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THE X-Y PLOTTER AS AN OUTPUT UNIT FOR ODRA 1325 COMPUTER,(U)
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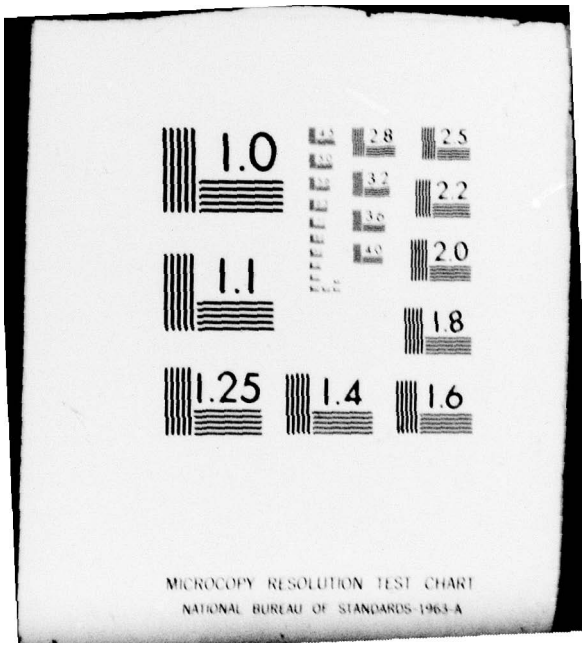
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THE X-Y PLOTTER AS AN OUTPUT UNIT FOR ODRA 1325 COMPUTER

By

Urszula Kreglewska, Tomasz Kreglewski, Andrzej Lewandowski

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THE X-Y PLOTTER AS AN OUTPUT UNIT FOR ODRA 1325 COMPUTER

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THE X-Y PLOTTER AS AN OUTPUT UNIT FOR ODRA 1325 COMPUTER

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The article describes the electronic equipment and programming systems which make it possible to use Hewlett- Packard X - Y plotters as output units for ODRA 1325 computers working in tandem with a paper tape punching machine. /

The Institute of Automatics at the Warsaw Polytechnic developed and put into operation a system linking the Hewlett Packard X-Y plotter type 9862 with an ODRA 1325 computer.

Cooperation between plotter and computer is made possible by a unit controlling the DT325 paper tape punching machine as well as by a small device adapting these units to the requirements of the plotter. According to the position of a reversing switch the DT325 controlling unit works either with the punching machine or with the plotter.

We elaborated and introduced a series of procedures for direct communication with the plotter which, when stored into the working program, facilitates the programming of the plotter. We also worked out a set of working programs.

The Principles of Plotter Operation

The plotter draws diagrams on a plate within a field defined by the coordinates X and Y. These coordinates are integral figures within the range [0.9999]. The pen of the plotter is shifted to points (XB,YB) where the equipment adopts the values of the coordinates of the new position, that is of

two integral numbers XB and YB. Controls can also be realized by lifting and lowering the pen..

The X-Y plotter is linked to the controlling unit by means of the line which transmits the logical signals TTL.

The data transmitting lines which relay the position coordinates of the pen are: A7, A6, ..., A0. The coordinates (consisting of 4 digit numbers) are transmitted in BCD code. To change the disposition of the plotter the data line has to be adjusted four times: the first two transmissions from the computer are conducted on the X coordinate, the following two on the Y coordinate.

The controlling lines transmitting the signals interpreting the situation in the data line are:

— SYC line over which the computer signals the start of a relay of data,

— MVR line which defines whether the transmission consists of a command for lifting or lowering the pen, or of point coordinates,

— PNC line, which decides whether the pen will be lifted or lowered (provided that the MVR line is correctly adjusted).

In addition to the lines defined above there are two other lines which organize the exchange of information transmitted over lines SYC, MVR, PNC, A7, ..., A6. Over the FLAG line the plotter signals to the controlling unit that it is ready to accept new information. Over the CONTROL line the controlling unit signals to the plotter that the latter should start to interpret the situation in the lines of information.

Cooperation between plotter and controlling unit is schematically shown in diagram 1.

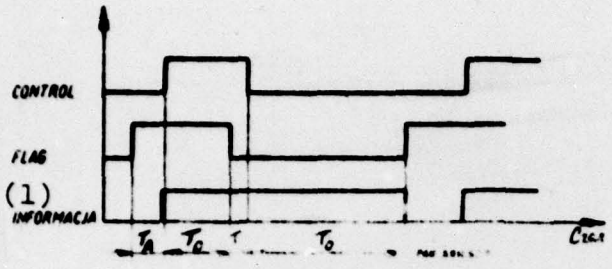

Diagram 1. Principles of Controlling the X-Y plotter.

(1) Information.

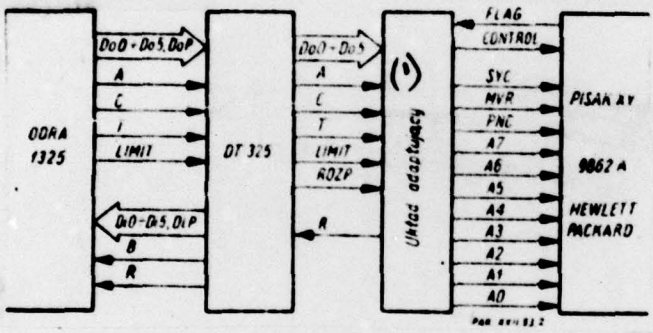

Diagram 2. Schematic diagram of computer - X-Y plotter.
(1) adjusting device

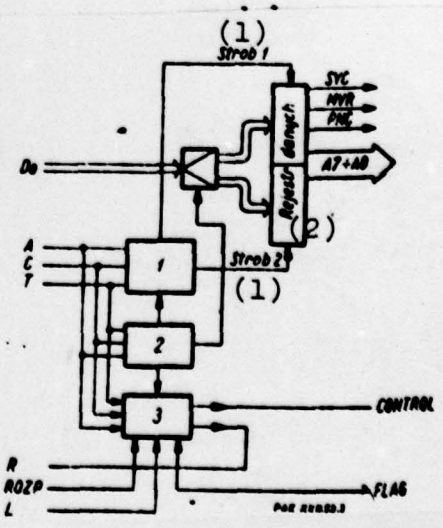

Diagram 3. Schematic diagram of the adjusting system.

(1) Strobe; (2) Data register.

After receiving the pilot signal FLAG the controlling unit transmits information over the lines of the plotter; as soon as the lines SYC, MVR, ... are correctly adjusted, that is after a period τ_A, the CONTROL signal is relayed to the plotter. Then, after a period τ_B, the equipment already in operation zeros on FLAG, thus inducing the controlling unit to transmit the signal CONTROL after a period τ_C. The situation in the lines of information is analyzed during the entire time of the plotter's operation and they are continuously aligned. When the plotter has accomplished the task of recording information (during the periods $\tau_C + \tau_{AJ}$, it again assumes a waiting position and realigns the FLAG line.

The Units Controlling Cooperation Between Computer and X-Y plotter

The schematic diagram of this equipment is shown in sketch No. 2

The computer communicates with the plotter by means of a controlling unit consisting of the DT 325 equipment and an adjusting device. The ODRA 1325 computer controls the operation of the equipment by means of an interface line in the same manner as its cooperation with a paper tape punching machine.

The controlling unit performs the following tasks:

1. It checks the correctness of information received from the computer and calibrates information transmitted to the computer;
2. It decodes incoming information;
3. It feeds the computer information about the feasibility of executing a command;
4. It informs the computer about its own situation and that of the equipment;
5. It signals to the computer interruptions for the purpose of informing it about:
   - possibility of beginning cooperation,
   - defects in equipment,
   - termination of cooperation.

6. Stores in its register information for transmission to the plotter;

7. Informs the computer about its readiness for accepting the successive signal (line R) from the series of transmitted signs.

The functions described in points 1 to 5 are performed over the logical circuit DT 325. Only functions 6 and 7 require an additional system, since:

1. The information unit of the tape punching machine is a 6 bit signal and the plotter requires in each transmission 11 bit information which necessitates the arrangement of signals from the computer into groups of two before their relay to the plotter.

2. The transmission frequency of signals from the computer depends on the speed of the equipment so that admission of a new signal by the unit controlling the ODRA 1325 computer must be realized in the adjusting device which communicates directly with the plotter.

To enable the DT 325 equipment to control the tape punching machine and the plotter at the same time it was necessary to introduce the following alterations in the DT325 equipment (the alterations given here are based on model [1]):

1. To start the operation of the plotter the START signal which activates the engine of the perforator must be switched off; the START signal is therefore transmitted to the control system of the engine by an additional contact of the equalizer switch of the equipment which is to be connected with the DT325 unit.

2. When the computer transmits to the plotter, the signal "ready for reception" (line R) comes from the adjusting unit. R signals from the punching machine and from the plotter are also transmitted from a second pair of contacts in the above mentioned switch.

3. In operation the plotter is in zero position for KD signals which, with the punching machine also in action, informs the controlling logical

units about the termination of the activities of operating mechanisms.

A schematic drawing of the adjusting system is shown in diagram 3. This system responds to the following signals transmitted directly from the DT325 unit:

1. Signals from the computer:

Do0 to Do5 - 6 bit data signs,

A-signal indicating that the computer is calling the plotter,

C-signal indicating whether lines Do0 to Do5 carry data or commands,

T-time signal,

LIMIT-signal indicating the last signs of a transmitted block of data.

2. Signals originating in the DT325 unit:

ZER-signal, putting the logical units into position "ready",

ROZP-impuls, appearing when the control units accept the command PISZ (WRITE) from the computer and initiating the operation of the logical systems which are responsible for data transmission.

The transmission of information from the computer is preceded by the command PISZ which is decoded in the DT325 unit. If it accepts this signal it generates the signal ROZP, which causes the command PISZ to be stored in the controlling part of the adjusting system.

When the recorder transmits the signal FLAG, the controlling system relays to the computer the demand for signals (line R). Answering this signal the computer transmits the sign written in the first part of the data register by the first strobe impuls. Simultaneously the system which counts the signs raises its position by 1. At the end of the transmission of the first sign the adjusting system immediately repeats signal R, asking for the second sign. The new sign is then stored in the second part of the data register. This repeated change in the sign counter triggers the transmission of the CONTROL signal to the plotter and the sign counter

again assumes the original value.

The recorder zeros on the FLAG signal, accepts information from the adjusting system, transforms it and switches to line FLAG as soon as it is ready to establish cooperation. This brings about the regeneration of signal R by the controlling unit and the repetition of the transmission cycle computer - control unit - plotter.

The transmission is terminated on the initiative of the computer which, together with the last sign of the transmission, relays the end signal L (LIMIT). The controlling part of the adjusting system then assumes the same position which it had before receiving the command PISZ.

Basic Programming of the Plotter

The basic programming makes it possible to use the plotter effectively as a output unit for programs written in FORTRAN language. Here is the consecutive set of subroutine in PLAN language for operating of the plotter:

PENDOWN - introduction of this subroutine triggers the transmission of the command "lower the pen" (two 6-bit signs) to the plotter,

PENUP - introduction of this subroutine triggers the transmission of the command "lift the pen" (two 6-bit signs) to the plotter,

POINT (IX,IY) - the introduction of this subroutine starts the transmission of eight 6-bit signs designating a shift of the plotter's pen to a point defined by the coordinates (X,Y) consigned by integral number (IX',IY') according to the equation:

IX' equals max (0, min (IX, 9999))

IY' equals max (0, min (IY, 9999))

Since the plotter is an independent external equipment we introduced

double blocking of all information transmitted to the plotter. This makes it possible to let program and plotter work at the same time. (designation of new points for drafting). The length of one block equals the maximal number of signs which can be transmitted by one command and amounts to 128. As soon as each block is completed its contents are automatically transmitted to the plotter. It may therefore become necessary to transmit an uncomplete block to complete a drawing. This is done by the following subroutine:

PLOTTEREND (N, nH communication n signs) N equal n less than or equal to 40 .

The execution of this subroutine includes ; transmission of the contents of the block to the plotter as well as suspension of the program and recording of the communication of n signs on the monitor..

Before calling any of the above mentioned subroutines in the program it is necessary to call the subroutine:

PLOTTER (I)

which sets of the connection of the plotter as an external equipment into the program and the value determination of the initial operational changes.

If the time necessary for selecting the coordinates of consecutive points by the program is too long in comparison with the time expended on drafting (the plotter has to wait for a considerable time for a new block of data) than a subroutine PLOTTER with the parameter I which is different from zero should be introduced. Consequently the pen of the plotter is lifted whenever the contents of a block has been transmitted. The pen is then again lowered at the start of the transmission of the new content of a block. This prevents pen marks when the plotter is waiting for further transmissions. Generally the time needed for selecting new coordinates is rather short and it is therefore necessary to introduce the parameter I equals zero.

Service Programming of the Plotter

The service programming of the plotter consists of a series of procedures written in FORTRAN language. These procedures considerably facilitate the utilization of a plotter. We would like to briefly discuss the possibilities offered by the service programming of plotters.

1. Determination of a Configuration of Coordinates

There are three systems of coordinates: the natural centimetric system, the centimetric system, and the user's system.

The natural centimetric system requires shifting of the pen by centimeters with the starting point for the system of coordinates in the lower left corner of the field of the plotter. The starting point of the configuration can be shifted to any arbitrarily chosen point to achieve a configuration in centimeters. In the user's system the center lines of the coordinates are expressed in units chosen by the user and the starting point of the configuration can be shifted arbitrarily according to the centimetric configuration.

2. Editing Procedures

These procedures make it possible to draft texts (chains) with arbitrary letter dimensions and to orient inscriptions, special signs (logograms), or numbers of the size E, F, and I.

3. Procedures for Drawing Curves

These procedures make it possible to draw curves and straight lines of arbitrary thickness, interrupted or continuous lines, stipplings, etc.

It is also possible to draw a curved pattern of points, diagrams of functions, and nomographs.

4. Procedures for Drawing Systems of Coordinates

These procedures make it possible to draw the lineal or [redacted] logarithmic axis of configurations of coordinates. It is possible to model the axis or to define it in words. It is further possible to draw lineal of logarithmic grids.

The methods for using these procedures are identical with those shown in the programs supplied by Benson Co. Due to this fact most of the programs applying Benson plotters can be performed without any alterations on ODRA 1325 computers which are coupled with this type of plotters. A full description of these programs is given in supplement [3].

The system plotter - ODRA 1325 computer described above is being used for several years by the Institute of Automatics at the Warsaw Polytechnic for scientific and technological computations.

It has found application for instance in the automatic designing of logical systems , in determining the disposition of pressure and flows in industrial gas pipelines , and for drawing static numerical characteristics for models of industrial constructions.

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[1] Dokumentacja techniczno-ruchowa: Czytnik-dziurkarka taśmy papierowej CDT 325-1. Warszawa, 1974, WPM „Mera".

[2] Service Manual. Hewlett-Packard, 9862A Calculator plotter. 1972, San Diego.

[3] Benson — Basic programs, Level 1; Drafting Subroutines, Level 2. Instrukcja programowania pisaków firmy Benson, 1973.

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