

## Features

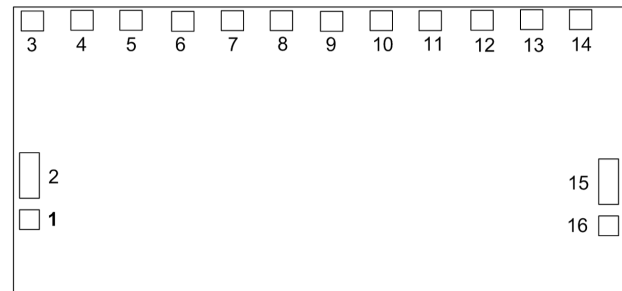
- 6 Bit Digital Phase Shifter
- 360° Coverage with LSB = 5.6°
- Low DC Power Consumption
- Minimal Attenuation Variation over Phase Shift Range
- 50 Ω Impedance
- EAR99
- RoHS\* Compliant

## Description

The MAPS-010165-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-010165-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.

## Functional Schematic



## Pad Configuration<sup>1</sup>

Pad #	Name	Function
1, 16	GND	Ground
2	RF <sub>IN</sub>	RF Input
3	A1	5.6° Control
4	B1	5.6° Control
5	A2	11.2° Control
6	B2	11.2° Control
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 <sub>OUT</sub>	RF Output

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

## Ordering Information

Part Number	Package
MAPS-010165-DIE	50 piece Gel Pak

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

**Electrical Specifications: Freq. = 3.5 - 6.0 GHz, T<sub>A</sub> = 25°C, Z<sub>0</sub> = 50 Ω**

Parameter	Test Conditions	Units	Min.	Typ.	Max.
Insertion Loss	Any Phase State 3.5 GHz 6.0 GHz	dB	—	4.9 5.8	6.5 7.0
Attenuation Variation	Across All Phase States	dB	—	± 0.8	—
RMS Attenuation Error <sup>2</sup>	All Values Relative to Insertion Loss at Reference Phase	dB	—	0.4	—
RMS Phase Error <sup>2</sup>	All Values Relative to Reference Phase	deg.	—	4	—
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.	—	4.7 10.5 23 42.5 90 182 352	—
VSWR	RF IN RF OUT	Ratio	—	1.5:1 1.5:1	—
1 dB Compression	Reference State	dBm	—	27	—
Input IP3	Two-tone inputs up to 5 dBm	dBm	—	40	—
T <sub>RISE</sub> , T <sub>FALL</sub>	10% to 90% RF, 90% to 10% RF	ns	—	50	—
V <sub>L</sub> V <sub>H</sub>	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 Table<sup>3</sup>

A1	B1	A2	B2	A3	B3	A4	B4	A5	B5	A6	B6	Phase Shift
V <sub>L</sub>	V <sub>H</sub>	V <sub>L</sub>	V <sub>H</sub>	V <sub>L</sub>	V <sub>H</sub>	V <sub>L</sub>	V <sub>H</sub>	V <sub>L</sub>	V <sub>H</sub>	V <sub>L</sub>	V <sub>H</sub>	Reference Phase
V <sub>H</sub>	V <sub>L</sub>	V <sub>L</sub>	V <sub>H</sub>	V <sub>L</sub>	V <sub>H</sub>	V <sub>L</sub>	V <sub>H</sub>	V <sub>L</sub>	V <sub>H</sub>	V <sub>L</sub>	V <sub>H</sub>	5.6°
V <sub>L</sub>	V <sub>H</sub>	V <sub>H</sub>	V <sub>L</sub>	V <sub>L</sub>	V <sub>H</sub>	V <sub>L</sub>	V <sub>H</sub>	V <sub>L</sub>	V <sub>H</sub>	V <sub>L</sub>	V <sub>H</sub>	11.2°
V <sub>L</sub>	V <sub>H</sub>	V <sub>L</sub>	V <sub>H</sub>	V <sub>H</sub>	V <sub>L</sub>	V <sub>L</sub>	V <sub>H</sub>	V <sub>L</sub>	V <sub>H</sub>	V <sub>L</sub>	V <sub>H</sub>	22.5°
V <sub>L</sub>	V <sub>H</sub>	V <sub>L</sub>	V <sub>H</sub>	V <sub>L</sub>	V <sub>H</sub>	V <sub>H</sub>	V <sub>L</sub>	V <sub>L</sub>	V <sub>H</sub>	V <sub>L</sub>	V <sub>H</sub>	45°
V <sub>L</sub>	V <sub>H</sub>	V <sub>L</sub>	V <sub>H</sub>	V <sub>L</sub>	V <sub>H</sub>	V <sub>L</sub>	V <sub>H</sub>	V <sub>H</sub>	V <sub>L</sub>	V <sub>L</sub>	V <sub>H</sub>	90°
V <sub>L</sub>	V <sub>H</sub>	V <sub>L</sub>	V <sub>H</sub>	V <sub>L</sub>	V <sub>H</sub>	V <sub>L</sub>	V <sub>H</sub>	V <sub>L</sub>	V <sub>H</sub>	V <sub>H</sub>	V <sub>L</sub>	180°
V <sub>H</sub>	V <sub>L</sub>	V <sub>H</sub>	V <sub>L</sub>	V <sub>H</sub>	V <sub>L</sub>	V <sub>H</sub>	V <sub>L</sub>	V <sub>H</sub>	V <sub>L</sub>	V <sub>H</sub>	V <sub>L</sub>	354.4°

3. V<sub>L</sub> = -5 V, V<sub>H</sub> = 0 V.

## Absolute Maximum Ratings<sup>4,5</sup>

Parameter	Absolute Maximum
Input Power 3.5 - 6.0 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

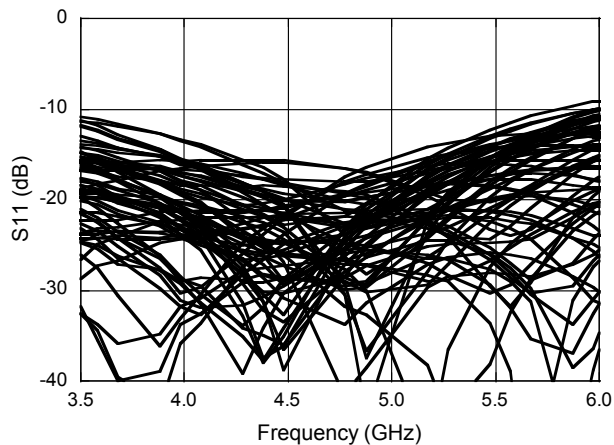
Please observe the following precautions to avoid damage:

### Static Sensitivity

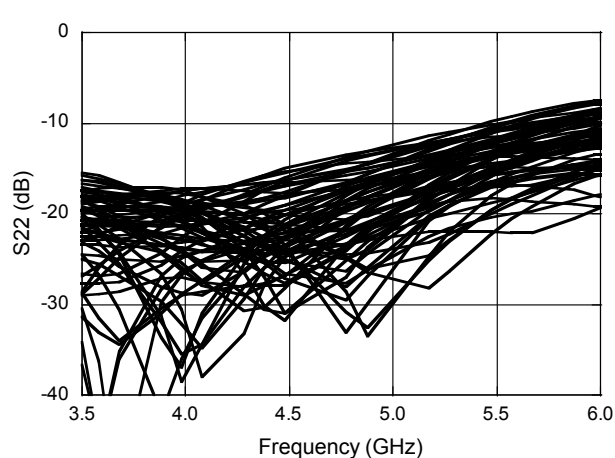
These electronic devices are sensitive to electrostatic discharge (ESD) and can be damaged by static electricity. Proper ESD control techniques should be used when handling these devices.

## Typical Performance Curves

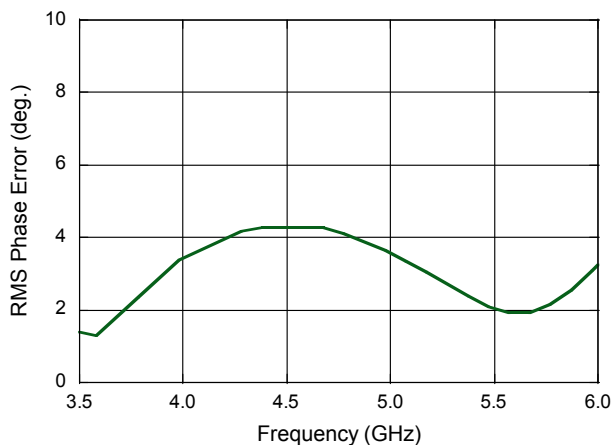
**$RF_{IN}$  Return Loss vs. Frequency (All States)**



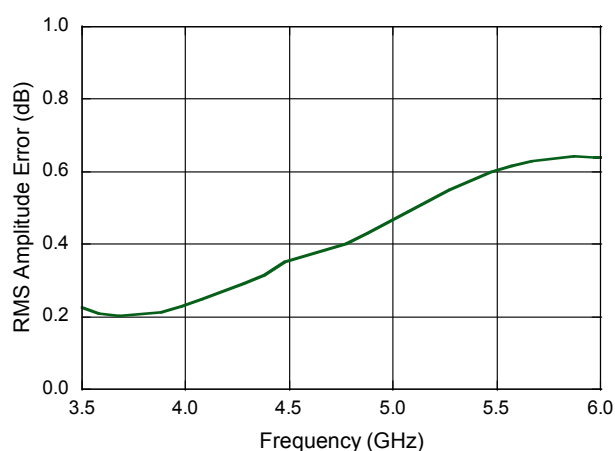
**$RF_{OUT}$  Return Loss vs. Frequency (All States)**



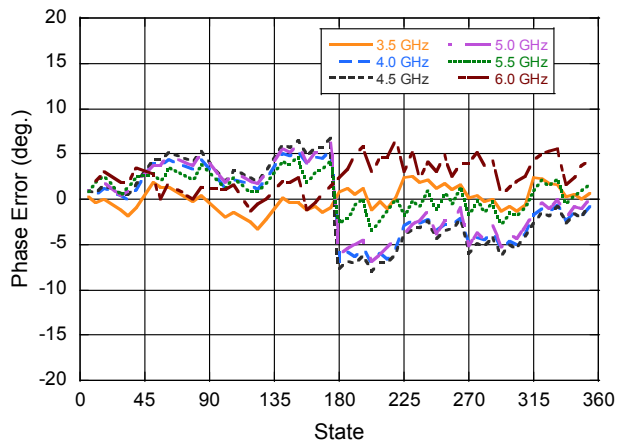
**Mean RMS Phase Error vs. Frequency**



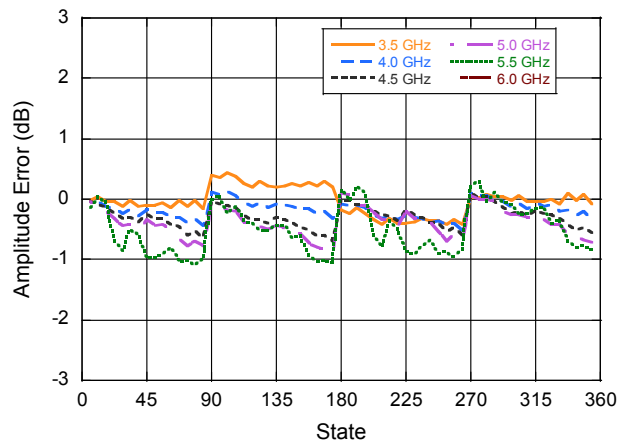
**Mean RMS Amplitude Error vs. Frequency**



**Phase Error vs. State**

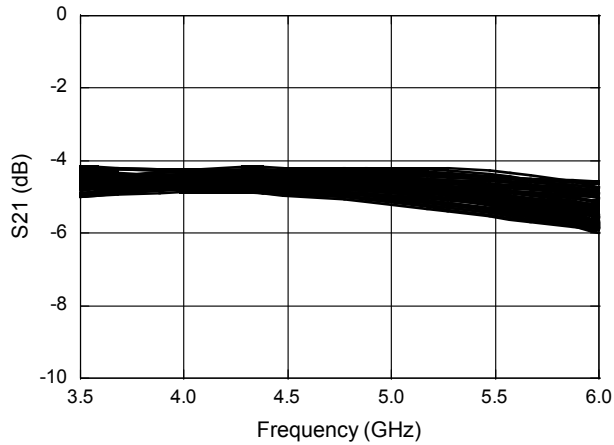


**Amplitude Error vs. State**

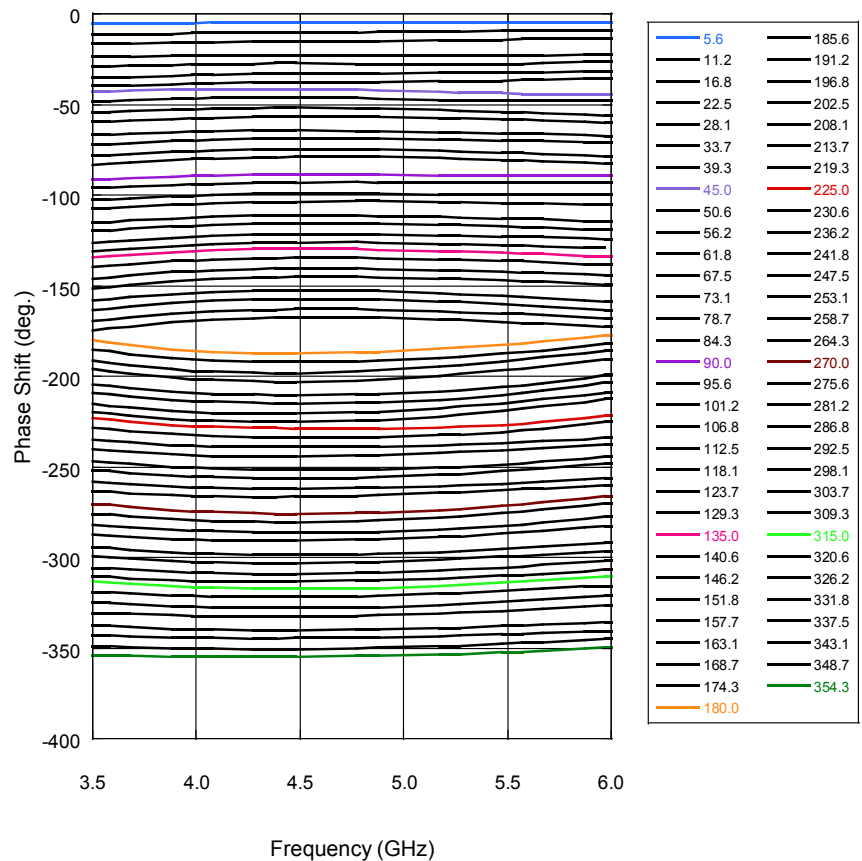


## Typical Performance Curves

*Amplitude Variation vs. Phase State*



*Phase Shift vs. Frequency (All States)*



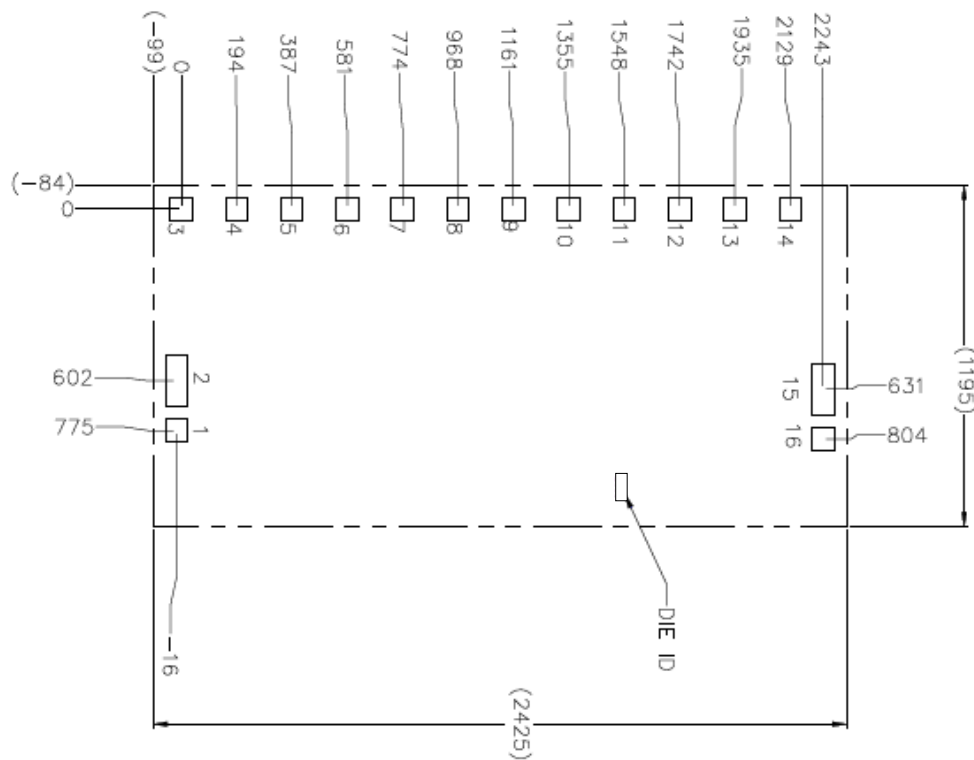
# MAPS-010165-DIE



Digital Phase Shifter  
6-Bit, 3.5 - 6.0 GHz

Rev. V1

## Outline Drawing <sup>6,7,8,9</sup>



- 6. Unless otherwise specified, all dimensions are  $\mu\text{m}$  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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