

## Semelab High Reliability Modules

by Dr Steve Jones

Semelab is able to offer a custom range of power modules incorporating various circuit topologies capable of operating in extreme environments whilst still offering excellent thermal and electrical performance. Typical applications include:

- Aerospace
- Military
- Drilling
- Advanced automotive electric drives

These modules find immediate application in areas where COTS (commercial off-the-shelf) devices would rapidly degrade. Semelab's hi-rel range of modules have been designed to eliminate such failure modes and have greatly extended module life such that they can easily cope with the mission profiles experienced in these applications.

Fig 1 depicts an advanced IGBT power module offered by Semelab in this case with an unconventional base plate structure employing pin fin cooling techniques for improved heat extraction.

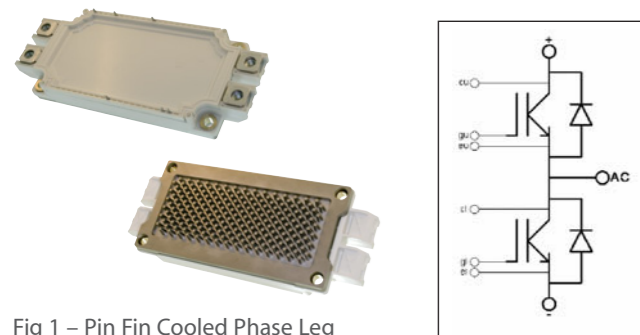


Fig 1 – Pin Fin Cooled Phase Leg

With the correct choice of packaging materials the module MTBF/FIT figures can be drastically improved. Matching the CTE's throughout the vertical construction of the module generates a benign environment for the materials and semiconductor die to operate in, thereby minimising destructive stresses and strains that cause the observed premature failure of COTS devices.

Key materials offered in Semelab Hi-Rel modules include:

- Metal matrix composite base plates
- Integrated cooling systems employing water, oil, glycol-water mixes etc.
- Aluminium Nitride active metal brazed substrates

In parallel with material choices both the ceramic and copper thicknesses also require optimisation - something that is not possible with standard COTS product.

Another identified failure mode is wire bond lift off due to power cycling. Semelab has mitigated failure modes by selective treatment of the bond wires to stop flexing and the optimisation of wire composition and diameter.

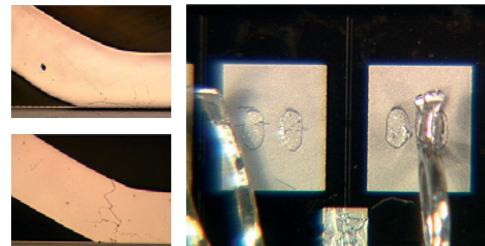


Fig2 - aluminium wire bond cracking and lift off

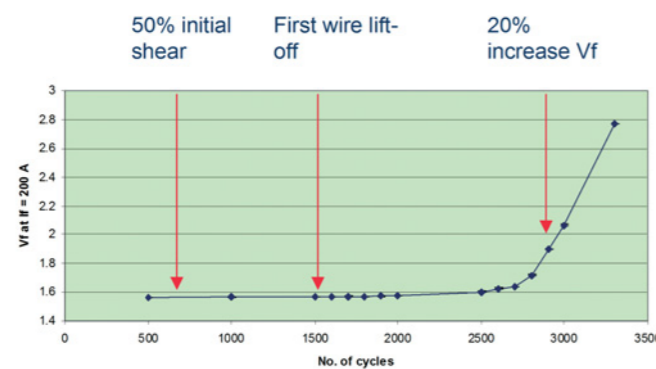


Fig 3 – Effect of temperature cycles on device forward voltage drop as wire bond lift-off progresses

Semelab is able to offer a whole range of custom and standard circuit topologies in modules constructed out of materials that will offer reliability figures that exceed the requirements of the application mission profiles.

Semelab is also actively incorporating silicon carbide devices into new module structures that enable the modules to operate at higher temperatures for the most arduous of applications.

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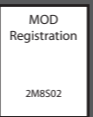
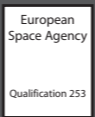
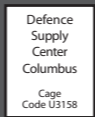
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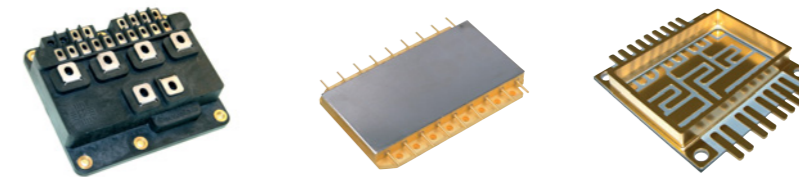
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## Power Products

High reliability modules for extreme environments

POWER



SEMELAB | experience and innovation

**SEME  
LAB**



#### A Proven Record

The Semelab Group has been a leading provider of high-end, innovative Power electronic solutions since 1974. A diverse, worldwide customer base benefits from our design innovation, our manufacturing strength, and our total commitment to quality.

Our key strengths, gained through experience, lie in our ability to advise and expertly interpret your requirements. This attention to detail is how we are able to process the required silicon and identify the most suitable and cost-effective packaging and die solutions for your particular individual needs. The enviable reputation we enjoy in the industry comes from working closely alongside our customers in order to acquire in-depth market knowledge and a genuine understanding of exactly what you require from us.

#### In-house Fab, Assembly, Test and Engineering

Semelab has its own ISO 9000 approved wafer fab at Glenrothes in Scotland - Semefab, and performs assembly, screening and test operations at its facility in Lutterworth, England. All aspects of design, processing, testing, packaging and qualification take place within the Semelab Group, thereby ensuring complete control over quality and reliability.

Semelab holds quality approvals for processes and products from major standards organisations, including ISO, ESA (European Space Agency), DSCC, and CECC amongst many others.

#### New Developments

Semelab offer a complete design and manufacturing service. We are able to customise component parts to meet our customers' specific applications.

All development of new Semelab products is undertaken in close collaboration with customers, and always bearing in mind their specific requirements. On numerous occasions, we have developed new processes to meet customer's exacting specifications.

Semelab are proud to be involved in numerous UK and European funded projects, working alongside a number of leading research organisations and Universities for the development of leading edge technologies.

At Semelab, whatever the challenge, we have the ability to meet it.

Please visit Semelab Power on the web at:  
[www.semelab.com/power/](http://www.semelab.com/power/)

#### Plastic Power Hybrids

Semelab are proud to bring you the latest generation in power module design. Plastic Hybrids designed for high-rel applications.

##### Key Features

- Lightweight design for weight-critical applications
- Rugged encapsulation to withstand harsh environments
- CTE Matched structure for enhanced Temperature Cycling capability
- Wide range of Die Types, Pin-outs & Cooling options for almost any application

##### Cost Effective

- Lower NRE on existing outlines
- Lower cost materials for price-critical applications

##### Flexible

- Your existing circuit implemented
- Standard designs available

##### Enhanced Performance

Using the latest Computer Aided Design & Simulation and advanced materials such as:

- Silicon Carbide Semiconductors
- AMB Hi-rel Substrates
- AlSiC Baseplate

##### Screened

- In accordance with accredited hi-rel screening flows
- To customers own specifications

##### Typical Circuits

- 3-phase bridges
- Single phase bridges
- Diode arrays

##### Typical Applications

- Military
- Aerospace
- Automotive

#### Hermetic Power Modules

For specialised Military and Aerospace applications we can provide you with rugged and proven designs.

Hermetic Modules offer exceptional performance and reliability with Screening & Qualification programmes tailored to your specific needs.

##### Key Features

- Hermetic chamber for extreme protection in harsh environments
- Multiple components in one package
- Ceramic & Glass Feed-throughs or Via Technology available

##### Cost Effective

- Long life in application
- Low NRE on standard packages

##### Flexible

- Your existing circuit implemented
- Standard designs available

##### Enhanced Performance

Using the latest Computer Aided Design & Simulation and advanced materials such as:

- Silicon Carbide Semiconductors
- AMB Hi-rel Substrates
- Liquid Cooling

##### Screening

- In accordance with accredited hi-rel flows
- To customers own specifications

##### Typical Circuits

- 3-phase bridges
- Single phase bridges
- Diode arrays

##### Typical Applications

- Military
- Aerospace
- Space

#### Other High Reliability Products

To complement its range of power hybrid technologies, Semelab manufactures a wide range of discrete semiconductors and linear IC's in high reliability packaging, from traditional packages to leadless chip carriers.

The product range continuously expands in device type and packaging technology. A recent development has been to develop a package to alleviate the problem of deep dielectric discharge in space applications.

##### Improving the Space Weather Forecast

As spacecraft navigate the oceans of space, satellites encounter severe storms in a 'similar' way as to Earth based ocean going vessels do. A documented phenomenon known as Deep Dielectric Discharge, associates high speed solar wind streams with the appearance of large numbers of highly energetic electrons in the magnetosphere. These high energy electrons are dangerous to the operation of the spacecraft as they bury themselves into dielectric materials deep within the satellite, (materials such as PCB materials, coaxial cables etc).

The build up of charge occurs when the total amount of high velocity electrons exceed 1MeV (1 Million electron Volts) during the storm event. The charge continues to build until the dielectric strength of the material is exceeded. Once this happens an instantaneous electrical discharge occurs, which is similar to a miniature lightning strike. This is a hazardous event capable of damaging semiconductor and other sensitive devices.

Part of the solution is to incorporate design improvements to mitigate the effects of Deep Dielectric Discharge. Semelab are currently offering LCC1-4 (Leadless Chip Carrier Number 1, 4 pads), which are based on the ESA qualified ceramic chip carrier technology, but have an additional feature which electrically connects the metal lid of the discrete device, to an additional solder pad at the base of the package, so the lid can be electrically connected to a known potential, (usually ground), therefore conducting away the charge as it occurs.

Available as a conversion from our Standard Package Range.

Contact Semelab Sales for more information.

Please visit Semelab Aerospace on the web at:  
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