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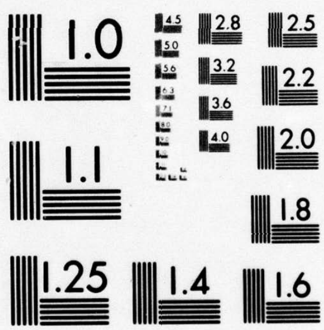
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A PROGRAM SYSTEM FOR MANUFACTURING CONTROL TAPES FOR A PRINTED CIRCUIT BOARD DRILLING MACHINE

by

W. Hoehne, G. Kuckelt,
et al.

FOREIGN TECHNOLOGY DIVISION

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A PROGRAM SYSTEM FOR MANUFACTURING CONTROL TAPES FOR A PRINTED CIRCUIT BOARD DRILLING MACHINE

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Report from the Center for Scientific Instrument Construction of the Academy of Sciences of the GDR

0. INTRODUCTION

With the increasing use of electronic circuits in products of the scientific instrument construction industry the development and finishing costs for printed circuit boards has increased. The introduction of miniaturized subassemblies and especially of integrated circuits has led to a further increase in the complexity of these printed circuit boards. Special significance is given therefore to a simplification of the processes in design, of manufacturing, of components and of testing of printed circuit boards employing computer technology. For reducing the labor expense in producing the bases for printed circuit boards various solutions have been suggested which range from manual procedures to partially automated, to fully automated techniques [1] to [5]. In scientific instrument construction where for the most part small quantity production predominates and where the development expenditure and the time of development are significant factors, an extensive automation, like that to be strived for in the case of mass production, may not lead to optimum results. Here it is a question of a flexible system which makes possible short running times.

It is obvious that the requirements for flexibility of the system and for short running times are easier to fulfill if in the manufacture of the bases computers are incorporated directly into the design process. Today, however, this can probably only be realized with small computers.

1. STATEMENT OF THE PROBLEM

For putting a printed circuit board drilling machine of the VEB Elektromat Dresden (Type SNCB-2) into operation in the Center for

Scientific Instrument Construction of the Academy of Sciences it was necessary to develop a program system which makes it possible, using an existing Hungarian small computer of the type TPA 1001, to automatically produce control tapes for the NC drilling machine. The output data necessary for this is gained following manual design of the conductive pattern at a digitizing point of the VEB Rechenelectronic Meiningen/Zella-Mahlis. For clarification of the mode of operation of the program it is first necessary to briefly look at the data format of the digitizing device and at the command format of the drillig machine.

$$h_1h_2h_3x_1x_2x_3x_4y_1y_2y_3y_4(m_1m_2\cdots). \qquad (1)$$

The digitizing point provides data items in the form

$h_1h_2h_3$ identifiable signal, data about character occurrence

$x_1x_2x_3x_4$ x-coordinate of the particular point in tenths of reference grid steps (0.125 mm)

$y_1y_2y_3y_4$ y-coordinate values

$m_1m_2\ldots$ macronumber (only present with macros).

By the term macro we understand frequently recurring structures which are not explicitly digitized each time but which are determined unambiguously by the indication of the macro identifiable signal, the coordinates of the macro reference point (which is always represented by a drilling point) and by the two-digit macronumber.

The command format of the printed circuit board drilling machine reads

$$N z_1 z_2 z_3 w_1 w_2 d_1 d_2 d_3 d_4 d_5 k v \quad (2)$$

N the flag for the beginning of the command

$z_1 z_2 z_3$ command numbers

$w_1 w_2$ number of equidistant bore holes

$d_1 d_2 d_3 d_4 d_5$ the distance between sequential starting points and drilling points

k coordinate

v sign of the displacement.

The command structure (2) makes it possible to see already that always only one movement in the x- or y-direction is possible. In order to realize processing times maximumly approaching the optimum under these conditions it is recommended that the bore holes which lie in row be drilled one after another and and that a meander-shaped sweep be made over the printed circuit board during drilling. In the event that there are bore holes with different diameters they can be worked with two drilling spindles into which the appropriate bits are to be placed. In this case it is expedient to first drill all of the holes of the same size and then to move to the holes of the second size since when changing bits, as well as when switching from one spindle to another the machine must be brought to the off position.

The drill holes belonging to a macro as a rule do not lie close to each other. Therefore they are finished with sequential drilling commands. Since the data tape supplies only the coordiates of the macro reference point and the macro number, the information for the execution of the remaining macro drillings must be obtained from parameter lists which are to be added to the drilling machine program. In the data tape of the digitization point the data items, as a rule, are ordered according to conductor features. Therefore they cannot be converted into control commands for the drilling machine in the order that they are input. First they must be sorted according to the type of drilling (macros, 0.8-mm bore holes, and 1.3-mm bore holes), according to the sequence of their finishing (in meander shape) and a check for equal distance between sequential drilling points must also be made. For this it is necessary to take over the data into the working storage of the computer whereby a considerable part of the available storage space is laid claim to which limits the scope of the storable data lists for both groups of individual Bore holes and also limits the macro bore holes.

2. DESCRIPTION OF THE PROGRAM SYSTEM

The structure of the program system which was written in the assembler language SLANG is to be described below using a greatly simplified structural plan (figure).

The program begins with the arrangement of the converted data of the digitizing unit in the sequence of its input into special lists while erroneous information is removed. An x-coordinate and y-coordinate list is kept for each type of drilling; for macros, a supplementary macro number list.

The following processing procedure is completed, depending on the number of types of drilling, in three cycles. Within one cycle there is command formation in the sequence of increasing Y-levels. In a large program loop after the determination of the actual Y-level (YS-value) all commands are formed which trigger the drillings during a movement of the drilling bench from left to right or vice versa.

For command formation it is necessary to collate all x-coordinates which belong to a Y-value and to sort them in an increasing sequence. From these absolute values, in a special program part, the incremental information DY and DX_{ν} which is necessary for the drilling machine is determined taking into account the differing values of the grid step of the digitizing pont and of the NC-drilling machine, of the different coordinate systems, as well as of the direction of displacement. The increment calculation is attached to command formation. The data required for a command is converted into decimal form, encoded by character in the ISO code and output through the output buffer AUPU.

During macro processing the control program has the task of first of all positioning the drilling spindle of the machine on the coordinates of the macro reference point and triggering the drilling procedure. Using the macro number which is always to be taken into consideration in this program cycle the address of the proper macro parameter list is determined. From this list is taken the information which is necessary for all further drillings of the macro. After finishing a macro the drilling bench should fundamentally occupy the y-coordinate of the reference point and the x-coordinate of the last bore point. For formation of the next starting command a correction of the x-increment DX_y is usually necessary.

After running through a cycle, i.e., when $YS = Y_{max}$ the cycle number Z is raised and in the case $Z \leq 3$ the following cycle is begun. If on the printed circuit board which is to be finished there are bore holes with two different diameters, at the beginning of cycle 3 the commands are fed into the control tape which transport the drilling bench to the initial position. Finally an end command is given whose purpose it is to stop the machine. After the conclusion of cycle 3 the return command and the end command are always added on.

The output of control commands takes place through the teleprinter, sometimes on a punch tape and sometimes as printout. Since this device operates relatively slowly the output processes as a rule limit the speed of program processing. For shortening processing times the output program was written as an interrupt-operator routine. Thereby there is parallel operation of the teleprinter and the computer. Several software switches and a waiting loop in the program part of the command formation assure a certain program run independent of whether the time required for setting up a command exceeds or is less than the time required for outputting the previous command. The program system contains a series of tests which, in the absence of certain information and in the case of incorrect punching of the tape as well as when certain limiting values are exceeded, lead to stopping of the program. The cause of the error can be recognized during each stoppage by the position of the error counter.

3. EXPERIENCE IN USE AND ADAPTATION POSSIBILITIES

Finishing of the program system requires a computer of the type TPA 1001, resp., TPA/i with a storage capacity of 8 K and an expanded arithmetic unit. With the presently developed system a maximum of 1008 single bore holes of 0.8 and 1.3 mm diameter as well as 64 macros can be processed per printed circuit board. A greater number of bore holes or macros requires a subdivision of the data tape. All bore holes must lie on grid points and there can be a maximum of 64 individual bore holes in a y-row.

The program processing time is determined basically by the output processes, especially since the calculations for preparing the drilling machine commands almost always run faster than the command output. It is not possible to give a generally valid relationship between the number of data items in the data tape and the number of drilling machine commands. The results of the test have shown, however, that the number of control commands for the drilling machine, depending on the number of macros, is greater by a factor of

1.5-4 than the number of data items in the data tape. The total processing time can be evaluated as the product of the number of data items and the output time for one command (1.5 s) and the named number factor. The computer time for producing a control tape could be reduced even further if output would take place with a gang punch instead of a teleprinter. A parallel printout would not be possible then. In the case of the availabiliy of a suitable punch-tape controlled typewriter the printout could be made off-line.

If the computer does not have an expanded arithmetic unit for permanently wired multiplication and division then these operations can be carried out with subroutines which must be inserted into the program system.

As a result of the extensive agreement of the program language SLANG with that of the KSR 4 100, with a few minor changes the program culd be run on that small computer. Since the teleprinter used as an output device in this case only works in the 5-channel code, here output with a gang punch would be preferred.

The program system at the present time does not use all of the storage space which is available. Therefore certain expansions can be considered such as:

- raising the number of macrotypes;

- raising the number of macros which can be accepted in the data lists;

- changing the ratio between the nubmer of 0.8 and 1.3-mm single bore holes through a dialog program before the beginning of the read-in process (with a constant total number of single bore holes).

Thus it would be possible to a certain extent to adapt the program system to different demands of other potential applications.

LITERATURE

[1] *Bürger, E.; Leonhardt, W.:* Die Konstruktion von Leiterkarten mit Hilfe der elektronischen Datenverarbeitung. Neue Technik im Büro 17 (1973) 6, S. 176–179.

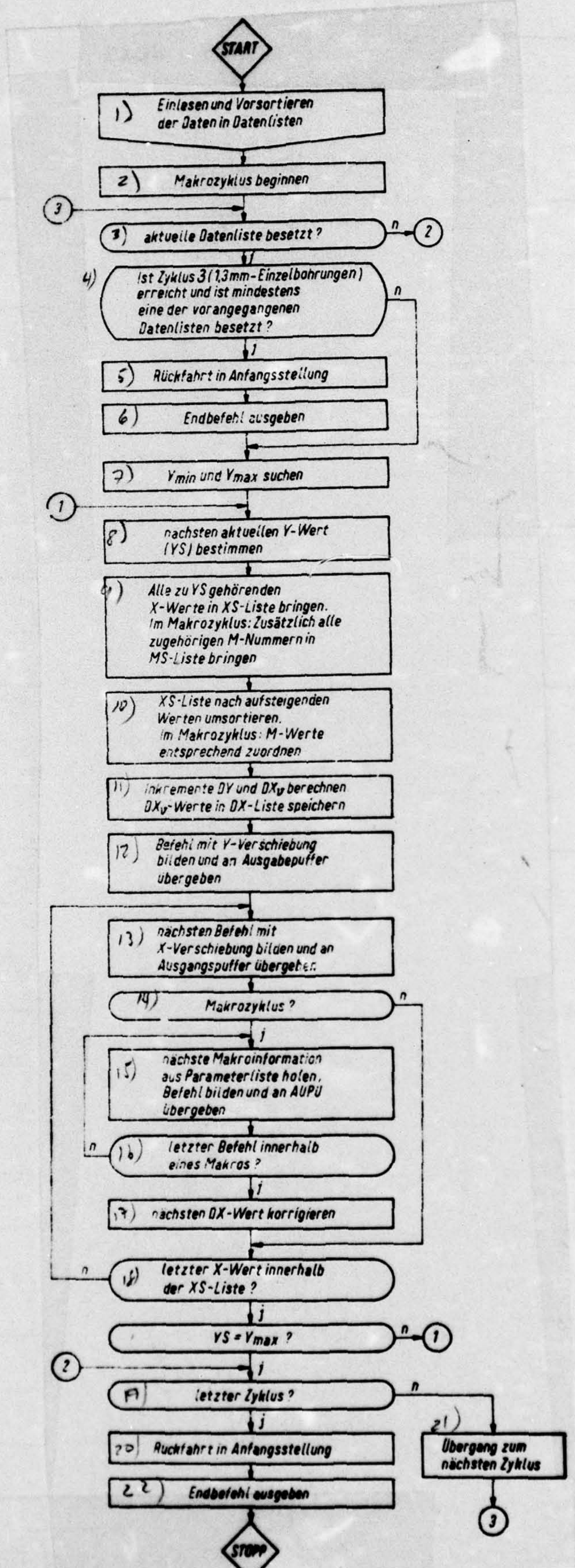
[2] *Fisk, C. J.; Caskey. D. L.; West, L. E.:* ACCEL. Automated circuit card etching layout. Proc. IEEE 55 (1967) 11, S. 1971–1982.

[3] *Hellmin, G.:* Die Unterlagenerstellung gedruckter Schaltungen. Elektroniker 11 (1972) 3. S. 109–116.

[4] *Morelj, A.:* PERFEKT – A programming system for NC-machines used in production of electrical sub-assemblies. Vortrag 2nd Internat. Conf. on Programming Languages for Numerically Controlled Machine Tools, PROLAMAT '73. Budapest, 10. bis 13. 4. 1973.

[5] *Schäller, K.:* Computergestützter Entwurf von zweiseitigen Leiterkarten. radio fernsehen elektronik 22 (1973) 12, S. 388–390.

Fig. Simplified structural plan of the program system (without data output). ((KEY: 1) Read-in and presorting of data in the data lists;


START
1) Einlesen und Vorsortieren der Daten in Datenlisten
2) Makrozyklus beginnen
3
3) aktuelle Datenliste besetzt ?
n
2
j
4) Ist Zyklus 3 (1,3mm-Einzelbohrungen) erreicht und ist mindestens eine der vorangegangenen Datenlisten besetzt ?
n
j
5) Rückfahrt in Anfangsstellung
6) Endbefehl ausgeben
7) Ymin und Ymax suchen
1
8) nächsten aktuellen Y-Wert (YS) bestimmen
9) Alle zu YS gehörenden X-Werte in XS-Liste bringen. Im Makrozyklus: Zusätzlich alle zugehörigen M-Nummern in MS-Liste bringen
10) XS-Liste nach aufsteigenden Werten umsortieren. Im Makrozyklus: M-Werte entsprechend zuordnen
11) Inkremente DY und DXv berechnen DXv-Werte in DX-Liste speichern
12) Befehl mit Y-Verschiebung bilden und an Ausgabepuffer übergeben
13) nächsten Befehl mit X-Verschiebung bilden und an Ausgangspuffer übergeben
14) Makrozyklus ?
n
j
15) nächste Makroinformation aus Parameterliste holen, Befehl bilden und an AUPU übergeben
n
16) letzter Befehl innerhalb eines Makros ?
j
17) nächsten DX-Wert korrigieren
n
18) letzter X-Wert innerhalb der XS-Liste ?
j
YS = Ymax ?
n
1
2
j
19) letzter Zyklus ?
n
j
20) Rückfahrt in Anfangsstellung
21) Übergang zum nächsten Zyklus
3
22) Endbefehl ausgeben
STOPP

2) Begin macrocycle; 3) Is the actual data list busy?; 4) Has cycle 3 (1.3-mm single bore holes) been reached and is at least one of the previous data lists busy?; 5) Return to initial position; 6) Issue end command; 7) Look for V_{min} and V_{max} ; 8) Determine the next actual Y-value (YS); 9) Bring all x-values belonging to YS into the XS-list. In the macrocycle: additionally, put all proper M-numbers into the MS-list; 10) Sort the XS-list according to increasing values. In the macrocycle: order m-values correspondingly; 11) Calculate increments DY and DX_v . Store DX -values in the DX-list; 12) Form command with y-displacement and transmit it to the output buffer; 13) Form the next command with X-displacement and transmit it to the output buffer; 14) Macrocycle?; 15) Obtain the next macroinformation from the parameter list, form the command and transmit it to the AUPU; 16) The last command inside a macro?; 17) Correct the next DX-value; 18) The last x-value in the XS-list?; 19) Last cycle?; 20) Return to original position; 21) Transition to next cycle; 22) Issue end command.))

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