# THE ISKRA SOLID STATE ENERGY METERS
# A single chip measuring module based on the integrated Hall effect sensor

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**KEYWORDS:** electrical energy measurement, electrical energy meters, solid state energy meters, electrical meters, integrated HALL sensors, single chip, measuring modules

**ABSTRACT:** In this article we would like to present the latest achievement of the ISKRA factory in the field of the Solid State meter, class 2, for household as well as for industrial applications.

# ISKRIN elektronski števec energije
## Enočipni merilni modul na osnovi Hallovega efekta

**KLJUČNE BESEDE:** merjenje energije električne, števci energije električne, števci energije polprevodniški, števci elektronski, HALL senzorji integrirani, rezine enojne, moduli merilni

**POVZETEK:** Članek podaja zadnje dosežke tovarne ISKRA ŠTEVCI na področju elektronskih števcev energije, razred 2, tako za širokopotrošno, kot industrijsko uporabo.

### Introduction

The very fast development of electronic technology and especially its most vital branch microelectronics lead to the discovery of many new principles of energy measurements in order to be competitive with the present dominant classic Ferraris energy meter. The first Solid State energy meters, developed in the early seventies, were high precision measurement instruments (accuracy class from 0.5 to 0.05). Since then, it has been necessary to spend 10 to 15 years on research in order to develop a reliable, cheap and accurate simple meter, class 2.

### Integrated Hall Effect Sensor

The physical principle of the Hall effect was discovered in the nineteenth century (1879) but its wide application became reality only with the introduction of the microelectronics technology. The Hall effect principle is a very attractive solution for energy measurement because it senses and multiplies current and voltage at the same time. When we put piece of a semiconductor in a magnetic field caused by load current (IL) and force the current trough te semiconductor caused by load voltage (UL), we can sense the Hall voltage (UH) on the edges of the semiconductor which is proportional to the power of the load (UH*K=PL=UL*IL). The other very important advantages of the Hall effect sensor are the frequency and the phase indenpendence as well as the small dimensions (s = 0.05 $mm^2$) and the wide dynamic range of sensing.

The Hall sensor can be produced by various semiconductor technologies (i.e. ITL, MOS, etc. ) as well as different substrates (i.e. Si, GaAs) but none of these technologies or substrates are ideal. The raw sensor has many disadvantages, i. e. non-linearity, temperature dependency, offset voltage, long-term non-stability, sensitivity to mechanical stress, low output voltage, voltage dependency, etc.

This means that it is imposibble to use the original Hall sensor for professional measuring techniques without significant improvements.

The ISKRA factory developed the concept of the integrated sensor which can be produced in a standard industrial process. After years of research and development efforts, ISKRA managed to make Hall sensor which can be integrated with analoque and digital electronics on the same substrate, with satisfactory results and regardless the limitations of standard technology.

### One-Chip-Meter - Integrated Solution of Measurement and functional Electronics

The measurement electronic of the Hall sensor, the analog/digital conversion of the very low sensor signals and the circutry for compensation of all undesirable effects are combined in the same chip. The temperature compensation assures a voltage reference with the programmed temperature coeficient in contrast with the sensor. Because of the common substrate there is no delay in compensation response.

The block of digital electronics controls the analoque functions and provides all the output signals which are important for various types of meter functions(i. e. direction indication of energy flow, starting current limiter, polyphase summator, stepped motor driver, active and reactive power selection, etc.).

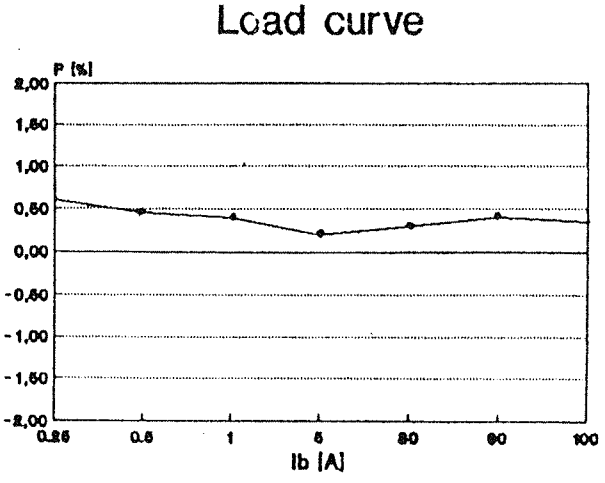
During the chip design phase full attention was focused on the lay-out in order to prevent mutual influences between analoque, digital and Hall sensor electronics.

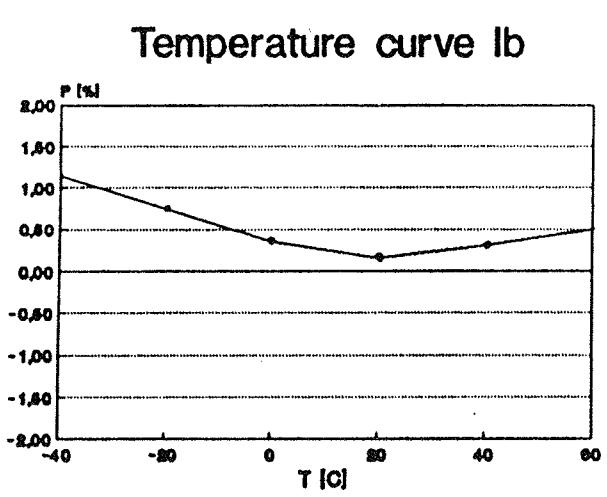
In order to meet high quality demands (long life, reliable and stable operation) a chip in a professional hermetic ceramic capsule has been used. ISKRA developed a special encapsulation line which can successfully satisfy specific parameters and allows high quality control over the most sensitive part of the meter.

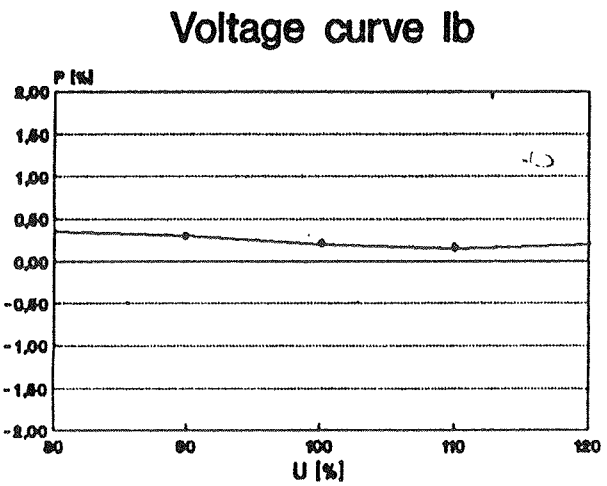
### ISKRA Universal One-Chip Measuring Module

A very high degree of integration minimizes the necessity of out-chip components. The measuring module consists of current leads (terminals), main voltage connections, calibration elements, the magnetic system and the printed circuit board with chip.

The measuring module is designed as an universal element for all types of Solid State meters. **Figure 1** shows some basic measuring characteristics of this module.



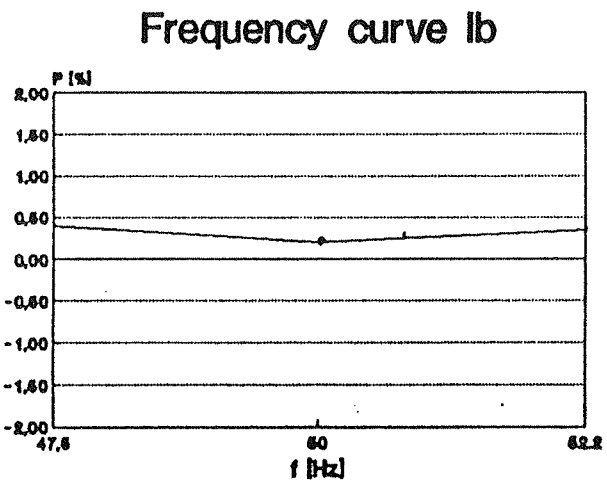




*Fig. 1: Measuring characteristics of the measuring module*

### Family of Electronic Meters of Energy

With this unique universal measuring module ISKRA is able to make all types of energy meters concerning various main voltages, load currents, directions of energy flow, active and reactive energies, single and polyphase measurements. With the support of the micropro-

cessor it is possible to enrich the basic functions with a wide range of tariffs, maximum demand registrations, real time clock, load control functions, communication port and data protection.

**Figures 2 and 3** show two typical representatives of the ISKRA Solid State meters. The first is a single-phase one-tariff kWh meter, the second is a three-phase kWh meter with a universal programmable multi-tariff unit with complete maximum demand possibilities, real time clock and communication port. The new technology, essentially microelectronics offers great challenge for classic measuring methods. With better and better results the Solid State energy meters have allready begun to replace classic Ferraris meters, espacially in the field of multifunctional measurements and communications. In the future the measuring unit will remain an important component in the system for energy control and management systems.

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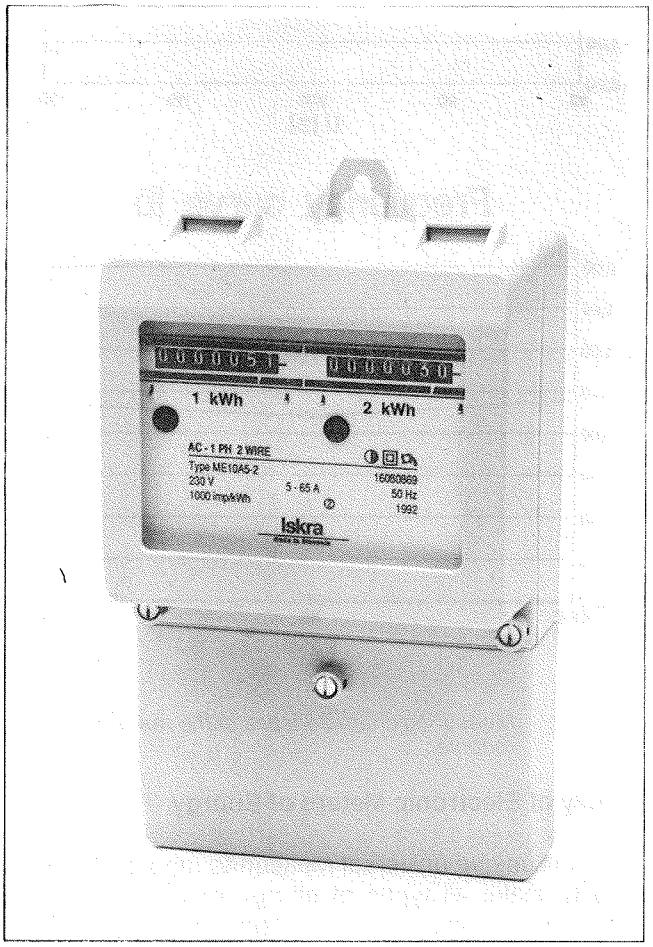


*Fig. 2: Single phase one tariff KWh meter*

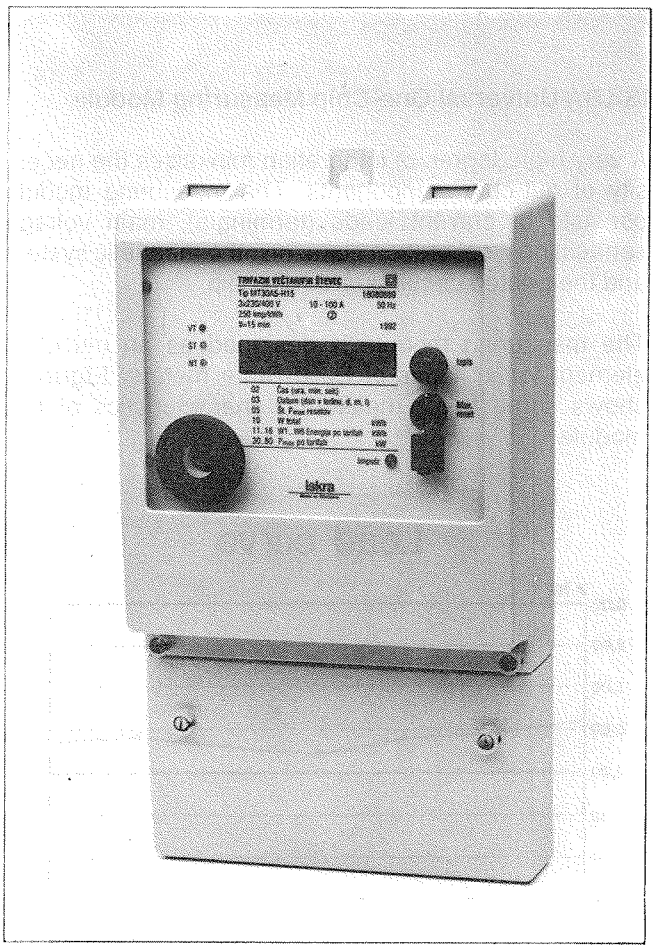


*Fig. 3: Three phase kWh meter*