熱設計

TO252 パッケージ熱抵抗情報

このアプリケーションノートは TO252 パッケージを使用して熱設計を行うために必要な、熱抵抗の情報を記載しています。設計初期の温度見積もりを行うときの参考値としてご使用ください。

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1. パッケージ概要

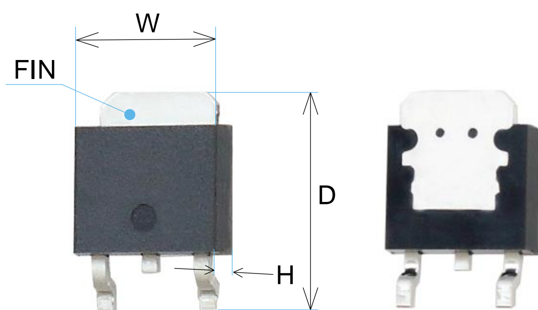
パッケージ名：TO252-3
TO252-J3
TO252-5
TO252-J5

パッケージグループ：TO

このアプリケーションノートでは代表的なパッケージとして TO252-3 の値を記載しています。上記以外のパッケージについては、厳密には熱抵抗値が異なりますが、設計初期の温度見積もり用途としては許容範囲に収まるため同じ値を使用できます。

TO252-3 外形寸法

W (typ) D (typ) H (max)
6.5mm × 9.5mm × 2.5mm



2. JEDEC STANDARD に準拠した環境での熱抵抗および熱特性パラメータ

2-1. 測定環境

内容	規格
測定環境	JEDEC STANDARD JESD51-2A (Still Air)
測定基板規格	JEDEC STANDARD JESD51-3 JESD51-5 JESD51-7

2-2. 数値

状態	θ_{JA} (°C/W)	Ψ_{JT} (°C/W)
1 層 (1s)	132.2	13
4 層 (2s2p)	23.3	2

θ_{JA}：ジャンクション T_J と 周囲温度 T_A 間の熱抵抗
Ψ_{JT}：ジャンクション T_J と パッケージ上面中央温度 T_T 間の熱特性パラメータ

注意：本アプリケーションノートでの熱抵抗および熱特性パラメータは、JEDEC STANDARD に準拠した測定環境での値であるため、必ずしも実機器と一致するものではありません。PCB 特性、PCB レイアウト、部品配置、筐体形状、周囲環境などの影響で値が変化することを考慮する必要があります。

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2-3. PCB 仕様 1 層 (1s)

JEDEC 規格 JESD51 準拠

項目		値
基板厚み		1.57mm
基板外形寸法		76.2mm × 114.3mm
基板材質		FR-4
トレース厚 (仕上がり厚)	Top	70µm (2 oz)
引き出し線幅		0.254mm
銅箔範囲	Top	49mm^2 (Footprint)

Table 2-3-1. 1 層 PCB 仕様

Figure 2-3-1. 1 層基板断面図

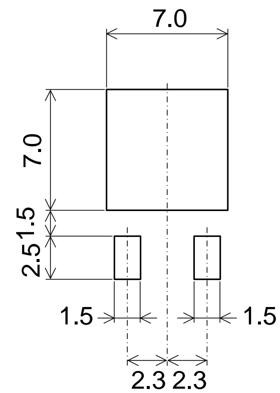

Figure 2-3-2. Footprint 寸法

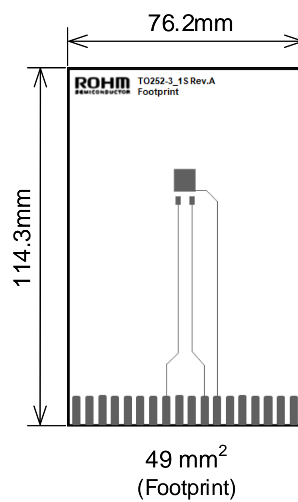

Figure 2-3-3. Top layer

2-4. PCB 仕様 4 層 (2s2p)

JEDEC 規格 JESD51 準拠

項目		値
基板厚み		1.60mm
基板外形寸法		76.2mm × 114.3mm
基板材質		FR-4
トレース厚 (仕上がり厚)	Top	70µm (2 oz)
	Middle 1	35µm (1 oz)
	Middle 2	35µm (1 oz)
	Bottom	70µm (2 oz)
引き出し線幅		0.254mm
銅箔範囲	Top	49mm^2 (Footprint)
	Middle 1	5505mm^2 (74.2mm×74.2mm)
	Middle 2	5505mm^2 (74.2mm×74.2mm)
	Bottom	5505mm^2 (74.2mm×74.2mm)

Table 2-4-1. 4 層 PCB 仕様

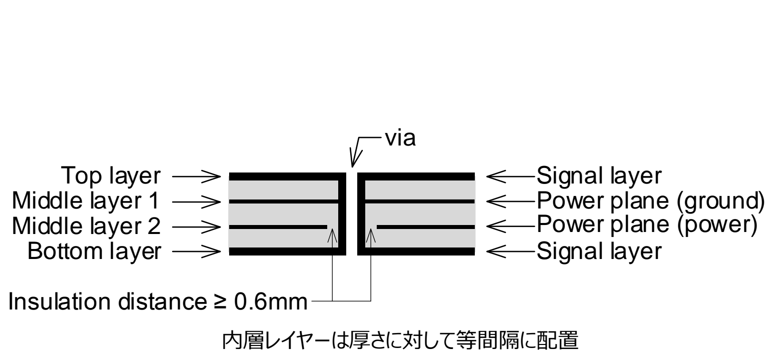

Figure 2-4-2. 4 層基板断面図

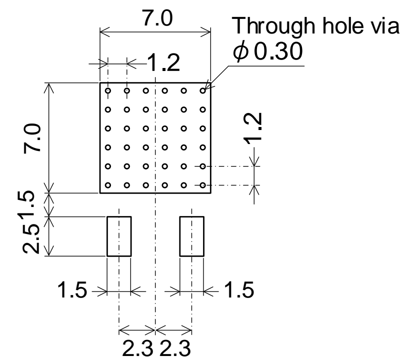

Figure 2-4-3. Footprint 寸法

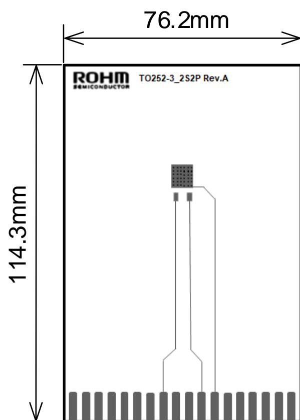

Figure 2-4-4.
Top layer

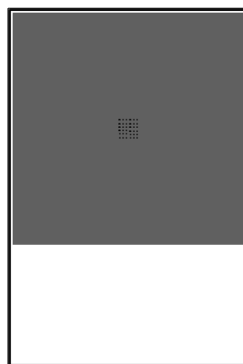

Figure 2-4-5.
Middle 1 layer

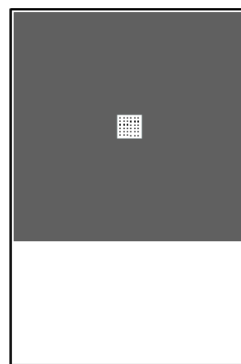

Figure 2-4-6.
Middle 2 layer

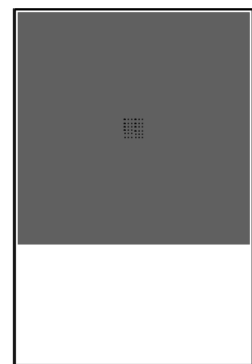

Figure 2-4-7.
Bottom layer

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3. 各パラメータを変化したときの熱抵抗および熱特性パラメータ

3-1. 銅箔面積を変化

3-1-1. 1 層

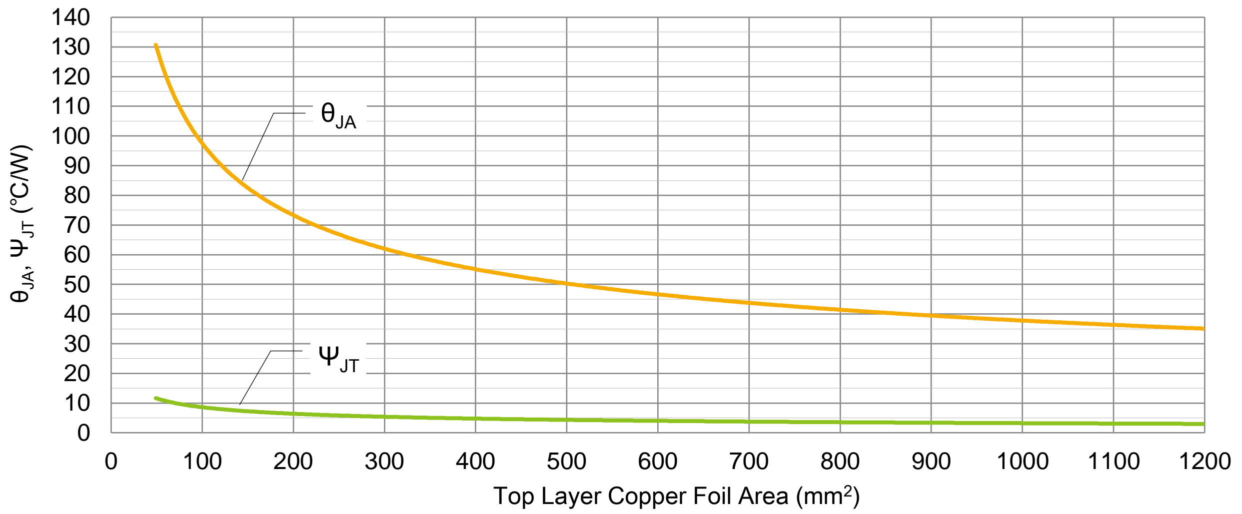

Figure 3-1-1-1. θ_{JA}, Ψ_{JT} vs 銅箔面積

Figure 3-1-1-2. 1 層基板断面図

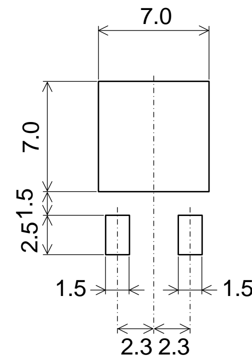

Figure 3-1-1-3. Footprint 寸法

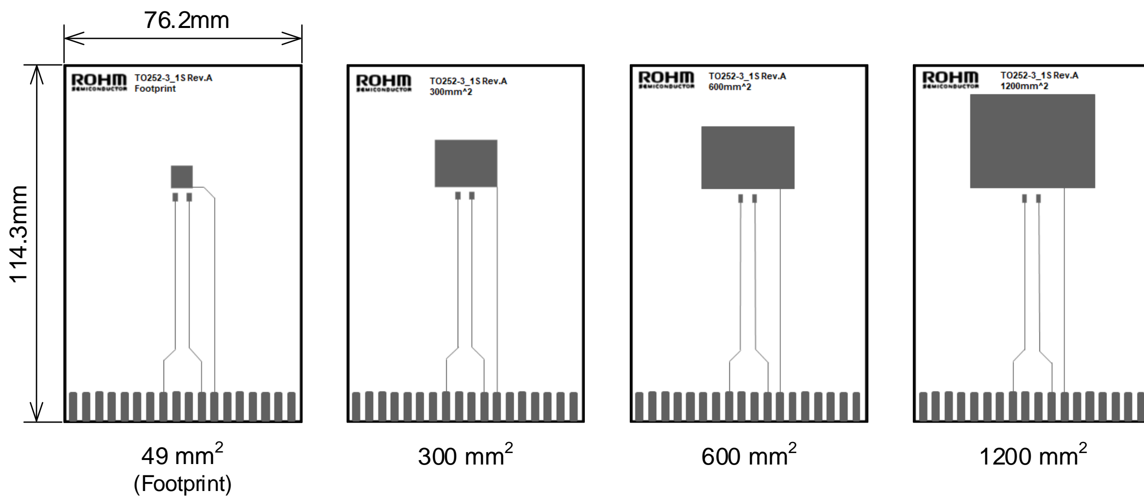

Figure 3-1-1-4. Top layer

3-1. 銅箔面積を変化（つづき）

3-1-2. 2 層、Bottom layer のみ銅箔面積を変化した場合

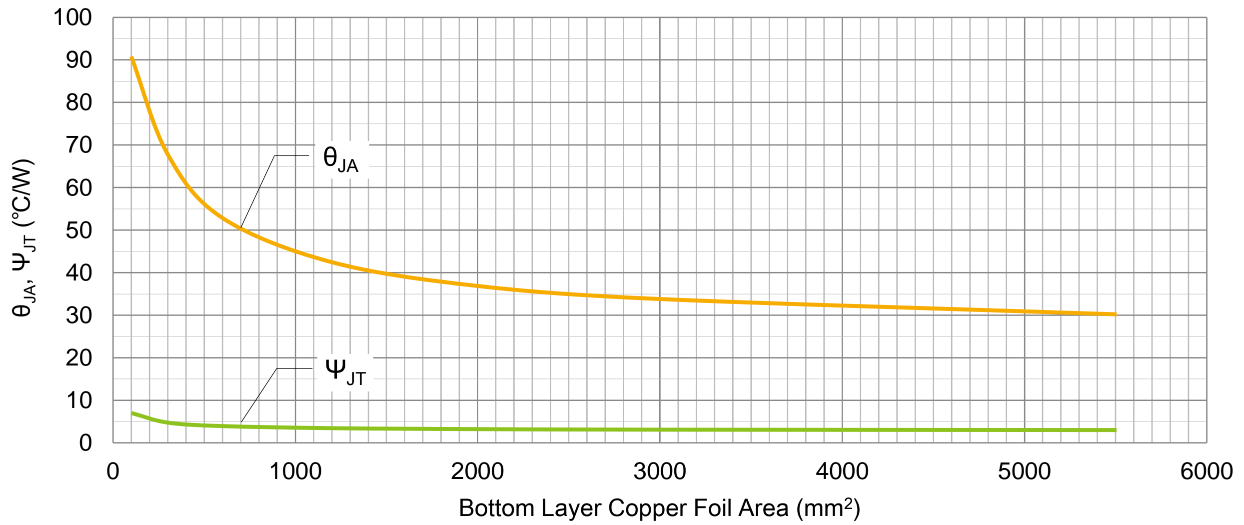

Figure 3-1-2-1. θ_{JA}, Ψ_{JT} vs 銅箔面積

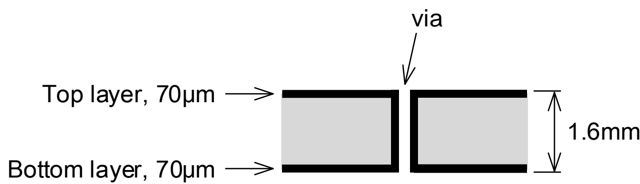

Figure 3-1-2-2. 2 層基板断面図

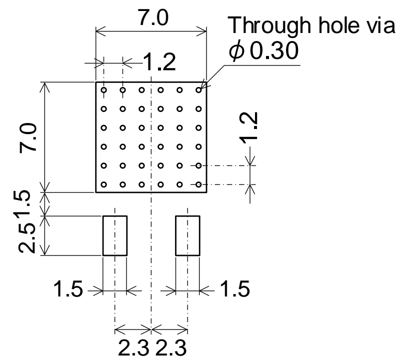

Figure 3-1-2-3. Footprint 寸法

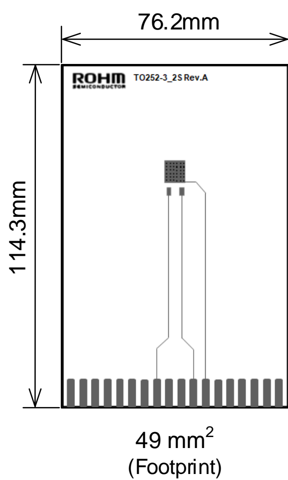

Figure 3-1-2-4. Top layer

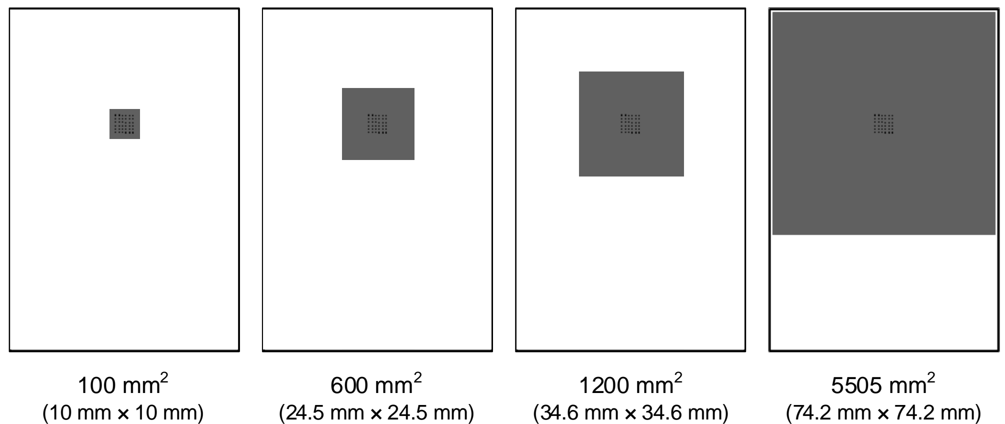

Figure 3-1-2-5. Bottom layer

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3-1．銅箔面積を変化（つづき）

3-1-3. 2 層、複数層で銅箔面積を変化した場合

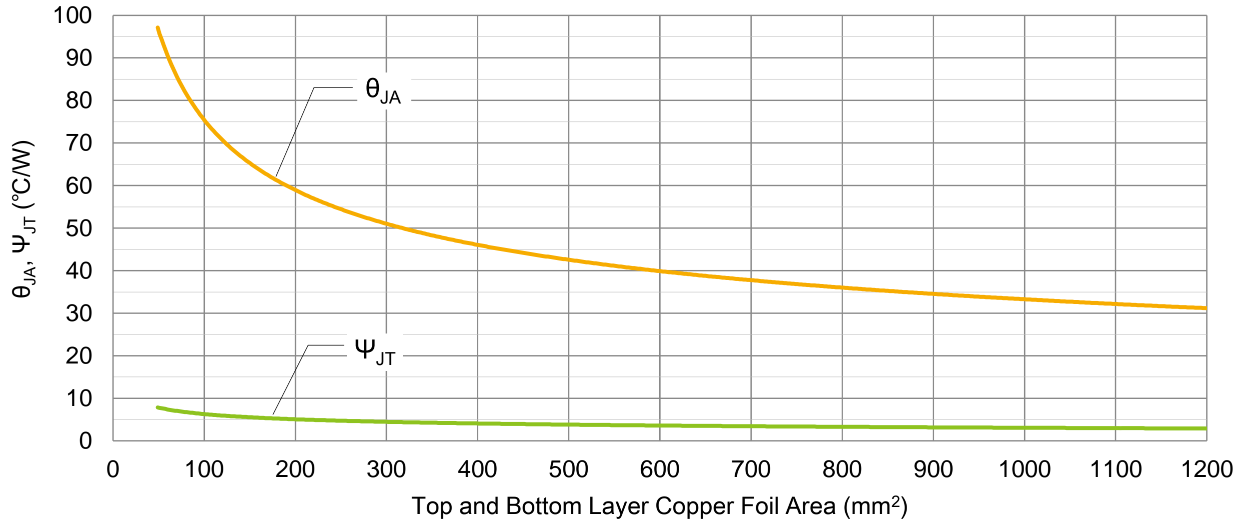

Figure 3-1-3-1. θ_{JA}, Ψ_{JT} vs 銅箔面積

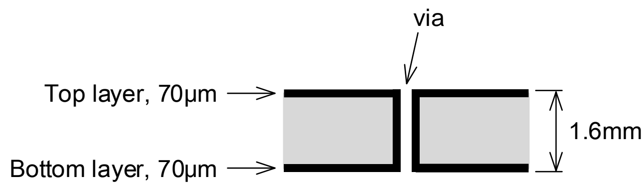

Figure 3-1-3-2. 2 層基板断面図

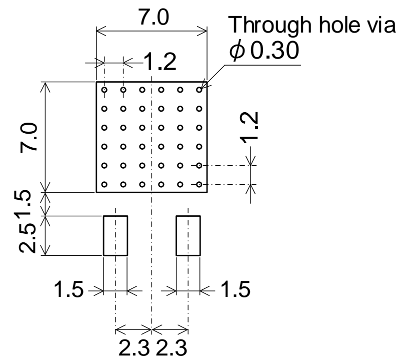

Figure 3-1-3-3. Footprint 寸法

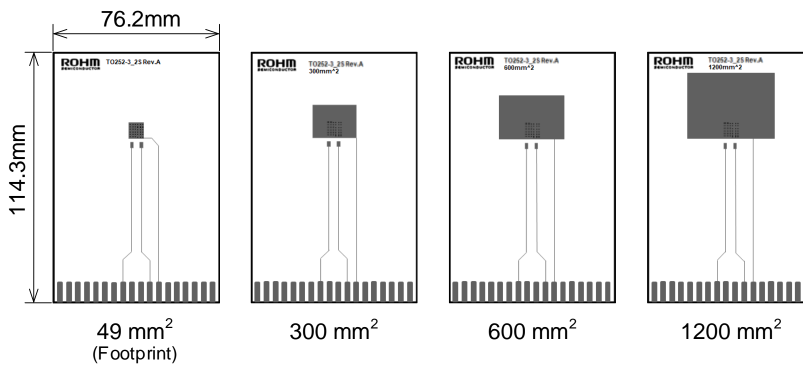

Figure 3-1-3-4. Top layer

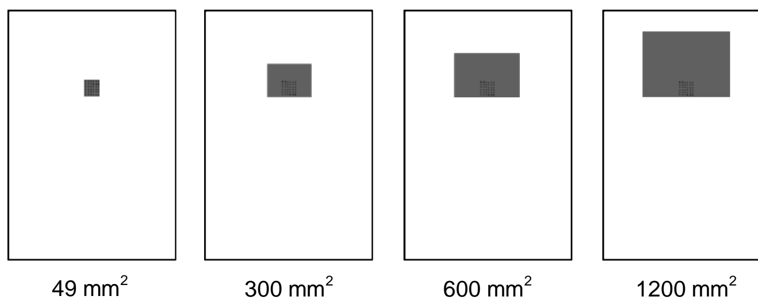

Figure 3-1-3-5. Bottom layer

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3-1. 銅箔面積を変化（つづき）

3-1-4. 4 層、複数層で銅箔面積を変化した場合

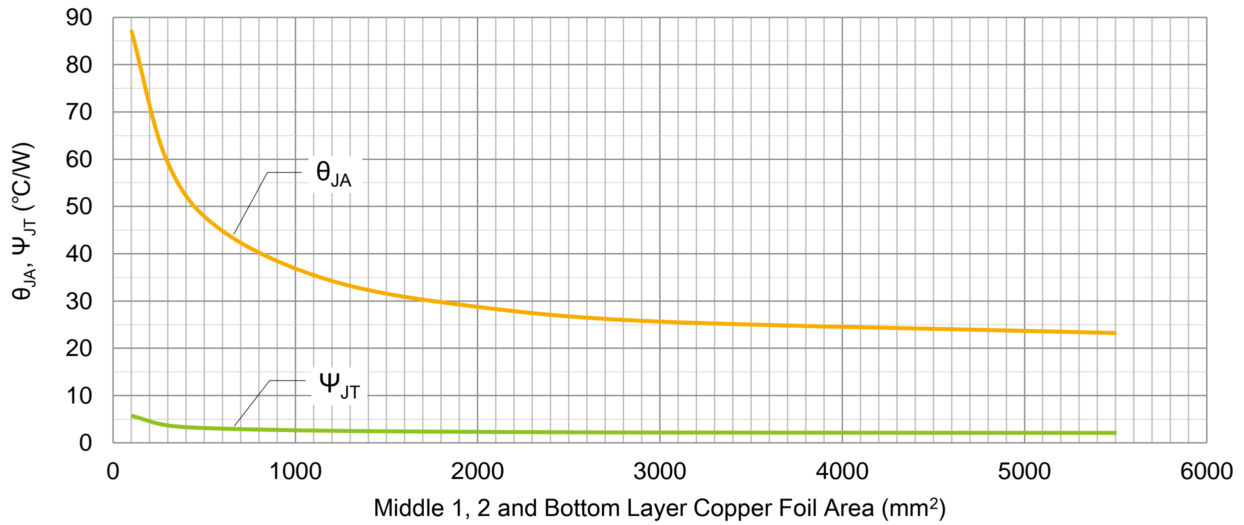

Figure 3-1-4-1. θ_{JA}, Ψ_{JT} vs 銅箔面積

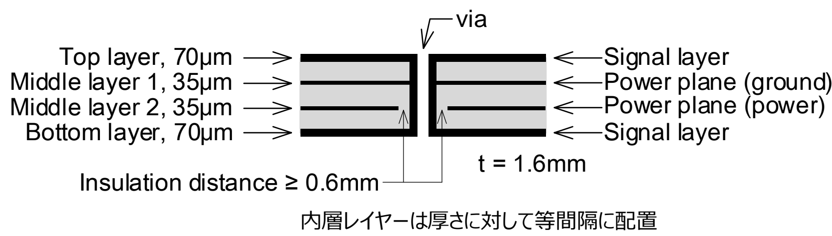

Figure 3-1-4-2. 4 層基板断面図

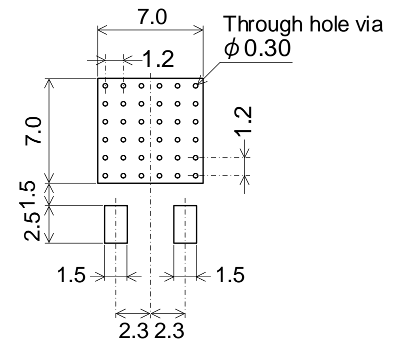

Figure 3-1-4-3. Footprint 寸法

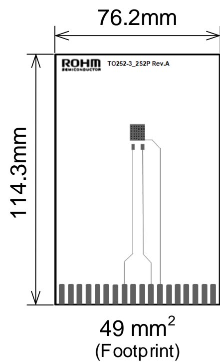

Figure 3-1-4-4. Top layer

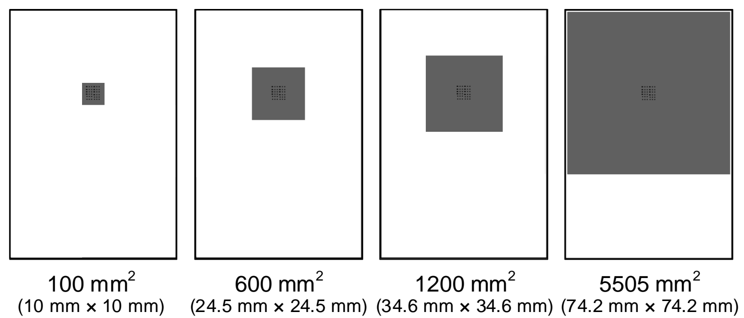

Figure 3-1-4-5. Middle layer 1, Bottom layer

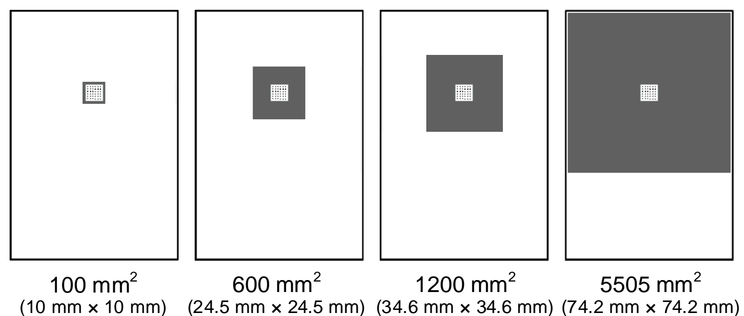

Figure 3-1-4-6. Middle layer 2

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3-1. 銅箔面積を変化（つづき）

3-1-5. 4 層、Bottom layer のみ銅箔面積を変化した場合

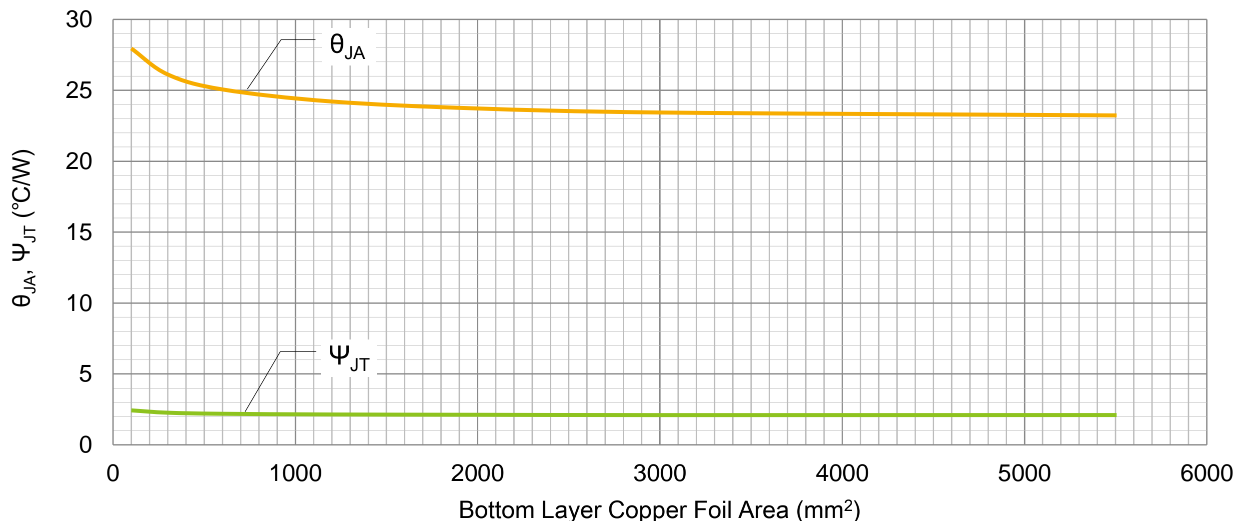

Figure 3-1-5-1. θ_{JA}, Ψ_{JT} vs 銅箔面積

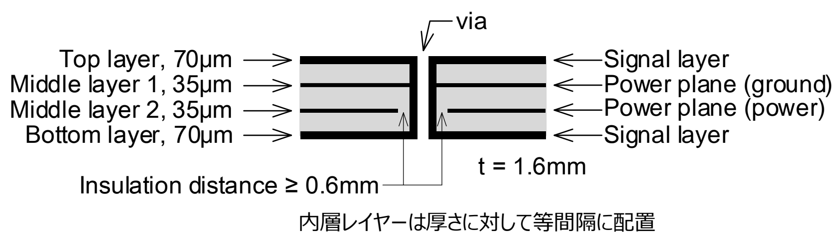

Figure 3-1-5-2. 4 層基板断面図

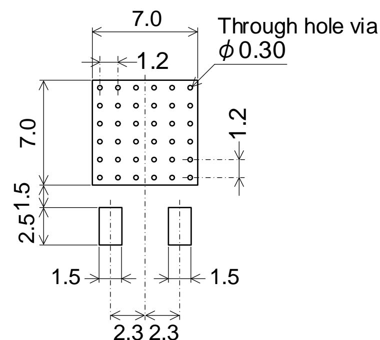

Figure 3-1-5-3. Footprint 寸法

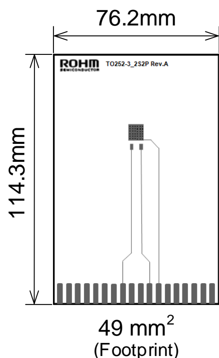

Figure 3-1-5-4. Top layer

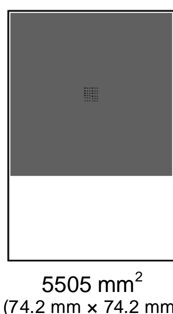

Figure 3-1-5-5. Middle layer 1

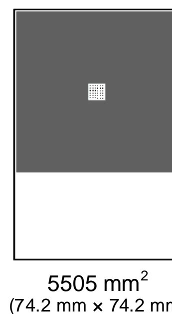

Figure 3-1-5-6. Middle layer 2

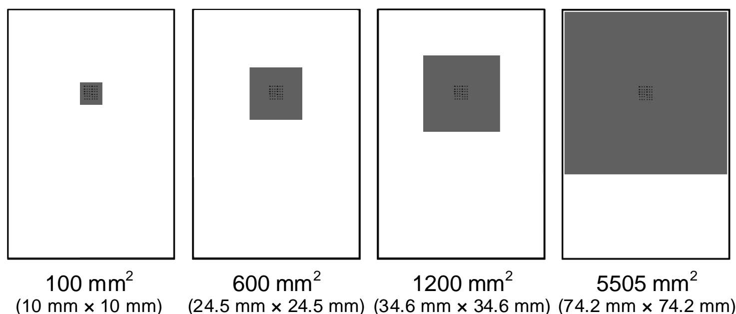

Figure 3-1-5-7. Bottom layer

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3-1. 銅箔面積を変化（つづき）

3-1-6. 6 層、複数層で銅箔面積を変化した場合

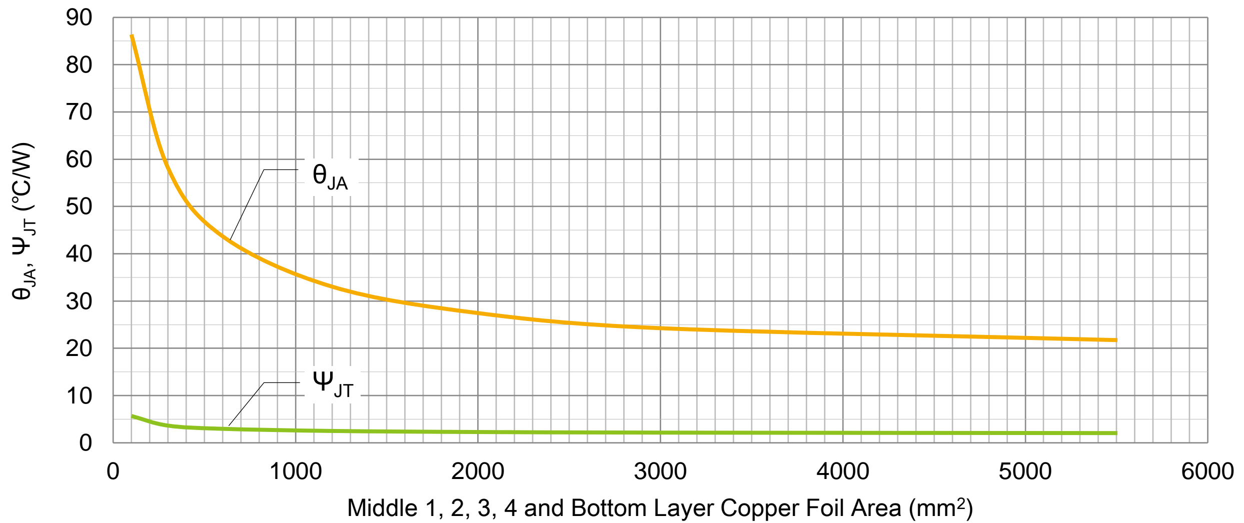

Figure 3-1-6-1. θ_{JA}, Ψ_{JT} vs 銅箔面積

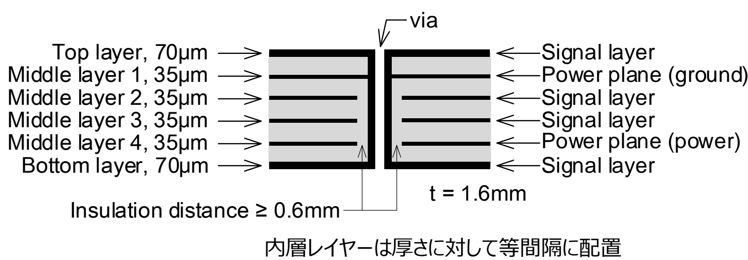

Figure 3-1-6-2. 6 層基板断面図

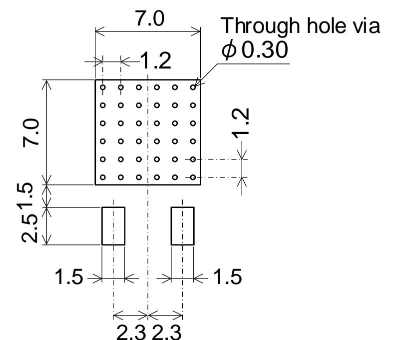

Figure 3-1-6-3. Footprint 寸法

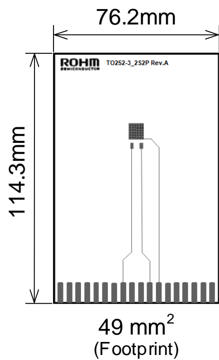

Figure 3-1-6-4. Top layer

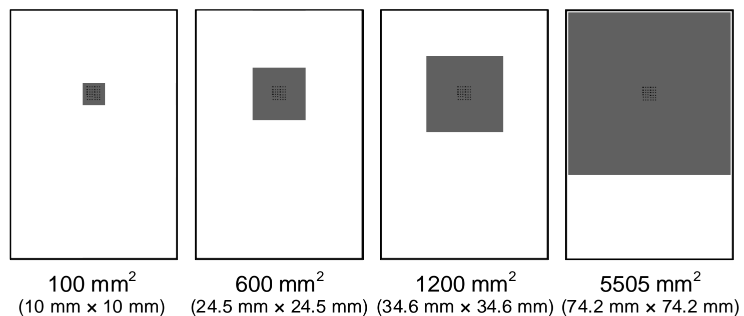

Figure 3-1-6-5. Middle layer 1, Bottom layer

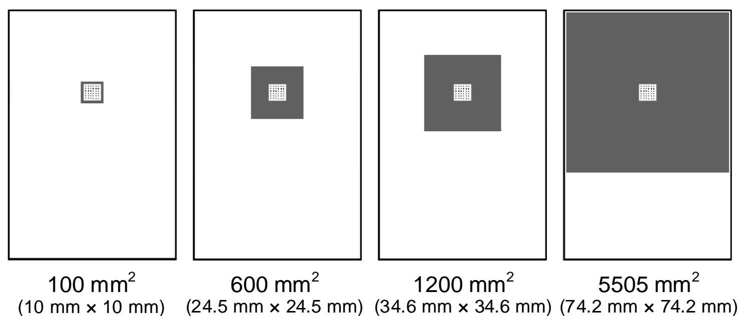

Figure 3-1-6-6. Middle layer 2, 3, 4

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3-1. 銅箔面積を変化（つづき）

3-1-7. 6 層、Bottom layer のみ銅箔面積を変化した場合

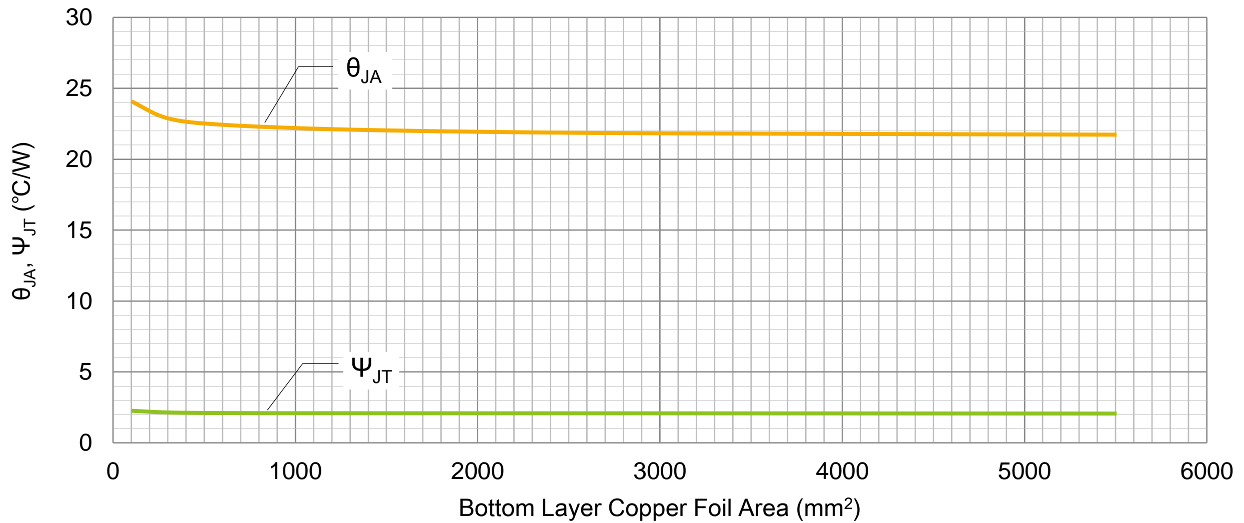


Figure 3-1-7-1. θ_{JA}, Ψ_{JT} vs 銅箔面積

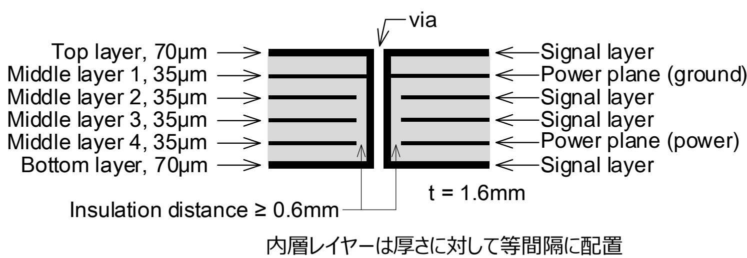


Figure 3-1-7-2. 6 層基板断面図

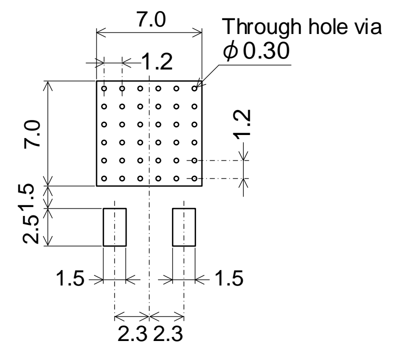
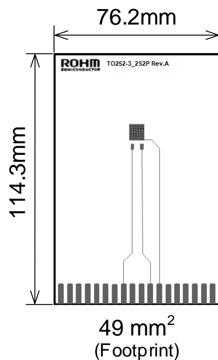
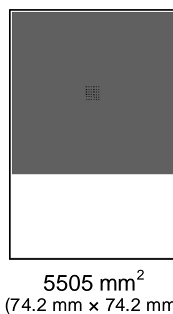


Figure 3-1-7-3. Footprint 寸法



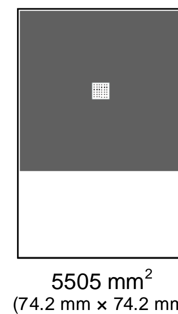
49 mm²
(Footprint)

Figure 3-1-7-4. Top layer



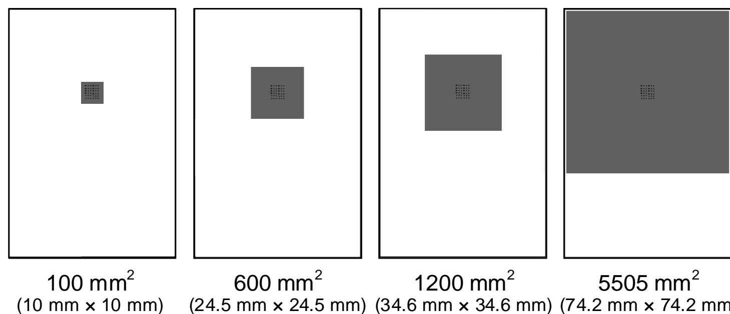
5505 mm²
(74.2 mm × 74.2 mm)

Figure 3-1-7-5. Middle layer 1



5505 mm²
(74.2 mm × 74.2 mm)

Figure 3-1-7-6. Middle layer 2, 3, 4



100 mm²	600 mm²	1200 mm²	5505 mm²
(10 mm × 10 mm)	(24.5 mm × 24.5 mm)	(34.6 mm × 34.6 mm)	(74.2 mm × 74.2 mm)

Figure 3-1-7-7. Bottom layer

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3-1. 銅箔面積を変化（つづき）

3-1-8. 8 層、複数層で銅箔面積を変化した場合

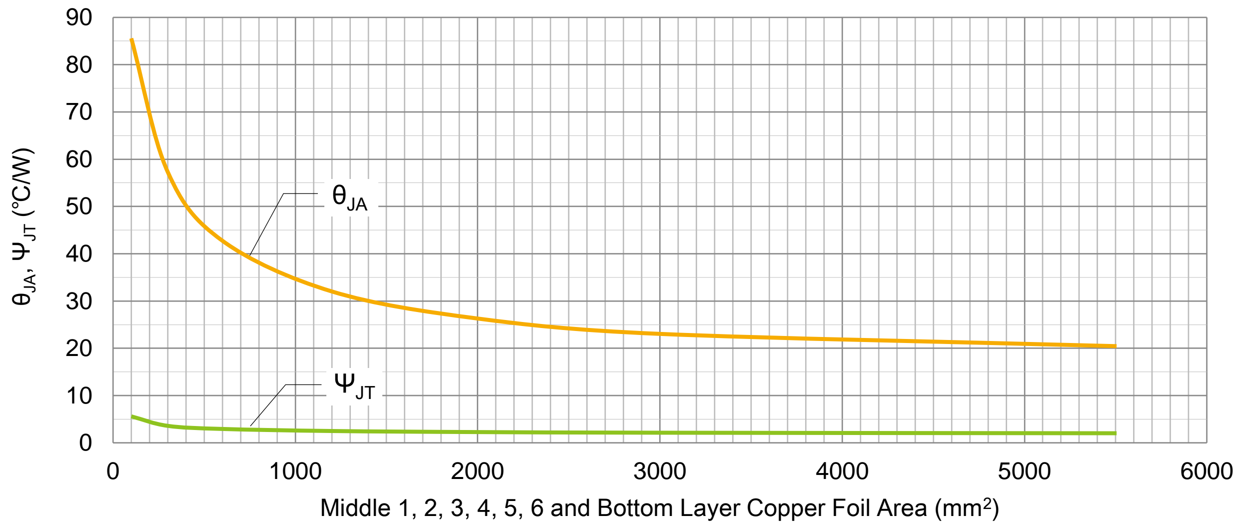

Figure 3-1-8-1. θ_{JA}, Ψ_{JT} vs 銅箔面積

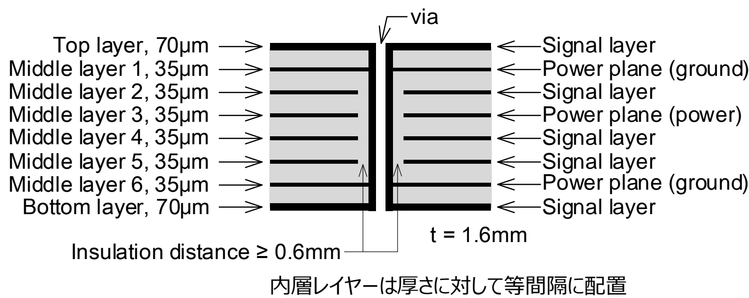

Figure 3-1-8-2. 8 層基板断面図

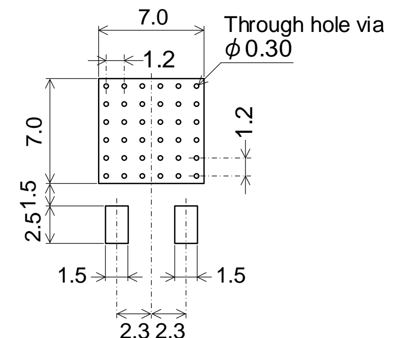

Figure 3-1-8-3. Footprint 寸法

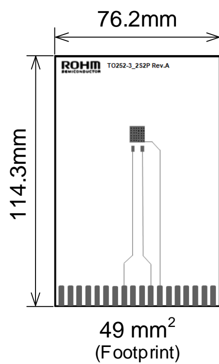

Figure 3-1-8-4. Top layer

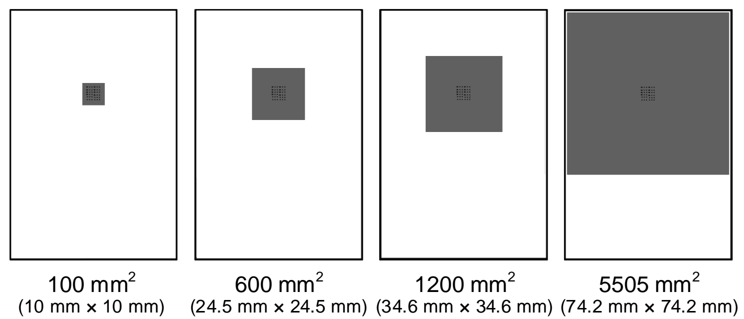

Figure 3-1-8-5. Middle layer 1, 6, Bottom layer

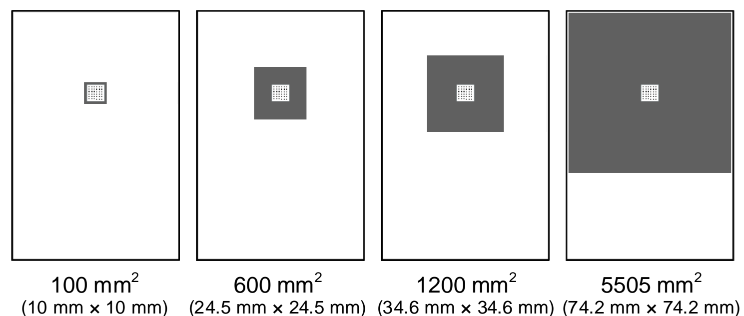

Figure 3-1-8-6. Middle layer 2, 3, 4, 5

3-1. 銅箔面積を変化（つづき）

3-1-9. 8 層、Bottom layer のみ銅箔面積を変化した場合

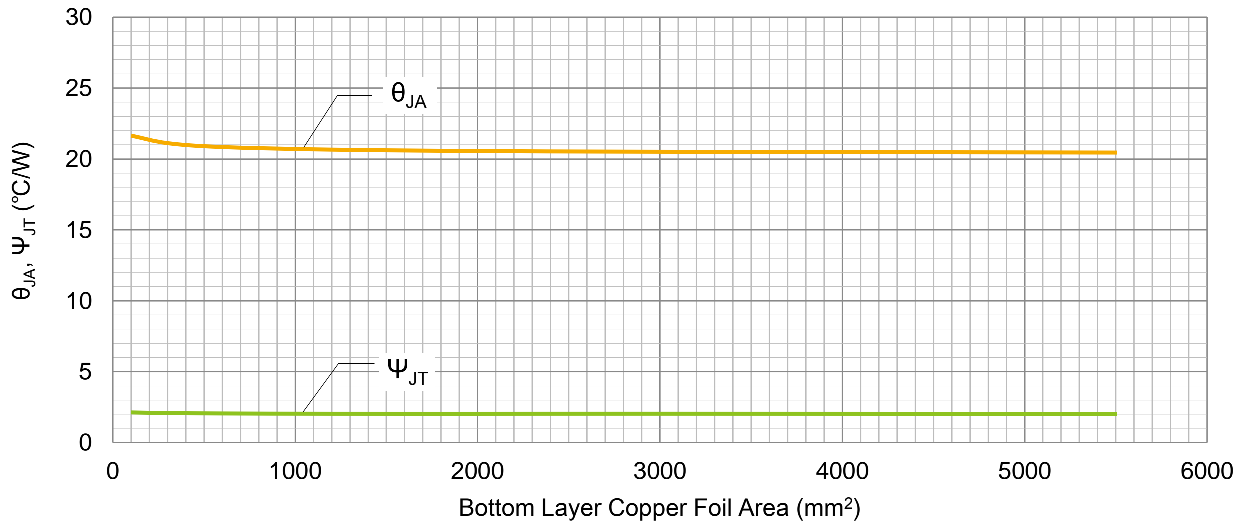

Figure 3-1-9-1. θ_{JA}, Ψ_{JT} vs 銅箔面積

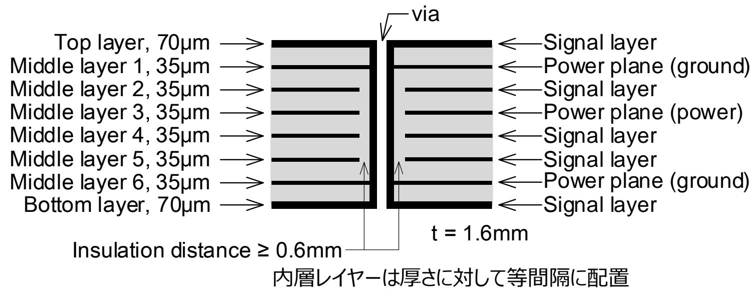

Figure 3-1-9-2. 8 層基板断面図

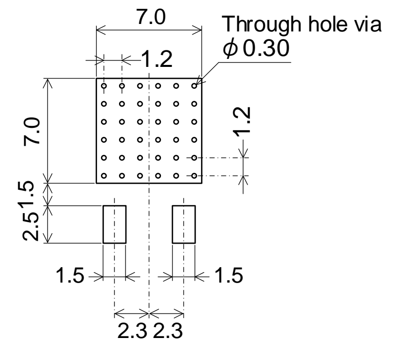

Figure 3-1-9-3. Footprint 寸法

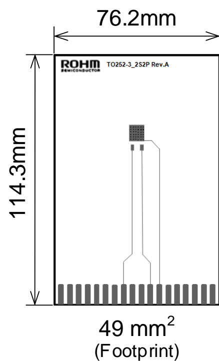

Figure 3-1-9-4. Top layer

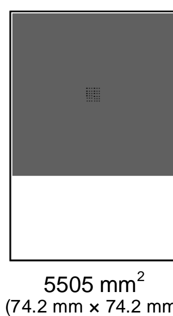

Figure 3-1-9-5. Middle layer 1, 6

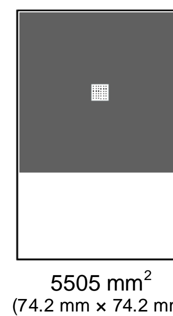

Figure 3-1-9-6. Middle layer 2, 3, 4, 5

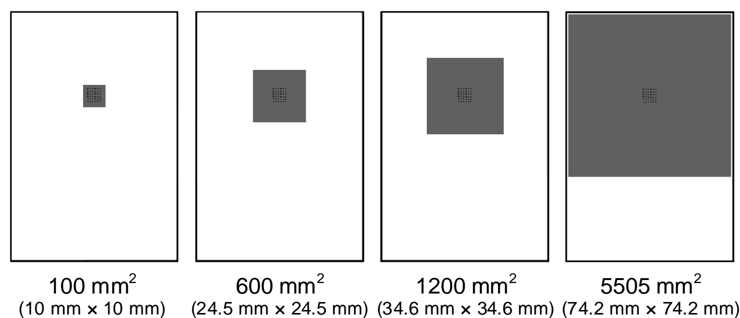

Figure 3-1-9-7. Bottom layer

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3-2. 銅箔厚を変化

3-2-1. 1 層

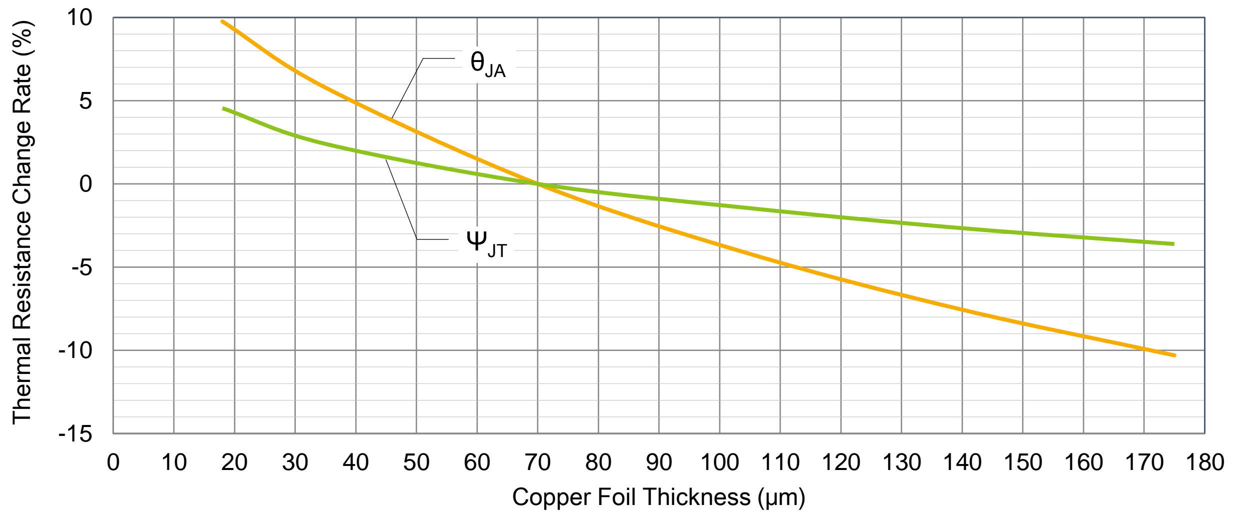


Figure 3-2-1-1. θ_{JA}, Ψ_{JT} 変化率 vs 銅箔厚

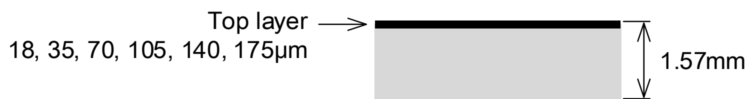


Figure 3-2-1-2. 1 層基板断面図

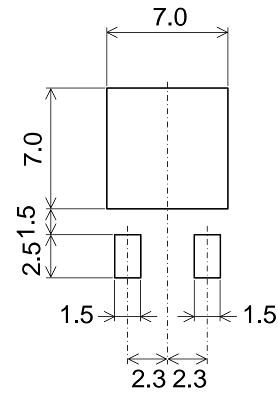
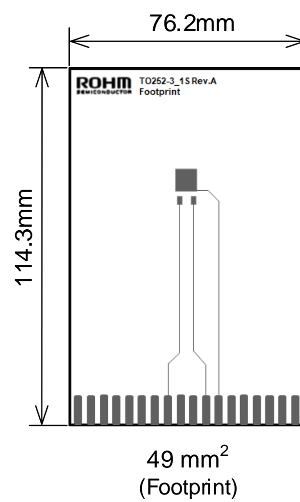


Figure 3-2-1-3. Footprint 寸法



49 mm^2
(Footprint)

Figure 3-2-1-4. Top layer

3-2. 銅箔厚を変化（つづき）

3-2-2. 2 層

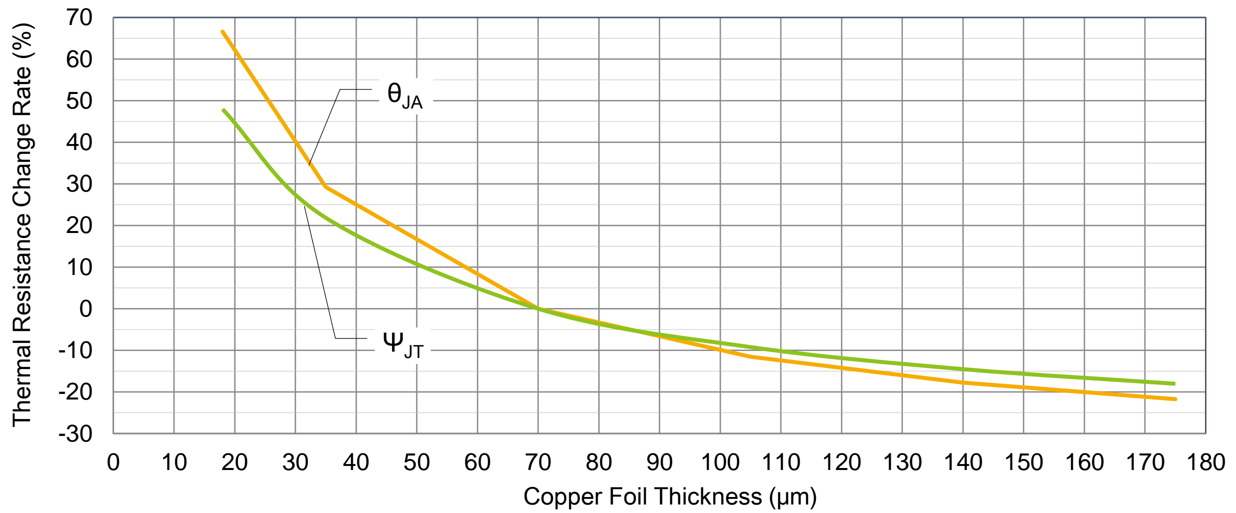


Figure 3-2-2-1. θ_{JA}, Ψ_{JT} 変化率 vs 銅箔厚

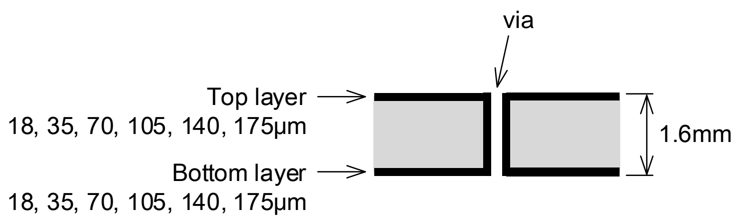


Figure 3-2-2-2. 2 層基板断面図

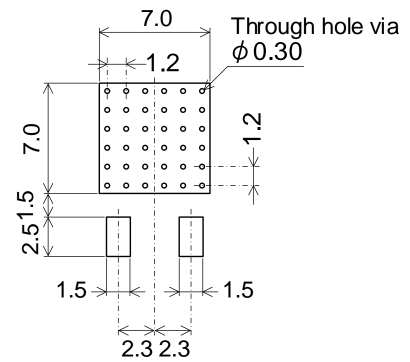
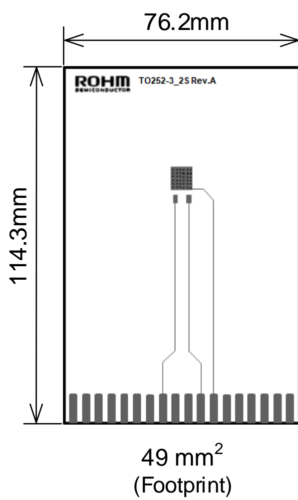
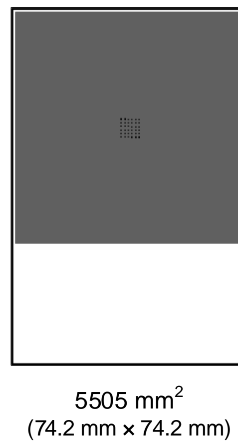


Figure 3-2-2-3. Footprint 寸法



49 mm²
(Footprint)

Figure 3-2-2-4. Top layer



5505 mm²
(74.2 mm x 74.2 mm)

Figure 3-2-2-5. Bottom layer

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3-2. 銅箔厚を変化（つづき）

3-2-3. 4 層

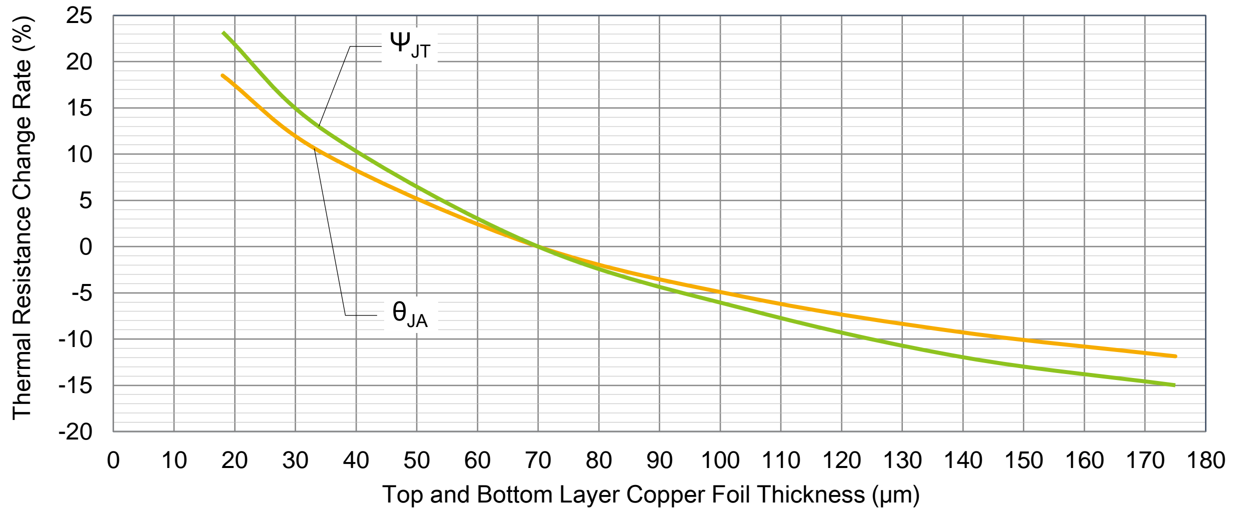

Figure 3-2-3-1. θ_{JA}, Ψ_{JT} 変化率 vs 銅箔厚

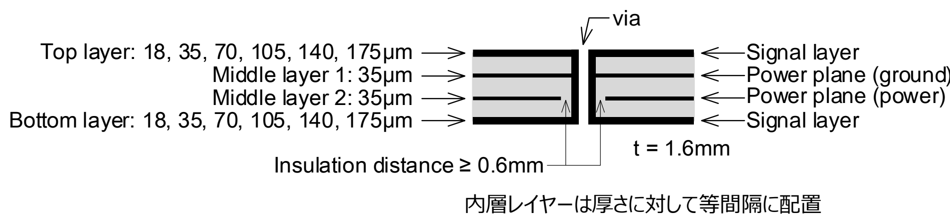

Figure 3-2-3-2. 4 層基板断面図

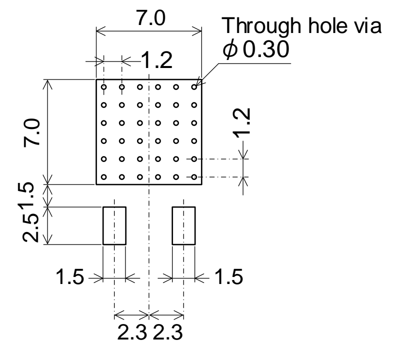

Figure 3-2-3-3. Footprint 寸法

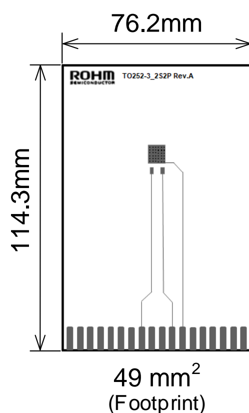

Figure 3-2-3-4.
Top layer

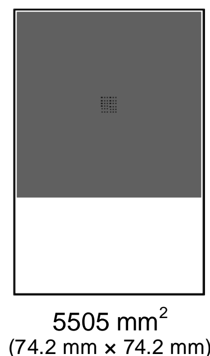

Figure 3-2-3-5.
Middle layer 1

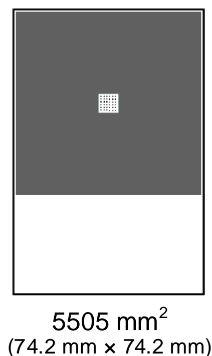

Figure 3-2-3-6.
Middle layer 2

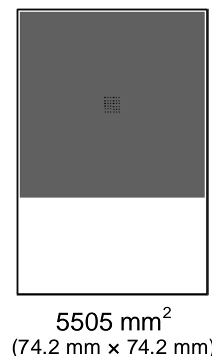

Figure 3-2-3-7.
Bottom layer

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3-3. サーマルビア配置

3-3-1. 2 層

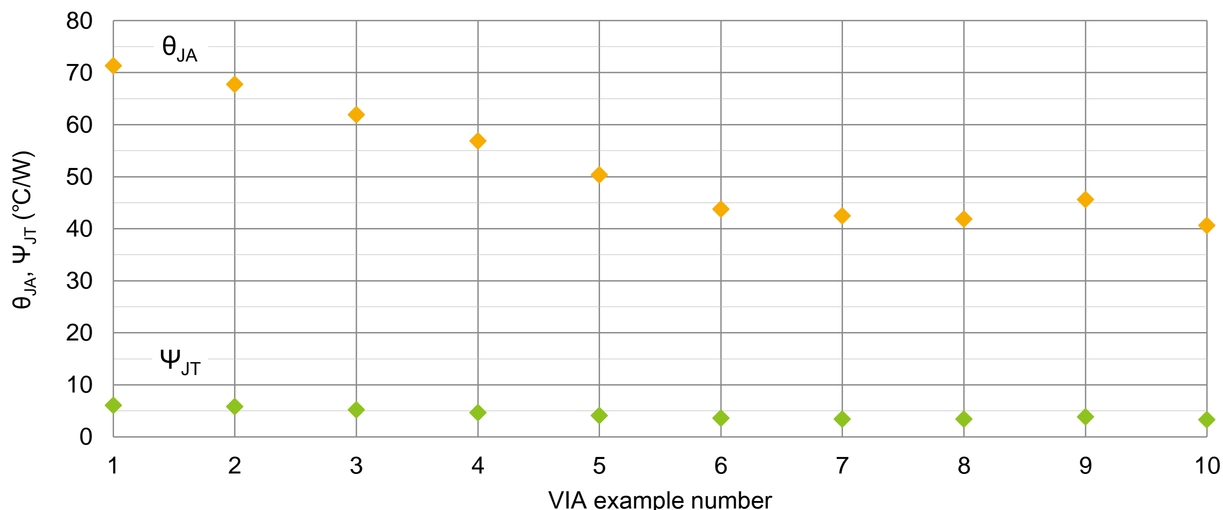


Figure 3-3-1-1. θ_{JA}, Ψ_{JT} vs サーマルビア配置

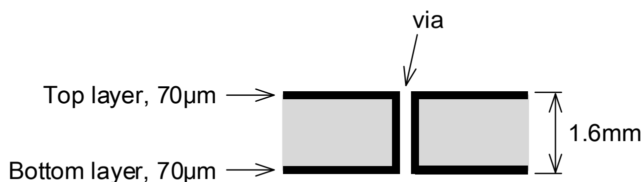


Figure 3-3-1-2. 2 層基板断面図

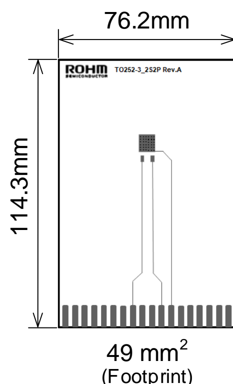


Figure 3-3-1-3. Top layer

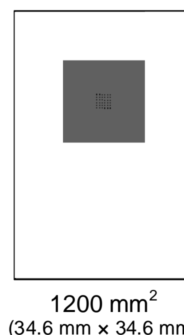


Figure 3-3-1-4. Bottom layer

ビア例の番号

■は FIN 部のはんだを示す

1. ビア なし	2. 1 個	3. 2 個	4. 2×2	5. 3×3
7.0, 7.0	φ0.3	1.6, φ0.3	1.6, φ0.3, 1.6	1.6, φ0.3, 1.6
6. 5×5	**7. 6×6**	**8. 6×6**	**9. 外周部**	**10. 8×7**
1.6, φ0.3, 1.6	1.2, φ0.3, 1.2	1.5, 7.0, 1.5, 1.2, φ0.3, 1.5, 7.0, 1.2	1.2, φ0.3, 1.2	1.2, φ0.3, 1.2

3-3. サーマルビア配置（つづき）

3-3-2. 4 層

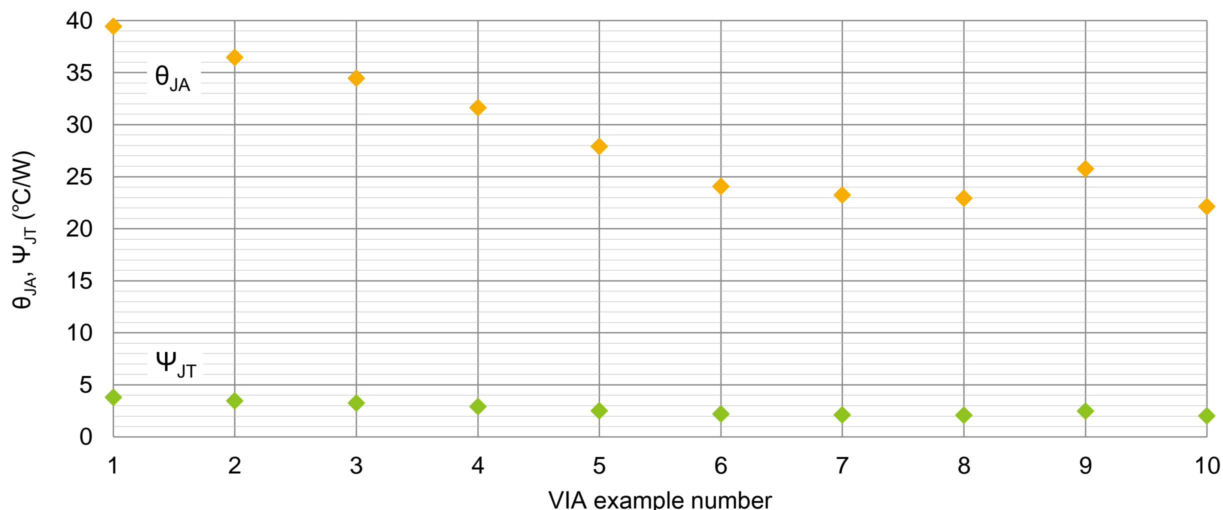


Figure 3-3-2-1. θ_{JA}, Ψ_{JT} vs サーマルビア配置

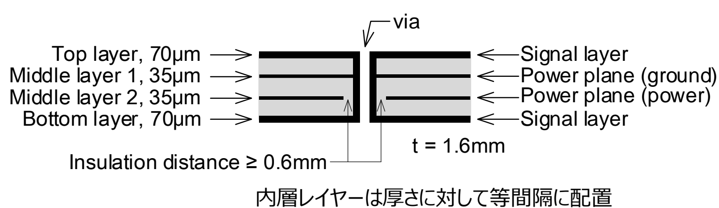


Figure 3-3-2-2. 4 層基板断面図

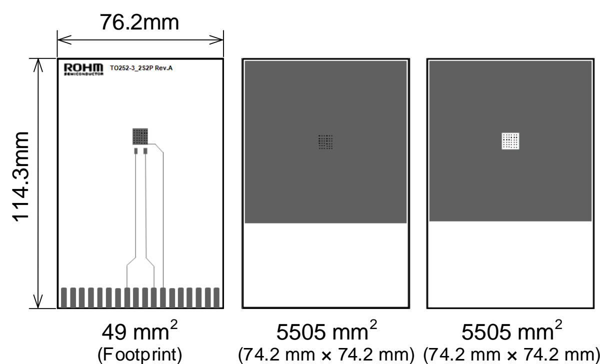
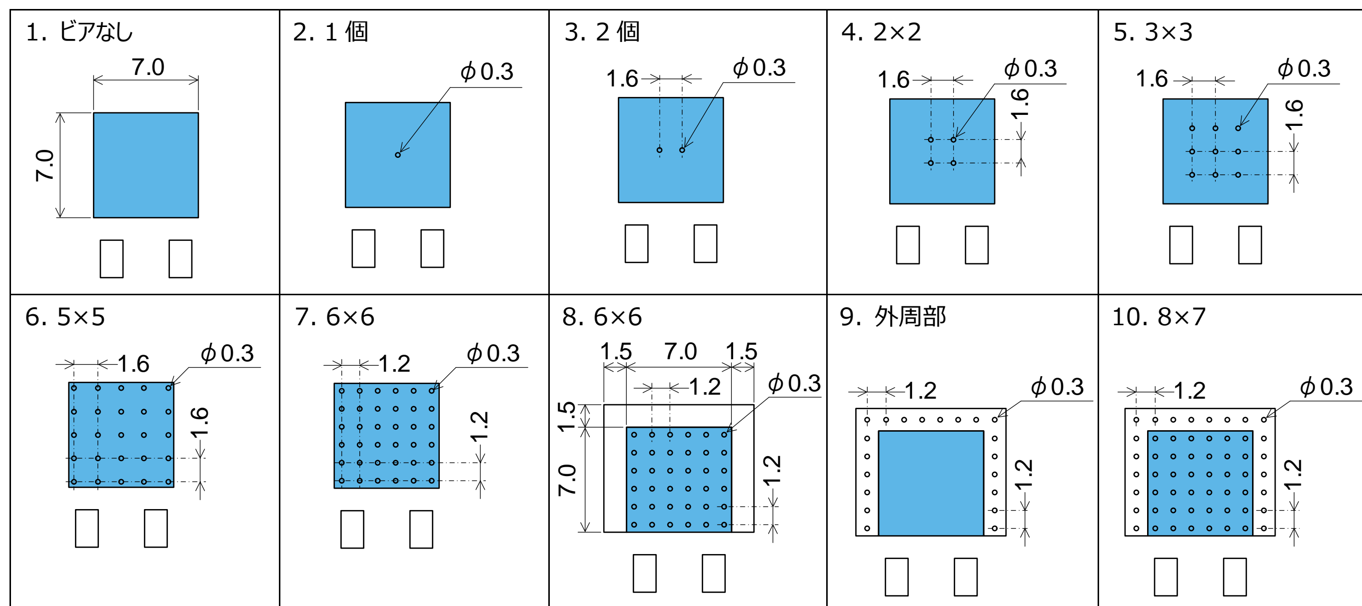


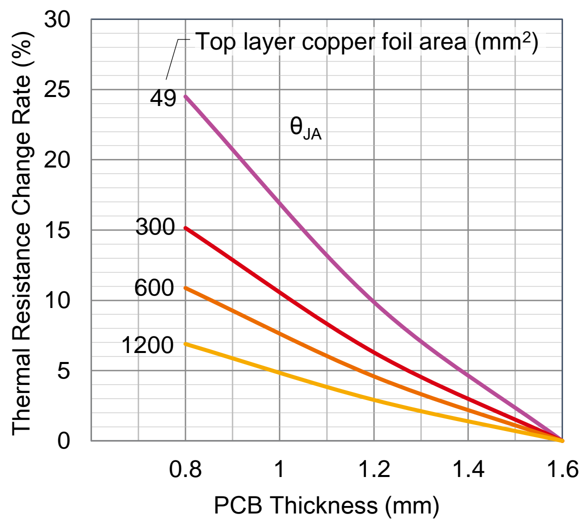
Figure 3-3-2-3. Top layer　Figure 3-3-2-4. Middle layer 1, Bottom layer　Figure 3-3-2-5. Middle layer 2

ビア例の番号　　　は FIN 部のはんだを示す



3-4. 基板厚を変化

3-4-1. 1 層



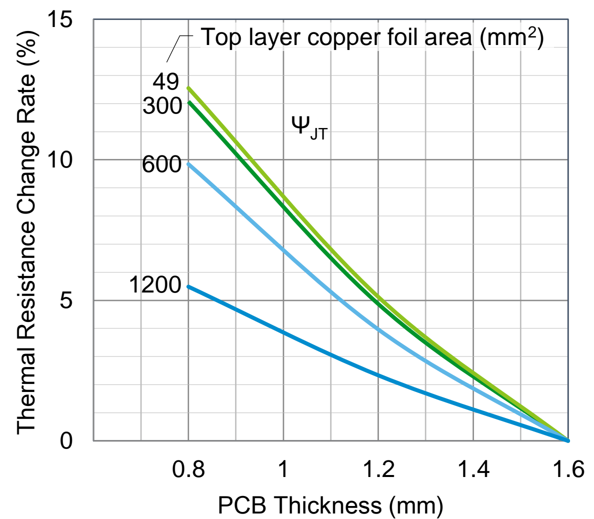


Figure 3-4-1-1. θ_{JA}, Ψ_{JT} 変化率 vs 基板厚

Figure 3-4-1-2. 1 層基板断面図

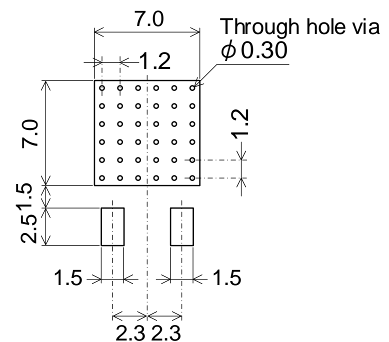


Figure 3-4-1-3. Footprint 寸法

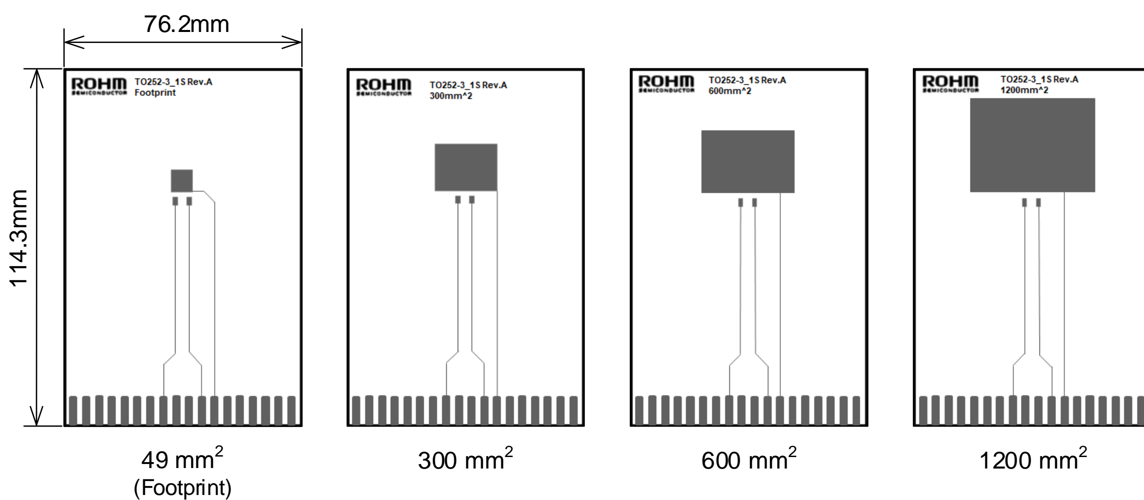
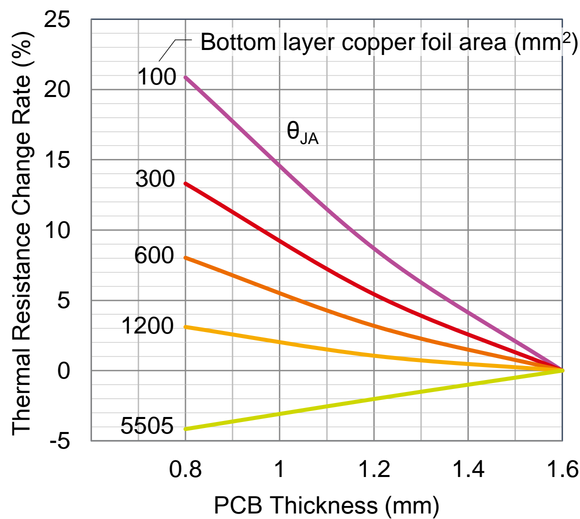


Figure 3-4-1-4. Top layer

3-4. 基板厚を変化（つづき）

3-4-2. 2 層



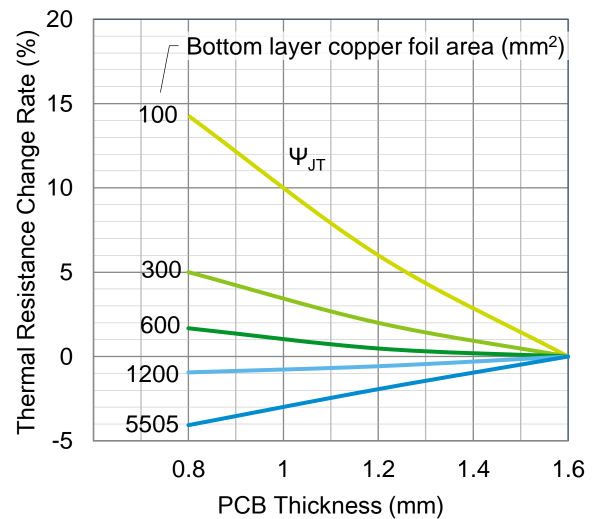


Figure 3-4-2-1. θ_{JA}, Ψ_{JT} 変化率 vs 基板厚

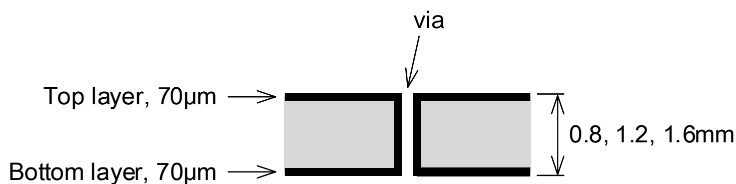


Figure 3-4-2-2. 2 層基板断面図

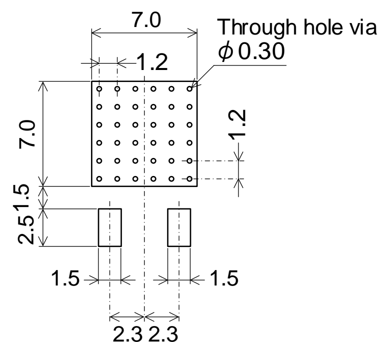


Figure 3-4-2-3. Footprint 寸法

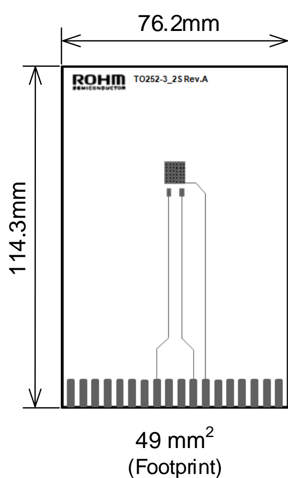


Figure 3-4-2-4. Top layer

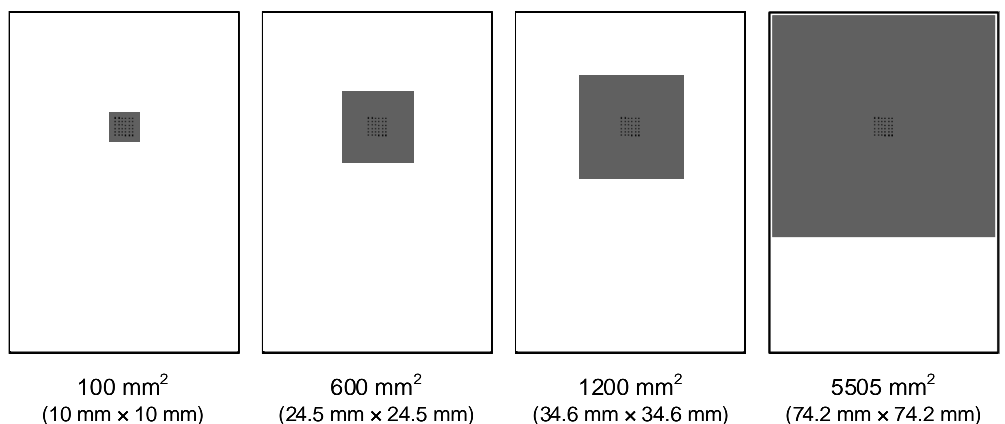


Figure 3-4-2-5. Bottom layer

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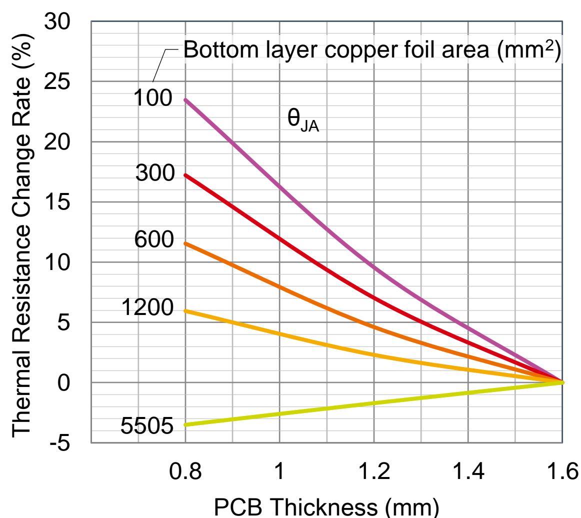
3-4. 基板厚を変化（つづき）

3-4-3. 4 層



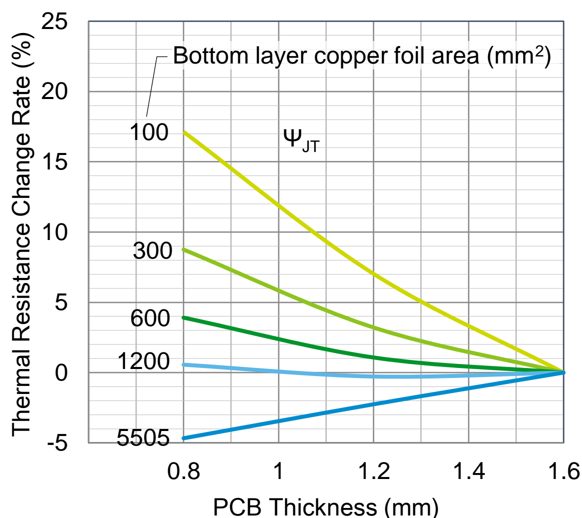


Figure 3-4-3-1. θ_{JA}, Ψ_{JT} 変化率 vs 基板厚

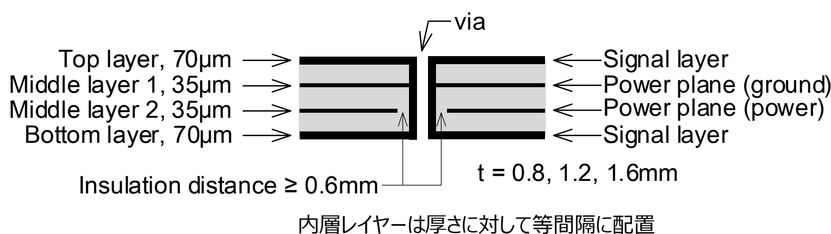


Figure 3-4-3-2. 4 層基板断面図

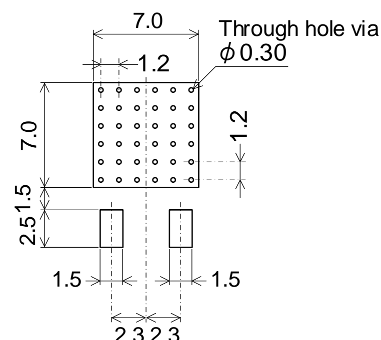


Figure 3-4-3-3. Footprint 寸法

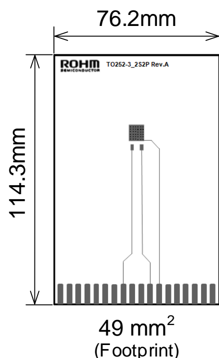


Figure 3-4-3-4. Top layer

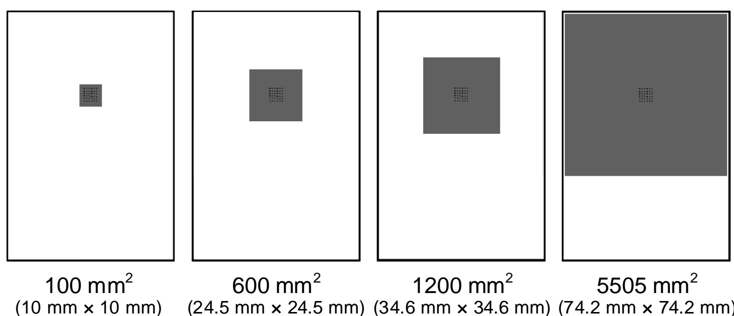


Figure 3-4-3-5. Middle layer 1, Bottom layer

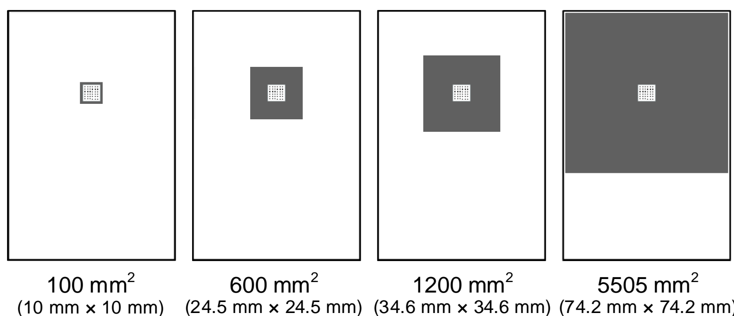


Figure 3-4-3-6. Middle layer 2

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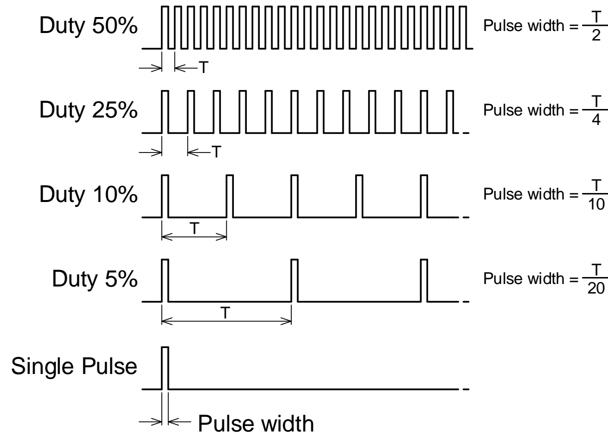
4. 過渡熱抵抗

グラフ軸の説明

X 軸：Pulse width はデバイスへの電力印加時間



Y 軸：過渡熱抵抗

4-1. 過渡熱抵抗 1 層

Figure 4-1-1. 1 層基板断面図

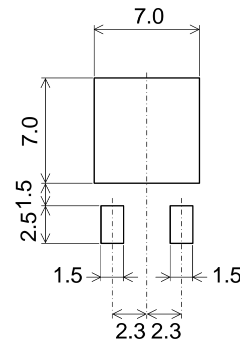


Figure 4-1-2. Footprint 寸法

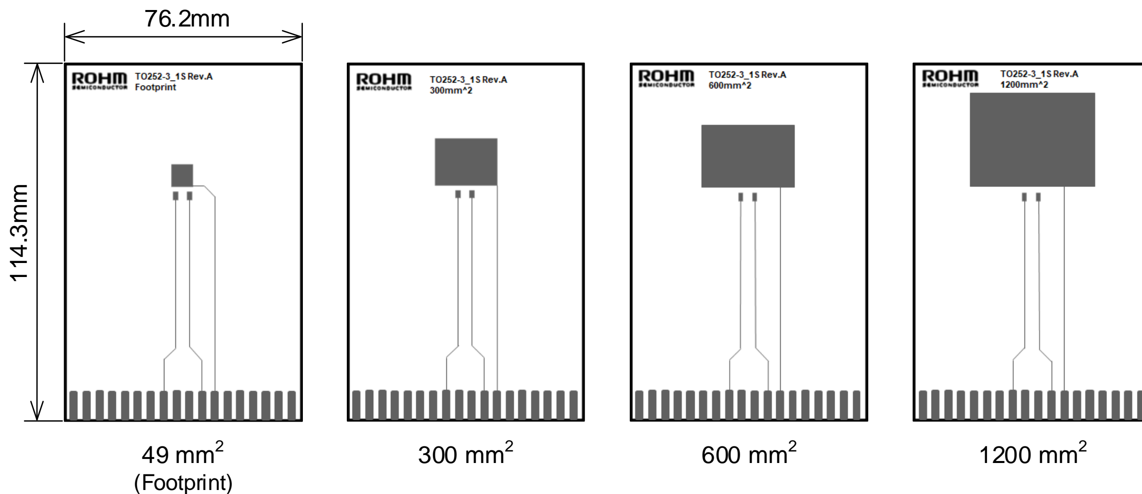


Figure 4-1-3. Top layer

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4-1. 過渡熱抵抗 1 層（つづき）

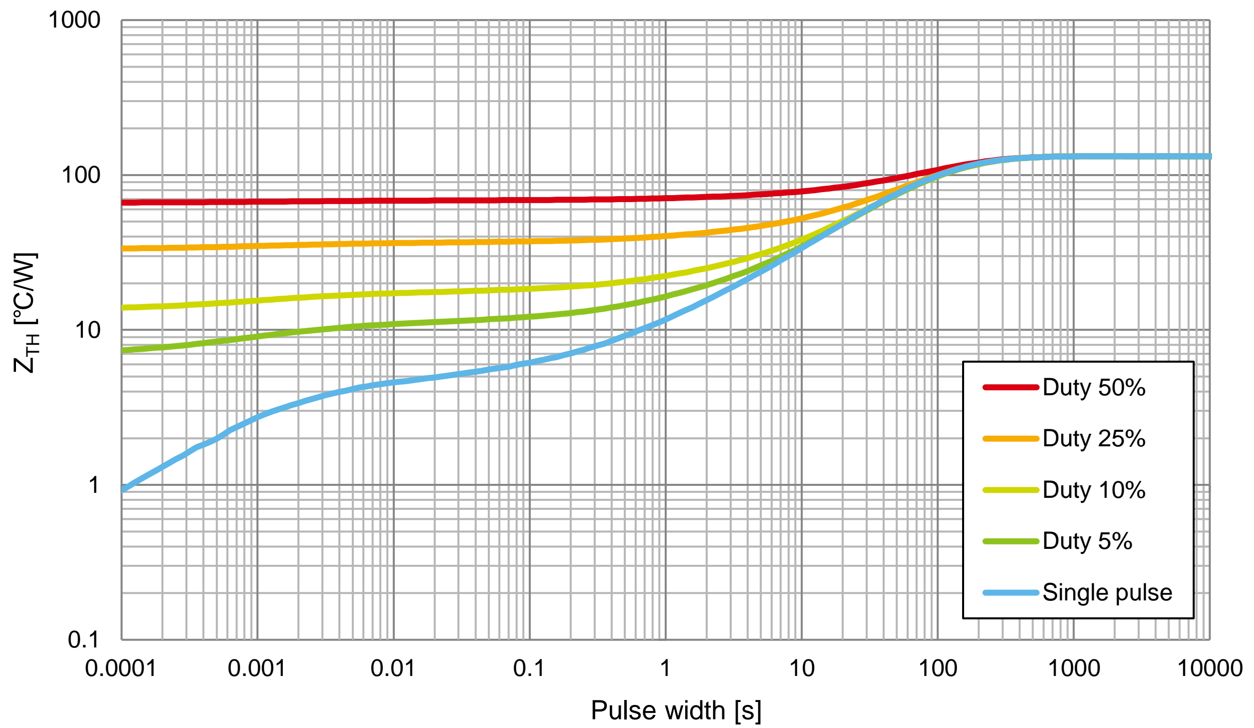

Figure 4-1-4. 過渡熱抵抗 1 層
銅箔面積 49mm^2 (Footprint)

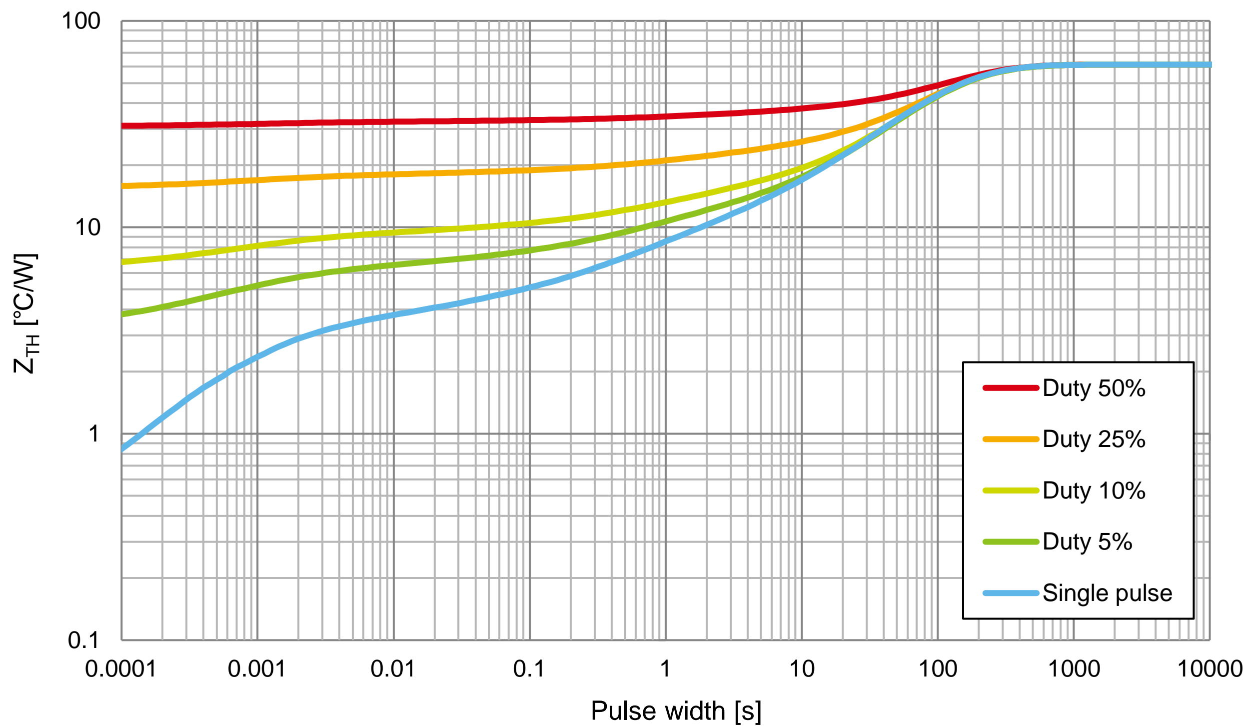

Figure 4-1-5. 過渡熱抵抗 1 層
銅箔面積 300mm^2

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4-1．過渡熱抵抗 1 層（つづき）

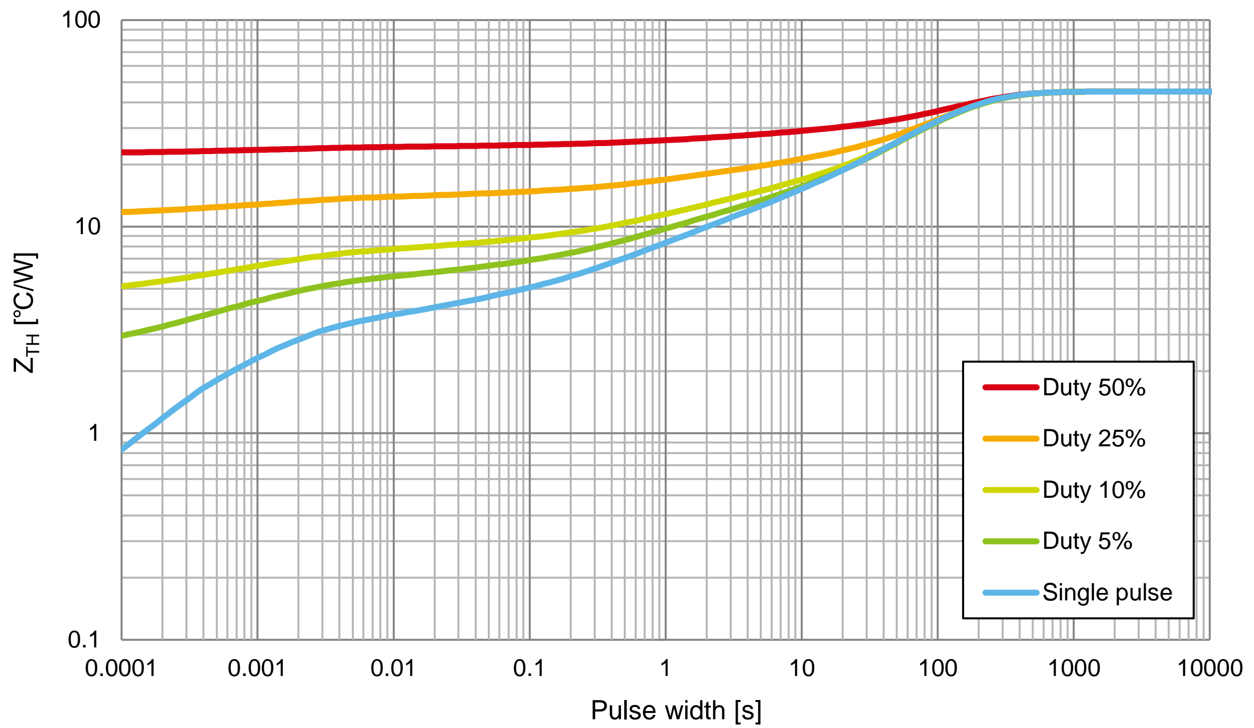

Figure 18．過渡熱抵抗 1 層
銅箔面積 600mm^2

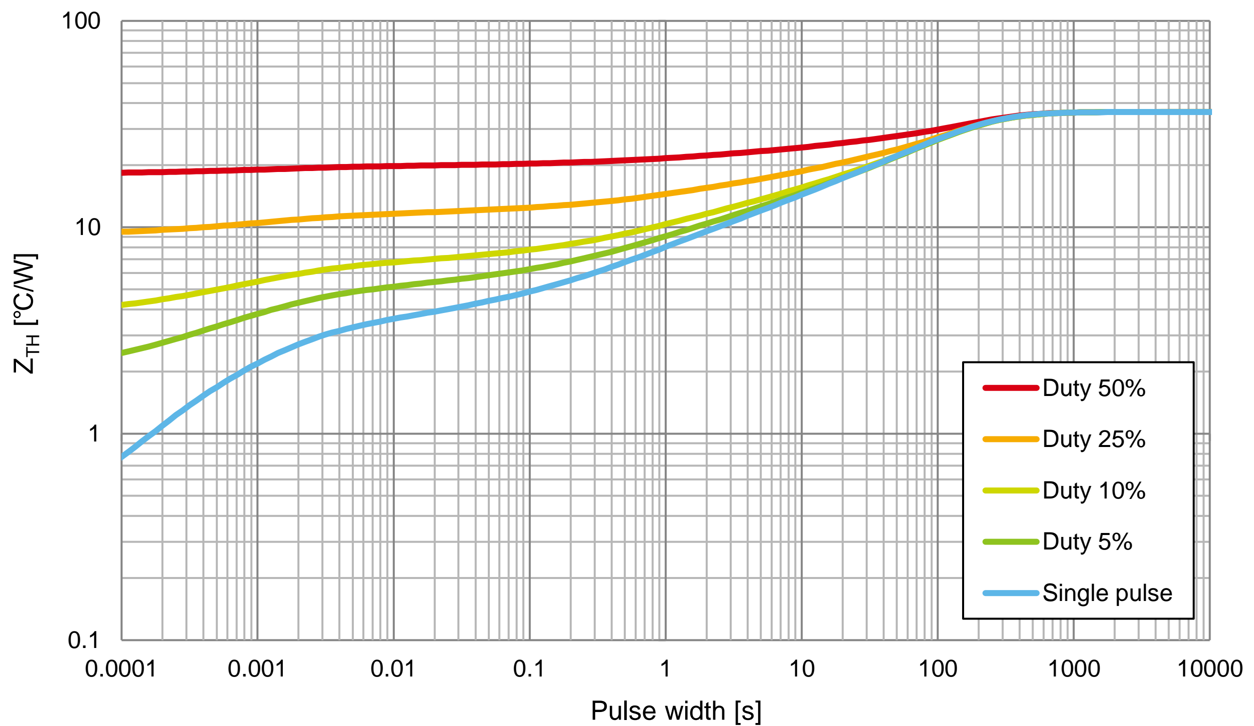

Figure 19．過渡熱抵抗 1 層
銅箔面積 1200mm^2

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4-2. 過渡熱抵抗 2 層

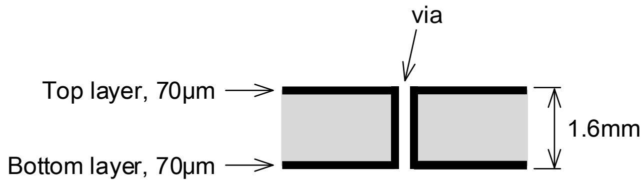


Figure 4-2-1. 2 層基板断面図

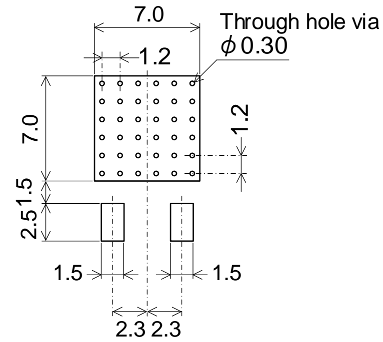
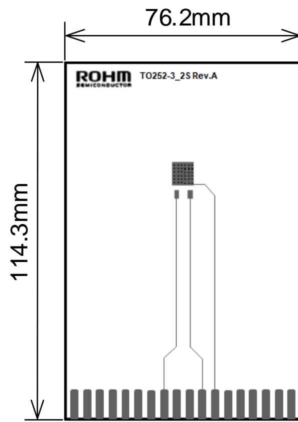
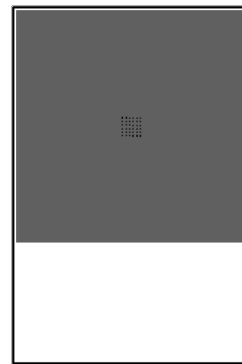


Figure 4-2-2. Footprint 寸法



49 mm^2
(Footprint)

Figure 4-2-3. Top layer



5505 mm^2
(74.2 mm × 74.2 mm)

Figure 4-2-4. Bottom layer

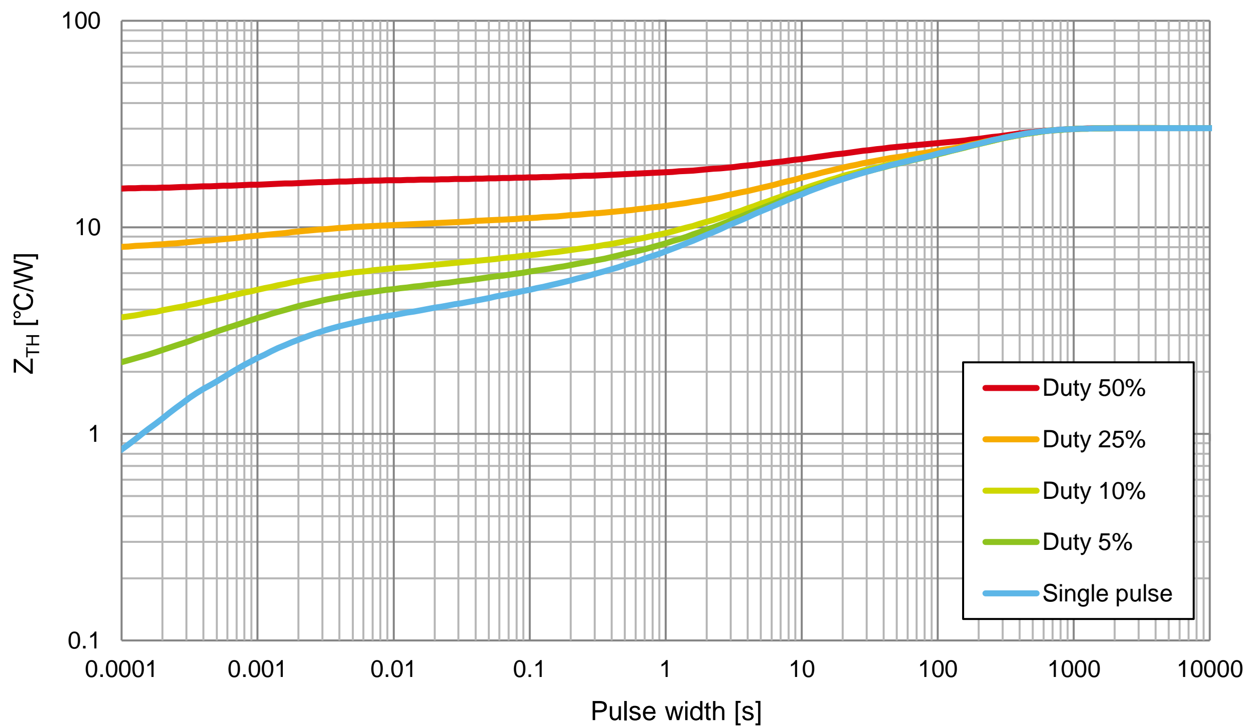


Figure 4-2-5. 過渡熱抵抗 2 層

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4-3. 過渡熱抵抗 4 層

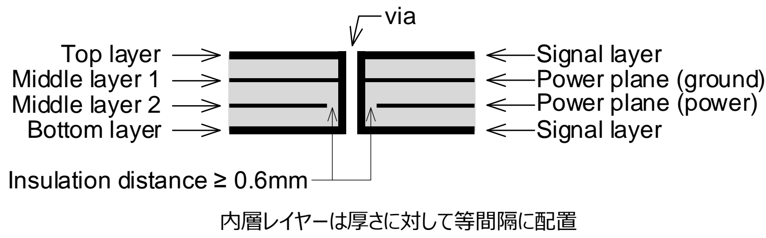

Figure 4-3-1. 4 層基板断面図

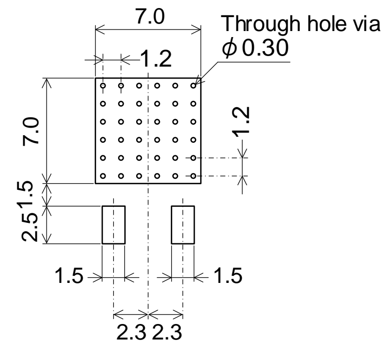

Figure 4-3-2. Footprint 寸法

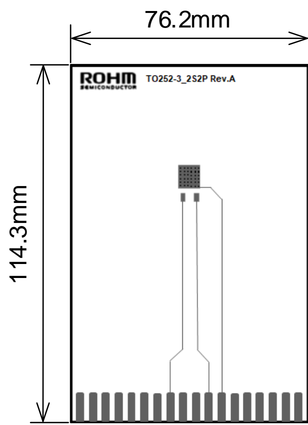

Figure 4-3-3.
Top layer

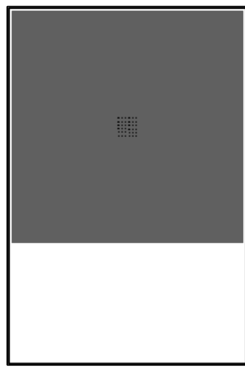

Figure 4-3-4.
Middle 1 layer

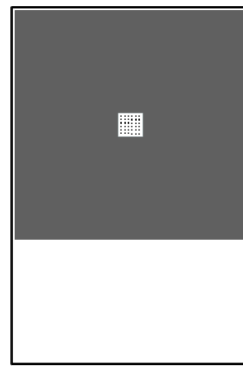

Figure 4-3-5.
Middle 2 layer

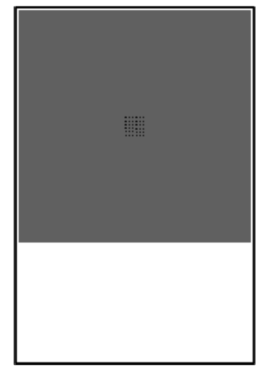

Figure 4-3-6.
Bottom layer

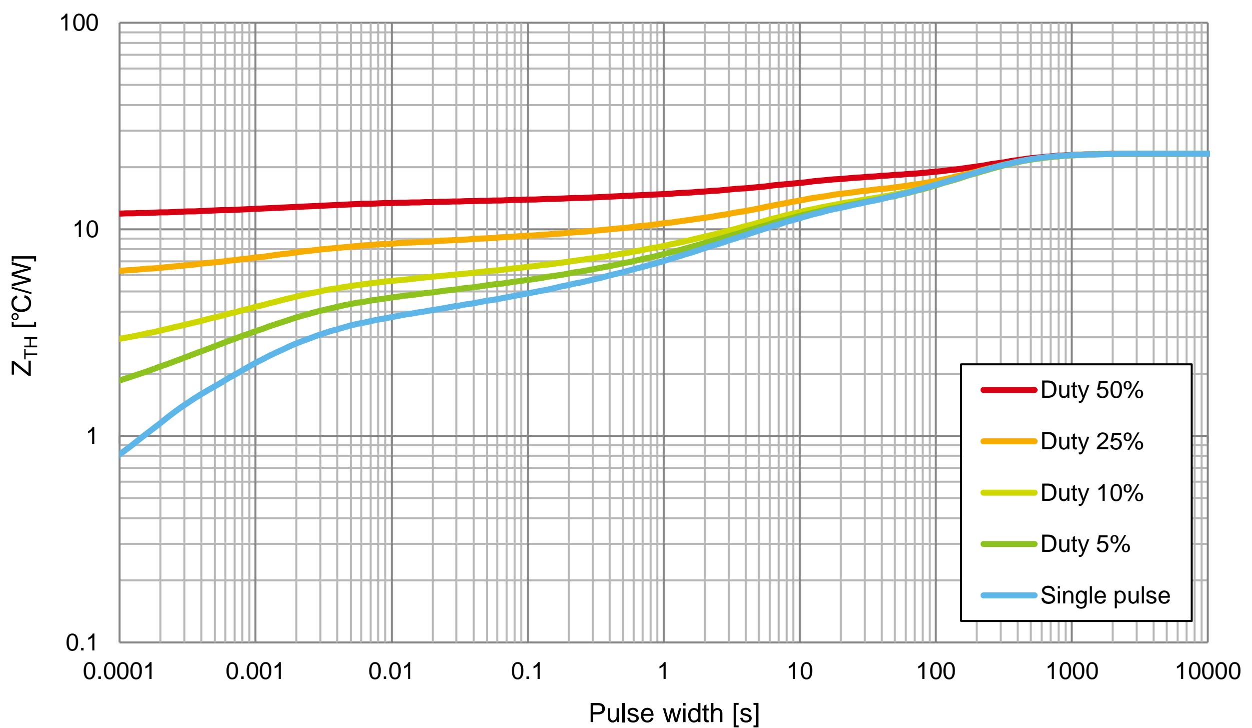

Figure 4-3-7. 過渡熱抵抗 4 層

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