Soldering Module Packages Having Large Asymmetric Pads

1.0 INTRODUCTION

Enpirion’s power converter packages utilize module package technology to form Land Grid Array (LGA) packages. LGA module package technology provides additional advantages over conventional leaded packages, such as smaller package thickness profile and footprint, lower package thermal resistance, broader heat dissipation from the package, large lead size and pitch, and excellent lead co-planarity. LGA module package technology is ideal for power conversion devices where various sized pads are required to accommodate the high power DC switching currents, the low power signal and control connections, and to provide sufficient ground connections. The Enpirion power converter LGA packages use a set of pads of uniform size, shape and spacing for the high power input and output DC currents. An additional pad that is larger than this set of uniform sized pads is used for the high power output DC currents to provide a secure current path from the package. Also, a large pad is used to ensure sufficient grounding of the package. All other pads for the lower power signal and control connections have uniform size, shape, and spacing.

This document provides recommendations for soldering Enpirion’s power converter packages to a PCB. The size variation and asymmetry of large pads on these power converter packages may require additional solder design for uniform and reliable solder joints between the packages and PCB’s.

2.0 SOLDERING ISSUES OF LARGE ASYMMETRIC PADS

When soldering an LGA package having a solder pad that is substantially larger in area than all other solder pads, a potential may exist during soldering (reflow) of the LGA package to the PCB for variations in the time to reach the solder solidus temperature (temperature when the solder solidifies) during cooling between the different sized pads. That is, the solder on the smaller solder pads will solidify before the solder on the large solder pad. Since the large pad has a higher volume of solder that is unexposed to the surrounding ambient temperature, the solder of the large pad may remain above the liquidus temperature (i.e., wet) after the solder of the smaller pads has reach the solidus temperature. This large area of wet solder under the package may cause the package to remain elevated during solidification of the smaller solder pads, resulting in the potential for minimized solder contact, or even opens, of the smaller solder pads.

If this large area solder pad is located asymmetrically in the package relative to the smaller pads, the LGA package may result in a non-planar package orientation with the
PCB caused by the wet solder of the large solder pad ‘holding up’ one side of the package during solder cooling. This non-planar orientation could also result in open solder connections for any smaller pad near to the large pad.

This relative variation in the solder solidification between the large and small solder pads is dependent on the solder paste material, reflow profile used for soldering, and the component density of the PCB around the LGA package. Each solder paste material is provided with a manufacturers recommended standard reflow profile with specified dwell times at various temperature and rates of heating and cooling. These reflow profiles typically consider only a single package with uniform sized solder pads. When an LGA package with various sized solder pads is used, reflow profiles should be adjusted for each specific application. Also, the density of components around an LGA package increases the thermal mass of the PCB around the LGA package, changing the reflow characteristics for the LGA package. All PCB solder assembly should be optimized for each application.

3.0 RECOMMENDATIONS FOR SOLDERING LARGE ASYMMETRIC PADS

Each of Enpirion’s power converter packages is supplied with an Applications Note that should be referenced for correct solder pad design and layout of the PCB for optimum electrical and thermal performance. The recommendations presented here provide general guidelines for soldering an Enpirion power converter package.

Figure 1 shows a typical PCB pad layout for an Enpirion power converter LGA module package. There are two solder pads that are significantly larger than the two columns of uniformly sized and spaced 36 smaller solder pads. One large solder pad is located symmetrically between the two columns of smaller pads and the other large solder pad is located asymmetrically and near a corner of the two columns of smaller pads. Figure 2 shows the placement of an Enpirion power converter package onto a PCB with a layer of solder paste. A standard solder paste application process with a solder stencil would be used for application of the solder paste.

3.1 Standard Solder Paste Pattern
The standard solder paste pattern that would be applied (stenciled) to this PCB pad layout is shown in Figure 3. The solder paste pattern would fill completely the PCB pad layout. The large solder pads would have full solder paste coverage. During soldering (reflow), the solder paste would completely wet the metal solder pads on the PCB and Enpirion power converter package. As discussed in Section 2.0, the size (volume) difference of solder on the large pads relative to the small pads, the potential would exist for variations in solder solidification between the large and small pads, possibly resulting in minimized or open solder connections for one or more small pads.

2.2. Reduced Solder Paste Pattern
To prevent the large solder pads from remaining wet after the solidification of the small solder pads, the volume of solder on the large solder pads can be reduced. Figure 4 shows a reduced solder paste pattern on the large pads of the PCB. The solder stencil
openings for the large solder pads were reduced in area by 75% resulting in a smaller volume of solder on these pads. During soldering (reflow) this reduced volume of solder will wet the entire metal solder pads of the PCB and Enpirion power converter. This ‘spreading’ of the solder to fill the large pads essentially reduces the height of the solder on these pads preventing the solder from ‘holding up’ the package. Also, this reduced volume of solder will allow the solder on the large pads reach solidus temperature at the same time as the small pads.

2.3. Segmented Solder Paste Pattern
A set of small solder paste segments nearly equal in size to the small solder pads can be applied onto the large solder pads to equalize and reduce the volume of solder on the large pads. Figure 5 shows an example of a segmented solder paste pattern on the large solder pads. The solder stencil will require additional design to segment the large pad openings. Best results can be achieved if the segment size can be nearly equal to the smaller solder pads. This will result in equalization of the reflow profile for each solder segment. The solder segments on the large solder pads will spread to fill (wet) the entire metal solder pads, reducing the height of the solder on the large solder pads.

5.0 SUMMARY
This paper presents guidelines and recommendations for soldering Enpirion power converter module packages, i.e., LGA package with solder pads that are substantially larger and asymmetrically located relative to other solder pads. The effect of solder paste material, solder reflow profile, and PCB component density will affect the wetting and solidification of the solder on the various sized pads. By reducing the volume of solder paste on the large solder pads, this soldering affect can be eliminated.
Figure 1: Typical PCB Pad Design and Layout for Enpirion Power Converter
Figure 2: Placement of Enpirion Power Converter with Solder Paste and PCB
Figure 3: PCB with Standard Solder Paste Pattern Having Full Coverage on Large Solder Pads
Figure 4: PCB with Reduced Solder Paste Pattern Having 75% Coverage on Large Solder Pads
Figure 5: PCB with Segmented Solder Paste Pattern Having Small Solder Segments on Large Solder Pads