# HMIC™ PIN Diode SPDT 50 W Switch for 0.05 - 6.0 GHz High Power Applications



## Features

- Exceptional Broadband Performance
- Low Loss:
  $T_X$ = 0.33 dB @ 2010 MHz, 5 V / 20 mA
  $T_X$ = 0.38 dB @ 3.5 GHz, 5 V / 20 mA
- High Isolation:
  $R_X$ = 44 dB @ 2010 MHz, 20 mA / 5 V
  $R_X$ = 36 dB @ 3.5 GHz, 20 mA / 5 V
- High $T_X$ RF Input Power:
  50 W CW @ 2010 MHz
- High $T_X$ RF Input Peak Power:
  >1000 W
- Suitable for Very High Power TD-SCDMA & WiMAX Applications
- Surface Mount 4 mm PQFN Package
- RoHS* Compliant

## Applications

- Aerospace & Defense
- Wireless Networking & Communication

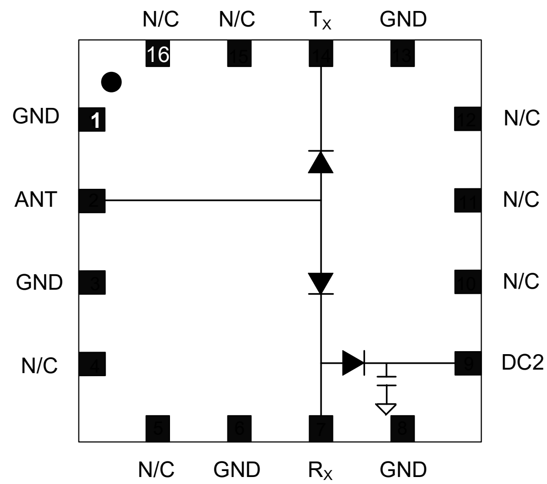
## Description

The MASW-000834 is a SPDT broadband, high linearity, common anode, PIN diode T/R switch, for 0.05 - 6.0 GHz applications, including WiMAX & WiFi. The device is provided in industry standard 4 mm PQFN plastic packaging. This device incorporates a PIN diode die fabricated with MACOMs' patented silicon-glass HMIC™ process. This chip features two silicon pedestals embedded in a low loss, low dispersion glass. The diodes are formed on the top of each pedestal. The topside is fully encapsulated with silicon nitride and has an additional polymer passivation layer that prevents damage and contamination during handling and assembly.

This compact SPDT switch offers wideband performance with excellent isolation to loss ratio for both $T_X$ and $R_X$ states. The PIN diode provides 50 W typical CW power handling and 65 dBm IIP3 at 2010 MHz for maximum switch performance.

This compact SPDT switch offers wideband performance with excellent isolation to loss ratio for both $T_X$ and $R_X$ states. The PIN diode provides 45 W CW power handling at an 85°C baseplate temperature and 72 dBm IIP3 at 2010 MHz for maximum switch performance.

## Functional Diagram (Top View)




## Pin Configuration[1]

| Pin | Function |
|---|---|
| 1,3,6,8,13,15 | GND |
| 2 | ANT |
| 4,5,10,11,12,16 | N/C[2] |
| 7 | RX |
| 9 | DC2 |
| 14 | TX |
| 17 | Pad |

1. The exposed pad centered on the package bottom must be connected to RF, DC and thermal ground.
2. MACOM recommends connecting all No Connection (N/C) pins to ground.

## Ordering Information[3]

| Part Number | Package |
|---|---|
| MASW-000834-13560T | 1000 piece reel |
| MASW-000834-001SMB | Sample Board |

3. Reference Application Note M513 for reel size information.

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

## Electrical Specifications[4]: $T_A$ = +25°C, 20 mA / 5 V, $P_{INC}$ = 0 dBm, $Z_0$ = 50 Ω

| Parameter | Symbol | Units | Min. | Typ. | Max. |
|---|---|---|---|---|---|
| **F = 900 MHz** | | | | | |
| Insertion Loss, $R_X$ | $R_X$ IL | dB | — | 0.34 | 0.56 |
| Insertion Loss, $T_X$ | $T_X$ IL | dB | — | 0.26 | 0.445 |
| Isolation, ANT To $R_X$ | $R_X$ ISO | dB | 45.8 | 52.1 | — |
| Isolation, ANT To $T_X$ | $T_X$ ISO | dB | 21.7 | 27.1 | — |
| **F = 1800 MHz** | | | | | |
| Insertion Loss, $R_X$ | $R_X$ IL | dB | — | 0.40 | 0.72 |
| Insertion Loss, $T_X$ | Tx IL | dB | — | 0.32 | 0.49 |
| Isolation, ANT To $R_X$ | Rx ISO | dB | 43.7 | 48.9 | — |
| Isolation, ANT To $T_X$ | $T_X$ ISO | dB | 18.4 | 21.4 | — |
| **F = 2010 MHz** | | | | | |
| Insertion Loss, $R_X$ | $R_X$ IL | dB | — | 0.42 | 0.75 |
| Insertion Loss, $T_X$ | $T_X$ IL | dB | — | 0.33 | 0.5 |
| Isolation, ANT To $R_X$ | $R_X$ ISO | dB | 43.2 | 44.6 | — |
| Isolation, ANT To $T_X$ | $T_X$ ISO | dB | 17.7 | 19.9 | — |
| Input Return Loss, $T_X$ | $T_X$ RL | dB | — | 32.1 | — |
| Input Return Loss, $R_X$ | $R_X$ RL | dB | — | 24.2 | — |

4. See Bias Table 1.

## Electrical Specifications[4]:
## $T_A$ = +25°C, 20 mA / 5 V, $P_{INC}$ = 0 dBm, $Z_0$ = 50 Ω

| Parameter | Symbol | Units | Min. | Typ. | Max. |
|---|---|---|---|---|---|
| **F = 2.3 - 2.7 GHz** | | | | | |
| Insertion Loss, $R_X$ | $R_X$ IL | dB | — | 0.46 | 0.84 |
| Insertion Loss, $T_X$ | $T_X$ IL | dB | — | 0.35 | 0.525 |
| Isolation, ANT To $R_X$ | $R_X$ ISO | dB | 40.2 | 41.2 | — |
| Isolation, ANT To $T_X$ | $T_X$ ISO | dB | 16.2 | 18.6 | — |
| Input Return Loss, $T_X$ | $T_X$ RL | dB | — | 30.5 | — |
| Input Return Loss, $R_X$ | $R_X$ RL | dB | — | 22.9 | — |
| **F = 3.3 - 3.8 GHz** | | | | | |
| Insertion Loss, $R_X$ | $R_X$ IL | dB | — | 0.56 | 1.0 |
| Insertion Loss, $T_X$ | $T_X$ IL | dB | — | 0.38 | 0.575 |
| Isolation, ANT To $R_X$ | $R_X$ ISO | dB | 33.7 | 35.9 | — |
| Isolation, ANT To $T_X$ | $T_X$ ISO | dB | 13.6 | 16.1 | — |
| Input Return Loss, $T_X$ | $T_X$ RL | dB | — | 27.4 | — |
| Input Return Loss, $R_X$ | $R_X$ RL | dB | — | 21.9 | — |
| **F = 4.9 - 5.9 GHz** | | | | | |
| Insertion Loss, $R_X$ | $R_X$ IL | dB | — | 0.78 | — |
| Insertion Loss, $T_X$ | $T_X$ IL | dB | — | 0.52 | — |
| Isolation, ANT To $R_X$ | $R_X$ ISO | dB | — | 26.4 | — |
| Isolation, ANT To $T_X$ | $T_X$ ISO | dB | — | 11.8 | — |
| Input Return Loss, $T_X$ | $T_X$ RL | dB | — | 20.3 | — |
| Input Return Loss, $R_X$ | $R_X$ RL | dB | — | 24.2 | — |

## Electrical Specifications[5]:
## $T_A$ = +25°C, 50 mA / 25 V, $P_{INC}$ = 0 dBm, $Z_0$ = 50 Ω

| Parameter | Symbol | Units | Min. | Typ. | Max. |
|---|---|---|---|---|---|
| **F = 900 MHz** | | | | | |
| Insertion Loss, $R_X$ | $R_X$ IL | dB | — | 0.27 | — |
| Insertion Loss, $T_X$ | $T_X$ IL | dB | — | 0.22 | — |
| Isolation, ANT To $R_X$ | $R_X$ ISO | dB | — | 53.3 | — |
| Isolation, ANT To $T_X$ | $T_X$ ISO | dB | — | 27.4 | — |
| **F = 1800 MHz** | | | | | |
| Insertion Loss, $R_X$ | $R_X$ IL | dB | — | 0.32 | — |
| Insertion Loss, $T_X$ | $T_X$ IL | dB | — | 0.27 | — |
| Isolation, ANT To $R_X$ | $R_X$ ISO | dB | — | 50.2 | — |
| Isolation, ANT To $T_X$ | $T_X$ ISO | dB | — | 21.6 | — |
| **F = 2010 MHz** | | | | | |
| Insertion Loss, $R_X$ | $R_X$ IL | dB | — | 0.34 | — |
| Insertion Loss, $T_X$ | $T_X$ IL | dB | — | 0.28 | — |
| Isolation, ANT To $R_X$ | $R_X$ ISO | dB | — | 45.5 | — |
| Isolation, ANT To $T_X$ | $T_X$ ISO | dB | — | 20.1 | — |
| Input Return Loss, $T_X$ | $T_X$ RL | dB | — | 33.1 | — |
| Input Return Loss, $R_X$ | $R_X$ RL | dB | — | 24.1 | — |

5. See Bias Table 2.

## Electrical Specifications[5]:
## $T_A$ = +25°C, 50 mA / 25 V, $P_{INC}$ = 0 dBm, $Z_0$ = 50 Ω

| Parameter | Symbol | Units | Min. | Typ. | Max. |
|---|---|---|---|---|---|
| **F = 2.3 - 2.7 GHz** | | | | | |
| Insertion Loss, $R_X$ | $R_X$ IL | dB | — | 0.38 | — |
| Insertion Loss, $T_X$ | $T_X$ IL | dB | — | 0.30 | — |
| Isolation, ANT To $R_X$ | $R_X$ ISO | dB | — | 41.8 | — |
| Isolation, ANT To $T_X$ | $T_X$ ISO | dB | — | 18.7 | — |
| Input Return Loss, $T_X$ | $T_X$ RL | dB | — | 31.3 | — |
| Input Return Loss, $R_X$ | $R_X$ RL | dB | — | 22.8 | — |
| **F = 3.3 - 3.8 GHz** | | | | | |
| Insertion Loss, $R_X$ | $R_X$ IL | dB | — | 0.47 | — |
| Insertion Loss, $T_X$ | $T_X$ IL | dB | — | 0.33 | — |
| Isolation, ANT To $R_X$ | $R_X$ ISO | dB | — | 36.2 | — |
| Isolation, ANT To $T_X$ | $T_X$ ISO | dB | — | 16.2 | — |
| Input Return Loss, $T_X$ | $T_X$ RL | dB | — | 28.0 | — |
| Input Return Loss, $R_X$ | $R_X$ RL | dB | — | 21.8 | — |
| **F = 4.9 - 5.9 GHz** | | | | | |
| Insertion Loss, $R_X$ | $R_X$ IL | dB | — | 0.72 | — |
| Insertion Loss, $T_X$ | $T_X$ IL | dB | — | 0.48 | — |
| Isolation, ANT To $R_X$ | $R_X$ ISO | dB | — | 26.6 | — |
| Isolation, ANT To $T_X$ | $T_X$ ISO | dB | — | 11.8 | — |
| Input Return Loss, $T_X$ | $T_X$ RL | dB | — | 20.5 | — |
| Input Return Loss, $R_X$ | $R_X$ RL | dB | — | 24.2 | — |

## Electrical Specifications: $T_A$ = +25°C, 50 mA / 25 V, $Z_0$ = 50 Ω

| Parameter | Symbol | Test Conditions | Units | Min. | Typ. | Max. |
|---|---|---|---|---|---|---|
| $T_X$ Input P1dB | $T_X$ P1dB | 2010 MHz, $T_X$ to Antenna<br>3.5 GHz, $T_X$ to Antenna | dBm | — | >45.5<br>>45.0 | — |
| $T_X$ 2nd Harmonic | $T_X$ 2Fo | 2010 MHz, $P_{IN}$ = 30 dBm<br>3.5 GHz, $P_{IN}$ = 30 dBm | dBc | — | 80<br>88 | — |
| $T_X$ 3rd Harmonic | $T_X$ 3Fo | 2010 MHz, $P_{IN}$ = 30 dBm<br>3.5 GHz, $P_{IN}$ = 30 dBm | dBc | — | 95<br>105 | — |
| $T_X$ Input IP3 | $T_X$ IIP3 | $P_{IN}$ = 10 dBm, F1 = 2010 MHz, F2 = 2020 MHz<br>$P_{IN}$ = 10 dBm, F1 = 3.50 GHz, F2 = 3.51 GHz | dBm | — | >64<br>>64 | — |
| $T_X$ CW Input Power | $T_X$ $P_{INC}$ | F = 2010 MHz | dBm / W | — | 47 / 50 | — |
| $R_X$ CW Input Power | $R_X$ $P_{INC}$ | F = 2010 MHz<br>F = 3.5 GHz | dBm / W | — | 41.5 / 14<br>40.5 / 11 | — |
| $T_X$ RF Switching Speed | $t_{RF}$ | F = 2010 MHz (10 - 90% RF Voltage)<br>F = 3.5 GHz (10 - 90% RF Voltage)<br>1 MHz Rep Rate in Modulating Mode | ns | — | 200<br>200 | — |

## Absolute Maximum Ratings[6,7]
### @ $T_A$ = +25°C (unless otherwise specified)

| Parameter | Absolute Maximum |
|---|---|
| Forward Current | 100 mA |
| DC Reverse Voltage | 100 V |
| $T_X$ Incident CW Power | 50 W (47 dBm)[8]<br>@ 2010 MHz |
| $T_X$ Peak Incident Power | >300 W, 5 µs, 1% duty cycle |
| Junction Temperature | +175°C |
| Operating Temperature | -40°C to +85°C |
| Storage Temperature | -55°C to +150°C |

6. Exceeding these limits may cause permanent damage.
7. MACOM does not recommend sustained operation near these survivability limits.
8. Baseplate temperature must be controlled to a constant +25°C. See derating curve.

## Handling Procedures

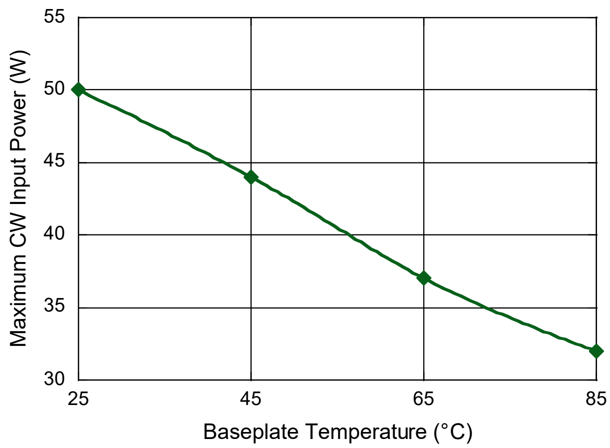
Please observe the following precautions to avoid damage:

## Static Sensitivity

Silicon Integrated Circuits are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these Class 1B Human Body devices.

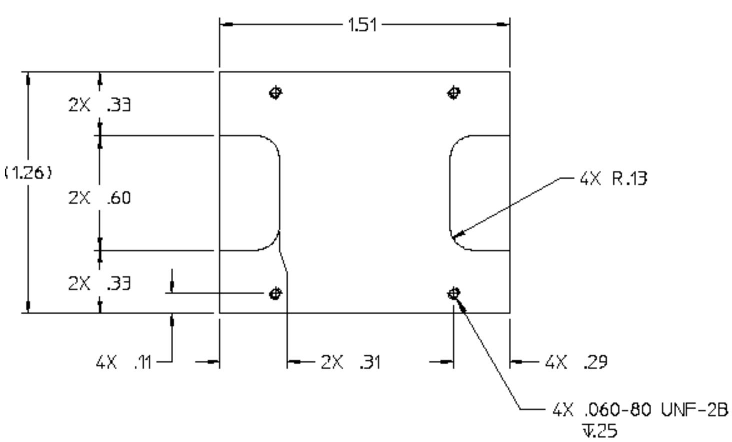
## Typical Power Derating Curve

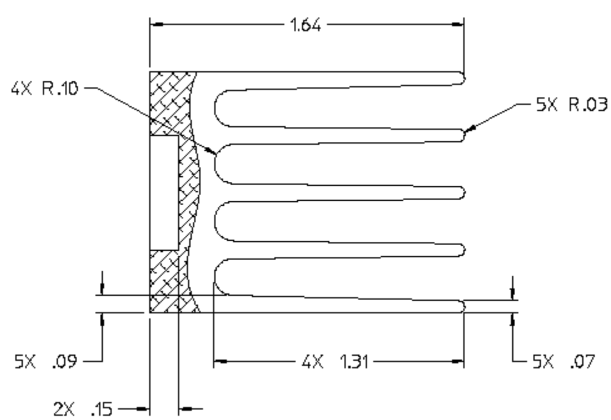
***$T_X$ Maximum CW Input Power***
***(50 mA Forward Bias, 2010 MHz)***




Note that this part must be held to a constant baseplate temperature to achieve the power handling results specified above. Adding a heatsink to the baseplate will improve performance to values greater than shown here. The increase in maximum input power from using a heatsink depends on the specific heatsink design.

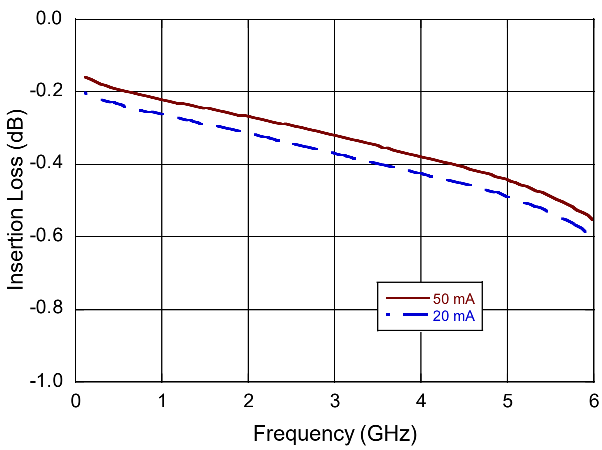
With a sample board mounted onto a heatsink of dimensions and fins shown below, this switch can handle up to 35 W CW of incident power.



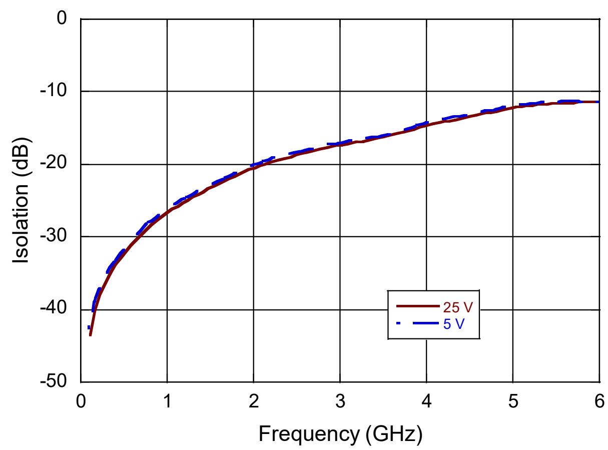



## $T_X$ Performance Curves @ +25°C, $Z_0$ = 50 Ω

***$T_X$ Insertion Loss, 20 mA & 50 mA***

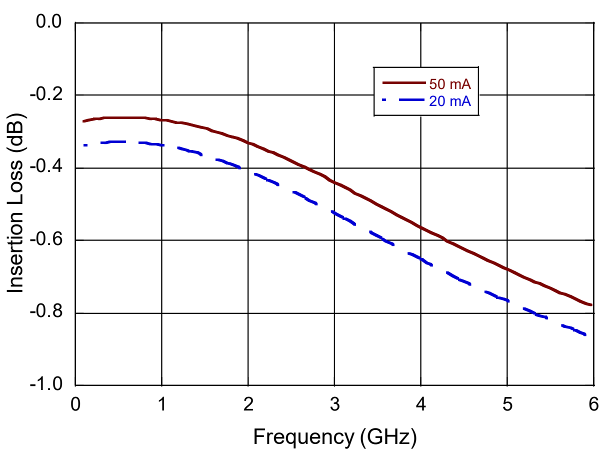



***$T_X$ Isolation, 5 V & 25 V***

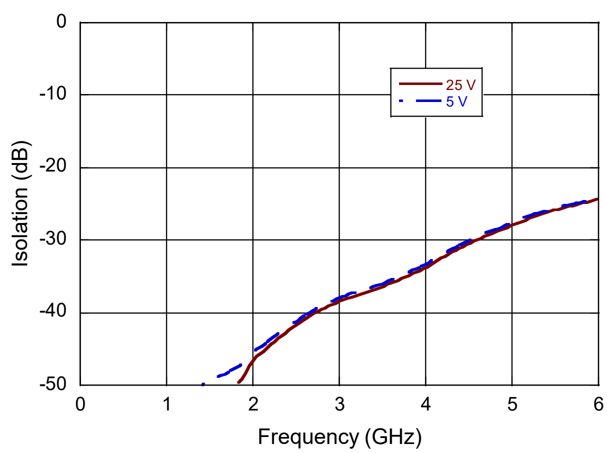



## $R_X$ Performance Curves @ +25°C, $Z_0$ = 50 Ω

***$R_X$ Insertion Loss, 20 mA & 50 mA***

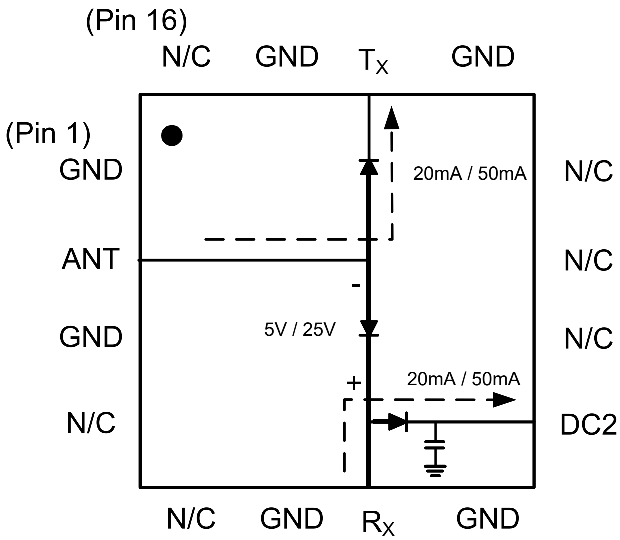



***$R_X$ Isolation, 5 V & 25 V***

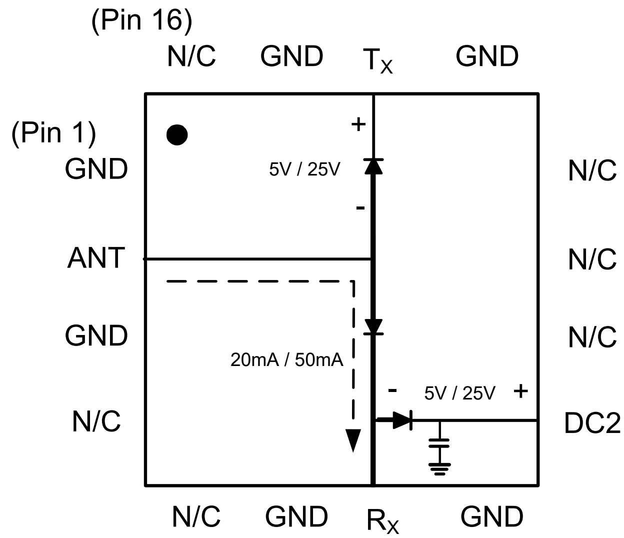


## Bias Diagrams & Tables[9]

### $T_X$-ANT Insertion Loss, $R_X$-ANT Isolation




### $R_X$-ANT Insertion Loss, $T_X$-ANT Isolation




### Bias Table 1

| Parameter | $T_X$ | $R_X$ | DC2 | ANT |
|---|---|---|---|---|
| | Pin 14 | Pin 7 | Pin 9 | Pin 2 |
| $T_X$-ANT Insertion Loss / $R_X$-ANT Isolation | -20 mA | +5 V, +20 mA | -20 mA | 0 V, +20 mA |
| $R_X$-ANT Insertion Loss / $T_X$-ANT Isolation | +5 V, 0 mA | -20 mA | +5 V, 0 mA | 0 V, +20 mA |

### Bias Table 2

| Parameter | $T_X$ | $R_X$ | DC2 | ANT |
|---|---|---|---|---|
| | Pin 14 | Pin 7 | Pin 9 | Pin 2 |
| $T_X$-ANT Insertion Loss / $R_X$-ANT Isolation | -50 mA | +25 V, +50 mA | -50 mA | 0 V, +50 mA |
| $R_X$-ANT Insertion Loss / $T_X$-ANT Isolation | +25 V, 0 mA | -50 mA | +25 V, 0 mA | 0 V, +50 mA |

9. Diode Based Products require different minimum reverse bias voltages depending on the frequency and incident power levels. More details can be found on page 10 of this datasheet.

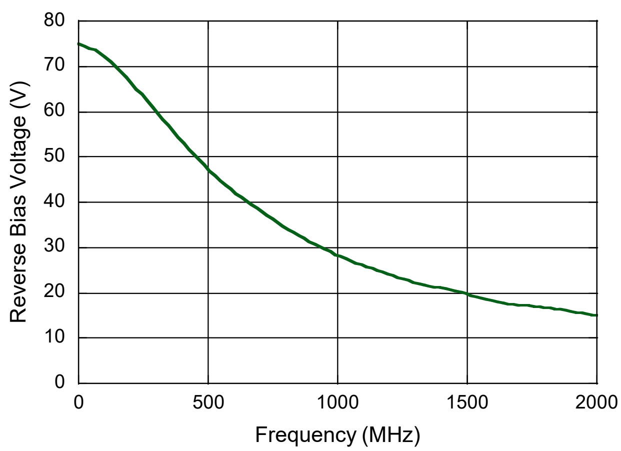
## Minimum Required Reverse Bias Voltage

Minimum reverse bias voltage on a PIN diode based product varies with frequency of operation and incident power levels. As a rule of thumb, a designer can always use the magnitude of the peak RF voltage or empirically locate lower bias values than the peak RF voltage magnitude. However, it has been shown that lower DC voltages can be used depending on the RF environment in which a diode is placed. In the plot below, the minimum required reverse voltage vs. frequency is shown for an incident RF power of 50 Watts. This trend line will shift lower if the incident RF power is decreased. The biasing values have not been verified through measurement at MACOM. As a result, please use the data below as a guide only for biasing requirements as this data is based solely on generic PIN diode equations.[10]

Please be cautious in that lower reverse bias levels can degrade isolation and distortion in a PIN diode based product. Also, if using the MARD-009150 driver, keep in mind the maximum voltage available is 55 V. If a voltage greater than 55 V is desired, then one may want to consider using the MADR-010574 driver.

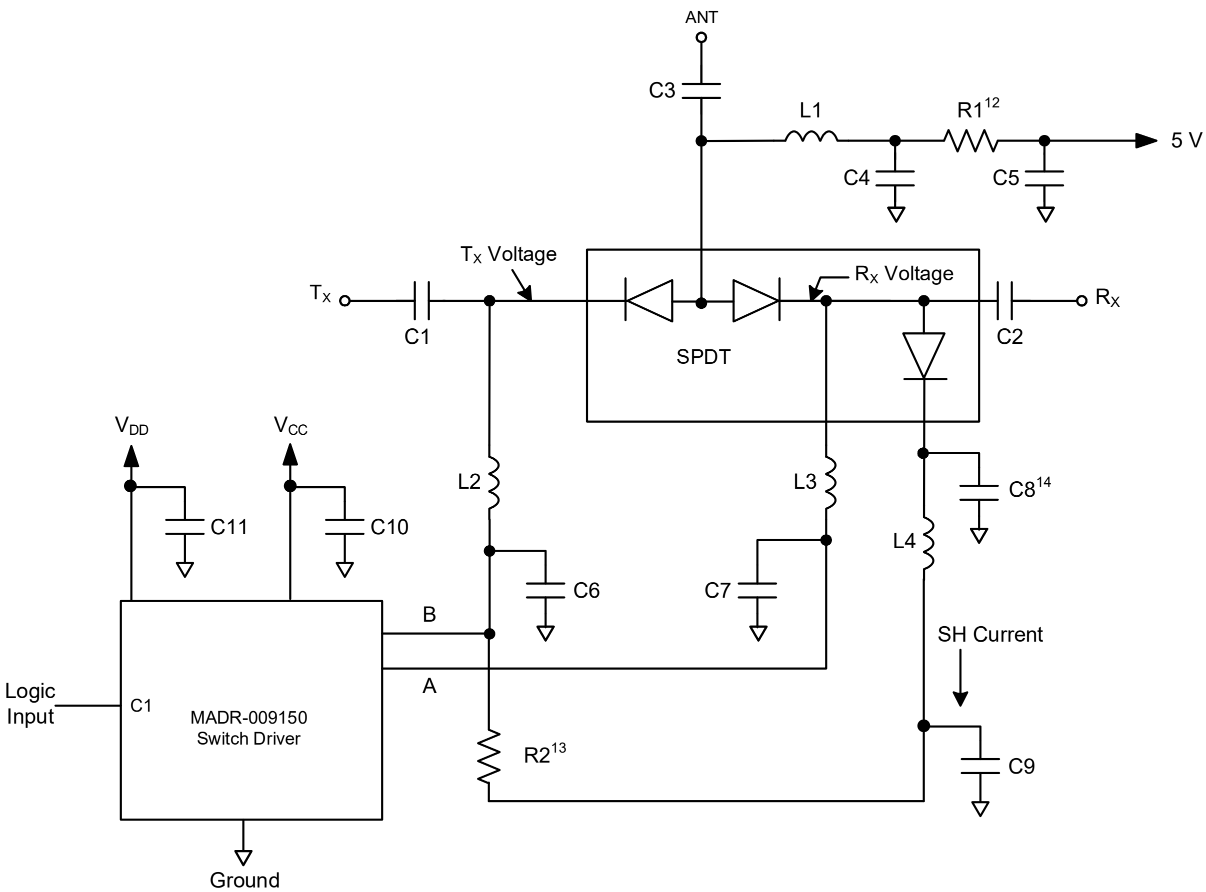
10. R. Caverly and G. Hiller, “Establishing the Minimum Reverse Bias for a P-I-N Diode in a High Power Switch,” IEEE Transactions on Microwave Theory and Techniques, Vol.38, No.12, December 1990.

***Reverse Bias Required vs. Frequency (50 W Power Handling)***



## MASW-000834 and Recommended Driver with 5 V & 28 V DC Power[11,12,13,14,15,16]

**MADR-009150 is the recommended driver for the MASW-000834 Switch.**

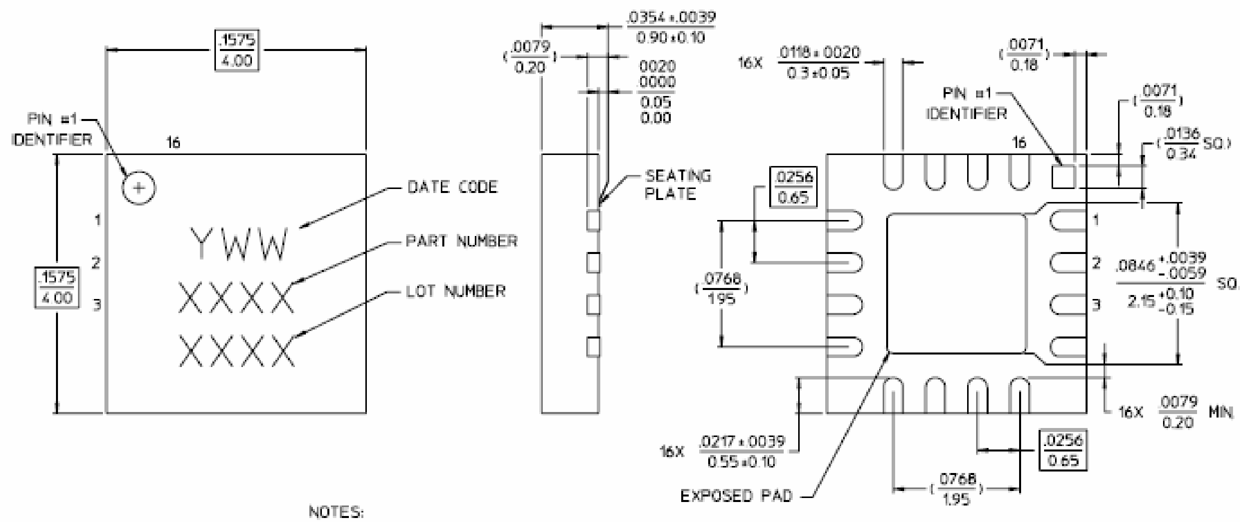



11. Forward bias diode voltage: $DV_F$ is ~0.9 V @ 22 mA; $DV_F$ is ~1.0 V @ 35 mA
12. R1 is calculated by ($V_{CC}$ - 1.3 V approximation since Tx and Rx voltages on driver will be slightly different)/$I_{SERIES}$, where $I_{SERIES}$ is the desired bias current for the series diodes.
13. R2 is calculated by ($V_{DD}$ - 1.5 V)/$I_{SHUNT}$, where $I_{SHUNT}$ is the desired forward bias current for the shunt diode. The power dissipation is calculated by $I_{SHUNT}$ x ($V_{DD}$ - 1.5 V).
14. C8 is already built-in for MASW-000834-13560T switch.
15. The current in through the back-biased diodes will be the leakage current for the diodes.
16. C1-C7, C9-C11, L1-L4, R1, R2, and the switch are discrete components that should be installed on the users board. It is recommended that Coilcraft 0603CS-27NXJLW or equivalent be used for L1-L4 at 2 GHz (values may vary based on the frequency).

## Parts List

| Part | Value |
|---|---|
| C1 - C3 | 27 pF, 100 V |
| C4 | 1000 pF |
| C5,C10,C11 | 0.1 µF |
| C6,C7,C8[14],C9 | 50 pF |
| L1, L2, L3,L4 | 27 nH |
| R1 | 100 Ω[12] |
| R2 | 480 Ω[13] |

## Outline: 4 mm PQFN 16-Lead Saw Singulated




NOTES:
1. REFERENCE JEDEC MO-220, VAR. VGGC FOR ADDITIONAL DIMENSIONAL AND TOLERANCE INFORMATION.
2. REFERENCE S2083 APPLICATION NOTE FOR PCB FOOTPRINT INFORMATION.
3. ALL DIMENSIONS SHOWN AS INCHES/MM.

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