Please Check

PRELIMINARY SPECIFICATIONS

22XX HALF INCH MAGNETIC TAPE DRIVE

I. TAPE DRIVE SPECIFICATIONS

We are currently considering the Wangco model 812 for the tape drive. The drive has the following specifications.

(a) Density - 9 Tracks, 800 BPI
(b) Speed - 12.5 ips (25 ips may be considered)
(c) Read after Write capability
(d) 8.5" Reels (1200 feet)
(A model supporting 10" reels may be considered)

A 1600 BPI phase encoded drive will be considered for a subsequent offering but is not a consideration for this model.

The Wang supplied tape controller will support the ANSI standard tape format, (see ANSI document X3.72-1973). This is also, with minor differences, "IBM Compatible".

The tape data format in ASCII code can be supported directly by the 2200 language structure. Tape records in other data format will require program conversion.

II. TAPE DRIVE 2200 PROGRAMMING REQUIREMENTS

All tape operations will be executed in 2200 BASIC with the $GIO statement available in the 2200 GENERAL I/O OPTION, (OPTION 2). The statement has the general form:

$GIO [comment] [/XXX] (Arg 1 , Arg 2) [Arg 3]

where

'comment'	=	any character string, (optional) (e.g., REWIND)
XXX	=	The device address(optional). If not specificated, the address currently selected for TAPE is used.
Arg 1	=	A string of hexadecimal characters or an alphanumeric variable. The string of hexadecimal characters or the value of the alphanumeric variable represents the signal sequence control word necessary to perform the I/O operation. (These vary with different tape operations).

Arg 2 = An alphanumeric variable of at least 10 bytes in length which receives the error codes and counts resulting from the I/O operation.

Arg 3 = (Optional) An alphanumeric array designator or alphanumeric variable which contains the data record to be written or receives the data record read.

Examples

Rewind Tape

```
100 $GIO REW /238 (6C07 4400 8A01, B$)
    or
100 A$ = HEX(6C0744008A01)
110 $GIO /238 (A$, B$)
```

Write a Record

```
100 $GIO WRT /238 (6C00 4400 A206 8A01, B$) C$()
    or
110 A$ = HEX(6C004400A2068A01)
120 SELECT TAPE 238
130 $GIO WRT (A$, B$) X$()
```

Valid Tape Commands

Arg 2 of the GIO statement contains a control word, (6 to 8 bytes), the value of which specifies the particular tape drive I/O operation requested. The control word can either be represented as a string of hexadecimal characters of an alphanumeric variable (or array element, or array). In the latter case the current value of the alphanumeric variable is the control word. All legal half inch magnetic operations are listed in Table I, (in the hexadecimal notation).

TABLE I $GIO HALF INCH MAG TAPE OPERATIONS

OPERATION	$GIO STATEMENT	FUNCTION
READ	$GIO READ /238 (6C02 4400 C221 8A01, A$) B$()	READ NEXT BLOCK ON TAPE
WRITE	$GIO WRITE /238 (6C01 4400 A206 8A01, A$) B$()	WRITE NEXT BLOCK ON TAPE
WEOF	$GIO WEOF /238 (6C1F 4400 8A01, A$)	WRITE TAPE MARK (EOF) ON TAPE
BSR	$GIO BSR /238 (6C27 4400 A801, A$)	BACKSPACE ONE BLOCK (RECORD) OR TO BEGINNING OF TAPE (BOT)
FSR	$GIO FSR /238 (6C37 4400 A801, A$)	FORWARD SPACE ONE BLOCK (RECORD)
BSF	$GIO BSF /238 (6C2F 4400 A801, A$)	BACKSPACE ONE FILE (TAPE MARK) OR TO THE BEGINNING OF TAPE (BOT)
FSF	$GIO FSF /238 (6C3F 4400 A801, A$)	FORWARD SPACE ONE FILE (TO NEXT TAPE MARK)
REW	$GIO REW /238 (6C07 4400 A801, A$)	REWIND TAPE TO LOAD POINT (BOT)
REREAD	$GIO REREAD /238 (6C0A 4400 A801, A$) B$() C223	BACKSPACE ONE BLOCK AND READ THE BLOCK JUST READ, CORRECTING FOR SINGLE TRACK ERRORS
WGAP (WRITE GAP)	$GIO WGAP /238 (6C17 4400 A801, A$)	(WRITE A GAP ON TAPE (2.5") (PASS OVER BAD SPOT ON TAPE)
CLEAN (TAPE)	$GIO CLEAN /238 (6C4A 4400 A801, A$)	BACKSPACE TAPE OVER TAPE CLEANER AND REPOSITION AS ONE BSR OPERATION. (FIVE BSR's, FOUR FSR's, OR LESS IF BOT ENCOUNTERED)

Error Codes and Record Count

Arg 2 of the $GIO statement is an alphanumeric variable (or alphanumeric array element, or array) in which error, condition and record count information will be stored when the $GIO statement is executed. The error and condition information is stored in the 7th and 8th bytes of the alphanumeric variable record count is stored in the 9th and 10th bytes. The normal procedure would be to test and compare this variable after the $GIO tape operation is executed, to determine if the operation was completed successfully. For example,

Read a Record

(Known length, 256 bytes)

```
90 SELECT TAPE /238
100 $GIO READ (6C02 4400 C221 8A01, A$) B$()
110 IF STR(A$, 7, 4) = HEX(0000 0100) THEN 150
                           └─┬─┘ └─┬─┘
                             │     └── Count = 256
                             └──────── No errors
```

(Unknown length)

```
90 SELECT TAPE /238
100 $GIO READ (6C02 4400 C221 8A01, A$) B$()
110 IF STR(A$, 7, 2) = HEX(0000) THEN 150
                           └─┬─┘
                             └── No errors
...
...
150 L = 256*VAL(STR(A$, 9, 1)) + VAL(STR(A$, 10, 1)) (Convert Record
                                                       length to Decimal)
```

The complete list of errors, conditions and count information available to the 4 bytes of Arg 2 is listed below. Table II lists the Error/Count information applicable for each tape operation.

ARG 2 ERROR, CONDITION, AND RECORD COUNT INFORMATION

BYTE	BIT	INTERPRETATION
1 - 6		Unused
7	1	Always 0
	2	1 = if tape drive 'Not Ready' (off-line, rewinding, etc.)
This information is generated by the tape drive controller microcode	3	1 = if end of file (tape mark) sensed (READ, FSR, BSR, FSF, BSF, REREAD only)
	4	1 = if EOT sensed (during WRITE, WEOF, READ, REREAD, FSR, FSF)
	5	1 = if tape file protection ring in (WRITE, WEOF only)
	6	1 = if at load point (BOT) (BSR, BSF only)
	7	1 = if single track (correctable) data error on tape (READ only)
	8	1 = if data error on tape (e.g., Bad LRC (on tape or transmission 2200 to controller), VRC, CRC, data overrun) (WRITE, WEOF, READ, REREAD, FSR, BSR, FSF, BSF)
8	1 - 5	Always 0
This information is generated by $GIO microcode	6	1 = Invalid command word (Arg 1) or transmission error between 2200 and tape controller
	7	1 = Data transmission error between 2200 and tape controller (READ, REREAD)
	8	1 = If the tape record read is larger than the receiving array (READ, REREAD).
9 - 10	two byte binary	Total count of data bytes transferred in read or write operation.

III. OPERATION OF THE TAPE CONTROLLER

All tape operations will be handled by the tape controller microprocessor with the 2200 microprocessor merely controlling the transfer of command, data, and error information to and from the controller. The 2200 $GIO microcode will also partially verify that the command given is valid for the device (and set bit 6 of byte 8 of Arg 2) and will monitor the data transfer count (and set bytes 9 and 10 of Arg 2) and set bit 8 of byte 8 if a record is read which exceeds the available space in buffer, (Arg 3). If necessary, it will also set bit 7 of byte 8 of Arg 2 in the event of lost data during controller to 2200 transmission on read operations.

The controller functions for each command issued to it are:

Command	FUNCTION	UNUSUAL CONDITIONS
Read	Read the next block and transmit to 2200. Maintain single track error indicator.	If EOF encountered, set status bit; if tape not ready, set status bit; if EOT encountered, set status bit; if single track error encountered, set status bit; if multi-track error or overrun encountered, set status bit.
Reread	Backspace one block, then read the next block, correcting single track errors based on parity track setting. Treat as correct read (no single track error) if only corrected single track errors encountered on same track.	Same as for Read, except that single track read errors (same single track) are to be considered 'correct' and different track errors are to be considered as a data error.
Write	Write the next block, receiving data from the 2200.	If tape not ready, set status bit; if EOT sensed during write, set status bit; if tape protected, set status bit; if read-after-write error encountered (any kind) set data error bit.
WEOF	Write tape mark	Same as for Write
BSR	Backspace one block, always position to beginning of block.	If tape not ready, set status bit; if EOF sensed, set status bit; if load point, set status bit; (Remain at load point if encountered) spacing is done via recognizing gaps and ignoring data on records.
BSF	Backspace to first record after the tape mark (or load point).	Same as BSR
FSR	Skip over next block on tape. Position to beginning of following block.	If tape not ready, set status bit; if EOF sensed, set status bit; if EOT sensed during skip, set status bit; spacing is done via recognizing gaps and ignoring data on records.
FSF	Skip to beginning of next file (just after next tape mark).	Same as FSR
REW	Rewind the tape	If tape not ready, set status bit; if load point, set status bit (optional).
WGAP (Write Gap)	Issue an 'Erase Gap' command (Write 2.5" of blank tape). 3	If tape not ready, set status bit; if EOT sensed during Write, set status bit; if tape protected, set status bit.
Clean (tape)	Backspace the tape five blocks and then forward space the tape four blocks (to pass the medium over the cleaner heads). If load point is encountered during the backspace operation, begin forward spacing to reposition.	Should be logically treated as BSR operation (Note, load point sensed only if at very beginning of tape).

The programmer should note that according to ANSI standards, the minimum permissible block length is 18 characters. However, occasionally, noise records are found on tape and these will be reported back in the status field as data reads with less than the minimum number of bytes. (Usually, data errors will also occur for these noise records). The error handling programming of the tape subsystem must take this into account and merely proceed with reading the next block on tape. Although the ANSI standard also sets a maximum block size of 2048 bytes, the 2200 will read or write any size block which it may hold in memory.

IV. 2200/TAPE CONTROLLER SINGLE SEQUENCE

This section defines the signal sequence between the 2200 microprocessor and the tape controller microprocessor for tape operations. The tape operations on the 2200 will be carried out by the $GIO statement in the 2200 General I/O ROM Option. As previously described, Arg 2 of this command is a string of hexadecimal characters or the alphanumeric variables whose value which actually defines the signal sequence and the tape operation.

The signal sequence can logically be divided into three parts:

1. Command Sequence
2. Data Sequence
3. Termination Acknowledgement Sequence

The command and termination acknowledgement sequences are similar for all tape operations, (differing only in the command code sent to the tape controller and error bits that could be set in the termination code returned). The data sequence is used in the record read and write operations (READ, REREAD, WRITE).

A. Command Sequence

($GIO microcommands 6CXX 4400, where XX = command byte sent). This sequence occurs first for all tape operations.

2200	TAPE CONTROLLER
	1. Set Ready (RBS on 2250 = logic 0)
2. Test for Ready (RBI on 2250 = logic 0)	
3. Strobe out one byte to tape controller via CBS strobe (value of byte is a code which identifies the requested tape operation)	
	4. Receive tape operation command byte via a CBS strobe. Verify that it is a legal code. If it is wait for READY and echo it back to 2200 via IBS strobe. If it is not, wait for READY and echo back the complement of the code.
5. Set CPU Ready/Busy bit to Ready. (KBD = 0) (e.g., CRB = 0 on 2250)	
6. Receive a byte from the tape controller via IBS (KBD = 1)	
7. Verify the byte is identical to the original command byte. If it is, test Ready and send out a zero byte via a CBS strobe. If not set error bit in Arg 2 and terminate command.	
	8. Set Ready. Wait for CBS output strobe. If character is zero proceed with operation. If unequal to zero treat is as a new command byte and proceed from step 4.

The legal command bytes are listed below:

OPERATION	COMMAND BYTE (HEXADECIMAL)
READ	02
WRITE	01
WEOF	1F
BSR	27
FSR	37
BSF	2F
FSF	3F
REW	07
REREAD	0A
WGAP	17
CLEAN	4A

B. Data Sequence

The data sequence follows the command sequence in the READ, REREAD and WRITE tape operations only. There is no data sequence for other tape operations.

READ, REREAD ($GIO microcommand C221)

2200	TAPE CONTROLLER
1. Set Ready (KBD = 0) (e.g., CRB = logic 0)	
	2. Start tape; wait for 1st byte
	3. Read next byte from tape. Wait for 2200 Ready (CRB = 0). Strobe byte to 2200 via IBS.
4. Receive next data byte if ENDI set to zero save in Arg 3 buffer and continue at step 1. If buffer overflow, discard data, set error bit in Arg 2.	
	5. When last byte of record read (1 - 4 byte gap) wait for Ready and strobe LRC byte to 2200 via IBS with ENDI bit set to logic 1. Proceed with tape LRC, CRC checking.
6. If ENDI set to logic 1 on received byte, compare byte with LRC of data received. Set error bit in Arg 2 if unequal, store count in Arg 2.	

WRITE ($GIO microcommand A206)

2200	TAPE CONTROLLER
	1. Start tape, write GAP
	2. Set Ready (RBI = logic 0)
3. Wait for Ready, (RBI = 0), strobe next data byte via CBS output strobe. Repeat for all data bytes.	
	4. Receive next byte, if OBS strobe write on tape, continue at step 2.
5. When all data sent, check Ready, send LRC byte via CBS output strobe.	

6. If next received byte sent via CBS strobe, it is LRC of data. Save it. Finish writing record (LRC, CRC, GAP). When done compare sent LRC with calculate LRC, if unequal set data error. (Note data error also set if read after write LRC bad).

C. Acknowledgement Termination Sequence

($GIO microcommand 8A01)

This sequence occurs last for all tape operations.

2200	TAPE CONTROLLER
	1. Complete tape operation. Set all valid status and error bits in the termination status byte.
2. Set CPU Ready (KBD = 0) (e.g., 2250 RBI = 0)	
	3. Wait for 2200 Ready (RBI = 0) and send termination status byte via IBS strobe.
4. Receive termination status byte, save in Arg 2. Terminate $GIO command.	

TERMINATION STATUS BYTE

BIT	CONDITION
1	Always 0
2	1 = Tape Not Ready
3	1 = EOF Read
4	1 = EOT Sensed
5	1 = File Protect Ring
6	1 = BOT
7	1 = Single Track Error
8	1 = Data Error

Summary of $GIO Micro Commands Useful for Half Inch Tape

6CXX - Wait for ready, send CBS with XX data, set CRB to ready, accept an echo, verify that it matches, and terminate if not.

44XX - Wait for ready, send CBS with XX data.

A206 - Fast data output, with LRC, wait ready, strobe buffer character with/OBS, repeat till buffer done. Wait for ready, send LRC and CBS.

8A0Z - Set CRB to ready (0), wait for IBS, and save character in reg Z.

C223 - Fast data input, calculate LRC too. Set CRB to zero, IBS, check for ENDI, if not, save character in buffer and repeat. ENDI character is LRC, compare with calculated LRC, if not equal set error bit and terminate.
[illegible] count.

V. OTHER TAPE CONTROLLER DESIGN CONSIDERATIONS

1. Inter-record Gap Noise

The current thinking is that inter-record-gap noise will be treated simply as bad records. In addition to a bad LRC, CRC, type data error a short record count will be indicated by the $GIO logic. It is not anticipated that inter-record-gap noise will occur very often. If it appears to be more of a problem than anticipated, other considerations can be made.

2. End-of-tape Sensing

Since there is approximately 10 - 12 feet beyond the EOT mark, (which is on the reverse side of the tape), records can normally be written beyond the EOT. Therefore, all read, write and skip operations will be completed irregardless of whether EOT is sensed during the operation.

3. Backspace and Skipping Records and Files

It should be sufficient to SKIP or backspace records (and files) without interpreting the validity of the skipped records other than looking for EOF records. The algorithm could possibly be:

(1) Start tape motion
(2) Look for EOT bytes, if found treat as a record.
(3) If not found pass record (>12 to 18 continuous bytes)
(4) Wait for gap (X byte times without data) (where X > 5)

4. Stopping Tape in Inter-record Gap

(a) When writing, write 1/2 the Gap before the record, 1/2 the Gap after the record.

(b) When reading, skipping or backspacing, stop the tape so as to position the head approximately in the middle of the IRG.

TABLE II APPLICABLE ERROR INFORMATION BY TAPE OPERATION

OPERATION	ERROR INFORMATION										
	BYTE 7							BYTE 8			BYTES 9 -
	2 READY	3 EOF	4 EOT	5 PROTECT	6 BOT	7 RECOV. ERR.	8 ERROR	6 INVAL. CMD.	7 DATA TRAN. ERR.	8 BUF. OVFLW	COUNT
READ	X	X	X			X	X	X	X	X	X
WRITE	X		X	X			X	X	X		X
WEOF	X		X	X			X	X			X
BSR	X	X			X			X			
FSR	X	X	X					X			
BSF	X	X			X			X			
FSF	X	X	X					X			
REW	X				X			X			
REREAD	X	X	X				X	X	X	X	X
WGAP	X		X	X			X	X			
CLEAN	X						X	X			

Bruce Patterson

WANG LABORATORIES, INC.

ROBERT S. KOLK
MANAGER, SYSTEMS PROGRAMMING

MEMORANDUM

TO: Dr. Wang
cc: Paul Congo, Joe Wang, Bob Siegel, Fred Wang, Harold Koplow, Fritz Eberle, Bruce Patterson, Dave Angel
FROM: Bob Kolk
DATE: April 11, 1974
SUBJECT: PRELIMINARY HALF INCH MAG TAPE SPECIFICATIONS

I. TAPE DRIVE SPECIFICATIONS

a. Encoding/Density

There appears to be two major areas of concentration. They are:

9 TRACK - 800 BPI - NRZI
9 TRACK - 1600 BPI - Phase Encoded

We should eventually offer both of these units, with the initial development first concentrating on 800 BPI - NRZI. We could consider an approach with the 1600 BPI unit, to offer a slightly more expensive drive (25%) that will support both 800 BPI - NRZI and 1600 BPI PE. This would take care of customers who want 1600 BPI or both 800 and 1600.

b. Tape Speeds

Although we could probably support 25 IPS there are some reasons to consider staying with 12.5 IPS.

At 12.5 IPS with the highest density (1600 BPI), timing between bytes is approximately 50 µsec. This should allow us to directly pass a record into the 2200 without having to buffer it in the controller.

There are several advantages in doing this.

1. Records of any length can be read or written on the tape; using the General I/O Commands which will buffer data directly to or from an alphanumeric array.

2. The cost of a memory buffer on the Controller is eliminated.

3. The 12.5 IPS speed can also be supported by the 8080 microprocessor.

25 IPS could be supported for 800 BPI. It may be marginal at 1600 BPI if the controller were not buffered and/or if character conversion and read-after-write are requirements. The data rate at 12.5 IPS is sufficiently high.

c. Read-After-Write Capability

Although Read-After-Write capability is a more expensive approach, it should be considered. It offers better reliability and operation and is generally available on half-inch tape drives. Read-After-Write does not have to be done with byte by byte comparison or CRC checking. (IBM does only VRC, LRC checking for read-after-write). Therefore, for read-after-write the tape controller would have to support only VRC, LRC checking. Read-after-write could also be accomplished by backspacing and rereading after each write. This would be somewhat arkward, slow, and cause excessive wear on drives and tapes.

II. CONTROLLER SPECIFICATIONS

a. Tape Format

NRZI

The general requirements for 800 BPI - NRZI are to be able to read and write:

1. Tape blocks which meet both ANS and IBM standards for GAP and Data Block including spacing, LRC, CRC and VRC (Parity). These are pretty much identical except ANS allows only 2048 byte blocks, IBM uses longer record lengths. IBM also has additional record bytes for variable length and block records. These should be specially handled by the controller during READ operations, if EBCDIC to ASCII code conversion is offered. We should be capable of supporting ODD parity only and record blocks of any length.

2. Tape marks conforming to ANS and IBM standards. This is single byte data block (HEX(13)) followed by a LRC character only.

PE

There are a number of unique differences in the tape format of PE on IBM drives. These include:

(1) Each Data Block is preceeded and followed by 41 sync characters. It has no LRC or CRC characters.

(2) A data burst is recorded at the load point to indicate 1600 BPI PE.

(3) The PE tape mark is a multi-byte control byte.

If we offer a 1600 BPI PE drive it should conform primarily to IBM standards. Parity will be ODD.

b. Operational Requirements

The control should be capable if performing the following tape operations:

1. READ

The selected tape unit reads forward to the next interblock gap and stops. The information recorded on the data block is read and strobed to the 2200, one byte at a time. A LRC of the data transferred to the 2200 will be sent after the last data byte by a special strobe (special function bit set) to validate data transmission. If a read error occurred (VRC, LRC, CRC) or if a tape mark was read or if the EOT marker was sensed, these conditions or other error conditions will be sent to the 2200 with a termination strobe (special function bit set). If the requested read indicated EBCDIC to ASCII conversion, the data will be converted before being sent to the 2200. (For a special case of this, variable length records, the first two bytes will not be converted).

2. WRITE

The selected tape units move forward, write a GAP, and the data block strobed from the 2200 one byte at a time. Each byte will be written with ODD parity. Following the record the appropriate LRC, CRC character (800 BPI - NRZI) will be written along with the STOP gap. The last data byte sent by the 2200 will be followed by a special strobe (CBS) with a LRC for the data (to validate data transmission). If requested the transmitted data will be converted from ASCII to EBCDIC before being recorded on tape. (In a special case of this, variable length records the first two bytes will not be converted). If the write operation cannot be completed or a VRC, LRC error is indicated in the Read-After-Write check or a EOT marked is sensed during the write, it will be indicated in a final termination strobe sent to the 2200, (special function bit set).

3. SENSE

The current status of tape drive and detailed error information from the last tape operation will be strobed to the 2200 by the controller in a 4-byte sequence. (See Signal Sequence for detail).

4. CONTROL

All control operations will not involve data transfer. They will be terminated by a termination strobe sent to the 2200 indicating successful completion of the operation or error conditions.

(a) Rewind

The selected tape unit will be rewound to the load point (BOT).

(b) Rewind and Unload

The selected tape drive is rewound to the load point an placed in the REMOTE mode.

(c) Erase Gap

The selected tape unit move forward, erasing tape for approximately 3 1/2 inches. (Sense EOT)

(d) Write Tape Mark

A tape mark is written on the selected tape drive. (Sense EOT and Read-After-Write error conditions).

(e) Forward Space Block

The selected tape unit moves forward to the next interblock gap. No data is transferred. (Tape mark and EOT are sensed)

(f) Forward Space File

The selected tape unit moves forward to the interblock gap beyond the next tape mark. No data is transferred. (EOT is sensed)

(g) Backspace One Block

The selected tape unit moves backward to the nearest interblock gap or to load point. No data is transferred. (Sense tape mark, BOT)

(h) Backspace File

The selected tape unit moves backward to the interblock gap beyond the next tape mark or to the load point. (Sense BOT)

(i) Halt I/O

The RESET signal will cause all I/O operations to be halted, and the controller and tape drive set to RESET conditions.

5. DATA CONVERSION

There is one extremely useful feature which we should strongly consider for implementation within the tape microprocessor controller. That is a selectable ASCII to EBCDIC character conversion for written records and a selectable EBCDIC to ASCII character conversion for read records. This would be done dynamically during the read or write operations by ROM chip lookup. This would provide a capability on the 2200 to conveniently read or write IBM records which are entirely in display (EBCDIC) format.

Although this conversion could probably be accomplished by a TRANSLATE command we are planning to incorporate in the General I/O ROM, there would be several disadvantages.

(1) The user must supply conversion tables in his program which would be arkward, error prone, and consume space.
(2) Translation operation would be slower and less flexible.

Since the tape drive will be relatively expensive product, this automatic conversion feature would greatly enhance the overall product performance at relatively little additional cost.

Data record numeric formats other than display will still have to be converted under program control.

If it is impossible to do the conversion, and still read and write records "on-the-fly", the feature should be omitted. (It is probably more valuable to be able to read or write records of any length than have automatic EBCDIC/ASCII conversion).

6. I/O SIGNAL SEQUENCE

This section defines the signal sequence between the 2200 and the tape controller microprocessor. The tape operations on the 2200 will be supported by the General I/O ROM. Therefore, the signal sequence will be relatively fixed for a 2200 tape drive. On the other hand, the tape controller microprogram is generated via PROM chips. Therefore, the signal sequence can be easily modified for interfacing to other CPU units, providing the dynamic processing requirements can be met.

The signal sequence for 2200 tape control can essentially be divided into three parts:

1. Command Sequence
2. Data Sequence
3. Termination Acknowledgement

A. Command Sequence

The command sequence consists of one byte being strobed to the tape controller from the 2200 CPU to indicate the tape operation requested. It will be done via the 2200 CBS output strobe. It is echoed back to the 2200 for verification. The sequence is as follows:

1. The 2200 sends the tape command byte to the tape controller via a CBS strobe when the controller is ready (RB).

2. The tape sends the byte back to the 2200 via an INPUT strobe IBS, when the 2200 is ready. (CRB = 0).

3. If the byte is correct the 2200 will send a zero byte to the tape controller via a second CBS strobe when the controller is ready (RB). The operation may then commence. Any non-zero byte strobed at this point indicates a RESET condition, (i.e., the command control byte is being sent again).

FIGURE 1 COMMAND CONTROL BYTE

	0	1	2	3	4	5	6	7
WRITE	0	0	M	M	M	0	0	1
READ	0	0	M	M	M	0	1	0
SENSE	0	0	0	0	0	1	0	0
CONTROL	0	0	C	C	C	1	1	1
	1	1	N	N	N	0	1	1

where CCC

000	=	REWIND (REW)
001	=	REWIND and UNLOAD (RUN)
010	=	ERASE GAP (ERG)
011	=	WRITE TAPE MARK (WTM)
100	=	BACKSPACE BLOCK (BSB)
101	=	BACKSPACE FILE (BSF)
110	=	FORWARD SPACE BLOCK (FSB)
111	=	FORWARD SPACE FILE (FSF)

NNN

000	=	set mode to 1600 BPI, PE
001	=	set mode to 800 BPI, NRZI

MMM

001	=	Convert Record (EBCDIC/ASCII) For FIXED LENGTH RECORD (All Data Bytes)
011	=	Convert Record (EBCDIC/ASCII) VARIABLE LENGTH RECORD (Do not convert 1st 2 bytes)

B. Data Sequence

Depending upon the command requested the data sequence is applicable or bypassed.

WRITE The data bytes will be strobed one at a time to the tape controller on a ready/busy (RB) basis via the OBS strobe. Each byte will then be dynamically written on the tape with or without conversion. Following the last data byte a LRC (for the data) will be strobed to the tape controller via a CBS strobe. This will indicate all data has been sent. (The 2200 must support the transfer within 25 μsec./byte).

READ The data will be read by the controller, converted if specified and strobed to the CPU one byte at a time and a ready/busy basis (CRB). The data sequence will be terminated by a INPUT strobe with the special function bit set to one. The 8-bits of data sent with this strobe will be equivalent to the LRC of the data block. (The 2200 must support 25 μsec./byte transfer).

SENSE Four status bytes are strobed to the CPU from the tape control via a normal input strobe on a ready/busy basis (CRB).

Status Byte 1

Bit		
0	Ready Status	(1 = Ready 0 = Not)
1	On-Line Status	(1 = Remote 0 = On-Line)
2	Rewinding Status	(1 = Rewinding 0 = Read Point)
3	EOT Status	(1 = EOT 0 = NOT)
4	BOT Status	(1 = BOT 0 = NOT)
5	File Protect	(1 = File Protect (ring) 0 = None)
6	Spare	
7	Spare	

Status Byte 2

Spare

Status Byte 3, 4

Track error information bits.

ALL CONTROL FUNCTIONS - No Data Sequence

C. Acknowledge Termination

Following the command and data sequence for all tape operations, the tape controller will send a one byte strobe to the 2200 to terminate the I/O operation. The strobe will be a normal input strobe, but the special function bit in the 2200 will be set to 1. The 8-bits of data sent with this strobe will represent a error code indicating whether or not the operation has been successfully completed, and if not when error or sense conditions were present:

Termination Code

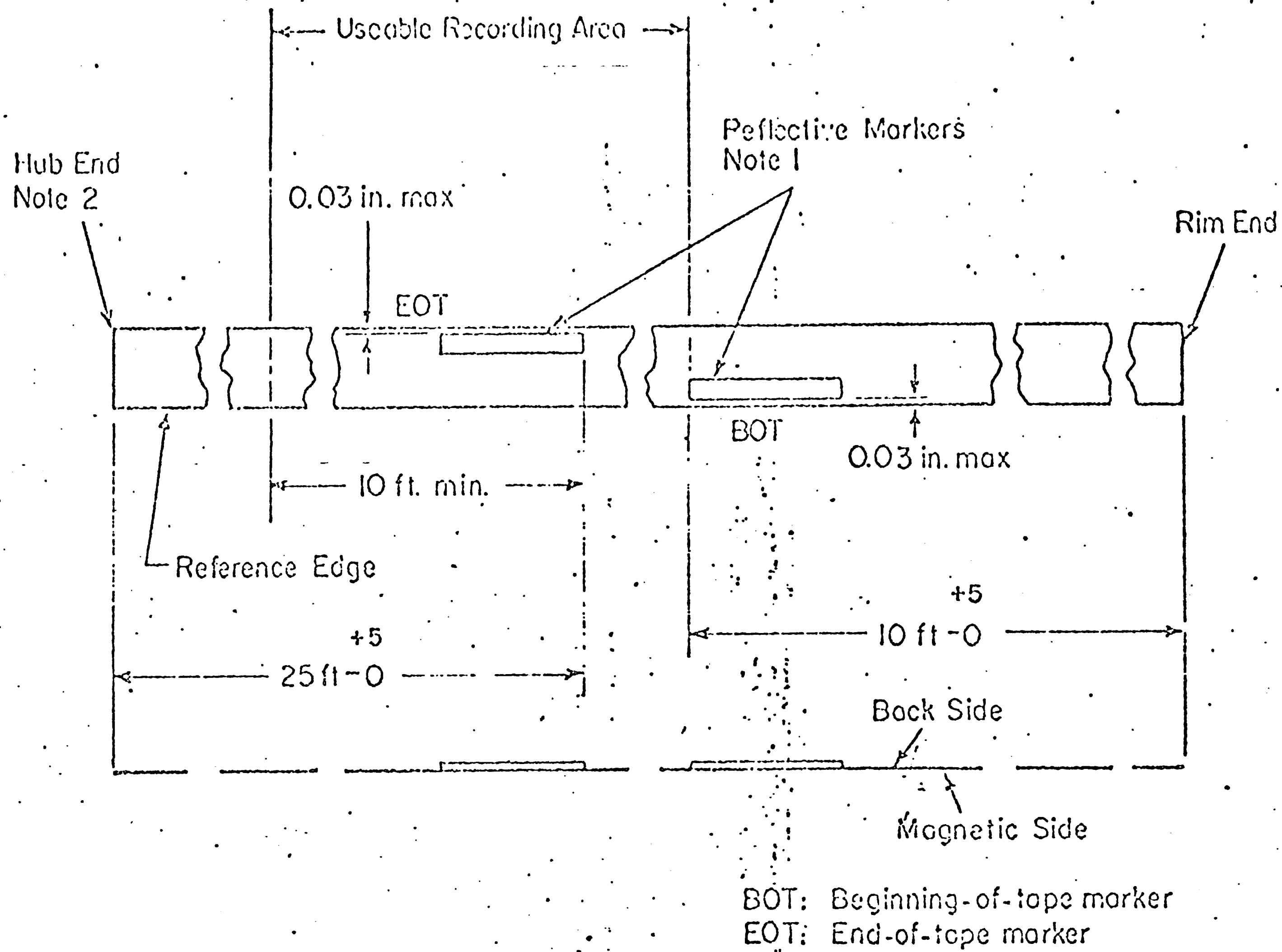
0	1	2	3	4	5	6	7		
0	0	0	0	0	0	0	0	=	No Error
1	0	0	0	0	0	0	0	=	Overrun (time-out)
0	1	0	0	0	0	0	0	=	Invalid VRC (R/W)
0	0	1	0	0	0	0	0	=	Invalid LRC (R/W)
0	0	0	1	0	0	0	0	=	Invalid CRC (R/W)
0	0	0	0	1	0	0	0	=	Other Error, (Use Sense)
0	0	0	0	0	1	0	0	=	BOT/EOT encountered
0	0	0	0	0	0	1	0	=	File Protected for Write
0	0	0	0	0	0	0	1	=	Data Transmission Error (2200 ⇄ Tape Controller)

7. ERROR AND SENSE CONDITIONS

The following table indicates the error checking and sense condition can be returned with each tape operation.

CONDITION

TAPE OPERATION		VRC	LRC	CRC	DATA TRANS LRC	LOAD POINT	EOT	TAPE MARK	OVERRUN
WRITE		X	X		X		X		X
READ		X	X	X	X		X	X	X
SENSE									
ERASE GAP							X		
FWD.SP.BLK							X	X	
FWD.SP.FILE							X		
BK.SP.BLK						X		X	
BK.SP.FILE						X			
WRITE TAPE MARK							X		



NOTES

1. Photo reflective markers shall not protrude beyond the edge of the tape and shall be free of wrinkles and excessive adhesive.

   Marker dimensions:

Length	1.1 inch ±0.2 inch
Width	0.19 inch ±0.02 inch
Thickness	0.0008 inch maximum

2. Tape shall not be attached to the hub.

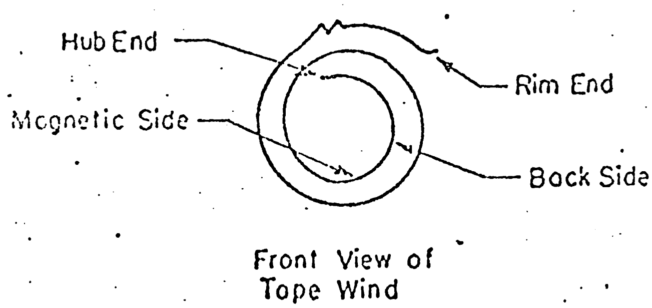
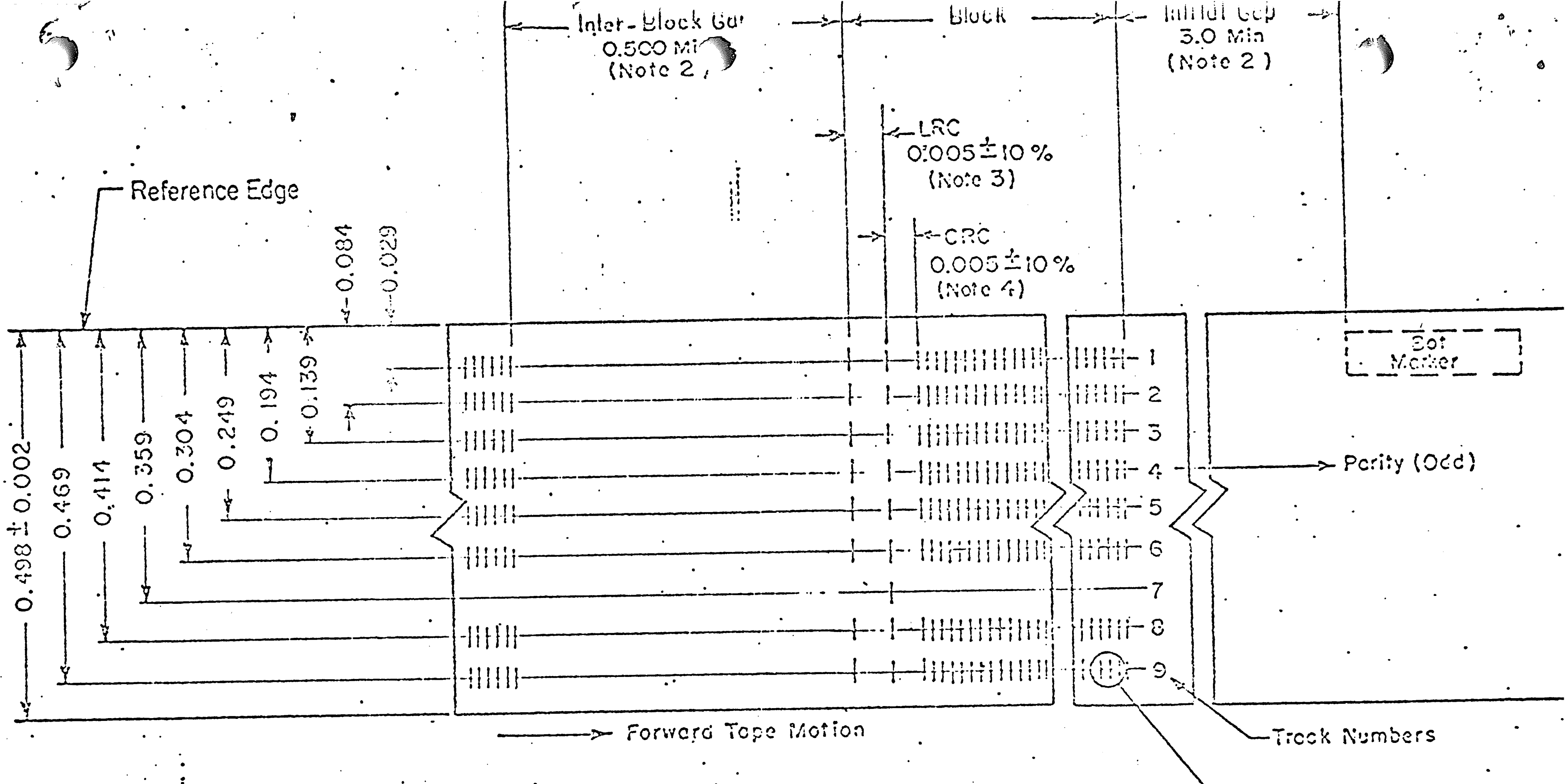


FIGURE 1. USEABLE RECORDING AREA



NOTES

1. Tape is shown with oxide side up, Read/Write head on same side as oxide. Tape shown representing NRZI recording; "1" bit produced by reversal of flux polarity, tape fully saturated in each direction.

2. Tape to be fully saturated in the erased direction in the interblock gap and the initial gap.

3. A longitudinal redundancy check bit is written in any track if the longitudinal count in that track is odd. Character parity is ignored in the longitudinal redundancy check character.

4. Parity of CRC character is odd, if an even number of data characters are written.

5. All dimensions are given in inches.

6. There is a track placement tolerance of

LEGEND

CPI - characters per inch
MIN - minimum
MAX - maximum
BOT - Beginning of Tape
LRC - longitudinal redundancy check
CRC - cyclic redundancy check

Figure 2. RECORDING FORMAT
(800 CPI)

draft Memo

To: H.A. Rothmann

From: D. Moros

Subj: 2200 Utility programs -- 1/2" Magnetic Tape

Date: 8-21-74

The 1/2" magnetic tape now under development is deisgned to be used ~~as a medi~~ primarily as a media transfer device between the 2200 and other computers. As such, Wang will be required to provide ~~with the device~~ a set of utilities with the device to perform the basic functions of data transfer to/from the tape from/to the various 'standard' 2200 media (disk, cassette, etc.).

This memo specifies the requirements of a pair of utility programs, one to read and one to write the 2200 tape peripheral.

In general, it is impossible to write a utility program which can handle all of the functions which a user could wish to perform on the data ~~present on~~ on a tape. Rather than attempt to over-generalize the utility programs, it is felt that a pair of relatively straightforward, well-documented programs should prove adequate for the large bulk of users. Indications within the program text itself should allow users to make ~~whatever~~ adjustments to the logic to handle specialized, unusual conditions.

Proper program design should ~~[illegible]~~ make for ~~[illegible]~~ relatively simple changes to the program to, for example, modify the 'get a record' subroutine to be changed from cassette to disk, or to allow the user to modify the contents of a record from EBCDIC or binary format to more suitable data types for 2200 manipulation. What should most carefully done, covering all possible conditions, is the process of error handling, when various types of transient and/or permanent anomalies are found on a tape written on another machine. The guiding principle of the utilities should be that if a tape is readable on another computer, it must be readable on the 2200.

I. Write Tape Utility

The Write Tape Utility (WTU) will start by requesting of the user the name of the file to be transferred and any positioning information which he may desire to enter. This will be expressed in terms of n files and/or m blocks. Once entered, the WTU will issue a REWIND command. If the tape is not ready (status word bit) or is write protected (status word bit), the program should issue an error message and stop. The user should have the option of restarting after taking necessary corrective action.

Next, the WTU should honor the positioning requests, spacing up the tape as necessary. The transfer file should then be opened (on the cassette -- or other -- medium), and the main read/write loop should be entered.

The main read/write loop consists of obtaining a record from the open data file, issuing a write command to the 1/2" tape device, and checking the results of the tape operation for unusual conditions, and, if none occurred, repeating the process. When an end of file condition is encountered on the open file, the main loop is terminated by issuing a WEOF command to the tape device. As records are written to the tape, a running display of the records should be displayed on the CRT screen.

In keeping with the concept of a 'representative' utility, the WTU should operate on an alphabetic array, (say, A$) of a nominal 400 bytes in length. This may be thought of as a set of card images, blocked as five logical records to a physical block. Convenient dimensions of the array could be:

DIM A$(10)40

but this dimension statement must agree with the contents of the data on the open file. Similarly, the reading of the open file must be clearly segregated as a modifiable subroutine, so that modifications can be made, as required, to change device types or data contents.

When an unusual condition is encountered after a tape device write operation, the below steps must be taken.

1) Tape not ready

   Display error message. Allow user to continue after taking appropriate action. Be sure to rewrite the current block.

2) Data Error

   Backspace the tape to the beginning of the record just written. Increment a displayed count of 'non-permanent write errors'. Issue an Erase Gap command, and attempt to write the block again. Maintain a count of the number of times this has been attempted without success. After 15 unsuccessful attempts on the current record, display a permanent write error message on the screen and stop processing.

~~processing~~.

3) End of Tape

If end of tape is encountered, write an end of file record on the tape device. Indicate the unusual condition on the screen, close all files, and terminate processing.

II. Read Tape Utility

The Read Tape Utility (RTU) will, in general, be similar to the operation of the WTU. It will be written to handle ~~xxx~~ data blocks of a nominal 400 bytes, presumably 80 character records blocked five. The nominal 2200 storage medium will be a tape cassette file. Where appropriate, the program should clearly indicate where and how code should be changed to handle larger or smaller blocks, use of a different 2200 device (e.g., disk or printer), operation on the contents of each text record (e.g., format conversion), and handling of variable length records.

The utility should operate properly as written for tapes with variable length records, with only the first portion of the array buffer variable (say, A$) being filled. It will probably not be necessary to prefill the array with blanks or other 'null' characters prior to each tape read, but indications of ~~how~~ where this can be done should be made. At the end of each tape read operation, the status field will contain a two byte binary count (bytes 9 and 10) indicating the number of bytes actually read. Indications should be shown as to how this field may be converted to a numeric ~~xxx~~ BASIC variable, so that the user may, if desired, construct variable length

~~output record~~

output records on the 2200 medium. The utility itself need not check for records of length less than that written to the 2200 medium.

As with the WTU, the RTU should begin by requesting of the user the name of the file to be transferred and positioning information: n files and/or m records to be skipped prior to the beginning of data read. Once entered, the RTU will issue a REWIND command. If the tape is not ready (status word bit) the program should issue an error message and stop. The user should have the option of restarting after taking necessary corrective action.

Next, the RTU should honor the positioning requests, spacing up the tape as necessary. The transfer file should then be opened, and the main read/write loop entered.

The main read/write loop consists of obtaining a record from the 1/2" tape device, checking the results of the operation for unusual conditions, and, if none occurred, writing the data record just read to the 2200 output medium, and continuing the loop. When an end of file condition is sensed on the tape, the main loop is terminated by writing an end of file record (this may be implicit in the 2200 close function) onto the 2200 medium and terminating processing. As records are read from the tape, a running display of the records should be displayed on the CRT screen.

When an unusual condition (other than end of file) is encountered after a tape READ operation, the below steps must be taken:

1) Tape not ready

Display error message. Allow user to continue after taking appropriate action.

2) Single track (correctable) error

Issue a REREAD command. If no errors on reread, continue normally. If reread error, consider as data error.

3) Data Error

Reposition the tape by issuing a backspace record (BSR) command. Reissue the READ command. If reissued read is successful, increment a displayed count of transient errors and continue normally. If reissued read indicates single track error issue a REREAD command. If sucessful, treat as successful reissued READ; if unsuccessful, treat as unsuccessful reissued READ. If reissued READ is unsuccessful, repeat the process forty times, or until a successful READ is obtained. After every fourth reissued READ, execute a CLEAN command in place of the BSR. If unsuccessful after this entire procedure, display a message indicating permanent read error on tape, display the contents of the record, and terminate processing.

4) End of Tape Sensed

If end of tape is sensed, accept the current block and set an indicator marking the presence of tape end. The next block on tape will be the last one to be read. If the next block is, as expected, a end of file block, terminate normally. If not, accept the next record and write it to the 2200 output medium. Display a message on the screen indicating that end of tape sensed without end of file, and terminate processing.

5) Input Record too long

If the block just read is ~~xxxxx~~ larger than the array variable specified in the READ command (status word bit), display a message indicating the condition, display the contents of the record on the CRT, together with its size, and stop. Allow the user the option of either terminating processing or accepting the partial record and continuing.

TO: H.A. ROTHMANN

FROM: R. GOODELL

2200 ½" Magnetic Tape Utility Package

The 2200 ½" Magnetic Tape Utility Package is composed of various hierarchical levels. The lowest level is the physical I/O level, the next higher level is the logical I/O level, and the highest ~~level~~ is utility program level. Routines on each level can reference routines on a ~~lower~~ lower level but not on a higher level i.e. the physical I/O routines can not reference the logical I/O routines.

Physical I/O.

The physical I/O level consists of routines for each of the valid tape commands e.g. READ (read next block), WEOF (write ~~end~~ tape mark). Each routine executes a specific tape command. ~~If no error is detected~~

If an error is detected, the routine takes remedial action. If the error can not be corrected, an appropriate message is written on the CRT. The user has the opportunity to perform corrective action and continue or terminate the program.

On successful execution, the routine returns to the calling program.

These routines make programming easier in that the programmer does not need to ~~remembe~~ remember the hexadecimal tape commands, the magnetic tape is more reliable through automatic error correction, and the routines provide a standard or basis for all higher levels. ~~There are routines for READ (read next block), REREAD (reread block: backspace and read), WRITE~~

The following routines are in the magnetic tape physical I/O level:

(1) READ (read next block),

(2) REREAD (backspace and read next block),

(3) WRITE (write next block),

(4) WEOF (write tape mark),

(5) BSR (backspace one block),

(6) BSF (backspace file),

(7) FSR (forward space block),

(8) FSF (~~sk~~ forward space file),

(9) REW (rewind tape).

~~F~~ Some of the above routines ~~will~~ can be ~~GS~~ GØSUB' routines with the GOSUB' reference integer < 16 so they can be ~~refer~~ executed via the keyboard (in order to position the magnetic ~~tape~~)

Logical I/O.

The logical I/O routines use the ~~pg~~ physical I/O level routines ~~and~~ to provide a file structure. ~~The~~ Open a file, read a logical record, write a logical record, and close a file ~~record~~ routines are provided. There are various file structures and methods of handling them depending on whether the file is input or output, the ~~systems~~ tapes of the file, i.e. IBM or ASCII, and method of processing the file parameters, i.e. whether supplied ~~&~~ directly by the program or through conversation with the user via the CRT. The read a record and write a record routines will block and unblock the physical records to logical records depending on the record format.

Utility Programs.

There are various utility programs that copy to and from ~~tt~~ the magnetic tape and other utility programs e.g. magnetic tape disk.

January 2, 1975

PRODUCT BULLETIN NO.110

Model 2209 Nine-Track Tape Drive

1. *Product Announcement and Description*

Wang Laboratories, Inc., is pleased to announce the availability of the Model 2209 Nine-Track Tape Drive. This is a highly reliable digital reading/recording unit, which can accept IBM compatible 1/2-inch (1.27 cm) tape reels up to 10.5 inches (26.7 cm) in diameter and tapes which conform to ANSI standard X3.72-1973 (see figures). A full 2400 foot (732m) tape can contain up to 20 megabytes of data. The unit reads and records in NRZI mode at a density of 800 bpi (bytes or characters/inch) [315 b/cm]. The Tape Drive transports tape at a velocity of 12.5 ips (inches/second) [32 cm/s] when reading or writing, and at up to 150 ips (381 cm/s) during rewind. The unit provides read-after write and single track error correction. It has a dual-gap read/write head containing an erase head, which automatically erases (degausses) any previously recorded data when a tape is being written. A tape cleaner is also contained in the unit.

2. *Product Fit*

With the capability to read and record IBM-compatible tapes, this unit fills a need for a large capacity medium which can interchange data between the 2200 and other computers and, secondarily, for a large capacity storage device for the 2200. Tape cassettes can store up to 78K bytes; the big disk, up to 10 megabytes (10 million bytes). A full 1/2 inch, 2400 foot tape can hold up to 20 megabytes. The only disadvantage of such tapes is the fact that data stored on them can only be accessed sequentially, but as a relatively inexpensive and large-capacity storage device a 9-track tape is superior to any other medium.

3. *Configuration*

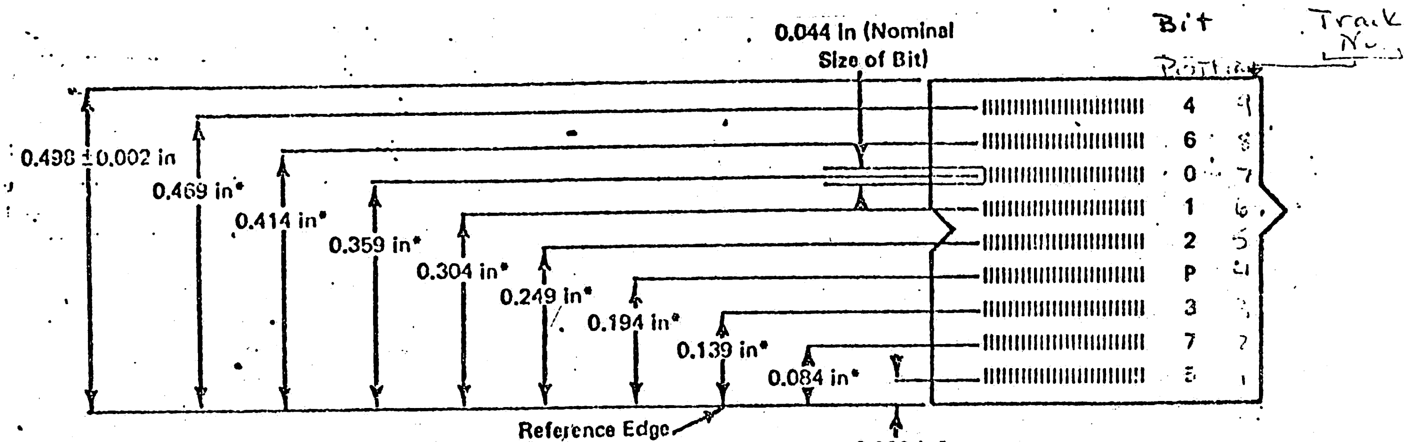
The Model 2209 Nine-Track Tape Drive requires a 2200B or C and the Option 2 I/O ROM (Read-Only-Memory). The Option 2 I/O ROM must be purchased separately.

4. *Associated Utilities*

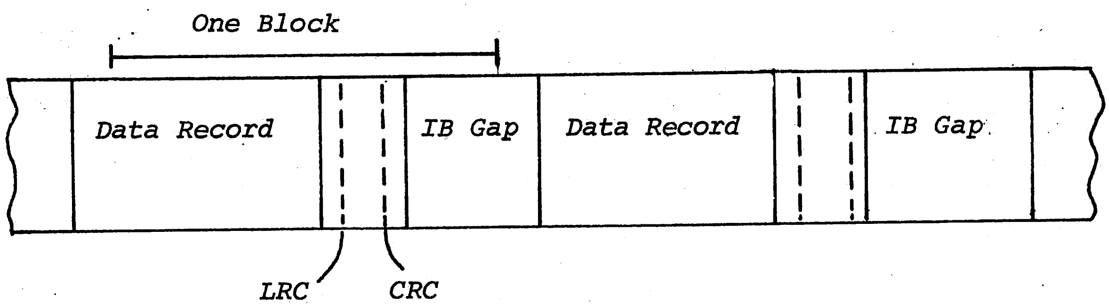
Planned utilities include a read/write and tape testing package and conversion routines to convert the most common IBM formats to the Wang 2200 formats. Note that the 9-track tape cannot be controlled with the usual System 2200 DATASAVE, DATALOAD statements; Option 2 statements ($GIO, etc.) must be used.

January 2, 1975

PRODUCT BULLETIN NO. 110



*All track locations ±0.003 in.



Recording Data Records in Blocks in the NRZI Mode

Figures Model 2209

WANG LABORATORIES, INC.
836 NORTH STREET, TEWKSBURY, MASSACHUSETTS 01876, TEL (617) 851-4111, TWX 710 343-6769, TELEX 94-7421

5. *Applications*

The most important application for which the Model 2209 can be used is the transfer of data between the System 2200 and other computers with tape drives.

6. *Features and Benefits*

FEATURES	*BENEFITS*
6.1. *Accepts reels up to 10.5 in (26.7 cm) in diameter with IBM compatible hubs.*	6.1. *Can read/write any full-length (2400 ft) standard size magnetic tape.*
6.2. *Records at 800 bpi (bytes or characters/in) (315 b/cm) in blocks; blocks are separated by interblock gaps (IBG) of 0.75 in (1.5 cm).*	6.2. *Can record up to 20 million bytes on a single full-length tape providing a large data file capability.*
6.3. *Read/Write tape operations at 12.5 ips (inches/sec) (32 cm/s).*	6.3. *This speed provides both optimum reliability and excellent data transfer rates.*
6.4. *Rewinds at speeds up to 150 ips (381 cm/s).*	6.4. *High-speed rewind minimizes rewind time.*
6.5. *Write Enable ring system is used.*	6.5. *Absolute file protection during read operations is provided; to write on a tape the WRITE ENABLE ring must be inserted in the slot in the back of the tape reel.*
6.6. *Flexible Record Sizes and Formats.*	6.6. *Utilizing the programming features provided in Option 2, records of any length up to 30,000 bytes can be read from or recorded onto tape. Record size depends on the amount of 2200 memory that is available. Because the read/write and the record data formatting and conversion operations are separated; it is possible (via programming) to format and write or read and convert a*

PRODUCT BULLETIN NO.110

variety of different record and code formats. If the record data is ASCII (American Standard Code for Information Interchange), programming is simplified. Other record formats can, however, be translated with appropriate conversion programming. Statements provided in Option 2 such as $TRAN, $PACK and $UNPACK can be extremely useful for the more efficient data conversion operations. Conversion of data to and from IBM external and internal decimal numeric formats can also be done efficiently with these statements.

6.7. The NRZI (non-return-to-zero, change on ones) mode of recording is used.

6.7. The NRZI mode has been designed for maximum reliability and error checking. Parity check bits are recorded in the most protected region of the tape and are used by the unit for automatic error checks during read operations.

6.8. The unit records a CRC (Cyclic Redundancy Character) and LRC (Longitudinal Redundancy Character) at the end of each data block.

6.8. The CRC and LRC's permit error checks as tape is read; in some cases, single-track errors can be automatically corrected by using the information in these characters.

6.9. Dual-gap read/write head.

6.9. The dual-gap configuration permits automatic checking as tape is written (read-after-write).

WANG LABORATORIES, INC.
836 NORTH STREET, TEWKSBURY, MASSACHUSETTS 01876, TEL (617) 851-4111, TWX 710 343-6769, TELEX 94-7421

7. *Competition*

Due to the great popularity of magnetic tapes, many companies manufacture tape drives; there are probably nearly 100 different units available. Tape drives that read and record in a 9-track format are currently the most popular because they provide the ability to read and record in the most universal USASCII-8 format (8 bits in 8 tracks) with the ninth track being used for recording the parity bit. However, even among the 9-track drives, many cannot accept large size 10.5 in. reels; the Model 2209 has this capability.

For interfacing any IBM format tapes with the System 2200, the Model 2209 is the obvious interchange medium since it provides not only the read/write capability which is required, but it is the only tape drive with a built-in interface to the Wang System 2200 and the only one which can provide adequate field service support for such an interface. Due to the complexity and sensitivity of this type of tape unit, field support is a critical factor.

Furthermore, the System 2200 is a minicomputer that provides the simplicity of the BASIC language, great ease of use and the enchanced flexibility of the I/O ROM to control nine track tapes. The controller and electronics of the Model 2209 have been specially designed to expand the use of tape drives and magnetic tapes into an operating environment which has significantly greater variation than normally permitted to a computer installation.

The Model 2209 additionally provides read-after-write redundancy checking and single-track error correction, features which are frequently absent from even much more expensive tape units.

8. *Operation*

This Tape Drive utilizes standard half-inch computer grade magnetic tape on reels with IBM-compatible hubs. File protection when reading a tape is provided by the unit with the usual WRITE ENABLE ring system (i.e., no data can be written on a tape unless the WRITE ENABLE ring has been inserted in the groove in the back of the tape reel).

Example 1:

The following routine writes a record on a nine-track tape. The record is in the System 2200 CPU as a 30-element array A$, with elements 20 characters long. The tape unit is selected with a SELECT TAPE statement; this becomes the default value for $GIO; X is the number of bytes/record.

```
10 DIM A$(30)20, B$(10)
20 DEFFN'1(X)
30 PRINT "WRITE"; X; "BYTE RECORD"
40 SELECT TAPE 07B
50 $GIO WRITE(6CFA 4400 A206 8607,B$)(A$()<1,X >
60 RETURN
```

Example 2:

The following routine rewinds a tape to the load point (BOT). In this example, the tape unit is selected via the file number designated.

```
5 SELECT #1 07B
10 DIM B$10
20 DEFFN'5: PRINT "REWIND"
30$GIO REWIND #1(6CF5 4400 8607,B$): RETURN
```

NOTE:

Updating in place equivalent to the operation of the DATA RESAVE statement cannot be programmed on the Model 2209.

Option 2 statements, particularly $GIO, must be used to operate the Model 2209; DATALOAD, DATASAVE statements cannot activate this unit.

9. *Specifications and Accessories*

Recording Density:	800 bpi in nine tracks (315 b/cm).
Recording Mode:	NRZI
Unit Type:	Reel-to-Reel
Tape Speed:	12.5 ips (32 cm/s)
Tape Specs:	Up to 10.5 in (26.7 cm) in diameter 1/2 in (1.27 cm) wide Full-width tested at 800 bpi Hubs compatible with IBM 2400 tape units
Rewind Speed:	150 ips (381 cm/s)
Head:	Dual gap
Compatible With:	ANSI X3.72-1973, IBM 2400 Series 9-Track, 800 bpi, NRZI.
Tape Buffer:	Tension Arms
Data Transfer Rate:	10KBS (Kilobytes/sec)
Drive Weight:	158 lbs. (71.6 kg) Approx. Net Weight
Drive Size:	Height: 28 in (71 cm)

PRODUCT BULLETIN NO.110

	Width:	*21 in (54 cm)*
	Depth:	*28 1/2 in (72 cm)*
Site Size:	*Height:*	*30 in (76 cm)*
	Width:	*23 in (59 cm)*
	Depth:	*Not less than 42 in (107 cm) to accommodate opening door.*
Power:	*115 VAC + 10%, 325 watts, 5amp circuit breaker*	
	230 VAC ± 10% 300 watts, 5amp circuit breaker	
	50 to 60 Hz ± 1 cps	
Operating Environment:	*Temperature: 60° to 90° F (16° to 32° C)*	
	Relative humidity: 20% to 80%, non-condensing.	
Non-Operating Environment:	*Temperature: -30° to 140°F(-34° to 60°C)*	
	Relative Humdiity: 15% to 95% non-condensing.	
	Altitude: not above 20,000 feet (6000 m)	
Accessories:	*Tape head cleaning pads*	
	1 reel of tape (up to 10.5 in [26.7 cm])	

WANG LABORATORIES, INC.
836 NORTH STREET, TEWKSBURY, MASSACHUSETTS 01876, TEL (617) 851-4111, TWX 710 343-6769, TELEX 94-7421

PRODUCT BULLETIN NO.110

10. Home-office Source for Questions

If you have any questions regarding this new product, call the Technical Information Center, Tewksbury.

DOMESTIC USA STATISTICS

Release Date February	Price $12,000.*
Initial Delivery April	Warranty Standard
Classified Mechanical	Commission 5%
Part No. 177-2209	

*includes Controller

WANG LABORATORIES, INC.
836 NORTH STREET, TEWKSBURY, MASSACHUSETTS 01876, TEL (617) 851-4111, TWX 710 343-6769, TELEX 94-7421

WANG LABORATORIES, INC.

M E M O R A N D U M

TO: Richard Kasson

FROM: Thea Iberall

DATE: August 16, 1977

SUBJECT: 800 BPI and 1600 BPI Tape Drive Utilities

It has been brought to our attention by John Urban that the Tape to Disk data transfer utility program fails to block the disk file correctly for certain blocking factors. It has also been observed that this program fails to place the trailer record in the correct location on the disk. The enclosed errata sheet points out all changes that any user should make to the current 1600 BPI and/or 800 BPI tape utilities so that these 2 problems will be corrected. These changes affect two programs only - the tape to disk data transfer program TPUT040B and the disk to tape data transfer program TPUT050B.

Thea Iberall

TI/slb

cc: P. Barthakur
D. Batcheldor
L. Conger
E. Demeo
B. Fallon
C. Glueck
D. Gowell
K. Lehto
W. Lynes
C. Masi
P. Proulx
J. Urban
B. Soucy
G. Tsetsilas

ERRATA SHEET
FOR 2209 AND 2209A TAPE UTILITIES

Statements that are starred (*) are changed or added.

Tape to Disk data transfer program - TPUTO40B - compressed code

1. Line 205 should have the following statements:

```
      DATA SAVE BA T#2, (A,A)D$()
      GOSUB 760
      STR(NO$(1),8,1) = "0"
*     DATA SAVE DC OPEN T#2, A-A1+2, NO$(1)
*     DSKIP #2, A-A1S
*     DATA SAVE DC #2, END
      DATA SAVE DC CLOSE #2
```

(The fourth statement is modified, two statements added, and the last statement removed).

2. Line 208 should be deleted.

3. Line 475 should have the following statements:

```
      DATA SAVE BA T#2, (A,A) D&()
*     IF A < A9-2 THEN 650
      GOSUB 760
      STR(NO$(1),8,1) = "1"
      DATA SAVE DC OPEN T#2, A9-A1, NO$(1)
*     DSKIP #2, A-A1S
*     DATA SAVE DC #2, END
      DATA SAVE DC CLOSE #2
```

(The second statement is modified, and two statements added.)

4. Line 481 should be deleted.

5. Line 670 should have the following statements:

```
IF P9 <= 0 THEN 635
IF (I8-1) * 64 + P2 > 256 THEN 470
RETURN
```

(The equal sign should be removed from the 2nd statement)

TPUT040B - source code

The following lines show the source program code in the three areas where the changes are needed:

```
205     DATA SAVE BA T#2,(A,A)D$()
206     GOSUB 760
207     STR(NO$(1),8,1)="0"
208     DATA SAVE DC OPEN T#2,A-A1+2,NO$(1)
209      DSKIP #2,A-A1S
210      DATA SAVE DC #2,END
211     DATA SAVE DC CLOSE#2
238     PRINT HEX(030A0A);" END OF THE PROGRAM"


475     DATA SAVE BA T#2,(A,A)D$()
476     IF A<A9-2THEN 650
477     GOSUB 760
478     STR(NO$(1),8,1)="1"
479     DATA SAVE DC OPEN T#2,A9-A1,NO$(1)
480      DSKIP #2,A-A1S
481      DATA SAVE DC #2,END
483     DATA SAVE DC CLOSE#2
545     GOSUB '248(1,0,8)


670     IF P9<=0THEN 685
671     IF (I8-1)*64+P2>256THEN 470
672     RETURN
```

Disk to Tape data transfer program - TPUTO50B - compressed code

1. Line 220 should have the following statements:

```
*    IF A >= A9 - 1 THEN 415
     DATALOAD BA T#2, (A,A) D$()
     I8, P2=1
     RETURN
```

(The first statement should compare A9-1 to A)

2. Line 355 should have the following statements:

```
     IF P9< = 0 THEN 370
*    IF (I8-1) * 64 + P2>256 THEN 220
     RETURN
```

(The equal sign should be removed from the 2nd statement)

TPUT050B - source code

The source program will look like this when the above changes are made to the 2 areas:

```
220     IF A>=A9-1THEN 415
221     DATA LOAD BA T#2,(A,A)D$()
222     I8,P2=1
223     RETURN

355     IF P9<=0THEN 370
356     IF (I8-1)*64+P2>256THEN 220
357     RETURN
```

Chris Glueck

WANG LABORATORIES, INC.

MEMORANDUM

'O: Bob Kolk, Pradeep Barthakur, Marty Saulenas, Chris Glueck, Sam Gagliano, Ed Demeo
'ROM: Roger Droz
ATE: March 16, 1978
UBJECT: New $GIO Sequences for the 2209A Tape drive on the MVP

he MVP specifications mention that the $GIO sequences for controlling the 2209A ape drive must be changed on the MVP. This memo documents these changes. All f the new sequences are compatible with the 2200VP. VP users may wish to adopt he new sequences as they do take advantage of some faster output capability on he VP.

he present $GIO sequences, documented in table 4-1 of the 2209A manual, will ead to an input timeout error (I92) on the MVP. The MVP cannot allow one artition to wait for an input strobe (8607) for a long time, as this would be fair to other users. The MVP hardware does not permit the MVP to switch users e an 860X microcommand has begun, because data may be lost in the process. he solution is to wait for the tape drive controller to become ready (1020) efore asking the board for input. Thus the change to the $GIO sequences is to nsert a 1020 microcommand after any CBS (44xx) that causes tape motion and efore the single character input (8607) that follows the tape motion commands.

s mentioned in the 2209A manual, it is not necessary to keep the tape ontroller board enabled throughout an entire tape operation. The example of a ook ahead read is given. In the example, the $IF ON statement is an acceptable ibstitute for the wait for ready microcommand (1020).

```
0 $GIO READ/07B (4400 1020 8607 442A C220, A$) B$()

r

0 $GIO LOOK AHEAD READ /07B (4400, A$)



0 $IF ON /07B, 500



00 $GIO READ CONTROLLER BUFFER /07B (1020 8607 442A C220, A$)
```

In the previous example, $IF ON and the 1020 microcommand in line 500 are redundant.

(An exception to the above is that tape motion stops if the tape drive controller is disabled during a skip file operation. The skip file operation is completed when the board again becomes enabled. A forthcoming ECN will fix this problem).

Another important MVP change is the increased importance of Master Reset (459C). The reset key on the 2236D console will not reset the tape drive controller. If a reset from the console happens to occur in the middle of the execution of a tape drive $GIO sequence, the tape drive controller will be left in a unpredictable state. In such cases, it is important that tape drive controller be reset by sending a CBS of HEX(9C) without waiting for ready (459C).

The Status $GIO sequence is currently documented as allowable at any time (CBS of 8B without waiting for ready). Experience has shown that reading controller status during tape operations sometimes interferes with proper controller operation. The status sequence should be used to read tape drive status when the tape is not in motion (448B rather than 458B). $IF ON or the $GIO microcommand 1010 should be used to test for "tape operation complete".

On the VP and MVP, the $GIO sequence 1300 A000 is a faster multi-character output than the A200 in the present tape drive manual. Because of the mechanics of starting and stopping the tape, the difference in data transfer time may not affect tape writing throughput, but it will allow better utilization of the MVP processor by other partitions.

To summarize, the new recommended VP/MVP $GIO sequences for the 2209A tape drive are listed below:

Backspace File	$GIO BSF /07B (4405 1020 8607, A$)
Backspace Record	$GIO BSR /07B (4404 1020 8607, A$)
Forwardspace File	$GIO FSF /07B (4402 1020 8607, A$)
Forwardspace Record	$GIO FSF /07B (4408 1020 8607, A$)
Read	$GIO READ /07B (4400 1020 442A C220, A$) B$()
Rewind	$GIO REWIND /07B (4446 1020 8607, A$)
Write EOF	$GIO WEOF /07B (4403 1020 8607, A$)
Write Gap	$GIO WGAP /07B (4407 1020 8607, A$)
Write	$GIO WRITE /07B (4429 1300 A000 4401 1020 8607, A$) B$()
Look Ahead Read (subset of Read)	$GIO LAR /07B (4400, A$)
Finish Read (subset of Read)	$GIO FR /07B (1020 8607 442A C220, A$) B$()

Buffer Write (subset of Write)	$GIO BW /07B (4429 1300 A000 4401, A$) B$()
Finish Write (subset of Write)	$GIO FW /07B (1020 8607, B$)
Master Reset	$GIO RESET /07B (459C, B$)
Status	$GIO STATUS /07B (448B 1020 8607, B$)

Proper operation of the 2209A with the MVP also requires at least Release 1.1 of the operating system.

4.7.5 DEFAULT DISK ADDRESS

Unlike the 2200VP, whose default disk address is always /310 after power on, the LVP's default disk address after power on is set to the address of the disk from which the system was loaded. That is

SF'00 sets default address to	/310
'01	/B10
'02	/320
'03	/B20

After partition generation, the default disk address for each partition is set to the default disk address of partition #1 at the time of partition generation.

4.7.6 CONTINUE

The LVP supports CONTINUE as an Immediate Mode statement rather than a command. Thus, CONTINUE need not be the only statement on a line; however, no statements may follow CONTINUE on the Immediate Mode line. This feature of CONTINUE is useful when program execution is to be continued with the terminal released to another partition. For example,

```
:$RELEASE TERMINAL : CONTINUE
```

4.8 PROGRAMMING THE 2209A ON THE 2200LVP or MVP

The present $GIO sequences, documented in table 4-1 of the 2209A manual, will lead to an input timeout error (I92) on the LVP. The LVP cannot allow one partition to wait for an input strobe (8607) for a long time, as this would be unfair to other users. The LVP hardware does not permit the LVP to switch users once an 860X microcommand has begun, because data may be lost in the process. The solution is to wait for the tape drive controller to become ready (1020) before asking the board for input. Thus the change to the $GIO sequence is to insert a 1020 microcommand after a CBS (44xx) that causes tape motion and before the single character input (8607) that follows the tape motion commands.

As mentioned in the 2209A manual, it is not necessary to keep the tape controller board enabled throughout an entire tape operation. The example of a look ahead read is given. In the example, the $IF ON statement is an acceptable substitute for the wait for ready micro-command (1020).

```
10 #GIO READ/07B (4400 1020 8607 442A C220, A$) B$ ()
or
20 $GIO LOOK AHEAD READ /07B (4400, A$)
.
.
.
30 $IF ON /07B, 500
.
.
.
500 $GIO READ CONTROLLER BUFFER /07B (1020 8607 442A C220, A$)
```

In the previous example, $IF ON and the 1020 microcommand in line 500 are redundant.

Another important LVP change is the increased importance of Master Reset (459C). The reset key on the 2236DE console WILL NOT reset the tape drive controller. If a reset from the console happens to occur in the middle of the execution of a tape drive $GIO sequence, the tape drive controller will be left in an unpredictable state. In such cases, it is important that tape drive controller be reset by sending a CBS of HEX (9C) without waiting for ready (459C).

The Status $GIO sequence is currently documented as allowable at any time (CBS of 88 without waiting for ready). Experience has shown that reading controller status during tape operations sometimes interferes with proper controller operation. The status sequence should be used to read tape drive status when the tape is not in motion (448B rather than 458B). $IF ON or the $GIO micocommand 1010 should be used to test for "tape operation complete".

On the LVP, the $GIO sequence 1300 A000 is a faster multi-character output than the A200 in the present tape drive manual.

To summarize, the new recommended LVP $GIO sequence for the 2209A tape drive are listed below:

Backspace file	$GIO BSF /07B (4405 1020 8607, A$)
Backspace record	$GIO BSR /07B (4404 1020 8607, A$)
Forwardspace file	$GIO FSF /07B (4402 1020 8607, A$)
Forwardspace record	$GIO FSF /07B (4408 1020 8607, A$)
Read	$GIO READ /07B (4404 1020 8607 442A C220, A$) B$()
Rewind	$GIO REWIND /07B (4446 1020 8607, A$)
Write EOF	$GIO WEOF /07B (4403 1020 8607, A$)
Write Gap	$GIO WGAP /07B (4407 1020 8607, A$)
Write	$GIO WRITE /07B (4429 1300 A000 4401 1020 8607, A$) B$()
Look Ahead Read (Subset of Read)	$GIO LAR /07B (4400, A$)
Finish Read (Subset of Read)	$GIO FR /07B (1020 8607 442A C220, A$) B$ ()
Buffer Write (Subset of Write)	$GIO BW /07B (4429 1300 A000 4401, A$) B$ ()
Finish Write (Subset of Write)	$GIO FW /07B (1020 8607, B$)
Master Reset	$GIO RESET /07B (459C, B$)
Status	$GIO STATUS /07B (448B, 1020 8706, B$)

WANG LABORATORIES, INC.

MEMORANDUM

TO: Bob Kolk, Pradeep Barthakur, Marty Saulenas, Chris Glueck, Sam Gagliano, Ed Demeo
FROM: Roger Droz
DATE: March 16, 1978, Revised March 29, 1978
SUBJECT: New $GIO Sequences for the 2209A Tape drive on the MVP

The MVP specifications mention that the $GIO sequences for controlling the 2209A tape drive must be changed on the MVP. This memo documents these changes. All of the new sequences are compatible with the 2200VP. VP users may wish to adopt the new sequences as they do take advantage of some faster output capability on the VP.

The present $GIO sequences, documented in table 4-1 of the 2209A manual, will lead to an input timeout error (I92) on the MVP. The MVP cannot allow one partition to wait for an input strobe (8607) for a long time, as this would be unfair to other users. The MVP hardware does not permit the MVP to switch users once an 860X microcommand has begun, because data may be lost in the process. The solution is to wait for the tape drive controller to become ready (1020) before asking the board for input. Thus the change to the $GIO sequences is to insert a 1020 microcommand after any CBS (44xx) that causes tape motion and before the single character input (8607) that follows the tape motion commands.

As mentioned in the 2209A manual, it is not necessary to keep the tape controller board enabled throughout an entire tape operation. The example of a look ahead read is given. In the example, the $IF ON statement is an acceptable substitute for the wait for ready microcommand (1020).

```
10 $GIO READ/07B (4400 1020 8607 442A C220, A$) B$()
```

or

```
20 $GIO LOOK AHEAD READ /07B (4400, A$)
•
•
•
30 $IF ON /07B, 500
•
•
•
500 $GIO READ CONTROLLER BUFFER /07B (1020 8607 442A C220, A$)
```

In the previous example, $IF ON and the 1020 microcommand in line 500 are redundant.

(An exception to the above is that tape motion stops if the tape drive controller is disabled during a skip file operation. The skip file operation is completed when the board again becomes enabled. A forthcoming ECN will fix this problem).

Another important MVP change is the increased importance of Master Reset (459C). The reset key on the 2236D console will not reset the tape drive controller. If a reset from the console happens to occur in the middle of the execution of a tape drive $GIO sequence, the tape drive controller will be left in a unpredictable state. In such cases, it is important that tape drive controller be reset by sending a CBS of HEX(9C) without waiting for ready (459C).

The Status $GIO sequence is currently documented as allowable at any time (CBS of 8B without waiting for ready). Experience has shown that reading controller status during tape operations sometimes interferes with proper controller operation. The status sequence should be used to read tape drive status when the tape is not in motion (448B rather than 458B). $IF ON or the $GIO microcommand 1010 should be used to test for "tape operation complete".

On the VP and MVP, the $GIO sequence 1300 A000 is a faster multi-character output than the A200 in the present tape drive manual. Because of the mechanics of starting and stopping the tape, the difference in data transfer time may not affect tape writing throughput, but it will allow better utilization of the MVP processor by other partitions.

To summarize, the new recommended VP/MVP $GIO sequences for the 2209A tape drive are listed below:

Backspace File	$GIO BSF /07B (4405 1020 8607, A$)
Backspace Record	$GIO BSR /07B (4404 1020 8607, A$)
Forwardspace File	$GIO FSF /07B (4402 1020 8607, A$)
Forwardspace Record	$GIO FSF /07B (4408 1020 8607, A$)
Read	$GIO READ /07B (4400 1020 8607 442A C220, A$) B$()
Rewind	$GIO REWIND /07B (4446 1020 8607, A$)
Write EOF	$GIO WEOF /07B (4403 1020 8607, A$)
Write Gap	$GIO WGAP /07B (4407 1020 8607, A$)
Write	$GIO WRITE /07B (4429 1300 A000 4401 1020 8607, A$) B$()
Look Ahead Read (subset of Read)	$GIO LAR /07B (4400, A$)
Finish Read (subset of Read)	$GIO FR /07B (1020 8607 442A C220, A$) B$()

Buffer Write (subset of Write)	$GIO BW /07B (4429 1300 A000 4401, A$) B$()
Finish Write (subset of Write)	$GIO FW /07B (1020 8607, B$)
Master Reset	$GIO RESET /07B (459C, B$)
Status	$GIO STATUS /07B (448B 1020 8607, B$)

Proper operation of the 2209A with the MVP also requires at least Release 1.1 of the operating system.

TECHNICAL NOTE #2608
Author: 2200 Development Group
Date: August 24, 1979
Subject: Additions to 2209A Documentation (Half Inch Tape)

A. Potential impact of ECN 12599/12600 on 2209A software

The recent ECN to the 2209A has the effect of increasing the error detection capability of the 2209A tape drive. While this is good generally, it has the side effect of causing phantom errors on certain operations. Hopefully, this won't cause any problems with the majority of software available, but this technical note will explain the proper method for identifying and correcting any difficulties.

The ECN involves the 80 bit of the tape controller status byte (called HARD ERROR in the documentation, 80 bit, byte 7 of arg 2 of the $GIO). Previously, the controller did not flag any error that didn't occur in conjunction with a data strobe. This meant that the 80 bit could only come on during a READ, WRITE, and WEOF. Unfortunately, it also meant that some errors went undetected. The ECN causes any error during any tape operation to be detected. This greatly improves reliability with marginal tapes.

According to the 2209A NINE TRACK TAPE DRIVE USER MANUAL, table 4-3, the 80 error is only indicated for the READ, WRITE, and WEOF commands. If software took this literally, it should mask off this bit for any other commands before checking for errors. In at least one program, our diagnostic, this was not done. Consequently, after the ECN our diagnostic will discover errors that are not meaningful. For example, if the 80 bit comes on during a BSR, it should not be considered as an error condition.

To clarify the manual, the following suggestion should be added. Before checking the status bytes, byte 7 should be ANDed with the following masks:

Operation	mask	conditions
READ	8C	Read error, EOT, EOF
WRITE	98	Read-after-write, File protect, EOT
WEOF	98	(same)
BSR	24	BOT, EOF
FSR	0C	EOT, EOF
BSF	20	BOT
FSF	08	EOT
REWIND	00	none
WGAP	18	File protect, EOT

After masking (e.g. STR(B$,7,1)= AND HEX(8C)), bytes 7 and 8 may be checked for errors with common logic. The only conditions remaining that do not represent errors are EOF, BOT, and EOT, all of which require special processing. The choice of the masks above eliminates flag bits that a program normally wouldn't care about.

B. Retry after a read-after-write error:

After detecting the 80 error on a WRITE or WEOF, do a BSR, WGAP, and repeat the original operation. If the error recurs, repeat up to ten times. At this point a hard error has occurred.

After the above-mentioned ECN has been installed, this retry method should prove to make very reliable tapes. The testing we have been doing involves the use of a tape which had been giving trouble even before we deliberately damaged the tape. Thus there are two bad spots on the tape that give different symptoms. In extensive testing on deliberately damaged tapes, the drive has encountered hundreds of read-after-write errors (each of which was correctable using the above algorithm) and zero read errors.

C. Hard read errors:

When a hard error is encountered in reading a tape, it is not sufficient to simply backspace the tape and rewrite the one record. The entire remainder of the tape should then be considered invalid. This points up the utter importance of read-after-write, as discovering the error during a later verify pass is totally inappropriate.

An example would consist of a copy from disk to tape, followed by a verify pass to check the validity of the copy. When an error occurs during the verify, it is essential to rewrite the remainder of the tape. In this case that involves simply issuing a BSR, and branching to the appropriate part of the copy loop. Obviously, this is timeconsuming if errors recur, but is much more reliable than attempting to trust an update in place.

D. Backing up multiplexed disks:

When backing up a multiplexed disk, it is essential to Hog the disk platter. Otherwise, a verify may "discover" differences that are in fact simply changes made during the backup by another CPU. In the extreme, these changes could make part of the backup useless, as a file may be in the process of changing during the copy.

Service Newsletter

NO. 173

November 16, 1979

MASS STORAGE DEVICES #37

FORMATTER MODIFIC. # 9219

2209A: HIGH ALTITUDE CONVERSION

The 2209A 9-Track Tape Drive, as it is shipped from Manufacturing, is designed to operate at an altitude between sea level and 4000 feet (8000 feet for 220/240 VAC units). Certain modifications have to be made to the tape drive if it is to be operated at altitudes above those previously specified. The necessary changes are related to the Vacuum Blower Assembly (RE: Kennedy manual: Model 9100 Vacuum Column Tape Transport Operation and Maintenance Manual; Section V, Parts Identification; Figure entitled 'Vacuum Blower Assembly: Bottom View'). The Blower Motor Pulley and Flat Belt (Items 2 and 3 in the assembly figure) have to be changed to adapt the unit for high-altitude use. The charts below show the appropriate part numbers for the various belts and pulleys.

110 VAC, 60 HZ UNITS

ALTITUDE	BELT		PULLEY	
	WL #	OEM #	WL #	OEM #
0'-4000'	726-6191	835-0056-001	726-6143	291-5845-101
4000'-8000'	726-6191	835-0056-001	726-1305	291-5845-102
ABOVE 8000'	726-1307	835-0056-002	726-1306	291-5845-103

220/240 VAC, 50 HZ UNITS

ALTITUDE	BELT		PULLEY	
	WL #	OEM #	WL #	OEM #
0'-8000'	726-6191	835-0056-001	726-1306	291-5845-103
ABOVE 8000'	726-1307	835-0056-002	726-1308	291-5845-104

WANG LABORATORIES, INC.
ONE INDUSTRIAL AVENUE, LOWELL, MASSACHUSETTS 01851, TEL. (617) 851-4111, TWX 710 343-6769, TELEX 94-7421

Printed in U.S.A.
13-266

After modification, the vacuum must be rechecked. Refer to Kennedy manual; Section IV, Maintenance Instructions; Subsections entitled 'Vacuum Switch' and 'Vacuum Column Adjustment' for correct adjustment procedure.

NOTE:

If a Vacuum Blower Assembly is modified, a notation should be made on the assembly stating its operating altitude ranges. For example, a sticker with the information "Blower Assembly is for use with 110VAC, 60HZ; 4000'-8000' altitude <u>only</u>" printed on it can be placed on the top of the blower.

On the LVP, the $GIO sequence 1300 A000 is a faster multi-character output than the A200 in the present tape drive manual.

To summarize, the new recommended LVP $GIO sequence for the 2209A tape drive are listed below:

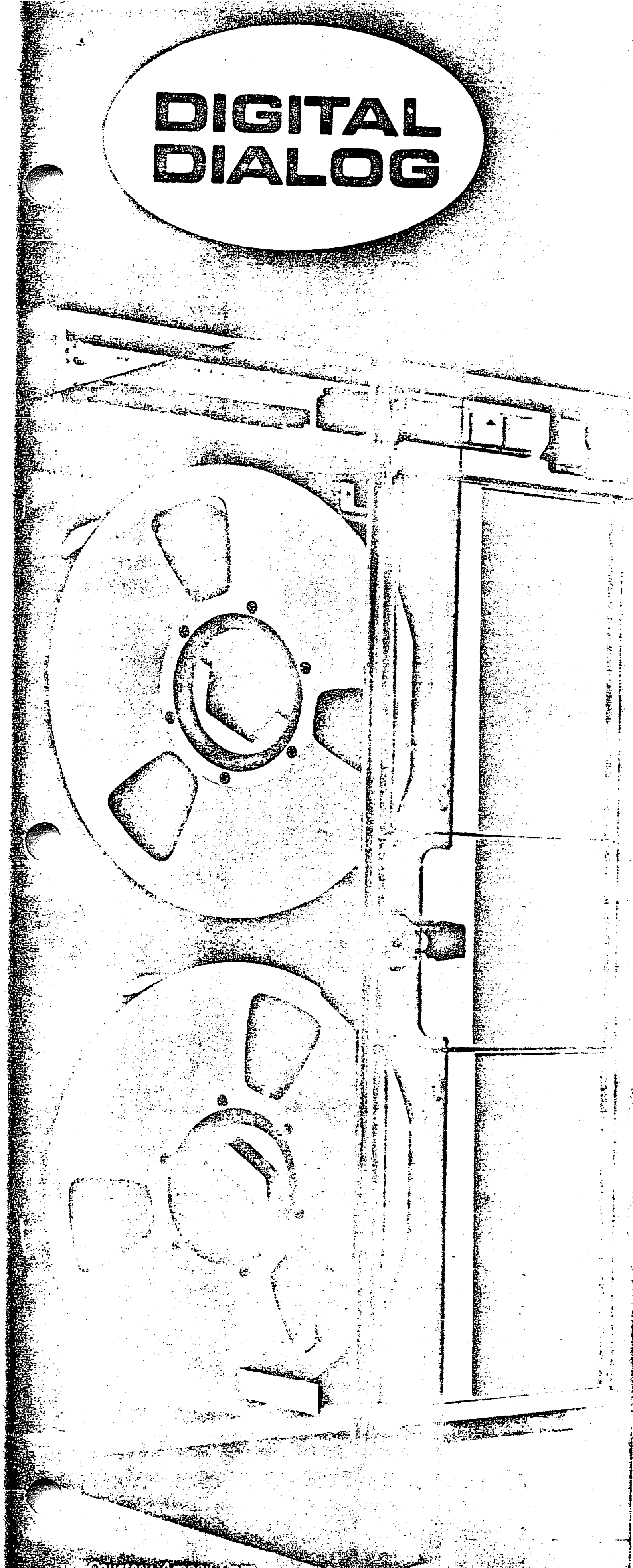
Backspace file	$GIO BSF /07B (4405 1020 8607, A$)
Backspace record	$GIO BSR /07B (4404 1020 8607, A$)
Forwardspace file	$GIO FSF /07B (4402 1020 8607, A$)
Forwardspace record	$GIO FSF /07B (4408 1020 8607, A$)
Read	$GIO READ /07B (4404 1020 8607 442A C220, A$) B$()
Rewind	$GIO REWIND /07B (4446 1020 8607, A$)
Write EOF	$GIO WEOF /07B (4403 1020 8607, A$)
Write Gap	$GIO WGAP /07B (4407 1020 8607, A$)
Write	$GIO WRITE /07B (4429 1300 A000 4401 1020 8607, A$) B$()
Look Ahead Read (Subset of Read)	$GIO LAR /07B (4400, A$)
Finish Read (Subset of Read)	$GIO FR /07B (1020 8607 442A C220, A$) B$ ()
Buffer Write (Subset of Write)	$GIO BW /07B (4429 1300 A000 4401, A$) B$ ()
Finish Write (Subset of Write)	$GIO FW /07B (1020 8607, B$)
Master Reset	$GIO RESET /07B (459C, B$)
Status	$GIO STATUS /07B (448B, 1020 8706, B$)

WANG LABORATORIES, INC.

OPERATING MANUAL ADDENDUM FOR MODEL 9025 DUAL DENSITY TAPE SYSTEM

IMPORTANT

As stated in the Utilities Manual (Pg. 1), & the User Manual (Pg. 2), the maximum physical record (block) can be up to 4096 bytes. This is the capacity of the I/O Buffer. That statement is true only when in the 1600 BPI Mode. When in the 800 BPI Mode, the usable buffer is two byte less than 4096, or 4094 bytes.



Courtesy Ampex Corp.

REEL TO REEL MAGNETIC TAPE DRIVES

how these higher-priced transports stack up against cassette, cartridge and floppy disk machines

What benefits does a reel-to-reel magnetic tape drive offer? When and why should you invest the extra capital for these larger capacity machines? How is their technology changing? Answers to these questions come from manufacturers who make reel-to-reel machines.

• How should a user decide whether to purchase a reel-to-reel magnetic tape drive vs. cartridge, cassette or floppy disk recording unit for his application?

"At least five criteria determine which type of drive to use: capacity, interchangeability, reliability, cost and transfer rate," claims Norman Gruczelak, president, Bright Industries.

John B. Koelle, manager, product support, Mohawk Data Sciences, agrees, but adds the criteria of operator convenience, space and (where appropriate) expansion capability. Gerald A. Lembas, product manager, magnetic products, Pertec Peripheral Equipment, wants to include power requirements in the selection criteria. However, John T. Jansen, vice president, engineering, Datran Corp., insists, "Probably the most important factor in the reel-to-reel vs. cartridge/cassette/floppy disk decision is whether the application involves computer-generated data or computer input data."

capacity

"Half-inch ANSI/IBM compatible tape reels cover a broad spectrum of large data storage requirements. A 10-½" reel of tape can easily store 46 million bytes of data at 1600 bpi: 8-½" reels, 23 million bytes; and 7" reels, 11 million bytes. On the other hand, the Philips cassettes using 2 channel 800 bpi recording are capable of storing one million bytes; the 3M cartridge, 3 million bytes at 1600 BPI; and the floppy disc, a half-million bytes. Whether the application is data entry or retrieval, if you need 5 million or more bytes of storage, your only choice becomes reel-to-reel tape," says Gruczelak.

interchangeability

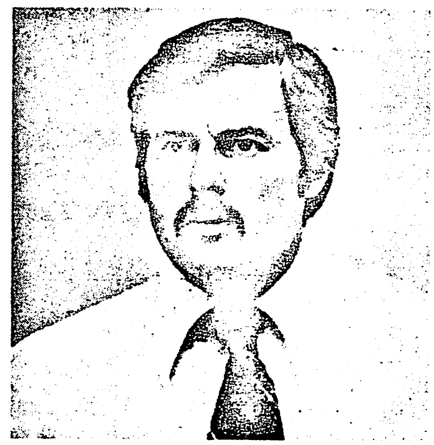
"Does the drive need to use tape with an industrywide compatability?" asks Lembas. "If interchangeability is necessary, is ANSI or IBM compatability important? A yes to both questions obviously reduces the inquiry to considering only ½"-wide tape and the floppy or moving-head disk. Most large data entry and gathering systems use the ½" tape and/or the moving-head disk. If you are not concerned with industry compatibility, then you may consider using other types of recording media."

Looking at the question of interchangeability from a different point of view, Peter A. Gilbody, director of marketing, Cipher Data Products, notes, "The user should consider several criteria before making his choice. First and perhaps most obviously he should answer the question, 'Do I need IBM compatibility?' If he is using an IBM computer or is tied into an IBM CPU, his choice is probably predetermined, even to the number of tracks, density and format. However, should the user not have to talk to an IBM machine, he can make a choice that will save him considerable money. A cassette system offering comparable error-free operation can be his answer. The main tradeoff may be merely transfer speed. My company offers the user full read-after-write data verification and transfers data at 2400 cps. It is fully ANSI/ECMA/ISO-compatible giving him interchange capability with other cassette devices meeting these international specifications."

Agreeing with Gilbody, John Jansen says, "In applications where the tape remains with the same system—a terminal or minicomputer—and doesn't require compatibility with any other equipment, cassette or cartridge machines can, in most cases, provide economic advantages."

John B. Koelle, Mohawk Data, "I do not expect vacuum buffering to be replaced in the foreseeable future" . . .

Norman Gruczelak, Bright Industries, "At least five criteria determine which type of drive to use: capacity" . . .



Gerald A. Lembas, Pertec, "If interchangeability is necessary, is ANSI or IBM compatibility important?"

reliability

"Half-inch reel-to-reel systems can easily provide reliability on the order of one error in 10^9 bytes. Also the tape can withstand 20,000-30,000 passes without significantly increasing error rates. Neither cassette nor cartridge have come close to achieving such reliability. Floppy disc reliability remains to be proved," claims Bright Industries' Gruczelak.

"As you match the requirements to equipment specifications," explains Pertec's Lembas, "the number of alternatives diminish, especially if you want long media life and data reliability greater than one bit in 10^7. Keep in mind that data density and format play an important role in establishing data reliability. Sophisticated self-correcting recording schemes for cassettes and cartridges could provide reliability approaching ½"-wide magnetic tape."

cost

According to C. deBree, senior product manager, Ampex, reel-to-reel equipment has the highest cost and reliability, and produces tapes which you can use for inputting data directly into a computer, thus avoiding a tape-to-tape conversation, if you need further computer processing. Cartridge transports are much lower in cost, are reliable and compact, but are not directly computer-compatible, unless the manufacturer has designed his equipment to match the computer needs. Cassette machines cost even less than their cartridge counterparts, but are reliable at very low rate densities, thus offering low data rates. Floppy disk drives are fast, reliable, small, but cost more than cartridge and cassette transports.

"Medium performance, ½"-reel transports are available to the OEM for approximately $3000, and 10-½" reels of tape in volume cost approximately $7. Cassette, cartridge and floppy disc recorders are presently available from between $500 and $750 apiece to the OEM, and the media ranges from between $2 to $5," quotes Mr. Gruczelak.

Attacking the question of cost in a somewhat different manner, Gerry Lembas asks us to think of cost as the cost/bit in relation to reliability. "What often turns out to

Peter A. Gilbody, Cipher, "The advantages of PE formatting center around the inherent self-clocking characteristics " . . .

Dr. Ben C. Wang, Wangco, "Improved tape could allow better performance by reducing or eliminating errors" . . .

be the least expensive device to purchase, can often be the most expensive to maintain, in service and media replacement. A thorough understanding of cost of ownership is essential to making the right decision. This includes ease of maintenance, available training service support, quality of the service manual, cost of spare parts, etc."

transfer rate

"Depending on the tape speed chosen, reel-to-reel transports can transfer data at rates ranging from 10-300k bytes/s," says Gruczelak. "3M cartridge machines can transfer up to 72k bytes/s; using two-track recording at 800 bpi, Philips cassette machines, 10k bytes/s; and floppy disks, 31k bytes/s."

conclusions

What does all this discussion mean? "Clearly, half-inch ANSI-compatible reel-to-reel tape drives make the most sense when the user needs a large capacity and interchangeability with other systems. When interchangeability is a prime requirement, the reel-to-reel tape drive still makes sense even though the user may not need the capacity, since smaller reels are readily available and are also interchangeable," concludes Mr. Gruczelak. He goes on to say that the only alternative, the floppy disk, is very limited in capacity, reliability and standards, which do not presently exist. When data reliability is a primary factor, none of these drives can approach the reliability of reel-to-reel drives particularly where the media is intended for long-term use and many passes on different types of drives.

"However, if the user is not thoroughly familiar with tape drives, he should consult an impartial authority," warns Koelle, Mohawk Data Sciences.

• State the advantages of the various encoding schemes, such as NRZI, PE, etc.

According to Potter Instrument's Robert Ceonzo, any company that manufactures IBM-compatible tape transports must use NRZI and phase encoding (PE) in its equipment. "However, our machines are not IBM plug-to-plug compatible," he adds. "But they read and write IBM-compatible tapes, specifically for providing data links between computers and other devices."

"Since Bright Industries manufactures ANSI/IBM-compatible drives, at this point we only utilize NRZI or PE for which world standards exist. Since IBM has announced group coded recording (GCR), we will, of course, make this format available as it comes into large scale use," explains Mr. Gruczelak.

"The advantage of phase encoding over NRZI is, of course, higher tape density and thereby better media utilization. However, phase encoding has other advantages which are also extremely important. Since phase encoding results in a flux transition occurring at least once for every bit, a clock, derived from the data, allows for recording tracks in parallel without regard for skew. Also, since NRZI allows for long periods of recording, it is much more sensitive to noise. The advantage of NRZI, aside from the fact that it is still a world interchange standard, is that formatting of data can be done more cheaply.

"Group coded recording at 6250 ironically utilizes NRZI. Inserting characters to allow clocking from the data eliminates skew from this format. At this high density, only a maximum of one flux reversal per bit occurs, reducing peak shift problems experienced at high flux reversal densities in magnetic media."

Agreeing with Gruczelak, Gilbody notes, "Cipher utilizes NRZI and PE recording schemes in its IBM-compatible recorders. In the Mini-Cette 2000, we adhere to the ANSI/ECMA/ISO format of PE at 800 bpi. The advantages of PE formatting center around the inherent self-clocking characteristics of the data. The clock is updated in each bit cell, thus providing inherently more reliable data transfer."

"The clocking feature within the PE format and the 4-character 'egg-crate' buffer control establish PE recording as a far more reliable scheme than NRZI," agrees Mr. Ceonzo.

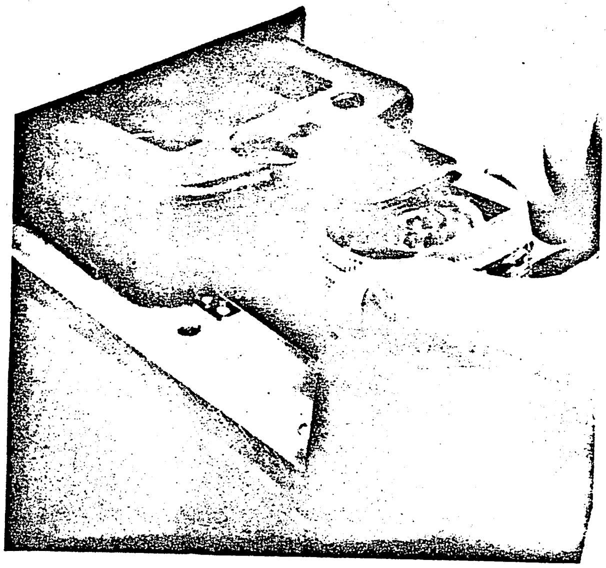
Adding a little more descriptive information, deBree from Ampex says, "Most cartridges use a phase-encoded format. Cassettes may use PE or NRZ formats, but in the case of the latter, the information is redundantly recorded on a second track, usually in complementary form."

• Does a better way than vacuum buffering exist for protecting the tape from stretching at high acceleration?

With but two exceptions, all respondents agreed with this statement: Above a tape speed of 75 ips, vacuum column tape storage is a necessity; below that speed, other types of mechanical tensioning, coupled to the proper drive, can perform a satisfactory job.

Stating the case for the majority, deBree says, "Vacuum buffering appears to be best method of protecting the tape

MINI REEL-TO-REEL TRANSPORT



If your application requires limited bit capacity, but interchangeability is of prime importance, you may want to consider the Cogar cartridge and transport. According to Chief Engineer, Bill Kelly, the cartridge provides a convenient container to protect the flanges. The drive and cartridge functions as a reel-to-reel recorder. Phase modulation provides reliable recording at a density of 1600 bpi, claims Kelly. A data-rate tracking servo in the read electronics allows the machine to operate reliably, in spite of speed-tolerant recording, because the servo is fast enough to track variations beyond the tape system's mechanical resonance.

Since the tape transport uses an unbuffered reel system with the capstan drive servo, it must control start/stop velocities to keep transients far below the level of the tape yield point. And though the capstan servo provides close speed control, speed perturbations caused by tape elasticity do occur in the unbuffered system. The data-rata tracking servo in the read electronics removes these perturbations, too, claims Kelly.

Available from Cogar Information Systems, Utica, NY, the 100-ft cartridges contain one-mil tape and handle about one-million bits. Company also supplies 200 ft x 0.5-mil cartridges, capable of recording about 2-million bits.

from stresses during acceleration, since the mass of the tape is the only mass being accelerated. This method is used in all high performance tape equipment. In the days when computers were heavily tape oriented and the tape medium was expensive, the utmost in gentle tape handling was very important. Now, systems with lower tape usage and costs, lower transfer speeds and low cost, use mechanical buffer arms. Even though the arms provide technically inferior performance than vacuum buffering due to their higher inertia, they tension tape adequately during acceleration."

Pertec's Lembas agrees with the majority, but he adds, "At speeds of 75 ips and below and under controlled acceleration which is found with properly designed single capstan servos, the need for vacuum column vs mechanical arms depends on a question of cost and environmental noise as opposed to tape reliability. Properly designed single capstans and mechanical servos cannot stretch tape. The choice is then one of determining where the unit will be used. For instance, if it is to operate in an office environment, the noise of a vacuum drive would be objectionable as well as fatiguing to the operator. On the other hand, if the vacuum device is used in an EDP center where other peripherals are equally noisy, then the choice is one of cost between mechanical and vacuum buffers."

Disagreeing with the majority over the point at which tape speed becomes excessive for mechanical buffering, Datran's Jansen claims, "Vacuum buffering is probably best for 10-½"-reel machines operating above approximately 45 ips. For smaller reel machines and lower speeds, mechanical servos are fully adequate and somewhat less expensive."

In the same vein, Gruczelak elaborates the minority case: "For some time now with the advent of the single capstan drive, very few machines have been manufactured on which tape stretching is a problem, regardless of the buffering used. The problem really boils down to one of data reliability. The only way provided in most high-performance machines to maintain head to media contact is by constant tape tension working through a fixed wrap angle over the head. The advantage of vacuum buffering is that no mechanical system having mass is used to achieve the buffering. Tension arm schemes add mass and thereby cause a change in tape tension during tape acceleration. This change of tension is by no means serious enough to damage the tape, but depending on the direction that the tape is required to move, acceleration may momentarily reduce tension enough to cause problems in head-to-tape contact, particularly if the tape is slightly damaged.

"Tension arm recorders have proved to be extremely reliable up to tape speeds of 45 ips, are in general lower in cost, and are extremely quiet. When speeds greater than this are required and half-inch ANSI/IBM compatibility is also required, the vacuum column buffer is the only means which will achieve data reliability of 1 error in 10^9."

Speaking of the future of vacuum buffering, Koelle, Mohawk Data Sciences, predicts, "I do not expect vacuum buffering to be replaced on high-performance tape drives in the foreseeable future. It does an excellent job of minimizing tape stretching and wear. A substantial technology in vacuum buffering is available to the tape transport designer.

"The 3M Company has ingeniously eliminated the need for buffering in the DC-300A data cartridge, but this approach does not appear feasible with ½-inch tape, large reels, and high speed–150 ips and higher."

• How will improvements in recording tape affect your product?

"Improvements in recording tape will not affect my company's tape drives," claims Ben C. Wang of Wangco Inc., "but will make them even more efficient. Look for tapes slit to closer tolerances and with more resistant coatings."

The following manufacturers contributed to REEL-TO-REEL TAPE TRANSPORT DIALOG:

Amprex Corp.
13031 West Jefferson Blvd.
Marina del Rey, CA 90291

Bright Industries, Inc.
683 West Maude Ave.
Sunnyvale, CA 94086

Caelus Memories
967 Mabury Rd.
San Jose, CA 95133

Cipher Data Products
7655 Convoy Court
San Diego, CA 92111

Control Data Corp.
2621 Van Buren Ave.
Norristown, PA 19401

Cogar Corp.
Cosby Manor Rd.
Utica, NY 13502

Daconics Corp.
925 Thompson Pl.
Sunnyvale, CA 94086

Datran Corp.
319 Peck St.
New Haven, CT 06513

Hewlett-Packard Co.
11000 Wolfe Rd.
Cupertino, CA 95014

Infotec, Inc.
70 Newtown Rd.
Plainview, NY 11803

Iomec, Inc.
3300 Scott Blvd.
Santa Clara, CA 95050

Kennedy Co.
540 Woodbury Rd.
Altadena, CA 91001

MFE Corp.
Keewaydin Dr.
Salem, NH 03079

Mohawk Data Sciences Corp.
781 Third Ave.
King of Prussia, PA 19406

Pertec Peripheral Equipment
9600 Irondale Ave.
Chatsworth, CA 91311

Potter Instrument Co. Inc.
532 Broadhollow Rd.
Melville, NY 11746

Precision Instrument
3170 Porte Dr.
Palo Alto, CA 94304

PSC Technology, Inc.
1200 Grand Central Ave.
Glendale, CA 91201

Wangco Inc.
5404 Jandy Pl.
Los Angeles, CA 90066

Echoing but elaborating on Wang's statement, Koelle says, "Well-designed present day tape drives give excellent performance with the better grades of tape now available. Improved tape could, however, allow better performance by reducing or eliminating errors and dropouts caused by flaking of oxide coatings, as well as extending usable tape life. Improvements in tape would permit future drives to be designed for higher speeds and packing densities. They might also allow cost reductions by relaxing the requirements for buffering and guidance."

According to deBree, improvements in the tape medium will permit more reliable recording and higher data densities. Thus, the transport can run slower for a given transfer rate, or higher transfer rates are possible for a given tape speed. Density is governed to a large extent by established interchange standards, which must also be modified to take advantage of better tape.

Pointing to the problem of wear, Cipher Data Products' Gilbody notes, "The development of oxide and binding of the lowest possible abrasive characteristic will result in longer head life for the user. The various tapes available today cause very large differences in head wear. Our experience indicates that 3M Type 777 magnetic tape has the most desirable characteristics."

"Tape improvements will profoundly affect tape life as opposed to performance," explains Gruczelak. "Since half-inch tape drives are the major interchange media used in the data processing industry today, the manufacturer of such drives must be sure that his machines will operate with all manufacturers tapes designed for this application. Even though means have been available for some time to allow for much higher densities, they have not been introduced nor accepted, simply because they could not be used with standard densities and formats. Note that high energy tapes for digital recording introduced approximately four years ago never became very popular. The tape which will be used for group coded recording at 6250 bpi is essentially the same medium which was used with 800-NRZI recording 14 years ago. We are tied, therefore, to the interchangeability requirements and standards for format largely determined in the past by IBM."

• What electronic interfaces do you offer, at what cost? What do most of your customers require?

Gruczelak notes, "Bright Industries manufactures a line of half-inch ANSI/IBM-compatible tape recorders that operate at between 12-½ and 45 ips. Since the tape transport interface in our markets has become standardized, we offer an industry standard interface as well as our own. In addition, we sell NRZI and PE formatters. NRZI formatters, operating at 200, 556 and 800 bpi are built into the tape transport or operate as a stand-alone package. PE formatters, operating at 1600 bpi, are available as a separate package.

"The formatter is, in essence, capable of taking the data as presented by a system, converting it to the appropriate tape format for recording, and/or taking the data from the transport and converting it to a system format. In this way, it takes the burden away from the system designer for assuring that his system will be compatible with the tapes he writes and/or reads.

"We also offer a line of buffers which are capable of accepting data asynchronously, formatting the data onto tape in NRZI or PE. The buffers range in size from 256 to 1024 bytes, single or dual-buffer configurations, depending on whether the customer chooses to verify whether he is writing his data in an error-free manner."

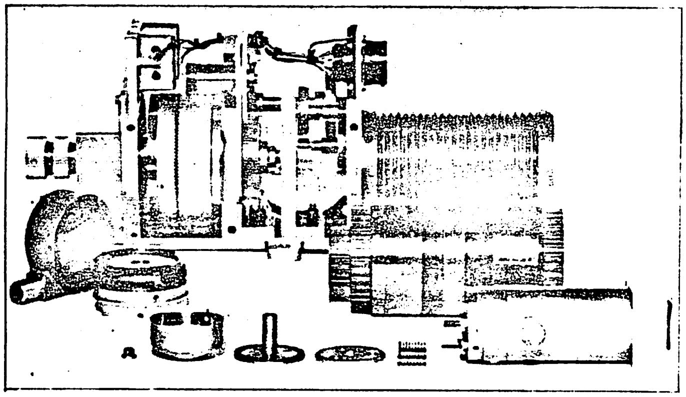
"Mohawk Data Sciences manufactures a standard TTL digital interface for the OEM, an IBM-compatible interface for plug-to-plug units, appropriate interfaces for use in MDS systems, and some customized interfaces for special applications. Outside of MDS systems, the major requirement is for the OEM-type digital interface," says John Koelle.

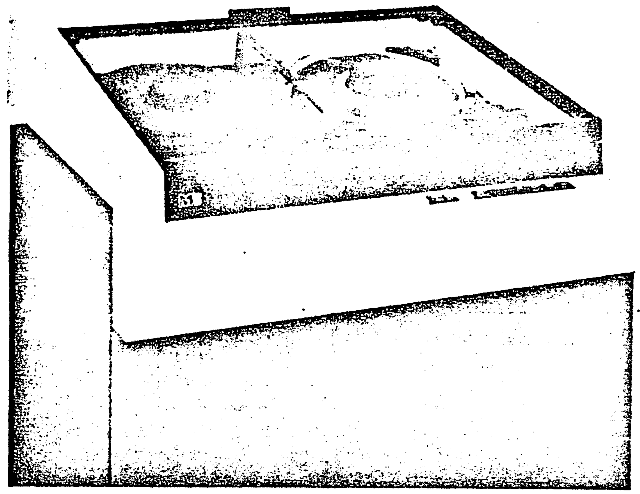
According to a Daconics spokesman, the company makes a magnetic tape system for all Hewlett-Packard 2100 series computers and for XDS, PDP-8 and NOVA computers.

Potter Instrument's Ceonzo explains that the interface for his company's reel-to-reel transports depend on customer application—IBM plug-compatible, etc.

"Wangco makes PE and NRZI formatters and controllers. They interface with most systems. Because customer

Continued on page 36.





Courtesy Mohawk Data Sciences

Typical reel-to-reel tape transport.

requirements vary so much, no one product can interface all applications. Rather, we need a controller that can meet a host of requirements," says Dr. Wang.

From deBree comes this quotation of company policy: "Ampex offers a variety of interfaces. For the OEM market, a standard Ampex interface utilizes basic motion commands and data lines, and a pseudo industry standard interface also offered by Pertec, Wangco, HP and others. Format control units are also available which do most tape controller functions. Ampex also offers plug-equivalent equipment to IBM 2400 and 3400 series tape units and IBM 2803 and 3803 tape control units for the end-user market."

"Cipher responds to customer requests," explains Gilbody, "for various interfaces in several ways: an IBM-compatible tape system which interfaces to most of the popular minicomputers, such as DEC, Data General, HP, Varian, etc.; an ANSI/ECMA-compatible cassette system interfaced to the same minis; and an OEM ANSI/ECMA/ISO digital cassette drive that allows the OEM customer to build his own formatter and interface."

"Other than our interface found on all of our tape and disk drives, Pertec offers and supplies formatters," notes Lembas. "These devices make the job of interfacing quite simple, since they in themselves comprise approximately 80% of a typical controller. The user performs the final coupling of his system at minimal expense and time. Many of our customers have started with these formatters and have eventually phased in their own versions."

"Datran offers standard RS 232 C interfaces for communications applications and interfaces to a variety of numerical control devices. The system can be made to look electrically like any paper tape reader. The application is a data source for devices designed to operate from paper tape, but when the data is computer-generated, thus eliminating the need for generating paper tape from computer data," explains Jansen.

If an industry consensus is possible, it would perhaps go like this: Reel-to-reel magnetic tape drives still perform valuable services in systems that use large amounts of data storage. They operate very dependably for long periods of time. On a world-wide basis, they offer an interchangebility that industry seems to be able to afford. ♦