



GaAs MMIC 6-BIT DIGITAL PHASE SHIFTER, 3 - 6 GHz

Typical Applications

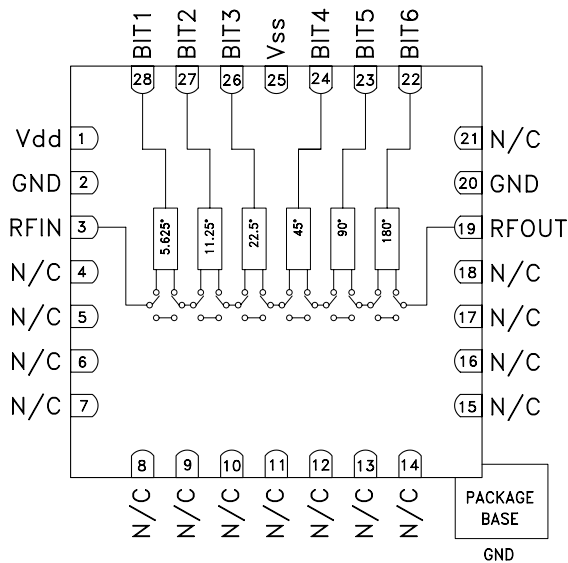
The HMC649ALP6E is ideal for:

- EW Receivers
- Weather & Military Radar
- Satellite Communications
- Beamforming Modules
- Phase Cancellation

Features

- Low RMS Phase Error: 4°
- Low Insertion Loss: 8 dB
- High Linearity: +40 dBm
- Positive Control Logic
- 360° Coverage, LSB = 5.625°
- 28 Lead QFN Leadless SMT Package: 36mm²

Functional Diagram



General Description

The HMC649ALP6E is a 6-bit digital phase shifter which is rated from 3 to 6 GHz, providing 360 degrees of phase coverage, with a LSB of 5.625 degrees. The HMC649ALP6E features very low RMS phase error of 4 degrees and extremely low insertion loss variation of ± 0.5 dB across all phase states. This high accuracy phase shifter is controlled with positive control logic of 0/+5V. The HMC649ALP6E is housed in a compact 6x6 mm plastic leadless SMT package and is internally matched to 50 Ohms with no external components.

Electrical Specifications

$T_A = +25^\circ\text{C}$, $V_{SS} = -5\text{V}$, $V_{DD} = +5\text{V}$, control Voltage = 0/ +5V, 50 Ohm System

Parameter	Min.	Typ.	Max.	Units
Frequency Range	3		6	GHz
Insertion Loss*		8	10.5	dB
Input Return Loss*		13		dB
Output Return Loss*		10		dB
Phase Error*	3.0 - 5.5 GHz 5.5 - 6.0 GHz	± 5 -10	+15 / -25 +15 / -32	deg
RMS Phase Error		4		deg
Insertion Loss Variation*		± 0.5		dB
Input Power for 1 dB Compression		31		dBm
Input Third Order Intercept		40		dBm
Control Voltage Current		35	250	μA
Bias Control Current		5	15	mA

*Note: Major States Only

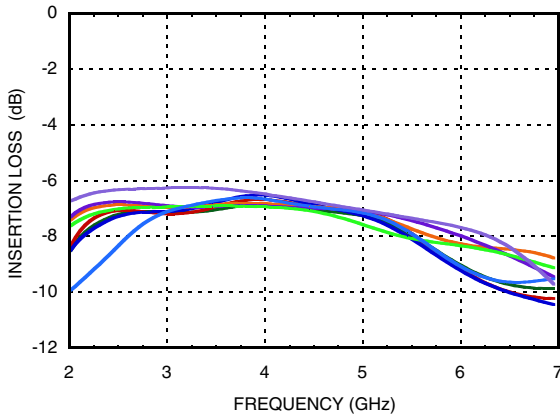
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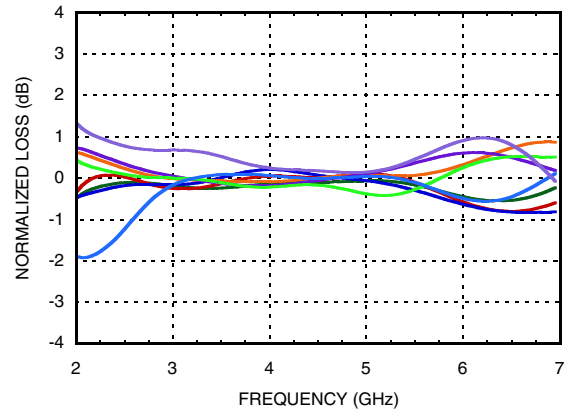


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PHASE SHIFTER, 3 - 6 GHz**

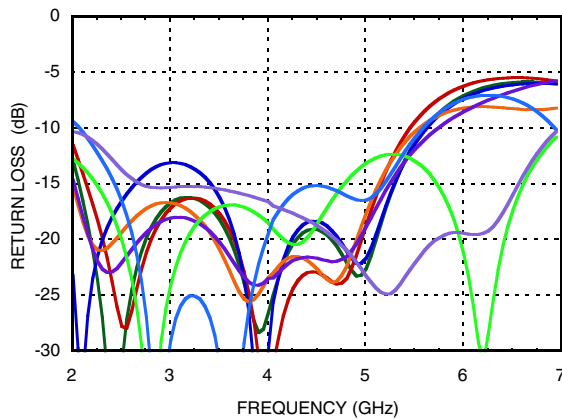
Insertion Loss, Major States Only



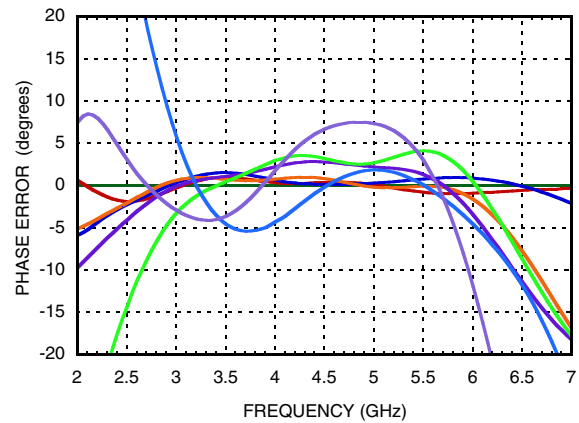
Normalized Loss, Major States Only



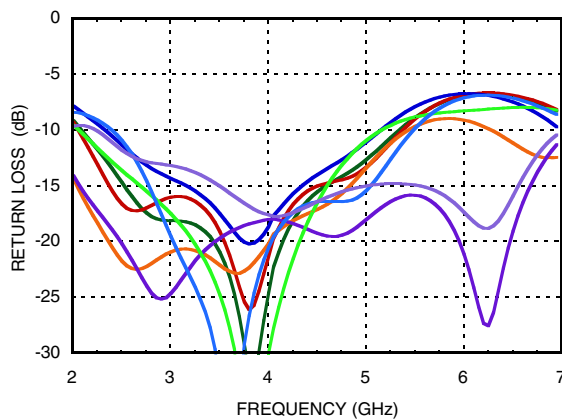
Input Return Loss, Major States Only



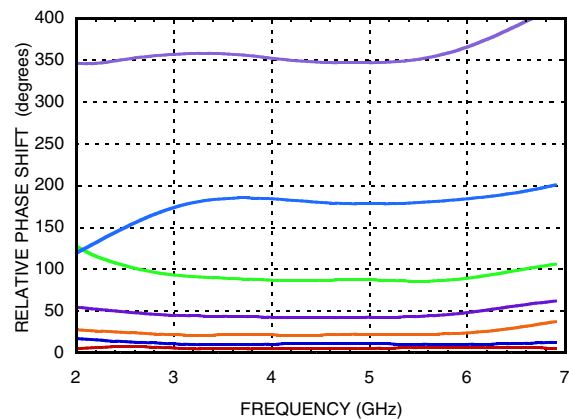
Phase Error, Major States Only



Output Return Loss, Major States Only



**Relative Phase Shift
Major States Including All Bits**



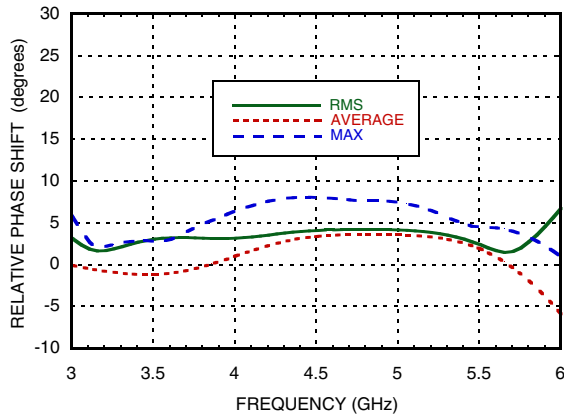
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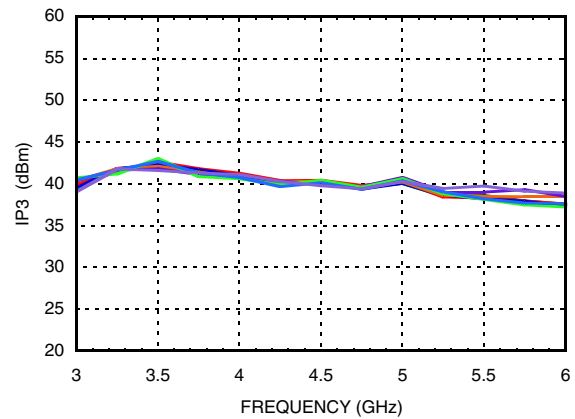


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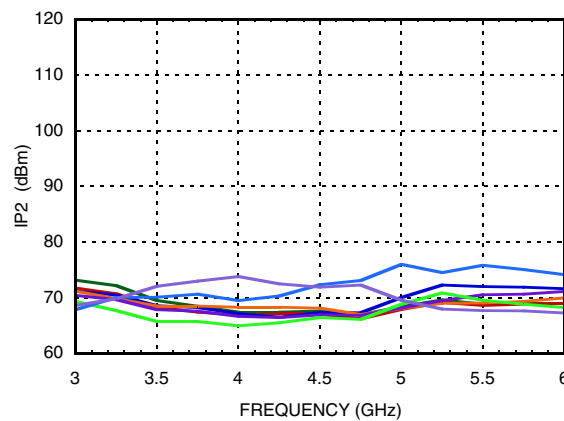
**Relative Phase Shift,
RMS, Average, Max, All States**



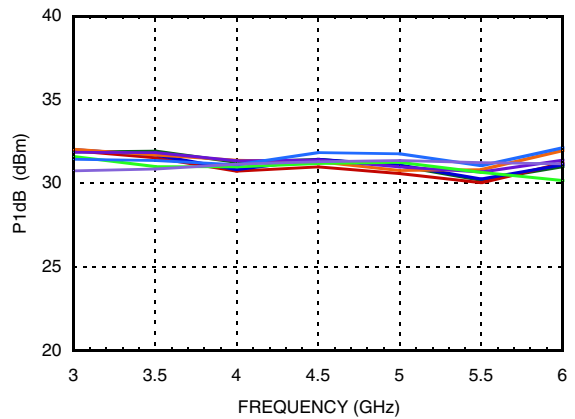
Input IP3, Major States Only



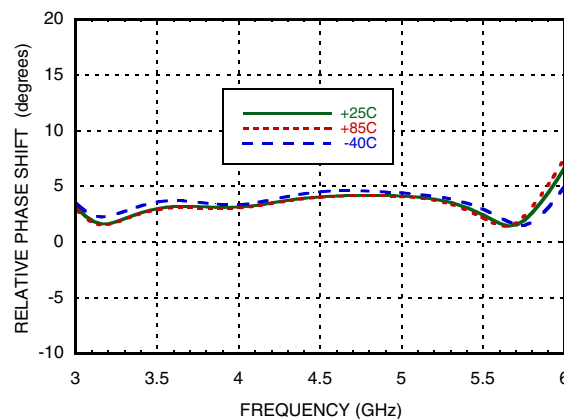
Input IP2, Major States Only



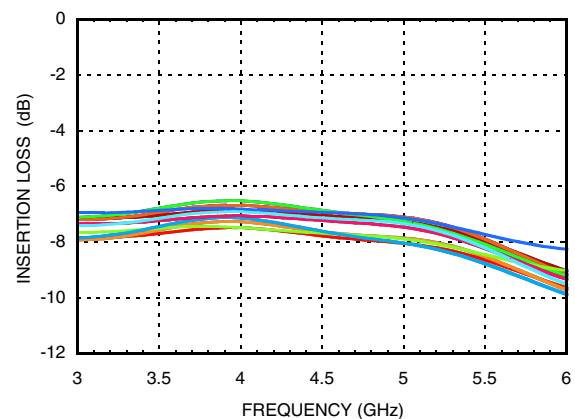
Input P1dB, Major States Only



RMS Phase Error vs. Temperature

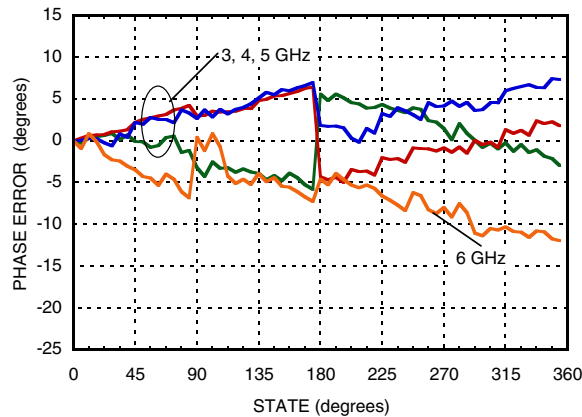


**Insertion Loss vs. Temperature,
Major States Only**



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Phase Error vs. State

Bias Voltage & Current

Vdd	Idd
5.0	5.4mA
Vss	Iss
-5.0	5.4mA

Control Voltage

State	Bias Condition
Low (0)	0 to 0.2 Vdc
High (1)	Vdd ±0.2 Vdc @ 35 µA Typ.

Absolute Maximum Ratings

Input Power (RFIN)	32 dBm (T= +85 °C)
Bias Voltage Range (Vdd)	-0.2 to +12V
Bias Voltage Range (Vss)	+0.2 to -12V
Channel Temperature (Tc)	150 °C
Thermal Resistance (channel to ground paddle)	200 °C/W
Storage Temperature	-65 to +150 °C
Operating Temperature	-40 to +85 °C
ESD Sensitivity (HBM)	Class1A (Passed 250V)


**ELECTROSTATIC SENSITIVE DEVICE
OBSERVE HANDLING PRECAUTIONS**
Truth Table

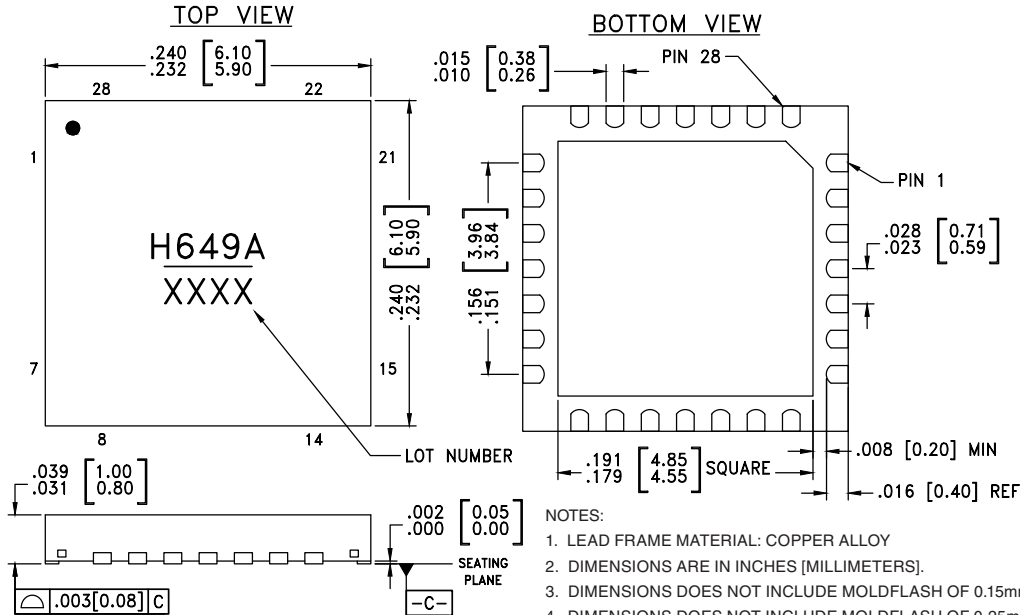
Control Voltage Input						Phase Shift (Degrees) RFIN - RFOUT
Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	
0	0	0	0	0	0	Reference*
1	0	0	0	0	0	5.625
0	1	0	0	0	0	11.25
0	0	1	0	0	0	22.5
0	0	0	1	0	0	45.0
0	0	0	0	1	0	90.0
0	0	0	0	0	1	180.0
1	1	1	1	1	1	354.375

Any combination of the above states will provide a phase shift approximately equal to the sum of the bits selected.
*Reference corresponds to monotonic setting



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Outline Drawing



Package Information

Part Number	Package Body Material	Lead Finish	MSL Rating	Package Marking ^[2]
HMC649ALP6E	RoHS-compliant Low Stress Injection Molded Plastic	100% matte Sn	MSL3 ^[1]	H649A XXXX

[1] Max peak reflow temperature of 260 °C

[2] 4-Digit lot number XXXX

Pin Descriptions

Pin Number	Function	Description	Interface Schematic
1	Vdd	Voltage Supply	
2, 20	GND	These pins and exposed ground paddle must be connected to RF/DC ground.	
3	RFIN	This port is DC coupled and matched to 50 Ohms.	
4 - 18, 21	N/C	No connection required. These pins may be connected to RF/DC ground without affecting performance.	
19	RFOUT	This port is DC coupled and matched to 50 Ohms.	
22 - 24 26 - 28	BIT6, BIT5, BIT4, BIT3, BIT2, BIT1	Control Input. See truth table and control voltage tables.	
25	Vss	Voltage Supply	