

## XIII MASS RANDOM ACCESS DATA STORAGE SUBSYSTEM

### GENERAL DESCRIPTION

The mass random data storage subsystem (abbreviated MRADS) adds storage capacity to the GE-225 System. Each MRADS disc unit adds a storage capacity of 34.4 million numeric decimal digits. As many as four such units can be added to one controller, adding a total of 103.2 million decimal digits.

MRADS storage has the advantage of permitting information to be accessed randomly rather than sequentially. This means that information may be stored in the order it is received instead of first having to be sorted. It also means that any information may be located quickly on a master file without starting

at the beginning of the file and reading until the desired information is reached. In random access processing, a key is used to directly address a particular record. The time required to match one piece of information to another is practically negligible, for it is possible to go directly to the desired data. The average access time is 225 milliseconds or less, depending on file organization.

The MRADS subsystem (Figure XIII-1) is connected to the central processor through the controller selector. Because of its high rate of data transfer, the MRADS subsystem is given the highest priority channel (lowest plug number) of any of the peripherals connected to the controller selector.

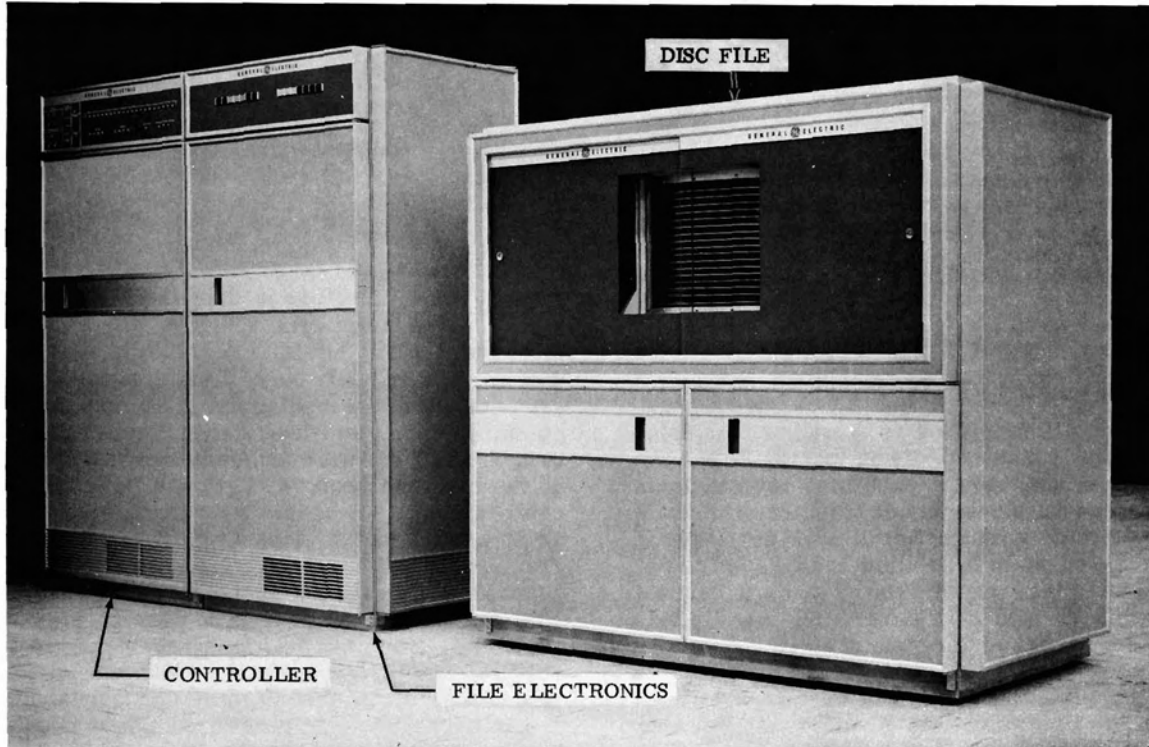


Figure XIII-1. The Mass Random Access Data Storage Subsystem

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The subsystem consists of a controller and from one to four disc units, each with its own electronics unit.

### Disc Unit

The most basic element of any mass random access memory system is the one in which information is stored. In the MRADS system, storage is on 16 rotating discs in the disc unit (Figure XIII-2). Reading and writing are done by magnetic heads which are mounted in pairs on 16 positioning arms. A head positioning motor, or actuator, moves the arms parallel to the disc surfaces. An air compressor motor is housed in the lower portion of the disc file cabinet. When on, the motor increases the air pressure inside the disc file unit so that the read/write heads float over the discs on a cushion of air.

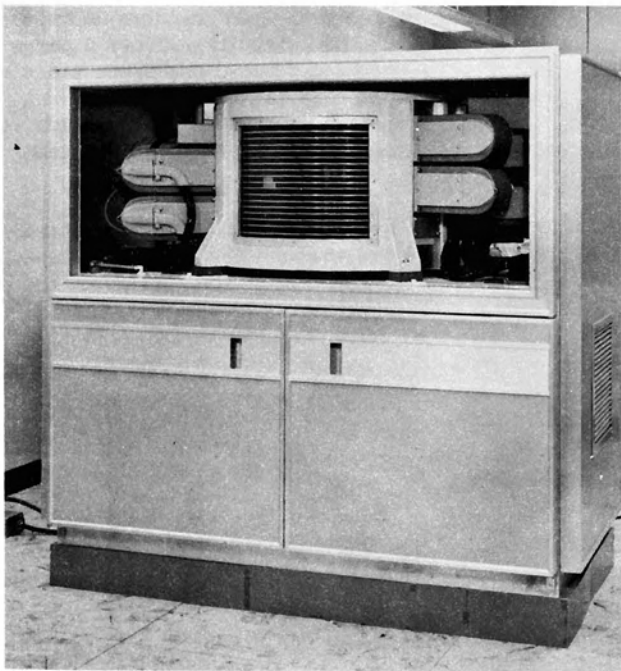


Figure XIII-2. Disc File Unit

**Rotating Discs.** Information is stored on both sides of the 16 metal data storage discs, making 32 storage surfaces in one disc unit. Each disc is made from two polished metal blanks joined together with resin, then treated with a magnetic film. The magnetic coating is the medium upon which information is recorded. Discs are rigidly mounted on a vertical spindle within the file unit and are dynamically balanced. They rotate at the rate of 1200 revolutions per minute.

Figure XIII-3 illustrates the division of recording areas on a disc. The surface of each disc is divided into 256 concentric circular tracks like the grooves

of a phonograph record. The outer 128 tracks are each divided into 16 sectors and are designated as outer zone tracks. The inner 128 tracks are each divided into 8 sectors and are designated inner zone tracks. Each sector is capable of storing one 64-word frame. Sectors are numbered on inner and outer tracks, as illustrated.

The disc unit actually has 18 metal discs, two of which are checking discs. The top and bottom discs are not for data, but revolve with the 16 data discs to create an air baffle. The lower side of the top disc or the upper side of the bottom disc is used for clock tracks.

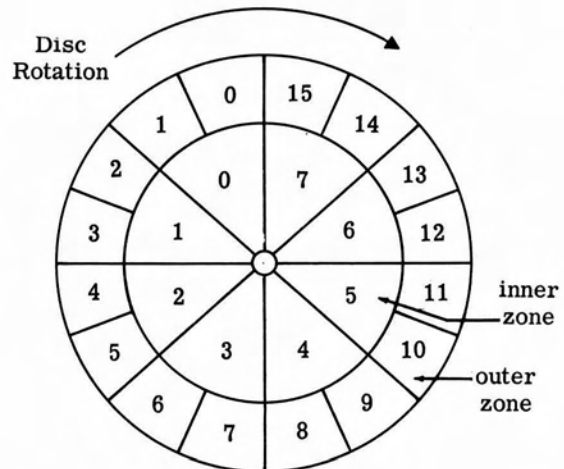


Figure XIII-3. Disc Format

**Read/Write Heads.** Each disc is served by an individual positioning arm (Figure XIII-4) containing eight read-write heads. Four heads serve the top disc surface and four serve the bottom surface. Heads are numbered according to their location on the positioning arm, as illustrated in Figure XIII-5. Heads 0, 1, 2, and 3 are used for frames on the inner tracks of the disc and heads 4, 5, 6, and 7 are used for the outer track. An actuator for each arm moves the arm parallel to the disc. Only 64 arm positions are required to cover all tracks on a disc. One head positioning operation can occur at a time on one disc unit, but since four disc units may be attached to a controller, four head positioning operations may occur at one time with one controller. Since input or output commands can be issued to sequentially address the tracks served by eight read-write heads, it is possible to read or write 96 consecutive frames without moving the positioning arm.

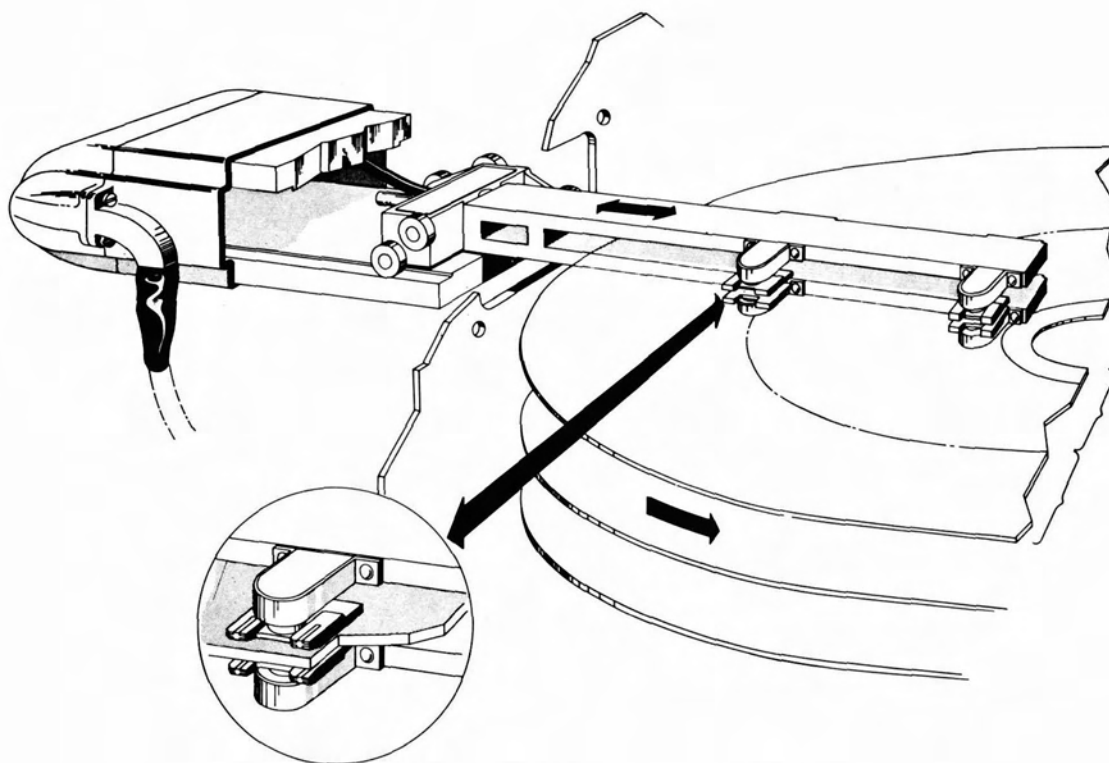


Figure XIII-4. Head Positioning Assembly

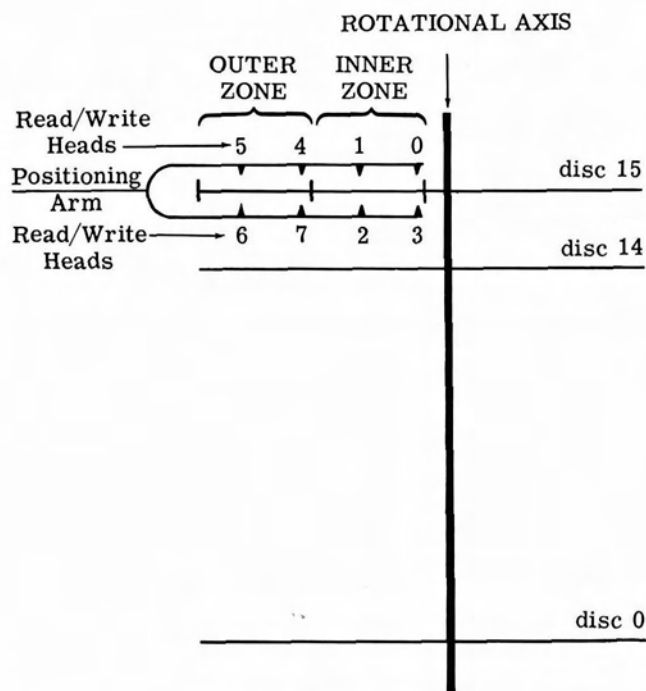


Figure XIII-5. Read/Write Heads

The read/write heads never actually touch the discs, but float over (or under) them on a cushion of air. The air pressure maintains the distance of a few thousandths of an inch between the heads and the discs. Magnetic contact is made through the air space.

### Controller

The MRADS controller (See Figure XIII-1) is connected to the central processor through the controller selector. Like other peripherals, it time-shares access to memory. The controller contains hardware which interprets MRADS instructions from the central processor and controls data flow between the central processor, the electronics unit, and the disc unit. It has buffer registers and shift registers, and generates timing pulses which, along with busy and not busy signals, direct the flow of information.

From the control and indicator panel on the controller, Figure XIII-6, one can obtain an indication of what is happening to the information within the controller. Some of the indicators on this panel are of concern to the operator and some are of interest only to service engineering personnel. The two indicators which are of vital concern to the operator are the WARNING alarm light and the CONTROLLER OPERABLE light. The following describes the controls and indicators.

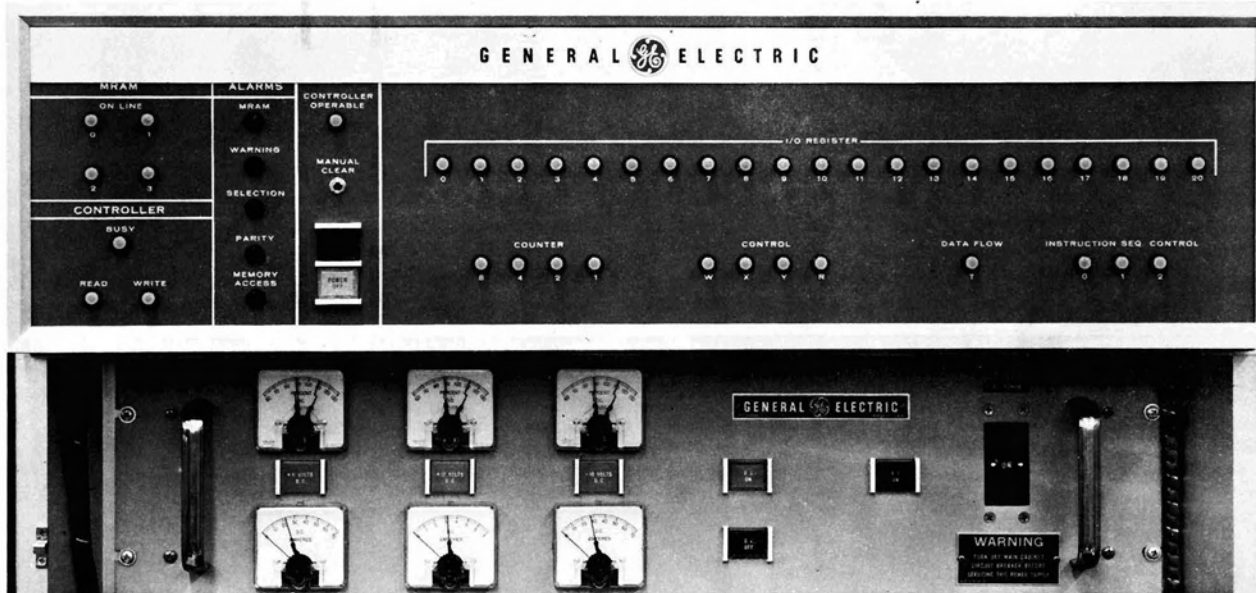


Figure XIII-6. Controller Panel

#### MRAM ON LINE 1, 2, 3, 4

These four indicators show by illumination which disc units are in an operable condition. As was stated previously, each controller may have as many as four disc units and four electronics units attached to it.

#### CONTROLLER BUSY, READ, WRITE

These three indicators show by illumination whether the controller is busy with the seek function, in which case, BUSY alone is illuminated, or whether it is busy with a read or write command, in which case BUSY and READ or BUSY and WRITE indicators are illuminated.

#### ALARMS

**MRAM.** This indicator is illuminated if the controller receives an error signal from any of the disc units. The program continues after this happens, so no operator action is required.

**WARNING.** When this indicator is illuminated, it is a danger signal which the operator must definitely heed. It indicates that a motor in one of the disc file units has become over heated. The operator must immediately halt all use of the MRADS unit and notify the service engineer. Operations which do not require the use of the MRADS can be continued.

**SELECTION.** When this is illuminated, it indicates that the program selected a disc file unit which was not on line. However, the program continues. The trouble may have been caused by a program error or by the fact that the operator neglected to turn the disc file power on. The operator must check the power switches to all disc file units. If these are all on, he must assume it to be a program error, and make a note to notify the programmer of the alarm condition.

**PARITY.** This indicator is illuminated when a parity error is present in the record address transmitted to a disc file or in data received from the disc file. No operator action is required unless operations halt with this indicator on. In this case, the programmer should be notified of the parity light.

**MEMORY ACCESS.** This indicator is illuminated when the controller is denied two successive memory access requests. The program turns the indicator off, so no operator action is required.

**CONTROLLER OPERABLE.** When this indicator is illuminated, it shows that controller power is on and it is properly set up for operation. The operator should always check to see that this indicator is on before he starts MRADS operation. If power is on and the indicator is not lit, depress the MANUAL CLEAR button. If the

indicator does not become lit, the service engineer must be called to remedy the situation before operation can commence.

**MANUAL CLEAR.** This pushbutton clears the controller of any errors, causing it to become operable after power is turned on. The operator should depress MANUAL CLEAR after power is turned on and before MRADS operation starts. When the switch has properly cleared the controller of errors, the CONTROLLER OPERABLE indicator is illuminated.

**POWER ON.** This switch is used by the operator to turn on power in the controller unit prior to MRADS operation. The pushbutton is illuminated yellow when power is on. (See Setup Procedure.)

**POWER OFF.** This switch is used by the operator to turn off power in the controller unit when MRADS operation is finished.

**SHIFT REGISTER.** These 21 indicators show the contents of the data buffer, and are only of use to engineering personnel during tests.

**COUNTER 8, 4, 2, 1.** These four indicators show the contents of the operating counter during read or write operations, and are only of use to engineering personnel.

**CONTROL W X Y R.** These four indicators show the status of shift register controls and are only of use to engineering personnel.

**DATA FLOW.** This indicator is illuminated when the controller requires access to memory. It is of no particular interest to the operator.

**INSTRUCTION SEQ. CONTROL A B C.** These three indicators show the status of instruction sequence controls, and are only of use to engineering personnel.

## File Electronics Unit

This unit is connected into the subsystem such that it receives information flowing in either direction between its disc file unit and the controller. Each file electronics unit (see Figure XIII-1) is in a separate cabinet and has its own maintenance panel and control and indicator panel. The unit contains sequencing

and control hardware which governs the operation of the positioning arms and read/write heads in the disc file unit. It tells the disc file unit when to start reading or writing, and determines the record address. Included in its hardware are buffer and storage registers.

The control and indicator panel of the file electronics unit (Figure XIII-7) has three switches and eleven illuminating indicators, described as follows:

**POWER OFF.** This switch turns off power to both the disc and the electronics units and is illuminated red when power is off. The operator uses the switch when he turns off the MRADS subsystem. (See Setup Procedure.)

**POWER ON.** This switch turns on power to both the disc and the electronics units and is illuminated green when power is on. The operator uses the switch when he turns on the MRADS subsystem. (See Setup Procedure.)

**LOGIC ALARM.** This indicator is illuminated yellow when the electronics unit is not turned on (by an internal switch) or is overheating. The operator should notify the service engineer when this indicator remains on.

**DISC ALARM.** This indicator is illuminated yellow when the disc unit is not turned on (by an internal switch) or the disc unit is not rotating at the proper speed. It could also indicate that the disc unit is overheating. If the DISC ALARM light does not go off after six minutes, the service engineer should be notified.

**TEST SWITCH.** This indicator is illuminated yellow when one or more of the test switches on the electronic unit maintenance panel are turned on. Since the maintenance panel is to be used only by service engineering personnel, the service engineer must be called to correct the situation.

**OVER TEMP.** This indicator is illuminated red when the electronics unit becomes overheated. When this happens, the operator should stop MRADS operations and call the service engineer. When the unit becomes sufficiently overheated, operations automatically halt, but the operator should not wait for this to happen.

**OPERABLE.** This indicator is illuminated green to indicate when the necessary power is on and



Figure XIII-7. Control and Indicator Panel of the File Electronics Unit



circuits are clear and ready for operation with the MRADS controller.

**SELECT.** This indicator is illuminated white to indicate when the electronics unit has been selected to receive data.

**ALERT.** This indicator is illuminated white when the electronics unit is alerted to get ready to receive data.

**READY.** This indicator is illuminated white when the electronics unit is ready to receive data from either the controller or the disc unit.

The following four indicators are illuminated red to indicate various error conditions. Each causes MRADS operations to halt. All of these errors require the same operator action.

**ADDRESS ERROR.** This is both a switch and an indicator. It glows red when an error has occurred during the address mode of a MRADS operation. When depressed, it resets the circuitry after any kind of an address error.

**PARITY EVEN.** This indicator glows red when a parity error has occurred.

**INVALID ADDRESS.** This indicator glows red when the program, due to an error, calls for a nonexistent address.

**POSITION ERROR.** This indicator glows red when the positioning arm of the disc unit is not positioned correctly for the address called for by the program.

When any one of the above four indicators comes on and operations halt, the operator must:

1. Depress the ADDRESS ERROR switch on the control and indicator panel of the file electronics unit.
2. Check to see if the CONTROLLER BUSY light on the controller's control and indicator panel is on. If it is, depress the MANUAL CLEAR switch on that panel.
3. To continue MRADS operation, return to a known restart point in the program or branch to a recovery routine.
4. Make a note of which of the four indicators came on so the programmer can be informed of the errors.

## INSTRUCTIONS and MRADS OPERATION

Operation of the MRADS subsystem will be described in its relation to program instructions.

Three instruction words are required for each MRADS seek, read, or write operation. In each case, the first word selects the proper controller and transfers to it the next two words, which specify the exact operation and the address involved.

### The SEEK Function

This function is performed by three instruction words which select the disc unit to be used and position the proper arm over (or under) the tract and sector where reading or writing is to commence. The coding and format of the three instructions follows:

	Operation	Operand	Modification
(1)	SEL	P	
(2)	PRF		F
(3)	OCT	(MRADS address)	

The first instruction (Select Controller Selector Address) selects the controller by its plug number. The plug number (P) is usually zero. Once selected the controller goes into a busy state and awaits the next two words from memory.

SEL															
0 ←				4	5	6	7	8	9	10	←	13	14	←	19
10101	Index			0	0	0	Plug No.			0	1	0	0	0	0

The second instruction (Position MRADS Unit) selects one of the four units. The format of the word is:

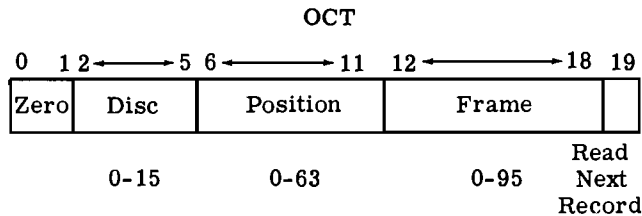
PRF															
0 ←				4	5	6	7	8	← 19						
10101				Unit No				Zero (Not used)							

Bit positions 5, 6 and 7 indicate the unit number by the following code:	5 6 7		
	Unit 0	0	0 1
	Unit 1	0	1 0
	Unit 2	1	1 1
	Unit 3	1	0 0

The third instruction contains the frame address within the particular unit and designates whether or not to read the next sector. The address specifies: which of 16 discs is to be used; which of 64 positions

the positioning arm is to take; and the sector and zone where the first frame will be read or written. The selection of the frame automatically selects the head to read or write. When bit position 19 contains a one, hardware is enabled to read the next sector. (Bit 19 is normally a zero.)

Format of this instruction is as follows:



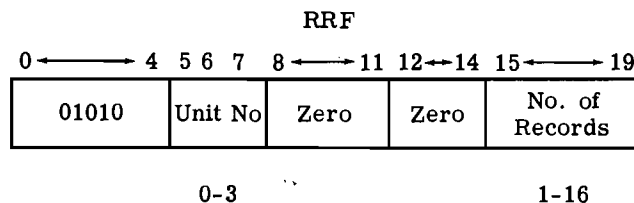
### The READ Function

Before the reading function can be initiated, the three instructions of the SEEK function must already have been executed. Reading is performed by three instruction words which specify the number of frames to be read and the starting address for storage in core memory. The mnemonic coding and format for the words are as follows:

	Operation	Operand	Modification
(1)	SEL	P	
(2)	RRF	N	F
(3)	(blank)	M	

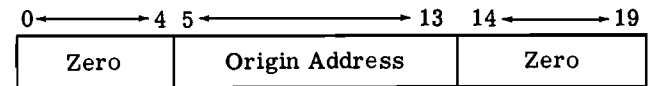
The first instruction selects the controller (P) and is identical to the SEL instruction illustrated as the first word of the SEEK function.

The second instruction (Read MRADS Unit) specifies which of four disc file units is to be used (F on the coding sheet), and the number of frames (N) to be transferred from disc storage to core storage. One READ instruction can transfer a minimum of sixty-four words (one frame) and a maximum of sixteen sixty-four-word frames.



The third instruction specifies the first core memory address (M on the coding sheet) into which information

from the disc file will be stored. The address must be a multiple of  $(64)_{10}$ . The format of the word is as follows:



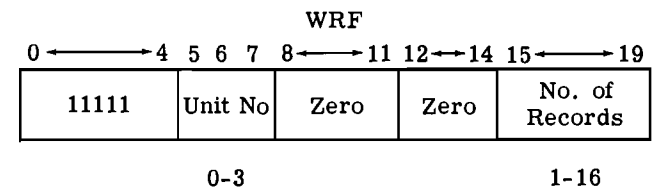
### The WRITE Function

Before the writing function can be initiated, the three instructions of the SEEK function must already have been executed. Writing is performed by three instruction words which specify the number of frames to be written and the starting address in core memory. The mnemonic coding for the words is as follows:

	Operation	Operand	Modification
(1)	SEL	P	
(2)	WRF	N	F
(3)	(blank)	M	

The first instruction selects the controller (P) and is identical to the SEL instruction illustrated in the SEEK function.

The second instruction (Write on MRADS Unit) specifies which of four disc units is to be used (F on the coding sheet), and the number of frames to be transferred from core memory to disc storage. The number of frames (N on the coding sheet) may be from 1 to 16. The format is as follows:



The third instruction specifies the first core memory address (M on the coding sheet) from which information will be written. The address must be a multiple of  $(64)_{10}$ . The format of the word is the same as that of the third word of the read function.

**Checking Features.** Numerous checking features are built into the hardware of the MRADS system. These include the means for making parity checks, timing checks, read after write checks, and address checks. Because these are described in the GE-225 Programming Reference Manual, they will not be described here.

**MRADS Instructions.** The following is a list of instructions which pertain to MRADS operation. The operator who uses the MRADS subsystem will want to be able to identify these octal codes.

<u>Instruction</u>	<u>Mnemonic Code</u>	<u>Octal Code</u>
Position MRADS unit	PRF	2500000
Read after write	RAW	1202000
Read MRADS and drop power	RRD	1201000
Read MRADS file	RRF	1200000
Write MRADS and drop power	WRD	3701000
Write MRADS file	WRF	3700000
Select Controller Address	SEL	2500P20
Controller number P appears in X field	BCS ---, P	****p**
Controller condition 0 false	BCS O&F	2516020
Controller condition 0 true	BCS O&T	2514020
Controller condition 1 false	BCS 1&F	2516021
Controller condition 1 true	BCS 1&T	2514021
Controller condition 2 false	BCS 2&F	2516022
Controller condition 2 true	BCS 2&T	2514022
Controller condition 3 false	BCS 3&F	2516023
Controller condition 3 true	BCS 3&T	2514023
Controller condition 4 false	BCS 4&F	2516024
Controller condition 4 true	BCS 4&T	2514024
Controller condition 5 false	BCS 5&F	2516025
Controller condition 5 true	BCS 5&T	2514025
Branch on I/O buffer correct	BCS BIC	2516025
Branch on I/O buffer error	BCS BIO	2514025
Branch on no error	BCS BNE	2516027
Branch on MRAF not ready	BCS BRN	2516020
Branch on MRAF ready	BCS BRR	2514020
Branch on file correct	BCS FAC	2516031
Branch on file error	BCS FAE	2514031
Branch on file 0 correct	BCS FOC	2516032
Branch on file 0 error	BCS FOE	2514032
Branch on file 0 not ready	BCS FON	2516021
Branch on file 0 ready	BCS FOR	2514021
Branch on file 1 correct	BCS F1C	2516033
Branch on file 1 error	BCS F1E	2514033
Branch on file 1 not ready	BCS F1N	2516022
Branch on file 1 ready	BCS F1R	2514022
Branch on file 2 correct	BCS F2C	2516034
Branch on file 2 error	BCS F2E	2514034
Branch on file 2 not ready	BCS F2N	2516023
Branch on file 2 ready	BCS F2R	2514023

<u>Instruction</u>	<u>Mnemonic Code</u>	<u>Octal Code</u>
Branch on file 3 correct	BCS F3C	2516035
Branch on file 3 error	BCS F3E	2514035
Branch on file 3 not ready	BCS F3N	2516024
Branch on file 3 ready	BCS F3R	2514024
Branch on MRADS parity correct	BCS RPC	2516026
Branch on MRADS parity error	BCS RPE	2514026
Branch on error	BCS BER	2514027

### SETUP PROCEDURE

The following steps must be taken to prepare the mass random access data storage subsystem for operation. (See Table XVIII for a description of controls and indicators used.)

1. Depress the POWER ON pushbutton on the electronic unit's control and indicator panel (will glow green).
2. Depress the following two pushbuttons on the controller's control and indicator panel:

POWER ON (will glow yellow)

MANUAL CLEAR

3. Notice whether the discs in the disc file unit are turning.
4. Wait for the OPERABLE light on the electronic unit's control and indicator panel to glow green. This takes about six minutes. The DISC ALARM light goes off when the OPERABLE light comes on. (First the main drive motor in the disc unit comes on, and after about three minutes, the air compressor comes on. After a delay of another three minutes air pressure causes the read/write heads to be positioned the proper distance from the discs.)
5. Depress the ADDRESS ERROR pushbutton on the control and indicator panel of the electronics unit. (This clears the circuitry of errors.)

When the controller and one or more disc units are operable, the ON LINE indicators on the controller's control and indicator panel will be illuminated to show which of the 1, 2, 3, or 4 units are ready for operation.

The MRADS subsystem is turned off by depressing first the POWER OFF pushbutton on the control and indicator panel of the electronics unit and then POWER OFF on the control and indicator panel of the MRADS controller.



**TABLE XVIII**  
**FUNCTIONS OF CONTROLS AND INDICATORS FOR THE MRADS UNITS**

Location	Control or Indicator	Function
Controller control and indicator panel (Figure XIII - 6)	MRAM 1, 2, 3, 4, indicators	Show by illumination which disc file units are operable.
	Controller BUSY, READ, WRITE indicators	When illuminated, indicate that the controller is busy with a SEEK command (BUSY only is lit) or with a read or write command (BUSY and READ lit or BUSY and WRITE lit).
	MRAM ALARM indicator	When illuminated, indicates that the controller received an error signal from a disc file unit.
	WARNING ALARM indicator	When illuminated, warns the operator that a motor in one of the disc file units is becoming over heated.
	SELECTION ALARM indicator	When illuminated, indicates that the program selected a disc file unit which was not on line.
	PARITY ALARM indicator	When illuminated, indicates a parity error in the record address transmitted to the disc file or in data transmitted or received from the disc file.
	MEMORY ACCESS ALARM indicator	When illuminated, indicates that the controller was denied two successive memory access requests.
	CONTROLLER OPERABLE indicator	When illuminated, shows that controller power is on and controller is cleared of error conditions. If indicator is not lit after power is on, depress the MANUAL CLEAR pushbutton.
	MANUAL CLEAR switch	When depressed, after power is on, clears the controller of any errors. Causes the CONTROLLER OPERABLE indicator to be lit.
	POWER ON switch and indicator	Turns on power to the controller. Glows yellow when power is on.
	POWER OFF switch	Turns off power to the controller.
	SHIFT REGISTER indicators	Are only of use to engineering personnel.
	COUNTER 8, 4, 2, 1 indicators	Are only of use to engineering personnel.
	CONTROL WXYR indicators	Are only of use to engineering personnel.
	DATA FLOW indicator	When illuminated, indicates that the controller requires memory access.

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TABLE XVIII (CONT.)

Location	Control or Indicator	Function
Controller control and indicator panel (cont'd.)	INSTRUCTION SEQ. CONTROL ABC indicators	Are only of use to engineering personnel.
File electronics unit control and indicator panel (See figure XIII - 7)	POWER OFF switch and indicator	Turns off power to disc and electronics units. Is illuminated red when power is off.
	POWER ON switch and indicator	Turns on power to disc and electronics units. Is illuminated green when power is on.
	LOGIC ALARM indicator (yellow)	Indicates when the electronics unit power is not turned on (internally) or unit is overheating.
	DISC ALARM indicator (yellow)	Indicates when the disc unit power is not turned on (internally) or discs are not rotating at the proper speed. Can also indicate overheating of disc unit.
	TEST SWITCH indicator (yellow)	Indicates when one or more of the test switches on the electronic unit's maintenance panel were not in the proper position. These switches are used in maintenance.
	OVER TEMP indicator (red)	Indicates when electronics unit has become overheated. Operation eventually halts.
	OPERABLE indicator (green)	Indicates when necessary power is on and circuits are clear and ready for operation with the MRADS controller.
	SELECT indicator (white)	Indicates when the electronics unit has been selected to receive data.
	ALERT indicator (white)	Indicates when the electronics unit is alerted to get ready to receive data.
	READY indicator (white)	Indicates when read/write heads are positioned and the electronics unit is ready to receive data from the controller or disc unit.
	ADDRESS ERROR switch and indicator (red)	When lit, indicates error in address mode of operation. When depressed, it clears circuitry of all address error conditions.
	PARITY EVEN indicator (red)	Indicates when a parity error has been detected on the disc during a read operation. The computer halts.
	INVALID ADDRESS indicator (red)	Indicates when the program, due to an error, calls for a nonexistent address.

TABLE XVIII (CONT.)

Location	Control or Indicator	Function
File electronics unit control and indicator panel (cont'd.)	POSITION ERROR	Indicates when the positioning arm of the disc unit is not positioned correctly for the address called for by the program.

## ERRORS AND OPERATOR CORRECTIVE ACTION

Table XIX lists numerous error indications which result from operator errors, errors in the program, or faulty equipment. Possible causes for these errors and suggested operator action are also listed. Whenever any of the units do not operate properly and the

cause cannot be readily diagnosed, the operator must notify the service engineer. It is probably not necessary to remind the operator that he should stop MRADS operation by turning off power whenever any unusual noise is heard coming from the disc file unit. The rotating disc file has many mechanically operated parts, and malfunctioning of these parts most likely results in an easily detected noise.

TABLE XIX  
MRADS ERROR CONDITIONS

Error Indication	Possible Cause	Operator Action
The program hangs up and the ECHO ALARM light on the control console is lit.	The program tried to read or write when the MRADS controller was busy	<ol style="list-style-type: none"> <li>1. Set the AUTO/MANUAL switch to MANUAL.</li> <li>2. Depress the RESET ALARM switch.</li> <li>3. Return program to programmer with notification of error.</li> </ol>
	The wrong plug number was addressed by the program	<ol style="list-style-type: none"> <li>1. Set the AUTO/MANUAL switch to MANUAL.</li> <li>2. Depress the RESET ALARM switch.</li> <li>3. Check plug number and compare with plug specified by the programmer in his instructions to the operator.</li> <li>4. Have the service engineer correct the plug if it was wrong.*</li> <li>5. Restart the program at a restart point.</li> </ol> <p>* If plug was as it should be, the error was probably made by the programmer. Return the program to the programmer with proper notification.</p>
WARNING ALARM on the controller control and indicator panel is lit	The motor of the disc file unit has become overheated	Halt MRADS operation immediately and notify the service engineer.
SELECTION ALARM on the controller control and indicator panel is lit	The disc file unit selected was not on line	Check to see if all disc file units had power on and discs are rotating. Turn power on if that is necessary. If equipment appears to be in order and the alarm continues, notify programmer of the alarm condition.

**TABLE XIX (CONT.)**

Error Indication	Possible Cause	Operator Action
LOGIC ALARM on the electronics unit control and indicator panel is lit.	The electronics unit power is not turned on or unit is overheating.	Check status of POWER ON switch on the electronics unit control and indicator panel. If switch was not on, depress it to turn it on. If switch was on, notify the service engineer of the difficulty.
DISC ALARM on the electronics unit control and indicator panel is lit	The disc unit's power is not turned on or discs are not rotating at the proper speed	Notify the service engineer of the difficulty.
TEST SWITCH on the electronics unit control and indicator panel is lit	Test switches on the electronics unit's maintenance panel were left on	Notify the service engineer of the difficulty.
OVER TEMP on the electronics unit control and indicator panel is lit and MRADS operations may automatically halt	The electronics unit has become overheated.	Halt operations by depressing POWER OFF on both the controller and the electronics unit. Notify the service engineer.
ADDRESS ERROR on the electronics unit control and indicator panel glows red	An error occurred during the address mode of a MRADS operation	<ol style="list-style-type: none"> <li>Depress the ADDRESS ERROR switch on the control and indicator panel of the file electronics unit.</li> <li>Check to see if the CONTROLLER BUSY light on the controller's control and indicator panel is on. If it is, depress the MANUAL CLEAR switch on that panel.</li> <li>To continue MRADS operation, return to a known restart point in the program or branch to a recovery routine.</li> <li>Make a note of which of four indicators came on and notify the programmer of the error indications.</li> </ol>
PARITY EVEN on the electronics unit control and indicator panel glows red	A parity error has occurred	
INVALID ADDRESS on the electronics unit control and indicator panel glows red	The program called for a nonexistent address	
POSITION ERROR on the electronics unit control and indicator panel glows red	The positioning arm of the disc unit is not positioned correctly for the address called for by the program	