Application Note for Phase shifter, PS-MCM-1.9G

Introduction:

The PS-MCM-1.9G is a continuously variable, voltage controlled phase shifter. The assembly is composed of two quadrature hybrids (QHD-2Z-1.9G), and four silicon hyper-abrupt junction varactor diodes, along with other resistors, inductors and capacitors. A schematic of the assembly is shown in figure 1.

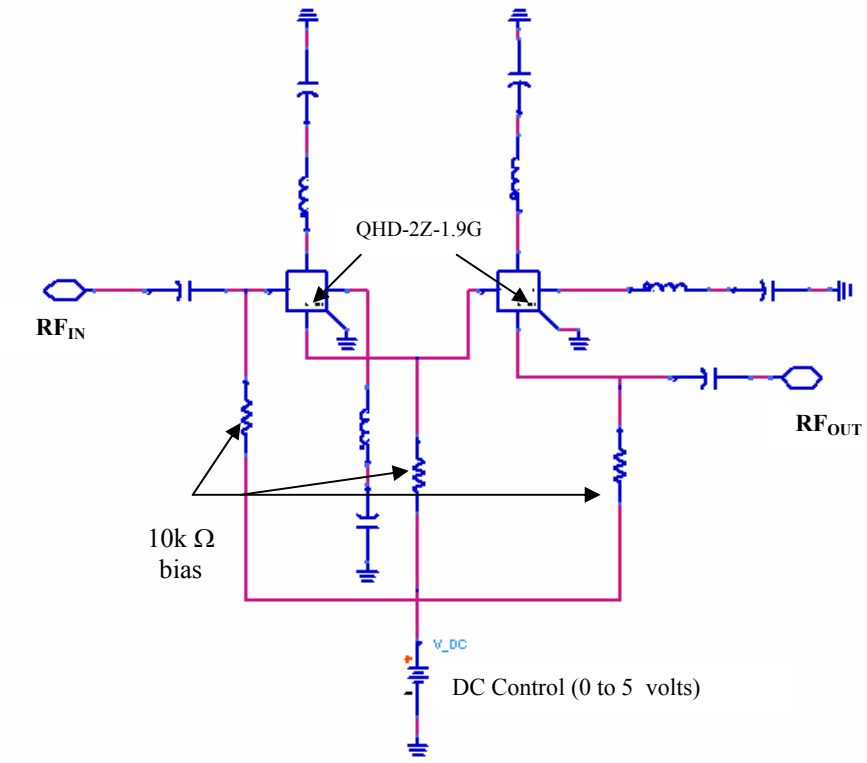


Figure 1: Schematic of PS-MCM-1.9G

Theory of Operation:

The PS-MCM-1.9G variable phase shifter can be characterized as a linear two port device, which alters the insertion phase of a signal in response to an external command voltage.
The phase shifter takes advantage of the symmetrical properties of the quad hybrid wherein a good impedance match is maintained at both the input (port 1) and isolated (port 3) for any condition of equal load at ports 2 and 4.
By terminating port 2 and 4 on both quadrature hybrids simultaneously with equal variable reactance (short circuits, open circuits or any values of reactance in between) by the use of the varactors diodes, variable insertion phase is achieved while maintaining low VSWR at ports 1 and 3. Signal reflection from ports 2 and 4 is transmitted to the isolation port (port3). The insertion phase from input to output (port 1 of QHD1 to port 3 of QHD2) varies as the capacitance ($C_{v)}$ of the varactors is increased or decreased.

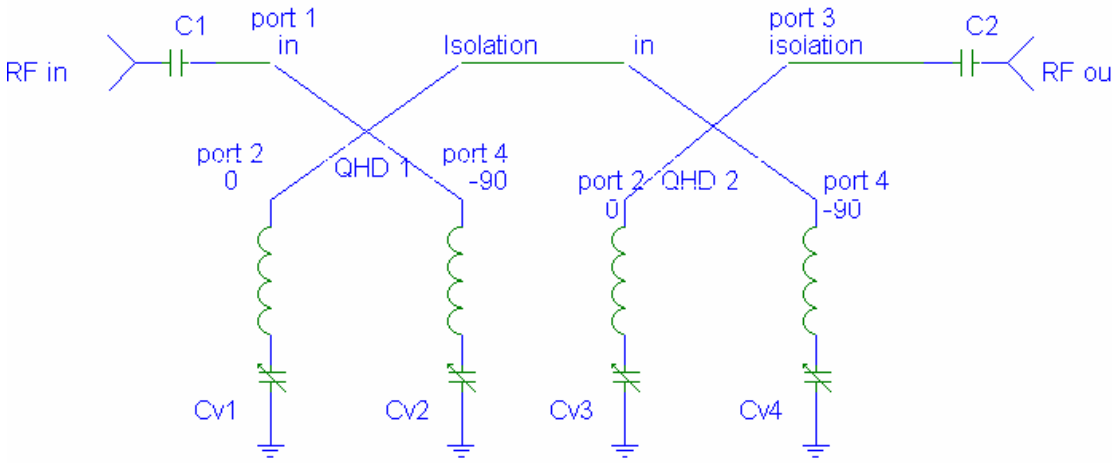


Figure 2: Simplified schematic for analysis

The PS-MCM-1.9G was assembled using coplanar lines on Rogers 4003 material, .060" thick. The overall board dimensions are (0.8 x 0.8) inches as shown in Figure 3 below. The module may be surface mounted or connectorized as required.

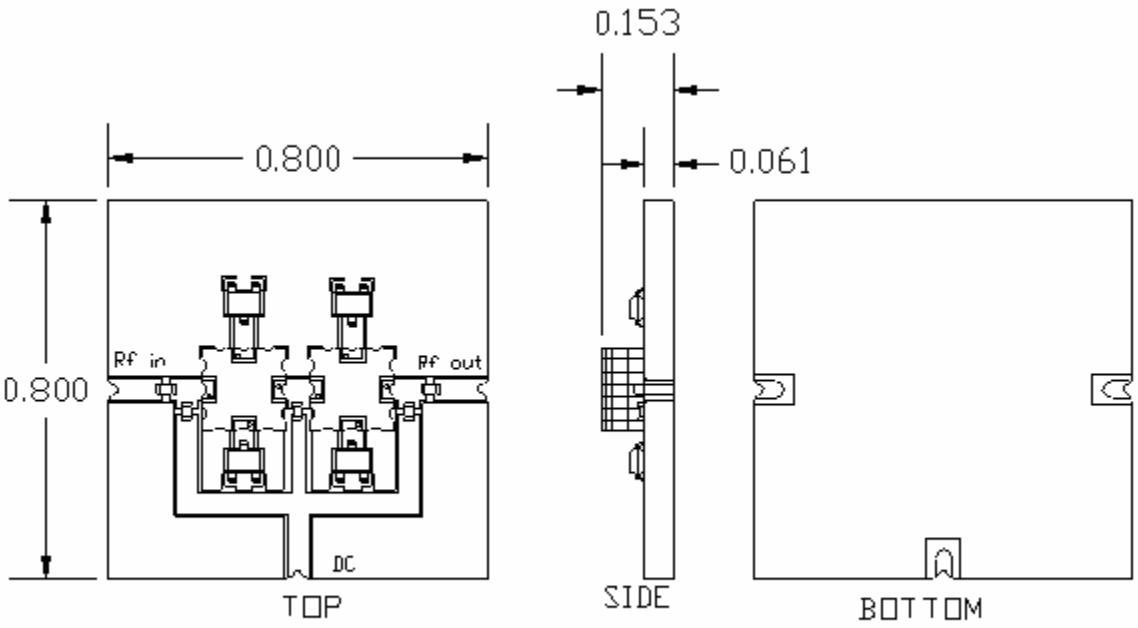


Figure 3: Outline drawing

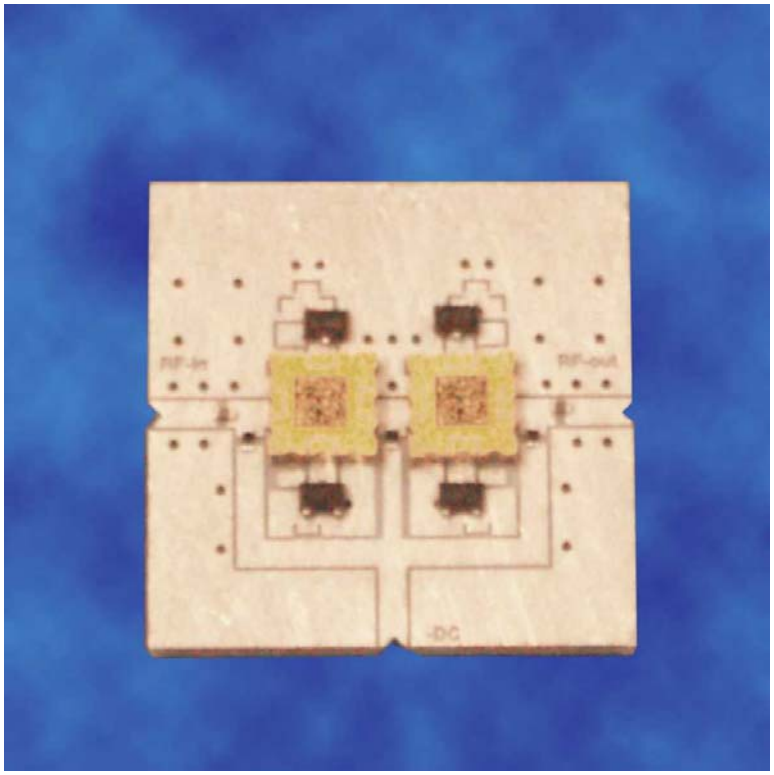


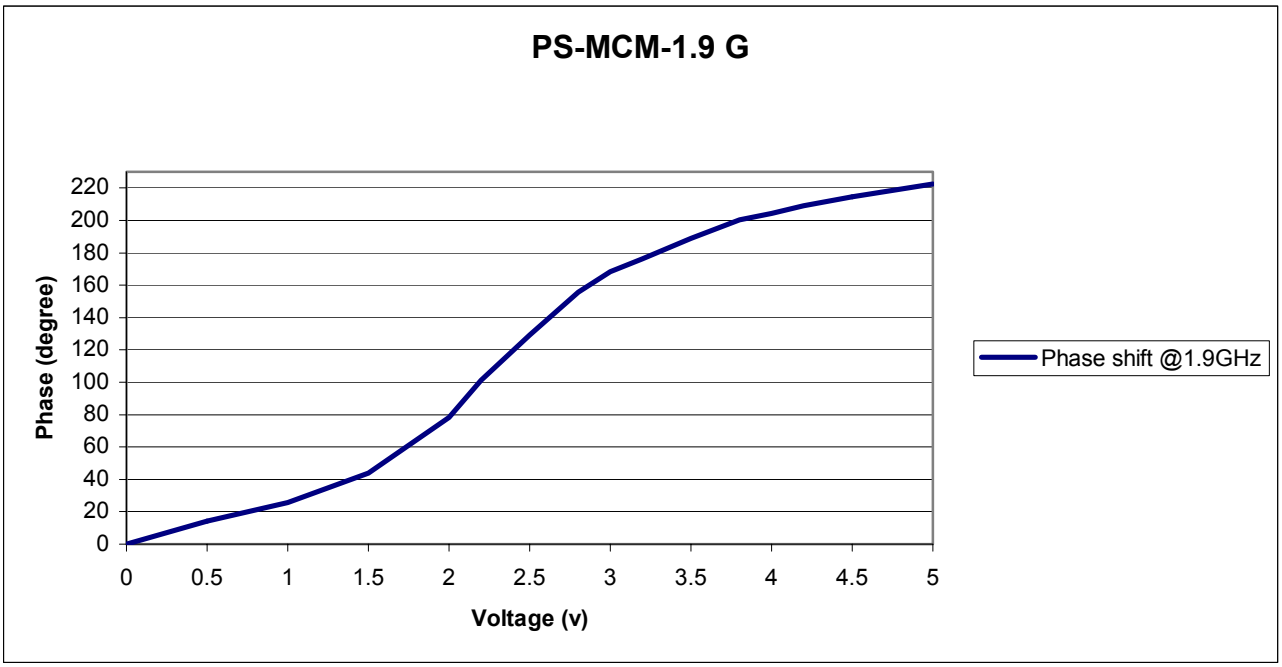
Figure 4: photograph of PS-MCM-1.9G

Results:

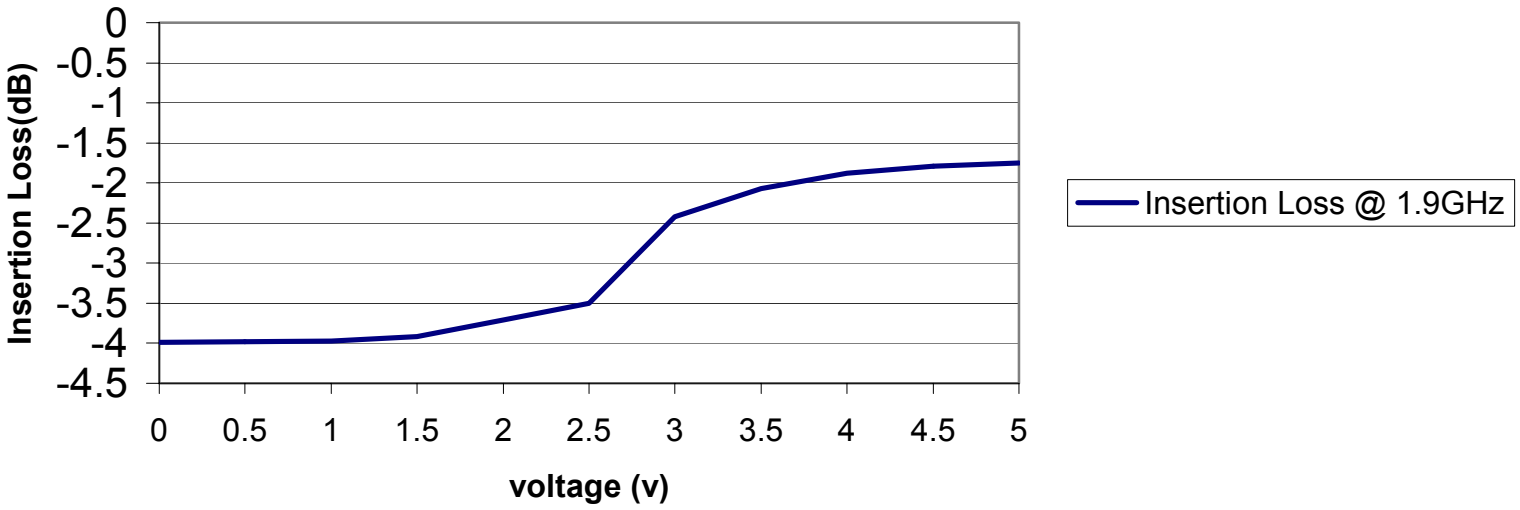
Upon implementation of the circuit shown in Figure 1 the following results were achieved:

Electrical Specification at 25° C

Parameter	Condition	Min.	Typ.	Max.	Unit
Frequency Range (BW)	Fo = 1.9	1.7		2.0	GHz
Control Voltage (C_V) Range		0		+5	V
Phase shift	@ fo, C_V =5v from C_V =0v	0		220	Degrees
Insertion Loss in BW	C_V =5v from C_V =0v	1.9		4.2	dB
VSWR in BW				1.5:1	
Input 1 dB Compression Point	@ fo, C_V =5v from C_V =0v		+22		dBm
Input Intercept Point	P_{in} =10 dBm, **C_V = 0 V**		+36		dBm
(2 Tone, 3rd Order)	P_{in} =10 dBm, **C_V = 2.5 V**		+22		dBm
Switching Speed			4µs		
Operating Temperature		-55	+25	+85	°C
Outline Dimensions			0.56 x 0.20 x 0.145		Inch



PS-MCM-1.9G



PS-MCM-1.9 G