Stripline PIN Diode Switches/Attenuators

Features
- **Low Cost to Use**
  Designed for Easy Mounting
- **Broadband Operation**
  HF Through X-Band
- **Low Insertion Loss**
  Less than 0.5 dB to 10 GHz (5082-3040, 3340)
- **High Isolation**
  Greater than 20 dB to 10 GHz
- **Fast Switching/Modulation**
  5 ns Typical (5082-3041)
- **Low Drive Current**
  Required
  Less than 20 mA for 20 dB Isolation (5082-3041)

Description/Applications
These diodes are designed for applications in microwave and HF-UHF systems using strip-line or microstrip transmission line techniques.

Typical circuit functions performed consist of switching, duplexing, multiplexing, leveling, modulating, limiting, or gain control functions as required in TR switches, pulse modulators, phase shifters, and amplitude modulators operating in the frequency range from HF through Ku-Band.

### Maximum Ratings

<table>
<thead>
<tr>
<th>Part No. 5082-</th>
<th>-3040, -3340</th>
<th>-3041</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junction Operating and Storage Temperature Range</td>
<td>-65°C to +125°C</td>
<td>-65°C to +125°C</td>
</tr>
<tr>
<td>Power Dissipation$^{(1)}$</td>
<td>2.5 W</td>
<td>1.0 W</td>
</tr>
<tr>
<td>Peak Incident Pulse Power$^{(2)}$</td>
<td>225 W</td>
<td>50 W</td>
</tr>
<tr>
<td>Peak Inverse Voltage</td>
<td>150 V</td>
<td>70 V</td>
</tr>
<tr>
<td>Soldering Temperature</td>
<td>230°C for 5 sec</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
1. Device properly mounted in sufficient heat sink at 25°C, derate linearly to zero at maximum operating temperature.
2. $t_p = 1 \mu s, f = 10$ GHz, $D_o = 0.0011, Z_o = 50 \Omega, T_A = 25°C.$
These diodes provide nearly ideal transmission characteristics from HF through Ku-Band. The 5082-3340 is a reverse polarity device with characteristics similar to the 5082-3040. The 5082-3041 is recommended for applications requiring fast switching or high frequency modulation of microwave signals, or where the lowest bias current for the maximum attenuation is required.

More information is available in HP AN 922 (Applications of PIN Diodes) and 929 (Fast Switching PIN Diodes).

**Mechanical Specifications**

The cover channel supplied with each diode should be used in balanced stripline circuits in order to provide good electrical continuity from the upper to the lower ground plane through the package base metal. Higher order modes will be excited if this cover is left off or if poor electrical contact is made to the ground plane.

The package transmission channel is filled with epoxy resin which combines a low expansion coefficient with high chemical stability. Outline 61 has a gold plated copper body with gold plated Kovar leads.

### Electrical Specifications at $T_A = 25^\circ C$

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Package Outline</th>
<th>Heat Sink</th>
<th>Min. Isolation (dB)</th>
<th>Max. Insertion Loss (dB)</th>
<th>Max. SWR</th>
<th>Max. Reverse Recovery Time $t_{rr}$ (ns)</th>
<th>Typical Carrier Lifetime $\tau$ (ns)</th>
<th>Typical CW Power Switching Capability $P_A$ (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3040</td>
<td>61 Anode</td>
<td>20</td>
<td>0.5</td>
<td>1.5</td>
<td>-</td>
<td>-</td>
<td>400</td>
<td>30</td>
</tr>
<tr>
<td>3041</td>
<td>61 Cathode</td>
<td>20</td>
<td>1.0</td>
<td>1.5</td>
<td>10</td>
<td>-</td>
<td>35*</td>
<td>13</td>
</tr>
<tr>
<td>3340</td>
<td>61 Cathode</td>
<td>20</td>
<td>0.5</td>
<td>1.5</td>
<td>-</td>
<td>-</td>
<td>400</td>
<td>30</td>
</tr>
</tbody>
</table>

**Test Conditions**

1. Test Frequencies: 8 GHz 5082-3041; 10 GHz 5082-3040, and -3340.

### Typical Parameters

![Typical Forward Characteristics](image1.png)

**Figure 1.** Typical Forward Characteristics.
Figure 2. Typical Insertion Loss vs. Frequency.

Figure 3. Typical SWR vs. Frequency.

Figure 4. Typical Isolation vs. Frequency.

Figure 5. Typical Attenuation above Zero Bias Insertion Loss vs. Bias Current at $f = 8\, \text{GHz}$.

**Equivalent Circuits**

- **Forward Bias (Isolation State)**
  
- **Zero Bias (Insertion Loss State)**
Typical Equivalent Circuit Parameters—Forward Bias

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Lp (pH)</th>
<th>Rp (Ω)</th>
<th>Rs (Ω)</th>
<th>L1 (pH)</th>
<th>T1 (mm)</th>
<th>T2 (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5082-3040</td>
<td>200</td>
<td>0.25</td>
<td>1.0</td>
<td>20</td>
<td>2.4</td>
<td>5.0</td>
</tr>
<tr>
<td>5082-3041</td>
<td>220</td>
<td>0.25</td>
<td>1.0</td>
<td>20</td>
<td>2.4</td>
<td>5.0</td>
</tr>
</tbody>
</table>

Typical Equivalent Circuit Parameters—Zero Bias

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Lp (pH)</th>
<th>Rp (Ω)</th>
<th>R1 (KΩ)</th>
<th>L2 (pH)</th>
<th>R2 (KΩ)</th>
<th>C_T (pF)</th>
<th>T1 (mm)</th>
<th>T2 (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5082-3040</td>
<td>200</td>
<td>0.25</td>
<td>∞</td>
<td>0</td>
<td>5.0</td>
<td>0.10</td>
<td>2.4</td>
<td>5.0</td>
</tr>
<tr>
<td>5082-3041</td>
<td>220</td>
<td>0.25</td>
<td>∞</td>
<td>0</td>
<td>1.5</td>
<td>0.15</td>
<td>2.4</td>
<td>5.0</td>
</tr>
</tbody>
</table>

Typical Switching Parameters

RF Switching Speed
HP 5082-3041
The RF switching speed of the HP 5082-3041 may be considered in terms of the change in RF isolation at 2 GHz. This switching speed is dependent upon the forward bias current, reverse bias drive pulse, and characteristics of the pulse source. The RF switching speed for the shunt-mounted stripline diode in a 50 Ω system is considered for two cases: one driving the diode from the forward bias state to the reverse bias state (isolation to insertion loss), second, driving the diode from the reverse bias state to the forward bias state (insertion loss to isolation).

The total time it takes to switch the shunt diode from the isolation state (forward bias) to the insertion loss state (reverse bias) is shown in Figure 6. These curves are for three forward bias conditions with the diode driven in each case with three different reverse voltage pulses ($V_{PR}$). The total switching time for each case includes the delay time (pulse initiation to 20 dB isolation) and transition time (20 dB isolation to 0.9 dB isolation). Slightly faster switching times may be realized by spiking the leading edge of the pulse or using a lower impedance pulse driver.

Pulse generator (positive pulse), the RF switching time from the insertion loss state to the isolation state was less than 2 nanoseconds. A more detailed treatise on switching speed is published in AN929 "Fast Switching PIN Diodes".

Reverse Recovery Time
Shown below is reverse recovery time ($t_{rr}$) vs. forward current, $I_p$ for various reverse pulse voltages $V_R$. The circuit used to measure $t_{rr}$ is shown in Figure 7.

The time it takes to switch the diode from zero or reverse bias to a given isolation is less than the time from isolation to the insertion loss case. For all cases of forward bias generated by the

Figure 6. Isolation vs. Time (Turn-on) for HP 5082-3041. Frequency, 2 GHz.

Figure 7. Basic $t_{rr}$ Test Setup.
Figure 8. Typical Reverse Recovery Time vs. Forward Current for Various Reverse Driving Voltages, 5082-3041.

Figure 9. Typical Reverse Recovery Time vs. Forward Current for Various Reverse Driving Voltages, 5082-3340.

Figure 10. Typical Reverse Recovery Time vs. Forward Current for Various Reverse Driving Voltages, 5082-3340.

Figure 11. Suggested Stripline Assembly.