# SOLID-METAL THERMAL COLUMNS IN CONVENTIONAL PCBs

**SMTA**
**Thermal Issues session**
Rosemount, IL
9/24/03

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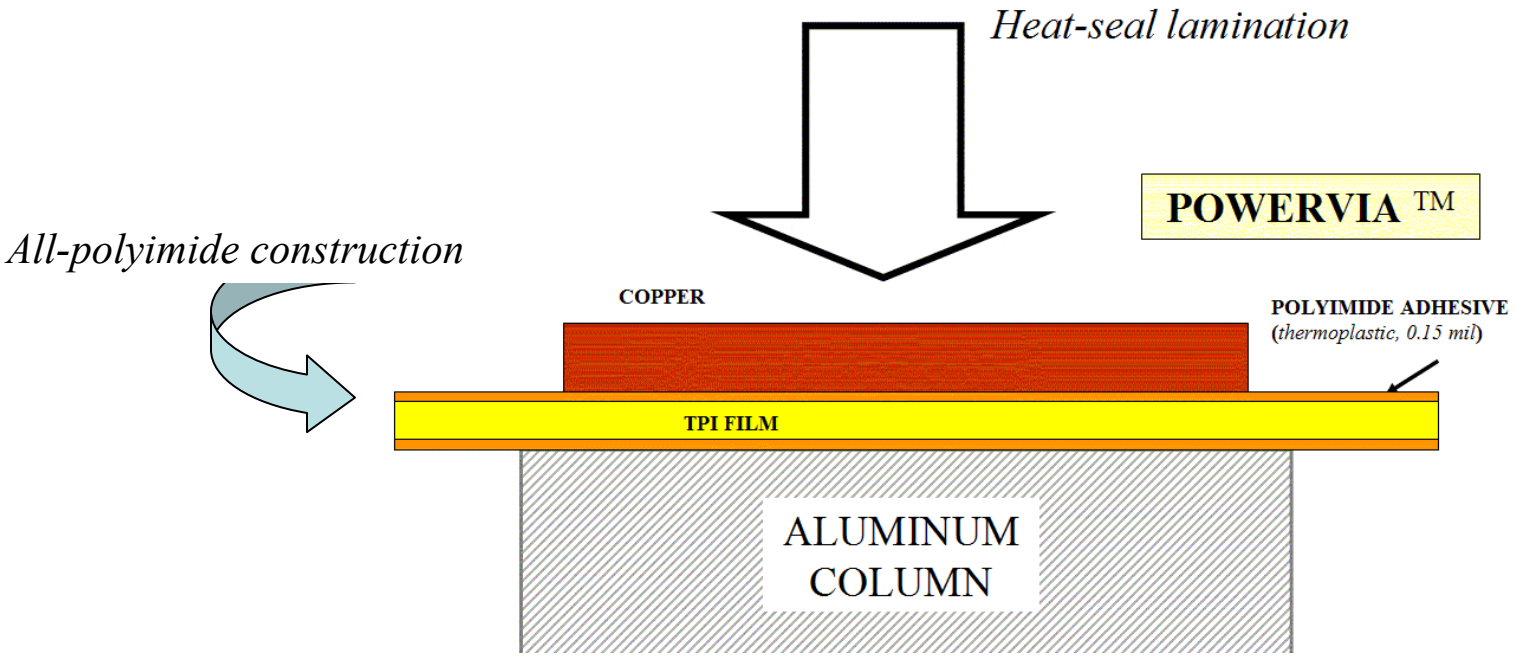
# PowerVia technology

*Optimal through-hole thermal transfer*

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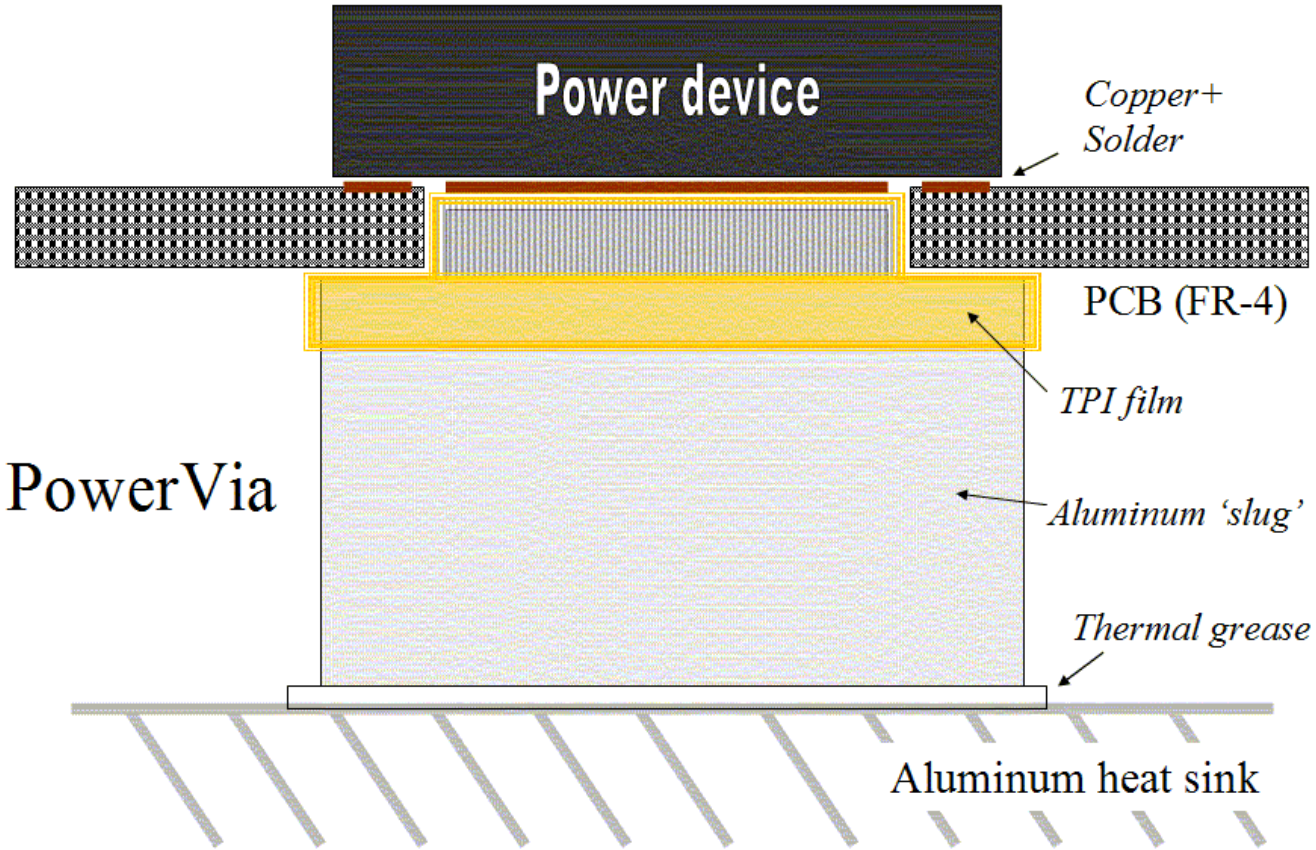
**IN CONVENTIONAL PCBs**

# PowerVia technology

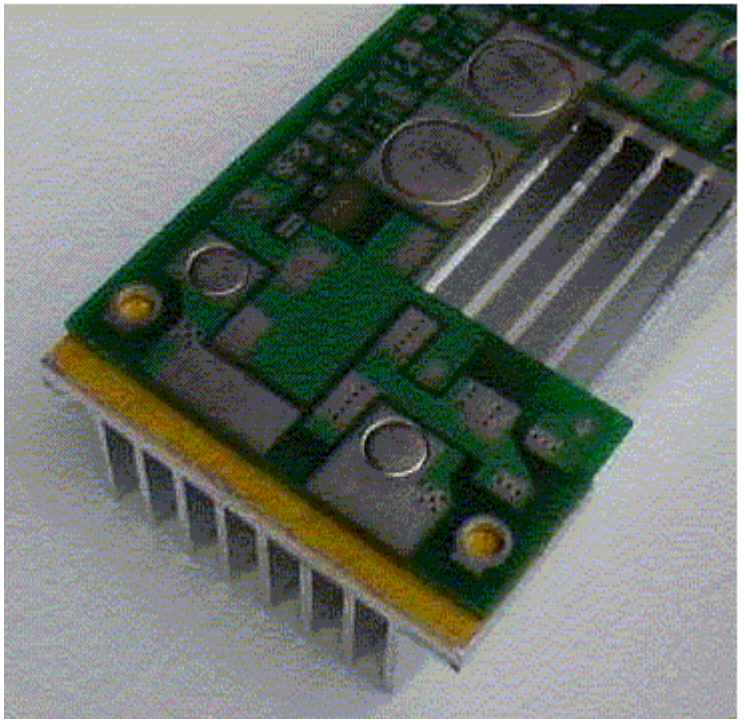
*Optimal through-hole thermal transfer*



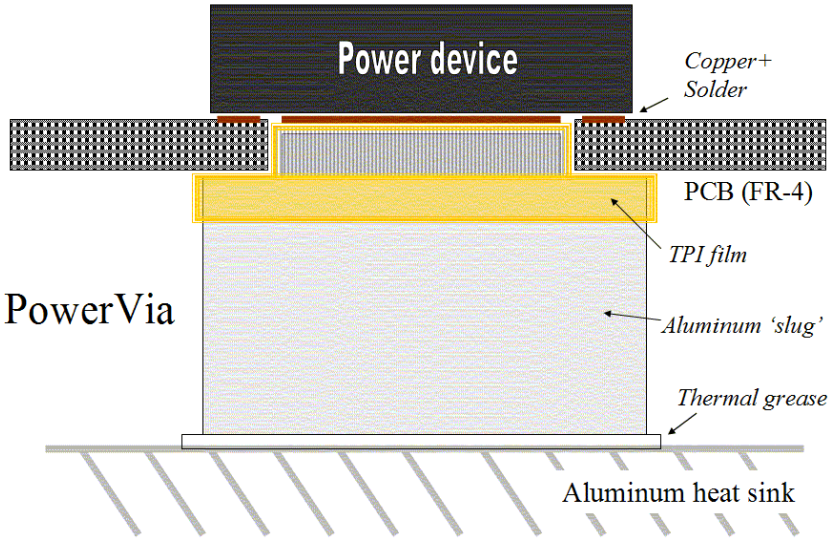
# PowerVia technology

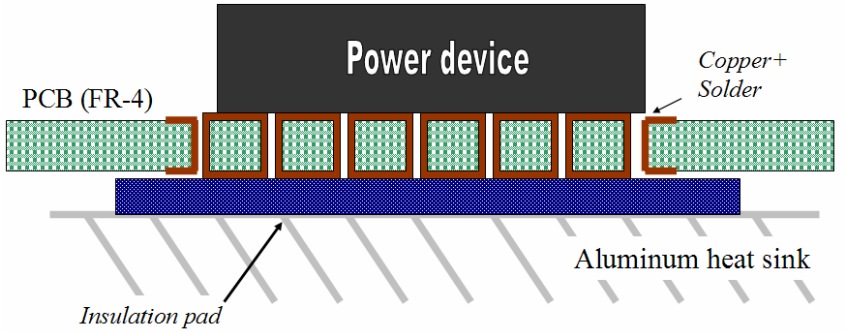
*Optimal through-hole thermal transfer*

PowerVias for D2Paks



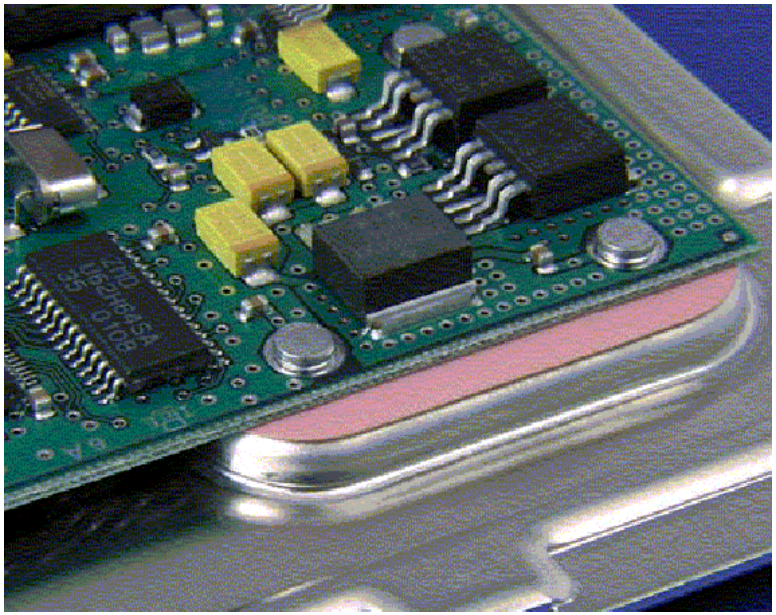
PowerVias inserted into PCB




**Conventional thermal via (drilled-and-plate)**

# Comparison with conventional thermal via



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# PowerVia technology advantages

- High thermal transfer
  *2X conventional plated-thru hole*
- No pressure dependency
- All polyimide durability
  Excellent electrical and physical properties

Design flexibility:

- Double-sided PCBs
- 'Snap-on' PCB to standard heat sink
- Optimize supply of both PCB and heat sink
- Testing flexibility
  (thermal mass of PowerVia)

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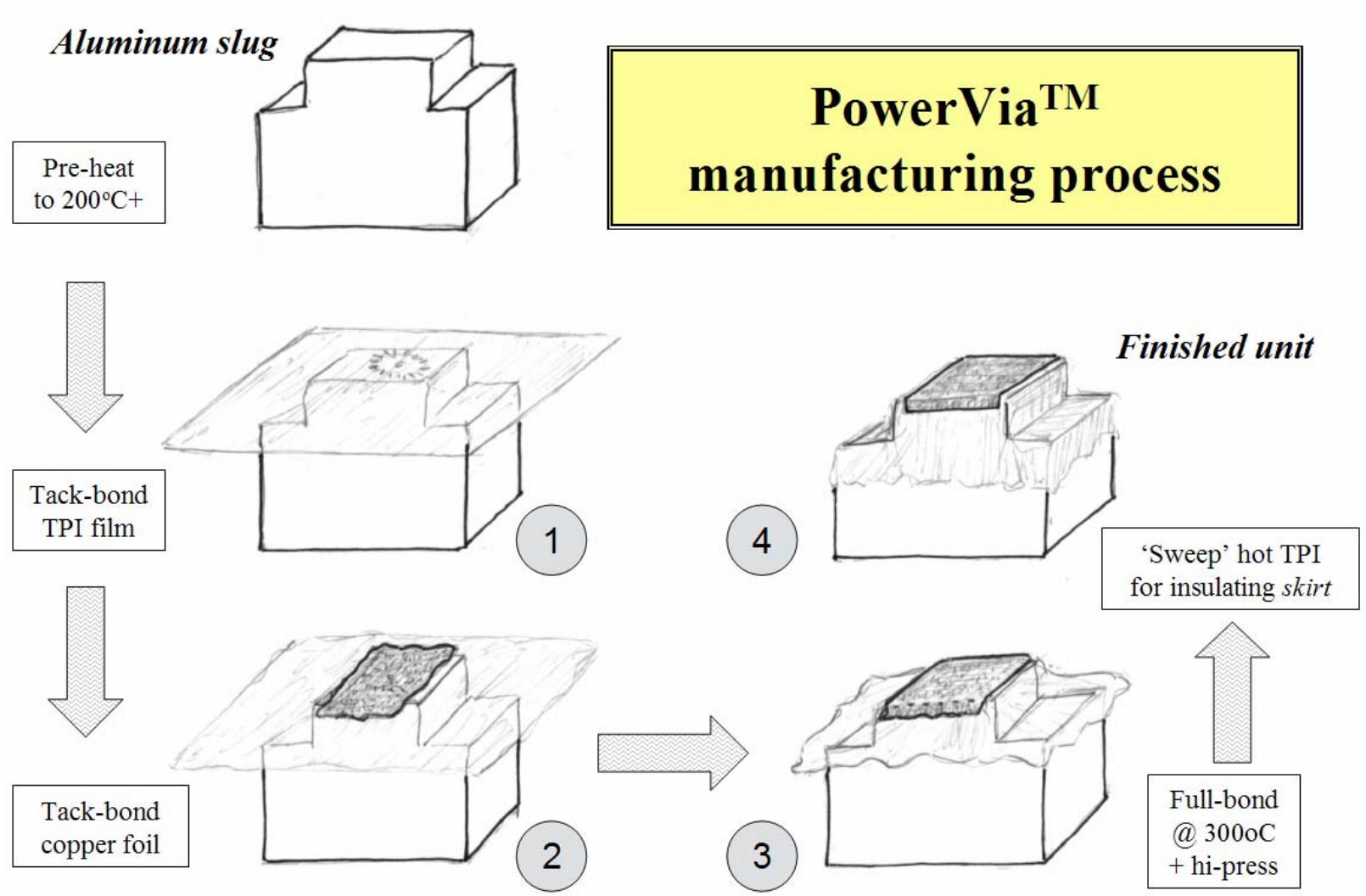


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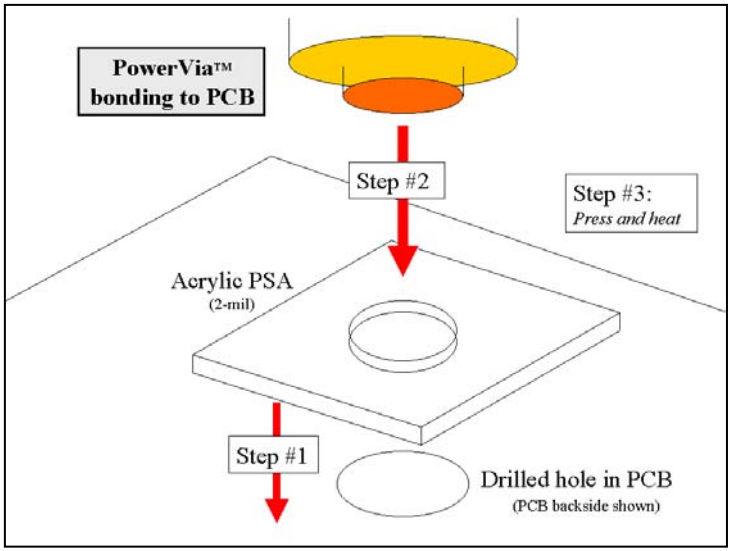
# PowerVia installation

1. Insert into pre-routed PCB (‘*bottom side*’)
2. Solder on power devices (‘*top side*’)
3. Mount assembled PCB on heat sink

PowerVias can be:

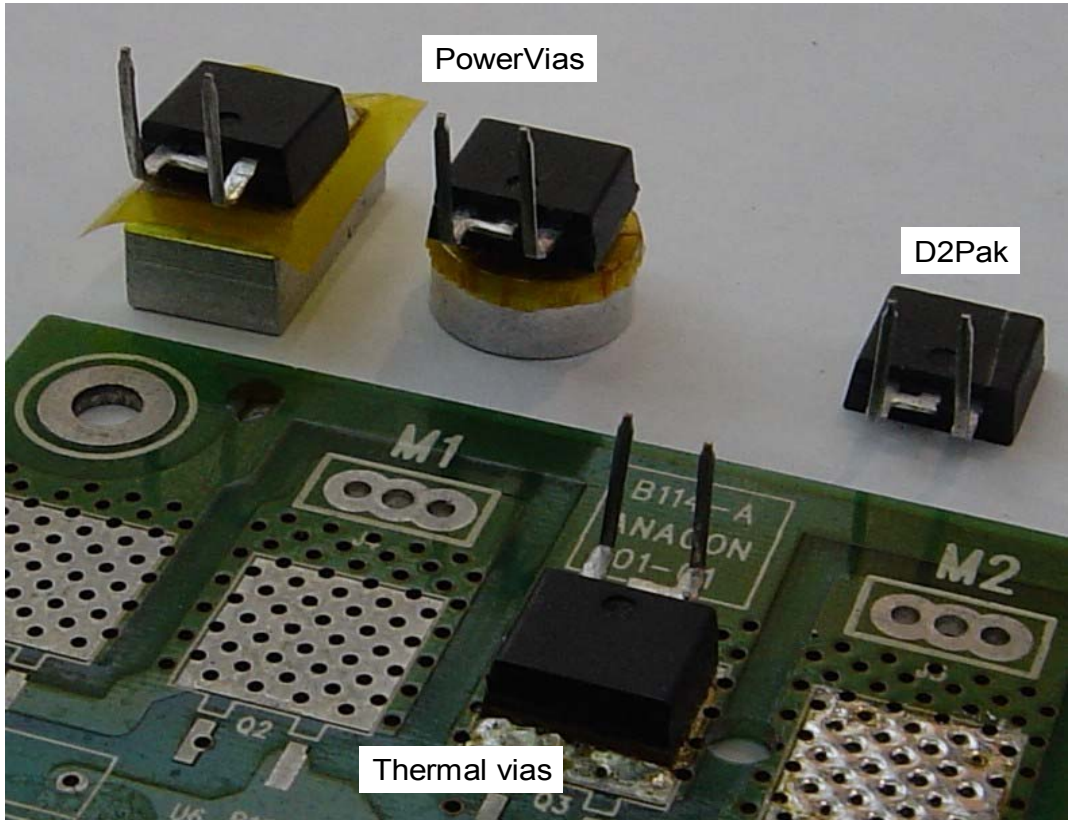
- Press-fit
- PS-adhesive attached




# Thermal transfer testing

Thermal resistance testing of D2Pak ($R_{j\text{-}s}$), using Anatech pulse tester:

- Conventional thermal via (plated-thru-hole + insulation pad + attachment hardware)
- *Cylindrical* column PowerVia
- *Rectangular* column PowerVia



## Thermal resistance comparison [5]

*Control board with soldered-on D2Pak, bolted to heat sink*

| Thermal method | Active area | Rj-s |
|---|---|---|
| PowerVia (circular footprint) | 0.08 => 0.20 sqin (Face-to-base) | 4.4 °C/W |
| PowerVia (rectangular footprint) | 0.20 => 0.30 sqin (Face-to-base) | 2.7 °C/W |
| Thermal via + pad | 0.30 sqin | 11.4 °C/W |

NOTE:

- Thermal resistance is junction-to-sink.
- Anatech measurement taken at steady-state.
- PCB secured to heat sink on PCB edges only (50-100 psi?).
- *Thermal via + pad thermal resistance* is about 7°C thru the power device+PCB and 4°C/W thru the insulation pad.

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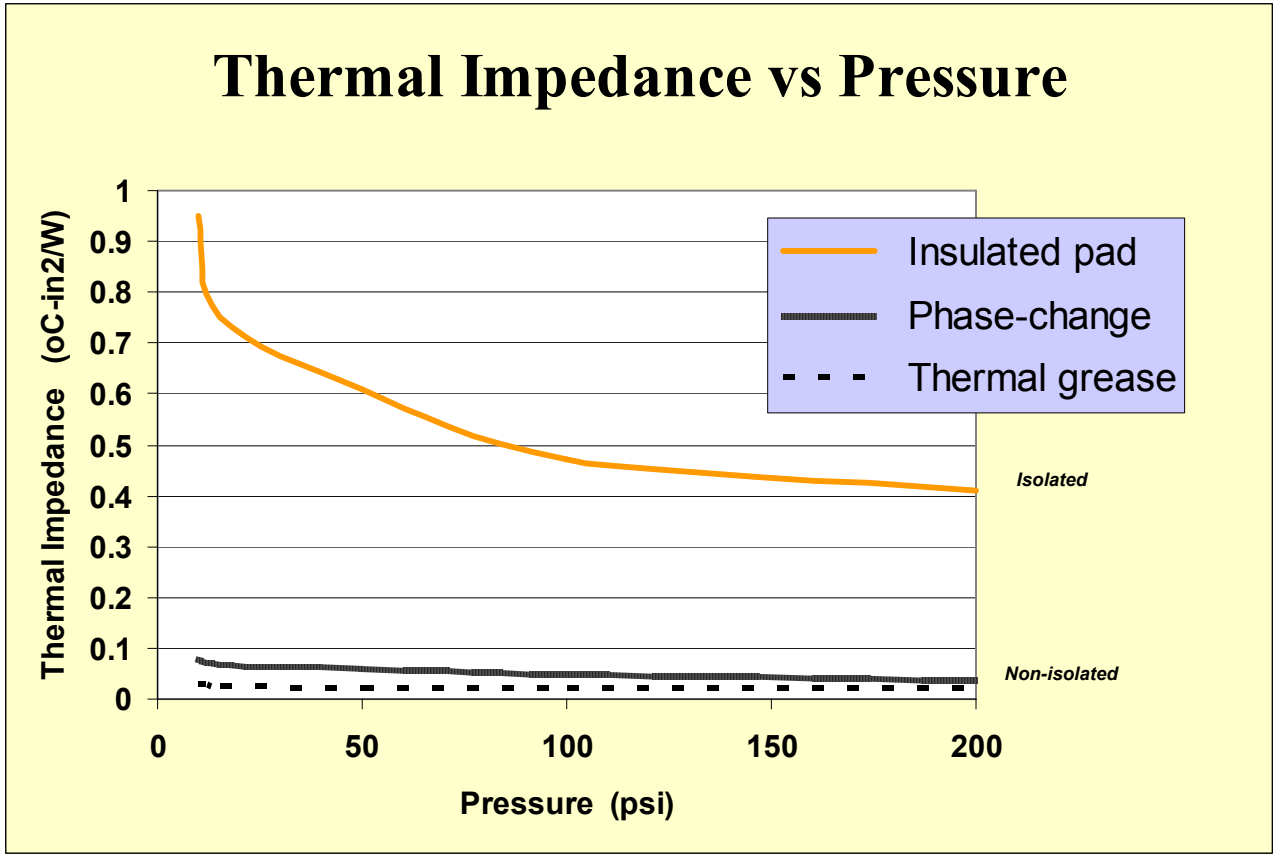
# Pressure dependency

Conventional thermal vias require insulation pads…

…***insulations pads require high-pressure to optimize thermal transfer*** to the heat sink.

PowerVias use non-isolating thermal grease or phase-change material…

….***these thermal compounds have little pressure dependency*** (and very high thermal transfer).



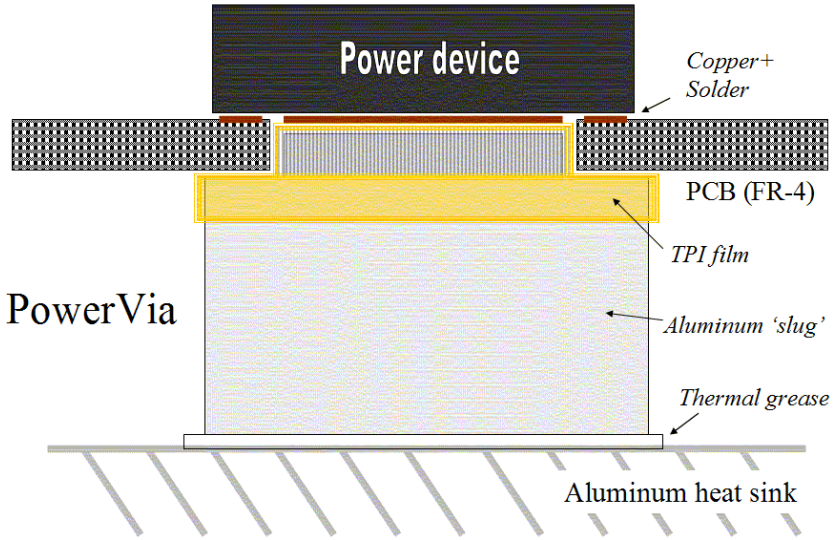

# PowerVia feature:

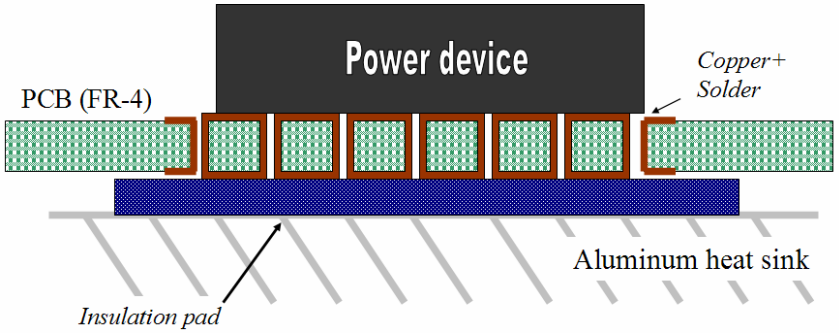
## Excellent thermal management with conventional PCB packaging

- Better thermal transfer and lower cost than Kapton+PSA circuits
- Much lower cost than IMS circuits
- Denser packaging – double-sided PCBs

# PowerVia design feature:

## Double-sided PCB, with flat-faced heat sink




**Conventional thermal via (drilled-and-plate)**

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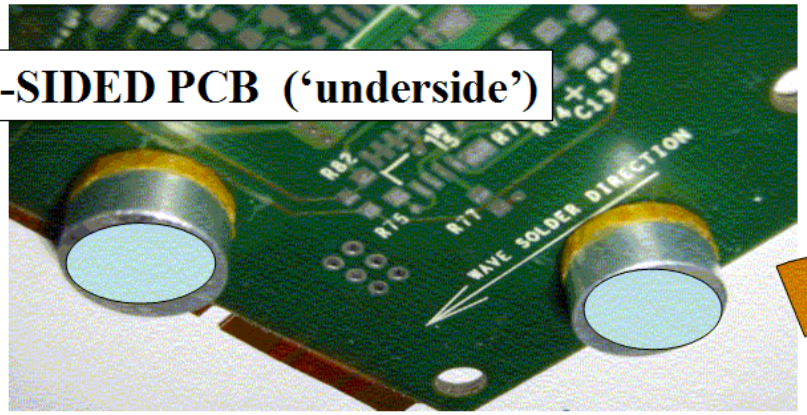
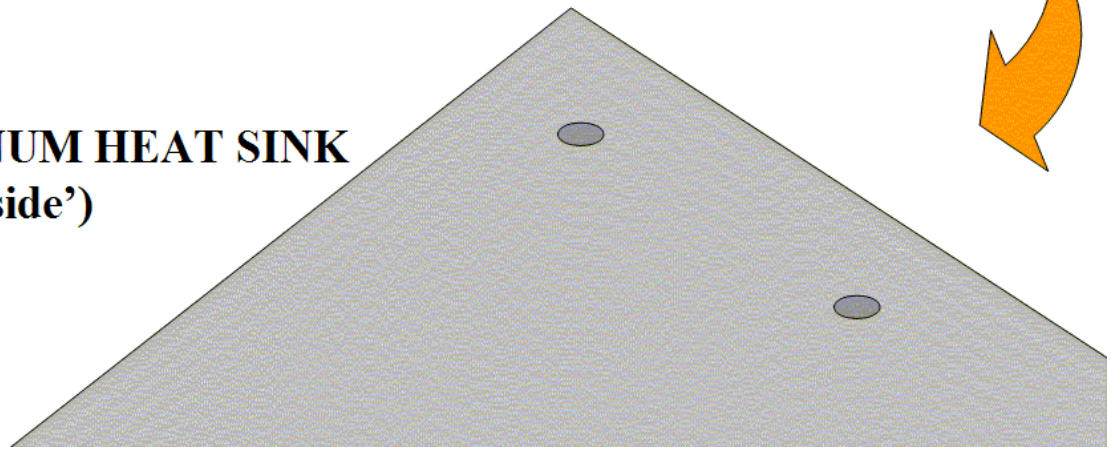
# PowerVia design feature:

**Fully-assembled PCB, 'snapped' on to heat sink**

(*with no pressure dependency*)



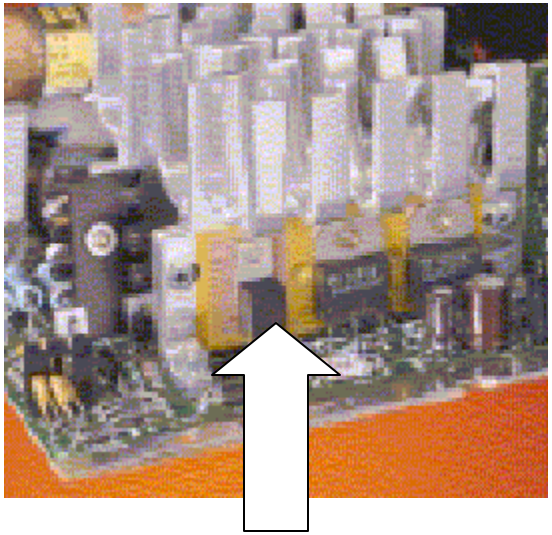




# PowerVia design features:

## Cool power devices on the PCB

***=> Move to SMT from through-hole (with off-the-board cooling)***

- Unified construction facilitates assembly and testing
- More compact designs (higher 'power density')
- Reduce system cost and SKUs



*Conventional mounting*
*(heat sink subassembly)*

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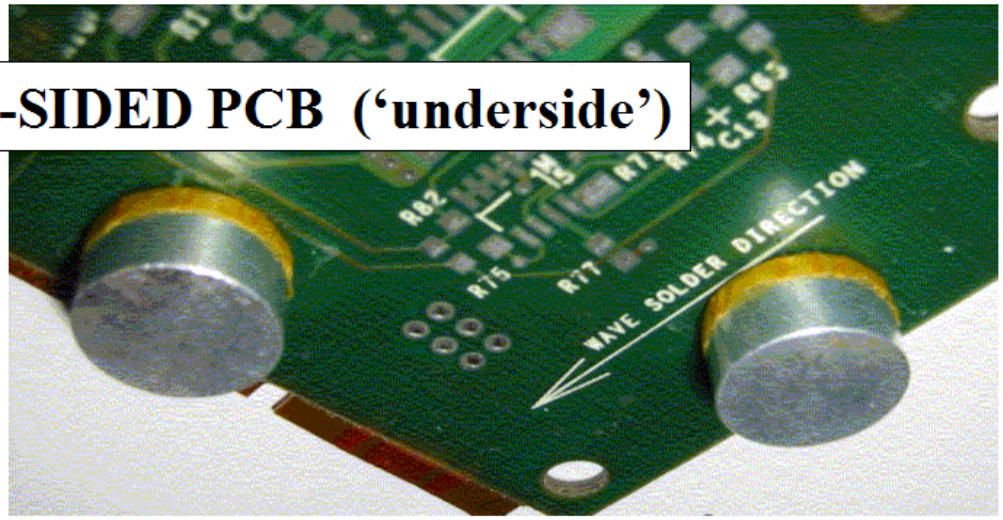
# PowerVia design feature:

## Fully-assembled PCB can be tested *without a heat sink*

**DOUBLE-SIDED PCB ('underside')**




**PowerVias have '*thermal mass*'**

- **R-value of 15-30°C/W** (est.)

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# PowerVia design considerations:

- PCB thickness consistency
- PCB precision routing for PowerVia ‘hole’
- Volume vs cost

# PowerVia applications

FORMAT:

| HOT | | COLD |
|---|---|---|
| Discrete SMT components | => | Heat sink |
| Thermal via (plated-thru hole) | => | Heat sink |
| Daughter PCB | => | Mother PCB |

END USE:

- Power supplies
- Automotive control modules
- Motion control
- Motor control

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