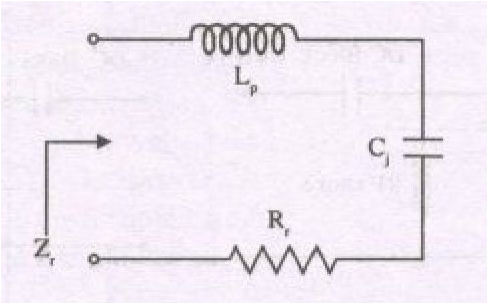

$$Z_d = Z_r = R_r + j\left(\omega L_p - \frac{1}{\omega C_j}\right)$$

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