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The power of precision

POWER ELECTRONICS & ENERGY STORAGE EVENT

PCB Challenges in Power Electronics & Energy Storage

POWER ELECTRONICS 2022

Power Electronics & Energy Storage event

14 juni 2022 | 1931 Congrescentrum 's-Hertogenbosch

ENERGY STORAGE EVENT 2022

SPEAKER PRESENTATION

Erik PEDERSEN

FAE & Quality Director

Few Words:

Erik started in the PCB industry in 1989.
He has been working as FAE for the last 10 years.
He joined ICAPE Group in 2020, first as Sales Engineer for ICAPE AB, and he is now FAE & Quality Director

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INTRODUCTION POWER PCB

PCB CHALLENGES IN POWER ELECTRONICS AND ENERGY STORAGE:

High current management

Define by the IPC 2221

$$I = K \times dT^{0,44} \times (W \times H)^{0,725}$$

I = maximal current
dT = temperature rise
W = trace width (mils)
H = trace thickness (mils)
K = 0,024 inner layer or 0,048 outer layer

PCB Solution : Multilayer Thick Copper

Thermal management for power components

$$Rth = \frac{e}{\lambda \times S}$$

Rth = Thermal resistance
e = dielectric thickness
λ = Thermal conductivity
S = Exchange surface

PCB Solution : IMS

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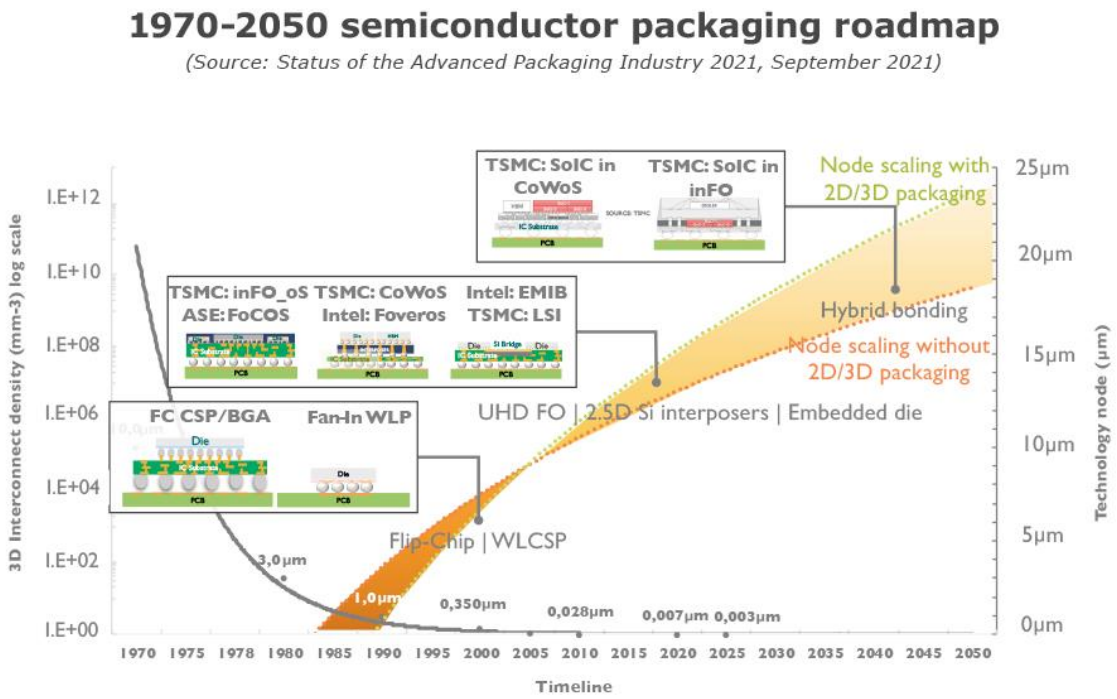
INTRODUCTION DRIVER

PCB CHALLENGES IN POWER ELECTRONICS AND ENERGY STORAGE:



Driver electronics

Power electronics need a driver system. The BGA/CSP pitch in the drivers keep decreasing and standard Multi-layer PCB technology with though holes can´t support advanced component density. HDI technology is needed for most new driver systems.

Another driver solution it's developing a dedicated Driver full integrate with a SIP (System In Package).

PCB Solution: UHDI or SLP

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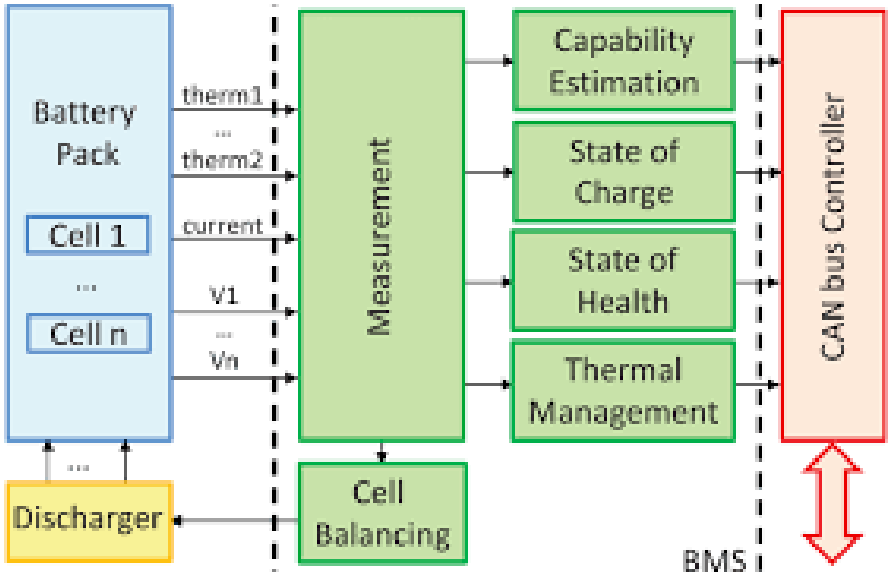
INTRODUCTION INTERCONNECTION

PCB CHALLENGES IN POWER ELECTRONICS AND ENERGY STORAGE:



INTERCONNECTION:

Interconnection Power board to driver board

Interconnection Battery cells for BMS (Battery Management System)

PCB Solution: Flexible PCB/Thin or Thick copper

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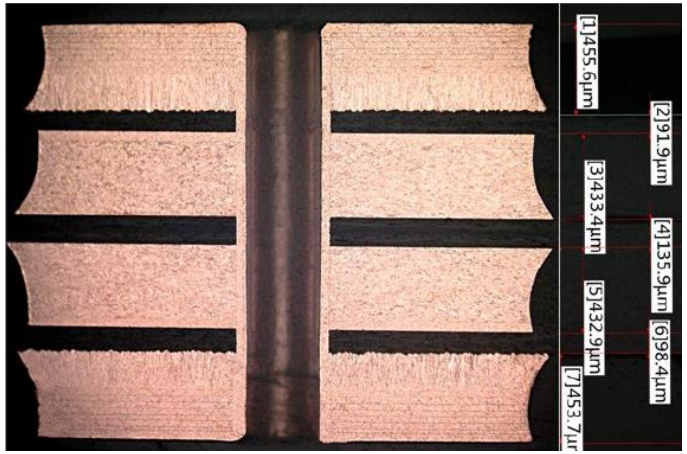
THICK Cu PCB

On standard PCB, the Copper Thickness is 35µm to 105µm, but it is with thick copper PCB technology possible to propose higher copper thickness in different PCB structures :

- Thick Cu PCB with copper thickness 105µm to 525µm on each layer
- Mix stack-up :
  - 35µm to 105µm for external layer for driver component.
  - Up to 105µm to 420µm for internal layer to manage high current flow.

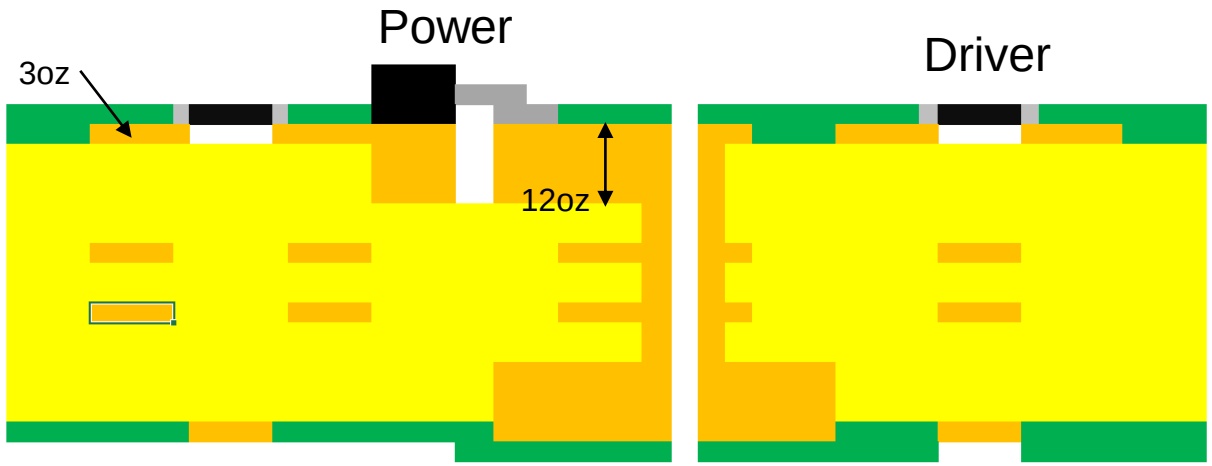


THICK Cu PCB

Differential copper thickness in the same copper layer

- 105µm for the thin part
- 420µm for the thick part

With this PCB technology, you can manage Power Component and Driver Component on the same solder side. All the first level drivers' components could be near the Powers components.



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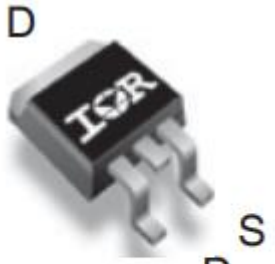
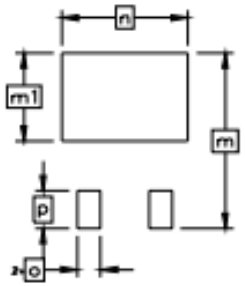
IMS PCB

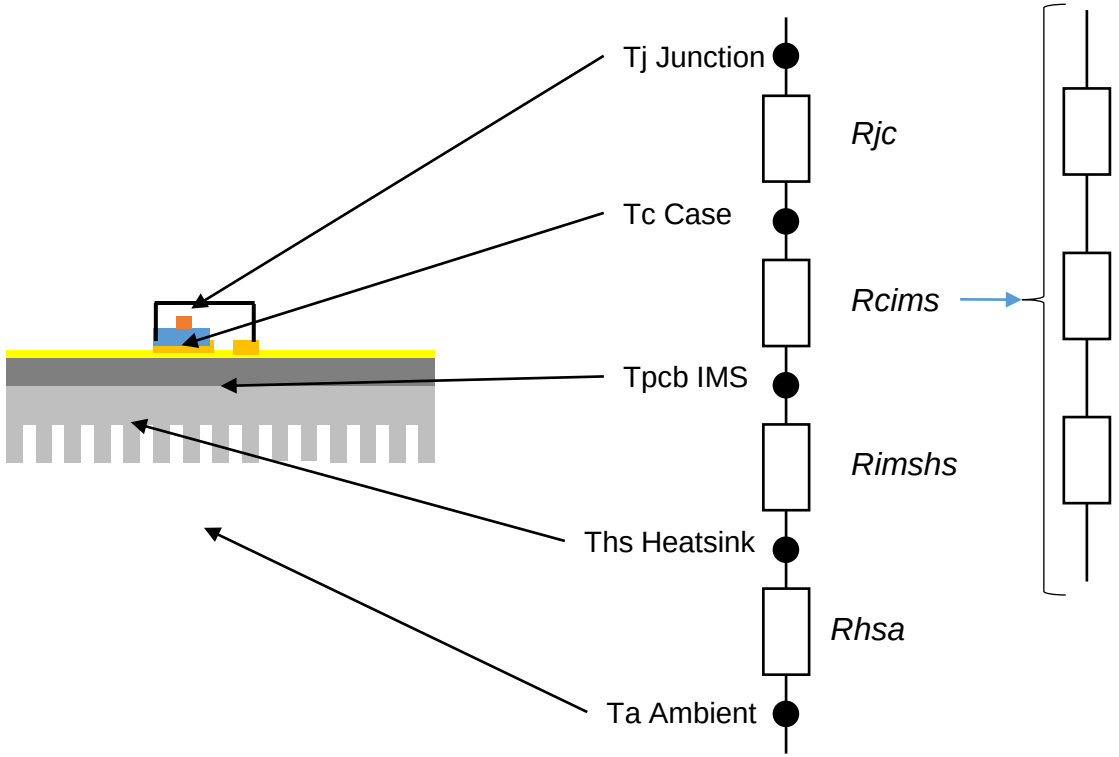
THERMAL RESISTANCE IN IMS PCB:





m1	8.89
n	11.43

S = 101.6mm²



EXAMPLE FOR D²PACK ON IMS WITH $2W.m^{-1}.K^{-1}$

$$Rcu = 35\mu m \div (390W.m^{-1}.K^{-1} \times 101{,}6cm^2) = 0{,}00088°C/W$$

+

$$Rdielec = \mathbf{75\mu m} \div (\mathbf{2W.m^{-1}.K^{-1}} \times 101{,}6cm^2) = \mathbf{0{,}36905°C/W}$$

+

$$Ralu = 1{,}5mm \div (237W.m^{-1}.K^{-1} \times 101{,}6cm^2) = 0{,}06229°C/W$$

=

$$0{,}43222°C/W$$

THE MOST IMPORTANT FOR IMS PERFORMANCE IN THERMAL MANAGEMENT:

Dielectric thickness

Dielectric thermal performance

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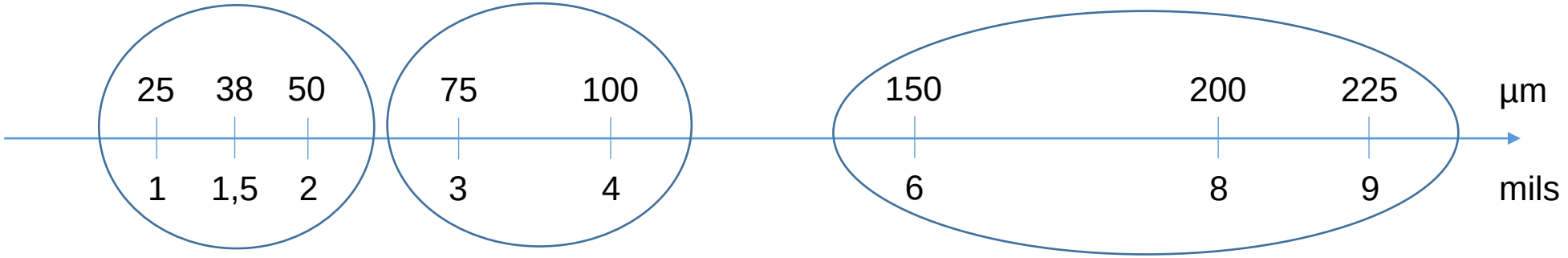
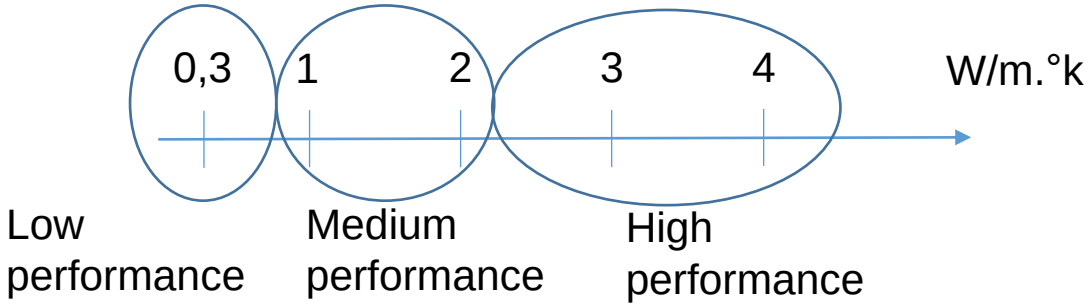
IMS PCB

DIELECTRIC LAYER: THICKNESS



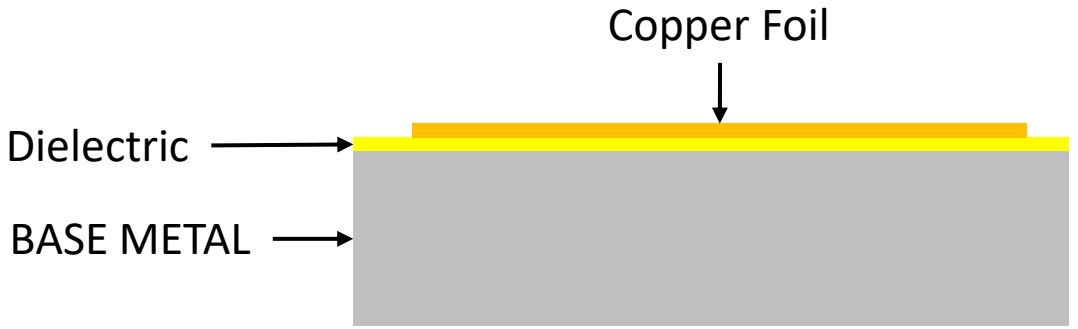
DIELECTRIC LAYER: THERMAL CONDUCTIVITY

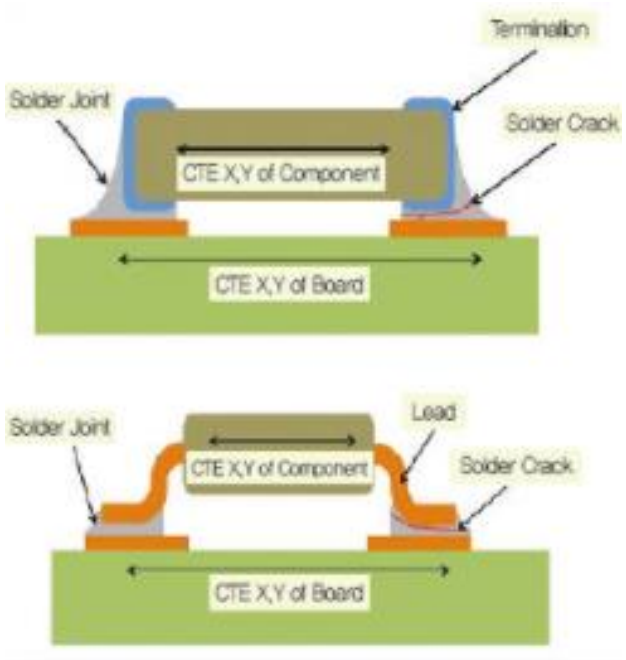


IMS PCB

COPPER FOIL THICKNESS:

35µm to 210µm in standard
210µm to 350µm in advanced





BASE METAL CHOICE

ALUMINUM:

Major application
Standard thickness **1,5mm** (0,5 to 3mm)
Aluminum grade : 1050, 5052, 6061

COPPER:

Lower CTE XY, 24ppm/°C for aluminum, 17ppm/°C for copper
Standard thickness **1mm** (0,5 to 2mm)

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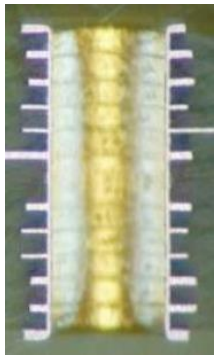
HDI TO SLP OR UHDI

THE DIFFERENT PCB SOLUTION TO DECREASE THE SIZE OF THE POWER DRIVING SYSTEM :

Type	Line/Space
Double-sided PCBs	100um
Multilayer PCBs	100um
HDI Microvia PCBs	60um
HDI any-layer PCBs	40um
Substrate-like PCBs	30um

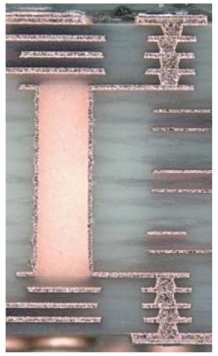
STANDARD MULTILAYER PCB:

Line/Space : 100µm
Layer count : 4 to 16
Hole diameter : 0,2mm



HDI PCB WITH MICRO VIA:

Line/Space : 60µm
Laser step : 1 to 5
Laser via diameter : 100µm



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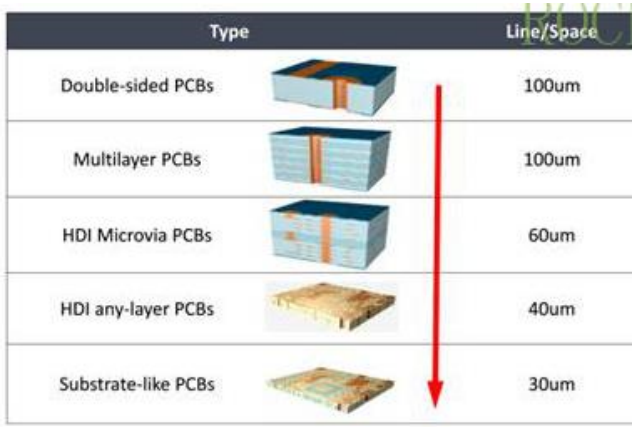
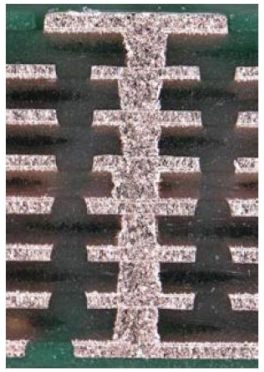
HDI TO SLP OR UHDI

THE DIFFERENT PCB SOLUTION TO DECREASE THE SIZE OF THE POWER DRIVING SYSTEM:



HDI ANY-LAYER PCB:

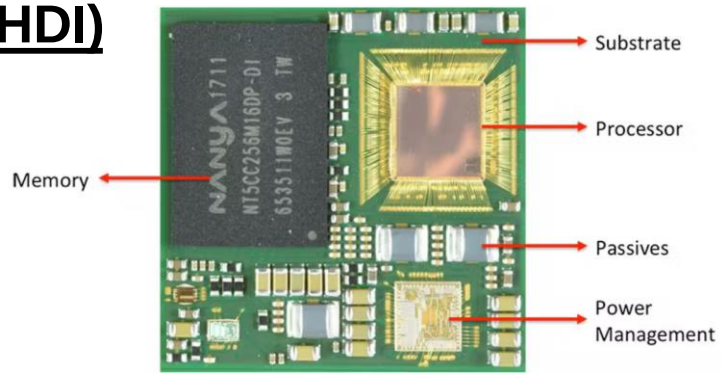
Line/space: 40µm
Layer count: 6 to 12



SLP (SUBSTRATE LIKE PCB) OU UHDI (ULTRA HDI)

Line/space: 30µm
Process: mSAP
Material: BT resin
CTE X/Y: 2/3 ppm/°C

SIP (SYSTEM IN PACKAGE) WITH SLP PCB



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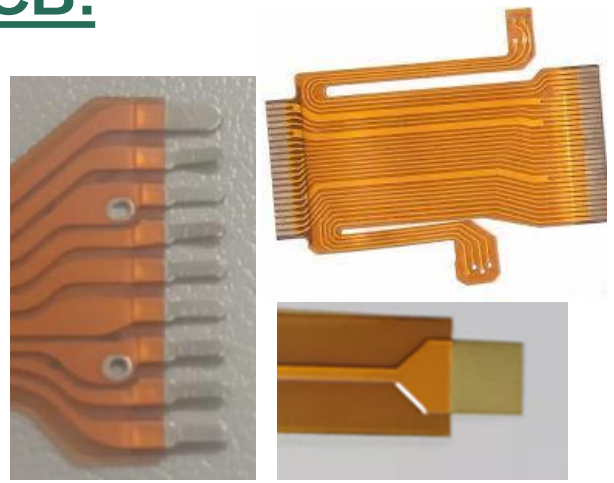
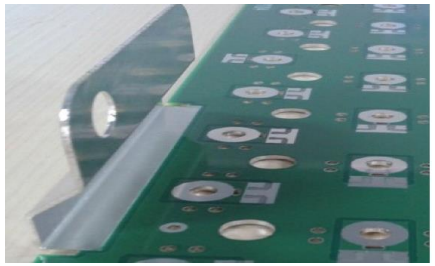
FLEXIBLE PCB

DIFFERENT INTERCONNECTION CHALLENGES IN POWER ELECTRONICS AND ENERGY STORAGE FOR PCB:

- Connection between Power board and Driver with Sculptured Flex PCB or standard flexible PCB.
- Flexible or thin PCB with specific finger connection for soldering directly on the Battery Cells , to measure temperature and voltage on each cell.
- Thick PCB or Copper base PCB, to connect each cell with the thick copper layer for the power and use the standard 35µm layer for measurement and Cell Balancing.





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THANK YOU!

Stay in touch : **www.icape-group.com**

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