

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-3880 switching diode is an ultra low distortion device optimized for higher power applications from 50 MHz to 1.5 GHz. The HSMP-389X series is optimized for switching applications where low resistance at low current and low capacitance are

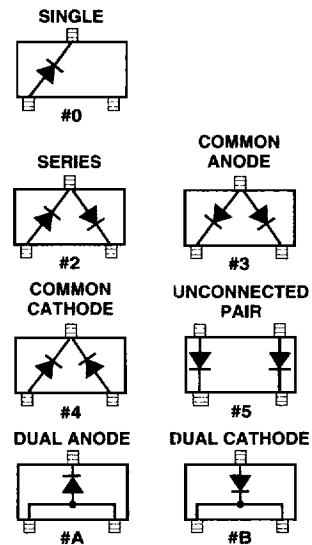
required. The HSMP-48XX series are special products featuring ultra low parasitic inductance in the SOT-23 package, specifically designed for use at frequencies which are much higher than the upper limit for conventional SOT-23 PIN diodes. The HSMP-4810 diode is a low distortion attenuating PIN diode 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 switching 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 performance, the general purpose HSMP-383X series is recommended. For low distortion

HSMP-38XX and HSMP-48XX Series

Package Lead Code Identification



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⁾ $T_A = 25^\circ\text{C}$

| Symbol | Parameter | Units | Absolute Maximum |
|-----------|------------------------------|-------------------|------------------|
| I_F | Forward Current (1 ms Pulse) | Amp | 1 |
| P_t | Total Device Dissipation | mW ⁽²⁾ | 250 |
| P_{IV} | Peak Inverse Voltage | --- | Same as V_{BR} |
| T_j | Junction Temperature | $^\circ\text{C}$ | 150 |
| T_{STG} | Storage Temperature | $^\circ\text{C}$ | -65 to 150 |

Notes:

- Operation in excess of any one of these conditions may result in permanent damage to this device.
- 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)

| Part Number HSMP- | Package Marking Code ⁽¹⁾ | Lead Code | Configuration | Nearest Equivalent Axial Lead Part No. 5082- | Minimum Breakdown Voltage V_{BR} (V) | Maximum Series Resistance R_S (Ω) | Maximum Total Capacitance C_T (pF) | Minimum High Resistance R_H (Ω) | Maximum Low Resistance R_L (Ω) |
|----------------------|-------------------------------------|-----------|----------------|--|--|---|---|--|--|
| 3800 | D0 | 0 | Single | 3080 | 100 | 2.0 | 0.37 | 1000 | 8 |
| 3802 | D2 | 2 | Series | | | | | | |
| 3804 | D4 | 4 | Common Cathode | | | | | | |
| 3810 | E0 | 0 | Single | 3081 | 100 | 3.0 | 0.35 | 1500 | 10 |
| 3812 | E2 | 2 | Series | | | | | | |
| 3813 | E3 | 3 | Common Anode | | | | | | |
| 3814 | E4 | 4 | Common Cathode | | | | | | |
| Test Conditions | | | | | $V_R = V_{BR}$ Measure $I_R \leq 10 \mu\text{A}$ | $I_F = 100 \text{ mA}$ $f = 100 \text{ MHz}$ | $V_R = 50 \text{ V}$ $f = 1 \text{ MHz}$ | $I_F = 0.01 \text{ mA}$ $f = 100 \text{ MHz}$ | $I_F = 20 \text{ mA}$ $f = 100 \text{ MHz}$ |

PIN Switching Diodes

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

| Part Number HSMP- | Package Marking Code ⁽¹⁾ | Lead Code | Configuration | Nearest Equivalent Axial Lead Part No. 5082- | Minimum Breakdown Voltage V_{BR} (V) | Maximum Series Resistance R_S (Ω) | Maximum Total Capacitance C_T (pF) | Maximum Shunt Mode Harmonic Distortion Hmd (dBc) |
|----------------------|-------------------------------------|-----------|------------------|--|--|--|--|--|
| 3820 | F0 | 0 | Single | 3188 | 50 | 0.6* | 0.8* | --- |
| 3822 | F2 | 2 | Series | | | | | |
| 3823 | F3 | 3 | Common Anode | | | | | |
| 3824 | F4 | 4 | Common Cathode | | | | | |
| 3880 | S0 | 0 | Single | --- | 100 | 6.5 | 0.40 | -55 |
| 3890 | G0 | 0 | Single | --- | 100 | 2.5 | 0.30** | --- |
| 3892 | G2 | 2 | Series | | | | | |
| 3893 | G3 | 3 | Common Anode | | | | | |
| 3894 | G4 | 4 | Common Cathode | | | | | |
| 3895 | G5 | 5 | Unconnected Pair | | | | | |
| Test Conditions | | | | | $V_R = V_{BR}$ Measure $I_R \leq 10 \mu\text{A}$ | $I_F = 5 \text{ mA}$ $f = 100 \text{ MHz}$ $I_F = 10 \text{ mA}^*$ | $V_R = 50 \text{ V}$ $f = 1 \text{ MHz}$ $V_{R1} = 20 \text{ V}^*$ $V_R = 5 \text{ V}^{**}$ | $2 f_o, Z_o = 50 \text{ W}$ $f_o = 400 \text{ MHz}$ $P_{in} = +30 \text{ dBm}$ 0 V bias |

Note:

- Package marking code is white.

PIN General Purpose Diodes, Electrical Specifications $T_A = 25^\circ\text{C}$

| Part Number HSMP- | Package Marking Code ^[1] | Lead Code | Configuration | Nearest Equivalent Axial Lead Part No. 5082- | Minimum Breakdown Voltage V_{BR} (V) | Maximum Series Resistance R_S (Ω) | Maximum Total Capacitance C_T (pF) |
|------------------------------|-------------------------------------|------------------|---|--|--|---|---|
| 3830 3832 3833 3834 | K0 K2 K3 K4 | 0 2 3 4 | Single Series Common Anode Common Cathode | 3077 | 200 | 1.5 | 0.3 |
| Test Conditions | | | | | $V_R = V_{BR}$ Measure $I_R \leq 10 \mu\text{A}$ | $I_F = 100 \text{ mA}$ $f = 100 \text{ MHz}$ | $V_R = 50 \text{ V}$ $f = 1 \text{ MHz}$ |

High Frequency (Low Inductance, 500 MHz – 3 GHz) PIN Diodes, Electrical Specifications $T_A = 25^\circ\text{C}$

| Part Number HSMP- | Package Marking Code | Lead Code | Configuration | Minimum Breakdown Voltage V_{BR} (V) | Maximum Series Resistance R_S (Ω) | Typical Total Capacitance C_T (pF) | Maximum Total Capacitance C_T (pF) | Typical Total Inductance L_T (nH) | Application |
|----------------------|----------------------|-----------|---------------|--|--|---|--|---|-------------|
| 4810 | EB | B | Dual Cathode | 100 | 3.0 | 0.35 | 0.4 | 1.0 | Attenuator |
| 4820 | FA | A | Dual Anode | 50 | 0.6* | 0.75* | 1.0 | 1.0* | Limit |
| 4890 | GA | A | Dual Anode | 100 | 2.5** | 0.33 | 0.375 | 1.0 | Switch |
| | | | | $V_R = V_{BR}$ Measure $I_R \leq 10 \mu\text{A}$ | $I_F = 100 \text{ mA}$ $I_F = 10 \text{ mA}^*$ $I_F = 5 \text{ mA}^{**}$ | $V_R = 50 \text{ V}$ $f = 1 \text{ MHz}$ $V_R = 20 \text{ V}^*$ | $V_R = 50 \text{ V}$ $f = 1 \text{ MHz}$ $V_R = 0 \text{ V}$ | $f = 500 \text{ MHz} - 3 \text{ GHz}$ $V_R = 20 \text{ V}^*$ | |

PIN General Purpose Diodes, Typical Specifications $T_A = 25^\circ\text{C}$

| Part Number HSMP- | Code Marking Code ^[1] | Lead Code | Configuration | Minimum Breakdown Voltage V_{BR} (V) | Typical Series Resistance R_S (Ω) | Typical Total Capacitance C_T (pF) |
|------------------------------|----------------------------------|------------------|---|--|---|---|
| 3860 3862 3863 3864 | L0 L2 L3 L4 | 0 2 3 4 | Single Series Common Anode Common Cathode | 50 | 3.0/1.5* | 0.20 |
| Test Conditions | | | | $V_R = V_{BR}$ Measure $I_R \leq 10 \mu\text{A}$ | $I_F = 10 \text{ mA}$ $f = 100 \text{ MHz}$ $*I_F = 100 \text{ mA}$ | $V_R = 50 \text{ V}$ $f = 1 \text{ MHz}$ |

Typical Parameters at $T_A = 25^\circ\text{C}$

| Part Number HSMP- | Series Resistance R_S (Ω) | Carrier Lifetime τ (ns) | Reverse Recovery Time T_{rr} (ns) | Total Capacitance C_T (pF) |
|----------------------|--------------------------------------|--|---|------------------------------|
| 380X | 55 | 1800 | 500 | 0.32 @ 50 V |
| 381X | 75 | 1500 | 300 | 0.27 @ 50 V |
| 382X | 1.5 | 70* | 7 | 0.60 @ 20 V |
| 383X | 20 | 500 | 80 | 0.20 @ 50 V |
| 388X | 3.8 | 2500 | 550 | 0.30 @ 50 V |
| 389X | 3.8 | 200* | - | 0.20 @ 5 V |
| Test Conditions | | $I_F = 50 \text{ mA}$ $I_R = 250 \text{ mA}$ $I_F = 10 \text{ mA}^*$ $I_R = 6 \text{ mA}^*$ | $V_R = 10 \text{ V}$ $I_F = 20 \text{ mA}$ 90% Recovery | |

Note:

1. Package marking code is white.

Typical Parameters at $T_A = 25^\circ\text{C}$ (unless otherwise noted), Single Diode

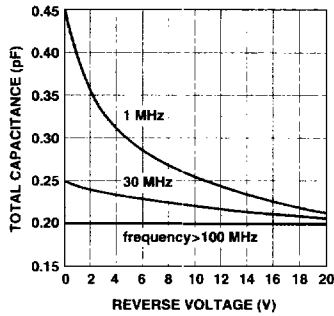


Figure 1. RF Capacitance vs. Reverse Bias, HSMP-3810 Series.

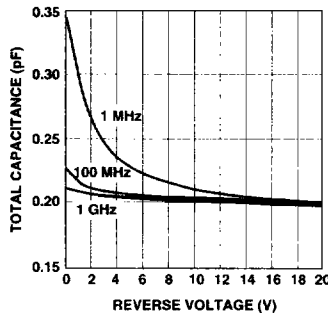


Figure 2. RF Capacitance vs. Reverse Bias, HSMP-3830 Series.

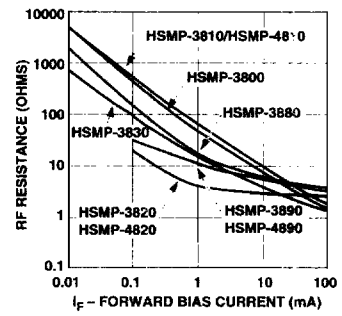


Figure 3. RF Resistance at 25°C vs. Forward Bias Current.

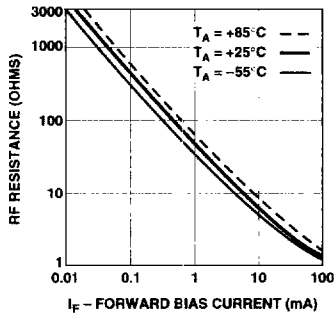


Figure 4. RF Resistance vs. Forward Bias Current for HSMP-3800.

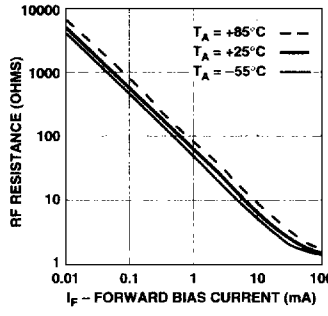


Figure 5. RF Resistance vs. Forward Bias Current for HSMP-3810/HSMP-4810.

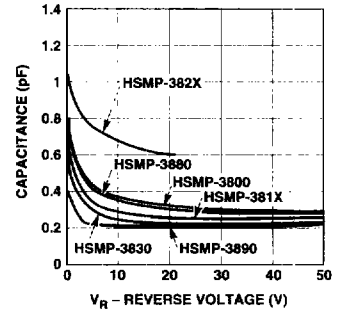


Figure 6. Capacitance vs. Reverse Voltage.

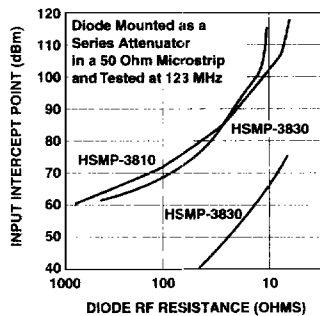


Figure 7. 2nd Harmonic Input Intercept Point vs. Diode RF Resistance for Attenuator Diodes.

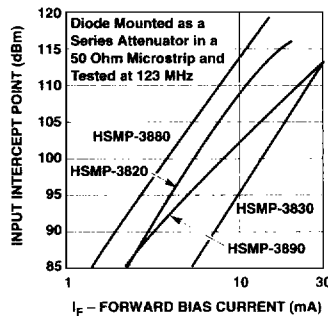


Figure 8. 2nd Harmonic Input Intercept Point vs. Forward Bias Current for Switch Diodes.

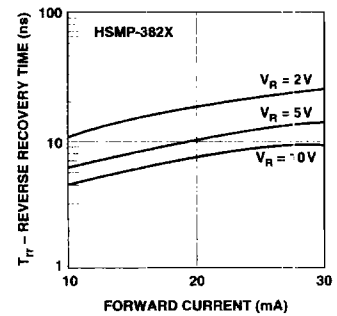


Figure 9. Reverse Recovery Time vs. Forward Current for Various Reverse Voltages, HSMP-3820 Series.

Typical Parameters (continued)

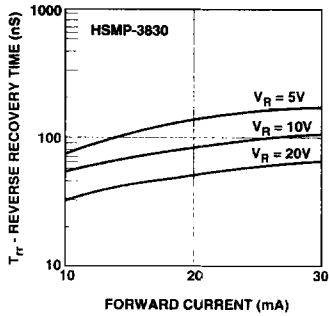


Figure 10. Reverse Recovery Time vs. Forward Current for Various Reverse Voltage. HSMP-3830 Series.

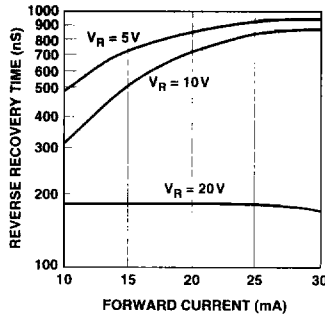


Figure 11. Typical Reverse Recovery Time vs. Reverse Voltage. HSMP-3880 Series.

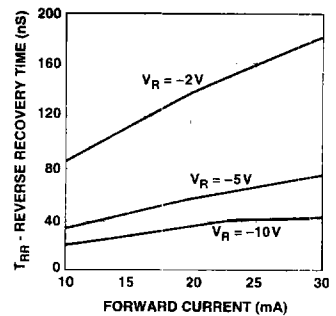


Figure 12. Typical Reverse Recovery Time vs. Reverse Voltage. HSMP-3890 Series.

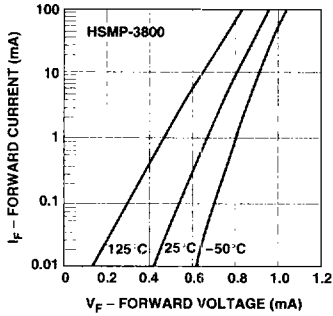


Figure 13. Forward Current vs. Forward Voltage. HSMP-3800 Series.

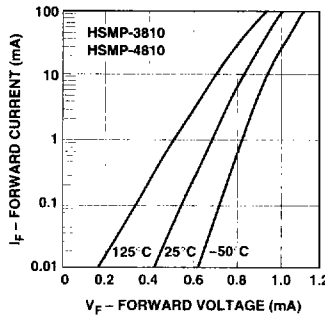


Figure 14. Forward Current vs. Forward Voltage. HSMP-3810 and HSMP-4810 Series.

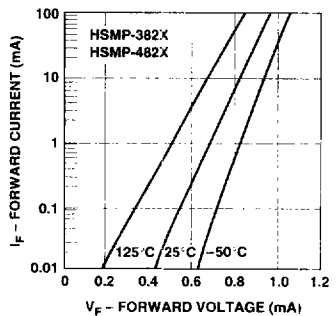


Figure 15. Forward Current vs. Forward Voltage. HSMP-3820 and HSMP-4820 Series.

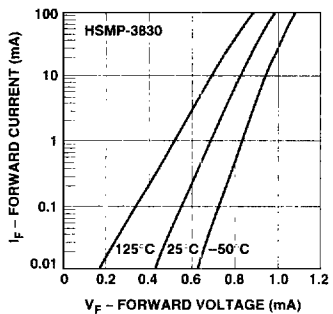


Figure 16. Forward Current vs. Forward Voltage. HSMP-3830 Series.

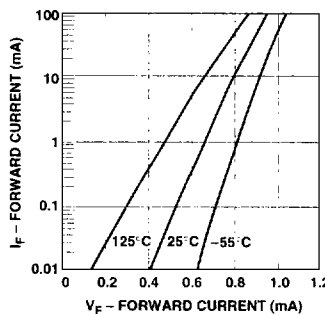


Figure 17. Forward Current vs. Forward Voltage. HSMP-3880 Series.

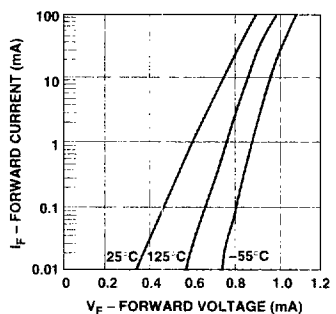


Figure 18. Forward Current vs. Forward Voltage. HSMP-3890 and HSMP-4890 Series.

Typical Parameters (continued)

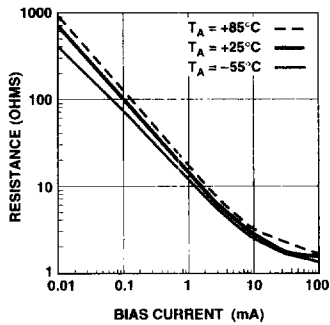


Figure 19. Typical RF Resistance vs. Forward Bias Current for HSMP-3860.

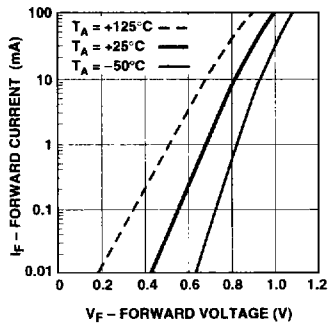


Figure 20. Forward Current vs. Forward Voltage for HSMP-3860.

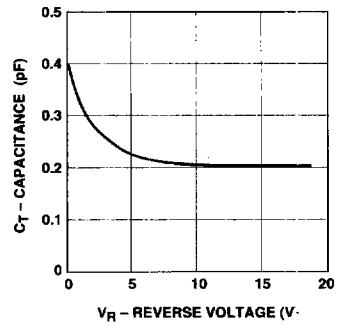
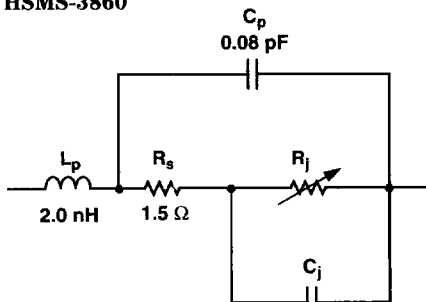


Figure 21. Typical Capacitance vs. Reverse Bias for HSMP-3860.

Equivalent Circuit Model HSMS-3860



$$R_T = 1.5 + R_j$$

$$C_T = C_p + C_j$$

$$R_j = \frac{12}{I^{0.9}} \Omega$$

I = Forward Bias Current in mA

* Measured at -20 V

Typical Applications for Multiple Diode Products

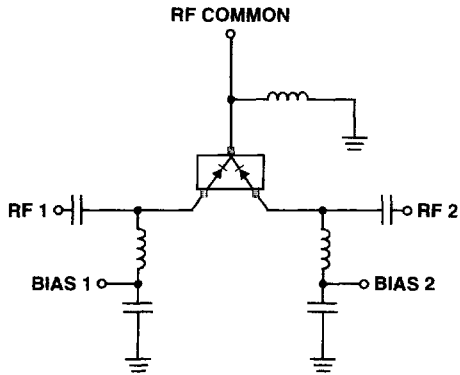


Figure 22. Simple SPDT Switch, Using Only Positive Current.

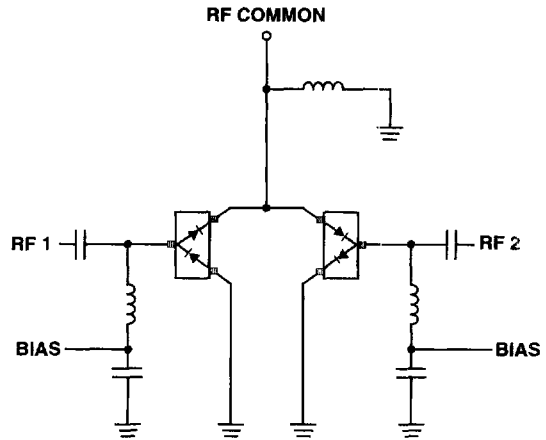


Figure 23. High Isolation SPDT Switch, Dual Bias.

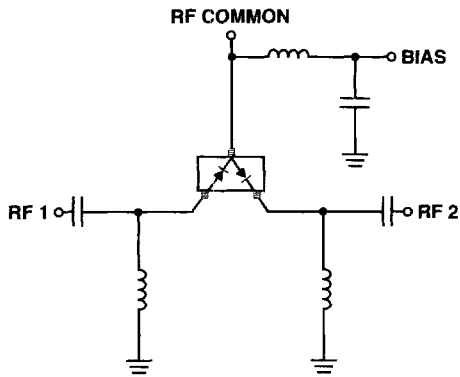


Figure 24. Switch Using Both Positive and Negative Bias Current.

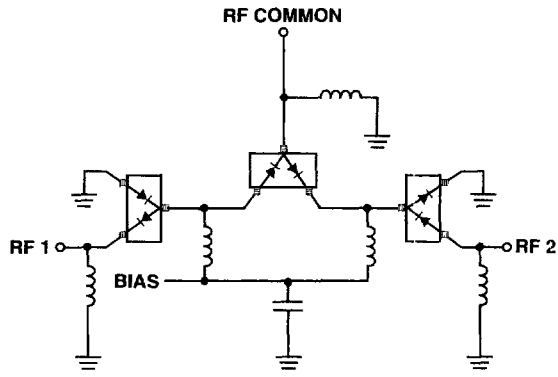


Figure 25. Very High Isolation SPDT Switch, Dual Bias.

Typical Applications for Multiple Diode Products (continued)

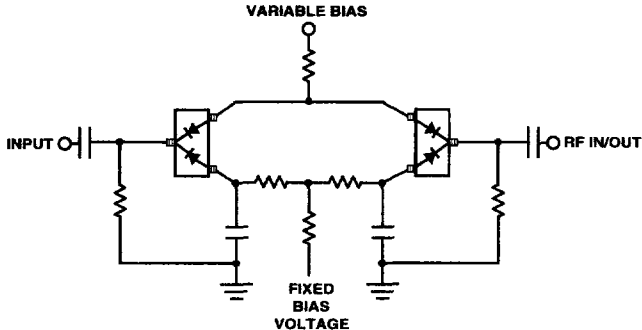


Figure 26. Four Diode π Attenuator.

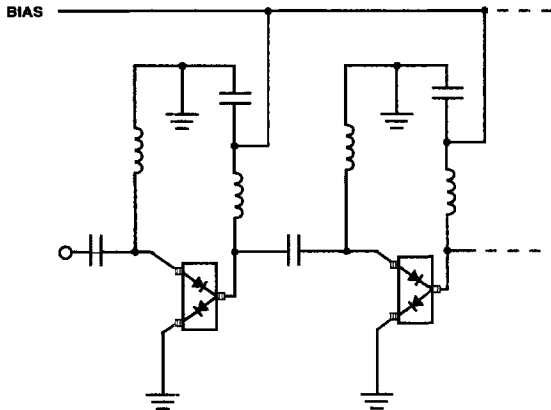


Figure 27. High Isolation SPST Switch (Repeat Cells as Required).

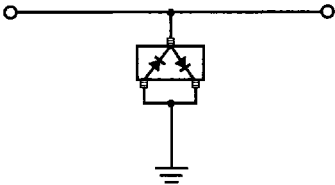


Figure 28. Power Limiter Using HSMP-3822 Diode Pair.

Typical Applications for HSMP-48XX Low Inductance Series

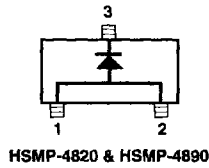
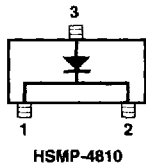


Figure 29. Internal Connections.

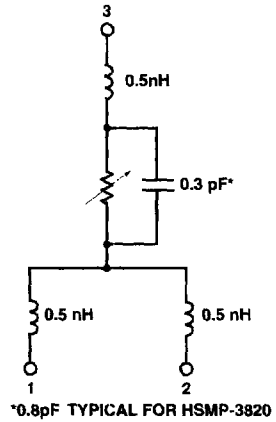


Figure 30. Equivalent Circuit.

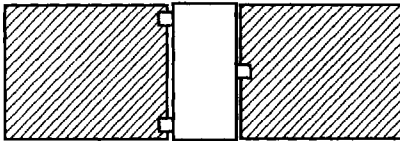


Figure 31. Circuit Layout.

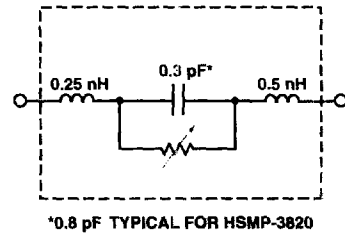


Figure 32. Equivalent Circuit.

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.

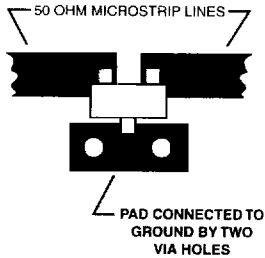
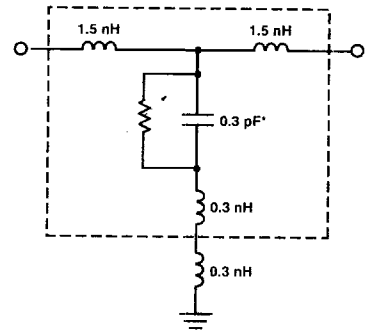


Figure 33. Circuit Layout.

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



*0.8 pF TYPICAL FOR HSMP-4820

Figure 34. Equivalent Circuit.

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.

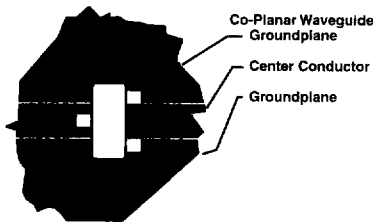
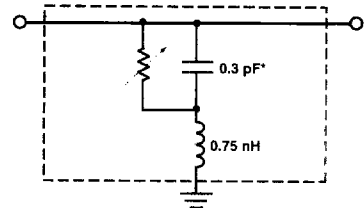


Figure 35. Circuit Layout.

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

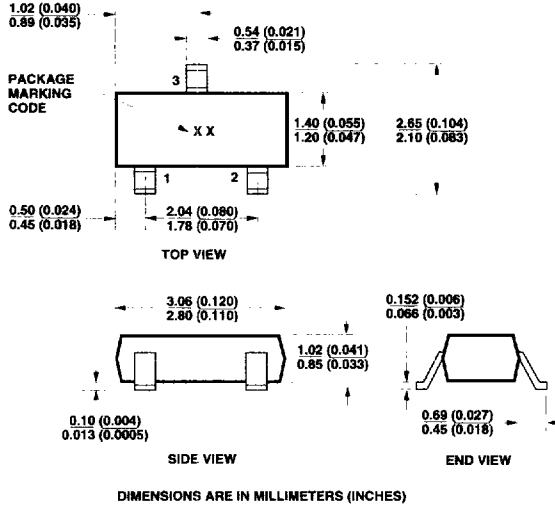
in the diagram above. Since it eliminates the need for via holes to ground, it offers lower shunt parasitic inductance and higher maximum attenuation when compared to a microstrip circuit.



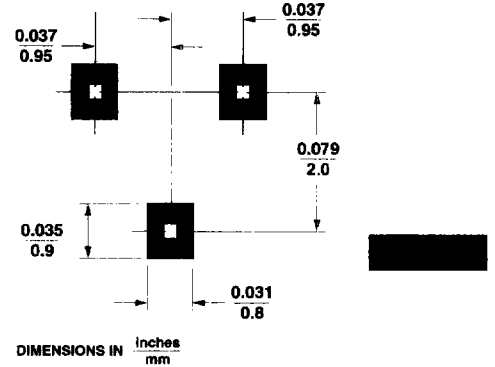
*0.8 pF TYPICAL FOR HSMP-4820

Figure 36. Equivalent Circuit.

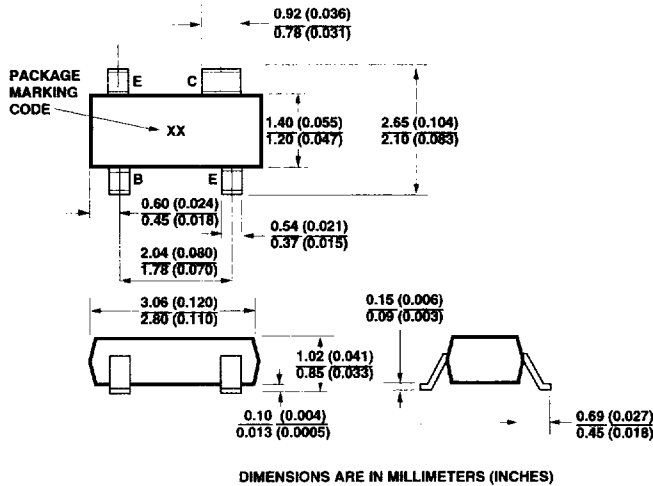
Package Dimensions
Outline 23 (SOT-23)



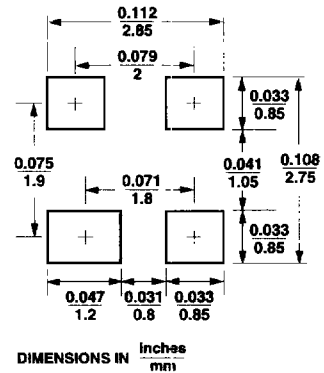
PC Board Footprints
SOT-23



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) |

Ordering Information

Option L30 = Bulk
 Option L31 = Tape and Reel,
 See Figures 37 and 38

Conforms to Electronic Industries
 RS-481, "Taping of Surface
 Mounted Components for Auto-
 mated Placement." Standard
 Quantity is 3,000 Devices/Reel.

Ordering Information

Specify part number followed by option under. For example:

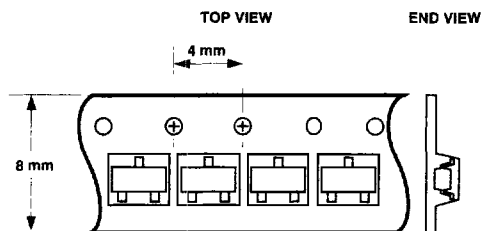
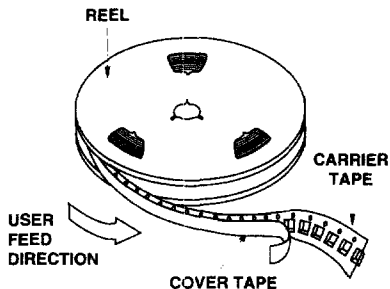
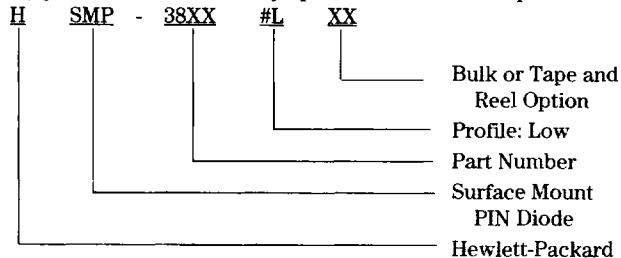


Figure 37. Option L31 for SOT-23 Packages.

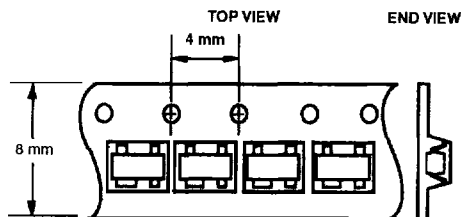


Figure 38. Option L31 for SOT-143 Packages.