

AlGaAs SP3T Switch with Integrated Bias Network

2 - 18 GHz



MASW-011174

Rev. V1

Features

- Insertion Loss: 0.8 dB @ 18 GHz
- Isolation: 30 dB @ 18 GHz
- Integrated DC Blocks and RF Bias Networks
- Fast Switching Speed
- Fully Monolithic
- Low Current Consumption:
 - 10 mA for Low Loss Path
 - +10 mA for Each Isolation Path
- Lead-Free 3 mm, 16-Lead QFN
- RoHS* Compliant

Applications

- Test & Measurement
- Broadband Communication Systems

Description

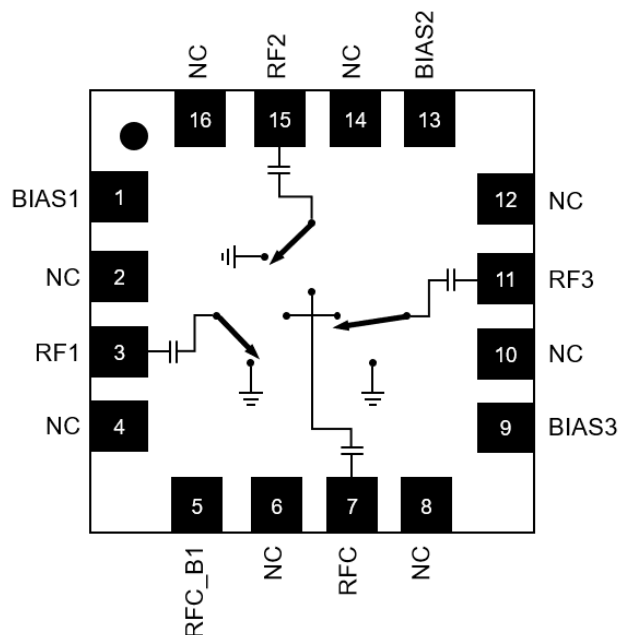
The MASW-011174 is an SP3T PIN diode switch with integrated bias networks offered in lead-free 3 x 3 mm QFN surface mount plastic package. This broadband, reflective switch operates from 2 - 18 GHz and provides 0.8 dB insertion loss and 30 dB isolation @ 18 GHz.

The combination of broadband performance along with very fast switching (<25 ns) and excellent settling time makes this device ideal for many applications, including Test & Measurement and broadband communication systems.

Ordering Information

| Part Number | Package |
|--------------------|----------------------|
| MASW-011174-TR0500 | 500 pc tape and reel |
| MASW-011174-SMB | Sample Test Board |

Functional Schematic



Pin Configuration¹

| Pin # | Pin Name | Description |
|----------------------------|----------|---------------------|
| 2, 4, 6, 8, 10, 12, 14, 16 | NC | No Connect |
| 1 | BIAS1 | RF1 DC Bias |
| 3 | RF1 | RF Input/Output 1 |
| 5 | RFC_B1 | RF Common Bias |
| 7 | RFC | RF Common |
| 9 | BIAS3 | RF3 DC Bias |
| 11 | RF3 | RF Input/Output 3 |
| 13 | BIAS2 | RF2 DC Bias |
| 15 | RF2 | RF Input/Output 2 |
| 17 | - | Paddle ² |

1. MACOM recommends connecting unused package pins to ground.
2. The exposed pad centered on the package bottom must be connected to RF, DC, and thermal ground.

* Restrictions on Hazardous Substances, compliant to current RoHS EU directive.

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Electrical Specifications: $T_A = +25^\circ\text{C}$, $I_{DC} = +/-10\text{ mA}$, $V_R = -10\text{ V}$, $Z_0 = 50\ \Omega$

| Parameter | Test Conditions | Units | Min. | Typ. | Max. |
|--------------------------------|---|-------|------|------|------|
| Insertion Loss | 2 GHz | dB | — | 1.1 | — |
| | 6 GHz | | | 0.7 | 1.0 |
| | 11 GHz | | | 0.7 | — |
| | 18 GHz | | | 0.8 | — |
| Input to Output Isolation | 2 GHz | dB | — | 46 | — |
| | 6 GHz | | 31 | 39 | |
| | 11 GHz | | — | 32 | |
| | 18 GHz | | — | 30 | |
| RF Common Return Loss | 2 GHz | dB | — | 14 | — |
| | 6 GHz | | | 14 | |
| | 11 GHz | | | 25 | |
| | 18 GHz | | | 24 | |
| Output Return Loss | 2 GHz | dB | — | 14 | — |
| | 6 GHz | | | 14 | |
| | 11 GHz | | | 25 | |
| | 18 GHz | | | 24 | |
| P_{IN} at 0.1 dB Compression | $V_R = -10\text{ V}$, @ 2 GHz | dBm | — | 26 | — |
| | $V_R = -10\text{ V}$, @ 10 GHz | | | 33 | |
| | $V_R = -10\text{ V}$, @ 18 GHz | | | 33 | |
| | $V_R = -5\text{ V}$, @ 2 GHz | | | 15 | |
| | $V_R = -5\text{ V}$, @ 10 GHz | | | 19 | |
| | $V_R = -5\text{ V}$, @ 18 GHz | 30 | | | |
| Input IP3 | 5 MHz Offset, Pin/tone = 15 dBm, $V_R = -10\text{ V}$ | dBm | — | >49 | — |
| T_{RISE} | 10% to 90% RF @ 5 GHz, $V_R = -5\text{ V}$ | ns | — | 23 | — |
| T_{FALL} | 90% to 10% RF @ 5 GHz, $V_R = -5\text{ V}$ | ns | — | 18 | — |
| T_{ON} | 50% control to 90% RF @ 5 GHz, $V_R = -5\text{ V}$ | ns | — | 25 | — |
| T_{OFF} | 50% control to 10% RF @ 5 GHz, $V_R = -5\text{ V}$ | ns | — | 19 | — |

Absolute Maximum Ratings^{3,4}

| Parameter | Absolute Maximum |
|-----------------------------------|-----------------------------------|
| Incident C.W. RF Power | 30 dBm @ 2 GHz 34 dBm @ 18 GHz |
| Bias Current | $\pm 20\text{ mA}$ |
| Junction Temperature ⁵ | +150°C |
| Operating Temperature | -40°C to +85°C |
| Storage Temperature | -65°C to +150°C |

- Exceeding any one or combination of these limits may cause permanent damage to this device.
- MACOM does not recommend sustained operation near these survivability limits.
- Operating at nominal conditions with $T_J \leq +150^\circ\text{C}$ will ensure $MTTF > 1 \times 10^6$ hours.

Handling Procedures

Please observe the following precautions to avoid damage:

Static Sensitivity

These electronic devices are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these HBM Class 1B (CDM Class C3) devices.

Truth Table & Bias Conditions

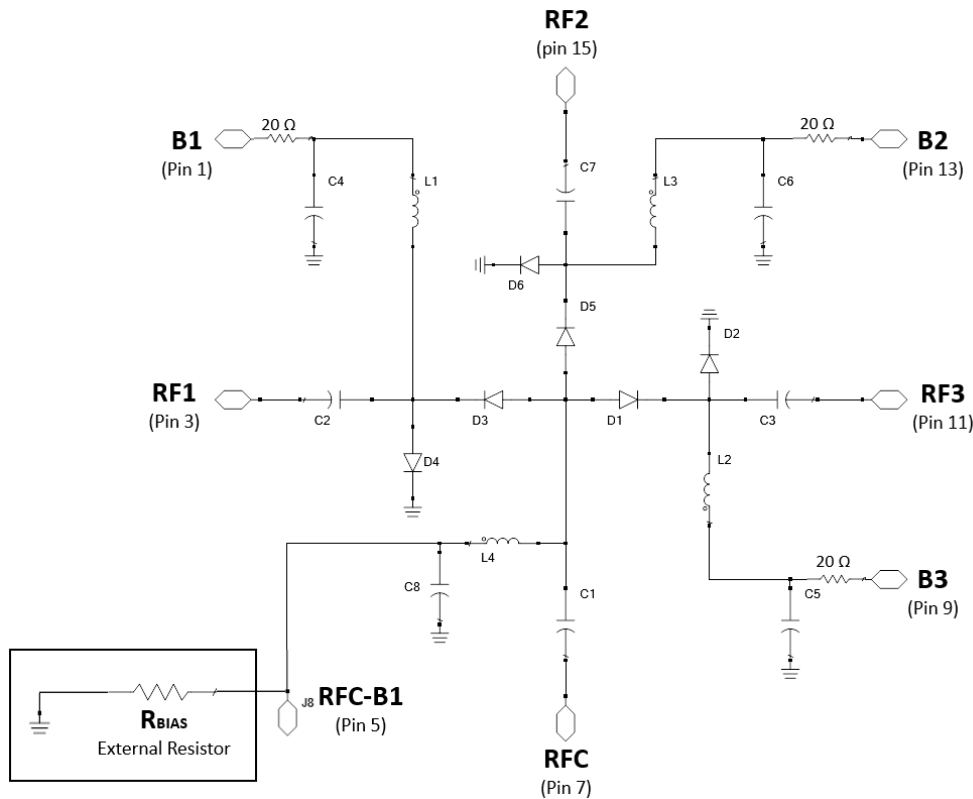
| RF Common Path | Bias 1 | Bias 2 | Bias 3 |
|--|-----------------|-----------------|-----------------|
| RF1 Low Loss RF2 Isolation RF3 Isolation | $V_R = -10 V^6$ | $I_F = +10 mA$ | $I_F = +10 mA$ |
| RF1 Isolation RF2 Low Loss RF3 Isolation | $I_F = +10 mA$ | $V_R = -10 V^6$ | $I_F = +10 mA$ |
| RF1 Isolation RF2 Isolation RF3 Low Loss | $I_F = +10 mA$ | $I_F = +10 mA$ | $V_R = -10 V^6$ |

6. Reverse bias voltage should be determined based on working conditions. For example, -10 V @ 2 GHz, 26 dBm input power. For lower power applications, a less negative voltage can be used. R. Caverly and G. Hiller, "Establishing the Minimum Reverse Bias for a PIN Diode in a High Power Switch," IEEE Transactions on Microwave Theory and Techniques, Vol. 38, No. 12, December 1990. See Compression Power and Junction Temperature Performance curves for guidance.

RF Common Bias Configuration:

- Pin 5 (RFC-B1) to external resistor (R_{BIAS}) to ground
- $R_{BIAS} \approx (|V_R| - 1.4 V) / |I_{DC}| - 20 \Omega$
 - $R_{BIAS} = 840 \Omega$ for $V_R = -10 V$, $I_{DC} = -10 mA$
 - $R_{BIAS} = 340 \Omega$ for $V_R = -5 V$, $I_{DC} = -10 mA$

Circuit Schematic



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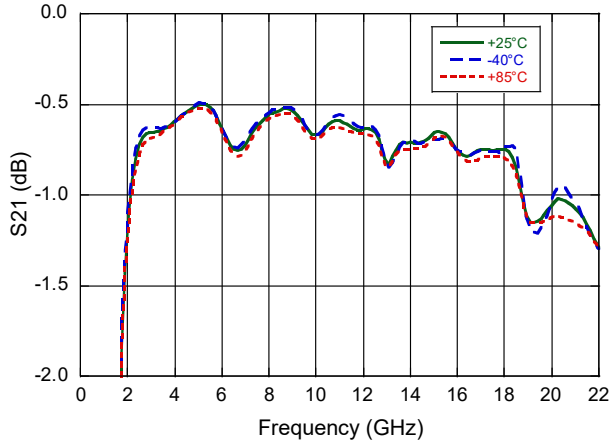


MASW-011174

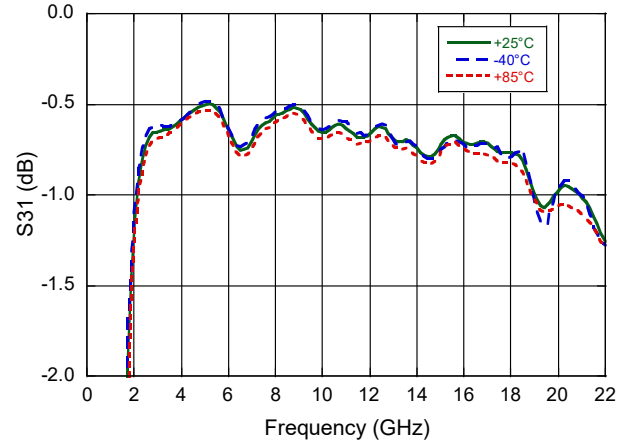
Rev. V1

Typical Performance Curves: Board Loss Removed, $I_{DC} = \pm 10$ mA, $Z_0 = 50 \Omega$

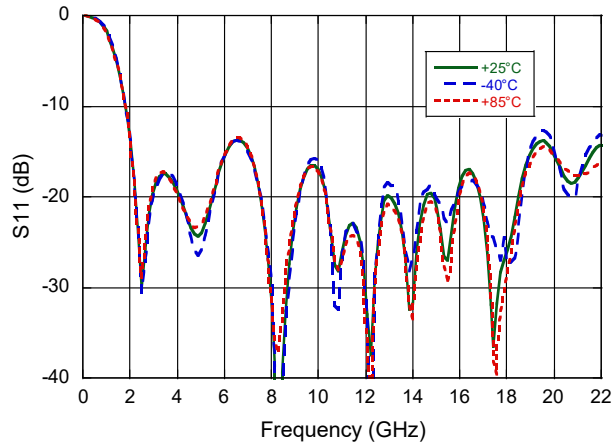
Insertion Loss, (S21) over Temperature, RF1_{ON}



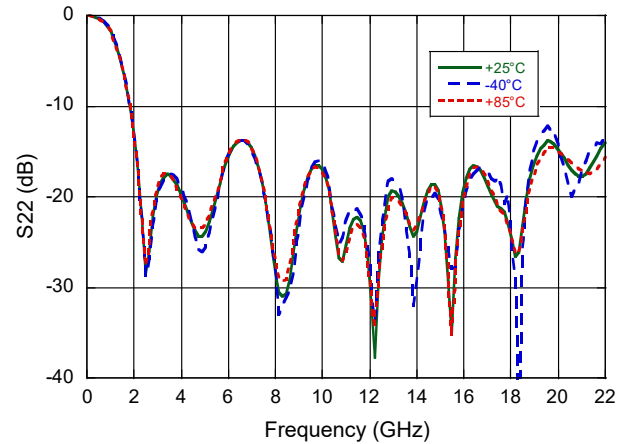
Insertion Loss, (S31) over Temperature, RF2_{ON}



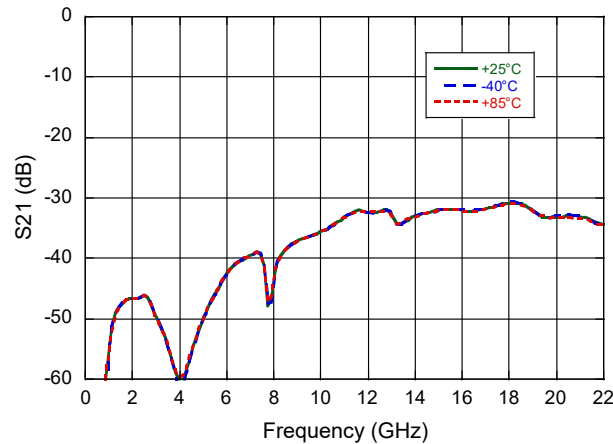
Input Return Loss (S11), over Temperature, RF1_{ON}



Output Return Loss (S22), over Temperature, RF1_{ON}



Isolation (S21), over Temperature, RF1_{ON}



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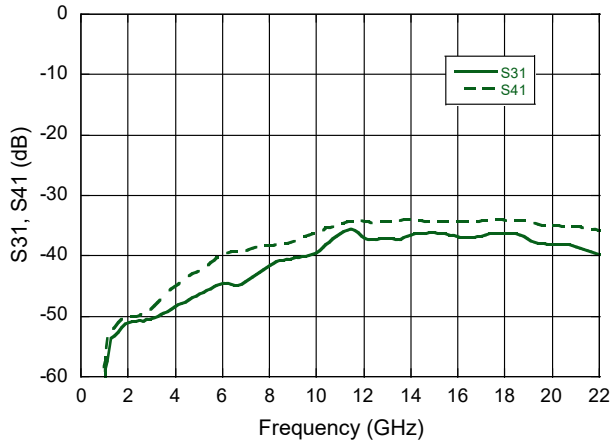


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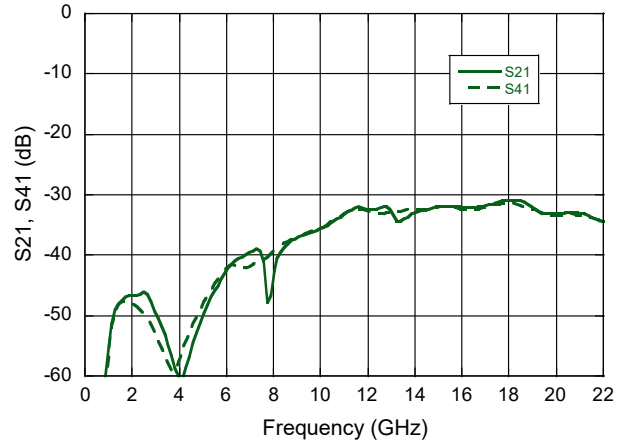
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Typical Performance Curves: Board Loss Removed, $I_{DC} = \pm 10$ mA, $Z_0 = 50 \Omega$

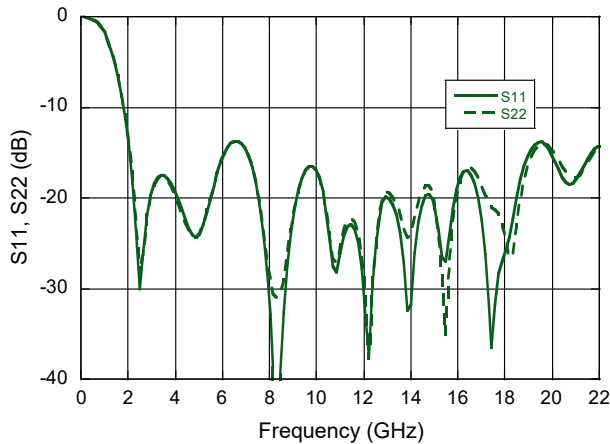
Isolation RFC to RF2 (S31) & RFC to RF3 (S41), RF1_{ON}



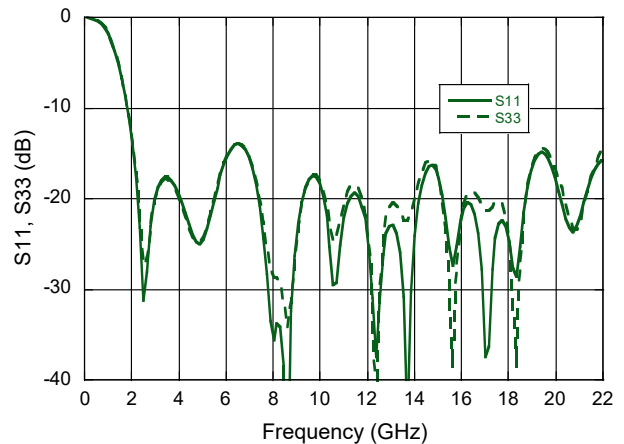
Isolation RFC to RF1 (S21) & RFC to RF3 (S41), RF2_{ON}



Return Loss, (S11, S22), RF1_{ON}

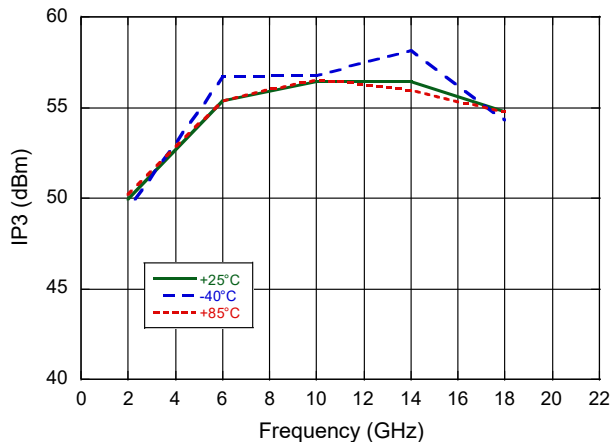


Return Loss, (S11, S33), RF2_{ON}

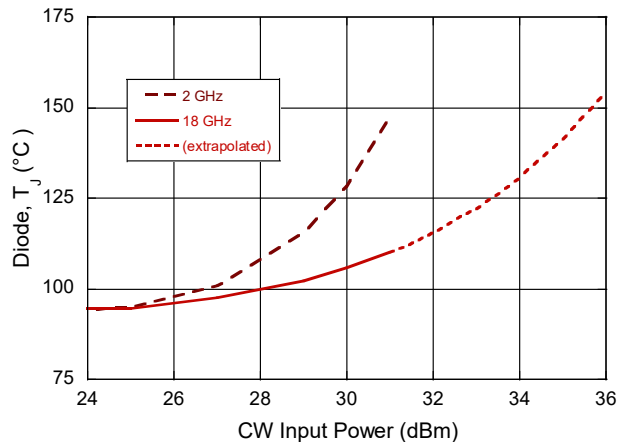


Typical Performance Curves: $I_{DC} = +/-10 \text{ mA}$, $Z_0 = 50 \Omega$

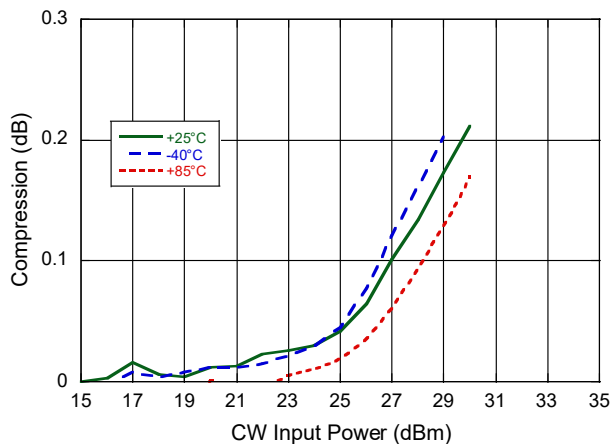
IP3 over Temperature, $P_{IN} = 15 \text{ dBm}$ per tone



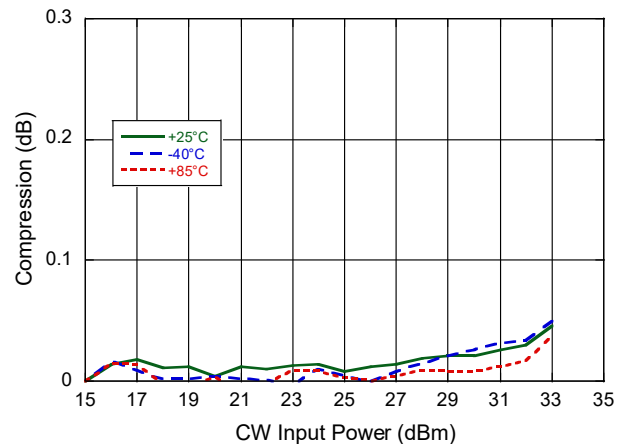
Junction Temperature @ $V_R = -10 \text{ V}$, +85°C Baseplate⁷



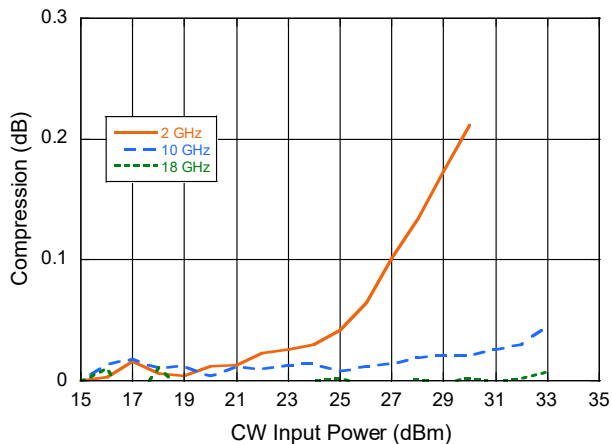
Compression Power over Temperature @ 2 GHz, $V_R = -10 \text{ V}$



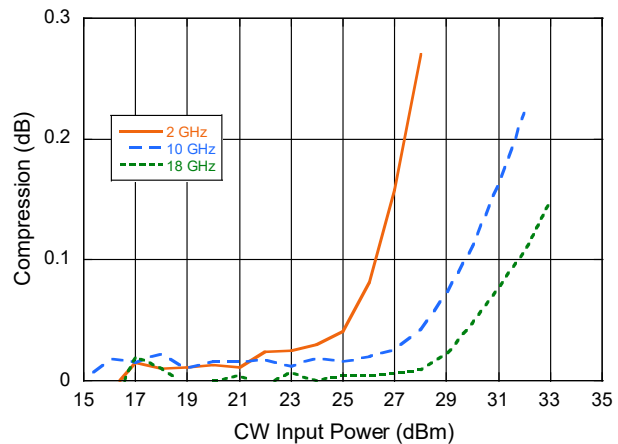
Compression Power over Temperature @ 10 GHz, $V_R = -10 \text{ V}$



Compression Power over Frequency, $V_R = -10 \text{ V}$, +25°C



Compression Power over Frequency, $V_R = -5 \text{ V}$, +25°C



6 7. Operating with Diode Junction Temperature $\leq +150^\circ\text{C}$ will ensure MTTF $> 1 \times 10^6$ hours.

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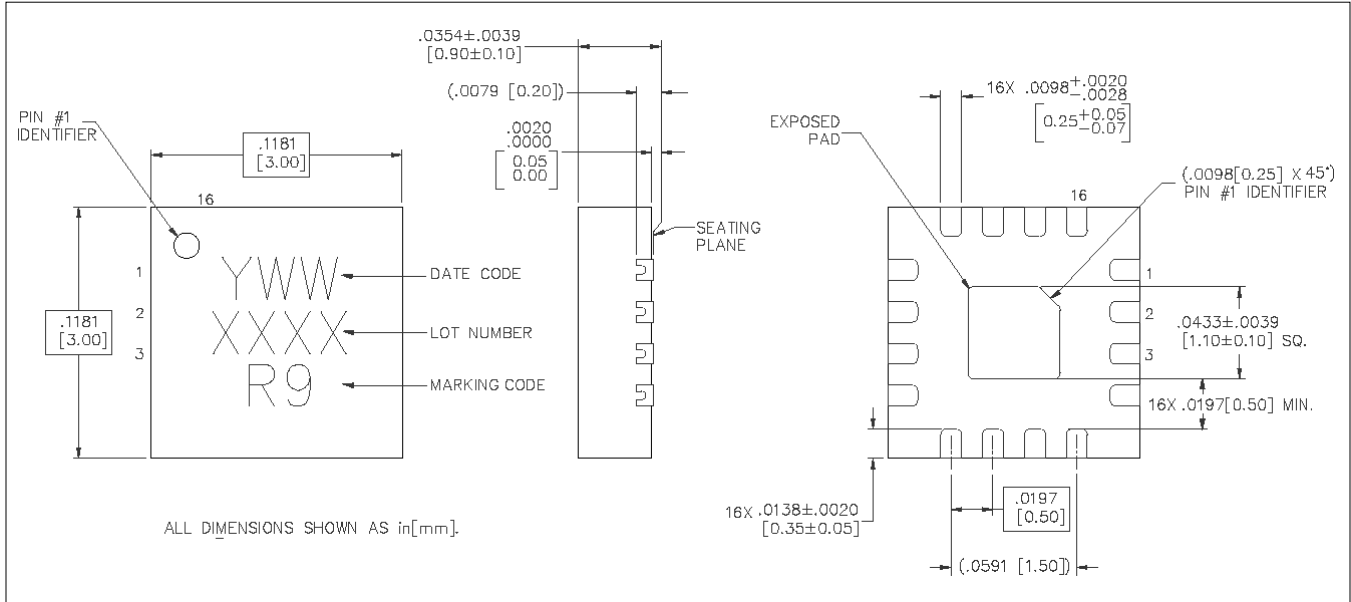
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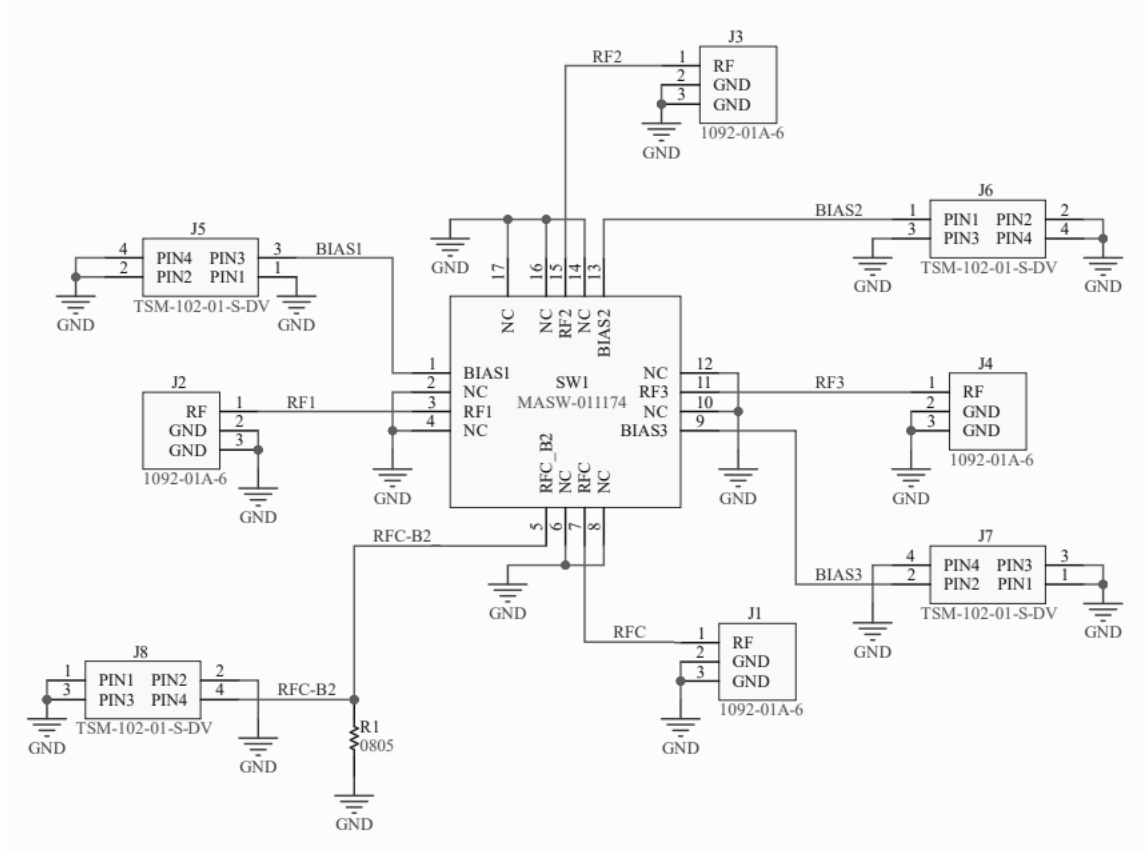
Package Outline Drawing†



† Reference Application Note S2083 for lead-free solder reflow recommendations.
Meets JEDEC moisture sensitivity level (MSL) 1 requirements.
Plating is NiPdAuAg

Application Section

Sample Board Schematic



| Component Designator | Description | P/N |
|----------------------|--|------------------|
| RFC, RF1-3 | 2.92 mm—Southwest Microwave connector | 1092-01A-6 |
| B1-3, RFC-B1 | Connector Header Surface Mount 4 position 0.100" (2.54 mm) | TSM-102-01-S-DV |
| R1 | SMD Resistor (845 Ω 0805 Chip Resistor) | CRCW0805845RFKEA |

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