Second-sourcing options for small-package amplifiers

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Introduction

The increase in demand for low-cost end products has caused designers to come up with innovative ways to stay below system price targets, while still meeting their product's performance specifications. For example, in addition to amplifier performance, designers must consider all amplifier characteristics, including cost and package size.

It's important to consider package size in low-cost designs because different amplifier packages may have different cost implications in the system. Many new devices are offered in innovative small packages that can help designers meet their goals. However, if multiple semiconductor manufacturers aren't offering an amplifier in a small package, that limits the options for second sourcing. Second sources are often required to prevent product manufacturing complications should a supplier have trouble meeting demand. Not having a second source can cost the end-product manufacturer large amounts of money if the semiconductor manufacturer is not able to meet their supply demand.

This article discusses how to provide a second-source option for small-package amplifiers that do not have a direct pin-to-pin-compatible second source. Also covered are the possible manufacturing and design challenges the designer may face during printed-circuit board (PCB) layout.

PCB-Layout Modifications

Modifying the PCB layout of the operational amplifier (op amp) to include two different op-amp package footprints provides a second source for small-package amplifiers by including a secondary, commonly used, industry-standard package footprint on the PCB that encompasses the small-package footprint. Figure 1 illustrates how this works in a PCB layout.

Small-outline integrated circuits (SOICs), thin-shrink small-outline packages (TSSOPs) and very-thin-shrink small-outline packages (VSSOPs) are the industry's most common packages. These packages therefore make for an excellent secondary footprint because many second sources are available. This article focuses on the PCB layout of dual amplifiers packaged with the industry-standard pinout (Figure 2) in relationship to dual small-package amplifiers such as small-outline no-lead (SON) and small-outline transistor (SOT) packages. However, the designer can use this method with any channel count and any package.

Figure 1. Solution example for PCB layout

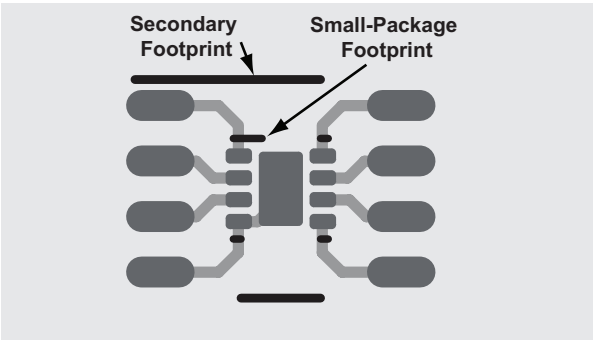
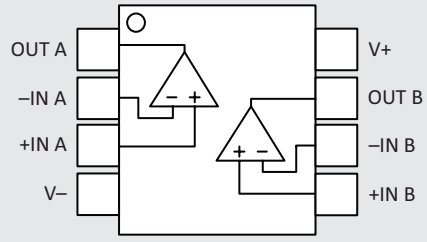


Figure 2. Industry-standard package pinout

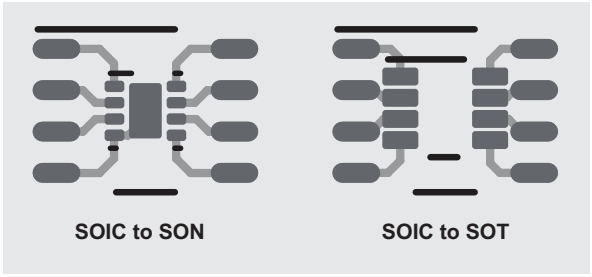


SOIC package layout

The spacing between the pads of the SOIC footprint allow many small-package amplifiers to fit between the pads of the footprint, making the SOIC package an excellent choice to use as a secondary package. Figure 3 shows PCB layouts for a dual-package amplifier for both the SON and SOT small-package amplifiers inside of an industry-standard pinout of a SOIC package.

Designers can easily replicate this layout by routing pin 1 through pin 8 of the SOIC package to pin 1 through pin 8 of the small-package amplifier. However, there are limitations and some possible manufacturing considerations the designer should take into account when using the SOIC package with the SOT package.

Figure 3. Dual-package layouts for SOIC



TSSOP package layout

Although the TSSOP package and SOIC package offer similar benefits, the TSSOP package offers more spacing between the pads of the footprint. This extra spacing allows the use of wider small-package amplifiers in the design and eliminates limitations and possible manufacturing concerns introduced with the SOIC and SOT package combination. The TSSOP package also has a smaller form factor, which requires less PCB area than the SOIC package—a benefit for space-constrained PCBs.

Figure 4 illustrates PCB layouts for a dual-package amplifier for both the SON and SOT small-package amplifiers inside of an industry-standard pinout of a TSSOP package. The PCB layout is similar to the SOIC package, with pin 1 through pin 8 of the TSSOP package routing to pin 1 through pin 8 of the small-package amplifier.

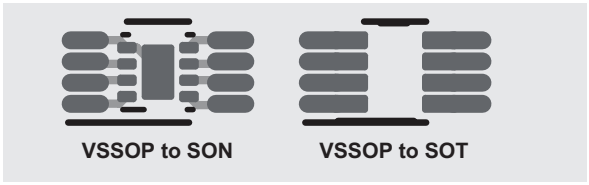
Figure 4. Dual-package layouts for TSSOP

VSSOP package layout

The VSSOP package has a smaller form factor than the TSSOP and SOIC packages, making it the smallest secondary common-package option to use as a second source. The VSSOP package does not have as much space between the pads of the footprint, reducing the number of small-package devices that the designer can use with the VSSOP package. However, the VSSOP package can still be used with the SOT package because the two devices have the same pitch, which allows the pads of the two footprints to align.

Figure 5 illustrates PCB layouts for a dual-package amplifier for both the SON and SOT small-package amplifiers inside of an industry-standard pinout of a VSSOP package. Again, pin 1 through pin 8 of the VSSOP package route to pin 1 through pin 8 of the small-package amplifier.

Figure 5. Dual-package layouts for VSSOP

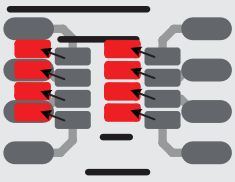


Manufacturing and design considerations

There are a few manufacturing and design effects to consider when including the secondary footprint. The main manufacturing concern is insufficient spacing between the pads of the secondary footprint and the pads of the small-package amplifier footprint. Insufficient spacing between the pads results in insufficient or no solder mask to fill the space between the pads of the two footprints.

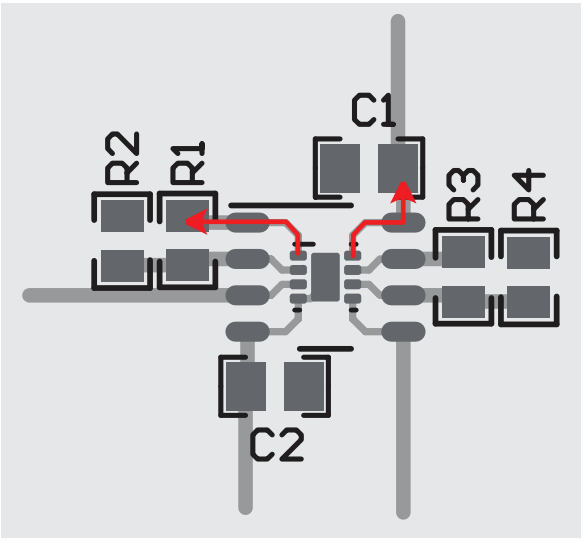
During the reflow soldering process, the lack of solder mask can cause the amplifier to move and short circuit, or leave the device pins floating. Allowing at least four mils of space between the pads of the devices minimizes the risk of this occurring. The four mils of space is a common design rule among PCB manufacturers and provides enough spacing to place the solder mask between the two device pads. Figure 6 shows how the device may shift during the reflow process if proper solder mask clearances aren't maintained.

Figure 6. Component shifting during reflow process



Designers must also consider that using a secondary footprint in the PCB layout may cause additional trace length in the routing. For example, components such as decoupling capacitors and other passive components must be placed further away from the pin of the device when populating a small-package amplifier in the end product. Not placing decoupling capacitors next to the device pin can cause noise to easily couple into the device when placed in noisy environments. Also, placing passive components that set the gain of the amplifier further away from the inverting pin of the small-package amplifier can also cause noise to couple into the circuit. Figure 7 shows the additional trace length that occurs when populating the small-package amplifier.

Figure 7. Additional trace length in layout



Conclusion

The SOIC, TSSOP, and VSSOP packages commonly used throughout the industry have an industry-standard pinout that equips designers with many options for a second source. The SOIC package offers many second-sourcing options and the footprint is large enough for use with most small-package amplifiers. The TSSOP package has more spacing between the footprint pads, enabling the use of wider small-package amplifiers and minimizing potential manufacturing issues. The VSSOP package has the smallest secondary-footprint option, benefitting space-constrained designs.

Although modifying the PCB to include a secondary footprint will not reduce total PCB area, it is an effective yet simple way to provide a second source for small-package amplifiers and reduce the cost of an end product.

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