Model 7218 Broadband I-Q Vector Modulator

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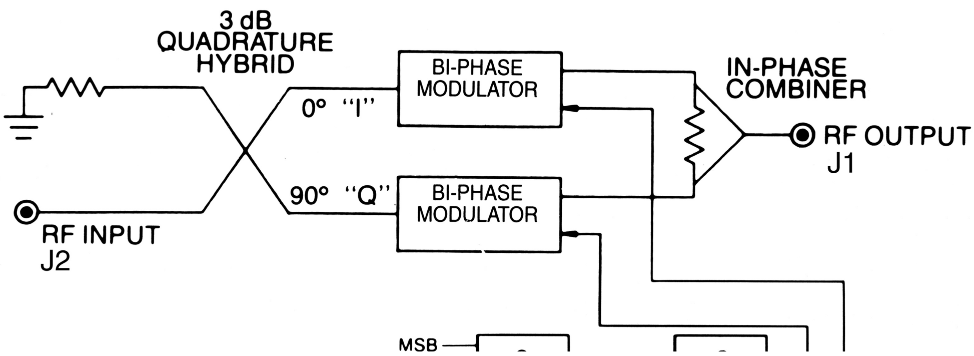
How to Buy Application Notes for Microwave Phase Shifter

The Model 7218 is the latest addition to the family of high performance I.Q. Vector Modulators. Its broadband capability is ideally suited for today's more demanding and complex Electronic Warfare systems

The Model 7218 covers a frequency range of 2 to 18 GHz, is capable of a full 360 Degrees phase control and a minimum of 20 dB amplitude control. Response time is 1 microsecond, maximum. Digital control is accomplished by two 12 bit TTL inputs, for I and Q channels, which provide for high precision calibration of phase and amplitude. Operation is guaranteed to be monotonic.

- **Broad Frequency range - 2 to 18 GHz**
- **Simultaneous control of phase and amplitude**
- **Digitally programmable - 12 Bits for both I & Q**
- **High Speed**
- **Guaranteed monotonic**



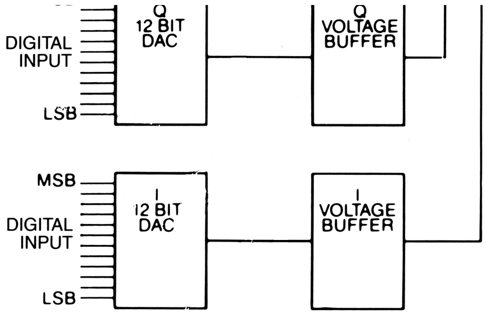


Fig. 1 - Model 7218 Block Diagram

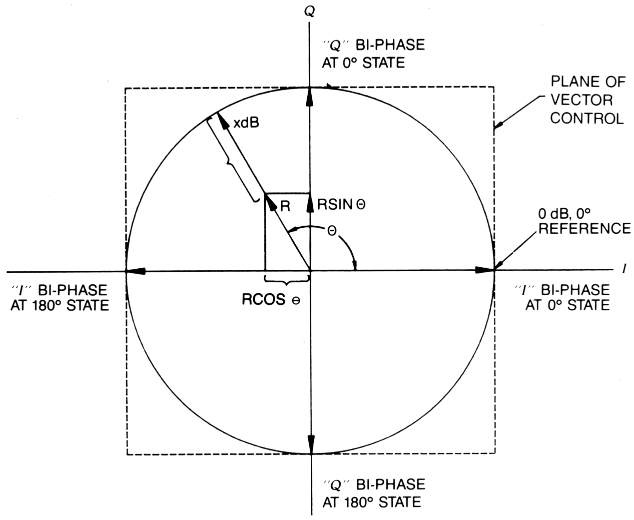


Fig. 2–I-Q Phase Relationship

THEORY OF OPERATION

The block diagram of the I-Q Vector Modulator is shown in Figure 1. An RF signal incident on a 3 dB quadrature hybrid is divided into two equal outputs, with a 90° phase difference between them. The in-phase, or 0°, channel is designated the I channel and the Quadrature, or 90°, channel is designated the Q channel. Each signal passes through a biphase modulator which sets the 0° or 180° state and the attenuation level for both the I and Q paths. The outputs of the I and Q path are combined to yield the resultant vector which may fall anywhere within the bounded area shown in Figure 2. Any signal applied to the I?Q Vector Modulator can be shifted in phase and adjusted in amplitude by applying the following relationships:

1. Let the desired attenuation level = X dB and the desired phase shift = θ° (with respect to 0 dB and 0° reference states).
2. The normalized output voltage magnitude is given by: ? V ? = $10^{?(x/20)}$.
3. The values of the I and Q attenuator control inputs are then expressed as:

$$I = V \cos \theta$$

and

$$Q = V \sin \theta.$$

Figure 3 shows the nominal value of I and Q vs. either digital word (Series 71) or analog voltage (Series 72). Thus, to achieve an attenuation level of 3 dB with a phase offset of 112.5° (with respect to 0 dB and 0° reference states) the values of I and Q can be calculated as follows:

$$V = 10^{-(3/20)} = 0.707$$
$$I = 0.707 \cos (112.5°) = –0.027$$
$$Q = 0.707 \sin (112.5°) = +0.65$$

From Figure 3, the control inputs to yield the desired amplitude and phase are approximately:

Analog Units (72 Series)	Digital Units (71 Series)
I = 5.78 volts	100101000000
Q = 2.84 volts	010010001011

While these values for I and Q will yield an output signal whose amplitude and phase are close to the nominal values over the entire operating frequency range of the vector modulator, the use of an iterative measurement procedure will determine the I and Q inputs which exactly define the desired parameter at any selected frequency.

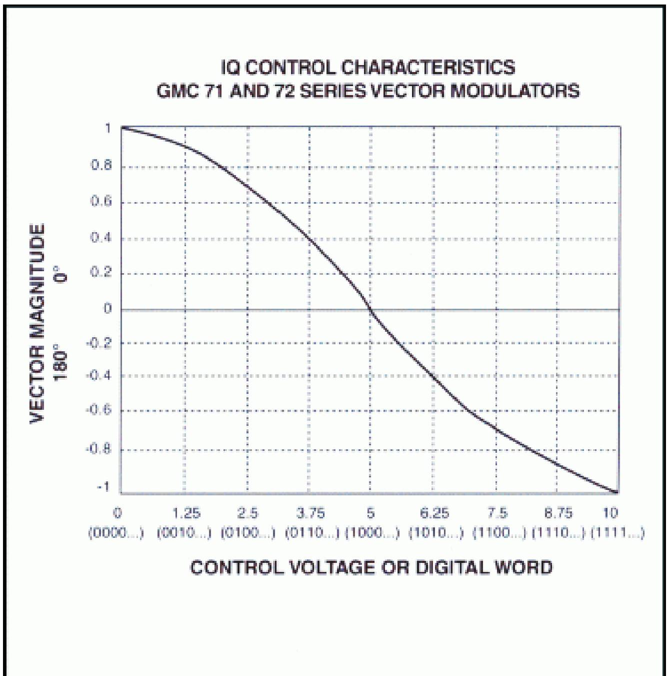


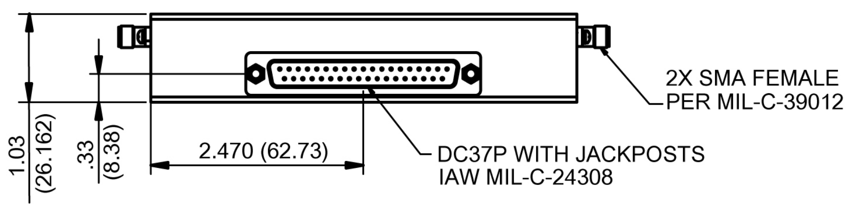
Fig. 3 – I-Q vs. Control Input

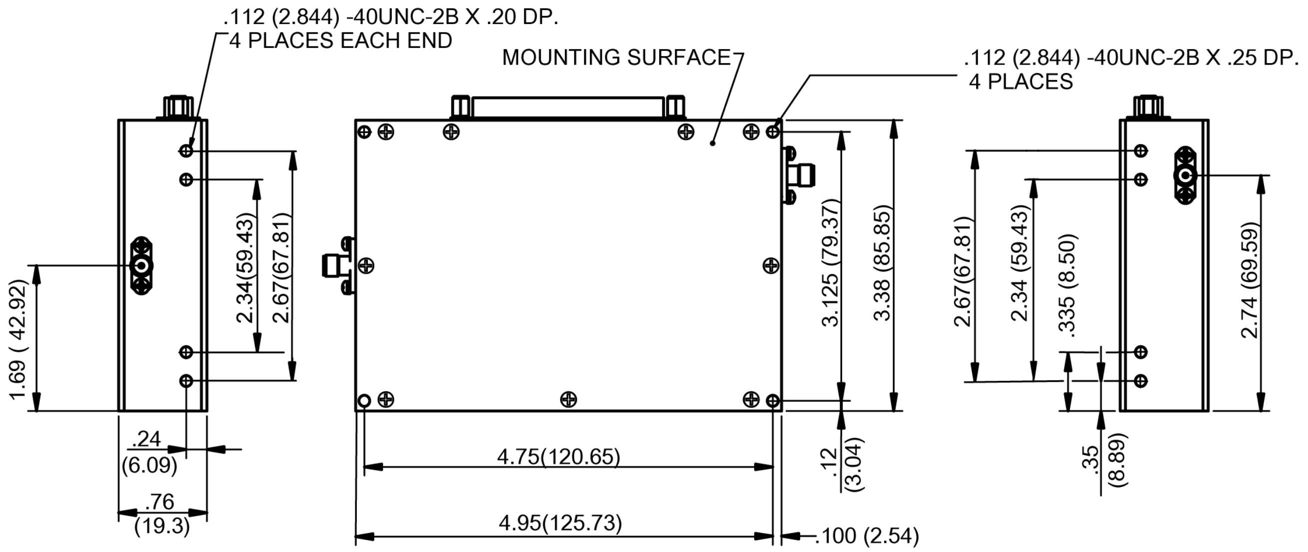
(Typical)

PERFORMANCE CHARACTERISTICS

PARAMETER	SPECIFICATION
OPERATING FREQUENCY RANGE	2.0 - 18.0 GHz
Band 1	2 - 6 GHz
Band 2	6 - 18 GHz
Band Switching Speed,max	250 nanoseconds
INSERTION LOSS (MAX)	16 dB
VSWR (MAX)	2.2:1
POWER HANDLING CAPABILITY	
Without performance degradation	+10 dBm
Survival	1 W
ABSOLUTE INSERTION PHASE ACCURACY VS. FREQUENCY (MAX)	±15° (in each band)
FINE GRAIN PHASE RIPPLE (50 MHz) (MAX)	2° pk-pk
VARIATION OF PHASE VS. TEMPERATURE (MAX)	±0.1 deg./ °C
ATTENUATION RANGE (MIN)	20 dB
VARIATION OF AMPLITUDE VS. TEMPERATURE (MAX)	0.02 dB/ °C
RESPONSE TIME (MAX)	1.0 µsec
POWER SUPPLY	+5 V ±2% @ 200 mA, max. +12 to +15V @ 150 mA, max. -5.2 V ±2% @ 400 mA, max. -12 to -15V @ 150 mA, max
MONOTONICITY	GUARANTEED
CONTROL INPUT	12 BIT TTL FOR BOTH I & Q INPUTS
CONNECTORS	
RF Input/output	SMA Female, 2X
Control/Power	Cannon DC-37P or Equivalent
TEMPERATURE RANGE	
Operating	-55 °C to +85 °C
Storage	-65 °C to +125 °C

DIMENSIONS AND WEIGHT





J3 PIN FUNCTION			
PIN	**FUNCTION**	**PIN**	**FUNCTION**
1	I-5	20	I-4
2	I-6	21	I-7
3	I-8	22	I-3
4	I-9	23	I-2
5	I-10	24	I-1 (LSB)
6	I-11	25	I-12 (MSB
7	BAND 1 (notes 1 & 2)	26	N/C
8	+12 to +15V	27	+5V ±2%
9	GND	28	GND
10	GND	29	BAND 1 (notes 1 & 2)
11	-12 to -15V	30	-5.2V ±2%
12	Q-3	31	BAND 2 (notes 1 & 2)
13	Q-2	32	Q-4
14	Q-1 (LSB)	33	BAND 2 (notes 1 & 2)
15	Q-5	34	N/C
16	Q-6	35	Q-12 (MSB)
17	Q-7	36	Q-11
18	Q-8	37	Q-10
19	Q-9		

ACCESSORY FURNISHED

Mating power/control connector

NOTES:

1. BAND SELECT: Band 1 (2 to 6 GHz) - Apply TTL 0 to Pin 7 or Pin 29
   Band 2 (6 to 18 GHz) - Apply TTL 0 to Pin 31 or Pin 33
2. With no band selected, there will be maximum Isolation between J1 and J2

Dimensional Tolerances, unless otherwise indicated: .XX ±.02; .XXX ±.005

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