Amplifier Application Notes

LCA - Low Cost Amplifiers

Introduction

The LCA product line is designed for use in high volume commercial applications. This application note provides mechanical, electrical and mounting details for proper use and installation of the LCA product line.

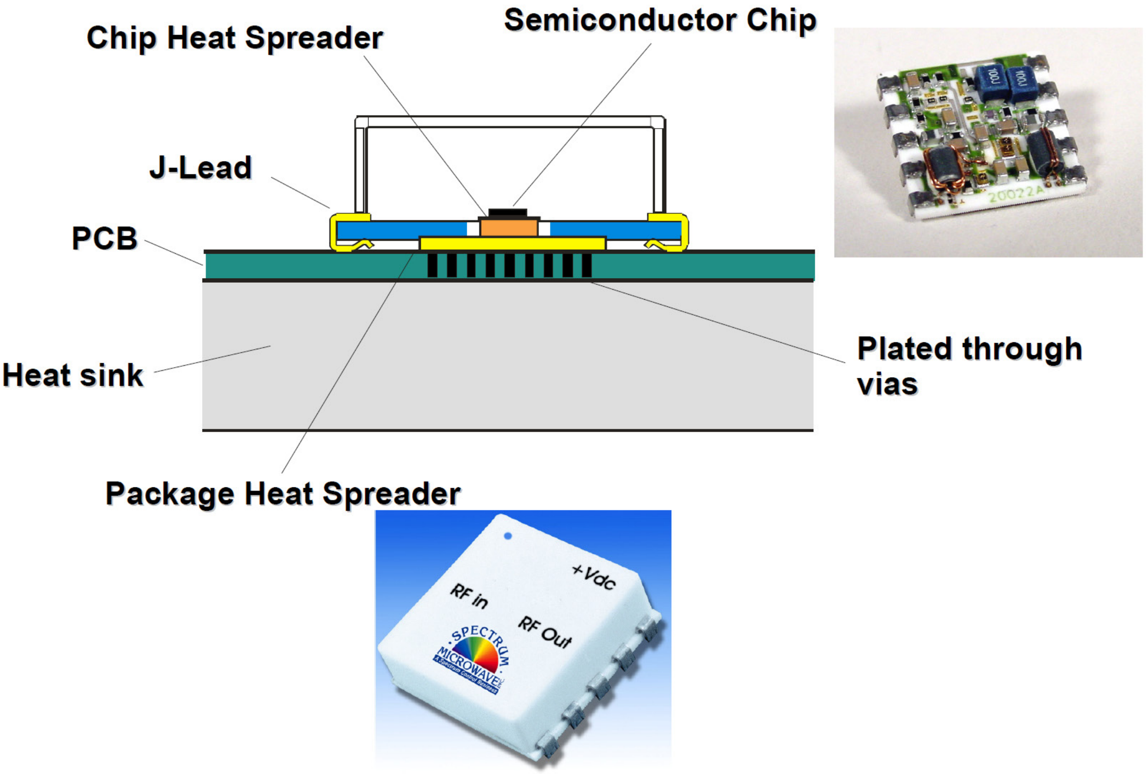
Package Outline and Printed Wiring Board Design

The LCA product line is manufactured in our standard package E52-19422. FIGURE 1 shows a crosssection of the LCA package and Figure 2 gives the mechanical outline dimensions of the package. The E52- 19422 outline drawing is available by request from the factory (phone 321-727-1838; FAX 321-727-3729).

The LCA product line is designed using a thick film ceramic substrate that contains printed and discrete lines and components. A gold plated copper (copper/moly/copper) heat spreader is eutectically attached to the underside of the ceramic substrate. This copper carrier serves two important functions which makes proper mounting to the printed wiring board very important.

First, the heat spreader removes heat from the LCA package. If not properly mounted, transistors inside of the LCA package could have excessively high junction temperatures. The second purpose of the heat spreader is for RF ground connection. If the copper carrier is not properly mounted amplifiers performance will be adversely affected and in severe cases oscillations could occur.

To insure proper thermal and RF interconnection to the printed wiring board, the PCB should be designed with the printed pattern shown in Figure 3.



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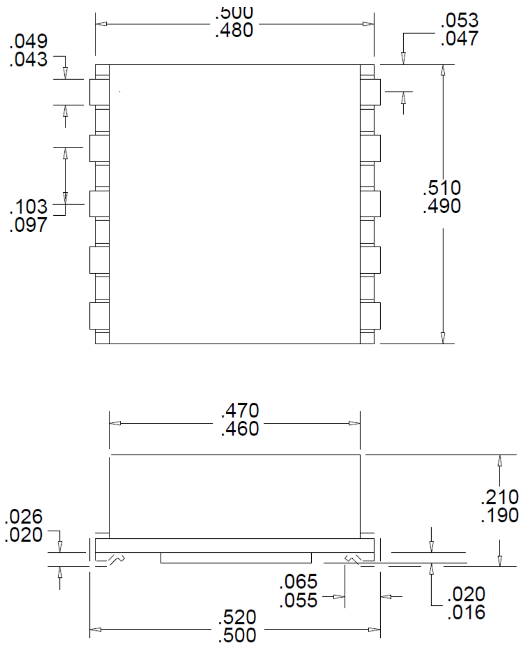
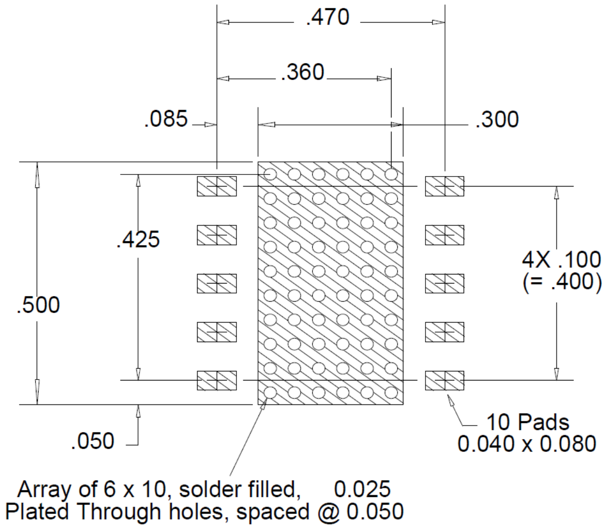


All dimensions are in inches.

Figure 2: Mechanical Outline Dimensions for LCA Package



PCB footprint

Figure 3: LCA Printed Wiring Board Layout

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LCA Package Standard Pin Designations

FIG. 4 shows the standard pin designations for all LCA amplifies.

All the pins designated as ground (GND) are internally interconnected. LCA amplifies should be mounted using the Figure 3 printed wiring board layout.

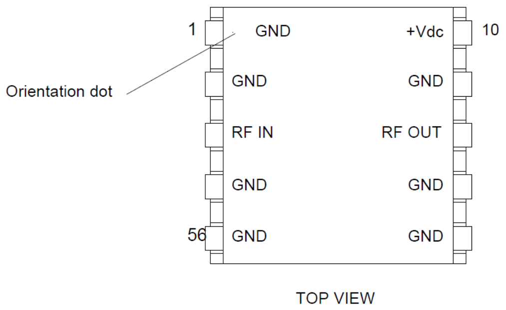

Figure 4: Typical Pin Designations for LCA Package

Printed Wiring Board Electrical Design

All LCA amplifiers contain internal blocking capacitors on the RF lines so that dc voltage is not present on the RF input or RF output lines. In a small number of designs, the dc resistance at the RF input and output pins is low because transformers or other components are connected before the dc blocking capacitors inside of the LCA package. If the RF input or RF output lines on the PCB contain a voltage, the amplifiers may provide a dc load to the power supply feeding these lines; therefore, good design practice is to use decoupling capacitors on the printed wiring board at the RF input and RF output. If it is not desirable to use PCB mounted blocking capacitors, APITech engineering should be contacted to verify that they can be omitted.

LCA amplifiers contain internal filter and RF decoupling capacitors on the dc input line. External PCB mounted capacitors are not required; however, it is good design practice to provide PCB mounted capacitors close to the amplifiers dc input pin.

Figure 5 shows typical LCA mounting with tips for optimum performance.

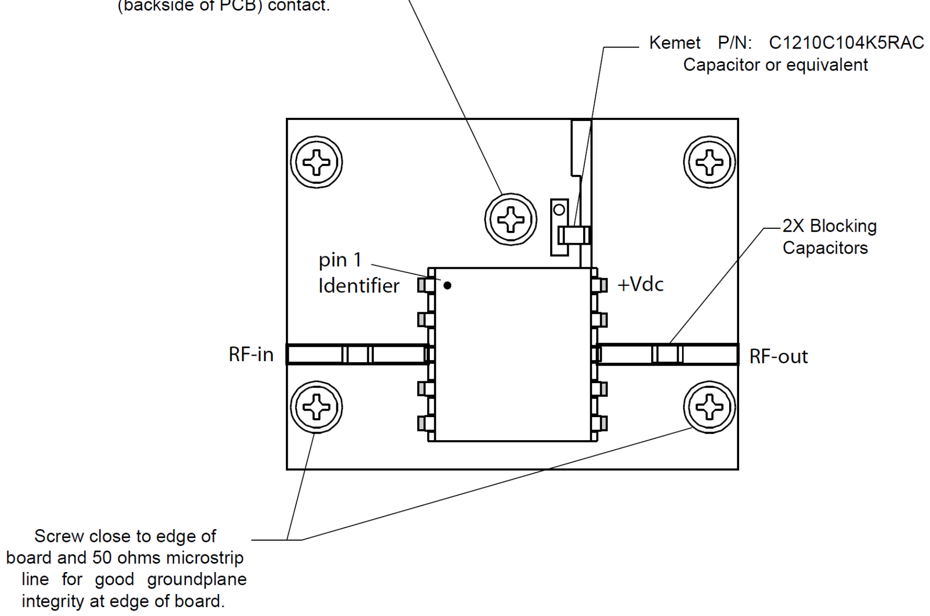

Figure 5: Typical LCA Mounting

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Solder Attachment of LCA Packages

SMT Devices Reflow Recommended Reflow Procedure:

Our SMT devices are manufactured using a high temperature Sn96.5/Ag3.5 no lead solder. This eutectic composition exhibits a liquidous temperature of 221 Centigrade.

This high melting temperature allows the use of a variety of solder compositions that exhibit liquidous temperatures at or below 190 Centigrade.

Our devices can be subjected to a lead temperature of 210 Centigrade during reflow.

Some of the recommended alloys are:

Composition	Melting Range Fahrenheit	Melting Range Centigrade
Sn60Pb40	361-374	183-190
Properties: Excellent leaching resistance due to Ag content.		
Sn63Pb37	361	183 (Eutectic)
Properties: Good capillary action.		

There are additional alloys that can be used, provided that the liquidous temperature does not exceed 190 Centigrade.

The following fluxes can be used to help wet the solder joint:

"R" Rosin Non-Activated

"RMA" Rosin Mildly Activated

"OA" Organic Acid: Halogenated/ nonhalogenated mixtures are used including water soluble and solvent soluble types.

Note: No-clean fluxes can be very sensitive to "flux activation time" and may require additional optimization of this reflow profile parameter.

The following reflow profile is typical of conditions necessary to achieve good reflow. The profile exhibits slow heat ramp-up, acceptable reflow dwell and rapid cool-down.

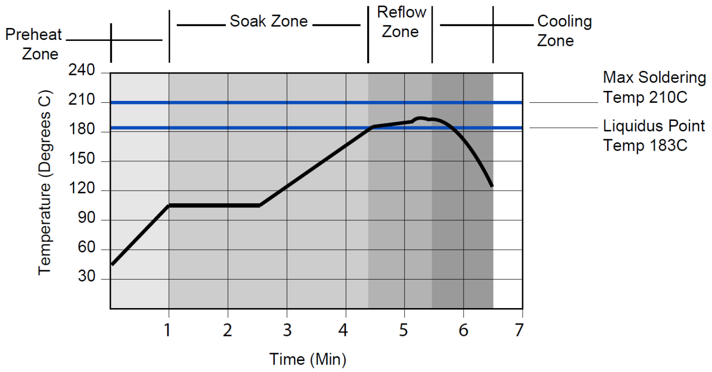

Figure 6: Typical Solder Reflow Time-Temp Profile

Convection and Infra-Red reflow methods are most commonly used for reflow. The total profile time varies by mass, density, and type of reflow equipment. Profile your ovens in a manner that will achieve best reflow results without damaging the circuit.

Remarks on Solder Profile

Preheat Zone

Ramp-up should not exceed 2C/sec; temperature should be 100-125°C. If the ramp is too fast, the solder paste may "explode" and cause solder balls & thermal shock to components made of ceramic.

Soak Zone

A soak zone at the beginning of profile will equilibrate temperature over large circuit boards. The length of the soak should be adjusted to achieve a maximum of 8-10°C temperature differential across the circuit board at the desired soak temperature (180°C for the referenced profile). The temperature is elevated to almost the melting point of the solder. The result of too high temperature in the soak zone will favor solder balls and solder splatter because of oxidation within the solder paste. This zone also acts as the flux activation stage.

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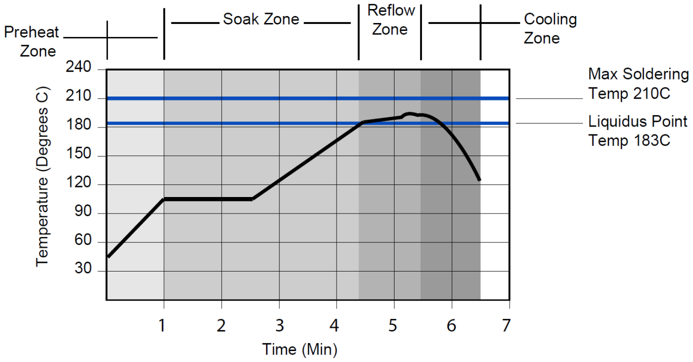
The maximum activation time between 150°C to 180°C should be 2.5 minutes for rosin solder paste and 2.0 minutes for water soluble solder paste.

Reflow Zone

If the temperature is too high, boards and components may char or burn. If too low, cold and grainy solder joints will result. The time above reflow is the measure of how long the solder on the PCB is liquidous. Generally solder liquidous times of 30-60 seconds are preferable, although liquidous times of 90 seconds or more are not uncommon on larger boards. If the solder is above reflow temperature too long, excessive growth of tin-copper intermetallics can occur and lead to a tin-depleted and brittle solder joint. If the solder is above the reflow temperature for less than 30 seconds, there is a risk that oven temperature fluctuation during sustained use could cause the profile to drop below reflow temperature.

Reflow Zone

The cooling rate after reflow is also important. The faster the cooling rate, the smaller the grain size of the solder. The cooling rate should be as fast as possible.



Thermal Dissipation Consideration

When LCSM components are mounted with the footprint pad as recommended in FIG. 3, ensuring that all plated through holes are filled with solder, that the heat spreader is soldered to the PCB pad, and that the backside of the PCB is flat and free of solder bumps to provide intimate contact between the PCB and the associated heatsink, as shown in FIG. 6, the worst case maximum junction temperature (Tjmax) for the active devices in the unit can be estimated as follows:

Tjmax = Max Thermal Rise (junction to case) + Th max + PDC * Reff

Where:

Max Thermal Rise (junction to case) for the LCSM device °C is provided in the device data sheet, Th max is the maximum heat sink temperature.

PDC is the DC power dissipated in the device that can be approximated by:

PDC [W] = DC Supply Voltage [V] * DC Supply current [A] as obtained from the LCSM device data sheet.

Reff is the effective thermal resistance between the Package Heat Spreader and the Heatsink, using Thermal Compound between the back of the PCB and the Heatsink, and using FR-4 PCB material with an array of Sn63 filled plated through holes, as shown in FIG.3.

TABLE 1 provides approximate values for Reff in °C/W, for 31mil and 62 mil thick FR-4 PCB material, assuming the use of thermal compound between the back of the PCB and the Heatsink or a PCB with solid copper (1/8" or 1/4" thick) clad* on the ground plane side.

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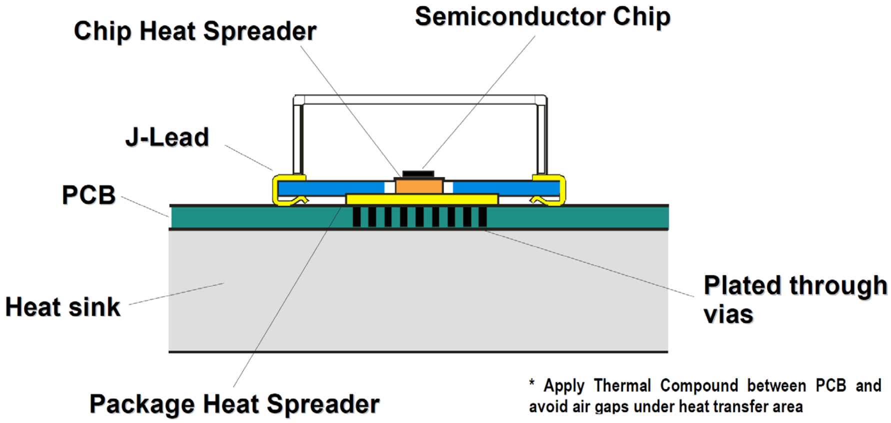
TABLE 1

Approximate Effective Thermal Resistance between LCSM Heat Spreader and Heatsink

	FR-4 thickness	
	31 mil	62 mil
Reff [°C/W]	7-9	15-18

Applicable to LCSM packages soldered to a PCB pad with solder-filled plated through holes on FR-4 (arrayed as per FIG. 3), with Thermal Compound between PCB and Heatsink, as per FIG. 6.

**** When using PCB materials with thick ground plane copper clad, ensure that the arrayed grounding plated through holes also go through the thick clad to prevent air trapping in the holes when filling these with solder.***



* Apply Thermal Compound between PCB and heatsink to avoid air gaps under heat transfer area