White Paper – High Frequency SMA End Launch Connectors

Low VSWR and Insertion Loss over a Wide Bandwidth

An accurate characterization of packaged microwave circuits, such as broadband MMIC power amplifiers, requires coaxial to planar transitions with low return and insertion loss. In order to achieve low loss, the transition design between the launch connector and the printed circuit board requires the optimization of both mechanical and electrical features. The mechanical design must physically match the electromagnetic field distribution as close as possible in order to keep the discontinuity reactances small, as shown in Figure 1. The electrical design must match the impedances and other interface discontinuity reactances over the entire bandwidth.

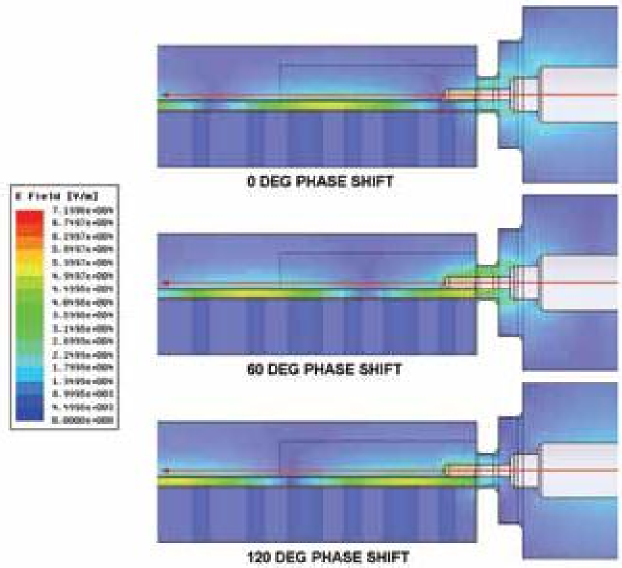


Figure 1 - Simulated Electric Field Distributions within the Dielectric Regions at 18 GHz

Minimizing the discontinuity reactances is desired rather than just compensating for them. Compensation can limit the usable frequency range of the connector, if the reactances are too large. The connector design incorporates an internal matched impedance transition from a large input coaxial connector interface, such as SMA, to a small coaxial output matched to the size of the PC board high frequency substrate. The internal transition between the input and output consists of graduated coaxial diametrical step sections, each optimized in size with inductive offsets to reduce the capacitive discontinuities created by the change in coaxial diameters. As shown in Figure 1, using multiple coaxial step sections to match the size of the circuit board reduces the overall effect of the discontinuities, thereby increasing the usable frequency range of the launch connector.

The transition between the launch and the PC board is designed for attachment to grounded coplanar waveguide (GCPW) transmission lines. The signal output pin of the launcher is optimized in both length and diameter to match the corresponding GCPW line. The geometrical size of the signal side ground leg pairs is optimized in height, length and center to center spacing to match the output pin and GCPW line. The combination of optimal signal pin and ground leg design minimizes the attachment discontinuity reactance.

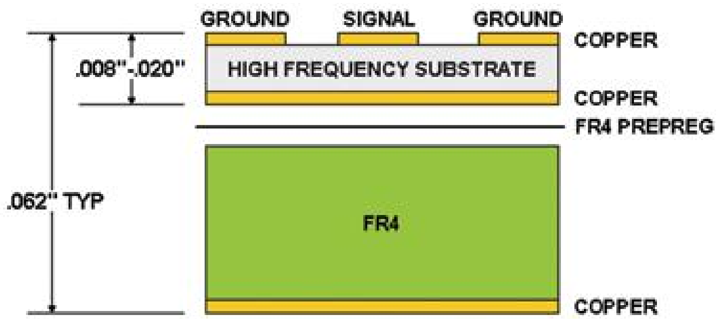
Easily connected to GPCW transmission lines with reproducible results

A coplanar waveguide transmission line is formed by a planar conductor separated by a pair of ground planes, all on the same plane, atop of a high frequency dielectric medium. A variant is formed when a ground plane is provided on the opposite side of the dielectric which is called grounded coplanar waveguide (GCPW). Although GCPW is the preferred transmission line structure on the circuit board for this connector, other lines such as microstrip can be used with good results.

At microwave frequencies, the coplanar waveguide can be equal to or better than the microstrip when loss and dispersion are used as a basis for comparison. Minimum loss for a given coplanar waveguide occurs at about 60 Ohms whereas the minimum loss for microstrip occurs at about 25 Ohms. A full wave analysis which includes space wave and surface wave radiation shows that coplanar waveguide discontinuities radiate much less energy than microstrip discontinuities.

The GCPW transmission line is fabricated on a high frequency circuit board substrate. Dielectric constant control, low dissipation factor and controlled thicknesses differentiate these high frequency circuit board materials from those typically used in the high volume printed circuit board world like FR4 and BT/epoxy. For higher frequencies, dielectric loss becomes an important contributor to the total loss. This is important because, as the frequency increases, the thickness of the material must decrease in order to avoid generating transverse modes on the transmission lines.

The high frequency material's low loss performance extends the useful range of these materials well above 20 GHz. However, very thin dielectric layers as small as .008" are not mechanically stable enough to support the connector and associated circuitry. Therefore, hybrid circuit board constructions consisting of high frequency laminates and epoxy/glass substrates have become an increasingly utilized alternative to lower overall circuit board costs. The DC, control and digital signal paths are designed onto the lower cost epoxy/glass FR4 layer and the microwave signals are carried on the high frequency top layer as shown in Figures 1A and 1B.



Typical HF/Digital Multilayer Hybrid Construction (GCPW Figure 1A, microstrip Figure 1B)

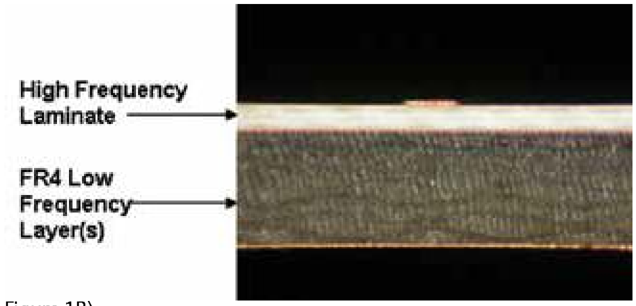


Figure 1B

As can be seen in the cut away portion of Figure 1, the connector's center conductor pin is directly attached in-line with the GCPW signal trace. The body of the connector is always attached to the signal side ground. The design of the center conductor pin is a compromise between ease of assembly and minimal discontinuity reactance. The diameter of the pin is matched approximately to the thickness of the GCPW structure. Scaling down the pin diameter matches the electromagnetic field distributions with the GCPW line in order to keep the discontinuity reactance small.

The output coax of the connector at the transition area is sized appropriately to match the thickness of the high frequency board substrate. The output coax section extends well within the connector by means of constant diameters, avoiding any abrupt diametrical changes at the circuit board edge which can create large discontinuities.

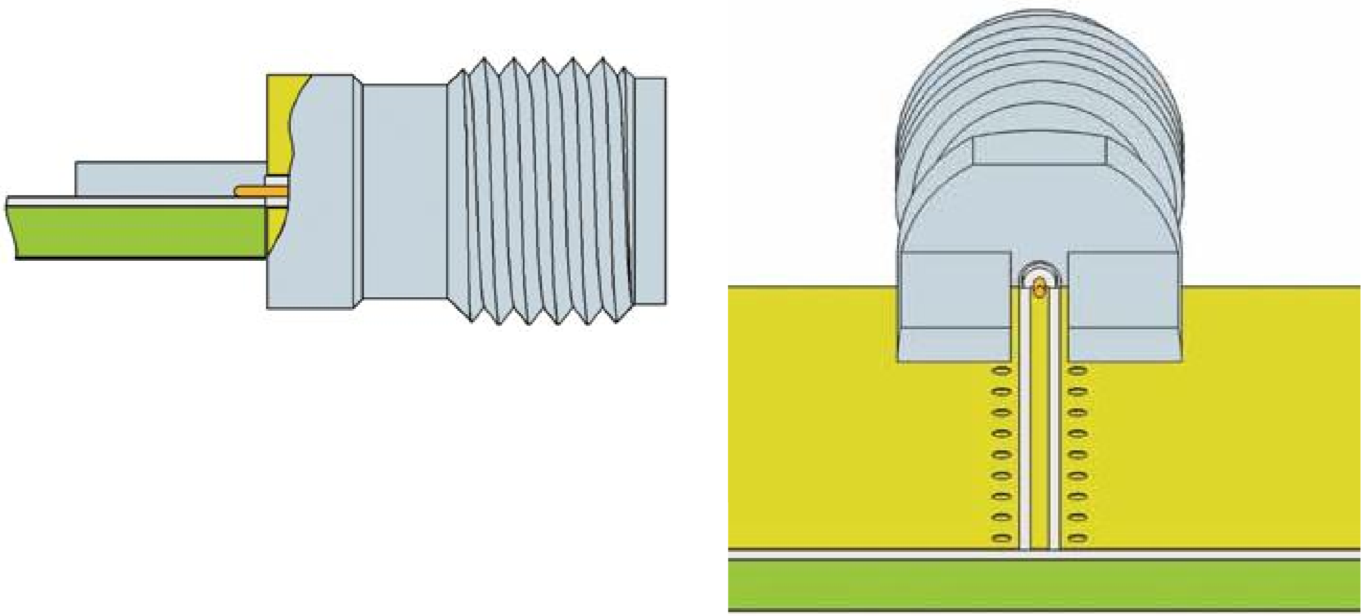
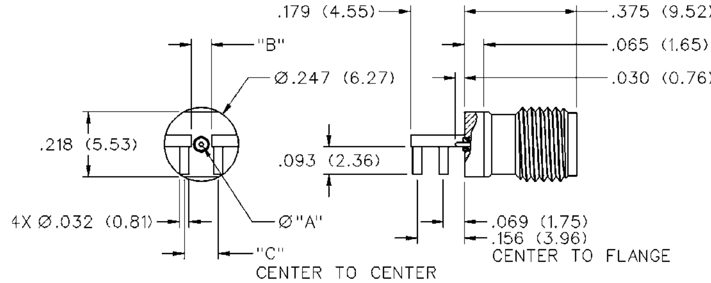


Figure 1 - End Launch Connector Shown Attached to the GCPW Transmission Line

High Frequency SMA End Launch Connectors for PC Mount

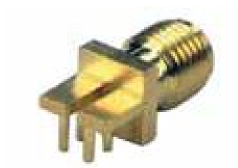
Jack Receptacle – Round Body

Coupling proof
torque 8 inch pounds
maximum
without support
wrench

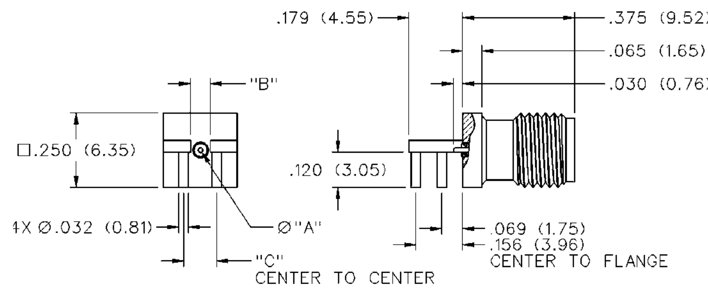


Gold Plated	High Frequency Substrate Thickness	"A"	"B"	"C"
142-0761-801	.008 (0.20) - .014 (0.36)	.010 (0.25)	.050 (1.27)	.096 (2.44)
142-0761-821	.014 (0.36) - .020 (0.51)	.015 (0.38)	.067 (1.70)	.113 (2.87)

Jack Receptacle, Square Body

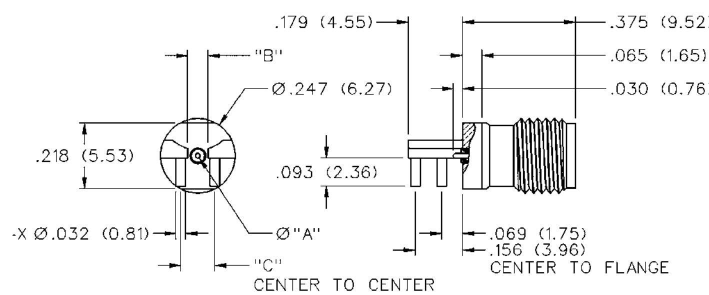


Coupling proof
torque 8 inch pounds
maximum
without support
wrench



Gold Plated	High Frequency Substrate Thickness	"A"	"B"	"C"
142-0761-811	.008 (0.20) - .014 (0.36)	.010 (0.25)	.050 (1.27)	.096 (2.44)
142-0761-831	.014 (0.36) - .020 (0.51)	.015 (0.38)	.067 (1.70)	.113 (2.87)

Jack Receptacle – PC Mount, Round Body with Thick Legs



Gold Plated	High Frequency Substrate Thickness	"A"	"B"	"C"
142-0761-881	.008 (0.20) - .014 (0.36)	.010 (0.25)	.050 (1.27)	.096 (2.44)
142-0771-821	.014 (0.36) - .020 (0.51)	.015 (0.38)	.067 (1.70)	.113 (2.87)