

# SP4T Reflective Switch DC - 44 GHz



MASW-011199

Rev. V2

## Features

- Ultra Wideband: 9 kHz to 44 GHz
- Insertion Loss:
  - 1.4 dB @ 18 GHz
  - 2.6 dB @ 44 GHz
- Isolation:
  - 48 dB @ 18 GHz
  - 34 dB @ 44 GHz
- Input P1dB: 28.5 dBm
- Input IP3: 51 dBm
- Return Loss at Each RF Port: 16 dB
- Power Handling including Hot Switching: 26 dBm
- No Low Frequency Spurious
- Compatible with 1.8, 2.5, and 3.3 V CMOS Logic
- 3 mm, 22 pin Laminate Package
- RoHS\* Compliant

## Applications

- Test & Measurement
- ISM, Multi Market

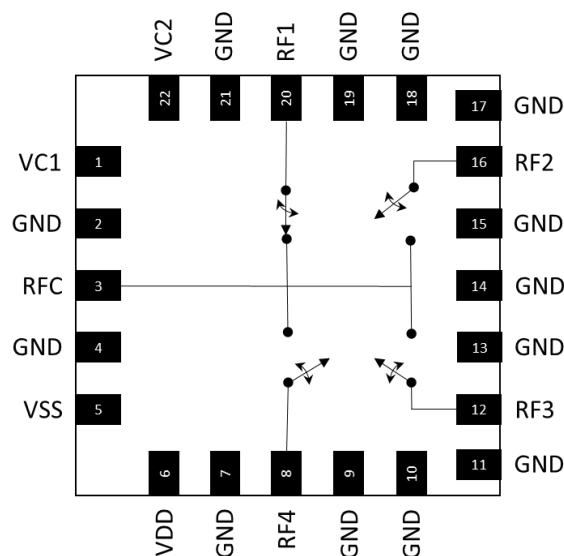
## Description

The MASW-011199 is a reflective, ultra wideband single pole four throw (SP4T) switch with 2.6 dB of insertion loss at 44 GHz. The power handling capability is 26 dBm. The input and output return losses in the thru path are typically 16 dB. The logic levels are compatible with standard 1.8, 2.5, or 3.3 V CMOS. Required bias supplies are +3.3 V and -3.3 V.

The MASW-011199 is designed for wideband applications such as Test and Measurement, Aerospace and Defense, Cellular infrastructure (5G millimeter-wave), military radios, radars, microwave radios and very small aperture terminals (VSATs).

The MASW-011199 is manufactured on a Silicon-on-Insulator process. The 3 mm laminate package is lead free and RoHS compliant.

## Functional Schematic



## Pin Configuration<sup>1</sup>

| Pin #                     | Pin Name         | Description            |
|---------------------------|------------------|------------------------|
| 1                         | VC1              | Control Voltage 1      |
| 2,4,7,9-11,13-15,17-19,21 | GND              | Ground                 |
| 3                         | RFC <sup>2</sup> | Common RF Input/Output |
| 5                         | VSS              | -3.3 V                 |
| 6                         | VDD              | +3.3 V                 |
| 8                         | RF4 <sup>2</sup> | RF Input/Output 4      |
| 12                        | RF3 <sup>2</sup> | RF Input/Output 3      |
| 16                        | RF2 <sup>2</sup> | RF Input/Output 2      |
| 20                        | RF1 <sup>2</sup> | RF Input/Output 1      |
| 22                        | VC2              | Control Voltage 2      |

1. The exposed pad centered on the package bottom must be connected to RF, dc, and thermal ground.
2. RF ports are dc-coupled to GND. There are no internal dc blocking capacitors.

## Ordering Information<sup>3,4</sup>

| Part Number        | Package        |
|--------------------|----------------|
| MASW-011199-TR0500 | 500 piece reel |
| MASW-011199-SB1    | Sample Board   |

3. Reference Application Note M513 for reel size information.
4. All sample boards include 3 loose parts.

<sup>1</sup> \* Restrictions on Hazardous Substances, compliant to current RoHS EU directive.

# SP4T Reflective Switch

## DC - 44 GHz



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### Electrical Specifications<sup>5</sup>:

$V_{DD} = +3.3\text{ V}$ ,  $V_{SS} = -3.3\text{ V}$ ,  $VC1 / VC2 = 0\text{ V or }1.8\text{ V}$ ,  $T_{PADDLE} = 25^{\circ}\text{C}$ ,  $Z_0 = 50\ \Omega$

| Parameter                                | Test Conditions  | Units         | Min.  | Typ.  | Max.  |
|--|--|---------------|-------|-------|-------|
| Insertion Loss                           | DC to 18 GHz   | dB            | —     | 1.2   | —     |
|  | 18 GHz   |               |       | 1.4   | 2.2   |
|  | 30 GHz   |               |       | 1.8   | 2.6   |
|  | 44 GHz   |               |       | 2.6   | 4.0   |
| Isolation, Between RF1 / RF2 / RF3 / RF4 | DC to 18 GHz   | dB            | —     | 48    | —     |
|  | 18 GHz   |               |       | 48    |       |
|  | 30 GHz   |               |       | 42    |       |
|  | 44 GHz   |               |       | 34    |       |
| Isolation, RFC to RF1 / RF2 / RF3 / RF4  | DC to 18 GHz   | dB            | —     | 50    | —     |
|  | 18 GHz   |               | 42    | 50    |       |
|  | 30 GHz   |               | 38    | 46    |       |
|  | 44 GHz   |               | —     | 41    |       |
| RFC Return Loss                          | DC - 44 GHz  | dB            | —     | 16    | —     |
| RF1/RF2/RF3/RF4 Return Loss, Thru Port   | DC - 44 GHz  | dB            | —     | 16    | —     |
| Input P0.1dB                             | 10 MHz - 44 GHz  | dBm           | —     | 27.5  | —     |
| Input P1dB                               | 10 MHz - 44 GHz  | dBm           | —     | 28.5  | —     |
| Input IP3                                | Two tone, $P_{IN}/\text{tone} = +14\text{ dBm}$<br>10 MHz - 44 GHz | dBm           | —     | 51    | —     |
| $T_{ON}$                                 | 50% control to 90% RF  | $\mu\text{s}$ | —     | 0.8   | —     |
| $T_{RISE}$                               | 10% to 90% RF  | $\mu\text{s}$ | —     | 0.3   | —     |
| $T_{OFF}$                                | 50% control to 10% RF  | $\mu\text{s}$ | —     | 0.17  | —     |
| $T_{FALL}$                               | 90% to 10% RF  | $\mu\text{s}$ | —     | 0.04  | —     |
| Voltage Supply, VDD                      | —  | V             | +3.15 | +3.3  | +3.45 |
| Voltage Supply, VSS                      | —  | V             | -3.45 | -3.3  | -3.15 |
| Logic Voltage, Input Low ( $V_{IL}$ )    | —  | V             | 0.0   | —     | +0.8  |
| Logic Voltage, Input High ( $V_{IH}$ )   | —  | V             | +1.2  | —     | VDD   |
| Supply Current, VDD                      | —  | mA            | —     | 0.3   | 0.5   |
| Supply Current, VSS                      | —  | mA            | —     | 0.65  | 1.0   |
| Logic Pin Current (VC1 / VC2)            | Pulled down to GND with<br>100 k $\Omega$ resistor                 | $\mu\text{A}$ | —     | VC*10 | —     |

5. Parameters are measured on a test board that includes impedance matching. Device shall be aligned to recommended PCB footprint +/- 1 mil for optimum performance

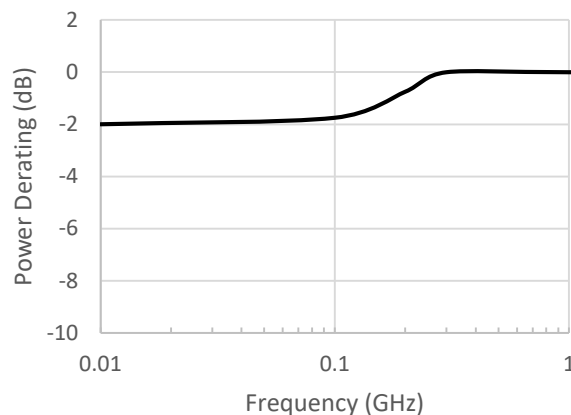
### Maximum Operating Conditions

| Parameter   | Maximum          |
|---|------------------|
| Input Power, 300 MHz to 44 GHz,<br>RFC Port <sup>6</sup><br>RF1 / RF2 / RF3 / RF4 Port <sup>6</sup> | 26 dBm<br>26 dBm |
| VDD   | -0.3 to +3.45 V  |
| VSS   | -3.45 to +0.3 V  |
| VC1 / VC2   | -0.3 to 3.45 V   |
| Operating Temperature <sup>7</sup>  | -40 to +105°C    |

6. T<sub>PADDLE</sub> = 105 °C. See power derating curves for details.

7. Guarantees 10 years lifetime.

### Low Frequency Power Derating Detail<sup>6</sup>



### Absolute Maximum Ratings<sup>8,9,10</sup>

| Parameter   | Absolute Maximum |
|---|------------------|
| Input Power, 300 MHz to 44 GHz,<br>RFC Port <sup>6</sup><br>RF1 / RF2 / RF3 / RF4 Port <sup>6</sup> | 27 dBm<br>27 dBm |
| VDD   | -0.3 to +3.6 V   |
| VSS   | -3.6 to +0.3 V   |
| VC1 / VC2   | -0.3 to 3.6 V    |
| Junction Temperature  | +135°C           |

8. Exceeding any one or combination of these limits may cause permanent damage to this device.

9. MACOM does not recommend sustained operation near these survivability limits.

10. Based on testing with input power applied for 30 seconds.

### Truth Table

| Control 1       | Control 2       | Condition of Switch |     |     |     |
|-----------------|-----------------|---------------------|-----|-----|-----|
|                 |                 | RF1                 | RF2 | RF3 | RF4 |
| V <sub>IL</sub> | V <sub>IL</sub> | On                  | Off | Off | Off |
| V <sub>IH</sub> | V <sub>IL</sub> | Off                 | On  | Off | Off |
| V <sub>IL</sub> | V <sub>IH</sub> | Off                 | Off | On  | Off |
| V <sub>IH</sub> | V <sub>IH</sub> | Off                 | Off | Off | On  |

### Handling Procedures

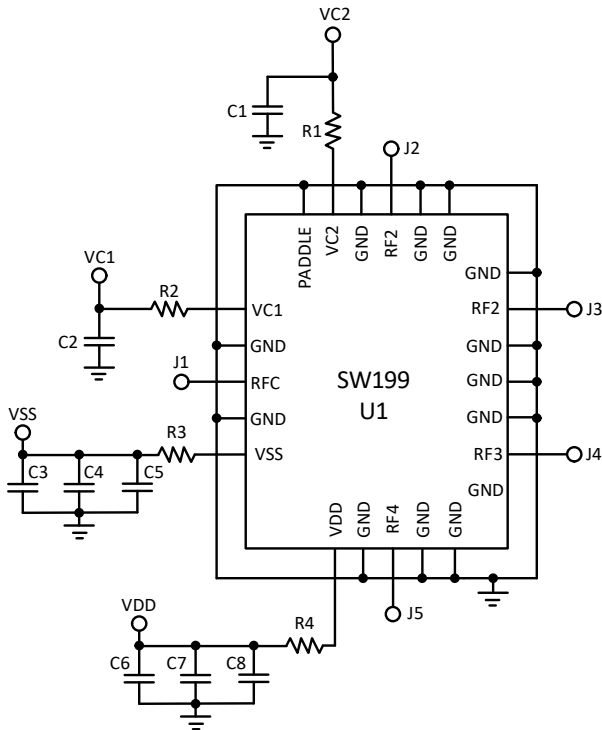
Please observe the following precautions to avoid damage:

### 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 devices.

| Parameter                  | Rating   | Standard          |
|----------------------------|----------|-------------------|
| Human Body Model (HBM)     | Class 1C | ESDA/JEDEC JS-001 |
| Charged Device Model (CDM) | Class C3 | ESDA/JEDEC JS-002 |

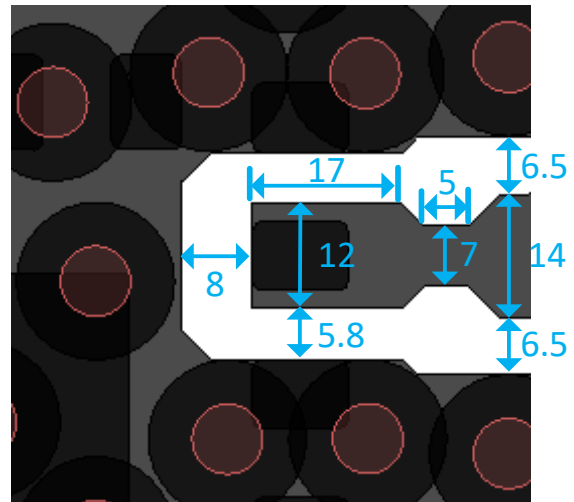
### Application Schematic



### Impedance Match

MASW-011199-SB1 is a 2-layer board with 8 mil Rogers RO4003 dielectric material and 1 oz copper on top and bottom layers. For this stack-up, 5 mil traces with 7 mil width are used for all RF port matching, as shown below.

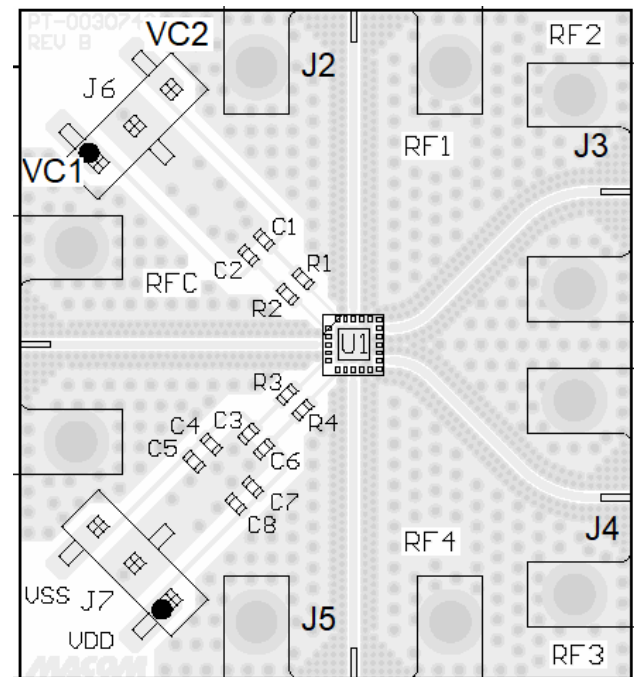
The 50Ω RF transmission lines are CPWG of 14 mil width with 6.5 mil gap.



### Parts List

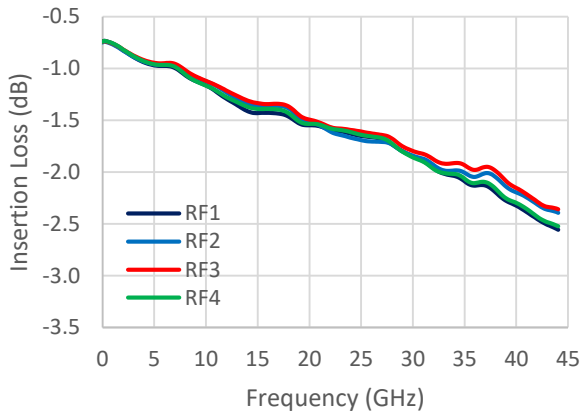
| Part    | Value                    | Case Style    |
|---------|--------------------------|---------------|
| U1      | MASW-011199              | 3 mm, 22 Lead |
| C1, C2  | Capacitor, 5 pF, 16 V    | 0402          |
| C3, C6  | Capacitor, 10 pF, 50 V   | 0402          |
| C4, C7  | Capacitor, 1000 pF, 25 V | 0402          |
| C5, C8  | Capacitor, 1 μF, 10 V    | 0402          |
| R1 - R4 | Resistor, 0 Ω            | 0402          |
| J1 - J5 | Southwest 1492-04A-5     | End Launch    |

### Evaluation Board Layout

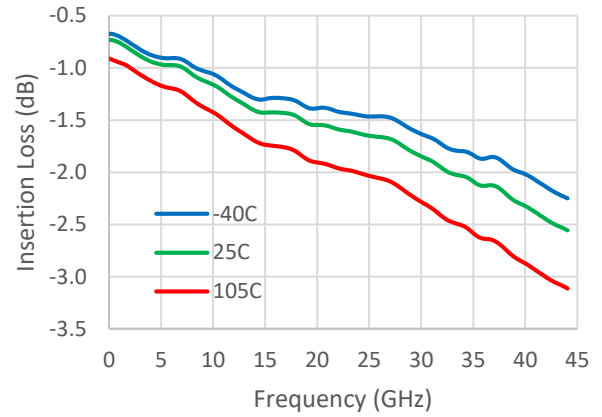


**Typical Performance Curves**

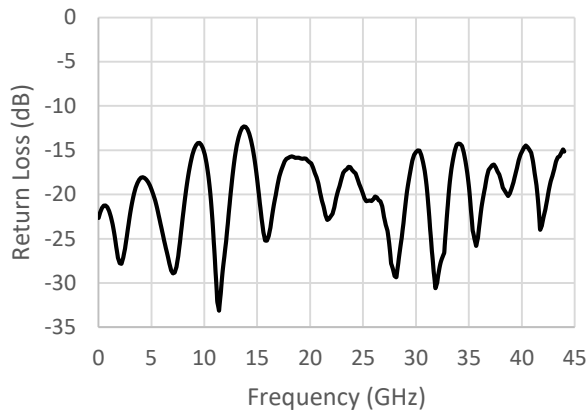
**Insertion Loss<sup>11</sup>**



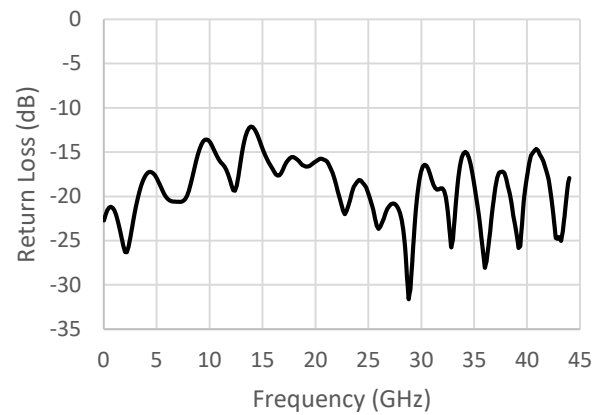
**Insertion Loss over Temperature<sup>11</sup>**



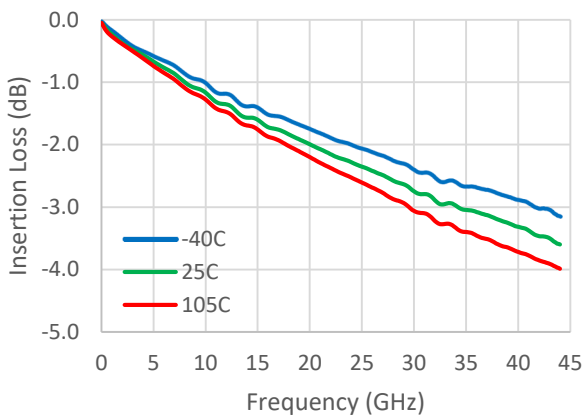
**RF1 Return Loss<sup>12</sup>**



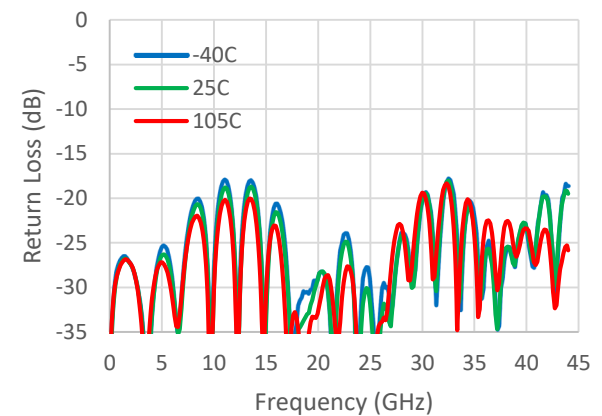
**RF1/RF2/RF3/RF4 Return Loss<sup>12</sup>**



**Evaluation Board Thru Line Insertion Loss**



**Evaluation Board Thru Line Return Loss**



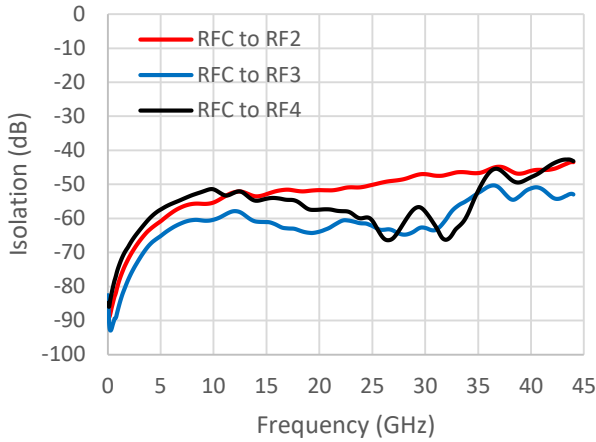
11. Insertion Loss and Isolation were measured using connectorized evaluation board with impedance match on RF transmission lines, and normalized using the insertion loss of the 50Ω thru line.

12. Return Loss with impedance match were measured using connectorized evaluation board with impedance match on RF transmission lines.

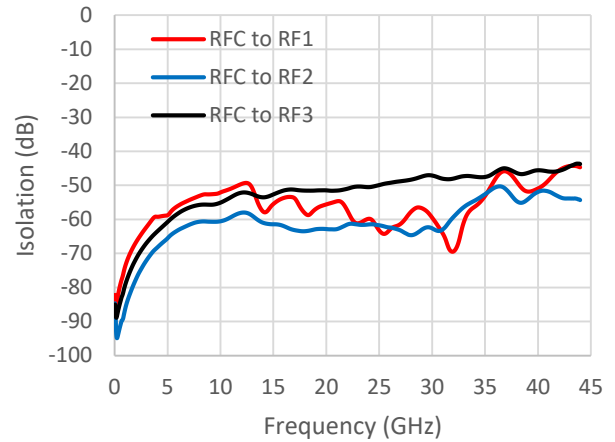
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**Typical Performance Curves**

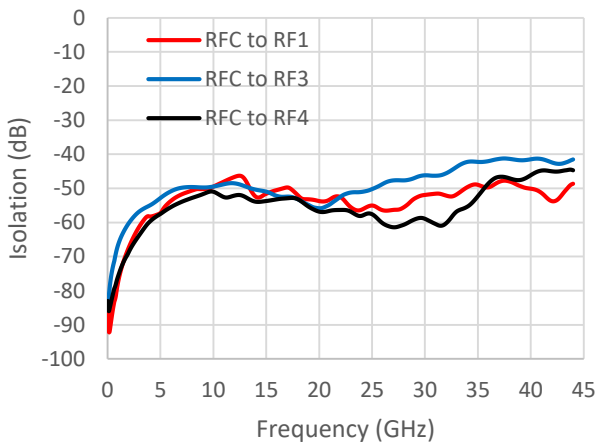
**RFC to RF2 / RF3 / RF4 Isolation, RFC to RF1 On<sup>11</sup>**



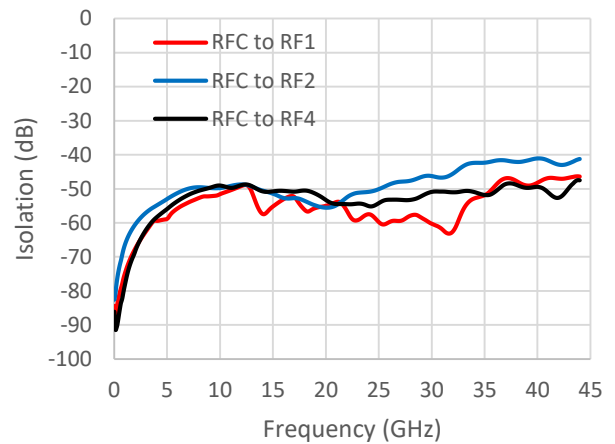
**RFC to RF1 / RF2 / RF3 Isolation, RFC to RF4 On<sup>11</sup>**



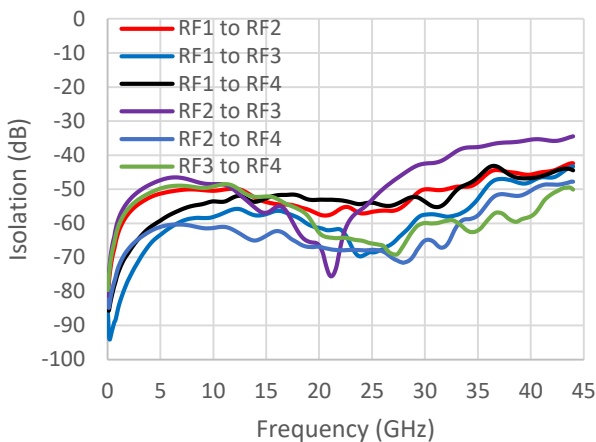
**RFC to RF1 / RF3 / RF4 Isolation, RFC to RF2 On<sup>11</sup>**



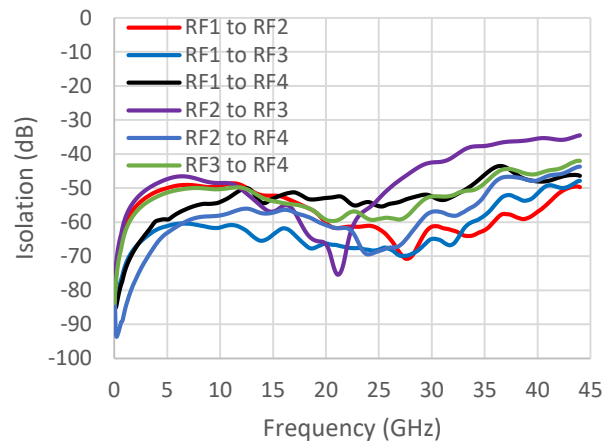
**RFC to RF1 / RF2 / RF4 Isolation, RFC to RF3 On<sup>11</sup>**



**Isolation between RF1 to RF4, RFC to RF1 On<sup>11</sup>**

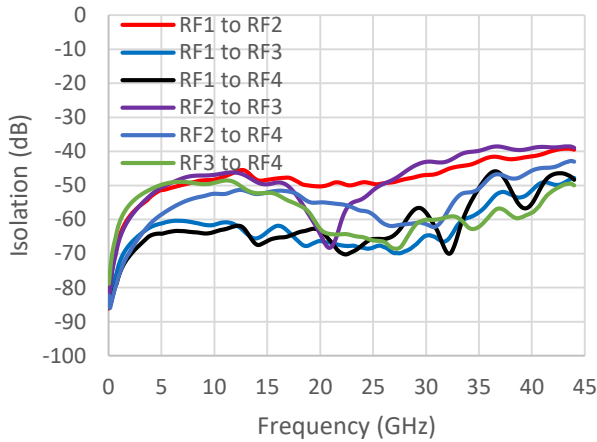


**Isolation between RF1 to RF4, RFC to RF4 On<sup>11</sup>**

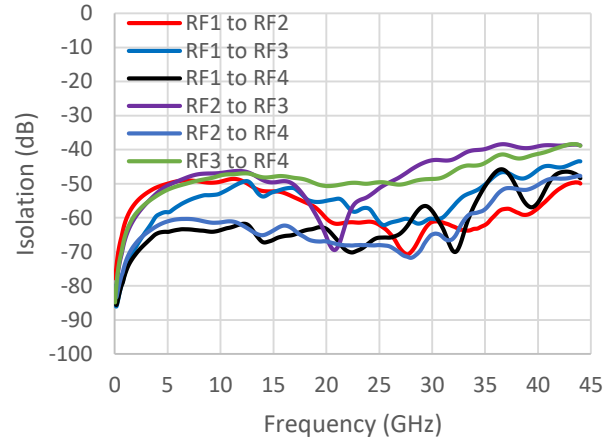


## Typical Performance Curves

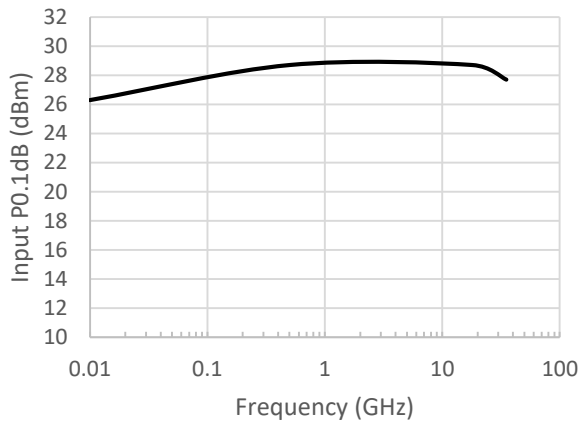
**Isolation between RF1 to RF4, RFC to RF2 On<sup>11</sup>**



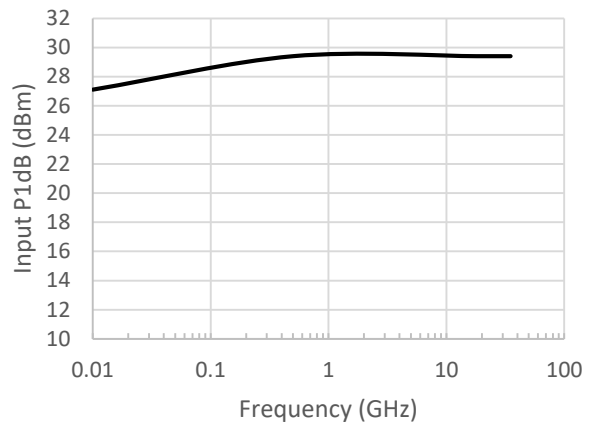
**Isolation between RF1 to RF4, RFC to RF3 On<sup>11</sup>**



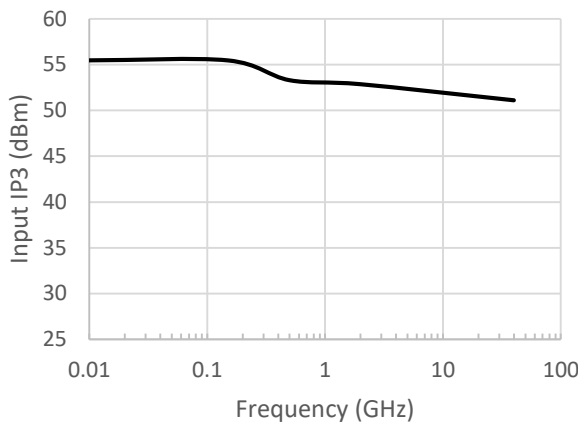
**Input P0.1dB**



**Input P1dB**



**Input IP3<sup>13</sup>**



13. Input IP3 were measured using connectorized evaluation board with impedance matching. The RF input power was 14 dBm per tone with spacing of 1 MHz.

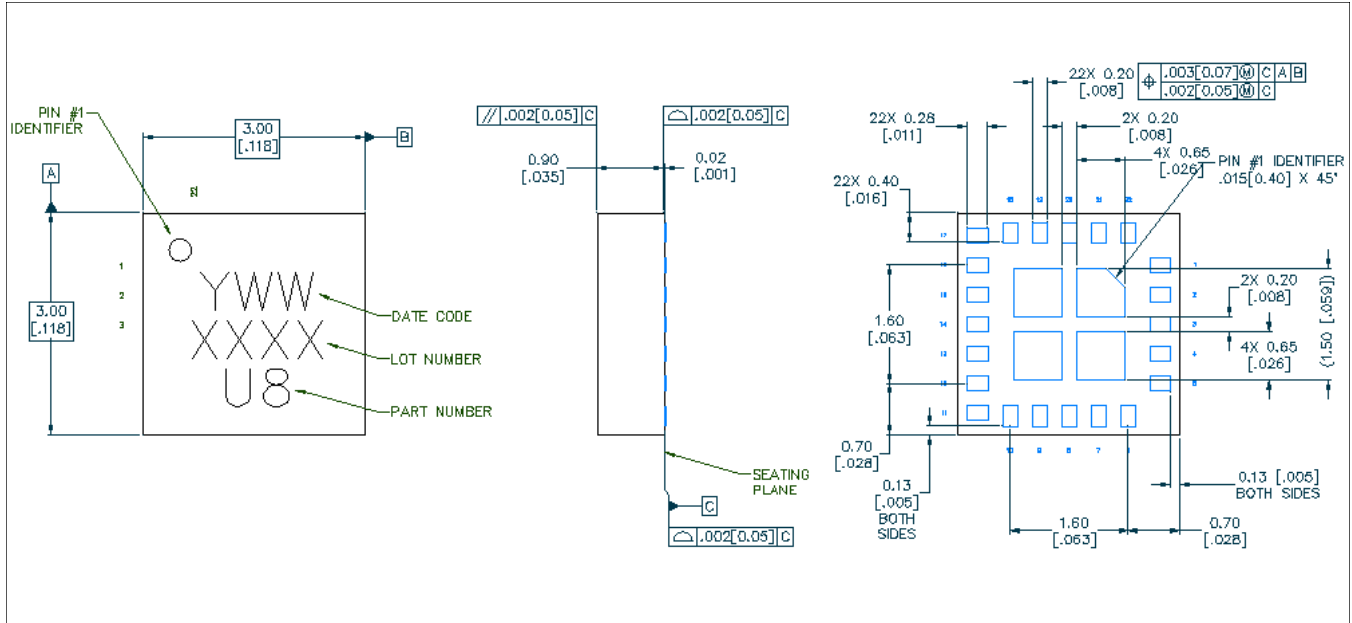
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Rev. V2

## Lead Free 3 x 3 mm 22-Lead Laminate Package †



† Reference Application Note S2083 for lead-free solder reflow recommendations.  
The part requires the use of "activated" flux.  
Meets JEDEC moisture sensitivity level 3 requirements.  
Plating is 100% matte tin over copper.