

6-18GHz Phase-shifter

GaAs Monolithic Microwave IC

preliminary

Description

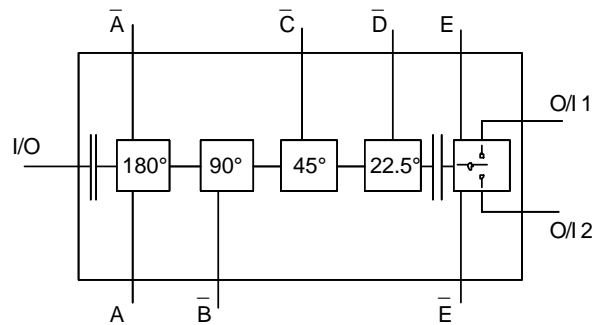
The CHP4511 is a 4-bit digital phase-shifter with an output single pole double through (SPDT) switch. It is designed for 6 to 18GHz frequency range applications. The backside of the chip is both RF and DC grounded.

The circuit is manufactured with a Power PHEMT process, 0.25 μ m gate length, via holes through the substrate, air bridges and electron beam gate lithography.

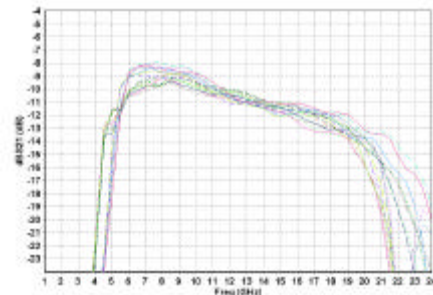
It is available in chip form.

Main Features

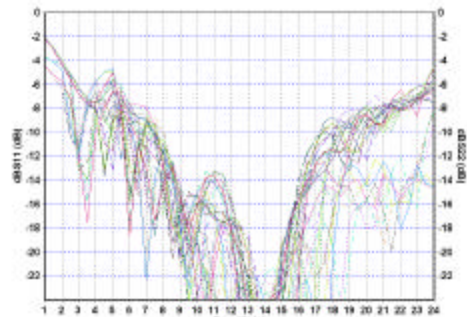
- Broadband performances : 6-18GHz
- 22.5° phase step
- Losses < 15dB
- 22dBm input power at -1dBc.
- I/O reversible.
- Adaptative SPDT
- 0/-5V control voltage
- Chip size : 4.62 x 3.0 x 0.1 mm



Typical on wafer measurements



$dB(S_{21})$ for 16 states



$dB(S_{11})$ and $dB(S_{22})$ for 16

Main Characteristics

Tamb. = 25°C

	Parameter	Min	Typ	Max	Unit
Fop	Operating frequency range	6		18	GHz
G	Small signal gain	-15		-7	dB
Poi1	Output power at 1dB compression		10		dBm
Vctrl	Voltage control	-5		0	V

ESD Protection : Electrostatic discharge sensitive device. Observe handling precautions !

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Electrical Characteristics

Low level control voltage = -5V, High level control voltage = 0V
 Pin = 5 dBm on the input, output on SPDT 1 or 2

Tamb = +25°C

	Parameter	Conditions	Min	typ.	Max	Unit
Fop	Operating frequency range		6		18	GHz
Phrange	Phase shifter range		0	to	360	deg.
Phstep	Phase step			22.5		deg
S11	Input reflection coefficient				-6	dB
S22	Output reflection coefficient				-7	dB
S22off	Output reflection coefficient path OFF				-15	dB
IL	Insertion loss	6 to 14GHz 15 to 18GHz			13 15	dB
ISO	Isolation between Output 1 and 2		25	35		dB
AV	Amplitude variation			-1.5 / +2.5		dB
Pio1dB	Output Power @1dB compression	In => out1 or 2		10		dBm
Poi1dB	Output Power @1dB compression	out1 or 2 => in		12		dBm

	Parameter	Conditions	average	std dev	pk to pk	Unit
PPE	Peak Phase Error	state 22.5° state 45° state 90° state 180°	22.5° ±5 45° ±5 90° ±5 180° ±10	< 3° < 6° < 6° < 6°	±6° / average ±10° / average ±10° / average ±10° / average	deg

Peak Phase Error (PPE) definition:

$$PPE_{(i)} = \text{measured_phase}(S21)_{(i)} - \text{measured_phase}(S21)_{(0)} - \text{theoretical_phase}_{(i)}$$

(i) = state ∈ [0,15]

Amplitude variation (AV) definition:

$$AV_{(i)} = \text{measured_dB}(S21)_{(i)} - \text{measured_dB}(S21)_{(0)}$$

(i) = state ∈ [0,15]

Absolute Maximum Ratings

Tamb = +25°C

Operation of this device above anyone of these paramaters may cause permanent damage.

Symbol	Parameter	Values	Unit
Vgi	Phase shifter control voltage	-7 to +0.6	V
Pin	Maximum peak input power overdrive (1)	+30	dBm
Top	Operating temperature range	-40 to +70	°C
Tstg	Storage temperature range	-55 to +125	°C

(1) duration < 1s.

*preliminary***Phase Shifter Control Interface**

The 4-bit phase shifter is controlled by 5 voltages:

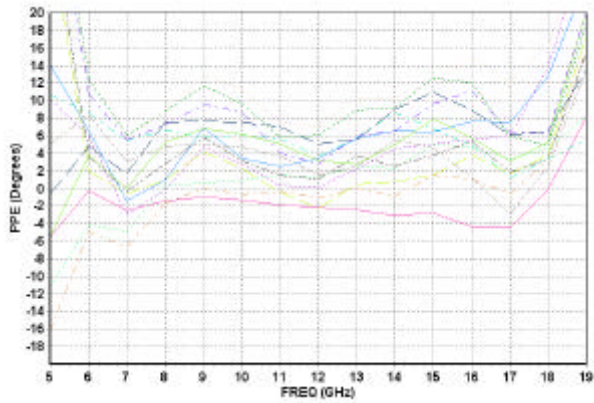
State	TOTAL PHASE SHIFT	\bar{D} 25°	\bar{C} 45°	\bar{B} 90°	A 180°	\bar{A} 180°
0	0°	0	0	0	-5V	0
1	22.5°	-5V	0	0	-5V	0
2	45°	0	-5V	0	-5V	0
3	67.5°	-5V	-5V	0	-5V	0
4	90°	0	0	-5V	-5V	0
5	112.5°	-5V	0	-5V	-5V	0
6	135°	0	-5V	-5V	-5V	0
7	157.5°	-5V	-5V	-5V	-5V	0
8	180°	0	0	0	0	-5V
9	202.5°	-5V	0	0	0	-5V
10	225°	0	-5V	0	0	-5V
11	247.5°	-5V	-5V	0	0	-5V
12	270°	0	0	-5V	0	-5V
13	292.5°	-5V	0	-5V	0	-5V
14	315°	0	-5V	-5V	0	-5V
15	337.5°	-5V	-5V	-5V	0	-5V

The SPDT switch allows to choice one of the output path:

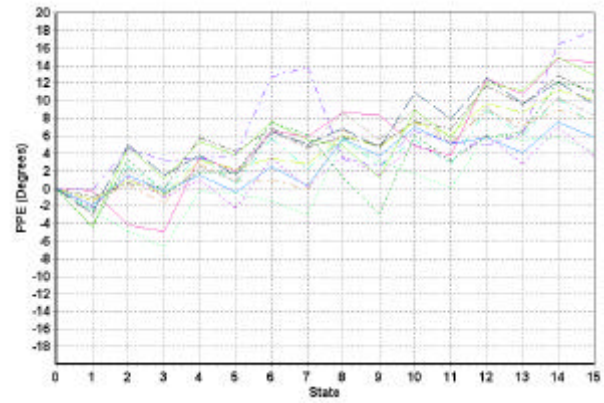
SPDT Control		Output Selected
E	\bar{E}	
0	-5V	O/I 1
-5V	0	O/I 2

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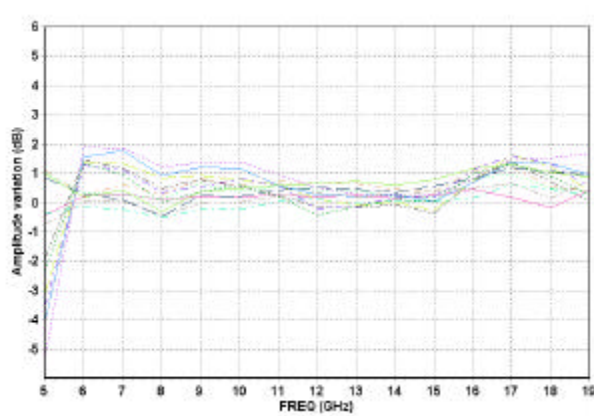
Typical on wafer [S] measurements at +25°C



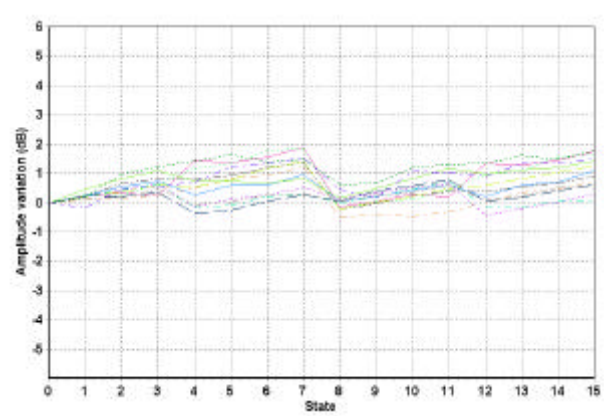
Peak phase error versus frequency for all states



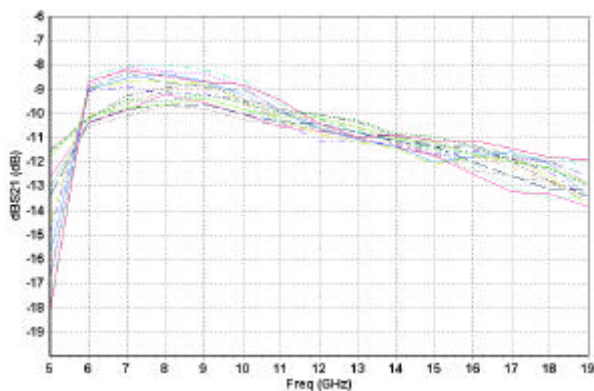
Peak phase error versus states
6GHz < frequency < 18GHz



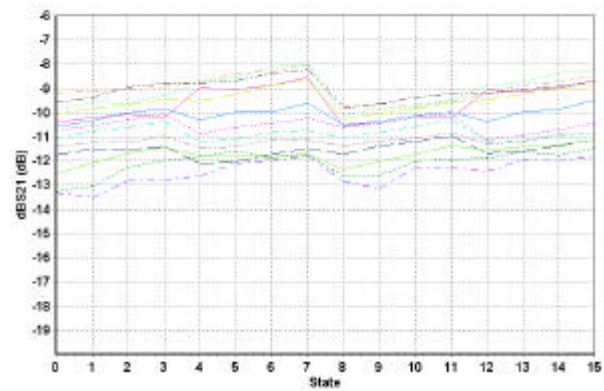
Amplitude variation versus frequency for all states



Amplitude variation versus states
6GHz < frequency < 18GHz

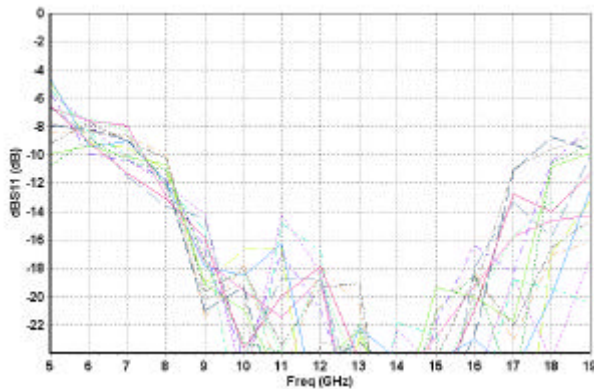


dB(S21) versus frequency for all states

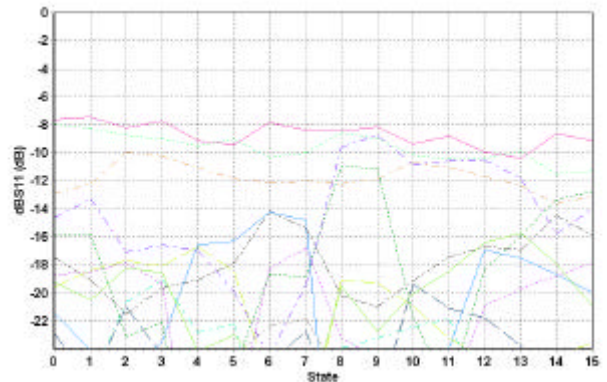


dB(S21) versus states
6GHz < frequency < 18GHz

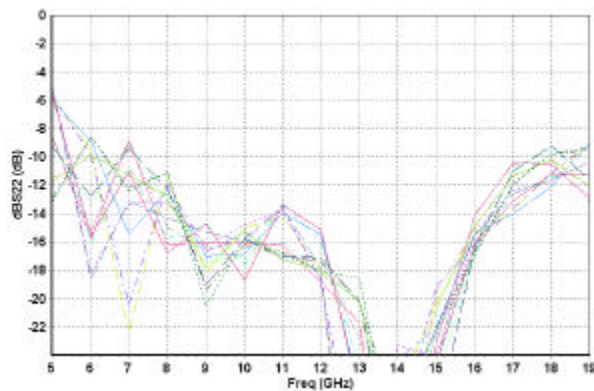
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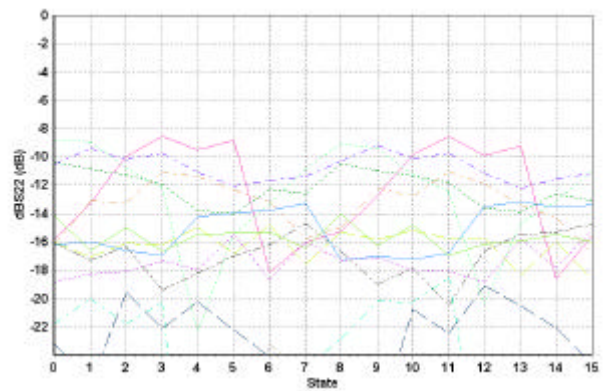
dB(S11) versus frequency for all states



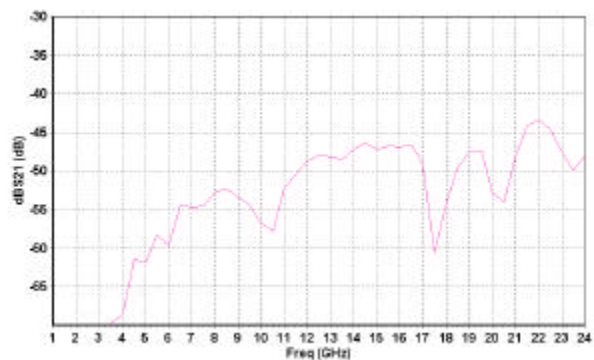
dB(S11) versus states
6GHz < frequency < 18GHz



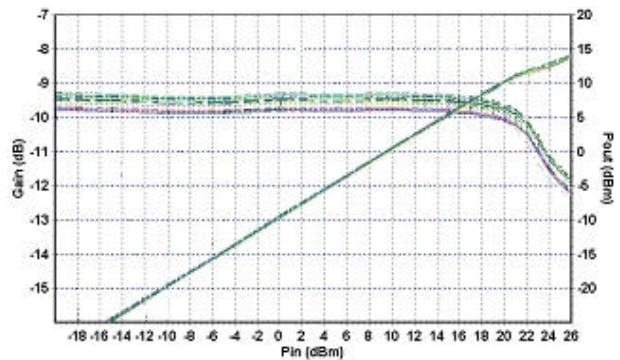
dB(S22) versus frequency for all states



dB(S22) versus states
6GHz < frequency < 18GHz



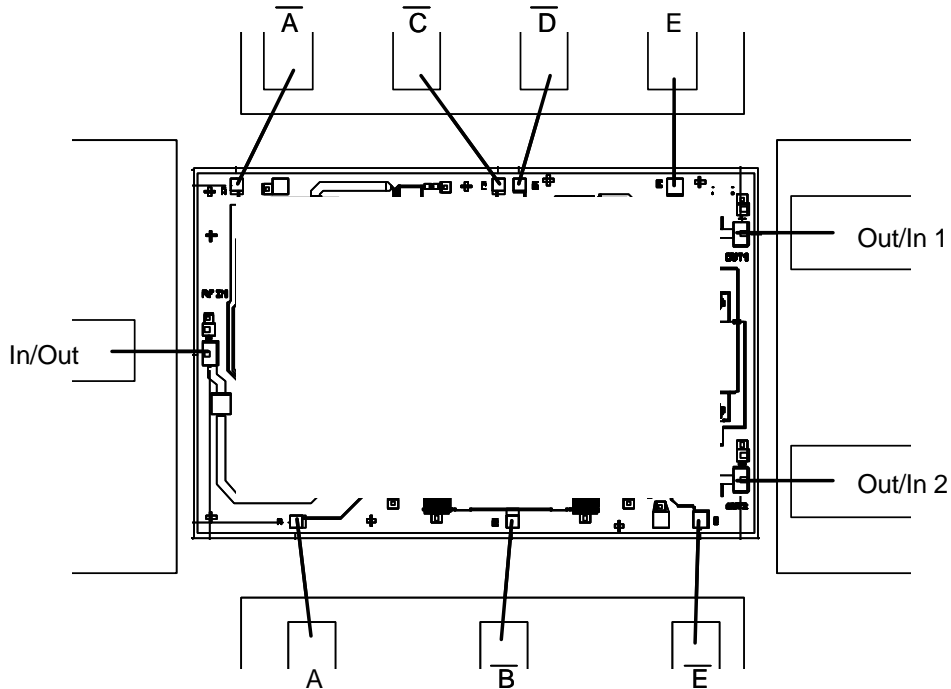
dB(S21) for path OFF: in => out1, state 0



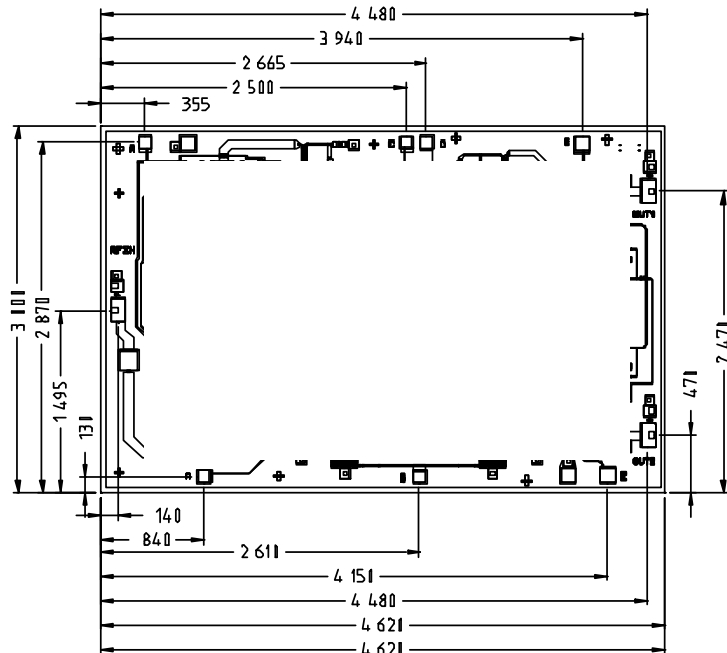
Gain and output power at 12GHz (input to output1)
(20 samples)

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Chip Assembly and Mechanical Data



Note : 25µm diameter gold wire is recommended



UNITS : µm
Tol : ±35µm

Bonding pad positions.

(Chip thickness : 100µm.all dimensions are in micrometers)

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Ordering Information

Chip form : CHP4511-99F

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