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Data acquisition system for complex and synchronous geonomic and space investigations

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The problems, methods and technical means for remote sensing of the Earth represent a sophisticated multinode system, where suborbital (and mainly ground-based) systems and complexes for data acquisition and processing occupy a major place. Data and information obtained from ground-based measurements not only complement and make possible the efficient data processing of information obtained by satellites, manned space vehicles and orbiting research laboratories. Simultaneously, they represent exclusively valuable material necessary for the solution of completely independent scientific fundamental and applied problems, as well as economic tasks in the field of geophysics, geology, geography, meteorology, hydrology, natural resource studies, ecology, agriculture, etc. Due to the broad scale of these studies and the large territories over which they must be implemented, as well as to the requirements for their synchronous realization for the majority of cases, it is useful and even imperative to apply radiotelemetric systems for data acquisition.

Within the framework of the BULGARIA-1300 space project [1], a data acquisition system for complex and synchronous geonomic and space investigations — DAS was developed at the Central Laboratory for Space Research of the Bulgarian Academy of Sciences. This system is the main device within the equipment facility of the Universal Mobile Laboratory for Conplex Geonomic Investigations (UMLCGI) and the Mobile Ground Station for Synchronous Satellite Investigations (MGSSSI) [2].

The data acquisition system — DAS is developed for automatic telemetric acquisition (transmission, receiving and registration) of digital information at synchronous and complex geonomic and space investigations. Generally, this information includes data on: spectral reflectance and natural emissivity of natural objects; temperature of the surface soil and contact air layers; humidity and electroconductivity of the surface soil layer; earth magnetic field parameters; atmospheric pressure; wind direction and velo-

city in the contact atmospheric layers; wave motion, current direction and velocity of rivers and other water basins; aerosolic particle density into the atmosphere; microseismic background and seismic fluctuations, etc.

The most general principle of DAS performance is based on the automatic switching of the respective peripheral points at determined time-intervals

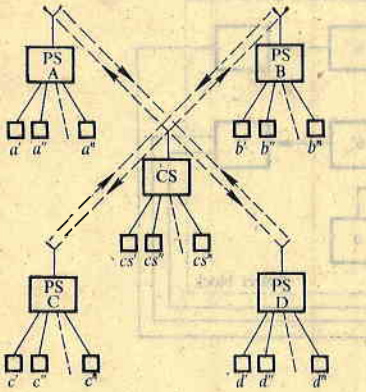

Fig. 1

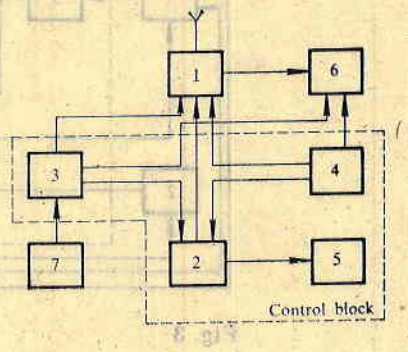

Fig. 2.

and information transmission for receiving and registration into a central point. The telemetric switching of the individual peripheral points is made via radiosignal emissions from the central point, modulated by different tone frequencies. The performance management of the entire system is made in the following manner: a) by hand, b) by instrumental program device, c) by microprocessor control.

Initially, it was reasonable to develop a DAS system incorporating one central and four peripheral points — DAS-5, i. e. with a possibility for information acquisition from 5 points.

The central point (CP) is mounted as in UMLCGI and MGSSSI or as in a stationary observatory. From there, the operation of the peripheral points (PP) is controlled and the receiving, registration, visualization, as well as primary and partial data processing are effected. Figure 1 illustrates the symmetric situation of the peripheral points PP-A, PP-B, PP-C, PP-D with regard to the central point CP of DAS-5. In dependence on the research goals and the conditions for their implementation this situation may vary widely. The different measurement instruments and sensors are connected with the central and peripheral points via cable links and may be located in various configurations at distances to several tens of the meter.

The receiving-transmitting DAS part is realized on the basis of USW radiostations.

Figure 2 shows the principal block-diagram of the CP in a program device controlled version. The operation of the radiostations *1* and the registration block *6* are controlled by a control block, the main subblocks of which are: *2* — tone generator block containing 5 tone generators; *3* — program block, *4* — hand operated block, *5* — indication. The program block *3* represents a device of the Universal Program Device for Geophysical Observatories (UPDGO) type [3] is joined to an electronic clock *7* with quarz generator for synchronization, with a possibility for automatic verification by reference radiosignals for exact time, for example the Exact Time System (ETS) [4].

The main node of the peripheral points (Fig. 3) is the selective block containing: amplitude reducer — *3;* active narrow band filters, the first *(4)* being adjusted to the respective tone frequency f_A, f_B, f_C or f_D, and the second *(5)* at the starting frequency f_{st}; keys — *6;* time releys — *7;* comparator — *8* and

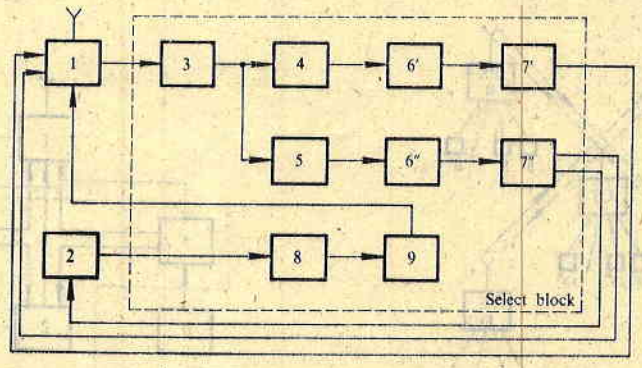

Fig. 3

forming device — *9*. The signals received by radiostation *1* are supplied to the selective block, which operates the radiostation and the data source, when she frequency corresponding to the peripheral points is received: the radiostation is reswitched from "service receive" mode into "transmission" mode and the data source *2* is switched to the radiostation input. The data source includes a coding device and different meters, transforming the investigated parameters into electric signals. These electric signals are supplied via multiplexor to an analog-to-digital converter from where a 10-bits signal is obtained. One bit is added to this signal for "start" and one for "stop." A third bit is also added for verification by evenness.

Service telephone calls are also made with the radiostation in addition to the data receiving and transmission.

The data transmission rate for DAS-5 is 1200 bit/sec. The selected radiostations provide the required reliability under this relatively low rate. One of the conditions for the normal functioning of the DAS system is the optimum situation of the peripheral points with consideration of all effects in such USW connection.

The radiostation of the peripheral point operates routinely into "service receive" mode. The sensors and instruments measuring the respective parameters within the block of data source are switched and transmit information only by call from the respective peripheral point. Hence, the high-level requirements to the performance of the selective block which is located between the radiostation and the data source. It can be seen from the mentioned above that mainly parameters of relatively slow variation are measured but many digital data are taken. The continuous observation of the peripheral station would result into large surplus in the registration. The periodical taking of information may be accompanied with errors from radiochannel gaps to the respective point or measurement device. Then, with the rigid instrumental program device realization, a data repetition should be requested, i. e. there is a danger of violating the registration cycle.

The microprocessor control of the DAS system provides for the implementation of the following control modes for the central and the peripheral points:

1. Cyclic switch of all peripheral points, taking of data from all the measuring devices and logical processing of the results. If the latter do not corre-

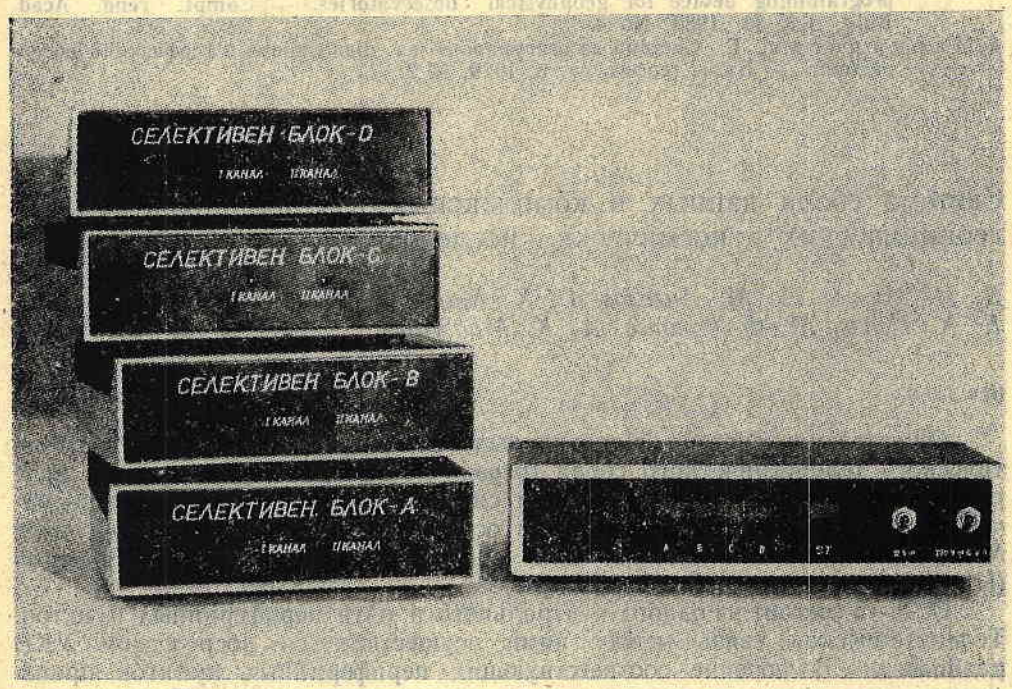

Fig. 4. A general view of the peripheral points and of the central point

late with the previous ones, the error, its occurence and location may be identified.

2. Priority switching of measuring devices with large dynamics into the registration process or with frequently occuring errors, and control of one or several parameters. The registration is made only if the results are considered adequate.

3. Cyclic switch-in of all the points and taking of data on the most rapidly varying parameters only.

4. Digital filtering and elimination of errors by averaging the results.

The system does not restrict the number of included points and measuring devices, if they guarantee the provision of normal measurement. Naturally, on the basis of the described system for data acquisition for complex and synchronous geonomic and space investigations it is possible to develop a more specialized version, for example for synchronous satellite studies, for magnetic investigations, for seismological research, for the needs of hydrology, etc., which is simpler and of a greater operational capacity.

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Система сбора данных в комплексных и синхронных геономических и космических исследованиях

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(Резюме)

Описываемая система сбора данных (ССД) предназначена для автоматического телеметрического сбора (передачи, приема и регистрации) цифровой информации в комплексных и синхронных геономических и космических исследованиях. Она является основным узлом аппаратурной части Мобильной наземной станции для синхронных спутниковых измерений (ПНСССИ).

ССД—5 состоит из одного центрального и пяти периферийных пунктов. Телеметрическая связь между ними осуществляется посредством УКВ радиосвязи. Включение соответствующих периферийных пунктов производится автоматически по команде с центрального пункта. Микропроцессорное управление ССД обеспечивает достижение высокой оперативности, осуществление различных режимов работы, а также первичную обработку данных на самом месте проведения исследований.

Коротко описаны основные блоки ССД, даны некоторые технико-эксплуатационные характеристики, рассмотрены различные типы организации работы.