Innovative Current Sensors, Planar Components, And Cores Take The Stage At PCIM Europe

by Cliff Keys, Contributor, How2Power.com

PCIM has become the European showcase for power electronics. This show, which is presented each spring in Nuremberg, Germany brings together a variety of exhibitors to present the latest offerings from the power electronics industry. Among the products on display in the PCIM exhibition are numerous magnetic components including inductors, chokes, transformers, and sensors as well as the cores and coil formers used in the construction of those types of components.

At the recently concluded PCIM Europe 2014, which ran from May 20 - 22, I met with a number of the magnetics vendors who showed me some of their latest developments in product and technology for power electronics applications. Among the noteworthy developments were improved current sensors and planar transformers featuring innovative design and construction techniques and high-performance core materials.

Rogowski Coils Detect Arc Faults, Planar Advances Address Higher-Power Designs

Pulse Electronics presented two papers in the poster sessions at the conference. The first paper, “Arc Fault Detection Using Rogowski Coils,” was presented at the Renewable Energy Systems poster session, while the second paper “Design of a High Efficiency Planar Transformer with Deep Interleave Flat Coil Windings for >250 W Converter Topologies,” was presented at the Converters poster session. The presenter in both cases was Gerard Healy, a field applications engineer with Pulse Electronics’ Power Division.

Arc fault failures in solar power inverters have become a recognized problem and arc fault detection will soon be required for all string inverters. Likewise, commercial-building HVDC power micro grids must also be protected from arc faults.

Accurately detecting arc faults requires sensing the current for a specific signature waveform. Rogowski coils are ideal for the signal sensing because they are immune to the dc current, have unlimited saturation characteristics, and are fully isolated. The sensors also have a very wide bandwidth from 1 Hz to greater than 1 MHz, which is needed to sense the specific signature waveform.

The Rogowski coil can be used to detect arc faults and provide a system with the information that a fault has occurred so it can be arrested. The company’s Sidewinder Current Sensor product is based on the application of the Rogowski coil principle. When an ac current flows through the center of the sensor, an output voltage is induced that is proportional to the rate of change of the current, di(t)/dt.

The Sidewinder products are described as the ultimate evolution of the Rogowski coil principle for ac current-sensing applications. Pulse’s patent-pending winding technique has been engineered to provide highly linear output voltage over a very wide dynamic range from 0.1 to 1000 A, making these products especially suited for applications such as distributed power generation, renewable energy and storage, load balancing, power monitoring, advanced metering infrastructure (AMI), circuit breaker panels, and smart meters.

Sidewinder products meet the Class 0.2% accuracy limits defined by the IEC 62053-22 and ANSI C12.20 standards for currents from 0.1 A to 200 A and above as well as the Class 1 requirement for immunity to external magnetic fields. They are immune to external ac magnetic fields and dc magnetic fields.

Basic planar winding structures are not optimum for converter topologies for higher power (>250W) applications. At Pulse Electronics, two new advances in planar transformers have been created to address this
and were showcased at PCIM. Finite element analysis of the flux paths in traditional planar cores can be redesigned for a more-uniform distribution, increasing the effective core cross-sectional area within a given geometry. Additionally, a novel winding technique can be implemented that will reduce the leakage inductance and increase the throughput power. Pulse’s paper in the poster session addressed these new-generation planar transformers.

“Although these topics, planar transformers and current sensors, are quite different, the solutions are based on similar magnetic core winding principles,” explained Gerard Healy. “Pulse Electronics has adapted and evolved these basic principles, like the Rogowski coil, to create innovative technologies and products.”

**Planar Innovation Supports High-Frequency Design**

The quest for high power density solutions in power conversion systems has yielded intriguing new engineering ideas and conversion topologies. Most if not all of these, hinge on the theoretical prediction that the size of magnetic components and capacitors should decrease as the conversion frequency is increased. Unfortunately, as many designers have learned the hard way, an increase in switching frequency, by itself, will not necessarily lead to higher power density if the conversion efficiency is to be maintained or improved. The benefits of high frequency conversion can be materialized, without compromising losses, only if a multitude of objectives are met.

At their booth, Payton Planar Magnetics presented their latest breakthroughs and technological innovations including a totally new concept of magnetic components for high-frequency, high-efficiency switch-mode power supply (SMPS) design.

Like other planar magnetic components, Payton’s Planetics range of planar transformers and inductors significantly differ from conventional magnetics as they usually do not use magnetic wires. Instead, windings are made of copper foils (lead frames) or flat copper spirals, laminated on thin dielectric epoxy (PCB/multilayer) and thin Mylar, Nomex or Kapton insulators provide the necessary interwinding insulation. By combining these pre-tooled windings in series and/or in parallel, customers’ requirements can all be fulfilled. Pre-tooled PCB/ML and lead frames winding design allow an easy and faster assembly of these transformers.

But unlike other planar components, Planetics AC Line and Power Transformers use a special high-isolation patented construction, which conforms to the strict creepage and clearance distance safety requirements of UL, IEC and VDE standards. A sandwiched assembly of this type greatly increases the primary-to-secondary coupling and significantly reduces the parasitic leakage inductance, thereby simplifying the power supply design. Additionally, the fixed and well-defined design geometry improves the calculation precision to a level that cannot be reached when using conventional wirewound magnetics.

Payton Planar Magnetics maintains a worldwide marketing network of representatives which promote Planetics technology and magnetics for a wide range of applications in telecom, industrial, electronics, military, avionics and other fields.
**Cores, Transformers, Chokes And Sensors Leverage High-Performance Materials**

The Cores and Components division of VACUUMSCHMELZE (VAC) focused its product presentations on cores, transformers and chokes using the nanocrystalline material VITROPERM and highlighted its IGBT drive transformers, tape-wound and cut cores for power transformers and common-mode chokes for EMC filters.

IGBT drive transformers based on nanocrystalline magnetic cores feature good sensitivity over a broad operating temperature range from -40 to +105°C, as well as low coupling capacitance for the precise control of high-power semiconductors. These components are remarkable for their compact size and outstanding dielectric strength. The transformers are 100% high-voltage tested, with partial discharge tested to international standards and insulation in compliance with EN50178, IEC 62109 or IEC 61800-5-1.

In line with the trend towards surface-mount packaging, VAC now offers several new models, including two models with typical transformation ratios of 1:1:1 and 1:1:1:1 and partial discharge voltage around 1.25 kV rms.

Power transformers in the kilowatt range for use in traction applications are based on nanocrystalline ring cores, which offer significantly higher saturation induction (1.2 Tesla) than ferrite cores and in addition, low hysteresis losses. These properties deliver the advantages of higher power density, enhanced efficiency and an extended operating range (up to 120°C.) Power transformers of this type are generally produced as custom designs.

VAC also supplies cut cores of nanocrystalline VITROPERM for power transformers with pre-wound coil bobbins. These cores are used for transformers in applications where low loss and/or low noise are critical. Compared to conventional core materials such as amorphous iron alloys, the losses of VITROPERM cores are two to four times lower at frequencies above 1 kHz.

A factor impacting the noise in power transformers is the inherent magnetostriction of the core material. With a factor of 10 to 100 lower than that of amorphous iron alloys, VITROPERM has extremely low magnetostriction. Cut cores are impregnated with resins which are suitable for temperatures of 105°C (standard) and higher.

The “Cores for Power Transformers” sample kit comprises 10 tape-wound cores and one small cut core, and enables developers to make direct comparisons of different core geometries.

Common-mode chokes with nanocrystalline toroidal tape-wound cores are suitable for EMC filters over a wide range of operating currents, from a few amperes to high rated currents of over 800 A. Various insulation concepts enable the cores to be operated in ac grids and at dc voltages of up to 1 kV.

Customers can select from an array of components for single-phase or multi-phase systems or inquire about customized designs. Recent industry developments have increased the focus on asymmetrical designs with neutral conductors for other types of current rather than phased current. VAC thus provides customers with the maximum flexibility in filter design.

A CMC Sample Kit, with a selection of 24 common-mode chokes, and a Core Sample Kit are available for customers’ in-house development tests.

VAC current sensors, unlike conventional Hall-effect sensors, use a VAC-developed magnetic field probe of cobalt-based amorphous alloy as a zero-field detector, which offers distinct benefits such as minimal offset.
current and negligible long-term drift. Since their offset current is mainly temperature-independent, the current sensors deliver reliable and ultra-precise readings under a wide variety of operating conditions.

The new 4646-X7xx range of current sensors for PCB mounting are largely identical to VAC’s highly successful ultra-compact 4646-X6xx range, but feature higher clearance and creepage distances that enable higher system and operating voltages to be used (600 V and 1020 V as per EN 61800). Current density is reduced by the use of four current bars instead of three, also allowing users more options for parallel and series connection, in order to tailor measurement ranges to their specific application.

Ac- and dc-sensitive differential current sensors, or DI sensors, form the core of residual current monitoring units (RCMUs) compliant with the EN 62109 standard for transformerless solar inverters. The sensors measure residual current to a precision level of 1.5% of the nominal residual current of 300 mA and generate an output voltage proportional to the differential current. The ac- and dc-sensitive differential current sensors offer a range of additional functions including sensor core demagnetization, which can be triggered by the supply voltage, or as required. VAC presented two new types with integrated primary conductors: the 4646-X975 sensor with two conductors for single-phase systems, and the 4646-X976 with four conductors for multi-phase systems. Both feature a test current winding integrated into the sensor housing.

As market trends continue to move towards increasingly high-power applications in wind converters, central solar inverters and high-power drives, demand for devices capable of detecting increasingly high current levels is growing. In response to this need, VAC has advanced the superior functional principle of its current sensor design and developed high-current sensors for currents of 1000 A rms with a measuring range of up to 2500 A.

Compared to existing devices, VAC’s solution offers the hallmark advantages of VAC sensors such as high measurement precision and stability, broad measurement range and outstanding dynamic properties, as well as low sensor power consumption thanks to a PWM driver for the compensation current. The wide primary conductor opening enhances flexibility for the user when connecting the primary conductor.

About The Author

Cliff Keys is a freelance writer and editor with more than 25 years of media and editorial experience covering semiconductors and power electronics. He has written, both for print and the web, for leading electronics trade publications in the U.S and Europe. He operates out of the U.K. and Germany and takes on writing and consulting projects for different trade publications and vendors. Prior to becoming an editor, Cliff worked in industry as an electronics engineer and became marketing communications director for National Semiconductor in Europe.