DISRUPTIVE INFLUENCE OF THE PERFECT VOLTMETER

This is a story in three parts: the rebirth of a British semiconductor legend; the value of blue-sky research; and the development of an exciting new sensor technology. Tim Fryer reports

"It started from a basic EPSRC-funded physics project, looking at the quantum behaviour of superconductors at liquid helium temperatures - a pure physics research project," said Professor Robert Prance of the University of Sussex in introducing a new type of sensor that is to be produced through a joint venture with Plessey Semiconductor. "We believe this is a disruptive technology," he continued. "It is going to change the way sensors are used."

Along with the good news aspect of this representing an interesting technology that the UK will by definition be at the forefront of, and that it represents the first major product development for the resurgent Plessey Semiconductors, it also demonstrates the value of centrally-funded R&D. In this case it was not the core programme that has resulted in a product realisation, but a spin-off that was developed as a necessary part of the original project.

The temperature of liquid helium is -269°C and to observe behaviour measurements must be taken. Professor Prance takes up the story once more:

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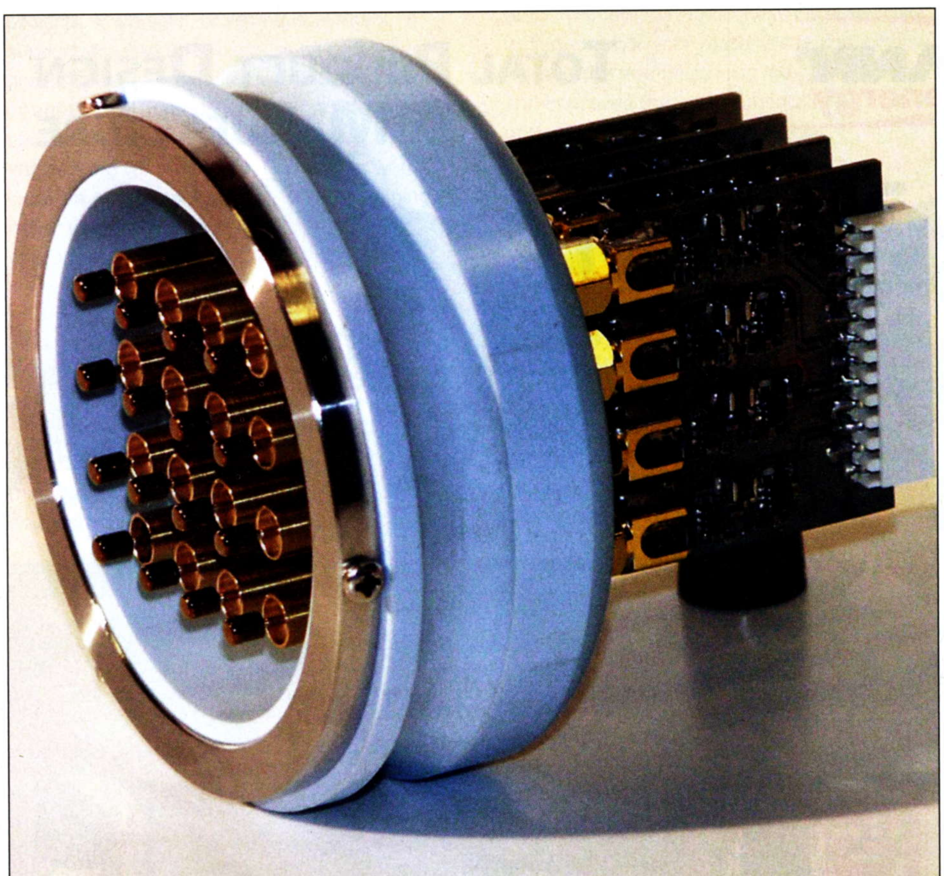
"During the project we needed to measure very small quantities of charge or voltage at those very low temperatures. That made us think about how we were going to do that as it turns out the conventional laboratory instruments were not suitable. They were difficult to use, they were very difficult to set up, and very difficult to make measurements that are a remote distance from the instrument, which, by necessity, when operating at low temperatures you need to do. So that is why we started designing our own systems, and we ended up producing an intrinsically very stable electrometer or electric field sensor [the Electric Potential Sensor]. We did this within the physics project, and then realised that we could be doing a lot more with it, so the EPS is directly a spin out from a science project.

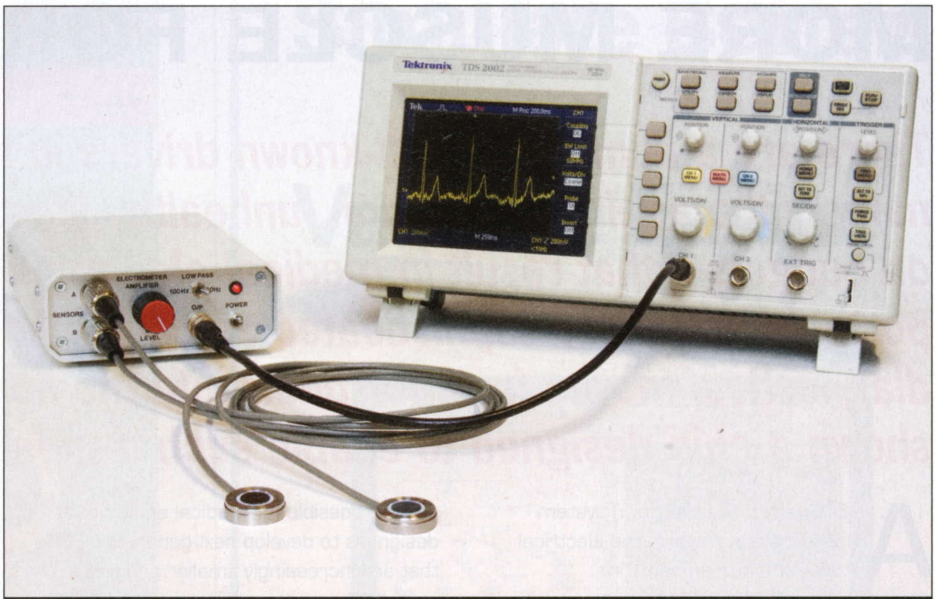
"It creates many new measurement possibilities. It does that because, being an intrinsically stable sensor - essentially an ultra high impedance measurement device, it doesn't actually disturb the system that you are looking at. It is truly, electrically, a non-invasive measurement. The easiest way of thinking about the electric potential sensor is to think about it as a perfect voltmeter. A perfect voltmeter is one that pulls no current whatsoever from the source. We are measuring either electric potential or electric field. We have a clever mechanism for injecting a very tiny bias electric current into the front end of the amplifier in order to stabilise its operation. This is one of the things that differentiates it from conventional benchtop electrometers. There are no adjustable parameters either in manufacture or set up for use of this device."

The EPS technology works at normal room temperatures and functions as an ultra high input impedance sensor that acts



16 element array with EPS

as a highly stable, extremely sensitive, contactless digital voltmeter to measure tiny changes in the electric field down to milliVolts. Most places on Earth have a vertical electric field of about 100 Volts per metre. The human body is mostly water and this interacts with the electric field. EPS technology is so sensitive that it can detect these changes at a distance and even through a solid wall. Thus, for example, in a fire situation, it could be possible to determine if there are any people in a smoke filled room before opening the door. The initial application areas for EPS will be in medical and sports as these are the applications that are most advanced and easiest to develop. Key to this is that EPS detects the voltage change in muscles and nerves without electrical contact so there is no need to have electrodes on or in the body to detect current changes.

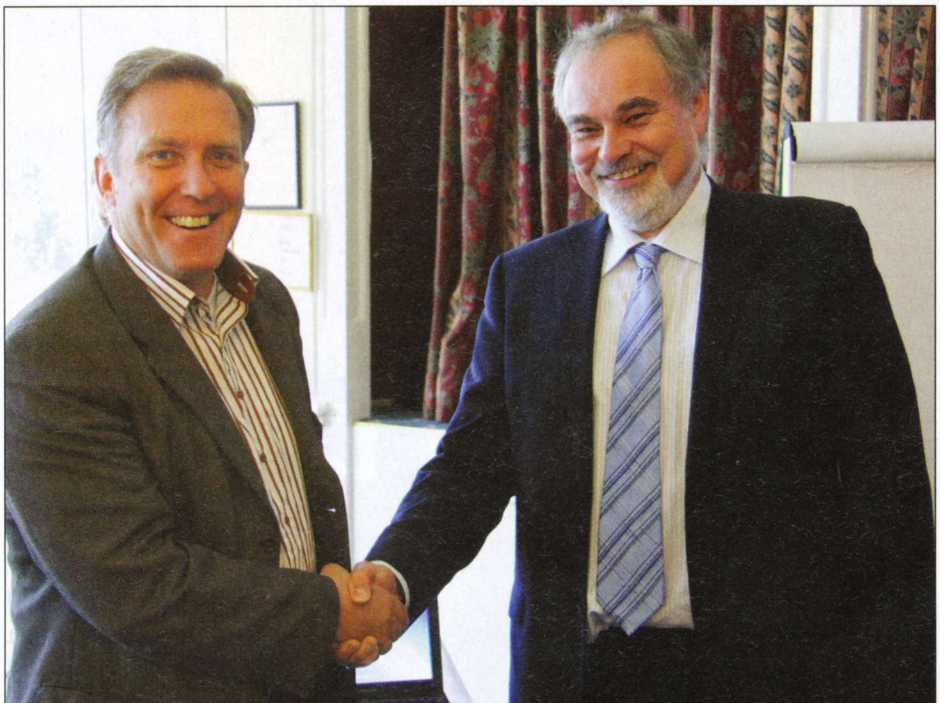


ECG Scope with EPIC sensors

While development of such technology demonstrates the value of R&D in the UK's further education establishments, it is not a core strength of an organisation like the University of Sussex to bring such a technology to commercial realisation. This is where Plessey Semiconductors comes in. This is a company that has travelled a bumpy road over recent years, but following a management buy-out in early 2010 has been reborn with a new sense of direction.

Michael LeGoff, Managing Director, said: "Plessey built its reputation on being able to create niche market opportunities from technologically advanced solutions. We are continuing with this business model because it enables us to stand out from the crowd of semiconductor vendors who are all competing with the same components manufactured in the same fabs in Asia. By providing innovative solutions that are non-standard, we are competing successfully on the world stage. Plessey is the semiconductor manufacturer of choice for people with unique requirements demanding something a little bit different."

Such technology as EPS would therefore appear to be a perfect fit into Plessey's strategy. Dr. Keith Strickland, Technology Director for Plessey Semiconductors, commented: "The EPS technology created by Professor Prance's team at the University of Sussex is a significant innovation that will have a wide-ranging disruptive impact in the sensor market. In conjunction with the University of Sussex, Plessey will be developing an exciting range of EPS sensors utilising our in-house expertise in semiconductor process technology and design. In particular, our expertise with CMOS image sensors will enable us to create very large chips with arrays of EPS sensors. We expect to have our first product prototype available in Q3 2011 for a medical diagnosis product that will significantly advance the ease and quality of cardiac measurements."


Michael LeGoff (left) MD Plessey Semiconductors Ltd and Professor Robert Prance of the University of Sussex

The initial applications of the EPIC (Electric Potential Integrated Circuit) technology are likely to be for Twin sensor Electrocardiograph (ECG – with one sensor on each wrist); Contactless ECG where an array of EPS sensors can just be held over the patient's chest; Electrooculograph (EOG) where sensors on the head can detect eye muscle movements; and Electromyograph (EMG) where sensors detect nerve impulses and muscle contractions which could be used to control artificial limbs from a simple pad on the surface on the skin.

Further non-medical uses could include security and human-machine interfaces. EPD