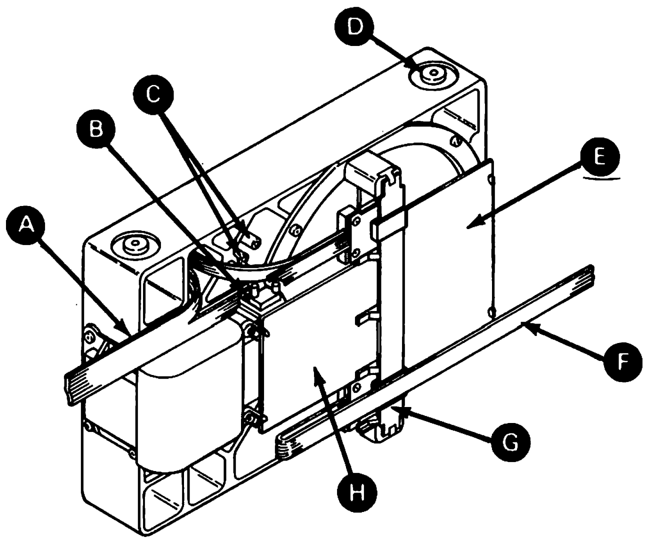
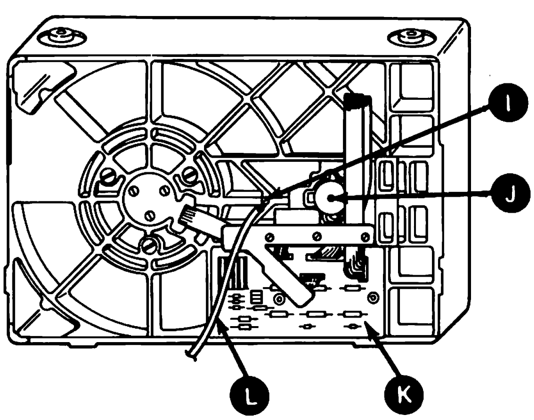
6004 Locations

Direct access storage device (DASD) (Version A1 and Version A2)

- **A** DASD dc power cable
- **B** Head flex cable
- **C** Head flex cable stowing holes
- **D** Shock mounts (1 of 4)
- **E** Digital card (01B A1 A2)
- **F** DASD signal cable
- **G** Maple connector block
- **H** Analog card (01B B1 A3)
- **I** Ground point
- **J** Head-lock solenoid
- **K** Motor/actuator card (01B C1 A1)
- **L** Ground cable



Front view

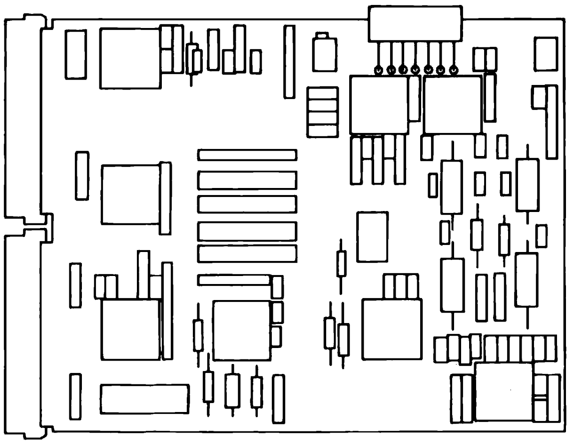


Rear view

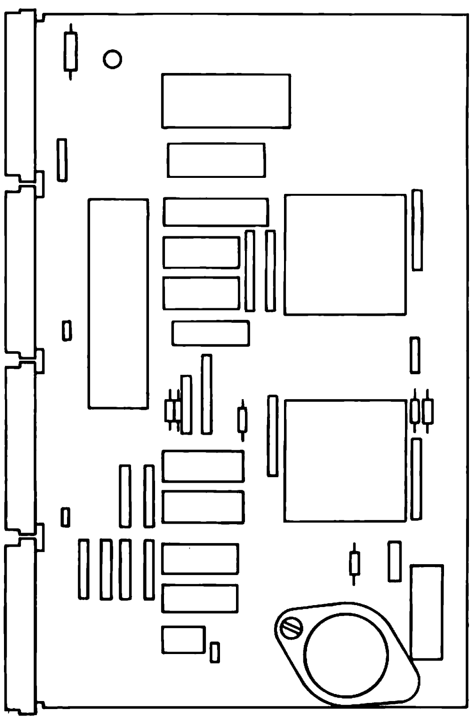
Maintenance procedures

6005 Locations--card diagrams (continued)

Analog card (01B B1 A3)

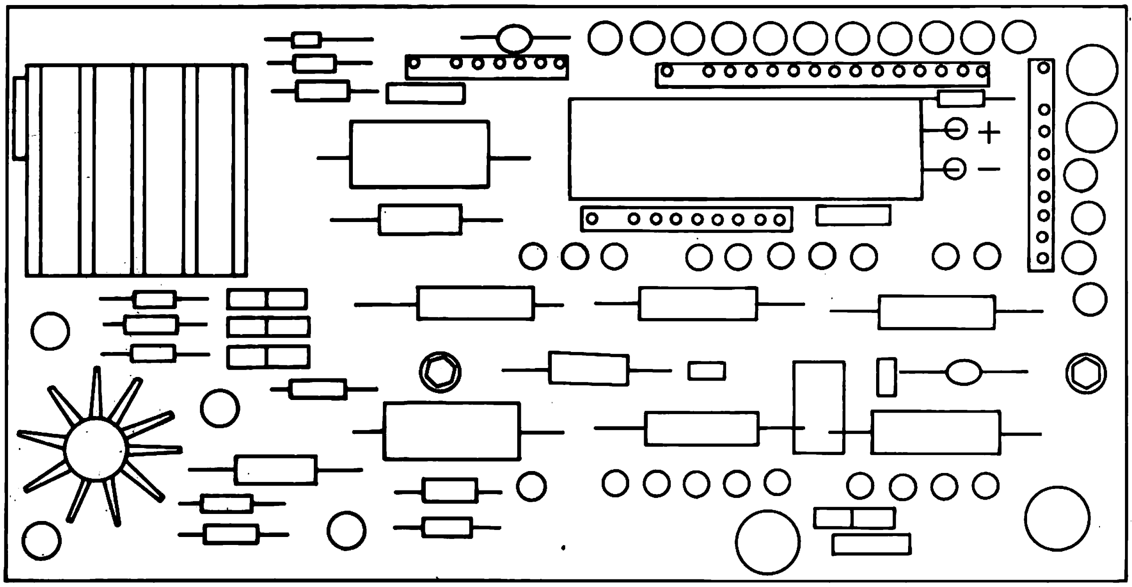


Digital card (01B A1 A2)



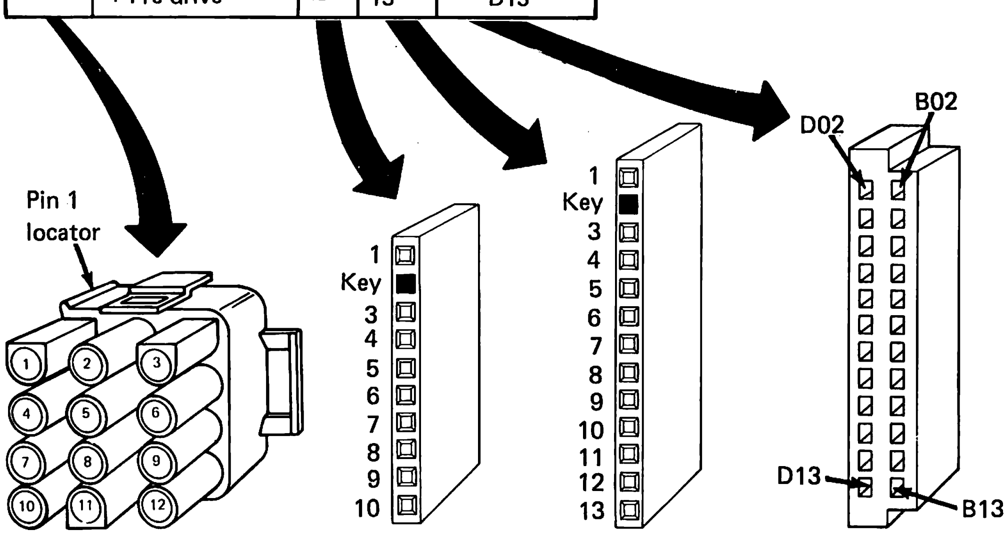
Note: The outline shapes of the card diagrams identify each card in the 5247. The exact location of the components and the number of components shown on each card may differ for your system.

Motor/actuator card (01B C1 A1)



D DASD dc power cable

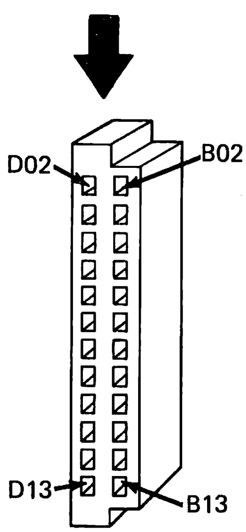
Power supply P7 Pin	Line name	Motor/actuator card P1 Pin	Motor/actuator card P2 Pin	Maple connector block B1A5 Pin
1	+5 Vdc	–	–	B02
1	+5 Vdc	–	–	B03
2	+5 Vdc	–	–	B04
2	+5 Vdc	–	–	B05
3	+5 Vdc	9	–	B10
4	Ground	–	–	B06
4	Ground	–	–	B07
5	Ground	–	–	B08
5	Ground	–	–	B09
6	Ground	–	–	B11
6	Ground	–	–	B13
7	Ground	3	–	–
7	Ground	4	–	–
8	Ground	6	–	–
8	Ground	8	–	–
9	–5 Vdc	10	–	B12
10	+24 Vdc	5	–	–
11	+24 Vdc	7	–	–
12	+24 Vdc	1	–	–
–	+ Hall 2	–	1	D02
–	+ Hall 1	–	3	D03
–	– Phase 1	–	4	D04
–	– Phase 2	–	5	D05
–	– Phase 3	–	6	D06
–	– Phase 4	–	7	D07
–	Logic ground	–	8	D08
–	+ Overcurrent	–	9	D09
–	– Host POR	–	10	D10
–	+ Actuator unlock	–	11	D11
–	– Pre drive	–	12	D12
–	+ Pre drive	–	13	D13

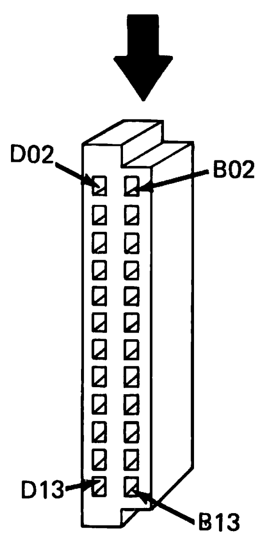


F DASD signal cable

Disk attachment card | **Maple connector block**

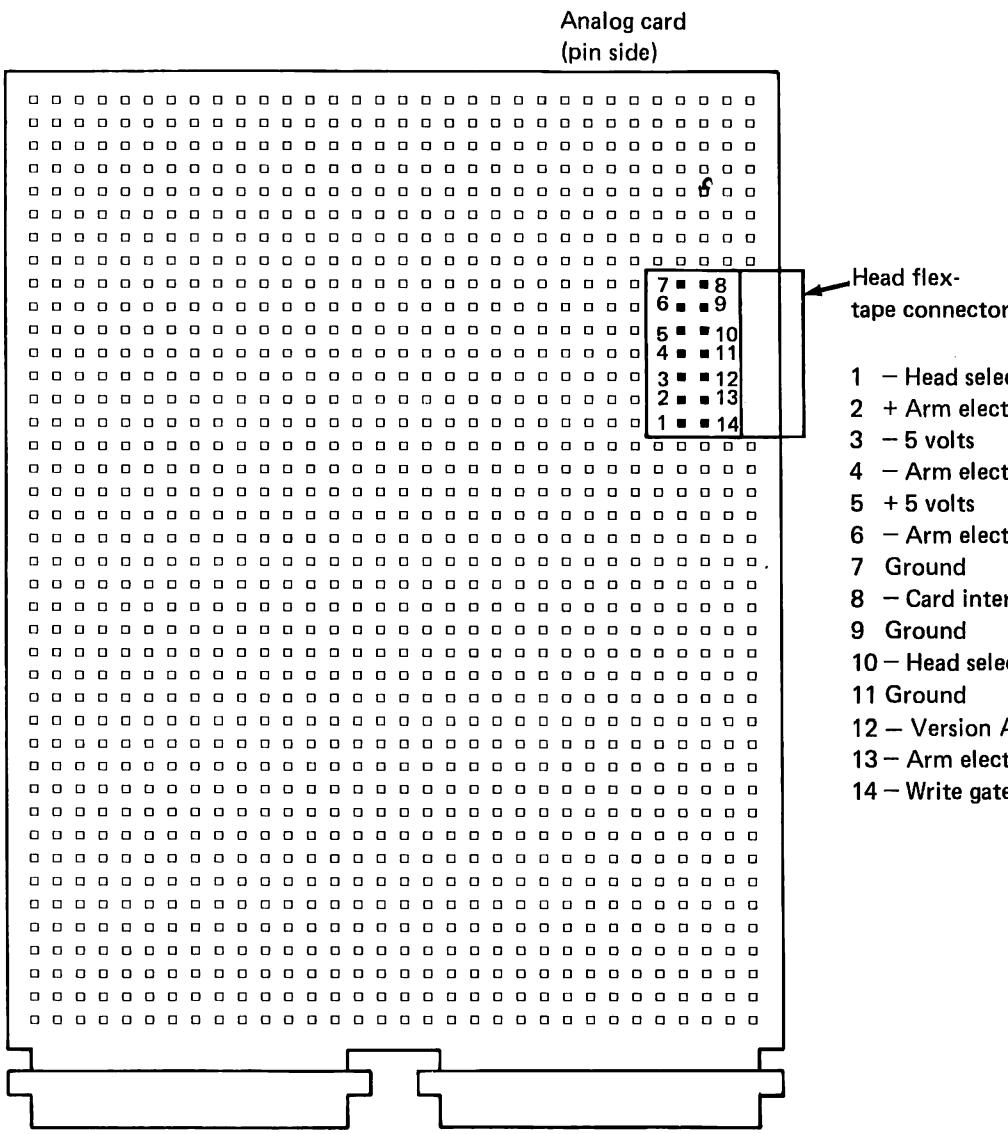
J12 Pin	Line name	Signal direction	B1A2 Pin
B02	– Command mode	→	D02
B03	Data bus 0	↔	D03
B04	Data bus 1	↔	D04
B05	Data bus 2	↔	D05
B06	Data bus 3	↔	D06
B07	Data bus 4	↔	D07
B08	Data bus 5	↔	D08
B09	Data bus 6	↔	D09
B10	Data bus 7	↔	D10
B11	– Register select 0	→	D11
B12	– Register select 1	→	D12
B13	– Cable interlock (to DASD)	→	D13
D02	– Cable interlock (from DASD)	←	B02
D03	+5 Vdc sense	←	B03
D04	– Command valid	→	B04
D05	– Command received	←	B05
D06	– Disk ready	←	B06
D07	20 MHz to disk	→	B07
D08	Ground	— —	B08
D09	– Write select to disk	→	B09
D10	– Read/write data	↔	B10
D11	+ Read/write data	↔	B11
D12	– Attachment reset to disk	→	B12
D13	– Odd parity	→	B13



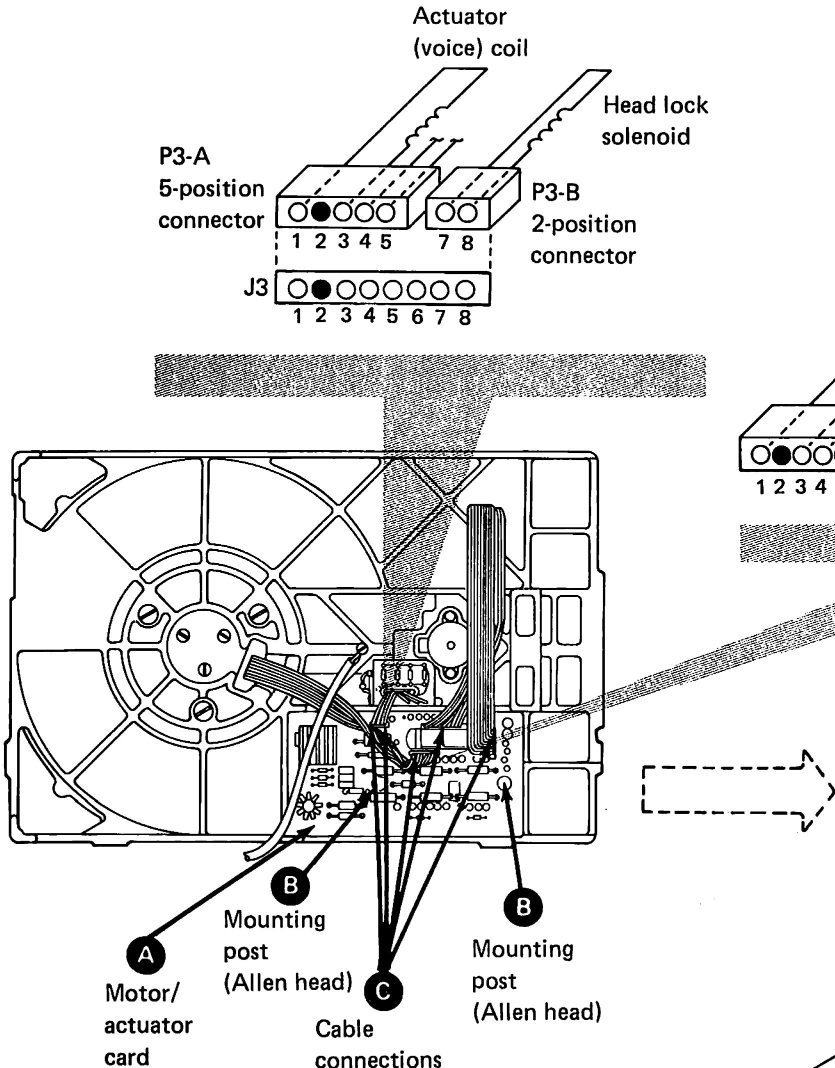


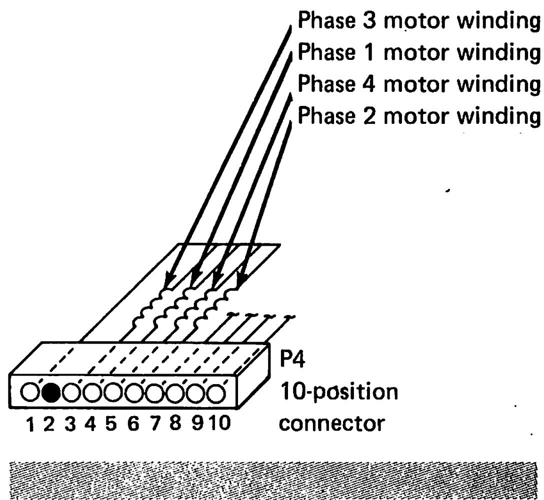
6190 Analog card (continued)

CE test points

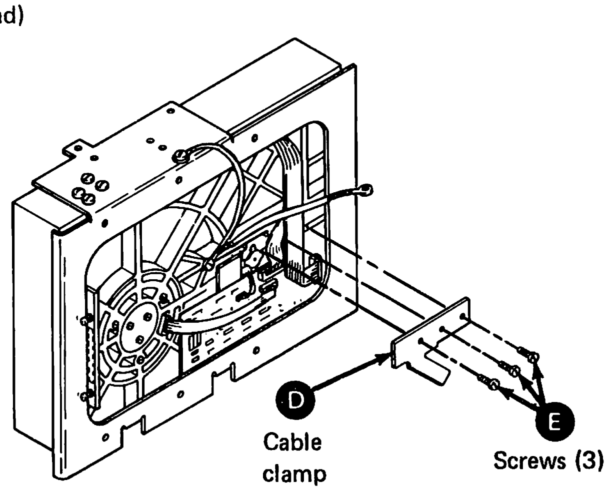


1 – Head select A
2 + Arm electronics R/W data
3 – 5 volts
4 – Arm electronics module error
5 + 5 volts
6 – Arm electronics module enable
7 Ground
8 – Card interlock
9 Ground
10 – Head select B
11 Ground
12 – Version A2
13 – Arm electronics R/W data
14 – Write gate





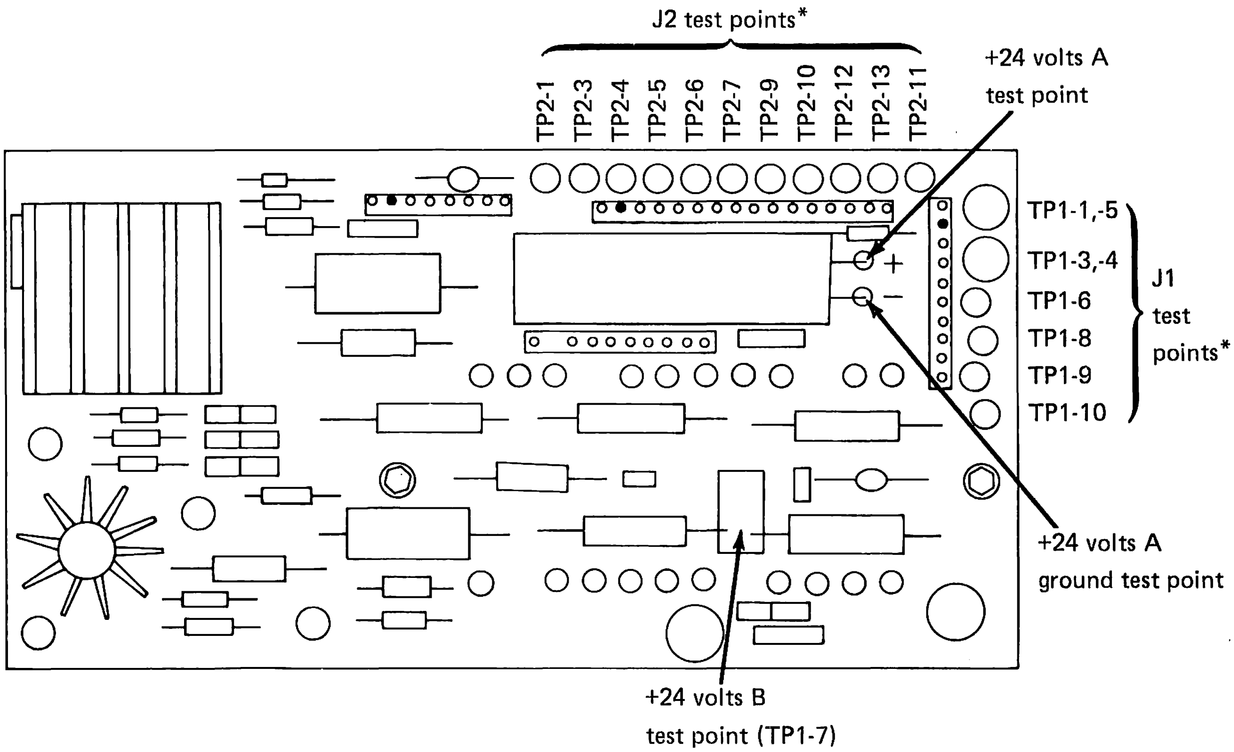
Note: In this figure, the cable clamp **D** located at the top of the motor/actuator board has been removed.



Maintenance procedures

6210 Motor/actuator card (continued)

CE test points



J1 Connector (System power)

Pin	Function	*TP
10	–5 volts	TP1-10
9	+5 volts	TP1-9
8	Logic ground (power supply ground)	TP1-8
7	24 volts B	TP1-7
6	24 volts B ground	TP1-6
5	24 volts A	TP1-5
4	+24 volts A ground	TP1-4
3	+24 volts A ground	TP1-3
2	Key	–
1	+24 volts A	TP1-1

J2 Connector (Drive cable)

Pin	Function	*TP
16	Logic gnd for CE use	–
15	Not used	–
14	Not used	–
13	+ Actuator predrive	TP2-13
12	– Actuator predrive	TP2-12
11	+ Actuator unlock	TP2-11
10	– Power on reset (POR)	TP2-10
9	+ Overcurrent	TP2-9
8	Logic ground	–
7	– Phase 4	TP2-7
6	– Phase 3	TP2-6
5	– Phase 2	TP2-5
4	– Phase 1	TP2-4
3	+ Hall sensor 1	TP2-3
2	Key	–
1	+ Hall sensor 2	TP2-1

J3 Connector (Actuator and head lock solenoid)

Pin	Function
1	Actuator drive
2	Polarized plug
3	Actuator drive
4	Gain adjustment
5	Logic ground
**6	Not used
7	– Pick/hold head lock
**8	+ Pick/hold head lock

J4 Connector (Motor)

Pin	Function
10	+ 5 volts
9	+ Hall sensor 2
8	+ Hall sensor 1
7	Logic ground
6	– Phase 2 drive
5	– Phase 4 drive
4	– Phase 1 drive
3	– Phase 3 drive
2	Key
1	+ 24 volts A

*TP is a test point
**J3-6 and J3-8 are common.

Maintenance procedures

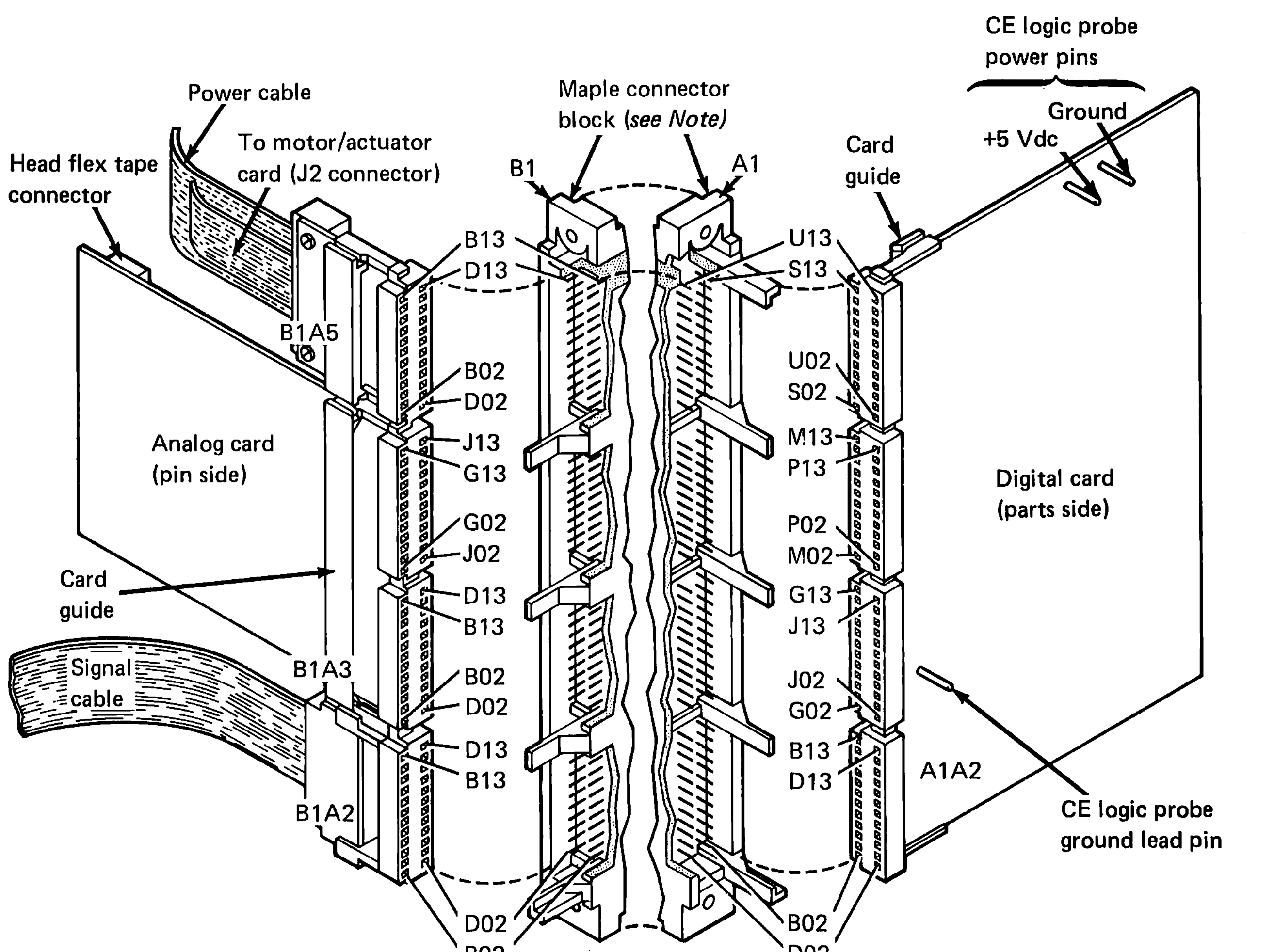
6220 Maple connector block

Removal

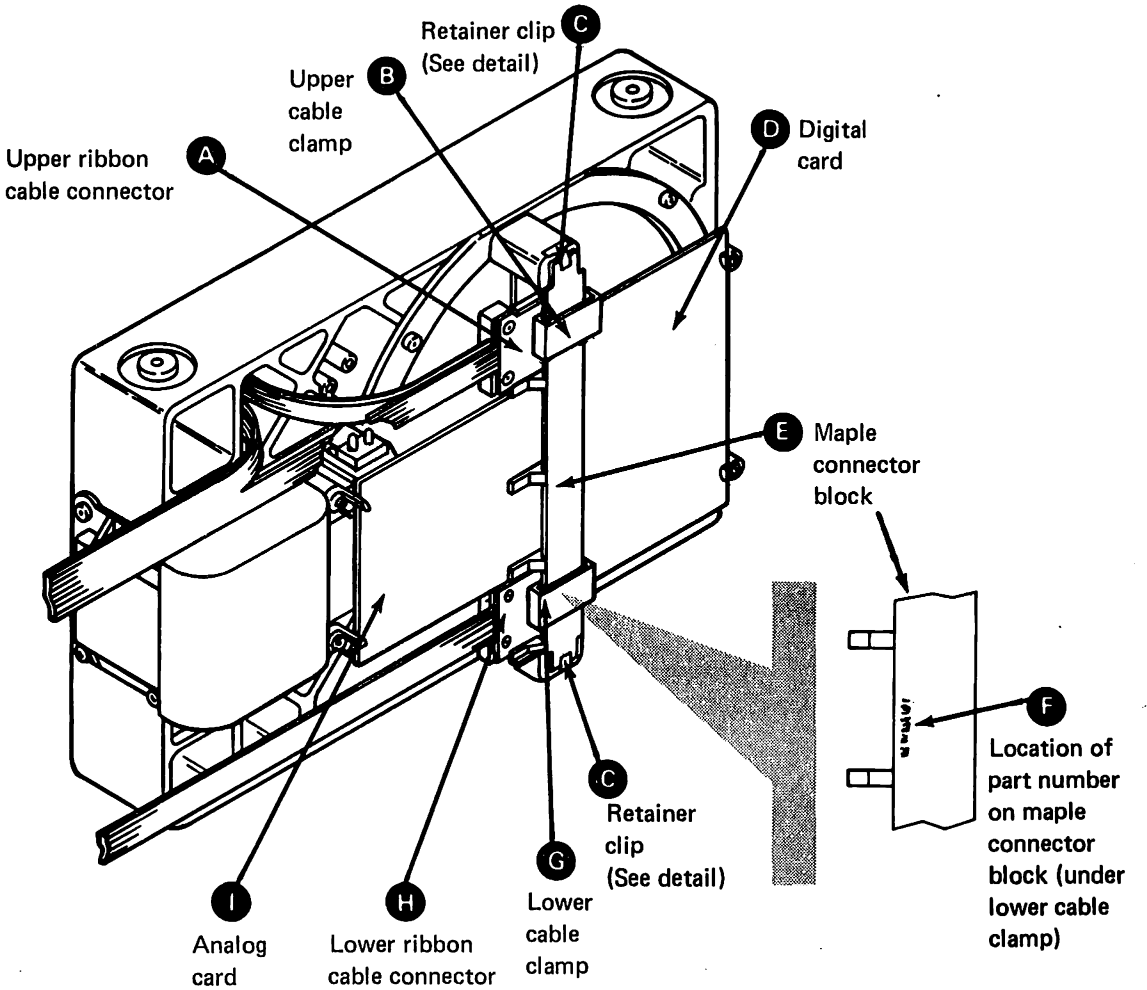
1. Switch off the 5247 power and wait until the Power indicator goes off.
2. Place the DASD in the Service position (6180).
3. Remove the upper cable clamp **B** and disconnect the upper ribbon cable connector **A**.
4. Remove the lower cable clamp **G** and disconnect the lower ribbon cable connector **H**.
5. Remove the analog card **I** (6190).
6. Remove the digital card **D** (6200).
7. Pry off the two retainer clips **C** with a small flat-blade screwdriver, then remove the maple connector block **E**.

Replacement

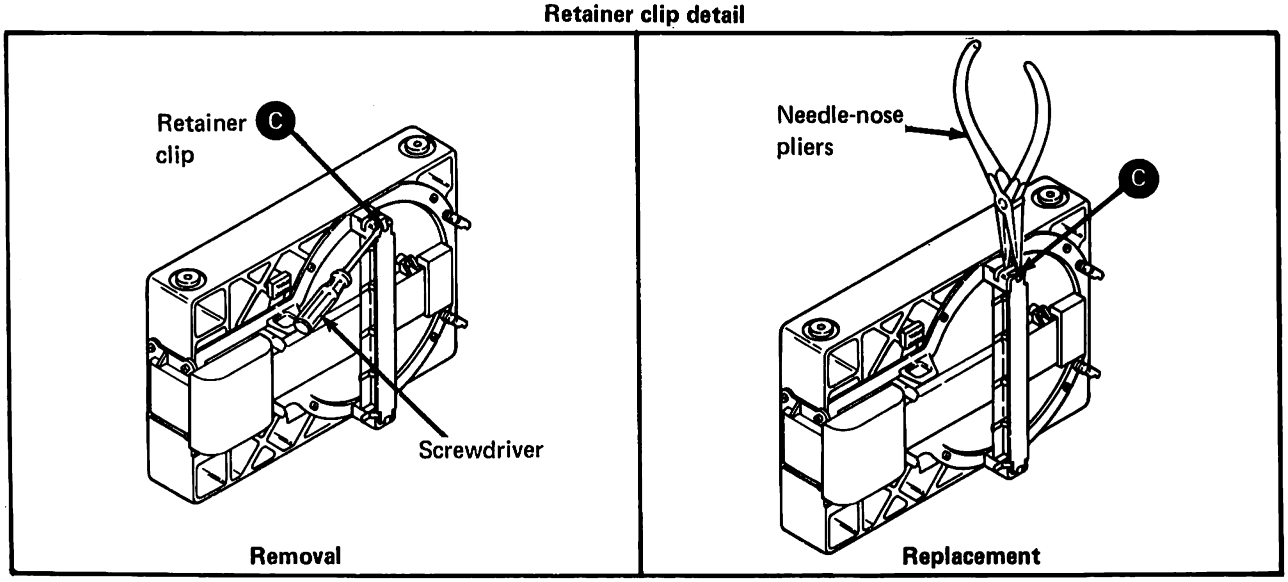
1. Locate the part number **F** on the maple connector block **E**. Insert the block into the casting with the part number facing out and toward the analog card **I** as shown in the figure.
2. Hold the maple connector block in place with the two retainer clips **C**. Use needle-nose pliers to fasten the clips in place.
3. Install the digital card **D** (6200).
4. Install the analog card **I** (6190).
5. Connect the lower ribbon cable connector **H** and install the lower cable clamp **G**.
6. Connect the upper ribbon cable connector **A** and install the upper cable clamp **B**.
7. Install the DASD in the 5247 enclosure (6180).



Note: The maple connector block is one piece; it is shown separated into two pieces for illustrative purposes only.



Retainer clip detail



Maintenance procedures

6240 Shock mounts

Removal

1. Switch off the 5247 power and wait until the Power indicator goes off.
2. Place the DASD **E** in the Service position (6180).
3. Disconnect the enclosure ground strap **P** by removing the screw **R** and the lockwasher **S**.
4. On the top surface of the DASD, loosen the two screws **A** and remove the other two screws **B**; then, slide the ribbon cable out of the two cable clamps **C**.
5. Remove the cable clamp **M** and disconnect the cable connector **N**. Move the ribbon cable out of the work area.

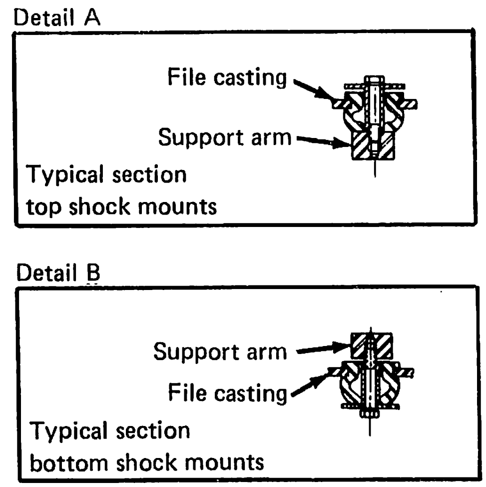
   Warning: Care must be taken to prevent damage to the DASD when it is not installed in the normal shock mounts.

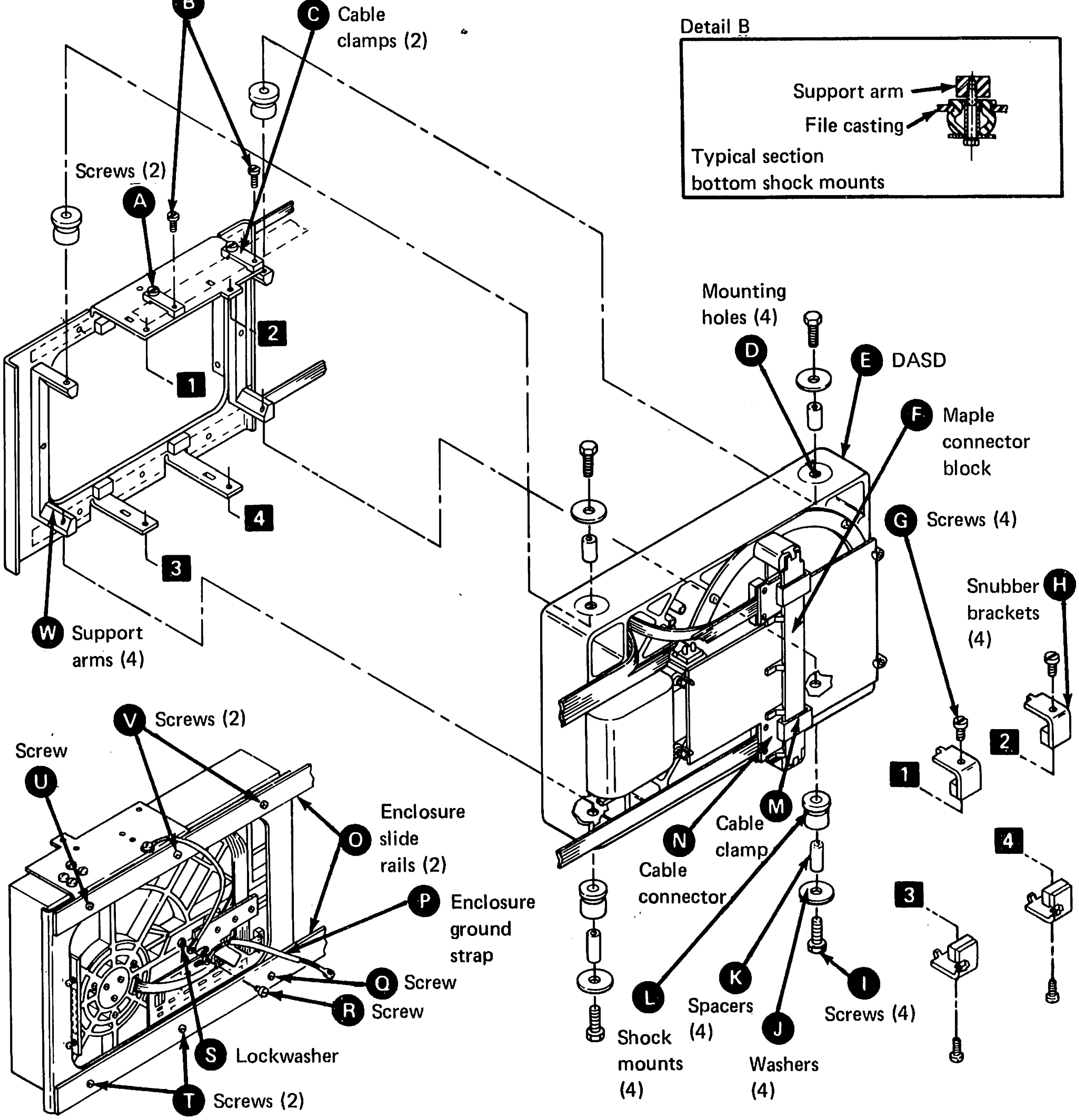
   Note: The DASD weighs 7.3 kg (16.1 lb) and can be lifted by one person.
6. Remove the four screws **V** and **T**.
7. Give support to the DASD and remove the screw **Q**; let the rear edge of the DASD gently rest on the enclosure. Note this position of the DASD for replacement.
8. While still supporting the DASD, remove the last screw **U** that holds the DASD to the enclosure slide rails **O**. Carefully place the DASD on a flat surface.
9. Remove the four screws **G** and remove the four snubber brackets **H**.
10. Remove the four screws **I** and the four washers **J** from the shock mounts **L**; separate the DASD from the four support arms **W**.
11. Grasp the round end of each shock mount **L** and pull the shock mount out of its mounting hole **D**.
12. Remove the spacer **K** from the center of each shock mount.

Replacement

1. With the DASD **E** on a flat surface and the maple connector block **F** facing up, insert the shock mount **L** into the mounting hole **D** with the round end of the shock mount facing down as shown. The flat portion of the shock mount should extend through the mounting hole as shown in Details A and B.
2. Repeat step 1 for the remaining three shock mounts.
3. Place the DASD onto the four support arms **W** so that the holes through the center of the shock mounts are aligned with the holes through the support arms.
4. Insert spacer **K** into the center of one of the shock mounts. Then install the washer **J**, and insert the screw **I** through the hole in the shock mount; finger-tighten the screw **I**.
5. Repeat step 4 for the remaining three shock mounts. Then, tighten the four screws **I**.
6. Install the four snubber brackets **H** and the four screws **G**.
7. While resting the rear edge of the DASD on the enclosure, lift the front of the DASD to align its top-front mounting hole with the hole in the top enclosure slide rail. Insert and finger-tighten the screw **U**.
8. Lift up the rear of the DASD and install the screw **Q**.
9. Install the four screws **V** and **T**; tighten the six screws **Q**, **T**, **U**, and **V**.
10. Connect the cable connector **N** and install the cable clamp **M**.
11. Insert the ribbon cable under the two cable clamps on the top surface of the DASD. Install the two screws **B** and tighten the four screws **A** and **B**.
12. Run the enclosure ground strap **P** between the DASD and the enclosure frame, then attach the enclosure ground strap to the DASD with the screw **R** and the lockwasher **S**.
13. Install the DASD in the 5247 enclosure (6180).

Note: Symbols **1**, **2**, **3**, and **4** are used to show where each of the four snubber brackets **H** attach to the support frame.





Introduction (continued)

Specifications

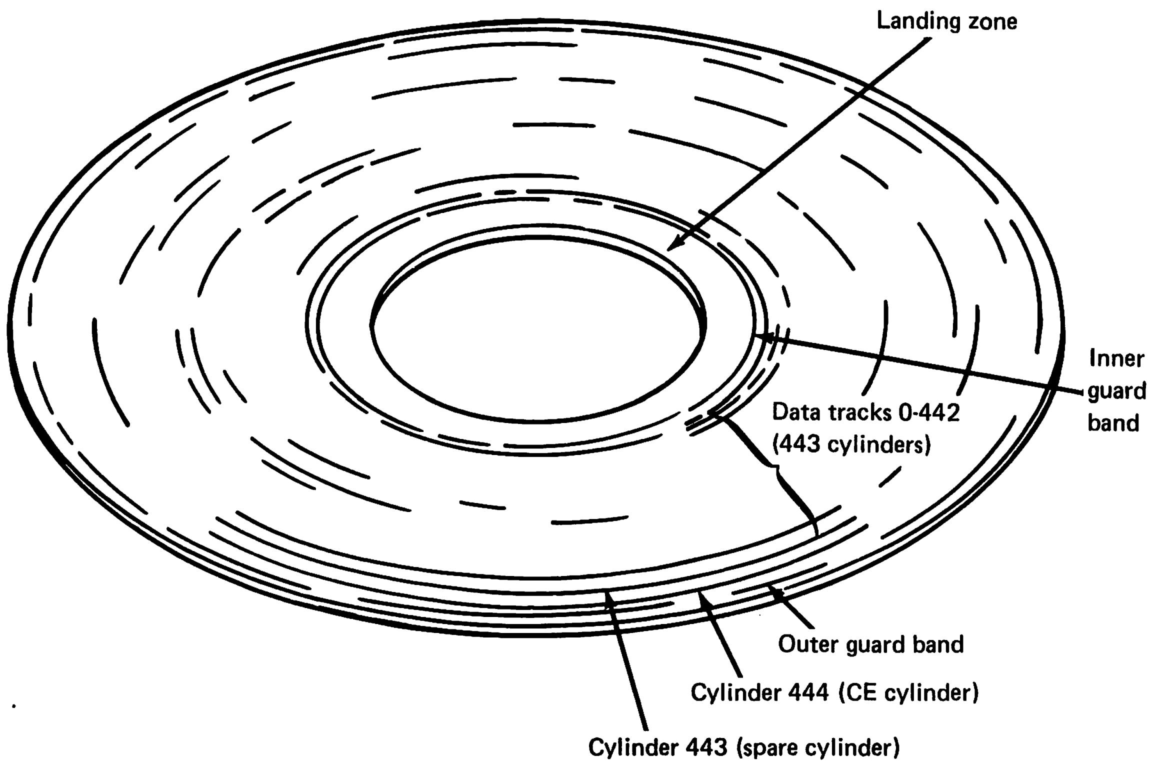
Functional

Storage capacity	
Model 11	15.4 Mbytes
Model 12	30.8 Mbytes
No. of read/write heads	
Model 11	2
Model 12	4
Cylinders, total	445
Data cylinders	443
Customer engineer (CE) cylinder	1
Spare cylinder with defect map	1
Tracks per cylinder	
Model 11	2
Model 12	4
Sectors per track	
Usable sectors	68
Spare sectors	2
Bytes per sector	
Total bytes	340
Data bytes	256
Data bytes per track (maximum)	17,408
Data bytes per cylinder (maximum)	
Model 11	34,816
Model 12	69,632
Rotational speed	3151 (±6.9) rpm
Time of rotation	19 (±0.04) ms
Average rotational delay (or latency)	9.52 ms
Average access time (without latency)	40 ms
Average single track access (without latency)	7 ms
Data transfer rate	
To or from link	1 Mbit, max.
On and off disk (instantaneous)	1.25 Mbytes

Disk surface format

Note: The Model 11 disk unit contains a Version A1 direct access storage device (DASD) and the Model 12 disk unit contains a Version A2 DASD. The Version A1 DASD has one operational disk, two read/write heads, and a storage capacity of 15.4 megabytes. The Version A2 DASD has two operational disks, four read/write heads, and a storage capacity of 30.8 megabytes.

Each side of a disk surface has a landing zone, an inner guard band, an outer guard band, and a data area. The landing zone provides an area for the read/write heads to rest during a start-up or a power-down cycle. The inner guard band is a buffer area between the data area and the landing zone. The outer guard band is a buffer area between the data area and the outer stop of the actuator. The data area is the portion of the disk on which information is written; it is divided into cylinders, tracks, and sectors.



Disk surface format (continued)

Tracks

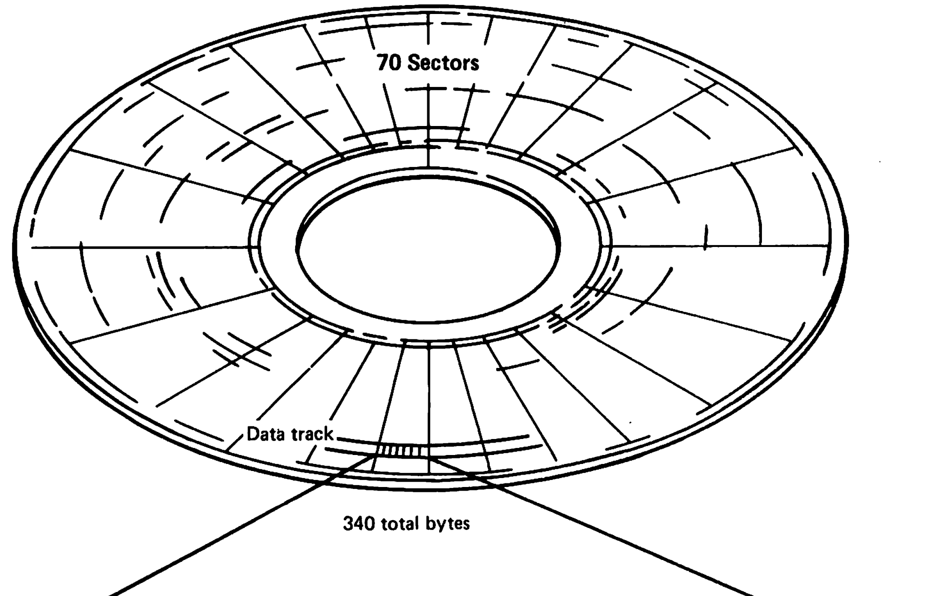
A track is a circular path on a disk that passes under a single data head in one revolution of the disk. The tracks form a series of concentric circles. Each side of a disk contains 445 tracks in the data area. The Version A1 direct access storage device (DASD) has two tracks per cylinder, and the Version A2 has four tracks per cylinder.

Cylinders

A cylinder consists of either two or four tracks (one on each side of each disk) that can be read or written without moving the position of the read/write heads. There are 445 cylinders in the data area; 443 of these cylinders are for reading and writing data; one cylinder is reserved for customer engineering use, and one cylinder includes the surface defect map and off-track alternate sector assignments. The cylinders are numbered 0 through 444, with cylinder 0 located nearest to the center of the disk.

Sectors

Each track on the disk is divided into 70 equally spaced parts, which are named sectors. Each sector is individually addressable, and provides storage for one 256-byte data field. Additional bytes provide for disk address identification, write recovery, synchronization, and error correction coding. Data storage uses 68 of the available 70 physical sectors on each track. The remaining two sectors are reserved, and are used as replacements for sectors that become defective. These two sectors are not used for storing data until they are assigned as alternate sectors during the defect mapping or in response to a user defect.



A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
11	18	1	17	1	1	3	2	3	17	1	256	6	1	2
Write recovery field	Servo field	Start write gap	ID VFO sync bytes	Sync byte	Flag byte	Address	CRC	R/W decision field	Data VFO sync bytes	Sync byte	Data	ECC	End write gap	Mis-reg

Write recovery field (A); Servo field (B); Write recovery field and Servo field: Written at the factory only

ID VFO sync field (D, E)

Sector ID field (F, G, H)

Data VFO sync field (J, K)

Data field (L, M)

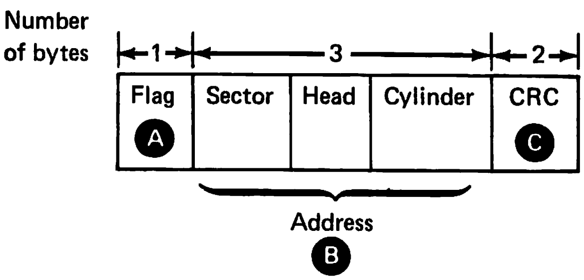
- **A** Write recovery field—allows the read circuits to recover after a write operation in the preceding sector.
- **B** Servo field—provides sector timing and actuator position information.
- **C** Start write gap—allows for write turn-on.
- **D** ID VFO sync bytes—permits the VFO to synchronize with the sector ID data read from the disk.
- **E** Sync byte—completes the VFO synchronization field and identifies the next character as the first sector ID character.
- **F** Flag byte—indicates the surface condition of the disk for the sector.
- **G** Address—indicates the logical address of the sector and identifies the head and the cylinder.
- **H** CRC—ensures valid sector ID information.
- **I** R/W decision field—allows time for read-to-write turnaround.
- **J** Data VFO sync bytes—permits the VFO to synchronize with the data read from the disk.
- **K** Sync byte—completes the VFO synchronization field and identifies the next character as the first data character.
- **L** Data—contains 256 bytes of data.
- **M** ECC—verifies the data **L** is correct.
- **N** End write gap—allows for write turn off.
- **O** Misregistration—permits the data area **L** to increase in size because of motor speed and clock frequency tolerances.

Disk surface format (continued)

Sector format

A sector is the addressable unit on the disk surface. Each sector contains a sector identification (ID) field and a 256-byte data field. Before the data field can be accessed, the sector ID field must be read to verify that the correct sector has been found.

Sector ID field format. The sector ID field is six bytes long. Each sector on the disk has a unique ID field, which has the following format:



(A) Flag. The flag byte indicates the surface condition of the sector on the disk. The following listing gives the description of each bit when it is at an up level:

Bit No.	*Description*
0 (MSB)	Not used; this bit should always be at a down level.
1	Not used; this bit should always be at a down level.
2	Indicates that this sector has a user defect.
3	Indicates that the logical sector normally in this physical location is displaced, pushed down, two sectors.
4	Indicates that the logical sector normally in this physical location is displaced, pushed down, one sector.
5	Indicates that this sector has been moved off-track.
6	Indicates that this sector has a defect. The first two (primary) defects will have the address of sectors 68 and 69, with 68 being used first. Secondary defects have the address of the alternative sector.
7 (LSB)	Indicates that this sector is a secondary alternative sector. This sector is a replacement for another sector that has more than two defects on another track.

B Address. The three address bytes indicate the logical address of the sector. Encoded within these bytes are the sector number, the head address, the cylinder number, and the relocation assignment of the sector ID field as a result of a surface defect. The relocation assignment of the sector ID field to a usable portion of the same sector is named an extension. One extension relocates the sector ID field 64 bytes later in the sector. Two extensions relocate the sector ID field 128 bytes later in the sector.

Byte	Bit No.	Bit Level	Bit Value	Function
1	0 (MSB)	Down	–	Not used
	1	Up	64	Sector number
	2	Up	32	
	3	Up	16	
	4	Up	8	
	5	Up	4	
	6	Up	2	
	7	Up	1	
2	0 (MSB)	Up	–	128 bytes (2 extensions)
	1	Up	–	64 bytes (1 extension)
	2, 3	Down	–	Spare
	4	Up	2	Head address
	5	Up	1	
	6	Down	–	Spare
	7	Up	256	Cylinder number
3	0 (MSB)	Up	128	
	1	Up	64	
	2	Up	32	
	3	Up	16	
	4	Up	8	
	5	Up	4	
	6	Up	2	
	7	Up	1	

On a sector marked defective (by bit 6 of the flag byte being at an up level), the first two bits (0 and 1) of byte 2 indicate which area of the sector is defective. With both of these bits at a down level, the data area is defective and the sector ID field is written in the normal position. With bit 1 at an up level and bit 0 at a down level, the normal sector ID field area is defective, and this information is written 64 bytes later (1 extension). When bit 0 is at an up level and bit 1 is at a down level, part of the normal sector ID field area and part of the data area are defective, and the sector ID field is written 128 bytes later (2 extensions).

C Cyclic redundancy check (CRC). The two CRC bytes are used to ensure valid sector ID address information. During a write operation, the four bytes of the flag and the address fields are used to generate two CRC bytes. The generated CRC bytes are then written on the disk. During a read operation, the four bytes of the flag and the address fields are once again used to generate a second group of CRC bytes. The second group of CRC bytes is then compared with the CRC bytes read from the disk. If the bytes are not the same, an error is indicated, and normal read/write operations are not permitted for that sector.

Data field. The data field consists of a 256-byte data area, followed by a 6-byte error correction code (ECC).

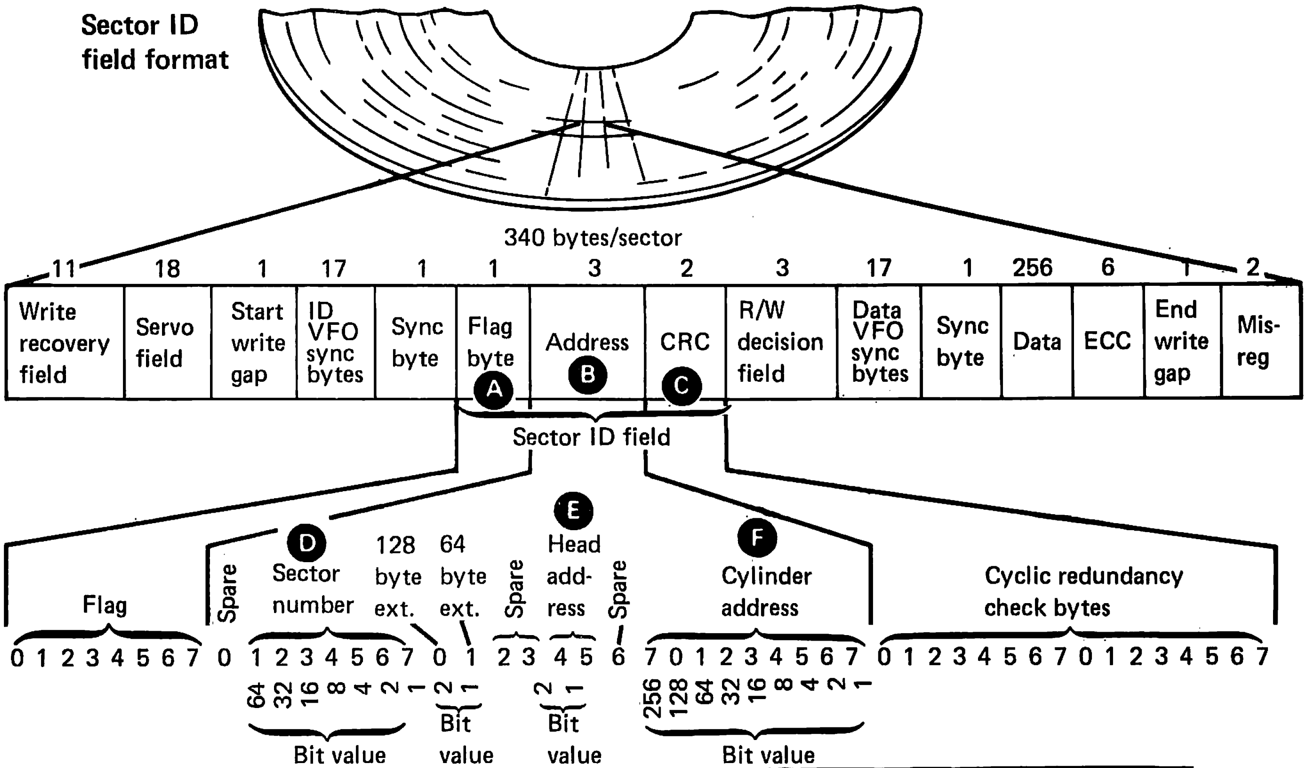
Data area. Work station records are stored in the data areas of the sectors. These records are arranged in a block size of 512 bytes, which is twice as large as the 256-byte sector size of the disk. A microprogram within the 5247 masks the 256-byte sector size from the work station, and lets data be read or written in two contiguous logical sectors, providing a storage capacity of 512 bytes.

If a record is less than 512 bytes, the remainder of the data field is padded with zeros before the error correction code bytes are written. If a record is longer than 512 bytes, it is written over as many blocks as are required to store the complete record.

Error correction code (ECC). The ECC is 6 bytes long. It verifies that the data read in the 256-byte data area that immediately precedes the ECC is correct. After reading a data field and its ECC, a 6-byte syndrome remains which contains information necessary to locate and correct an error in the data area. This syndrome permits correction of:

- Any one error burst that is less than 9 bits
- Up to a 16-bit error burst that is within a 2-byte boundary.

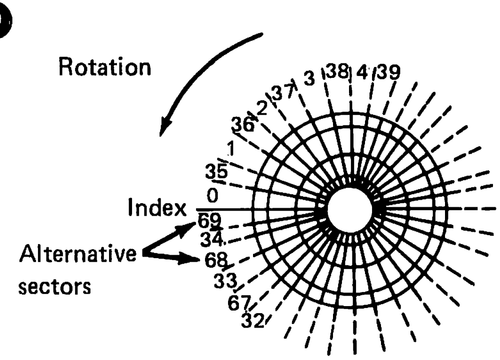
Disk surface format (continued)



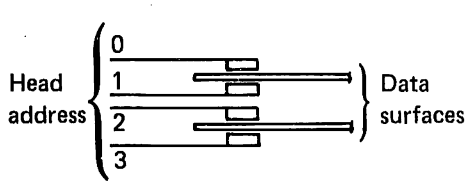
A **Flag byte**

Bit	Description
0 (MSB)	Not used
1	Not used
2	Sector has a user defect.
3	Logical sector normally here is 2 sectors later.
4	Logical sector normally here is 1 sector later.
5	Sector moved off track.
6	Sector has defect.
7	Secondary alternative sector

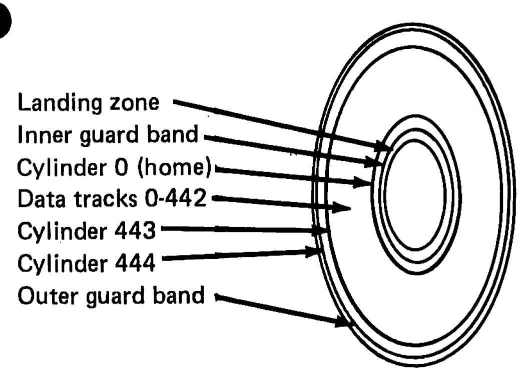
D



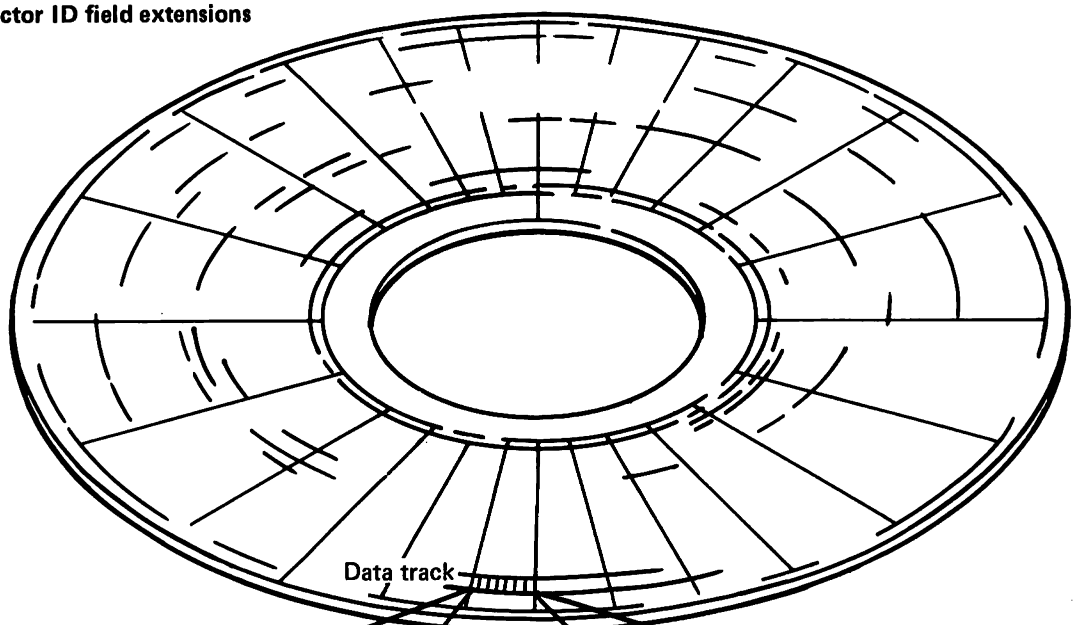
E



F



Sector ID field extensions



340 total bytes

11	18	1	64	17	1	1	3	2	219	1	2	
Write recovery field	Servo field	Start write gap	1 Extension	ID VFO sync bytes	Sync byte	Flag byte	Address	CRC	Fill	End write gap	Mis-reg	One extension

Write recovery field, Servo field — Written at the factory only

ID VFO sync field

ID field

340 total bytes

11	18	1	128	17	1	1	3	2	155	1	2	
Write recovery field	Servo field	Start write gap	2 Extensions	ID VFO sync bytes	Sync byte	Flag byte	Address	CRC	Fill	End write gap	Mis-reg	Two extensions

Write recovery field, Servo field — Written at the factory only

ID VFO sync field

ID field

Disk surface format (continued)

Physical sectors and logical sectors

An index code, written on each track in the dedicated servo field, identifies the beginning of all tracks for a specific cylinder. When the index code is read, the DASD generates an index pulse. After each revolution of the disk, the index pulse occurs instead of a sector pulse for the first physical sector (sector 0). All index codes on the disk surfaces are aligned vertically.

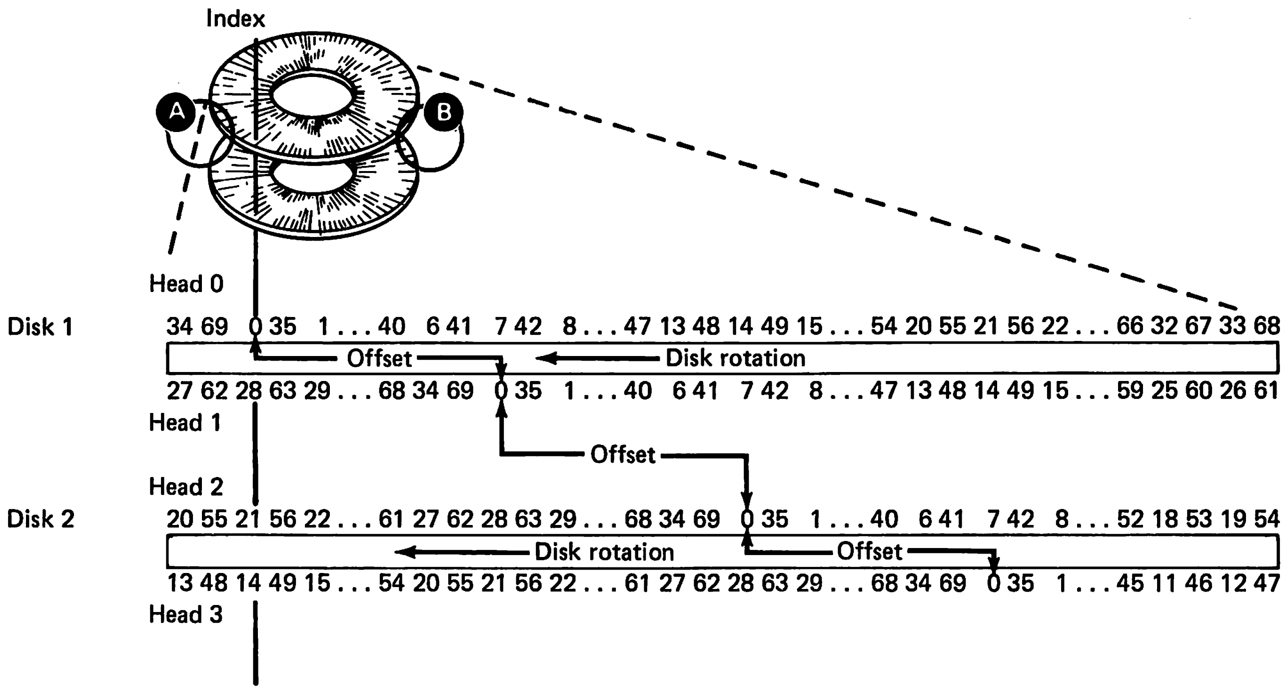
Because of sector number interleaving and head-switch timing, the logical sector number assignments are not necessarily the same as their physical location assignments.

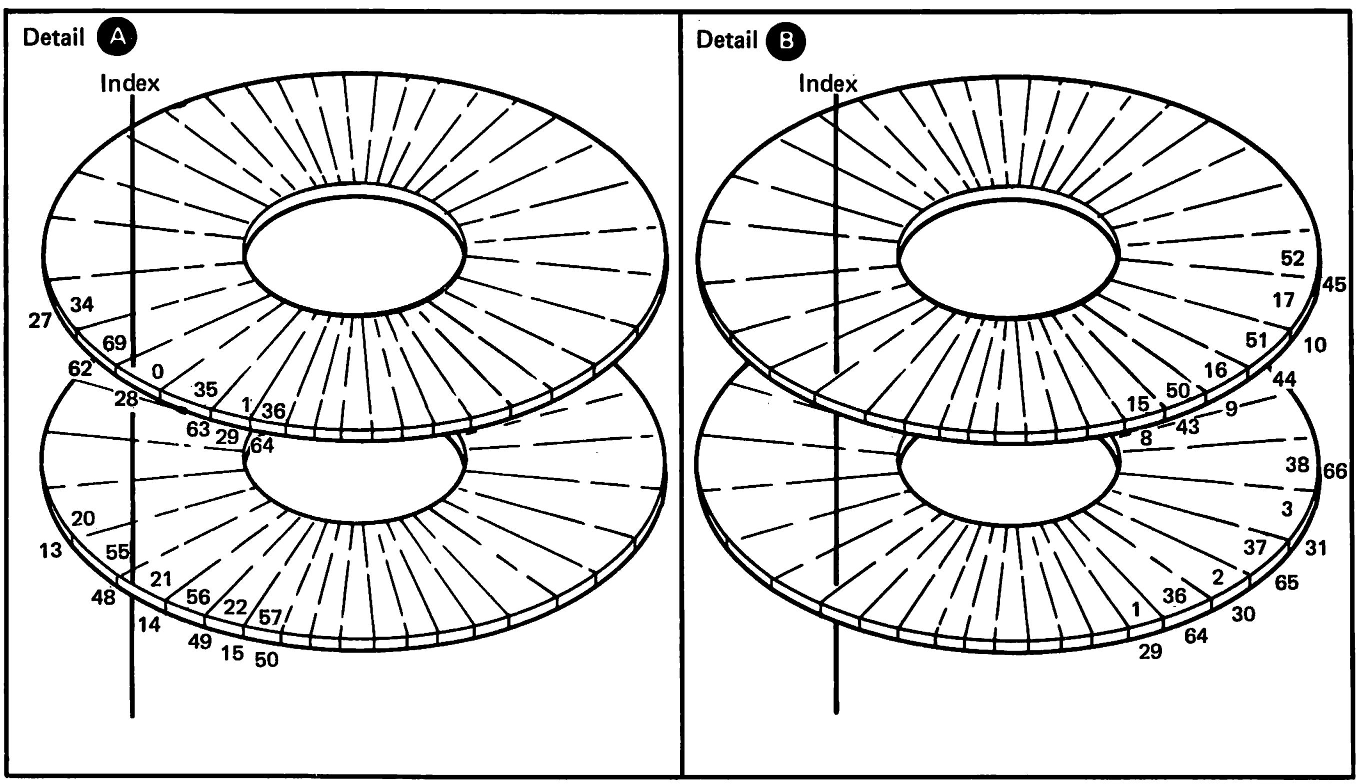
With sector number interleaving, the 70 sectors are logically numbered consecutively 0, 35, 1, 36, 2, 37,......33, 68, 34, 69. To minimize the operational delay resulting from head switching, the logical sector numbering is offset 14 sectors (with respect to the physical position) for each head switch (0 to 1, 1 to 2, 2 to 3, and 3 to 4). The sector interleaving and the sector shifting are shown (for a cylinder without any defects) in the following table and in the figure on the next page.

	Logical location			
Physical location	Head 0	Head 1	Head 2	Head 3
0	0 (Index)	28 (Index)	21 (Index)	14 (Index)
1	35	63	56	49
2	1	29	22	15
3	36	64	57	50
4	2	30	23	16
5	37	65	58	51
6	3	31	24	17
7	38	66	59	52
8	4	32	25	18
9	39	67	60	53
10	5	33	26	19
11	40	68	61	54
12	6	34	27	20
13	41	69	62	55
14	7	0	28	21
15	42	35	63	56
16	8	1	29	22
17	43	36	64	57
18	9	2	30	23
19	44	37	65	58
20	10	3	31	24
21	45	38	66	59
22	11	4	32	25
23	46	39	67	60
24	12	5	33	26
25	47	40	68	61
26	13	6	34	27
27	48	41	69	62
28	14	7	0	28
29	49	42	35	63
30	15	8	1	29
31	50	43	36	64
32	16	9	2	30
33	51	44	37	65
34	17	10	3	31

	Logical location			
Physical location	Head 0	Head 1	Head 2	Head 3
35	52	45	38	66
36	18	11	4	32
37	53	46	39	67
38	19	12	5	33
39	54	47	40	68
40	20	13	6	34
41	55	48	41	69
42	21	14	7	0
43	56	49	42	35
44	22	15	8	1
45	57	50	43	36
46	23	16	9	2
47	58	51	44	37
48	24	17	10	3
49	59	52	45	38
50	25	18	11	4
51	60	53	46	39
52	26	19	12	5
53	61	54	47	40
54	27	20	13	6
55	62	55	48	41
56	28	21	14	7
57	63	56	49	42
58	29	22	15	8
59	64	57	50	43
60	30	23	16	9
61	65	58	51	44
62	31	24	17	10
63	66	59	52	45
64	32	25	18	11
65	67	60	53	46
66	33	26	19	12
67	68	61	54	47
68	34	27	20	13
69	69	62	55	48

Logical sector numbering





Theory of operation

Disk surface format (continued)

Alternate sector assignment

When a sector is found to be defective, it is assigned to an alternate sector on the same track. These are named primary track defects. For tracks that contain more than two defective sectors, the additional defective sectors are assigned to an alternate sector on another track. These sectors, named secondary defective sectors, are then reassigned with the penalty of an access operation to the reassigned track, and another access back to the original track.

The status of each sector with respect to defects is identified by bits within the flag byte of the sector ID field.

The list of defects found by the factory and written on the defect map track cannot be changed.

Primary track defects. The first defective sector (counting logically from logical sector 0) detected on any track will have its address changed to sector 68; also flag bit 6 (defective sector) and flag bit 4 (displaced 1 sector) will be at an up level. This sector and the remaining sectors on this track will be displaced one sector. The sectors will be rearranged as if the defective sector was not physically present. See the example given for head 0, physical location 14 on the next page. In the special case where sectors 68 and 69 are both defective, they are flagged as defective, but are not displaced.

The second defective sector has its address changed to sector 69; also flag bit 6 (defective sector) and flag bit 3 will be at an up level. Bit 3 (displaced 2 sectors) is written in this sector and the following displaced sectors to indicate how many sectors the logical sector normally in that physical position has been displaced. See the example given for head 0, physical position 28 on the next page.

Secondary track defects. The third or subsequent defective sector on any track will be flagged as defective and reassigned off-track to spare cylinder 443. Flag bit 6 (defective sector) and flag bit 5 (reassigned defect) will be at an up level, except where the defective sector falls within the band of displaced sectors following the primary defect. In this case, the defective sector will be flagged defective, reassigned, and displaced. The alternate sector address will have the address of the sector it replaces, and it will have flag bit 7 (secondary assigned alternative) at an up level. See the example given for head 0, physical position 42 on the next page.

Sector ID defects. Defective sectors on any track where the normal track sector ID is not recoverable will be formatted and reassigned as described in the preceding paragraphs, but with the ID field extended 64 bytes later in the sector. If the extended ID field is not recoverable, the ID field will be extended an additional 64 bytes, making a total extension of 128 bytes.

Alternate sector assignment (head 0)

Index

No defects	Physical sector	68 69 0 1 2 . . . 11 12 13 14 15 16 . . . 25 26 27 28 29 30 . . . . 39 40 41 42 43 44 . . . 63 64 65 66 67
	Logical sector	34 69 0 35 1 . . . 40 6 41 7 42 8 . . . 47 13 48 14 49 15 . . . . 54 20 55 21 56 22 . . . 66 32 67 33 68
One defect	Physical sector	68 69 0 1 2 . . . 11 12 13 [14 def] 15 16 . . . 25 26 27 28 29 30 . . . . 39 40 41 42 43 44 . . . 63 64 65 66 67
	Logical sector	34 69 0 35 1 . . . 40 6 41 [7] 42 8 . . . 47 13 48 14 49 15 . . . . 54 20 55 21 56 22 . . . 66 32 67 33 68
	Reassigned logical sector	33 69 0 34 1 . . . 39 6 40 [68] 41 7 . . . 46 12 47 13 48 14 . . . . 53 19 54 20 55 21 . . . 65 31 66 32 67
Two defects	Physical sector	68 69 0 1 2 . . . 11 12 13 [14 def] 15 16 . . . 25 26 27 [28 def] 29 30 . . . . 39 40 41 42 43 44 . . . 63 64 65 66 67
	Logical sector	34 69 0 35 1 . . . 40 6 41 [7] 42 8 . . . 47 13 48 [14] 49 15 . . . . 54 20 55 21 56 22 . . . 66 32 67 33 68
	Reassigned logical sector	32 67 0 33 1 . . . 38 6 39 [68] 40 7 . . . 45 12 46 [69] 47 13 . . . . 52 18 53 19 54 20 . . . 64 30 65 31 66
Three defects	Physical sector	68 69 0 1 2 . . . 11 12 13 [14 def] 15 16 . . . 25 26 27 [28 def] 29 30 . . . . 39 40 41 [42 def] 43 44 . . . 63 64 65 66 67
	Logical sector	34 69 0 35 1 . . . 40 6 41 [7] 42 8 . . . 47 13 48 [14] 49 15 . . . . 54 20 55 [21] 56 22 . . . 66 32 67 33 68
	Reassigned logical sector	32 67 0 33 1 . . . 38 6 39 [68] 40 7 . . . 45 12 46 [69] 47 13 . . . . 53 18 54 [*] 55 21 . . . 64 30 65 31 66

*First logical sector number that is available on the secondary alternate track.

→ Reassigned logical sector 19 is located off-track at cylinder 443, head 1.

Disk surface format (continued)

Fixed block addressing

Fixed block addressing (FBA) is used to mask the physical characteristics of the DASD from the microprogram. Storage requests from the work station, or replies from the 5247, are coded in an FBA numbering system. The FBA is part of the operating system program that is written onto the disk during the initial microprogram load (IMPL). The FBA is transferred from the disk to read/write storage following the power-up routine. A lower-level of microcode in the 5247 converts the FBA into cylinder, head, and sector information. This information is then used to access a specific location on the disk.

The FBA microcode used in the 5247 maps the DASD storage area into 512-byte blocks. For the Version A1 DASD (15.4 megabytes), the FBA numbers range from 0 to 30,123 (75AB hex); for the Version A2 DASD (30.8 megabytes), the upper FBA limit is increased to 60,247 (EB57 hex). A hexadecimal and decimal conversion chart is given below.

Hexadecimal-to-decimal conversion

To find the decimal number, locate the hex number and its decimal equivalent for each position. Add these to obtain the decimal number.

Decimal-to-hexadecimal conversion

To find the hex number, locate the next lower decimal number and its hex equivalent. Each difference is used to obtain the next hex number until the entire number is developed.

Hexadecimal columns							
4		3		2		1	
Hex	= Dec	Hex	= Dec	Hex	= Dec	Hex	= Dec
0	0	0	0	0	0	0	0
1	4,096	1	256	1	16	1	1
2	8,192	2	512	2	32	2	2
3	12,288	3	768	3	48	3	3
4	16,384	4	1,024	4	64	4	4
5	20,480	5	1,280	5	80	5	5
6	24,576	6	1,536	6	96	6	6
7	28,672	7	1,792	7	112	7	7
8	32,768	8	2,048	8	128	8	8
9	36,864	9	2,304	9	144	9	9
A	40,960	A	2,560	A	160	A	10
B	45,056	B	2,816	B	176	B	11
C	49,152	C	3,072	C	192	C	12
D	53,248	D	3,328	D	208	D	13
E	57,344	E	3,584	E	224	E	14
F	61,440	F	3,840	F	240	F	15
0 1 2 3		4 5 6 7		0 1 2 3		4 5 6 7	
Byte				Byte			

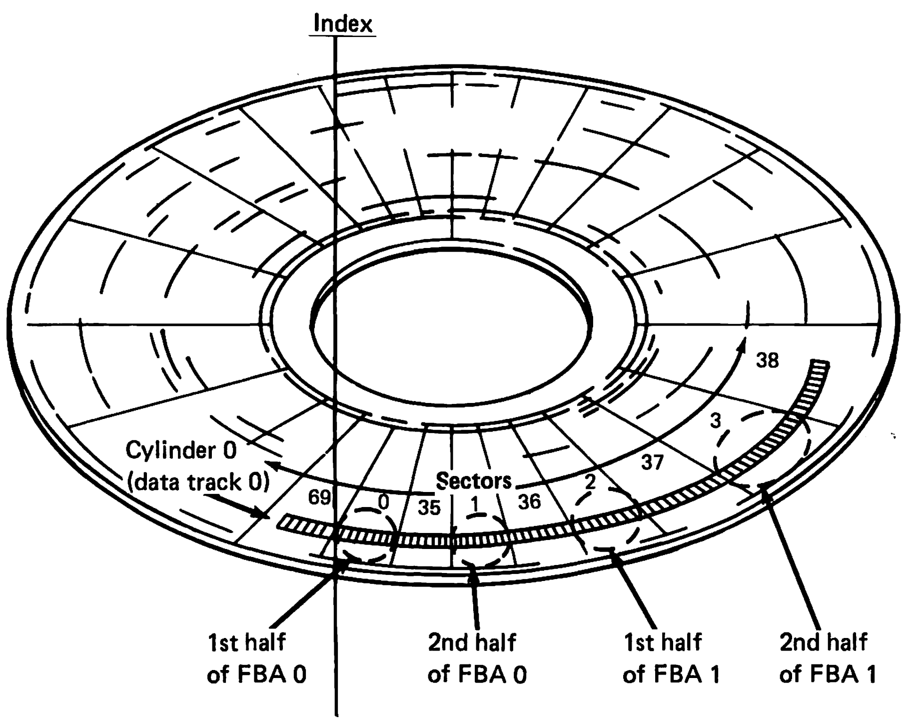
To determine the fixed block address from the cylinder, head, and logical sector number for a given version of the DASD, solve the following equation:

```
FBA = (cylinder number x maximum number
      of heads + head number) X (34)
      + (logical sector number/2)
```

For example, if the cylinder number is 0, the head number is 0, the logical sector number is 2, and the DASD version has 2 read/write heads, the FBA calculates to be 1.

```
FBA = (0 X 2 + 0) X (34) + (2/2) = 1
```

The FBA numbering assignment appears as one large, continuous loop. Every logical, even-numbered sector is the beginning of the first 256-byte FBA block, and the following logical odd-numbered sector is the second 256-byte block of the FBA. For the example given, the first half of FBA 1 would be in logical sector 2, and the second half of FBA 1 would be in logical sector 3. (A second level of microcode converts the logical sector number to a physical sector location on the disk.)



Disk attachment card

The disk attachment card plugs into the base planar board. This card performs the following major functions:

- Interprets and transfers MPU commands to the DASD.
- Supplies DASD status to the MPU.
- Does a parallel-to-serial conversion of the data sent to the DASD, and a serial-to-parallel conversion of the data sent to R/W storage.
- Checks the integrity of the transferred data.
- Does a sector ID comparison of the ID field written on the disk with the ID field mask in R/W storage.
- Controls direct memory access transfers.
- Encodes and decodes the data transferred to, and from, the DASD.

The types of ID or data operations that the disk attachment card performs include:

- Read ID—transfers only the ID from a physical sector to R/W storage.
- Write ID—writes the ID and the data field to a physical sector from R/W storage.
- Read recovery—transfers the data from a physical sector to R/W storage, but ignores the ID of that sector.
- Read data—locates a specific sector using the logical sector ID, then transfers its data field to R/W storage.
- Write data—locates a specific sector using the logical sector ID, then writes its data field from R/W storage.
- Scan sector—locates a specific sector using the logical sector ID, then compares its data field with a data field mask in R/W storage.

The disk attachment card consists of the following major stages:

Ⓐ **DASD interface registers.** These registers are used during the transfer of commands to, and the receipt of status from, the DASD.

Ⓑ **DASD drivers/receivers.** These circuits provide the proper source and termination characteristics for the DASD interface lines.

Ⓒ **Attachment command/status registers.** These registers send commands to the attachment's R/W channel, and read the status of the R/W channel back to the MPU.

Ⓓ **Timing and control.** This logic provides the signals required to synchronize the operation of the disk attachment card's circuits.

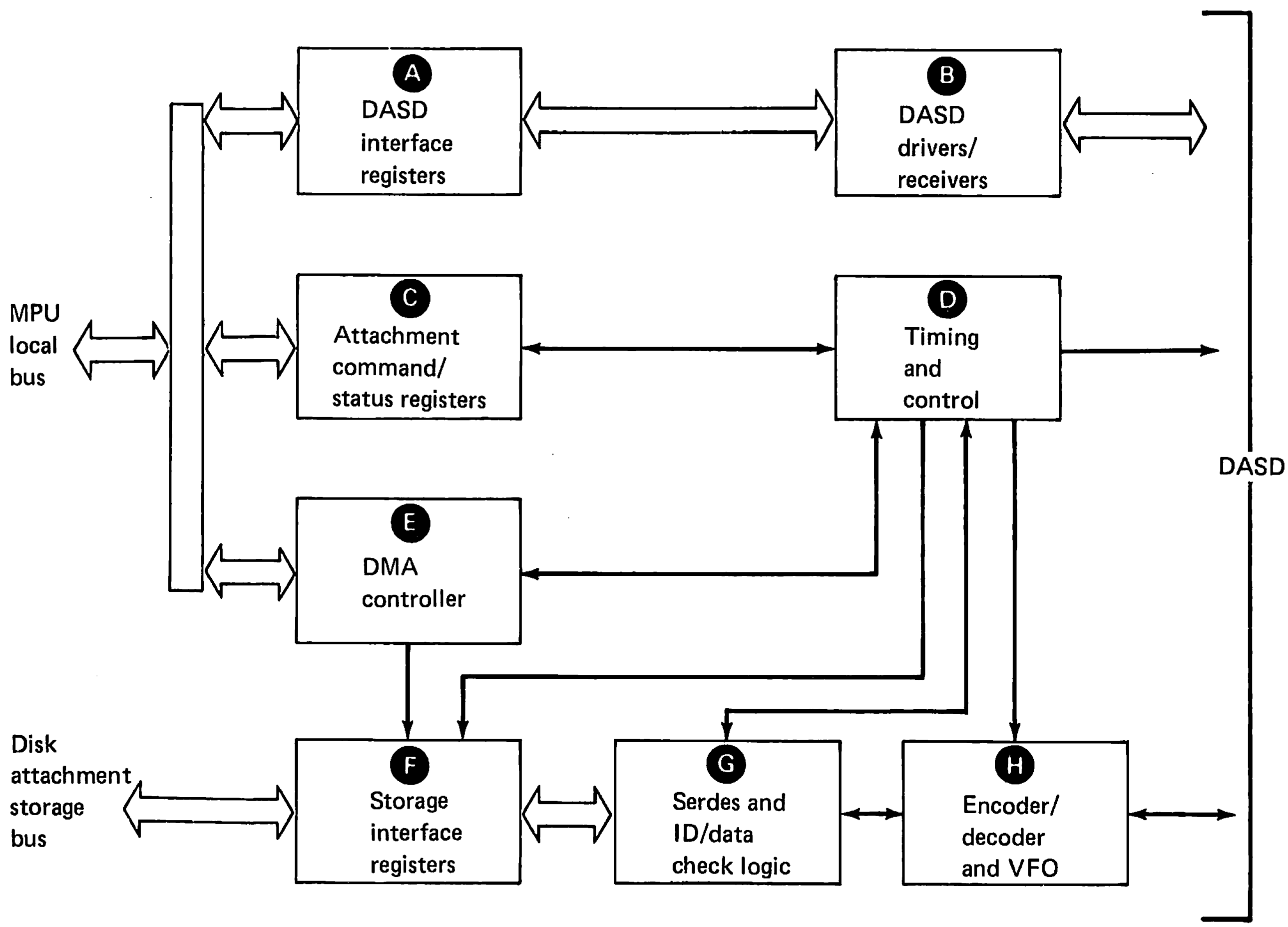
Ⓔ **DMA controller.** This stage holds the 16-bit addresses for data to be read from, or written to, R/W storage. The count in the controller is increased after each word transfer. There are three DMA channels. One channel is used for data, one channel for sector ID, and one channel for ECC codes generated during *write-to-disk* operations.

Ⓕ **Storage interface registers.** These registers hold the 16-bit address or data word to be transferred to, or from, R/W storage.

G Serdes and ID/data check logic. This logic performs several major functions:

- Does a parallel-to-serial conversion of the data sent to the DASD, and a serial-to-parallel conversion of the data sent to the MPU.
- Generates error correction codes (ECCs) for all data written to the disk, and checks the ECCs of all data read from the disk.
- Identifies to the MPU if data that is not valid can be corrected using the ECC syndrome.
- Generates cyclic redundancy codes (CRCs) for all sector IDs written to the disk, and checks the CRCs of all sector IDs read from the disk.
- Performs a comparison check to locate a specific sector on the disk or to locate a specific data pattern in a data field.

H Encoder/decoder and VFO. During a write operation, these circuits encode the data into a DASD-compatible digital format, and convert the data to a differential signal. During a read operation, they remove the clock and data from the differential signal, and convert the DASD-formatted data to a standard binary format.



Disk attachment card block diagram

Functional unit descriptions (continued)

Disk attachment-to-DASD interface lines. The following is a description of the interface lines between the disk attachment card and the direct access storage device (DASD). Where needed, the active polarity of the line is indicated. A minus (–) sign before the signal name means the line is active at a down level; a plus (+) sign means the line is active at an up level.

Command/status bus. This group of eight bidirectional lines transfer the commands to, and the status from, the DASD.

– Odd parity. This line maintains odd parity across the command/data bus and the two register select lines (RS0 and RS1) during transfers to the DASD.

– Attachment reset to disk. When this line is active, it initializes the DASD circuitry.

– Command valid. This line indicates to the DASD that the command/status bus contains a valid command.

– Command mode. This line identifies to the DASD the direction of information flow on the command/status bus. When the command mode line is active, command data is sent to the DASD. When the command mode line is inactive, status information is obtained from the DASD.

– Register select 0 (RS0) and –register select 1 (RS1). These two lines select the desired DASD command or status register.

– Cable interlock (to DASD). This line provides a continuity-check input level to the DASD.

– Cable interlock (from DASD). This line completes the continuity return path from the DASD to the disk attachment card. It is at a down level when there is continuity to, and from, the DASD; it is at an up level when there is an open-circuit condition.

– Disk ready. This line signals the disk attachment card that the DASD is ready to perform seek, read, and write commands. It indicates that:

- The disk motor is up to speed
- No data unsafe conditions exist

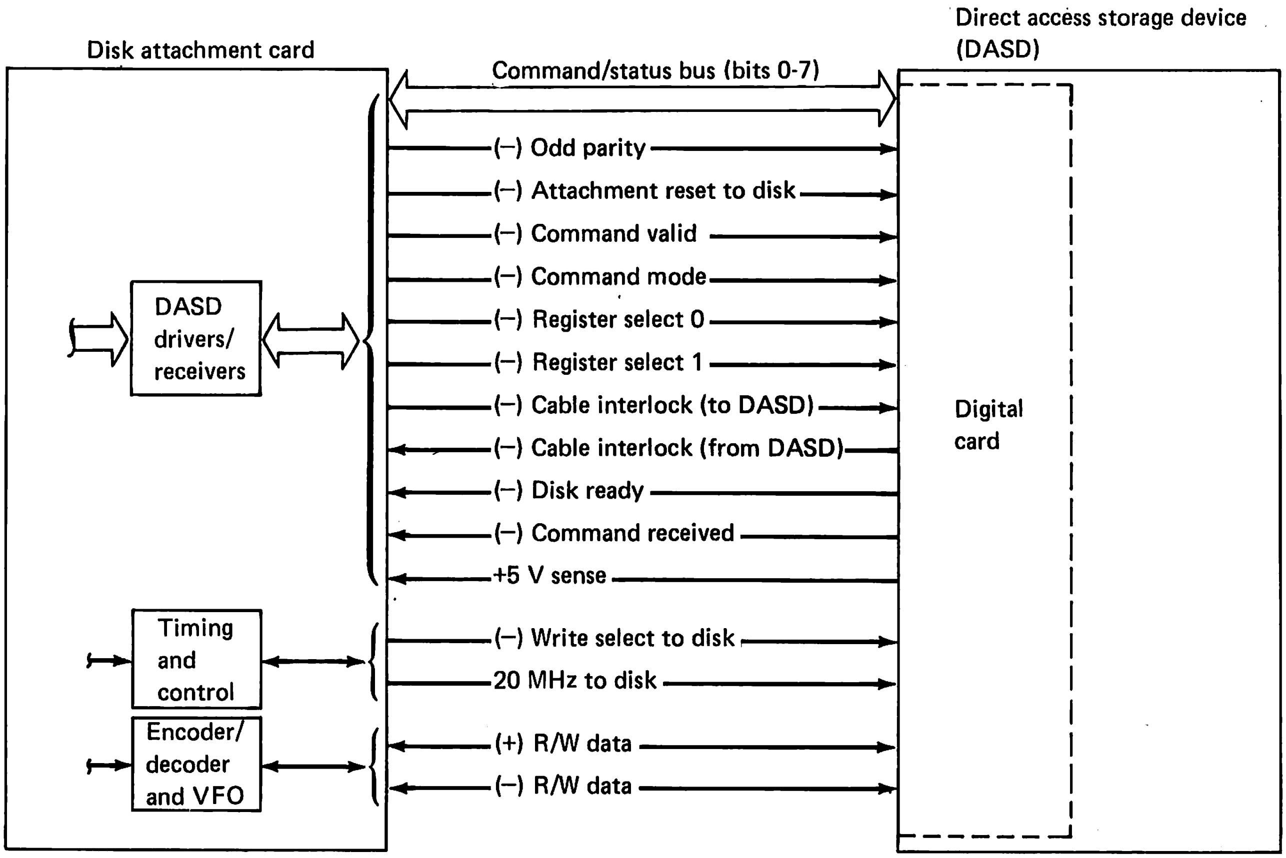
– Command received. This line indicates the DASD received the command from the disk attachment card.

+5V sense. The disk attachment card senses this line to determine that +5V power is sent to the DASD.

– Write select to disk. This line causes the data on the R/W data lines to be written on the disk.

20 MHz to disk. This line provides a 20 MHz clock signal to the DASD.

+ R/W data and –R/W data. These two bidirectional lines transfer encoded data between the DASD and the disk attachment card.



DASD interface lines

Theory of operation

Direct access storage device (DASD)

The direct access storage device (DASD) is available in two storage capacities:

- Version A1 contains two usable read/write heads, and has a storage capacity of 15.4 megabytes.
- Version A2 contains four usable read/write heads, and has a storage capacity of 30.8 megabytes.

Both versions, A1 and A2, contain two disks. However, only one of the disks in Version A1 is operational; the other disk is used to maintain mechanical integrity and to provide air movement. The DASD consists of the following major units:

(A) Disk enclosure
(B) Analog card
(C) Digital card
(D) Motor/actuator card

(A) Disk enclosure

The disk enclosure is a field replaceable unit. It consists of a casting that contains the disks, the spindle assembly, the actuator, the disk drive motor, the head-lock solenoid, and limited electronics. The disk enclosure is a sealed unit, and no customer engineer access is permitted inside the enclosure. Built-in filters maintain clean air and the correct pressure in the disk enclosure.

Data heads attached to the actuator are positioned over the correct track to write data to, or read data from, either side of the disk. The actuator is driven by a voice coil motor (VCM) that moves a carriage assembly. The carriage assembly contains the read/write heads and the arm electronics module. The arm electronics selects the correct head, has a preamplifier for the read data, and contains the necessary write drive circuits.

(B) Analog card

The analog card is a field replaceable unit that plugs into the maple connector block. The analog card contains two channels:

- Data channel
- Servo channel

The data channel performs the following functions:

- Interfaces with the arm electronics module.
- Provides automatic gain control for the data.
- Supplies analog servo information for the servo channel.
- Supplies data pulses for the variable frequency oscillator (VFO).

The servo channel performs the following functions:

- Stabilizes the control of the read/write heads.
- Permits the digital card to control the actuator during multiple-track seek operations.
- Supplies on-track indications and position-error signals to the digital card.

(C) Digital card

The digital card is a field replaceable unit that plugs into the maple connector block. The digital card:

- Supplies timing for the analog card.
- Contains write-protect safety circuits for the servo field.
- Ensures that the read/write heads do not write off track.
- Checks the arm electronics module for loss-of-data conditions.
- Interfaces with the disk attachment card.
- Controls the actuator during multiple-track seek operations.
- Checks and controls the speed of the disks.

Ⓓ Motor/actuator card

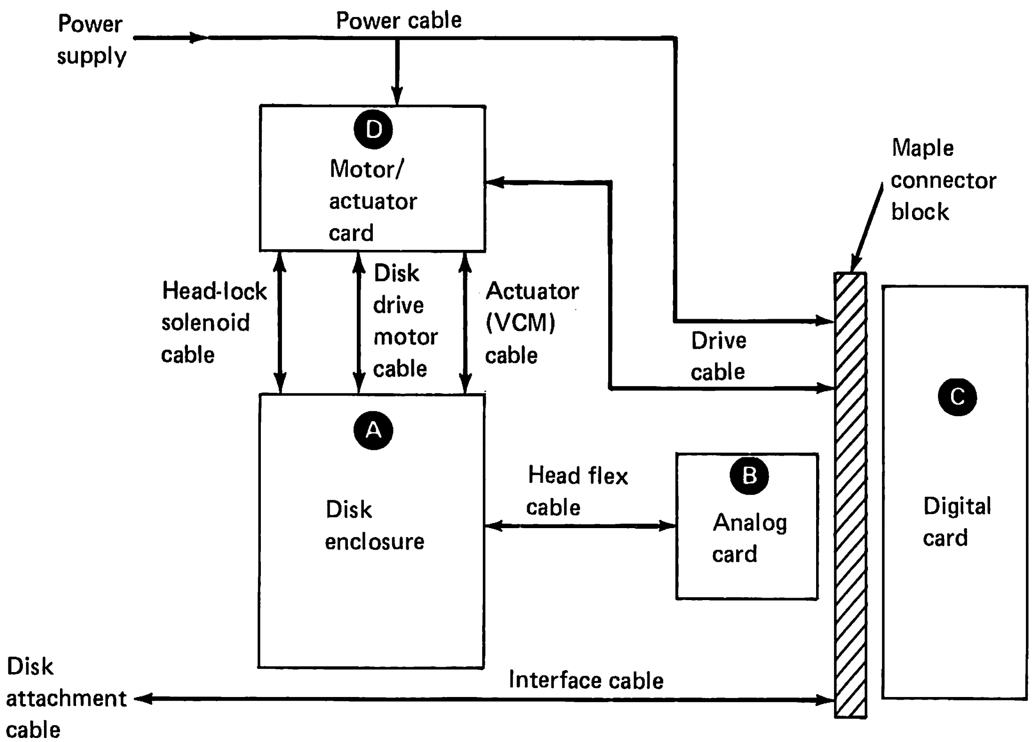
The motor/actuator card is a field replaceable unit that is mounted to the disk enclosure casting. The motor/actuator card contains drive circuits for the following items:

- Disk drive motor
- Actuator voice coil motor
- Head-lock solenoid

Disk operations

The DASD performs the following disk operations:

- Start motor—starts the disk drive motor.
- Stop motor—positions the read/write heads to the landing zone and stops the disk drive motor.
- Read—reads ID or data from the disk.
- Write—writes ID or data to the disk.
- Recalibrate—moves the read/write heads to the home position. Under some error conditions, the read/write heads may move to the inner guard band or to the landing zone.
- Head select—selects one of the read/write heads.
- Cylinder seek—moves the read/write heads toward the seek address location.
- Settle sequence—moves the read/write heads over the correct track.
- Track follow—keeps the read/write heads aligned correctly over the selected track.



DASD block diagram

Figure 7. File assembly

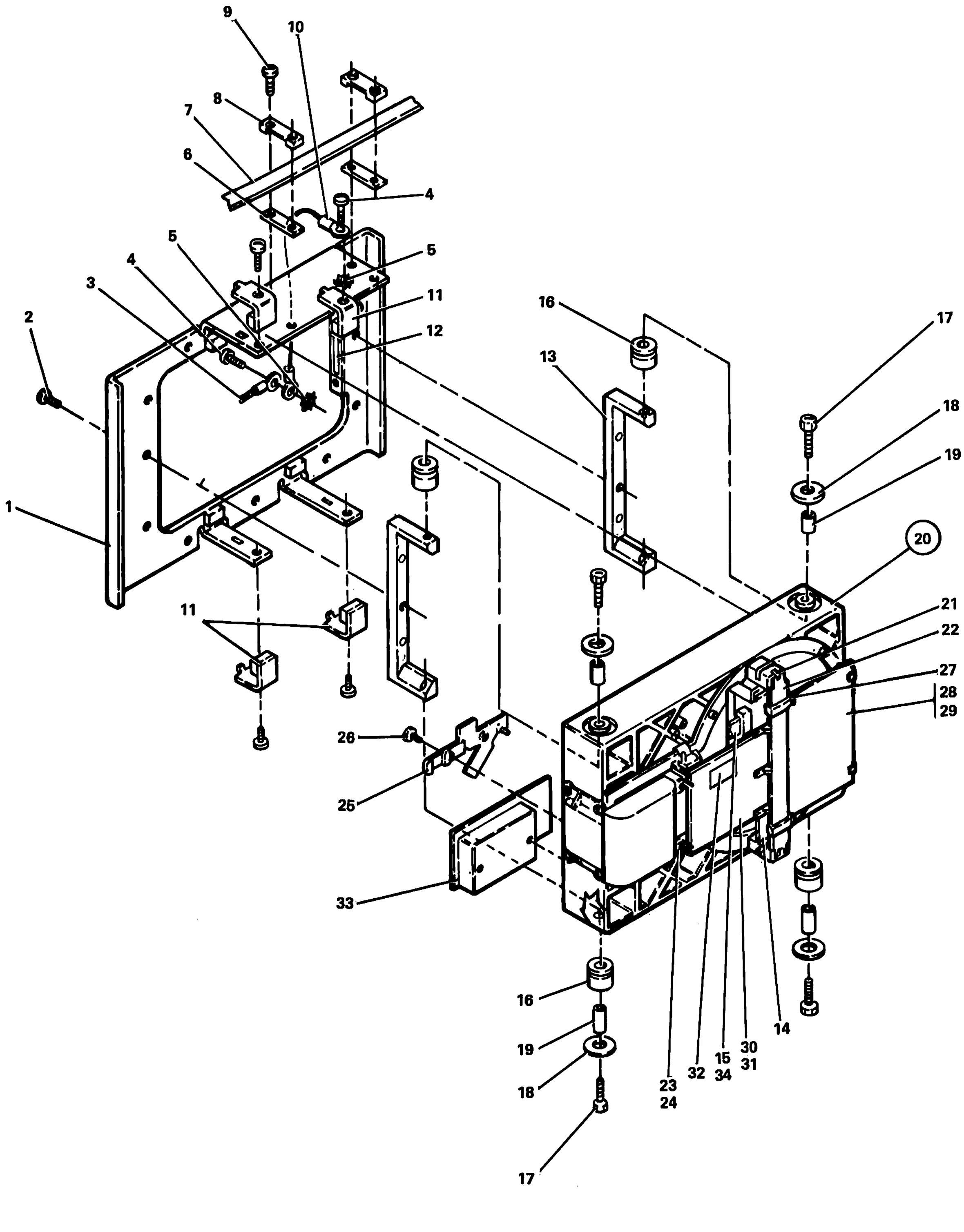


FIGURE 7. FILE ASSEMBLY. SEE LIST 7.

FIGURE-INDEX NUMBER	PART NUMBER	UNITS PER ASM.	DESCRIPTION 1 2 3 4
7 -	NO NO.	REF	FILE ASM FOR NEXT HIGHER ASM SEE LIST 1-5 AND FOR ILLUSTRATION FIGURE 7
- 1	6060884	1	. FRAME,SUPPORT
- 2	1621192	6	. SCREW,MACH PAN HD- M4 X 12 LG ATT PT
- 3	6060893	1	. JUMPER ASM
- 4	1621190	2	. BOLT,PAN HD- M4 X 8 LG ATT PT
- 5	1622346	2	. WSHR,LK EXT TH- 4.15 ID X 9.0 OD X .4 T ATT PT
- 6	652683	2	. FILLER
- 7	8257706	1	. CABLE ASM
- 8	652650	2	. STRAIN RELIEF
- 9	1621170	4	. SCREW,MACH PAN HD- M3 X 6 LG ATT PT
- 10	1249650	1	. JUMPER
- 11	6060905	4	. SNUBBER,BRACKET ASM
- 12	6060897	1	. LABEL,ATTENTION
- 13	8257664	2	. ARM,SUPPORT
- 14	8257706	1	. CABLE ASM,SIGNAL TO FILE
- 15	8257696	1	. CABLE ASM,POWER TO FILE
- 16	1616580	4	. SHOCKMOUNT
- 17	1621599	4	. SCREW,HEX CAP HD- M6 X 1 X 3 LG ATT PT
- 18	1616732	4	. WASHER ATT PT
- 19	1616733	4	. SPACER
- 20	1616698	1	. DISK ENCLOSURE,A01
- 20	1616699	1	. DISK ENCLOSURE,A02
- 21	1616617	2	. . CLIP
- 22	818039	1	. . CONNECTOR,MAPLE BLOCK
- 23	1616752	4	. . RETAINER,CARD
- 24	1621182	4	. . SCREW,MACH PAN HD- M3 X .5 X 8 LG ATT PT
- 25	1616784	1	. . RETAINER,CARD
- 26	1621285	3	. . SCREW,FL HD- M3 X .5 X 6 LG ATT PT
- 27	4233751	2	. CLAMP
- 28	NO NO.	1	. CARD ASM,DIGITAL FOR PART NUMBER SEE CARD
- 29	813590	1	. GUIDE,CARD
- 30	NO NO.	1	. CARD ASM,ANALOG FOR PART NUMBER SEE CARD
- 31	811804	1	. GUIDE,CARD
- 32	1616634	1	. LABEL
- 33	NO NO.	1	. CARD ASM,DRIVE FOR PART NUMBER SEE CARD
- 34	811802	1	. GUIDE,CARD