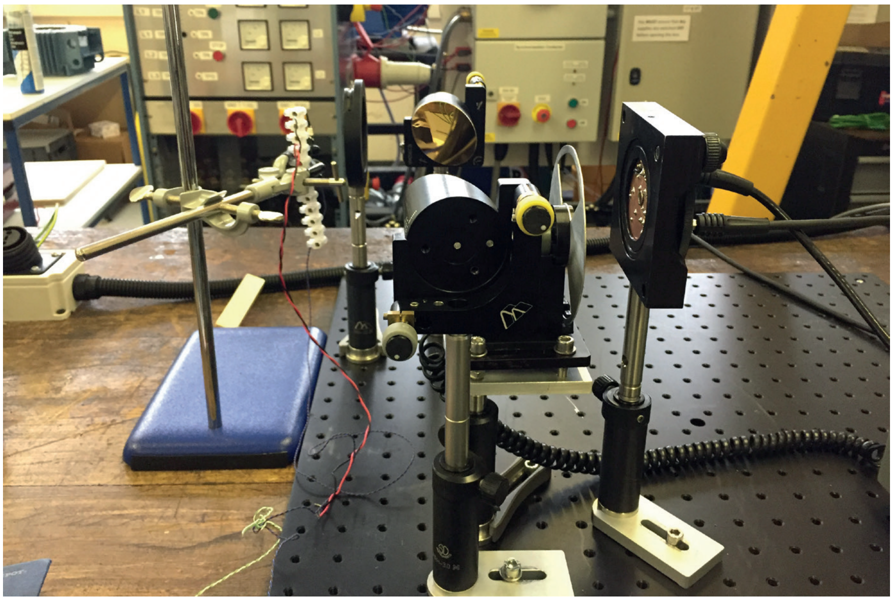
Anecto testing

Innovative developments: increasing the reliability of power electronic modules in wind turbine applications

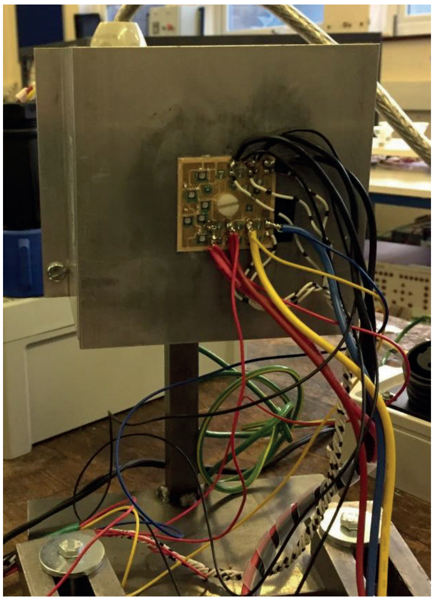
Words: Justo Lapiedra, Engineer and Design Group Lead for the Energy & Motion Technologies division, Anecto

The search for reliability in the renewable energy sector is an ongoing one. Increasing reliability in wind turbine parts reduces downtime and costs while allowing for a constant flow of power to the grid. Also, by finding new ways to improve processes and reduce the time and effort taken to identify and replace faulty parts, companies can drastically improve efficiency.

For engineers in the Energy & Motion Technologies division at Galway-based Test Laboratory Anecto, striking a balance between innovation and quality control is essential to increasing reliability. They insist that innovation and research comes in tandem with quality control; citing as examples, their in-house refurbishment processes as well as recent work with the UK's Durham University that has breathed new light on the stresses that changing wind patterns cause to a power converter's IGBT and led to their conclusion that a 'holistic



2-slot blade IR sensor calibration



DUT mounted on the heat sink

approach to wind turbine power converter reliability' is more advisable in future.

Anecto test laboratory started as an electronics test house in 1994 but developed into a major provider of product and packaging testing for the medical devices and many other sectors. By leveraging the engineering talent they had on site and innovating, the company pushed into the renewable energy market in 2010 and have since developed into a major third party test, repair and refurbishment provider for wind turbine power electronics components.

Our adherence to reliability and willingness to innovate is one of the reasons we were able to grow quickly to reach our current stage. It also helped in building the partnership between Durham and ourselves with the research, centred on measuring IGBT and diode junction temperatures using infra-red sensors, which has revealed some very useful results.

In order to test the units as close as possible to the way they are going to be used in the wind turbine, we collaborated with Durham. Basically they came up with wind profiles that stress the IGBT more than, for example, a constant load. In order to stress the IGBT a bit further they thought it would be interesting to emulate wind conditions where the power is not constant and the wind goes up-and-down, up-and-down. That translates into different power delivery to the grid.

During this collaboration we gained knowledge about different wind profiles that could be applied to their testing in order to have realistic wind conditions and prove that a device will not only work in static conditions but also in dynamic, real-world conditions.

These wind profiles, which we now use in our testing, are taken from real measurements from the field. These specific transitions are really affecting and stressing the IGBT within a particular design.

However, reliability in wind turbines does not stop at the theoretical. Using this information under a variety of headings including; testing, repair, redesign, refurbishment and monitoring, has influenced how much of the testing is done at Anecto moving forward.

We test to the full power, full capacity, of the unit, exposing it to the kind of high power it will be exposed to in the field and to the limitations it has been designed for. This is less innovative and more like quality control but it is an essential part of the process, as is full power testing, where we test to extreme conditions.

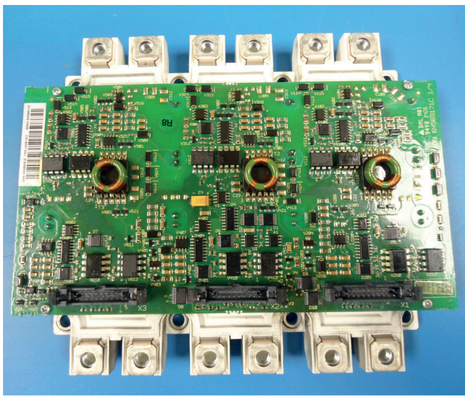
For example, if a power supply works at 24 volts, we will test at 24, at 20, at 26. At different voltage ranges to be sure that it is not only functional but that it operates within the design ranges of that product.

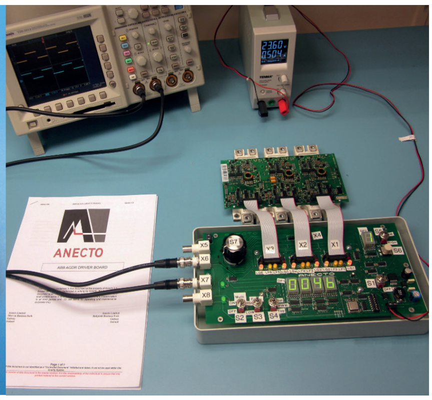
An insistence on a full operational range, for refurbished products leaving the Anecto laboratory, is an essential part of maintaining high quality and reliability standards. Another part of maintaining those high standards is to only use the best parts for the job.

We make like-for-like replacements of parts. When we can't find the part we need, most usually an IGBT or driver card, or that part goes out of production; we get the better modern alternative. For example if capacitors on a unit are more than 6 years old, we replace them.

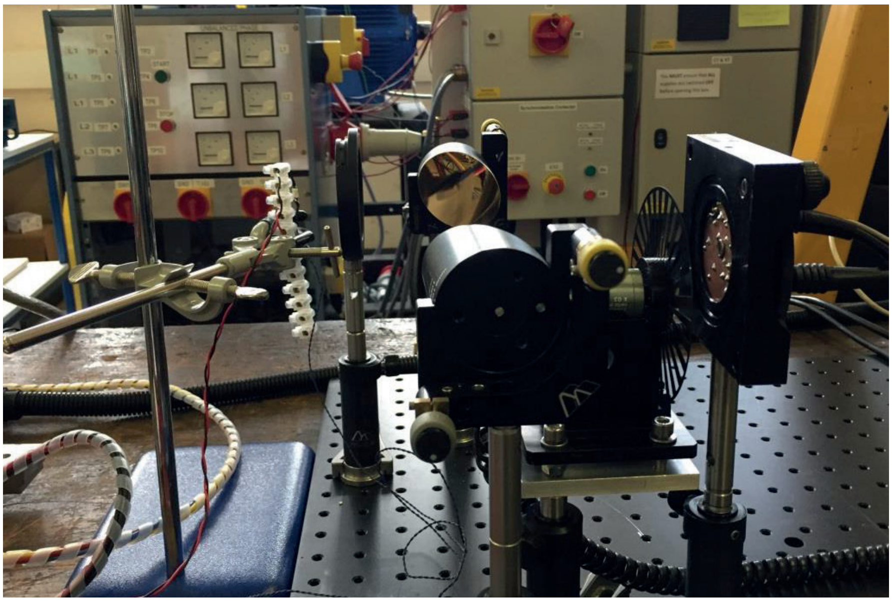
Of course things so often are never as easy as that and Anecto have to adapt and innovate when the parts for a unit are no longer available. Cases like this however are a problem the company learned to deal with a long time ago; they just build it in-house. Usually this means replacing driver cards and for Anecto, as with replacing any parts, like-for-like is so often not good enough.

If we have a product that's end-of-life, and





Sample driver & custom-built low power tester



Temperature Measurement 2

Test bed setup

we are not able to source the required part, we have to re-design. In these cases we always try to improve the design. In some cases the parts were designed 15-20 years ago so engineering has evolved since then and improvements can be made. In those cases there are two options, we don't repair the unit or we design our own elements.

Or for example, if A type of capacitor [being used in the unit] will fail after X amount of hours, we should use capacitor B because they are more reliable. Certain variations over time have proven they are more reliable than the original parts so this redesign is about continuing the repairs of that part and also improving the reliability, of course.

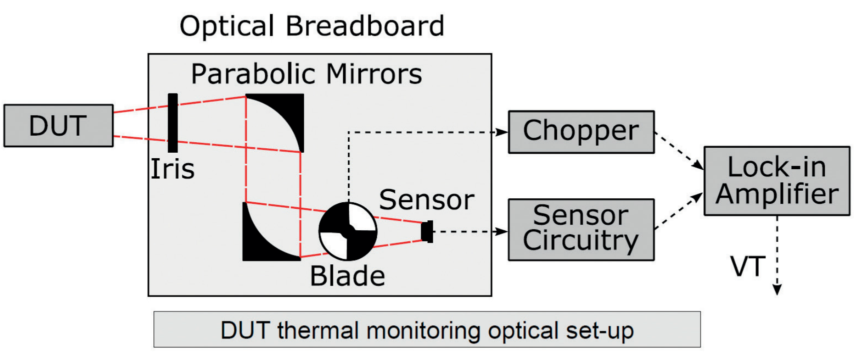
In our R&D we have a frame of reference, from the existing unit, so we know how it has to behave. While we are not really designing something completely new, there are still some degrees of freedom on the new designs that are up to us, so we try to keep them as robust as possible.

The insistence on the most robust repair and refurbishment job possible means that in some cases customers will be returned a unit with almost totally new parts.

There are many different elements in a power module and we may have to replace them all. That happens in a lot of units that we do here. Some elements of a unit that we are going to repair, are going to be brand new, but which at times, maybe the chassis is the only original component that will go back to the customer. But it will get brand new IGBTs, brand new driver cards, including ones we are designing, brand new cables, caps and more. Sometimes it could even include a redesign.

To push the reliability and innovation agenda even further, putting a refurbished unit back into the turbine does not have to be the end of it. On-site monitoring means a constant stream of information can be gained from particular parts in a turbine, 24-hours-a-day if required.

We go to a wind turbine and leave, equipment that is monitoring and is logging some parameters, for a period of time, in order to understand better why a particular wind turbine is failing or to get a better understanding of why maybe that wind turbine is not performing as well as other wind turbines beside it.



Thermal monitoring optical setup

Typically this monitoring is done online, after our engineers leave equipment on-site, while the wind turbine is operating, allowing them to monitor it remotely at any time during the connection of the monitoring equipment. I believe this is another very useful way to increase reliability.

In some cases we have seen that electromagnetic noise was causing some elements to behave in a different way and leading to on/off failures. This monitoring can improve the reliability of the wind turbine.

Of course continually monitoring a part, using Anecto engineers can be a costly outlay, if a company needs to do it over a longer period of time. We have already put in place a solution. It is possible to allay customer concerns regarding this, by offering a custom bespoke tester design service. It is a service that can also mean massive time and labour savings for repair teams in the field.

Companies wanting to know if a particular part is working, while still connected to the turbine, can call us and we will build a custom tester to check for specific faults in a particular unit.

This testing could be done in the field, for example, on units that we don't know whether they are faulty or not. Anecto can design a customised tester that means the customer is able to go and connect this tester to the machine, press a button and see if it passes or fails. This is instead of disassembling everything in the unit only to find out there is 'No Fault Found', meaning it's still working.

Reliability is not easy in the wind turbine industry but with innovators striving for the highest standards, it's certainly possible.

www.anecto.com