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Market News

PEE looks at the latest Market news and company developments.

Short-Circuit Simulation of Power Semiconductors

Simulations tools such as PSpice and SABER find an increasing use in the design process of power electronic circuits. By redesigning, they lower design costs and time to market of new products. In the following electrical and thermal measurements are compared to simulation results and the impact of the accuracy of the thermal models on the simulation results is investigated. Dr. Daniel Lindenmayer and Dr. Peter Türke, Infineon Technologies, Munich, Germany.

A Plug-and-Play Approach for Active Power Factor Correction

Power electronics is following the trend of system integration in which a large part of the circuit is included in a microelectronics chip or module. The following study explores the possibilities of achieving high levels of integration. Prof. Em Reu-Yaskov and Eya Zeliser, Green Power Technologies Ltd., Israel.

Lowering Cost and Standby Consumption of Set Top Box Power Supplies

Designing AC/DC power supplies around highly integrated power conversion ICs has already been shown to reduce the overall cost. Other sources of excessive material and labour costs are heat sinks and linear post regulators. A 23W multiple output supply, designed around the TOPSwitch-GX family, needs no heat sink for the power chip and requires no linear post regulators for any of its outputs. Dr. Iain Cockey, Power Integrations Europe, Farnham, UK.

Press-Pack IGBTs for Tractor Applications

Press-pack IGBTs offers a new alternative for GTO traction drive and auxiliary refurbishment, as well as new build. High reliability, in conventional ceramic package outlines, permits the use of traditional cooling systems and mechanical designs, while system performance is enhanced by the most advanced silicon technology. F. Wackern and A. Golland, Westcode Semiconductors, Chippenham, UK.

New 1700V IGBT™ Modules for Tractor Applications

Converters using 1700V IGBTs are widely used for low power industrial 3-phase motor drives up to the high power range of tractor application. This extensive application field requires a corresponding and tailored product spectrum. For traction an IGBT™ chip is combined with the latest housing technology for highest reliability. Christoph Lohke, Supcon, Wiesbaden, Germany.

Linear Regulators can replace Switchers

As electronic devices shrink in size and grow in circuit complexity, efficiency becomes critical. Traditionally, only switching converters offered high-efficiency in supplying regulated output voltages. But linear regulators which can operate with very low voltages are replacing switchers in many places. Chuck Dunlap, National Semiconductor, USA.

Products

A digest of the latest innovations and new product launches.

Website Product Locator

Press-Pack IGBTs for Tractor Applications

Press-pack IGBTs offers a new alternative for GTO traction drive and auxiliary refurbishment, as well as new build. High reliability, in conventional ceramic package outlines, permits the use of traditional cooling systems and mechanical designs, while system performance is enhanced by the most advanced silicon technology. Press-pack IGBTs offer a convenient path to upgrade existing GTO thyristor based power electronics systems. In the majority of applications it is possible to retain the existing powercircuits, controllcircuits and the mechanical arrangement by simply replacing the power switches plus associated gate drivers. In recent traction projects no changes were made to the design or control other than the replacement of the GTO thyristor and its associated gate drive unit. Full story on page 28.
Press-Pack IGBTs for Traction Applications

Press-pack IGBTs offers a new alternative for GTO traction drive and auxiliary refurbishment, as well as new build. High reliability, in conventional ceramic package outlines, permits the use of traditional cooling systems and mechanical designs, while system performance is enhanced by the most advanced silicon technology.

F. Wakeman and A. Golland, Westcode Semiconductors, Chippenham, UK

Les modèles compacts de transistor bipolaire à grille isolée offrent une nouvelle alternative à l'entraînement par commutateur à grille de contrôle et la remise à neuf auxiliaire ainsi qu'une nouvelle construction. Ce huit niveau de fiabilité intégré à un boîtier en céramique d'aspect conventionnel permet l'utilisation de systèmes de rétroéclairage et modules mécaniques traditionnels, tandis que la performance du système est améliorée grâce à la technologie de silicium la plus sophistiquée qui soit. F. Wakeman et A. Golland, Westcode Semiconductors, Chippenham, R.U.

Druckkontaktierte IGBTs bieten sowohl eine neue Alternative zu GTO-Antrieben, deren Erneuerung als auch für neue Aufbauten. Hohe Zuverlässigkeit in konventionellen Keramikgehäusen erlaubt die Verwendung herkömmlicher Kühlsysteme und mechanischen Vorrichtungen, während die Systemeignenschaften durch fortschrittliche Siliziumtechnologie verbessert werden. F. Wakeman und A. Golland, Westcode Semiconductors, Chippenham, UK

The foundation for the design of press-pack IGBTs is reliability through simplicity [1]. The elimination of all wire and substrate bonds minimises stress in the die. Each IGBT or diode die is mounted in its own individual subassembly. The subassemblies for each die are paralleled to give the required rating. Figure 1 illustrates an exploded internal view of a 900A, 5.2kV device, with an exploded view of a single die subassembly inset. Individual gates are contacted via a spring pin, which is communally connected to the external gate termination via a planar distribution board. As the die subassembly is common for a given voltage, different configurations are possible, subject only to the design of an appropriate package.

Projected ratings are only limited to what is practical both in housing design and power circuit implementation [2].

Substantial environmental and accelerated life testing of the devices has demonstrated a performance, which exceeds many alternative technologies. Failure under thermal cycling has been identified as a reliability issue for some alternative packaging solutions. Elimination of stress, due to wire and substrate bonds, plus the relatively small size of the die give the pressure contact IGBT a performance level in excess of even conventional thyristor technology.

Particular emphasis can also be placed on the impressive thermal properties offered by the pressure contact design. A distinct advantage over other packing technologies is the ability to directly cool both sides of the die, doubling the effectiveness of any external cooling system. An additional performance enhancement is seen due to the direct cooling of the emitter contact, offering improved SOA and transient behaviour.

The hermetic package offers one additional option not seen in other packaging technologies, total immersion cooling - particularly useful in refurbishment of Preon and oil cooled systems.

**APPLICATION IN TRACTION**

Press-pack IGBTs offer a convenient path to upgrade existing GTO thyristor based power electronics systems. In the majority of applications it is possible to retain the existing power-circuits,
control-circuits and the mechanical arrangement by simply replacing the power switches plus associated gate drivers.

Press-pack IGBTs offer a practical alternative to GTO thyristors in both DC and AC propulsion converters, as well as auxiliary converters based on all of the commonly used topologies such as Undeland and McMurray arrangements.

Whilst comparing the voltage ratings of GTO thyristors and IGBTs is relatively straightforward, more care must be taken when comparing their current ratings. GTO thyristors are normally rated for maximum controllable anode current, i.e. the maximum current that may be commutated by gate control. Whereas, IGBTs are normally rated for a nominal DC collector current based on the maximum permissible power dissipation at a given case temperature. In general, an IGBT can control at least twice its rated collector current and more in applications with both turn on and turn off snubbers, as required by GTO thyristors. As a general rule of thumb, a press-pack IGBT will normally replace a GTO thyristor with twice the nominal current rating.

Let us take the example of a conventional 2 level, three-phase, PWM controlled, voltage sourced GTO thyristor inverter, as typically applied to both propulsion and auxiliary converters. Based on the assumption that a 500A IGBT (Westcode T0500NA25E) will be used to replace a 1000A GTO (Westcode G1000LL250) and normalizing losses to that of the GTO thyristor we can conclude the following: Conduction losses are increased to 150%, but switching losses are reduced to 32%. Under these conditions it is clear that switching frequency dictates the total losses, the IGBT having superlub losses above 140Hz (Figure 2). As the majority of propulsion applications operate at 150Hz or above, IGBTs are a practical choice. Auxiliary converters tend to operate at 500Hz or above and here IGBTs offer a distinct efficiency advantage. In this case both devices are of press-pack construction with comparable mounting force and thermal impedance.

**Warsaw Tram**

During September 2003 the innovative IEL (Instytut Elektrotechniki) in Warsaw Poland installed a single press-pack IGBT chopper into a Warsaw tram. No changes were made to the design or control other than the replacement of the GTO thyristor and its associated gate drive unit. The now obsolete 1200A 2.5kV GTO thyristor (Westcode type WG12025) was swapped for a 2.5kV 500A press-pack IGBT (Westcode type TS00NA25E). This simple exchange of the two devices was possible only because the devices were packaged in housings with identical outlines. Each tram has two chopper unit drives two motors, only one was replaced with IGBT. The unit continues to function without incident.

**PKP Shunting Loco**

For a slightly more ambitious project also in Poland IEL sought to use pressure contact IGBTs in the refurbishment of a shunting loco (Figure 3). This shunting loco is designed to operate directly from a nominal 3kV DC overhead line. The loco is a Bo-Bo type and as such there are 4 traction motors arranged in two groups of series connected pairs. Motor power control is effected by a chopper arrangement connected via a filter to the DC line. The line voltage can routinely increase to 4kV DC close to substations with transient conditions to 5kV, for this reason the series connection of two-off 5.2kV press-pack IGBTs (Westcode T0850TA52B) was implemented with a split DC link capacitor arrangement. The chopper consists of three identical assemblies, each containing two series connected IGBTs and two series connected freewheel diodes. The assemblies incorporate Westcode C0030BG400 isolated gate drives and RC snubbers for the diodes, while the IGBTs operate snubberless. One assembly controls current for each of two pairs of series connected motors with a third assembly used for over-voltage protection (Figure 4).
Each chopper subassembly is constructed with pressed fin Aluminium heatsinks that offer exceptional power dissipation in a compact assembly. The devices are mounted in two series stacks, one for IGBTs and one for diodes arranged for low self inductance, utilising clamps which feature spherical washers and disc springs to give a good degree of self levelling. The heatsinks are mounted in a flame-retardant GPO3 frame that incorporates ducting to direct cooling air into the heatsinks while keeping air away from the critical insulating surfaces. When installed the two motor chopper units mount directly to a ducted fan for forced air-cooling while the over voltage protection chopper is cooled by convection alone.

Motor current is controlled via pulse width modulation with switching frequency of up to 400Hz. Maximum average current per motor is 320A and the peak commutating current is 400A. The chopper is microprocessor controlled and features advanced slip/slide control with automatic acceleration and braking. The chopper power assemblies are also used for Rheostatic braking, with the braking resistors being connected when required by electromechanical means.

The chopper assemblies have been rigorously tested, in conjunction with the complete control systems, in IEL's laboratories in Warsaw (figure 5). Satisfactory assessment of the press-pack IGBT power assemblies, up to full load conditions, have been completed. The Choppers have now been installed into the locos and will commence further testing before the locos are returned to service later this year. IEL may be contacted through Pawel Gizinski at gizinski@iel.waw.pl.

REFERENCES
[1]. F. Wakeman, K. Billett, R. Irons and M. Evans, 'Electromechanical characteristics of a bondless pressure contact IGBT', APEC 1999, pp 512-517
[2]. F. Wakeman, G. Lockwood, M. Davies, K. Billett, 'Pressure contact IGBT, the ideal switch for high power applications,' IAS 1999, CD Rom

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