

Presented Paper

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Coordimeter G - a new instrument for data acquisition on the  
basis of a microcomputer

Abstract

The Coordimeter G recording instrument meets the most varying requirements of photogrammetric practice by using a micro computer in connection with a VDU and different peripheral units as printer, magnetic tape and paper tape units.

With the described characteristics Coordimeter G is suited both for routine work of considerable extent and for work with varying demands to be made on the format of the data record, the output code, the quantity of data to be recorded and different computations as coordinate transformations and so on.

Advances made in electronics have in recent years led to a rapid development of computer hardware. The increasing efficiency of electronic computers expanded the application possibilities for electronic data processing in all domains of economy. Also for such technologies as aerial triangulation, cadastral photogrammetry or terrestrial photogrammetry working techniques were increasingly developed, which thanks to the application of digital information processing solve many tasks with economic advantage.

An essential prerequisite for the utilization of these advantages is the reliable acquisition and recording of all necessary measuring data, which are gained by the photogrammetric restitution of the photographs. With automatically controlled digitization of line-like elements in the pictures the number of points to be recorded increases rapidly. Only a high-speed recording instrument is in the position of handling a multitude of measuring data at an economically justifiable expenditure of time. In electronic recording instruments the time required for counting, storing, sorting, and coding is negligible compared with the time needed for printing or punching a character (10 to 100 ms). Thus the maximally achievable operating speed is decisively dependent on the peripheral devices usable for data output. A transition to faster peripheral units is practically equivalent to the replacement of the punched tape by other data carriers (as, for example, magnetic tape).

If a recording device is to be used for different tasks, it must be capable of being adapted to varying requirements. This specially concerns the arrangement of data (measuring values, point numbers, operation characters) in the data record and their coding.

Systems of modern electronic large-scale integration circuits allow the construction of microcomputers, by which the requirements for large adaptability and functional reliability also in photogrammetric instruments can be satisfied. Therefore, an efficient microcomputer was the prerequisite for the development of the new COORDIMETER G electronic recording instrument in the Jena Works.

#### 1. Application possibilities

COORDIMETER G (Fig. 1) same as its predecessor COORDIMETER F can readily be connected to all photogrammetric measuring instruments of the Jena Works. The outfit of the instrument includes the recording equipment with screen display and alphanumeric keyboard, a special keyboard for the input of point numbers (keyboard E) and a table for peripherals. In connection with STEREOMETROGRAPH, STECOMETER, TOPOCART, TECHNOCART, TOPOFLEX, TOPOMAT, and the Precision Coordinator-graph COORDIMETER G can be used for the

- recording of single points,
- recording of contour line intersection points,
- digitization of contour lines in the planimetric grid,
- digitization of line-like planimetric elements in the

- planimetric grid pattern,
- digitization of lines in dependence on time for achieving an approximately optimum point density,
- digitization of lines with a change of the distance interval in dependence on the curvature of the line.

Incremental rotary encoders (IGR) are used as data transducers. All necessary operating voltages are supplied to them by the COORDIMETER G. If these transducers have not yet been incorporated in the measuring instrument, connection to COORDIMETER G can be made through the DIGITIZER BOX (synchro connection on measuring instrument) or through the IGR BOX (mechanical connection on measuring instrument). Detailed data on the connection accessories required for the particular type of measuring instrument may be taken from the order list of COORDIMETER G.

## 2. Instrument conception

Acquisition and processing of the measuring values and their output to the peripheral units are controlled and checked in COORDIMETER G by a microprocessor (Central Processor Unit - CPU). The programs required for this are contained in programmable read only memories (PROM), whose capacity can be increased to 22 k byte with the maximum equipment of the instrument. So as to adapt it to special requirements a series of important data can according to customers' wishes be written into partial areas of the read only memory in the manufacturing plant.

These include:

- 2 different sequences for the output of the measuring values (standard formats),
- 2 different code lists with 64 characters each for the output of data to the punch or magnetic tape unit, and
- 1 set of 30 "symbol point numbers" with up to 4 digits each.

This information is then permanently stored in the instrument and can be called up through DIALOG in the most simple way. The program memory is supplemented by a random access memory (RAM) with a capacity of maximally 2 k byte. Interface modules for connecting keyboards, displays, transducers, and peripheral units constitute together with the microprocessor and the afore-mentioned memories a modularly built-up microcomputer (Fig. 2). Basic concepts and special problems of the use of microcomputers are described in a clear-cut presentation in /1/.

Since a great part of the instrument functions is no longer controlled by a multitude of printed circuit boards with the appropriate special partial functions, but by the program, the number of the necessary circuit boards is strongly reduced, and this the more so as the microcomputer consists of large-scale integration circuits (LSI). The uniform connection of these circuit boards among each other by a system of bus lines allows the use of a "printed back-wiring" by a further circuit board. Large-scale integration, low number of circuit boards and back-wiring circuit board ensure high reliability of the instrument /2/. Control routines of

the program in input operations and in the data output form another reliability factor in working with the instrument. Thus, faulty operations are indicated and functional failures are signalized on the peripheral devices.

### 3. Description of important functional operations

#### 3.1. Data acquisition

COORDIMETER G has been designed for the acquisition of the measuring values of 4 different coordinates. The counter interface required for this is minimal, since the formation of the measuring values after a precount in the counter interface is made by the microprocessor. Each transducer supplies 4 pulse sequences to the correlated counter interface. The special evaluation of these pulse sequences ensures a reliable transfer of the measuring values from the measuring instrument to COORDIMETER G. It further permits an increase of resolution of the measuring system by double or quadruple evaluation of the input pulses. The coordinates required for practical work and their number of digits are chosen with the call-in of a standard format or by means of the DIALOG mode of operation.

#### 3.2. Point numbering

For the identification of the measuring data various forms of point numbering are used in practice. In order to meet all requirements the following possibilities exist in COORDIMETER G for forming the point number:

- a counting point number (up to 6 digits),
- an optionally settable point number being similar in use as a full keyboard (up to 12 digits, subdividable in 3 groups), and
- 30 "symbol point numbers" (up to 4 digits each).

The symbol point number is intended for frequently recurring parts of point numbers. It is released by one of the 30 symbol buttons of keyboard E and in the subsequent recording operation it is output in the appropriate position of the data record. Depending on the task in hand the described possibilities of point numbering can be used individually or in any combination.

Keyboard E can be placed in a position suiting the operator best. It serves for the input of point numbers, the check of the settable point number, and the control of a series of instrument functions. For these purposes keyboard E has

- an LED indication for maximally 12 digits of the settable point number,
- buttons for the selection of digits of the settable point number,
- 30 symbol buttons for the input of the "symbol point number",
- 10 functional buttons for the control of the instrument function.



### 3.3. Format of the data record

The data record may contain maximally 72 characters. It always starts with the character "carriage return" (CR) and "line feed" (LF). The parts of the point number and the coordinates can be separated from each other by up to 3 alphanumeric characters, called operation characters. The number and combination of these characters can be freely chosen, same as the sequence, in which the point numbers, coordinates and operation characters in the data block can be arranged. Frequently required sequences are permanently stored in the instrument as standard formats (customers' PROM). Further sequences can be optionally "programmed" with the help of the DIALOG mode of operation up to the maximum length of the data record. Special knowledge of computer programming is not necessary. The DIALOG mode allows to modify parameters of the recording program by simple alphanumeric command information. This concerns, for example, the choice of initial values for the coordinate counters, the change of the code for data output, the choice of the type and interval of the automatic system etc.

The cancellation of an output data record is possible after each completed output. A group of maximally 4 arbitrary digits or letters is released as STORNO by the cancellation button of keyboard E. The character sequence of STORNO can likewise be chosen through the DIALOG mode.

Irrespective of the agreed structure of the data record any alphanumeric information can directly be transferred to the data carrier by a special command in DIALOG.

### 3.4. Display

A screen assumes the function of alphanumeric display. The programming commands and the alphanumeric information directly to be output through the peripherals are indicated in DIALOG. In the operating mode MEASUREMENT the screen displays in addition to the actual results of all coordinate counters the measuring values of the last 5 recordings. For each last recording also the symbol point number and the counting point number are indicated. The 12-digit point number is displayed by LED indication on keyboard E.

Furthermore, it is made possible by the screen to obtain fast information on the operating state of the instrument, on stored and calculated constants for the data transformation.

### 3.5. Recording

Recordings can be released manually or automatically. For single recordings the appropriate button of keyboard E or a foot button may be used. Automatic recording is started and stopped on keyboard E. It is possible to work with one release in distance or time intervals. Choice is made through DIALOG.

The outfit for the automatic release of recordings is on request supplied additionally to the basic equipment of COORDIMETER G. For recording in time intervals (automatic

time release) distances of recordings can be chosen between 0.1 s and 80.0 s. The intervals are subdivided in steps of 0.1 s. For recording in distance intervals (automatic distance release) the recording intervals range from 10 pulses to 4000 pulses in gradations of 1 pulse. Depending on the measuring instrument either 0.1 mm, 0.01 mm or 0.001 mm are made to correspond to 1 pulse. Thus one obtains the following distance intervals:

from 1 mm to 400 mm (in steps of 0.1 mm),  
from 0.1 mm to 40.0 mm (in steps of 0.01 mm) or  
from 0.01 mm to 4.0 mm (in steps of 0.001 mm).

Counting the intervals is optionally made with or without considering the sign. In the automatic distance release without consideration of the sign the coordinates can be used singly or as a sum of two or three coordinates for counting over the interval.

Automatic distance release with the sign taken into account allows the recording in real grid steps. This grid digitization is particularly suited for the meander-type scanning of models. By means of two independent interval counters work with different grid sizes is possible in two axes simultaneously.

Another mode of automatic release changes the distance interval in dependence on the curvature of the line to be measured, so that independent of the working speed of the operator the line curve is recorded with the optimum point density. In this procedure the microprocessor, in addition to its tasks for the control and checking of the total process, is used for calculation in the proper sense of the word. This is also the case when with the help of the additional program "data transformation" transformation constants are calculated or the transformed coordinates are ascertained in on-line operation. In a further article detailed information will be given on the practical work with the additional program "data transformation" and on the last mentioned automatic distance release.

### 3.6. Peripheral units

In the standard version of COORDIMETER G data output is made through the daro 1154 serial printer (45 characters/s) and the daro 1215 tape punch (50 characters/s). Failures in the function of the peripheral devices are acoustically and optically signalized. On elimination of the fault work can be continued. With respect to the output speed the efficiency of COORDIMETER G with 50 characters/s is in no way exhausted. On connecting a buffered magnetic tape unit, it is for example possible to output 10 and more recordings per second and to make a checked record on computer tape.

The modular design of the microcomputer in COORDIMETER G allows the exchange of operating programs and interface units for the connection of peripheral devices. For the FACIT 4070 punch and the Kennedy 9832 magnetic tape deck there exist well-proven interface units.

Literature

/1/ Jugel, A.: Microprocessor systems  
Berlin, VEB Verlag Technik 1978

/2/ Müller, G.: On questions of reliability in photogrammetric  
instrumentation  
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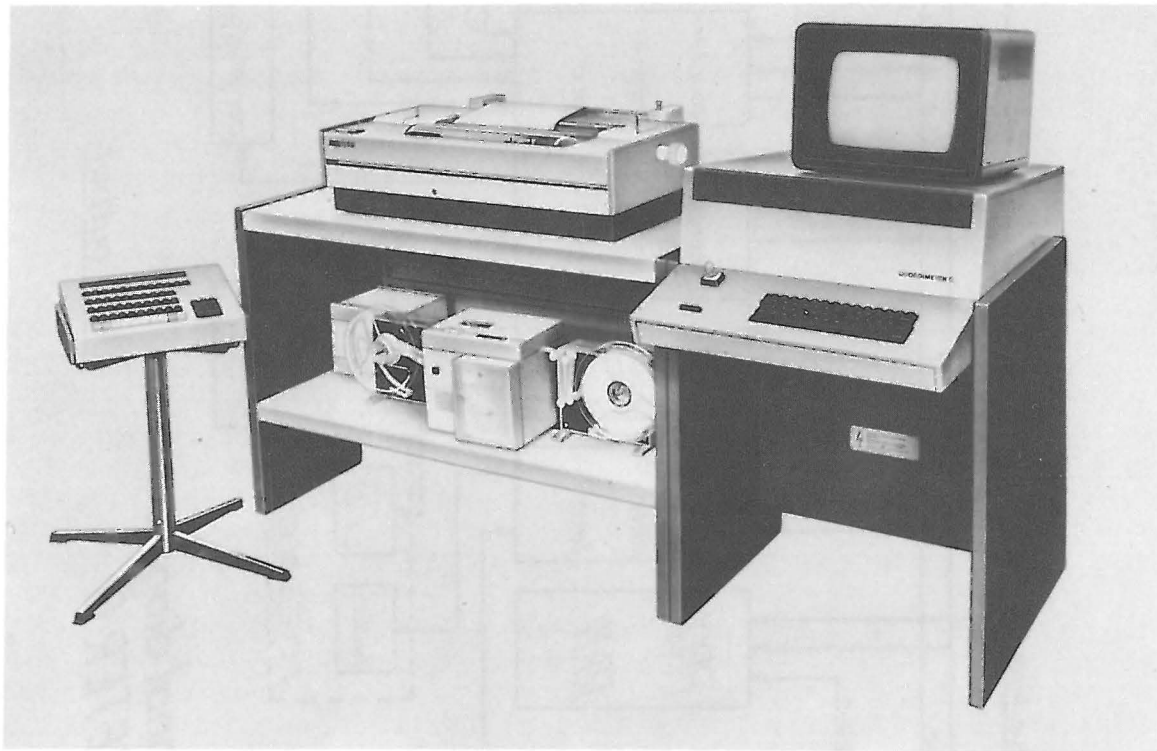


Fig. 1 COORDIMETER G electronic recording instrument

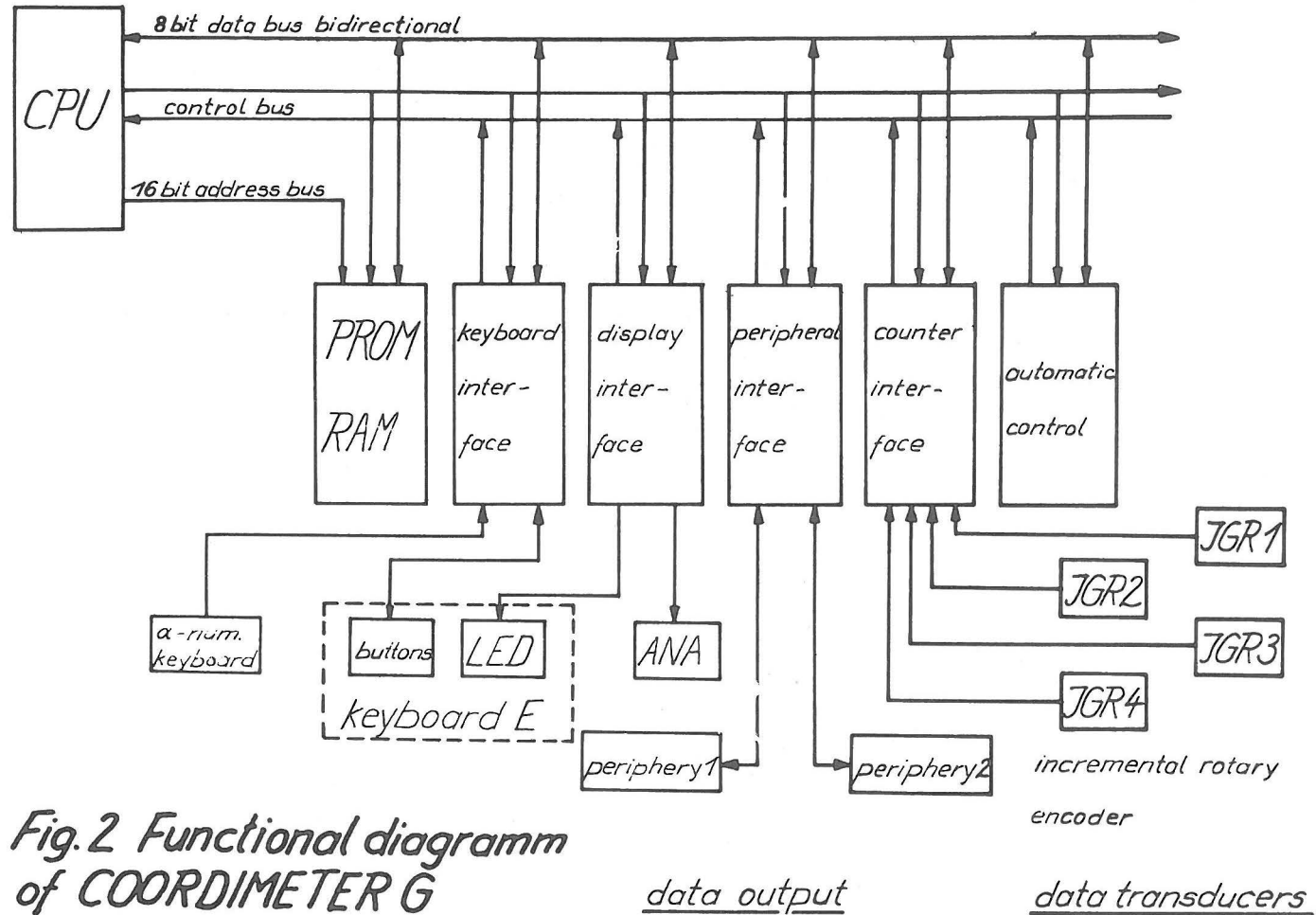


Fig. 2 Functional diagramm of COORDIMETER G

data output

data transducers