# Proton magnetometer (English)

Good morning, dear examination board. I want to suggest to your attention my research "The Proton Magnetometer".

The proton magnetometer is designed to detect various emptiness, magnetic anomalies, underground water sources, pipelines, military equipment and ammunition of past wars.

## 1. How it works

In the foundation of the proton magnetometer has been put an atom constant, that determines the frequency of the precession of the axis of the spin of the proton in the magnetic field. In physics and other sciences it is known as the Larmor frequency.

The magnetic sensor is the proton liquid, for example, water, kerosene, alcohols and other hydrocarbon liquids.

The coils of the sensor are required for proton polarization in our proton liquid and for the catching of weak signals of the relaxation precession of the polarized protons.

That is why the indications of the proton magnetometers don't depend on the sensor construction. The proton magnetometers are the most precise devices of all the types of magnetometers.

Proton magnetometer consists of a sensor, a resonance amplifier, power supply, and timer.

The timer is used to operate the relay that connects up the coil to the source of polarization and to the amplifier input – in turn.

Usually the "bottle" sensors are used. The most preferable coil length is one hundred millimeters. Amplifier gain should be one hundred and twenty decibels (dB) or one million times.

## 2. Operating principle by the schemes.

Generator with a fourteen-bit counter is stabilized with a quartz resonator (PK 169 MA) with frequency of 32768 Hz. The output frequency of counter/divider is 2Hz. Then the signal is fed to the four-bit counter D6 to control the switching relay. Output pulse duration is 4 seconds.

Polarizing current is fed to the coils for a few seconds to get proper amplitude of the reference signal. Usually, the proton polarization demands no less than three seconds. In our case it is four seconds.

The switching relay (RES-9), after disconnecting the coil from the source of the polarizing current, connects the coils to the input of the resonance amplifier. After this amplification the signal has to arrive at the counter.

In order to measure the relaxation frequency property we need more than 1 second. So, we have to use the scheme of phase auto adjustment of frequency.

In our scheme the output frequency of the voltage-controlled oscillator (VCO) is divided by 10 and 8 with two digital counters/dividers. When the outward loop of chip's communication D13 is locked, the frequency of VCO is constantly maintained as the output frequency of the resonance amplifier, multiplied by coefficient N that is equal to 80, and equal to the total coefficient of division for all connected dividers.

The first-hand removal of the output signal from VCO till the dividers gives an indication with a resolution of 0.1 Hz. The signal after the decimal divider gets a resolution of 1 Hz.

The signal from the decimal counter is fed to one input of the comparator (D1 point 2). The other input is fed with a pulse of 0.125 seconds from logical elements D1.1 and D1.3, plus signals from the counter D2 and from the second half of the multivibrator D3. During this time there is a counting of the pulses.

Reset of the counters reading carries out in 4 seconds by 0.1 second pulse, that was formed by the first half of the multivibrator 74123. This multivibrator is shown as D3.

The counting carries out by 4 decimal counters D4, D9, D14, and D17. Indication of the result carries out by the decoders K514ID2 and by 4 seven-segment indicators ALS324B.

On the display device there will be the frequency of the proton relaxation. When we know this frequency we can find the found object, its magnetic induction and sizes, using the special tables. If there will be shown the frequency, that is about 2250 Hz, then it will be usual ground.

## 3. The substantiation of the design and the cost

During my research I have done electrical calculations of the basic functional units. As a result of the calculation of the receiving amplifier the models of transistors were calculated, the necessary amplification (100 000 One hundred thousand) times was achieved.

As the amplifying transistors were chosen low-frequency transistors KT3107I. There were chosen resistors and capacitors for the desired filtering.

The board is made by semi-additive way that is based on foiled double-sided fiber-glass laminate SF2-35G. The electroradioelements mounting is one-sided. The layout and routing were made with graphic programs AutoCAD and P-CAD.

Overall dimensions of the printed-circuit board (PCB) are 120 (one hundred and twenty) by 150 mm.

The setting-up with printed mounting was chosen as a main process. The setting-up process was described in detail in the route charts.

In addition I considered the accidents prevention in the time of the device assembly installation and adjustment.

Operator's positions have to be filled out with good ventilation, and have to be lighted. On the work there must be people who had studied the instructions and the device. All the works with high voltage have to be done in rubber gloves.

## 4. Conclusion

In the future, all the account part of the device can be replaced by a microcontroller. The resonance amplifier can be assembled on operational amplifiers.

If a proton magnetometer is watertight, it can be used underwater.

Because of lack of time the model of the proton magnetometer wasn't made, but it will be made later in the workshop of our college.