TO-263 THIN Package

National Semiconductor
Application Note 1797
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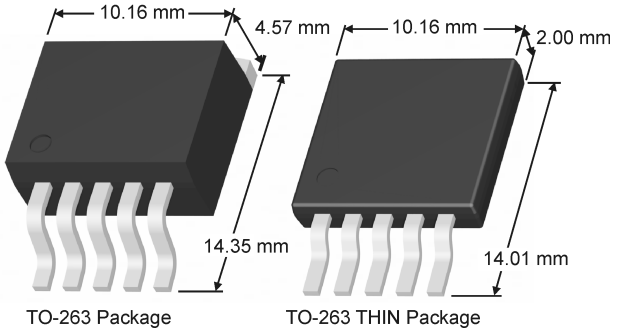


Introduction

The TO–263 THIN Package is a family of surface mount power packages designed with the following features:

1. Footprint/drop-in compatible with the standard TO-263 package but with a thinner and smaller molded body package outline.
2. Qualified using Halogen-Free “Green” Compound.
3. Moisture Sensitivity Level 1 (MSL) at 260° C.
4. Efficient thermal heat dissipation similar to that of the standard TO-263 package.
5. JEDEC registered as TO-279.

Package Key Attributes

- TO-263 THIN is designed using the same body size and thickness for all 3, 5, 7 and 9 lead options, see *Figure 1*.
- The leads are formed into a Gull-Wing configuration.
- All TO-263 THIN package leads are Pb-Free compliant.
- Shipped in non conductive Tape and Reel. Tube form will be available upon special request.
- Detailed package dimensions are shown in *Table 1*.

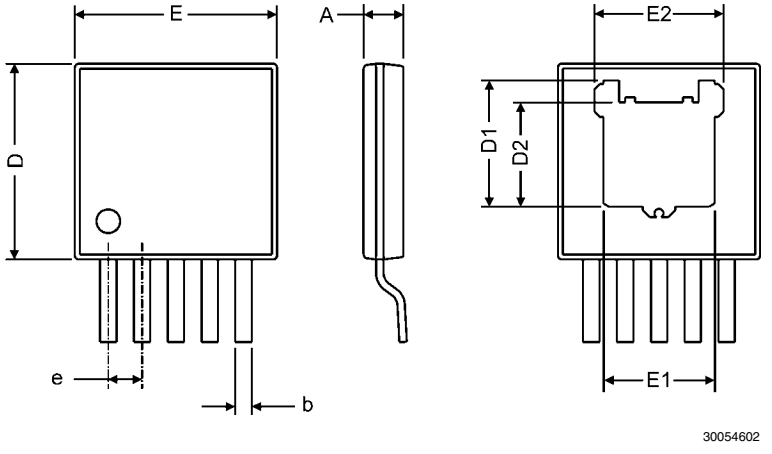


FIGURE 1. TO-263 THIN Package Attributes (see *Table 1*)

TABLE 1. TO-263 THIN Package Dimensions (see *Figure 1*)

Package Attribute	Symbol	Dimensions mm[inches]			
		3 Lead	5 Lead	7 Lead	9 Lead
Lead Width	b	0.83[0.033]		0.685[0.027]	0.51[0.020]
Lead Pitch	e	2.54[0.100]	1.7[0.067]	1.27[0.050]	0.965[0.038]
Package Thickness	A	2.00 [0.079]			
Package Length	D	9.85[0.387]			
Exposed DAP Length w/extended tab	D1	6.35[0.25]			
Exposed DAP Length	D2	5.24[0.206]			
Package Width	E	10.16[0.400]			
Exposed DAP Width w/extended tab	E1	5.59[0.220]			
Exposed DAP Width	E2	6.49[0.256]			

PCB Surface Mount (SMT) Quality

SURFACE MOUNT IPC STANDARDS

To demonstrate that the TO-263 THIN is PCB drop in compatible with the standard TO-263 packages, parts were tested using the standard IPC-A-61D surface mount reject criteria: A mounted package is rejected if the package lead overhang (A) is greater than 25% of lead width (W), see *Figure 2*.

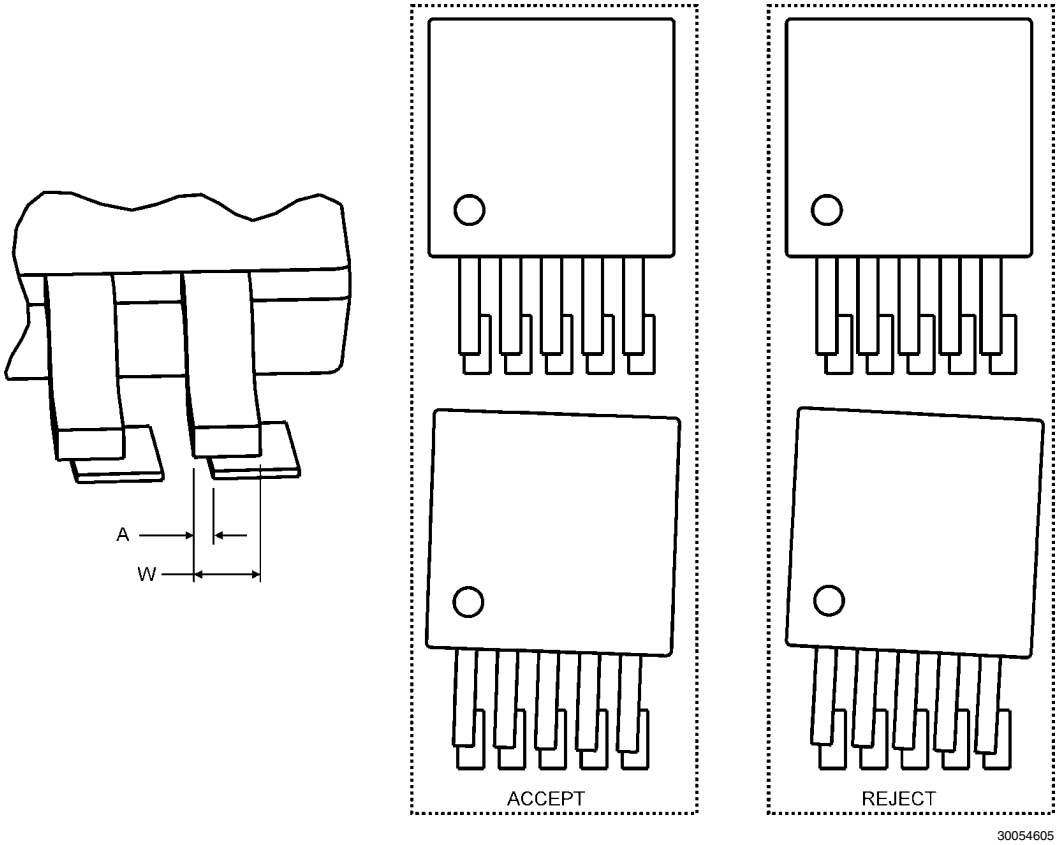


FIGURE 2. IPC-A-61D Surface Mounting Specifications

PCB DROP IN COMPATIBILITY

Three different PCB stencil layouts, TS5A, TS5B and TJ5A were designed to match the standard TO-263 package and the TO-263 THIN package exposed metal footprints as shown in *Figure 3*. Tape & Reel and Tube carriers were used in loading the parts into the pick and place IR furnace. The TO-263 THIN package post solder reflow inspection results show 100% mounting package alignment and post 750 cycles TMCL yield, see *Table 2*. Further X-Ray and cross-section analysis show leads and exposed DAP solder thickness and alignment are positioned relatively center to the PCB pads, meeting IPC requirements as shown in *Figure 4*, *Figure 5* and *Figure 6*.

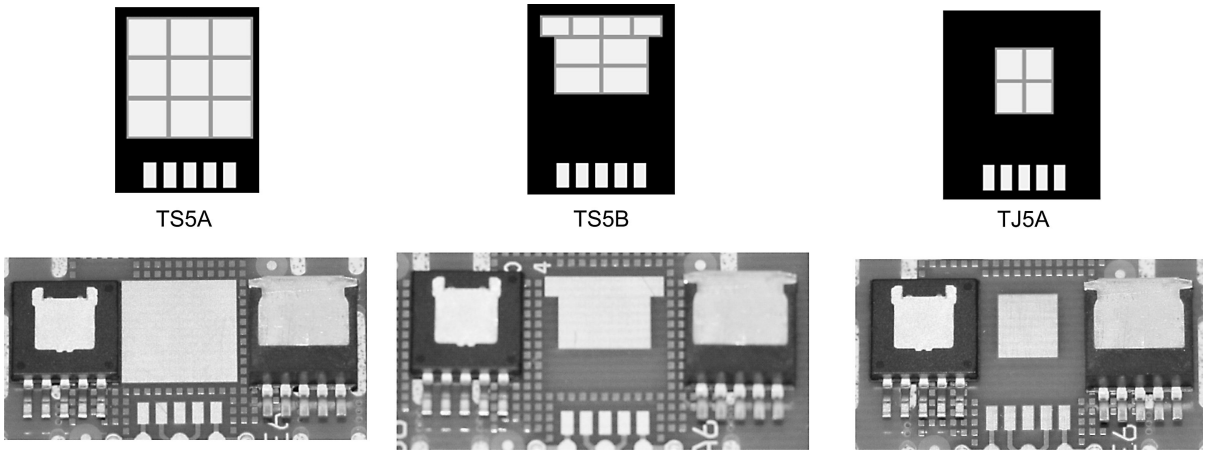


FIGURE 3. TO-263 THIN and Standard TO-263 Packages with the TJ5A PCB Layout

TABLE 2. SMT PCB Board Mounting Assembly and Post 750 Cycles TMCL Yield

PCB Footprint	Package Type	Sample Size	Assembly Yield	TMCL 750 Cycles Failure
TS5A	TO-263 Standard	352	100%	0/64
TS5A	TO-263 THIN	352	100%	0/64
TS5B	TO-263 Standard	352	100%	0/64
TS5B	TO-263 THIN	352	100%	0/64
TJ5A	TO-263 Standard	352	100%	0/64
TJ5A	TO-263 THIN	352	100%	0/64

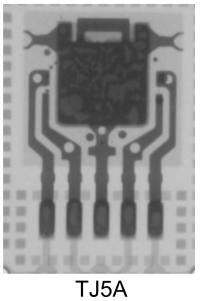


FIGURE 4. X-Ray Analysis of the TO-263 THIN Package Mounted on a TJ5A PCB layout

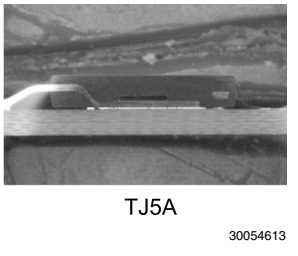
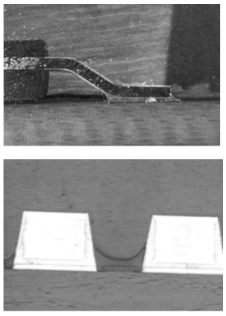


FIGURE 5. Cross-Section of Package DAP to TJ5A PCB Pad



TJ5A

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FIGURE 6. Package Leads are 100% Aligned to TJ5A PCB Pads

Thermal Performance

TO-263 PACKAGE TO TO-263 THIN PACKAGE THERMAL COMPARISON

Thermal measurements between the standard TO-263 package and the TO-263 THIN package were compared using a Power Switcher device (LM2596). The results demonstrate that the TO-263 THIN junction-to ambient (θ_{JA}) performance is better, see *Table 3* and *Figure 7*.

TABLE 3. Thermal Comparison Between TO-263 and TO-263 THIN

Package	TO-263			TO-263 THIN		
Test Power	0.5 W	1.0 W	2.0 W	0.5 W	1.0 W	2.0 W
θ_{JA} (°C/W)	24.9	24.8	23.6	22.5	22.3	22.0
Qual Vehicle: LM2596 Test Condition: No Air Flow, JEDEC 4 Layer Test Board						

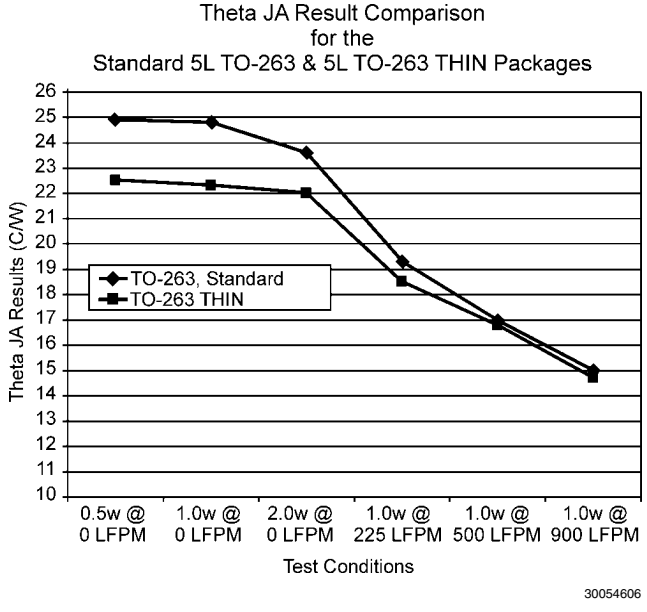

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FIGURE 7. Thermal Performance Comparison of Various Power and Air Flows

Printed Circuit Board (PCB) Layout

- The PCB layout is design per JEDEC JESD51-7 and JESD51-5 thermal boards.
- The thermal test boards are 16 square inch (4.0” x 4.0”) with a 4-layer Cu configuration of 2oz/1oz/1oz/2oz. Cross section thermal boards has 25 thermal vias connecting the DAP landing pattern on the top layer to the bottom layer assigned as ground layers as shown in .

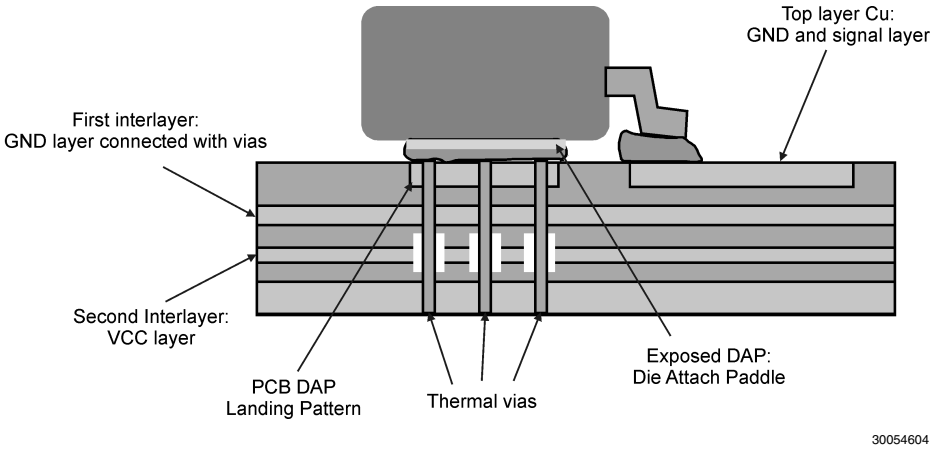

FIGURE 8. Thermal Board Cross Section

PCB BOARD ENHANCEMENT TO THERMAL PERFORMANCE

The effective thermal resistance between junction-to-ambient (θ_{JA}) is highly dependent on the PCB (Printed Circuit Board) design. To demonstrate this dependency, two identical JEDEC thermal board one with 2 layer, 2oz.Cu and one with a 4 layer 2oz.Cu were compared using a standard TO-263 package. Results validate that the 4 layer board had an average of 50% Junction-to-ambient (θ_{JA}) improvement over the 2 layer board, see *Figure 9* and *Figure 10*.

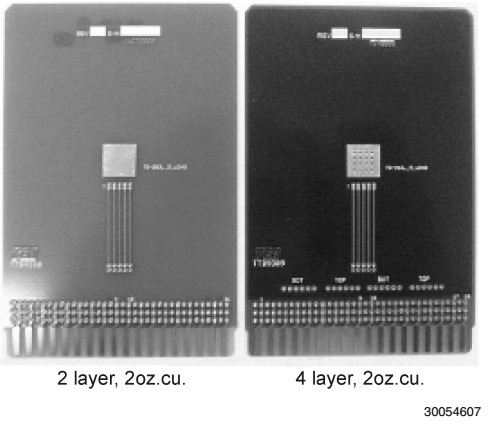

FIGURE 9. JEDEC Thermal Boards

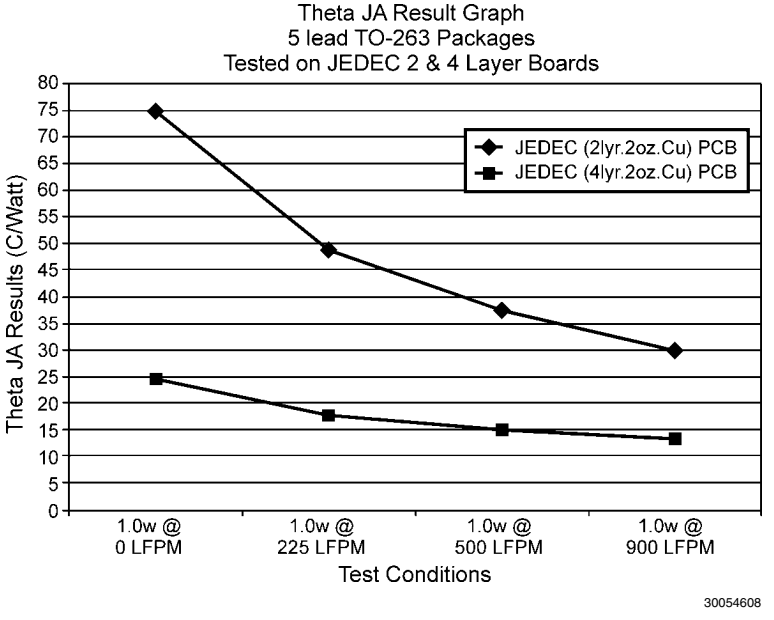

FIGURE 10. Thermal Performance Comparison of 2 to 4 layer Board

Package Reliability

The TO-263 THIN package has been subjected to 260° C lead-to-PCB IR furnace mounting and has passed the following stringent reliability qualification, see *Table 4*.

TABLE 4. TO-263 THIN Package Reliability Testing

Low Dropout Regulator Product	Time Point	TO–263 Standard	TO–263 THIN TL1	TO–263 THIN TL2	TO–263 THIN TL3	Comment
ACLV	96 hrs	0/77	0/77	0/77	0/77	Pass
TMCL	500 cyc	0/77	0/77	0/77	0/77	Pass
	1000cyc	0/77	0/77	0/77	0/77	Pass
THBT	168 hrs	0/77	0/77	0/77	0/77	Pass
	500 hrs	0/77	0/77	0/77	0/77	Pass
	1000hrs	0/77	0/77	0/77	0/77	Pass
HTSL	168 hrs	0/77	0/77	--	--	Pass
	500 hrs	0/77	0/77			Pass
	1000hrs	0/77	0/77			Pass
DOPL	168 hrs	0/77	0/77	0/77	0/77	Pass
	500 hrs	0/77	0/77	0/77	0/77	Pass
	1000hrs	0/77	0/77	0/77	0/77	Pass
ESD (H/M/C)	Up to 2500V	--	0/15	0/15	0/15	Pass
Latch Up	Up to 85oC	--	0/6	0/6	0/6	Pass
Simple Switcher Power Converter Voltage Regulator Product	**Time Point**	**TO–263 Standard**	**TO–263 THIN TL1**	**TO–263 THIN TL2**	**TO–263 THIN TL3**	**Comment**
ACLV	96 hrs	0/77	0/77	0/77	0/77	Pass
TMCL	500 cyc	0/77	0/77	0/77	0/77	Pass
	1000cyc	0/77	0/77	0/77	0/77	Pass
HTSL	168 hrs	0/77	0/77	0/77	0/77	Pass
	500 hrs	0/77	0/77	0/77	0/77	Pass
	1000hrs	0/77	0/77	0/77	0/77	Pass

Die Adhesion Strength

The TO-263 THIN package was tested to MIL-STD-883E method 2019.5 die shear strength requirements. The results show die shear strength exceeded test requirements even on un-molded parts that were subjected to various temperature cycles beyond 883 method conditions, see *Table 5*.

TABLE 5. Post -65/+150° C Temperature Soak Die Shear Testing

After DA Epoxy Cure		TMCL 300 cycles		TMCL 500 cycles		TMCL 1000 cycles	
DAT (kg)	Ave (kg)	DAT (kg)	Ave (kg)	DAT (kg)	Ave (kg)	DAT (kg)	Ave (kg)
5.5	4.9	1	2.1	3	2.4	2	2
4.5		1.5		3		3	
4		2		1.5		2	
5		3		1.5		1.5	
5.5		3		3		1.5	

Notes

Notes

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