Surface Mount PIN Diodes

Technical Data

Features
• Diodes Optimized for:
  Low Current Switching
  Low Distortion Attenuating
  Ultra-Low Distortion
  Switching
  Microwave Frequency
  Operation
• Surface Mount SOT-23 and
  SOT-143 Packages
  Single and Dual Versions
  Tape and Reel Options
  Available
• Low Failure in Time (FIT)
  Rate[1]

Note:
1. For more information see the
   Surface Mount PIN Reliability Data
   Sheet.

Description/Applications
The HSMP-380X and HSMP-381X
series are specifically designed for
low distortion attenuator applications. The HSMP-382X series is
optimized for switching applications where ultra-low resistance is
required. The HSMP-48XX series
are special products featuring
ultra low parasitic inductance in
the SOT-23 package, specifically
designed for use at frequencies
which are much higher than the
upper limit for conventional
SOT-23 PIN diodes. The
HSMP-4810 diode is a low distor-
tion attenuating PIN designed for
operation to 3 GHz. The
HSMP-4820 diode is ideal for
limiting and low inductance
switching applications up to
1.5 GHz. The HSMP-4890 is
optimized for low current switch-
ing applications up to 3 GHz.

The HSMP-386X series of general
purpose PIN diodes are designed
for two classes of applications.
The first is attenuators where
current consumption is the most
important design consideration.
The second application for this
series of diodes is in switches
where low cost is the driving
issue for the designer.

The HSMP-386X series Total
Capacitance (C_T) and Total
Resistance (R_T) are typical
specifications. For applications
that require guaranteed perfor-
mance, the general purpose
HSMP-383X series is recom-
mended. For low distortion

HSMP-38XX and
HSMP-48XX Series

Package Lead Code
Identification

<table>
<thead>
<tr>
<th>SINGLE</th>
<th>SERIES</th>
<th>COMMON ANODE</th>
</tr>
</thead>
<tbody>
<tr>
<td>#0</td>
<td>#2</td>
<td>#3</td>
</tr>
<tr>
<td>COMMON CATHODE</td>
<td>UNCONNECTED PAIR</td>
<td>DUAL CATHODE</td>
</tr>
<tr>
<td>#4</td>
<td>#A</td>
<td>#B</td>
</tr>
</tbody>
</table>

The HSMP-386X series Total
Capacitance (C_T) and Total
Resistance (R_T) are typical
specifications. For applications
that require guaranteed perfor-
mance, the general purpose
HSMP-383X series is recom-
mended. For low distortion

attenuators, the HSMP-380X or
-381X series are recommended.
For high performance switching
applications, the HSMP-389X
series is recommended.

A SPICE model is not available
for PIN diodes as SPICE does not
provide for a key PIN diode
characteristic, carrier lifetime.
### Absolute Maximum Ratings[^1] $T_A = 25^\circ\text{C}$

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Units</th>
<th>Absolute Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_f$</td>
<td>Forward Current (1 ms Pulse)</td>
<td>Amp</td>
<td>1</td>
</tr>
<tr>
<td>$P_t$</td>
<td>Total Device Dissipation</td>
<td>mW[^2]</td>
<td>250</td>
</tr>
<tr>
<td>$P_{IV}$</td>
<td>Peak Inverse Voltage</td>
<td>—</td>
<td>Same as $V_{BR}$</td>
</tr>
<tr>
<td>$T_j$</td>
<td>Junction Temperature</td>
<td>$^\circ\text{C}$</td>
<td>150</td>
</tr>
<tr>
<td>$T_{STG}$</td>
<td>Storage Temperature</td>
<td>$^\circ\text{C}$</td>
<td>-65 to 150</td>
</tr>
</tbody>
</table>

**Notes:**
1. Operation in excess of any one of these conditions may result in permanent damage to this device.
2. CW Power Dissipation at $T_{LEAD} = 25^\circ\text{C}$. Derate to zero at maximum rated temperature.

### PIN Attenuator Diodes

#### Electrical Specifications $T_A = 25^\circ\text{C}$ (Each Diode)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>HSMP-5082-3800</td>
<td>D0 0</td>
<td>0</td>
<td>Single Series Common Cathode</td>
<td>3080</td>
<td>100</td>
<td>2.0</td>
<td>0.37</td>
<td>1000</td>
<td>8</td>
</tr>
<tr>
<td>HSMP-5082-3802</td>
<td>D2 2</td>
<td>2</td>
<td>Single Series Common Cathode</td>
<td>3081</td>
<td>100</td>
<td>3.0</td>
<td>0.35</td>
<td>1500</td>
<td>10</td>
</tr>
<tr>
<td>HSMP-5082-3804</td>
<td>D4 4</td>
<td>4</td>
<td>Single Series Common Cathode</td>
<td>3080</td>
<td>100</td>
<td>2.0</td>
<td>0.37</td>
<td>1000</td>
<td>8</td>
</tr>
</tbody>
</table>

**Test Conditions**
- $V_R = V_{BR}$
- $I_R \leq 10 \mu\text{A}$
- $I_F = 100 \text{ mA}$
- $f = 100 \text{ MHz}$
- $V_R = 50 \text{ V}$
- $f = 1 \text{ MHz}$
- $I_F = 0.01 \text{ mA}$
- $f = 100 \text{ MHz}$
- $I_F = 20 \text{ mA}$
- $f = 100 \text{ MHz}$

### PIN Switching Diodes

#### Electrical Specifications $T_A = 25^\circ\text{C}$

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>HSMP-5082-3820</td>
<td>F0 0</td>
<td>0</td>
<td>Single Series Common Cathode</td>
<td>3188</td>
<td>50</td>
<td>0.6*</td>
<td>0.8*</td>
<td>—</td>
</tr>
<tr>
<td>HSMP-5082-3822</td>
<td>F2 2</td>
<td>2</td>
<td>Single Series Common Cathode</td>
<td>3188</td>
<td>50</td>
<td>0.6*</td>
<td>0.8*</td>
<td>—</td>
</tr>
<tr>
<td>HSMP-5082-3823</td>
<td>F3 3</td>
<td>3</td>
<td>Single Series Common Cathode</td>
<td>3188</td>
<td>50</td>
<td>0.6*</td>
<td>0.8*</td>
<td>—</td>
</tr>
<tr>
<td>HSMP-5082-3824</td>
<td>F4 4</td>
<td>4</td>
<td>Single Series Common Cathode</td>
<td>3188</td>
<td>50</td>
<td>0.6*</td>
<td>0.8*</td>
<td>—</td>
</tr>
<tr>
<td>HSMP-5082-3880</td>
<td>S0 0</td>
<td>0</td>
<td>Single Series Common Cathode</td>
<td>3188</td>
<td>50</td>
<td>0.6*</td>
<td>0.8*</td>
<td>—</td>
</tr>
<tr>
<td>HSMP-5082-3889</td>
<td>G0 0</td>
<td>0</td>
<td>Single Series Common Cathode</td>
<td>3188</td>
<td>50</td>
<td>0.6*</td>
<td>0.8*</td>
<td>—</td>
</tr>
<tr>
<td>HSMP-5082-3892</td>
<td>G2 2</td>
<td>2</td>
<td>Single Series Common Cathode</td>
<td>3188</td>
<td>50</td>
<td>0.6*</td>
<td>0.8*</td>
<td>—</td>
</tr>
<tr>
<td>HSMP-5082-3893</td>
<td>G3 3</td>
<td>3</td>
<td>Single Series Common Cathode</td>
<td>3188</td>
<td>50</td>
<td>0.6*</td>
<td>0.8*</td>
<td>—</td>
</tr>
<tr>
<td>HSMP-5082-3894</td>
<td>G4 4</td>
<td>4</td>
<td>Single Series Common Cathode</td>
<td>3188</td>
<td>50</td>
<td>0.6*</td>
<td>0.8*</td>
<td>—</td>
</tr>
<tr>
<td>HSMP-5082-3895</td>
<td>G5 5</td>
<td>5</td>
<td>Single Series Common Cathode</td>
<td>3188</td>
<td>50</td>
<td>0.6*</td>
<td>0.8*</td>
<td>—</td>
</tr>
</tbody>
</table>

**Test Conditions**
- $V_R = V_{BR}$
- $I_R \leq 10 \mu\text{A}$
- $I_F = 5 \text{ mA}$
- $f = 100 \text{ MHz}$
- $I_F = 10 \text{ mA}$
- $f = 20 \text{ V}$
- $V_R = 50 \text{ V}$
- $f = 5 \text{ V}$
- $2 f_0 \text{ Z}_0 = 50 \text{ W}$
- $P_{in} = 400 \text{ dBm}$
- $0 \text{ V bias}$

**Note:**
1. Package marking code is white.
### PIN General Purpose Diodes, Electrical Specifications $T_A = 25^\circ C$

<table>
<thead>
<tr>
<th>Part Number HSMP-</th>
<th>Package Marking Code[1]</th>
<th>Lead Code</th>
<th>Nearest Equivalent Axial Lead Part No. 5082-</th>
<th>Minimum Breakdown Voltage $V_{BR}$ (V)</th>
<th>Maximum Series Resistance $R_S$ (Ω)</th>
<th>Maximum Total Capacitance $C_T$ (pF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3830</td>
<td>K0</td>
<td>0</td>
<td>Single</td>
<td>3077</td>
<td>200</td>
<td>1.5</td>
</tr>
<tr>
<td>3832</td>
<td>K2</td>
<td>2</td>
<td>Series</td>
<td></td>
<td></td>
<td>0.3</td>
</tr>
<tr>
<td>3833</td>
<td>K3</td>
<td>3</td>
<td>Common Anode</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3834</td>
<td>K4</td>
<td>4</td>
<td>Common Cathode</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Test Conditions

$V_R = V_{BR}$

$I_R \leq 10 \text{ mA}$

$I_f = 100 \text{ mA}$

$f = 100 \text{ MHz}$

$V_g = 50 \text{ V}$

$f = 1 \text{ MHz}$

### High Frequency (Low Inductance, 500 MHz - 3 GHz) PIN Diodes, Electrical Specifications $T_A = 25^\circ C$

<table>
<thead>
<tr>
<th>Part Number HSMP-</th>
<th>Package Marking Code</th>
<th>Lead Code</th>
<th>Configuration</th>
<th>Minimum Breakdown Voltage $V_{BR}$ (V)</th>
<th>Maximum Series Resistance $R_S$ (Ω)</th>
<th>Typical Total Capacitance $C_T$ (pF)</th>
<th>Typical Total Inductance $L_T$ (nH)</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>4810</td>
<td>EB</td>
<td>B</td>
<td>Dual Cathode</td>
<td>100</td>
<td>3.0</td>
<td>0.35</td>
<td>0.4</td>
<td>Attenuator</td>
</tr>
<tr>
<td>4820</td>
<td>FA</td>
<td>A</td>
<td>Dual Anode</td>
<td>50</td>
<td>0.6*</td>
<td>0.75*</td>
<td>1.0</td>
<td>Limiter</td>
</tr>
<tr>
<td>4890</td>
<td>GA</td>
<td>A</td>
<td>Dual Anode</td>
<td>100</td>
<td>2.5**</td>
<td>0.33</td>
<td>0.375</td>
<td>Switch</td>
</tr>
</tbody>
</table>

Test Conditions

$V_R = V_{BR}$

$I_R \leq 10 \mu A$

$I_f = 100 \text{ mA}$

$f = 100 \text{ MHz}$

$V_R = 50 \text{ V}$

$f = 1 \text{ MHz}$

$V_R = 20 \text{ V}$

$V_R = 50 \text{ V}$

$V_R = 20 \text{ V}$

### PIN General Purpose Diodes, Typical Specifications $T_A = 25^\circ C$

<table>
<thead>
<tr>
<th>Part Number HSMP-</th>
<th>Code Marking Code[1]</th>
<th>Lead Code</th>
<th>Configuration</th>
<th>Minimum Breakdown Voltage $V_{BR}$ (V)</th>
<th>Typical Series Resistance $R_S$ (Ω)</th>
<th>Typical Total Capacitance $C_T$ (pF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3860</td>
<td>L0</td>
<td>0</td>
<td>Single</td>
<td>50</td>
<td>3.0/1.5*</td>
<td>0.20</td>
</tr>
<tr>
<td>3862</td>
<td>L2</td>
<td>2</td>
<td>Series</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3863</td>
<td>L3</td>
<td>3</td>
<td>Common Anode</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3864</td>
<td>L4</td>
<td>4</td>
<td>Common Cathode</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Test Conditions

$V_R = V_{BR}$

$I_R \leq 10 \mu A$

$I_f = 10 \text{ mA}$

$f = 100 \text{ MHz}$

$V_R = 10 \text{ mA}$

$f = 100 \text{ MHz}$

$I_f = 100 \text{ mA}$

$V_R = 50 \text{ V}$

$f = 1 \text{ MHz}$

### Typical Parameters at $T_A = 25^\circ C$

<table>
<thead>
<tr>
<th>Part Number HSMP-</th>
<th>Series Resistance $R_S$ (Ω)</th>
<th>Carrier Lifetime $\tau$ (ns)</th>
<th>Reverse Recovery Time $T_{rr}$ (ns)</th>
<th>Total Capacitance $C_T$ (pF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>380X</td>
<td>55</td>
<td>1800</td>
<td>500</td>
<td>0.32 @ 50 V</td>
</tr>
<tr>
<td>381X</td>
<td>75</td>
<td>1500</td>
<td>300</td>
<td>0.27 @ 50 V</td>
</tr>
<tr>
<td>382X</td>
<td>1.5</td>
<td>70*</td>
<td>7</td>
<td>0.60 @ 20 V</td>
</tr>
<tr>
<td>383X</td>
<td>20</td>
<td>500</td>
<td>80</td>
<td>0.20 @ 50 V</td>
</tr>
<tr>
<td>388X</td>
<td>3.8</td>
<td>2500</td>
<td>550</td>
<td>0.30 @ 50 V</td>
</tr>
<tr>
<td>389X</td>
<td>3.8</td>
<td>200*</td>
<td>–</td>
<td>0.20 @ 5 V</td>
</tr>
</tbody>
</table>

Test Conditions

$I_f = 1 \text{ mA}$

$f = 100 \text{ MHz}$

$I_f = 10 \text{ mA}$

$V_R = 10 \text{ V}$

$I_f = 20 \text{ mA}$

$90\%$ Recovery

---

**Note:**

1. Package marking code is white.
Typical Parameters at $T_A = 25^\circ C$ (unless otherwise noted), Single Diode

![Graph 1: RF Capacitance vs. Reverse Bias, HSMP-3810 Series.](image1)

![Graph 2: RF Capacitance vs. Reverse Bias, HSMP-3830 Series.](image2)

![Graph 3: Resistance at 25$^\circ$C vs. Forward Bias Current.](image3)

![Graph 4: RF Resistance vs. Forward Bias Current for HSMP-3800.](image4)

![Graph 5: RF Resistance vs. Forward Bias Current for HSMP-3810/HSMP-4810.](image5)

![Graph 6: Capacitance vs. Reverse Voltage.](image6)

![Graph 7: 2nd Harmonic Input Intercept Point vs. Diode RF Resistance for Attenuator Diodes.](image7)

![Graph 8: 2nd Harmonic Input Intercept Point vs. Forward Bias Current for Switch Diodes.](image8)

![Graph 9: Reverse Recovery Time vs. Forward Current for Various Reverse Voltages. HSMP-3820 Series.](image9)
Typical Parameters (continued)

Figure 10. Reverse Recovery Time vs. Forward Current for Various Reverse Voltage. HSMP-3830 Series.

Figure 11. Typical Reverse Recovery Time vs. Reverse Voltage. HSMP-3880 Series.

Figure 12. Typical Reverse Recovery Time vs. Reverse Voltage. HSMP-3890 Series.

Figure 13. Forward Current vs. Forward Voltage. HSMP-3800 Series.

Figure 14. Forward Current vs. Forward Voltage. HSMP-3810 and HSMP-4810 Series.

Figure 15. Forward Current vs. Forward Voltage. HSMP-3820 and HSMP-4820 Series.

Figure 16. Forward Current vs. Forward Voltage. HSMP-3830 Series.

Figure 17. Forward Current vs. Forward Voltage. HSMP-3880 Series.

Figure 18. Forward Current vs. Forward Voltage. HSMP-3890 and HSMP-4890 Series.
Typical Parameters (continued)

Figure 19. Typical RF Resistance vs. Forward Bias Current for HSMP-3860.

Figure 20. Forward Current vs. Forward Voltage for HSMP-3860.

Figure 21. Typical Capacitance vs. Reverse Voltage for HSMP-3860.

Equivalent Circuit Model

HSMS-3860

$$\begin{align*}
C_P &= \text{0.08 pF} \\
L_p &= 2.0 \text{ nH} \\
R_s &= 1.5 \quad \Omega \\
R_j &= \text{0.12 pF}^* \\
C_j &= \text{Measured at -20 V} \\
R_T &= 1.5 + R_j \\
C_T &= C_P + C_j \\
R_j &= \frac{12}{I^{0.9}} \quad \Omega
\end{align*}$$

$I = \text{Forward Bias Current in mA}$
Typical Applications for Multiple Diode Products

Figure 22. Simple SPDT Switch, Using Only Positive Current.

Figure 23. High Isolation SPDT Switch, Dual Bias.

Figure 24. Switch Using Both Positive and Negative Bias Current.

Figure 25. Very High Isolation SPDT Switch, Dual Bias.
Typical Applications for Multiple Diode Products (continued)

**Figure 26. Four Diode π Attenuator.**

**Figure 27. High Isolation SPST Switch (Repeat Cells as Required).**

**Figure 28. Power Limiter Using HSMP-3822 Diode Pair.**
Typical Applications for HSMP-48XX Low Inductance Series

Microstrip Series Connection for HSMP-48XX Series
In order to take full advantage of the low inductance of the HSMP-48XX series when using them in series application, both lead 1 and lead 2 should be connected together, as shown above.
**Microstrip Shunt Connections for HSMP-48XX Series**

In the diagram above, the center conductor of the microstrip line is interrupted and leads 1 and 2 of the HSMP-38XX series diode are placed across the resulting gap. This forces the 0.5 nH lead inductance of leads 1 and 2 to appear as part of a low pass filter, reducing the shunt parasitic inductance and increasing the maximum available attenuation. The 0.3 nH of shunt inductance external to the diode is created by the via holes, and is a good estimate for 0.032" thick material.

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**Co-Planar Waveguide Shunt Connection for HSMP-48XX Series**

Co-Planar waveguide, with ground on the top side of the printed circuit board, is shown in the diagram above. Since it eliminates the need for via holes to ground, it offers lower shunt parasitic inductance and higher maximum attenuation when compared to a microstrip circuit.
Package Dimensions
Outline 23 (SOT-23)

PC Board Footprints
SOT-23

Outline 143 (SOT-143)

SOT-143

Package Characteristics
Lead Material ................................................................. Alloy 42
Lead Finish ................................................................. Tin-Lead 85-15%
Maximum Soldering Temperature ......................... 260°C for 5 seconds
Minimum Lead Strength .................................................. 2 pounds pull
Typical Package Inductance ............................................. 2 nH
Typical Package Capacitance .............................. 0.08 pF (opposite leads)
Profile Option Descriptions
- **BLK** = Bulk
- **TR1** = 3K pc. Tape and Reel, Device Orientation; See Figures 37 and 38
- **TR2** = 10K pc. Tape and Reel, Device Orientation; See Figures 37 and 38

Tape and Reeling conforms to Electronic Industries RS-481, “Taping of Surface Mounted Components for Automated Placement.”

Ordering Information
Specify part number followed by option under. For example:

<table>
<thead>
<tr>
<th>H</th>
<th>SMP</th>
<th>38XX</th>
<th>XXX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulk or Tape and Reel Option</td>
<td>Part Number</td>
<td>Surface Mount PIN Diode</td>
<td>Hewlett-Packard</td>
</tr>
</tbody>
</table>

Figure 37. Options -TR1, -TR2 for SOT-23 Packages.

Figure 38. Options -TR1, -TR2 for SOT-143 Packages.