OOO NPP MARS-ENERGO

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- **Name of organization: OOO NPP Mars-Energo**
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- **Additional Organization Information**
- Company size: 100 employees; 30 researches
- Years in operation: 25 years

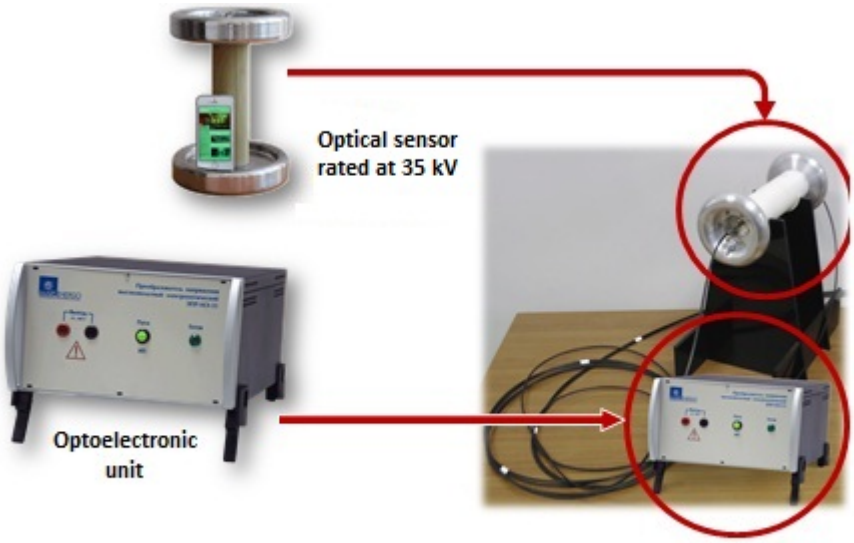
Title of Proposal: Electro-optical voltage transducer with analogue or digital outputs

Proposed Technical Approach

- **Electro-optical Voltage Transducer used to convert instantaneous values of primary (high) AC or pulse voltage into the proportional values of secondary (low) voltage or into SV (Sampled value) data is based on electro-optical effect of electro-gyration. The transducer consists of an optical sensor (electro-gyration cell made of a specially grown centrosymmetric crystal) and opto-electronic unit.**

¶ **Overview of the proposed technology**

¶ **Photo of the prototype:**



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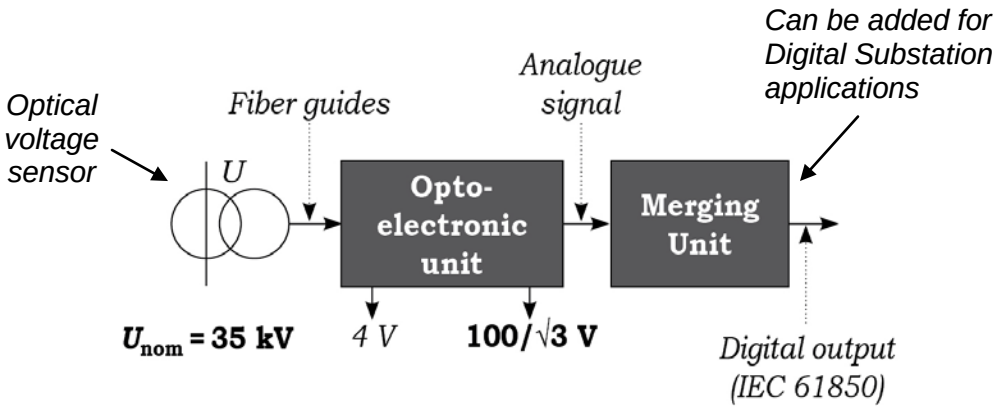
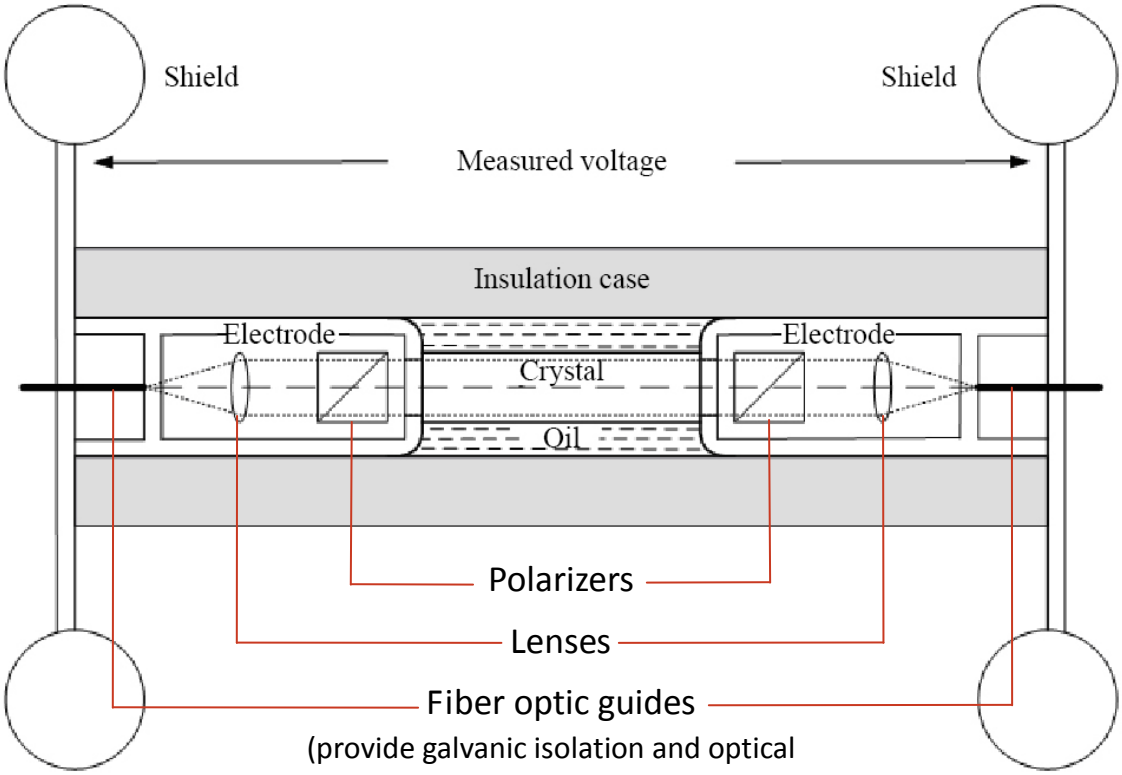
Block diagram:



Design and operating principle of optical voltage sensor (optical cell)

Optical (electro-gyration) cell:



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Operation of the optical voltage sensor is based on electro-optical effect of electro-gyration – a phenomenon of a change in optical activity of centrosymmetric monocrystals under an external electric field induced by the measured voltage.

Electro-gyration effect (linear type) - electric-field induced excitation or change in optical activity of some crystals that causes rotation of polarization plane of linearly polarized light, propagating through the crystal, by an angle that depends on the strength of electric field, length of the light path in the crystal, and electro-gyration constant.


Workpiece for producing a crystal of the required length

The rotation angle can be expressed by the formula:

$$\varphi = G\int_1^2 \vec{E}d\vec{l} = G \times U$$

G — electro-gyration constant of the crystal;

$\vec{E}$ — vector of electric field strength;

$d\vec{l}$ — elementary part of the path on the interval between the electrodes

Unique design feature:

Higher measurement accuracy (in comparison with the existing electro-gyration sensors) is achieved owing to Faraday effect compensation, namely:

Additional polarization rotation angle caused by the Faraday effect (induced by magnetic fields of large currents passing through the circuits) is compensated in the optical path designed so that “electro-gyration” polarization rotation angles of oppositely directed light beams are forced to be of the same sign, and “Faraday” polarization rotation angles become opposite in sign.

Design benefits:

1. Measured voltage is directly applied to the centrosymmetric crystal ends.

2. No piezoelectric effect.

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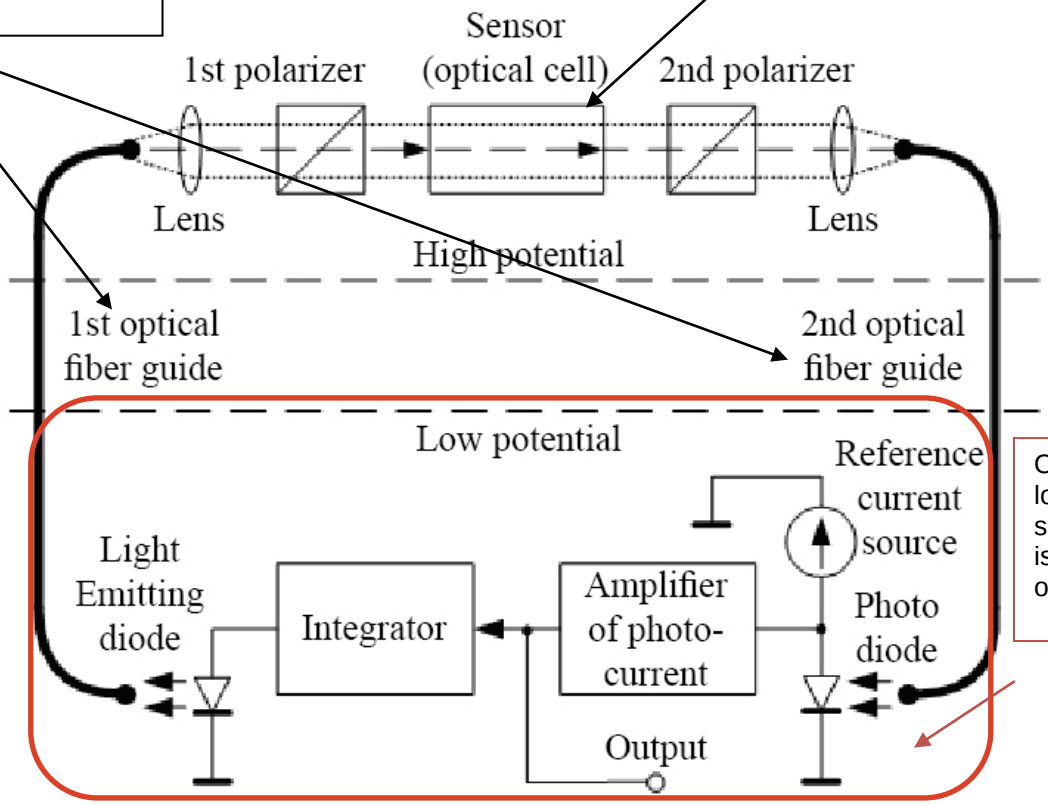
"Transducer +Sensor" Assembly

Two fiber optic guides provide:
-Optical connection between optical sensors and opto-electronic unit;
-Galvanic isolation between high-potential and low-potential sides.

Electro-optical (electro-gyration) cell for voltage measurements or Magneto-optical (Faraday) cell for current measurements – depending on the optical sell in use the module can be used either for voltage or current measurements



Opto-electronic unit located on low-potential side (the desired signal is picked out from its output).

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Basic specifications

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	Existing prototype	To be achieved
Rated AC voltages	35 kV	From 10; 20; 35 kV to 110 kV
Accuracy class	0.5	0.2
Frequency range	1Hz ~ 10 kHz	1Hz ~ 10 kHz
Output signal • Analogue • Digital	 4; 100/√3; 100 V According to IEC 61850-9-2LE	 4; 100/√3; 100 V According to IEC 61850-9-2LE
Thermal and electrodynamic withstand	100; 150 kA	100; 150 kA
Fiber guide length between the optical sensor and opto-electronic unit	Up to 200 m	Up to 200 m
Size	Optical sensor (Diameter×H): 130×290 mm Opto-electronic unit (W×D×H): 134×215×450 mm	Optical sensor (Diameter×H): 130×290 mm Opto-electronic unit (W×D×H): 134×215×450 mm
Weight, no more than	Optical sensor: 5 kg; Optoelectronic unit: 3 kg	Optical sensor: 5 kg; Optoelectronic unit: 3 kg

Unique Selling Point

- The crystal selected as an optical cell material provides high temperature stability of the electro-gyration constant and exhibits no piezoelectric effect, which gives the possibility to create a voltage sensor operating in wide temperature and frequency ranges;
- High measurement accuracy owing to Faraday effect compensation;
- The transducer can also be used for current measurements – the only thing to do is to replace the voltage (electro-gyration) optical cell with the current (Faraday) one.

Development level

Applied research or development]

Development plan

Further steps:

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1. Adaptation of the design and output signal level to transformer applications according to IEC 60044-8;
2. Improving measurement accuracy characteristics;
4. Testing of the transducer and preparation for serial production.

Conditions to submit sample

The sample can be provided according to the agreement signed by the parties.

Desired form of collaboration

Cooperation in bringing up the transducer to serial production.

Intellectual property conditions

To be negotiated

¶ Patents

Utility model patent N 144464 granted by FIPS (Federal Institute of Industrial Property, Russia); registered in State Registry of Utility Models on 17 July 2014.
http://www1.fips.ru/wps/wcm/connect/content_en/en/main+