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PCB Tuning the 1P503 for Optimal Isolation and Impedance

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Abstract

3dB, 90-degree hybrid couplers are found in many applications where the performance of the hybrid coupler must have optimized isolation and impedance match, such as PIN diode attenuators, vector modulators and variable phase shifters. In addition to demanding performance requirements, components must also take up less physical space and offer cost effective solutions. Recently, Anaren Microwave, Inc. in East Syracuse, NY has released a new pico-Xinger® operating in the 1.7-2.0GHz frequency range. In the following application note, a relatively simple method for improving the electrical performance (return loss in particular) is presented for the 1P503 pico-Xinger.

Introduction

The 1P503 pico-Xinger is a further extension to the Xinger product offering that satisfies the lower cost, more compact requirements and further minimizes PCB space while maintaining excellent RF performance in an easy to use, surface mount package. The 1P503 is primarily intended for lower power (less than 30 watts average) DCS and PCS applications and is outlined in Figure 1. The electrical specifications of the 1P503 are presented in Table 1, where special attention must be made to the isolation and voltage standing wave ratio (VSWR) specifications. In applications such as the variable attenuator, it is essential to minimize VSWR and improve isolation at all four ports of the hybrid coupler to maximize the dynamic range of the attenuator.

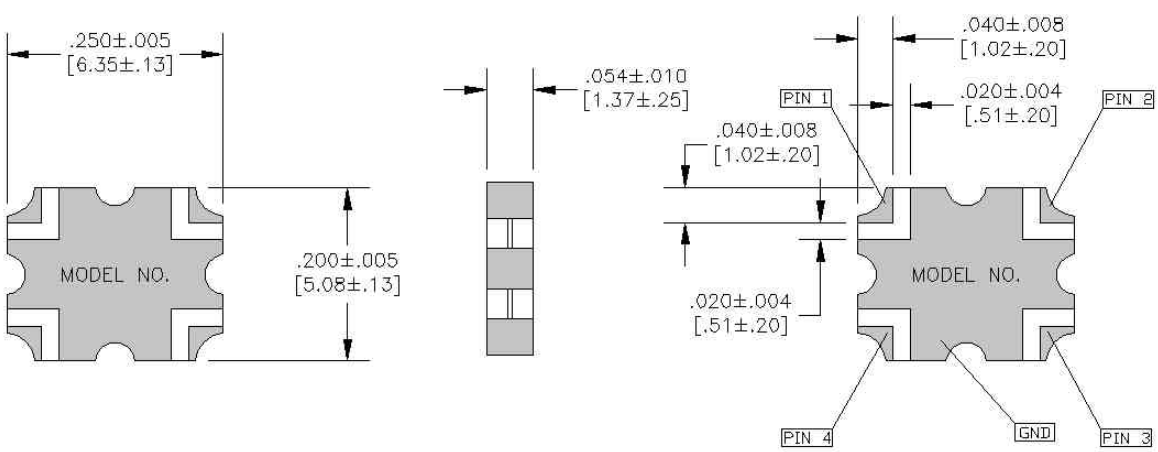

Figure 1 – Outline Drawing for the 1P503 pico-Xinger

1P503 Electrical Specifications		
Frequency	1.7 – 1.8 GHz	1.8 – 2.0 GHz
Isolation	18 dB min.	18 dB min.
Insertion Loss	0.25 dB max.	0.25 dB max.
VSWR	1.28:1 Max	1.28:1 Max
Amplitude Balance	$\pm$ 0.45 dB max.	$\pm$ 0.30 dB max.
Phase Balance	3 Degrees max.	3 Degrees max.

Table 1 - 1P503 Electrical Specifications

Tuning for Impedance Match and Isolation

Figure 2 shows a modified test board with open stubs to tune impedance match and isolation. The characteristic impedance of the test board runs and open stubs are 50Ω.

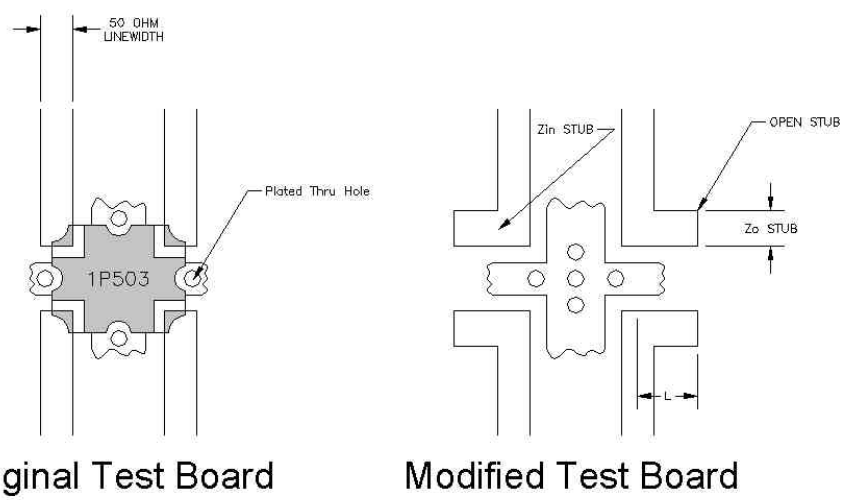

Figure 2 - Mounting Footprint

The modified test board includes four electrically short, open-ended stubs at the board interface with the coupler. The stubs are used to create shunt capacitance at the interface of the test board runs and the surface mount part. The input impedance of the open stub is found using:

$$Z_{in\_stub} = -jZ_{0stub} \cot \quad bl$$ Equation 1

where β is the propagation constant, and l is the stub length. Both the length and impedance of the stub are variable. For lengths shorter than a quarter wavelength, the input impedance of the stub will be purely capacitive. As such, we can define an equivalent capacitance value as seen at the input of the stub,

$$C_{in\_stub} = \frac{1}{2pf \cdot Z_{0stub} \cot bl} \qquad \text{Equation 2}$$

where f is the frequency. Figure 4 illustrates the typical effect that stub tuning has on return loss, isolation, amplitude balance and phase balance. From the graphs in Figure 3, the return loss and isolation of the 1P503 is significantly improved by adding shunt capacitance at the coupler interface. In this example, the shunt capacitance is achieved with the use of open-ended microstrip stubs. To reduce the overall length of the stub however, one could choose to use lower impedance coplanar stubs instead of regular microstrip stubs.

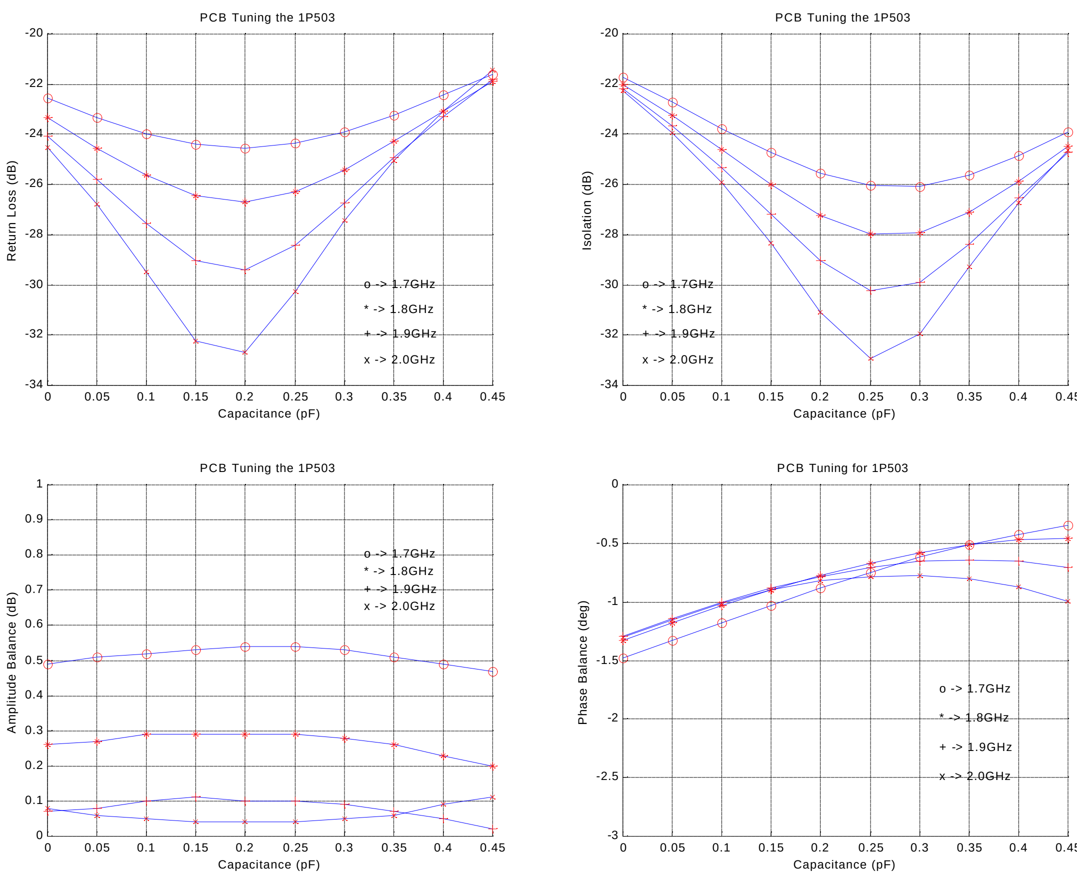

Figure 3 - Effect of Stub Tuning on the Various Coupler Parameters