General Description

RANDEX

MASS STORAGE, RANDOM ACCESS FOR

UNIVAC® FILE-COMPUTER SYSTEMS

Remington Rand Univac
DIVISION OF SPERRY RAND CORPORATION

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Mass Storage, Random Access

for UNIVAC File-Computer Systems

CONTENTS

RANDEX SYSTEM

The RANDEX System is an input/output system providing mass storage for the UNIVAC File-Computer. It consists of a RANDEX Control Unit and a variable number of RANDEX Drum Units. When connected to a demand station of a Model 1 File-Computer, the RANDEX System may have between one and ten drum units; when connected to a Model 0 File-Computer, it may have between one and eight drum units. Since each drum unit can store six million 7-bit alphanumeric characters, the capacity of a RANDEX System connected to a Model 1 File-Computer may range between six million and sixty million characters; that of a system connected to a Model 0 File-Computer may range between six million and forty-eight million characters.

FEATURES

The RANDEX System is a mass storage system characterized by variable capacity, random access, time-shared operation, and full checking of data transfers. The main features of the system are described in the following paragraphs.

Capacity

Each drum unit contains two drums, with each drum having 1000 tracks divided into 25 sectors per track. Each sector is capable of storing 120 seven-bit characters. The capacity of each drum, therefore, is three million characters; that of a drum unit is six million characters. The capacity of a given RANDEX System depends on the number of RANDEX Drum Units it contains. This capacity may range up to sixty million characters for a Model 1 System or up to forty-eight million characters for a Model 0 System. As many RANDEX Systems may be connected to a UNIVAC File-Computer System as there are demand stations available.

Random Access

Each sector of a drum track stores the basic unit of information handled by the RANDEX System, the 120-character blockette. The addressing structure of the RANDEX System permits the direct selection of any sector in the system. The time required to gain access to a given sector is a function of the head-positioning time and of the drum period (latency).

A read or write operation to be performed in a track on which the head has already been positioned requires an average time of 35 milliseconds and a maximum time of 69 milliseconds, plus the time required to process the sector (2.6 milliseconds). In addition, the transfer of a blockette to or from the computer takes an average of 7.5 milliseconds and a maximum of 10 milliseconds. The average time required for the operation is therefore 45 milliseconds; the maximum time is 82 milliseconds.

In a read or write operation where the head must be positioned over a new track, additional access time is required. Transmitting the new track address to the drum unit requires 15 milliseconds. Then, if the change in track address is in only the low-order (10^0) section of the track address, the fine-positioning section of the head-positioning mechanism must be actuated, an operation requiring 100 milliseconds. If the change in track address is in the high order (10^1 or 10^2) section of the track address, the coarse-positioning portion of the head-positioning mechanism must also be actuated, an operation requiring an average of 400 milliseconds and a maximum of 600 milliseconds. The average time required for a read or write operation with a change only in the low-order section of the track address is 160 milliseconds; the maximum time is 197 milliseconds. The average time required for an operation with a change in a high-order section of the track address is 460 milliseconds; the maximum time is 697 milliseconds. If future memory references can be anticipated, head positioning may proceed concurrently with other operations being performed in the RANDEX System.

Time-Shared Operation

The RANDEX System, like other UFC Input/Output systems, executes instructions off-line, permitting time-shared operation of the RANDEX System with the computer and with other UFC Input/Output systems.

Checking

During every transfer of data either between the computer and RANDEX System or within the RANDEX System, a check is made to insure that the data is parity-correct.

INSTRUCTION REPERTOIRE

This section describes the instruction repertoire of the RANDEX System. The instructions fall into several broad categories: drum preparation, addressing, read, write, and search.

The drum preparation instructions (write, check, and erase) are used in the initial preparation of a new drum. Each sector is examined and, if good, is tagged and identified; those sectors, if any, containing bad spots are left untagged and are never used.

The addressing instructions (load, load and seek, and unload the RANDEX Address Register) are used to transmit RANDEX addresses between the computer and the RANDEX System.

The read instruction (Read Unit Record) transfers data from the RANDEX System to the computer.

The write instructions (Write Unit Record, and Write Unit Record and Check) transfer data from the computer to the RANDEX System.

The search instructions (Search Equal and Search Unequal) search a specified portion of the RANDEX System for equality or inequality with a stated identifier, and notify the computer of the results obtained.

Load RANDEX Address Register (L RAR)*

Initiated by Computer-to-I/O (C-to-I/O) line "A" signal, this instruction is used for loading the RANDEX Address Register (RAR) when no movement of the head to a new track is intended. It transmits an address from a computer I/O track to RAR. The address must have been previously stored in word 9, character 1 through (word 9,) character 6 of the I/O track. Table 1 lists, for each character of the address, its location in the I/O track; destination in RAR; address designation; and valid characters. When RAR has been loaded, the RANDEX System reverts to a ready condition and is prepared to accept a new instruction from the computer.

TABLE I. LOADING OF RANDEX ADDRESS REGISTER

SOURCE (I/O Track)	Word 9, CHAR 6	Word 9, CHAR 5	Word 9, CHAR 4	Word 9, CHAR 3	Word 9, CHAR 2	Word 9, CHAR 1
DESTINATION (RAR)	RAR 6	RAR 5	RAR 4	RAR 3	RAR 2	RAR 1
ADDRESS DESIGNATION	DRUM UNIT	TRACK (10^2)	TRACK (10^1)	TRACK (10^0)	SECTOR (10^1)	SECTOR (10^0)
VALID CHARACTERS	0-9	0-9	0-9	0-9	0-2 5-7	0-9

*If an inactive drum unit address is loaded or an alpha character is loaded in RAR, control line "Z" is set on Model 1 or control line "L" is set on Model 0.

Load RANDEX Address Register and Seek (L RAR & SK) *

Initiated by C-to-I/O line "B" signal, this instruction is used for loading RAR when the address to be loaded requires a movement of the head to a new track. It is identical to the L RAR instruction, except that its completion is delayed 15 milliseconds while the track section of the address is transferred to the designated drum unit address register. When the 15-millisecond delay has elapsed, the RANDEX System goes ready, and the head-positioning mechanism proceeds independently of the RANDEX Control Unit to position the head over the track specific by the address in the drum unit address register.

When the head comes to rest at the specified track, a "head-at-rest" signal notifies the control unit that this drum unit is ready to accept an instruction. A head in motion has no effect on subsequent instructions requiring the use of other drum units in the system.

Unload RANDEX Address Register (UNL RAR).

Initiated by C-to-I/O line "C" signal, this instruction transfers the contents of RAR to character address 2 through 7 (word 9, character 1 through word 9, character 6) of the I/O track. When the transfer is complete, the RANDEX System goes ready.

Read Unit Record (RUR).

Initiated by C-to-I/O line "D" signal, this instruction reads the blockette from the address specified by RAR and writes it on the I/O track; the system then goes ready.

Write Unit Record (WUR)

Initiated by C-to-I/O line "E" signal, this instruction writes the blockette stored on the I/O track into the address specified by RAR.

Write Unit Record and Check (WUR & CK)

Initiated by C-to-I/O line "F" signal, this instruction writes the blockette stored on the I/O track into the address specified by RAR, then reads back what has just been written and checks it with the original blockette. If the check is successful, the instruction is complete and the RANDEX System goes ready. If the check is successful, a signal is sent over line "Z" in Model 1 or line "L" in Model 0.

*If an inactive drum unit address is loaded or an alpha character is loaded in RAR, control line Z is set on Model 1 or control line "L" is set on Model 0.

Search Equal (S=)

Initiated by C-to-I/O line "G" signal, this instruction searches a RANDEX track, comparing for equality between the contents of the I/O track and the contents of each sector in a track. The instruction begins at the address specified in RAR and continues until a find is made or until the end of the addressed RANDEX track is reached. Comparison is made only at those character addresses where the I/O track contains non-ignore characters. The following results may be obtained from a SEARCH Equal instruction.

Program Error - All character addresses of the I/O track contain ignore characters. A signal is sent over line "Z" in Model 1 or line "L" in Model 0.

+ Find - All non-ignore characters in the I/O track are identical to the corresponding characters of the RANDEX sector being checked. The contents of the sector are transmitted to the I/O track, a signal is sent over I/O-to-C line "W" in Model 1 or "K" in Model 0, and the RANDEX System goes ready. RAR controls the address of the found sector.

0 Find - All non-ignore characters in the I/O track are matched with ignore characters in the RANDEX sector being checked. The contents of the sector are transmitted to the I/O track, a signal is sent over I/O-to-C line "Y" in Model 1 or "K" in Model 0, and the RANDEX System goes ready. RAR contains the address of the found sector.

- Find - The end of the RANDEX track has been reached; at least one good sector has been found, and neither a "+" nor a "0" find has occurred in any sector. The contents of the last good sector that was checked are transmitted to the I/O track, a signal is sent over I/O-to-C line "X" in Model 1 or "J" in Model 0, and the RANDEX System goes ready. RAR contains the address of the last good sector.

Abnormal Condition - The end of the track has been reached, and no good sector has been found. A signal is sent over I/O-to-C line "Z" in Model 1 or "L" in Model 0, and the RANDEX System goes ready.

Search Unequal (S≠)

Initiated by C-to-I/O line "H" signal, this instruction searches a RANDEX track, comparing for inequality between the contents of the I/O track and the contents of each sector of the RANDEX track. The instruction begins at the address specified in RAR, and continues until a find is made or until the end of the addressed RANDEX track is reached. Comparison is made only at those character addresses where the I/O track contains non-ignore characters.

The instruction proceeds to the next RANDEX sector if all I/O track non-ignore characters are identical to the corresponding sector characters, or if they are all matched with sector ignore characters. The following results may be obtained from a S≠ instruction.

Program Error - All character addresses of the I/O track contain ignore characters. A signal is sent over line "Z" in Model 1 or line "L" in Model 0.

+ Find - At least one non-ignore character in the I/O track is not identical with the corresponding character of the RANDEX sector being checked. The contents of the sector are transmitted to the I/O track, a signal is sent over I/O-to-C line "W" in Model 1 or "I" in Model 0, and the RANDEX System goes ready. RAR contains the address of the found sector.

- Find - The end of the RANDEX track has been reached; at least one good sector has been found, and no S≠ "+" find has occurred. The contents of the last good sector that was checked are transmitted to the I/O track, a signal is sent over I/O-to-C line "X" in Model 1 or "J" in Model 0, and the RANDEX System goes ready. RAR contains the address of the last good sector.

Abnormal Condition - The end of the RANDEX track has been reached, and no good sector has been found. A signal is sent over I/O-to-C line "Z" in Model 1 or "L" in Model 0, and the RANDEX System goes ready.

Drum Preparation Write (DRUM PREP WRITE)

Initiated by C-to-I/O line "I" signal, this instruction prepares a drum track for use by recording in its sectors the sector format listed in Table 2. Preparation of the track begins at the track sector specified by the address in RAR, and continues through all succeeding sectors to the end of the track. When the last sector in the track has been prepared, the system goes ready. A DRUM PREP CHK instruction (explained in the succeeding paragraph) usually follows to check the results of the DRUM PREP WRITE instruction. The following initial conditions must be present before the DRUM PREP WRITE instruction is initiated.

(1) The drum preparation switch in the RANDEX Control Unit must be set; otherwise a program error signal to the computer results when a drum preparation instruction is issued.

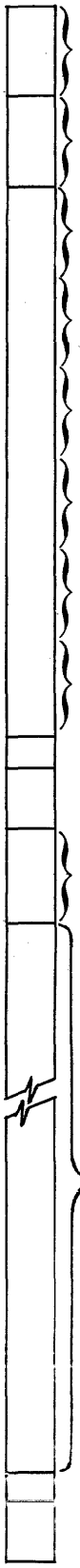
(2) RAR must contain the starting address of the instruction.

(3) The I/O track must be fully loaded with parity-correct characters.

Drum Preparation Check (DRUM PREP CHK)

Initiated by C-to-I/O line "J" signal, this instruction checks the contents of each sector prepared by a previous DRUM PREP WRITE instruction to see that the sector was prepared correctly. The instruction begins at the address in RAR and continues until a bad sector is detected or until the end of the track is reached. A bad sector is recognized when the information read from the sector is not identical with that which was recorded in it.

Table 2. Preparation of a RANDEX SECTOR

RANDEX SECTOR FORMAT	CONTENTS	SOURCE OF DATA
 Self-Sprocket Pattern A	0010101	RANDEX Control Circuitry
Self-Sprocket Pattern B	0101011	RANDEX Control Circuitry
Sector 10^0 (Address Tag)	1 Char. (0-2, 5-7)	Sector Counter - 10^0
Sector 10^1 (Address Tag)	1 Char. (0-9)	Sector Counter - 10^1
Track 10^0 (Address Tag)	1 Char. (0-9)	RAR - track 10^0
Track 10^1 (Address Tag)	1 Char. (0-9)	RAR - track 10^1
Track 10^2 (Address Tag)	1 Char. (0-9)	RAR - track 10^2
Drum 10^0 (Address Tag)	1 Char. (0-9)	RAR - Drum ^{0}
Guard Band	2 Bits	"Ones" as left in DSR after writing previous character.
Dead Space	5 Bit-Spaces	None
Self-Sprocket Pattern B	0101011	RANDEX Control Circuitry
Information	120 Char. (Any Parity-Correct, Characters)	I/O Track-Word 9, Char. 5 through Word 0, Char. 11
Guard Band	2 Bits	I/O Track-Word 9, Char. 5, 1st 2 Bits
Spare	30 Bits	None

The following initial conditions must be present before the DRUM PREP CHK instruction is initiated.

(1) The drum preparation switch in the RANDEX Control Unit must be selected; otherwise a program error signal to the computer results when a drum preparation instruction is issued.

(2) The RANDEX buffer must contain the same information as during the preceding DRUM PREP WRITE sequence. (This is true when the DRUM PREP CHK instruction immediately follows completion of the DRUM PREP WRITE instruction.)

(3) RAR must contain the address of the first sector to be checked. (As the sequence proceeds, RAR is advanced as each sector is checked.)

If a bad sector is found, a signal is sent over I/O-to-C line "W" and the RANDEX System goes ready; RAR contains the address of the bad sector. The computer program then determines what should be done next.

(1) A DRUM PREP WRITE instruction might be given in an attempt to successfully rewrite the bad sector. In this case, the I/O track and RAR contain the data necessary to initiate the DRUM PREP WRITE sequence at the address of the bad sector; the sequence then continues to the end of the track.

(2) A DRUM PREP ERASE instruction (discussed below) could be issued to obliterate the bad sector.

In either case, another DRUM PREP CHK instruction is issued after the bad sector is rewritten or obliterated. If the sector was rewritten, it must be checked again, and RAR contains the correct address. If the sector was obliterated, RAR must be advanced by one before the subsequent DRUM PREP CHK instruction is issued.

When the end of the track is reached without the detection of a bad sector, a signal is sent over I/O-to-C line "X," and the system goes ready.

Drum Preparation Erase (DRUM PREP ERASE)

Initiated by simultaneous C-to-I/O line "I" and "J" signals, this instruction follows a DRUM PREP CHK instruction in which a bad sector has been detected; It erases the first self-sprocketing section and the address tag of the bad sector, so that the entire sector is unavailable for future RANDEX operations. When the instruction has been completed, the RANDEX System goes ready.

FUNCTIONAL DESCRIPTION

RANDEX Control Unit

The RANDEX Control Unit contains the circuitry which enables the RANDEX System to accept instructions from the computer, to perform the requested instructions, to accept data from or transmit it to the computer, and to notify the computer of conditions existing in the RANDEX System. Included among the major functional sections comprising the control unit are demand station, sequence control, address, buffer, comparator, timing pulse, read-write amplifier, and parity checker sections.

Demand Station - The demand station is similar to that of other UFC input/output systems. It permits off-line execution of all instructions, so that the computer may proceed with its program after it initiates a RANDEX System operation.

The computer-to-I/O control lines transmit the instruction from the computer to the control unit. In a Model 1 system I/O-to-computer lines "A" through "J" indicate "head-at-rest" conditions in RANDEX Drum Units 0 through 9 respectively; lines "W" through "Z" identify the type of comparator result. In a Model 0 System, I/O-to-C lines "A" through "H" indicate "head-at-rest" conditions in RANDEX Drum Units 0 through 7 respectively, and I/O-to-C lines "I" through "L" identify the type of comparator result.

Sequence Control - The sequence control synchronizes and controls the operation of the various sections of the control unit in accord with the various operations called for by the instructions.

Address - The address section consists of the RANDEX Address Register (RAR), which holds a RANDEX System address loaded in the register by the computer; the sector mark counter, which monitors the current sector address of the selected RANDEX Drum Unit; the sector coincidence detector, which detects coincidence between the sector mark count and the RAR sector address; and the address coincidence detector, which detects coincidence between the contents of RAR and the address tag read from the selected sector.

Buffer - The buffer is a core memory storing 120 characters. All data enters or leaves the buffer through a one-character shift register. The buffer and/or shift register take part in the following basic operations.

(1) Store a blockette read from the I/O track.

(2) Store a blockette read from a RANDEX Drum Unit.

(3) Transmit the blockette stored in the buffer to the I/O track.

(4) Transmit the blockette stored in the buffer to a RANDEX Drum Unit.

(5) Transmit the blockette stored in the buffer to the comparator for comparison with a blockette being read from a RANDEX Drum Unit.

(6) Transmit the address tag read from a RANDEX Drum Unit through the shift register to the address coincidence detector for comparison with the contents of RAR.

Comparator - The comparator compares the blockette stored in the buffer with a blockette read from a RANDEX Drum Unit In a WRITE CHECK or DRUM PREP CHECK instruction, every character from the buffer is compared with every character from the RANDEX Drum Unit. In a SEARCH EQUAL or SEARCH UNEQUAL instruction, comparison is made only between non-ignore characters from the buffer and the corresponding characters from the RANDEX Drum Unit. For a description of the results obtained from operation of the comparator, see the appropriate instruction described in the "Instruction Repertoire" section.

Timing Pulse Section - Three sources of timing pulses are used in the RANDEX System:

(1) The computer timing pulses, used when data is being transferred between the computer and the RANDEX Control Unit.

(2) An oscillator in the RANDEX Control Unit, used when data from the buffer is being written on a RANDEX drum.

(3) Self-sprocketing timing pulses from the RANDEX drum, used when data is being read from the RANDEX drum to the buffer or to the comparator.

The sequence control section controls and distributes the timing pulses in accord with the sequence being performed.

Read and Write Amplifiers - One read amplifier and one write amplifier located in the control unit are used to transmit data between the control unit and all RANDEX Drum Units. Designation of one particular drum unit by the RAR drum address connects the read and write amplifiers to that drum unit. The sequence to be performed, read or write, determines whether the read amplifier or the write amplifier is used. The read and write amplifiers described above are separate from those of the demand station which are also located in the control unit and are used to transmit data between the I/O tracks and the control unit.

Parity Checker - If a parity error occurs, an error signal is sent to the computer, and operation of the RANDEX System is stopped. If a parity error occurs in data being read from a RANDEX Drum Unit, another attempt is made to read that data. If the error persists on the second attempt, the parity error signal will occur. A parity error signal sets the demand station error flip-flop, stopping further operation of the RANDEX System.

RANDEX Drum Unit

A RANDEX Drum Unit consists of a cabinet containing two magnetic storage drums mounted in an over-and-under configuration together with associated electronic and mechanical mechanisms. The lower drum is designated as Drum A, the upper drum as Drum B. Each drum contains 1000 tracks for information storage, with each track divided into 26 sectors. (See Drum Unit Specifications appearing later in this paragraph for details.) Figure 1 page 13 shows the control and data connections between the RANDEX ControlUnit and Drum Units.

Read/Write Head - Each drum has associated with it one magnetic read/write head which is air-floated over the drum surface at a small and stable head-to-drum clearance. The head consists of a main element used for both reading and writing and of a pair of small trim elements located ahead, with respect to drum motion, and to either side of the read/write element. The trim elements function only during writing; they erase a narrow band along either side of and slightly overlapping the track about to be written by the read/write element. Use of the trim elements insures against troubles that might arise when writing is done with the head not exactly centered over a track that was previously written; the trim heads erase any unwanted information that might remain at the edges of the track and cause trouble in subsequent read operations. In a read operation, the head of the drum selected for use is switched to the RANDEX Control Unit read amplifier. In the write operation, the head of the drum selected for use is switched to the write amplifier of the RANDEX Control Unit.

Head Positioning - Both heads in the drum unit, one head each for Drum A and Drum B, are mounted on a common head-positioning mechanism which moves them to the track specified in the address register of the drum unit. The positioning mechanism consists of: a movable carriage holding the heads; and a notched bar or rack extending the full length of carriage travel and having one notch for every ten track positions. Coarse positioning of the heads to an area 10 tracks wide is accomplished by moving the carriage to the desired notch using a cable and pully arrangement driven by a closed-loop servo system, then by dropping a mechanical pawl from the carriage into the proper notch. Fine positioning is accomplished by moving the notched rack itself until the head is over the specified track; movement of the rack is controlled by a lever adder which is an arrangement of solenoid-actuated levers whose output is a mechanical displacement equal to the sum of the individual lever movements. The drum unit track address register supplies the necessary addressing signals to the servo system and to the lever adder. Coarse and fine positioning occur concurrently. When the positioning mechanism has come to rest at the specified track address, a head at rest signal to the control unit indicates that the drum unit is ready to accept an instruction.

Addressing - An address in the RANDEX System is fully defined by six, four-bit decimal characters: one character specifying the RANDEX Drum Unit, three the drum track, and two the sector. The RANDEX Address Register (RAR) in the RANDEX Control Unit stores the address associated with the current instruction. The stages of RAR and the corresponding address designations are listed below.

RAR Stage	6	5	4	3	2	1
Designation	Drum Unit	Track 10^2	Track 10^1	Track 10^0	Sector 10^1	Sector 10^0

In addition, each sector (with the exception of bad sectors incapable of storing information) contains a six-character address tag identifying that sector by its drum unit, track, and sector address.

The following information describes the roles played by the various sections of the address in each drum unit.

(1) Drum Unit address - The drum unit address stored in REAR 6 activates the following lines between the specified drum unit and the RANDEX Control Unit:

Read-Write Select - Selects the head circuitry in the designated drum unit for connection to the read amplifier or write amplifier as specified by the instruction.

Read Amplifier - Connects the read amplifier in the control unit to the proper head in the designated drum unit.

Write Amplifier - Connects the write amplifier in the control unit to the proper head in the designated drum unit.

Sector Mark Amplifier - Connects the sector mark amplifier in the control unit to the sector mark circuitry of the designated drum unit.

Trim Current - Connects the trim current circuitry in the control unit to the designated drum unit.

Drum A-B Select Enable - Enables the Drum A-B select line in the designated drum unit; Drum A or Drum B is then selected depending on the 10^1 sector address stored in RAR 2 or upon the setting of the sector counter in the control unit.

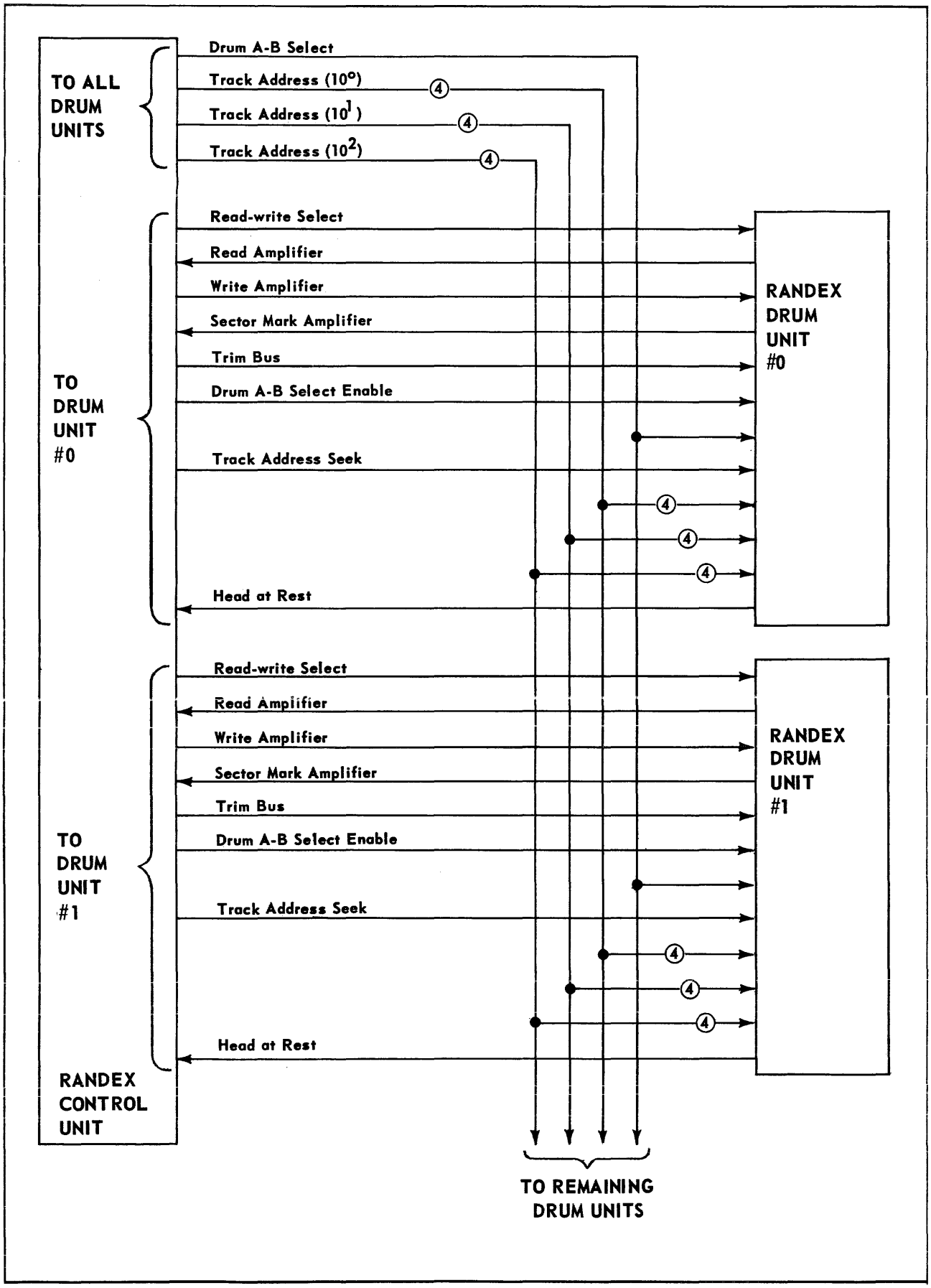


Figure 1. Randex Interconnections-Control and Data

Drum Unit Seek - During the final 15 milliseconds of a Load RAR & Seek instruction, causes the contents of RAR 3, 4, and 5 to be captured in the track address register of the designated drum unit.

(2) Track Address - Each drum unit contains a drum unit address register which stores the track address specified for that unit. A 12-wire address bus connects the track address in RAR 3, 4, and 5 to all drum unit address registers. During the final 15 milliseconds of a LOAD RAR & SEEK instruction, a Drum Unit Seek signal to the one selected drum unit causes the track address in RAR 3, 4, and 5 to be captured in the drum unit address register of the selected drum unit. At the end of the instruction the RANDEX System is free to perform instructions using other drum units, while the drum unit address register continues to provide signals to the head-positioning servo system and lever adder, causing the head-positioning mechanism to seek the new track address stored in the register. The 10^2 and 10^1 sections of the address register provide signals to the coarse-positioning servo system which moves the head to the selected notch in the rack. The 10^0 section of the register provides energizing signals to the appropriate lever adder relays to accomplish fine-positioning of the head. In general, a new address usually calls for action by both the coarse-positioning servo system and the fine-positioning lever adder. If the new address differs from the previous one only in the 10^0 position; there is no need to use the servo system. Since considerable head-positioning time can be saved by avoiding use of the servo system, the address register is examined upon receipt of a new address to determine if there is a change in the 10^1 or 10^2 sections of the address; if there is none, the servo system is not activated.

(3) Sector Address - A drum track in the RANDEX System is defined as the two identically addressed tracks on Drum A and Drum B of a drum unit. A specified track begins on Drum A, which contains sectors 00 through 25, and continues on Drum B which contains sectors 50 through 75. Each drum has associated with it a sector mark track having a sector reference mark locating the starting point of the first sector, and subsequent sector marks locating the starting points of all remaining sectors. As described in (1) above, the character stored in RAR 6 specifies the drum unit, activating a number of lines between the designated drum unit and the control unit. Among the lines activated is the Drum A-B Select Enable, which connects the Drum A-B Select line to the designated drum unit. The character stored in RAR 2 (or, in portions of the channel search or drum prep write instructions, the character in the 10^1 section of the sector mark counter) determines whether Drum A or Drum B is selected by the Drum A-B Select line. If the character is smaller than 5, Drum A is selected; if it is 5 or larger, Drum B is selected. Selection of a drum by the Drum A-B Select line switches its read-write, trim, and sector mark heads to the drum selected.

Another line activated by the drum unit address in RAR 6 is the sector mark amplifier line from the designated drum unit. This line transmits sector mark pulses from the selected drum in the designated drum unit to the sector mark counter in the control unit. The sector mark counter is reset at the beginning of the drum track by the sector reference mark; it is reset to 00 if drum A has been selected or to 50 if drum B has been selected. Each sector mark thereafter advances the sector mark counter by 1. The setting of the sector mark counter therefore identifies the sector approaching the read-write head.

Read Sequence - One of the basic sequences forming a part of many of the RANDEX instructions is the read sequence which transfers information from a drum unit to the control unit. The control unit may elect to read from any drum unit that is transmitting a "head-at-rest" signal. With the desired address in RAR, the necessary connections between the control unit and the designated drum unit are complete, and the head is at rest over the track specified in RAR. The track is scanned to locate the sector called for by the sector address in RAR; this is done by comparing the RAR sector address with the count in the sector mark counter. When the two coincide, indicating that the sector currently approaching the head is the one specified in RAR, the reading circuits are activated and the contents of the sector are read. The format of the sector is described in Table 2, page 7.

If the track portion of the address tag does not agree, a signal is sent to the drum unit to reposition, and another attempt is made to check the tag. If the second attempt fails, an error signal sets the demand station error flip-flop and halts further operation of the RANDEX System.

Reading of the sector consists of two operations:

(1) Verification that the sector being read is actually located at the sector, track, and drum address specified in RAR.

(2) Reading the blockette of data, once verification has been established.

The first self-sprocketing patterns locate the beginning of the address tag and set up the control circuitry to start reading the address tag. The address tag is then read, and is compared for coincidence with the contents of RAR. If the two are identical, the sector being read is verified as being the one called for in RAR. The guard band following the address tag serves only to insure that the last bit of the address tag is read out correctly and is not affected by noise which might otherwise be present on the drum. The dead space which next passes the read head is necessary to permit time for switching from read to write during a write sequence.

With the address verification established, the next self-sprocketing pattern in the sector is read to locate the beginning of the blockette. The blockette is then read and is transmitted to the control unit, where it is

either loaded into the buffer or transmitted to the comparator depending on the instruction being executed. This completes the read sequence. The guard band following the last bit of the blockette serves the same purpose as that following the address tag. The spare portion of the sector is approximately 30 bits long, and is unused.

Write Sequence - Another basic sequence is the write sequence which writes information at a specified address in a drum unit. The write sequence is similar in many respects to the read sequence with the following exceptions.

(1) Trim current must be turned on quite some time before writing can be done.

(2) After verification of the address tag in the same way as in a read sequence, the read-write circuitry must be switched to "write" to allow writing of the blockette.

Trim current is turned on as soon as verification is obtained that the drum unit and track being scanned are the ones specified in RAR. To accomplish this verification, the first sector mark read from the drum activates the read circuitry; when the beginning of the address tag is indicated by the self-sprocketing pattern, the address tag is read. In this case, only the drum and track sections of the address tag are compared for coincidence with those of the RAR address. If they are identical, the drum unit and track being read are verified as being the correct ones, and the trim current is turned on.

With the trim current on, the track is then scanned, as in the read sequence, for the sector specified by the sector address in RAR. When the sector mark count is the same as the RAR sector address, the sector currently approaching the head is the one specified in RAR. The reading circuits are activated, and the entire address tag is verified as in a read operation.

When this complete address verification has been established, the read-write circuitry is switched from read to write. The switching takes place while the dead space passes the head. The control unit then writes the self-sprocketing pattern, the contents of the buffer, and the guard band onto the RANDEX drum. When writing has been completed, the trim current is turned off and the write sequence is complete.

Bad Sectors - Certain small areas of the drum may be unsuitable for recording because of imperfections in the drum surface. Where such an area occurs, the entire sector in which it is located is recognized during the drum preparation routine as a bad sector, and is left unaddressed and therefore unused. To compensate for such bad sectors and still maintain a minimum storage capacity of 3 million characters per drum, one spare

sector is provided for each track on a drum. Each track therefore has 26 sectors, all of which may be used if there are no bad sectors. The maximum storage per drum unit is therefore 6.24 million characters.

Landing Strip - In addition to the 1000 information tracks on a drum, there is another track, called a landing strip, located at one end of the drum some distance away from the information tracks. In normal operation, the head can be lowered (flown) only when it is positioned over the landing strip. In this way, any damage to the drum surface or to information is avoided should the head fail to fly properly when it is lowered. One portion of the drum starting procedure positions the two heads over their landing strips and lowers (files) them after the drums are up to full speed. Should an abnormal event cause the heads to raise while the drum is in operation, the heads must be returned to the landing strip and lowered again before normal use of the drum unit can be resumed.

Drum Drive Characteristics - Each of the two drums in a drum unit has its own drive motor, and also a speed-sensing device to indicate when the drum reaches 90% of full speed during a starting sequence. Both drums in a given drum unit are started together, but to avoid extremely high starting current requirements, only one drum is started at a time. An automatic starting sequence starts drum units sequentially, starting each succeeding drum unit when the one previously started reaches 90% of full-rated speed. Since it is extremely important that a drum be up to full speed before it is used in a RANDEX instruction, a timer insures that, before a drum unit can be used, at least one minute elapses after both drums in the drum unit reach 90% of full speed. This insures that both drums reach full speed. The total time required for a drum to reach full speed is approximately five minutes.

Drum Unit Specifications - Following are the basic specifications of the RANDEX Drum Unit.

(1) Storage Capacity (Guaranteed Minimum)

	Characters	Bits
Drum Unit	6 million	42 million
Drum	3 million	21 million
Track	3000	21,000
Sector	120	840

(2) Information Format

	Maximum	Guaranteed Average
Tracks per Drum	1000	1000
Sectors per Track	26	25

(3) Sector Format - See Table 2, page 7.

(4) Drum Parameters

Drum Dimensions	
Length	44.0 inches
Diameter	24.0 inches
Circumference	75.4 inches
Speed of Rotation, etc.	
Nominal Speed	870 rpm (14.5 rps)
Surface Velocity	1093 in/sec.
Speed Variation for ± 10% line voltage variation	±1% max.
Speed variation, drum to drum	±0.7% max.
Storage Characteristics	
Bit density	325 ppi
Bit frequency	356 kc ±3%
Bit period	2.82 μ sec.
Capacity	
Possible bit positions per sector	942
Possible bit positions per track	24,492
Tracks per drum	1,000
Tracks per drum unit	2,000
Track Spacing	
Tracks per inch	25
Mean track spacing	.040 inches

(5) Access Times

Drum Latency	
Maximum	69 ms.
Mean	35 ms.
Carriage Positioning Time	
Minimum (change in track 10^{o} address only)	100 ms.
Maximum	600 ms.
Mean (assuming random addresses)	400 ms.

(6) Recording

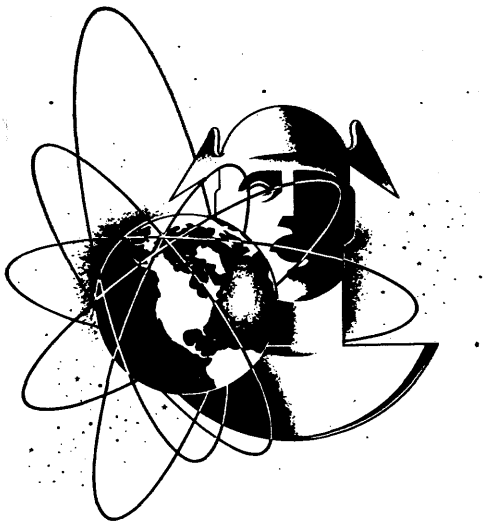
Read-Write Element Width	.025 inches
Trim Element Width	.010 inches
Distance from read-write element gap line to trim element gap line	.100 inches

Carriage-positioning tolerance	±.002 inches
Read-write element inductance	40 μh
Write current	150 ma
Read Voltage	5-40 mv
Trim current	40 ma
Trim current rise or fall time (to 90% of final value)	50-100 μs
Read to write switching time	16 μs
Write to read switching time	26 μs

PHYSICAL CHARACTERISTICS

The physical characteristics of the RANDEX Control Unit are described below. The characteristics of a given complete RANDEX System are determined by the number of drum units in the system.

	Control Unit	Drum Unit
Size and Weight:		
Width	30 in.	34 in.
Depth	80 in.	77 in.
Height	71 in.	69 in.
Weight	2000 lb.	2000 lb.
Electric Service:		
kva	6.6	3.9
Volts	208-240 vac	220 vac
Phase	1Ø - 3 wire	1Ø - 3 wire
Max. Line Variation	±5%	±5%
Power Dissipation:		
AC	5.5 kw	2.2 kw
DC		0.5 kw (from Control Unit)
Cooling:		
Heat Dissipated	18,800 BTU/hr	9,200 BTU/hr
Max. Room Temperature	85 F	100 F
Max. Room Humidity	90%	90%



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