PenultiCopy

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INTRODUCTION

PenultiCopy lets you copy standard 13- and 16-sector Apple-compatible disks rapidly and accurately. To use the program, you need a 48K Apple II ("Apple" is a trademark of Apple Computer Inc.) with either Integer or Applesoft BASIC (although Integer BASIC is preferred), a video monitor connected to the Apple (or television set with modulator), and one or more Apple disk drives (with controller).

If you wish to make major disk drive adjustments, you will have to understand electronics (and be fairly familiar with disk drive operation), and have the following test equipment:

A two-channel oscilloscope with differential mode and sweep times down to 1 microsecond per division, such as the Tektronix T932A (or T935A).
Shugart Associates SA400 Service Manual (#54096). The OEM Manual (#54102) may also be useful.
Shugart Associates Alignment Diskette #SA 124.

Also required from Shugart Associates is a supply of replacement parts (listed in the maintenance section). Shugart Associates can be reached at 435 Oakmead Parkway; Sunnyvale, CA 94086 or telephone (408) 733-0100.

SETTING UP

PROGRAM CONFIGURATION

First you must configure PenultiCopy for your particular system set-up. It is assumed that you know how to operate the Apple II computer and run programs using Integer or Applesoft BASIC. It is best to keep the supplied disk as a backup, rather than configure the program onto the supplied disk, so obtain an initialized 13 sector disk to copy the program on to. (If you normally use 16 sector, you can make an initialized 16 sector disk and use MUFFIN to copy the programs onto your 16 sector disk.) A copyright label, matching the one supplied on the disk, must be attached to your disk. Federal law prohibits the copying of programs on the supplied disk other than for backup purposes. A program called COPY MOVER is supplied which will move the binary COPY program onto your disk, and also allow you to change the configuration. (When using Applesoft, use the program A COPY MOVER rather than COPY MOVER.) During configuration, you can specify the slot and drive numbers of your disk drives. You need one drive as a "master" drive (which the disk to be copied is placed in) and 0-9 "slave" drives (which disks to be copied on are placed in). When no slave drives are used (that is, when there is only one drive available), the master drive will also be used as a slave drive.

Begin by typing RUN COPY MOVER (or, from Applesoft, RUN A COPY MOVER). Once the program runs, it will load the copy program from the disk. As soon as the drive turns off, you should remove the supplied disk and insert your initialized disk. (If you've used MUFFIN to make a 16-sector disk, you'll be running the programs off your 16-sector disk, so you can just leave it inserted.) The program will display the currently selected slot/drive numbers for the master and slave drives. It also asks "(10 TO STOP) MASTER/SLAVE NUMBER?". Input 0 (and press return) to change the slot/drive number of the master, any digit from 1 to 9 to change the slot/drive number of a slave (or to add or remove a slave), or 10 to go on. If you typed 0, the program will ask "SLOT NUMBER?". Input the desired slot number for the master drive. This is the drive the original disk (to be copied) must be placed in. Slot numbers must be 1-7. The program next asks "DRIVE NUMBER?"; enter 1 or 2 to select drive 1 or 2. Illegal inputs cause the sequence to be ignored. If you typed 1-9 for "(10 TO STOP) MASTER/SLAVE NUMBER?", the program will ask "(0 TO REMOVE) SLOT NUMBER?". Input 0 to remove the drive, or a 1-7 slot number to change the slot number (or add a new slave drive). The program continues, as before, with "DRIVE NUMBER?" unless you are removing a drive. Never enter a drive at more than one position or enter non-existent drives. When using only one drive, enter it as the master and remove any slave drives shown.

Typing 10 to stop causes the program to continue with "ERASE DOS?". Typing YES causes the copy program, when run, to erase Apple's DOS in memory; providing more memory for the copy program to use (and thus faster operation). Exit from the program requires re-booting when DOS has been erased. If erasing DOS is not desirable, type NO. The program continues with "DESTROY POWER SUPPLY?". Type NO. Many people have had success with running two drives simultaneously (with two control cards) from an Apple with no other peripherals plugged in. If you wish to do this, type YES. ALF will not be responsible for damage to your Apple power supply.

The program now asks "INITIAL FORMAT (13/16)?". Type 13 if you will normally be copying 13 sector format disks, or 16 if you will normally be copying 16 sector disks. This will not prevent you from copying the format you do not select. Next, "INITIALLY SET WITH *?" is asked. Type NO. The star option will be

explained later. The program then asks "INITIALLY SET WITH -?"; again type NO.
This option will also be explained later. Now the program asks "INITIALLY COPY OR
VERIFY?". Normally, you will answer COPY. Answer VERIFY only if you wish the
program to normally check disks rather than copy them. The program will now
write the modified copy program onto your disk.

You will also need the program DRIVE TESTER, even if you are not planning on
making drive adjustments yourself. It is moved to your disk in a similar fashion,
using the program TESTER MOVER (or A TESTER MOVER). Run the program. As before,
when the first question appears remove the supplied disk and insert your
initialized disk. The program asks "STANDARD CLOCK?". Answer YES unless you will
be doing major drive adjustment and plan to have a clock modifier installed. When
you press return, the program will write the modified DRIVE TESTER program on
your disk.

To complete the move, load CLEANER (or A CLEANER) and save it on your disk.
There is no CLEANER MOVER program since the CLEANER program is written in BASIC
and needs no configuration.

DRIVE SPEED ADJUSTMENT

The copy program is probably unlike any copy program you've previously used.
Since it is designed for speed and accuracy, it does not operate quite the same
as, for example, Apple's copy programs. The most obvious difference is probably
that it doesn't check the speed of the drive and adjust the format to match. This
means that the speed of the drive must be set fairly accurately or the resultant
copies will not be up to normal standards. Thus it is very important that you
check the speed of all drives you intend to use, and adjust any that are too far
off. To do this, insert your disk and type BRUN DRIVE TESTER. At the bottom of
the screen at the left side will be an S, cursor, D. You should now press the
number corresponding to the slot number of the drive to be tested. The cursor
will then move to after the D, and you can press the drive number. For example,
for slot 6 drive 1, press 6 and then 1. The first letters of SPEED, WRITE, READ,
HOME, and TRACK will light up, indicating you can use these commands. The "safe"
commands, READ, HOME, and TRACK are requested by typing their first letter (R, H,
or T); but you will not need these commands at this time. The commands which
write on the disk, SPEED and WRITE, are requested by typing the control letter
corresponding to their first letter (control S or control W). To test drive speed,
insert a disk that you don't mind having erased. It doesn't have to be initialized.
Select a typical disk of the brand you will usually be using, and make sure it
isn't obviously damaged or difficult to turn. Now hold down the control key while
pressing S.

During the speed test, the line at the bottom of the screen will be NOW MIN MAX
VAR. The number directly above the word NOW shows the most recently computed
speed of the drive. The number above that number shows the previous speed, and
so on. Negative numbers indicate the drive speed is too slow, positive numbers
indicate the drive speed is too fast. The numbers above MIN show the minimum
speed number so far. The numbers above MAX show the maximum speed number so
far. The numbers above VAR show the difference between MIN and MAX. The object
of speed adjustment is to get the MIN and MAX into an acceptable range, preferably
with MIN and MAX approximately the same (except with MIN being negative and MAX
being positive).

To adjust drive speed, be sure the "IN USE" light is off, then remove the drive

cover by removing the four screws on the bottom, and sliding the cover off away from the face of the drive. NOTE: this procedure may void your Apple warranty. Inside the drive there are two circuit cards, a large one covering most of the top of the drive and mounted horizontally, and a small one at the rear mounted vertically. CAUTION: do not attempt to adjust any of the adjustments on the large circuit card. See the maintenance section for details. There is one adjustment on the small card, at the far right of the card. It is slotted for turning with a small regular screwdriver.

Turning this adjustment will change the drive speed. Watch the NOW column when turning the adjustment, not the MIN and MAX columns. After adjustment, press RETURN (or virtually any key except space) to reset MIN, MAX, and VAR. Try to adjust the speed so MIN and MAX read about the same, but with MIN being negative and MAX being positive. For proper operation, they should be less than 5$\emptyset$. If it isn't easy to get MIN above -5$\emptyset$ and MAX below +5$\emptyset$, the drive probably needs repair. During a short period after pressing RETURN, a VAR number greater than 2$\emptyset$ is also suspicious. Note that the longer the drive runs, the more the speed "drifts" as it warms up. Pressing space will turn off the drive motor, and control S will resume the speed test. After complete cooling, drive speed should stay within acceptable ranges for the first 3$\emptyset$ seconds of operation.

To replace the cover after adjustment is complete, be sure the "IN USE" light is off. Then, check the ribbon cable connector which plugs into the large circuit card. It should be pressed all the way onto the mating pins. Now just reverse the disassembly procedure: slide the cover back on (from the back, sliding toward the face), and replace the four screws.

When adjustment is finished, press space to stop the test. Note that a "beep" during testing means that the speed cannot be computed (probably because there is no disk or it is write-protected). To exit the DRIVE TESTER program, press RESET. It is best if you have an auto-start monitor ROM.

ROMS

One final note concerning 13 and 16 sector formats is in order. There are two ROMs on an Apple drive controller card. One is labeled P5 and the other is labeled P6 (in white paint on the circuit card). The P5 ROM determines whether your system will boot from 13 or 16 sector disks; the ROM labeled P5 is for 13 sector and the ROM labeled P5A is for 16 sector disks. The P6 ROM is used to decode the data on the disk. A ROM labeled P6 is only suitable for reading 13 sector disks, and should not be used to read 16 sector disks. A ROM labeled P6A will read both 13 and 16 sector disks. For best results when using the speed test in the DRIVE TESTER program, use a P6A ROM. Lately, a new P6A ROM has been released which does not have the read timing errors present in the P6 or the original P6A. However, it is apparently labeled only 341-$\emptyset\emptyset$28-$\emptyset$1. You will probably wish to use only this version of the P6A ROM.

COPYING

The copy program uses one "master" drive and one to nine "slave" drives. The disk to be copied is placed in the master drive, and a blank disk is put in each slave drive. The copy program then reproduces the data and format information on the disk in the master drive onto each disk in a slave drive. When only one drive is available, it is used alternately as a master and slave drive.

Unlike most previous copying programs, the ALF copy program does not have to "format" the disk prior to copying data onto it. The writing of both format information and data is done simultaneously in one step. Also unlike most copying programs, the ALF copying program then reads the format information and data from the copied disk and compares it with the format information and data from the master disk. This helps to assure that the copy is correct, and also serves to help find disks with physical defects. To improve overall copying speed, disks with physical defects are detected much more rapidly than on most copying programs. The process of reading the slave disks and comparing them with the master is called "verifying". Although Apple's DOS has a verify command, it does not work by comparing the desired data with the actual data; it works by computing check words and comparing the check words with the check words found in the disk information. Experience shows that often incorrect sectors will show as "good" using only Apple's check.

SETS and PASSES

When space is pressed to begin copying, PenultiCopy copies in the following fashion. First, as many tracks of the original as will fit in memory are read. [Setting the copy program to erase the DOS in memory (see the set-up section) may allow more tracks to be read.] Then this information is written one track at a time on the first slave drive. After each track is written, it is immediately read for the verify step. Once all available tracks have been written and verified, the copy program continues with the next slave drive. This procedure of reading the master and writing/verifying all slaves is called a "pass". Once the pass is completed, another pass begins until all 35 tracks have been copied. The complete operation of copying 35 tracks, using several passes, is called copying a "set".

BIP and SPACE

During each set, the screen shows a "pass number" which counts down to zero. When zero is displayed, the last pass is being performed. When pass zero begins, a short bip emerges from the Apple speaker. This warns you that copying is nearly finished. Note that any keys pressed before the bip will be cleared.

BEEP and THE G KEY

If you don't notice the bip, the program will beep when copying is complete. The program will continue to beep periodically until the next set is begun. To stop the beeping, press the G key (the G key is also labeled BELL); or press RESET to exit the program (on some Apples, you must hold down CTRL while pressing RESET).

DOUBLE BEEP

If no disk is inserted in a slave drive, the program will begin double-beeping. The double-beep also occurs when a disk which cannot rotate is inserted, or when a write-protected disk is inserted. If you wish to insert a disk or correct the problem, do so and then press space. The program will wait for the new disk to

come up to speed before continuing. If you wish to skip that drive, press RETURN
(or any of various other non-space keys).

BOOP and SCREEN MESSAGES

During copying, if the verify step shows a track to be bad, the copy program
will attempt to write that track several times. If this does not solve the
problem, it will make a boop sound, and display a cryptic error message next to
the appropriate slave drive line in the display. This message begins with the
track number where the error occurred, in hex ($\emptyset\emptyset$-22); this is followed by a colon
(:) and a list of each sector ($\emptyset$-C for 13-sector format or $\emptyset$-F for 16-sector
format) which could not be read or did not match. Such a problem is usually due
to a defective disk, but is sometimes due to a dirty or misadjusted drive; or in
the case of 16 sector disks a magnetic pattern that is particularly difficult to
read; or any combination of the above. Note that if all sectors are unreadable or
don't match on track $\emptyset\emptyset$, a double-beep will be done instead of an error message.

If during copy the master drive shows an error, copying stops and all "copies"
in slave drives are incomplete and thus must be re-copied. If during copy any
slave drive gets an error (including NO DISK), pressing space will not start the
next set. This is to call the error to your attention. Pressing a non-space key,
such as RETURN, will allow space to be used. (The key pressed is ignored, except
pressing G will work as it normally does.) If all slave drives get an error,
copying stops when the last drive gets an error. It is important to remember that
any slave drive with an error shown on the screen contains a "bad" disk which
may or may not contain the desired information; such a disk should be re-copied.
Prior to re-copying a disk, it should be inspected for physical defects which may
adversely affect the drive (such as binding, creases, or glue spots).

DIGIT KEYS

A variety of options are available when using the copy program. First, the
slot and drive number of any master or slave drive may be changed; and slave
drives added or removed. Begin by typing the slave number (1-9) or $\emptyset$ for the
master. A cursor will appear at the appropriate spot, and you can type the slot
number and then the drive number. Slave drives can be removed by typing a slot
number of $\emptyset$. Slave drive numbers need not be continuous; e.g., one can have
slaves 1, 2, and 4 active without needing to have a slave 3.

STAR (*) KEY

One important option when copying 13 sector disks is the star option. As
"initialized" by DOS 3.2 (or DOS 3.2.1), 13 sector disks contain uninitialized
sectors. These are a major source of bad copies which are not detectable by
normal check-word checks. Since it is impossible to tell the difference between
an uninitialized sector and a read error while the master is being read,
uninitialized sectors present a major obstacle to accurate copying. Therefore, the
ALF copy program is written so no copy contains uninitialized sectors; all
uninitialized sectors are initialized when they are read off the master. Normally,
the copy program is configured with the star option off, which prohibits the
reading of uninitialized sectors. This prevents read errors from being
interpreted as uninitialized sectors instead. To read a master with uninitialized
sectors, the star option must be on. This is done by pressing * or :. A star (*)
will appear in front of the message "13 SECTOR." at the top of the screen.
(Pressing * or : again turns off star mode.) Copy with star mode on only when

necessary.

DASH (-) KEY

Another option is the dash option. It is turned on and off by pressing -. When the dash option is on, a - will appear between "MASTER" and "∅" on the screen. When dash is on, the master will be verified after it is read. If a sector was read incorrectly but Apple's check words happened to work out anyway, all copies in the set would be bad. With dash mode on, the same incorrect read would have to occur twice the same way to create a bad set. In ALF's experience, this option is not normally needed, but it is available for the paranoid. Note that dash should not be used with star, as uninitialized sectors will be interpreted as differences.

CONTROL S and CONTROL T

Pressing control S is used to select the 16 sector format when you have been copying 13 sector format. Likewise, pressing control T selects the 13 sector format. Pressing control S turns off star mode if it is on, and pressing * or : sets the program to 13 mode; this is because star mode is not allowed in 16 sector mode. (Apple fixed the uninitialized sector problem in the 16 sector systems.) Note that you must have a P6A (not a P6 version) ROM in the P6 slot of each controller to copy the 16 sector format. The P5 ROM doesn't matter.

CONTROL V and CONTROL C

Finally, pressing control V puts the program in verify mode, and control C puts the program in copy mode. Verify mode is the same as copy mode except that tracks are not written; the master is read and then all slaves are read and compared with the data read from the master. [Note that a disk with uninitialized sectors placed in a slave drive will never verify as good.] The verify option is handy for quick checks on copying accuracy, and for creating copies with extremely low reject rates. This is done by copying the disks, and then also verifying them. If possible, verify each disk in a different drive than the drive that wr.ote it. This will assure you that at least one other drive can read it. Note that reading a track just after it is written is very easy compared to reading it with another drive. If one drive has its track positioning off, it will be able to read the track but another drive won't. Doing a separate verify also checks for centering problems. If a disk is copied off center, due to a mispunched disk or due to a faulty or worn centering mechanism in the drive, it can only be read when it is off center in an identical fashion. Once it is removed from the drive, it is unlikely it will ever be off center in the same way again.

SEEK ERRORS

A special procedure is done during pass zero which helps detect a failing stepping motor in the head positioning mechanism. Head positioning is called "seeking", and if any problem is detected the message "SEEK ERROR" will be displayed. One or two seek errors could indicate simply a difficult to read disk. Repeated seek errors on a drive may indicate failure of the stepping motor. (Note: a seek error also occurs if the copy is removed too soon but not so soon as to cause an error on track ,34.) Another sign of failing stepping motors can be repeated "home" (or recalibrate) occurances. "Home" is a method of positioning the drive head to track ∅∅ when its current position is unknown, and it results in the

familiar "buzzing" noise heard when booting up. The copy program does a home the first time it uses a drive after being run. If a home occurs at any other time, it is because a track number read from a disk did not match the track number expected. Note that this could also indicate an off center disk, because adjacent tracks can be read if a disk is sufficiently off center (tracks are spaced only 1/48" apart).

MOVING COPY

Never attempt to save the copy program after it has been run. It will not work properly. Either use the COPY MOVER program, or (when desperate) BLOAD and BSAVE without running.

CLEANING DRIVES

All drives should be cleaned periodically. The program CLEANER (or A CLEANER for Applesoft) is handy for turning the desired drive's motor on for about 30 seconds. Load buttons must be periodically replaced, although not so often, and various drive parameters should be periodically checked. Instructions for these procedures are in the maintenance section.

MAINTENANCE

Basically, drive maintenance is done as described in the Shugart Associates SA4ØØ Service Manual (#54Ø96). Certain changes have to be made due to various components left out on the Apple version, and due to differences between Shugart's electronics and Apple's electronics. If you're doing a lot of maintenance, the following replacement parts are very convenient:

REPLACEMENT PARTS

Load Button, #54145. This is a "pressure pad" which keeps the disk in contact with the recording head. Since these wear out periodically, it's good to have several on hand.

Collet Hub (Hub Clamp), #54Ø66; Hub Collar, #54131; Clamp Spring, #54132; E-Ring, #113Ø5. The hub clamp centers the disk and presses it tightly to the rotating spindle. Eventually these wear out; but also any old design clamps (i.e., those that aren't brown with an off-white center) should be replaced. Usually both the clamp (54Ø66) and the spring (54132) are replaced; the other two parts are handy to have in case they are broken or fly off into oblivion.

CHECK OUT

The cover is removed from an Apple drive by unscrewing the four bottom screws, then sliding the cover off toward the back (along the ribbon cable). It doesn't seem to want to come off when pulled to the front. (It is best to remove and replace the cover only when the "IN USE" light is off.) Then the drive looks basically like the standard SA4ØØ, except for various missing components and a different circuit card (in the case of the larger card). When using a drive for the first time (whether a new drive or an old drive), you'll want to check the speed, the load button, the head positioning alignment, the hub clamp, the read signal amplitude, and the R28 adjustment.

SPEED ADJUST and DRIVE TESTER

Speed is checked as explained in the "Setting Up" section. Usually, speed is adjusted while at track ØØ, although Shugart recommends adjusting speed while the head is positioned at track 1Ø (which they call 16, in decimal). While running the DRIVE TESTER program, the heads can be moved either by typing T (for TRACK) followed by a two-digit hex track number (ØØ-22) or by pressing the left and right arrow keys. Note that the actual head position of a drive is unknown until a "home" function is done. The DRIVE TESTER automatically does a home the first time a drive is used, but if the head position is changed manually (or a different drive is plugged in while the program is running) a home function must be requested by typing H to have the program adjusted to the drive.

HUB CLAMP

Load button replacement/adjustment is covered in the Shugart manual, as is head alignment and read signal amplitude. The hub clamp is checked as follows. If the hub clamp is not the latest version (brown with a white center), replace. Also replace if visibly worn. If pressure required to close door (with typical disk inserted) is abnormally small, replace hub and spring. Finally, with 'scope set up for the read amplitude check, go to track 22 and write a test pattern; then open and close door. If excessive "wobbling" is noted on the 'scope, replace hub and spring. Repeat test for track ØØ.

R28 adjustment is best left for last. Meanwhile, changes necessary to

information in the Shugart manual are as follows.

CHANGES TO SHUGART MANUAL

2.4.7.1 Hub Frame Assembly Installation and Adjustment. Apple format is "soft-sectored", so ignore index timing adjustment used only on "hard-sectored" formats.

2.4.9 Index Detector Assembly Removal. There is no index detector on Apple drives. Same for 2.4.10 Index LED Removal and 2.4.11 Track Zero Switch Removal.

2.4.12 Head Amplitude Check. Use internal trigger (sync) rather than external since there is no equivalent to TP7 on the Apple drives; adjust trigger level for best view. Set all coupling to DC. TP1 and TP2 are TP8 and TP9 on the Apple drive, use TP2 and TP4 for grounds. "Add and invert one input" is DIFF mode on the Tektronix T932A or T935A. Set both channels to 0.2 volts/division and time base to 5 microseconds/division. Writing an entire track with all one's is done by using the WRITE function of the DRIVE TESTER program (press control W). NOTE: the SPEED and WRITE functions (control S and control W) erase whatever track the head is currently positioned at; be sure to use a disk with no important data (disk must be reinitialized before it can be reused). 80 millivolts minimum amplitude does not apply to the Apple electronics, correct number is unknown. Expect a signal greater than 1 division at track 22 (Shugart's 34). Track 00 amplitude will be much larger (3 or more).

2.4.13 Motor Speed Adjustment. Do not use this procedure or 2.4.13.1. Use the SPEED command of the DRIVE TESTER program.

2.4.14 Read/Write Head Load Button Adjustment. Connect 'scope as in 2.4.12 above.

2.4.15 Track Zero Switch Adjustment. There is no track zero switch.

2.4.16 Carriage Limiter. Adjust so gap between sheet metal stop (on head carriage) and stepper cam is small when at track 00 (i.e., gap should be small in relation to the increase in gap size between track 00 position and track 01 position).

2.4.17 Index/Sector Timing Adjustment. There is no index detector.

2.4.18 Head/Radial Alignment (head position alignment). Shugart's alignment disk must be used, but remember Shugart's track 16 will show as track 10 on the DRIVE TESTER program. Set 'scope as for 2.4.12 except with time base set to 50 milliseconds/division. It may be necessary to increase 'scope intensity. Study figures 11 and 12 (head radial alignment), as it may be very difficult to view on the 'scope. Set eyes for maximum image retention. Since there is no equivalent to TP7 on the Apple, it will not be possible to know which lobe is the "left" lobe and which is the "right". (At the suggested time base setting, many lobes will be displayed.) Estimation of 70% may be difficult, but this adjustment is crucial. Rotating the stepper motor is very difficult and its position may change when the screws are tightened. Test by setting for track 10, press H for home. This shows "fast access" positioning. Press left arrow for track 0F, then right arrow for track 10. This shows "normal" positioning and is most crucial for copying (the copy program always steps in this fashion, never in reverse except back to track 00). If life isn't complicated enough for you already, press right arrow for track 11 and left arrow for track 10. This shows "reverse" positioning, and is probably

not significant during copying.

    2.4.2∅ Head Load Bail Adjustment. There is no head load bail.

    2.4.21 Read/Write Head Cleaning Procedure. The 3M head cleaning diskette
(#744∅) seems satisfactory. Procedure is given in the "Copying" section.

A TIP

    Keep alignment diskette in a safe place, free from vast temperature changes.
Never write on the alignment diskette. Don't even try (your write protect switch
may be improperly adjusted).

DRIVE TESTER

    All commands in the DRIVE TESTER program turn on the drive motor. Drive
motor is turned off by pressing space. All commands except SPEED do their thing,
and then go into continuous read mode. READ is a no operation command that goes
into continuous read mode. Right and left arrows count as commands. Press any
digit 1-7 to change slot/drive numbers.

CLOCK MODIFIER

    To check the R28 adjustment, you must have a clock modifier installed
(available from ALF, part number 1∅-1-3). This is done by unplugging IC B2, a
74S86 on the motherboard near the keyboard; and then plugging in the
header/socket/74S86 gadget supplied. Be sure to get pin 1 aiming the right
direction, otherwise the 74S86 is destroyed (fortunately one is supplied with the
modifier, so you have a spare). This will make the timing used by the read and
write circuitry on the controller card stable rather than extended occasionally.
Note that the color capability of the Apple is lost while the clock modifier is
installed. You may want to remove the clock modifier when it's not needed, as it
may be incompatible with some peripheral cards.

R28 ADJUSTMENT

    To check R28 adjustment, connect the 'scope to TP7 (using TP2 or TP4 as
ground). Set for 2 volts/division and 2 microseconds/division. Remember to go to
normal (rather than DIFF) mode. Be sure you're seeing the far left side of the
trace (that horizontal position is not adjusted to show the "end" or "middle" of
the trace); you should probably always do this. Use the WRITE command to write a
test pattern. Note that some pulses show two images, this is due to a different
positive-going setting than negative-going setting of R28 (alternate pulses are due
to positive-going flux changes). Optimum adjustment has only one image, but
probably cannot be obtained on all tracks with any given R28 setting. Ignore
large-scale stretching/shrinking due to normal disk "wobble". The R28 setting only
affects read, and doesn't seem to matter much on 13-sector disks, but seems
crucial on 16-sector disks. Since most difficulty is found on the innermost
tracks (say, 1F to 22), it is probably best to adjust this while at track 22. Note
that adjusting the hold off (delay between end of sweep and next trigger), if your
'scope is so equipped, may help visualization. Pressing control W occasionally to
write a new test pattern sometimes helps. Note that any slime painted on the R28
adjustment must be loosened before attempting adjustment; you may wish to reslime
after any adjustments. Since single-turn potentiometers tend to be temperature
sensitive it may be best to adjust in expected temperature. Since R28 can be

messy to adjust, it is best left alone unless a problem is suspected.

MORE TIPS

Remember that most difficulties are due to problems in reading disks. In copying, maladjusted read circuitry may present only annoyances due to rejecting of good disks, but may not cause production of bad disks. Thus, most effort should be on parameters that affect write. Mostly: head positioning alignment, load button quality/adjustment, motor speed, head wear (reflected in read amplitude), centering (hub adjustments), and perhaps occasionally little things like carriage limiter adjustment, head cable catching on things, ribbon cable not fully plugged in, and so forth.

FIFTH EDITION OF THE
STANDARD INTER-GALACTIC INTELLIGENCE TEST

AS REVISED BY ALLEN L. FOSTER
FOR THE
COMBINED HUMANOID SCHOLASTIC REVIEW BOARD