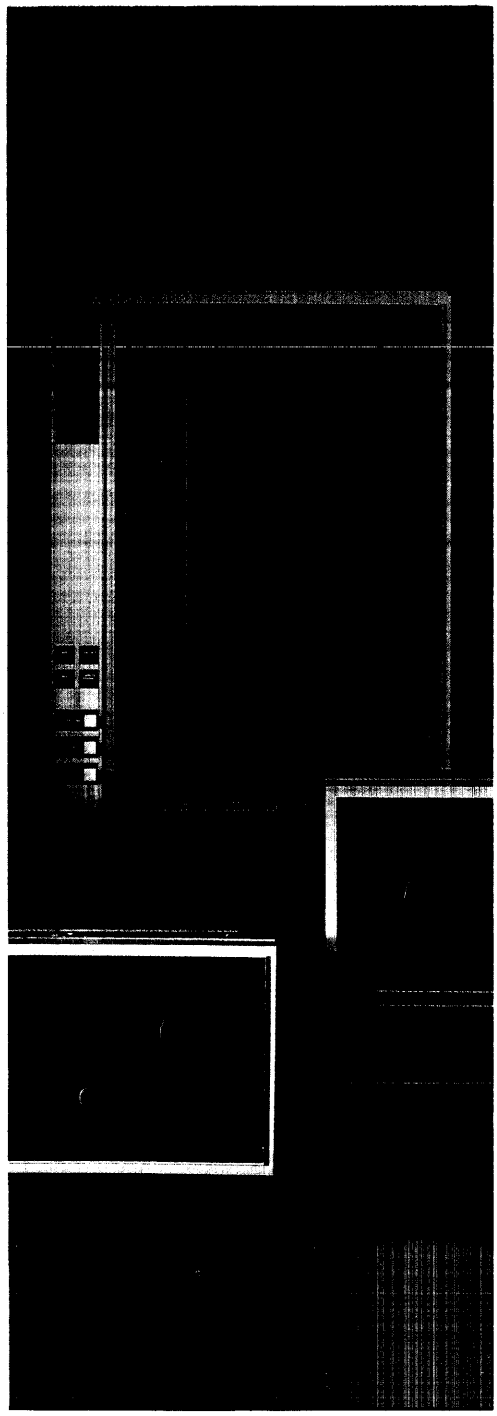
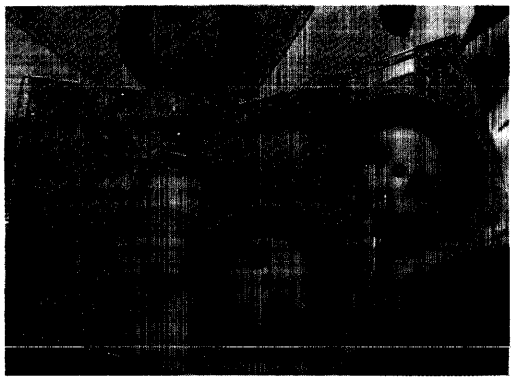
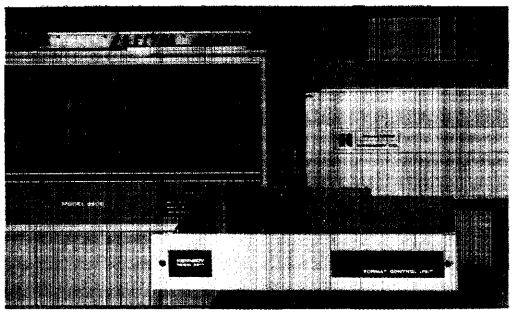
Application and interface guide

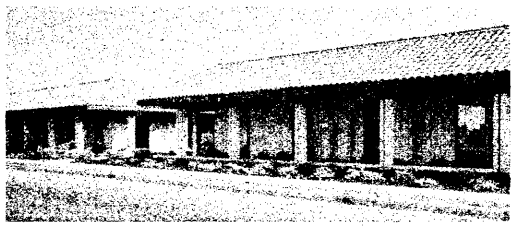
KENNEDY CO.

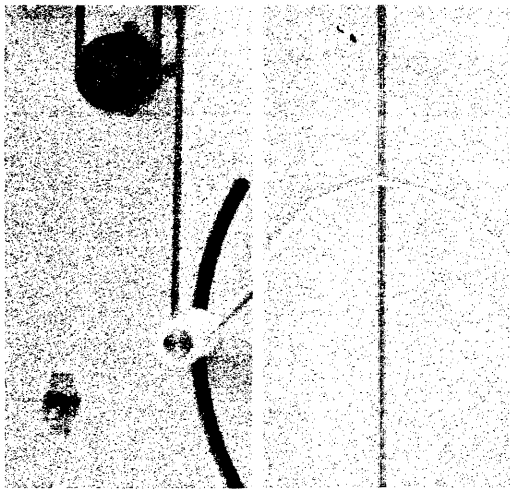
Model 1600/360
Magnetic Tape Recorder

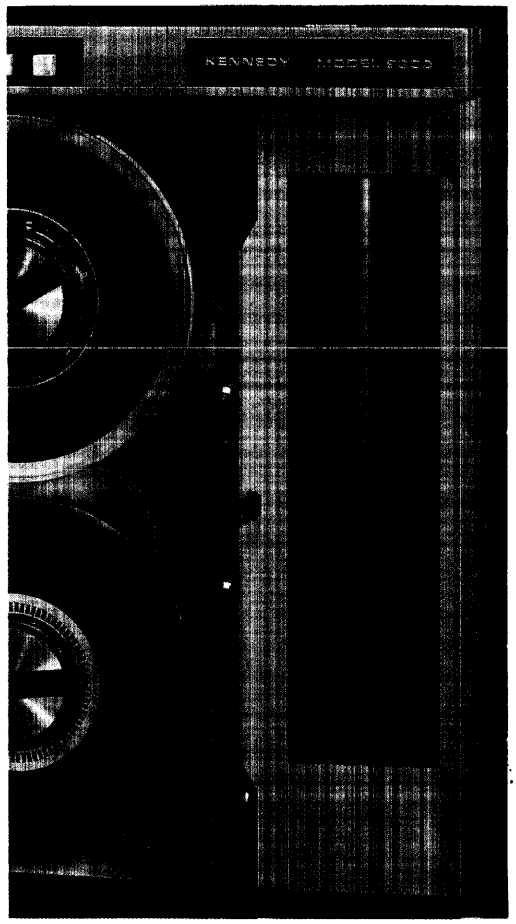


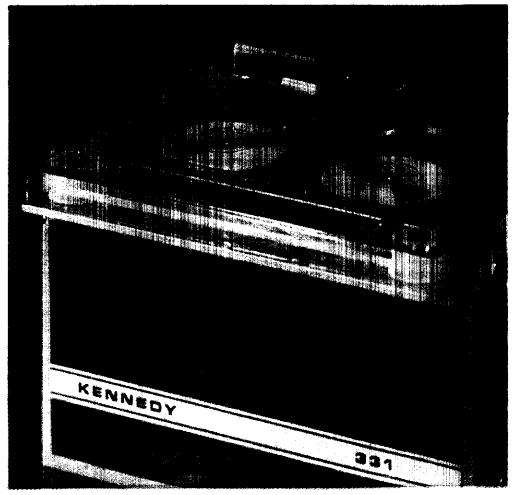












SECTION I

GENERAL INFORMATION

PRINCIPLES OF OPERATION

Kennedy Incremental Recorders prepare IBM compatible tape from sources of data operating at random or non-standard rates. This means that tapes recorded can be mounted on standard computer tape drives and read as though they had been written by the computer itself.

All the characteristics of computer written tape are duplicated. Data characters are evenly spaced as required by the computer, parity bits are generated internally and properly placed on tape and gaps of standard lengths are inserted on command.

Incremental recorders are capable of producing evenly spaced data even though the data source may be operating in a sporadic or random manner. Continuous, or start-stop tape drives, cannot do this without use of a large and costly memory.

As an example, consider the problem of recording the output of an electric typewriter operated manually. Keys are struck with variable rapidity and if the recording tape were in smooth motion, the variability would result in uneven spacing on the tape. Even if the operator were capable of absolutely consistent typing, time for carriage return would differ from key stroke time.

In an incremental recorder, each character is recorded upon command. The tape then steps one increment--which may be 0.005" for 200 BPI; 0.0018" for 556 BPI; or 0.0012" for 800 BPI--then stops and awaits the next step command, thus the data is evenly recorded assuming that the maximum asynchronous stepping rate of the recorder has not been exceeded. The incremental recorder has numerous advantages over other methods of performing this function:

1. The recorder is an inexpensive device because tape speeds are very low.

2. No expensive memory is required.

3. The recorder is mechanically simple with almost no moving parts to fail--highly reliable.

4. Tapes produced are immediately usable on computers without conversion.

Stepping Mechanism

The heart of the incremental recorder is its stepping mechanism which must be accurate and reliable. Not only must its step size be accurate, but there must be no possibility that the step is not accurately transmitted to the tape itself. When the drive is stationary, as

it may be for long periods of time, there must be no possibility that the tape may creep or otherwise move.

All these requirements together with the obvious requirement for high asynchronous stepping rates are met by the stepper motor drive used in Kennedy Incremental Recorders. The stepping motor itself is a special ultra-high speed, variable reluctance motor which moves 15^{o} per step. Each position of the motor is strongly detented magnetically. This 15^{o} step motion is reduced through precision gearing to the proper angular motion to advance the tape the required increment.

Tape is driven by a capstan and pinch roller in such a way as to make slippage a virtual impossibility at any speed.

The drive mechanisms on all standard Kennedy Incremental Recorders are identical--the only variation being in step size as determined by gear ratio and capstan diameter.

Electronics

Ease of application has been the primary consideration in design of the recorder interface. Internally, recorder electronics are all solid state, silicon. Integrated circuits are used in all appropriate applications.

INCREMENTAL RECORDING SYSTEMS

A block diagram is shown in Figure 1-1 of a typical Kennedy Incremental Recorder illustrating its principal components. It will be noted that electronics may be divided into sections having inter-related but separate functions.

1. Parity-Write Amplifier section produces the actual recording on tape.

2. Gap generation system develops the drive signals necessary to insert gaps.

3. Control section provides circuits operable by pushbuttons and remote signals to control tape motion.

4. Stepper drive system receives step commands and produces signals which cause the stepper motor to increment.

Each of these sections will be shown in detail in this book.

In addition to the basic system shown, there are other functions which may be added for special purposes. They do not basically alter the system but add to its complexity.

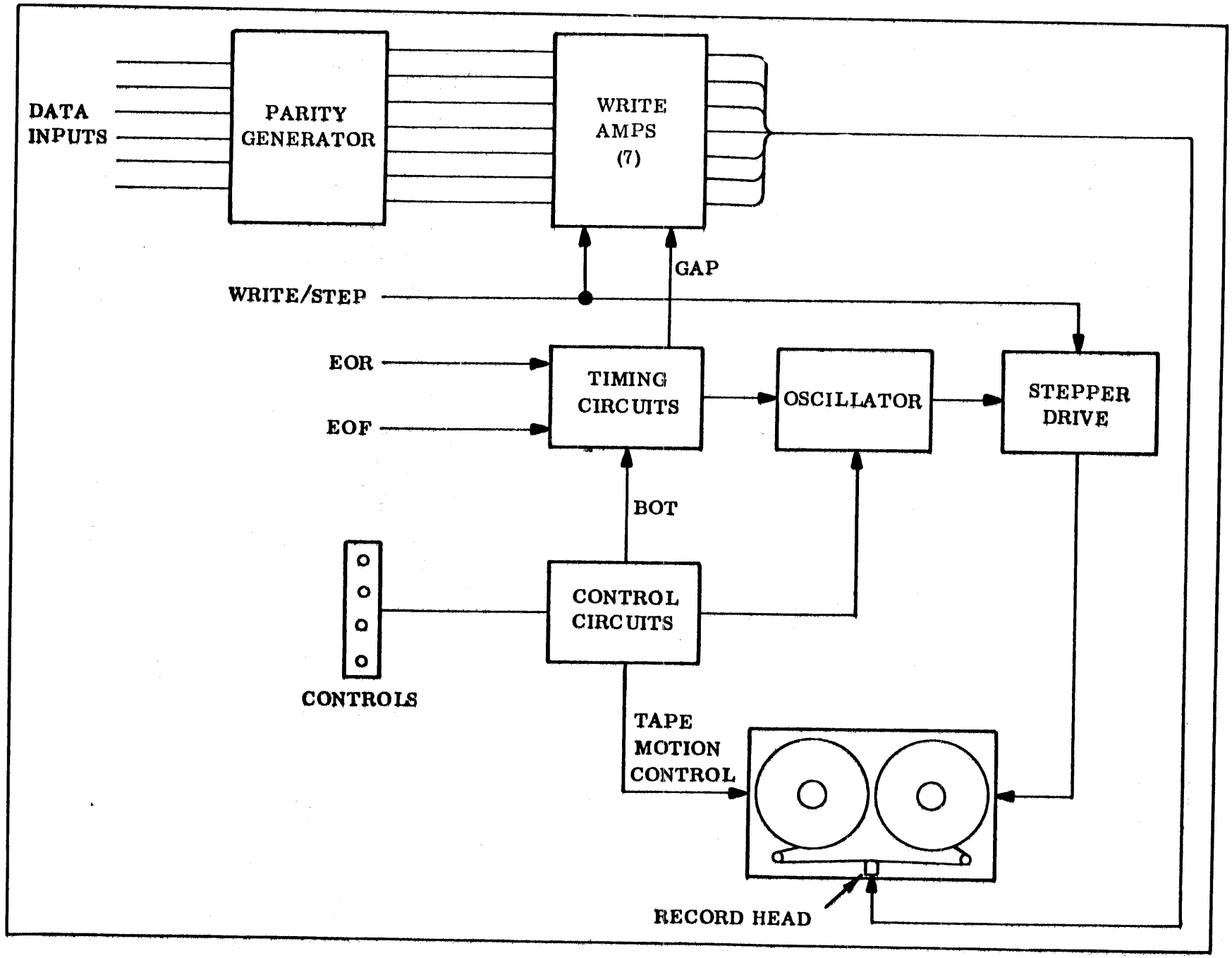


Figure 1-1. Incremental Recording System

DIGITAL MAGNETIC RECORDING

To record digital data on magnetic tape it is necessary, in some way, to magnetize the tape discretely to indicate binary ones and zeros. Of several different schemes, the IBM NRZI system has been most widely adopted. As shown in Figure 1-2, ones are represented by transitions between saturation magnetism (+ and -) on the tape.

Since magnetic heads respond to the rate of change of flux but not to steady flux, when tape is read output waveforms, such as those shown in Figure 1-2, are produced. No change in flux represents a binary zero and no voltage is recovered from the head.

In order to be usable as a recording scheme, the NRZI system requires at least one bit to be recorded for all characters; otherwise, in an all zero character there would be no indication that a character was supposed to be in that location.

NRZI recording is implemented by driving current through the head winding in a direction determined by a flip-flop which toggles for each one to be recorded.

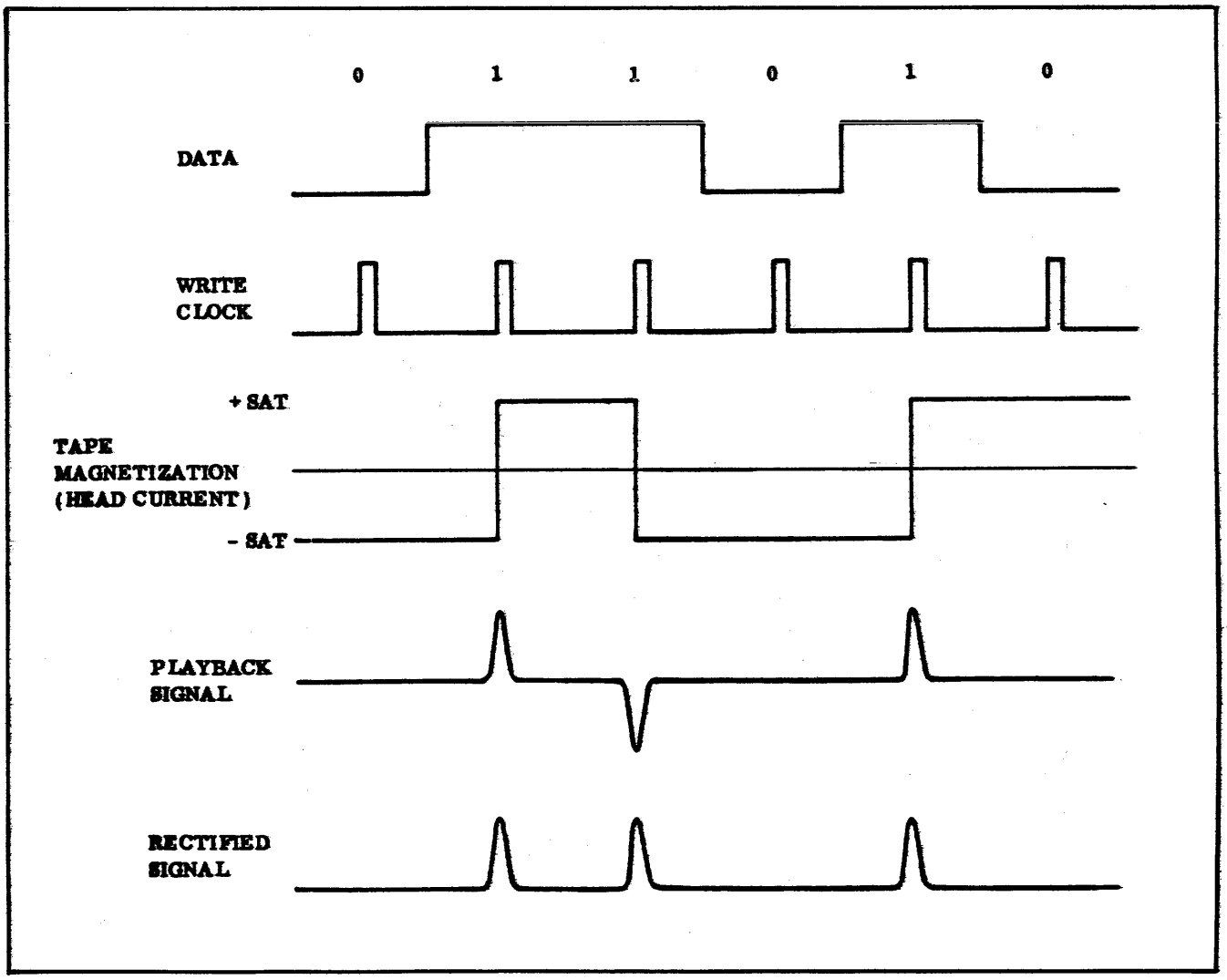


Figure 1-2. NRZ Waveforms

In a seven-track system, as shown in Figure 1-3, six of the tracks are data channels while the seventh is the parity channel. Parity may be either odd or even which is to say that bits may be added in the C track to make the sum of the bits in the character either odd or even. Even parity is used with BCD coding while odd parity is used when operating in the binary mode.

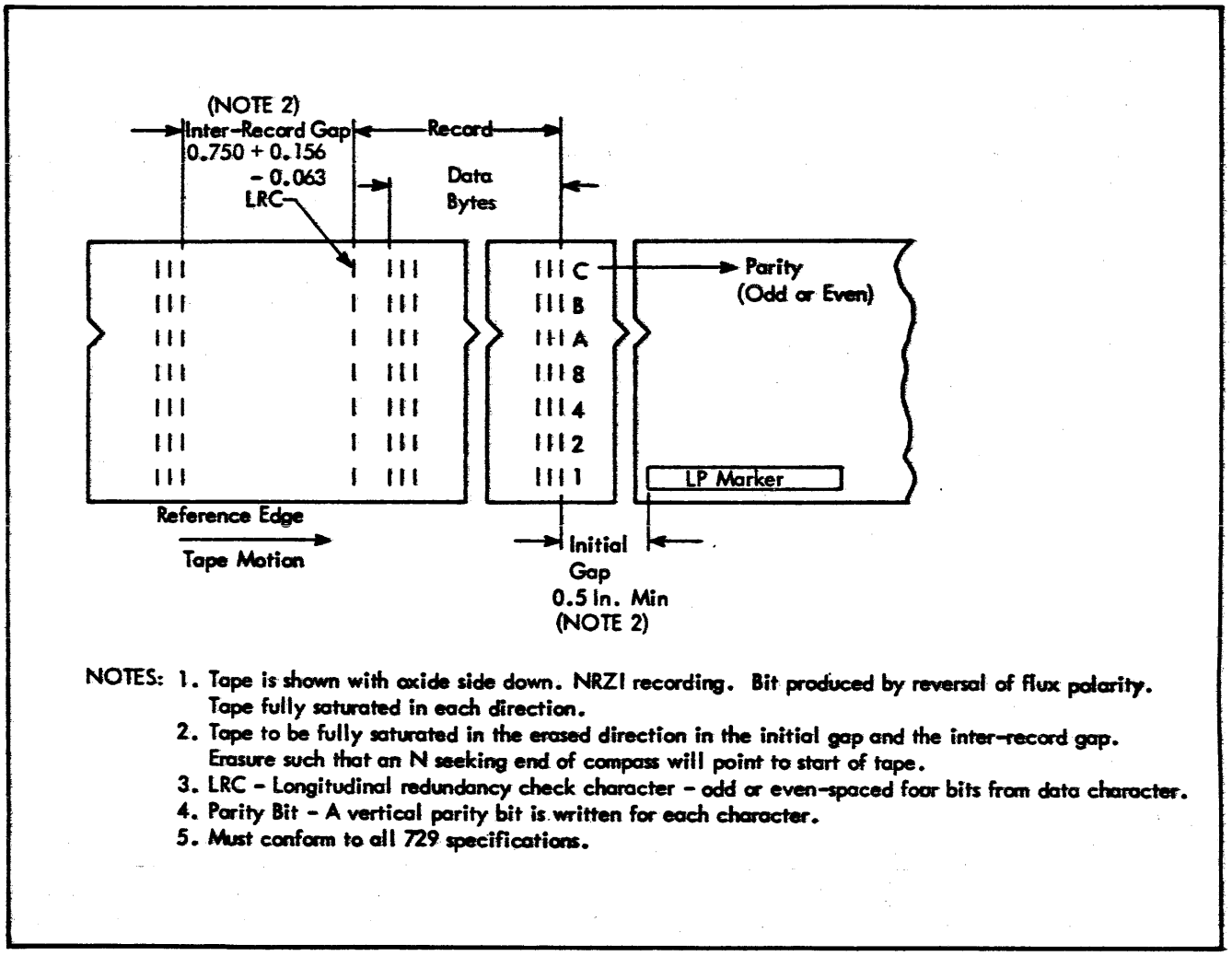


Figure 1-3. Data Format - Seven Track

BCD

IBM seven-channel BCD code is shown in Figure 1-4. It will be noted that there are 63 combinations of the 6-data bits available to stand for numerics, letters, and special symbols. Actually, a somewhat larger variety of symbols may be used, depending upon the print chain, by leaving out some unused symbols and substituting others.

Collating Sequence	Graphics 8 Bit	Graphics BCD	Eight - Bit Code 0	1	2	3	4	5	6	7	BCD B	A	8	4	2	1
00	blank	blank	0	1	0	0	0	0	0	0	0	0	0	0	0	0
01	.	.	0	1	0	0	1	0	1	1	1	1	1	0	1	1
02	←	¤)	0	1	0	0	1	1	0	0	1	1	1	1	0	0
03	(	⊏	0	1	0	0	1	1	0	1	1	1	1	1	0	1
04	+	<	0	1	0	0	1	1	1	0	1	1	1	1	1	0
05	GM	GM	0	1	0	0	1	1	1	1	1	1	1	1	1	1
06	&	& +	0	1	0	1	0	0	0	0	1	1	0	0	0	0
07	$	$	0	1	0	1	1	0	1	1	1	0	1	0	1	1
08	*	*	0	1	0	1	1	1	0	0	1	0	1	1	0	0
09	)	⌋	0	1	0	1	1	1	0	1	1	0	1	1	0	1
10	;	;	0	1	0	1	1	1	1	0	1	0	1	1	1	0
11	MC	MC	0	1	0	1	1	1	1	1	1	0	1	1	1	1
12	-	-	0	1	1	0	0	0	0	0	1	0	0	0	0	0
13	/	/	0	1	1	0	0	0	0	1	0	1	0	0	0	1
14	,	,	0	1	1	0	1	0	1	1	0	1	1	0	1	1
15	%	% (	0	1	1	0	1	1	0	0	0	1	1	1	0	0
16	WS	WS	0	1	1	0	1	1	0	1	0	1	1	1	0	1
17	↓	\	0	1	1	0	1	1	1	0	0	1	1	1	1	0
18	SM	SM	0	1	1	0	1	1	1	1	0	1	1	1	1	1
19	↑	↑	0	1	1	1	1	0	1	0	0	1	0	0	0	0
20	#	# =	0	1	1	1	1	0	1	1	0	0	1	0	1	1
21	@	@ '	0	1	1	1	1	1	0	0	0	0	1	1	0	0
22	▽	:	0	1	1	1	1	1	0	1	0	0	1	1	0	1
23	=	>	0	1	1	1	1	1	1	0	0	0	1	1	1	0
24	TM	TM	0	1	1	1	1	1	1	1	0	0	1	1	1	1
25	∂	∂	1	1	0	0	0	0	0	0	1	1	1	0	1	0
26	A	A	1	1	0	0	0	0	0	1	1	1	0	0	0	1
27	B	B	1	1	0	0	0	0	1	0	1	1	0	0	1	0
28	C	C	1	1	0	0	0	0	1	1	1	1	0	0	1	1
29	D	D	1	1	0	0	0	1	0	0	1	1	0	1	0	0
30	E	E	1	1	0	0	0	1	0	1	1	1	0	1	0	1
31	F	F	1	1	0	0	0	1	1	0	1	1	0	1	1	0
32	G	G	1	1	0	0	0	1	1	1	1	1	0	1	1	1
33	H	H	1	1	0	0	1	0	0	0	1	1	1	0	0	0
34	I	I	1	1	0	0	1	0	0	1	1	1	1	0	0	1
35	∂	∂	1	1	0	1	0	0	0	0	1	0	1	0	1	0
36	J	J	1	1	0	1	0	0	0	1	1	0	0	0	0	1
37	K	K	1	1	0	1	0	0	1	0	1	0	0	0	1	0
38	L	L	1	1	0	1	0	0	1	1	1	0	0	0	1	1
39	M	M	1	1	0	1	0	1	0	0	1	0	0	1	0	0
40	N	N	1	1	0	1	0	1	0	1	1	0	0	1	0	1
41	O	O	1	1	0	1	0	1	1	0	1	0	0	1	1	0
42	P	P	1	1	0	1	0	1	1	1	1	0	0	1	1	1
43	Q	Q	1	1	0	1	1	0	0	0	1	0	1	0	0	0
44	R	R	1	1	0	1	1	0	0	1	1	0	1	0	0	1
45	RM	RM	1	1	1	0	0	0	0	0	0	1	1	0	1	0
46	S	S	1	1	1	0	0	0	1	0	0	1	0	0	1	0
47	T	T	1	1	1	0	0	0	1	1	0	1	0	0	1	1
48	U	U	1	1	1	0	0	1	0	0	0	1	0	1	0	0
49	V	V	1	1	1	0	0	1	0	1	0	1	0	1	0	1
50	W	W	1	1	1	0	0	1	1	0	0	1	0	1	1	0
51	X	X	1	1	1	0	0	1	1	1	0	1	0	1	1	1
52	Y	Y	1	1	1	0	1	0	0	0	0	1	1	0	0	0
53	Z	Z	1	1	1	0	1	0	0	1	0	1	1	0	0	1
54	0	0	1	1	1	1	0	0	0	0	0	0	1	0	1	0
55	1	1	1	1	1	1	0	0	0	1	0	0	0	0	0	1
56	2	2	1	1	1	1	0	0	1	0	0	0	0	0	1	0
57	3	3	1	1	1	1	0	0	1	1	0	0	0	0	1	1
58	4	4	1	1	1	1	0	1	0	0	0	0	0	1	0	0
59	5	5	1	1	1	1	0	1	0	1	0	0	0	1	0	1
60	6	6	1	1	1	1	0	1	1	0	0	0	0	1	1	0
61	7	7	1	1	1	1	0	1	1	1	0	0	0	1	1	1
62	8	8	1	1	1	1	1	0	0	0	0	0	1	0	0	0
63	9	9	1	1	1	1	1	0	0	1	0	0	1	0	0	1

Figure 1-4. Eight Bit Code - BCD Relations

Binary Mode

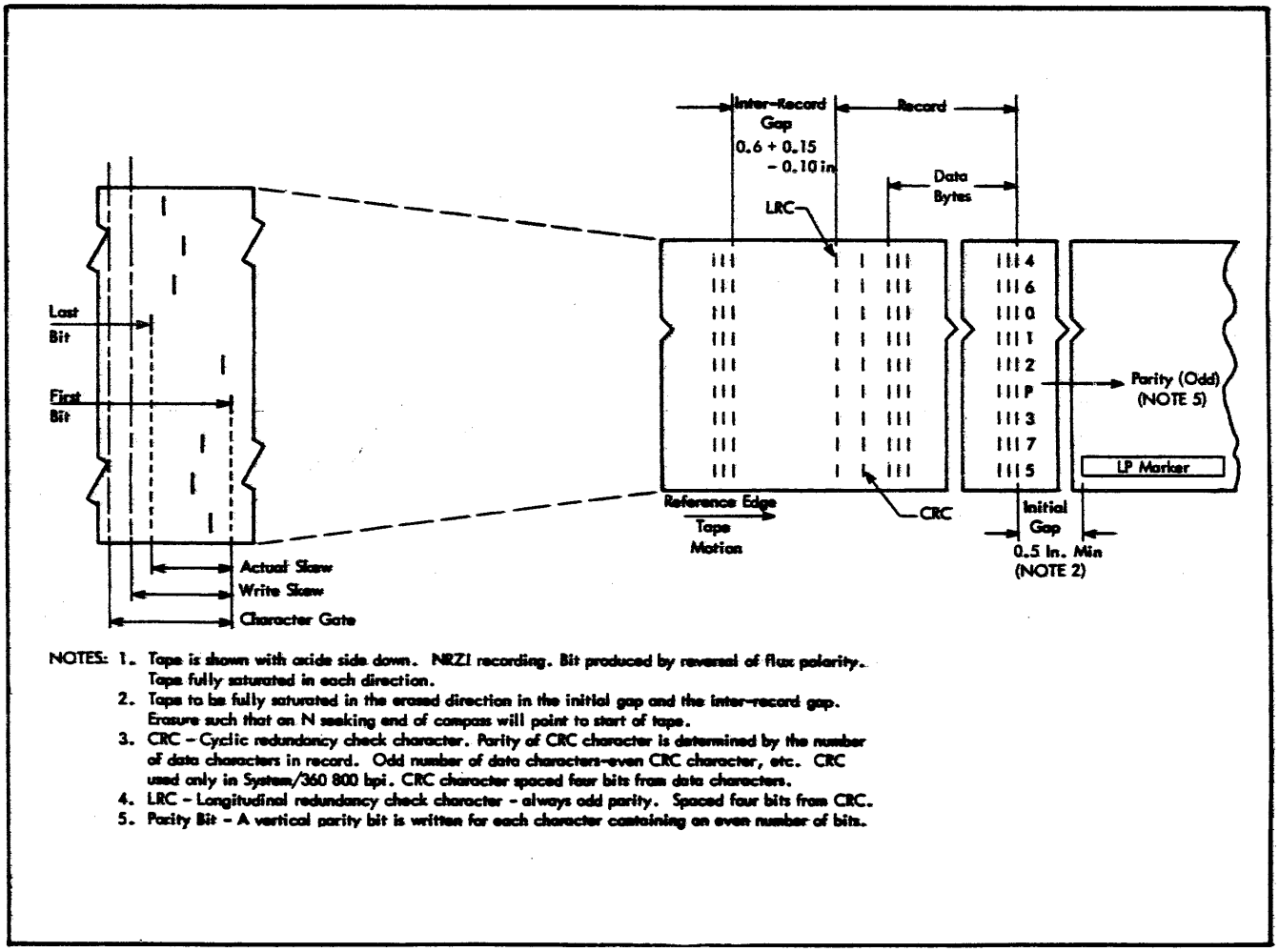
In the binary mode, the computer is programmed to accept tape characters as binary numbers. This mode obviously is useful only with straight numeric input.

Thus, a six-bit character can represent a six-digit binary number, or 0-63. By using more than one character, larger numbers may be represented. In some cases this results in considerable saving in space on the tape and in computer time. For example, the number 56 would require two character spaces in BCD but only one in binary. Obviously, odd parity must be used because six zeros can be a perfectly valid portion of a binary number.

Nine-track Coding

Nine-track tape, as used in IBM System/360, uses a modified ASCII code also shown in Figure 1-5. Parity in the nine-track 800 BPI system is always odd.

Operation in binary mode is possible with proper programming. An interesting possibility is recording two 4-bit numerics per byte with consequent doubling of effective data rate.



NOTES:
1. Tape is shown with oxide side down. NRZI recording. 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 initial gap and the inter-record gap. Erasure such that an N seeking end of compass will point to start of tape.
3. CRC - Cyclic redundancy check character. Parity of CRC character is determined by the number of data characters in record. Odd number of data characters-even CRC character, etc. CRC used only in System/360 800 bpi. CRC character spaced four bits from data characters.
4. LRC - Longitudinal redundancy check character - always odd parity. Spaced four bits from CRC.
5. Parity Bit - A vertical parity bit is written for each character containing an even number of bits.

Figure 1-5. Data Format - Nine Track

Longitudinal Parity

In writing blocks on tape, it is necessary to return to the reference magnetic condition in the gaps if records are to be rewritten at any future time. Otherwise, the direction for any track would not be known and spurious characters would result. In returning to reference state those tracks which are in the opposite state, spurious characters are also generated. This difficulty has been cleverly converted to an asset in the NRZI system by accurately locating the "spurious" character and using it as a check.

Since it started and returned to reference level, each track must have had an even number of transitions. The number of transitions are counted and if the result is odd, an error is indicated.

The Longitudinal Check Character, as it is called, is spaced four or five character spaces from the end of the block so that it will not be interpreted as data.

Other Checks

In the newer IBM transports built for 800 BPI, nine-track recording, another check, called "Cyclic Redundancy Check", is included. This check has the ability to direct correction of a certain limited class of errors. Kennedy Incremental Recorders built for System 360 compatibility include circuits for generation of the CRC.

Additionally, in the nine-track system there is a "Lost Character Check" which implements the error correction routine. In this check a character is expected to have been read within 15 clock times of the last. If it has not been read in 17 clock times, an error is flagged.

This requirement places fairly stringent criteria on character spacing accuracy. While not used in the seven-track 2400 series transport, lost character detection circuits are retained placing the same restrictions on spacing as in the nine-track system.

FLUX CHECK™

Flux Check™ is a system of checking data as it is written on tape. A true read-after-write check, it uses only one gap for both operations. If a character is incorrectly written for any reason, including tape flaws, an error signal is produced before another character is due to be written.

Available as an option on nearly all Kennedy Incremental Recorders, Flux Check™ is the ultimate safeguard against lost data.

While it may be argued with perfect logic that good tape operating in a good machine will not have any errors recorded on it, the human factor cannot be entirely eliminated, and once precious data is lost it may be impossible to replace.

Basic principles of Flux Check™ recording are shown in Figure 1-6. Magnetically neutral tape is passed over the head which is built with a 0.006" gap--wider than the widest increment, 0.005" at 200 BPI. The head has two windings, a write winding and a read winding. Short pulses of current in the head magnetize a portion of the tape as wide as the gap. Polarity of the pulses is controlled by a flip-flop in the Flux Check™ Write Amplifier.

If zeros are being recorded, pulses are all in the same direction. This produces smooth magnetism on the tape as required for zeros. Polarity of write pulses reverses for ones. After writing, the tape moves, pulling the recorded section out of the gap and inducing a signal in the read windings.

Write pulses are suppressed by the Flux Check™ read amplifiers; but the read signal is amplified and compared on a bit-by-bit basis with the input data. If disagreement is found, an error is signalled.

Time to signal an error does not exceed 1.9 ms. This allows for a maximum operating speed of 500 steps per second, still retaining the ability to locate an erroneous character before the next is recorded.

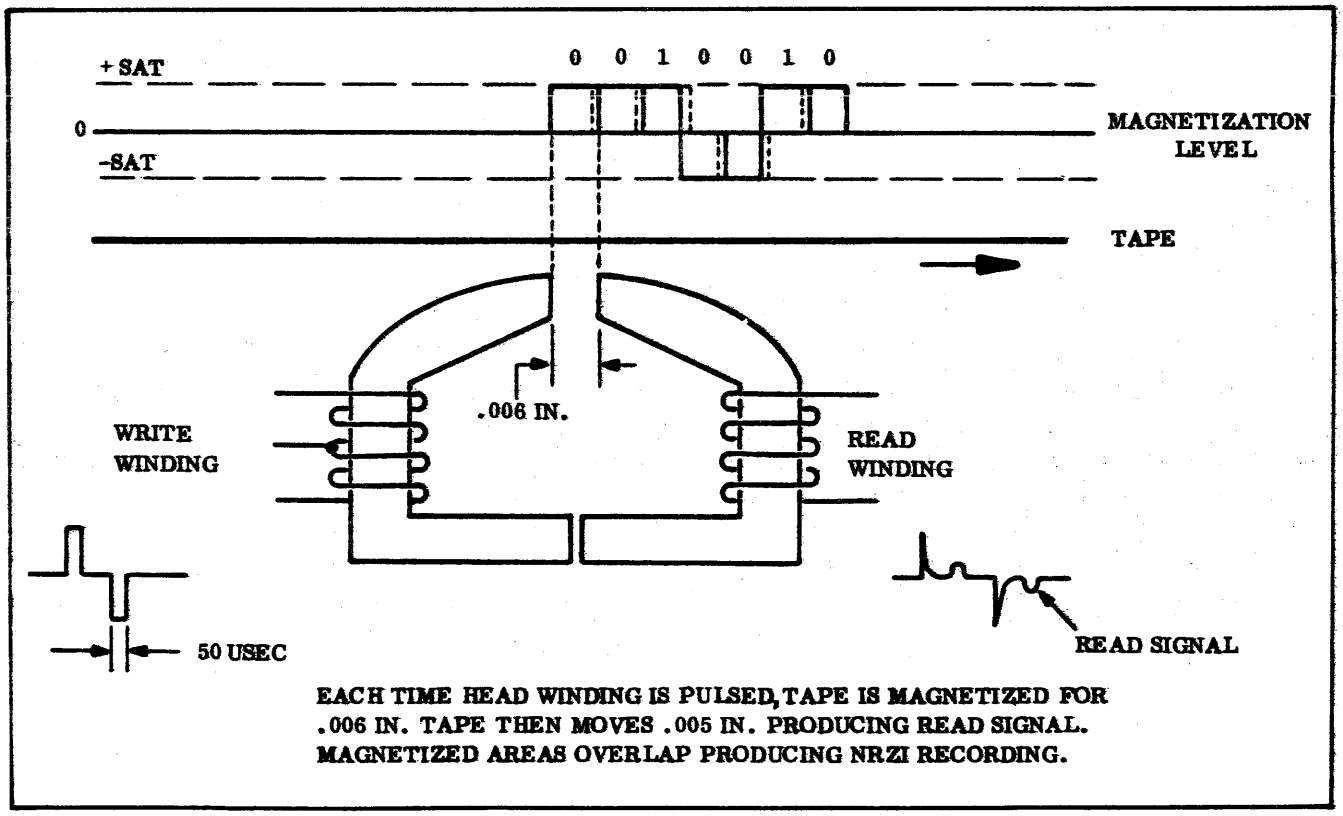


Figure 1-6. Flux Check Recording

READERS

Kennedy Company Incremental Magnetic Recorders may also be equipped for reading as well as writing tape. Model numbers are suffixed by designation as shown in the following examples:

1600R	Incremental Record/Continuous Read
1600IR	Incremental Record/Incremental Read
2059RO	Continuous Read Only

Principles and equipment requirements for the various models are identical or similar and, in many cases, the read portion of the machine is modular to simplify interfacing and construction.

The description in this section is general in nature. Specifics for a particular model may be found in the Performance Specifications section and in the circuit descriptions of the circuit cards used.

File Protect Switch

Kennedy recorders equipped for both reading and writing are also equipped with a File Protect Switch and Indicator Light. This switch detects the presence of the File Protect Ring in the reel of tape mounted on the supply side of the machine. If this flexible ring is removed from the reel, it indicates that the tape must not be written on under any circumstances. This treatment is often reserved for library and program tapes or, in some instances, the ring may be removed immediately after the tape is written to prevent erasure of a tape.

On a machine so equipped it is impossible to select the Write mode in the machine or to write or erase data on tape when the File Protect Ring has been removed from the reel. If an attempt is made to write on a tape which does not have the File Protect Ring in place, the red FILE PROTECT Light will glow either immediately or when the machine goes into Ready, depending on the model, to indicate to the operator that he has made a procedural error. An indication of this is also provided to the interface plug so that external equipment may sense this condition. Machines which are Write Only or Read Only do not have a File Protect Switch.

Controls and Loading Procedure

The controls and loading procedure for a Read machine are identical to those of a Write Only machine. However, when the tape is loaded, no Beginning of Tape gap is inserted. The read head will come to a stop at a point prior to the place where recording began. In other words, it will stop immediately when the Load Point sensor is under the photo cell instead of the customary 3-1/2" after this point.

Interface Connector

On all recent Kennedy Incremental Recorders a separate interface connector is provided for the functions associated with reading. This enables a machine equipped for reading to be directly substituted for a Write Only machine using the same wiring. The read signals do not compromise or affect the normal signals on the connector associated with writing.

Skew Delay

In writing a tape certain tolerances with regard to the gap scatter in the heads, the skew of the head (that is, the failure of the gaps to be absolutely perpendicular to the tape), and other causes can accumulate in tolerances which make it necessary to provide electronic circuitry to compensate for these variables and to assure that the output data is timed correctly. These conditions are aggravated when a tape is written on one machine and read on another which is a normal circumstance. The common method for achieving this is to read each track independently and sense the first "one" that is detected on any track. This is done by connecting the outputs of all of the data tracks into an "OR" gate. The first "one" then triggers a delay which is usually set to be approximately 45% of the prescribed time for one character.

At this time the data in the output register is changed to reflect the new character, and a few microseconds later a Clock pulse is provided to enable strobing this data into the external system This assures that data is transferred at a time when it is valid and correct and eases the interfacing of the machine to an external system. (On old machines the output register was not provided, and Data pulses and Clock pulses were coincident with each other.)

Gap Detector

Another output provided at the interface connector is the Gap Detector output. In either Incremental Read or Continuous Read machines a Clock pulse should be detected within a prescribed time after a Read/Step or Read command is given. Internal circuitry has been provided to detect whether or not this clock is available within approximately two or three time intervals. If no clock is received within this time, then it follows that the read head must be passing through a gap. This output is called the Gap Detect output and may be used to control stopping of a Continuous machine in the gap.

Longitudinal Check Character

This Gap Detect output is also used internally to inhibit the Clock pulse for the Longitudinal Check Character. The Longitudinal Check Character will appear at the data output terminals and will remain there during the gap until the first character of the succeeding block is detected. However, the Clock pulse for it is deliberately inhibited since, in most simplified systems where a reader of this type is employed, the character is not desired. Where it is required, it may be reconstituted by a simple modification to one of the circuit cards. The factory should be consulted regarding this if it is required.

Error Rates

Maximum error rates are difficult to define. Many variables, such as tape condition, environment, etc., enter the picture. Continuous reading with error rates of less than one error in 10^6 characters is reasonable to expect under ordinary conditions and may be improved several orders of magnitude with reasonable precautions. Incremental reading is much more difficult to implement and is less tolerant of tape imperfections. Therefore, typical error rates may be expected to be slightly higher.

CONTINUOUS READING

On machines equipped for Continuous reading, the tape is run at a fixed speed and should be stopped only in Inter-Record gaps. In most recorders this is done by running the stepper motor at a slewing rate fast enough so that the steps blend together into a smooth continuous motion. This speed is usually 1000 steps per second.

On some machines, such as the 3700 Series, an auxiliary capstan motor is employed to run the tape at a pre-selected speed of up to 30 inches per second. Other machines, such as the 2059 Series, use a servo controlled dc motor system which allows pre-selected tape speeds of 1.5 inches to 6 inches per second. All of these systems have in common the fact that:

1. the tape is running at a pre-selected fixed speed,

2. a data register is filled at a synchronous rate,

3. a Read Clock output is provided to enable strobing out the register into memory or other external devices.

The control of these recorders is relatively simple. A Read Select level is applied followed by a Slew level which will cause the tape to accelerate rapidly to the prescribed speed and run continuously at that speed emitting Data and Clock pulses. When a gap is detected, a signal is available which may be used to control the slew level which should be removed to enable the tape to stop in the desired gap.

INCREMENTAL READING

The Incremental Read feature permits reading of 200 BPI NRZI tapes one character at a time. Standard computer tapes may be read into such low speed devices as typewriters, data sets, plotters, etc. without the necessity of buffering. In operation the machine is given a Read/Step command. The tape advances to the next character (read search) and stops upon having read that character. Output information is held in storage until the next Read/Step command. Read commands may be repeated at rates up to 150 characters per second.

In order to read incrementally, a means must be provided to assure orientation with the information on the tape. The motion of the tape must be such that the head gap falls between characters when the tape comes to a stop. A step size equal to the character spacing cannot be used since density and step size variations will eventually accumulate to a point where information could be lost.

Kennedy Incremental Recorders use a unique method of correcting tape position. The step size, instead of being 0.005" as it is in Incremental Write Only machines, is set at 0.0025". Thus, two steps will be required to move the tape one character space under ideal conditions. However, since magnetic tape does not have sprockets or other mechanical means to assure that the tape is between characters over the recorder gap, a technique is required which will assure that the tape always stops between characters and that it takes the correct number of steps to assure this. While two steps are usually required, one may be adequate or perhaps

three may be necessary. To achieve this an internal oscillator is started when the Read/Step pulse is applied at the interface. The stepper motor then advances the tape. As soon as a character is sensed, the oscillator is cut off and no more pulses are produced and the motor stops. In this way a closed loop system is produced which keeps the tape properly oriented.

Upon entering a blank region of tape, that is, an Inter-Record gap or End of File gap, the stepper drive will advance as many steps as may be required to reach the next character. A Read/Stop input is provided at the interface to allow stopping this action at the end of data on the tape.

Since the stepper motor and gear box must be arranged to provide two steps per character in the Incremental Read mode, it follows that the same unit being used in the Write mode requires that two steps be taken for each character written. This is automatically provided for internally so that each Write/Step results in a character on the tape with the proper 0.005" spacing. However, this does restrict the upper speed of the writing to 300 characters per second, and the high speed option is thus not available on machines equipped to incrementally read.

SECTION II

MODEL 1600/360R

PERFORMANCE SPECIFICATIONS

GENERAL SPECIFICATIONS

TAPE USED	0.5" wide, 1.5 mil thick computer tape
TAPE FORMAT	9-track NRZI
TAPE REELS	Up to 8.5-inch diameter, IBM compatible
TAPES COMPATIBLE WITH	IBM 2400 Series tape transports
WRITE MODE	
Recording Speed	0-500 characters per second
Density	800 BPI
RECORD GAP TIME	550 milliseconds (maximum)
SLEW RATE	1000 characters per second (1.25 ips)
REWIND TIME	Less than 2 minutes
READ MODE	
Continuous Reading Speed	1000 characters per second (nominal)

OPERATOR CONTROLS AND INDICATORS

All front panel controls (except AC POWER Switch) are duplicated by logic inputs at Write Interface connector P1.

AC POWER Switch

Applies power to the tape unit, presets the control circuits, and places dc braking voltage across the reel motors.

LOAD FORWARD Pushbutton With Indicator

Automatically advances the tape to the Load Point marker during a loading operation. In the Write mode, the tape unit automatically generates a Beginning of Tape (BOT) Gap (see below)

when the Load Point marker is sensed. After the loading operation, pressing this button causes tape to be advanced at 1000 characters per second. Indicator illuminates when the button is first pressed and remains lit until the automatic stop following a Rewind operation. The indicator also goes out if Broken Tape is sensed.

READY Indicator With Pushbutton

Indicator illuminates whenever the tape unit is in the Read mode or the Write mode. The push-button may be used to place the tape unit in either mode (whichever is selected) by pressing it simultaneously with the LOAD FORWARD Pushbutton. This is an interlock to guard against inadvertently pushing this button. Since the tape unit automatically enters the mode selected when the Load Point marker passes under the sensor assembly, this feature should be used only in the rare instances where no Load Point marker is present.

Note

Use of this feature in the Write mode will not result in a BOT Gap.

FILE GAP Pushbutton Only

Manually inserts the IBM File Gap (see below), File Mark, and IRG. Enabled only in the Write mode.

REWIND Pushbutton With Indicator

Drops the tape unit from the Read mode or the Write mode and rewinds tape at high speed until the Load Point marker is sensed or until tape winds off the reel. In either case, stop is automatic.

FILE PROTECT Indicator Only

Illuminates whenever the File Protect Ring is omitted from the tape supply reel and a Write Select level is present at the interface. This function is duplicated by an output at the Read Interface, P2.

INTERNAL CONTROLS AND FEATURES (Also See Figure 1-5, Data Format - Nine Track)

Parity Generator (Write)

Lateral Parity is generated and written on Channel P. Odd parity is supplied as required by IBM standards.

The Cyclic Redundancy Check Character (CRCC), required in the 9-track format in addition to Lateral Parity and the LCC, is written four character spaces after the last data character in a block. Its generation is part of the Inter-Record Gap and File Gap sequences.

Longitudinal Parity (the Longitudinal Check Character, or LCC) is written eight character spaces after the last data character in a block and four character spaces after the CRCC. Its generation is part of the Inter-Record Gap and File Gap sequences.

Continuous (Slew) Operation

For applications requiring a higher data input rate, continuous writing at 1000 characters per second may be achieved with this tape unit. In this mode, data is recorded in bursts, and all starts and stops take place in the IRG (see below).

The high speed is achieved by accelerating the motor beyond its normal asynchronous rate. Internally generated motor clock pulses are brought out to the interface for use as a system data clock whenever the Slew level is applied to the interface. Thus, stepping and writing are exactly synchronized.

Gaps and Marks

Inter-Record Gaps and File Gaps which are compatible with IBM format are generated automatically on command from the interface. File Gaps may also be automatically generated with a front panel control.

Inter-Record Gap (IRG)	Also called End of Record Gap (EOR). A 0.6" IRG generated upon command from the interface. A properly spaced CRCC and LCC are inserted as part of the gap timing sequence.
File Gap (EOF)	Standard 3-3/4" File Gap generated upon command from the interface or with a front panel control.
File Mark	Also called Tape Mark. A "one" in Channels 3, 6, and 7 written automatically upon completion of the File Gap. The File Mark is followed automatically by a properly spaced File Mark Check Character (another 3, 6, 7) and an additional 0.6" IRG. A CRCC is not written at this time.
Beginning of Tape Gap (BOT)	Also called Initial Gap. In the Write mode, a 1/2" (minimum) BOT Gap is automatically inserted when the Load Point marker is sensed during a loading operation. In the Read mode, the tape stops when the Load Point marker is sensed and no gap is generated.

File Protect

To prevent accidental writing on tapes, a File Protect Ring must be on the supply reel. Without this ring, the machine remains in the Read mode, regardless of interface or other commands.

Tape Sensors

Load Point, End of Tape, and Broken Tape sensors are provided. Signals generated by the first two of these sensors are amplified and brought out to the interface connector. The Load Point sensor is used during a loading operation to generate a BOT Gap (Write mode) or stop the tape (Read mode). It is also used to halt a Rewind operation.

The End of Tape sensor has no internal function. It provides a control signal to the external equipment when the End of Tape marker is under the sensor assembly.

The Broken Tape sensor halts all machine operations in the event of broken or missing tape at the sensor assembly.

INTERFACE CHARACTERISTICS

Two interface connectors are provided. The first, P1, is associated primarily with the Write mode. The other, P2, is associated with the Read mode. The signals are described below with their interface pin identified.

P1 Signals

Model 1600/360R Standard Write interface is compatible with current sinking positive logic having a "one" level of +4V to +6V and a "zero" level of 0V ±0.5V. "Zero" levels should be capable of sinking 5 ma. All input functions except remote controls are initiated by "one" levels. Remote control inputs require closures to ground to be activated. Maximum current through the closure is 5 ma; open circuit voltage is +10V. This may be loaded to +5V (minimum) for use with IC logic.

Note

Because of the nature of DTL logic used in the tape unit, the following inputs must be tied to Signal Ground if they are not used: COUNT ENABLE, CONTROL COMMON, SLEW, EOF COMMAND, and EOR COMMAND. All P1 pins not assigned are reserved by Kennedy Company for future use and should not be used as tie points.

The P1 connector is Part No. 121-5004-036 (Amphenol 57-40360 or equivalent). The mating connector (supplied) is Part No. 121-5003-036 (Amphenol 57-30360 or equivalent).

Modified interfaces are available. Consult the factory.

Inputs

PULSES are to be a minimum of 20 usec long and a maximum of 100 usec long.
LEVELS are to be static at the time of the leading edge of the pulse which clocks them in. They must remain static for at least 50 usec thereafter.

CLOSURES TO GROUND are to be a minimum of 20 usec long and a maximum of 100 ms long.

DATA LINES	LEVEL	Channel 7	P1-18
		6	P1-19
		5	P1-17
		4	P1-20
		3	P1-21
		2	P1-16
		1	P1-22
		0	P1-23

WRITE/STEP Command PULSE P1-14
Clocks in information on data lines when machine is in Write mode.

EOR Command PULSE P1-30
Starts IRG sequence. Must be applied no sooner than 2 ms after the trailing edge of final Write/Step Command.

EOF Command PULSE P1-29
Starts File Gap sequence. Must be applied no sooner than 2 ms after the trailing edge of final Write/Step Command. This function is duplicated by the File Gap front panel control.

WRITE SELECT LEVEL P1-1
Enables Write mode when True only if a File Protect Ring is inserted in the supply reel. Enables Read mode when False. The tape unit remains in the Read mode regardless of the condition of this input if a File Protect Ring is omitted.

Note

A BOT Gap is generated only when the tape unit enters the Write mode.

REMOTE LOAD FORWARD CLOSURE TO GROUND P1-2
Prepares tape unit for reading or writing after tape has been loaded. Causes tape to feed at 1000 characters per second until Load Point marker is reached. BOT Gap is automatically generated at this point if the tape unit is in the Write mode. This function is duplicated by the Load Forward front panel control.

REMOTE READY CLOSURE TO GROUND P1-3
Not normally used. Places machine in the Read or Write mode, depending on the condition of the Write Select input. This input should be used only in the rare instances where no Load Point marker is present on tape.

REMOTE REWIND CLOSURE TO GROUND P1-4
Drops the Read or Write mode and rewinds tape at high speed until the Load Point marker is sensed. To further rewind the tape off the reel for unloading, the tape unit must be placed in the Load Forward mode after the tape has stopped. Rewind

may then be activated again to remove tape completely from the take-up reel. Rewind stops automatically when tape is completely wound on to the supply reel. This function is duplicated by the front panel Rewind control.

COUNT ENABLE LEVEL P1-6

Not used during incremental writing. During continuous writing at 1000 characters per second, a True level enables a four-count circuit which properly spaces the LCC from the final data character of a record. This level must be False at all other times to avoid writing errors on the tape.

CONTROL COMMON P1-7

Connected to Signal Ground to enable front panel pushbuttons. Buttons are disabled if this connection is not made.

SLEW LEVEL P1-8

Used only during a reading or continuous writing operation. A True level activates an oscillator which gradually accelerates the stepper motor to 1000 steps per second. Outputs from this oscillator are brought to the interface (see below) for use in synchronizing the system to the stepper motor pulses during a continuous writing operation.

FORWARD SELECT LEVEL P1-10

Used to control the direction of the stepper motor. A True Forward Select level causes the stepper motor to run forward. A False level causes the stepper motor to run backward. A False level should be applied only in the Read mode and should only be used to search for a previous IRG. Information passing through the read amplifiers is unreliable in this mode, but is sufficient to determine the difference between IRG and no IRG. Change this level only with the motor stopped.

CAUTION

Never apply a False level in the Write mode, as this will cause previous information to be erased.

+5V P1-12

The internal +5V supply is brought to this pin for use as an external reference. Maximum external loading is 100 ma.

SIGNAL GROUND P1-11

CHASSIS (FRAME GROUND) P1-36

Signal Ground and Chassis Ground are not connected together within the tape unit. For best results, run these two lines separately to the Main System Ground and connect them together only at that point.

Outputs

P1 signal outputs are terminated in the tape unit through a source impedance of 1.5K (nominal), and are capable of sinking up to 10 ma of external load current. Levels are +5V ±1V True and 0V ±0.5V False. Outputs may be loaded or clamped to +3V (minimum).

READY LEVEL P1-27

Normally used in Write-Only machines to indicate that the loading process is complete and head current is flowing. Data may be recorded whenever this output is True and the Gap in Process output is False. It may be similarly used in the Model 1600/360R except that no indication is present when the tape unit is in the Read mode. This output is duplicated by the Write Status output on P2 (see below).

GAP IN PROCESS LEVEL P1-28

Indicates that the tape unit is under the control of the gapping electronics and is inserting an IRG, End of File, or BOT Gap. The output includes a delay at the end of each gap for the tape unit to come to a stop. Writing should not be attempted while this level is True. The output functions during the Write mode only.

END OF TAPE LEVEL P1-5

Indicates that the End of Tape marker is under the sensor assembly. This function is not used internally.

WRITE ERROR LEVEL P1-24

Indicates that the Echo Check circuits have detected an error in the write electronics. Level will go True a maximum of 1.95 ms after the Write/Step Command has been given and will remain True until the next Write/Step Command is given.

OSCILLATOR OUT PULSE P1-26

Pulse duration 10 usec (minimum). Pulses from an internal oscillator, used primarily to drive the stepper motor at high speed during gapping operations, are brought out to this pin for use as a system clock in the Continuous Writing mode. Pulses are produced whenever the Slew input is applied or whenever the tape unit is inserting a gap. Nominal rate is 1000 pulses per second; however, the motor must accelerate to this speed over a number of steps.

Note

These pulses are used internally to drive the stepper motor during gapping operations in either the Incremental or the Continuous Writing mode. They also drive the stepper motor in the Read mode. Therefore, they must be properly gated externally to avoid system errors when operating in a mode other than Continuous Write.

Outputs

P1 signal outputs are terminated in the tape unit through a source impedance of 1.5K (nominal), and are capable of sinking up to 10 ma of external load current. Levels are +5V ±1V True and 0V ±0.5V False. Outputs may be loaded or clamped to +3V (minimum).

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Note

These pulses are used internally to drive the stepper motor during gapping operations in either the Incremental or the Continuous Writing mode. They also drive the stepper motor in the Read mode. Therefore, they must be properly gated externally to avoid system errors when operating in a mode other than Continuous Write.

P2 Signals

All P2 standard outputs are compatible with current sinking positive logic having a "one" level of +5V ±1V True and 0V ±0.5V False. All outputs are terminated through a source impedance of 470 ohms and are capable of sinking up to 10 ma of external load current in the False condition.

Note

All P2 pins not assigned are reserved by Kennedy Company for future use and should not be used as tie points.

The P2 connector is Part No. 121-5004-024 (Amphenol 57-40240 or equivalent). The mating connector (supplied) is Part No. 121-5003-024 (Amphenol 57-30240 or equivalent).

Modified interfaces are available. Consult the factory.

Outputs

DATA OUTPUTS	LEVEL	Channel 7	P2-1
Data outputs are True at least 2 usec before the Read Clock output and remain True until the next character is presented to the output lines.		6	P2-2
		5	P2-3
		4	P2-4
		3	P2-5
		2	P2-6
		1	P2-7
		0	P2-8
		P	P2-9
READ CLOCK	PULSE		P2-10
Pulse duration is 10 usec ±2 usec. One clock pulse occurs for each character read, except for the CRCC and LCC. The clock pulse is suppressed for these characters. This pulse should be used to clock information on the Data Output lines into external equipment.			
GAP	LEVEL		P2-12
Level goes True when the tape unit is in a gap and remains True until the next character is read.			
ERROR	PULSE		P2-13
Pulse duration is 10 usec ±2 usec. This output occurs for both vertical and longitudinal (LCC) parity errors. Vertical error output pulses occur simultaneously with the Read Clock output of the character in error. Longitudinal error output pulses occur no later than 20 ms after the LCC is read. Vertical parity of the CRCC and LCC is not checked nor is the CRCC checked for content.			

Note

This output is supplied only when the Read Parity Check option is ordered.

READ STATUS LEVEL P2-14
Indicates that the tape unit is in the Read mode.

WRITE STATUS LEVEL P2-15
Indicates that the tape unit is in the Write mode. A File Protect Ring must be on the supply reel for the tape unit to enter the Write mode. This output is duplicated by the Ready Level output on P1 (see above).

FILE PROTECT LEVEL P2-17
Output is True if a File Protect Ring is missing from the supply reel and a Write Select input is applied to P1-1. This function is duplicated by the front panel FILE PROTECT Indicator.

SIGNAL GROUND P2-18
CHASSIS (FRAME) GROUND P2-24
Signal Ground and Chassis Ground are not connected together within the tape unit. For best results, run these two lines separately to the Main System Ground and connect them together only at that point.

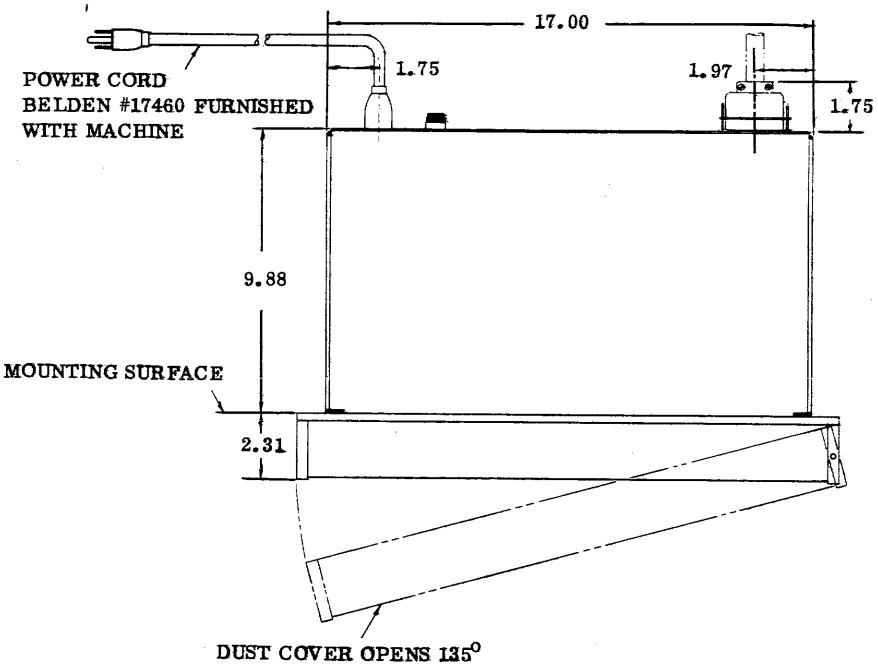
POWER REQUIREMENTS	115V/230V ±10%, 50/60 Hz is standard. Power consumption: 150 VA.
PHYSICAL CHARACTERISTICS	Panel 19 inches x 12-1/4 inches, fits standard rack. Depth behind panel: 10 inches Added 8-inch depth clearance required to open auxiliary card cage. Weight: 40 lbs.

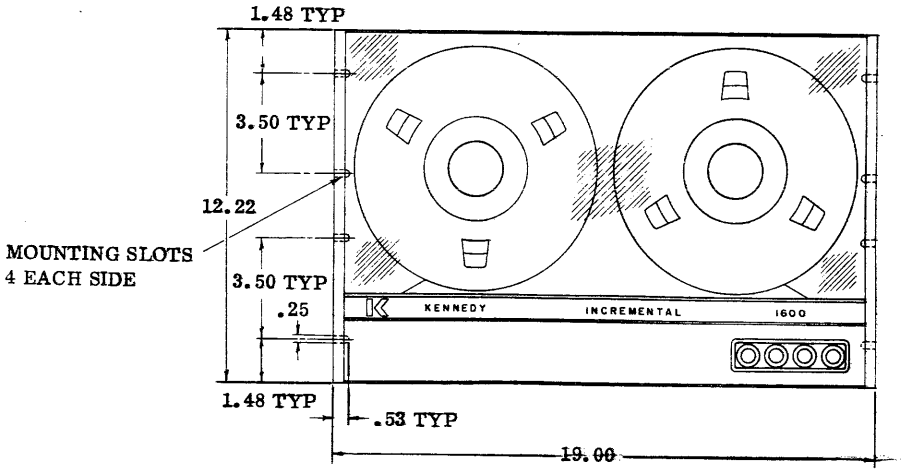
ENVIRONMENTAL

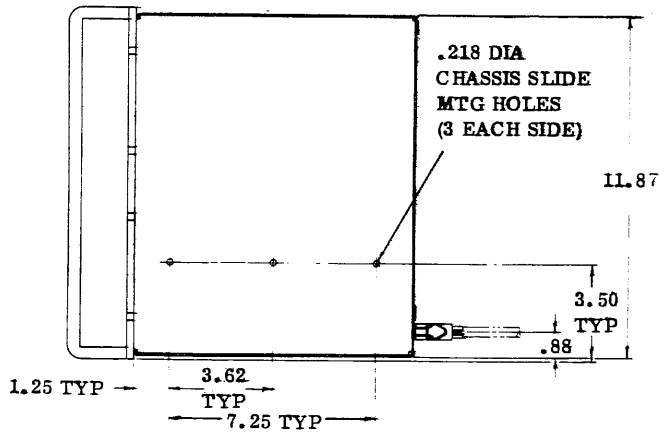
Operating Temperature	+2°C to +50°C (+35°F to +122°F)
Storage Temperature	-40°C to +75°C (-40°F to +167°F)
Storage Altitude	20,000 feet (maximum)
Relative Humidity	15% to 95%

Note

No condensation is allowed on any portion of the tape unit during operation. Any condensation accumulated during shipping and/or storage must be thoroughly removed before tape unit is operated. Tape manufacturers' specifications may impose more stringent environmental limitations than those given above. Consult tape supplier.







Model 1600 Outline and Installation Drawing

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