HP 7908, 7911, 7912
Integrated Disc/Tape Drives

HEWLETT PACKARD

General Information Manual

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7908, 7911, 7912
GENERAL INFORMATION MANUAL

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CONVENTIONAL SOLUTIONS

If you deal with computing systems, you probably won't be surprised that peripheral storage can cost as much as $40,000, or more! This solution normally includes a hard disc for mass storage, a 1/2" tape drive for backup, and a floppy disc for user I/O. (See figure 1.) The price associated with this solution can create quite a challenge for management when budget constraints exist.

Today, Hewlett-Packard offers a cost-effective solution to the traditional high cost of mass storage, backup, and user I/O — with products that can save you up to 60%!

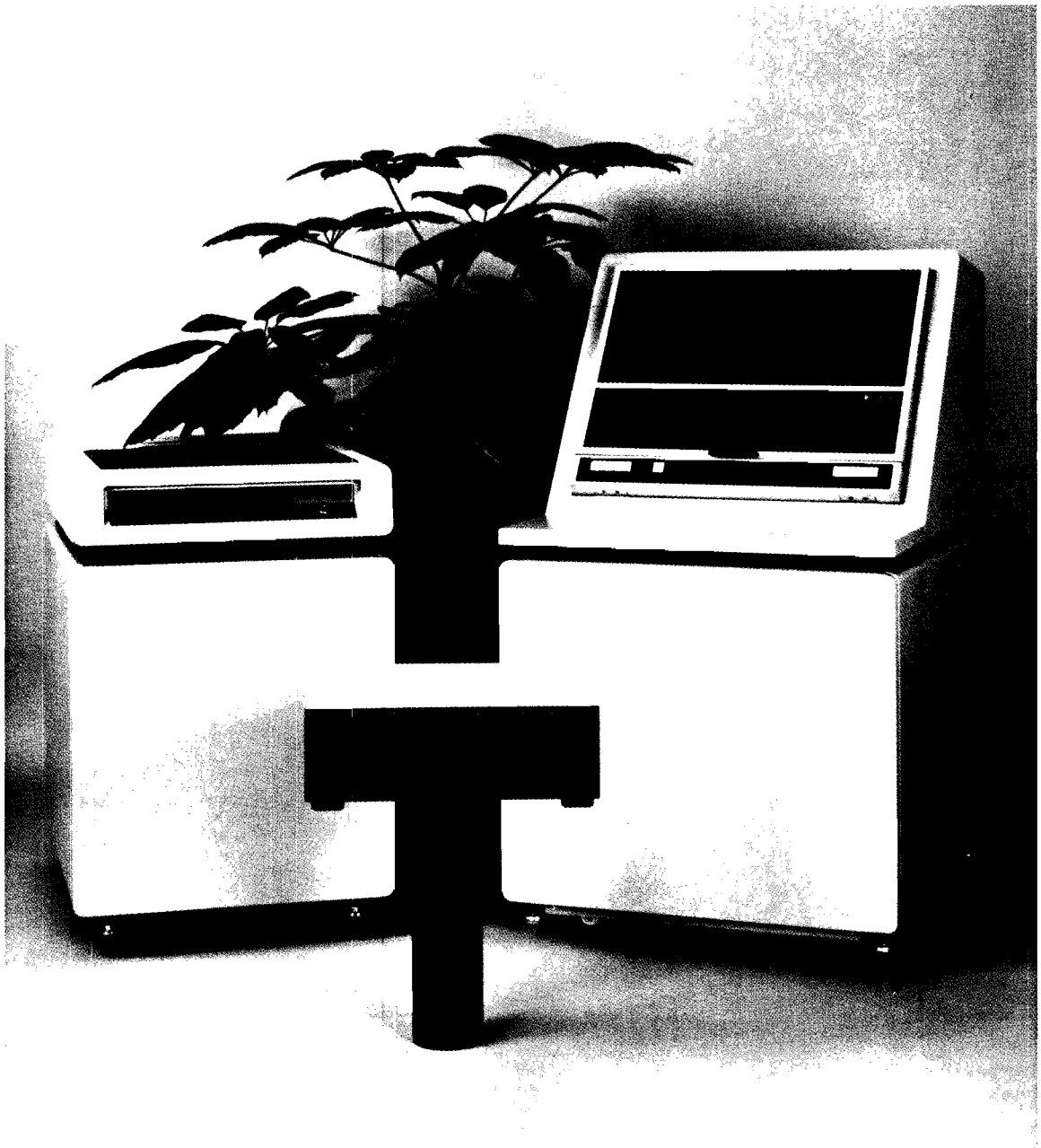


Figure 1. Conventional Solution

HP'S ALTERNATIVE TO CONVENTIONAL SOLUTIONS

For small to medium-sized systems, the 7908, 7911 and 7912 can supply the system's complete peripheral storage requirements of mass storage, I/O and backup for $10,900 to $17,000.* These products contain not only a Winchester disc drive for mass storage, but also a cartridge tape drive providing both backup and I/O capabilities. (See table 1.)

Table 1. Total Storage Solution

SYSTEM NEEDS	PREVIOUS SOLUTION		INTEGRATED STORAGE SOLUTION	
User I/O	Floppy	$ 3 - $ 5K	Cartridge Tape Drive/ 16.7 or 67 Mb	$ 2K
Mass Storage	Disc	$ 8 - $20K	7908/11/12 Disc Drive	$8.9 - $15K
Backup Storage	1/2" Tape	$10 - $15K	Cartridge Tape Drive/ 16.7 or 67 Mb	N/C
Total Price	$21 - $40K		$10.9 - $17K	

The 7908/11/12 disc/tape drives are designed to fill the mass storage, backup and I/O requirements of lower cost systems. They offer all these basic capabilities in one compact package at a significantly lower price, and only require about one-fourth of the floor space of a conventional solution. (See figure 2.)

**U.S. based prices. Subject to change.*

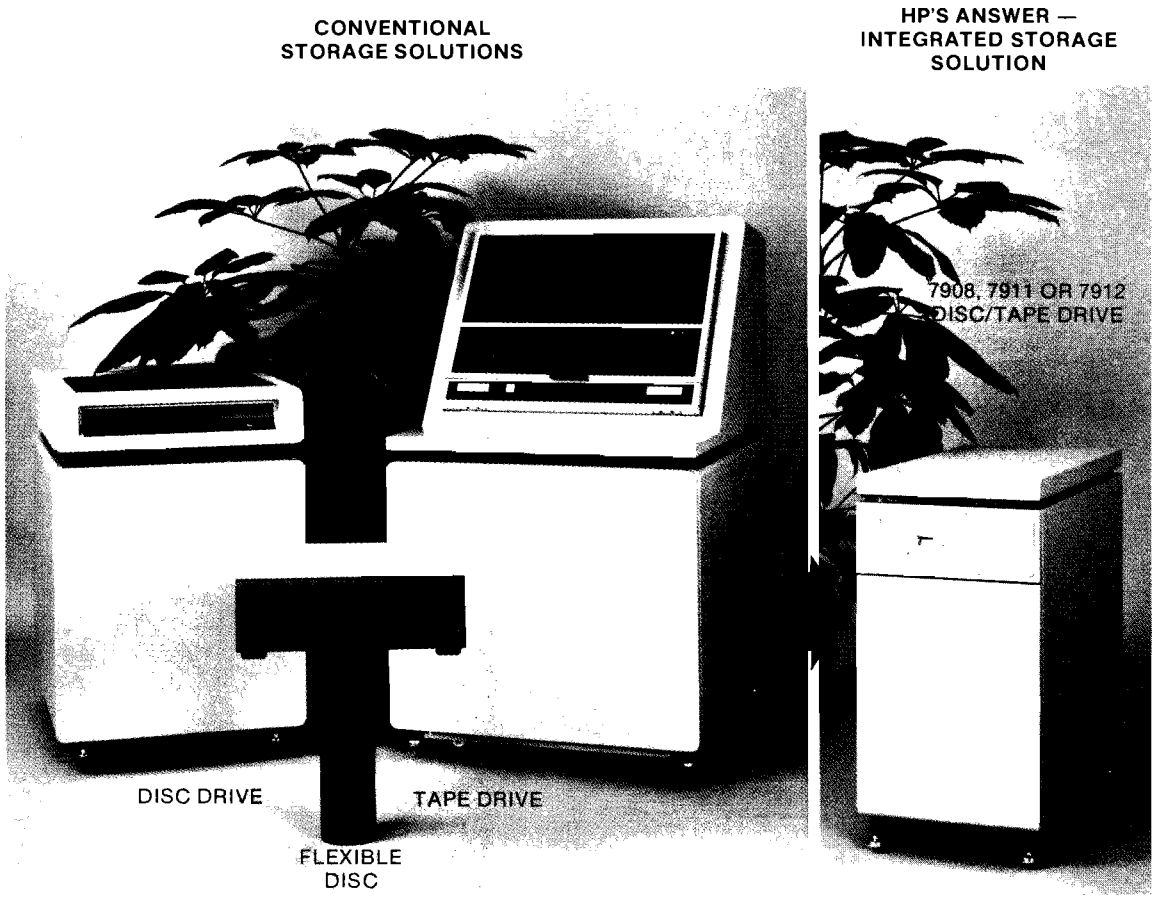


Figure 2. Floor Space Comparison

PRODUCT DESCRIPTION

The 7908/11/12 consist of three fundamental components: an intelligent disc drive, a streaming-mode cartridge tape drive, and compact modular packaging. The packaging physically integrates the disc, tape drive, controller, and power supply into a very compact unit. A brief description of these components will help to fully appreciate their contribution. (See figure 3.)

INTELLIGENT DISC DRIVE

The basic element of every 7908/11/12 is a fixed disc drive based on Winchester technology. These drives offer formatted capacities from 16.5 to 65.6 megabytes. Intelligence stems from implementing the latest microprocessor technology within the controller.

The microprocessor revolution is changing our way of life. It is also changing the way we design computer peripherals. In the past, the cost of the controller function was so high that HP developed the "shared" controller concept, yielding "master" and "slave" disc drives. Today, the increased power and diminishing costs of microprocessors make the implementation of a resident controller very cost effective.

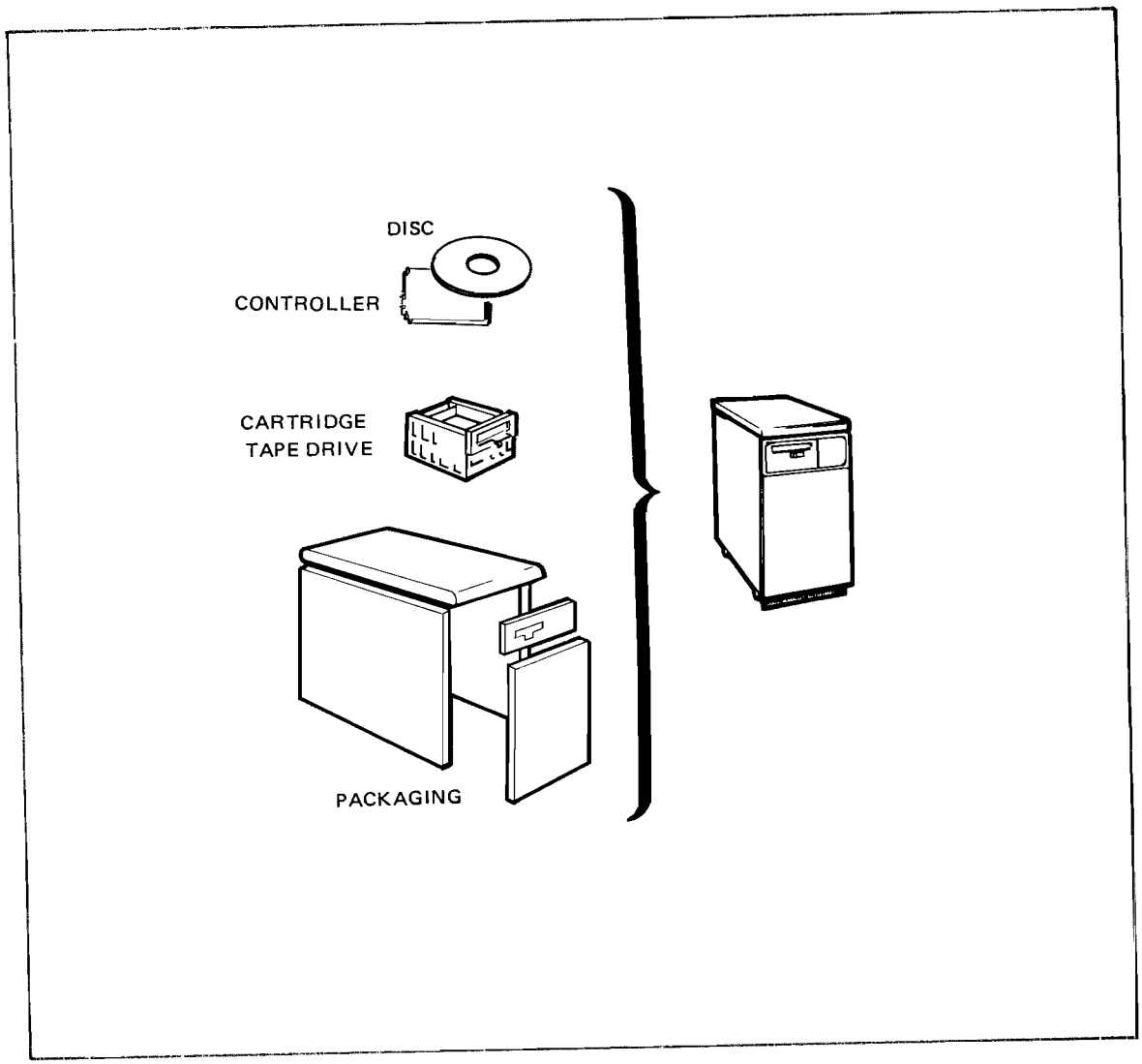


Figure 3. The 7908, 7911 and 7912

Depending on system requirements, the disc drive and the cartridge tape drive may be controlled by individual controllers or by one controller integrating both devices.

All HP 3000 systems utilize a separate controller for each disc drive and each cartridge tape drive. Data is transferred between the disc drive and cartridge tape drive via the CPU. (See figure 4.) Transfer times are dependent on the cartridge tape drive transfer rate, CPU availability, the host system utilities, and user applications.

All other supported systems (HP 1000, 9845, 9835, 250, and 64000 systems) utilize a single controller to integrate and manage the disc drive and cartridge tape drive. An internal data path allows the controller to manage disc-to-tape and tape-to-disc data transfers without CPU intervention. The controller also handles traditional CPU managed data transfers. During this type of operation only one device (disc or tape) is active at a time.

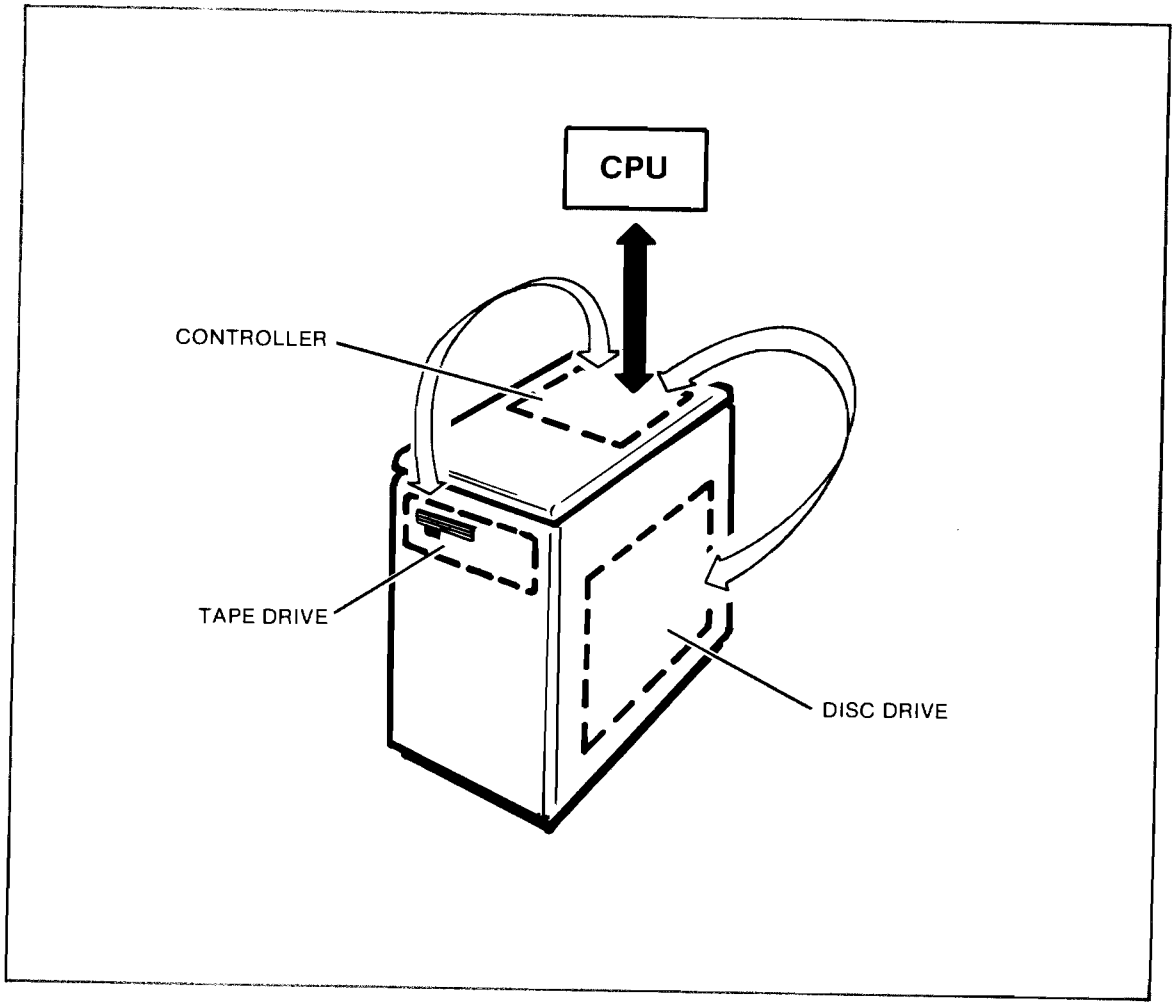


Figure 4. Data Path

DISC TECHNOLOGY. The 7908 is a medium performance disc ideal for the lower cost commercial and technical system markets. As an entry level product, the 7908 provides price/performance benefits comparable to the 7911 and 7912. (See table 2.)

The 7908 is based on a 16.5 Mbyte drive utilizing three 8-inch platters in a totally sealed enclosure. The sealed enclosure ensures successful operation in high particulate environments. There is one read/write head per surface in the 7908, totaling six heads per drive. One head (and surface) is dedicated to servo information, which is used to sense and control the radial position of the heads for both 'seeking' to a new track and 'track following'.

The heads are positioned by a linear voice coil actuator providing an average random seek time of 41.6 ms. The disc rotation speed is 3600 rpm, controlled by optical sensing electronics in the brushless dc spindle motor. The average latency, which is the time required for one-half revolution, is approximately 8.3 ms. The data transfer rate, which is dependent upon system buffering techniques, has a maximum value of 540 kilobytes per second.

Both the 7911 and 7912 utilize 14-inch media. The 7911 has one platter that yields 28.1 megabytes and the 7912 has two platters yielding 65.6 megabytes. Like the 7908, the 7911/12 disc mechanisms are totally enclosed. The 7911/12, however, have two read/write heads per surface and dedicate one head and half of a surface for servo information.

The disc rotation speed of the 7911/12 is also 3600 rpm, but the spindle is belt driven by an ac drive motor. The average latency of the 7911/12 is also 8.3 ms, but with the improved seek times, the average random seek time is a very fast 26.7 ms. The fast seek times are mainly a result of the two heads per arm configuration and the more powerful rotary actuator. The average data transfer rate is 983 kbytes per second, but is also system dependent.

For more details on the capabilities of the 7911/12, see the section entitled "Selecting the Proper Disc".

All of these products utilize Winchester disc technology. Briefly, Winchester technology is a combination of a lightly loaded, simpler designed head and specially lubricated media. The simpler head design makes manufacturing faster, easier and less costly. The geometry of the head's mechanical structure allows it to "fly" closer to the media surface, allowing increased recording densities. The lighter head loading force, combined with the lubricant media coating, greatly reduces the likelihood of a catastrophic head crash, thus enhancing reliability.

Table 2. Product Comparison

SPECIFICATIONS	7908	7911	7912
Disc Diameter (cm/in.)	20.32/8	35.56/14	35.56/14
Number of Platters	3	1	2
Formatted Capacity (Mb)	16.5	28.1	65.6
Average Random Seek (ms)	41.6	26.7	26.7
Average Rotational Latency (ms)	8.3	8.3	8.3
Average Transfer Rate (kb/s)	538	983	983
Rotation Rate (rpm)	3600	3600	3600
Technology	3350 Winchester Heads/Media Fixed Disc Design	3350 Winchester Heads/Media Fixed Disc Design	3350 Winchester Heads/Media Fixed Disc Design

Note: Overall I/O rates are system dependent.

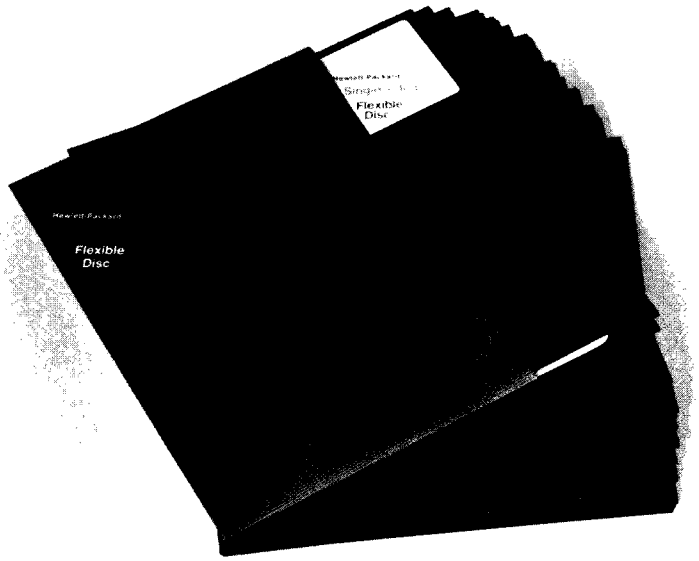
CARTRIDGE TAPE DRIVE

The cartridge tape drive, integrated into each 7908/ 11/12, provides new conveniences for the mass storage user. It offers very cost-effective, backup capabilities as well as a convenient solution for I/O and software distribution.

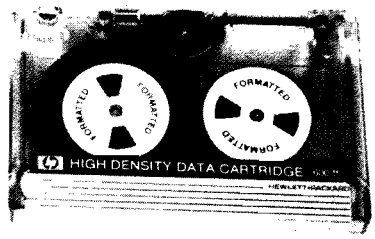
The tape drive utilizes a standard DC-600 type tape cartridge, capable of storing up to 67 megabytes of formatted information. There are two versions of the tape cartridge, offering 16.7 or 67 megabytes of storage. Both are fully interchangeable in the tape drive requiring no special system reconfiguring or operator adjustments. With these cartridges, the tape drive has the ability to backup any 7908/11/12 on a single, low cost cartridge. Gone are the days when small system backup required managing a multitude of floppy diskettes. (See figure 5.)

The 16.7 megabyte cartridge has 75 percent less tape than the 67 megabyte version. This means that a full volume search (beginning-of-tape to end-of-tape) takes 75 percent less time than the 67 megabyte cartridge. Thus, the 16.7 megabyte cartridge is better suited for applications requiring more frequent cartridge loading and unloading, such as personal I/O, software distribution, or file searching.

Every cartridge tape drive unit comes equipped with a tape cartridge and a head cleaning kit. A 16.7 megabyte cartridge comes with the 7908 and a 67 megabyte cartridge comes with the 7911/12 drives. Extra cartridges and other accessories are available from HP's Computer Supplies Operation (CSO) in the U.S. and HP supply organizations outside the U.S.



SIXTY 1-MBYTE
FLOPPIES
(~ $500)



ONE 67 MBYTE
CARTRIDGE
(~ $33)

Figure 5. The Media Choice

TECHNOLOGY AND KEY OPERATIONAL FEATURES. The high capacities achieved by the cartridge tape drive are a result of unique 16-track recording. Each track is further preformatted into addressable 1 kilobyte user blocks. (See figure 6.) This recording scheme allows individual files or records to be addressed in a similar fashion to discs. The data is recorded in a serpentine fashion (each track is recorded in the opposite direction of its adjacent tracks) to eliminate rewind time between tracks.

The tape drive can seek randomly to each of the 16 tracks by way of a stepper motor-driven movable read/write head. Once on the proper track, the drive has the ability to read forward or backward to locate the addressed user block. Search speed is 90 inches per second (ips) and the read/write speed is 60 ips. Therefore, the average amount of time required to find any file on the tape is approximately 10 seconds for the 16.7 megabyte tape and 40 seconds for the 67 megabyte version.

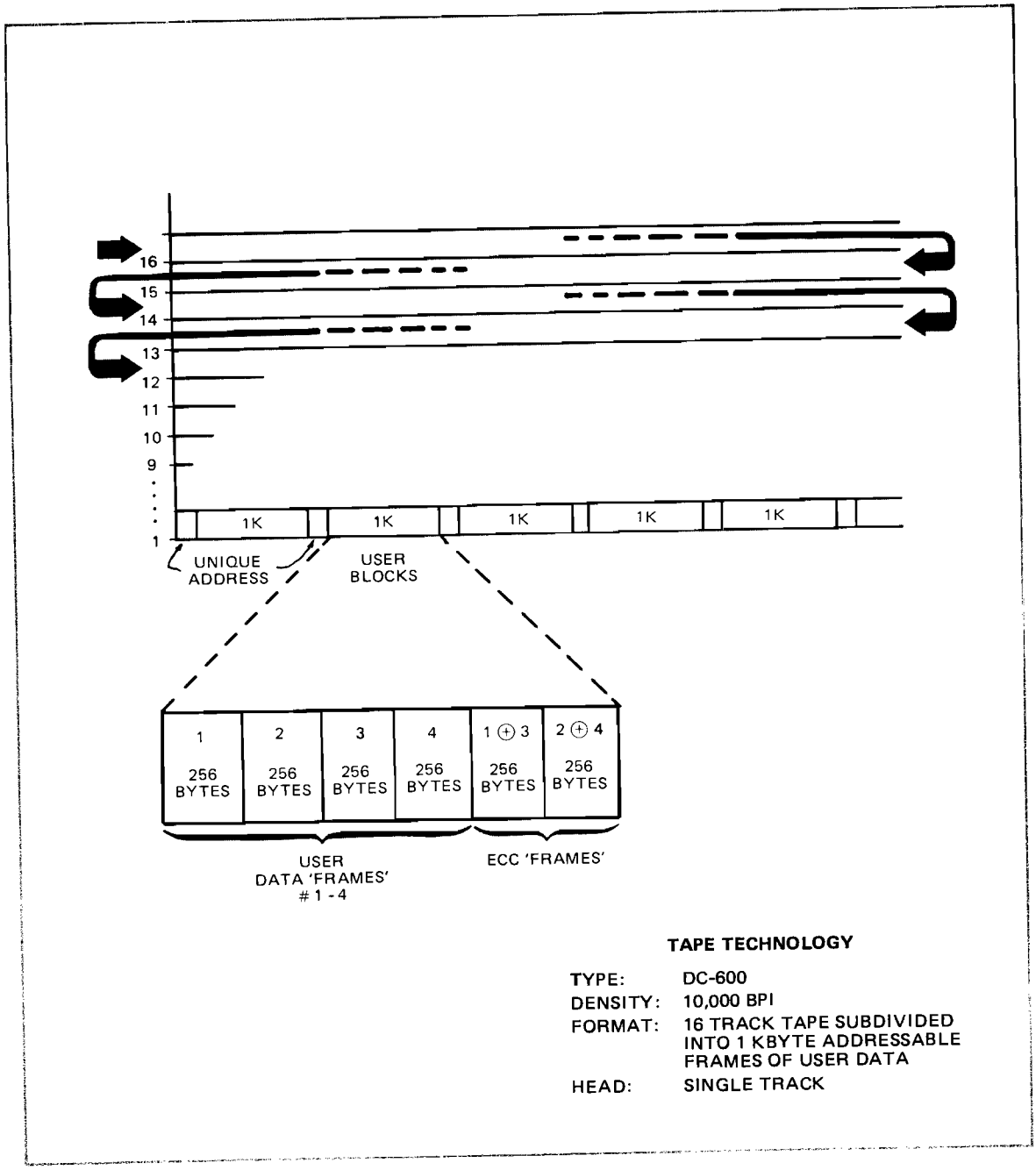


Figure 6. Tape Formatting and Technology

To enhance the level of data integrity required by system users, the tape drive utilizes an "exclusive-or" Error Correction Code (ECC) technique capable of recovering most data errors due to tape defects. All data is written with 50 percent redundancy (1024 bytes of user data maps into six 256 byte "frames"). (See figure 6.) This technique makes it possible for up to two consecutive data frames to be lost without affecting data integrity, or tape performance, since the correction is done in "real-time". In other words, the tape's ECC scheme can correct data errors up to a full 512 bytes in length!

Every time a tape cartridge is plugged into the drive, a retensioning and auto-calibration routine is invoked. During this routine, the tape is rewound from its "storage position" to the beginning of the tape. The tape drive head is then calibrated to the particular cartridge in the drive, insuring proper head positioning.

After the tape has been used, it is rewound to its "storage position" again. This is done automatically when the unload button is pushed. These operations help ensure the cleanliness, proper tensioning and alignment of the media, resulting in very high data reliability.

BACKUP. Systems which utilize a single controller to integrate and manage both the disc drive and the cartridge tape drive (HP 1000, 9845, 9835, 250 and 64000 systems) have an image copy transfer rate (disc-to-tape) of 2 megabytes per minute. At this rate, an exact copy of the 16.5 megabyte 7908 can be made to the integral tape in under 10 minutes. A copy of the larger 7912 drive can be made in only 35 minutes via the shared controller. These copies can be completely executed by the drive controller, i.e., no host intervention! The host computer is free to perform other processing tasks while the drive controller manages backup (as long as no disc accesses are requested by the host).

The more familiar "selected file" backups are also possible, with performance dependent on system-provided utilities. Consult your system user's manual for details of host backup utilities.

All HP 3000 systems utilize a separate controller for each disc drive and each cartridge tape drive. *Only* "selected file" backups are possible on 3000 systems. Data is transferred between the disc and tape via the host CPU. Transfer rates are dependent on the tape drive transfer rate, CPU availability, the host system utilities, and user applications.

RELIABILITY. The mechanical simplicity of the tape drive contributes greatly to the drive's high reliability. A dedicated microprocessor has replaced traditional analog circuitry normally associated with tape drives. Additionally, all tape tensioning is performed internal to the cartridge, eliminating complex mechanics and electronics present in larger drives. The retensioning and auto-calibration conditioning process serves to properly tension the tape, prior to any read/write operations. In addition, all of the tape's driving and guiding mechanisms are housed inside the tape cartridge. As a result, the drive mechanism never touches the media. This allows an average life expectancy of 5,000 cycles (end-to-end) for the cartridge comparable to a complete daily backup for 2 years!

The tape's ECC scheme is capable of recovering most data errors. In addition, all "marginal" data areas are flagged automatically when the tape is used and later skipped when the tape is rewritten. Consequently, the error rate actually decreases as the tape is used! (Up to a point, of course.)

This tape drive is designed to perform optimally in streaming operations. Therefore, start/stops should be kept to a minimum. An increase in the number of start/stops will accentuate the wear of the mechanism. Performance, as well as reliability, is at its maximum when the tape is kept streaming.

RESIDENT CONTROLLER . . . FUNCTIONAL INTEGRATION, RELIABILITY

The benefits of having an intelligent controller resident in each drive are quite significant. One benefit is that system reliability and, hence, availability is increased; one drive can fail without bringing down the whole system. Serviceability of the drive is also greatly enhanced by the presence of the sophisticated internal "brain" inside each disc drive. (See figure 7.)

To elaborate, the following paragraphs present some of the major capabilities of the 7908/11/12, mainly attributable to the controller.

INTERNAL DIAGNOSTICS. One of the major goals guiding the design of these products was low cost of ownership. Highly reliable and serviceable drives are essential to low maintenance costs. The 7908/11/12 have a set of tools that simplify the process of diagnosing and repairing failures, if and when they occur.

These tools are a set of sophisticated diagnostics that are resident in the controller's firmware. These diagnostic routines are capable of isolating a malfunction, in a disc-based system, to the disc with 99 percent accuracy. In addition, once the disc has been identified as the cause of the system failure, the diagnostic routines can identify the particular subassembly within the disc that failed, with 95 percent confidence. This aids service personnel and greatly reduces the cost of maintenance.

A special set of tracks on the disc are set aside as maintenance tracks. The results of the special internal diagnostic utilities are stored on the disc maintenance tracks and are accessible by service personnel to review the drive's fault history and error rate performance. Drive faults and data errors are automatically logged on the maintenance track, providing service personnel with a useful tool for diagnosing intermittent failures. This is a tremendous aid in diagnosing drive failures, and results in a significant reduction over the mean time to repair (MTTR). HP continues to focus on this very important factor in the cost-of-ownership.

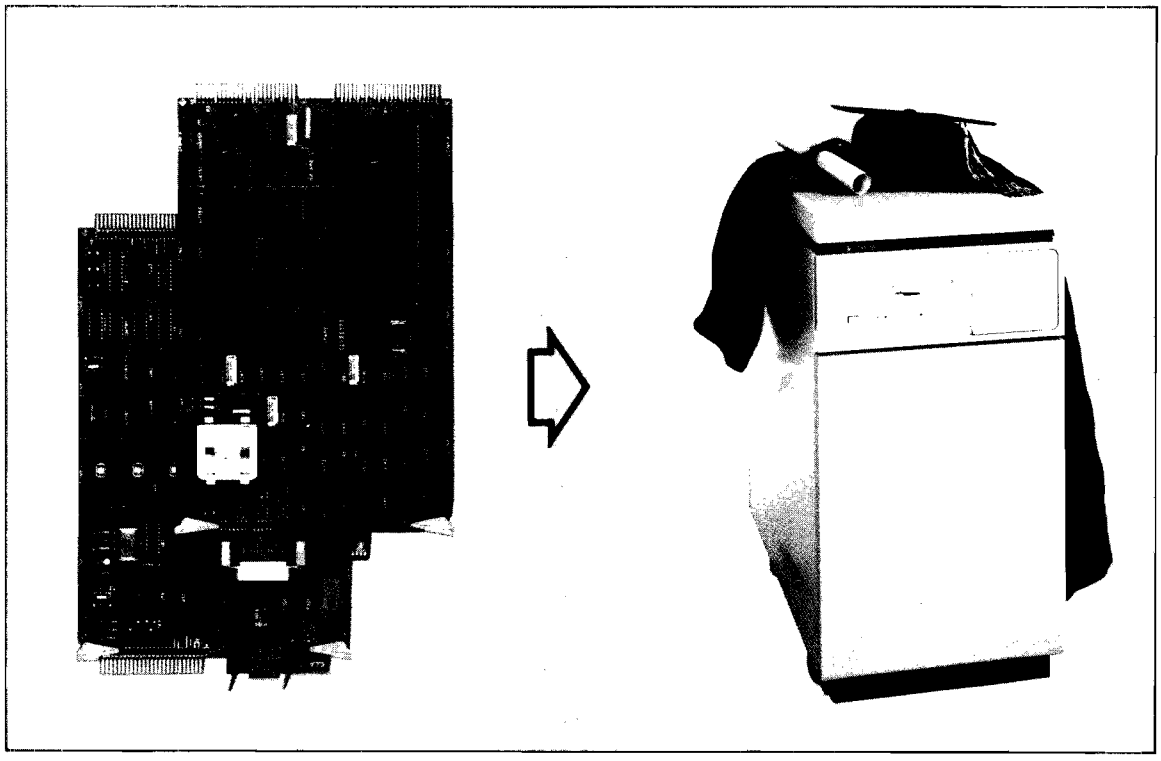


Figure 7. Intelligent Controller

"Background" diagnostics are a subset of the internal diagnostics package. The purpose of the background diagnostics is to preserve the integrity of the disc by testing some critical areas of the drive between periods of host-user activity.

The background tests are short (less than 100 microseconds) and are nondestructive of current drive status. These tests are related to the preservation of the integrity of the drive in operation and are not intended to isolate faults (the job of the Internal Diagnostics). They complement the internal diagnostics by monitoring areas of the drive not covered by hardware fault indications. If a potential problem is found, a status message is sent to the CPU. The CPU now determines whether to ignore the status message or invoke the major diagnostics to further isolate the problem.

EXTERNAL EXERCISER. Host system diagnostic exercisers are provided for each system utilizing the 7908/11/12 disc/tape drives. These exercisers are loaded into the host system in the same manner as a user program. This "external exerciser" is capable of:

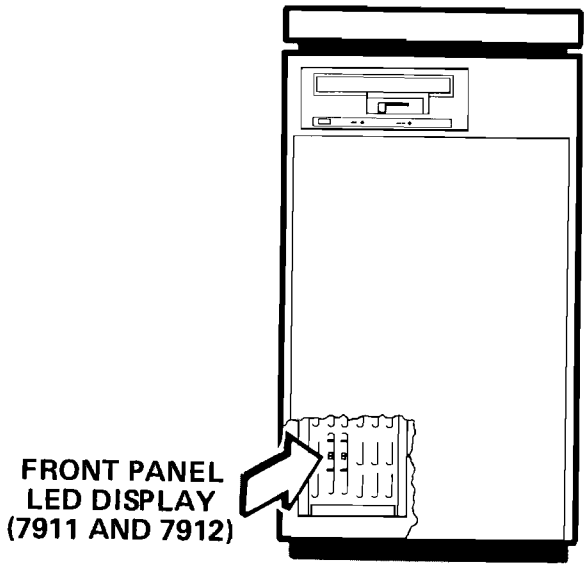
- Invoking the internal diagnostics (or a subset thereof).
- Calling special utilities in the drive firmware that perform error rate and fault tests of the drive, as well as reading the performance history of the drive from the maintenance tracks.
- Performing checks of the channel to the host as well as the complete interaction of the drive with the host CPU.

From the operator's standpoint, the external exercisers look the same for all HP systems. They use the same input prompts and issue identical reporting messages. This minimizes training of service personnel required to support installations involving diverse types of HP systems.

In order to simplify the usage of these diagnostic capabilities, a diagnostic interface was added to the drives. The diagnostic interface for the 7908/11/12 consists of two switches and a seven-segment light-emitting diode (LED). (See figure 8.) The display will show the status of the drive during normal operations. However, during diagnostic operations, it will display information on the test being performed. If a subassembly has been found to fail, the appropriate information will be displayed. The code displayed by the LED allows trained personnel to isolate drive faults to the module level in 95 percent of the instances. To find out more on the diagnostic interface, consult the appropriate service manual.

The diagnostic routines can be initiated in three ways. First, the entire set of routines are executed at power on; second, via the diagnostic interface included with each drive; and lastly, by program control through the external exerciser within the host.

CS/80 AND HP-IB. The 7908/11/12 and 7933 disc products utilize HP-IB and CS/80. CS/80 is the instruction set for mass storage devices adopted by HP to increase the efficiency of channel operations between mass storage devices and their associated host computers. The disc communicates with the host CPU over the HP-IB via CS/80. CS/80 optimizes the efficiency of the HP-IB. For example, in previous non-HP-IB drives, in order to read data from the disc, two commands were issued across the bus. One command was specified to locate the data and the other command was issued to read the data. In CS/80, one command accomplishes both. In addition, because these drives utilize CS/80, the user has flexibility in configuring a system and a tremendous mass storage growth path. (See figure 9.) Any system programmed to communicate with one CS/80 disc can essentially utilize all four types. (However, not all four drives are supported on all systems. Only drives offering the most practical configurations are typically supported — see appropriate system configuration guide for details.)



NOTE: LED DISPLAY IS ON THE BACK PANEL OF THE 7908.

Figure 8. Diagnostic Interface

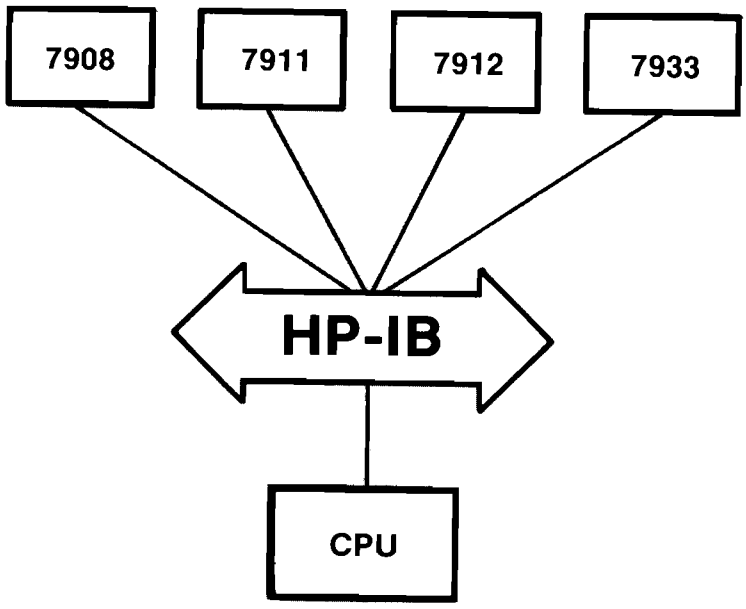


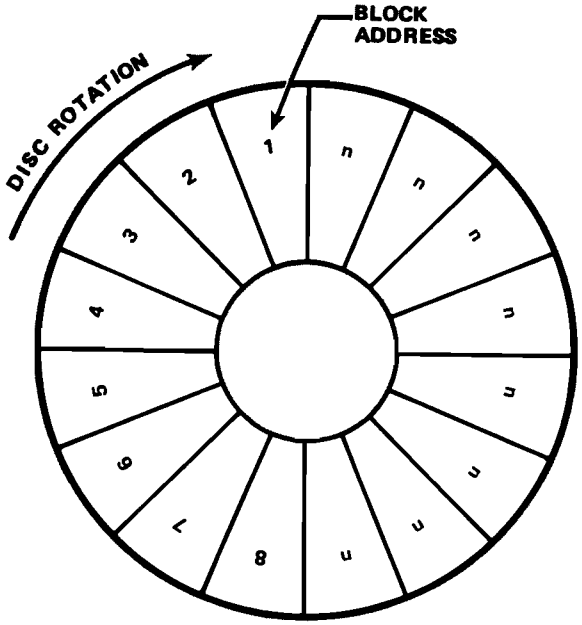
Figure 9. Configuration Flexibility

The following four functions of the controller are designed to off-load most of the device management responsibilities normally associated with the CPU:

- Auto Track and Sector Sparing — One sector per track is held in reserve as a spare. This allows a defective sector to be spared without losing the complete track. Track sparing will occur if a second defective sector is found on a given track. This sparing occurs transparent to the host, thus contributing to system performance by reducing CPU overhead normally associated with disc management.
- Auto Error Recovery — If the controller seeks for a particular sector and discovers that it is on the wrong track, "retries" or attempts to reseek will be initiated from track zero to find the proper track. Also, if a sector read fails, then the controller will initiate retries to read the sector. The number of retries are system dependent. This results in improved system performance and reduced system overhead, since the controller initiates the retries as opposed to the host.
- Programmable Performance — A data buffer resident in the controller and programmable sector interleaving allow the disc's data transfer rate to be tailored to fit the requirements of various host systems.
- Real Time ECC — Error Correction (7911 and 7912 only) is performed in real time via a VLSI silicon-on-sapphire chip resident in the disc electronics. The ECC chip replaces an entire printed circuit board needed to implement ECC by previous methods.

The performance of these HP disc products exceeds the performance of some host CPU's. Therefore, slowing down the disc's average transfer rate, accomplished here by interleaving, serves to match the performance of the CPU. Interleaving is the process of alternately numbering sectors on the disc. This reduces the occurrence of latencies on the disc that are associated with reading a requested sector before the host is ready to accept it. In this way system performance is optimized. (See figure 10.)

The interleaving process is very similar to that found on the HP 9895 flexible disc. This optimizes throughput by matching disc and system performance.

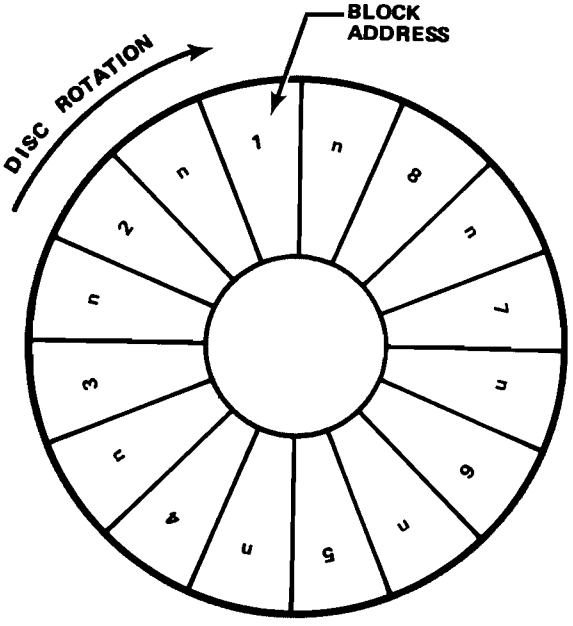


CASE 1

INTERLEAVE = 1

DATA TRANSFER SEQUENCE (BLOCKS 1 - n)

1. The disc drive reads and transmits block 1.
2. The disc drive head is now at block 2 but, because the host is still busy with the first transfer, the drive can not read and transmit the second block.
3. The host finishes accepting block 1 and readies itself for block 2. By this time the drive head has passed the beginning of block 2 and the host will now have to wait for the disc to make a complete revolution back to this block. This induces a latency and degrades system throughput.



CASE 2

INTERLEAVE = 2

DATA TRANSFER SEQUENCE (BLOCKS 1 - n)

1. The disc drive reads and transmits block 1.
2. The host finishes accepting block 1 and readies itself for block 2. Because the blocks are interleaved, the disc drive head is over the intervening block and is approaching block 2.
3. The disc drive head arrives at block 2, and reads and transmits it to the waiting host. By using block interleave to alternate the data blocks, latencies have been eliminated and system throughput has been enhanced.

Figure 10. Sector Interleaving

PACKAGING: QUIET, GOOD LOOKS

The final element of the 7908/11/12 line is innovative packaging which mechanically integrates the intelligent disc drive and tape drive into a single compact unit. (See figure 11.) The disc drive and tape drive share both controller and power supply, as well as the same cabinetry. This packaging cuts manufacturing costs, reducing the price of the finished product, at the same time reducing floor space requirements.

There are two packaging options available for the 7908/11/12 line: a rackmount and low profile cabinet. The rackmount version is designed to fit standard 19" E.I.A. cabinets with the 7908 seven inches high and 7911/12, 12-1/4 inches high.

The serviceability of this rackmount design has been vastly improved over past HP rackmount configurations. The drive no longer has to be removed completely for servicing. The 7908 PC cards are accessible from the rear, whereas the 7911/12's are in the front, and can be serviced by simply removing the front panel.

The low profile version is an attractive cabinet ideally suited for office environments. It was designed with aesthetics and convenience in mind. It is supplied with ample sound-deadening material resulting in very quiet operating sound levels (approximately 52 DBA for the 7908), a must for the office environment. (See figure 12.)

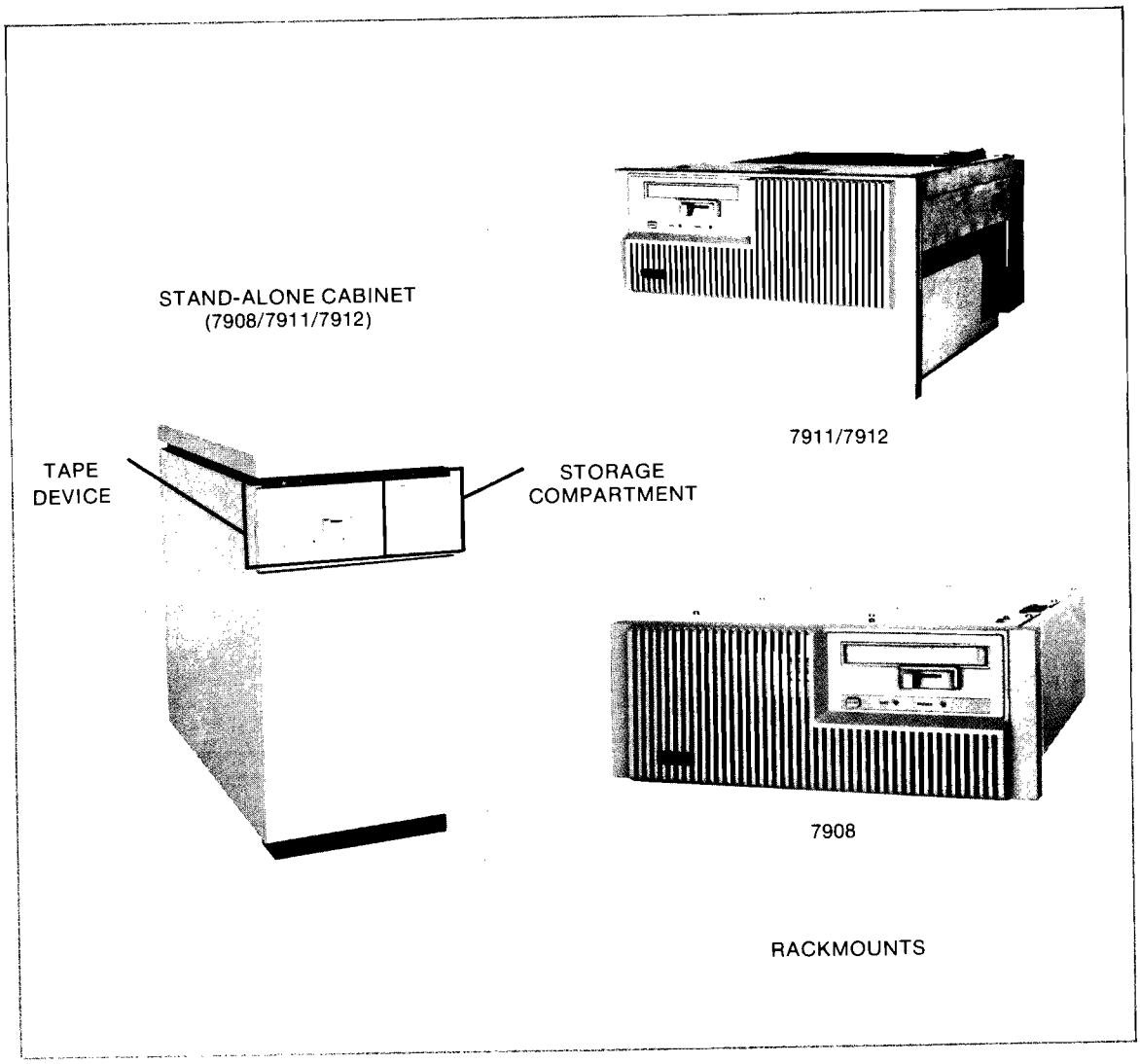


Figure 11. Packaging

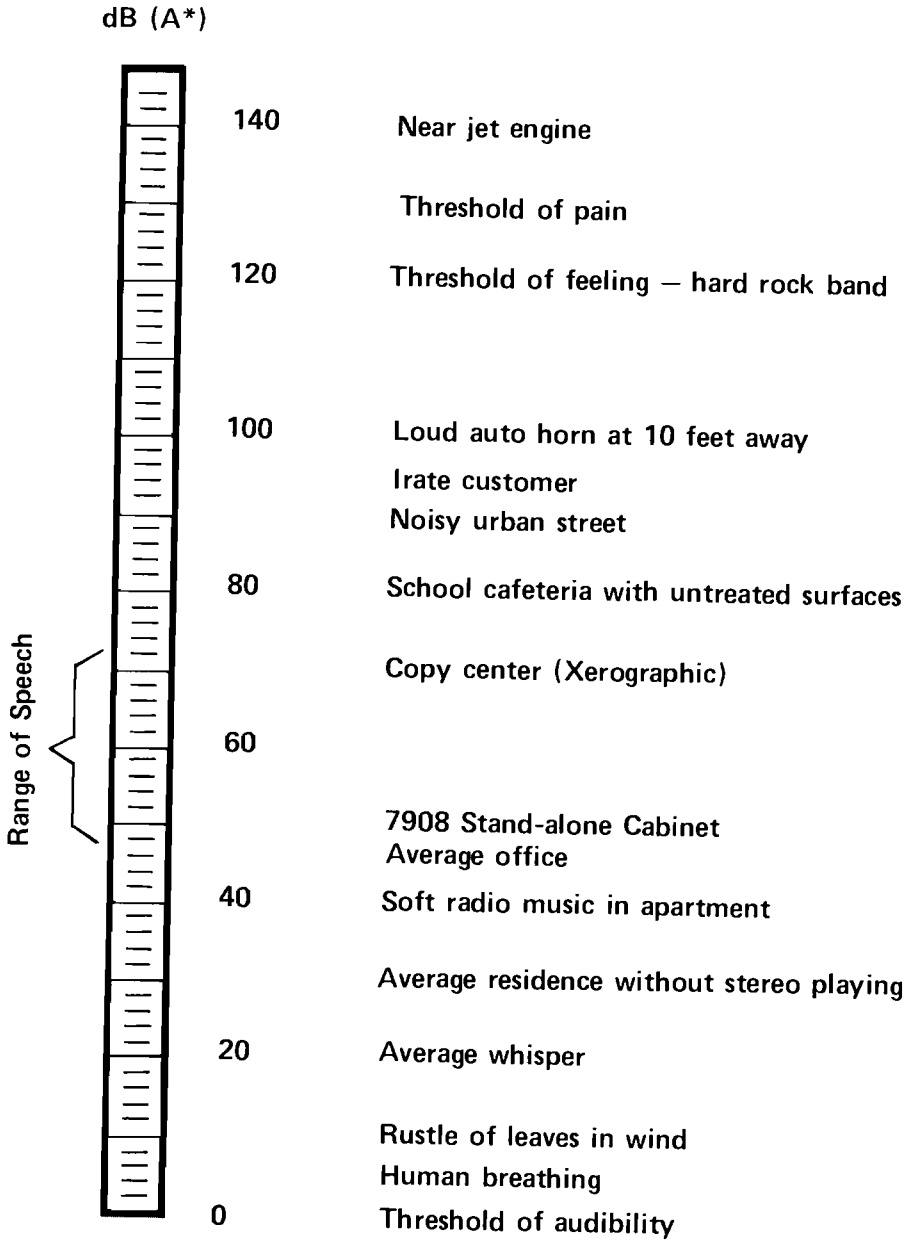


Figure 12. Sound Level Comparison

The cabinet is convenient in several ways. First, it is set on casters for easy movement. Second, the tape drive is in a convenient position for tape cartridge loading and unloading. (See figure 11.) There is also a special compartment right next to the cartridge tape drive for convenient storage of cartridges, head cleaner and other user necessities. (See figure 11.)

This approach to packaging an intelligent disc with the cartridge tape drive provides the user with a *total* compact solution to peripheral storage requirements.

SELECTING THE PROPER DISC

When making a disc selection, the situation will arise where short-term needs are satisfied with a 7908. In many instances, the *best* decision might be a 7911 or 7912, for reasons of growth and performance.

The growth of the system means a growth in peripheral storage requirements. The 7908 may get the job done today, but tomorrow new applications or larger file systems may exceed its capacity. This is dramatized by the statistic that the average data growth of a "typical" system is 30 percent per year!

The 7911 offers 70 percent more capacity than the 7908 while the 7912 has four times the capacity. The 7911 offers 11 megabytes of additional storage for only a 26 percent increase in price! The 7912 gives four times the capacity of the 7908 for only a 52 percent increase in price! Buying a 7911/12 initially is much less expensive than adding an extra disc at a later date.

SUMMARY

The 7908/11/12 disc products represent a significant contribution to the computing industry. The 7908, 7911 and 7912, with capacities of 16.5, 28.1, and 65.6 megabytes, respectively, are all Winchester discs with a resident, sophisticated controller and an integrated cartrdige tape drive. The combination results in a package that performs the three major peripheral storage functions: mass storage, backup and I/O, at *40 percent of the price* associated with the traditional solution (disc, 1/2″ tape, and floppy) and *25 percent of the floor space requirements.*

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