

Ka-Band High Power Terminated SPDT PIN Switch 24 - 37 GHz

Rev. V2

Features

- Low Loss: 0.6 dB, 28 to 34 GHz
- High Isolation: >26 dB
- >40 W CW Power Handling @ +85°C
- Switching Speed: <65 ns
- Integrated DC Blocks and RF Bias Networks
- Die with G-S-G RF Pads and DC Bias Pads
- RoHS* Compliant

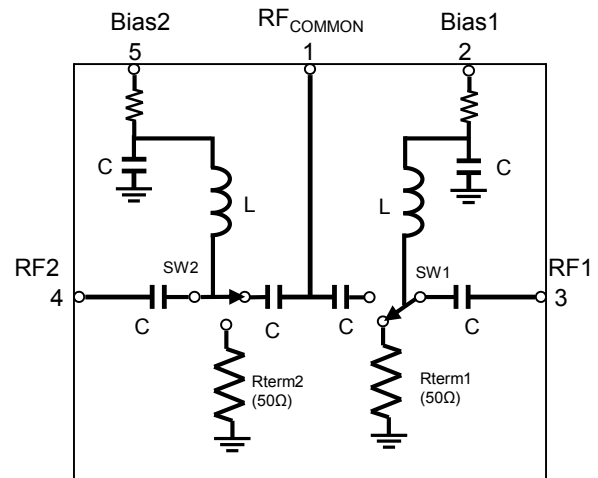
Description and Applications

The MASW-011094 is a high power SPDT with 50 Ω terminated RF ports. This broadband, high linearity, SPDT switch was developed for Ka-Band applications that require up to 40 Watts CW power handling at an environmental temperature of +85°C while maintaining low insertion loss and high isolation.

The SPDT MMIC utilizes MACOM's proven AlGaAs PIN diode technology. The switch is fully passivated with silicon nitride and has an added polymer layer for scratch protection. The protective coating prevents damage to the junction and the air-bridges during handling and assembly. The die has backside metallization to facilitate an epoxy die attach process.

These switches are ideally suited for satellite and Point-to-Point communications systems, radar systems, radiometers, test and instrumentation equipment and other high frequency applications.

Functional Schematic



Pin Configuration

(Backside metal is RF, DC, and thermal ground)

| Pin No. | Function |
|---------|----------------------|
| 1 | RF _{COMMON} |
| 2 | Bias 1 |
| 3 | RF1 |
| 4 | RF2 |
| 5 | Bias 2 |

Ordering Information¹

| Part Number | Package |
|-------------------|--------------------------|
| MASW-011094-DIE0G | Die in Gel Pack |
| MASW-011094-DIERI | Die, Inked on Wafer Ring |

1. Die quantity varies.

* Restrictions on Hazardous Substances, European Union Directive 2011/65/EU.

Ka-Band High Power Terminated SPDT PIN Switch 24 - 37 GHz

Rev. V2

Electrical Specifications: $T_A = 25^\circ\text{C}$, $V_R^2 = -5\text{ V}$, $V_F = +7.5\text{ V}$, $Z_0 = 50\ \Omega$

| Parameter | Test Conditions | Units | Min. | Typ. | Max. |
|---|---------------------------------|-------|------|---------|------|
| Insertion Loss (RF _{COMMON} to RFx ON state) | 26 - 28 GHz | dB | — | 0.8 | — |
| | 28 - 32 GHz | | | 0.6 | 1.0 |
| | 32 - 36 GHz | | | 0.8 | — |
| | 36 - 37 GHz | | | 1.0 | — |
| Isolation (RF _{COMMON} to RFx OFF state) ³ | 26 - 28 GHz | dB | — | 26 | — |
| | 28 - 32 GHz | | 25 | 27 | |
| | 34 GHz | | 25 | 28 | |
| | 32 - 36 GHz | | — | 28 | |
| | 36 - 37 GHz | | — | 29 | |
| Return Loss (RF _{COMMON}) | 26 - 28 GHz | dB | — | 14 | — |
| | 28 - 32 GHz | | | 17 | |
| | 32 - 36 GHz | | | 12 | |
| | 36 - 37 GHz | | | 11 | |
| Return Loss (RFx ON state) | 26 - 28 GHz | dB | — | 14 | — |
| | 28 - 32 GHz | | | 18 | |
| | 32 - 36 GHz | | | 12 | |
| | 36 - 37 GHz | | | 10 | |
| Return Loss (RFx OFF state) | 26 - 28 GHz | dB | — | 10.5 | — |
| | 28 - 32 GHz | | 10 | 15.0 | |
| | 32 - 36 GHz | | — | 11.0 | |
| | 36 - 37 GHz | | — | 9.5 | |
| CW Power Handling (ON state) ² | 28.5 GHz, -60 V @ +85°C | dBm | — | 46 | — |
| Switching Speed T _{RISE} / T _{FALL} | 10% - 90% RF, 26.5 GHz | ns | — | 16 / 34 | — |
| Switching Speed T _{ON} / T _{OFF} | 50% control to 90% RF, 26.5 GHz | ns | — | 42 / 65 | — |
| I _R - Reverse Bias Current | V _R = -60 V | nA | — | 50 | — |
| I _F - Forward Bias Current ⁴ | V _F = +7.5 V | mA | 30 | 38 | 45 |

2. Reverse bias voltage should be determined based on working conditions. For example, -60 V @ 46 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 P-I-N Diode in a High Power Switch," IEEE Transactions on Microwave Theory and Techniques, Vol.38, No.12, December 1990.

3. Isolation defined with 1 port in low loss state.

4. Forward bias voltage should be determined based on working conditions.

Absolute Maximum Ratings^{5,6,7}

| Parameter | Absolute Maximum |
|--------------------------|------------------|
| Reverse Bias Voltage | -100 V |
| Forward Bias Current | 83 mA |
| Forward Bias Voltage | 11 V |
| Incident Power (ON path) | 47 dBm |
| Junction Temperature | +150°C |
| Operating Temperature | -40°C to +85°C |
| Storage Temperature | -55°C to +150°C |

5. Exceeding any one or combination of these limits may cause permanent damage to this device.
6. MACOM does not recommend sustained operation near these survivability limits.
7. Operating at nominal conditions with junction temperature less than 150°C will ensure MTTF > 1 x 10⁹ hours.

Truth Table

| State | B1 | B2 |
|--------------------------------|--------|--------|
| RF _{COMMON} to RF1 ON | -5 V | +7.5 V |
| RF _{COMMON} to RF2 ON | +7.5 V | -5 V |

Handling Procedures

Please observe the following precautions to avoid damage:

Static Sensitivity

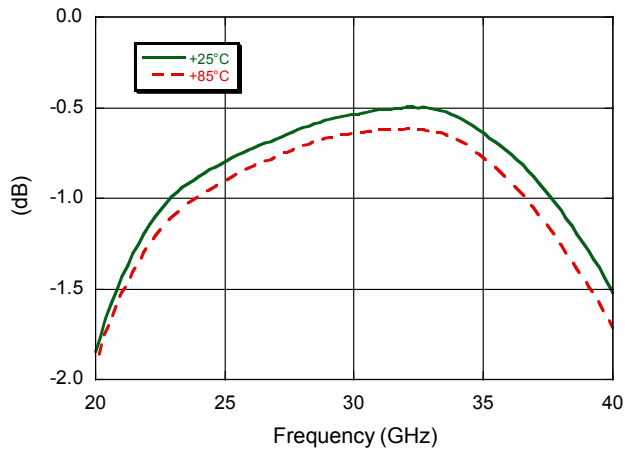
Integrated Circuits are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these HBM class 1A devices.

Ka-Band High Power Terminated SPDT PIN Switch 24 - 37 GHz

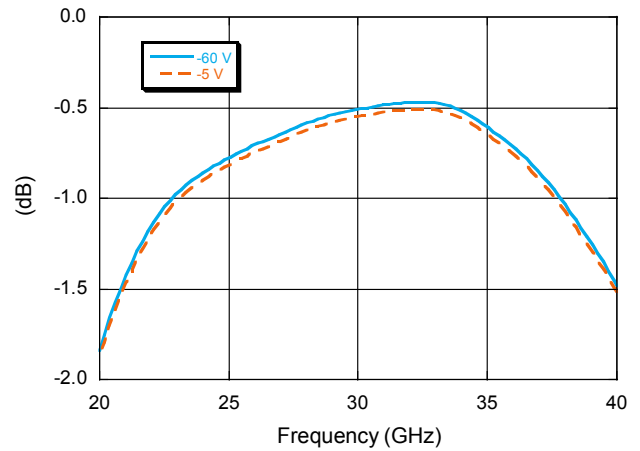
Rev. V2

Typical Performance Curves

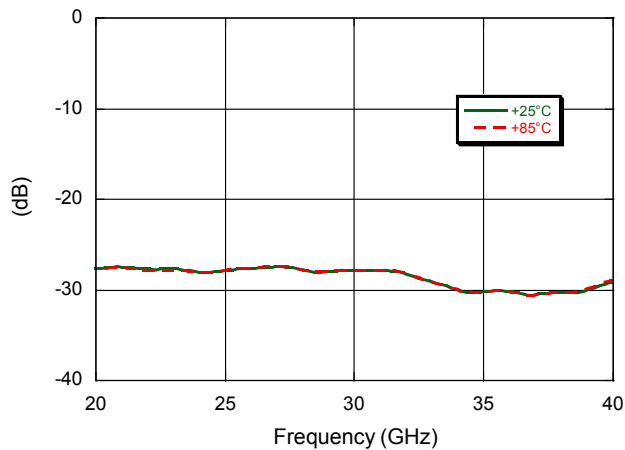
Insertion Loss



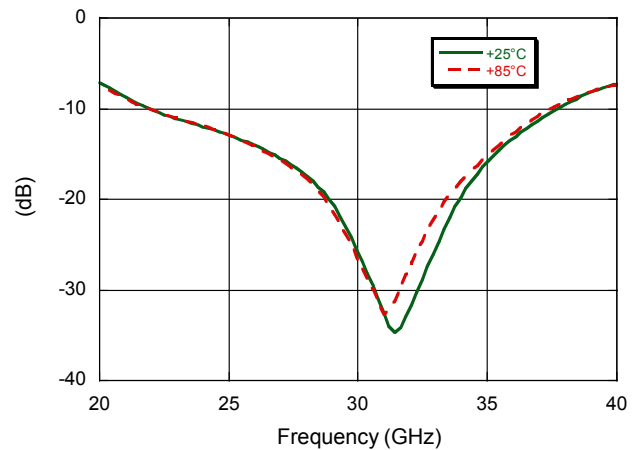
Insertion Loss over Reverse Bias Voltage



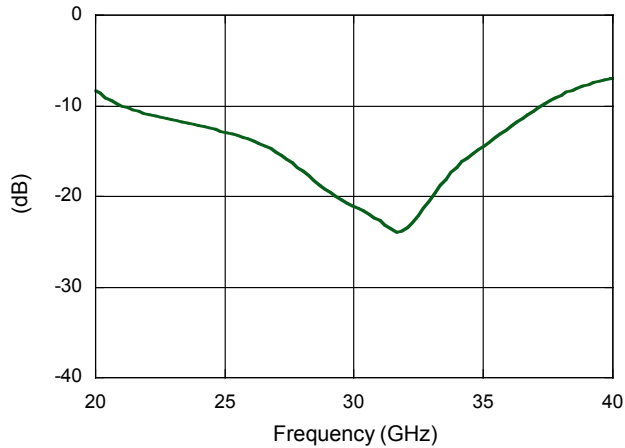
Isolation RF_{COMMON} to RF_x



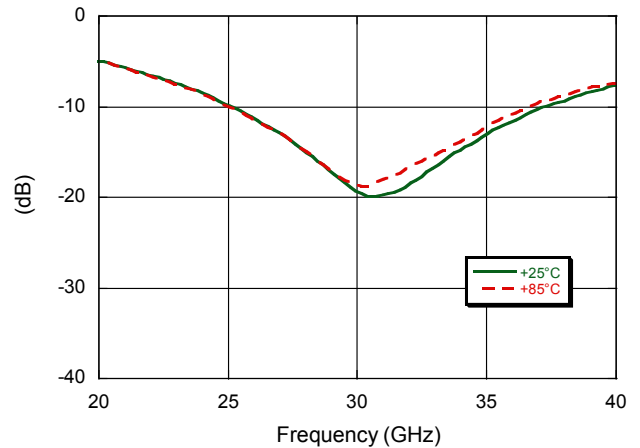
RF_{COMMON} Return Loss in ON State



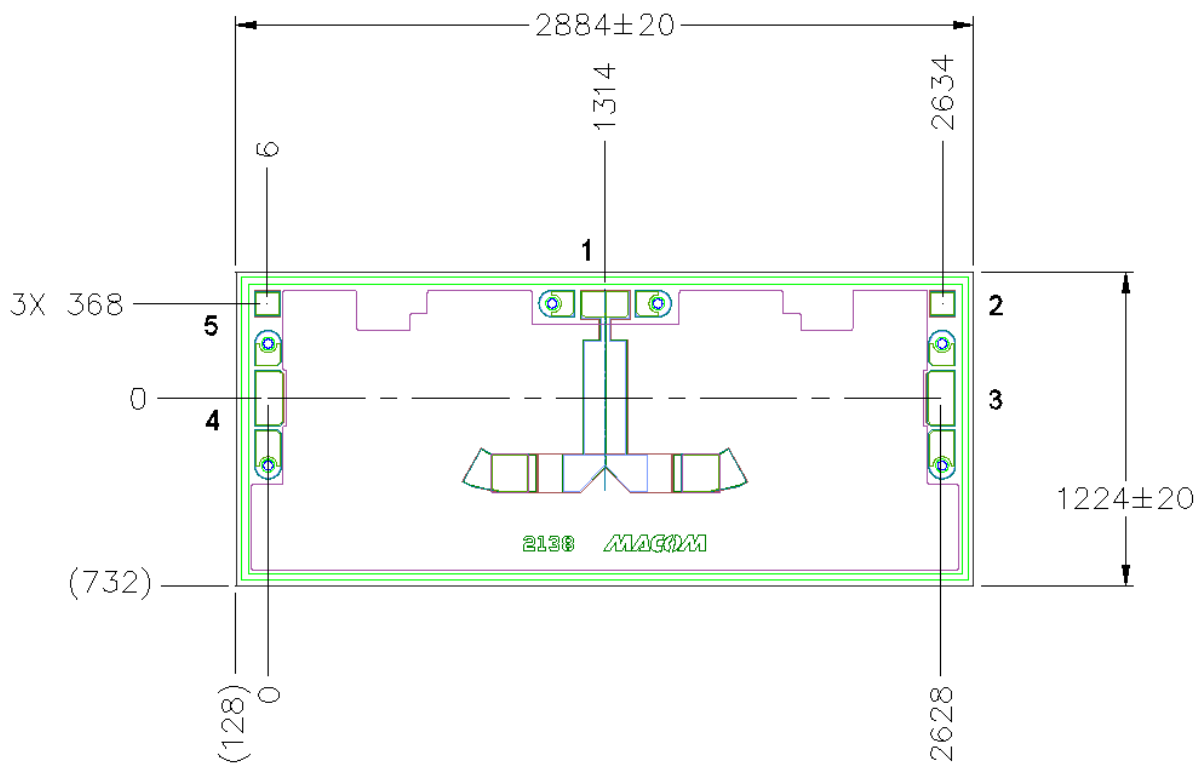
RF_x Return Loss in On State



Return Loss of Terminated Port RF_x



Outline Drawing



Notes:

Unless otherwise specified, All dimensions shown as μm with a tolerance of $\pm 5 \mu\text{m}$.

Die thickness is $100 \mu\text{m} \pm 12.5 \mu\text{m}$.

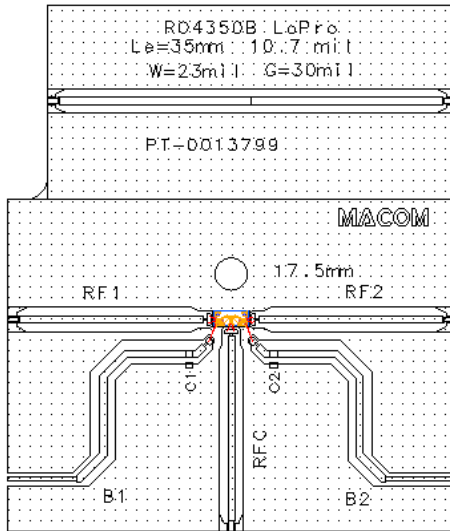
Pad 1 = $178 \times 101 \mu\text{m}$.

Pads 2 & 5 = $88 \mu\text{m sq}$.

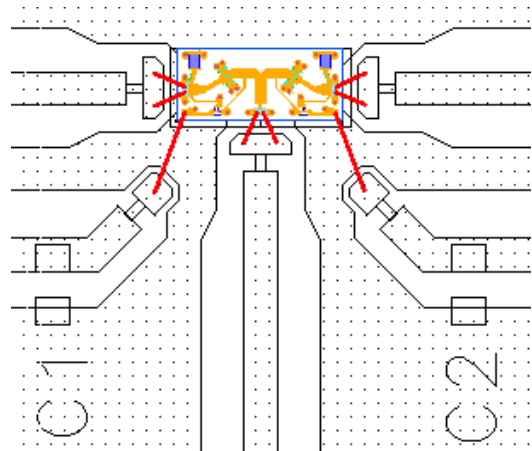
Pads 3 & 4 = $101 \times 208 \mu\text{m}$.

Applications Section

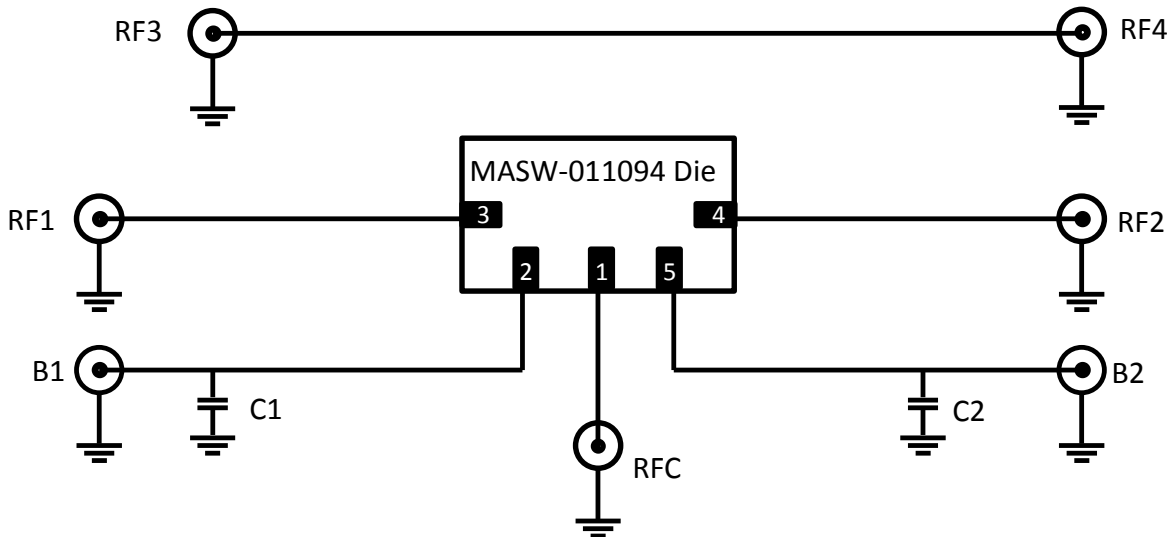
Sample Board Layout



Sample Board Layout - Detailed View



Sample Board Schematic

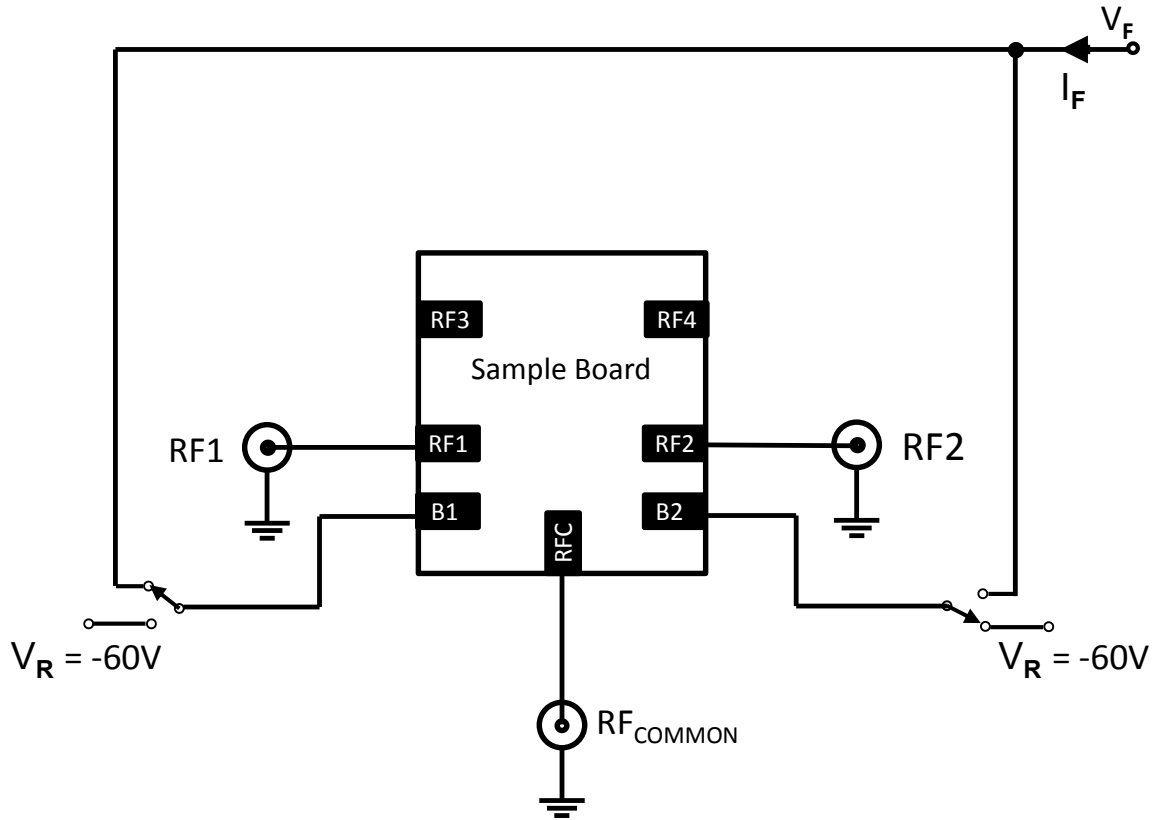


| Component Designator | Description | P/N |
|-----------------------|--|-------------------------|
| RFC, RF1, 2, 3, and 4 | 2.4 mm - Southwest Microwave connector | 1492-03A |
| B1, B2 | Johnson/Emerson RF connector Or SSMA - Southwest Microwave connector | 142-0761-821 292-06A |
| C1, C2 | 22 pF High Frequency Capacitor | ATC600L220 |

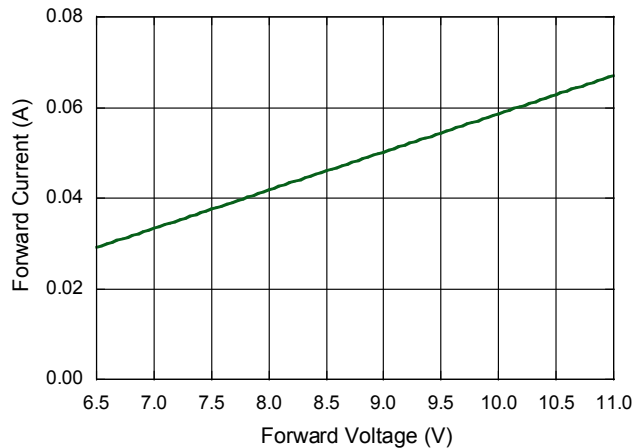
Applications Section

Sample Board Application Schematic

The schematic shown below depicts the switch in ON state of the RF_{COMMON} to RF2 and RF1 input in OFF state. The switch bias conditions are set for high power (40 W) application.



Typical Forward Current vs. Forward Voltage



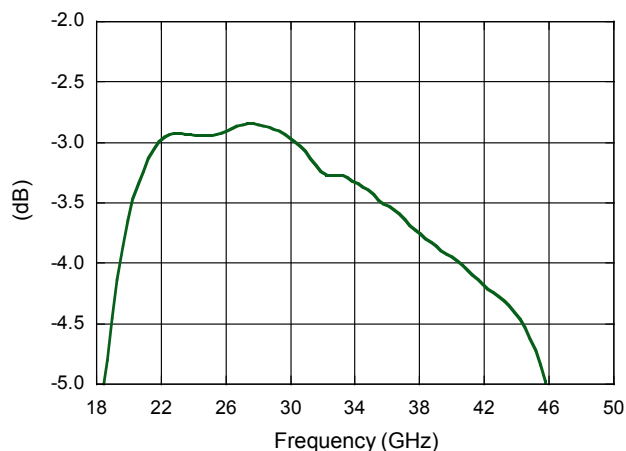
Truth Table

| State | B1 | B2 |
|--------------------------------|--------|--------|
| RF _{COMMON} to RF1 ON | -60 V | +7.5 V |
| RF _{COMMON} to RF2 ON | +7.5 V | -60 V |

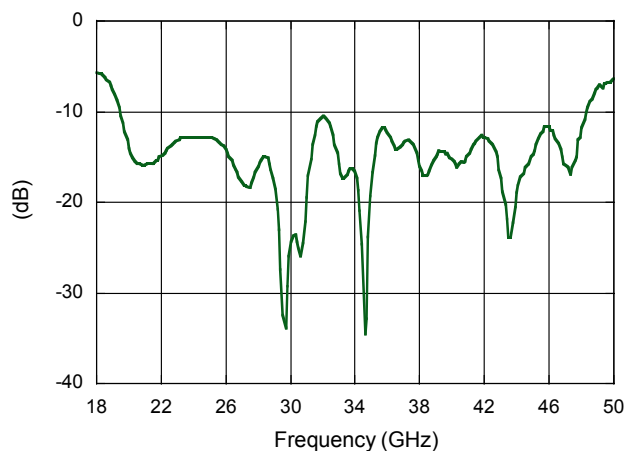
Applications Section

Typical Sample Board Performance (Not De-embedded)

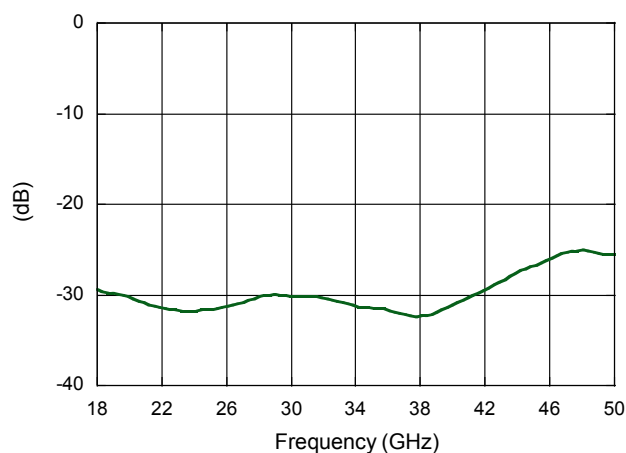
Insertion Loss



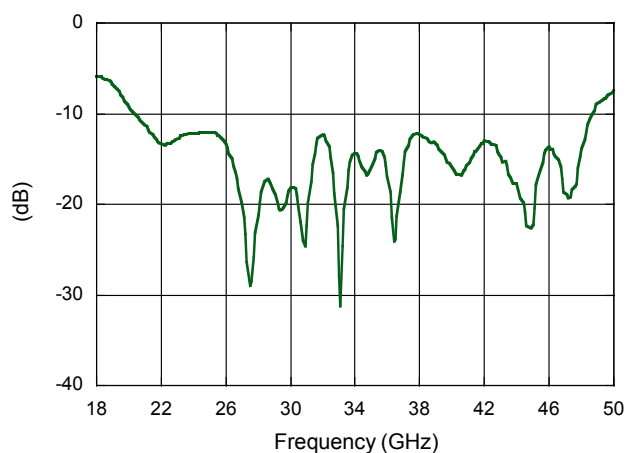
RF1 and RF2 Return Loss in On State



Isolation RF1 and RF2



RF_{COMMON} Return Loss in ON State



MACOM Technology Solutions Inc. All rights reserved.

Information in this document is provided in connection with MACOM Technology Solutions Inc ("MACOM") products. These materials are provided by MACOM as a service to its customers and may be used for informational purposes only. Except as provided in MACOM's Terms and Conditions of Sale for such products or in any separate agreement related to this document, MACOM assumes no liability whatsoever. MACOM assumes no responsibility for errors or omissions in these materials. MACOM may make changes to specifications and product descriptions at any time, without notice. MACOM makes no commitment to update the information and shall have no responsibility whatsoever for conflicts or incompatibilities arising from future changes to its specifications and product descriptions. No license, express or implied, by estoppels or otherwise, to any intellectual property rights is granted by this document.

THESE MATERIALS ARE PROVIDED "AS IS" WITHOUT WARRANTY OF ANY KIND, EITHER EXPRESS OR IMPLIED, RELATING TO SALE AND/OR USE OF MACOM PRODUCTS INCLUDING LIABILITY OR WARRANTIES RELATING TO FITNESS FOR A PARTICULAR PURPOSE, CONSEQUENTIAL OR INCIDENTAL DAMAGES, MERCHANTABILITY, OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT. MACOM FURTHER DOES NOT WARRANT THE ACCURACY OR COMPLETENESS OF THE INFORMATION, TEXT, GRAPHICS OR OTHER ITEMS CONTAINED WITHIN THESE MATERIALS. MACOM SHALL NOT BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, INCLUDING WITHOUT LIMITATION, LOST REVENUES OR LOST PROFITS, WHICH MAY RESULT FROM THE USE OF THESE MATERIALS.

MACOM products are not intended for use in medical, lifesaving or life sustaining applications. MACOM customers using or selling MACOM products for use in such applications do so at their own risk and agree to fully indemnify MACOM for any damages resulting from such improper use or sale.