Race with “Mercedes”

In the magazine “Electronic components” was published an article with the name “Mercedes of power electronics” that was devoted to achievements of firm SEMIKRON – one of world’s leader in manufacturing of components of power electronics. The high level of the firm lays beyond doubt and causes a well-deserved respect, but in Russia today there are firms that have high scientific and technical potential in this field and are able to compete to “Mercedes”.

The power of many large foreign companies – in a wide production nomenclature covered the entire range of applications of power electronics, high quality, in good technical support of developed fields. By no means are important factor big financial resources of these companies. The Russian manufactures of power conductors that long to success in this field, are obliged to offer to their partners that work in field of creation of different electrical engineering systems (power supplies, frequency converters, power converters, power commutators), the same quality level, service, the widest products nomenclature as and the leading foreign companies. Because it is objective reasons, and sometimes subjective ones, the biggest manufactures of power semiconductors – enterprises that were created in the time of “developed socialism”, today they don’t have any possibility to offer it to native developers and manufactures. But nevertheless intellectual potential of our developers let new young companies engage actively in this field and succeed.

Use of thick-film and thin-film hydride assemblies’ technologies and semiconductor elements of digital, analogue assemblies and optoelectronics allows you to create unique elements with parameters that match to best foreign samples or even exceed them.

Small elements’ dimensions of power electronics allow you to build in them to the execution units of electrical systems (motors, valves, pumps, etc) supplying them high technical level.

The tendency of modern element base of power electronics is transition from discrete components to functionally complete modules with integrated to them control elements and protection ones. It allows you to increase significantly the power density per unit volume, to decrease the parasitic effects, to increase the frequencies of conversion processes, to decrease the cost of the final product. The manufacture of the units is based on microelectronics technology:

- thin-film hybrid technology;
- thick-film hybrid technology;
- producing of ceramic substrate technology with thick (up to 300 μm) copper plating with picture of high definition (up to 0.3 μm);
- surface mount technology;
- assembly technology of power units with use of soldering and welding with aluminum wire up to 500 μm;
- housing technology with use of highly adhesive silicone compounds;
- housing technology to standard and non-standard metal-glass houses;
- producing technology of non-standard metal-glass houses of hermetic construction;
- chemical components milling technology with definition up to 10 μm, including stencils for surface mounting and “lead-frame units” made of steel, nickel and copper having the thick up to 300 μm for semiconductor devices’ mounting.
- Low-resistant technology (<1 μΩ) of non-inductive resistors of large power (up to 100 W).

Specialists and companies that possess in perfection of these technologies, actively use it when producing the new power electronics devices.

The use of the technologies allows the manufactures to produce the following modules' types:

1. Thyristor-diode modules on base of crystals with middle current for 1 crystal from 10 to 250 (1000) A with small voltage falling (1 V), with high commutating frequency (up to 3 kHz), with large values dU/dt (1000 V) and large voltages (not less than 1200 V), with small control currents (not higher than 3 mA), as well as similar modules with opto-coupler circuits to control (control current is not higher than 15 mA, isolating voltage 4000 V of peak value or 2500 V of root-mean-square deviation).

   Structure:

   1) thyristor-thyristor (10…1000 A);
   2) thyristor-diode (10…1000 A);
   3) thyristor-thyristor in opposite connection switch (10…1000 A);
   4) thyristor-thyristor in opposite-parallel connection switch (10…1000 A);
   5) one-phase thyristor bridge (10…250 A);
   6) one-phase half-controlled bridge (10…250 A);
   7) three-phase thyristor bridge (10…250 A);
   8) three-phase half-controlled bridge (10…250 A);
   9) three-phase thyristor inverter (10…250 A);
   10) three opposite-parallel thyristor pair (10…50 A).
2. One-phase and three-phase bridges on Shottky diodes with voltage 100, 200, 600, 800 V on rectified current from 10 to 400 A.
3. The power thyristors driver up to 5000 A with galvanic isolation up to 7500 V of peak value and maximum frequency up to 1 kHz. Drivers' stability to dU/dt is not less than 15 kV/μsec.
4. The load commutators (solid state relays) of DC and AC with galvanic (optocoupler with isolating voltage up to 4000 V of peak value) or transformer isolation (up to 7500 V of peak value) for currents from 10 to 250 A with control current not higher than 15 mA.
5. Solid state load controllers (SLC) and supply circuits are highly integrated hybrid assemblies that include digit-analog schemes of management and controlling, inbuilt a power supply with a galvanic isolation not less than 1000 V, powerful power switches on field or IGBT with control gates schemes, a clamp low impedance shunt and a voltage and current limit's scheme. The device allows us to control the current-time characteristics of supplying chains supplying current and temperature protection of supply and load chains.
6. IGBT drivers and of field transistors with galvanic isolation of the control circuit for single transistors and half-bridges with operating voltage up to 4500 V and operating currents up to 2000 A with commutating frequency up to 100 kHz and a complete set of protection functions. Drivers' stability to dU/dt not less than 15 kV/μs. The drivers supply the following functions of transistors' control and protection:
   - voltage saturation control on the collector of managed transistors;
   - adjustment of protection threshold switching off on saturation voltage;
   - duration regulation of the voltage saturation control prohibition at controlled transistor active state from 2,8 to 100 μs;
   - saturation voltage control prohibition on the power transistor at controlled transistor active state for minimal time 1 μs (with regulating the time possibility);
   - controlled transistor on-off time regulation
   - level control of supplying driver's voltage (inbuilt comparator with threshold 11 V);
   - control blocking on time of emergency;

- duration regulation of blocking from 1 to 500 ms on emergency time;
- scheme auto reset of the control signal (without blocking time);
- availability of inverted control input;
- availability of the upper and lower arm switching regulation inputs delay;
- regulation switching delay from 1 to 100 μs of upper and lower arm;
- simultaneous switching on of upper and lower arm blocking;
- availability of inbuilt DC/DC-adapter;
- smooth emergency switching off of controlled transistor and time adjustment of smooth emergency switching off from 1 to 15 μs;

7. Modules on field n- and p-channel transistors or IGBT with voltage “source-drain”: 60, 100, 200, 400 V, “emitter-collector”: 600, 1200 V, with a transistor amount of 1, 2 (half-bridge, 4 (H-bridge), 6 (3-phase inverter), 7. The module can include the gate circuit limiter circuit 20 V and voltage limiters (source-drain) of necessary power, as well as controlled gates’ drivers and schemes of WPM-controllers.
8. The motor controlling modules are highly integrated hybrid assemblies that include a digit-analog monolithic control circuit, an inbuilt power supply with galvanic isolation not less than 1000 V, power output keys on field or IGBT with control transistors’ gates optocoupler circuits that supply the galvanic isolation not less than 4000 V. The devices allow you to manage both DC 3-phase motors with the Holl sensor and collector DC motors that supply the motor speed change, motor inhibition, the current control through the motor, the temperature control of the module itself and the motor, the giving of signal “emergency” in critical cases.
   The motor controlling module consists of the following functional parts: a decoder of the rotor position, controlling logics (spinning direction, phasing system, dynamic breaking, protection and shutdown), output field or IGBT control gates’ drivers of control, output transistors that connected according to the 3-phase inverter scheme or according the H-bridge scheme, a generator of ramp signal with changeable frequency, a motor rotor rotation speed regulation scheme (of changing and stabilizing) that contains an amplifier of mismatch for feedback systems, and a WPM comparator; a controlling and motor current limiting scheme; isolating supply sources for elements and assemblies’ device, including an reference voltage source with high temperature stability; a control scheme of device temperature and necessary levels of supplying voltages for providing trouble-free operation of the device. As well as the motor controlling module consists of a galvanically isolated emergency signal former in a controlled motor.
9. Non-inductive low-resistance current sense resistors from 0,1 to 100 mΩ.