

JOHNSON[®]

High Frequency End Launch Connectors

***Emerson Network Power
Connectivity Solutions***




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High Frequency SMA End Launch Connectors for Microwave PC Board Substrates

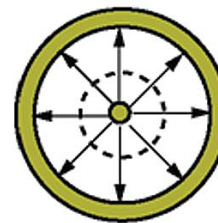
The Johnson[®] Patent Pending High Frequency End Launch connectors are used to transition energy from coaxial to planar transmission line structures. These patent pending connectors provide a unique solution for microwave engineers who fabricate circuit designs on very thin high frequency substrates. The in-line connector design minimizes reflections as compared to a right-angle (perpendicular) pc mount transition.

Applications for these connectors include:

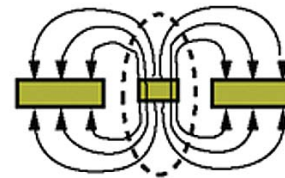
- Cellular Linear Power Amplifiers
- Broadband MMIC Power Amplifiers
- Microwave Filters, Mixers and Combiners
- Wireless Infrastructure Antennas
- DBS Low-Noise Block Down Converters
- Remote Sensing and Metering
- Global Positioning Satellite Antennas
- Phased Array Antennas
- Radar Systems
- High Speed Routers and Switches
- Automated Test Equipment
- RF Identification Tags

The Johnson[®] High Frequency End Launch connector is designed to attach directly to a high frequency coplanar waveguide (CPW) circuit board transmission line, although other lines such as microstrip can be used with good results. These connectors can be used on high frequency PC board substrate layers as thin as 8 mils, and operate at frequencies up to 26.5 GHz (see Return Loss chart).

“PATENT PENDING”



COAXIAL

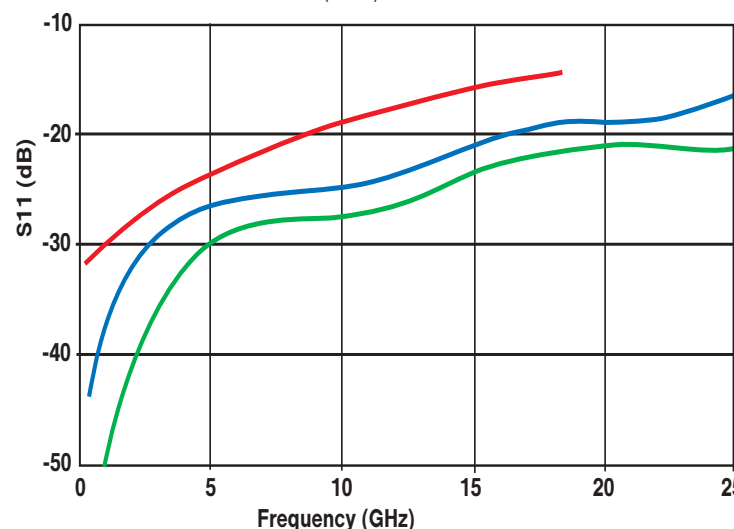


COPLANAR

Typical Return Loss

Measured on 50 ohm GCPW fabricated on Rogers[®] RO-4003™

— 142-0761-811 (8 mil substrate) — 142-0761-871 (16 mil substrate)
— VSWR = 1.05+ .02F(GHz)



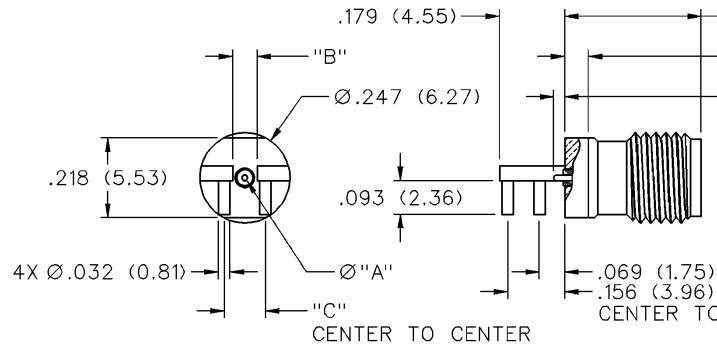
This connector is an economical alternative to other high frequency designs in the industry. This pending design differentiates itself from other launch connectors:

- Design of the connector is self contained, no external mounting screws, adapter sections, screws, clips, etc. are required for assembly to the circuit board.
- Center contact pin does not require special orientation to the surface of the circuit board. The center contact is mechanically captivated and optimized to maintain proper impedance while standing torque and axial force stress.
- Output coax of the connector at board launch is sized appropriately to match the thickness of high frequency board substrate. The output coax section extends well within the connector maintaining constant inner and outer coaxial diameters.
- Signal side grounding legs of the connector are spaced close enough to keep grounding pads short, but far enough apart to maintain constant impedance in the launch transition area.
- Signal side grounding legs and GCPW geometry control radiation, no additional shielding required to prevent signal cross-talk effects in the transition area. The launch transition is effectively isolated from adjacent transmission lines in the signal plane.
- Connector is not locked into position when placed on the circuit board. Intentional floating design allows proper alignment in X, Y and Z, minimizing discontinuities due to manufacturing tolerances.
- The new distinctive through hole mounting technique allows the use of one connector with various circuit board thicknesses. The connectors are also available in a traditional straddle mounted launch design, which was pioneered by Emerson Network Power Connectivity Solutions over 20 years ago.
- A small amount of PTFE insulation projects from the rear mating plane of the connector, acting as a seal when soldering the center conductor pin to the trace. The connector is held against the circuit board edge during the soldering process, compressing the PTFE insulation. This effect creates a barrier between the inner and outer conductors, preventing the bridging of solder.
- Appropriate sized connectors do not require additional compensation to standard coplanar microstrip matched impedance line geometries. Transition can be fine-tuned by pulling the connector back a slight amount from the board edge.

Jack Receptacle – PC Mount, Round Body

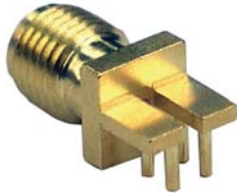


Coupling proof torque 8 inch-pounds maximum without support wrench

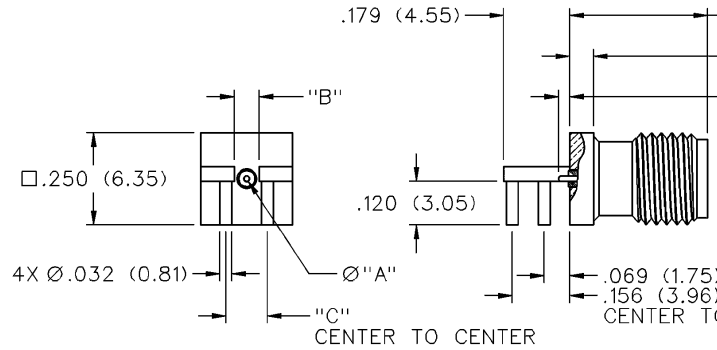


FREQ RANGE	GOLD PLATED	HIGH FREQUENCY SUBSTRATE THICKNESS	"A"	"B"
0-26.5 GHz	142-0761-801	.008 (0.20) - .014 (0.36)	.010 (0.25)	.050 (1.27)
	142-0761-821	.014 (0.36) - .020 (0.51)	.015 (0.38)	.067 (1.70)

Jack Receptacle – PC Mount, Square Body

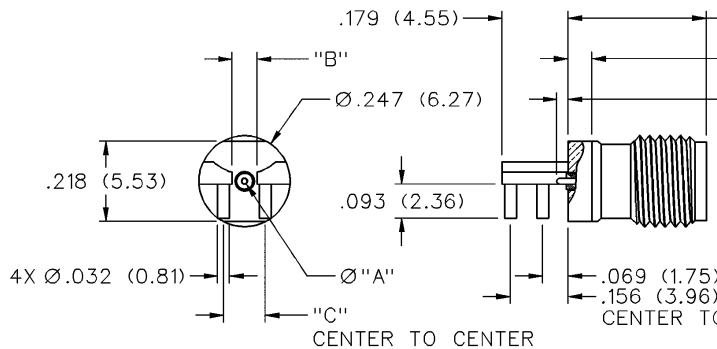


Coupling proof torque 8 inch-pounds maximum without support wrench



FREQ RANGE	GOLD PLATED	HIGH FREQUENCY SUBSTRATE THICKNESS	"A"	"B"
0-26.5 GHz	142-0761-811	.008 (0.20) - .014 (0.36)	.010 (0.25)	.050 (1.27)
	142-0761-831	.014 (0.36) - .020 (0.51)	.015 (0.38)	.067 (1.70)

Jack Receptacle – PC Mount, Round Body with Thick Lead

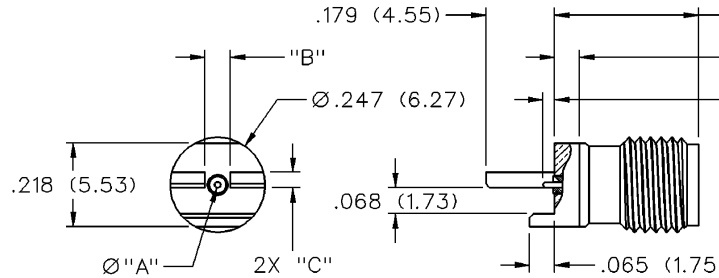


FREQ RANGE	GOLD PLATED	HIGH FREQUENCY SUBSTRATE THICKNESS	"A"	"B"
0-26.5 GHz	142-0761-881	.008 (0.20) - .014 (0.36)	.010 (0.25)	.050 (1.27)
	142-0771-821	.014 (0.36) - .020 (0.51)	.015 (0.38)	.067 (1.70)

Jack Receptacle – Edge Mount for .062 Board, Round Board



Coupling proof torque 8 inch-pounds maximum without support wrench

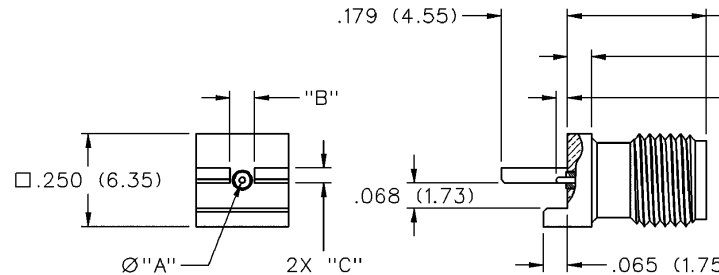


FREQ RANGE	GOLD PLATED	HIGH FREQUENCY SUBSTRATE THICKNESS	"A"	"B"
0-26.5 GHz	142-0761-841	.008 (0.20) - .014 (0.36)	.010 (0.25)	.050 (1.27)
	142-0761-861	.014 (0.36) - .020 (0.51)	.015 (0.38)	.067 (1.70)

Jack Receptacle – Edge Mount for .062 Board, Square Board

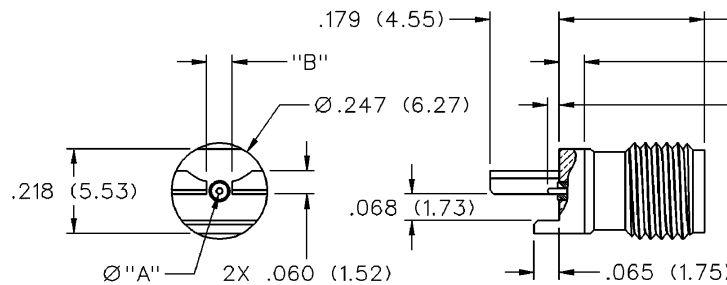


Coupling proof torque 8 inch-pounds maximum without support wrench



FREQ RANGE	GOLD PLATED	HIGH FREQUENCY SUBSTRATE THICKNESS	"A"	"B"
0-26.5 GHz	142-0761-851	.008 (0.20) - .014 (0.36)	.010 (0.25)	.050 (1.27)
	142-0761-871	.014 (0.36) - .020 (0.51)	.015 (0.38)	.067 (1.70)

Jack Receptacle – Edge Mount for .062 Board, Round Board with Thick Legs



FREQ RANGE	GOLD PLATED	HIGH FREQUENCY SUBSTRATE THICKNESS	"A"	"B"
0-26.5 GHz	142-0761-891	.008 (0.20) - .014 (0.36)	.010 (0.25)	.050 (1.27)
	142-0771-831	.014 (0.36) - .020 (0.51)	.015 (0.38)	.067 (1.70)

PC MOUNTING INSTRUCTIONS

High frequency end launch performance is dependent upon proper mounting. The following factors must be considered for optimum performance:

- The connector should fit tightly against the circuit board edge, avoid gaps.
- The center contact pin must lie parallel and flat against the circuit board, avoid gaps.
- The contact pin should be centered on the circuit board signal trace.
- Use a minimal amount of solder between the contact pin and signal trace. Do not allow excess solder to bridge the signal trace or flow down the trace.
- Clean all excess flux and other residue from the launch area, especially between the trace and ground.

The basic steps required to mount the end launch connector to the circuit board are as follows:

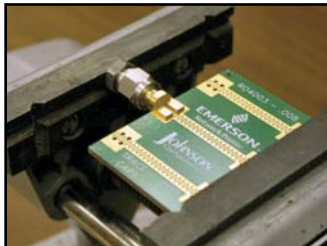


Figure 1

- Fixture 140-0000-973 should be used as an aid during manual mounting. The fixture protects the connector from damage during clamping and maintains the proper location of the connector's insulator and center pin. To use the fixture, thread the coupling nut on the mating end of the connector and hand tighten. This mounting assembly can now be held in place by a similar clamping device, as shown in Figure 1.

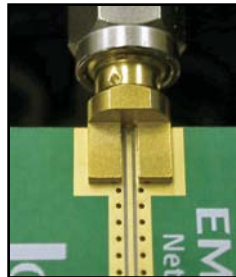


Figure 2

- Position connector on the circuit board, making sure the center contact pin is aligned with the center of the signal trace as shown in Figure 2. The connector legs and contact pin are held flush against the edge of the circuit board, keeping the axis of the connector parallel to the plane of the circuit board, as shown in Figure 3.

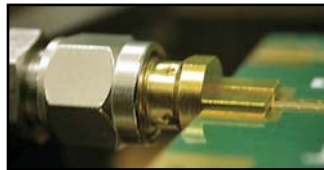


Figure 3

- A small amount of Teflon® insulation projects from rear mating port of the connector, which acts as a seal when soldering the center contact pin to the trace. Clamp the connector tightly against the edge of the board. This action compresses the insulator seal against the board edge, effectively creating a barrier between the inner and outer conductors, preventing the bridging of solder.

- While ensuring the connector is held in the correct position, clamp the ground legs and/or ground posts to the top and bottom of the board edge, bonding the center pin to the trace.

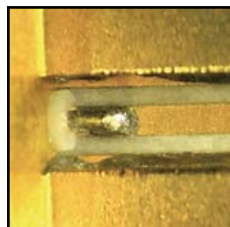


Figure 4

- Once the connector body is properly grounded to the board, the center contact pin can be bonded to the trace by using a minimal amount of solder as shown in Figure 4. It is important that solder flows over the length of the exposed pin, creating a good electrical and mechanical connection. Remove any excess solder that is not required for a good connection.



Figure 5

- Clean all flux and other residues from the trace area between the signal trace and side ground legs, as any flux present between the signal trace and ground will affect performance. The completed mounting assembly is similar to the one shown in Figure 5.

Mounting Footprint Info

1. All of the drilled holes are plated through the entire circuit board stackup.
2. All hole patterns are symmetrical about center of the trace.
3. The recommended mounting footprints are shown for the top (signal) side of the board only. Use ground planes on additional layers as appropriate.
4. For optimum high frequency circuit board performance, use the following fabrication guidelines:
 - A. Maintain a solid ground plane below the high frequency substrate layer.
 - B. Control the pullback of the trace and grounds from the board edge.
 - C. Continue the grounded coplanar waveguide line beyond the ground pad area.
 - D. Place 16 mil diameter ground vias on both sides of the coplanar waveguide line, spaced at 50 mil intervals along the length of the line.
 - E. Immersion gold plate (ENIG) all high frequency conductors per IPC-4552.
 - F. Do not coat the coplanar waveguide signal trace or open ground gaps with soldermask.

Reference dimensions for 50 ohm grounded coplanar waveguide using Rogers Corporation RO4003C™ high frequency substrate laminate *

Part Number	GCPW 50Ω Impedance Reference Dimensions *				Mounting and Via Hole Dimensions		
	Substrate Thickness	Conductor Thickness	Trace Width "A"	Ground Gaps "B"	Fig	"C"	"D"
142-0761-801	.0080 (0.203)	.0014 (0.036)	.0155 (0.394)	.0100 (0.254)	1	.066 (1.68)	.066 (1.68)
142-0761-811	.0080 (0.203)	.0014 (0.036)	.0155 (0.394)	.0100 (0.254)	1	.066 (1.68)	.066 (1.68)
142-0761-821	.0160 (0.406)	.0014 (0.036)	.0285 (0.724)	.0100 (0.254)	1	.084 (2.13)	.112 (2.84)
142-0761-831	.0160 (0.406)	.0014 (0.036)	.0285 (0.724)	.0100 (0.254)	1	.084 (2.13)	.112 (2.84)
142-0761-841	.0080 (0.203)	.0014 (0.036)	.0155 (0.394)	.0100 (0.254)	2	.066 (1.68)	.066 (1.68)
142-0761-851	.0080 (0.203)	.0014 (0.036)	.0155 (0.394)	.0100 (0.254)	2	.066 (1.68)	.066 (1.68)
142-0761-861	.0160 (0.406)	.0014 (0.036)	.0285 (0.724)	.0100 (0.254)	2	.084 (2.13)	.112 (2.84)
142-0761-871	.0160 (0.406)	.0014 (0.036)	.0285 (0.724)	.0100 (0.254)	2	.084 (2.13)	.112 (2.84)
142-0761-881	.0080 (0.203)	.0014 (0.036)	.0155 (0.394)	.0100 (0.254)	1	.066 (1.68)	.066 (1.68)
142-0761-891	.0080 (0.203)	.0014 (0.036)	.0155 (0.394)	.0100 (0.254)	2	.066 (1.68)	.066 (1.68)
142-0771-821	.0160 (0.406)	.0014 (0.036)	.0285 (0.724)	.0100 (0.254)	1	.084 (2.13)	.112 (2.84)
142-0771-831	.0160 (0.406)	.0014 (0.036)	.0285 (0.724)	.0100 (0.254)	2	.084 (2.13)	.112 (2.84)

* These calculated dimensions assume a quasi-static mode of propagation, but dispersion does exist for coplanar waveguide. The effective impedance and effective dielectric constant may increase slightly for X-band and higher frequencies, unless very small ground gap spacing is used.

It is assumed the conductors have rectangular cross-sections. The etching process used in circuit board fabrication actually produces trapezoidal shapes. Therefore, the GCPW impedance may increase somewhere between that of a perfect rectangular conductor and that of a zero thickness conductor.

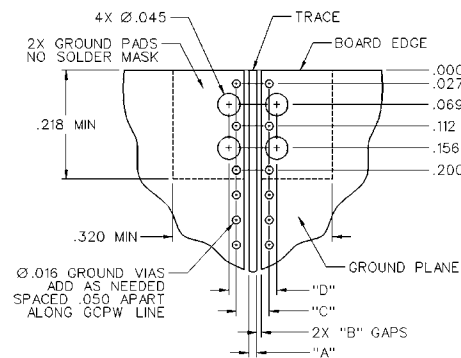


Figure 1

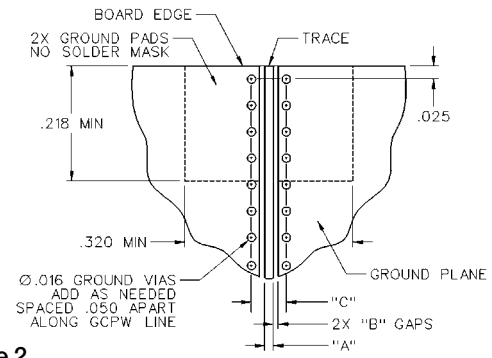


Figure 2

Low VSWR and Insertion Loss over a Wide Bandwidth

An accurate characterization of packaged microwave circuits, such as broadband MMIC 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 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 reactance small, as shown in Figure 1. The electrical design must match the impedances and other internal discontinuity reactances over the entire bandwidth.

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 PCB board. The internal transition between the input and output consists of gradual 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 step sections to match the size of the circuit board reduces the overall effect of the discontinuity, 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 height 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.

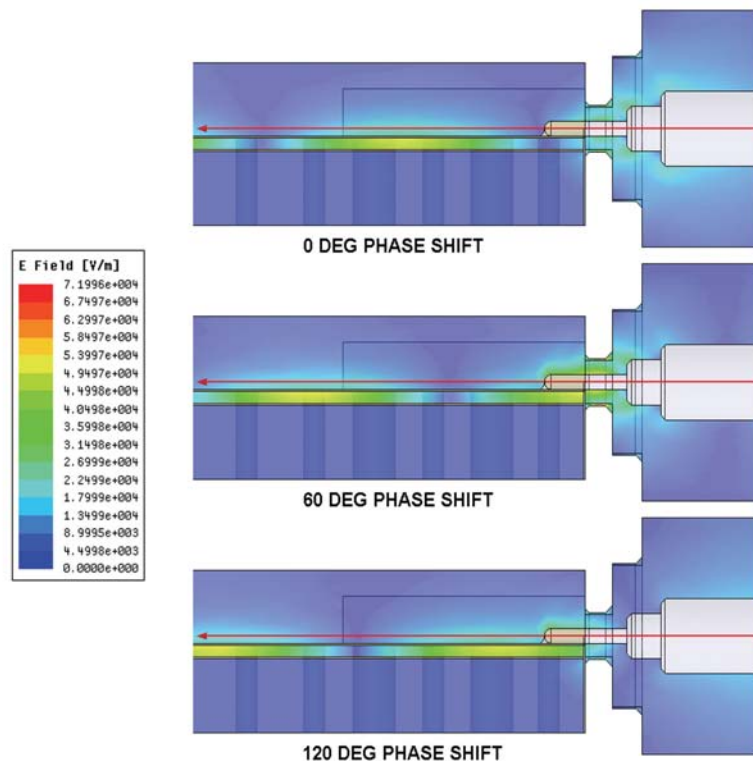


Figure 1 - Simulated Electric Field Distributions within the Dielectric Regions at 18 GHz

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 planes, all on the same plane, atop of a high frequency dielectric medium. A variant is formed if 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. 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 detailed 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 BCB. 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 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 construction consisting of high frequency laminates and epoxy/glass substrates have become an increasingly popular alternative to lower overall circuit board costs. The DC, control and digital signal paths are designed on the lower cost epoxy/glass FR4 layer and the microwave signals are carried on the high frequency layer as shown in Figures 1A and 1B.

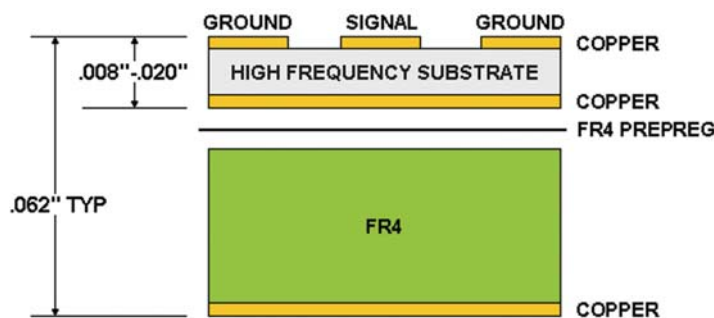


Figure 1A

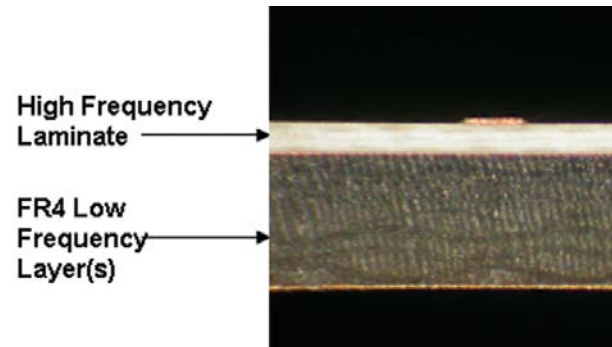


Figure 1B

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

As can be seen in the cut away portion of Figure 1, the connector's center conductor pin is attached in-line with the GCPW signal trace. The body of the connector is always attached to 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 distribution of 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 constant diameters, avoiding any abrupt diametrical changes at the circuit board edge which cause large discontinuities.

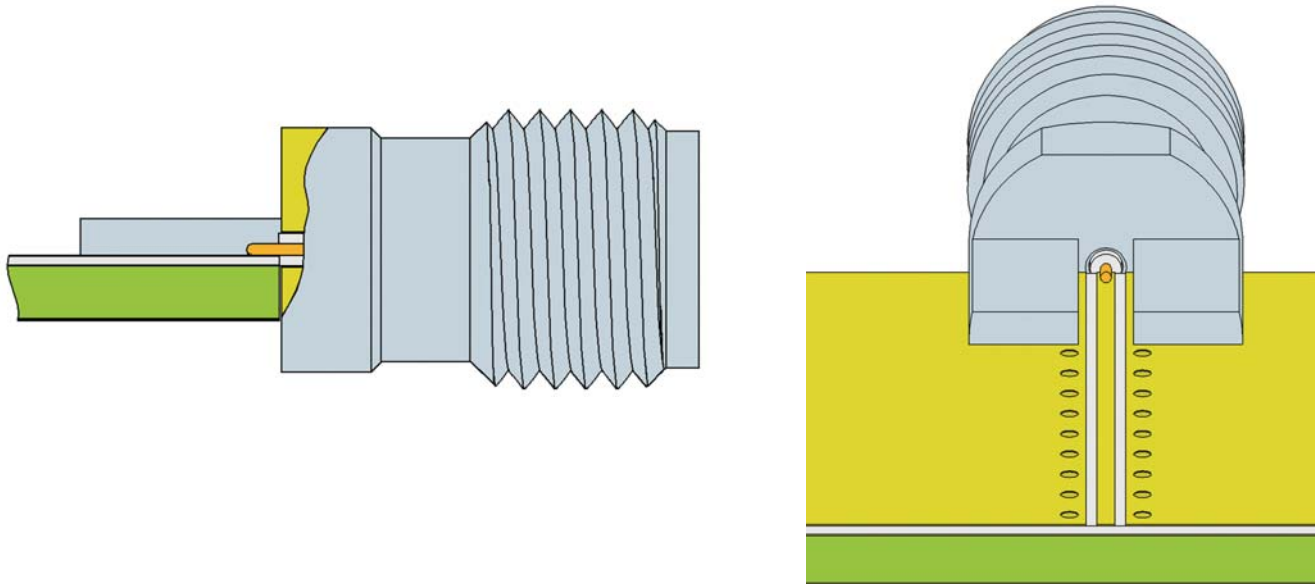


Figure 1 - End Launch Connector Shown Attached to the GCPW Transmission Line

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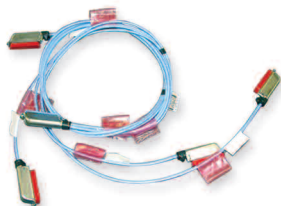
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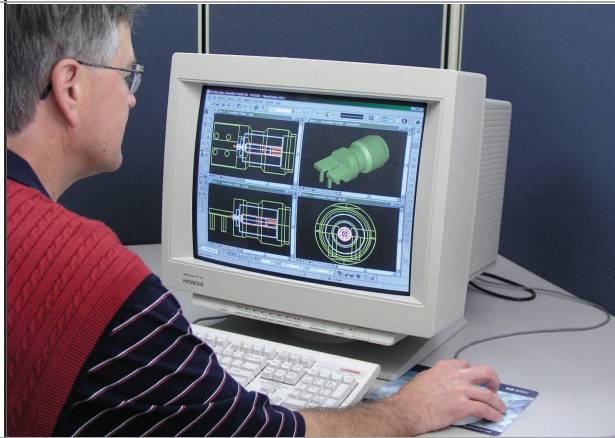
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