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Construction of an Interface Between a Minicomputer and an X, Y Digitizer

UNITED STATES DEPARTMENT OF THE INTERIOR

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Construction of an Interface Between a Minicomputer and an X, Y Digitizer

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CONSTRUCTION OF AN INTERFACE BETWEEN A MINICOMPUTER AND AN X, Y DIGITIZER

by

Richard G. Burdick,[1] Edward L. Douglas,[2] and Joe Sena[3]

ABSTRACT

This Bureau of Mines report describes an interface between a minicomputer and a peripheral device. The logic used to develop the device is discussed briefly, after which the device is described in detail; complete construction and operational details are given. The report should aid both in duplicating this device and in designing similar devices for different uses.

INTRODUCTION

During the past 5 years, the minicomputer has evolved from a curiosity into a common tool, used in a multitude of applications ranging from sophisticated laboratory control and analysis to truck-mounted units able to sustain very rough usage and still perform complicated, repetitive tasks. The next 5 years will probably see the minicomputer used for a variety of mining and field applications.

Normally, minicomputers are used for specific purposes only, and therefore only a small portion of their capability is utilized. One of the reasons for this has been the difficulty encountered in interfacing various nonstandard peripherals to them. Standard peripherals are those for which the hardware-software package for interfacing is available from the computer manufacturer.

However, when interfacing peripherals other than these, recourse is often made to custom interface designers and/or softward firms. While this type of assistance is necessary in some cases, the costs are usually very high, and in many cases, the time element is excessively long.

This report deals with one of several computer interfaces constructed in-house by the Denver Mining Research Center. The problem is explained, the solution is discussed, and a set of schematics for the interface is shown. While equipment is mentioned by name, this in no way implies endorsement of

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any product by the Bureau of Mines. Rather the equipment used is specified by name in order to fully define operational characteristics of the various components. The time involved for construction of this interface was approximately 4 to 5 man-days, including design, construction, and testing. The cost of the various components required was about $28. Although this report deals with interfacing a specific type of equipment to a minicomputer, one of its main purposes is to show the type of logic involved in designing such an interface, and the relative ease with shich such a device may be constructed.

STATEMENT OF PROBLEM

One of the components required for the premining conditions data analysis system was a device capable of digitizing the X, Y coordinates of graphic materials, such as well logs, maps, or airphotos, in such a manner that the data could be input directly into a computer. It was decided to use a piece of equipment already on hand, the Grafpen digitizer marketed by Science Accessories Corp. This equipment consists of an acoustic-source stylus, with a two-dimensional strip microphone used as a sensor. Its output is in BCD (binary coded decimal) form, with 11 bits for each of the X and Y coordinates (a total of 22 bits). The minicomputer used in the system is an Interdata Model 70 that is capable of receiving only up to a 16-bit word. Therefore, the two components are not directly compatible.

After discussion, it was decided that the computer could, owing to its speed, read the X and Y coordinates sequentially, if a digital switch were available to present first the X and then the Y values. As no off the shelf switch was available to perform the functions desired, a digital switch was designed and constructed in our own facilities.

LOGIC AND OUTPUT CHARACTERISTICS OF INTEGRATED CIRCUITS USED FOR INTERFACE

7400N integrated circuit (IC) chips were used as NAND gates. Their function in this device as shown in figure 1. A 7402N NOR gate was used to invert the logic between the computer and the digitizer. The 7402N IC and the transistors are shown in figures 2 and 3.

In a general way, the switch functions as described below. The logics of the two types of IC's are shown in detail in figures 1, 2, and 3. It should be explained that the computer uses a logic where +5 volts represents a zero or false condition while the ground state represents a 1 or true condition. The digitizer has a reverse logic where +5 volts represents a 1 or true condition and the ground state is a zero or false.

For this reason the 7402N IC was chosen to be used as a logic reversal element between the computer and the switch, and 7400N IC's were used to get the correct logic output from the switch to the computer. The 40361 transistors are used for power amplification only because the signal coming from the computer through the 7402N IC is not sufficient to drive the other IC's.

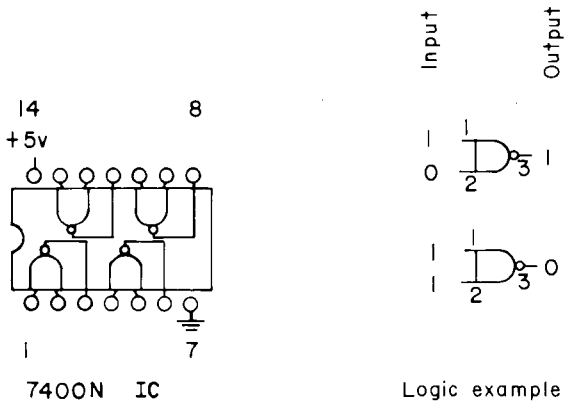


FIGURE 1. - Configuration and function of 7400N IC.

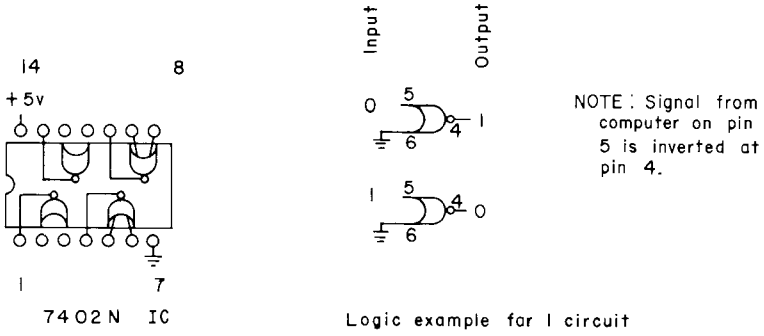


FIGURE 2. - Configuration and output function of 7402N IC.

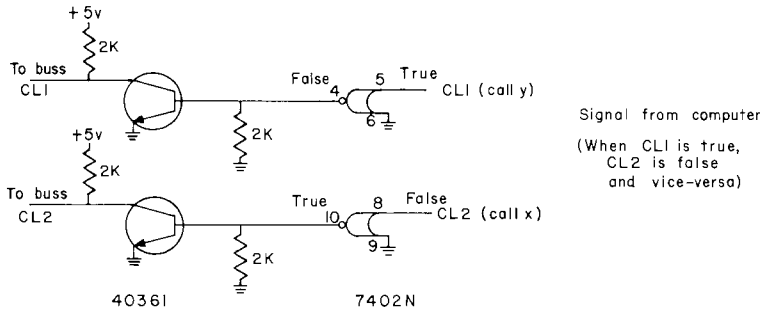


FIGURE 3. - Detail schematic of how output from 7402 IC is amplified in 40361 transistor in order to drive 7400N NAND gates.

When the computer is ready to accept an X coordinate value, it transmits a true or a zero (0) to the switch over line COT040 (fig. 8). When this happens, the 7402N IC changes the zero to a 1 and passes this signal to the CL2 buss line. Each IC terminal connected to CL2 goes to the high state; that is, +5 volts or 1. As may be seen from figure 1, if the BCD bit from the Grafpen X coordinate is zero at this time, the IC outputs a 1 (+5 volts) to the computer which represents a false to the computer. If the binary bit from the Grafpen is a 1, the circuit outputs a zero which the computer accepts as a true. This occurs simultaneously for each of the 11 X coordinate BCD bits which may be coming from the Grafpen at any given time.

Immediately after requesting and accepting an X coordinate, the computer similarly requests a Y coordinate by transmitting a true over line COT050, and the process is repeated with CL1 buss line in a high state.

CONSTRUCTION DETAILS OF DIGITIZER-COMPUTER INTERFACE

The interface was constructed on a 4-1/2- by 6-inch circuit board, which accepts a slotted 44-contact plug (Vector R644).

The 14-pin IC sockets were mounted using a staked pin arrangement, in order to facilitate connecting several wires to a single socket pin.

With the exception of the resistors for the two 40361 transistors, the bottom of the board was used for buss wiring, while the top was reserved for the various data lines.

Figures 4 and 5 are photos of the top and bottom of the board, respectively. Figure 6 shows the interface mounted inside the computer. Figure 7 shows the layout of the buss wiring on the bottom of the board. Figure 8 is a comprehensive schematic diagram, showing the complete interface from the Grafpen output and its nomenclature, through the cabling and interface, to the Interdata 70 and its nomenclature.

DISCUSSION OF SOLUTION

It is rather difficult to tabulate exactly the manpower required for the design, construction, and testing of the digital switch, as all phases were conducted concurrently with the various men's normal duties. The design and a set of rough working sketches were accomplished in 1 working day. The construction was performed by an engineering technician, with no previous electronic fabrication experience, during a period of 3 working days. The testing and a design modification, consisting of the introduction of two power transistors into the switch, occupied about 1 working day. It is estimated that the switch, from conception to being on line, occupied 4 to 5 man-days. No problems of any consequence were encountered during the building of this switch, other than the normal delay of acquiring the parts needed for its construction.

It should be noted that this device would not necessarily work to interface all devices into all minicomputers. However, it could be expected to interface this digitizer to any minicomputer that uses a 16-bit word, or to interface any device that outputs in a similar manner to the digitizer to any 16-bit computer.

The use of a NOR gate (for logic reversal) is dictated by the relative logic of the device being interfaced to the computer used. If both devices have similar logic (either positive or negative) the NOR is not required; if the logics are dissimilar it will be required. While being somewhat unique in application, this device is still versatile enough, or easily enough modified, to warrant this publication.

The appendix gives a program listing of the software required to complete and test the interface.

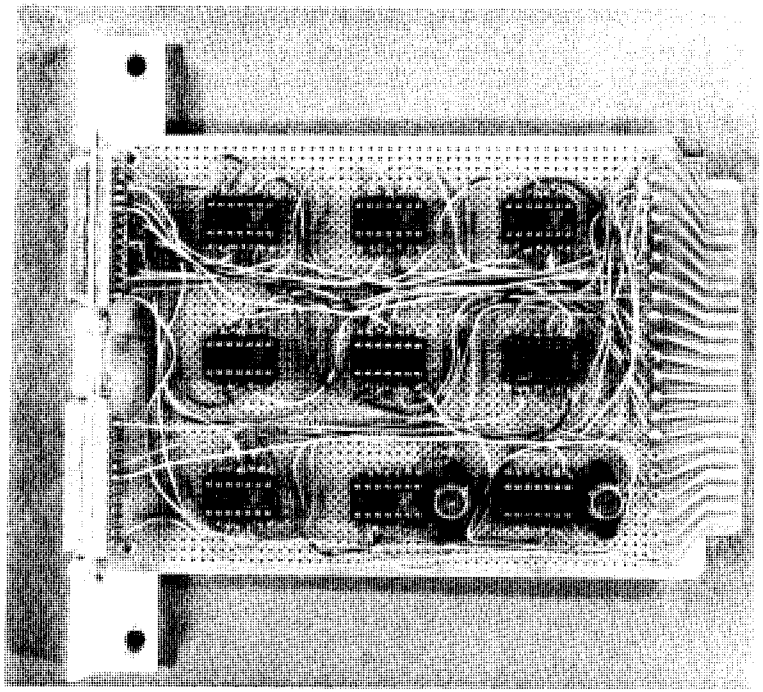


FIGURE 4. - Top of interface board showing IC's, transistors, and data lines from 44-contact input from device to two, 25-pin outputs to computer.

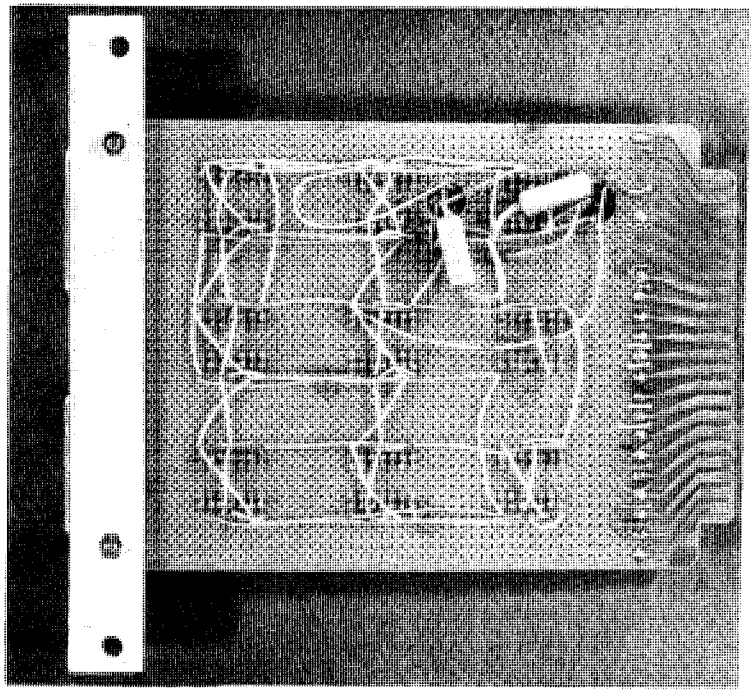


FIGURE 5. - Bottom of interface board showing buss wiring and resistors used with transistors.

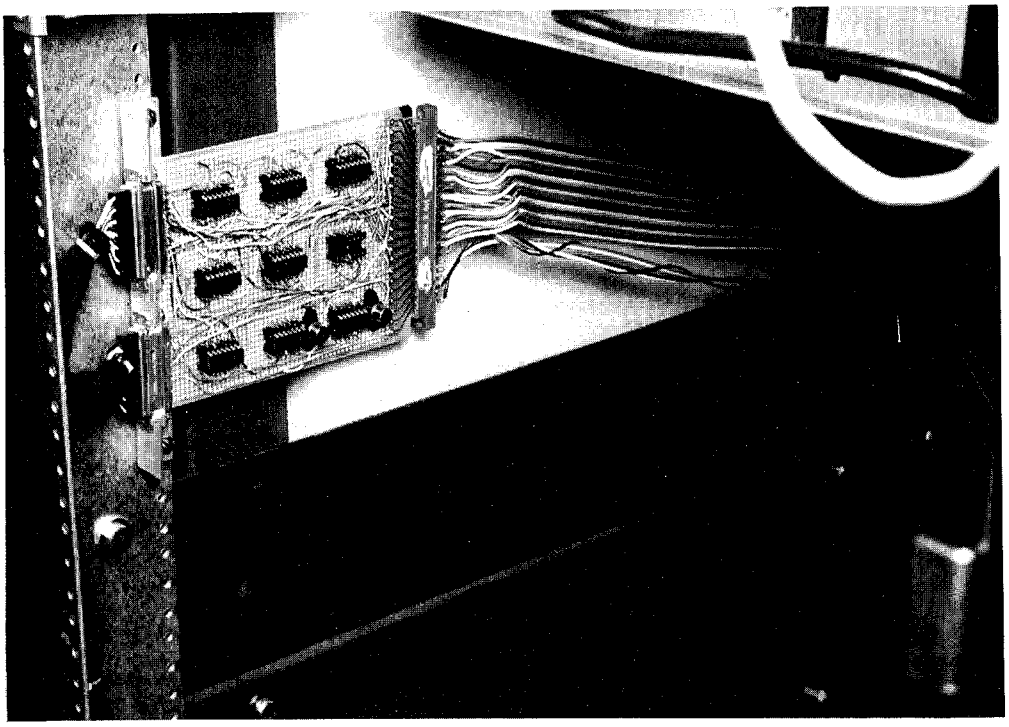


FIGURE 6. - Interface mounted on side frame of computer.

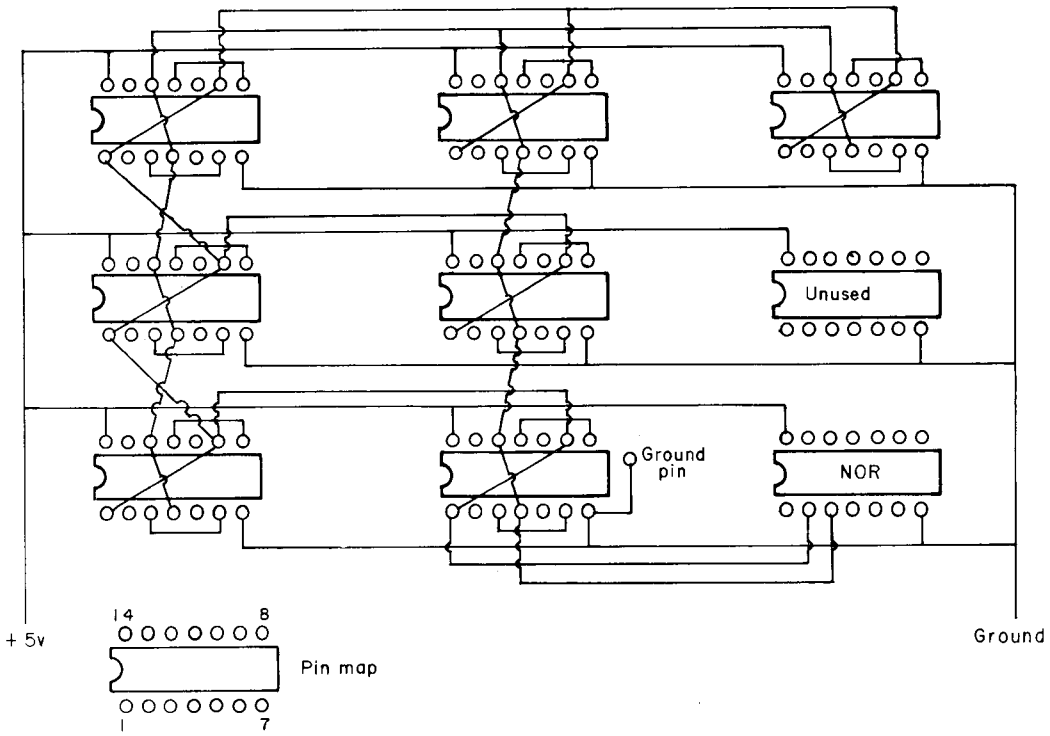
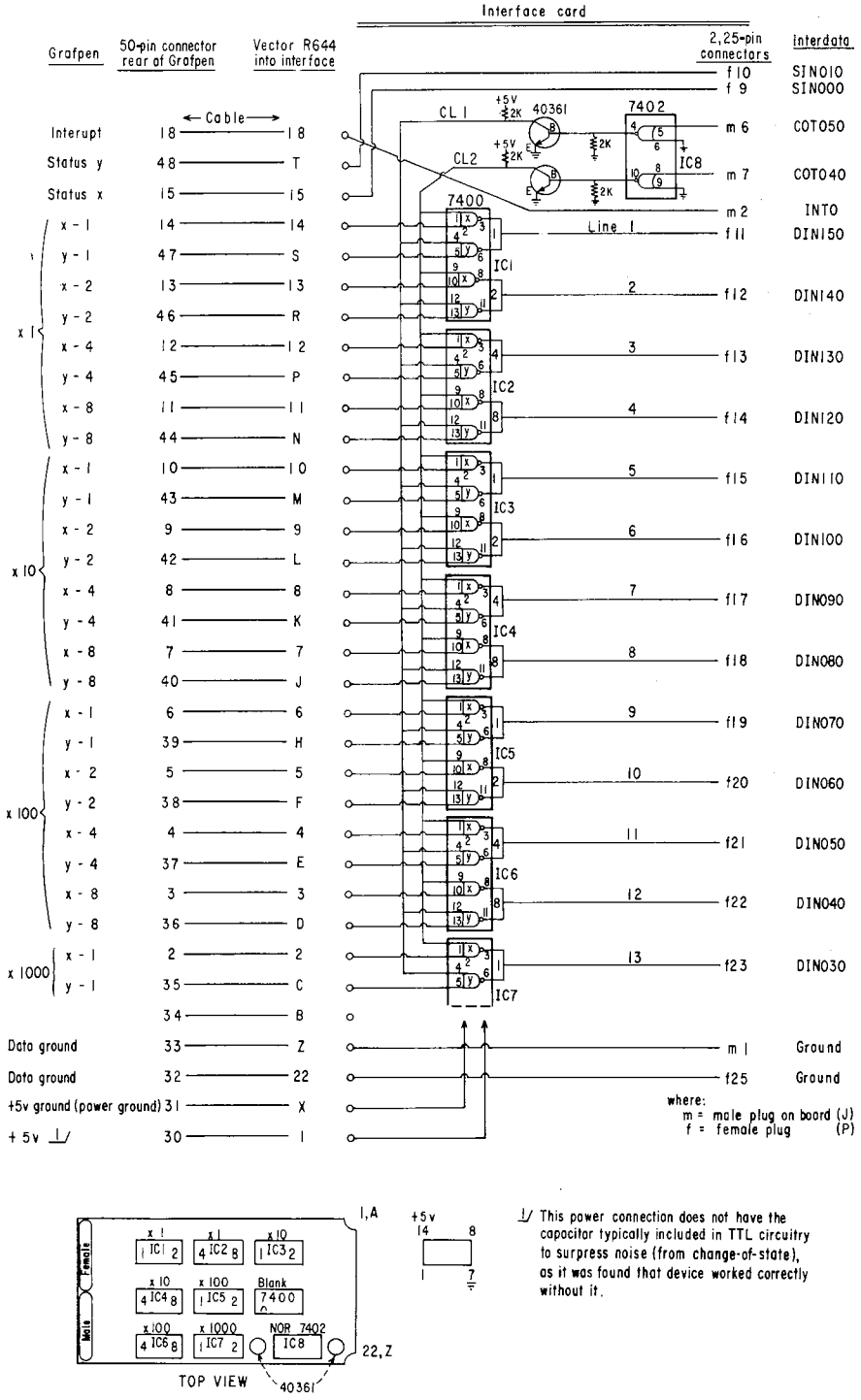


FIGURE 7. - Grafpen-Interdata 70 interface diagram of buss wiring on bottom of board.



1/ This power connection does not have the capacitor typically included in TTL circuitry to surpress noise (from change-of-state), as it was found that device worked correctly without it.

FIGURE 8. - Grafpen-Interdata 70 interface and cabling diagram.

APPENDIX.--INTERDATA 70 SOFTWARE REQUIRED TO READ FROM GRAFPEN INTERFACE

The following listing is a simple machine language program used to test the interface between the Grafpen-Interdata 70.

In use, either 0064 or 0068 is entered at the computer, by means of switches, to read either Y or X coordinates, respectively.

For operational use of the Grafpen device, a somewhat more sophisticated program was incorporated into the computer's operating system, which is FORTRAN addressable and automatically reads both X and Y coordinates.

DENVER BUREAU OF MINES CROSS ASSEMBLER

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* TEST PROGRAM FOR THE INTERDATA/GRAFPEN INTERFACE
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INTERDATA NUMONIC CODE	ADDRESS	CODE
`     LHI   0,X"8B"`	0000	04 C800008B
`* REG. 0 CONTAINS THE DEVICE ADDR.`		
`     LHI   2,1`	0004	04 C8200001
`* REG. 2 CONTAINS THE ADDRESS OF THE CONSOLE DISPLAY`		
`     RDR   2,1`	0008	02 9B21
`* REG. 1 NOW CONTAINS THE COMMAND TO READ EITHER X OR Y`		
`* THIS IS EITHER X"68" OR X"64" RESPECTIVELY`		
`     OCR   0,1`	000A	02 9E01
`L    LPSW  *+4`	000C	04 C2000010
`* THIS SETS UP INTERRUPTS ON THE INTERDATA`		
`     DA    X"4000"`	0010	02 4000
`     DA    BL2`	0012	02 0014
`* NOW JUST LOOP WAITING FOR AN INTERRUPT`		
`BL2  B     BL2`	0014	04 43000014
`GRI  ORG   *`		
`* BRANCHED TO ON AN INTERRUPT`		
`     AIR   3,4`	0018	02 9534
`     RHR   3,4`	001A	02 9934
`     WHR   2,4`	001C	02 9824
`* WE ACKNOWLEDGED THE INTERRUPT, READ THE X (OR Y) VALUE,`		
`* AND DISPLAYED IT ON THE CONSOLE`		
`     B     L`	001E	04 4300000C
`* NOW GO WAIT FOR ANOTHER INTERRUPT`		
`     ORG   X"44"`		
`     DA    0`	0044	02 0000
`     DA    GRI`	0046	02 0018
`* LOC. X"44" IS SET UP FOR THE PSW SWAP ON THE INTERRUPT`		

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