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 10°C 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

- Dielectric Layer
- Circuit Copper
- Metal Base
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 CRITERIA

- 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](http://www.interpcb.it/doc/alcup.pdf))
AI Technology ([www.aitechnology.com](http://www.aitechnology.com))
Arlon ([www.arlon-med.com](http://www.arlon-med.com))
Bergquist ([www.bergquistcompany.com](http://www.bergquistcompany.com))
Denka ([www.denka.co.jp](http://www.denka.co.jp)) ([www.lamar-uk.com](http://www.lamar-uk.com))
DuPont ([www.led.dupont.com](http://www.led.dupont.com))
Laird ([www.lairdtech.com](http://www.lairdtech.com))
Taconic ([www.taconic-add.com](http://www.taconic-add.com))
Thermastrate ([www.thermastrate.com](http://www.thermastrate.com))
Ventec ([www.ventec-europe.com](http://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
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