HEWLETT® PACKARD

Surface Mount PIN Diodes

Technical Data

HSMP-38XX and HSMP-48XX Series

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

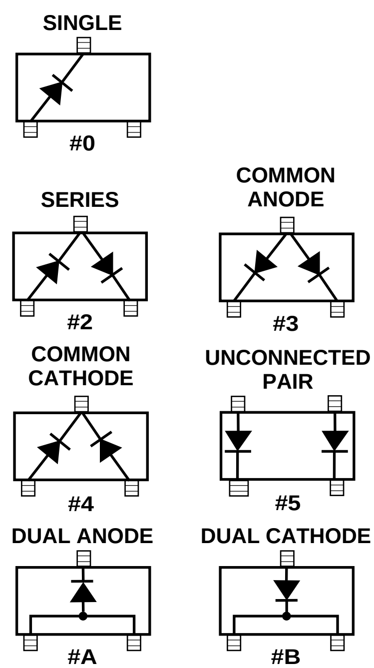
The HSMP-380X and HSMP-381X series are specifically designed for low distortion attenuator applications. The HSMP-382X series is optimized for switching applications where ultra-low resistance is required. The HSMP-3880 switching diode is an ultra low distortion device optimized for higher power applications 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 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 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.

Package Lead Code Identification



Absolute Maximum Ratings[1] T_A = 25°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	°C	150
T_{STG}	Storage Temperature	°C	-65 to 150

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°C. Derate to zero at maximum rated temperature.

PIN Attenuator Diodes
Electrical Specifications T_A = 25°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 3802 3804	D0 D2 D4	0 2 4	Single Series Common Cathode	3080	100	2.0	0.37	1000	8
3810 3812 3813 3814	E0 E2 E3 E4	0 2 3 4	Single Series Common Anode Common Cathode	3081	100	3.0	0.35	1500	10
Test Conditions					$V_R = V_{BR}$ Measure $I_R \leq 10\ \mu A$	I_F = 100 mA f = 100 MHz	V_R = 50 V f = 1 MHz	I_F = 0.01 mA f = 100 MHz	I_F = 20 mA f= 100 MHz

PIN Switching Diodes
Electrical Specifications T_A = 25°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 3822 3823 3824	F0 F2 F3 F4	0 2 3 4	Single Series Common Anode Common Cathode	3188	50	0.6*	0.8*	—
3880	S0	0	Single	—	100	6.5	0.40	–55
3890 3892 3893 3894 3895	G0 G2 G3 G4 G5	0 2 3 4 5	Single Series Common Anode Common Cathode Unconnected Pair	—	100	2.5	0.30**	—
Test Conditions					$V_R = V_{BR}$ Measure $I_R \leq 10\ \mu A$	I_F = 5 mA f = 100 MHz I_F = 10 mA*	V_R = 50 V f = 1 MHz V_R = 20 V* V_R = 5 V**	2 f_o, Z_o = 50 W f_o = 400 MHz P_{in} = +30 dBm 0 V bias

Note:
1. Package marking code is white.

PIN General Purpose Diodes, Electrical Specifications $T_A = 25°C$

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 $I_R \le 10$ mA	$I_F = 100$ mA f = 100 MHz	$V_R = 50$ V f = 1 MHz

High Frequency (Low Inductance, 500 MHz – 3 GHz) PIN Diodes, Electrical Specifications $T_A = 25°C$

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*	Limiter
4890	GA	A	Dual Anode	100	2.5**	0.33	0.375	1.0	Switch
				$V_R = V_{BR}$ Measure $I_R \le 10$ µA	$I_F = 100$ mA $I_F = 10$ mA* $I_F = 5$ mA**	$V_R = 50$ V f = 1 MHz $V_R = 20$ V*	$V_R = 50$ V f = 1 MHz $V_R = 0$ V	f = 500 MHz – 3 GHz $V_R = 20$ V*	

PIN General Purpose Diodes, Typical Specifications $T_A = 25°C$

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 $I_R \le 10$ µA	$I_F = 10$ mA f = 100 MHz *$I_F = 100$ mA	$V_R = 50$ V f = 1 MHz

Typical Parameters at $T_A = 25°C$

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	$I_F = 1$ mA f = 100 MHz $I_F = 10$ mA*	$I_F = 50$ mA $I_R = 250$ mA $I_F = 10$ mA* $I_R = 6$ mA*	$V_R = 10$ V $I_F = 20$ mA 90% Recovery	

Note:
1. Package marking code is white.

Typical Parameters at T_A = 25°C (unless otherwise noted), Single Diode

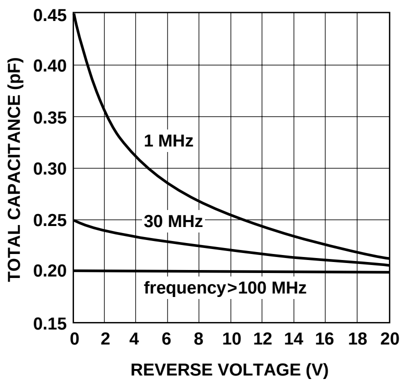


Figure 1. RF Capacitance vs. Reverse Bias, HSMP-3810 Series.

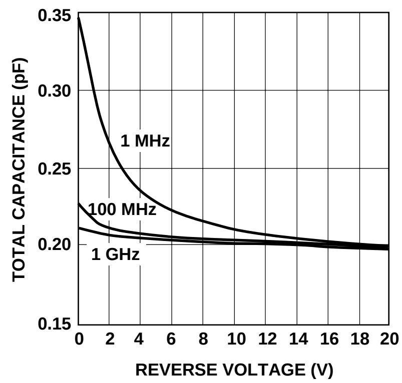


Figure 2. RF Capacitance vs. Reverse Bias, HSMP-3830 Series.

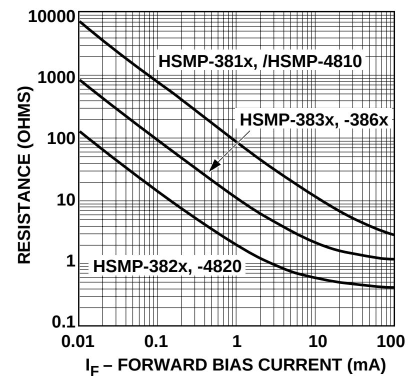


Figure 3. Resistance at 25°C vs. Forward Bias Current.

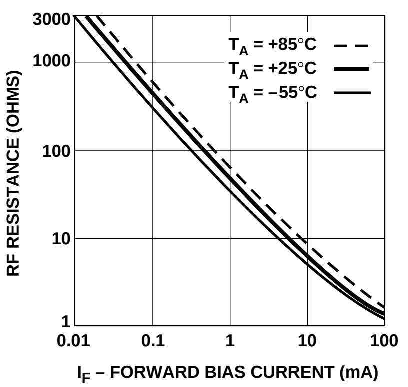


Figure 4. RF Resistance vs. Forward Bias Current for HSMP-3800.

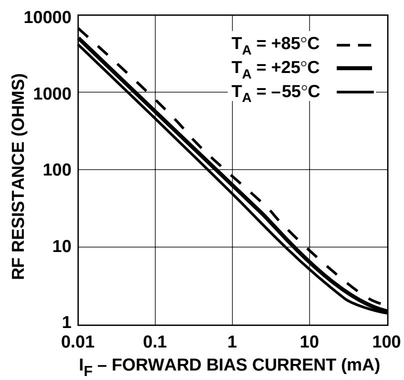


Figure 5. RF Resistance vs. Forward Bias Current for HSMP-3810/ HSMP-4810.

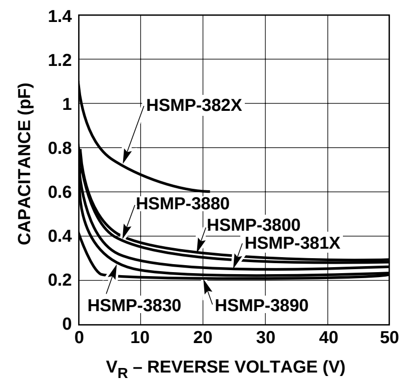


Figure 6. Capacitance vs. Reverse Voltage.

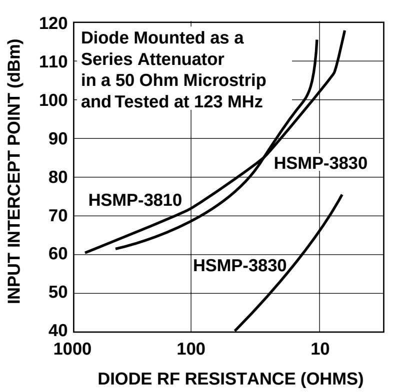


Figure 7. 2nd Harmonic Input Intercept Point vs. Diode RF Resistance for Attenuator Diodes.

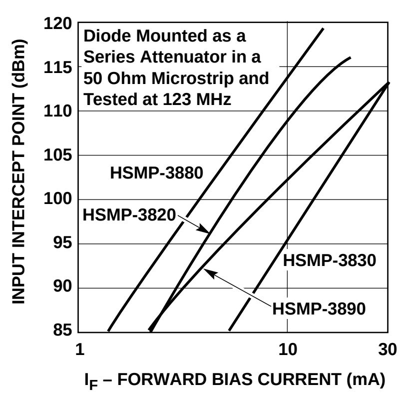


Figure 8. 2nd Harmonic Input Intercept Point vs. Forward Bias Current for Switch Diodes.

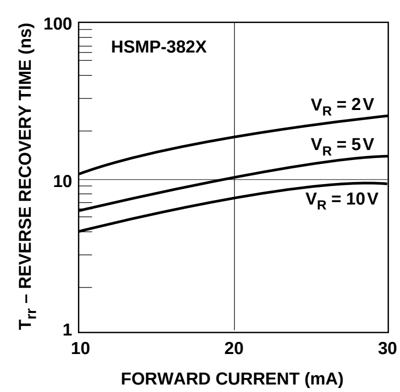


Figure 9. Reverse Recovery Time vs. Forward Current for Various Reverse Voltages. HSMP-3820 Series.

Typical Parameters (continued)

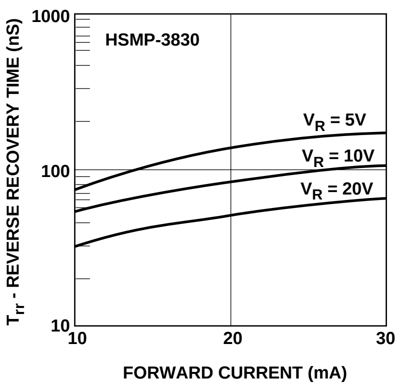


Figure 10. Reverse Recovery Time vs. Forward Current for Various Reverse Voltage. HSMP-3830 Series.

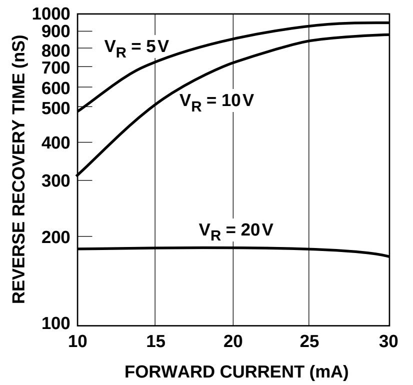


Figure 11. Typical Reverse Recovery Time vs. Reverse Voltage. HSMP-3880 Series.

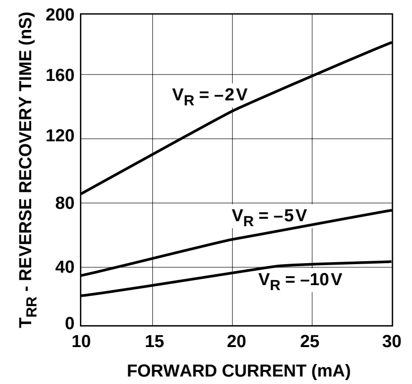


Figure 12. Typical Reverse Recovery Time vs. Reverse Voltage. HSMP-3890 Series.

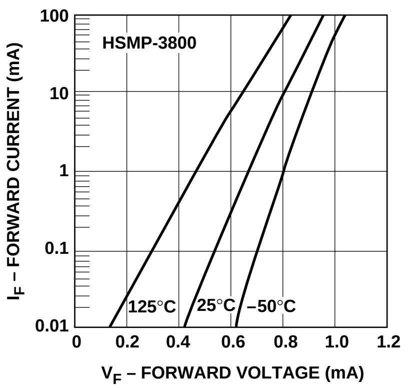


Figure 13. Forward Current vs. Forward Voltage. HSMP-3800 Series.

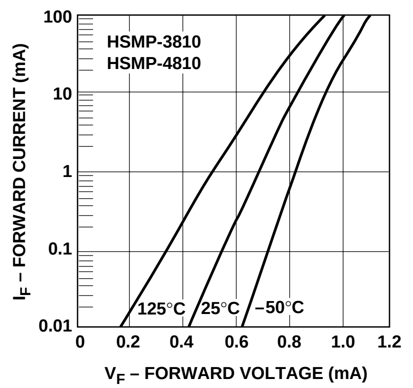


Figure 14. Forward Current vs. Forward Voltage. HSMP-3810 and HSMP-4810 Series.

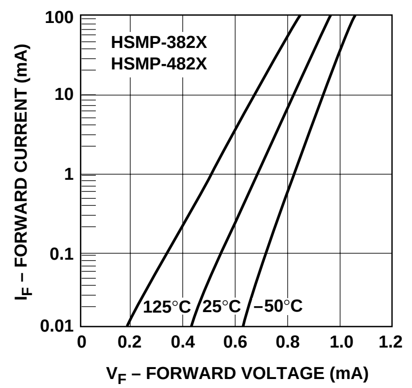


Figure 15. Forward Current vs. Forward Voltage. HSMP-3820 and HSMP-4820 Series.

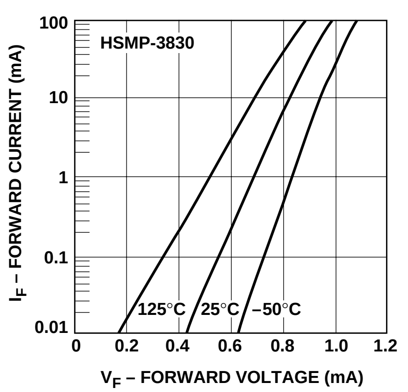


Figure 16. Forward Current vs. Forward Voltage. HSMP-3830 Series.

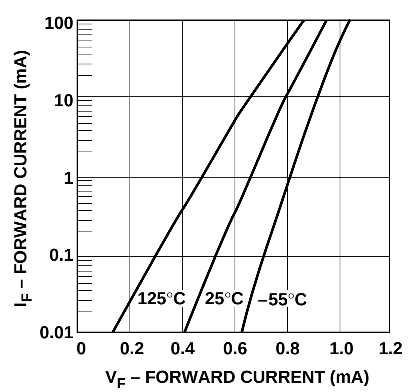


Figure 17. Forward Current vs. Forward Voltage. HSMP-3880 Series.

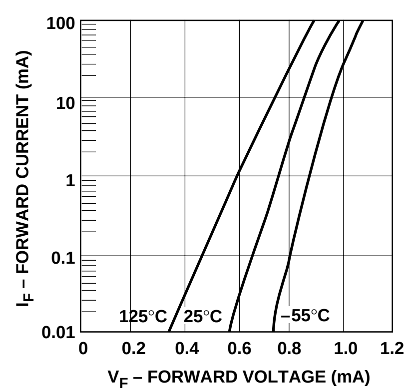


Figure 18. Forward Current vs. Forward Voltage. HSMP-3890 and HSMP-4890 Series.

Typical Parameters (continued)

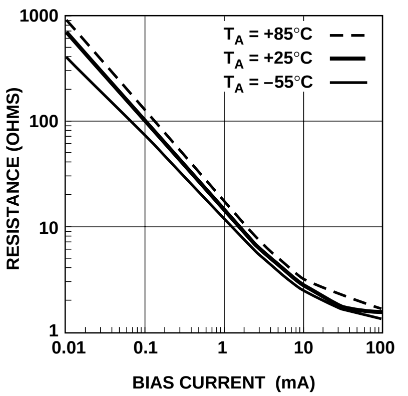


Figure 19. Typical RF Resistance vs. Forward Bias Current for HSMP-3860.

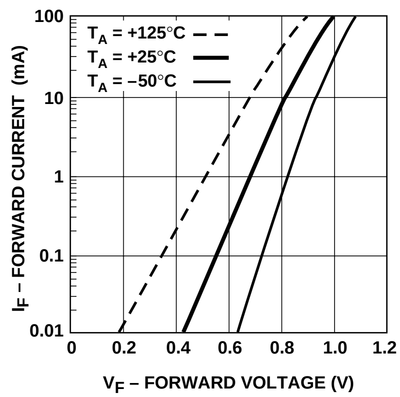


Figure 20. Forward Current vs. Forward Voltage for HSMP-3860.

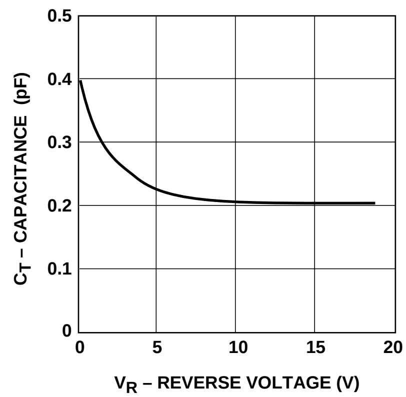
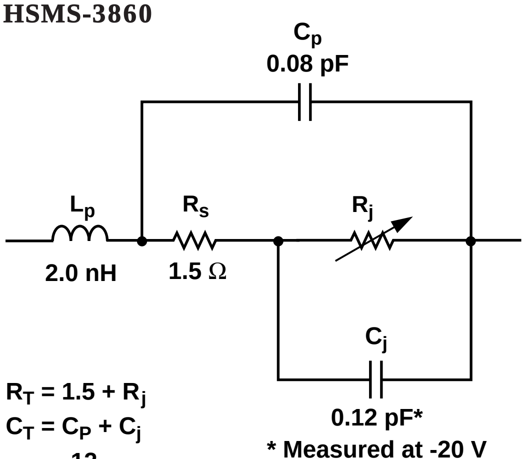


Figure 21. Typical Capacitance vs. Reverse Bias for HSMP-3860.

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

Typical Applications for Multiple Diode Products

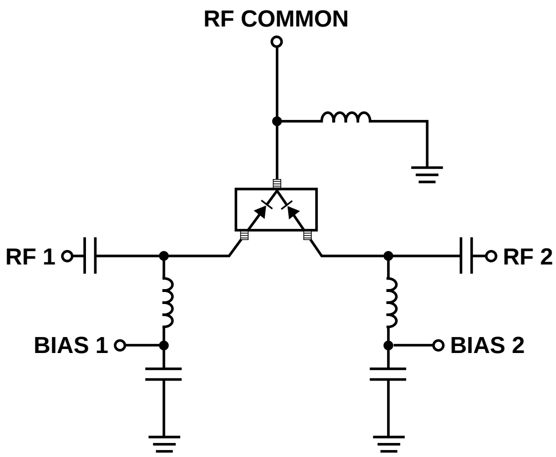


Figure 22. Simple SPDT Switch, Using Only Positive Current.

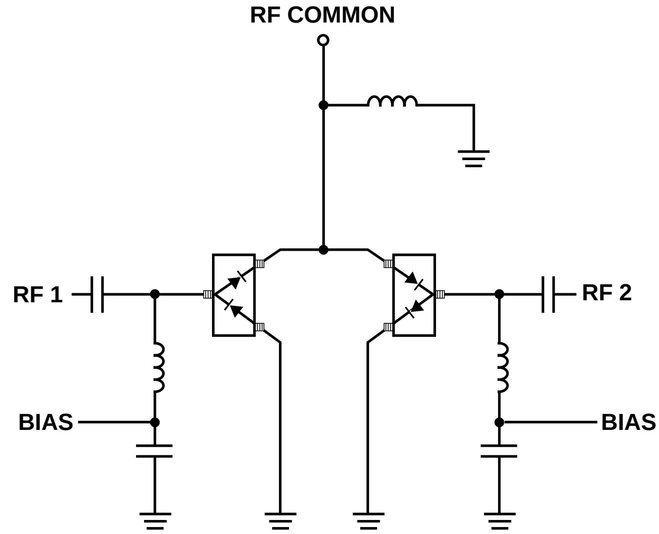


Figure 23. High Isolation SPDT Switch, Dual Bias.

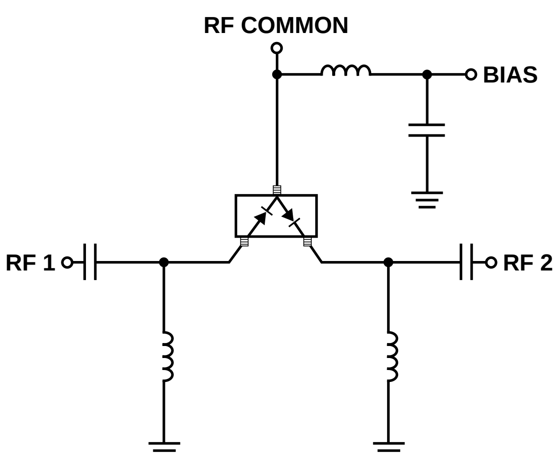


Figure 24. Switch Using Both Positive and Negative Bias Current.

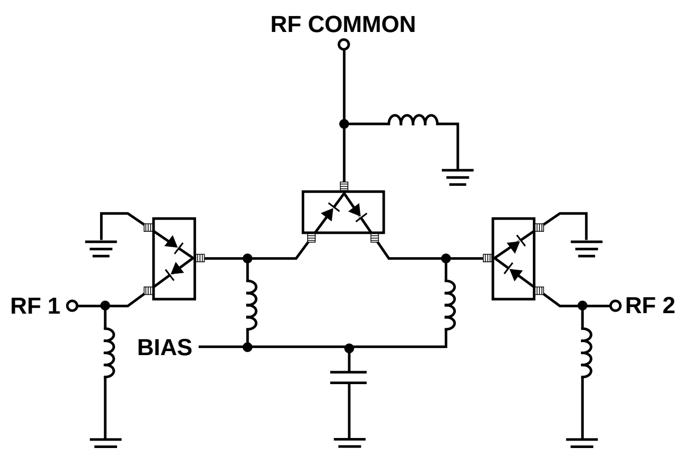


Figure 25. Very High Isolation SPDT Switch, Dual Bias.

Typical Applications for Multiple Diode Products (continued)

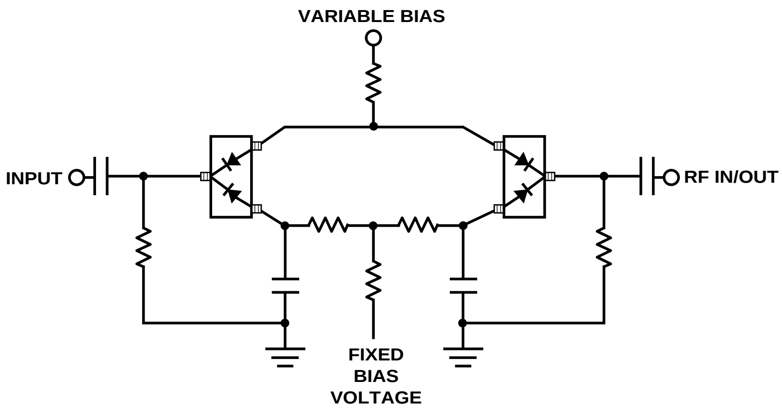


Figure 26. Four Diode π Attenuator.

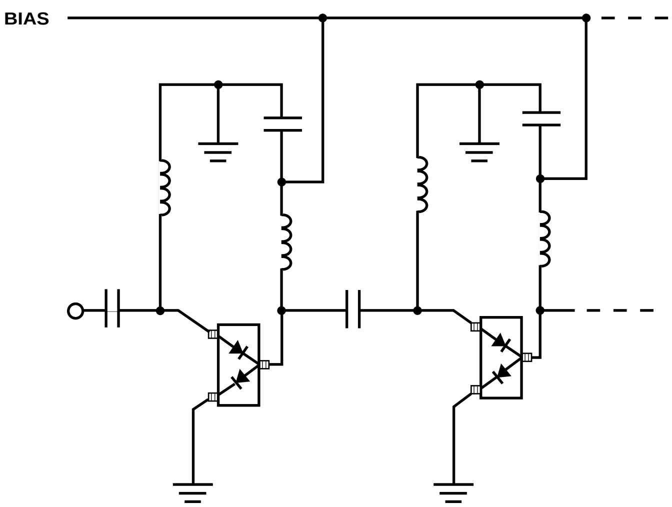


Figure 27. High Isolation SPST Switch (Repeat Cells as Required).

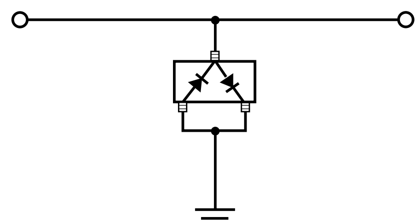


Figure 28. Power Limiter Using HSMP-3822 Diode Pair.

Typical Applications for HSMP-48XX Low Inductance Series

Figure 29. Internal Connections.

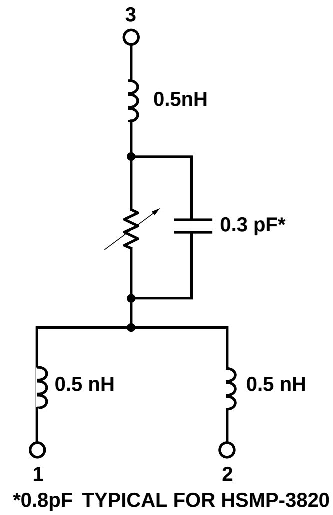


Figure 30. Equivalent Circuit.

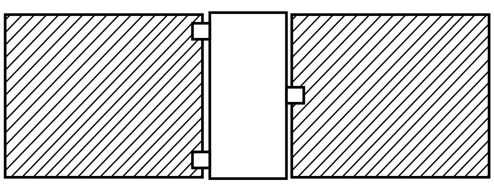


Figure 31. Circuit Layout.

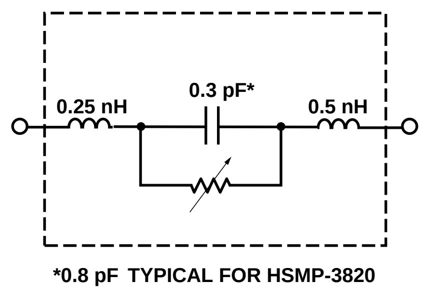


Figure 32. Equivalent Circuit.

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.

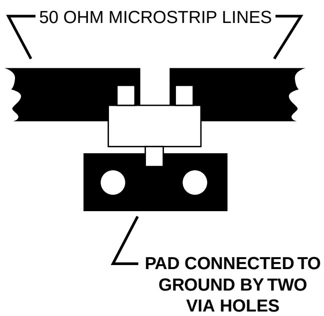


Figure 33. Circuit Layout.

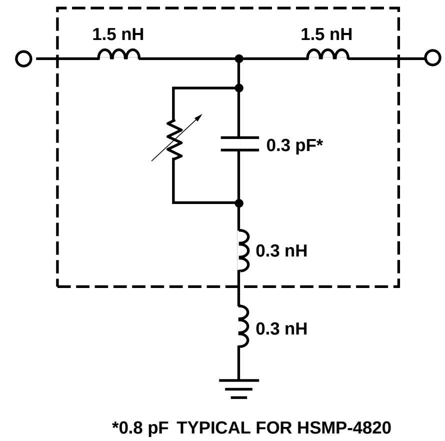


Figure 34. Equivalent Circuit.

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.

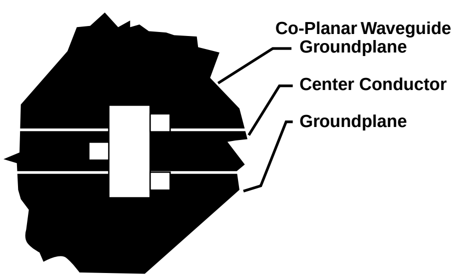


Figure 35. Circuit Layout.

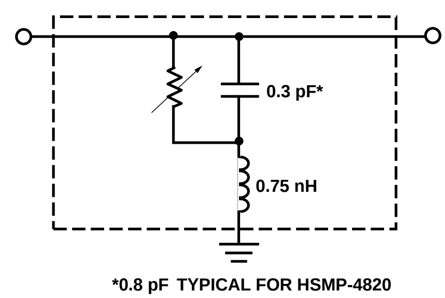


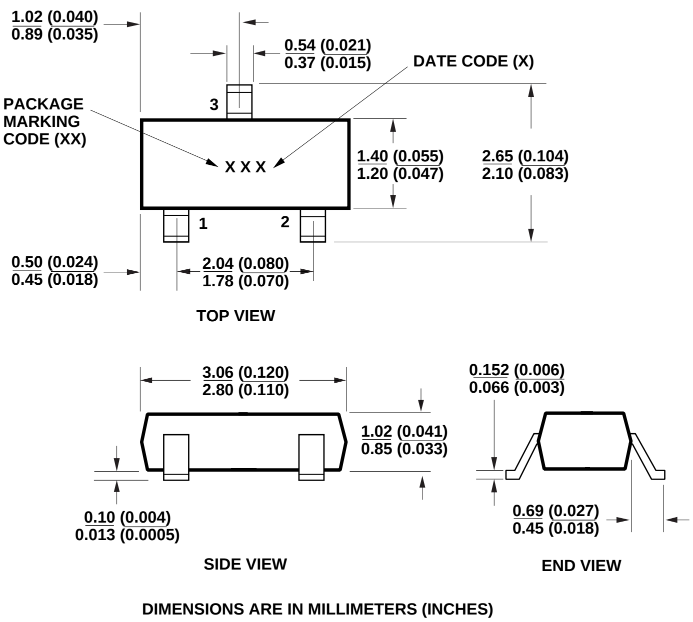
Figure 36. Equivalent Circuit.

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.

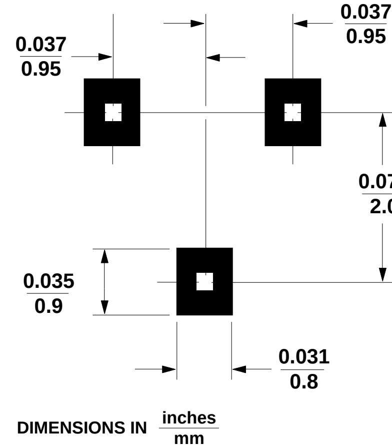
Package Dimensions

Outline 23 (SOT-23)

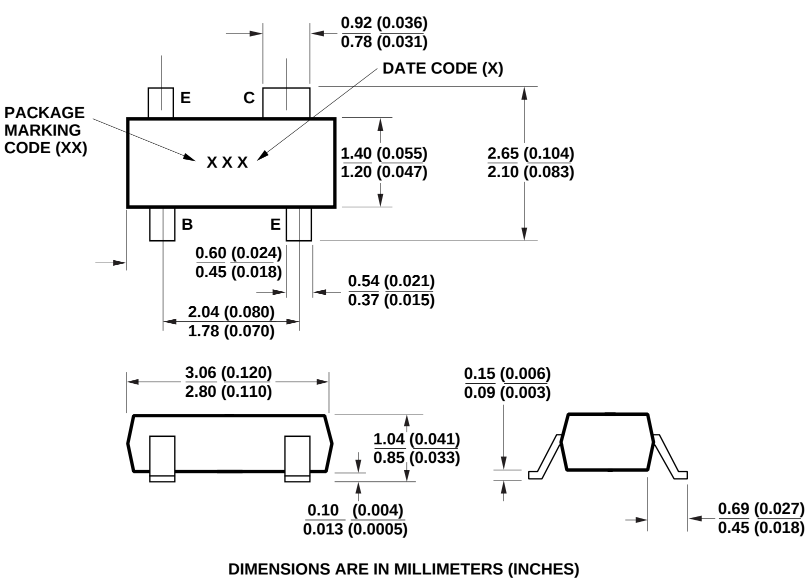


PC Board Footprints

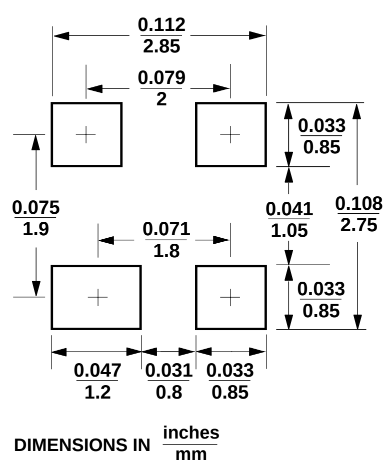
SOT-23



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

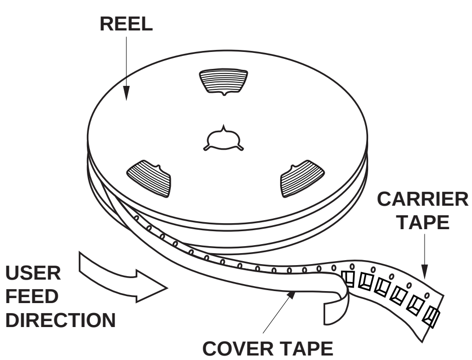
Tape and Reeling conforms to Electronic Industries RS-481, "Taping of Surface Mounted Components for Automated Placement."

Ordering Information

Specify part number followed by option under. For example:

H SMP - 38XX - XXX

- XXX: Bulk or Tape and Reel Option
- 38XX: Part Number
- SMP: Surface Mount PIN Diode
- H: Hewlett-Packard



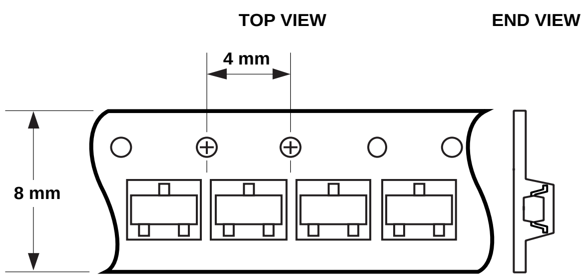


Figure 37. Options -TR1, -TR2 for SOT-23 Packages.

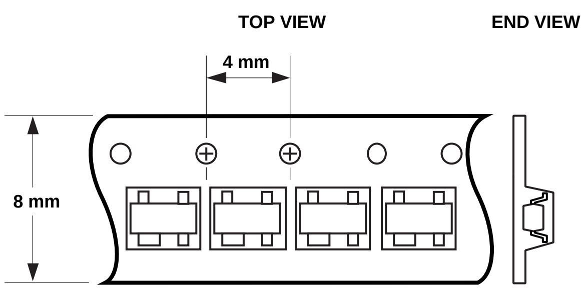


Figure 38. Options -TR1, -TR2 for SOT-143 Packages.

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Data subject to change.

Obsoletes 5968-3435E

5968-5439E (6/99)