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Automotive ATPAK
Idea for Improving Heat Radiation

ON Semiconductor®

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APPLICATION NOTE

1. Overview

This application note is to discuss that ON Semiconductor's original ATPAK package is superior to DPAK (TO-252) in heat dissipation by using heat sink and measuring actual thermal resistance.

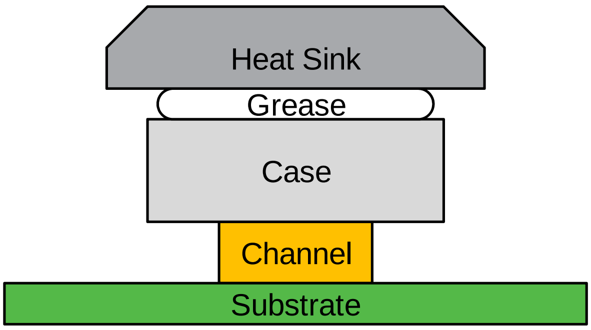
However, this paper is not any guarantee for operation. Installation of heat sink is on your own responsibility.

2. Thermal Resistance

Thermal resistance is the coefficient that indicates to what extent the temperature increases to an object when applying 1W heat to it. Its unit is °C/W. it is common that, the lower the thermal resistance is, the better the heat dissipation performance is.

Thermal design model that uses a heat sink can be shown by an equivalent circuit of series resistors (see Figure 1).

In case of Surface Mount type packages like ATPAK and DPAK, because the heat dissipates almost to the underneath substrate, measurement of Case Temperature (RθJC) is difficult. So, in this test, we evaluated the superiority of heat dissipation from surface by relatively comparing in the substrates with the same copper foil area.



$$R\theta JA = R\theta JC + R\theta GR + R\theta HS$$

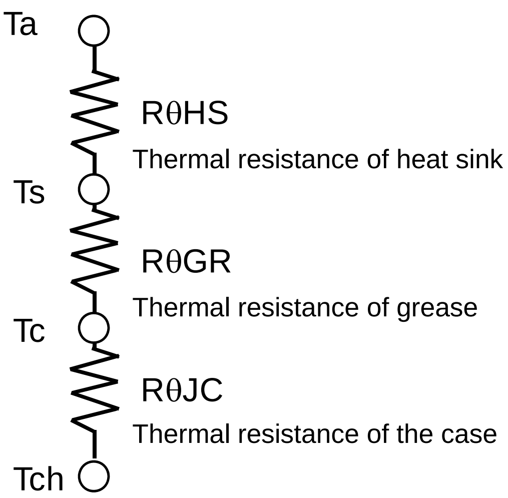


Figure 1. Thermal Resistance Model

3. Channel Temperature

Power MOS Max. Power Dissipation (PD max) is calculated as follows:

$$PD\ max = \frac{Tch\ max - Ta}{R\theta JA} \quad (1)$$

$$Tch = R\theta JA \times PD + Ta \quad (2)$$

Channel Temperature (Tch) can be calculated from the ambient temperature and power consumption. It is recommended that Tch is designed to be about 80% of the allowable maximum temperature (Tch max).

4. Spec. Comparison

Table 1 shows the performance comparison between ON Semiconductor's ATPAK and other company's DPAK. You can see from the table that devices with identical performance were selected as much as possible in order that the heat dissipation of the package can be compared relatively.

5. Initial comparison of thermal resistance

As previously stated, we selected ATPAK and DPAK devices with almost identical spec., and measured their actual thermal resistance and made comparison. For the measurement, we used glass-epoxy substrates with the same copper foil area of 1.0x1.0inch (Figure 2). ATPAK and DPAK have almost the same foot-pattern, so completely the same substrate can be used.

Table 1. Spec comparison between ATPAK and DPAK

Parameter	Symbol	Condition	Value		Unit
			ATPAK	DPAK	
Drain-Source Voltage	VDSS		-60	-60	V
Gate-Source Voltage	VGSS		±20	±20	V
Drain Current	ID		-38	-36	A
Drain Current(PW)	IDP	PW ≤ 10us,Duty ≤ 1%	-114	-108	A
Allowable Power Dissipation	PD	Tc = 25°C	60	56	W
Channel Temperature	Tch		175	175	°C
Zero Gate Voltage Drain Current	IDSS	Vds=-60V,Vgs=0V	-1	-10	uA
Gate Leakage Current	IGSS	Vgs=±16V,Vds=0V	±10	±10	uA
Gate-Source Cut-off Voltage	VGS(off)	Vds=-10V,Id=-1mA	-2.6	-2.5	V
Drain-Source On-state Resistance	RDS(on)	Vgs=-10V,Id=-18A	29.5	30	mΩ
Chip Size			same-size		mm
Package Size			6.5x9.5x2.3	6.5x9.8x1.5	mm

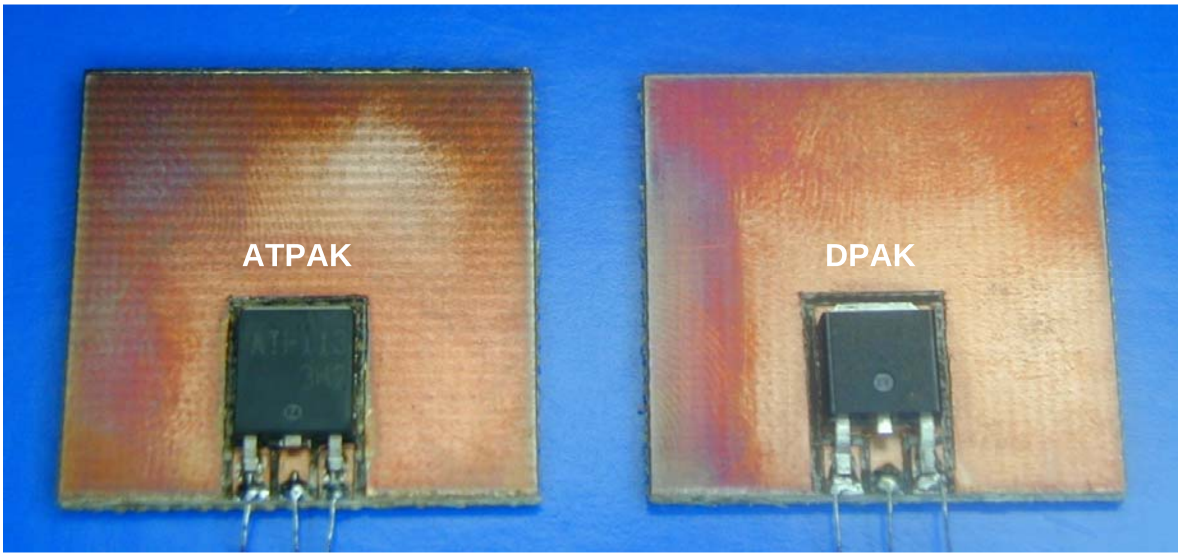


Figure 2. Actual Evaluation Board

Figure 3 shows the transient thermal resistance measurements. You can see from the graph that thermal resistance (RθJA) of either ATPAK or DPAK is 80.3°C/W, the same results are obtained, so there is no difference in the heat dissipation.

6. Comparison of heat resistance using the heat sink

For ATPAK and DPAK selected and measured previously, we applied silicon grease on the surfaces of both packages and measured thermal resistances with heat sink mounted (Figure 4). Detail of the heat sink is shown in Figure 5.

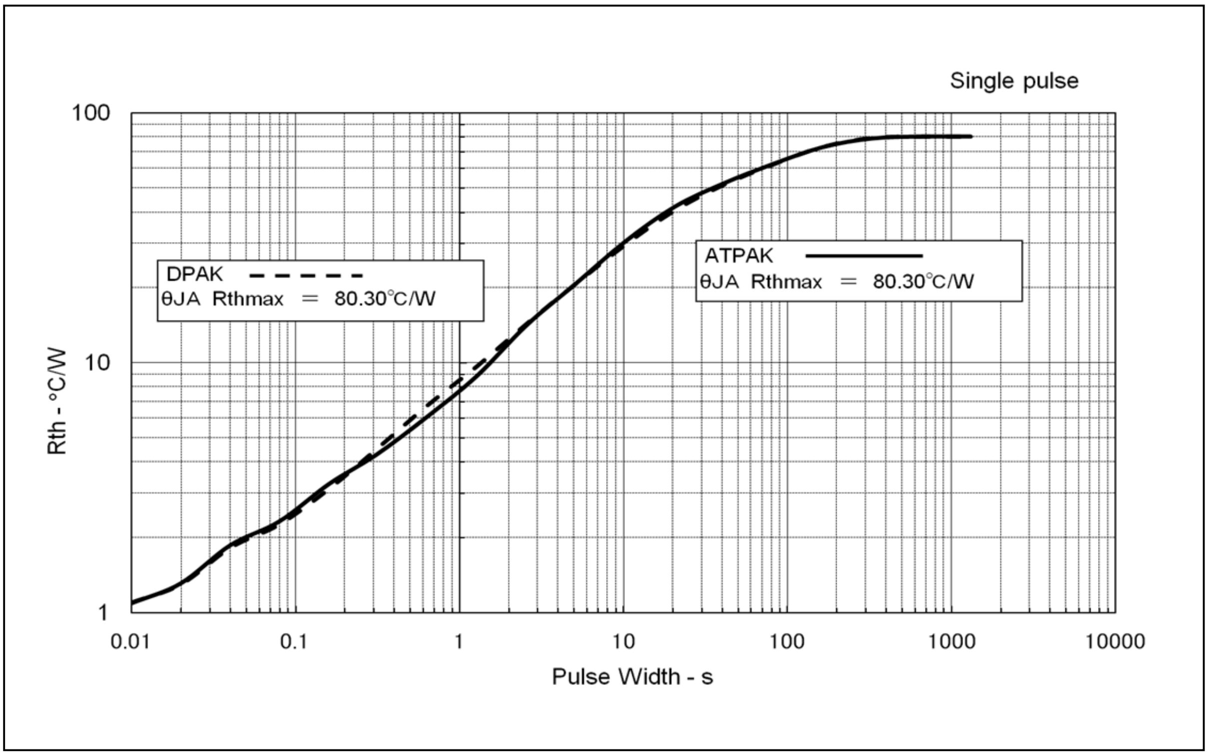


Figure 3. Transient Thermal Resistance

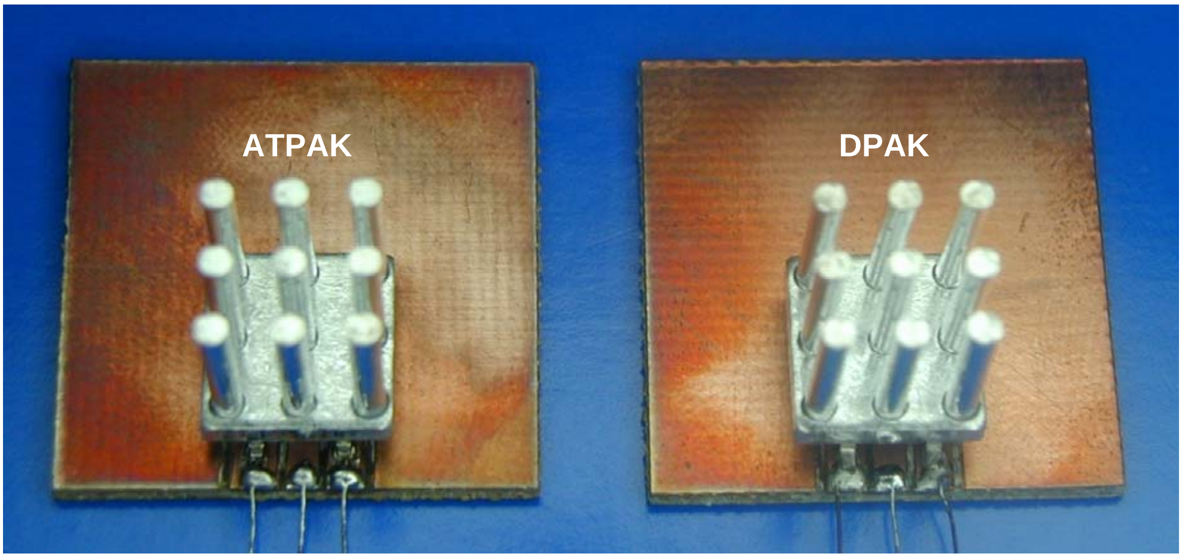
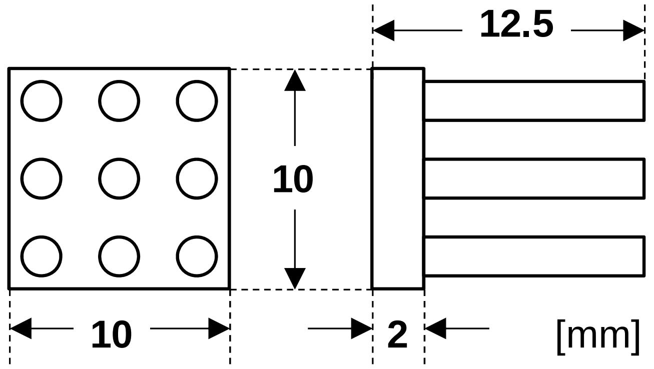


Figure 4. Actual Evaluation Board with Heat Sink

Figure 6 shows the measurements of transient thermal resistance.
For DPAK, thermal resistance (RθJA) is 62.5°C/W; for ATPAK, it is 56.4°C/W.
The result shows that, even though the two packages have the same thermal resistance under the condition of no heatsink, by using heatsink, the thermal resistance of ATPAK becomes 6°C/W lower than that of DPAK.

7. Summary

This test suggests that ON Semi's original ATPAK package shows more possibility of lowering the inside semiconductor chip (die) even than DPAK package in case of using heatsink due to its good heat dissipation from the surface.
Therefore, ATPAK can support applications with high heat dissipation by using heatsink.



Maker : Fischer Elektronik
Part No. : ICKS 10x10x12.5
Thermal Resistance : 26.3KW

Figure 5 Specification of Heat Sink

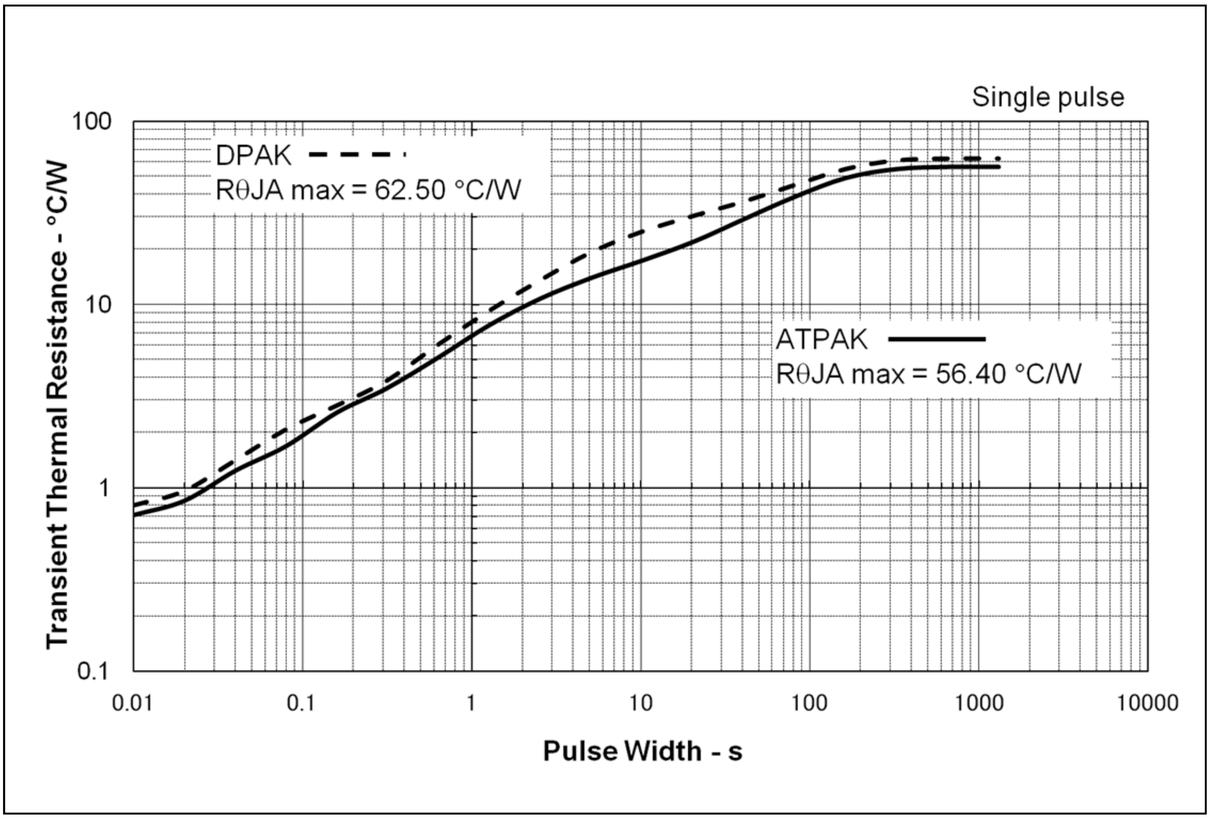


Figure 6 Transient Thermal Resistance with Heat Sink