

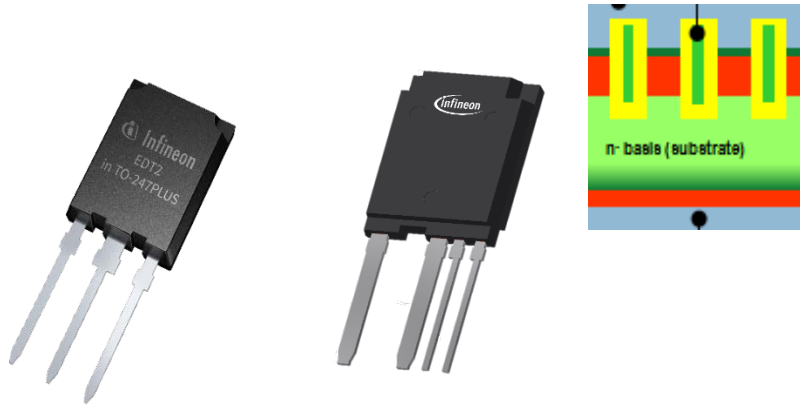
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Application benefits of TO-247 PLUS package reflow soldering in Vehicle Traction Inverter

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Motivation of TO-247 PLUS reflow soldering package



TO-247 PLUS with 4pin

TO-247 PLUS with 3pin

Higher EDT2 chip current density with 2.8A/mm² with best in class

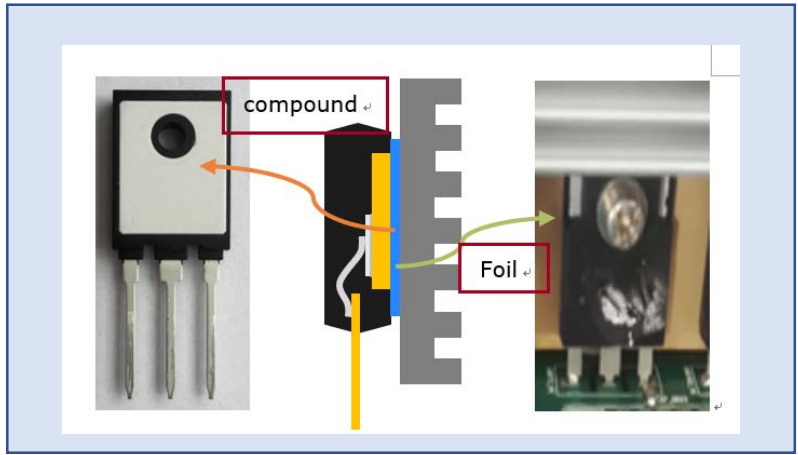
Up to 200A/750V EDT2 in TO-247 PLUS with leading edge technology

Traditional cooling limit in TO-247 PLUS package with low thermal transfer

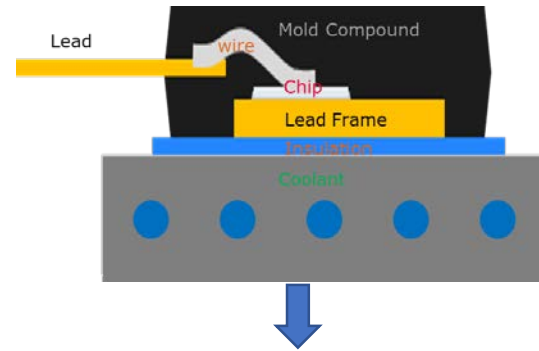
Long reliability requirement in traction inverter with discrete package



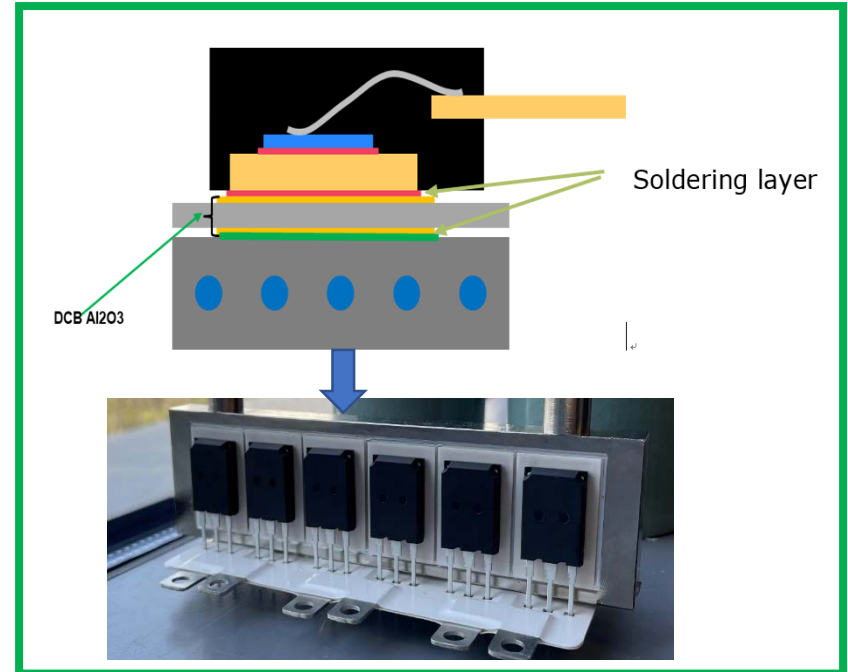
- Two challenges from application design
- a. Extend T_{jop} for higher output and reliability
 - b. Thermal stress for high efficiency



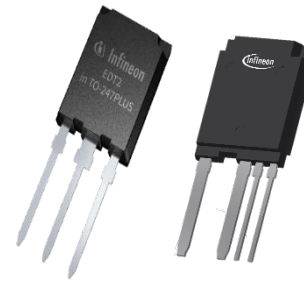
Reflow soldering TO-247 PLUS package with innovative technology



like SMD package with reflow soldering



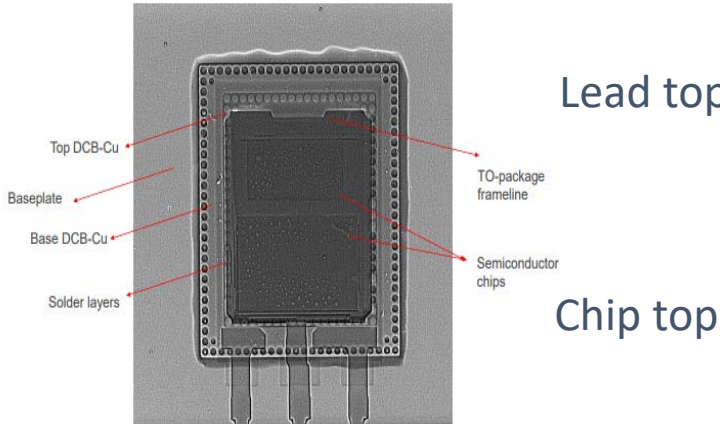
Thermal interface material	Strength	Thermal conductivity λ
Si_4N_3	>600Mpa	60
Al_2O_3	400Mpa	24
AlN	300-400Mpa	170
ZTA with 30% ZrO	>500Mpa	23-27
Thermal pad/sheet	-	1.3



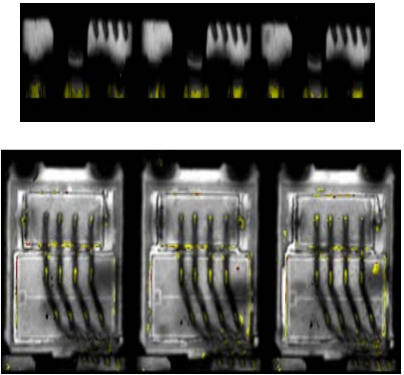
TO247PLUS 3pin reflow	
$I_{C(nom)} 100^\circ \text{C} \text{ [A]}$	Part name
200A	AIKQB200N75CP2
160A	AIKQB160N75CP2
120A	AIKQB120N75CP2
TO247PLUS 4pin reflow	
$I_{C(nom)} 100^\circ \text{C} \text{ [A]}$	Part name
200A	AIKYX200N75CP2
160A	AIKYX160N75CP2
120A	AIKYX120N75CP2

Innovative TO-247 PLUS package can meet JEDEC STD qualified reflow profile + MSL level 2

Standard qualification for this package



No delamination

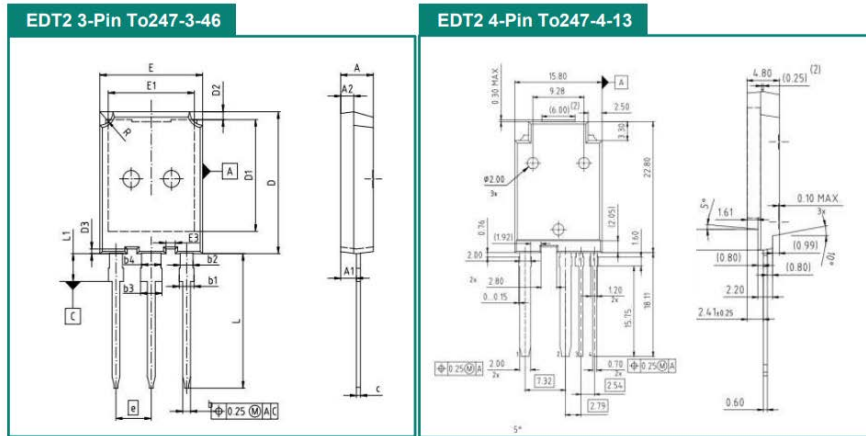


SAT MSL2 260°C

Zero hour

After pre-con 3x reflow

After TC500x



	3-pin	4-Pin
Volume [mm ³]	21x15.9x5 = 1670	22.8x15.8x4.8 = 1729
Package Thickness [mm]	5	4.8

JEDEC J-STA-020

Table 4-1 SnPb Eutectic Process - Classification Temperatures (T_c)

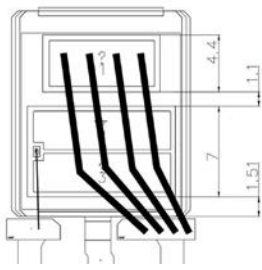
Package Thickness	Volume mm ³ <350	Volume mm ³ ≥350
<2.5 mm	235 °C	220 °C
≥2.5 mm	220 °C	220 °C

Table 4-2 Pb-Free Process - Classification Temperatures (T_c)

Package Thickness	Volume mm ³ <350	Volume mm ³ 350 - 2000	Volume mm ³ >2000
<1.6 mm	260 °C	260 °C	260 °C
1.6 mm - 2.5 mm	260 °C	250 °C	245 °C
>2.5 mm	250 °C	245 °C	245 °C

Infinion qualify the device beyond standard requirement.

Application benefits – thermal interface reduction



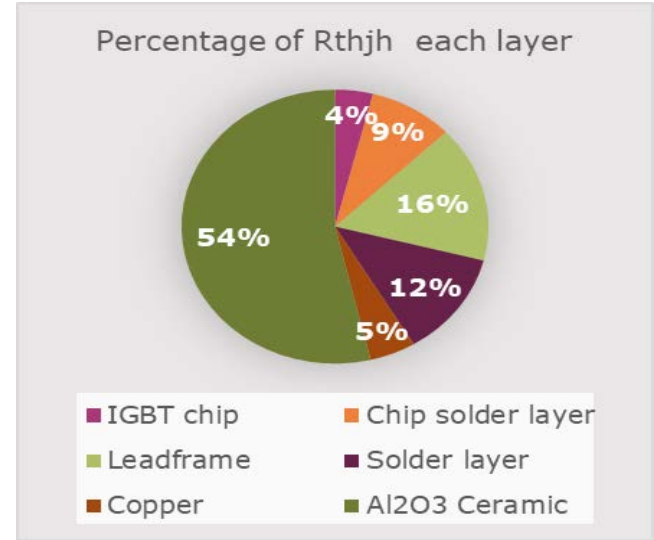
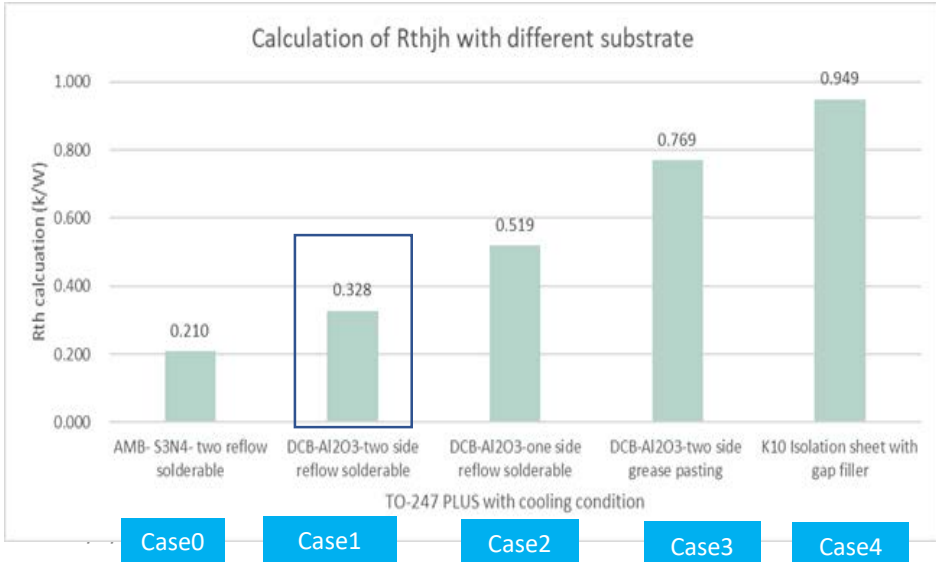
	Chip size (y"xz) mm ²
IGBT	11.5 * 7.0 * 0.072
Diode	9.10 * 4.40 * 0.085



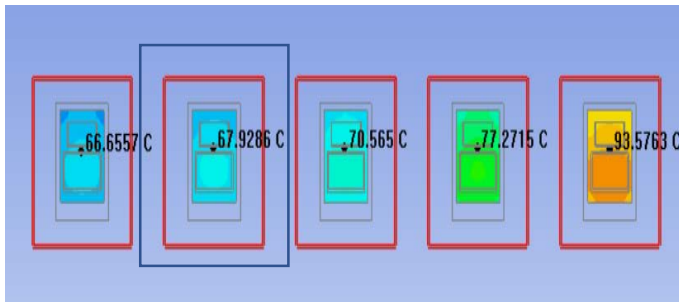
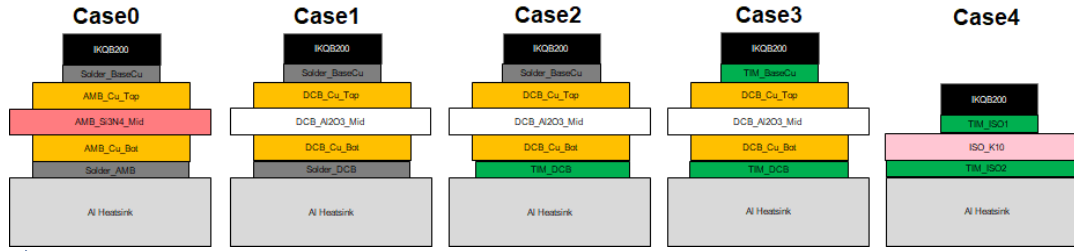
Typical example with TO-247 PLUS package+ substrate

Discrete stack	Each layer	thickness(mm)	λ (W/m*k)
Internal Chip + Lead frame	IGBT/FWD chip	0.08	148
	Solder layer	0.06	50
	Lead frame	2	385
External Substrate + soldering layer	Solder layer	0.1	50
	Copper layer	0.3	385
	AL ₂ O ₃ layer	0.38	22
	Copper layer	0.3	385
	Solder layer	0.1	50

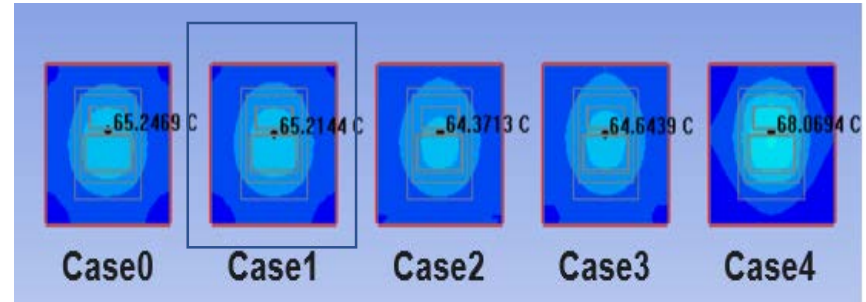
Just calculation
for $R_{th} = d / (\lambda * A)$



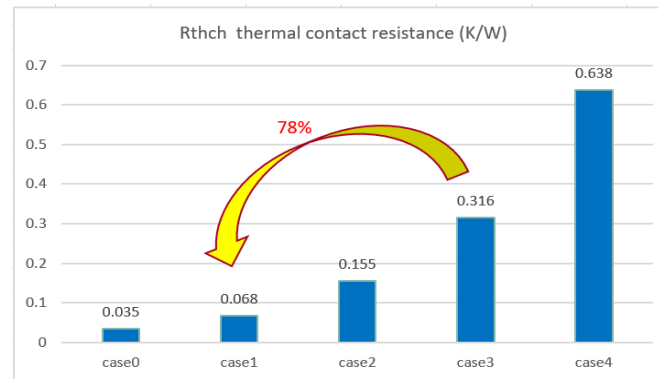
Application benefits – heat spread effect



temperature distribution
on lead frame



temperature distribution
on heat sink

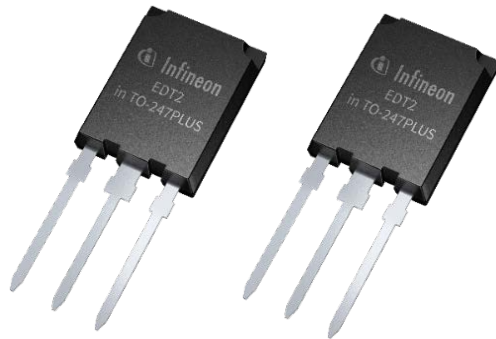


Thermal interface Rthch

Application benefits – higher output current from system level

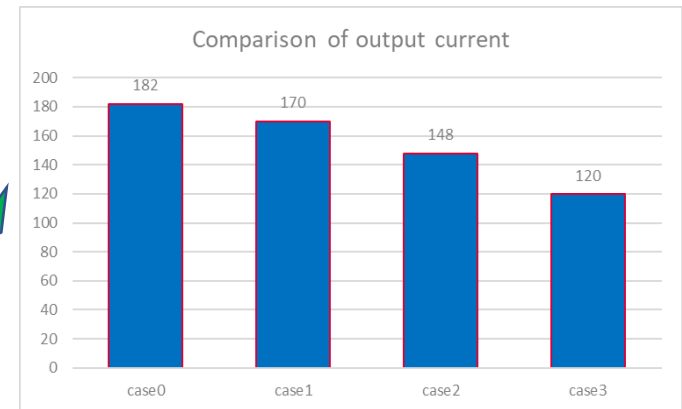
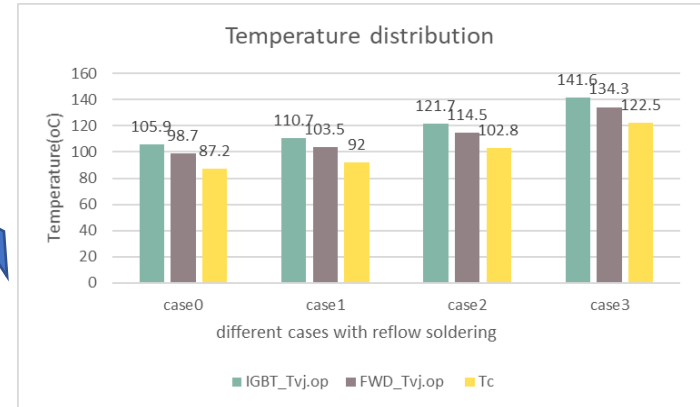
Traction inverter can be covered with the range of 20kW~100kW power rating by discrete solution for design flexibility and power extension.

Items	Values
Power Po	30kW
Peak power P	60kW
Max Output current Io	240A
Switching frequency fs	8kHz
DC-link voltage Vdc	400V
Modulation	SVPWM
Tinlet	95°C
R _{gon/off}	5ohm



same power output

Max Tvj.op allowed



Summary

1. 200A EDT2 with TO-247 PLUS is the innovative solution to achieve the device performance by reflow soldering capability, which is qualified by JEDEC standard for MSL1 and peak temp. 260°C.
2. Higher output current and lower $T_{vj,op}$ are better choice from design perspective and application requirement by reflow soldering package.
3. Reflowable discrete version can solve thermal dissipation limit and isolation of lead frame package on cooler.

