KENNEDY CO.

WORLD'S LEADER IN LOW-COST DIGITAL RECORDERS

Incremental Recording Techniques

Computers are playing an increasingly important part in all phases of business, science, industry and government. Equipment that can offer a bridge between events occurring in nature, or human activity and the computer become necessary in more applications.

One of the tools available for this purpose is the Incremental Magnetic Tape Recorder, which is able to accept data occurring at slow rates and odd intervals and compress it into a form acceptable to high-speed computers. Traditional methods used in accomplishing this conversion are cumbersome, redundant and needlessly expensive.

Kennedy incremental recorders, long the standard of the industry, have evolved a third generation. Time-proven mechanisms have been combined with all new electronics to provide unmatched standards of performance and ease of application.

In addition to the performance advantages, these design improvements have led to substantially lower prices in many models.

Kennedy Company has the only really complete line of recorders in their class: there is a unit for every conceivable application.

You can look with confidence to Kennedy Company to supply your needs in every incremental application.

We present this booklet describing the features and advantages of incremental magnetic recorders for the attention of anyone who is asked to make decisions about the proper equipment to use in gathering data in a computer-compatible format.

General information

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 steps one increment — which may be .005″ for 200 BPI; .0018″ for 556 BPI; or .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.

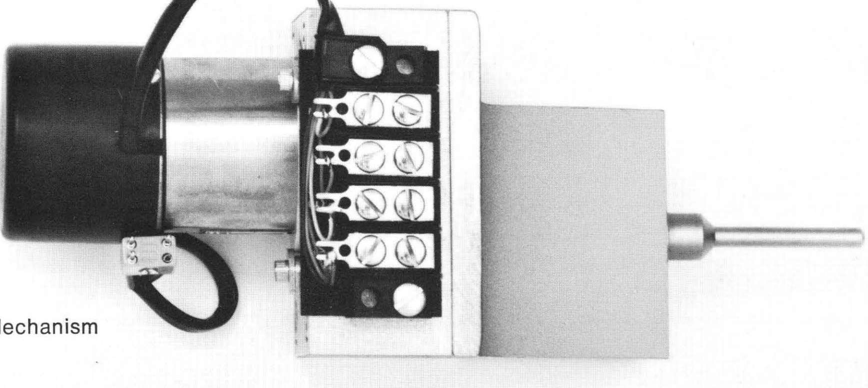
All these requirements together with the obvious requirement for high asynchronous stepping rates are met by the stepper motor drive used in Kennedy Incremental Recorders. The stepping motor itself is a special ultra-high speed, variable reluctance motor which moves 15° per step. Each position of the motor is strongly detented magnetically. This 15° 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. Internal recorder electronics are all solid state, silicon. Integrated circuits are used in all appropriate applications.



Incremental Drive Mechanism

Glossary of terms

American Standard Code for Information Interchange (ASCII). — A standard code developed by the American Standards Association (ASA) having seven code channels and an eighth channel for parity. In some data processing systems, the code has been expanded to eight bits with a ninth added for parity. The extended code is referred to as ASCII-8.

Asychronous operation. — A mode of operation in which each step starts as a result of a signal generated by the completion of the previous step, rather than on signal from a master clock.

Asynchronous device. — A unit which has an operating speed not related to any particular frequency of the system to which it is connected. A device that operates upon a signal, one step at a time.

Beginning-of-tape (BOT) marker. — A reflective strip on the non-oxide side of magnetic tape, 10 feet from the physical beginning of the tape which is sensed photoelectrically to indicate the point on tape at which recording may begin.

Binary code. — A code in which each allowable position has one of two possible states. A common symbolism for binary states is 0 and 1. The binary number system is one of many binary codes and is based on the radix two.

Binary-coded character. — An alphanumeric character represented by a predetermined configuration of consecutive binary digits.

Binary-coded decimal (BCD). — Pertaining to a decimal notation in which the individual decimal digits are each represented by a binary code group; i.e., in the 8-4-2-1 coded decimal notation, the number 23 is represented as 0010 0011. In pure binary, notation 23 is represented by 10111. This code is based on the radix ten.

Binary digit (BIT). — A single digit of a language employing exactly two distinct kinds of states. They correspond to on and off conditions in digital processing units. The bit may be zero or one. In magnetic tape recording, a bit, either zero or one, is recorded in each track of tape for each binary-coded character.

Bit density. — A physical specification referring to the number of bits which can be recorded per unit of length or area on tape. Also called character or byte density.

Bit parallel. — Handling all bits of a character simultaneously, opposed to handling one bit at a time (BIT SERIAL).

Byte. — A sequence of adjacent binary digits (bits) operated upon as a unit and usually shorter than a word. In tape usage, usually one vertical character containing a parity bit.

Capstan. — The rotating shaft on a magnetic tape handling unit which is used to impart uniform motion to the tape when activated.

Channel. — A path for digital data through which information may flow in processing equipment. In magnetic tape recording, a path parallel to the edge of tape or longitudinal row, where bits of information data are recorded along the length of the tape. Also known as tracks.

Character. — A letter, digit, elementary mark, or event that may be used in various combinations to express information that can be read, stored, or written. A group of characters in one context may become a single character in another, as in the binary-coded decimal (BCD). A sequence of adjacent binary bits in one line across the tape. A byte containing six or eight bits plus a parity bit for seven- and nine-track recording, respectively. A character may represent symbols such as those corresponding to the keys on a typewriter or may contain parity bits or check character information such as Cyclic Redundancy Check, etc.

Character crowding. — The effect of reducing the time interval between subsequent characters read from tape, caused by a combination of mechanical skew, gap scatter, jitter, amplitude variation, etc. Also called packing.

Cyclic redundancy check (CRC). — An error correction technique employing a modified cyclic code in conjunction with character parity to correct error bursts of unlimited length in any one of nine tracks.

Dropout. — An erroneous bit or character on recorded tape due to tape imperfection. A missing bit or character.

Dump. — To read out a portion or all of the contents of recorded magnetic tape, usually as an aid in detecting mistakes or errors.

Echo check. — A check of accuracy of transmission in which the information that was transmitted to a tape unit is returned to the information source and compared with the original information. In read-after-write tape units, the information recorded is read back to the source for checking data recorded in its intended form.

End-of-file (EOF). — The end of a group of records or blocks representing related data of a file. Normally indicated by an EOF gap and File Mark.

End-of-record (EOR). — The end of a record block. Normally contains an IRG (inter-record gap) and check character or characters. IRG is preferred usage, opposed to EOR gap.

End-of-tape (EOT). — Area nearing the physical end of magnetic tape. Normally represented by an EOT marker. Recording must end shortly after the EOT marker but record and file mark may be completed.

Erase. — To replace all the binary digits on magnetic tape by binary zeros.

Extended binary-coded decimal interchange code (EBCDIC). — A BCDIC extended to eight information bits with a ninth added for parity.

File. — A collection of related records treated as a unit; e.g., in inventory control, one line of an invoice forms an item, a complete invoice forms a record, and the complete set of such records forms a file. The word file is used in the general sense to mean any collection of information items similar to one another in purpose, form, and content. Thus, a magnetic-tape master file is a file. A tape may contain many files, but are separated by a coded character called filemark. A file may also contain one or more tape reels, but each reel is terminated by a coded record block or filemark. Files normally are identified by a file label or trailing label.

File gap. — An interval of space on tape to indicate the end of a file. It normally contains a filemark character

Filemark. — An identification mark for the last record in a file. Filemarks may be followed by a trailer label and/or reelmark.

File protection. — A device or method that prevents accidental erasure of operative data on magnetic tape reels.

File protect ring. — An insert ring that must be in position in standard computer magnetic tape reels if data is to be recorded on that particular tape. A tape reel not equipped with a file protection ring can be read but not written. Also called Write Enable ring.

Flux check. — Kennedy trademark for an error detection system which reads each character immediately after it is written to verify that it appears on the tape in the intended form. Performed internally without presenting data on output lines for external echo checking, but produces an error signal if erroneous data is written.

Gap. — An interval of space or time used as an automatic sentinel to indicate the end of a word, record, or file of data on a tape; e.g., a word gap at the end of a word; a record or item gap at the end of a group of words, and a file gap at the end of a group of records or items. The space between the reproducing and recording heads. (Related to head gap on magnetic tape handlers). The space between the reproducing or recording head and the tape. (Related to tape-head gap, which is intentionally inserted into the magnetic circuit in order to force or direct the recording flux into the tape).

Head. — A device that reads (reproduces), writes (records), or erases information on a magnetic drum or tape.

Incremental tape unit. — A tape handling unit that operates in an asynchronous mode. The unit steps incrementally from bit position to bit position one bit at a time. An asynchronous device.

Interblock gap. — The space on magnetic tape separating two blocks of data or information without check characters. Usually all zero characters (erased).

Interrecord gap (IRG). — The unrecorded portion between records on magnetic tape, deliberately left between portions of data. Such spacing is used to prevent errors through loss of data or overwriting, and permits stop-start tape operations. The IRG may contain parity and/or other check characters.

Load point (LP). — The preset point at which magnetic tape is initially positioned under the head. The load point is normally 0.5 inch minimum after the trailing edge of the beginning-of-tape (BOT) marker and at the end of the Initial gap.

Longitudinal redundance check (LRC). — A check in which the bits in each track or channel of a magnetic tape record must contain an even total of one-bits. The term is usually used in conjunction with the character written in an inter-record or end-of-record gap. The character is referred to as LRCC.

Magnetic tape developer. — A solution containing fine iron particles which are attracted to the fringing magnetic flux reversals written on magnetic tape, usually one-bits. Used for bringing invisible magnetized spots on tape to a visible state.

Marker. — Strips of reflective foil affixed to tape to indicate beginning-of-tape and end-of-tape areas.

Nonreturn-to-zero (NRZ). — A mode of recording and readout in which it is not necessary for the signal to return to zero after each item of recorded data. Full positive current levels represent digital 1. Full negative current levels represent digital 0. The levels are present during the bit interval without between-bit intervals. This permits packing about twice as much data on tape as can be recorded with the return-to-zero (RZ) mode.

Nonreturn-to-zero change at one (NRZ1). — A recording mode similar to NRZ, but alternates the direction of current flow each time a logical 1 is to be recorded, and allows current to flow unaltered for a zero. Flux reversals indicating 1 simplify detection circuits and increase reliability. This is the most common form of digital recording.

Octal code. — A notation for writing language programs with the use of octal numbers instead of binary numbers. Octal numbering system is based on the radix eight. Octal digits are restricted to the values 0 through 7.

Off line. — Pertaining to peripheral equipment or devices not in direct communication with the central processing unit of a computer.

On line. — Pertaining to peripheral equipment or devices in direct communication with or under control of the central processor of a computer.

Packing density. — The number of units of digital information per unit length or area of a recording tape, such as the number of binary digits of polarized spots per inch of tape length. Commonly used packing densities are 200, 556, and 800 bits per inch (bpi). See also Bit Density.

Parity bit. — A supplementary bit added to an information word (LRC) or character byte (VRC) on tape to make the total of 1-bits be always either odd or even. This permits checking the accuracy of data transfers.

Record. — A group of related facts or blocks of information treated as a unit usually contained in a file.

Rewind. — To return a magnetic tape to its starting position or LP. Also called Rewind-to-Load Point as a command, opposed to unload, which winds the tape completely off the takeup reel.

Skew. — The degree of nonsynchronism of supposedly parallel bits when bit-coded characters are read from magnetic tape. The angular displacement of an individual character, group of characters, or other data from the intended or ideal placement. Expressed numerically as the tangent of the angle of this deviation.

Tape guides. — Grooved pins of nonmagnetic material mounted at either side of a magnetic head assembly to position the tape on the heads as it is recorded or reproduced.

Track. — A path for recording one channel of information on magnetic tape. The location of the track is determined by the recording equipment rather than by the tape as opposed to a groove, such as in disk or drum recording.

Word. — A set of binary digits handled by the computer as a unit of information. Its length is determined by the program or hardware design of the processor; e.g., the number of cores per location, and the number of flip-flops per register.

Application of incremental magnetic recorders

Data collection systems designed to use incremental recorders must provide properly coded input data to the recorder and a command to initiate the writing sequence.

Help from a computer programmer in the system planning stage is advisable, particularly if the application is unusual in any respect.

In addition to data inputs and write commands, the recorder must be signalled externally to insert inter-record gaps. A counter of appropriate length is used for this purpose. A typical block diagram of a basic system is shown in Figure 1. More complexity may be added by external mechanization of File Gap commands, remote controls, interlocks, etc., as required.

NRZI Recording

Data is recorded on IBM compatible tapes by the NRZI method in which "ones" are represented by transitions from one saturation state (either + or —) to the other. "Zeroes" produce no flux transitions. Figure 4 illustrates the process. In order for a character (or byte) to be detected, it must contain at least one "one."

NRZI recording is inherently self-erasing — consequently, new data may be written over old data without fear of producing errors. There is no need for an erase head as in audio recording.

Figure 4 also shows read signals obtained when data is recovered from NRZI tapes.

Skew

Tolerances in the recording system produce recording that is not exactly perpendicular to the reference edge of the tape. This lack of perpendicularity is termed skew. Skew, in general, is of two types, static skew and dynamic skew. Static skew, the only type of importance in incremental recording, is produced by mechanical tolerances in the tape guides and head. Permissible skew limits are diagrammed in Figure 3.

In Kennedy Incremental Recorders, skew is held to very low limits by extreme mechanical precision in the guides and head. In no event will skew exceed one-half the theoretical limits as shown in Figure 3.

There are no skew adjustments on Kennedy Incremental Recorders since to have adjustments would invite errors.

Dynamic skew is produced in high speed transports by circuit tolerances which produce variable current rise-times in write head coils. The head coil whose current rises first will write ahead of other tracks. At low rates as in incremental recordings, rise-times are so fast that any variations are negligible.

Tape Format

Two IBM compatible tape systems are in use: Seven-track 200, 556, 800 BPI, and Nine-Track 800 BPI. The nine-track system is available on System/360 transports (2400 series) only. Seven-track transports are also available for use with System/360 computers.

Figure 2 shows tape format in the seven-track system while Figure 3 depicts the nine-track format. Kennedy Incremental Recorders duplicate exactly the formats shown.

Data bits are spaced according to density requirements along the tape; .005″ at 200 BPI, .0018″ at 556 BPI, and .00125″ at 800 BPI. At intervals, as required by the computer memory, record gaps are inserted. Blocks or records may vary in length from some minimum (12 bytes in System/360) to whatever maximum is prescribed by program requirements.

File gaps are used to separate major portions of the tape — one day's experiment may be separated from the next for instance. Since file gaps are infrequently inserted it often suffices to insert them manually rather than providing the required logic in the interface. File gaps are 3.5″ (min.) followed by a tape mark (TM). Data following a Tape Mark must be separated from it by at least one record gap length. Again, this sequence is automatic in Kennedy Incremental Recorders.

Vertical parity

In the IBM system one bit in each byte is a parity bit. In seven-track systems vertical parity is even for BCD coding and odd for operation in the binary mode. The parity bit is added to make the number of bits in a byte even (even parity) or odd (odd parity). Nine-track parity is always odd.

Parity is generated internally in Kennedy Incremental Recorders: either even or odd may be selected in seven-track versions.

Longitudinal parity

The Longitudinal Check Character (LCC) is written at the end of each data block but separated from data bytes. The LCC is composed of bits required to make the number of bits, including the LCC, in each track even.

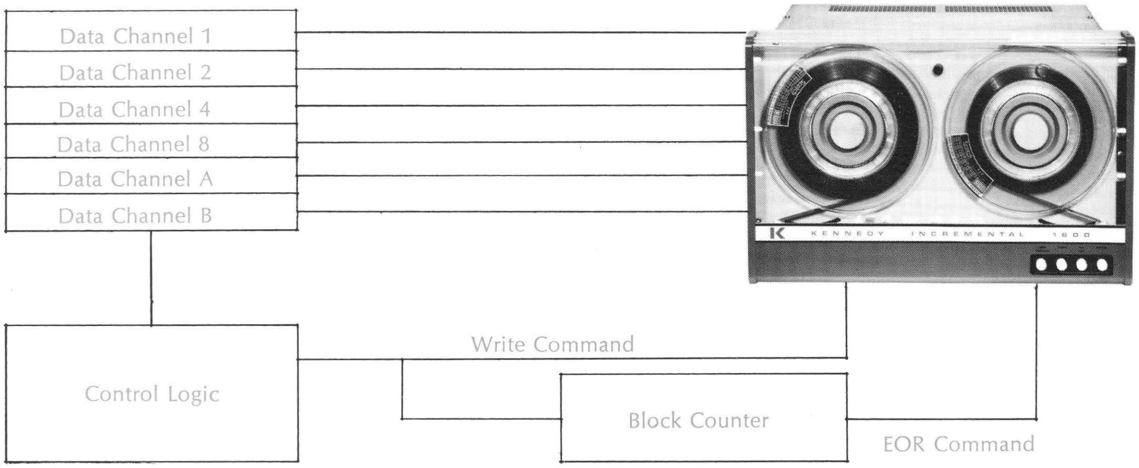
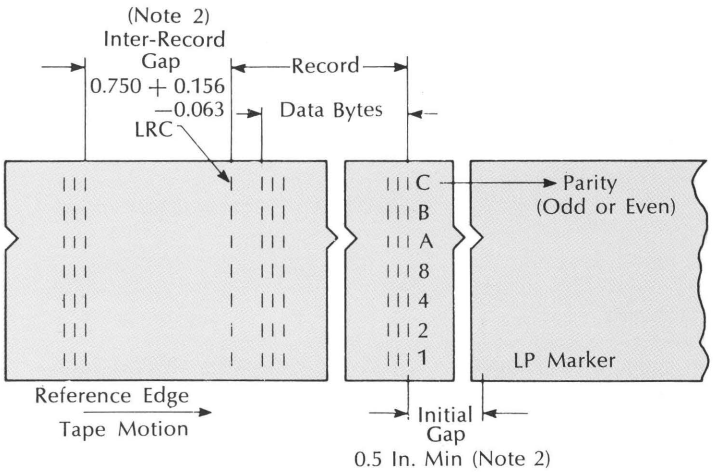


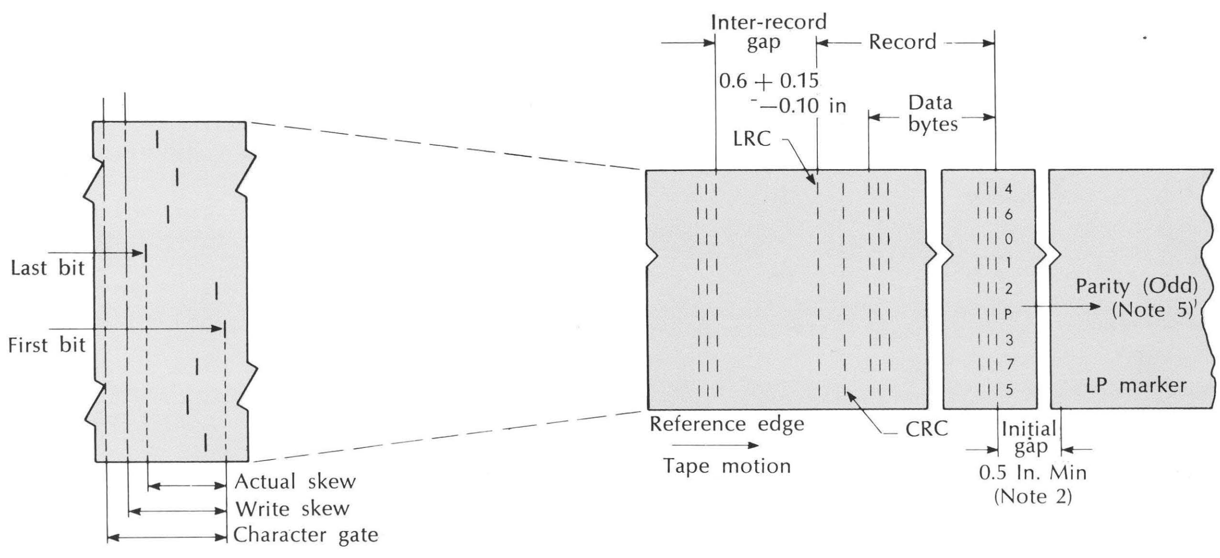
FIGURE 1. TYPICAL DATA RECORDING SYSTEM



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 than an N seeking end of compass will point to start of tape.
3. LRC — Longitudinal redundancy check character always even parity spaced four bites from data character.
4. Parity Bit — A vertical parity bit is written for each character.

FIGURE 2. DATA FORMAT — SEVEN TRACK



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. A longitudinal redundancy check bit is written in any track if the longitudinal count in that track is odd. Character parity is ignored in the longitudinal check character.
4. CRC — Parity of CRC character is odd if an even number of data characters are written, and even if an odd number of data characters are written.
5. Parity Bit — A vertical parity bit is written for each character containing an even number of bits.

FIGURE 3. DATA FORMAT — NINE TRACK

The LCC is written as an inevitable consequence of returning to reference flux direction in the record gap. In computer usage direction of gap magnetization must be uniform to allow re-writing blocks.

Parity error detection

Parity bits allow detection of most read errors. Thus, if in even parity a byte is read having an odd number of bits, it must be in error. If two bits in a byte were dropped however, no vertical error would be indicated. The LCC determines that all tracks have even numbers of bits; if an odd number of bits should be dropped, an error would be indicated. The combination of vertical and longitudinal parity checks makes undetected read errors unlikely.

Cyclic redundancy check

System/360 nine-track 800 BPI tape system incorporates still another check in addition to vertical and longitudinal parity check. Called Cyclic Redundancy Check, this system allows correction of a certain limited class of read errors, namely dropped bits in a single track.

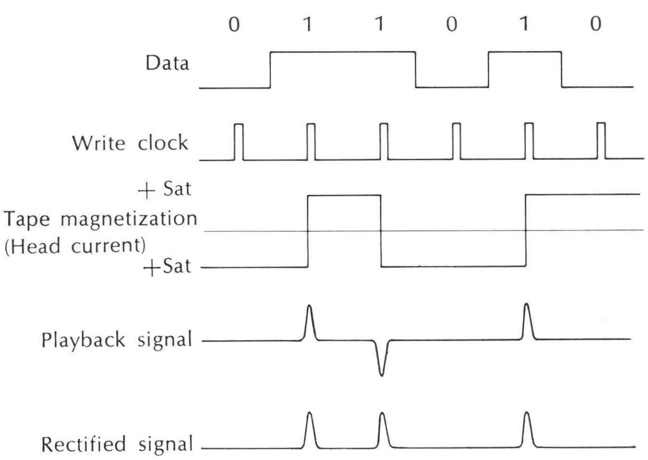
A complicated logic equation is mechanized to produce a special character (CRC) which is recorded four character spaces from the end of a block. In addition, an error pattern register is incorporated in the tape controller. Error bytes appearing in the error pattern register can be located and corrected through use of the CRC.

For complete compatibility the Cyclic Redundancy Character is automatically generated in nine-track Kennedy Incremental Recorders.

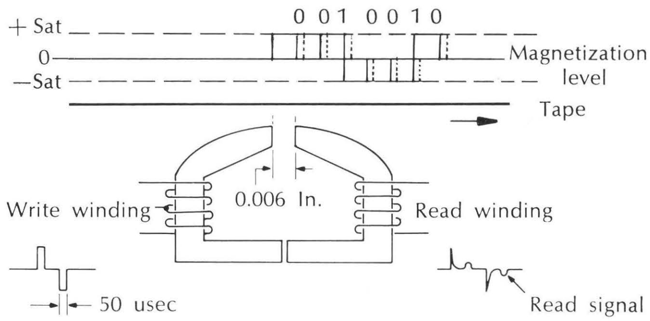
Recording checks

Since data on magnetic tape is invisible, those accustomed to other recording media often feel uneasy about magnetic recording systems. There are certain checks available in incremental recorders which guard against inadvertent loss of data with varying degrees of certainty. In computer tape systems read-after-write checks are performed using a read head located downstream from the write head, usually .300''. This system provides an excellent check for tapes in smooth motion but does not offer much for incremental recorders since the time required to traverse .300'' can be hours under some circumstances. Alignment of the read head also becomes extremely critical.

NRZI RECORDING



FLUX CHECK RECORDING



Each time head winding is pulsed, tape is magnetized for 0.006 in. tape then moves 0.005 in. producing read signal. Magnetized areas overlap producing NRZI recording.

FIGURE 4.

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	ƀ	ƀ	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	0̄	0̄	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 5. EIGHT BIT CODE — BCD RELATIONS

Flux Check™

Flux Check™ is an exclusive Kennedy feature which allows checking each bit as it is written. Any tape, operator or machine malfunction which would prevent proper recording is detected before the next byte is due to be written even at the top recording rate.

A special recording mode is utilized to make this check possible. Figure 4 shows the conventional recording method and the Flux Check™ mode as well. It will be seen that recording is in overlapping segments which add together to produce a magnetic flux pattern identical to standard recording.

An erase head is used in Flux Check™ recording to prevent old data from being read in addition to new data with resulting confusion of the electronics.

The Flux Check™ feature is of particular importance in applications where good tape must be produced every time and where the recorded data cannot be replaced. An outstanding example is telephone toll-ticketing where a reel of tape may represent thousands of dollars worth of billings.

Echo check

Echo Check is a feature included as standard on all Kennedy Incremental Recorders. Circuits in the machine check whether head current transitions occurred in response to input data as required. Echo Check assures that write electronics is operating correctly but does not indicate anything about tape motion or other possible sources of malfunction.

Tape readers

Most Kennedy Incremental Recorders are available with read electronics in addition to write electronics. Reading is performed in two modes: continuous read, in which the recorder runs smoothly in its slew mode, and incremental, or character-at-a-time reading.

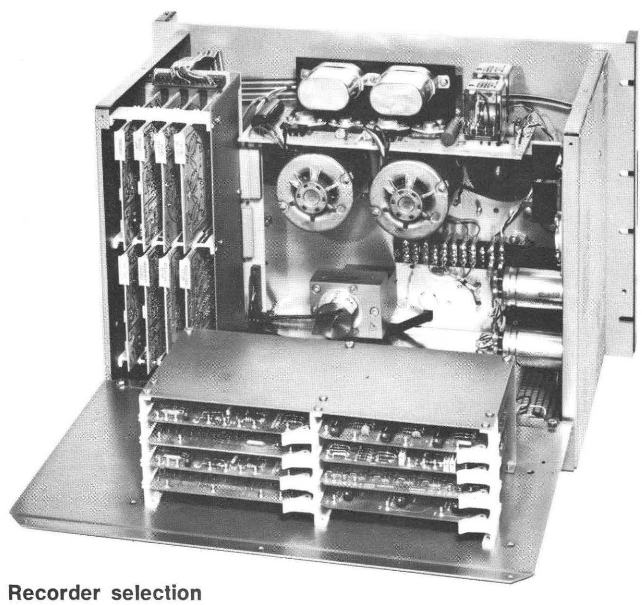
Incremental Read is limited to 0-150 characters per second speed range and only 200 BPI tape can be accommodated. At 556 and 800 BPI, tape speeds become too low for practical operation in the incremental read mode and pulse crowding on the tape makes character at a time start-stop impractical.

Continuous mode reading is available at 1000 bytes per second or faster depending upon machine model.

In contrast to paper tape readers which run tape at the uncomfortably high speed of 100 inches per second, 200 BPI tape at 1000 characters per second runs at the very modest speed of 5 ips.

The read feature is most useful in off line and small computer applications.

Rear view of Models 1600 and 1600R, (below) illustrating placement of components.



Recorder selection

Selecting the proper recorder for the job at hand requires some analysis of machine economics. Reliability is a function of several variables and should be given careful consideration. The following points should be considered:

A. The lowest density recording feasible under existing circumstances should be used. Computer time and tape usage are not usually important factors when carefully considered but reliability is always important.

B. Data capacity increases cost. Usually 8½″ reels (1200′) will suffice at incremental speeds.

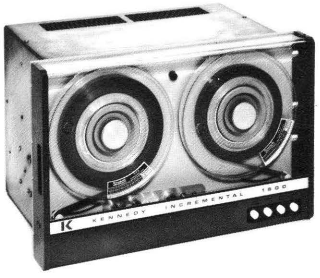
C. Time to insert gaps will vary from machine to machine. The least costly require relatively long gap insertion times. Often gap time is not of importance. Cost and reliability factors favor longer gap times.

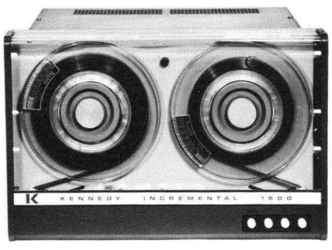
D. Flux Check™ can under many circumstances pay for its additional cost in one tape saved.

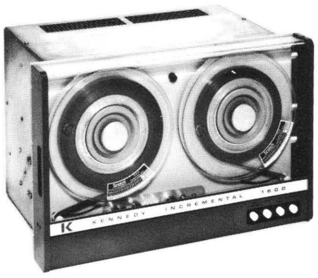
E. Read/Write machines offer advantages in cost over two special purpose machines.

Kennedy Company manufactures a full range of incremental recorders from simple, low-cost models through far more elaborate recorders offering the ultimate in features.

Incremental recorders quick reference chart

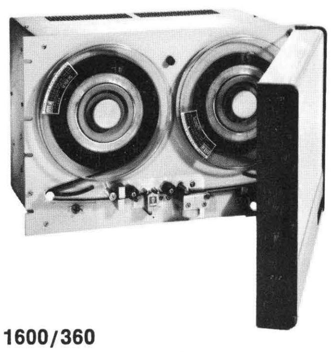


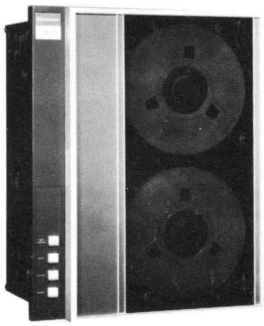


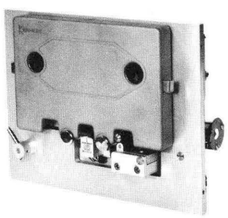


	1600	1600R	1600IR
Write/Rate	0-300 ch/sec	0-300 ch/sec	0-300 ch/sec
Density	200, 556, 800 BPI ±3%	200,556,800 BPI ±3%	200 BPI
Read/Rate		1000 ch/sec ±5%	0-150 ch/sec
IRG Time	180ms @ 200BPI 470ms @ 556BPI 550ms @ 800BPI	180ms @ 200BPI 470ms @ 556BPI 550ms @ 800BPI	350 ms @ 200BPI
Tape Format	7-track, IBM compatible NRZI 8½″, 1200 ft. reels	7-track, IBM compatible NRZI 8½″, 1200 ft. reels	7-track, IBM compatible NRZI 8½″, 1200 ft. reels
Gaps	BOT, IRG, EOF automatically generated upon command	BOT, IRG, EOF automatically generated upon command	BOT, IRG, EOF automatically generated upon command
Parity	Vertical and Longitudinal parity automatically generated	Vertical and Longitudinal parity automatically generated	Vertical and Longitudinal parity automatically generated
Physical Specifications	19″ x 12¼″ x 10″	19″ x 12¼″ x 10″	19″ x 12¼″ x 10″
Environmental Specifications	Temperature: 0-50°C (operating) Altitude: 20,000 ft. (operating)	Temperature: 0-50°C (operating) Altitude: 20,000 ft. (operating)	Temperature: 0-50°C (operating) Altitude: 20,000 ft. (operating)
Interface	DTL compatible +5V True (TTL compatible avail.)	DTL compatible +5V True (TTL compatible avail.)	DTL compatible +5V True (TTL compatible avail.)
Flux Check*	Available as an option	Available as an option	Not Available
Comments	Ideal for all applications requiring a reliable, low-cost recorder for virtually any data collection requirement.	For applications requiring synchronous read and incremental write, Model 1600R is a versatile adjunct for small computers or for data transmission over telephone lines.	Designed for applications requiring asynchronous reading or reading at rates too low for continuous tape motion.

*Flux Check—An exclusive Kennedy feature which checks data on the tape as it is written. A true read-after-write check, an error output is produced if the desired character is not successfully written for any reason.







1600/360	1610	DSP340	1530
0-500 ch/sec	0-500 ch/sec	0-50 ch/sec	0-300 ch/sec
800 BPI	200, 556, 800 BPI ±3%	200 BPI	200 BPI
1600/360R 1000 ch/sec	(1610 R) 1000 ch/sec		
550 ms at 800BPI	180ms @ 200BPI 470ms @ 556BPI 550ms @ 800BPI	180ms @ 200BPI	180ms @ 200BPI
9-track, IBM/360 compatible, NRZI 8½", 1200 ft. reels	7-track, IBM compatible NRZI 10½". 2400 ft. reels 1610/360 9 track IBM comp. NRZI	7-channel, IBM compatible NRZI Cartridge capacity: 300', ½", 1.5 mil tape	7-track, IBM compatible NRZI 10½", 2400 ft. reels
BOT, IRG, EOF automatically generated upon command	BOT, IRG, EOF automatically generated upon command	Optional	BOT, IRG, EOF automatically generated upon command
LCC, CRC, LRC automatically generated	Vertical and Longitudinal parity automatically generated	Optional	Vertical and Longitudinal parity automatically generated
19" x 12¼" x 10"	19½" x 24½" x 10"	11" x 8⅝" x 4" Wt: 12 lbs.	19½" x 24½" x 10"
Temperature: 0-50°C (operating) Altitude: 20,000 ft. (operating)	Temperature: 0-50°C (operating) Altitude: 20,000 ft. (operating)	Temperature: 0-50°C (operating) Altitude: 20,000 ft. (operating)	Temperature: 0-50°C (operating) Altitude: 20,000 ft. (operating)
DTL compatible +5V True (TTL compatible avail:)	DTL compatible +5V True (TTL compatible avail.)	DTL compatible	DTL compatible
Available as an option	Available as an option	Not Available	Included as standard
For applications requiring 9-track, IBM compatibility, Model 1600/360 produces tapes for use on IBM 2400 series transports.	Model 1610 is identical in all respects to the 1600 series, plus having the advantage of additional storage with 10½" reels.	The battery-operated DSP340 is ideal for such requirements as oceanography, etc., where high reliability and low current drain are considerations.	Model 1530 is designed for use in extremely demanding situations, such as telephone toll ticketing, where high reliability is important.

Facilities

Kennedy Company's factory occupies a new 37,000 square ft. building specially designed and built for electronic production. Architecture is Spanish in motif to fit into the Southern California landscape.

Manufacturing facilities include a complete and modern machine shop, sheet metal fabrication, circuit card etch and fabrication, silk screening, assembly and wiring. Well equipped test department and quality control functions assure that machines produced will be as trouble-free as it is possible to make them.

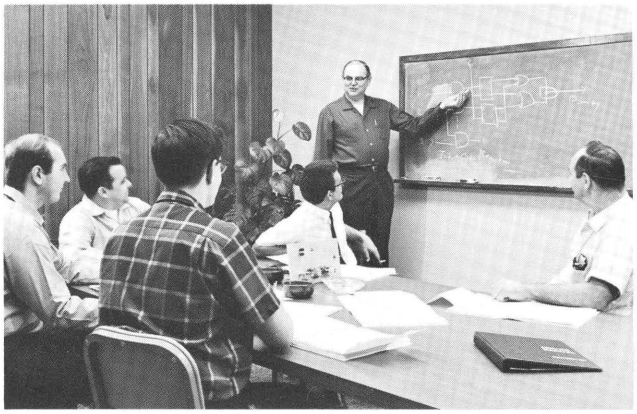
In-house capability in all major manufacturing areas enables close control of quality and scheduling. Short runs, as are often required in production of special machines, may be made economically.

Office and Engineering facilities are pleasant and well equipped. An unusual feature is a very complete graphic arts department.

Kennedy Company is prepared to supply your recorder needs whether for one machine or a thousand, standard or special.

In many instances we fabricate entire recorder systems for end user application. In any case our facilities are at your disposal. Let us know where we can help.

Ordering information



To order any Kennedy Co. product, specify:

Model Number
Options:
(Density
Speed, Logic)
Power Requirement
(If not 115V, 50/60 Hz)

Method of Shipment
Bill to
and Ship to address
Resale
Special features
Special Requirements

Our terms are: Net 30 Days
Delivery is f.o.b. Altadena unless otherwise specified.
Quantity discounts are available. Contact Kennedy Co. for further information.

Service

Kennedy Company recognizes the need for quick, efficient service for its products. Often vital operations can be held up by the malfunction of one small part of a system.

A fully staffed service department is maintained at the main plant to expedite needed actions when problems arise. In many instances consultation with factory service engineers can solve minor difficulties or interface snarls.

Many of our sales representatives maintain service organizations and are able to assist in maintaining recorders in the field.

Seminars in recorder maintenance are given on request at the factory for service people of customer organizations.

If time permits, repairs at the factory where all the necessary parts and facilities are at hand is preferable to field service. In emergency situations, however, service people from the factory will always be available.

We stand behind what we build and sell.

Warranty

Kennedy Company products are warranted to be free from defects in materials and workmanship for a period of one year.

Kennedy Company reserves the right to inspect any defective parts or material to determine damage and cause of failure.

This warranty does not apply to any Kennedy equipment that has been subject to neglect, misuse, improper installation and maintenance, or accident.

Liability under warranty is limited to no charge repair of defective units when equipment is shipped prepaid to factory or authorized service center after authorization from Kennedy Company to make such return.

Kennedy Company is continually striving to provide improved performance, value and reliability in their products, and reserves the right to make these improvements without being obligated to retrofit delivered equipment.

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