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Handling Continuous Power in Bonded Stripline on RT/duroid® Laminates

Design of printed circuits for high continuous power transmission should take into account the heat generated by transmission lines and a means for dissipating it.

Data has been published showing the temperature rise of the center conductor for a stripline transmission line having several ground plane spacings with the center conductor width selected for 50 ohm characteristic impedance ([1]). It is clearly desirable for a given Z_0 to use as large a ground plane spacing as possible since this allows for the maximum width of the center conductor and thus reduces resistive heating in the metal.

For maximum conduction of heat to the ground planes it is advisable to bond the cover and circuit board together to improve thermal conductivity to the cover board. This may be done with several types of bonding films or by direct bonding (fusing the two boards without film). (See literature 4.4.1 for bonding information). Direct bonded assemblies will withstand temperatures in excess of 260°C (500°F), but assemblies with lower melting point films will suffer impaired bonding if the center conductor reaches the melt point of the film.

From the investigation reported here, it appears that the limitation in power for a stripline circuit will be the connections to the circuit board. The following results were obtained in an investigation and serve to illustrate this:

Bonded stripline assemblies were prepared with cards of RT/duroid® 5870 copper clad reinforced PTFE laminate. The cards were clamped with an interleaved film of 0.001-inch thick TEFLON® FEP in a platen press at 155 psi with platen temperature of 288°C (550°F) for one hour and allowed to cool under constant pressure.

The resulting 16-inch-long bonded card assemblies were fitted with Type N/stripline launcher adapters for test at a series of continuous power levels at 5.5 GHz to determine the degree of heating and degradation of performance.

Assembly	1	2
Thickness of dielectric, inches	0.063	0.125
Ground plane spacing, inches	0.125 nom.	0.250 nom.
Type of copper foil	E.D.	E.D.
Line width, inches	0.098	0.196
Ground plane temperature °C (ambient 28°C)		
150 watts average power		
5 minutes	44	35
10 minutes	55	42
15 minutes	64	45
25 minutes	58	no data
200 watts average power		
5 minutes	70	51
10 minutes	76	55
15 minutes	80	57
20 minutes	82	no data
250 watts average power		
5 minutes	90*	62
10 minutes	no data	66
15 minutes	no data	69.5

**Note: At about 9 minutes of power reflection occurred. This was a connector failure caused by thermal expansion of the coaxial insulation which displaced the launcher pin.*

According to Howe ([1]) the center conductor should have come to a steady state temperature as outlined below:

Power level (watts)	150	200	250
Ground plane spacing			
0.125 inch	153°C	194°C	222°C
0.250 inch	110°C	138°C	166°C

The 260°C (500°F) melting temperature of the TEFLON FEP bonding film will limit the continuous power level attainable without bonded assembly failure. In the case of the tests described, the failure in the launcher adapter appears to be a limiting factor rather than the type of film used.

The most likely explanation for the failure observed at 250 watts is that the connecting pin heated rapidly due to transfer of heat from the center conductor. This caused the coaxial insulator to expand and build up pressure, causing movement of the pin and failure by reflection of power.

These results show the effect of continuous power level with no consideration of the effect of pulsed or peak power. It is expected that peak power levels would be limited by dielectric strength and corona inception levels for the assembly.

(1) Howe, Harland, Stripline Circuit Design (1974) Artech House, pp 26-30.

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