

Application Note: AN0005 Chip Device Mounting Instructions

All of the chip products in this catalog use thick film metallization for terminations — either platinum gold or platinum silver. Each material is used to accommodate the different bonding practices that are commonly used in RF and microwave applications. Some of these chips are offered with wraparound grounds and/or metal tabs. The wrapped parts use the same metallizations noted above for the ground plane. The tabbed parts are available in a variety of base metals and surface finishes. This application note describes the proper mounting technique for ensuring good RF performance, proper heat sinking, and mechanical support.

Overview

Each of the chip types discussed here is designed for a specific mounting application. **Table 1** shows the attachment techniques that are recommended for each of the products. The table is organized by termination type. Consult the product description for each specific part to determine which types are available.

Table 1
RECOMMENDED ATTACHMENT

TERMINATION TYPE		Epoxy	Wire or Die Bond	Solder Preform	Solder Paste	Pretinned Solder Reflow	Rosin Core Wire Solder	Flip Chip (Figure 1)
Planar	Term	X		X	X			X
	Ground	X		X	X			X
Pretinned (S)	Term				X	X		X
	Ground				X	X		X
Gold (G)	Term		X					
	Ground		X					
Three Tabs* (T3)	Term	X					X	
	Ground	X					X	
Two Tabs* (T2)	Term	X					X	
	Ground	X					X	
One Tab* (T)	Term	X					X	
	Ground	X	X	X	X			
Wraparound Ground (M)	Term	X						
	Ground	X	X	X	X			

* See Figure 2

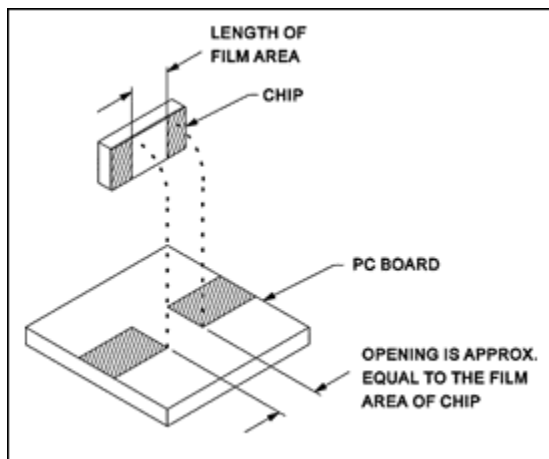


Figure 1

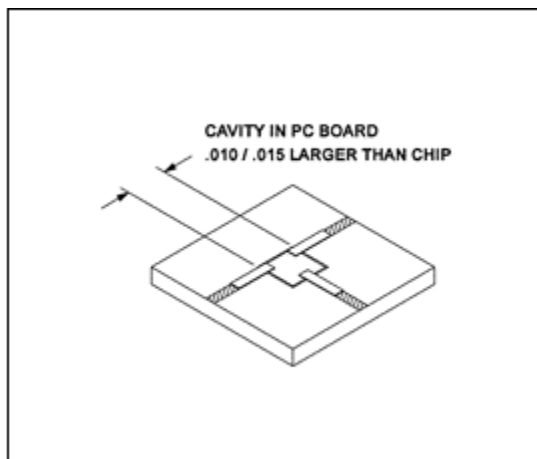


Figure 2

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When choosing an attachment technique, the primary concern is to achieve the desired RF performance. All the chip designs have been optimized to perform best when mounted according to the guidelines in Table 1. The most common use for these devices is on a 50 Ohm microstrip transmission line. RF performance will vary with the ground plane spacing under the device, as well as with the dielectric constant of any insulating material. Any device parasitic reactance can usually be compensated for with external circuitry. In general, for attenuation values of 1 through 8 dB, capacitance to ground should be minimized. This can be accomplished by using a thick, low dielectric ground plane spacing. For values of 8 dB and higher, the best performance is achieved if low inductance ground connections are made. In all cases, grounding is critical. If the device is surface mounted, you must provide plated thru-holes in close proximity to the topside ground pad (**Figure 3**). For terminating resistors, the same rules apply to the ground connections. For in-line resistors, the parasitic reactances associated with the termination connections must be minimized. This can be accomplished by matching both the chip pad size and the attachment method to the line width of the circuit board. In some cases, a matching circuit is required to optimize the chip performance.

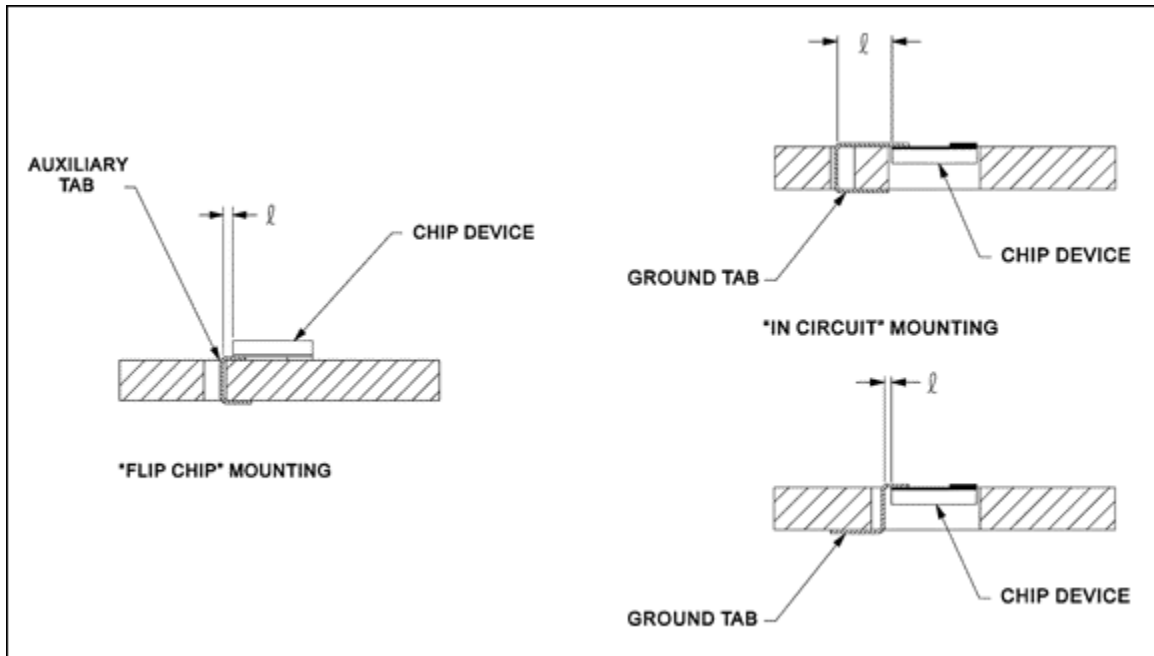


Figure 3

Part Preparation

Prior to mounting, both the parts and the mounting surfaces must be free of any impurities that may interfere with the attachment process. Common contaminants include finger oils, surface oxides and organic compounds associated with component processing and packaging.

Begin cleaning with a burnishing step on both surfaces. Use a solvent-resistant plastic eraser for this operation. After burnishing, clean the two surfaces using a low-boiling point solvent such as isopropyl alcohol. Use ultrasonic cleaning, followed by a rinse.

Epoxy

You may use epoxy bonding for most applications but be aware that its most serious drawback is outgassing. When used in a sealed package, outgassing can contaminate other parts.

We recommend silver conductive epoxies for RF applications. Select the epoxy based on its compatibility with the termination material. Silver epoxy is the best choice for platinum gold and platinum silver terminations. Solvent-free epoxies such as Ablestik 84-1LMI or EPO-Tek H20E are acceptable. The epoxy can be screened or dispensed onto the substrate surface prior to placing the part onto the board.

Where possible, an epoxy fillet should be visible to ensure full coverage. To ensure that the part does not move while making the connections, hold the chip in place using non-conductive epoxy.

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Epoxy preforms may be used for the ground planes of the M and T configurations. Ablestik ECF564A is a suitable conductive film adhesive. When using epoxy preforms, clamp the part in place with a spring clip or a weight to ensure that the preform adheres to both surfaces.

Soldering and Circuit Board Considerations

As with any other surface mount component, success when soldering depends upon the soldering surface. The size and location of the solder pads is critical. Provide a circuit board pad that is 0.010" to 0.020" over the termination size. Center the pad along the axis of the chip and bias it slightly from each end to allow for a solder fillet. Isolate the pads from the connecting lines to prevent solder wicking. Use either insulating solder dams over the conductors or narrow traces off of the pads. Failure to follow these guidelines can lead to component skewing and/or tombstoning (draw bridge).

EMC designed the mounting pads of chips to minimize the possibility of tombstoning¹. Pad size can help minimize tombstoning in two ways. First, by making the pad areas equal, the force from the surface tension of the liquid solder on the two pads will be equal. Second, since the chip is tipped by the lifting moment produced by the solder fillet, the smaller the chip height to pad width ratio is, the smaller will be the resulting lifting force². For flip-chip-mounting of attenuators, see the EMC series of TS0300 and TS0500 components. These are specially designed for surface mount applications. **Figure 4** and **Figure 5** may be used as guidelines for circuit board designs for TS0300 and TS0500 attenuators, respectively. For reliability reasons, W3 components are best mounted with the attenuator film facing the circuit board. When mounted in this manner, the three terminations that make direct contact to the film also make contact to the traces on the circuit board. Six of the nine terminations of the W3 may be damaged without producing an electrical failure if the part is mounted with the film side down.

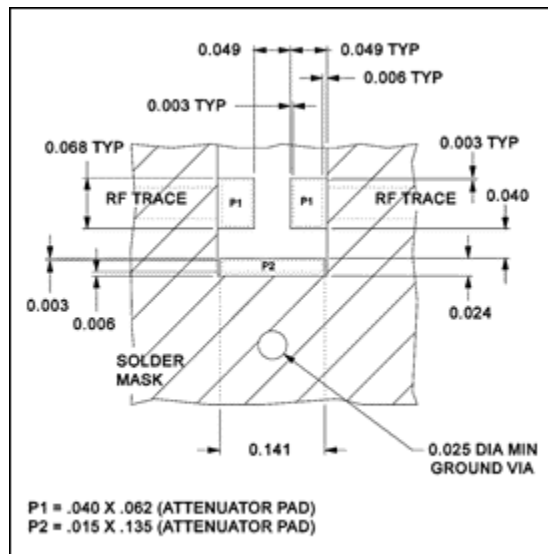


Figure 4

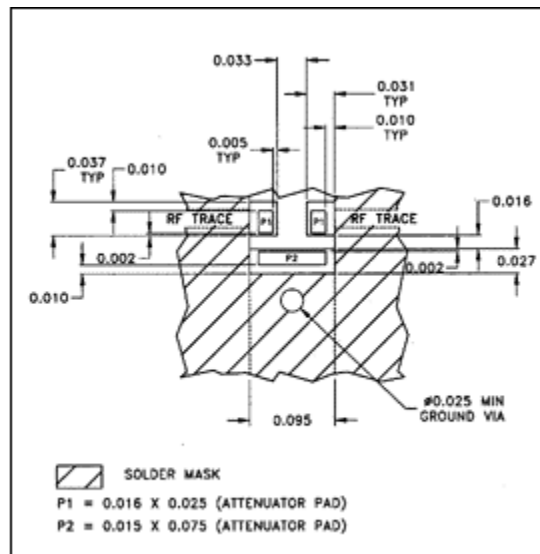


Figure 5

Flux

Flux is an acid-based solution used to clean the metal surfaces and remove any oxides prior to soldering. A mildly activated RMA flux (MIL-F-14256) normally works well. Apply the flux directly to all surfaces, including the solder, or as part of the solder paste, preform or wire.

Solder Preforms

Preforms are solid sheets of solder, available with or without flux, that are used primarily for soldering large ground plane areas. Set the preform on a prefluxed surface with the chip positioned over it. Hold the chip in the proper position during reflow with a non-solder wetting jig (e.g., Vespel[®], stainless steel, aluminum, etc.). Apply pressure to the top of the chip to prevent any trapped air from causing the part to tip or allowing gaps to form. The scrubbing action of a die bonder can prevent both. Die bonding is commonly performed using a heated stage with the reflow heat produced by a hot air torch or an infrared (IR) lamp. You may also solder the chip using a hot plate or furnace reflow technique. Set the soldering schedule to minimize the duration and intensity of the part exposure to high temperatures. Limit the time on the hot plate to 3 minutes if you are using a good

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thermally conductive and moderate thermal mass fixture. The short time interval will prevent flux “burning” and reduce the amount of brittle intermetallic compound formation. To ensure the formation of the proper solder fillet, select a preform size that is 0.005” to 0.010” larger than the size of the solder pad.

We recommend Sn 62 Pb 36 Ag 2 solder (178°C eutectic) for all soldering operations. However, soldering temperatures of 250°C for 30 seconds will not damage the parts.

Solder Paste

Solder paste is a solution of solder, flux, and solvents. Other materials are often added to optimize the screening or dispensing operation. Drying the paste slightly prior to soldering will eliminate any solvents that might boil and cause solder splashes. However, care must be taken not to dry out the flux completely. When large areas must be pasted, screening is the preferred method because it provides an even and repeatable deposition.

Deposit the paste onto the substrate either by dispensing or screening. Next, place the chips on the pasted areas. The tackiness of the paste will hold the surface mounted components in place. Next, flow the parts by heating the substrate up to the soldering temperature. Starting with a preheating stage will help reduce the thermal shock to both the parts and the substrate. Follow the preheating with a second stage heating up to the soldering temperature using an IR, soldering iron, flame, hot air torch, or with a furnace. Profiles of furnaces for various types of solder paste may be found in reference 3.

Pretinning

Pretinning is the solder coating of the component and/or the substrate prior to soldering the two together. This is most often accomplished by dipping the parts in a pot of molten solder. Pre-tin the substrate by plating during fabrication or by depositing and reflowing solder paste. Remove excess solder with a squeegee wipe. Solder the parts using the paste reflow techniques described above. Be particularly careful when pretinning these extremely small parts.

Tabs

We supply the T, T2, and T3 configurations with tabs already attached to the part. The base metal of the tab is always copper or a copper alloy. The finish is usually gold, however tin, 60/40 tin lead, and 10/90 tin lead finishes are available. Use high temperature (Sn 96.5 Ag 3.5 220°C eutectic) solder to attach the tabs to the parts. To reduce the possibility of the formation of any brittle intermetallic compounds at the joints, EMC uses a unique method to remove the gold on the tabs in the area of the solder joint. Use a standard Sn 62 solder to attach these tabs to the circuit board. You may use either paste or wire solder that is melted by reflowing or adding heat with an iron, torch, or other localized source. Welding is also acceptable, as long as the solder joint on the part is kept below its melting point (220°C).

Cleaning

After soldering, clean the substrate to remove any flux or residual solvents. Ultrasonic cleaning followed by a solvent rinse is the most common method. Many flux manufacturers also supply flux solvents.

Wire Bonding

EMC supplies chip attenuators (part number suffix “G”) with gold terminations for wire and ribbon bonding. Thermal compression and ultrasonic wedge and ball bonding are the most common methods. First, attach the chip to the substrate using epoxy. Heat the substrate to about 150°C. A gold metallic bond will form between the wire and the bonding pad by adding thermal and/or ultrasonic energy while compressing them together. As with the soldering operation, clean all surfaces prior to bonding, as described in the Part Preparation section.

References

¹ Erickson, David. “How to Design for Manufacturability.” *Surface Mount Technology*. February 1989.

² Giordano, Jerry and David Khoe. “Chip Resistor Design Helps Prevent Tombstoning.” *Surface Mount Technology*. August 1988.

³ Manko, Howard H. *Solders and Soldering*. McGraw Hill, Inc., 1992.