Insulated Metal Substrates

Presented by Les Round of Spirit Circuits

ICT Evening Seminar: 15th September 2010

Venue: Newtown Hotel, Hayling Island

Why use Thermal Management

The failure rate of an electronic device doubles with every 10C increase in chip junction temperature.

(Source: AI Technology)

So it pays to keep it cool.

Growth in demand for Metal-back PCB’s

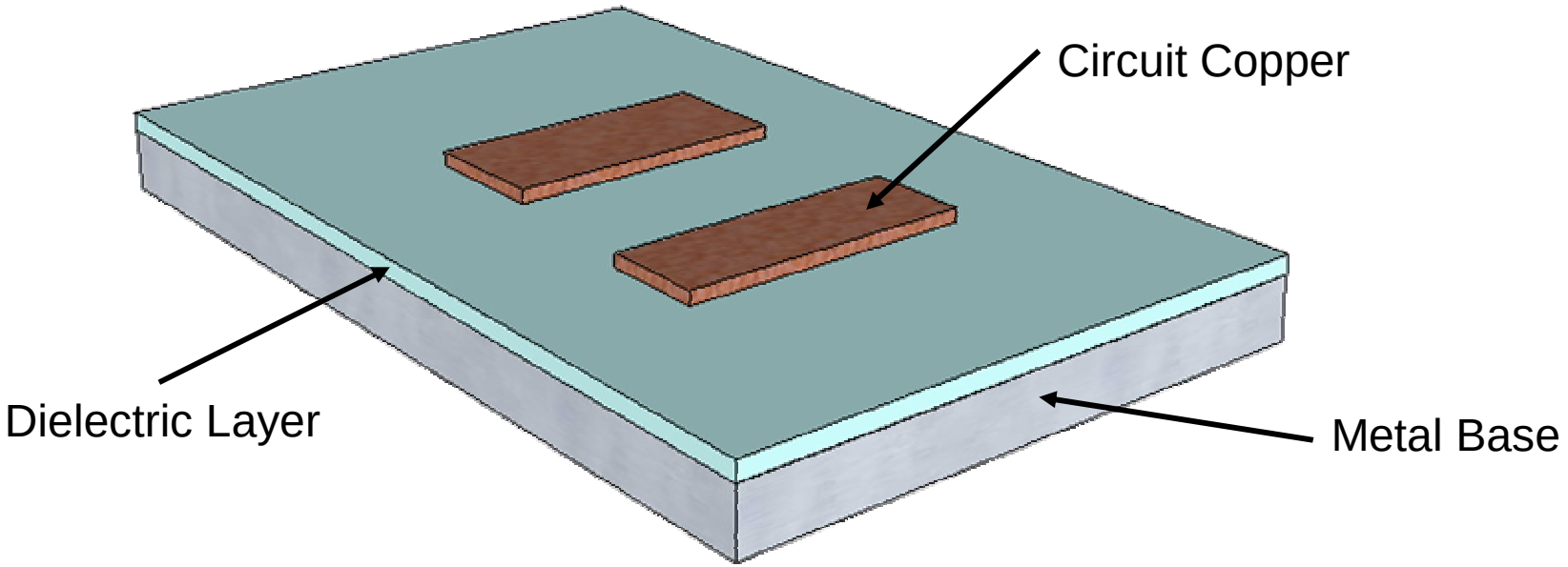
LED Lighting – provides energy efficient, low maintenance & long-life lighting solutions.

Power Solutions – power conversion, distribution, charging and storage systems (aided by new generating technology – wind, solar power etc).

Electric Cars – PCB’s associated with actual vehicles and potential from a network of charging points.

LCD TV – LED back-lighting.

Typical Metal-back Substrate



What are Metal-back Substrates

- Copper foil – track & pad layer. (1 – 10oz).
- Dielectric layer – electrical insulation (500 -1kV/25micron)
  - thermally conductive (1 – 8W/mK)
  - thickness (0.017 – 0.300mm)
- Metal Base – heat sink. (0.5 - 3.2mm)
  - aluminium (150W/mK)
  - copper (400W/mK)

IMS SELECTION CITERIA

- Electrical performance
- Thermal requirements
- Metal base
- Cost

Electrical Performance

Copper cladding:

- select copper weight based on required current carrying capacity and thermal needs.

Electrical isolation:

- select based on breakdown voltage (0.5 – 1kV/mil) versus dielectric thickness.

Thermal Requirements

Thermal Impedance of an IMS indicates how effective heat is removed from a component – lower the thermal impedance the more efficient heat is dissipated.

In practice, the selection is based on the dielectric thickness versus the Thermal Conductivity.

Metal Base

Aluminium is; typically; the default material because of cost & weight.

Copper selected where:

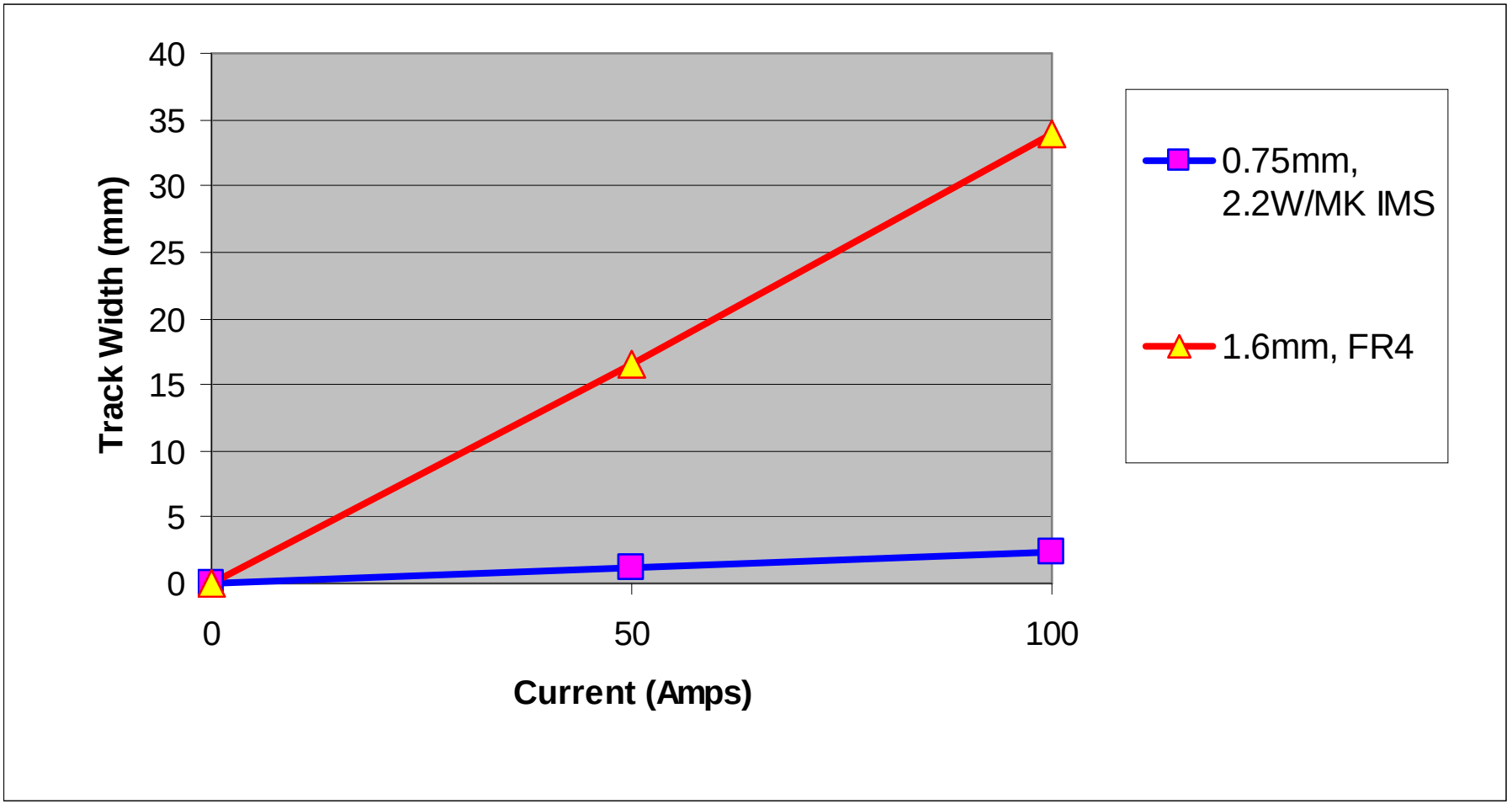
- CTE may be an issue (heavy copper)
- electrical contact to the base may be required (especially via a PTH)
- better thermal conductivity required

Cost

Cost is a key factor in the choice of an IMS material because; especially in the LED arena; a low unit price is critical.

Therefore, selection is usually based on the lowest cost option in order to achieve the required overall performance.

Comparison or IMS v FR4 for a given design (Temp. rise 10°C/3oz Copper tracks)



IMS Suppliers

Aismalibar (www.interpcb.it/doc/alcup.pdf)

AI Technology (www.aitechnology.com)

Arlon (www.arlon-med.com)

Bergquist (www.bergquistcompany.com)

Denka (www.denka.co.jp) (www.lamar-uk.com)

DuPont (www.led.dupont.com)

Laird (www.lairdtech.com)

Taconic (www.taconic-add.com)

Thermastrate (www.thermastrate.com)

Ventec (www.ventec-europe.com)

Manufacturing

1. Engineering and tooling
2. Imaging
3. Etch
4. Inspect
5. Solder Resist and Ident
6. Solderable Finish
7. Profile
8. Final Test and Inspection

Engineering & Tooling

- Flexible tooling system preferred for optimum panel utilisation.

- Provide feedback to customer about panelisation (where possible, design around 18x24inch panel).

- Drill or punch tooling holes into panels.

Imaging

- Produce ‘etch resist’ image using photoresist or etch-resist inks.

Etch

- Mask-off the metal base with either photoresist or etch-resist ink; or, buy-in IMS with a polyester protective film applied to metal base.

- Etch with either alkaline or acid etchant.

Inspect

- AOI is a useful tool especially where no final test is required.

Solder Resist & Ident

- Solder resist is applied either by standard screenprint or photoimageable process.
- White resist is commonly specified for LED applications and there are a range of bespoke resist available that are colour stable (through assembly and in use).
- Ident is applied using standard screenprint process but photoimageable or ‘jet-print’ used for high copper weights.

Solderable Finish

- All popular finishes are used (including special finishes for gold wire bonding).
- ENIG used for aluminium wire bonding applications and for use with copper based materials.
- OSP & LF HASL most common for LED market.

Profile

- Routing – used for smaller volume production using fluted cutters.
- Scoring – common for square or rectangular boards using diamond or zirconium nitride tipped blades.
- Blanking – for high volumes using hardened steel or tungsten carbide tools.

Test

- Standard electrical test.

- Flash test – batch test (typically 1KV) or bespoke testing (up to 5KV).

Thermal Tapes

- Basically a thermally conductive, electrically insulating, double-sided tape used for ‘screw-less’ fixing and aides heat dissipation.
- Simple application but need to ensure no air is trapped between tape & heat sink.
- Profile needs to be optimised to ensure the tape is cut cleanly.

Non-Standard IMS boards

Example 1:

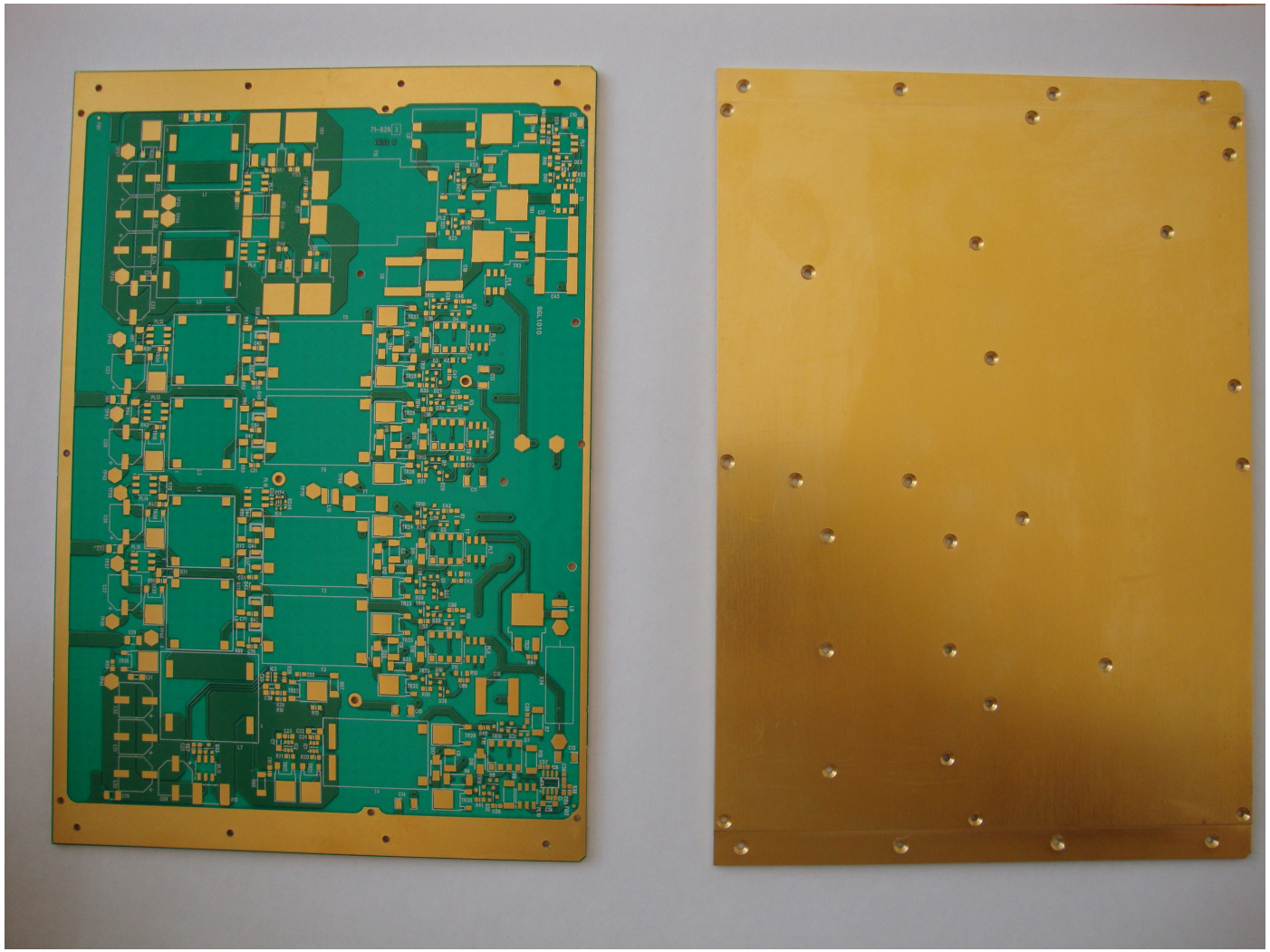
4oz, PTH or multilayer PCB using Laird material bonded to a 2mm metal base (copper or aluminium) with Laird TPreg.

Base is machined with rebates, countersink & counterbore holes.

Some versions have the PCB connected to the base using plated through holes.

ENIG finish to circuit side & copper bases with anodising for the aluminium bases.

Example 1



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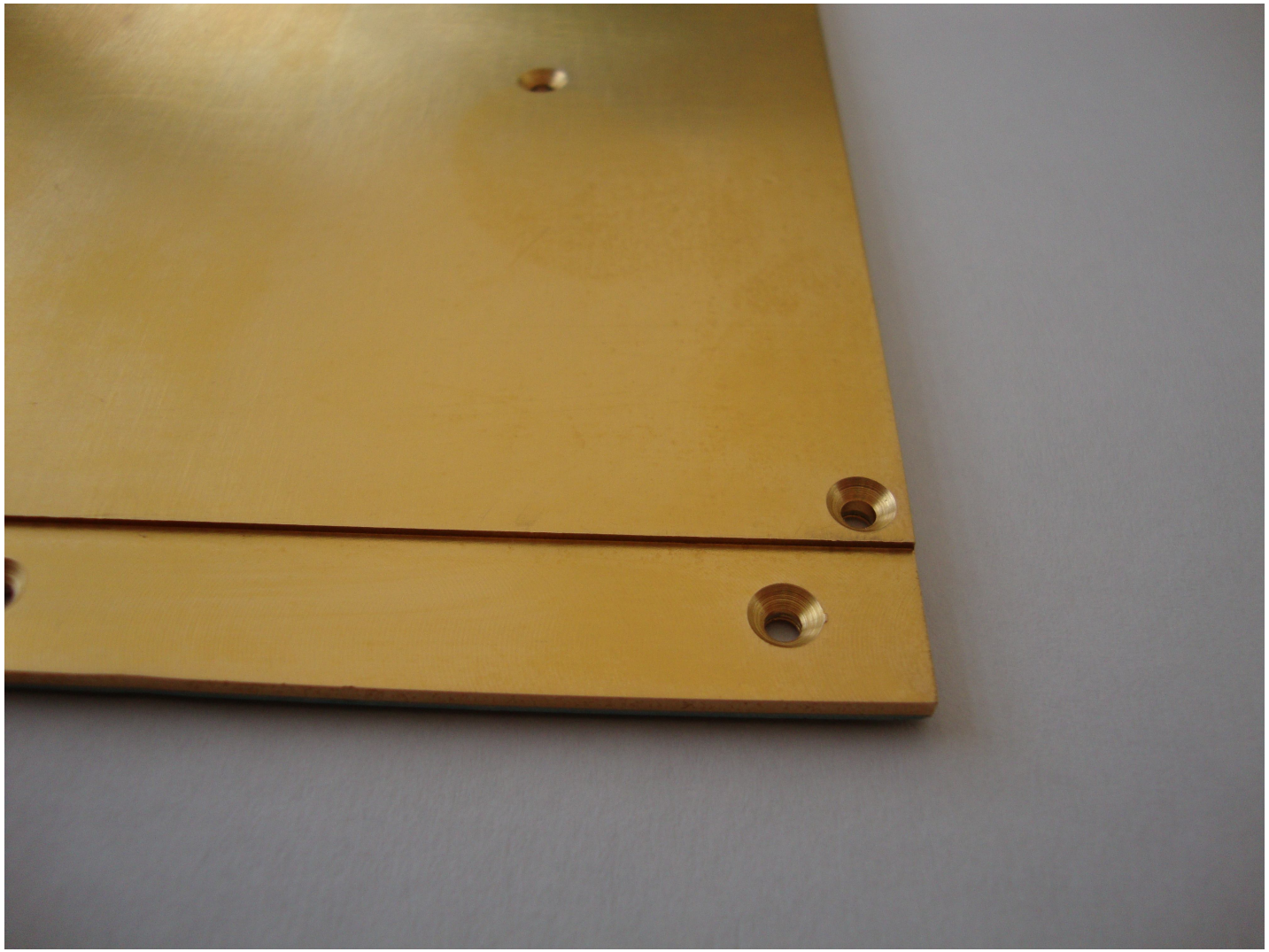


Non-Standard IMS boards

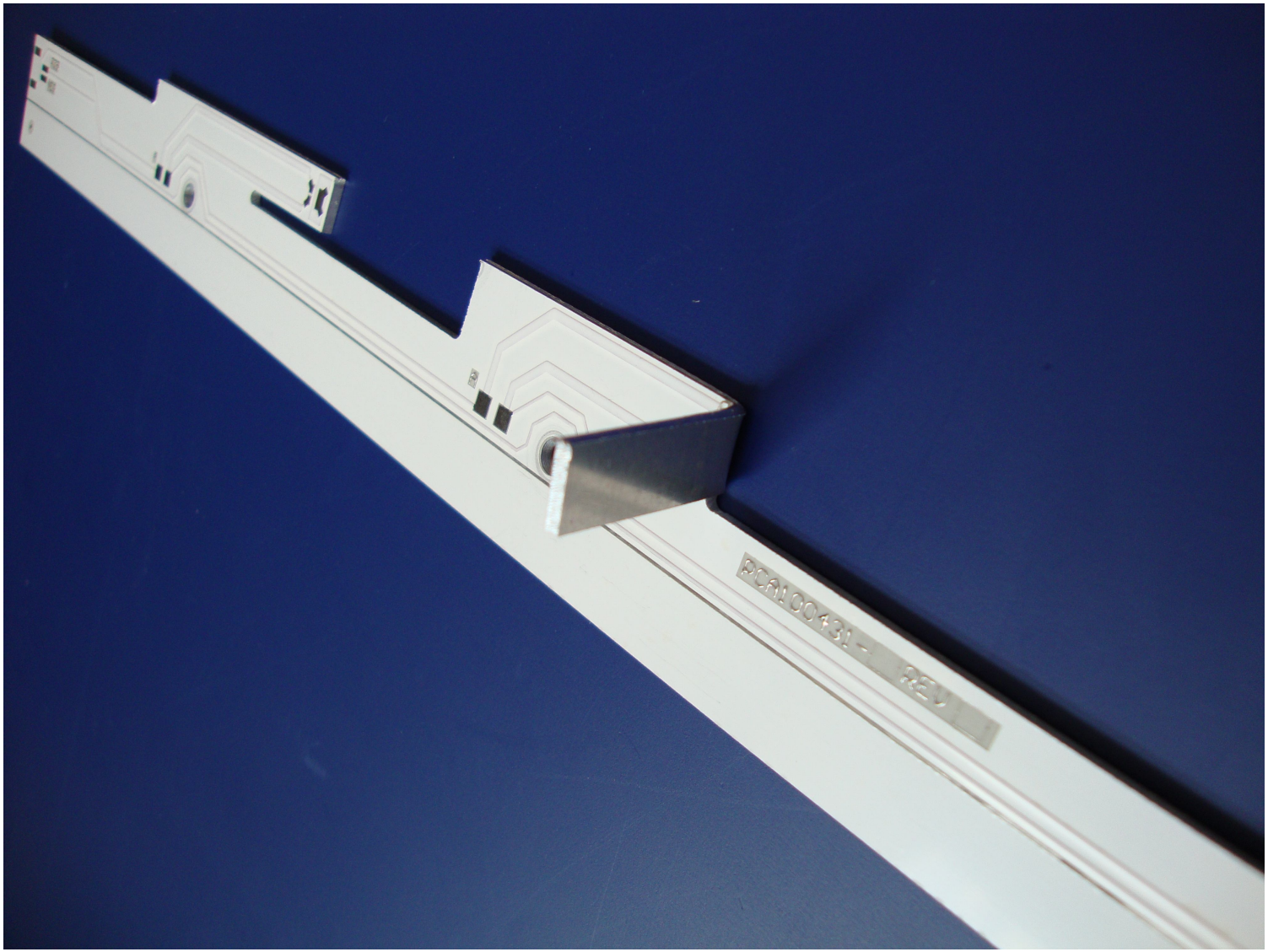
- Example 2.

Customer requirement was for an IMS circuit to be supplied in an array for mass assembly and then the circuit would be broken-out of the array and specific areas of the board would be bent through 90 degrees without affecting the integrity of the circuit.

Solution: trials were carried-out by bonding custom-made materials; after a successful evaluation by the customer, the job went into production. Ventec now supply a similar material which is used for all production requirements.

Example 2

Example 2



Non-Standard IMS boards

Example 3.

5oz, 0.1mm FR4 PTH board bonded to a pre-machined 1.00mm copper base.

Finish is immersion silver.

Example 3