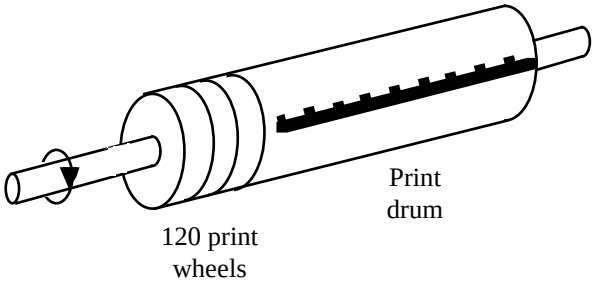
Computer Science 773

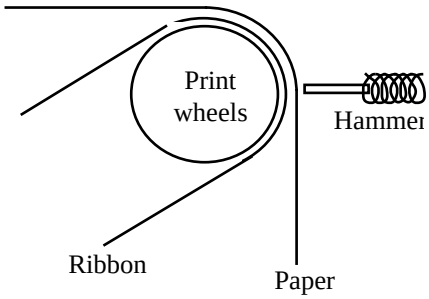
Robotics and Real-time Control

THE IBM 1132 PRINTER

This device was designed to go with the IBM 1130 computer. In its unusually complex connection to the computer, it resembles an item of engineering plant to be controlled rather than a conventional printer.

The figures below show - *very* schematically - the basic printing mechanism. The printing characters are moulded on the rim of 120 print wheels, one for every printing column, which are arranged as a cylinder called the print drum. A hammer is triggered at the correct moment to print a character in much the same way as in a typewriter.





The description below is from the manual for the printer.

IBM 1132 Printer

The 1132 Printer provides printed output for the 1130 system at maximum rates of 80 lines per minute (lpm) for alphamerical printing and 110 lpm for all-numerical printing. The print line is 120 print positions long; horizontal spacing is ten characters per inch. Vertical spacing, which is preselected by the operator, is six or eight lines per inch.

FUNCTIONAL DESCRIPTION

The 1132 contains a printwheel with 48 alphabetic, numeric, and special characters for each of the 120 printing positions. Special (FORTRAN) characters are as follows:

& - / . $, * ( ) ' + =

All printwheels rotate continuously and in synchronization with each other. Each wheel moves forward to print when the data in the output record specifies that the character to be printed is in position. Thus, all similar characters for the entire line are printed on the same cycle. Forty-eight cycles (one for each character possible) are required to print a complete line.

The 1132 uses interrupt circuitry and responds on level 1.

Forms Control

Forms control is provided through a tape-controlled carriage that uses the standard IBM carriage tape. Channels 1 through 6, 9, and 12 are available to the stored program.

Spacing is always performed one line at a time under control of the stored program in the CPU.

Carriage skipping is initiated by the stored program and stopped by the program when the predetermined line is reached. Skipping speed is 10 inches per second.

Note: A skip operation must not be less than four lines.

Data Format

The 1132 character code is shown in the appendix. Each character occupies the first eight bits of a core storage word. The data to be printed is assembled in core storage in the same order, including spaces, as the line that is to be printed. During each of the 48 cycles necessary to print all 48 characters, the character next in position to

print is read from the character emitter and is compared with each character of the output record, all by the CPU program. For each equal comparison, the program places a 1-bit in the printer scan field in the position corresponding to the printwheel to be fired. The printer scans the field in a cycle-steal mode and fires each printwheel whose position contains a 1-bit. The printer scan field is located in core storage locations 32 through 39. The 16 bits of each of the first seven words and bits 0 through 7 of the eighth word represent the 120 printwheels .

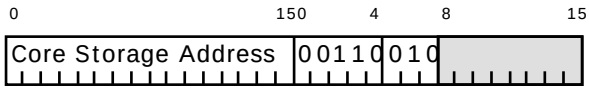
PROGRAMMING

Ihe IBM 1132 Printer operates under direct program control of the CPU.

Printer I/O Control Commands

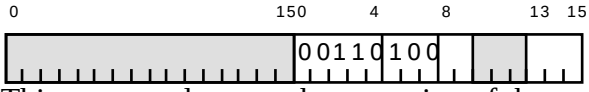
The 1132 is addressed by the binary device code of 00110.

Read Emitter (010)



This command causes the eight-bit EBCDIC code of the next character emitted by the printer to be read into bits 0-7 of the core storage location specified. Bits 8-15 are reset to zero.

Control (100)



This command causes the execution of the function specified by the modifier bit. A 1-bit in the position indicated in parentheses after each command causes the operation described.

Start Printer (Bit 8): This causes the printer to start taking the printer scan field information. The printer continues to take print scan cycles at 11.2 ms intervals until it receives a stop printer command. Each position that contains a 1-bit causes the corresponding printwheel to print the character in position on that cycle. After the field of eight words has been scanned, a 1-bit is placed in bit position 0 of the 1132 device status word. (See Figure 49) This causes an interrupt when level 1 is the highest level waiting.

Stop Printer (Bit 9): This instruction causes the printer to be put in a ready (not busy) state and inhibits subsequent printer interrupts. The stop printer instruction should not be given until all of the following conditions are met:

• Eighteen scan cycles have been completed after the command to print the last character.

• The carriage has stopped after a skip operation.

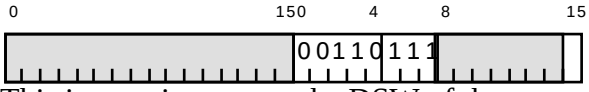
• The interrupt response from the last space command has occurred.

Start Carriage (Bit 13): This command initiates a skip operation, which is halted by a stop carriage instruction.

Stop Carriage (Bit 14): This command stops the carriage at the end of a skip operation. A punch in carriage control tape channel 1, 2, 3, 4, 5, 6, 9, or 12 initiates an interrupt request, identified by bit 1 of the DSW. When the desired tape channel bit in the DSW is on, a stop carriage command should be given.

Space (Bit 15): This command is given to space the carriage one line. After the space operation, an interrupt is initiated and a 1-bit is put in bit position 2 of the DSW to indicate spacing is completed. Another space can now be initiated.

Sense Device (111)



This instruction causes the DSW of the 1132 Printer to be placed in the ACC. The functions of the bit positions of the DSW are shown in Figure 49.
If bit 15 contains a 1, the interrupt responses in the DSW are reset.

DSW Indicators

Three interrupts are associated with the 1132, each on level 1. The associated indicators are turned on in the DSW.

Read Emitter Response (Interrupt): After a start printer command has been executed, the 1132 will interrupt the CPU program each time the printwheels are aligned to print another character. The read emitter command must then be executed to determine the character to be printed.

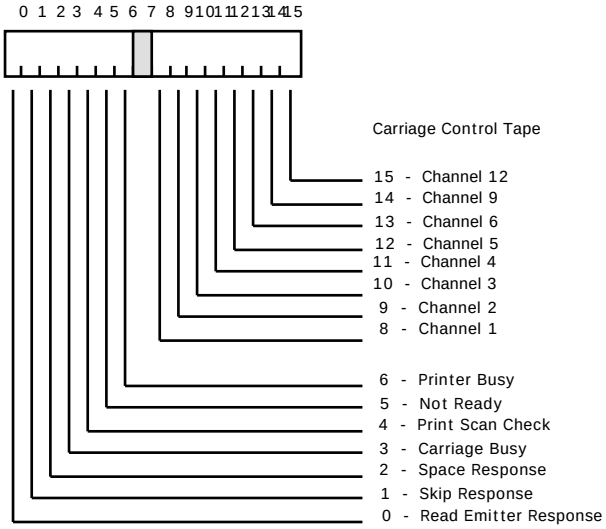


Figure 49. 1132 Device Status Word

Skip Response (Interrupt): This indicates an interrupt which is initiated by the 1132 each time the carriage brushes detect a punch in the carriage tape while a skip operation is in progress. The CPU program must test the DSW bits to determine if the carriage is at the proper channel.

Space Response (Interrupt): This indicates an interrupt which turns on at the completion of a space operation to signal the CPU program.

Note: After an interrupt has been serviced, the level must be reset by a BOSC instruction.

Carriage Busy: This indicator turns on when the 1132 begins carriage movement. It turns off when movement stops.

Print Scan Check: This indicator is turned on when the printer attachment addresses word 39 and there is not a 1-bit in position 15. A 0 in bit 15 indicates that the printer subroutine did not finish setting up the print scan field.

Not Ready: This indicator is turned on by an out-of-forms condition, motor power off, or at the end of the operation in progress if the stop key is pressed.

Carriage Control Channels: As each hole in the carriage tape is read after a start carriage control command, the associated indicator in the DSW is turned on.

Programming Notes

The status of the 1132 indicators should be checked before a line is printed. This is accomplished by transferring the printer DSW into the ACC with a sense device command. The modifier bit (bit 15) of the sense device command should be set to 0 to prevent reset of the DSW responses and indicators. Bits 3, 5, and 6 of the DSW are tested and if all three positions are 0, the printer is ready to print the next line. A start printer control command is then given to start the sequence. A scan field transfer, using cycle steal cycles, takes place under control of the printer. Therefore, the scan field must be clear and have a 1-bit in position 15 of core storage word 39 before the start print command is Given.

After the code of the next character has been emitted by the printer, a level 1 interrupt is given and the character is read into core storage by a read emitter command There are 11.2 ms available to test each position of the output record with the character read and set up the 1 bits in the printer scan field. At the end of the 11.2 ms, the 1132 attachment begins its scan and fires each printwheel with a corresponding 1-bit in the printer scan field. If the program has been interrupted for a considerable period by higher levels, the scan may not have been completed To insure that the program detects this condition, the first steps of the printer subroutine for each charac er should clear the printer scan field to 0's and, upon completion of the programmed scan, place a 1 bit in position 15 of the eighth word (39). When the printer attachment scans the field it checks this position. If it is 0, the print scan check indicator (bit 4 of the DSW) is turned on. The program can test this indicator and branch to an error routine that provides 47 idle scan cycles and resumes programmed scanning at the point where the scanning was interrupted. This results in overprinting of the characters

that were printed unless the error routine keeps track of the positions that were printed and does not set them up again on this scan.

After the final scan cycle for a line of printing, 16 idle scan cycles must be taken before spacing or skipping is started to allow time for completion of the mechanical operation of printing the last character. If the operation is a single or double space, the next scan cycle can be started two scan cycles after the last space command is given.

During an idle scan cycle the printer scan field should be set to 0's, except for bit 15 of the eighth word (39), to prevent the print scan check indicator from being turned on.

SOME NOTES.

- The IBM 1130 memory was composed of 16-bit words. It had six interrupt levels, numbered 0 to 5, with level 0 at the highest priority. In normal use, only the card reader column interrupt took precedence over the printer emitter interrupt.
- ACC is the 1130's 16-bit accumulator.
- A DSW is a Device Status Word; it contains information about the state of its device. The usual procedure is for the 1130 to respond to an interrupt from a device by reading its DSW to determine what the interrupt is about.

OLD AND NEW DEVICES.

The 1132 was built in this way to make it cheap. At the time, digital electronics was expensive, so it made sense to use the computer's electronics rather than to build it into the printer. (The 1130 package was designed specifically as a cheap machine to be sold to impoverished organisations; they were rather common in universities.)

Nowadays, all this detail still goes on in one way or another, but it's all done in the printers. Electronics is cheap, and it's worth it to simplify the connections. That's why I don't talk much about computer devices in the course - they've been specially designed to be so easy to drive that from the computer control point of view there's not much to say about them.

REFERENCE.

IBM 1130 Functional Characteristics (IBM, 1970), pages 142 - 144.

Alan Creak,
March, 1998.