



Is Now Part of



ON Semiconductor®

**To learn more about ON Semiconductor, please visit our website at
www.onsemi.com**

ON Semiconductor and the ON Semiconductor logo are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of ON Semiconductor's product/patent coverage may be accessed at www.onsemi.com/site/pdf/Patent-Marking.pdf. ON Semiconductor reserves the right to make changes without further notice to any products herein. ON Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ON Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using ON Semiconductor products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by ON Semiconductor. "Typical" parameters which may be provided in ON Semiconductor data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. ON Semiconductor does not convey any license under its patent rights nor the rights of others. ON Semiconductor products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use ON Semiconductor products for any such unintended or unauthorized application, Buyer shall indemnify and hold ON Semiconductor and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that ON Semiconductor was negligent regarding the design or manufacture of the part. ON Semiconductor is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

AN-9078

Motion SPM® 7 系列表面贴装指南

引言

该应用指南提供 MotionSPM® 7 系列 PQFN 封装的贴装指南。本文主要介绍钢网的设计，这对于生成可靠焊点至关重要。设置条件符合一般建议。参考设计和相关应用指南在相关资源相关资源部分列出。

封装说明

功率四边扁平无引脚 (PQFN) 是一种表面贴装的塑料封装，引脚焊盘位于封装底面。图 1 显示了 MotionSPM® 7 系列封装的外观。

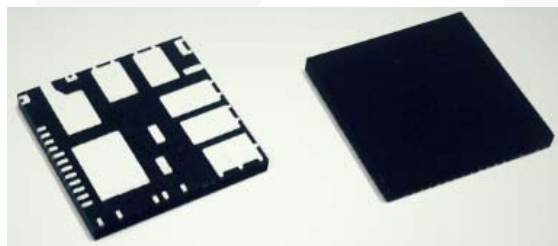


图 1. Motions SPM® 7 系列 PQFN 封装的外观

SPM 7 系列具有六个快速恢复 MOSFET (FRFET®) 和一个三相 HVIC。图 2 显示 MotionSPM® 7 系列的结构。

铜引线框架底部镀锡 (Sn)，以增强焊接的粘附性。

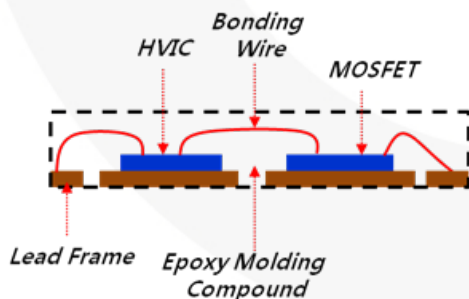


图 2. Motion SPM® 7 系列的结构

焊接条件

焊膏

SPM® 7 系列非常适合无铅焊接。对无铅、无卤的焊膏 HeeSungLFM-48W NH(M) 进行了评估测试。表 1 显示该焊膏的相关信息。

表 1. 焊膏信息

器件编号	粉末粒度 [μm]	成分 [%]	助焊剂 [%]
LFM-48W NH(M)	20-38	Sn /Ag/Cu 96.5 / 3.0 / 0.5	11.0

SPM7 系列同样也非常适合焊膏 SenjuM705-GRN360-K2-V。

焊膏通过钢网印刷添加到焊盘上。焊膏的印刷过程对于预防 PCB 组装缺陷非常重要。

回流焊曲线

加热需将焊膏融化到焊盘周围同时不过度加热和破坏电子元件。加热可通过将元件在红外热辐射下穿过回流焊炉或使用热风笔焊接各个焊点实现。回流焊是一种通过加热将表面贴装元件固定至电路板的最常见方法。图 3 显示焊膏 HeeSungLFM-48W NH(M) 厂家提供的推荐回流曲线。

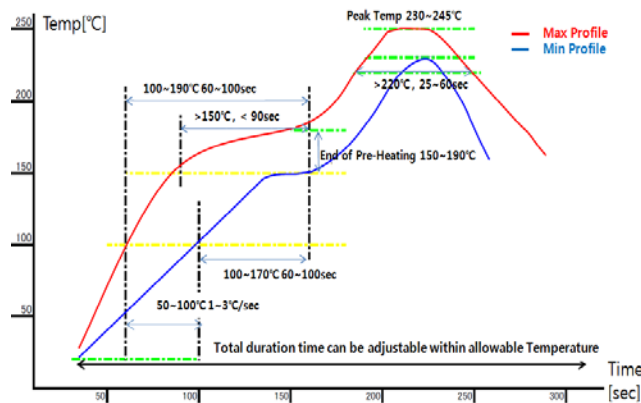


图 3. 推荐回流焊曲线

回流焊曲线通常由 SMT 机器进行调节，以优化热曲线，实现大批量生产。图 4 显示在评估中实现的测得回流焊曲线。移动速度设置为 ~0.79 m/min。

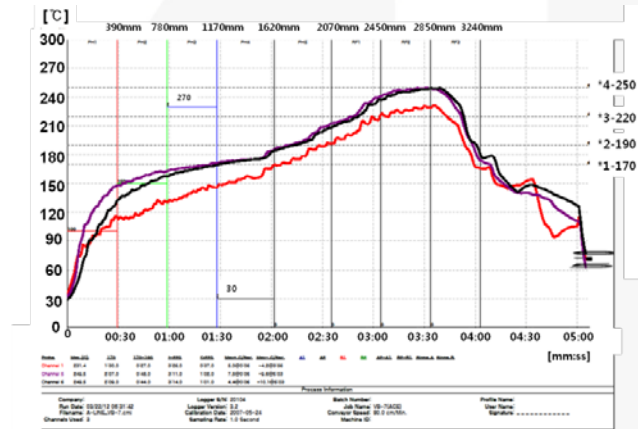


图 4. 测得的回流焊曲线

图 5 显示温度测量点。红线为相邻点，可以忽略。

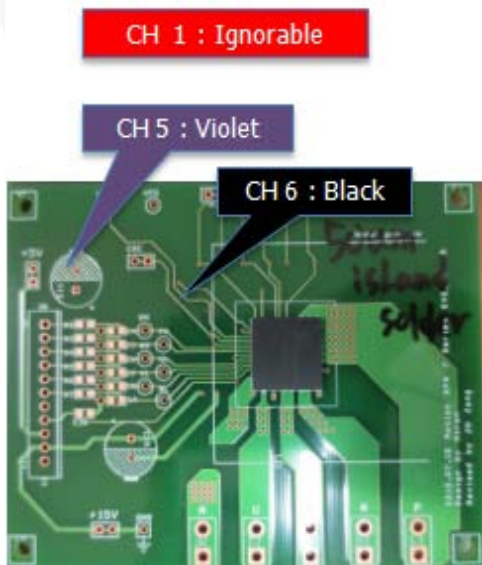


图 5. 温度测量点

SMT 机器（回流焊炉）

表 2 介绍评测中使用的 SMT 机器的信息，图 6 显示机器图片。

表 2. SMT 机器规格

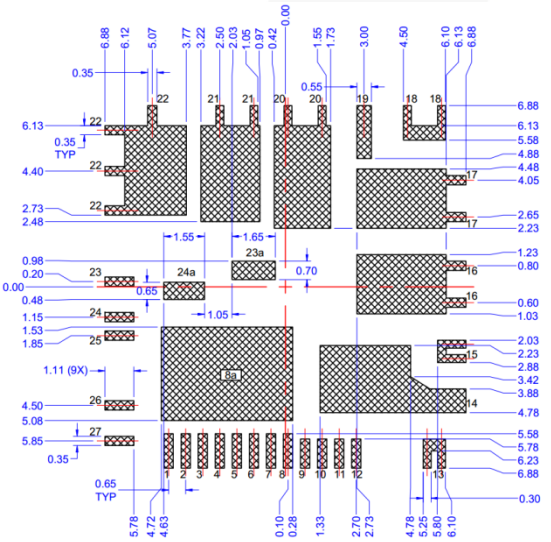
厂商	型号	加热区
TSM	AIS-K20-82C	8



图 6. SMT 机器图片

推荐焊盘形状

电路板合理的焊盘形状设计对于确保焊点与周围焊膏的可靠连接非常重要。图 7 显示 SPM® 7 系列数据表中规定的推荐焊盘形状。隔离开的焊盘 23a 和 24a 可以省略，因为它们通过引线框架分别连接到 23 和 24。如果焊接，可能在两个焊盘之间形成焊料桥接。焊膏量大时，可能会出现这种桥接问题。



推荐钢网设计

图 8 显示 SPM 7 系列的推荐钢网设计。为确保焊点可靠,通常建议厚度为 150 μm 。钢网的厚度决定形成焊点的焊料量以及窗孔宽度。

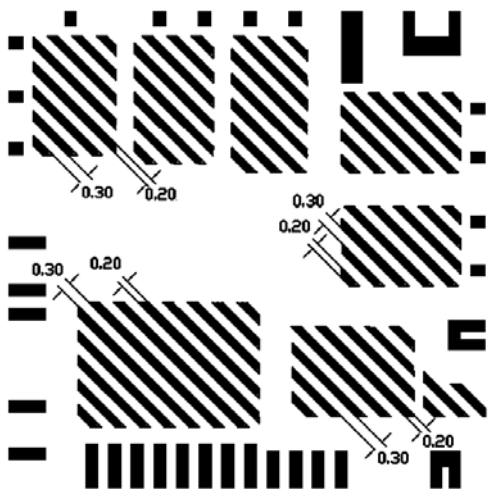


图 8. 推荐钢网设计

图 9 显示钢网和焊盘图形的叠加图像。根据评估结果,隔离开的焊盘 23a 和 24a 被阻焊,从而避免因焊膏量过大而导致的焊料桥接现象。

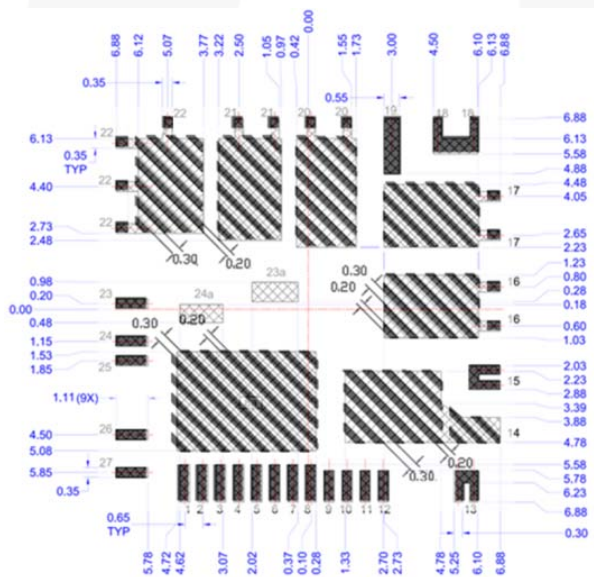


图 9. 叠加后的模板和焊盘图形

评测结果

焊洞定义

焊洞是指焊点中的空白空间，它是造成焊点缺陷的主要原因之一。图 10 中显示的红色区域就是焊洞。

焊洞主要是由回流过程中助焊剂含有气体所导致。

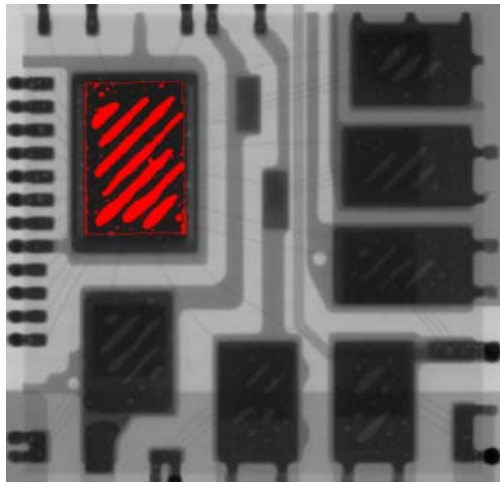


图 10. 焊洞

钢网图形

为了确定合适的钢网图形,对多个设计进行了评估,如表3所示。

锡洞程度参照 HVIC 部分的焊点, 计算如下:

$$\text{空隙程度} [\%] = \text{单个空隙区域之和} / \text{总区域} \times 100$$

如表 3 所示, 梳状图形显示没有溢出焊料时相对较小的空隙程度。

在具有通孔的正方形图形中，焊料溢出至岛状区域周围。溢出的焊料是由大量焊膏所导致的。对于同一 PCB 中部件的各种要求，很难控制焊料量，对于 SPM 7 系列而言，由于存在通孔，焊料量可能不足。

表 3. 图形类型

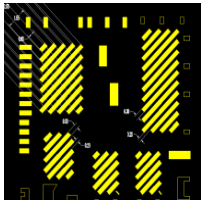
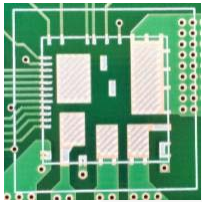
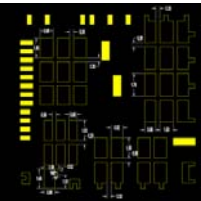
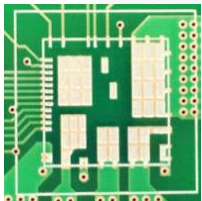
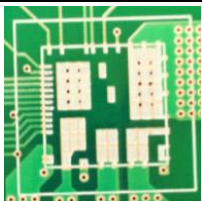
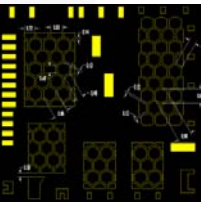
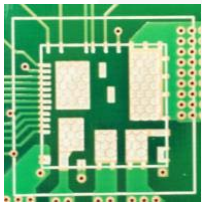
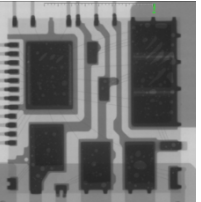
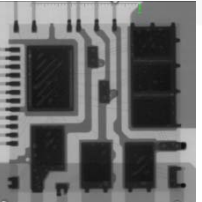
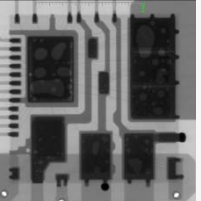
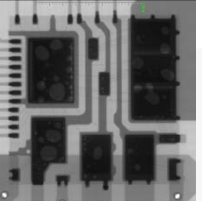
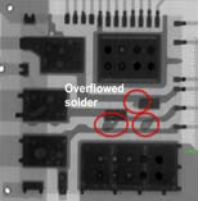
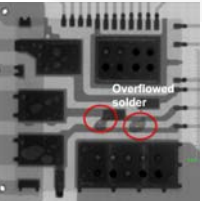
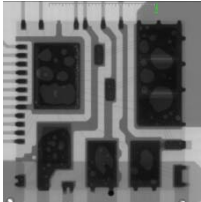
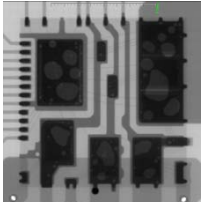
图形	钢网	PCB
梳状		
没有通孔的正方形		
有通孔的正方形		
蜂窝状		

表 4. 不同图形的结果

图形	X 射线	
梳状	 空隙程度 ≈ 23%	 空隙程度 ≈ 24%
没有通孔的正方形	 空隙程度 ≈ 38%	 空隙程度 ≈ 27%
有通孔的正方形	 空隙程度 ≈ 10%	 空隙程度 ≈ 18%

图形	X 射线	
蜂窝状	 空隙程度 ≈ 42%	 空隙程度 ≈ 38%

注意:

1. 钢网的厚度为 100 μm 。

钢网厚度和窗孔宽度

为了确定合适的钢网图形，对多个厚度和窗孔宽度进行了评估，如图 11 和表 5 所示。与、表 10 和表 7 表 6 中的空隙程度结果相比较而言，首选 150 μm 的厚度和 200 μm 表 5 的窗孔宽度。通常来说，对于 PQFN 封装，不建议采用 50 μm 和 100 μm 的厚度，因为焊料量可能不足以确保可靠的焊点。

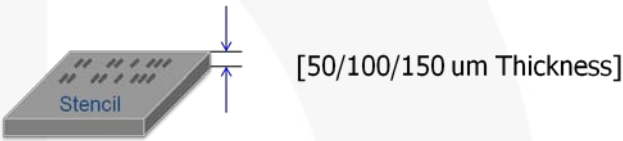


图 11. 钢网厚度

表 5. 钢网窗孔宽度

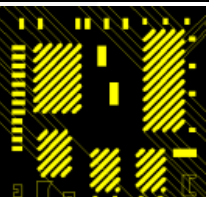
窗孔宽度	钢网	
200 μm	 200um Opening width 300um Masking width	
300 μm	 300um Opening width 200um Masking width	

表 6. 100 μm 厚度、300 μm 窗孔宽度的结果

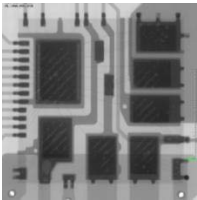
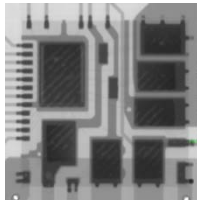
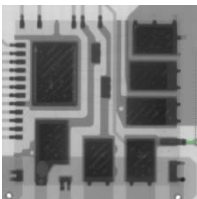
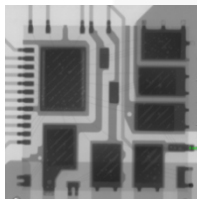
条件	X 射线	
50 μm 厚度、300 μm 窗孔宽度		空隙程度 $\approx 20\%$
		空隙程度 $\approx 22\%$
		空隙程度 $\approx 21\%$
		空隙程度 $\approx 20\%$

表 7. 100 μm 厚度、300 μm 窗孔宽度的结果

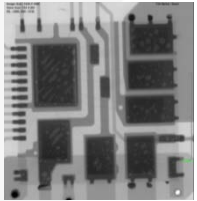
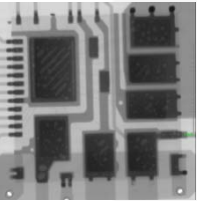
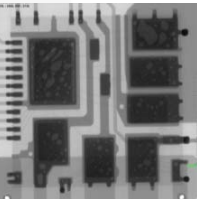
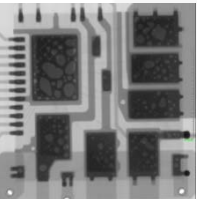
条件	X 射线	
100 μm 厚度、300 μm 窗孔宽度		空隙程度 $\approx 23\%$
		空隙程度 $\approx 25\%$
		空隙程度 $\approx 30\%$
		空隙程度 $\approx 38\%$

表 8. 100 μm 厚度、200 μm 窗孔宽度的结果

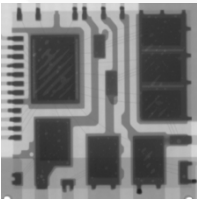
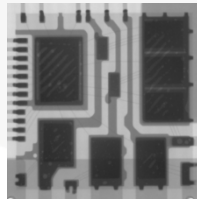
条件	X 射线	
100 μm 厚度、200 μm 窗孔宽度		空隙程度 $\approx 19\%$
		空隙程度 $\approx 20\%$

表 9. 150 μm 厚度、300 μm 窗孔宽度的结果

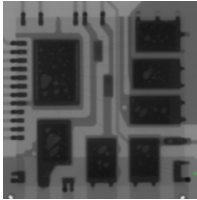
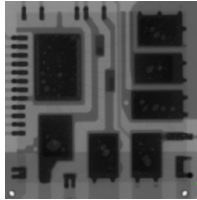
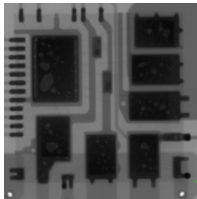
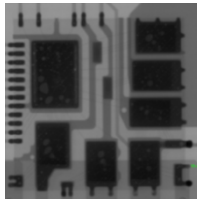
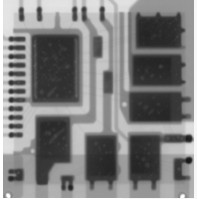
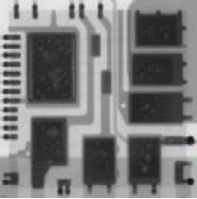
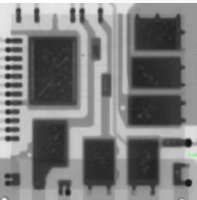
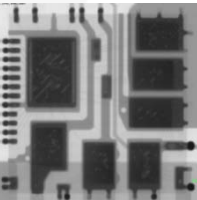
条件	X 射线	
150 μm 厚度、300 μm 窗孔宽度		空隙程度 $\approx 25\%$
		空隙程度 $\approx 24\%$
		空隙程度 $\approx 25\%$
		空隙程度 $\approx 22\%$

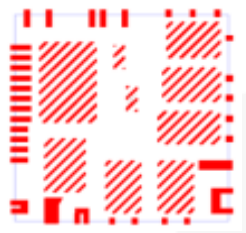
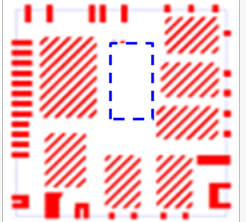
表 10 显示最佳性能，具有适当的 30 μm 刷焊膏深度，这表示给器件刷上锡膏之后进入回流焊接之前的焊膏厚度。

表 10. 150 μm 厚度、200 μm 窗孔宽度的结果

条件	X 射线（最佳情形）	
150 μm 厚度、200 μm 窗孔宽度		空隙程度 $\approx 18\%$
		空隙程度 $\approx 20\%$
		空隙程度 $\approx 18\%$
		空隙程度 $\approx 17\%$

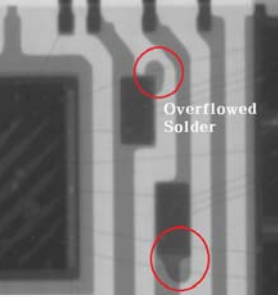
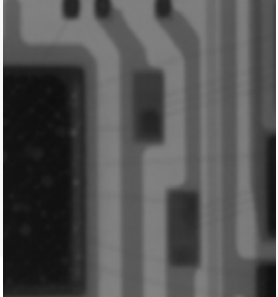
为确定岛状区域的有效性，对部分掩模进行了评估，如表 11 所示。

表 11. 钢网岛状区域

类型	钢网
岛状焊接	
岛状阻焊	

如表 12 所示，发现间歇性溢出的焊料。因此，推荐岛状阻焊。

表 12. 岛状阻焊的结果

类型	钢网
岛状焊接	
岛状阻焊	

回流方向

图 12 显示本次评估中执行的回流方向。

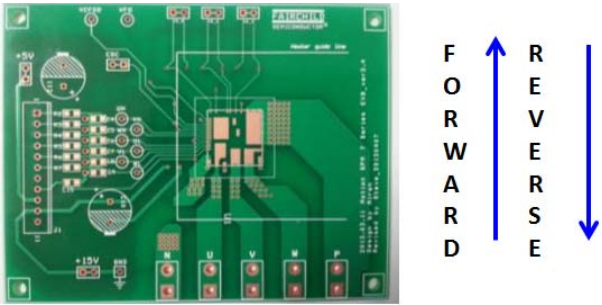


图 12. 回流方向

图 13 和图 14 显示每个回流方向上的类似空隙程度。通过 X 射线比较判断，没有显著的不同。

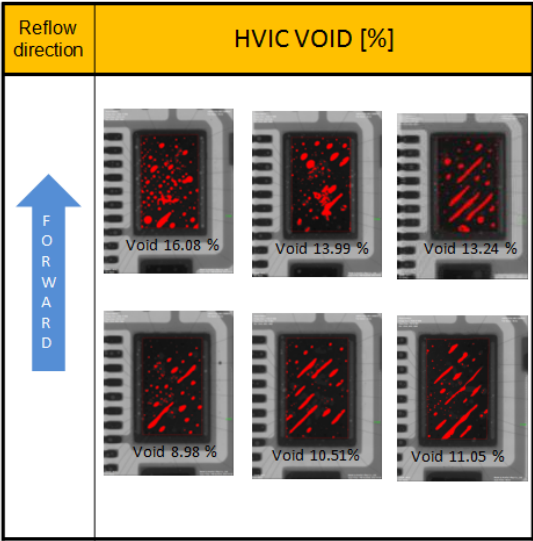


图 13. 正向 HVIC 焊接空隙

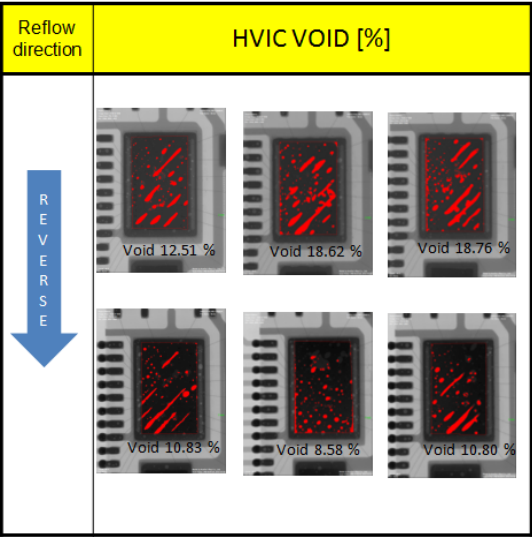


图 14. 反向 HVIC 焊接空隙

总结和结论

评估目的在于确定适用于采用 PQFN 封装 SPM7 系列的优化焊接条件。

对不同的钢网设计进行了研究，以减少可能导致焊点缺陷的焊洞。根据评估结果进行判断，推荐的钢网设计为梳状图形，具有 200 μm 宽阻焊窗孔、150 μm 钢网厚度以及岛状阻焊。

图 15 显示与钢网设计相关的推荐条件选择指南。

焊点中较大的焊洞可能会导致失效和可靠性问题。图 16 显示最差和最佳 PCB 贴装之间的差别（最差情况为 100 μm 的钢网厚度和蜂窝状图形）。为确保业界期望的性能，在以推荐条件进行焊接后进行了电路板级测试。条件和结果如表 13 所示。

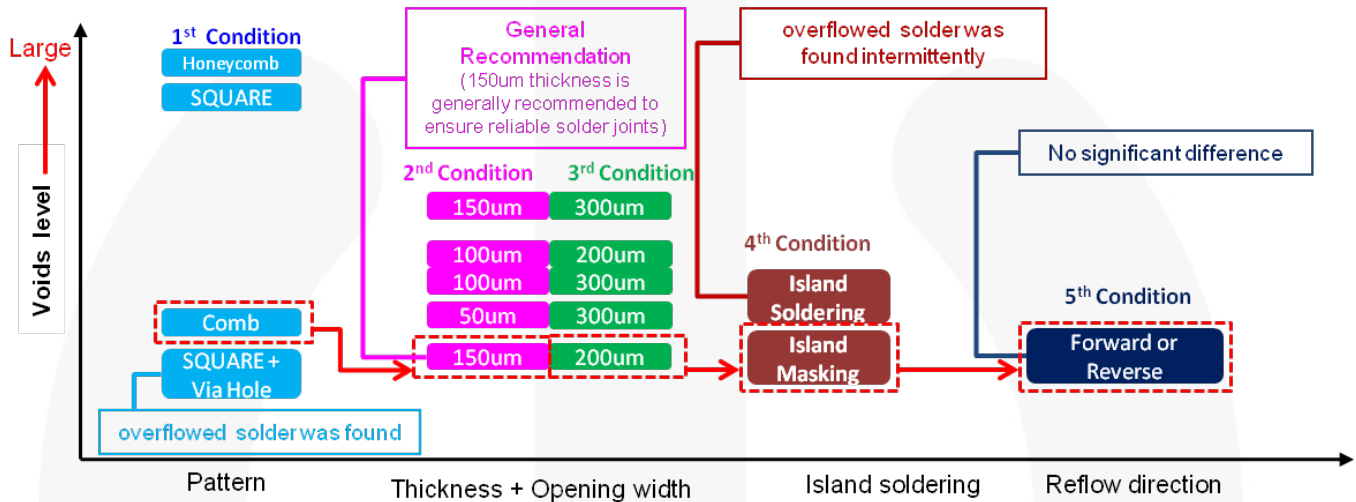


图 15. 推荐条件选择图表

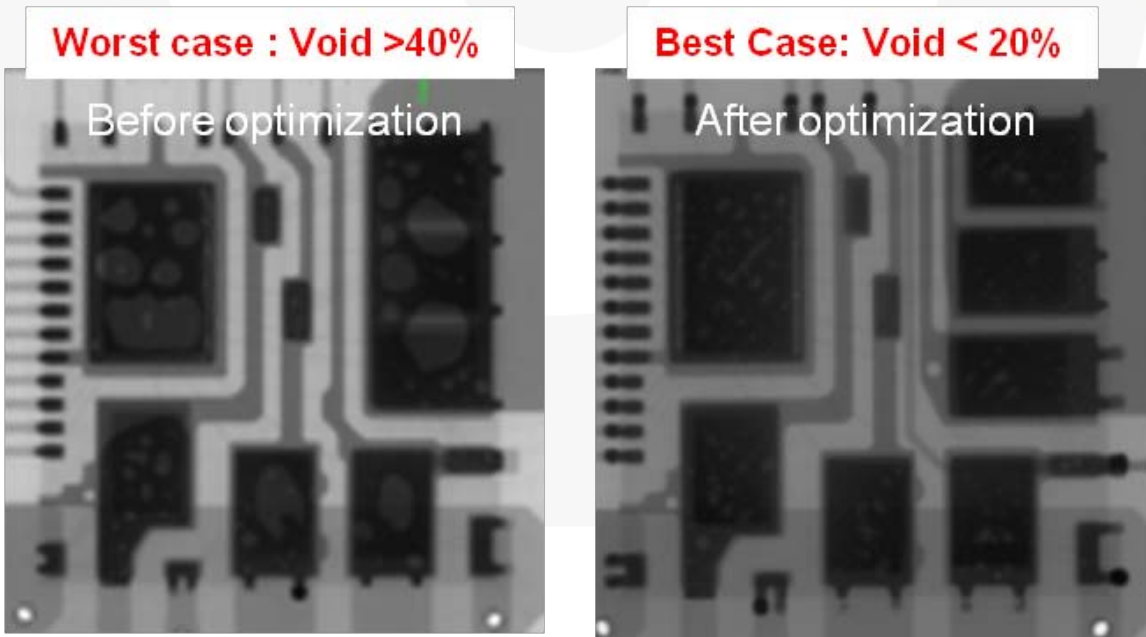


图 16. 最差和最佳情况下的 X 射线比较

表 13. 电路板级测试结果（温度循环）

测试条件	PCB 类型	参考标准	结果
- 温度循环 -40°C /+ 80°C 温度限值 10 分钟停留时间 ≤ 0 分钟停留速率 400 个温度循环	CEM3 (1.0t)	IPC-9017	合格
	FR4 (1.0t)		
	FR4 (1.2t)		
	FR4 (1.6t)		

注意：

- 焊接条件以图 15 中的推荐条件为基础。

相关资源

[AN-9077 — Motion SPM® 7 系列表面贴装指南](#)

[RD-356 — Fairchild Motion SPM® 7 系列参考设计](#)

[FSB70325 — Motion SPM® 7 系列](#)

[FSB70625 — Motion SPM® 7 系列](#)

[FSB70250 — Motion SPM® 7 系列](#)

[FSB70450 — Motion SPM® 7 系列](#)

[FSB70550 — Motion SPM® 7 系列](#)

[SPM® 模块设计指南](#)

[运动控制设计工具](#)

DISCLAIMER

FAIRCHILD SEMICONDUCTOR RESERVES THE RIGHT TO MAKE CHANGES WITHOUT FURTHER NOTICE TO ANY PRODUCTS HEREIN TO IMPROVE RELIABILITY, FUNCTION, OR DESIGN. FAIRCHILD DOES NOT ASSUME ANY LIABILITY ARISING OUT OF THE APPLICATION OR USE OF ANY PRODUCT OR CIRCUIT DESCRIBED HEREIN; NEITHER DOES IT CONVEY ANY LICENSE UNDER ITS PATENT RIGHTS, NOR THE RIGHTS OF OTHERS.

LIFE SUPPORT POLICY

FAIRCHILD'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT OF FAIRCHILD SEMICONDUCTOR CORPORATION. As used herein:

- Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, or (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in significant injury to the user.
- A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

ON Semiconductor and  are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of ON Semiconductor's product/patent coverage may be accessed at www.onsemi.com/site/pdf/Patent-Marking.pdf. ON Semiconductor reserves the right to make changes without further notice to any products herein. ON Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ON Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using ON Semiconductor products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by ON Semiconductor. "Typical" parameters which may be provided in ON Semiconductor data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. ON Semiconductor does not convey any license under its patent rights nor the rights of others. ON Semiconductor products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use ON Semiconductor products for any such unintended or unauthorized application, Buyer shall indemnify and hold ON Semiconductor and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that ON Semiconductor was negligent regarding the design or manufacture of the part. ON Semiconductor is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:

Literature Distribution Center for ON Semiconductor
19521 E. 32nd Pkwy, Aurora, Colorado 80011 USA
Phone: 303-675-2175 or 800-344-3860 Toll Free USA/Canada
Fax: 303-675-2176 or 800-344-3867 Toll Free USA/Canada
Email: orderlit@onsemi.com

N. American Technical Support: 800-282-9855 Toll Free
USA/Canada

Europe, Middle East and Africa Technical Support:
Phone: 421 33 790 2910

Japan Customer Focus Center
Phone: 81-3-5817-1050

ON Semiconductor Website: www.onsemi.com

Order Literature: <http://www.onsemi.com/orderlit>

For additional information, please contact your local
Sales Representative