

# 基于热性能的 NIS(V)3071 PCB 设计考虑因素

## AND90246/D

### 介绍

单片电子保险丝 (eFuse) NIS(V)3071能够提供高达10 A 连续电流。在设计它的PCB时热性能是重要的考量因素，在设计PCB热特性时，需要考虑 eFuse 的两种工作模式: 软开关开通阶段和稳定工作状态。在软开关开通阶段，eFuse的短期功率耗散可达几十瓦，而稳定工作状态时则可能为几瓦。本文将通过比较四层和两层PCB，说明使用多层PCB为器件散热带来的性能优势。图 1 显示的是两层PCB，图 2 显示的是面积同样为 2000 平方毫米的四层PCB。

以下对两种PCB在相同条件下的热参数进行比较。FAULT引脚上ESD结构的线性温度曲线用于测量结温。该器件在输入电压  $V_{in} = 12\text{ V}$  且无负载的情况下驱动芯片，在此电压下，以 1 mA 的电流对两个测试板上的ESD结构进行温度特性分析，并使用 Temptronic X-Stream 4300对温度进行扫描。此温度特性分析的电路原理图如图 3所示: 温度特性测试配置。

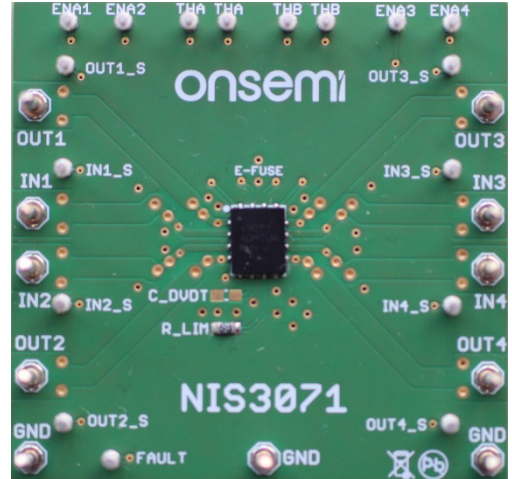


图 1. 双层PCB

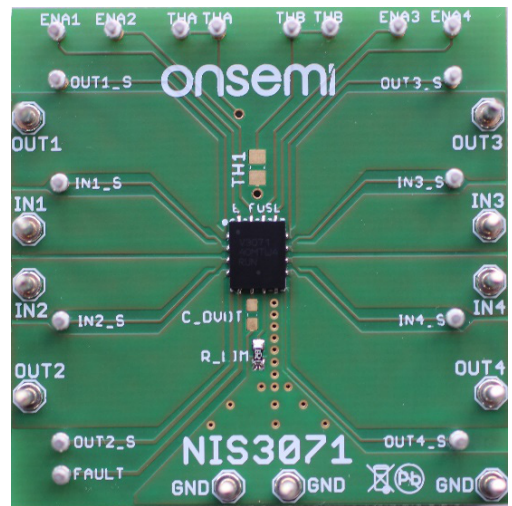


图 2. 四层PCB

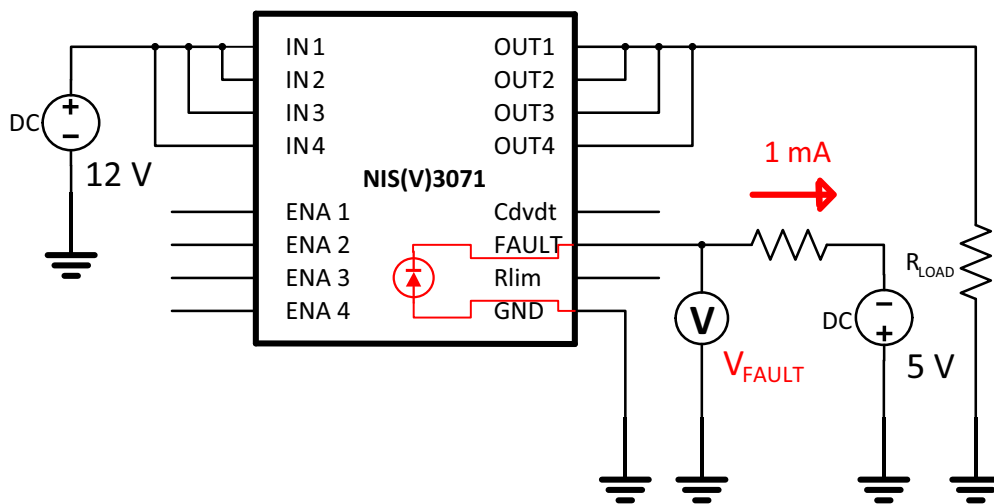


图 3. 温度特性测试配置

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在 30°C 至 150°C 的温度范围内，ESD 结构的两块测试板上的电压如图 4 所示：热性能分析。

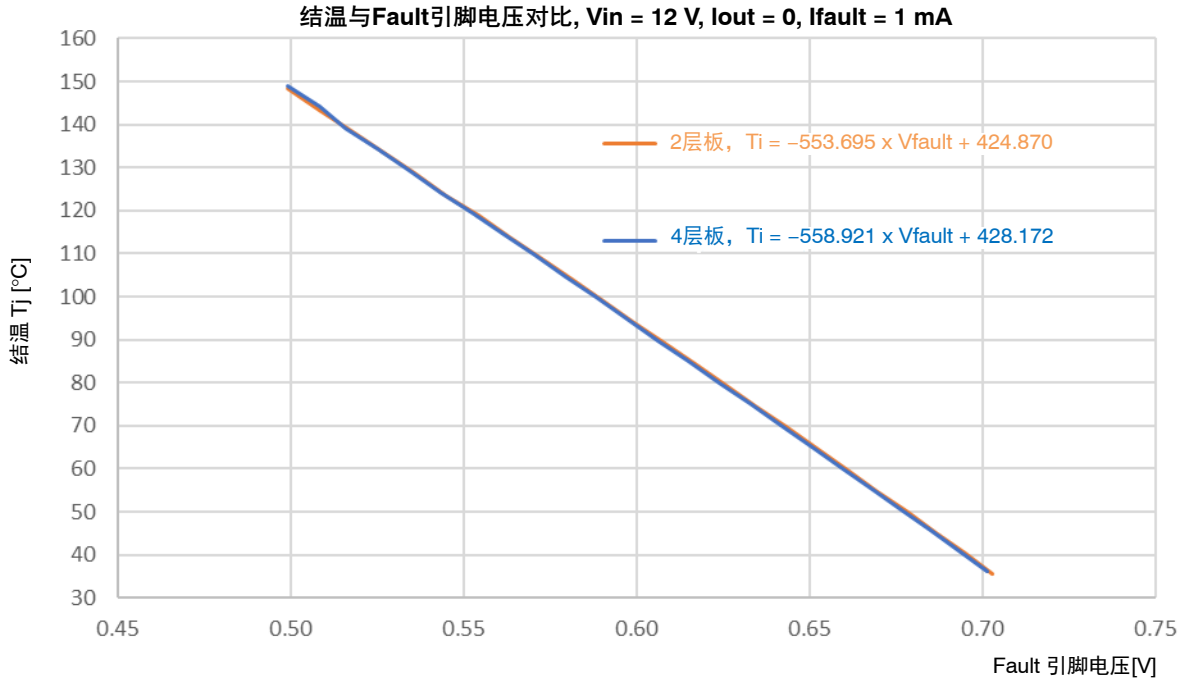


图 4. 温度特性测试配置

在供电电压  $V_{in} = 12\text{ V}$  的情况下，设定所有四个并联通道的输出电流，使两块测试 eFuse PCB 上的功耗都正好为  $1\text{ W}$ 。

表 1 显示了在相同电流 ( $1\text{ mA}$ ) 下，两块被测 PCB 上 FAULT 引脚基于 ESD 结构的电压。根据这些电压，

按照图 4 所示公式可计算出每块电路板上的结温。测量是在环境温度为  $T_a = 23^\circ\text{C}$  的自然空气对流条件下进行的。两层和四层 PCB 的结至环境热阻 ( $R_{thja}$ ) 值由下式给出。

$$R_{thja} = (T_j - T_a) / P_d \text{ [}^\circ\text{C/W]}$$

表 1.

Board	$V_{in}$ [V]	$I_{out}$ [A]	$V_{in} - V_{out}$ [mV]	$R_{dson}$ [m $\Omega$ ]	$P_d$ [W]	$-V_{fault}$ [mV]	$T_j$ [°C]	$T_a$ [°C]	$R_{thja}$ [°C/W]
4-Layer	12.00	6.84	149.22	21.82	1.02	636.16	72.61	23.04	48.57
2-Layer	12.00	6.09	165.11	27.09	1.01	615.16	84.26	23.18	60.71

图 5. 热像仪显示了作为对比的两个 PCB 的温度分布。相比于相同面积的两层 PCB，四层 PCB 具有低  $12^\circ\text{C/W}$  的热阻。结温  $T_j$  也可以通过  $R_{dson}$  的变化来计

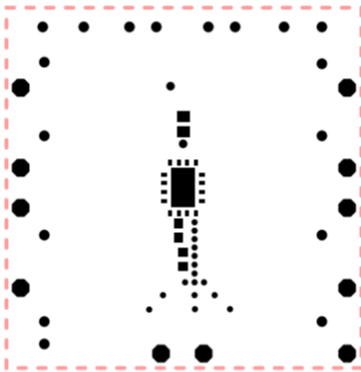
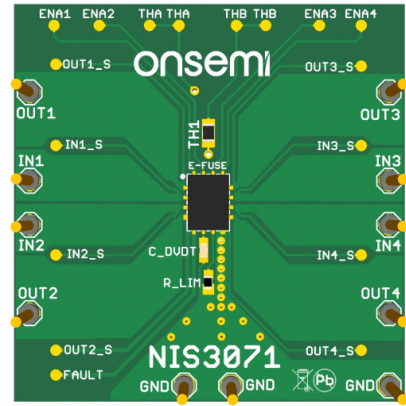
算，但在大约  $6\text{ A}$  的输出电流下，自热效应使得这种相关性的表征变得复杂，并且  $R_{dson}$  随温度以及输出电流的变化并非线性。



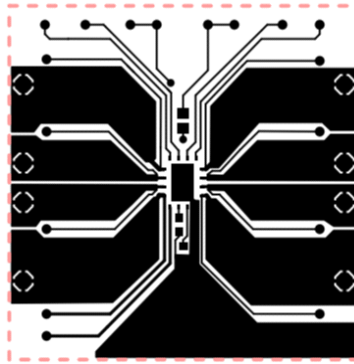
附录

双层PCB设计

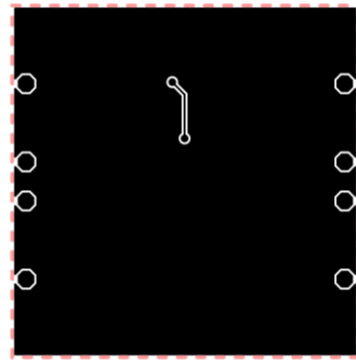
镀铜层	材料	厚度[微米]	
	阻焊层	20	1
L1	铜	35+25 Plt	2
	刚性层压板	1430	
L2	铜	35+25 Plt	3
	阻焊层	20	



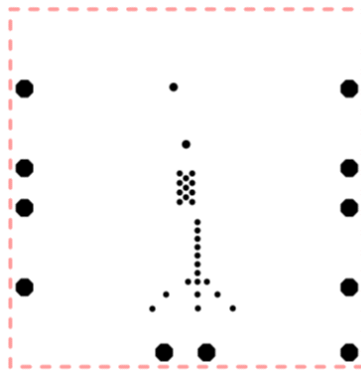
1. 顶部阻焊层



2. L1 覆铜



2. L2 覆铜



4. 底部阻焊层

图 6. 双层PCB设计

四层PCB设计

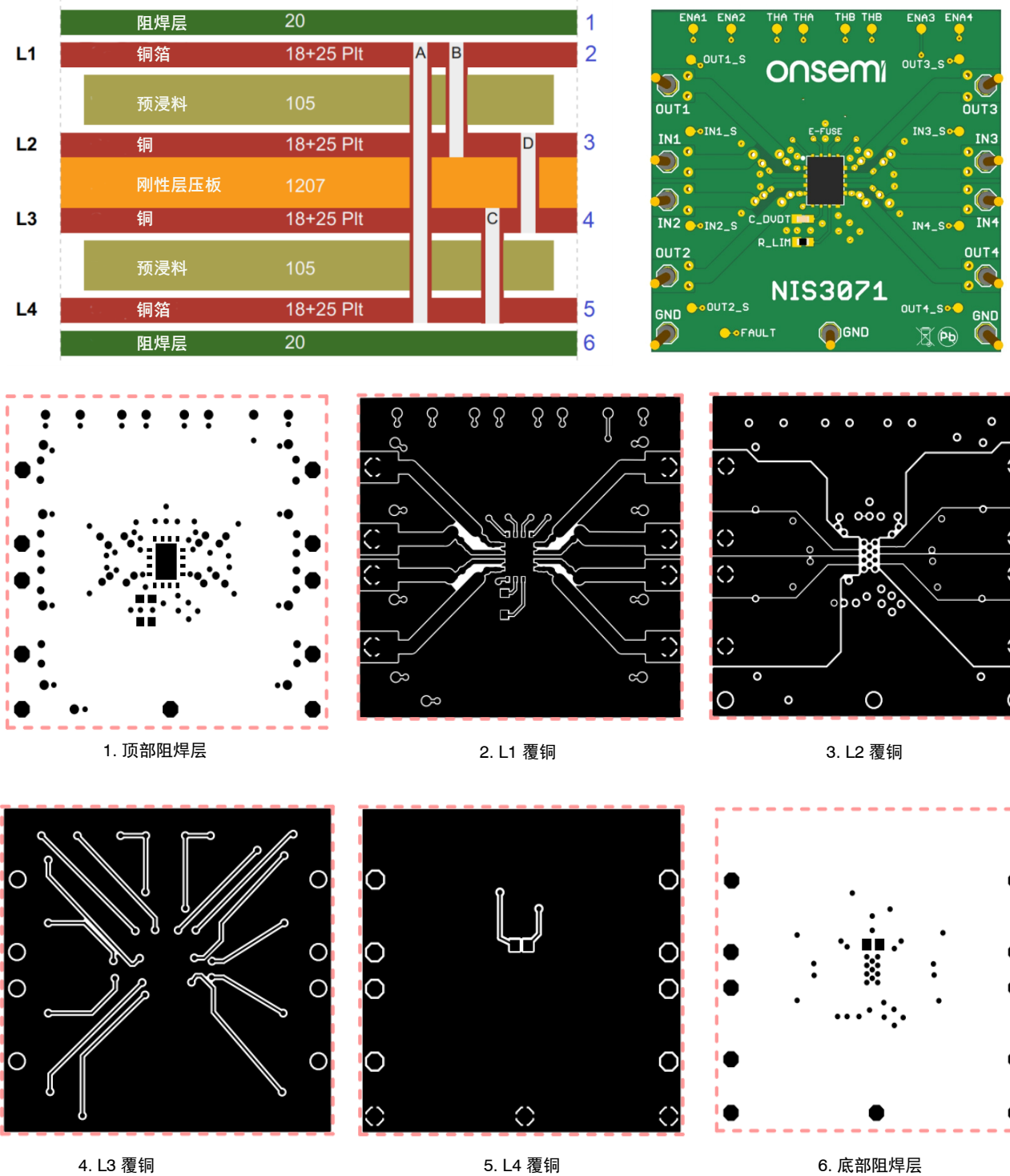


图 7. 四层PCB设计

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