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Model 2209A Nine Track Tape Drive User Manual

HOW TO USE THIS MANUAL

This manual is designed to introduce the Wang Model 2209A Nine-Track Tape Drive to the user. Chapter 1 provides a general discussion of the hardware configuration, emphasizing its uses, capabilities, and environmental needs. Chapter 2 serves as an operator's guide to the tape drive. Chapter 3 introduces the user to the concepts of information storage and retrieval on tape used in the Model 2209A. Chapter 4 is intended to serve as a programmer's guide to the available Wang instructions which govern tape utilization. Additionally, specifications, options, and additional reference information are collected in the Appendices.

This manual assumes that the reader is generally familiar with the available Wang system and BASIC programming, or has access to other relevant System 2200 hardware and utility documentation. Such documentation might include:

- The Programming in BASIC Manual
- The Wang BASIC or BASIC-2 Language Reference Manual
- The Model 2209A Utility Manual

The Model 2209A can be utilized with any Wang System 2200 CPU (except the 2200VS) which contains a minimum of 12K memory, supports the General Input/Output ($GIO) Instruction set, and has an available I/O port.

Model 2209A Nine Track Tape Drive User Manual

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CHAPTER 1 GENERAL INFORMATION

1.1 INTRODUCTION TO THE MODEL 2209A

The Wang Model 2209A magnetic tape drive is a versatile peripheral used primarily for on-line, serial-access program and data storage, file backup, and interfacing the Wang System 2200 to other digital computer systems. This manual contains information designed to facilitate the programmer's and/or operator's use of the Wang Model 2209A.

Figure 1-1. The Wang Model 2209A (3/4 View)

1.2 UNPACKING AND INSPECTION

The Model 2209A must be unpacked, inspected and installed by a qualified Wang Service Representative. Failure to follow this procedure will void the warranty. Upon delivery of the unit, call the Wang Service Office and request that this service be performed.

1.3 INSTALLATION

The physical dimensions of the tape drive, site clearance requirements, and other specifications are collected in Appendix B. The tape unit should be configured such that the required cabling between the tape drive and the I/O controller be no more than 12 feet (3.7 m), as cable extension is not recommended.

A Wang Service Representative will verify the installation when the Model 2209A Nine-Track Tape Drive and controller have been connected in the system, inspected for foreign material and shipping damage, powered "on", and fully tested to insure its proper operation.

1.4 ENVIRONMENTAL CONSIDERATIONS

The Wang system is designed to operate in normal office environments. In general, any environment comfortable to the operator is sufficient for the system. However, the environment can greatly affect a system's performance. Therefore, some preparation prior to delivery may be necessary to select the best location. An ideal environment is one in which the temperature and humidity are controlled, dirt and airborne contaminants are minimal, and the AC power source is adequate, regulated and noise free. The location should be adequate for future expansion and easily accessible to operating personnel, yet sufficiently removed from the main traffic flow so as not to interfere with the system's smooth operation. For details, see Appendix A "Preventive and Routine Maintenance Information."

CHAPTER 2 OPERATION OF THE TAPE DRIVE

2.1 THE TAPE UNIT (TAPE TRANSPORT, TAPE FORMATTER, CPU, AND I/O CONTROLLER)

Physical tape movement during execution of tape commands is handled by the tape transport. Writing of data on the tape in the ANSI format for Phase Encoded tapes is handled by the tape formatter. (The formatter electronics are located in the tape unit's chassis.) Data transfer, code translation, status and error return information are controlled by the system CPU. The I/O controller buffers the speed discrepancy between the tape drive and CPU data transfer rates. The tape transport, formatter, I/O controller, and CPU operate in conjunction to perform the different phases of tape operations. The actual $GIO sequences used to execute tape operations, the general processes which the CPU, formatter, and I/O controller coordinate, and the conditions which set the status and/or error bits for each tape operation are described in Chapter 4.

2.2 PHYSICAL OPERATION OF THE TAPE UNIT

Any tape reel having the standard 3.7 in. (9.37 cm) hub which is less than 10.5 in. (26.7 cm) in outer diameter, can be used on the Model 2209A. Reels of this size can contain over 2400 ft (731 m) of 1/2-in. wide (1.3 cm) tape. However, lengths as short as 50 ft (15 m) can be used.

Tapes are read and written at 75 ips (190 cm/sec) (writing requires a WRITE ENABLE ring). The rewind speed is 200 ips (508 cm/sec). The tape may be forwardspaced or backspaced over tape blocks and files or rewound to the beginning of the reel under program control. Neither reading nor writing may take place while tape is moving backward. The tape may not be rewound beyond the load point under program control.

When a tape statement is executed, the reel servos move the tape to/from the top (supply) reel to/from the lower (take-up) reel using the loops in the vacuum columns to act as a buffer for the sudden start and stop motion of the tape. Switches in the columns control the servo motors and brakes to permit the two reels to rotate semi-independently.

Writing and reading of information occurs as the tape is moved across the read/write head, (see (10) Figure 2-1.) a stationary two-section assembly. Writing occurs at the write gap portion, and reading occurs at the read gap portion of the read/write head. Information is written onto the tape by magnetizing bit patterns which represent characters on the tape. Information is read from the tape by decoding these bit patterns. Details of how the Phase Encoded electronics store and retrieve information on the tape are discussed in the next chapter.

The Model 2209A dual gap read-after-write head configuration permits immediate write verification. Read-after-write errors are flagged to alert the user to rewrite the data. Write errors cannot be corrected automatically by the tape unit. Multiple-track read errors are flagged, and require rereading the data. Single-track read errors are corrected automatically using VRC (vertical redundancy characters) in an algorithm for parity reconstruction.

The data transfer rate from the tape to the 4096-byte I/O buffer is about 120 KBS (120 kilobytes per second). The data transfer rate from the buffer to the CPU is limited by the processing speed of the CPU. Since tape motion and data transfer are distinct operations in any read or write sequence, a program can overlap tape motion with other CPU processing, significantly speeding the overall data throughput.

Because of the high density at which data is written or read, tape drives are sensitive devices. Rough treatment and very small particles of dust or oxide from the tape can cause data errors. Never use the top of a tape unit as a work area. Materials placed here may contaminate the unit, misalign the cover assembly and interfere with cooling. These materials will also be exposed to heat and dust. The Model 2209A should be cleaned after every eight hours of use or prior to any extensive tape operations. Careful attention to the cleaning procedures described in Appendix A, and quarterly servicing, will assure trouble-free operation.

Table 2-1. 2209A Parts List (see Figure 2-1.)

Item	Description
1	Door Assembly (Door Removed)
2	Control/Text Panel Cover Latch/Release Assembly
3	Door Hinge Pin
4	Deck Assembly
5	Capstan
6	Takeup Vacuum Column Cover
7	Takeup Vacuum Column Assembly
8	Split Tape Guide Assembly (Ceramic)
9	Magnetic Head Cover Assembly
10	Head and Head Mount Assembly
11	LP/EOT Photosensor Assembly
12	Broken Tape Photosensor Assembly
13	Tape Cleaner Assembly (Synthetic Sapphire Blade)
14	Supply Vacuum Column Cover
15	Supply Vacuum Column Cover Catch
16	Supply Vacuum Column Assembly
17	Test Panel Assembly
18	Reel Hub (part of deck assembly)
19	Pushbutton Control Panel Assembly
20	Test/Control Panel Cover Assembly
21	Thumbwheel Switch for parallel configurations. (Not used)
22	Vacuum Column Tape Guide
23	Adjustable Deck Grip Latch

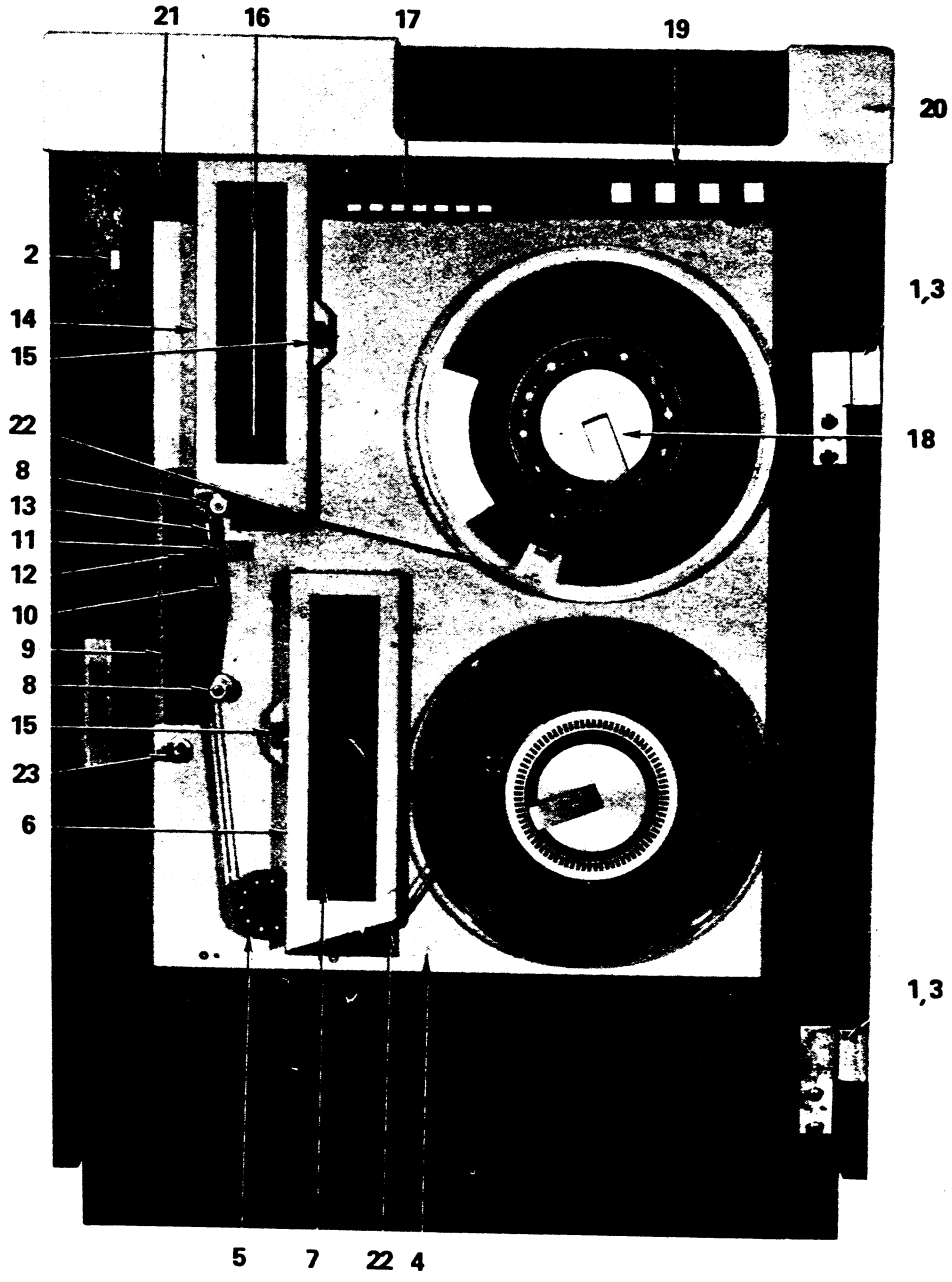


Figure 2-1. Model 2209A Front View

2.3 CONTROLS AND INDICATORS

Test and control panels containing pushbutton switches and lamp indicators for operator control of the tape drive are located on the upper front of the unit. The switches and their operation are described below. To access the Test and Control panels, press the cover assembly release/latch (see (2) Figure 2-1). The cover assembly will rise approximately four (4) inches and fully expose these controls.

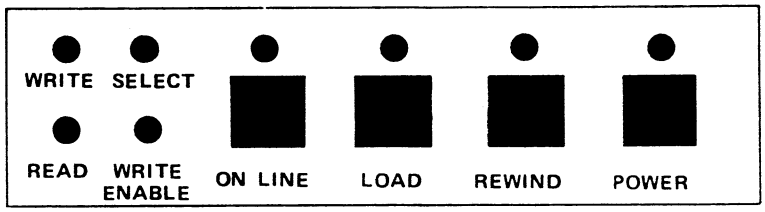


Figure 2-2. The Control Panel Controls and Indicators

POWER — Push the POWER switch once to turn the tape drive on. The indicator lamp illuminates when power is available to the unit. To turn the unit off, push the POWER switch a second time. The POWER indicator extinguishes when pressure is released.

LOAD — Press the LOAD switch to initiate the load sequence. The LOAD sequence activates the reel servos and vacuum buffer columns (tensions tape) and causes the capstan to pull the tape forward until the BOT marker reaches the photosensor assembly. Whenever the tape is at or past the load point or beginning-of-tape (BOT), the LOAD indicator is illuminated.

If you must perform the load operation when the tape is already past the load point marker (when restoring power after a shutdown, for example), a slightly different procedure occurs during LOAD. The tape will move forward for approximately six (6) seconds while it searches for the BOT marker. If BOT is not encountered, the tape will then automatically rewind to the load point.

ON LINE — The CPU cannot access the tape under program control until it is on-line. Press the ON LINE switch to put the tape unit on-line. The indicator is illuminated when the tape drive can be operated under program control. To put the unit off-line (as is required when manually rewinding the tape, using the Test panel, etc.), press ON LINE a second time. The indicator should extinguish when pressure is released.

WRITE INDICATOR — Illuminates when a write operation has been performed.

READ INDICATOR — Illuminates when a read operation has been performed.

SELECT INDICATOR — Illuminates whenever the tape unit is on-line and power is available to the CPU/controller. The unit cannot be addressed in a program, however, until its device address has been enabled with the SELECT statement, or a $GIO tape command.

WRITE ENABLE INDICATOR — Illuminates whenever a tape reel with a WRITE ENABLE ring inserted is mounted on the supply hub. If the indicator is not illuminated, the tape can only be read.

REWIND — Push REWIND to rewind the tape at high speed (200 ips). Note that the tape unit must be OFF-LINE during REWIND if the rewind operation is to be performed manually. If the tape is beyond the load point, REWIND rewinds to the BOT marker, load point. The tape is drawn out of the tape path and unloaded from the unit if REWIND is pressed when the tape is <u>at</u> the load point (BOT).

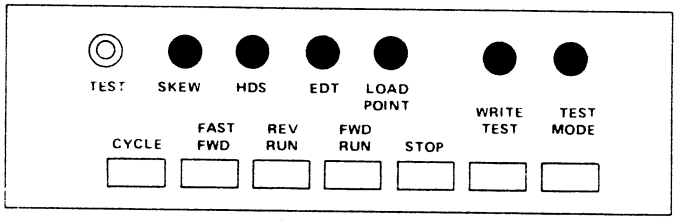


Figure 2-3. The Test Panel Controls and Indicators

The Test panel is essentially used by Wang Customer Engineers in servicing and testing the unit. However, there are certain buttons and indicators on this panel which the user may find helpful. This section describes the functions of the Test panel which the user might employ. The light indicators are functional whenever power is available to the unit. The tape unit must be off-line and the STOP and TEST MODE buttons depressed before any other buttons on the Test panel are activated. The indicator above the TEST MODE button illuminates when the TEST MODE is activated by pushing the TEST MODE button. To deactivate the TEST PANEL (when putting the unit back on-line), press TEST MODE and be sure that the indicator extinguishes when pressure is released.

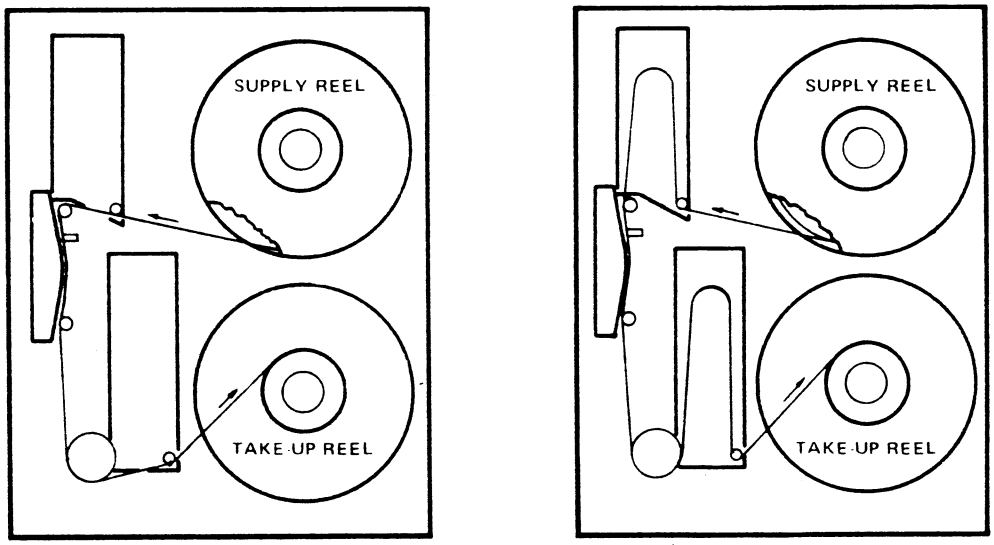
FAST FORWARD — Press this button to high speed advance (200 ips) the tape. To stop forward motion, push STOP. Arrival of the tape to EOT will also terminate forward tape motion.

LOAD POINT - Illuminates whenever the tape is <u>at</u> the load point. If illuminated (i.e. tape is at BOT), pressing REWIND will unload the tape to the supply reel.

SKEW - Illuminates whenever the tape skew exceeds the appropriate read/write head gate setting. If this indicator illuminates consistently during on-line tape operation, call Wang Service Personnel for adjustment of the tape unit.

EOT - Illuminates whenever the tape is at or past the EOT (end-of-tape mark).

HDS - Illuminates whenever a 1600 BPI Phase Encoded tape is mounted on the unit, at or past the load point.



TAPE THREADED TAPE LOADED

Figure 2-4. Model 2209A With a Tape Mounted

2.4 TAPE MOUNTING PROCEDURE (SEE FIGURE 2-1.)

1. Put the Tape unit off-line if it is not off-line already. Power may be on or off.

2. Remove a tape reel of the appropriate size from its canister, or ring, holding it by the rigid central hub.

3. Open the cover of the tape unit (pull forward using the finger grip at left center of the cover). Unlock the tape hub for the supply reel by pulling the end of the latch. It remains open.

4. Touching the reel hub only, place the tape reel (with or without a WRITE ENABLE ring) over the supply reel hub. Be sure the WRITE ENABLE ring groove is in the back (machine side) of the reel.

5. Press the protruding end of the latch knob back into position to hold the tape onto the hub. The snap action of the latch is felt as it locks.

6. Pull out about eight feet of tape leader. Pass it under the vacuum column tape guide (22) and over the upper head guide (8).

7. Thread the leader past the read/write head (10) to the left of the lower head guide (8).

8. From the left side, pass the leader beneath the capstan (5) and under the take-up column guide (22).

9. Wrap the tape leader clockwise around the take-up reel.

10. Hold the end of the tape against the hub of the take-up reel, and turn the reel clockwise until the tape end is overlapped and secured by several tape windings.

11. Close the cover of the tape unit. If the unit was off, press the POWER switch.

2.5 LOADING THE TAPE AND PUTTING THE UNIT ON-LINE

After the tape is properly mounted, push LOAD and wait for the load sequence to complete and the load indicator to illuminate. Then press ON LINE to pass control of the tape unit to the CPU. Tape operations can be performed under program control once the unit is on-line (the ON-LINE indicator is illuminated).

2.6 TAPE UNLOADING AND REWINDING

Always rewind the tape to the supply reel before removing (unloading) the tape reel from the tape drive. Provision is made in the Model 2209A transport for rewinding a tape to the load point under program control. However, this operation may also be performed manually. To manually rewind a tape, the unit must be off-line. (If the ON-LINE indicator is illuminated, press ON-LINE and check that the indicator extinguishes when pressure is released.) When the tape is beyond the load point, push REWIND to rewind the tape to the load point. If the tape is already at the load point when REWIND is executed, it will be unloaded from the tape drive (i.e, the tape is pulled through the tape path and returned to the supply reel). Unlock the tape hub latch to remove the tape reel, holding it by the hub.

> NOTE:
>
> The rewind sequence cannot be stopped once it is initiated. The tape will either rewind to the load point or the supply reel before rewind ceases. The tape cannot be backspaced or rewound beyond the load point under program control with General Input/Output ($GIO) statements.

2.7 POWER SHUTDOWN PROCEDURE

The tape transport should not be turned off when tape is loaded (at or past the load point marker). The Wang Model 2209A transport is designed to prevent physical damage to the tape in the event of power failure, and minimize operator error which could destroy recorded data. If a power failure occurs when the tape unit is operating, the vacuum ceases relaxing the tension on the tape, and the tape interlocks are lost (it must be reSELECTed, and placed ON-LINE). Always re-perform any operation which was in process when the power failure occurred.

To restore operation after a power failure occurs, manually wind the tape forward several feet removing all slack in the tape before restoring power. When power has been restored, press LOAD. After the tape has repositioned to the load point, it can then be advanced to the data block nearest the point at which the power failure occurred, by initiating the appropriate control commands. Normal processing could continue at that point.

Although it is possible to develop procedures which would allow power shutdown between the access of files or record blocks on a tape, this is not recommended. Where data files are short, it is preferable to use smaller tape reels.

CHAPTER 3 TAPE CHARACTERISTICS

In producing magnetic tape, microscopically small particles of iron oxide are mixed with a binding agent and uniformly applied to the surface of long strips of flexible mylar plastic. The tape is approximately 1.5 mil (0.04 mm) thick. (The plastic base is about as thick as cigarette paper; the magnetic coating is about one-third the thickness of the plastic base). Recording occurs on this ferromagnetic coating. The tape is full length tested at 1600 FRPI (flux reversals per inch) because the magnetic tape used for data processing must be of particularly high quality.

Since recorded information comes very close to the edge of nine-track tape, tiny nicks and kinks which impede the contact of the tape and heads by less than 1/1000th of an inch may affect the quality of magnetic reading or recording. Proper storage and use of the tape are essential. For details about the care and handling of tapes, see Appendix E.

3.1 HOW INFORMATION IS RECORDED ON TAPE

Irrespective of the bit configuration (character code), information is recorded on tape by driving a current through the head windings in alternate directions for one and zero bits in coincidence with a write clock as the tape moves past the read/write head. This magnetizes small discrete areas (bits) in nine parallel channels or tracks producing a series of bit columns along the length of the tape. Each column of bits represents one byte. A parity bit is written in track four (4) of any byte which contains an even number of bits. This parity bit is in addition to the eight data bits. For example, if the ASCII code for zero (00110000) were written, a parity bit would be generated and written in track four. The value of one in ASCII (00110001) would not generate a parity bit. Thus each column will contain an odd number of bits (odd parity). These parity bits are vertical redundancy checksum (VRC) characters used for determining and correcting single track errors during read operations. Missing bits are reconstructed by placing the remaining bits in a parity generator and adjusting the pattern so that odd parity is achieved. To correct multiple track read errors, however, the data must be reread.

The Model 2209A is used to read and write tapes at the density of 1600 BPI (bytes per inch) (630 B/cm). Tapes are usually written in a Wang format which is similar to ASCII (American Standard Code for Information Interchange). However, EBCDIC (EXtended Binary Coded Decimal Interchange Code) character format is fully supported by Wang in the optional utility program set for the Model 2209A. Almost any character formats can be translated using the $TRAN statement in an appropriate user-written conversion routine. Additionally, most other custom applications can be user-programmed with General I/O ($GIO) instruction sequences.

3.2 THE PHASE ENCODED RECORDING MODE

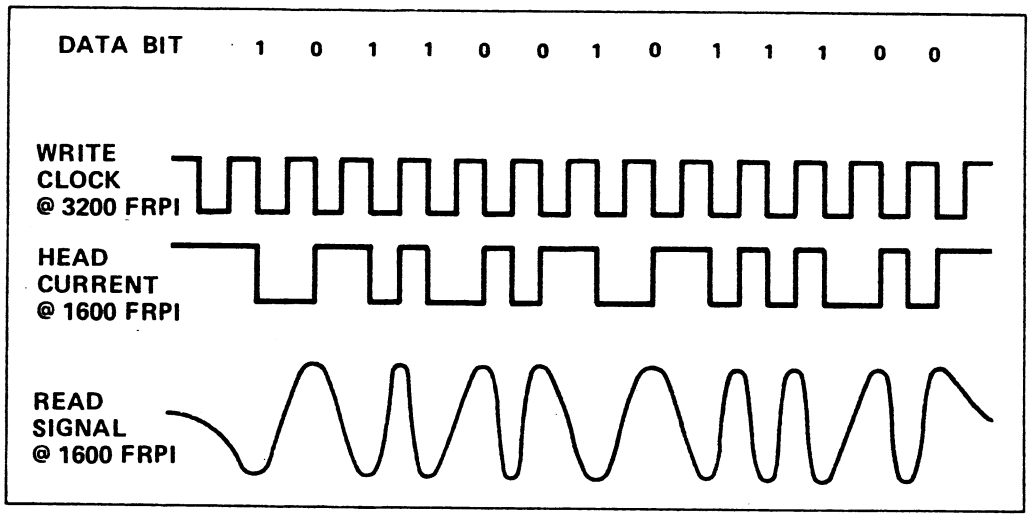
In the Phase Encoded mode, one-bits are produced by a flux reversal toward the reference polarity, zero-bits are produced by a flux reversal opposite the reference polarity, and a "phase flux reversal" occurs at the nominal midpoints of successive one or zero bits to maintain the proper reference orientation. Recording both zero and one-bits provides an improved writing check, and independent track decoding with less critical skew requirements. Reference polarity orientation is such that a "north" pole exists along the reference edge of the tape (e.g. edge closest to BOT marker). Tapes are recorded with full saturation, which means that each bit (zero or one) is represented by a magnetic flux reversal from the maximum positive to maximum negative magnetic potential.

Data is recorded at the density of 1600 BPI (630 B/cm). A clock is simultaneously recorded at 3200 FRPI. A preamble and postamble of bits written on the tape in track four prior to each data block, allows synchronization with the data signals by a phase-locked oscillator which compensates for speed variation and data timing.

The Phase Encoded read electronics detect input data trasitions from the transport, decode and deskew read data, generate the read clock, detect any formatting or parity errors, correct single track errors, and detect file marks.

While the detection of input data transitions is performed separately for each channel, the data is multiplexed after the initial detection stages. The data is processed by a single set of electronics which scans all nine channels sequentially, processing one channel at a time. The status of the control circuits is updated after each nine-channel scan. The decoded data is demultiplexed by the deskew circuitry and supplied to the microprocessor and ultimately to the interface.

When any track error is detected, the data signal of the respective track is disabled for the remainder of the block. If the error occurs on one track only, it is correctable. However, if an error is detected on more than one track, a multiple track error is indicated, inhibiting the data enable signal, which in turn inhibits the output data lines, and flags incorrectable error.



At 3200 FRPI, the clock is 1/2 phase ahead of the bit cycle; this allows normalization of the reference polarity prior to the data bit signal.

Figure 3-1. Phase Encoding Diagram for a Typical Track

3.3 THE ANSI RECORDING FORMAT

In accordance with the American National Standards Institute standards (ANSI) for nine-track, half-inch magnetic tape, bits are arranged so as to place the most used bits of each byte in the most protected region of the tape; i.e., in the center of the tape. Beginning at the reference edge of the tape, tracks are numbered consecutively as shown in Figure 3-2.

The correspondence of individual tracks to bits in a given byte is shown in Appendix C. The reader should note that data could be processed in any character format by translating from the default character code of the CPU with the $TRAN statement in an appropriate user-written conversion routine.

The ANSI Format For Phase Encoded Tapes:

a) Identification Code - Beginning at least 1.7 in. (4 cm) before the load point marker, but ending at least 0.5 in. (1.27 cm) before the first data block, a burst of characters is recorded in track 4 (parity channel) which identifies PE tapes.

b) Initial Gap - A gap of at least 3 in. (7.6 cm) between the load point marker and the beginning of the first data block.

c) Preamble - A burst of 40 zeros followed by a one in every track.

d) Tape Labels (optional) - Standardized label blocks for tape identification and security.

e) Data - Nine tracks, any character code.

f) Postamble - A one followed by 40 zeros in every track.

g) Interblock Gap - A gap 0.6 in. long nominal (0.5 in. minimum, 25 ft. maximum) is erased in the reference direction used to identify block boundaries on the tape (IBG).

h) Tape Marks - Special multi-byte control blocks used to identify file boundaries on the tape (EOF).

i) Reflective Strips - Load point and end-of-tape, photoelectrical, reflective, indicator, strips which are fastened to the base (uncoated) side of the tape to enable the tape unit to sense the beginning and the end of the usable portion of tape.

Load Point Marker: At least 10 feet of tape must be allowed between the beginning of the tape and the load point marker, as a leader for threading the tape on the tape unit.

End-of-Tape Marker: About 14 feet of tape are usually reserved between the end-of-tape marker and the end of the tape. This space includes at least 10 feet of leader and four feet of tape for the recording of data after the end-of-tape marker is sensed.

j) Check Characters - Odd vertical parity characters are used for the detection and correction of track error.

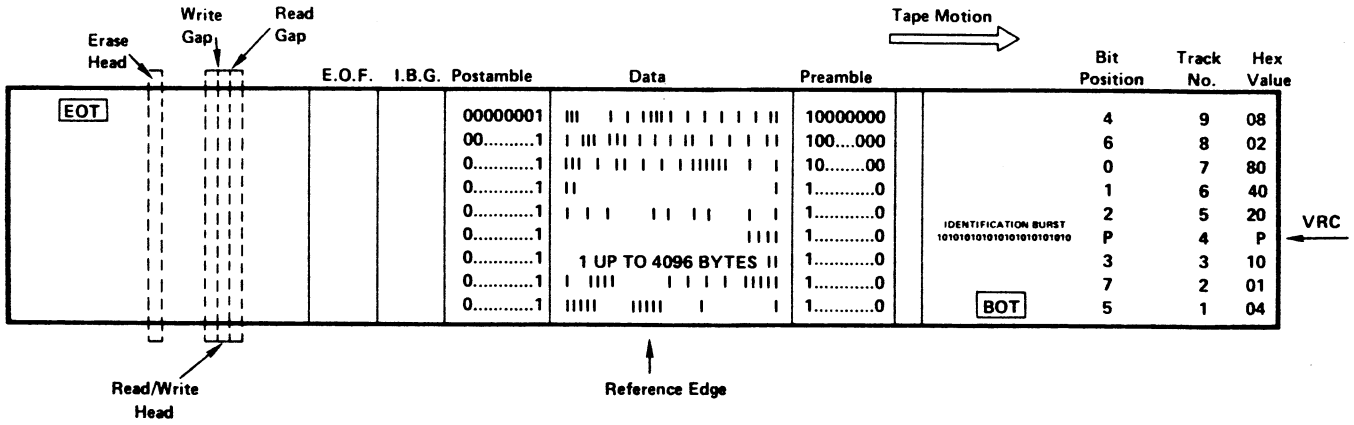


Figure 3-2. The ANSI Format for Nine-Track Tapes

NOTE:

Since BOT and EOT are photoelectrically sensed, avoid subjecting the tape unit to intense light sources (direct sunlight, flashbulbs, etc.) to prevent possible tape drive malfunction.

3.4 TAPE BLOCKS

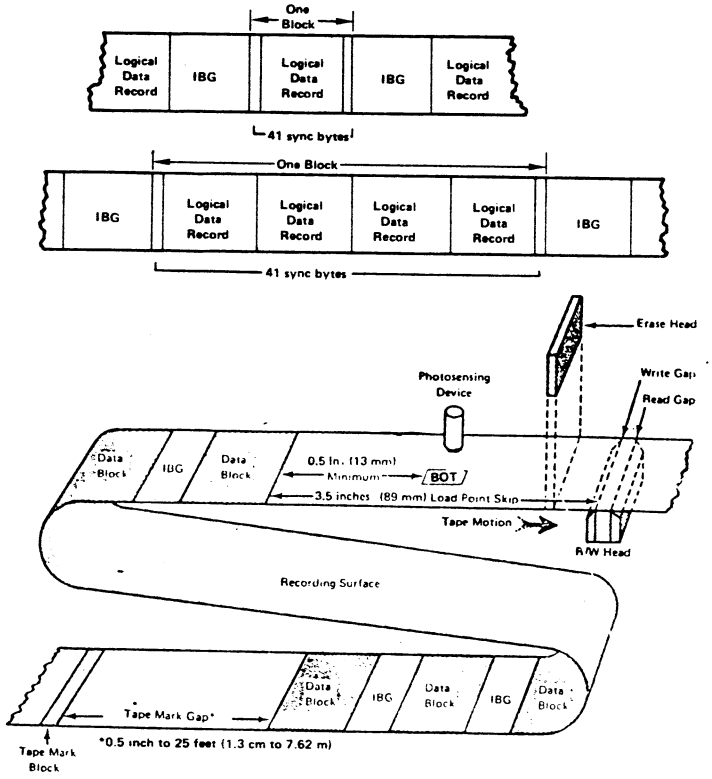


Figure 3-3. Tape Blocks

Information is stored on the tape in blocks, the area between two IBG's (inter-block gap). See Figure 3-4. An interblock gap is a length of blank tape at least 0.60 inch (1.5 cm). During writing, the gap is automatically produced at the end of a block. A tape block is therefore defined or marked by an interblock gap before and after the block. Several blocks of data can be grouped together in a file, which is the area between tape marks or EOF (end-of-file) characters. The 2209A can process tapes containing several files. (If labeled, the tape can contain several volumes.) Utilizing the maximum block size, the Wang Model 2209A has an on-line storage capacity of approximately 35 megabytes (35 million bytes). This is equivalent to 450,000 data cards punched in all 80 columns. See Figure 3-3.

Blocks of any practical size (18 bytes up to 4096 bytes) may be written. The minimum length was established to distinguish noise from data blocks. There is no machine check for compliance with this minimum length, however. The maximum block size in the Model 2209A is determined by the capacity of the I/O buffer (4096 bytes).

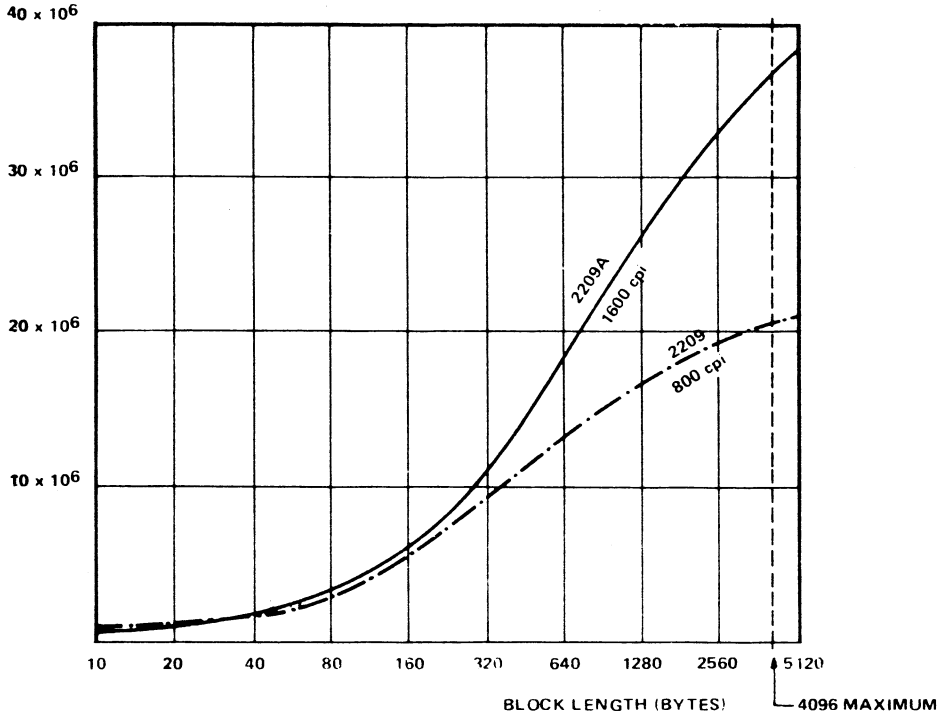


Figure 3-4. Comparison of Block Density in the 2209 and 2209A

3.5 FILE PROTECTION DEVICE

The file protection device is a plastic "WRITE ENABLE" ring (see Figure 3-5) which fits in a circular groove molded in the back (machine side) of the tape reel. When the ring is removed, only reading can take place; the file is protected from accidental writing, which could erase valuable information. When a tape is write enabled (with ring), the WRITE ENABLE light on the operator's panel is illuminated.

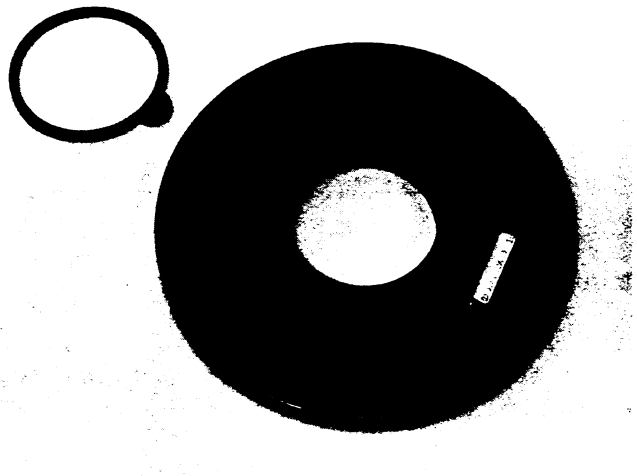


Figure 3-5. Magnetic Tape Reel Showing WRITE ENABLE Ring

CHAPTER 4 UTILIZING THE MODEL 2209A

4.1 THE GENERAL INPUT/OUTPUT INSTRUCTION SET

Most tape applications can be handled with a set of utility routines which are optionally available from Wang. Users whose needs are not met by the Wang supported utilities can custom-program the 2209A using five Wang BASIC statements designed for special I/O operations and code conversion; $GIO, $TRAN, $IF ON, $PACK and $UNPACK. They allow all or part of an array to be referenced without regard to its boundaries, and automatically feed back the error/status information generated during the specified operation. Only $GIO syntax is discussed in this manual. $TRAN, $PACK, $UNPACK and $IF ON are discussed in the General Input/Output Instruction Set Manual for the 2200T Series, and see the BASIC-2 Language Reference Manual for the 2200VP/MVP Series. The operations supported by the General Input/Output Instructions are:

$GIO - Facilitates general input/output and control operations.

Backspace one record.
Forward space a record.
Backspace a file.
Forward space a file.
Rewind.
Write a gap.
Write a file mark (EOF).
Write a record or block.
Read a record or block.
Status request.
Master reset.
Buffer write.
Finish write.
Buffer read.
Finish read.

$IF ON - Tests the device ready condition of a specified input or output device and initiates a branch to a specified line-number when a ready condition is sensed.

$TRAN - Offers high-speed character code translation using table look-up or character replacement procedures.

$PACK - Facilitates gathering and formatting data (by fields, delimiters, $UNPACK or Wang's standard record format) between an alphanumeric array buffer and specified arguments.

> NOTE:
>
> The General I/O Statements must be used to operate the Model 2209A. The cassette tape commands, LOAD, SAVE, DATALOAD, DATASAVE, etc., cannot activate this unit.

As with all BASIC statements, the syntax of I/O statements is critical. As a review, syntax rules are given below.

1. Uppercase Alphanumerics (A to Z, 0 to 9), and the following characters

   $ dollar sign
   , comma
   () parentheses
   # pound sign
   / slash
   <> angle parentheses

   must occur exactly as shown in the general form.

2. Lowercase words represent items which can be changed at the discretion of the user; a hyphenated string of lowercase words (e.g., arg-2) represents a single item.

3. The order of parameters shown in the general form must be followed.

4. Items in brackets [ ] are optional.

General Form:

$GIO [comment] [#n / /xyy] (arg-1, arg-2) [arg-3 <s,n>]

where:

comment — Any character string used to describe the operation of the $GIO statement. (Optional)

#n or xyy — This parameter specifies the tape's device address. (Optional)

arg-1 — A string of hexdigits, an alpha-variable, or all or part of an alpha-array, which defines the microcommand sequence for the I/O operation (see Table 4-2).

arg-2 — A string function, an alpha-variable or all or part of an alpha-array (at least ten bytes), which receives error codes and data-transfer character counts resulting from the I/O operation (see Table 4-3).

arg-3 — An alpha-variable, or all or part of an alpha-array, which the CPU uses as a data buffer when reading or writing a record. An array is treated as contiguous bytes. Array delimiters within angle brackets can specify the starting byte and number of bytes to transfer, limiting that portion of the alpha-array used for arg-3. This must always be $\leq$ 4096 bytes. Data above this amount will be lost because of the capacity constraint physically imposed by the controller buffer.

s = starting byte
n = ending byte

Purpose:

$GIO provides a capability similar to machine-level programming within the framework of Wang's high-level BASIC languages to operate and control the Model 2209A. (See Table 4-2 for the available $GIO sequences.)

Comment - Characters, digits or spaces are valid in this parameter, which describes the operation of the $GIO statement. For example, 100 $GIO REWIND TAPE/07B (6CF5 4400, A$) is clearer to the user than the equivalent 100 $GIO/07B (6CF5 4400, A$).

Device Address - Three different methods can be used to specify a device address for a $GIO operation.

1. Direct address specification using a slash (/) followed by a three-hexdigit address code. For example,

```
200 $GIO READ /07B (M$, R$) B$()
```

2. Indirect address specification using a pound sign (#) followed by a file number to which the desired address has been previously assigned. For example,

```
300 SELECT #2 07B
310 $GIO READ #2 (M$, R$) B$()
```

3. Omitting the address implying the device address currently selected for TAPE operations is to be used. Note that this cannot be the default address for tape a cassette. For example,

```
400 SELECT TAPE 07B
410 $GIO READ (M$, R$) B$()
```

The device code 07B is generally assigned; it is in the form xyy, where x is the device type and yy is the device address set on the controller board. $GIO ignores the device type. The device address (yy) of the controller is usually preset to 7B by Wang Laboratories before the unit is shipped. Device addresses for the Model 2209A can also be set to 7C, 7D, 7F, etc., if more tape units are configured in the system.

Microcommands - Arg-1 contains the command sequence for the operation. A microcommand sequence can be specified directly or indirectly in a $GIO statement. If specified directly as a string of hexdigits, each four-hexdigit sequence can be separated from the previous one by a space for readability. If specified indirectly by assigning the sequence to a variable, spaces cannot exist between the four-hexdigit sequences; furthermore, the dimension of the variable must be large enough for two trailing space characters (2020) denoting the end of the sequence. Unpredictable results may occur if the trailing blanks do not follow an indirectly specified microcommand sequence. The following examples are used to demonstrate valid microcode specification.

```
10 DIM A$8
20 A$ = HEX(6CF544008607)
30 $GIO (A$,B$)
```

or

```
10$GIO (6CF5 4400 8607, B$)
```

Error and Status Registers - This parameter, arg-2, contains either an alpha-variable or an alpha-array at least ten bytes in length used to report the errors, status and byte count of the I/O operation.

$GIO treats the first ten bytes of the arg-2 variable or array as ten eight-bit registers (each byte contains eight bits). These ten bytes contain the status and count information given in Table 4-3. The status, error, and count information for each bit of bytes 7 through 10 is provided in Table 4-4. for each $GIO command.

> NOTE:
>
> Unless otherwise specified in a DIM or COM statement, the system automatically dimensions any alpha-variable as sixteen bytes long; however, only the first ten bytes are used. Arg-2 must be initialized to zero before operations are begun (use INIT).

Data Buffer - This parameter, arg-3, is required whenever the tape unit is to perform a read or write operation. It specifies a data buffer which holds the record to be written or read. This parameter can be either all or part of an alpha-array or an alpha-variable. The size of the data buffer is specified in a DIM or COM statement.

When transferring data, the following rules apply:

1. When arg-3 is an alpha-array, bytes are stored in (or read from) arg-3 without regard for array element boundaries, i.e., the entire array is treated as a contiguous group of bytes.

2. For a READ operation, the data buffer in arg-3 must be larger than the largest record to be read. If not, the record is truncated and an error bit is set in byte 8 of arg-2.

3. For a WRITE operation, the arg-3 buffer defines the size of the record written.

Table 4-1. 2209A $GIO Processes During Tape Operations

Command	Operation	Conditions to Set Status or Error Bits
READ	Read the next block of data from the tape into the CPU. Set the status bits and byte count.	If End-of-Tape (EOT) or End-of-File (EOF) encountered, tape not ready, multi-track error, buffer overrun encountered, or tape protected (no WRITE ENABLE ring).
WRITE	Write the next block of data from the CPU onto tape. Set status bits and byte count.	If tape not ready, EOT sensed, tape protected (no WRITE ENABLE ring). If read-after-write error encountered.
WEOF	Write a tape mark (EOF). Set status bits.	If tape not ready, EOT sensed, tape protected (no WRITE ENABLE ring). If read-after-write error encountered.
BSR	Backspace to beginning of current block (i.e., to first record after IBG or BOT). Set status bits. Set status bits.	If tape not ready, EOF sensed, tape at load point, or tape protected (no WRITE ENABLE ring). (If BOT (beginning-of-tape) is encountered, the tape remains at load point.)
BSF	Backspace to beginning of current file (i.e., to first record after EOF or loadpoint BOT). Tape is left positioned before the file mark. Set status bits.	If tape not ready, tape protected, (no WRITE ENABLE ring), EOF sensed or EOT sensed, or tape at loadpoint (BOT). (If BOT is encountered, the tape remains at load point.)
FSR	Forward space a block, position to record beginning after next IBG. Set status bits.	If tape not ready, tape protected (no WRITE ENABLE ring), EOF or EOT sensed.
FSF	Space forward a file, position to file beginning after next EOF. Set Status bits.	If tape not ready, tape protected (no WRITE ENABLE ring), EOF or EOT sensed.

Command	Operation	Conditions to Set Status or Error Bits
REWIND	Rewind tape at high speed. Set status bits.	If tape not ready, tape protected (no WRITE ENABLE ring), at or past BOT. (If at BOT, tape remains at load point.) Rewinding past the load point cannot occur under program control.
WGAP	Erase 3.5 in. of tape ("write" a gap). Set status bits.	If tape not ready, EOT sensed, tape protected, (no WRITE ENABLE ring).
MASTER RESET	Initialize the drive, controller and status bits. Equivalent to pressing keyboard RESET (except for 2236D terminal).	If tape not ready, tape protected (no WRITE ENABLE ring).
STATUS	Report condition of drive's status bits. (i.e., write enable, on-line, etc.)	If tape not ready, tape protected (no WRITE ENABLE ring), or at BOT.
LOOK AHEAD READ	Start tape motion reading into controller buffer. Set status bits.	If EOF or EOT encountered, if tape not ready, multi-track error, or tape protected (no WRITE ENABLE ring).
FINISH READ	Read from controller buffer to CPU, receive status bits, byte count.	If buffer overrun encountered.
BUFFER WRITE	Write from CPU to controller buffer. Set byte count.	None
FINISH WRITE	Write from controller buffer to tape. Set status bits.	If tape not ready, EOT encountered, tape protected, (No WRITE ENABLE ring), if read-after-write error encountered.

Table 4-2. $GIO Statements for Use with the Model 2209A Tape Drive

Comment	BASIC $GIO Statement	*BASIC-2 $GIO Statement
BACKSPACE FILE	$GIO BSF/07B (4405 8607, A$)	$GIO BSF/07B (4405 1020 8607, A$)
BACKSPACE RECORD	$GIO BSR/07B (4404 8607, A$)	$GIO BSR/07B (4404 1020 8607, A$)
FORWARDSPACE FILE	$GIO FSF/07B (4402 8607, A$)	$GIO FSF/07B (4402 1020 8607, A$)
FORWARDSPACE RECORD	$GIO FSR/07B (4408 8607, A$)	$GIO FSR/07B (4408 1020 8607, A$)
READ	$GIO READ/07B (4400 8607 442A C220, A$) B$()	$GIO READ/07B (4400 1020 8607 442A C220, A$) B$()
REWIND	$GIO REWIND/07B (4446 8607, A$)	$GIO REWIND/07B (4446 1020 8607, A$)
WRITE EOF	$GIO WEOF/07B (4403 8607, A$)	$GIO WEOF/07B (4403 1020 8607, A$)
WRITE GAP	$GIO WGAP/07B (4407 8607, A$)	$GIO WGAP/07B (4407 1020 8607, A$)
WRITE	$GIO WRITE/07B (4429 4401 8607, A$) B$()	$GIO WRITE/07B (4429 1300 A000 4401 1020 8607, A$) B$()
LOOK AHEAD READ	$GIO LAR/07B (4400,A$)	$GIO LAR/07B (4400, A$)
FINISH READ	$GIO FR/07B (8607 442A C220, A$) B$()	$GIO FR/07B (1020 8607 442A C220, A$) B$()
BUFFER WRITE	$GIO BW/07B (4429 A200, A$) B$()	$GIO BW/07B (4429 1300 A000 4401, A$) B$()
FINISH WRITE	$GIO FW/07B (8607, A$)	$GIO FW/07B (1020 8607, A$)
MASTER RESET	$GIO RESET/07B (449C, A$)	$GIO RESET/07B (459C, A$)
STATUS	$GIO STATUS/07B (448B 8607, A$)	$GIO STATUS/07B (448B 1020 8607, A$)

* Normally, the BASIC-2 interpreter can recognize BASIC instructions. $GIO is a special case, however. The 2200VP may utilize the BASIC instructions; however, the 2200MVP must utilize the BASIC-2 instructions.

Table 4-3. Arg-2 Status and Count Information

Following execution of all Model 2209A General I/O commands, the following status information is set in bytes one thru ten of the arg 2 alpha-variable.

Byte	Bit	Contents
1 to 6	all	Always 0 (zero) not used
7		
(controller generated)	02	1 if tape unit NOT READY (i.e., off-line, rewinding, etc.).
	04	1 if EOF (tape mark) sensed.
	08	1 if EOT sensed.
	10	1 if no FILE PROTECT ring.
	20	1 if BOT sensed (load point) during BSR, BSF and rewind operations.
	80	1 if uncorrectable data error on tape.
8 ($GIO-generated)	01	1 if buffer overflow (i.e. tape record is larger than the receiving arg-3 array) during the operation.
9 and 10	two bytes	Binary count of data bytes transferred in a read or write operation. Note: this count does not include the EOF.

Table 4-4. Status, Error and Count Guide for Arg-2, Bytes 7 through 10

This table indicates what status information is indicated for each type of command.

Byte	7						8	9&10
Bit	80	20	10	08	04	02	01	all
Condition	Error	BOT	File Protect	EOT	EOF	Ready	Buffer Overflow	Count
READ	X		X	X	X	X	X	X
WRITE	X		X	X		X		X
WEOF	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		
REWIND		X	X			X		
RESET			X			X		
WGAP			X	X		X		
BUFFER WRITE			X					X
FINISH WRITE	X		X	X		X		
BUFFER READ	X		X	X	X	X		
FINISH READ							X	X
STATUS		X	X			X		

Several sample statements are provided to illustrate operation of the nine-track drive with the BASIC General I/O statements. All the routines in the examples are called from Special Function Keys; the Tape Drive is SELECTed with the statement SELECT #1 (xyy) where xyy is the Device Address set on the unit's Controller Board. To execute any of these routines, be sure to use the appropriate Device Address.

Example 1: The following routine writes a record from the CPU to the tape drive. The number of bytes/record is specified by Z.

```
10  DIM A$(130)30
20  SELECT #1 07B
30  STOP
100 DEFFN' 10(Z):PRINT "WRITEA";Z; "BYTE RECORD"
110 $GIO WRITE #1 (4429 A200 4401 8607, B$)A$()    <1,Z>
120 RETURN
```

Example 2: The following routine writes a file mark to indicate an end-of-file (EOF).

```
10  DIM B$10
20  SELECT #1 07B
25  STOP
30  DEFFN'9:PRINT "WRITE FILE MARK"
40  $GIO WFM#1 (4403 8607 B$)
50  RETURN
```

Example 3: The following routine reads a record, and provides error diagnostics based on the contents of BO$.

```
10   DIM B$10,A$(130)30,BO$1,B1$1,B2$20,ZO$1
15   A = 30: ZO$ = HEX(00):INIT(08)A$()
20   SELECT #1 07B
25   STOP
30   DEFFN' 11:PRINT "READ A FILE""
40   $GIO READ #1 (4400 8607 442A C220, B$)A$()
50   GOSUB'16
60   GOSUB'15 : RETURN
100  DEFFN'15 : GOSUB150 : GOTO 1000
150  HEXPRINT STR (B$,7,2);: PRINT"     ";
160  HEXPRINT STR (B$,9,2): RETURN
200  DEFFN'16 : N=256 * VAL(STR(B$,9))+VAL(STR( B$,10)) : PRINT N
210  FOR I = 1 TO N STEP 30
220  HEXPRINT A$(INT(I/30)+1) : NEXT I : RETURN
1000 BO$ = STR (B$,7) : RESTORE
1010 FOR I=1 TO 8 : B1$=BO$ : READ B2$
1020 AND (B1$,01) : ROTATE (BO$,7) : IF B1$=ZO$ THEN 1030 : PRINT B2$
1030 NEXT I : RETURN
2000 DATA "*", "TAPE NOT READY", "FILE MARK", "EOT", "PROTECTED TAPE",
"BOT", "TRACK ERROR," "DATA ERROR"
```

Example 4: The following statements space along the tape several inches to provide a tape gap on which no data are written. In general, this operation is done to space over a bad section of tape. Dimensioning, drive selection, and subroutine '15 are the same as for Example 3.

```
420 DEFFN'6 : PRINT "WRITE GAP"
430 $GIO WRITE GAP #1 (4407 8607, B$) : GOSUB'15 : RETURN
```

Example 5: The following statements rewind a tape. The tape is rewound to the load point (BOT). To unload a tape, a second REWIND must be manually activated. Dimensioning, tape selection, and subroutine '15 are the same as in Example 3.

```
440 DEFFN'5 : PRINT "REWIND"
450 $GIO REWIND #1 (4446 8607, B$) : GOSUB'15 : RETURN
```

Example 6: The following statements space forward one record. Dimensioning, drive selection, and subroutine '15 are the same as for Example 3.

```
460 DEFFN'2 : PRINT "FORWARD SPACE RECORD"
470 $GIO FSR#1 (4408 8607, B$) : GOSUB'15 : RETURN
```

Example 7: The following statements space forward one file. Dimensioning, drive selection, and subroutine '15 are the same as for Example 3.

```
480 DEFFN'4 : PRINT "FORWARD SPACE FILE"
490 $GIO FSF#1 (4402 8607, B$) : GOSUB'15 : RETURN
```

Example 8: The following statements backspace one record. Dimensioning, drive selection, and subroutine '15 are the same as for Example 3.

```
500 DEFFN'1 : PRINT "BACKSPACE RECORD"
510 $GIO BSR#1 (4404 8607, B$) : GOSUB '15 : RETURN
```

Example 9: The following statements backspace one file. Dimensioning, drive selection, and subroutine '15 are the same as for Example 3.

```
520 DEFFN'3 : PRINT "BACKSPACE FILE"
530 $GIO BSF#1 (4405 8607, B$) : GOSUB'15 : RETURN
```

Example 10: The following statements check for the end of the file (EOF) during a read sequence (byte 7 of arg-2, B$)

```
240 W$ = HEX (04)
250 AND (W$, STR (B$, 7, 1))
260 IF W$ = HEX (04) THEN LINE NUMBER (EOF was sensed, proceed to line
number for processing EOF)
```

NOTE:

Do not attempt a READ, FSR or FSF after the tape has passed EOF. When such an attempt is made, the tape will unsuccessfully attempt to read past the EOF.

If a read-after-write error occurs during a WRITE, immediately rewrite your data. If the error persists, use WGAP to "write" a gap over the local defect on the tape.

NOTE: (CONT'D)

Saving-in-place is not recommended, as data so written and all records beyond that point may prove unreliable. Add data to the end of a tape already containing records. Read to the current end of data, then write the new data over the old EOF. Since the end of data can only be found if indicated by an End-of-File, the rewritten tape should have a new EOF written at its end.

4.2 THE MODEL 2209A UTILITY SET

Wang optionally supports a utility package (part no. 195-0032) consisting of a software diskette and reference manual which facilitate use of the Model 2209A by users with little programming experience. The utilities are discussed briefly in this section. Details are described in the Model 2209A Nine-Track Tape Utilities Manual. To transfer data from card reader or disk to tape or from tape to disk, or to dump data from tape, the appropriate peripheral(s) must also be available. The routines can process single data set (file) tapes. (If labeled, the tape can contain only a single volume.) Tapes may have IBM/ANSI standard tape labels, or have no labels. Non-standard labels cannot be processed with the Wang Model 2209A Utilities.

The routines provide the following capabilities:

A LOADER to load all nine-track routines and subroutines into memory and to provide a user 'menu' to simplify program selection.

A set of primary routines to facilitate identification of the tape and allow its interface with the system's other peripherals. The primary routines are:

INITIALIZE/REWRITE VOLUME LABEL	Initializes or rewrites tape volume labels.
WRITE DATA ON or READ DATA FROM TAPE	Writes on or reads from nine-track tape; the user must supply certain program lines.
TAPE TO DISK DATA TRANSFER	Transfers data from tape to disk, with or without translation.
DISK TO TAPE DATA TRANSFER	Transfers data from disk to tape, with or without translation.
CARD READER TO TAPE DATA TRANSFER	Transfers data from punched cards to tape.
DUMP THE TAPE CONTENTS	Reads variable length blocks and outputs block size, untranslated hex image, and translated alphanumeric image of the data on the available output device.

A Logical I/O Control System (Logical IOCS) containing the subroutines which perform logical I/O operations. The Logical IOCS subroutines are:

'OPEN WRITE'.
'OPEN READ'.
'CLOSE WRITE'.
'CLOSE READ'.
TRANSLATION (ASCII to EBCDIC or EBCDIC to ASCII).

A Physical I/O Control System (Physical IOCS) containing the subroutines which perform physical operations on tape. The Physical IOCS subroutines are:

Backspace a record.
Forward space a record.
Backspace a file.
Forward space a file.
Rewind the tape.
Write a gap.
Write a Tape Mark (File Mark or EOF).
Write a block.
Read a block.
Look-ahead read.
Finish read.
Buffer write.
Finish write.
Status request.
Master reset.

Additionally, the utility package includes a standalone program (not loaded by the LOADER) which can be used for tape-to-tape 800 bpi NRZ1 to 1600 bpi Phase Encoded Conversion.

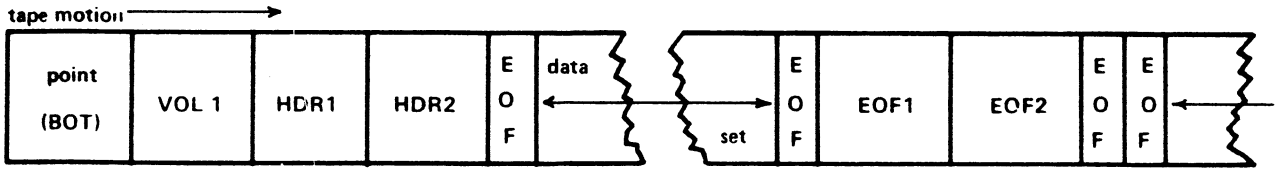
The following table compares the contents of Wang, IBM and ANSI tape labels, which are optionally written by the Model 2209A utilities.

Table 4-5. Tape Label Records

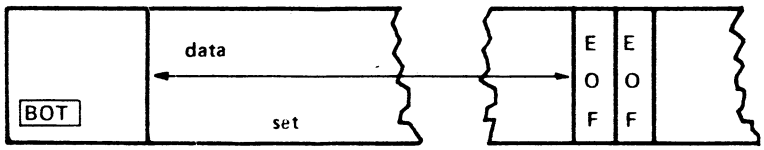
Item	Wang	IBM	ANSI
Volume Label	VOL1	VOL1	VOL1
Dataset Headers	HDR1	HDR1	HDR1
	HDR2	HDR2	HDR2
Dataset Trailers	not used	EOV1*	EOV1*
	not used	EOV2*	EOV2*
Dataset Trailers	EOF1**	EOF1**	EOF1**
	EOF2**	EOF2**	EOF2**
User Headers	not used	UHL1***	UHL1***
	not used	UHL8***	UHLn***
User Trailers	not used	UTL****	UTL1****
	not used	UTL8****	UTLn****

* = End-of-Volume
** = End-of-File
*** = user-header-label
**** = user-trailer-label

On labeled tapes, the physical label and file structure is as follows:



An unlabelled tape has the following form:



Volume Label

The volume label which identifies the volume and its owners is 80 bytes long.

Header/Trailer Label 1

The Header/Trailer labels contain data used to identify and describe the data set recorded on tape and to protect data from unauthorized use. Except for the first field, which contains either HDR1 or EOF1, header and trailer labels contain the same 80 bytes of information.

Header/Trailer Label 2

Header Label 2 always follows Header Label 1; Trailer Label 2 always follows Trailer Label 1. They each contain 80 bytes of information similar in content to Header/Trailer 1.

NOTE:

The user can process tapes with multiple files with $GIO. If labelled, the tape can possess several volumes. Label records can be non-standard (i.e., not IBM, Wang or ANSI).

APPENDIX A: PREVENTIVE AND ROUTINE MAINTENANCE INFORMATION

Preventive Maintenance Information

It is recommended that this equipment be maintained in an environment which conforms to the parameters listed below, undergo routine customer maintenance at the recommended intervals, and be professionally serviced quarterly. A Wang Maintenance Agreement is available to assure this quarterly servicing automatically. If no Maintenance Agreement is acquired, all servicing must be arranged for by the customer. A Maintenance Agreement protects your investment and offers the following benefits:

Preventive Maintenance:

The equipment is inspected for worn parts, lubricated, cleaned and updated with any engineering changes. Preventive maintenance minimizes "downtime" by anticipating repairs before they are necessary, and reduces the possibility of a maladjustment which could cause equipment degradation if unnoticed and uncorrected.

Fixed Annual Cost:

With a Maintenance Agreement, you receive one annual billing. More frequent billing can be arranged, if desired.

Further information regarding Maintenance Agreements can be acquired from the Wang Sales-Service Office.

> NOTE:
>
> Wang Laboratories, Inc. does not honor Maintenance Agreements for nor guarantee any equipment modified by the user. Damage to equipment incurred as a result of such modification is the financial responsibility of the user.

Recommended Environmental Conditions

The recommended operating temperature ranges from 65°F to 75°F (18°C to 24°C). When these temperatures are exceeded, increased component failure rates and loss of data through distortion and magnetic oxide shed of the tape may increase.

The recommended humidity range is from 40% R.H. to 60% R.H. Low humidity increases the possibility of static build-up, and oxide shed of the tape. Static discharge is uncomfortable, and might also cause system errors or destruction of data.

Airborne contaminants can form a film which may prevent adequate heat dissipation from circuit elements, create leakage paths for the system signals, and cause excessive wear in the tape read/write heads and the oxide coatings of the tape. To prevent unnecessary failure, remove excess airborne contaminants.

Any carpeting installed at computer sites should have good non-static characteristics. If it does not, it must either be treated with non-static spray, or grounded electrically with a conductive mat.

Computers and peripherals are susceptible to System errors through Electro-Magnetic Interference (EMI) which can enter the system by conduction through wiring and cabling or by radiation. To minimize such interference, the AC power line should be dedicated to the system and properly installed in steel conduit. Interference generating devices like office machines, lighting, motors, HVAC units, etc., must be relocated, repaired, or filtered to prevent them from disturbing the system. In cases of high residual EMI, it may also be necessary to shield peripheral cables.

Routine Maintenance Procedures

Wang tape transports are highly reliable precision instruments, which will provide years of trouble-free performance when properly maintained. A program of routine inspection and maintenance is essential for the unit's optimum performance and reliability. The maintenance procedures involved are simple but important to proper tape transport operation. The need for routine maintenance will vary with the condition of the environment and the degree of use of the transport, so a rigid schedule applying to all machines is difficult to define. The recommended maintenance periods below apply to units in regular operation in average environments. They should be modified if experience shows another schedule more suitable.

The entire room should be vacuumed every 24 hours. A nonconducting nozzle should be used to minimize any possibility of destructive electrical discharge. An external system is recommended; however, an adequately sealed portable cleaner may be used. The entire floor should also be thoroughly cleaned every day with a damp mop. Under no circumstances should sweeping or the use of dust-cloths, dry mops, steel buffing pads, etc., occur.

Daily Check

Visually check the machine for cleanliness and obvious misadjustment. If any items in the tape path show evidence of dirt or oxide accumulation, clean them thoroughly. All items in the tape path must be kept scrupulously clean. This is particularly true of the tape head and guides. The inside of the dust cover must not be allowed to accumulate dirt, since transfer of dirt to the tape could cause malfunction.

Cleaning the Model 2209A (See Figure A-1.)

Oxide or dirt accumulations on the head surfaces are removed using a mild organic solvent and a swab. Q-tip cotton swabs are convenient for this but must be used with caution. Be sure the wooden portion does not contact head surfaces. An ideal solvent is the trichlorothane contained in the Wang maintenance kit. However, others such as pure isopropyl alcohol will do.

Do not use acetone or lacquer thinner, contents from aerosol spray cans, or rubbing alcohol, etc., for cleaning. Use only the recommended cleaners "sparingly", and be careful not to allow the solvent to penetrate ball bearings of the guide rollers, capstan motor, etc., since it will destroy their lubrication. The procedure for cleaning is as follows:

1. Remove tape from the tape unit.

2. Moisten a soft, lint-free cloth or Q-tip applicator with cleaner, and swab the read/write and erase head surfaces, ceramic tape cleaner, and roller guides. Rotate the roller guides and make sure that all surfaces are clean. Guide wear occurs principally at the point of contact with the front guide surface. Although guides are ceramic, in time grooves will appear. Since guides are symmetrical it is only necessary to loosen the guide mounting screw, rotate the guide, and tighten to present an unworn surface to the tape. After these surfaces have been carefully swabbed, dry them with a separate clean, lint-free cloth.

3. Moisten a cloth with water; it should be damp, not wet. Rotate the capstan slowly with one hand, without touching the rubber surface, cleaning the surface of the capstan with a damp cloth. Check the capstan surface for abrasion or polish; if defects are observed, contact your Wang Service Representative.

4. Reel containers should be periodically inspected. Remove any accumulation of dust by washing containers with a household detergent.

CAUTION:

Tape transport cleaner should never be permitted to come into direct contact with magnetic tape because the interaction of tape and cleaner may damage the tape. To clean magnetic tape, wipe it gently with a clean, lint-free cloth moistened with recommended tape cleaner. Do not use carbon tetrachloride and vythene for cleaning magnetic tape units under any circumstances.

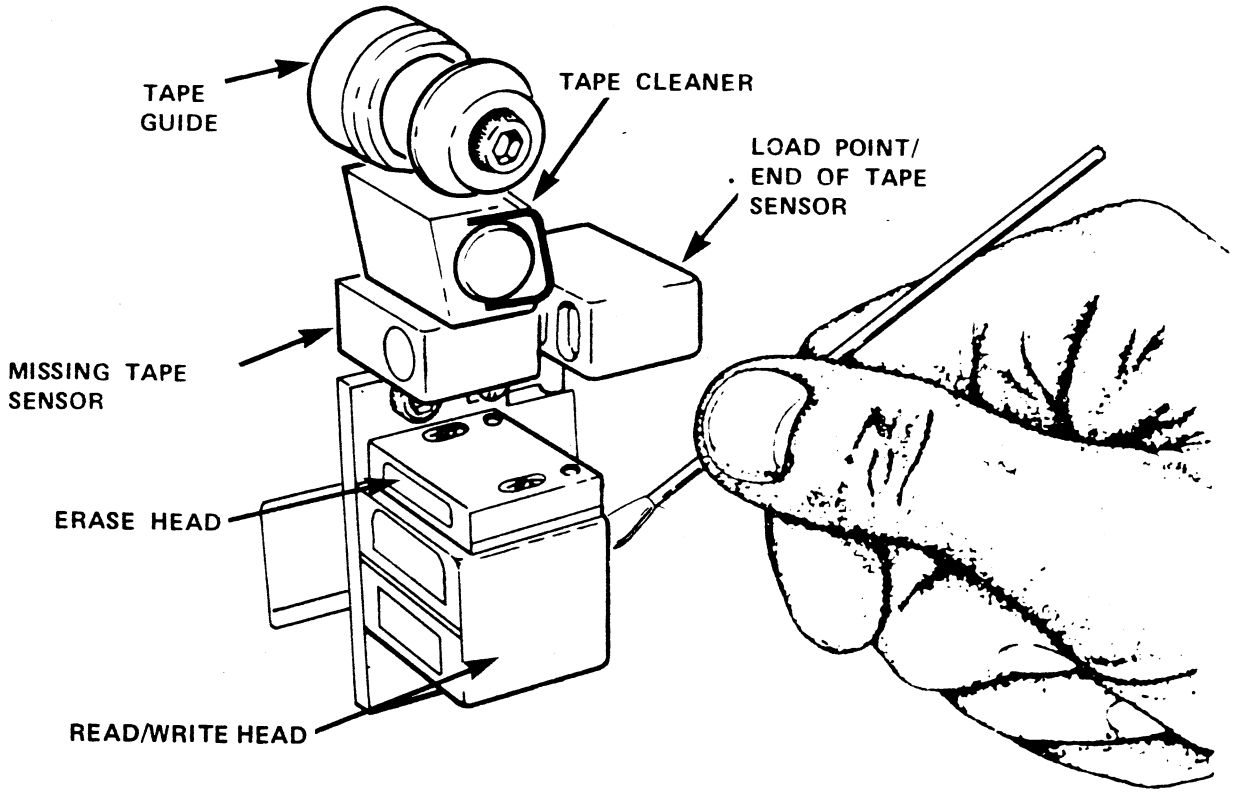


Figure A-1.
Cleaning the Model 2209A

APPENDIX B: SPECIFICATIONS

Minimum Equipment Configuration:		System 2200 with 12K RAM, General I/O available statements, and an available I/O port.
Unit Type:		Reel-to-Reel
Recording:	Density:	1600 bpi (bytes/in.) (630 bytes/cm)
	Mode:	Phase Encoded
	Format:	ANSI
	Tracks:	nine
Tape Speed:		75 ips (190 cm/s) Read/Write 200 ips (nominal) (508 cm/s) During Rewind
Head:		Dual Gap, Read-After-Write
Tape Transport Buffer:		Vacuum Columns
Data Transfer Rate:		120 KBS (kilobytes/sec) head to buffer
Interblock Gap:		0.60 in. (1.5 cm)
File Protection Device:		WRITE ENABLE ring
Tape Specifications:		quality: computer grade width: 0.5 in. x 2400 ft (1.3cm x 732m) thickness: 1.5 mil reel size: up to 10.5 in. (26.7 cm) diameter hub: standard 3.7 in. (9.4 cm) inner diameter, compatible with IBM Series 2400 tape units.
Approximate Net Weight:		170 lb (77 kg)
Drive Size:		*height: 35 in. (78 cm) width: 24 in. (61 cm) depth: 21 in. (53 cm)
Site Size:		*height: 37 in. (94 cm) width: 26 in. (66 cm) depth: not less than 73 in. (107 cm) to accommodate opening front and rear access doors.
Accessories:		Tape unit cleaning pads, 1 reel of tape.
Power:		115 VAC ± 10% or 230 VAC ± 10% 50 to 60 Hz ± 1 cps 475 watts 26 AMP @ 115 VAC 14 AMP @ 230 VAC

* Height varies because unit is available with or without integral storage cabinet in heights up to 64 in. (163 cm).

Cable to Controller:	(2) 12 ft (3.7 m) cables to controller (50 pin) (1) 8 ft (2.4 m) to power source (3 prong)
Operating Environment:	Temperature: $60^{\circ}F$ to $90^{\circ}F$ ($16^{\circ}C$ to $32^{\circ}C$) Relative Humidity: 40% to 60%, non-condensing.

APPENDIX C: WANG ASCII BIT TO HEX, TRACK TO HEX EQUIVALENT VALUES TABLE

Bit to Hex Value

Low Order High Order

Binary Weight	0 2^2	1 2^2	2 2^2	3 2^2	0 2^2	1 2^2	2 2^2	3 2^2	P
*Wang ASCII bits	b_1	b_2	b_3	b_4	b_5	b_6	b_7	b_8	P
hex value	01	02	04	08	10	20	40	80	P

* With the normal ASCII code, the high-order bit is not used (i.e., b_8 = zero). The 80-bit is available in Wang ASCII for underlining codes 10-7F and specifying additional characters (codes 80-8F).

Tape Track to Hex Value

Track	1	2	3	4	5	6	7	8	9
Bit Value	2^2	0^2	4^2	P	5^2	6^2	7^2	1^2	3^2
Hex Value	04	01	10	P	20	40	80	02	08

This assignment of bits to the available tracks was established for maximum reliability. Tape stretching, reel wobble, etc., can cause the outside tracks to be as many as three byte cells skew before the Mode 2209A Phase Encoding electronics will have difficulty in deskewing and decoding the data.

APPENDIX D: CROSS REFERENCE CHART OF BIT CONFIGURATIONS EBCDIC AND ASCII

Note the Wang character code is written to and read from tape, unless some Wang-supplied or user-written translation routine is executed by the CPU.

Wang Code*

High-order: 4-bits / Low-order: 4-bits hex-digit	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
hex-digit	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0000 0	NUL 0	SOH (Cursor home) 1	2	(Clear screen, Cursor home) 3	4	Cursor on 5	Cursor off 6	(Alarm) 7	(Cursor Back-Space) 8	RT or Cursor right 9	LF or Cursor down 10	VT 11	FF (Rev. Index) 12	CR 13	(Elongated Char.) 14	SI (Shift Down) 15
0001 1	â 16	ê 17	î 18	ô 19	û 20	ä 21	ë 22	ï 23	ö 24	ü 25	à 26	è 27	ù 28	Ä 29	Ö 30	Ü 31
0010 2	SP (Space) 32	! 33	" 34	# 35	$ 36	% 37	& 38	' (Quote) 39	(40	) 41	* 42	+ 43	, (Comma) 44	— (Dash) 45	. (Period) 46	/ 47
0011 3	0 48	1 49	2 50	3 51	4 52	5 53	6 54	7 55	8 56	9 57	: 58	; 59	< 60	= 61	> 62	? 63
0100 4	@ 64	A 65	B 66	C 67	D 68	E 69	F 70	G 71	H 72	I 73	J 74	K 75	L 76	M 77	N 78	O 79
0101 5	P 80	Q 81	R 82	S 83	T 84	U 85	V 86	W 87	X 88	Y 89	Z 90	[91	\ 92	] 93	↑ 94	← 95
0110 6	(Prime) 96	a 97	b 98	c 99	d 100	e 101	f 102	g 103	h 104	i 105	j 106	k 107	l 108	m 109	n 110	o 111
0111 7	p 112	q 113	r 114	s 115	t 116	u 117	v 118	w 119	x 120	y 121	z 122	¢ 123	£ 124	é 125	‹ 126	› 127
1000 8	NULL 128	♦ 129	▶ 130	◀ 131	→ 132	← 133	| 134	¨ 135	´ 136	` 137	^ 138	■ 139	!! 140	: 141	¸ 142	¶ 143

ASCII Code*

High-order: 4-bits / Low-order: 4-bits hex-digit	0_{0_0}	0_{0_1}	0_{1_0}	0_{1_1}	1_{0_0}	1_{0_1}	1_{1_0}	1_{1_1}	0_{0_0}	0_{0_1}	0_{1_0}	0_{1_1}	1_{0_0}	1_{0_1}	1_{1_0}	1_{1_1}
hex-digit	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0000 0	NUL 0	SOH 1	STX 2	ETX 3	EOT 4	ENQ 5	ACK 6	BEL 7	BS 8	HT 9	LF 10	VT 11	FF 12	CR 13	SO 14	SI 15
0001 1	DLE 16	DC1 17	DC2 18	DC3 19	DC4 20	NAK 21	SYN 22	ETB 23	CAN 24	EM 25	SUB 26	ESC 27	FS 28	GS 29	RS 30	US 31
0010 2	Space 32	! 33	" 34	# 35	$ 36	% 37	& 38	(apos.) ' 39	(40	) 41	* 42	+ 43	(comma) , 44	(dash) — 45	(period) . 46	/ 47
0011 3	0 48	1 49	2 50	3 51	4 52	5 53	6 54	7 55	8 56	9 57	: 58	; 59	< 60	= 61	> 62	? 63
0100 4	@ 64	A 65	B 66	C 67	D 68	E 69	F 70	G 71	H 72	I 73	J 74	K 75	L 76	M 77	N 78	O 79
0101 5	P 80	Q 81	R 82	S 83	T 84	U 85	V 86	W 87	X 88	Y 89	Z 90	[91	\ 92	] 93	↑ 94	(underline) — 95
0110 6	grave accent ` 96	a 97	b 98	c 99	d 100	e 101	f 102	g 103	h 104	i 105	j 106	k 107	l 108	m 109	n 110	o 111
0111 7	p 112	q 113	r 114	s 115	t 116	u 117	v 118	w 119	x 120	y 121	z 122	{ 123	¦ 124	} 125	~ 126	DEL 127

*Numbers in the lower right corner of each box represent the decimal equivalent of the binary and the hexadecimal code for the character shown in the box, e.g., A = $(41)_{16} = (01000001)_2 = (65)_{10}$.

APPENDIX D: CROSS REFERENCE CHART OF BIT CONFIGURATIONS EBCDIC AND ASCII

EBCDIC Code*

High-order: 4-bits / Low-order: 4-bits hex-digit		0_{0_0}	0_{0_1}	0_{1_0}	0_{1_1}	0_{0_0}	0_{1_0}	0_{1_1}	0_{1_1}	1_{0_0}	1_{0_1}	1_{1_0}	1_{1_1}	1_{0_0}	1_{1_0}	1_{1_1}	1_{1_1}
		0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0000	0	NUL 0	SOH 1	STX 2	ETX 3	PF 4	HT 5	LC 6	DEL 7	8	RLF 9	SMM 10	VT 11	FF 12	CR 13	SO 14	SI 15
0001	1	DLE 16	DC1 17	DC2 18	DC3 19	RES 20	NL 21	BS 22	IL 23	CAN 24	EM 25	CC 26	27	IFS 28	IGS 29	IRS 30	IUS 31
0010	2	DS 32	SOS 33	FS 34	35	BYP 36	LF 37	ETB 38	ESC 39	40	41	SM 42	43	44	ENQ 45	ACK 46	BEL 47
0011	3	48	49	SYN 50	51	PN 52	RS 53	UC 54	EOT 55	56	57	58	59	DC4 60	NAK 61	62	SUB 63
0100	4	Space 64	65	66	67	68	69	70	71	72	73	¢ 74	(period) . 75	< 76	(77	+ 78	79
0101	5	& 80	81	82	83	84	85	86	87	88	89	! 90	$ 91	* 92	) 93	; 94	¬ 95
0110	6	(dash) — 96	/ 97	98	99	100	101	102	103	104	105	¦ 106	(comma) , 107	% 108	(underline) — 109	> 110	? 111
0111	7	112	113	114	115	116	117	118	119	120	grave accent ` 121	: 122	# 123	@ 124	(apos.) ' 125	= 126	" 127
1000	8	128	a 129	b 130	c 131	d 132	e 133	f 134	g 135	h 136	i 137	138	139	140	141	142	143
1001	9	144	j 145	k 146	l 147	m 148	n 149	o 150	p 151	q 152	r 153	154	155	156	157	158	159
1010	A	160	~ 161	s 162	t 163	u 164	v 165	w 166	x 167	y 168	z 169	170	171	172	173	174	175
1011	B	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191
1100	C	{ 192	A 193	B 194	C 195	D 196	E 197	F 198	G 199	H 200	I 201	202	203	204	205	206	207
1101	D	} 208	J 209	K 210	L 211	M 212	N 213	O 214	P 215	Q 216	R 217	218	219	220	221	222	223
1110	E	\ 224	225	S 226	T 227	U 228	V 229	W 230	X 231	Y 232	Z 233	234	235	236	237	238	239
1111	F	0 240	1 241	2 242	3 243	4 244	5 245	6 246	7 247	8 248	9 249	250	251	252	253	254	255

*Numbers in the lower right corner of each box represent the decimal equivalent of the binary and the hexadecimal code for the character shown in the box, e.g., A = $(C1)_{16} = (11000001)_2 = (193)_{10}$.

9193 BLKS 37096 = DATA SECTORS - 50F 1ST TAPE
TOTAL 11463 BLKS, 46404 SECTORS - START of FILE

APPENDIX E: CARE AND HANDLING OF TAPE MEDIA

Tape Handling

Tape will normally wind on the reel with some of its edges slightly protruding. These irregularities result from air being trapped between adjacent layers of tape. In itself, this condition will not interfere with proper operation of tape, but it requires that proper care in handling tape be exercised by all operating personnel. The exposed tape edges can be badly damaged by squeezing them through the reel openings, or by pinching the edges of the reel. Handle reels near the hub whenever possible. In picking up reels, grip the reel between the center hole and the outer edge.

If a reel wobbles or appears to be warped during use, check that it is seated properly on the tape drive hub (i.e., the file protect ring may not be inserted completely). When the tape reel is improperly mounted, the edges of the tape receive excess wear and become blurred. In time, the edges of the tape will be permanently stretched. A tape in such condition proves unpredictable and generally unsatisfactory. Read errors, usually random and nonrepetitive, are increased.

Dropping a reel of tape can damage both the reel and the tape, even while they are protected in their containers. The reel may be broken and/or the tape may be crimped and soiled. Inspect the tape and the reel immediately. Breaking or bending of the reel can usually be found by visual inspection. Never check the reel by mounting it on the hub of a tape unit. If the reel has been bent or broken, it must not be used. The tape may be serviceable, however. Discard damaged tape. Splicing is not recommended. If possible, test the tape for proper functioning before using it for subsequent applications.

Tape Storage

Reels must be properly enclosed and supported in their ring or other container when not in use. While a reel of tape is on the machine, its container should be placed where it is not exposed to dust and dirt. When a tape is removed from a tape unit, immediately place it in a dust-proof container. Always place tape end retainers on the reels as they are stored, to prevent the free end from unwinding in the container. Store tapes in a cabinet elevated from the floor and away from sources of paper or card dust. This should minimize the transfer of dust from the outside of the container to the reel during loading or unloading operations.

Tapes that contain useful information must not be exposed to excessive humidity, temperature, or magnetic fields with an intensity greater than 50 oersteds, or direct sunlight for prolonged periods. Also, smoking is not recommended in the computer room. Ashes can contaminate tape and produce permanent damage if they touch the surface of the tape.

Labeling Tapes

To label a reel of tape for identification, use a label material that leaves no residue. Adhesive stickers that can be applied and removed easily are satisfactory. Never use an eraser to alter the identification on a label.