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MANAGEMENT SUMMARY

UPDATE: *IBM has withdrawn the 3310 and 3340/3344 Direct Access Storage Devices (DASDs) from active marketing. The 3380 single-capacity Models AA4, A04, and B04 were not upgradable to the extended capability Models AD4, BD4, AE4, and BE4, and therefore were also withdrawn from marketing. The 3880 Model 4 Storage Control Unit and all models of the 3375 DASD had a substantial purchase price decrease to make these older models more attractive in the marketplace.*

Supercomputers and large-scale mainframes have high storage requirements, and data processing users have been adding to their on-line storage systems despite the downturn in mainframe sales. The emphasis is on the high-capacity, direct access devices for large computer centers specializing in on-line transaction processing. IBM disk drives meet these expanding storage requirements by providing the ability to store more data in less space. The top-of-the-line 3380 DASD stores 5.04 gigabytes of data in a single unit. It also requires less electrical power and generates less heat when compared to the older models. The AD4 and BD4 models can be field upgraded to the AE4 and BE4 models for a performance improvement of up to 15 percent.

Each 3380 model includes two HDAs, each with two actuators. Up to four of these units can be configured to form a string with a maximum of 16 actuators. All actuators in this string operate independently, with seeking and rotational position sensing (RPS) of any actuator overlapped with seeking and rotational position sensing of any other actuators, and any two actuators can transfer data simultaneously. The 3380 AD4 and AE4 models include the control functions required to attach to two storage directors of a 3880 Model 3 or Model 23 Storage Control Unit. The 3380 storage units are supported by Dynamic ▷

IBM leads the large-capacity disk drive market with its line of four Direct Access Storage Devices (DASDs). The disk subsystems feature fixed Head/Disk Assemblies (HDAs) with storage capacities ranging from 317.5 megabytes per HDA for the 3350 to 5.04 gigabytes per HDA for the 3380.

MODELS: 3350 DASD, 3370 DASD, 3375 DASD, 3380 DASD, and the 3880 Storage Control Unit.

CONFIGURATION: A typical configuration consists of a 3880 Storage Control Unit, a Model A storage unit with string controller, and a Model B storage unit. For more detailed configurations, please refer to the *Characteristics* section of this report.

COMPETITION: 3350—Memorex 3650/3652; 3370—Memorex 3690-2; 3375—Memorex 3695; 3380—Amdahl 6380, Memorex 3682, NAS 7380, and StorageTek 8380.

PRICING: Purchase prices range from $25,360 (3350 Model B02) to $122,480 (3380 Model AE4).

CHARACTERISTICS

MANUFACTURER: International Business Machines Corporation, Old Orchard Road, Armonk, New York 10504. Contact your local IBM representative.

CANADIAN ADDRESS: International Business Machines (IBM Canada Limited), 3500 Steeles Avenue East, Markham, Ontario L3R 2Z1. Telephone (416) 474-2111.

MODELS: 3350 Direct Access Storage Device (DASD) Models A2, A2F, B2, B2F, C2, and C2F; 3370 DASD ▶
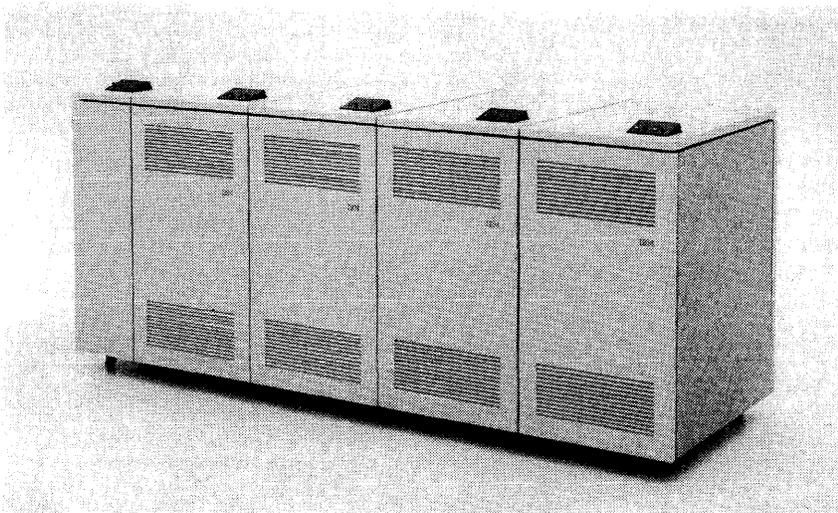
The IBM 3375 Direct Access Storage Device consists of up to four disk storage units. Each storage unit has a Head Disk Assembly (HDA) and two actuators, each actuator accesses 409.8 megabytes of data, a total of 819.7 megabytes per HDA.

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▷ Path Selection (DPS). In System/370 mode, reconnection is established only on the path of the original connection; in Extended Architecture (XA) environments, reconnection is established along any available path for faster reconnection.

COMPETITIVE POSITION

IBM is still the number one player in the large-capacity disk storage game. The company holds an approximate 88 percent market share, with Amdahl and NAS having a 3.9 percent share each, followed by StorageTek with 1.4 percent. But with the yearly increase in demand for on-line storage systems and the more aggressive marketing by Amdahl and NAS, these market share figures are likely to shift somewhat in favor of the plug-compatible vendors. To accomplish this shift, the vendors must keep up with IBM's frequent price reductions and offer lower purchase prices for their disk subsystems, because the biggest inducement for buying an IBM-compatible peripheral has always been price.

The plug-compatible replacements for the 3380 are the Amdahl 6380, the Memorex 3682, the NAS 7380, and the StorageTek 8380. All vendors offer both single-capacity, 2.52-gigabyte, and double-capacity, 5.04-gigabyte direct access storage devices. The average access time of 17 milliseconds with a rotational delay of 8.3 milliseconds, and a transfer rate of 3 megabytes is standard for all large-capacity disk subsystems.

The Amdahl 6380 prices are $71,200 for 2.52-gigabyte, and $104,110 for 5.04-gigabyte drives. The Memorex 3680 and 3682 drives are priced at $36,086 and $122,480, respectively. The price for the NAS 7380 single-capacity drive is $85,500, and the price is $166,355 for the double-capacity drive. The StorageTek 8380 2.52-gigabyte drive is priced at $87,225 and the 5.04-gigabyte drive is priced at $120,275.

Amdahl, NAS, and StorageTek no longer manufacture plug-compatible models for the IBM 3350, 3370, or 3375 disk subsystems. Memorex is the only vendor to market plug-compatible models for the IBM 3370 and 3375. The Memorex 3690-2 with a storage capacity of 729.8 megabytes is priced at $26,600, and the price for the 819.7-megabyte 3695 model is $28,770.

ADVANTAGES AND RESTRICTIONS

The IBM disk subsystems feature thin-film head technology that improves performance but demands a very clean and dust-free computer room environment. To further improve performance and reduce I/O response time, the 3880 Storage Control Unit contains a solidstate cache memory with a capacity ranging from 8 megabytes to 64 megabytes of frequently used data for fast access by the host computer. Holding data in cache eliminates the slowdown caused by the system's searching for the data in memory or storage. As more users buy the bigger but slower double-capacity 3380 models, the use of cache will increase to enhance the performance of the system. To facilitate problem determination and system recovery procedures, an ▷

► Models A1, A2, B1, B2, A11, A12, B11, and B12; 3375 DASD Models A1, B1, and D1; 3380 DASD Models AD4, AE4, BD4, and BE4.

CONTROLLERS: The 3880 Storage Control Models 1, 2, 3, and 4; Model 21 paging cache; and Model 23 cache controller use a combination of hardware and microcode to direct the operations of the Direct Access Storage Devices. Models 1, 2, 3, 21, and 23 provide two independent control unit paths, or storage directors; Model 4 has only one storage director. Each storage director executes file control commands and provides a data path from the storage devices to block multiplexer channels on medium- and large-scale IBM computers.

The 3880 Storage Control Model 1 and Model 2 storage directors each support up to four 3370 Model A1 and A2 DASDs in any combination, or up to four 3375 Models A1 and D1, or up to four 3350 Models A2, A2F, C2, and C2F in any combination. Each of the two Model 3 storage directors provides for attachment of up to two 3380 Model AD4 or AE4 DASDs. The Model 4 single storage director supports up to four 3370 Models A1 and A2 in any combination, or up to four 3375 Model A1 DASDs.

The 3880 Model 21 paging cache modifies both storage directors to dynamically manage a 16-, 32-, 48-, or 64-megabyte solidstate storage unit to page and swap data. The storage unit is divided into a directory and a cache. Up to two 3350 Models A2 or A2F DASDs can be attached, one Model B2, B2F, C2 or C2F may be attached to the A models. All attached A2, A2F, C2, and C2F models must have the special String Switch feature.

The 3880 Model 23 provides two independent cache storage directors for the 3380 Models AD4, BD4, AE4, and BE4 DASDs. Each cache storage director shares access to an electronic cache memory and to the attached 3380 storage devices. The cache memory of 8, 16, 32, 48, or 64 megabytes includes a cache and a directory. Cache contents are dynamically managed by a modified least recently used (LRU) algorithm. The Two-Channel Switch feature is required for both the Model 21 and Model 23 storage controllers.

The Two-Channel Switch Pair attaches each storage director to a second channel. Four unique channels may be switched, two to each storage director, or the same two channels may be switched to both storage directors. The channels to be switched may be on the same or on different processors. The Two-Channel Switch Pair Additional adds switching for two additional channels per storage director on a 3880 controller equipped with the Two-Channel Switch Pair feature, providing four-channel switch capability for both storage directors. Up to eight unique channels may be switched, four to each storage director. The Eight-Channel Switch adds switching for four additional channels per storage director on a 3880 controller equipped with both the Two-Channel Switch Pair and the Two-Channel Switch Pair Additional features, providing eight-channel switch capability for both storage directors. The same eight channels must be switched to both storage directors.

COMPUTERS INTERFACED: IBM 4300, 303X, 308X, and 3090, or compatible mainframes with a 3-megabyte block multiplexer channel.

The 3350 DASD connects to any virtual storage 4331 Model Group 2, 4341, 4361, 4381, 30XX, or System/370 processor (except 3115 or 3125) with appropriate attachment and features.

The 3370 DASD requires the following: a DASD Adapter base for 4321 and 4331 Model Group 1 processors; a DASD Adapter or a 3880 Storage Control Model 1, 2, or 4 attached to the high-speed block multiplexer channel on the 4331 ►

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TABLE I. PERFORMANCE CHARACTERISTICS

MODEL	3350	3370	3375	3380
Cabinets per subsystem	1 to 32	1 to 32	1 to 32	1 to 16
Disk packs/HDAs per cabinet	2	1	1	2
Capacity	317.5MB per HDA	729.8MB per HDA	819.7MB per HDA	2520/5040MB per HDA
Tracks/segments per drive unit	33,300	—	—	—
Average seek time, msec.	25	19	19	17
Average access time, msec.	33.4	29.1	29.1	25.3
Average rotational delay, msec.	8.4	10.1	10.1	8.3
Data transfer rate	1.19MB/sec.	1.85MB/sec.	1.85MB/sec.	3.0MB/sec
Controller model	3880 Model 1, 21	3880 Model 4	3880 Model 4	3880 Model 3, 23
Comments	Models A2, A2F, B2, B2F, C2, C2F	Models A1, A2, B1, B2, A11, A12, B11, B12	Models A1, B1, D1	Models AD4, AE4 BD4, BE4

▷ operator panel on the 3380 provides a ready light and an enable/disable switch on each actuator in the string and a power switch and ready light on each of the two controllers to indicate device status and to isolate a suspected failing device. □

▶ Model Group 2 or 4361 processor; a DASD Adapter for a 4331 Model Group 11 processor; a DASD/8809 Adapter on the 4361, or a 3880 Storage Control Model 1, 2, or 4 attached to a high-speed block multiplexer channel; a 3880 Storage Control Model 1, 2, or 4 connected to a two-megabyte block multiplexer channel on the 4341 or 4381 processor; and an attachment feature on the System/38 5381 System Unit (Models 4, 5, 6, 7, and 8).

The 3375 DASD requires a block multiplexer channel with a data rate of at least 1.86 megabytes to attach a 3880 to a 4341, 4331 Model Group 2, 4361, or 4381 processor; the datastreaming or speed matching buffer feature for attachment to a 3031, 3032, or 3033 processor; and any block multiplexer channel for attachment to a 3081, 3083, 3084, or 309X processor.

The 3380 DASD attaches to 4341, 4361, 4381, 3031, 3032, 3033, 3081, 3083, 3084, and 3090 processors. Attachment to a 3031, 3032, or 3033 processor through a 3880 Model 2, 3, or 23 requires datastreaming on those processor units.

CONFIGURATION: The 3350 Disk Subsystem consists of a 3880 Model 1, 2, or 21 Storage Control Unit and from one to four A2 or A2F dual-drive disk storage units with string controllers. Up to three B2 or B2F, or two B2/B2F and one C2/C2F, dual-drive disk units can be attached to the A2 or A2F drives. The A2 or A2F storage units perform string control functions and must be the first drive units in the string. The C2 or C2F dual-drive disk storage units with associated controllers provide an alternate controller function within a 3350 string. A maximum configuration is eight drives per string. The capacity per drive is 317.5 megabytes, for a maximum string capacity of 2.54 gigabytes of storage.

The 3370 Disk Subsystem consists of a 3880 Model 1, 2, or 4 Storage Control Unit and Model A1 or A2 single-drive disk storage units with two independent, movable access mechanisms (actuators) and associated controllers. A string can contain a maximum of four storage units (eight actuators). Models A1 and A2 each can support up to three Model B1 or B2 disk storage units. The Models A11 and A12 single-drive units with two actuators and associated controllers can support up to three Model B11 or B12 storage units each. The 3370 has a capacity of 364.9 megabytes per actuator. The capacity per drive is 729.8 megabytes, for a maximum string capacity of 2.92 gigabytes of storage.

The 3375 Disk Subsystem consists of a 3880 Model 1, 2, or 4 Storage Control Unit and up to four Model A1 disk storage units with one Head/Disk Assembly (HDA), two actuators, and associated controller. Up to three Model B1 disk storage units can be attached to the Model A1 disk storage unit. The Model D1 disk storage unit with two actuators and associated controller provides a dual controller function with a second data path to each HDA. A 3375 string containing a Model D1 requires a Model A1 and two Model B1 storage units. Each storage unit has one HDA and two actuators; each actuator accesses 409.8 megabytes of data, for a total of 819.7 megabytes per HDA. The maximum number of storage units per string is four (eight actuators) with a capacity of 3.27 gigabytes.

The 3380 Disk Subsystem consists of a 3880 Model 3 or 23 Storage Control Unit and a Model AD4 or AE4 disk storage unit with two associated controllers. Up to three Model BD4 or BE4 disk storage units with a total of twelve actuators can be attached to the Model AD4 or AE4 disk storage unit. Models BD4 and BE4 can be intermixed in any sequence within strings headed by either a Model AD4 or AE4. Each 3380 disk storage unit contains two HDAs, each with two actuators. On the AD4/BD4, two actuators access 1.26 gigabytes per HDA for a total of 2.52 gigabytes per storage unit. A maximum string containing 16 actuators has a capacity of 10.08 gigabytes of storage. On the AE4/BE4, two actuators access 2.52 gigabytes per HDA for a total of 5.04 gigabytes per storage unit. A maximum string containing 16 actuators has a capacity of 20.16 gigabytes of storage.

PHYSICAL CHARACTERISTICS: The weight and dimensions of the IBM disk storage units are listed in the following table.

Models	Width (in.)	Ht. (in.)	Depth (in.)	Wt. (lb.)
3350	48.0	47.0	34.0	800
3370	30.5	39.5	32.0	375
3375	30.5	79.5	32.0	375
3380	42.0	70.5	32.0	1000

Power requirements for the 3880 control units and 33XX storage units are 3 phase, 4 wire, 60 Hz alternating current (AC), 208 or 240 volts. The 240 VAC is compatible with 230 VAC systems.

PERFORMANCE: The 3350 DASD employs a fixed storage medium and features a selective data recording format. Operating in native mode, the 3350 has 555 logical cylinders per drive with 30 tracks per logical cylinder, and 19,069 bytes per track. ▶

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► The 3370 DASD features a fixed, sealed Head/Disk Assembly and fixed-block format. The 3370 has 512 data bytes per block, 558,000 blocks per actuator, 285.6 megabytes per actuator, and 571.3 megabytes per HDA (Models 1 and 11). Model 2 and 12 drives have 512 data bytes per block, 712,752 blocks per actuator, 364.9 megabytes per actuator, and 729.8 megabytes per HDA. Blocks are separately addressable and jointly form a contiguous address space.

Each 3375 DASD contains one sealed and permanently mounted Head/Disk Assembly and two actuators. Each of the actuators is separately addressable and accesses one half of the HDA storage. The data recording format is count-key-data. Count-key-data provides format continuity with current IBM large systems direct access storage products.

The 3380 DASD employs a fixed-medium Head/Disk Assembly that contains the heads, disks, and actuators within a sealed enclosure. The Models AD4/BD4 have 15 tracks per cylinder and 885 cylinders per actuator. Each actuator accesses 630 megabytes of data. The Models AE4/BE4 have 15 tracks per cylinder and 1,770 cylinders per actuator. Each actuator accesses 1.26 gigabytes of data. The 3380 uses the count-key-data recording format.

For more performance characteristics of each disk drive model please refer to Table 1.

SYSTEM FEATURES: The 3350 features Write Format Release, which frees the subsystem while the drive erases from the end of a formatted write record to the end of the track. Command Retry allows the storage control to recover from errors without interfering with the system error recovery procedures. Rotational Position Sensing permits channel disconnect during periods of rotational latency to provide greater channel availability. The String Switch links the subsystem to a second attachment to the same, or a different CPU. The 3350 also provides the capability to correct single

data error bursts of up to four bits span, and to detect all single error bursts of up to ten bits span.

The 3370 features Automatic Position Sensing within its fixed-block architecture. This architecture provides for relative block addressing with each block automatically addressable. The 3370 also features Command Retry and error detection codes to correct error bursts occurring in nine bits or less and detect errors that span three bytes or less.

The 3375 features Rotational Position Sensing and the capability to correct and detect single data error bursts of up to 16 bits if the burst spans no more than two contiguous bytes.

The 3380 features Dynamic Path Selection, which attaches to two 3880 storage directors, and controls access to the actuators, providing paths via both storage directors to all actuators in the string. The Device Level Selection (DLS) function permits concurrent data transfer from any two actuators within a string, including those of the same HDA. The 3380 also features Rotational Position Sensing, Command Retry, and Data Recovery.

The 3880 Storage Control Unit features the Remote Switch Attachment which removes the enable/disable switches from the 3880 operator panel and allows them to be moved to a remote configuration control panel. The Speed Matching Buffer supports attachment of 3380 DASDs to a 1.5-megabyte datastreaming and non datastreaming block multiplexer channel. Two 3880 storage control units may be attached in a dual-frame configuration allowing alternate path access to all attached DASDs, even if one of the Model 23 controllers is unavailable. In this configuration, each string must attach to a cache storage director in each control unit.

PRICING AND SUPPORT: The IBM Direct Access Storage Devices are available for purchase, monthly rental, and two-year lease. Maintenance included in the two-year lease plan is 24 hours per day, 7 days per week.

EQUIPMENT PRICES

		Purchase Price ($)	Monthly Maint. ($)	Monthly Rental ($)	2-Year Lease ($)
3350 Direct Access Storage Device					
A02	Direct Access Storage	32,030	173.00	2,103	1,740
A2F	Direct Access Storage	39,970	224.00	2,622	2,230
B02	Direct Access Storage	25,360	130.00	1,674	1,425
B2F	Direct Access Storage	33,300	182.00	2,191	1,865
C02	Direct Access Storage	33,130	182.00	2,191	1,865
C2F	Direct Access Storage	41,070	234.00	2,708	2,305
1320	Primary Controller Adapter	220	1.50	15	13
6148	Remote Switch Attachment	—	—	—	—
8150	String Switch	3,690	9.50	257	219
3370 Direct Access Storage Device					
A01	Direct Access Storage	35,480	147.00	1,563	1,330
A02	Direct Access Storage	35,480	134.00	2,030	—
A11	Direct Access Storage	35,480	147.00	1,563	1,330
A12	Direct Access Storage	35,480	134.00	2,030	—
B01	Direct Access Storage	26,600	110.00	1,173	998
B02	Direct Access Storage	26,600	101.00	1,520	—
B11	Direct Access Storage	26,600	110.00	1,173	998
B12	Direct Access Storage	26,600	101.00	1,520	—
8150	String Switch	3,830	15.00	168	143

NC—No charge.

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		Purchase Price ($)	Monthly Maint. ($)	Monthly Rental ($)	2-Year Lease ($)
3375 Direct Access Storage Device					
A01	Direct Access Storage	24,730	139.00	1,563	1,330
B01	Direct Access Storage	18,700	105.00	1,251	1,065
D01	Direct Access Storage	23,590	128.00	1,486	1,265
4951	Model D1 Attachment for Model A1	2,590	6.00	95	81
4952	Model A1 Attachment for Model B1	—	—	—	—
8150	String Switch	3,795	1.50	168	143
3380 Direct Access Storage Device					
AD4	Direct Access Storage	88,780	295.00	4,730	—
BD4	Direct Access Storage	64,440	215.00	3,440	—
AE4	Direct Access Storage	122,480	295.00	7,030	—
BE4	Direct Access Storage	98,140	215.00	5,735	—
3880 Storage Control Unit					
001/002/003	Storage Control Unit	60,270	176.00	3,819	3,250
004	Storage Control Unit	30,000	82.50	2,195	—
D21	Storage Control Unit; 8 megabytes of memory	143,750	575	7,765	—
E21	Storage Control Unit; 16 megabytes of memory	183,750	600	10,470	—
G21	Storage Control Unit; 32 megabytes of memory	263,750	650	14,800	—
H21	Storage Control Unit; 48 megabytes of memory	343,750	700.00	19,130	—
J21	Storage Control Unit; 64 megabytes of memory	423,750	750.00	23,460	—
D23	Storage Control Unit; 8 megabytes of memory	143,750	575	8,350	—
E23	Storage Control Unit; 16 megabytes of memory	183,750	600	10,470	—
G23	Storage Control Unit; 32 megabytes of memory	263,750	650	14,800	—
H23	Storage Control Unit; 48 megabytes of memory	343,750	700.00	19,130	—
J23	Storage Control Unit; 64 megabytes of memory	423,750	750.00	23,460	—
3880 Model Upgrades					
	Model 1 to Model D21	83,480	—	—	—
	Model 1 to Model E21	123,480	—	—	—
	Model 1 to Model G21	203,480	—	—	—
	Model 1 to Model H21	283,480	—	—	—
	Model 1 to Model J21	363,480	—	—	—
	Model D21 to Model E21	55,000	—	—	—
	Model D21 to Model G21	135,000	—	—	—
	Model D21 to Model H21	215,000	—	—	—
	Model D21 to Model J21	295,000	—	—	—
	Model E21 to Model G21	80,000	—	—	—
	Model E21 to Model H21	160,000	—	—	—
	Model E21 to Model J21	240,000	—	—	—
	Model G21 to Model H21	80,000	—	—	—
	Model G21 to Model J21	160,000	—	—	—
	Model H21 to Model J21	80,000	—	—	—
	Model X21 to Model X23	2,745	—	—	—
	Model 3 to Model D23	83,480	—	—	—
	Model 3 to Model E23	123,480	—	—	—
	Model 3 to Model G23	203,480	—	—	—
	Model 3 to Model H23	203,480	—	—	—
	Model 3 to Model J23	283,480	—	—	—
	Model D23 to Model E23	55,000	—	—	—
	Model D23 to Model G23	135,000	—	—	—
	Model D23 to Model H23	215,000	—	—	—
	Model D23 to Model J23	295,000	—	—	—
	Model E23 to Model G23	80,000	—	—	—
	Model E23 to Model H23	160,000	—	—	—
	Model E23 to Model J23	240,000	—	—	—
	Model G23 to Model H23	80,000	—	—	—
	Model G23 to Model J23	160,000	—	—	—
	Model H23 to Model J23	80,000	—	—	—
6148	Remote Switch Attachment	NC	NC	NC	NC
6149	Remote Switch Attachment, Additional	NC	NC	NC	NC
6150	Remote Switch Attachment for Eight-Channel Switch	NC	NC	NC	NC
6550	Speed Matching Buffer for 3380	9,705	40.00	553	471
6560	Speed Matching Buffer	11,420	40.00	481	409
8160	Two-Channel Switch	3,850	5.00	390	332
8170	Two-Channel Switch Pair	6,225	11.00	390	332
8171	Two-Channel Switch Pair, Additional	16,610	38.50	1,053	896
8172	Eight-Channel Switch	22,850	53.50	1,451	1,235

NC—No charge. ■