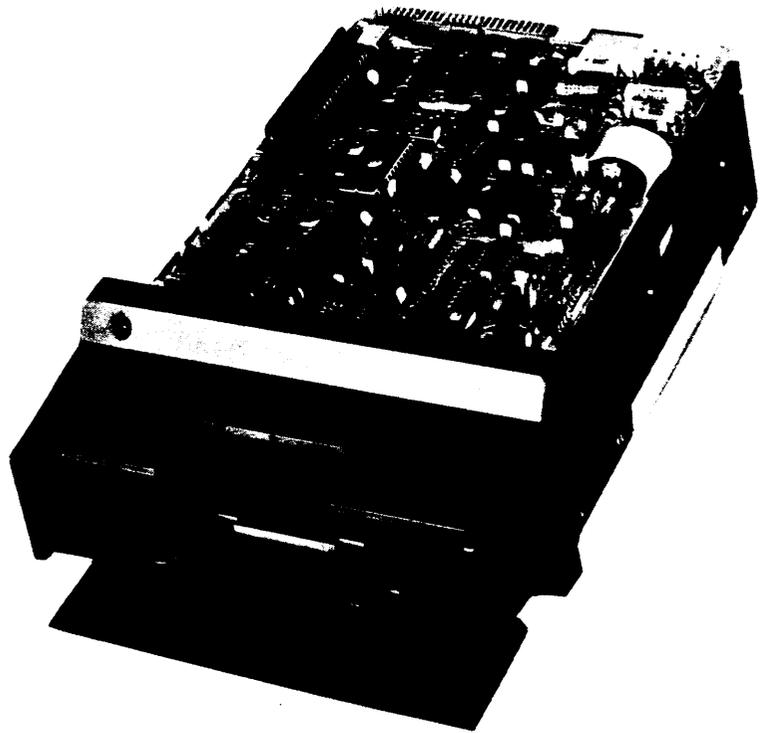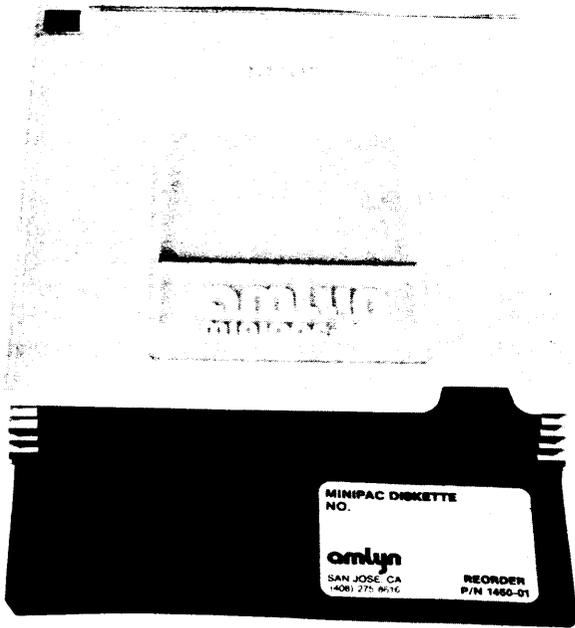# AMLYN DISK DRIVES

With the ever growing popularity and sophistication of desktop computer systems, the need for higher storage capacity continues to accelerate. Until recently systems designers were limited to the relatively low capacities and performance characteristics of floppy disk drives due to cost, size, packaging and power requirements. In 1980, the 5-1/4" Winchester disk drive was introduced to the OEM marketplace to respond to the need for low cost, high capacity storage for desktop systems, and has become quite popular as witnessed by the large number of suppliers of this type of product. With the emergence of 5-1/4" Winchesters, systems designers are offered a solution to one problem and are presented with yet another. The problem is the selection of a suitable backup device to the Winchester.

Amlyn Corporation of San Jose, California offers both a suitable solution to the backup problem and also an alternative to the Winchester drive where total system cost is important. This is possible by the intelligent employment of currently available technologies in a minifloppy size package to provide a total of eight megabytes of unformatted data capacity.

This is achieved by the use of high resolution 5-1/4"
media certified at 9500 bits-per-inch and 170 tracks-per-inch,
packaged within a removable MiniPac cartridge with five
diskettes per cartridge. Data are recorded on 154 tracks using
one surface providing 1.6 megabytes of unformatted capacity,
the same capacity as an eight" double sided, double density
floppy disk drive, on each diskette. The formatted capacity
of each cartridge is dependent upon the host system as with
other magnetic media devices and typically ranges from 5.1
to 7.2 megabytes.

To address the need for higher storage capacity than currently available with other floppy disk drives, the Model 5850 as shown in Figure 1, uses a Shugart Associates SA850 interface allowing the systems designer to use present controller and software designs. With this model, the Amlyn device appears on-line as five separate eight-inch double sided, double density floppy disk drives. Individual drive select or binary coded unit address lines determine which diskette is removed from the cartridge and loaded onto the drive spindle. With this particular application, a backup device is not necessary, allowing for a low cost entry level or single user system.

Until now, a suitable backup device for 5-1/4" Winchester disk drives was not available due to cumbersome software and interface requirements. Low cost tape devices are currently being used, but one must contend with the need for special software for backup management, the source for a suitable controller, and the situation that develops when the Winchester malfunctions causing the system to be inoperative. These problems are solved with the Amlyn A506 because it is physically and electrically compatible with the ST506 Winchester disk drive and has random access capability. By being compatible with the ST506, the Amlyn device may function with the same software and controller as the Winchester. It is interesting to note that the same change required to a floppy disk controller to function with a 5-1/4"
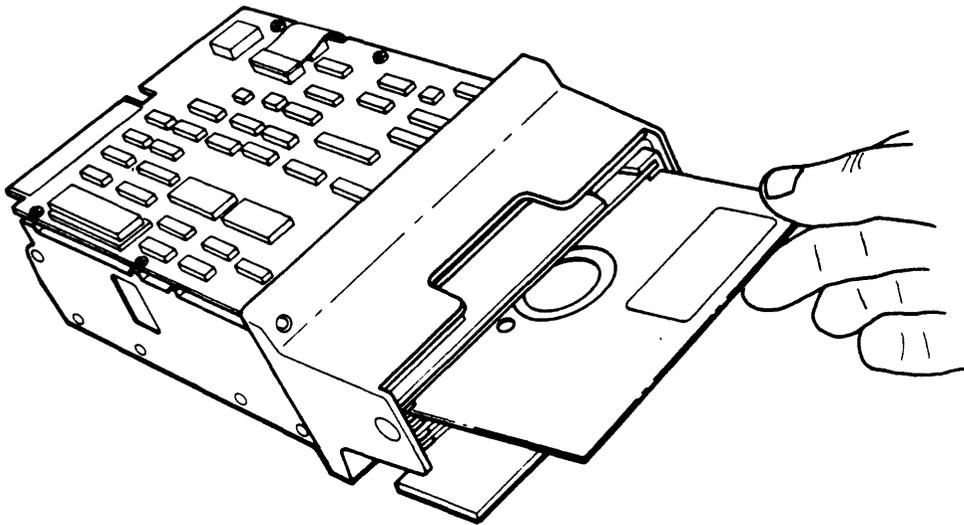
Winchester also applies to the Amlyn device, except in reverse. For the floppy disk controller to accommodate a 5-1/4" Winchester, it is necessary to modify the data encoder/decoder to operate with a data transfer rate of five megabits per second, much higher than either 5-1/4" or 8" floppy disk drives. Since the Amlyn device transfers data at five hundred kilobits per second, a 5-1/4" Winchester controller must only be modified to accept the lower transfer rate of the Amlyn device.

In the Winchester backup application, the encoded head select lines, used for individual head selection by the 5-1/4" Winchester, are used to select a particular diskette for reading or writing. Since there are five diskettes within the MiniPac cartridge and only four heads in an ST506 or equivalent, one diskette is a spare and may be used for program loading or additional storage.

To achieve these levels of flexibility and performance a number of developments were necessary and are described in the following paragraphs. Major development areas were the MiniPac cartridge and diskette, cartridge articulation tray, diskette picker, spindle drive, composite read/write head, and thermal compensation. All mechanisms are under the control of an Intel 8051 microprocessor and support chips, including 256 bytes of RAM and 4K bytes of PROM.

MINIPAC CARTRIDGE AND DISKETTE

Each MiniPac cartridge contains up to five individual 5-1/4" diskettes and may be removed and replaced as desired. Each individual diskette within the cartridge may also be removed and replaced for system flexibility as shown in Figure 2. The cartridge is used to hold and protect the diskettes, and to function as one part of a stable surface for the diskette jacket while the unit is operating. A mechanical detent is located on the side of the cartridge to hold the diskettes in place.

To reliably achieve a track density of 170 tracks-per-inch each diskette is pre-recorded with a "reference track" located outside of track 0. See Figure 4. The reference track serves as a known point from which all data tracks are located. Since the reference track is located on the diskette and subsequently travels with it, interchangeability of diskettes between units is assured without the need for a track 0 sensor and alignment, or any head adjustment.

When the cartridge is inserted into the drive and the front panel is closed, a stepper motor is in control of tilting the cartridge for individual diskette selection.

CARTRIDGE ARTICULATION TRAY

The task of the cartridge articulator tray is to properly align the cartridge to an angle where the picker mechanism can grasp the diskette and remove it from the cartridge to be loaded onto the drive spindle.

A photosensor is employed to identify a "cartridge home" position. Depending upon the application, when drive select or head select lines are activated on the interface the microprocessor decode the lines, determines which diskette is to be used and supplies the necessary number of step pulses to the cartridge articulator stepper motor. This causes the cartridge to be aligned with the picker mechanism.

DISKETTE PICKER

The diskette picker is also controlled by the microprocessor and is used to remove a diskette from the MiniPac cartridge and load it onto the drive spindle. This is a very simple device that is driven down a linear shaft to a cam. The cam causes the picker to open and grasp a diskette at the hole in the diskette jacket provided for this purpose. The picker motor then reverses and pulls the diskette towards the spindle for loading. To replace a diskette in the cartridge the sequence is reversed.

SPINDLE DRIVE

A DC motor is used to provide for worldwide applications and is connected to the spindle by a drive belt. The normal rotational speed of the spindle is 360 revolutions per minute. To facilitate reading of 5-1/4" diskettes written at densities of 48, 96 and 100 tracks-per-inch, the speed of drive motor is controlled by the microprocessor. When a diskette which does not contain a reference track is loaded onto the drive spindle, the microprocessor causes the spindle to be rotated at 600 revolutions per minute to provide a data transfer rate of 500 kilobits per second.

By controlling the rotational speed of the diskette and microstepping the read/write head, upward media compatibility
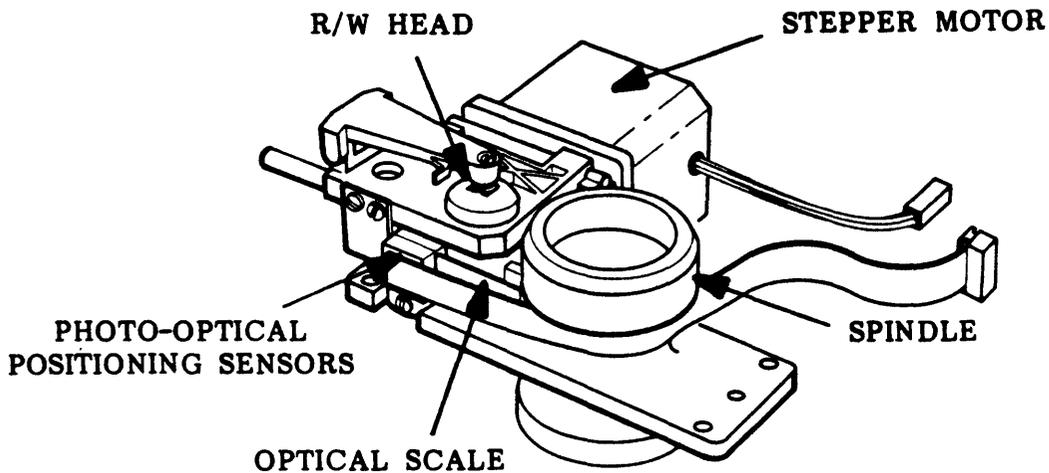
is provided for with 5-1/4" diskettes written at other track densities.

READ/WRITE HEAD

To ensure reliable operation and compatibility with existing systems, a conservative approach to the high capacity of each diskette is taken. The Amlyn device uses single sided recording at a bit density of 9500 bits-per-inch and 170 tracks-per-inch. The read/write head is a composite design consisting of manganese, zinc and ferrite and is glass bonded in a ceramic slider. The composite design was chosen due to volume supply and the relatively high track density employed. This basic head design is also used by Winchester disk manufacturers at much higher track densities.

HEAD POSITIONING

Read/Write head carriage positioning is accomplished in a similar manner as 5-1/4" Winchester disk drives with some differences. The drive mechanism depicted in Figure 3 consists of a stepper motor connected to the read/write head carriage by a stainless steel band. The carriage is supported by two guide bars for stability and accuracy of positioning. The read/write head carriage rides on a main guide bar using teflon bushings to reduce friction and wear.

R/W HEAD   STEPPER MOTOR

PHOTO-OPTICAL
POSITIONING SENSORS   SPINDLE

OPTICAL SCALE

      Since the stepper motor is controlled by the on-board microprocessor a number of stepping techniques are possible with appropriate firmware. This also facilitates easy system integration. The Amlyn device can operate in three modes of operation, all user transparent.

      The normal step rate for both floppy disk drives and 5-1/4" Winchesters is 3 milliseconds per step which causes the read/write head carriage to move one track. To lower access times some manufacturers offer a buffered step mode where step pulses are supplied at a much faster rate, allowing the drive to develop a slew or acceleration profile. Other manufacturers recommend a certain slew algorithm output by the controller with a half step option installed within the drive to allow it to increase and decrease the rate of carriage travel in accordance with stepper motor performance characteristics.
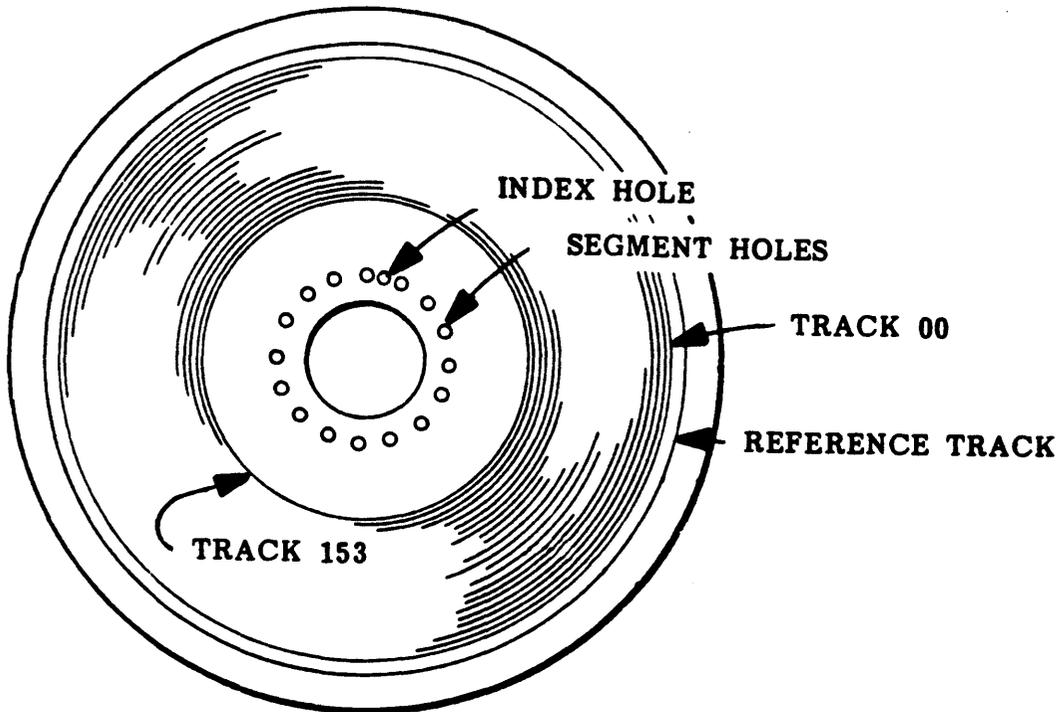
Since the Amlyn device is microprocessor controlled all of the three approaches mentioned are accommodated by the drive using resident firmware. If step pulses are supplied faster than a 3 millisecond rate they are stored in PROM and dynamically examined by the microprocessor. A velocity profile is then applied to the stepper motor to achieve the lowest access time possible. This results in an average access time of 85 milliseconds.

THERMAL COMPENSATION

One of the biggest concerns and limiting factors to achieving higher capacities with floppy disk drives is the uneven expansion and contraction of the diskette's mylar substrate caused by temperature and humidity. This phenomenon also causes both track 0 and head adjustments to be relatively difficult to make. Diskette damage or wear to the centering hole also contributes to this problem because if the diskette is not properly centered on the spindle read errors occur.

To solve these problems, Amlyn uses both a reference track prewritten on each diskette as depicted by Figure 4, and an etched mylar scale located on the head carriage. The scale is made of the same substrate material as the diskette and expands and contracts at the same rate as the diskette.
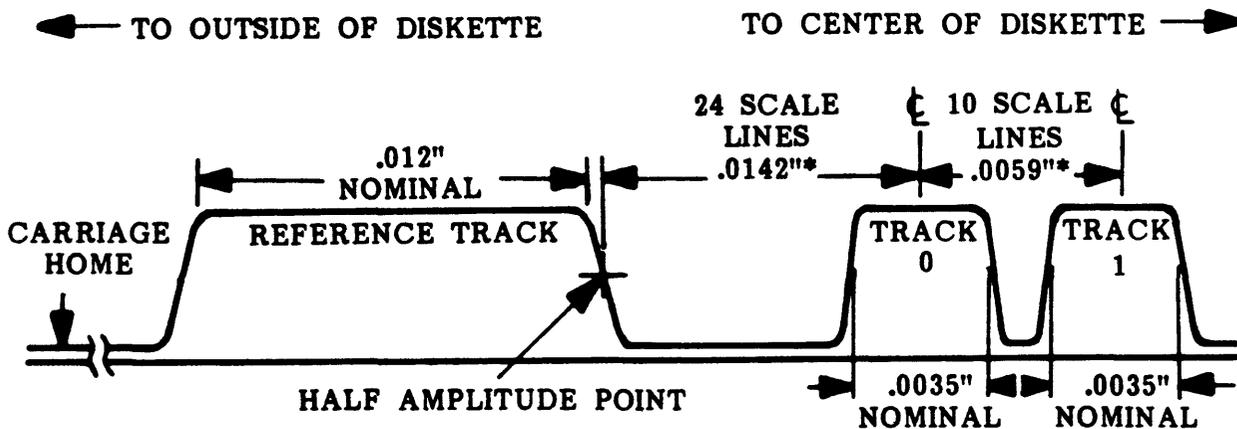
By periodically comparing the location of the reference track
to the mylar scale, expansion or contraction of the diskette
can be determined and compensated for with the stepper motor.

The reference track is also used to calculate and correct
for improper registration of the diskette. When a diskette is
loaded onto the drive spindle, the head   automatically seeks
the reference track which is pre-recorded with a known data
pattern and reads it.   At eight positions around the track
identified by segment holes, eccentricity, or runout, is
calculated and stored in RAM. If the eccentricity is equal to
or greater than two mils, the centering cone is automatically
reclamped to more precisely center the diskette.   If the

diskette is centered within two mils, the head is moved to the object track and, as the diskette rotates, the correction factor previously calculated and stored in RAM is used to cause the head to dynamically follow the centerline of the data track.

At periodic intervals, the head is driven to the reference track and the correction factors are again calculated. The head is then returned to the object track. If the drive is selected at the recalibraton time, the recalibration is not performed until the drive is deselected by the controller. With this method, compensation for changes in temperature and humidity effects is dynamic and transparent to the host system. See Figure 5 for reference and data track locations.

◄— TO OUTSIDE OF DISKETTE   TO CENTER OF DISKETTE —►

24 SCALE   ₵ 10 SCALE ₵
LINES   LINES
.0142"*——►|◄ .0059"*—►|

|◄—— .012" ——►|◄   ◄——
NOMINAL

CARRIAGE / REFERENCE TRACK \   / TRACK \ / TRACK \
HOME   \ 0   / \ 1   /

HALF AMPLITUDE POINT   —►| .0035" |◄─►| .0035" |◄—
                                NOMINAL   NOMINAL

UPWARD COMPATIBILITY

To accommodate reading of diskettes written at other than 170 tracks-per-inch, Amlyn detects the absence of a reference track on the diskette. If a diskette which does not contain a reference track is loaded into the unit, a number of things are caused to occur. The microprocessor will sense the absence of the reference track and cause the diskette to rotate at 600 revolutions per minute to produce a data transfer rate of 500 kilobits per second. Following this, the read/write head is microstepped toward the drive spindle until the first data track is encountered and the half-amplitude point of the track is determined. The head is then microstepped across the track until the trailing half amplitude point is also determined. Since the physical width of the track is then known the microprocessor positions the head to track centerline for reading. This process is repeated until all tracks are read. With this method a 5-1/4" diskette of any track density up to and including 170 tracks-per-inch may be read by the device.

INTERFACES

To address both the need for high capacity, low cost on-line storage, and a suitable backup device for 5-1/4" Winchester disk drives, Amlyn offers two product models. The Model 5850 employs a SA850, 8" double sided, double density floppy

disk drive interface and appears on line to a host system as five separate drives. As mentioned previously, individual diskette selection is determined by the drive select lines on the interface.

For 5-1/4" Winchester backup applications, the Model A506 is designed to be interface compatible with the ST506 with head select lines determining diskette selection.

To facilitate low cost of inventory, both Amlyn models are the same product with an interface adapter used to convert the Model 5850 to the A506. With this approach, an OEM having multiple applications which require both models, only one model and spare adapter boards need be inventoried and drive conversion accomplished as necessary.

SUMMARY

The widespread usage of desktop computers is now beginning. As with most computers, the need for greater capacity, higher performance and lower system cost also continues to grow and is now more significant than ever before due to the wide variety of applications now possible at a reasonable cost to the user. The introduction of the 5-1/4" Winchester disk drive to the OEM marketplace responds to the need for low cost, high capacity disk storage for desktop

systems, but there still exists a need for both a suitable backup device, and a stand-alone removable disk product for entry level systems.

The new 5-1/4" floppy disk drives from Amlyn Corporation are designed to be the suitable answer to the 5-1/4" Winchester backup problem as well as a low cost, high capacity storage device for entry level systems and are designed specifically for these purposes.

By intelligently employing proven, state of the art technologies in a conservative, straightforward manner, the Amlyn device provides low cost, reliable performance with modest integration effort required by the systems designer.