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April 1st, 2010
Renesas Electronics Corporation

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Diode

PIN Diodes

1. PIN Diode Features

A PIN diode has an intrinsic semiconductor layer (I layer) in the middle of the PN junction, which makes it a diode with a P-I-N junction. It is a high frequency variable resistor that can change its high frequency series resistance (r_f) by controlling the forward current applied to the junction.

A PIN diode:

- Allows high-frequency series resistance to vary over a wide range while maintaining its linear characteristics in relation to the signal by means of forward direct current
- Has a small junction capacitance for a small forward bias and maintains excellent isolation at high frequencies

Figure 1.1 shows the operating principles of a PIN diode. If forward bias is applied to the PIN diode, electrons and positive holes pour into the I layer. The electrons and the positive holes bond, generating those that become the forward current and those that accumulate in the I layer. Electrons and positive holes that accumulate in the I layer function as carriers. The resistivity of the I layer varies according to the quantity of electrons and positive holes, and this changes the high frequency series resistance (r_f).

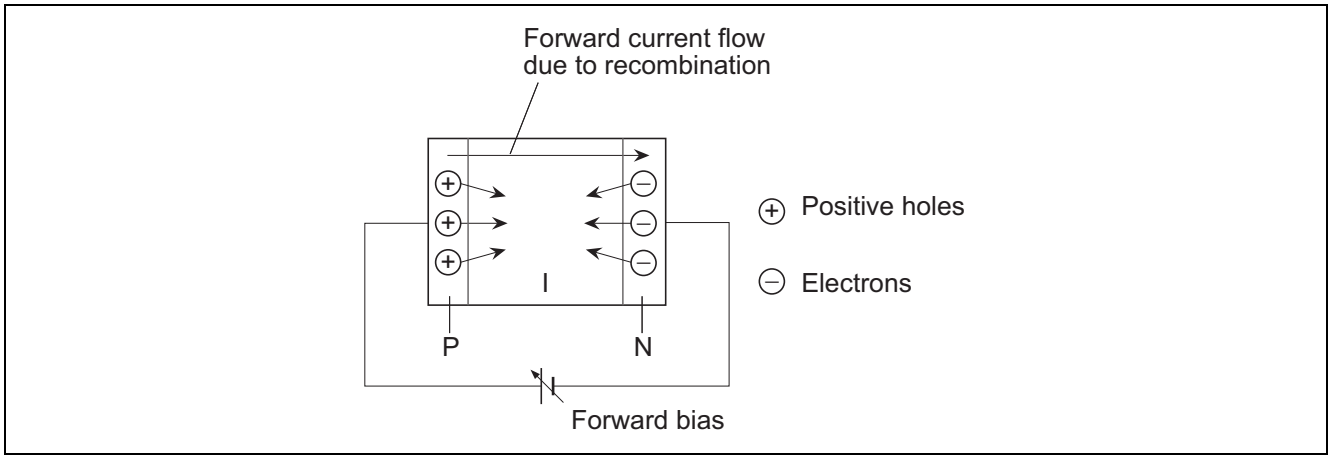


Figure 1.1 PIN Diode Operation

Figure 1.2 shows a cross section of the PIN diode structure. The silicon substrate has a high resistivity of several hundred ohm-centimeters. On part of the substrate surface a p^+ layer is formed, and on top of that layer, a metal such as aluminum forms the electrode.

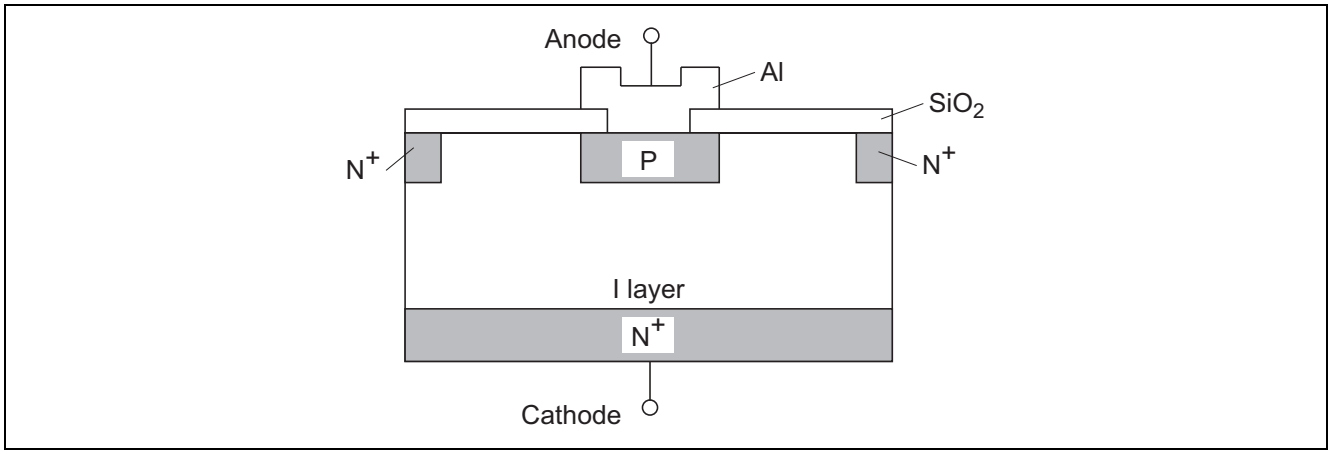


Figure 1.2 Cross Section of PIN Diode

2. PIN Diode Application Circuits

2.1 π Type Attenuator Circuit

A π type attenuator circuit is shown in figure 2.1.

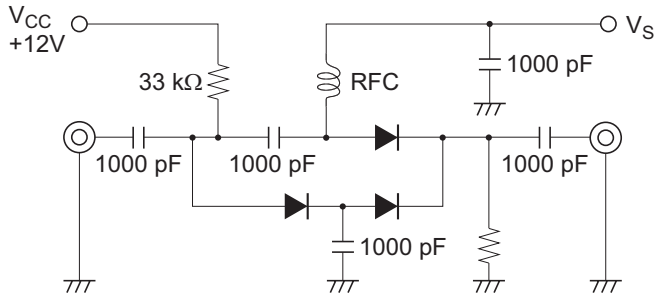
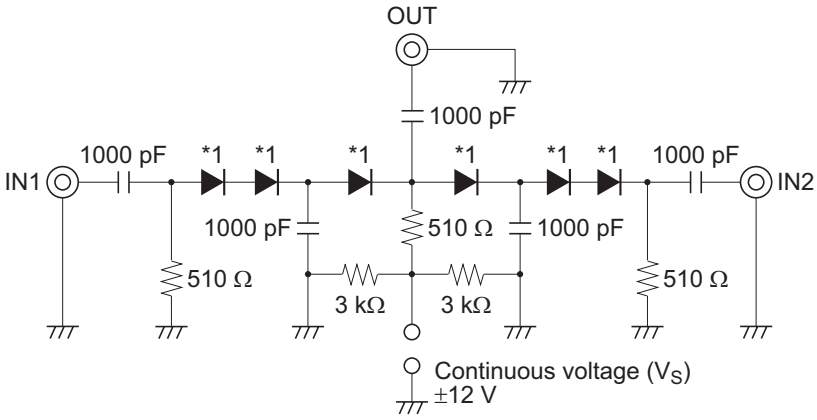


Figure 2.1 π Type Attenuator Circuit

2.2 RF Modulator High-Frequency Switching Circuit

Figure 2.2 shows a high-frequency switching circuit that emphasizes the isolation characteristics.



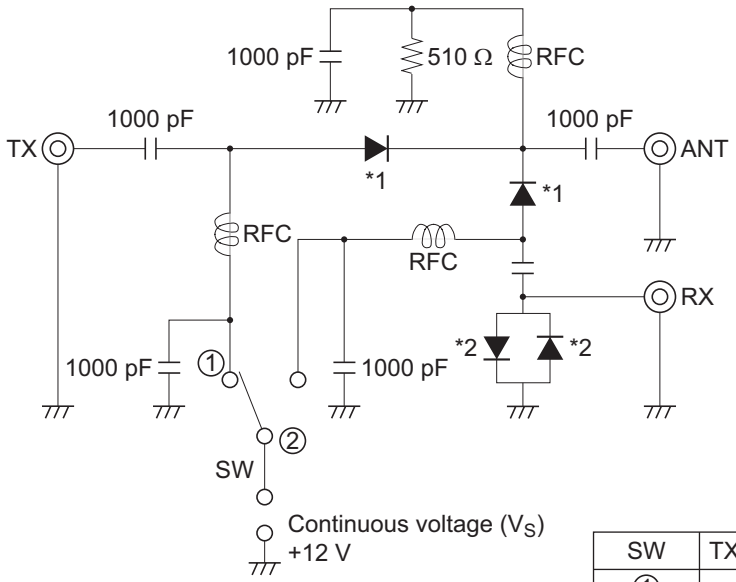
Note: *1. PIN diode (D.U.T)

V_S	IN1→OUT	IN2→OUT
+12V	OFF	ON
–12V	ON	OFF

Figure 2.2 RF Modulator High-Frequency Switching Circuit

2.3 Transceiver Switching Circuit

Figure 2.3 shows a simple high-frequency switching circuit of a transceiver.



SW	TX→ANT	ANT→RX
①	ON	OFF
②	OFF	ON

Notes: *1. PIN diode (D.U.T)
*2. Band switch diode (HSC277)

Figure 2.3 Transceiver Circuit

2.4 Antenna Switching Circuit

Figure 2.4 shows an antenna switching circuit.

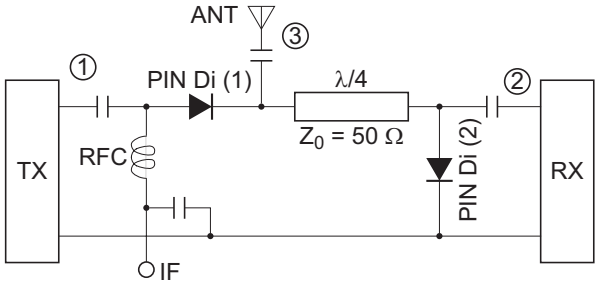


Figure 2.4 Antenna Switching Circuit

2.5 Off Through Switch

The circuit in figure 2.5 is a high-frequency switch used in VCRs. The more PIN diodes used, the lower the resistance when the power is turned on, and the better the high-frequency shutoff characteristics.

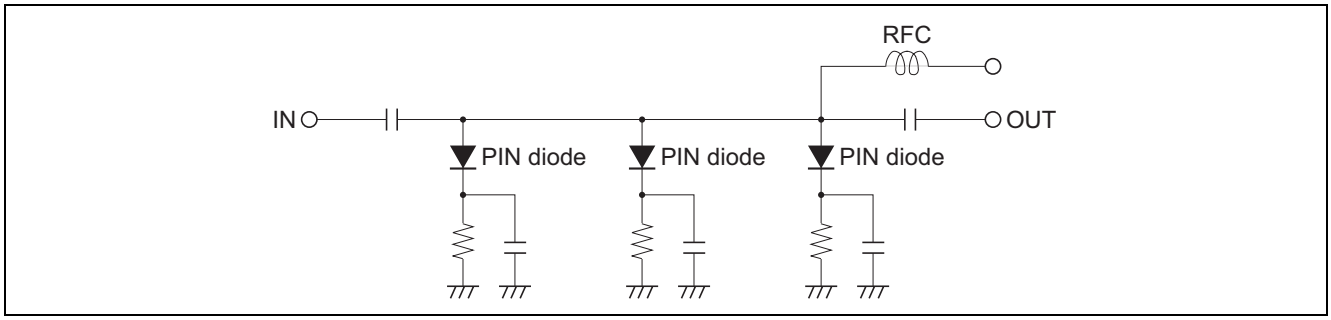


Figure 2.5 Off Through Switch Circuit

2.6 On Through Switch

The circuit in figure 2.6 is a standard on through switching circuit that uses a PIN diode.

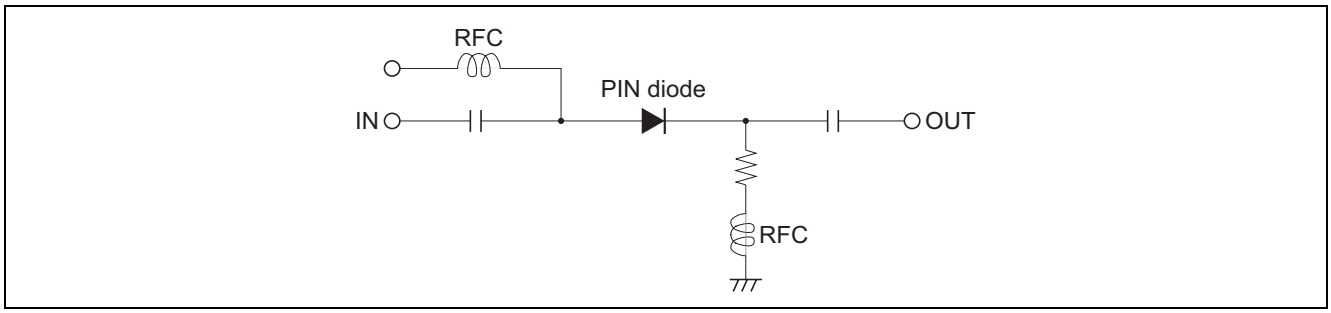


Figure 2.6 Standard on Through Switch Circuit

Revision Record

Rev.	Date	Description	
		Page	Summary
1.00	Feb.09.06	—	First edition issued

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