EZiCoax – Novel Single-piece miniature coax for transmission of signals capable to 67 GHz

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INTRODUCTION

Traditionally, board to board coax solutions require three pieces, two shrouds with contact pins that are soldered to each board and a bullet style contact that connects the two (Fig. 1.). These solutions have high mating forces and even higher de-mating forces usually in the order of Kilograms (Kg) per contact. The assembly of these contacts require precision in manufacturing and can lead to rework and even scrap in production. Due to the high mating and un-mating forces of these types of connectors, the end user risks damaging their assembly if rework is needed.

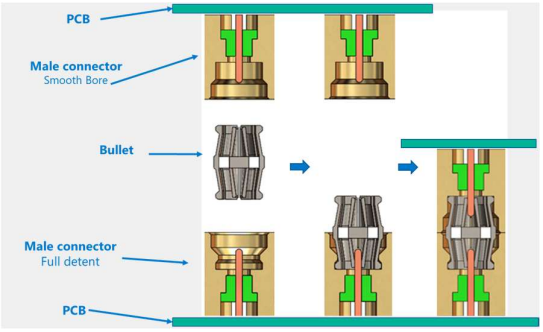

Fig. 1. Example of Bullet Style Coax

This paper describes a novel approach to interconnect RF signals from one board to another up to 67 GHz without the need for laborious soldering or rework using a low force coax contact that has been designed for Space and Defense applications.

INVENTION

Smiths Interconnect has designed and developed a single piece, compression mounted, spring-loaded, miniature 50 Ohm coax connector that can perform up to 67 GHz. The coax is spring loaded with moving plungers on each end for signal and ground that is designed into an interposer to provide alignment to the Printed Circuit Board (PCB). The signal probe is pressed into a Polytetrafluoroethylene (PTFE) dielectric that has been specially designed with splines to reduce the dielectric constant of the material so the diameter of the outer coax can be reduced to achieve the 50 ohms impedance. The coax is designed to have a max compression of 3.3 mm with +0.2 mm of working range and can be

used on 3mm centers. Fig. 2 and Fig. 3 below show the CAD design and a sample of 4 Coax with an array of probes to demonstrate how the technology can be integrated into hybrid interposers.

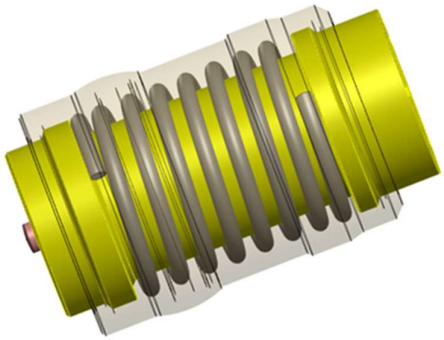

Fig. 2 EZiCoax CAD Model

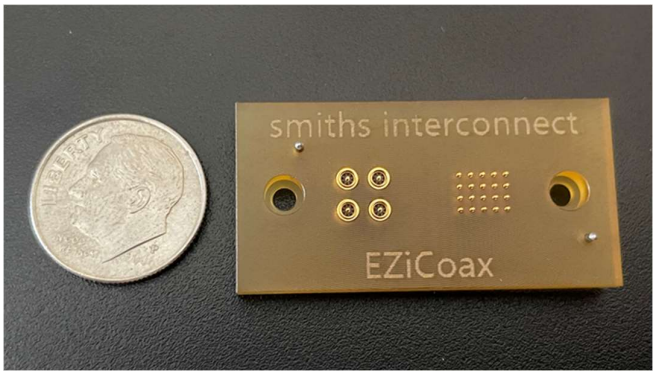

Fig. 3 EZiCoax Hybrid Sample

VALUE PROPOSITION

EZiCoax (pronounced “Easy”) was developed to provide the market with a low-force coax contact that can transmit signals between two PCB’s with out the need to solder the assembly in place. An Interposer system is used to align the contact with the PCB and hybrid solutions with power and signal contacts can be integrated into the interposer to provide a total solution. The interposer is service removable and can be reworked without potential damage to other components and the PCB. It can absorb X and Y tolerances up to half the diameter of the signal pad and Z tolerances up to 0.2mm from the minimum working height.

MECHANICAL DESIGN PARAMETERS

EZiCoax is designed with materials that are known to have low outgassing properties and can withstand space and harsh environments. The critical components are plated with 1.27 um of type II hard gold. Fig. 4 below shows the critical dimensions and materials used in the construction of EZiCoax.

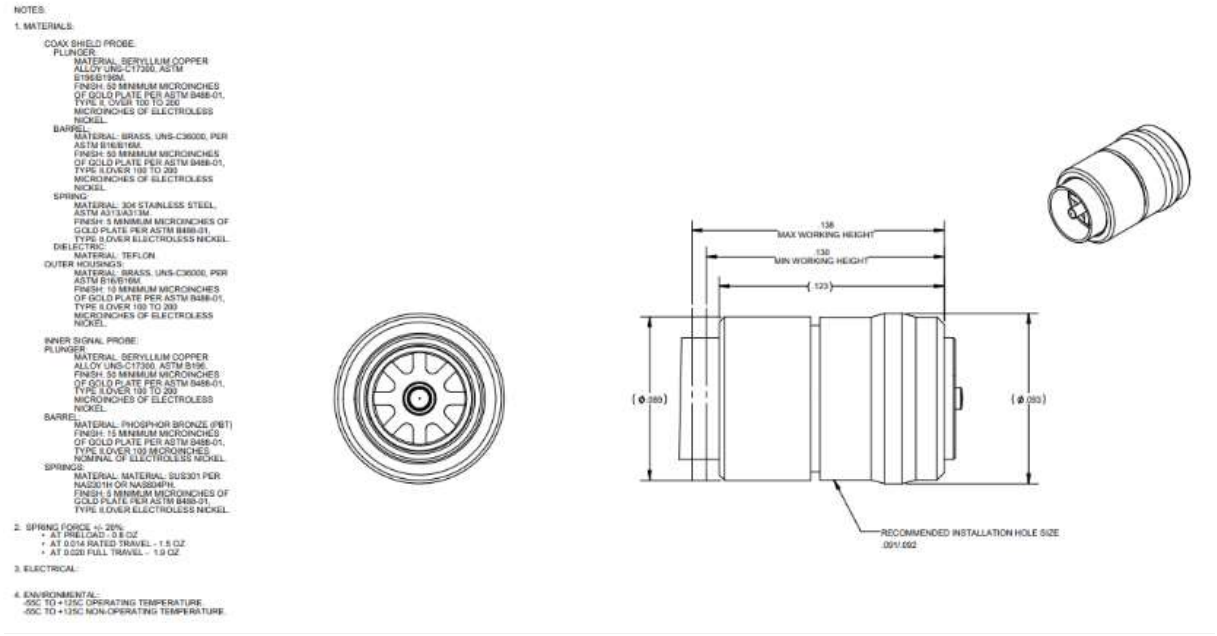

Figure 4. Materials and Critical Dimensions

ELECTRICAL DESIGN REQUIREMENTS

EZiCoax is designed to match 50 Ohms impedance and to have less than 1 decibel (dB) Insertion Loss (IL) and greater than -20 dB return loss through 40 Gigahertz (GHz). The design requirement for mating cycles is 1000 mates and de-mates but it has been tested through 10,000 mating cycles without degradation. It can operate at temperatures from -50 to 125 degrees Celsius and withstand shock and vibration. Table 1 below lists all the design requirements for EZiCoax which are expected to go through final qualification early in the spring of 2023.

Table 1

Attribute	Spec	Units	Comments
Impedance	50	Ohms	
Mating Cycles	1000		
Current Capacity	1	A	DC
Power Capacity	20	W	CW**
Voltage Rating	60	V rms	
Dielectric Withstanding Voltage	5000	V	DC
Impedance	50	Ω	
Insertion Loss	-1	dB	DC to 40 GHz
Insertion Loss	-2	dB	40-67 GHz
Return Loss	>20	dB	DC to 40 GHz
Return Loss	>10	dB	40-67 GHz
NEXT	> 60	dB	DC to 67 GHz
FEXT	> 60	dB	DC to 67 GHz
Temperature Range	-50 to 125	° C	

Thermal Shocks	100		
Vibration	10 to 2000	Hz	EIA-364, Condition IV, 10 Nanosecond
Shock	300	G	EIA 364, Half Sine
EMI	> 65	dB	Immunity
Shock	300	G	EIA 364, Half Sine

** This has not been tested

RF TEST RESULTS

The initial results showed promising performance for IL and RL. The results shown in Fig. 5 below met the design requirement as expected.

Figure 5

As more samples were tested, a high Q resonance was detected at the middle frequency as shown in Fig. 6. below.

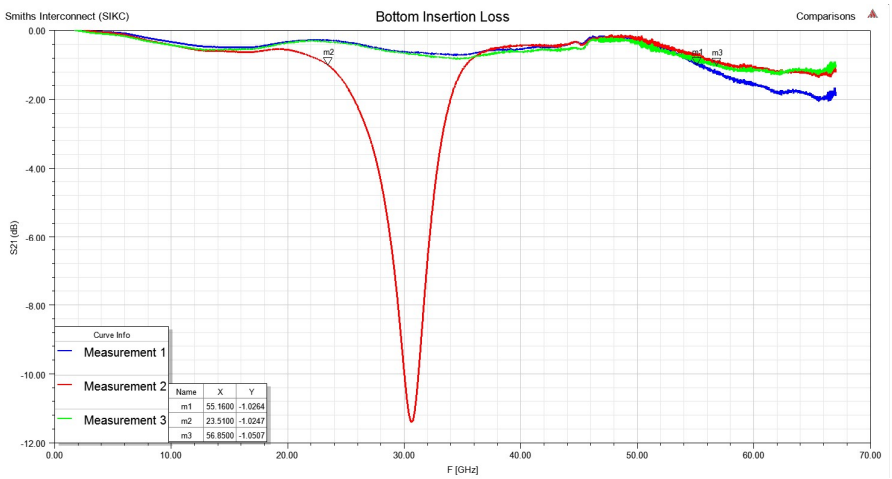

Fig. 6. Coax Repeatability

SIMULATION

It was hypothesized that the cause of the high Q resonance was due to disruption in contact with the return plane of the coax. This coax shield plunger contact was modeled in HFSS to see if the resonance could be replicated. Fig. 7. below shows a series of models that were simulated. The first simulation (top left) reproduced the resonance at the mid-frequency range. Looking left to right, the contact area is increased, and the resonance moves to the right as the contact area exceeds 50 percent of the circumference of the barrel.

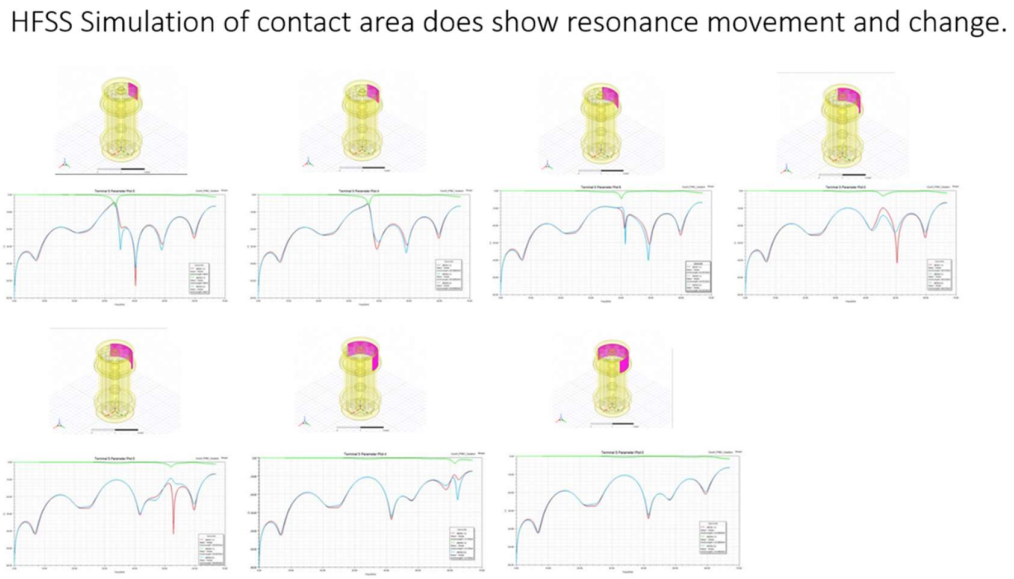

Figure 7. Simulation of shield plunger contact

SUMMARY

EZiCoax is a single-piece, solderless, low-force, compression-mounted, coax capable of performing to 67 GHz. It has a low cost of ownership because of its ease of installation and is service removable without potential damage to the PCB and the surrounding components. It has been designed with materials that can withstand the harsh environments and has low out-gassing properties. Electrically, it has shown that it can perform up to 67 GHz but has a high Q resonance at the middle frequency, around 30 GHz. Simulation confirmed that the cause of the high Q resonance is due to disruption of contact between the shield plunger of the coax and the outer barrel that is the return plane for the coax. Engineering is working diligently to resolve the issue. For now, the coax is under evaluation with a beta customer for an application in radar that is below the resonant frequency. The 3.3mm long coax is the first of its kind and other coax lengths are on the roadmap along with right-angle versions and cabled solutions.