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Typical Applications

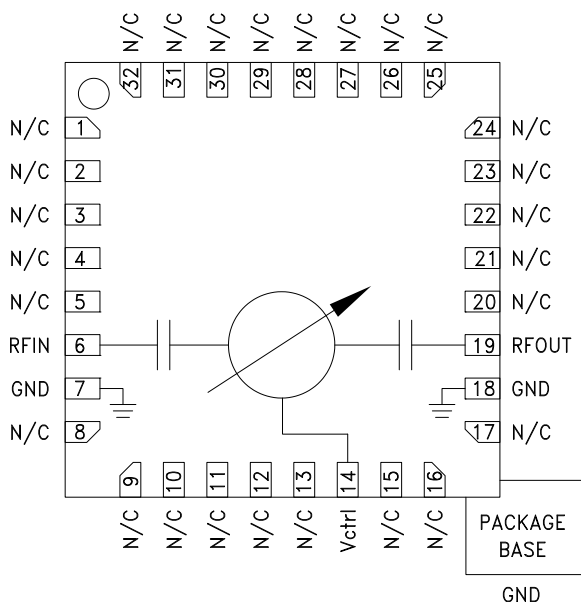
The HMC928LP5E is ideal for:

- EW Receivers
- Military Radar
- Test Equipment
- Satellite Communications
- Beamforming Modules

Features

- Octave Bandwidth: 2 - 4 GHz
- 450° Phase Shift
- Low Insertion Loss: 3.5 dB
- Low Phase Error: ± 5 Typical
- Single Positive Voltage Control
- 32 Lead 5x5 mm SMT Package: 25 mm²

Functional Diagram



General Description

The HMC928LP5E is an Analog Phase Shifter which is controlled via an analog control voltage from 0 to +13V. The HMC928LP5E provides a continuously variable phase shift of 0 to 450 degrees from 2 to 4 GHz, with extremely consistent low insertion loss versus phase shift and frequency. The high accuracy HMC928LP5E is monotonic with respect to control voltage and features a typical low phase error of ± 5 degrees over an octave bandwidth. The HMC928LP5E is housed in an RoHS compliant 5x5 mm QFN leadless package.

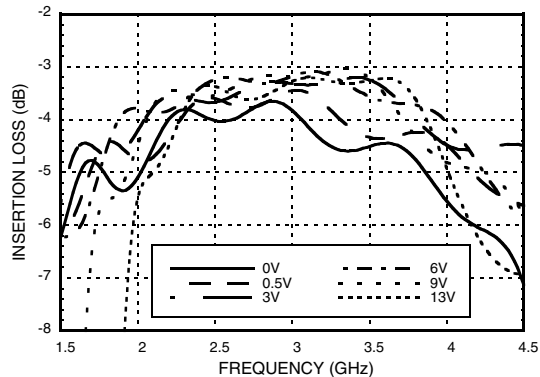
Electrical Specifications, $T_A = +25^\circ\text{C}$, 50 Ohm System

Parameter	Frequency (GHz)	Min.	Typ.	Max.	Units
Phase Shift Range	2 - 4 GHz		450		deg
Insertion Loss	2 - 4 GHz		3.5		dB
Return Loss (Input & Output)	2 - 4 GHz		15		dB
Control Voltage Range	2 - 4 GHz	0		13	V
Control Current Range	2 - 4 GHz			± 1.0	mA
Maximum Input Power for Linear Operation	2 - 4 GHz			10	dBm
Phase Voltage Sensitivity	2 - 4 GHz		35		deg/V
Phase Error *	2 - 4 GHz		± 5		deg
Phase Error (average)	2 - 4 GHz		3		deg
Modulation Bandwidth	2 - 4 GHz		20		MHz
Insertion Phase Temperature Sensitivity	2 - 4 GHz		0.10		deg/ $^\circ\text{C}$

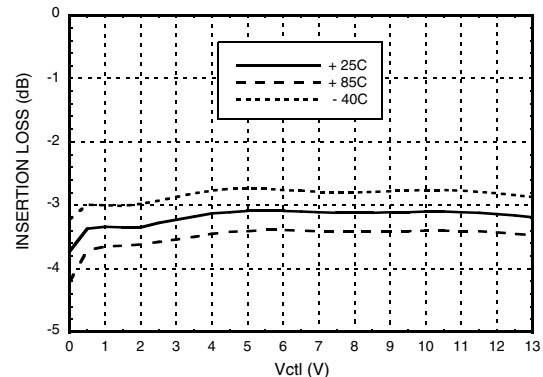
* Up to a phase shift range of 400 degrees.

450° ANALOG PHASE SHIFTER, 2 - 4 GHz

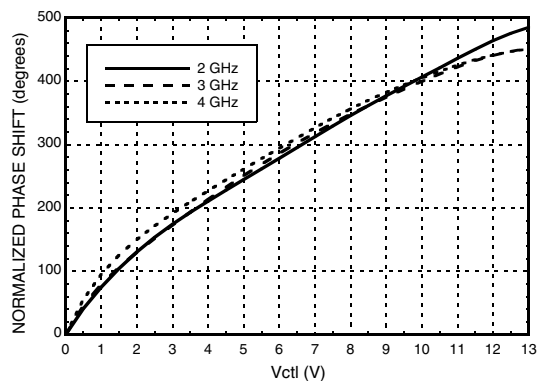
Insertion Loss vs. Frequency



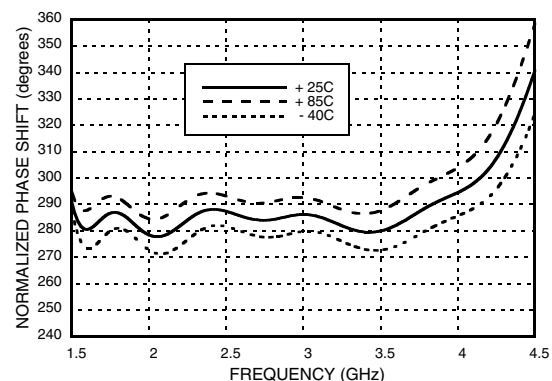
Insertion Loss vs. Vctl, F = 3 GHz



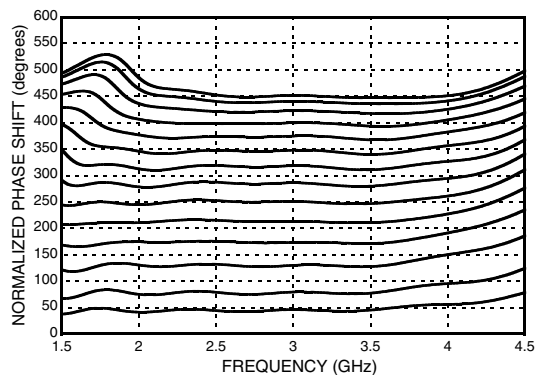
Phase Shift vs. Vctl



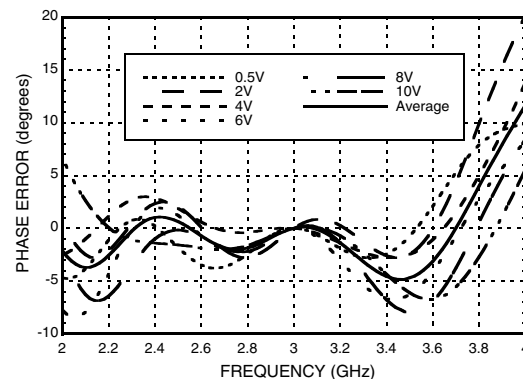
**Phase Shift vs. Frequency @ Vctl = 6V
(Relative to Vctl = 0V)**



**Phase Shift vs. Frequency
(Relative to Vctl = 0V) Vctl = 0.5 to 13V**



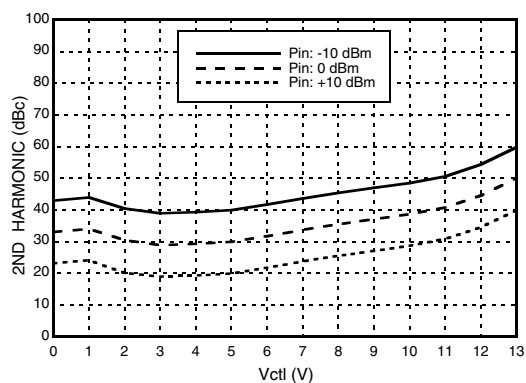
**Phase Error vs.
Frequency, Fmean = 3 GHz [1]**



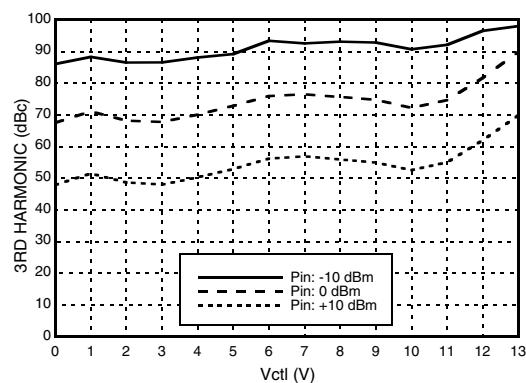
[1] 0 - 10V provides 0 - 400 degrees phase shift range

450° ANALOG PHASE SHIFTER, 2 - 4 GHz

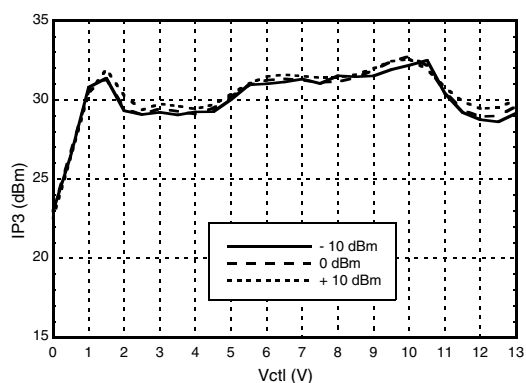
Second Harmonics vs. Vctl, F = 6 GHz



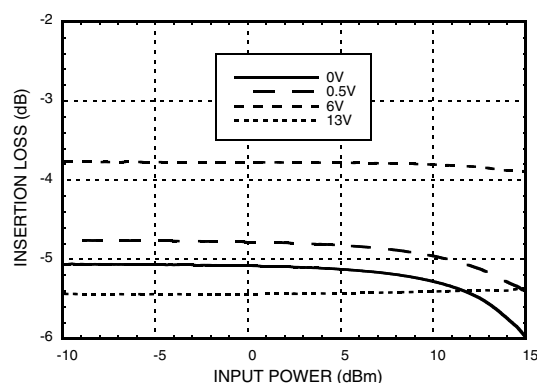
Third Harmonics vs. Vctl, F = 3 GHz



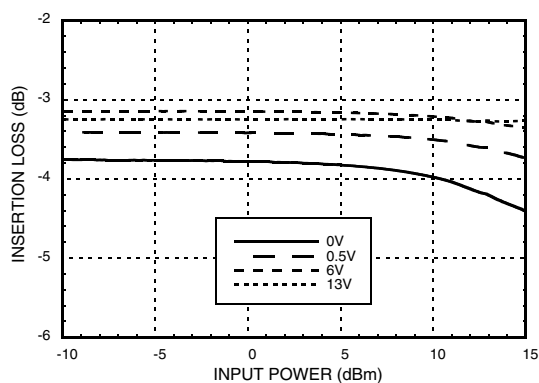
Input IP3 vs. Vctl, F = 3 GHz



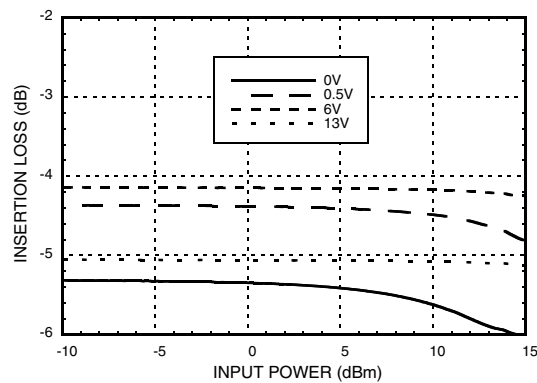
Insertion Loss vs. Pin @ 2 GHz



Insertion Loss vs. Pin @ 3 GHz

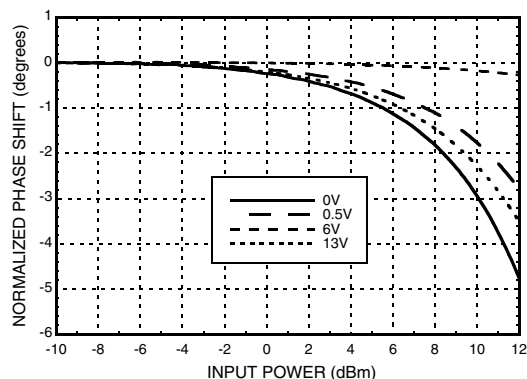


Insertion Loss vs. Pin @ 4 GHz

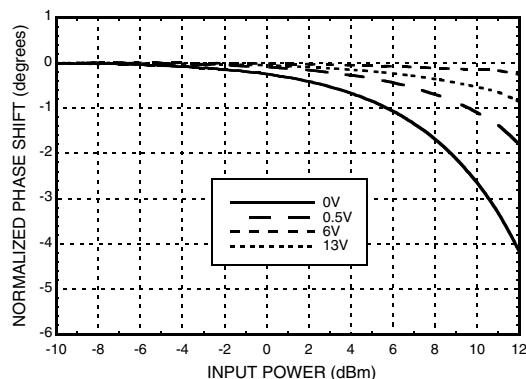


450° ANALOG PHASE SHIFTER, 2 - 4 GHz

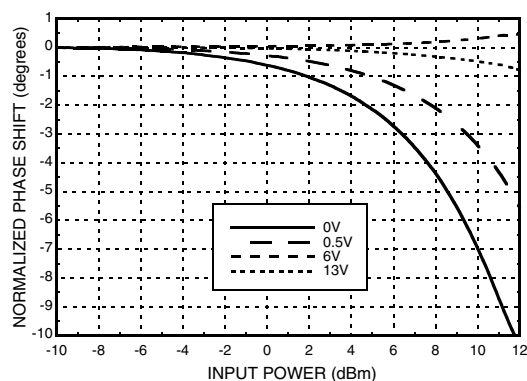
Phase Shift vs. Pin @ 2 GHz



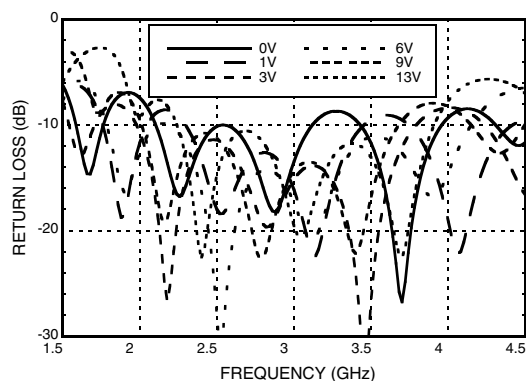
Phase Shift vs. Pin @ 3 GHz



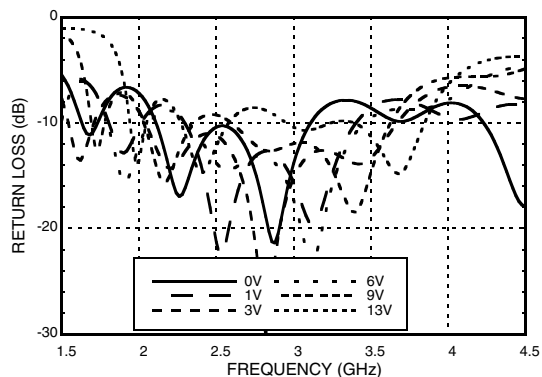
Phase Shift vs. Pin @ 4 GHz



**Input Return Loss vs.
Frequency, Vctl = 0 to +13V**



**Output Return Loss vs.
Frequency, Vctl = 0 to +13V**



Reliability Information

Junction Temperature (Tj)	150 °C
Nominal Junction Temperature (T = 85° C and Pin = 10 dBm)	87 °C
Thermal Resistance (Junction to GND paddle)	45 °C/W
Operating Temperature	-40 to +85 °C

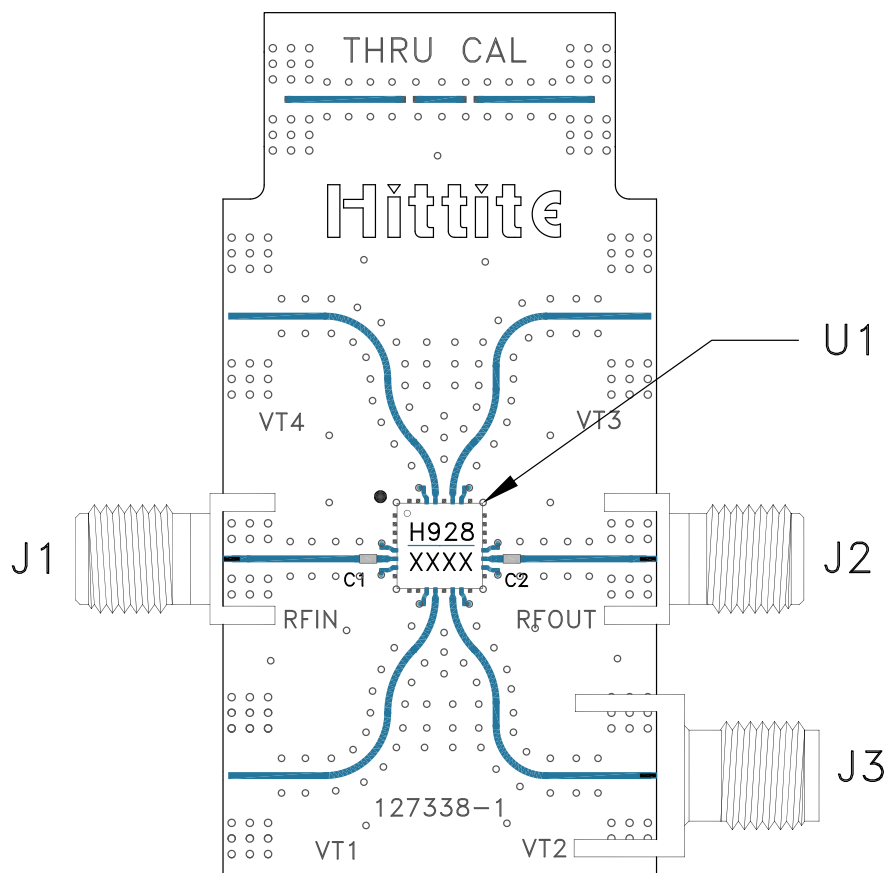
Absolute Maximum Ratings

Input Power (RFIN)	+27 dBm
Control Voltage (Vctl)	-0.5V to +15V
Storage Temperature	-65 to +150 °C
ESD Sensitivity (HBM)	Class 1B



ELECTROSTATIC SENSITIVE DEVICE
OBSERVE HANDLING PRECAUTIONS

Evaluation PCB



List of Materials for Evaluation PCB 131046 ^[1]

Item	Description
J1 - J3	PCB Mount SMA Connector
U1	HMC928LP5E Analog Phase Shifter
C1, C2	Capacitor, 100 pF, 0402 Pkg.
PCB [2]	127338 Evaluation PCB

[1] Reference this number when ordering complete evaluation PCB

[2] Circuit Board Material: Rogers 4350

The circuit board used in the application should use RF circuit design techniques. Signal lines should have 50 Ohm impedance while the package ground leads and exposed paddle should be connected directly to the ground plane similar to that shown. A sufficient number of via holes should be used to connect the top and bottom ground planes. The evaluation board should be mounted to an appropriate heat sink. The evaluation circuit board shown is available from Hittite upon request.