HEWLETT® PACKARD

Surface Mount RF Schottky Barrier Diodes

Technical Data

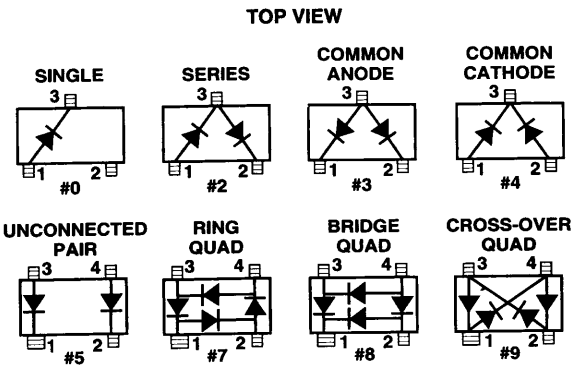
HSMS-28XX Series

Features

- **Surface Mount SOT-23/SOT-143 Package**
- **Low Turn-On Voltage (As Low as 0.34 V at 1 mA)**
- **Low FIT (Failure in Time) Rate***
- **Six-sigma Quality Level**
- **Single, Dual and Quad Versions**
- **Tape and Reel Options Available**

* For more information see the Surface Mount Schottky Reliability Data Sheet.

Package Lead Code Identification



Description/Applications

These Schottky diodes are specifically designed for both analog and digital applications. This series offers a wide range of specifications and package configurations to give the designer wide flexibility. Typical applications of these Schottky diodes are mixing, detecting, switching, sampling, clamping, and wave shaping. The HSMS-2800 series of diodes is optimized for high voltage applications. The HSMS-2810 series of diodes features very low flicker (1/f) noise. The HSMS-2820 series of diodes is the best all-around choice for most applications, featuring low series resistance, low forward voltage at all current levels and good RF characteristics. The HSMS-2860 series is a high performance diode offering superior V_f and ultra-low capacitance.

Note that HP's manufacturing techniques assure that dice found in pairs and quads are taken from adjacent sites on the wafer, assuring the highest degree of match.

Electrical Specifications T_A = 25°C, Single Diode[4]

Part Number HSMS[5]	Package Marking Code[3]	Lead Code	Configuration	Nearest Equivalent Axial Lead Part No. 5082-	Minimum Breakdown Voltage V_{BR} (V)	Maximum Forward Voltage V_F (mV)	Maximum Forward Voltage V_F (V) @ I_F (mA)	Maximum Reverse Leakage I_R (nA) @ V_R (V)	Maximum Capacitance C_T (pF)	Typical Dynamic Resistance R_D (Ω)[6]
2800	A0	0	Single	2800 (1N5711)	70	400	1.0 15	200 50	2.0	35
2802	A2	2	Series							
2803	A3	3	Common Anode							
2804	A4	4	Common Cathode							
2805	A5	5	Unconnected Pair							
2807	A7	7	Ring Quad[6]							
2808	A8	8	Bridge Quad[6]							
2810	B0	0	Single	2810 (1N5712)	20	400	1.0 35	200 15	1.2	15
2812	B2	2	Series							
2813	B3	3	Common Anode							
2814	B4	4	Common Cathode							
2815	B5	5	Unconnected Pair							
2817	B7	7	Ring Quad[6]							
2818	B8	8	Bridge Quad[6]							
2820	C0	0	Single	2835	15*	340	0.7 30	100 1	1.0	12
2822	C2	2	Series							
2823	C3	3	Common Anode							
2824	C4	4	Common Cathode							
2825	C5	5	Unconnected Pair							
2827	C7	7	Ring Quad[6]							
2828	C8	8	Bridge Quad[6]							
2829	C9	9	Cross-over Quad							
2860	T0	0	Single	None	5	320	0.6 30	—	0.30	10
2862	T1	2	Series Pair							
2863	T3	3	Common Anode							
2864	T4	4	Common Cathode							
2865	T5	5	Unconnected Pair							
Test Conditions					I_R = 10 μA *I_R = 100 μA	I_F = 1 mA[1]			V_F = 0 V f = 1.0 MHz[2]	I_F = 5 mA

Notes:

1. ΔV_F for diodes in pairs and quads in 15 mV maximum at 1 mA.
2. ΔC_{TO} for diodes in pairs and quads is 0.2 pF maximum.
3. Package marking code is in white.
4. Effective Carrier Lifetime (τ) for all these diodes is 100 ps maximum measured with Krakauer method at 5 mA, except HSMS-282X which is measured at 20 mA.
5. See section titled "Quad Capacitance."
6. $R_D = R_S + 5.2\,\Omega$ at 25°C and I_f = 5 mA.

Absolute Maximum Ratings[1] T_A = 25°C

Symbol	Parameter	Value
I_f	Forward Current (1 ms Pulse)	1 Amp
P_t	Total Device Dissipation	250 mW[2]
P_{IV}	Peak Inverse Voltage	Same as V_{BR}
T_j	Junction Temperature	150°C
T_{stg}	Storage Temperature	-65 to 150°C

Notes:

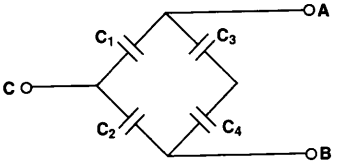
1. Operation in excess of any one of these conditions may result in permanent damage to this device.
2. CW Power Dissipation at T_{LEAD} = 25°C. Derate to zero at maximum rated temperature.

Quad Capacitance

Capacitance of Schottky diode quads is measured using an HP4271 LCR meter. This instrument effectively isolates individual diode branches from the others, allowing accurate capacitance measurement of each branch or each diode. The conditions are: 20 mV R.M.S. voltage at 1 MHz. HP defines this measurement as "CM", and it is equivalent to the capacitance of the diode by itself. The equivalent diagonal and adjacent capacitances can then be calculated by the formulas given below.

In a quad, the diagonal capacitance is the capacitance between points A and B as shown in the figure below. The diagonal capacitance is calculated using the following formula

$$C_{DIAGONAL} = \frac{C_1 \times C_2}{C_1 + C_2} + \frac{C_3 \times C_4}{C_3 + C_4}$$



The equivalent adjacent capacitance is the capacitance between points A and C in the figure below. This capacitance is calculated using the following formula

$$C_{ADJACENT} = C_1 + \frac{1}{\frac{1}{C_2} + \frac{1}{C_3} + \frac{1}{C_4}}$$

This information does not apply to cross-over quad diodes.

SPICE Parameters

Parameter	Units	HSMS-280X	HSMS-281X	HSMS-282X	HSMS-286X
B_V	V	75	25	15	7.0
C_{J0}	pF	1.6	1.1	0.7	0.18
E_G	eV	0.69	0.69	0.69	0.69
I_{BV}	A	10E-5	10E-5	10E-4	10E-5
I_S	A	3x10E-8	4.8x10E-9	2.2x10E-8	5.0x10E-8
N		1.08	1.08	1.08	1.08
R_S	Ω	30	10	6.0	5.0
P_B	V	0.65	0.65	0.65	0.65
P_T		2	2	2	2
M		0.5	0.5	0.5	0.5

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

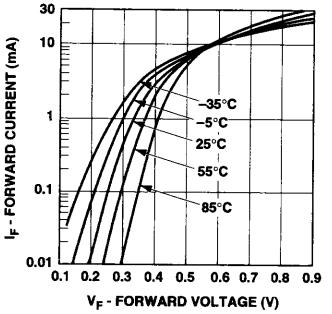


Figure 1. Typical Forward Current vs. Forward Voltage at Temperatures—HSMS-2800 Series

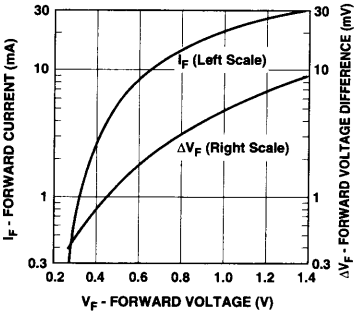


Figure 2. Typical V_f Match, HSMS-2800 Series Pairs and Quads.

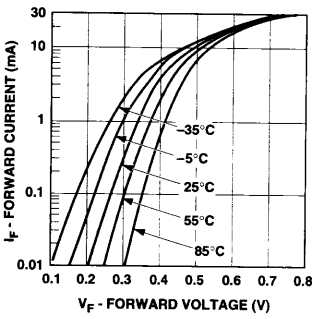


Figure 3. Typical Forward Current vs. Forward Voltage at Temperatures—HSMS-2810 Series.

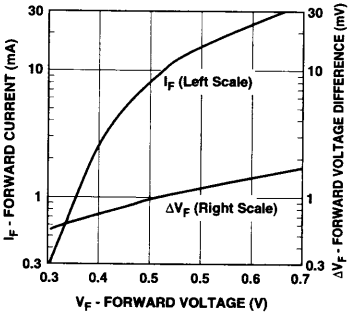


Figure 4. Typical V_f Match, HSMS-2810 Series Pairs and Quads.

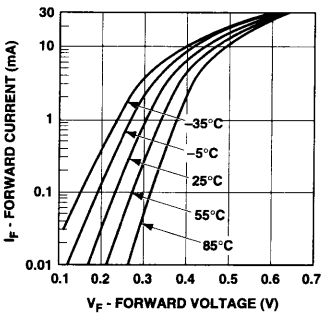


Figure 5. Typical Forward Current vs. Forward Voltage At Temperatures—HSMS-2820 Series.

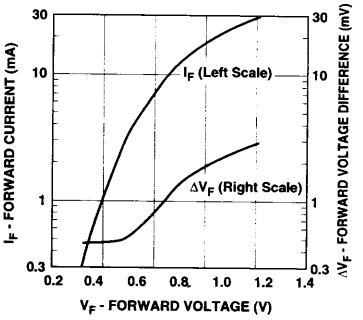


Figure 6. Typical V_f Match, HSMS-2820 Series Pairs and Quads at Mixer Bias Levels.

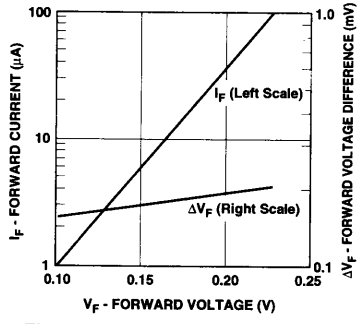


Figure 7. Typical V_f Match, HSMS-2820 Series Pairs at Detector Bias Levels.

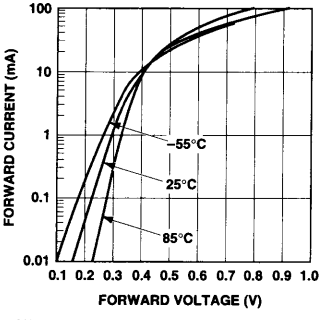


Figure 8. Typical Forward Current vs. Forward Voltage at Temperature, HSMS-2860 Series.

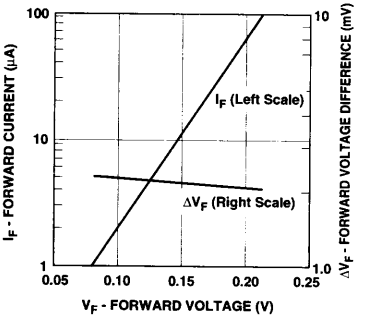


Figure 9. Typical V_f Match, HSMS-2860 Series Pairs at Detector Bias Levels.

Typical Parameters, continued

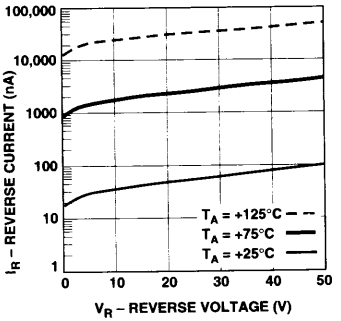


Figure 10. Reverse Current vs. Reverse Voltage at Temperatures—HSMS-2800 Series.

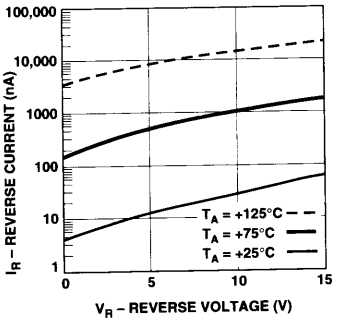


Figure 11. Reverse Current vs. Reverse Voltage at Temperatures—HSMS-2810 Series.

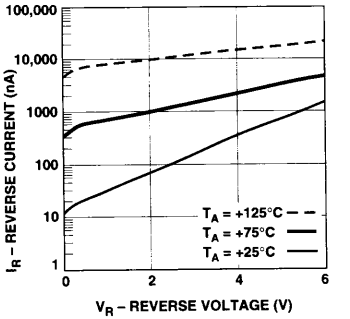


Figure 12. Reverse Current vs. Reverse Voltage at Temperatures—HSMS-2820 Series.

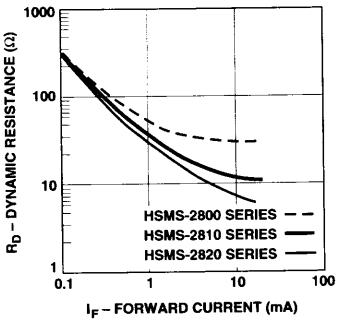


Figure 13. Dynamic Resistance vs. Forward Current—HSMS-2800 Series.

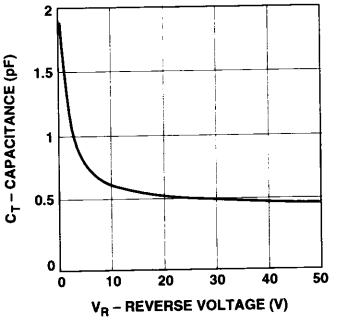


Figure 14. Total Capacitance vs. Reverse Voltage—HSMS-2800 Series.

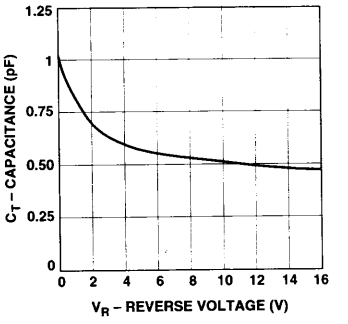


Figure 15. Total Capacitance vs. Reverse Voltage—HSMS-2810 Series.

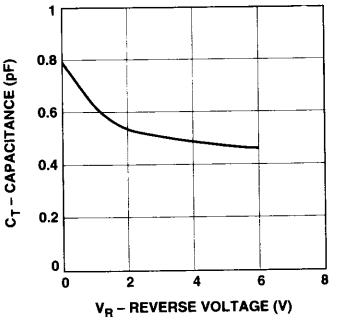


Figure 16. Total Capacitance vs. Reverse Voltage—HSMS-2820 Series.

Applications Information

Schottky Diode Fundamentals

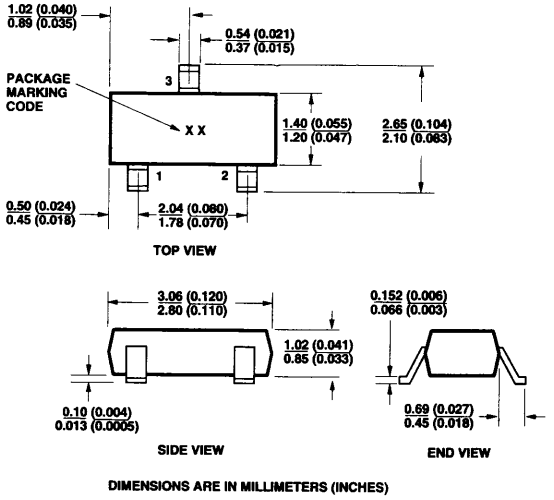
See the HSMS-280A series data sheet.

Package Characteristics

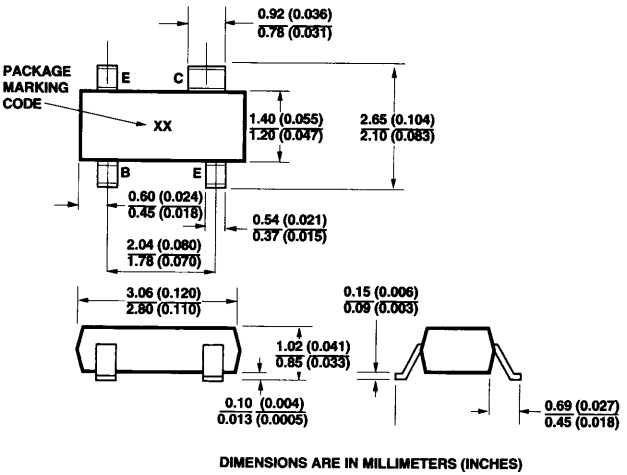
Lead Material ..... Alloy 42
Lead Finish ..... Tin-Lead 85/15%
Max. Soldering Temperature .... 260°C for 5 sec
Min. Lead Strength ..... 2 pounds pull
Typical Package
Inductance ..... 2 nH (opposite leads)
Typical Package
Capacitance ..... 0.08 pF (opposite leads)

Package Dimensions

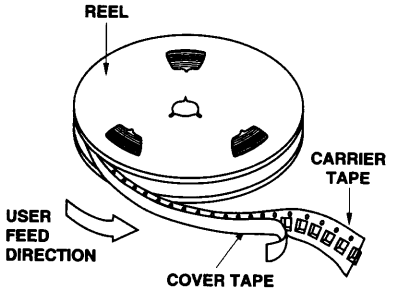
Outline 23 (SOT-23)



Outline 143 (SOT-143)



Device Orientation



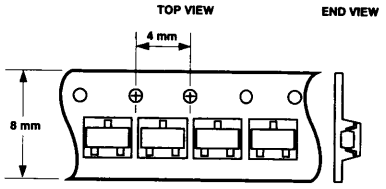


Figure 17. Option L31 for SOT-23 Packages.

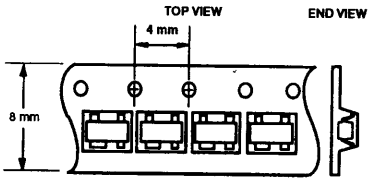


Figure 18. Option L31 for SOT-143 Packages.

HEWLETT® PACKARD

Surface Mount Microwave Schottky Detector Diodes

Technical Data

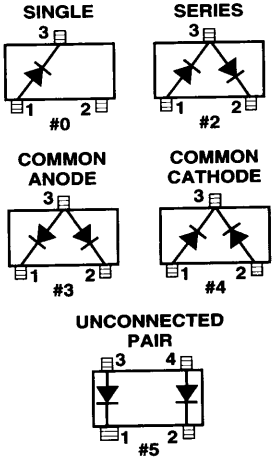
HSMS-2850 Series
HSMS-2860 Series

Features

- **Surface Mount SOT-23/ SOT-143 Package**
- **High Detection Sensitivity:**
  up to 50 mV/μW at 915 MHz
  up to 35 mV/μW at 2.45 GHz
  up to 25 mV/μW at 5.80 GHz
- **Low Flicker Noise:**
  -162 dBV/Hz at 100 Hz
- **Low FIT (Failure in Time) Rate***
- **Tape and Reel Options Available**

* For more information see the Surface Mount Schottky Reliability Data Sheet.

Package Lead Code Identification



Description

Hewlett-Packard's HSMS-2850 family of zero bias Schottky detector diodes and the HSMS-2860 family of DC biased detector diodes have been designed and optimized for use from 915 MHz to 5.8 GHz. They are ideal for RF/ID and RF Tag applications requiring small and large signal detection, modulation, RF to DC conversion or voltage doubling.

Available in various package configurations, these two families of detector diodes provide low cost solutions to a wide variety of design problems. Hewlett-Packard's manufacturing techniques assure that when two diodes are mounted into a single SOT-23 or SOT-143 package, they are taken from adjacent sites on the wafer, assuring the highest possible degree of match.

DC Electrical Specifications, T_A = +25°C, Single Diode

Part Number HSMS-	Package Marking Code[1]	Lead Code	Configuration	Maximum Forward Voltage V_F (mV)		Typical Capacitance C_T (pF)
2850 2852 2855	P0 P2 P5	0 2 5	Single Series Pair [2,3] Unconnected Pair [2,3]	150	250	0.30
2860 2862 2863 2864 2865	T0 T2 T3 T4 T5	0 2 3 4 5	Single Series Pair [2,3] Common Anode [2,3] Common Cathode [2,3] Unconnected Pair [2,3]	250	320	0.30
Test Conditions				I_F = 0.1 mA	I_F = 1.0 mA	V_R = –0.5 V to –1.0 V f = 1 MHz

Notes:

1. Package marking code is in white.
2. ΔV_F for diodes in pairs is 15.0 mV maximum at 1.0 mA.
3. ΔC_T for diodes in pairs is 0.05 pF maximum at –0.5 V.

RF Electrical Specifications, T_A = +25°C, Single Diode

Part Number HSMS-	Typical Tangential Sensitivity TSS (dBm) @ f =			Typical Voltage Sensitivity γ (mV/μW) @ f =			Typical Video Resistance RV (KΩ)
	915 MHz	2.45 GHz	5.8 GHz	915 MHz	2.45 GHz	5.8 GHz	
2850 2852 2855	–57	–56	–55	40	30	22	8.0
Test Conditions	Video Bandwidth = 2 MHz Zero Bias			Power in = –40 dBm R_L = 100 KΩ, Zero Bias			
2860 2862 2863 2864 2865	–57	–56	–55	50	35	25	5.0
Test Conditions	Video Bandwidth = 2 MHz I_b = 5 μA			Power in = –40 dBm R_L = 100 KΩ, I_b = 5 μA			

Absolute Maximum Ratings, T_A = +25°C, Single Diode

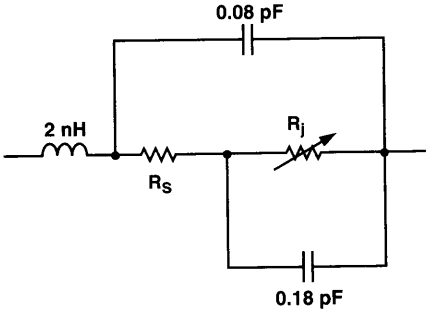
Symbol	Parameter	Absolute Maximum[1]
P_T	Total Device Dissipation[2]	75mW
P_{IV}	Peak Inverse Voltage	2.0V
T_J	Junction Temperature	150°C
T_{STG}	Storage Temperature	-65°C to 150°C
T_{OP}	Operating Temperature	-65°C to 150°C

Notes:
1. Operation in excess of any one of these conditions may result in permanent damage to the device.
2. CW Power Dissipation at T_{LEAD} = +25°C. Derate linearly to zero at maximum rated temperature.

ESD WARNING: Handling Precautions Should Be Taken To Avoid Static Discharge.

Equivalent Circuit Model

HSMS-2850, HSMS-2860; Singles



R_S = series resistance (see Table of SPICE parameters)

$$R_j = \frac{8.33 \times 10^{-5}\ nT}{I_b + I_s}$$

where
I_b = externally applied bias current in amps
I_s = saturation current (see table of SPICE parameters)
T = temperature, °K
n = identity factor (see table of SPICE parameters)

SPICE Parameters

Parameter	Units	HSMS-285X	HSMS-286X
B_V	V	3.8	7.0
C_{J0}	pF	0.18	0.18
E_G	eV	0.69	0.69
I_{BV}	A	3x10E-4	10E-5
I_S	A	3x10E-6	5.0x10E-8
N		1.06	1.08
R_S	Ω	25	5.0
P_B(VJ)	V	0.35	0.65
P_T(XTI)		2	2
M		0.5	0.5

Typical Parameters, Single Diode

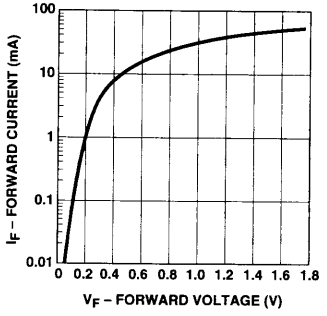


Figure 1. Typical Forward Current vs. Forward Voltage, HSMS-2850 Series.

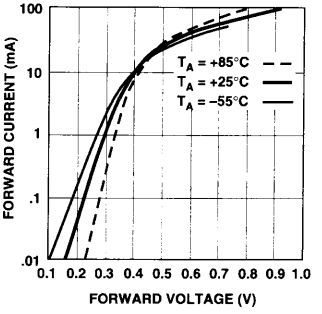


Figure 2. Typical Forward Current vs. Forward Voltage at Temperature, HSMS-2860 Series.

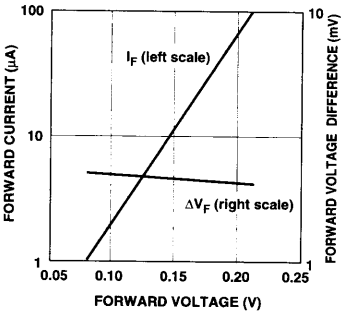


Figure 3. Typical Forward Voltage Match, HSMS-2860 Pairs.

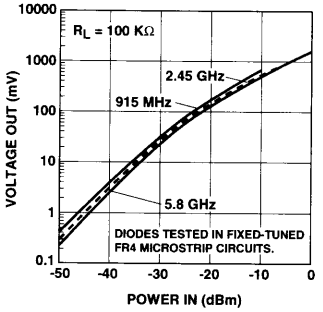


Figure 4. +25°C Output Voltage vs. Input Power, HSMS-2850 at Zero Bias, HSMS-2860 at 3 μA Bias.

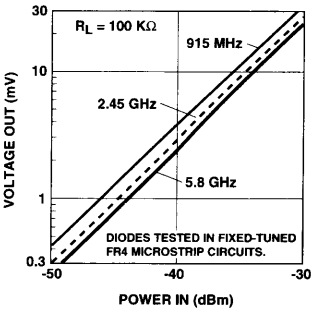


Figure 5. +25°C Expanded Output Voltage vs. Input Power. See Figure 4.

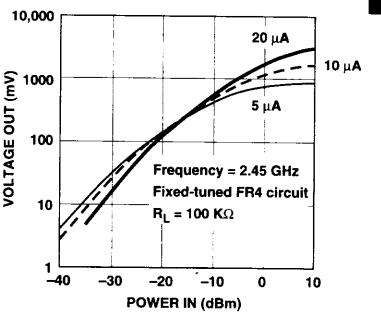


Figure 6. Dynamic Transfer Characteristic as a Function of DC Bias, HSMS-2860.

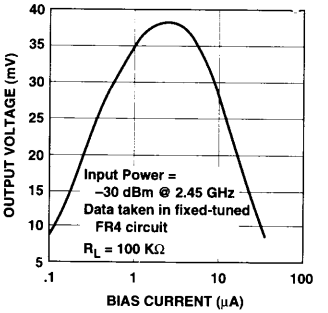


Figure 7. Voltage Sensitivity as a Function of DC Bias Current, HSMS-2860.

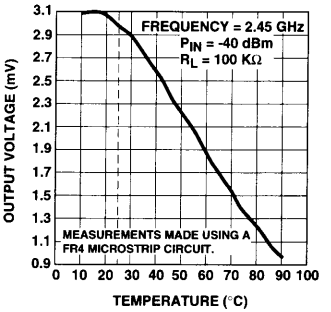


Figure 8. Output Voltage vs. Temperature, HSMS-2850 Series.

Applications Information

See the HSMS-285A data sheet.

Ordering Information

Specify part number followed by option. For example:

H SMS-285X #X XX

- XX — Bulk or Tape and Reel Option
- #X — Profile: Low = L
- 285X — Part Number
- SMS — Surface Mount Schottky
- H — Hewlett-Packard

Profile Option Descriptions

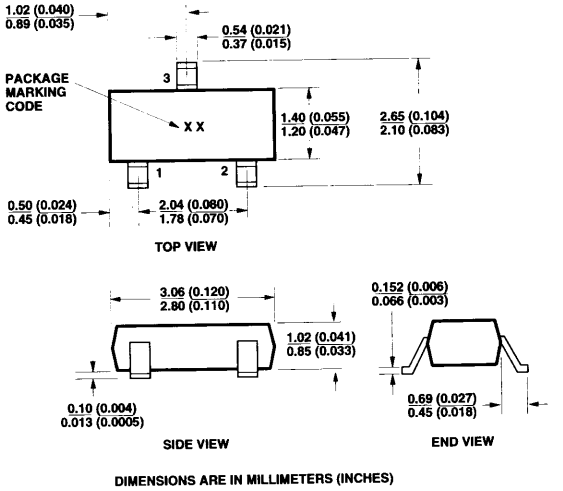
#L30 = Bulk

#L31 = 3K pc. Tape and Reel, Device Orientation Figures 9, 10

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

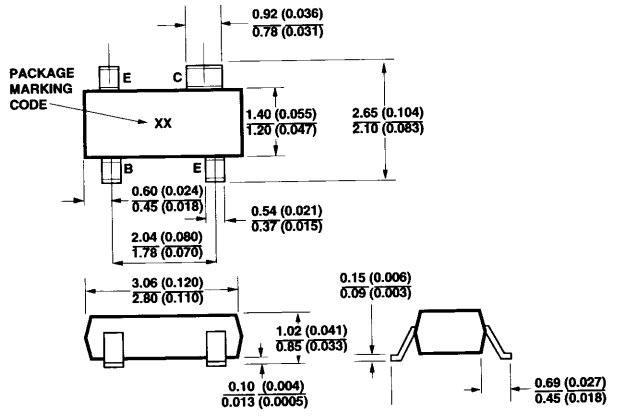
Package Dimensions

Outline 23 (SOT-23)



DIMENSIONS ARE IN MILLIMETERS (INCHES)

Outline 143 (SOT-143)



DIMENSIONS ARE IN MILLIMETERS (INCHES)