THE SYSTEM/7 TAPE CASSETTE ATTACHMENT

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The System/7 tape cassette attachment is intended for FE loading of diagnostic programs; for user storage dump, verify, and load by RPQ S65008; and for user loading of disc programs. The attachment was designed to provide a high performance, low cost replacement for 5028 paper tape, to reduce FE costs in diagnostic program loading, and to provide a low cost bulk storage media with long range competitive capabilities.

The attachment was released for multiple bid on December 31, 1971, and the first customer ship date was February 11, 1972.

System/7 Tape Cassette Features

The attachment employs a Norelco 1420 cassette recorder without modification, but it is not supplied by IBM to the user, nor is it tested or checked. Standard audio tape cassettes are employed without specification, but they are not supplied by IBM unless prerecorded. Recorder start-stop is controlled by System/7 power, while the recorder mode is selected manually. The performance is about 30 times faster than 5028 paper tape, and the error rate is less than 1 error in 10^8 bits, typical. Error checking is done by program control. The record and playback is amplitude insensitive, relatively insensitive to tape drop out, and to response bandwidth degradation. Read interface on System/7 consists of a single 2H x 2W MST-1 card added to the I/O channel previously existing for 5028, with a connecting cable and including:

- Data detector and clock separator
- Byte data register and format decoder
- End-of-record decoder
- Recorder power supply and control
- Interface with System/7 5028 channel

Initial program load capability is provided similar to 5028 paper tape reader. The write interface is optional by RPQ, and is provided by connection to a digital output feature with a cable, and by use of three cassette operating programs for dump, verify, and load functions.

Prerecorded FE diagnostic programs for System/7 are produced on a 4-station duplicator built in Boca Raton, attached to an 1130. PID plans to produce prerecorded tapes for loading 5022 disc programs.

System/7 Tape Cassette Technology

Phillips-type audio cassette specifications are as follows:

Standard oxide (gamma ferric)
0.150 inch wide tape, half-mil thick polyester
Two 0.050 inch tracks, one each side
Single gap read/write head
AC bias and erase, separate erase head
1 7/8 inch per second tape speed, ±5%
100 to 5,000 Hz combined record-playback linear bandwidth, ±3 decibels
> 30 decibel signal-to-noise ratio
150 feet tape reel length - C-30

The recorder is powered by +5.0 to +8.0 volts at 150 milliamps maximum. It also contains preamplifiers and tape equalization. Data modulation employs modified phase encoded or double-frequency FSK, with positive interrecord identification and noise suppression. The following items describe the record technology performance:

3340 flux changes per inch, maximum
1670 bits per inch data density
3125 bits per second data rate
11 bits per data byte, asynchronous data format, no error check bits
285 bytes per second data rate
17,100 bytes per minute data rate
200,000 bytes per track capacity (C-30)
4 inch interrecord gap to allow slow recorder start and stop time

Data Format While Writing on Tape

At the beginning of the tape, including the leader, approximately 16,384 "no data" symbols of 800 µsec duration each (.00150 inch wave length) are recorded to allow mechanical stabilization of the tape and to allow variable length leaders up to 20 inches.

The data bits are of 320 µsec duration (.00060 inches wave length) and contain either one or two half cycles of signal, respectively, for zeros and ones.

No synchronizing bytes are required, so the first data byte may start immediately after a "no data" bit. Each data byte contains a "001" preamble to establish bit synchronization and the "1" immediately

S/7 is 2 byte machine.

preceding the data is used as a start bit. The bits in the byte are reversed, with the first bit occurring last in the sequence. No error-checking bits are included within the 11-bit byte format.

Any number of zero bits may be inserted preceding a preamble or following a data byte, since the format is asynchronous by byte. These zero bits are stripped out by the detector, as are the "001" preamble bits. Approximately 2,048 zero bits are added to the end of each record to advance the recorded portion of tape beyond the capstan and pinchroller.

At least two "no data" symbols are recorded after the last zero bits of a data record before the tape is stopped while recording. When beginning a new data record, approximately 2,048 "no data" symbols are written simultaneously with the application of power to the recorder and before the first data byte is written.

No automatic identification of beginning-of-tape while rewinding, or end-of-tape while writing is provided with this type of recorder. Mode changing from record, play, and rewind is manual. Fast forward is not employed, as tapes are always begun from the fully rewound state and advanced forward in a single mode by program control.

The write waveform is generated by a special System/7 program operating through a 4 bit digital output interface to the RPQ adapter, with 1 bit controlling the on/off power to recorder. A 3-bit elementary digital-to-analog converter and equalization filter generates the voltage to be recorded. Figure 1 shows the frequency-shift keying waveform modified by amplitude modulation and by the addition of a third, low frequency to generate the "no data" bits.

Data Detection and Clocking

The data is recovered and clocked from the single-track playback signal by measurement and decoding of the time interval between each polarity change. The detection is made independent of signal amplitude and polarity by use only of the zero crossings. No equalization is employed external to the cassette recorder during playback.

The signal polarity generates a time-quantized pulse which decodes and resets a clock counter as shown in Figure 2. The count decoded for each pulse is further quantized into three time categories.

$$0 < T_1 < 0.75\ T_c$$
$$0.75\ T_c < T_o < 1.5\ T_c$$
$$1.5\ T_c < T_n < \infty$$

A data record does not begin, after applying power to the recorder, until two T_n intervals are decoded followed by two T_o, two T_1, and

then eight valid bit combinations of T_1 and T_o intervals. After the first byte is thus detected and read out, additional bytes are identified preceded by a single pair of T_1 intervals indicating a start bit. The first T_n interval detected after the first valid data byte terminates the message, signalling an EOM to the interface. If a T_n occurs in the midst of a byte, the partial byte is discarded as the message is terminated, and the recorder power is interrupted.

Interested potential users of this released high-performance, low cost cassette data recording system should contact the author. Upward compatible versions with higher speed cassette drives are being considered for new products.

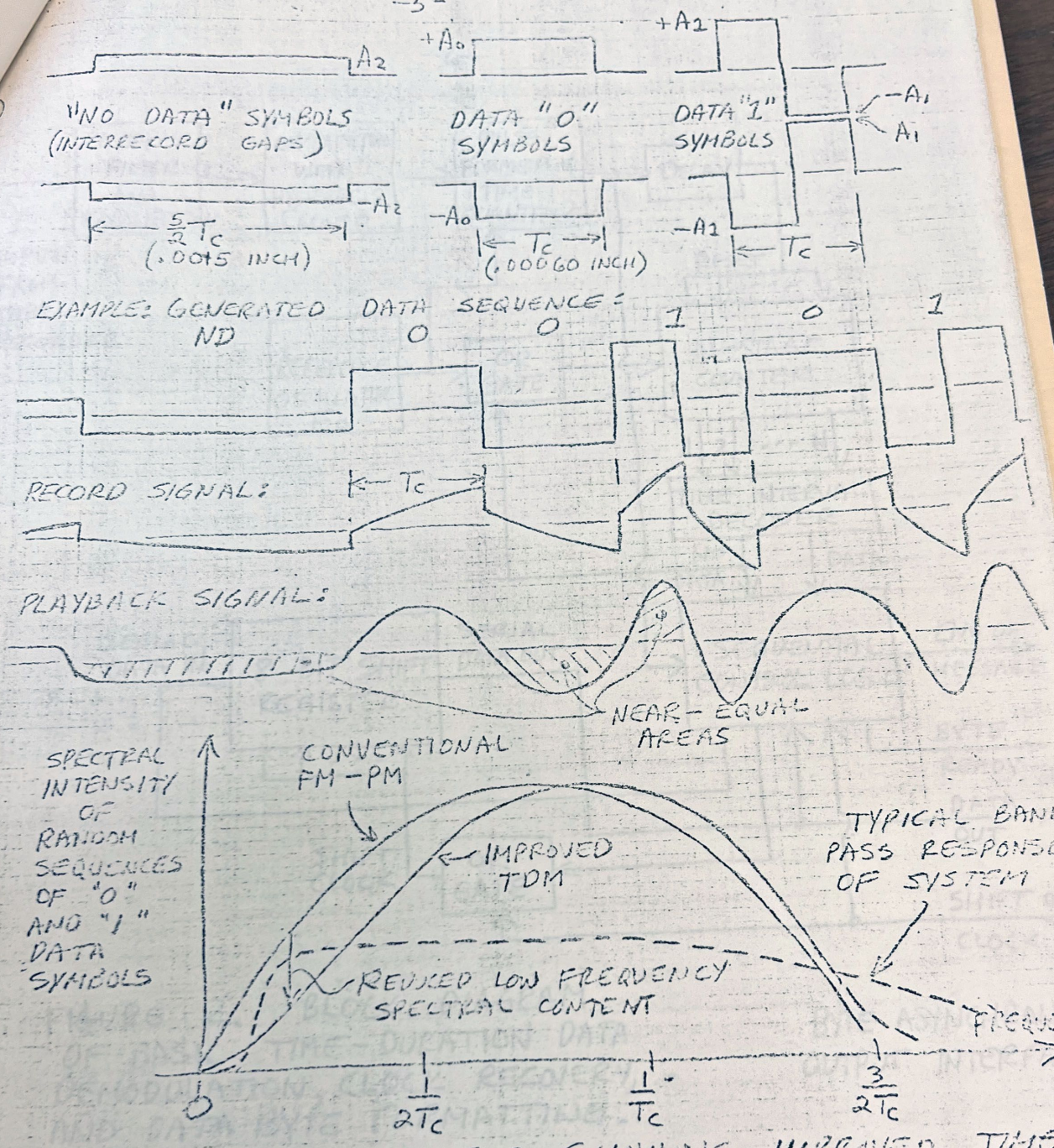

FIGURE 1: WAVEFORMS SHOWING IMPROVED TIME-DURATION MODULATION (TDM) WITH CONTROLLED SYMBOL AMPLITUDE AND REDUCED SPECTRAL BANDWIDTH.

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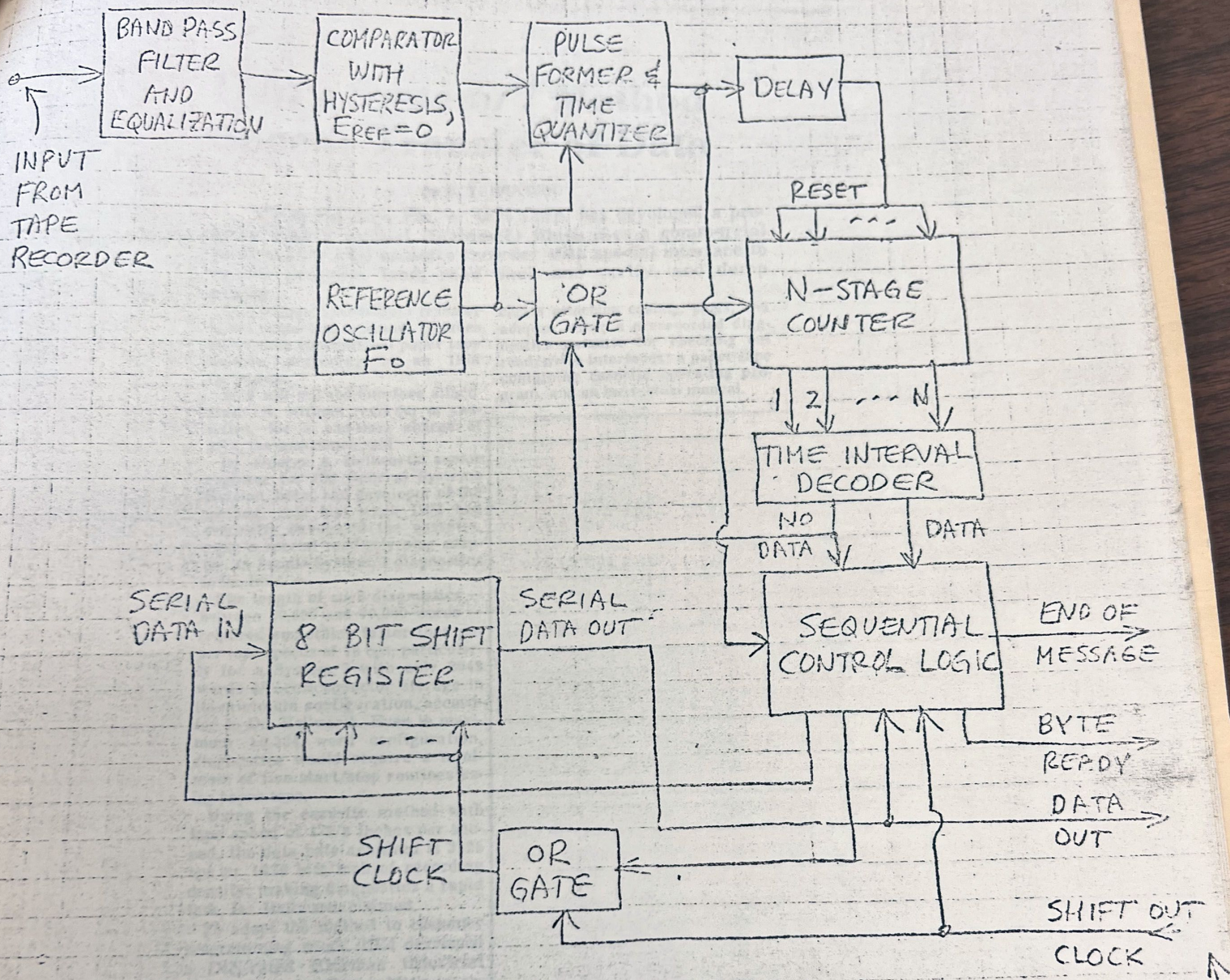

FIGURE 2. BLOCK DIAGRAM OF BASIC TIME-DURATION DATA DEMODULATION, CLOCK RECOVERY, AND DATA BYTE FORMATTING.

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IBM's System/7 Method Speeds Transfer of Data

By G. T. HORTON

BOCA RATON, Fla. — IBM Corp. has developed a program loading method (System/7) which uses a commercial voice-quality tape cassette recorder with special interface to handle program load, read back and verify, and dump modes.

The method speeds data transfer to 285 characters a second, 10 times faster than conventional paper tape devices, according to an IBM spokesman.

IBM will sell the interface attachment kit, without recorder or cassettes, for a one-time charge of $275, the spokesman said.

Dr. George A. Hellwarth, senior engineer for the General Systems division, here, and developer of the method, said last week IBM had originally developed the cassette, using a special read-only plug adaptor, to handle System/7 diagnostics in the field.

The length of such diagnostics — between 50,000 and 70,000 words — required something faster than paper tape speeds of 10 cps, particularly for a System/7 with only 2048 words of semiconductor storage in its minimum configuration, according to Dr. Hellwarth. Even in maximum 16,384 word configuration, diagnostics would require a minimum of five start/stop routines using paper tape.

Using the cassette method with tape speed of 1-7/8 inches per second, the data rate achieved is 3125 bps or 1670 bits/inch of recording density, making diagnostics a rapid task, Dr. Hellwarth claimed.

To adapt the method to customer programming needs, IBM developed a DIN-rated (German industrial standard) three-plug cabling interface to connect the System/7 and cassette for audio output, mike and power adaptor. The plugs also allow the cassette to run diagnostics. The customer programming version of the interface attachment uses a digital output PC card adaptor with a three-bit D/A converter. The adaptor also contains an equalization filter for linear analog signal filtering and a transistor for on-off switching.

For loading from the cassette, an input port on the System/7 transmits taped audio signals through a 1-bit A/D converter in the System/7 which operates on signal polarity.

The interface attachment kit includes attaching cabling, plugs, and adaptor card; a prerecorded diagnostics cassette for checking out read/write interfaces; a paper tape containing cassette operating program, and an instruction manual.

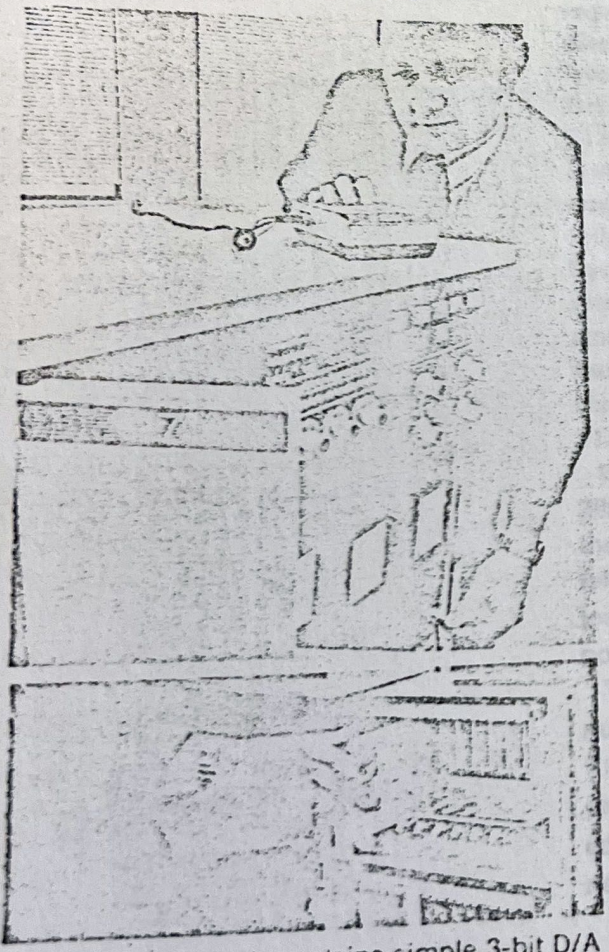
nterface Kit puts Zip in program Loading

Commercial grade cassette recorder and tape program process computer

Tom Balmer, Senior Editor

Program load and dump procedures for minicomputers usually rely on methods where inexpensive paper tapes are used. But, low-cost paper tape methods are very slow (10 cps). Depending on the number of stops required, a load or dump operation can take about an hour or more.

The problem is even more critical when diagnostic program loading for check-out or repair is required, where the length of such diagnostics can be 50,000 words or more. What is required is a low cost alternate method that would not only handle operational programs, but one that also could load and update diagnostic programs.



Adaptor card, which contains simple 3-bit D/A converter, equalization filter and transistor for on-off control, is placed into digital output feature plug in rear of System/7. Built-in program loading interface inside computer's front door is attached to cassette recorder through cable set of program load/dump package.

Three connector jacks in foreground are displayed above their respective plugs in commercial recorder. Dr. George A. Hellwarth, senior engineer at IBM and developer of the device, holds elements at other end of cable set—adaptor card and plug that attaches to internal System/7 program loading interface. Plug set fits into any European DIN-style cassette recorder.

For their System/7 minicomputer, General Systems Div. of IBM, Boca Raton, Fla., has developed a program loading method that uses a commercial voice-quality tape cassette recorder. The computer and recorder are interfaced using a special attachment that permits the system to handle program load, read back and verify, and dump modes. What results is a method that speeds-up data transfer to 285 characters per second, almost 30 times faster than conventional paper tape devices.

Using the voice-quality cassette and tape (not data tape) with speeds of 1-7/8 in/sec, the data rate achieved is 3,125 bits/sec or 1,670 bits/inch of recording density. It now takes 10 minutes to go through an entire diagnostic-load and execute, where previously, approximately 3 hours were required.

Used to adapt the method to programming needs is a three-plug cabling interface that connects the System/7 computer and the cassette for audio output, mike and power adaptor. The interface attachment uses a digital output PC card adaptor with a three-bit D/A converter. The adaptor also contains an equalization filter for linear analog signal filtering and a transistor for on-off switching. For loading from the cassette, an input port on the System/7 transmits taped signals through a 1-bit A/D converter in the System/7, which operates on signal polarity.

The interface kit includes attaching cabling, plugs and adaptor card; a prerecorded diagonostics cassette for checking out read/write interfaces; a paper tape containing cassette operating program and an instruction manual. The commercial-grade cassette recorder is not supplied with the kit.

Design News 9-18-72

Boca Raton News

General Systems Division
August 25, 1972

'CRAVES' PRODUCES DIAGNOSTIC CASSETTES

CRAVES — a cryptic sounding designation but descriptive of a newly developed piece of equipment which is helping speed diagnostic programs for use in the field.

Standing for Cassette Recording and Verification System, CRAVES simultaneously records and verfies up to four cassettes with diagnostic programs used for checking the operation of IBM System/7s.

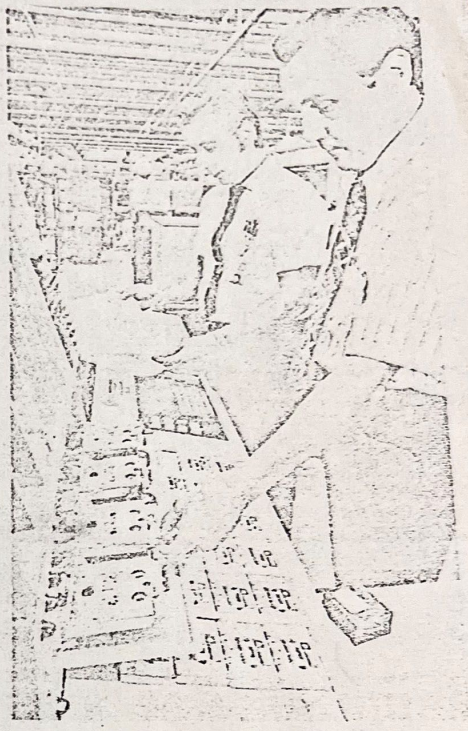
All System/7s being shipped now go out with these cassette diagnostic programs. Previously, paper tapes were used to load these programs into the System/7.

For those already in operation in the field, the process of obtaining them starts with a request from the field for a specific diagnostic cassette at a certain engineering level. The request is received by Card Reproduction. An operator, using an IBM 1130 System to which the CRAVES unit is attached, keys in the identification numbers of the cassettes. The 1130 has a telecommunications link to the IBM System/360 Model 40 in the Manufacturing area where the System/7 programs are stored on disks. The System/360 "finds" the desired programs and their engineering change levels and prints the list on the 1130's printer for use by Quality Control.

When the listing is complete, the System/360 transmits the diagnostic programs to the 1130 disk. Then a message is printed telling the operator that the programs are loaded on the disk and the cassette-write portion of the process has started.

The CRAVES program detects the number of tapes installed (maximum of four) and the writing and verification of the programs on the tapes begins. No further communication with the System/360 is necessary.

Richard Epley, technical associate in Technical Services, was responsible for the CRAVES hardware, assisted by Vernon Kendrick, senior associate engineer and Quinton Benedict, electronics specialist, both in Power EMC and Circuit Design.



Richard Epley, foreground, inserts tape cassette into CRAVES unit prior to the cassette-write process in which diagnostic programs are recorded on tape. Frank Newlands checks 1130 printout on which IBM System/360 Model 40 has indicated that required programs are now stored on 1130 disk and are ready for recording on tape cassettes.

Frank Newlands, senior electronics specialist in Technical Services, developed the required programming.

Because the process requires only a simple identification number, an operator with only a minimum of 1130 familiarization, and who may be unfamiliar with diagnostics, engineering change levels, etc., can produce complex diagnostic cassettes at any engineering change level or configuration.