

Digital Phase Shifter 6-Bit, 1.4 - 2.4 GHz

Rev. V1

Features

- 6 Bit Digital Phase Shifter
- 360° Coverage with LSB = 5.6°
- Low DC Power Consumption
- Minimal Attenuation Variation over Phase Shift Range
- 50 Ω Impedance
- EAR99
- RoHS* Compliant

Description

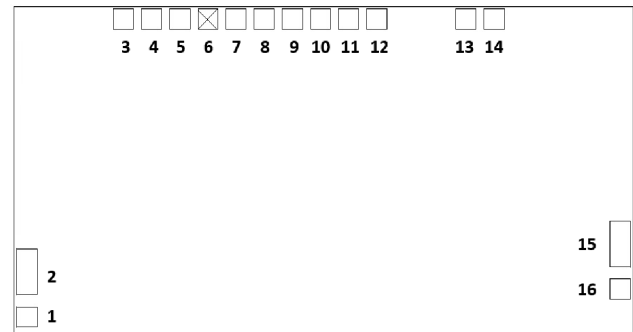
The MAPS-010163-DIE is a GaAs pHEMT 6-bit digital phase shifter. Step size is 5.6° providing phase shift from 0° to 360° in 5.6° steps. This design has been optimized to minimize variation in attenuation over the phase shift range.

The MAPS-010163-DIE is ideally suited for use where high phase accuracy with minimum loss variation over the phase shift range are required. Typical applications include communications antennas and phased array radars.

Ordering Information

| Part Number | Package |
|-----------------|------------------|
| MAPS-010163-DIE | 50 piece Gel Pak |

Functional Schematic



Pad Configuration¹

| Pad # | Name | Function |
|-------|-------------------|---------------|
| 1, 16 | GND | Ground |
| 2 | RF _{IN} | RF Input |
| 3 | A1 | 5.6° Control |
| 4 | B1 | 5.6° Control |
| 5 | A2 | 11.2° Control |
| 6 | N/C | No Connect |
| 7 | A3 | 22.5° Control |
| 8 | B3 | 22.5° Control |
| 9 | A4 | 45° Control |
| 10 | B4 | 45° Control |
| 11 | A5 | 90° Control |
| 12 | B5 | 90° Control |
| 13 | A6 | 180° Control |
| 14 | B6 | 180° Control |
| 15 | RF _{OUT} | RF Output |

1. The backside of the die must be connected to RF, DC, and thermal ground.

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

Electrical Specifications: Freq. = 1.4 - 2.4 GHz, T_A = 25°C, Z₀ = 50 Ω

| Parameter | Test Conditions | Units | Min. | Typ. | Max. |
|--|---|-------|------|---|------------|
| Insertion Loss | Any Phase State 1.4 GHz 2.4 GHz | dB | — | 3.8 4.5 | 5.5 6.0 |
| Attenuation Variation | Across All Phase States | dB | — | ± 0.8 | — |
| RMS Attenuation Error ² | All Values Relative to Insertion Loss at Reference Phase | dB | — | 0.4 | — |
| RMS Phase Error ² | All Values Relative to Reference Phase | deg. | — | 3 | — |
| Phase Relative to Reference Loss State | 5.6° Bit 11.2° Bit 22.5° Bit 45° Bit 90° Bit 180° Bit Sum of All Bits | deg. | — | 6.3 11.5 22 45 90 180 355 | — |
| VSWR | RF IN RF OUT | Ratio | — | 1.5:1 1.5:1 | — |
| 1 dB Compression | Reference State | dBm | — | 25 | — |
| Input IP3 | Two-tone inputs up to 5 dBm | dBm | — | 45 | — |
| T _{RISE} , T _{FALL} | 10% to 90% RF, 90% to 10% RF | ns | — | 50 | — |
| V _L V _H | LOW-level input voltage HIGH-level input voltage | V | — | -5 0 | — |

2. RMS is calculated across all 63 amplitude or phase states relative to the amplitude or phase in the 0° phase state at a given frequency.

Truth Table³

| A1 | B1 | A2 | A3 | B3 | A4 | B4 | A5 | B5 | A6 | B6 | Phase Shift |
|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|-----------------|
| V _L | V _H | V _L | V _L | V _H | V _L | V _H | V _L | V _H | V _L | V _H | Reference Phase |
| V _H | V _L | V _L | V _L | V _H | V _L | V _H | V _L | V _H | V _L | V _H | 5.6° |
| V _L | V _H | V _H | V _L | V _H | V _L | V _H | V _L | V _H | V _L | V _H | 11.2° |
| V _L | V _H | V _L | V _H | V _L | V _L | V _H | V _L | V _H | V _L | V _H | 22.5° |
| V _L | V _H | V _L | V _L | V _H | V _H | V _L | V _L | V _H | V _L | V _H | 45° |
| V _L | V _H | V _L | V _L | V _H | V _L | V _H | V _H | V _L | V _L | V _H | 90° |
| V _L | V _H | V _L | V _L | V _H | V _L | V _H | V _L | V _H | V _H | V _L | 180° |
| V _H | V _L | V _H | V _H | V _L | V _H | V _L | V _H | V _L | V _H | V _L | 354.4° |

3. V_L = -5 V, V_H = 0 V.

Absolute Maximum Ratings^{4,5}

| Parameter | Absolute Maximum |
|------------------------------|------------------|
| Input Power 1.4 - 2.4 GHz | 27 dBm |
| 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.

Handling Procedures

Please observe the following precautions to avoid damage:

Static Sensitivity

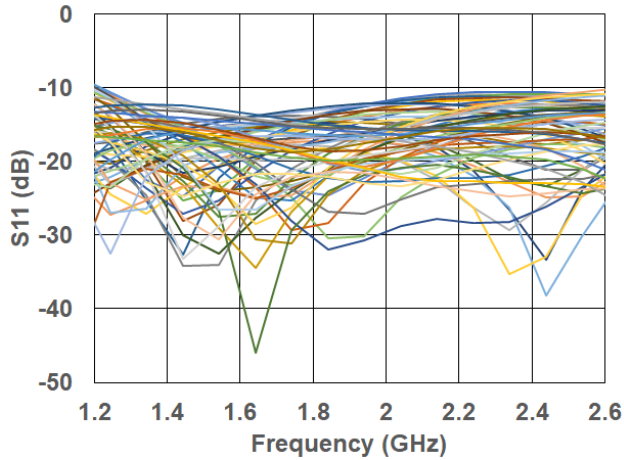
These electronic devices are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these devices.

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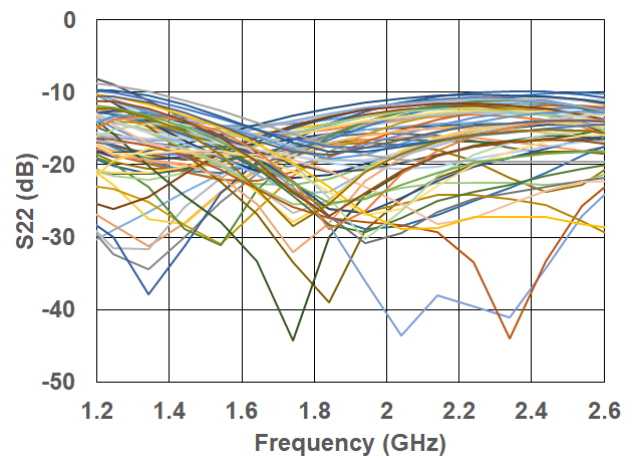
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Typical Performance Curves

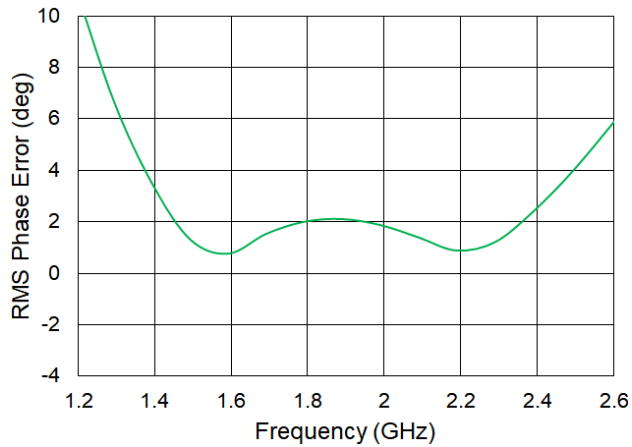
RF_{IN} Return Loss vs. Frequency (All States)



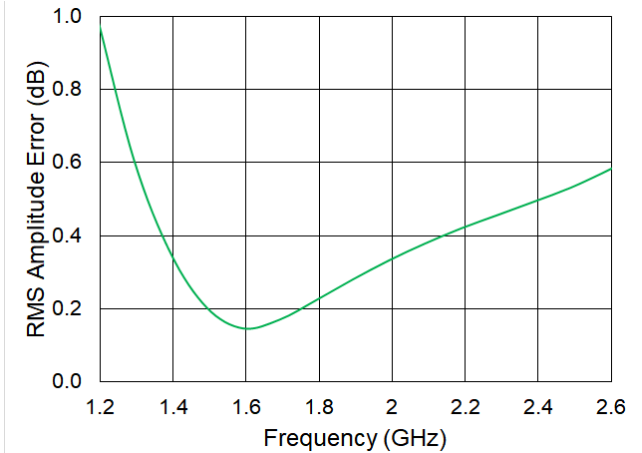
RF_{OUT} Return Loss vs. Frequency (All States)



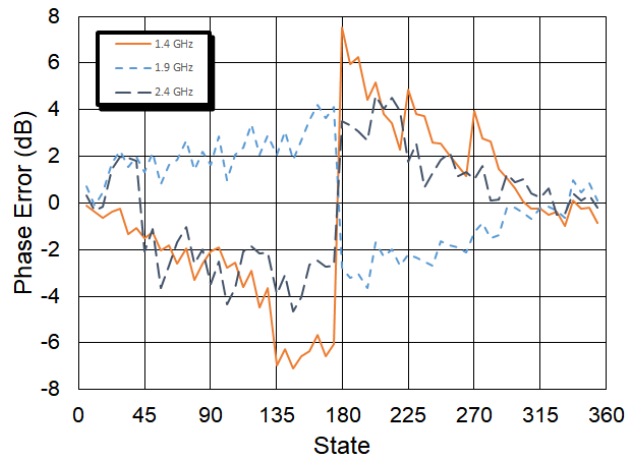
Mean RMS Phase Error vs. Frequency



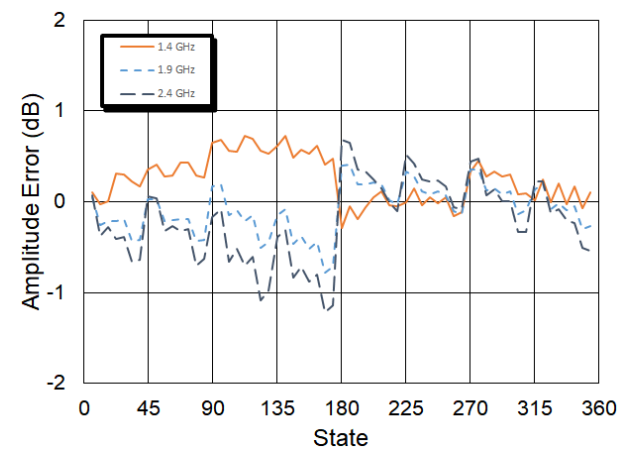
Mean RMS Amplitude Error vs. Frequency



Phase Error vs. State

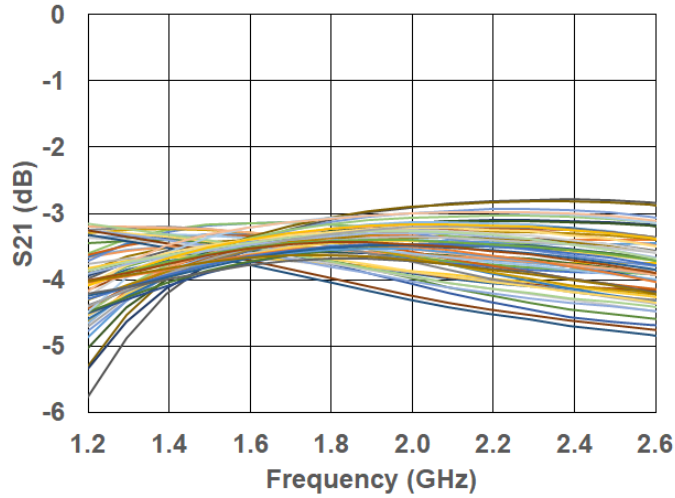


Amplitude Error vs. State

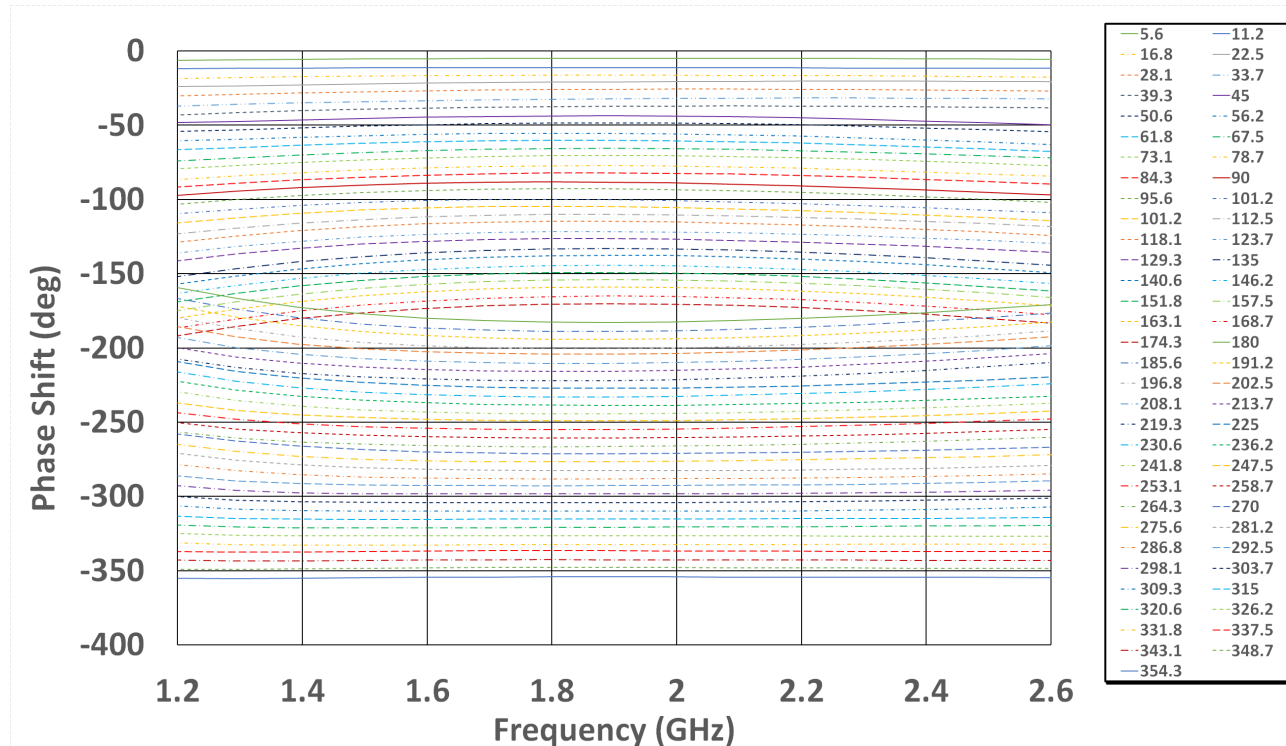


Typical Performance Curves

Amplitude Variation vs. Phase State



Phase Shift vs. Frequency (All States)



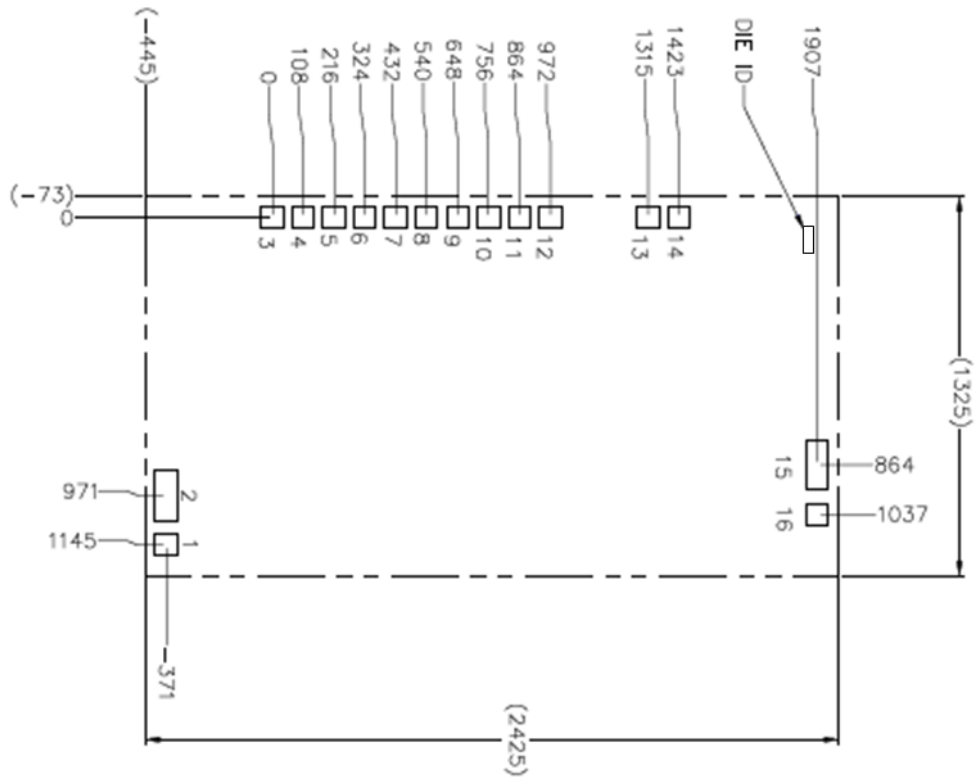
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Outline Drawing ^{6,7,8,9}



6. Unless otherwise specified, all dimensions are μm with a tolerance of $\pm 5 \mu\text{m}$.
7. Die thickness is $100 \pm 10 \mu\text{m}$.
8. Bond pad/backside metallization: Gold.
9. Die size reflects uncut dimensions. Saw or laser kerf reduces die size by $\sim 25 \mu\text{m}$ each dimension.

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