DISK SERVICE MANUAL III

BY: JOHN J. WILLIAMS, M.S.E.E

UNLEASH THE POWER OF YOUR SYSTEM!!

Consumertronics Co.
2011 CRESCENT DR., P. O. DRAWER 537,
ALAMOGORDO, NM 88310

Publishers Of Invaluable Survival Information
UVETEC 320 SUPER-MINIFLOPPY, 5¼ DS, 160 Tk (192 TPI), 0 RPM, 3 msec access time. Stores up to 3.33M Bytes. Downward compatibility with 48 TPI drives is included. One of the new, exotic breeds of super-dense, high performance drives. The 192 TPI density is achieved by using two stepper motors - one for coarse Steps (48 TPI equivalent), and one for fine Steps (four with each 48 TPI track). Requires special, high-quality, expensive 5¼ skettes. Uses an absolutely vertical clamping mechanism, brushless DC drive motor and on-board BIOS. Half-height and low power, the 320 can be easily used to upgrade high performance systems; it is a recommended back-up for hard drives.

ADDRESSES

FLOPPY DRIVES

Most drives - no matter whose label actually appears on them, are manufactured by the firms below (list may not be complete). Many firms purchase OEM drives from these manufacturers and re-package them under their own names.

CONTROL DATA CORP.
P.O. Box O
Minneapolis, MN 55440

HEWLETT-PACKARD
1000 NE Circle Blvd.
Corvallis, OR 97330

DRIVETEC
1031 South Milpitas Blvd.
Milpitas, CA 95035

INTERFACE INC.
7630 Alabama Ave.
Canoga Park, CA 91304

DYSAN CORP.
3201 Patrick Henry Dr.
Santa Clara, CA 95050

MATCHLESS SYSTEMS
18444 S. Broadway
Gardena, CA 90248

MICROCOMPUTER TECHNOLOGY
1530 S. Sinclair St.
Anaheim, CA 92806

MICRO DATA SUPPLIES
22295 Euclid Ave.
Euclid, OH 44117

MICRO PERIPHERALS INC.
9754 Deering Ave.
Chatsworth, CA 91311

MITSUBISHI ELECTRONICS
2205 W. Artesia Blvd.
Compton, CA 90220

MICROCOMPUTER TECHNOLOGY
1530 S. Sinclair St.
Anaheim, CA 92806

QUME CORP.
2330 Qume Dr.
San Jose, CA 95131

RADIO SHACK NATIONAL
900 E. Northside Dr.
Fort Worth, TX 76102

SHUGART ASSOCIATES
475 Oakmead Parkway
Sunnyvale, CA 94086

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Chapter I: GENERAL

Disk drives are complex in their electronics and precise in their mechanics. When taken care of, they can last for decades. **Note:** To properly service a drive, one must usually remove the drive from an enclosure and/or loosen or remove other screws and parts, thus voiding any warranty that may apply. While every attempt has been made to provide complete and accurate information in this comprehensive manual, we do not assume responsibilities for any errors or omissions. We assume no liability whatsoever for loss or damage caused directly or indirectly, or alleged to be caused by information found herein. DISK SERVICE MANUAL is sold as is.

The phrase, "remove drive enclosure" simply means remove enough of whatever the drive is inside of to do the defined task. In free-standing drives, the "enclosure" is simply the drive's cover. Most drives are designed with a MTBF. This is an estimated design life before repairs are needed.

In some cases, Mr. Wolinsky is right. Some people simply were not born to turn a screwdriver! If one is reasonably bright, alert, eager to learn, organized and careful, and is not clumsy or rushed, one doesn't need to be trained at a drive shop or be a computer scientist to maintain computer equipment. Whether one does his own work or not, to wait until the MTBF arrives is plain idiocy! The savvy person performs maintenance on drives during the years. We believe that the MTBFs specified by the manufacturers are mostly sales puffery. The MTBF is supposed to represent an average figure anyway.

**SAVE ADVICE**

Mr. Mike Wolinsky, President of FLOPPY DISK SERVICES, wrote in the Aug. 15, 1983 issue of COMPUTER SHOPPER: "One question most often asked by my customers is what maintenance they can perform themselves? My answer is simple, nothing. Most drives are designed with a MTBF. This is an estimated design life before repairs are needed."

We wish you the best of luck. We developed many computer publications, programs and services:

**COMPUTER AND ELECTRONIC PUBLICATIONS:** DISK DRIVE TUTORIAL II, DISK SERVICE MANUAL III, PRINTER & PLOTTER MANUAL II, COPIER MANUAL, COMPUTER PHREAKING, ABSOLUTE COMPUTER SECURITY, CRYPANALYSIS TECHNIQUES, SUPER RESOURCES, SUPERNUMERARY INFORMATION, TELEPHONE RECORDER INTERFACE, TV SOLUTRONICS COMPUTER SECURITY, CRYPTOANALYSIS TECHNIQUES, SUPER RE-INKING METHOD, STOCKPRO II, ULTIMATE REVERSIBLE JOURNAL, TELEPHONE RECORDER INTERFACE, TV DECODERS AND CONVERTERS, etc. These publications are described on the back cover, and along with our other mostly non-controversial publications, are described in our TECHNOLOGY SURVIVAL CATALOG. You can order from the back cover or the catalog, but the catalog is mostly recommended because it describes our latest publications, editions and prices. Please send $1 for our new TECHNOLOGY SURVIVAL CATALOG to the address below.

**SURVIVAL PUBLICATIONS:** We also publish a book of brutally frank survival publications on electronics, energy, weapons, security, intelligence, medical and financial. You may have heard me talk about some of them on CBS "60 Minutes", ABC Talkshows, etc. Please send $1 for our new SUPER-SURVIVAL CATALOG, which describes all of our frank, shocking and controversial publications, to the address below.

**SERVICES:** See our ad on the back cover for our TECHNICAL RESEARCH SERVICES. In addition, for a fee, we will design, develop and/or build virtually any device you need. Please describe to us exactly what you need designed, developed and/or built. Please include a non-refundable $25 so that we can spend the time to work up an outline and estimate for you. Send to the address below.

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Don't fully understand how drives and diskettes work together and with computer systems? The numero uno source of drive and diskette theory and practical facts is DISK DRIVE TUTORIAL II. See the description of DISK DRIVE TUTORIAL II on the back cover.
Chapter II: OPERATION ADVICE & TIPS

DISKETTES

1) To avoid physical damage: Do not tear, fold or distort diskettes, or impress upon them with any hard object including pens, ball point pens and pencils. Do not get them wet, expose them to temperature extremes, sunlight, microwaves, x-rays or infrared. Do not use dirty, bent, creased or torn diskettes.

2) Do not assume that an error-prone diskette is a bad diskette. If the diskette is merely dirty, it can be cleaned. Some manufacturers do not recommend the use of any solvent whatsoever to clean diskettes. We have found that rubbing alcohol on cotton or a soft Q-tip does an excellent job with no known damage to diskettes. Clean diskettes. We have found that rubbing alcohol on cotton or a soft Q-tip does an excellent job with no known damage to diskettes. Do not use a cleaning solution on diskettes because the particles get onto the Read-Write Head, felt pressure pad and-or diskette.

3) For shipping diskettes, label the container, "Do not Fold, Bend, or Spindle. Do not X-Ray. Contains Magnetic Material."

4) To avoid magnetic or electrostatic damage: To avoid magnetic damage, do not place diskettes near magnets, CRTs, telephones, VAC power lines, motors, transformers, relays, buzzers, bells, transistors, solenoids or switching power supplies, or on top of the keyboard. Properly ground drives and work in a static-free environment.

5) Before formatting diskettes, vigorously erase them one side at a time with a magnetic bulk-eraser. This refreshes and vivifies the drives that load the head during Motor-On, and do not turn the system ON or OFF with diskettes inside. Head and diskette wear, and diskette heat and contamination are a threat to all diskettes in a system's drives when they are not being accessed.

6) Even in systems specified otherwise, do not leave diskettes inside drives unless they are being accessed (except head-loaded drives that load the head during Motor-On), and do not turn the system ON or OFF with diskettes inside. Head and diskette wear, and diskette heat and contamination are a threat to all diskettes in a system's drives when they are not being accessed.

7) Carefully and correctly insert and remove diskettes from drives. Carefully and correctly insert and remove diskettes from drives. Carefully and correctly insert and remove diskettes from drives. Carefully and correctly insert and remove diskettes from drives. Carefully and correctly insert and remove diskettes from drives. Carefully and correctly insert and remove diskettes from drives.

8) ALWAYS - ALWAYS - ALWAYS back-up important diskettes. A MASTER (1 diskette) Stored in a safe, cool, low humidity environment (ex: refrigerator, safety deposit box). Only used to make Copy Masters. PROTECTED (1 diskette) Stored away from Working Copies. WORKING COPIES (10 diskettes) The only diskette used in day-to-day operations. High-speed bulk-eraser diskettes are recommended for masters.

DISK DRIVES

1) Never smoke, drink or eat around drives, or use them in a dirty or dusty environment (a good policy for ALL computer equipment). Keep all small metal objects (ex: staples, paper clips, screws, nuts, metal shavings) away from computer systems. Always cover the drives with a lint-free cover after turning them OFF. In fact, cover ALL computer equipment when not in use. Equipment exposed to normal office and household air pollutants collect a lot of dust in a year's time, and the lubricants dry out. Dust and smoke are death to drives and diskettes because the particles get onto the Read-Write Head (DS) to press onto the diskette surface. Open two 120 VAC plug's hot and neutral prongs to the equipment chassis (case). Resistance should be zero. Then use a line checker for maintenance is done on computer's 120 VAC wall and power strip outlets to verify that they are wired correctly (many are not).

2) Never remove or replace any connector, or a drive or system enclosure, or do any drive or system repair work, without first turning OFF power to the system. Entire computer systems were destroyed simply by an operator with system power ON! When removing or replacing connectors, always turn the system OFF. Do not force a connector as force can damage or short contacts. Before turning system ON, be sure that all connectors are solidly and squarely connected.

3) Do not touch the diskette's recording surface with fingers. Hold diskettes at their rear. Do not leave diskettes uncovered. Do not store diskettes horizontally, or lay them on rough, uneven or dirty surfaces, or lay anything on top of them. Do not use a writing eraser on diskettes - the debris produced is abrasive.

4) For shipping diskettes, label the container, "Do not Fold, Bend, or Spindle. Do not X-Ray. Contains Magnetic Material."

5) To avoid magnetic or electrostatic damage: To avoid magnetic damage, do not place diskettes near magnets, CRTs, telephones, VAC power lines, motors, transformers, relays, buzzers, bells, transistors, solenoids or switching power supplies, or on top of the keyboard. Properly ground drives and work in a static-free environment.

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Chapter II:
OPERATION ADVICE & TIPS

DISKETTES

(1) TO AVOID PHYSICAL DAMAGE: Do not tear, fold or distort diskettes, or impress upon them with any hard object including pencils, ball point pens and paper clips (use a felt-tip pen), or get them oily or greasy, or expose them to temperature extremes, sun, micro waves, x-rays or infrared. Do not use dirty, bent, creased or worn diskettes. Do not touch the diskette's recording surface with fingers. Hold diskettes at their rear. Do not leave diskettes uncovered. Do not store diskettes horizontally, i.e., with them resting even or dirty surfaces, or lay anything on top of them. Do not use a writing eraser on diskettes - the debris produced is abrasive.

(2) Do not assume that an error-prone diskette is a bad diskette. If the diskette is merely dirty, it can be salvaged. Some drive manufacturers do not recommend the use of any solvent whatsoever to clean diskettes. We have found that rubbing alcohol on cotton or a soft Q-tip does an excellent job with no known damage to diskettes (do not run while wet). Rotate the diskette element inside its drive if the diskette is merely dirty, it can be salvaged. Some drive manufacturers do not recommend the use of any solvent whatsoever to clean diskettes. We have found that rubbing alcohol on cotton or a Soft Q-tip does an excellent job with no known damage to diskettes (do not run while wet).

(3) For shipping diskettes, label the container, "Do not Fold, Bend, or Ship. Do not X-Ray. Contains Magnetic Material."

(4) TO AVOID MAGNETIC OR ELECTROSTATIC DAMAGE: To avoid magnetic damage, do not place diskettes near magnets, CRTs, telephones, VAC power lines, motors, transformers, relays, buzzers, bells, speakers, solenoids or switches that are subjected to motor-on, or head-loaded drives. Moving a diskette in a selected head-loaded drive can severely damage (or misalign) the Read-Write Head, felt pressure pad, and the diskette's recording surface. Be extra careful when connecting and disconnecting power supplies and while working in the vicinity of power supplies. Power MUST be OFF and the power cord must be disconnected from the wall! Polarity MUST be rigidly observed!

(5) Before formatting diskettes, vigorously erase them one side at a time with a magnetic bulk-eraser. This refreshes and livens up their magnetic particles. Diskettes have discrete shelf lives (about five years). For long term storage, a cool, dry and clean area is much preferred. Aged diskettes shed their oxide coating.

(6) Even in systems specified otherwise, do not leave diskettes inside drives unless they are being accessed (except head-loaded drives that load the head during Motor-On), and do not touch or remove diskettes while power on or OFF with diskettes inside. Head and diskette wear, and diskette heat and contamination are the same for all diskettes in a system's drives whether or not being accessed.

(7) Carefully and correctly insert and remove diskettes from drives. Latch-tight drive mechanisms, and typical head loads, do not allow a diskette to be removed from its bay while its power is on. Some drives with spring-loaded drive mechanisms do, but they are very rare and not practical for most home use. Move a diskette-inserted diskette in a selected head-loaded drive can severely damage (or misalign) the Read-Write Head, felt pressure pad and or diskette.

(8) ALWAYS - ALWAYS - ALWAYS back-up important diskettes. The three-tier approach is preferred for critical diskettes: (A) MASTER (1 diskette): Store in a safe, cool, low humidity environment (ex: refrigerator, safety deposit box). Only used to make Copy Masters. (B) COPY MASTERS (2 diskettes): Only used to make Working Copies. (C) WORKING COPIES (1+ diskettes): The only diskettes used in day-to-day operations. Only new, high-shine bulk-erasable diskettes are recommended for masters.

DISK DRIVES

(1) Never smoke, drink or eat around drives, or use them in a dirty or dusty environment (a good policy for ALL computer equipment). Keep all small metal objects (ex: paper clips, screws, nuts, metal shavings) away from computer systems. Always cover the drives with a lint-free cover after turning them OFF. In fact, cover ALL computer equipment when not in use. Equipment exposed to normal office and household air pollutants collect a lot of dust in a year's time, and the lubricants dry out. Dust and smoke are death on drives and diskettes because the particles get onto the Read-
Chapter III: ERROR MESSAGES

ERROR MODES & RECOVERIES

Disk errors are easy to occur. A 99.3% class average may put you at the top of your class, but you would fail miserably as a drive! A 1-bit error out of 50,000 bits can ruin a very expensive program or data file.

Different drives have different sensitivities. Before tossing away a "damaged" diskette or using a disk utility to repair it, try to Read it using different drives and at different times. Temperature, humidity, VAC level and the presence of previous operation impairs sometimes enough to make a previously un

Readable diskette Readable and vice-versa.

Extraordinary efforts are taken to minimize disk errors. During Format, bad sectors are locked out. EDC codes are used in both the ID and Data fields to Verify accuracies. Many EDC schemes are possible, but the two main ones are CRCs and checksums.

Checksumming adds up all the bytes in a field and produces a check. The corresponding check byte computed by the controller is compared to the check byte calculated during a READ or WRITE. If they differ, error correction and/or error detection takes place.

The CRC EDC results from a complex algorithm for checking byte values stored in the Sector Header. READ (and WRITE) errors are mostly caused by a defective diskette, head misalignment or contamination Read-Write Head, and occasionally by hardware failures.

ERROR SOURCES

(1) DISKETTE (MEDIA): If the diskette is warped, AM results as it flutters past the head. If the oxide coating is inconsistent, AM also occurs due to changing magnetic properties. If either is severe enough, zone dropouts also occur. If the media is dirty or creased, or its oxide contains pits, scratches or impurity, bit and zone dropouts result. If the oxide is rough, bit dropouts and noise result. Surface sheen is important!

(2) READ-WRITE HEADS: A dirty head results in zone dropouts that may worsen as the same or different bits in a track head up and out. Drive speed variations, and head, Sector Index and/or TOO misalignments can put the head in the wrong place at the wrong time. The aerodynamic design of the head is also important. If poor, AM results as the head skips across the diskette surface.

FORMAT VARIATIONS

Soft-sector diskettes can be Formatted (machine language programma) for any number of sectors per track and sectors per track. And the number can be varied per track. The encoding scheme can also be varied even with the same or different bytes appearing per track! The risk of too few sectors per track is that the controller can get lost due to small variations in diskette speed, resulting in Parity or ECC-type errors. This problem is particularly prevalent in the inner, higher bit density tracks. Reliability is much increased when a PLL "Data Separator" is used. A PLL Data Separation...

DISK SERVICE MANUAL III

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WRITE errors occur when data is incorrectly Written to the diskette. They are detected by using a VERIFY. VERIFY Reads the bytes just Written to the diskette and Verifies that they match the EDC. Under some circumstances, a VERIFY error message can result from a READ error during a VERIFY after the WRITE. Try READ operations that do not entail a WRITE to verify that the error is due to a bad WRITE — not a bad READ.

**BDOS ERRORS**

The catch-all disk error message used in CP/M systems is the BDOS (BASIC DOS) error. The BDOS flags several types of system errors. Some relate to user errors, others to format errors (usually EDC). The worst possible BDOS error is one indicating that a sector can't be found or correctly Read, or the expected ID Field sector, track or side number cannot be found. These errors indicate a diskette failure, or more seldomly, a DOS or applications software bug.

Most BDOS errors occur during a READ. If one occurs during a WRITE, it is probably due to a READ error resulting from the FDC Reading the sought ID Field (Sector Header) before it can Write system parameters, or by the system.

(4) GATE READ/WRITE ERROR: An error resulted during a Directory GAT sector READ/WRITE.

Now, let’s look into the error messages in more detail to see what they mean.

**ERROR MESSAGES**

The following are common disk-related errors, with some common variations. Since there are some differences between the many computer systems, they may not be identical to the error messages of your system but should be at least similar. In some systems, errors are given in terms of error codes, and one must use a look-up table or type in a command to obtain the actual error message:

**DISK DIRECTORY-TYPE ERRORS**

1. **DIRECTORY READ/WRITE ERROR:** An error resulted during a Directory GAT sector READ/WRITE.
2. **ILLEGAL LOGICAL FILE NUMBER:** The file Control Block (FCB) in the Directory contains bad data.
3. **GATE READ/WRITE ERROR:** An error resulted during a Directory GAT sector READ/WRITE.
4. **DISK DIRECTORY-TYPE ERRORS:**
   - (1) **DIRECTORY READ/WRITE ERROR:** An error resulted during a Directory sector READ/WRITE.
   - (2) **ILLEGAL LOGICAL FILE NUMBER:** The file Control Block (FCB) in the Directory contains bad data.
   - (3) **GATE READ/WRITE ERROR:** An error resulted during a Directory GAT sector READ/WRITE.
5. **READ/WRITE ERROR:** An error resulted during a Directory sector READ/WRITE.
6. **FILE OR PROGRAM NOT IN DIRECTORY:** Your program tried to open a non-existing file during a READ/WRITE. (Shame on you.)
7. **DIRECTORY SPACE FULL — FULL DIRECTORY:** The Diskette has no more room on it to log-in a new file, even though the diskette may have room for the new file’s data.

**PROGRAM TYPE ERRORS**

1. **ILLEGAL FILESPEC:** The filespec was too long, or contained illegal characters.
2. **FILE OR PROGRAM ACCESS DENIED — IMPROPER ACCESS CODE OR PASSWORD — ACCESS TO PROTECTED FILE DENIED:** You tried to access a protected file or program by not using a password or access code or by using an incorrect one.
3. **DISKETTE SPACE FULL:** The diskette is filled up and can’t fit more file data, even though its Directory may have room to log-in the file.
4. **PAST EOF OR END OF FILE:** Results from trying to Read/Write beyond a file’s EOF. Immediately CLOSE the file.
5. **EOF ENCOUNTERED:** The byte/record just accessed was the EOF byte/record. Usually results when trying to Read a file that has been created but the last page is still empty.
6. **FILE OR PROGRAM NOT FOUND:** The sought file or program was not found.
7. **ILLEGAL FILE/DIRECTIVE NUMBER:** The drive number in the filespec indicated a drive not permitted by the DOS drive configuration parameters, or by the system.
8. **LOAD OR FORMAT ERRORS:** An attempt was made to Load non-object code in the command mode.
9. **FILE/PROGRAM DELIMITERS TOO FAR APART:** An attempt was made to Load object code or a data file as a BASIC program.

**DISK SERVICE MANUAL III**

**ERROR MESSAGES**

(1) **FILE NOT OPEN:** The Directory File Control Block was not OPEN prior to a READ/WRITE.

**OTHER COMMON ERRORS**

1. **PARITY or CRC ERROR DURING READ/WRITE:** A CRC or checksum error resulted from Reading/Writing the data field of a sector (the data data examined did not correspond to the expected CRC or checksum).
2. **PARITY or CRC ERROR DURING HEADER READ/WRITE:** A CRC or checksum error resulted when the DOS tried to Read/Write an ID field but couldn’t find the correct sector. Usually due to a glitched diskette. Can be due to Sector Index out-of-adjustment. A header WRITE error is rare and indicates a defective DOS or controller because the header should never be Written to except during a FORMAT.
3. **SEEK ERROR DURING READ/WRITE:** The head won’t SEEK properly during a READ/WRITE. The track found, as Read from the sector header, does not correspond to the track that should be at that physical position of the diskette. Usually due to head misalignment or diskette eccentricity.
4. **SECTOR/TRACK NOT FOUND DURING READ/WRITE:** The expected sector/track number was not found in the current sector 1D during a READ/WRITE. The error is usually displayed after two or more failed attempts. Means the same thing as (2) (SECTOR (and (3) (TRACK) above.
5. **DATA RECORD NOT FOUND DURING READ/WRITE:** Same as (4) above.
6. **LOST DATA DURING READ/WRITE:** The software was too slow for the flow of data from the FDC during a READ/WRITE. The software was unable to fully Read/Write the current byte of data before the next byte was Read/Written. Primarily due to incorrect drive speed, or bad diskette.
7. **READ PROTECTED SECTOR:** The sector DOS Read was of a Read-protected sector, not necessarily error.
8. **DRIVE or DEVICE NOT AVAILABLE:** The currently selected drive is not available for access (disconnected, turned OFF, improper diskette detected, defective Sector Index Optical Coupler, speed far off, etc.).
9. **DISK DRIVE WRITE FAULT:** A hardware defect or disconnect in the controller, drive interfacings, and/or drive.
10. **WRITE PROTECTED DISKETTE:** The diskette either has a Write-Protect tab, is inserted in the wrong way, or the Write Protect Detector or related circuitry is bad.

The #1 source on floppy drive theory and practical facts is DISK DRIVE TUTORIAL (CONSUMERTECHNICS CO., P.O. Drawer 537, Alamosa, NM 88310). If you still want more information on diskette directories, file storage, passwords, error recovery routines and diskette drive specifications, try DISK MYS TERY 2 OTHER MYS TERY and MACHINE LANGUAGE DISK TUTORIAL & OTHER MYSTERIES (DIG, inc., 1953 W. 11th St., Upland, CA 91786).

**DRIVE STORAGE CAPACITIES (WESTERN DIGITAL)**

<table>
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<tr>
<th>SIZE</th>
<th>DENSITY</th>
<th>UNFORMATTED CAPACITY (Nominal)</th>
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<tr>
<td>5¼&quot;</td>
<td>SINGLE</td>
<td>1255</td>
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<tr>
<td>5¼&quot;</td>
<td>DOUBLE</td>
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</tbody>
</table>

*Based on 5½ Tracks/Side
**Based on 10 Sectors/Track (128 bytes/sector)
***Based on 19 Sectors/Track (256 bytes/sector)
Chapter IV: DIAGNOSTICS & TROUBLESHOOTING

The relationship of drives to their computer systems is a complex one, and sometimes it is difficult to ferret out problems. Apparent drive problems can be caused by a malfunctioning drive (mechanical/electronic), by the drive cable (electrical), and/or by the computer (electronic).

A bad controller part, memory IC, or buffer can manifest itself as apparent drive problems. All of the major computer manufacturers we were able to check (11 of them) made 25%-35% of their total 1985 income from their repair and parts operations alone. For drives, you might as well salvage the computer and buy a new one! It can pay you $500 BIG to learn to do-it-yourself. Very brisk sales of our DISK SERVICE MANUAL, DISK DRIVE TUTORIAL, PRINTER & PLOTTER MANUAL, COPIER MANUAL, etc. attest to the great interest people have in repairing their own equipment and in doing-it-themselves.

PARTS SUBSTITUTION

Computer repairs by professional shops can be extremely costly! For example, IBM charges (at this writing) $120/hr., two hour minimum, regardless of the problem, for labor alone! Other computer manufacturers and independent repairers are similarly stiff. All of the major computer manufacturers we were able to check (11 of them) made 25%-35% of their total 1985 income from their repair and parts operations alone. For drives, you might as well salvage the computer and buy a new one! It can pay you $500 BIG to learn to do-it-yourself! Very brisk sales of our DISK SERVICE MANUAL, DISK DRIVE TUTORIAL, PRINTER & PLOTTER MANUAL, COPIER MANUAL, etc. attest to the great interest people have in repairing their own equipment and in doing-it-themselves.

If you were to send your troubled system to a repair shop, and hardware failure was suspected, their solution would probably mostly consist of the parts substitution method. Repair shops keep on hand spare drives, logic and servo motor boards, motors, etc. They usually first swap out suspected culprits with good board and subsystem-level replacements. If that solves the problem, they may assess your system, and charge you $400 for a new board, power supply, etc., when the problem may only be a solder ball on a 25 cent IC requiring 1 minute of repair time. (An IBM PC motherboard costs $200+) They may attempt to repair your board or subsystem to sell to the next customer at full price, or return it to the factory for a replacement.

I've heard it said that pro repair shops charge you $400 for a new PC board and $30 in labor to spare hurting your feelings if they repaired to the parts level and charged you $400 for labor and $30 for parts! This is bull because, by temporary board substitution, the problem can be isolated to a particular board. Then, an inspection of the board by an alert and experienced repair technician and some voltage checks should isolate the problem to the part in 90%-10% of all cases. The repair can be made, and the original board restored — all within one hour! In 90%-10% of all repairs (not due to a catastrophic event) the total cost of the repair should not honestly be over $50!

Another popular scam used by computer makers (sometimes without telling their field repair shops) is to hide a fuse(s) inside the power supply. When this secret fuse blows, the power supply fails, in which case the shop usually replaces the entire unit. The power supply is then returned to the factor, who pop the cover off, replace the fuse, and resell it as a new unit!

Many equipment makers profit more from their repair and parts operations than they do from selling the actual equipment. Many purposely engineer in obsolescence, time-programmed defects, special proprietary parts, and repair traps to swindle you out of $50-$100 of parts and repair the cost of the part.

I don't know what the profit margin in repair shops are but it must be huge. I have been told that not all repair shops are using readily available replacement parts. Some are left alone in the bottom line. If they can "justify" charging you $200 for a repair that should cost $2, they'll gladly do it. If the board or subsystem-level swap doesn't solve the problem, and it isn't due to something obvious, they usually declare the drive, interface or even the entire computer system at fault, and charge you even more!

DIAGNOSIS

Drive maintenance or repair is immediately required if the noise level of the drive significantly increases or changes, or performance or reliability decreases — even gradually. Performance changes can be subtle. The number of READ attempts increases, sometimes beyond what the DOS is programmed to tolerate, resulting in over increasing error messages.

Don't be alarmed if you get an error once in awhile. Under IDEAL conditions, a good drive's inherent error rates are about: (A) SEeks: 1 attempt/million. (B) Soft READ Errors 1 bit/trillion. Power supply glitches and externally-triggered EMI can increase error rates by a factor of 1,000 or more! And glitched diskettes are very confusing. When you consider how many SEEK attempts are made and bits Written and Read when operating (under practical usages), an error message once in awhile is expected. Be concerned if error rates significantly increase or develop a pattern.

Experience drive users often learn to detect small changes in drive noise levels. Drives and diskettes of different types and makes sound somewhat differently. Lead-screw actuated drives are quiet; split-band actuated drives are noisy. If you don't observe a change, there may be problems.

When listening to drives operate, ignore the normal swishing diskette sounds, and its reliability. But one can easily pick-up on malfunctions or impending malfunctions from sound changes. When listening to drives operate, ignore the normal swishing diskette sound, and normal drive Step and head-load sounds. But listening during head Stepping is a strong indication of dirty or dry guide rails, and less often, of bad motor bearings. Scraping sounds usually indicate a dirty head and/or diskette.

Another good indicator of a dirty drive is diskette wear. New scratches on diskettes call for immediate cleaning of the head(s) and drive. Make a habit of closely inspecting new diskettes before using them, and after about 3 minutes of use.

Study the drive's service/maintenance/OEM manual and DISK SERVICE MANUAL. When they may contain important information about the manufacture's manual. Review all problems and errors and record them, and make a plan of attack PRIOR to the start of the repair. We do not recommend repair work on a bare, hard surface! Mechanical shocks can wreck a drive instantly. Place the drive on a clean, lint-free and static-free folded towel, felt pad or carpet pad. We prefer a padded, vinyl-covered tool-seat-cover. I usually work in my bare feet to prevent any kind of static build-up.

The most important thing is not to lose your head. If you approach the problem in a careful, systematic and logical way, you'll likely solve your problem. Treat it as a challenge and not as a chore. Don't let it anger or frustrate you. If you do have a unsolvable problem, you may choose to please describe your system and problem. WRITE — DO NOT PHONE IT! And please include a $10 SASE. If we can help you, we'll respond.

Unless you have spare drives, maintain or repair only one drive at a time. If you make a mistake, you will still have a good drive available to use as the boot drive to run your DOS on. If you must switch drives, how do you know you depend upon whether or not you have a keyed (gapped) drive cable, and whether or not you have front panel switches (see modifications chapter). If keyed, you must physically disconnect and remove the drives, switch them over and reconnect them. If the entire drive board is affected, IC for the new end drive must be installed, and the one installed in the former drive drive be removed. If the cable is not keyed, all you need to do is switch Select DIP switch or jumpers on each affected drive accordingly.

Consumertronics Co.
2011 CRESCENT DR., P. O. DRAW 537, ALAMOGORDO, NM 88310
DEDUCTIVE REASONING

Most PC owners find life expensive enough without having to keep spare parts on hand. Those parts are out there and can be obtained. Most problems can be solved in a more elegant fashion. Also, he usually cannot afford to own sophisticated electronic gear, nor has the time to learn it and to properly use them. However, with little more than a good volt-ohm-meter, logic probe and a lot of common sense, effective troubleshooting can be easily performed.

First analyze the nature of your problems. Run through your normal operations and carefully record all factors relating to the problem.

(1) Are the problems constant or intermittent; progressively increasing with age and use; or thermally-related (occurs before/after warm-up and more specifically on hot/cold days)?

(2) What are the error messages and other error symptoms?

(3) Did you recently change your DOS or software?

(4) Did you recently change the location of your system or parts of it?

(5) Did you recently repair, modify, add, remove or re-arrange any peripheral cards or devices?

(6) Can you relate the problems particularly to any user? Particular sequence of events or external situations? Time of day? Season?

(7) Was the first occurrence of the problems preceded by a line power glitch? Static discharge? Spillage? Shock or vibration?

(8) Can you pinpoint the problem to a particular unit, subsystem, board or part due to noise, smell, discoloration, diskette wear, etc.?

(9) How many operations are affected by the problems? Are problems limited to drive function alone?

Based upon your answer to these questions, consider the following:

TROUBLESHOOTING

Adding and Changing Equipment

One of the most common problems is adding or changing a peripheral or card to your system and finding that it, the system or both no longer work! This phenomenon most frequently occurs when adding or changing drives. The most likely causes are:

(A) Wrong or wrong configuration.

(B) Wrong drive options.

(C) Wrong system configuration.

(D) Drive access time is too slow for your system.

A common problem with installing drives in the IBM-PC XT/AT and most compatibles is that the computer does not issue a "Motor-On" command to the drive. This results in a Drive Not Available" error in all drives in which the Motor-On line is not internally jumpered to the DS line. This jumpering is required so that the DS command also causes Motor-On. This justifying option comes as a drive option in most modern drives. In systems that require this, the drive spindle motor must be stable so that the drive can reliably Read and Write to diskettes. This all but limits IBM and compatible systems to 5 1/4 drives with direct-drive brushless DC motors.

The most common spindle motors used with 5 1/4 drives are DC motors with brushes. As the drive ages, the brushes wear out and spark more causing erratic start-up speeds and electrical noise that interferes with the drive's clock recovery circuit. The result is a lot of Read errors. Don't use drives with DC motors with brushes.

Also, while DC motors with brushes last 2,000-3,000 hours, brushless DC motors can expect to last over 10,000 hours and they use less than half the power! Many 8" drives use capacitor-start motors, which run hot, are electrically noisy, and don't last very long.

If you are adding a drive to your system, don't forget to move the TRN IC, usually to the drive at the end of the cable! In some systems, you need to change internal dip switches and/or jumpers to properly connect the addition. In the IBM-PC, to add a 3rd or 4th drive, Pos. #1 and Pos. #8 of SW1 (located near Drive A) must be OFF. Pos. #7 must be ON for a 3rd drive, and OFF for a 4th.

If you are adding a drive to a different drive model, you must also change the FDC (Floppy Disk Controller) settings. These are usually: Track, type of controller used, etc., as needed. If you have a defective FDC IC, usually to the drive at the end of the cable! In some systems, you need to change internal dip switches and/or jumpers to properly connect the addition.

Speed adjustment & Lubrication

If the problem is in a drive, adjust its speed. Clean and lubricate it. About 90% of drive problems are due to speed out of adjustment, lack of lubrication or contamination. Label and switch drive logic and servo motor boards and power supplies.

Connector & Cable Diagnoses

The most common computer problems are cable/connection problems, which most frequently occur after moving, re-arranging or working on your system. And after physical accidents. Examine all external cables and connectors. With your system OFF, remove all external cables and examine connector contacts both in the cables and on the hardware. Are there any bent, broken or corroded contacts? Are the cables OK? Replace all suspect and damaged cables and connectors. Carefully clean, either using a contact cleaner (ex: CRAMOLIN) or a pencil eraser (remove all debris), all connector contacts that appear to be dirty or oxidized (tarnished). After re-installing the cable connectors (squarely and firmly but don't force), repeatedly turn the system ON and OFF and watch for errors. Did they go away? Are they better, worse, about the same? Try lightly jiggling the various external cables and connectors. Changes in errors indicate a cable/connection problem.

Inspect for Bad Parts

About 75% of all electronic malfunctions leave some sort of visible damage. Look for burns, smoke stains, swells, cracks, pin holes and exploded parts. Electronic capacitors usually leak, sweat, crack or form bulges at the plus end. With age, clock back-up batteries sometimes leak and must be replaced and the area cleaned up.

IC coloration is an important indicator. The center of the IC should be the same coloration as the rest of the IC. If the center looks a lighter shade, dull, blistered or crystalized, it probably overheated.

The parts to go first are usually the hardest working parts. Except for power supply parts, the most endangered are peripheral drives. They are small, FET, PIN, and Transistor parts. These devices usually progressively malfunction as heat progressively degrades their integrity. If you do get into your computer, you should, if possible, heat sink all of these parts.

Parts Swapping

Once you've isolated the part of the system or circuit that is apparently causing the problem, you can swap parts just like the pros do. Unless you have spare boards, electronic swaps will usually be limited to cables and socketed ICs. Unless you have spare mechanical parts, there is not much you can do in your drive if your problem is mechanical. Swap out stepper motors, head assemblies and T00 Sensor and End Stop cautiously as an alignment is required each time. Try whatever substitutions you can make. Substitute various cables. Switch the drives around, and substitute with known good drives. If not, the problem is most likely located in your computer or expansion boards. If the problem affects computer systems, label all of their subsystems, PC boards, and plug-in components (ICs, etc.). Then make substitutions. This should pinpoint the subsystem or IC board at fault. If you can narrow the problems down to one board or subsystem, you usually reduce the effort by a factor of 10!

If the problem is in the expansion interface or computer, substitute the FDC IC and any other socketed controller ICs. Substitute the µP (Microprocessor) on the RAM (Random Access Memory) board. Carefully scrub the drive, controller and main PC boards (both sides) with alcohol and a toothbrush. Allow to completely dry. By then, the eighth seed of an offending solder ball/splash/hair, discovers the defect, eliminate an EMI problem caused by cross-talk, or eliminate a short-circuit.

See Photographs for More Detail on Drive Anatomy
Almost all intermittent type problems are either thermal or stress related, or due to poor alignment. As computer systems become more and more compact, thermal-related failures are increasing. Thermal problems can be mechanical, electrical or electronic in nature.

Small but significant mechanical dimensional changes occur when temperature changes. A drive that is marginally aligned can go out of alignment just by warming up or cooling down. Electrical connectors, socketed parts, pots, relays, switches, coil or resistor leads, etc., can loosen, short or become intermittent when heated or cooled. This problem is particularly bad in aged equipment, and equipment with the history of large temperature changes. A drive that is marginally aligned can go out of alignment just by warming up or cooling down. Minute shifting of socket contacts and IC pins, aged equipment, and equipment with the history of large temperature changes. This problem is particularly bad in aged equipment, and equipment with the history of large temperature changes.

Almost all intermittent type problems are either thermal or stress related. Electrical connectors, socketed parts, pots, relays, switches, coil or resistor leads, etc., can loosen, short or become intermittent when heated or cooled. Thermal problems can be mechanical, electrical or electronic in nature.

Small but significant mechanical dimensional changes occur when temperature changes. A drive that is marginally aligned can go out of alignment just by warming up or cooling down.
stuck input, output, clock or control pin. A hard DC voltage less
than 0.7 volts usually indicates a short to ground. A hard DC volt-
age within 0.5 volts of Vcc usually indicates a short to Vcc.

IC EMULATOR
If all else fails, you can use an IC emulator to ferret out malfun-
tioning chips. An IC emulator consists of a dip clip test clip con-
ected to a PC board consisting of a socket, a quad dual-input ex-
clusive or (XOR) gate, 30 kHz and LEDs (10 ma). The socket con-
nects to each IC and the socket is removed to the test clip. The
socket box is then inserted into the socket on the board. The IC
chip wires are attached to the leads of the socket box. The IC
chip is then removed from the socket and the socket box is
placed in the socket on the board. The IC chip wires are then
attached to the leads of the socket box. The IC chip is then
removed from the socket and the socket box is placed in the
socket on the board. The IC chip is then removed from the
socket and the socket box is placed in the socket on the board.

SUBTLE TIMING
This is the most difficult method of circuit diagnosis and should
only be resorted to if all else fails. The various timing relationships
of each part to each other are critical in the proper operation of a
computer. Fortunately, since your system was once a fully func-
tional system, timing problems will usually occur only due to the
aging of an already marginal IC, which, along with heat, causes in-
creases in the propagation delay. Usually high temperature ag-
graves the problem and the marginal or failing IC can be dis-
covered using a thermal method.

To solve timing problems, a thorough understanding of system and
individual part operations is a must. So are excellent eyesight,
bench and tools, and schematics with waveforms and timing infor-
mo. Also, you will require a logic probe, an oscilloscope (dual,
channel, 30 kHz, LEDs or probes), minimum), and, possibly, a
logic or signature analyzer. Unless you have all of these, it’s time
to call in the pros.

MORE SOURCES
For additional information and photos on drive maintenance and
repair, see 80 MICRO, Sept. 1984, p. 93. For APPLE drives, see

TROUBLESHOOTING GUIDE
Below is listed drive malfunction symptoms, followed by possible
causes and recommended remedies. First, test with several disk-
ettes to verify part operation. If possible, operational tests by indi-
vidual part operations is a must. Thus clean the Logic Board and system con-
ectors, and verify or replace the drive cable. Also, properly clean
and lubricate the drive. If problems still persist. Unless otherwise
noted, the problems indicated below are described in the
miscellaneous repairs chapter.

(1) DRIVE NOT READY AND/OR NO INDEX - SPEED CAN BE ADJUSTED:
(A) Diskette Not Or Improperly Inserted: Insert diskette in correct orientation.
(B) Door Not Closed: Close drive door. - Replace broken door.
- Verify operation of door switch (if drive has one).
(C) Drive Not Selected: Verify proper jumper configuration and connec-
tions. - Switch drives to test controller Drive Select function.
(D) Disconnected Index Sensor: Verify connection to logic board (usually P10).
(E) Maladjusted Index Sensor: Replace or repair index sensor.
(F) Defective Index Sensor: Replace index sensor LED and-or photosensor.
(G) Bad Index Sensor Electronics: Replace or repair logic board.
(H) Poor Compliances: Replace felt pressure pad, adjust upper arm assembly, repair/replace head or clamp assembly, replace head carriage assembly, repair/replace logic board.
(I) EMI: (1) Usually Intermittent: Verify proper drive and system grounding. - Verify proper head shielding.-- Verify proper drive cable routing (stay away from 120 VAC and the CRT). - Verify that EMI is not coming from the computer, 120 VAC line, or power supply.

(2) DRIVE NOT READY AND/OR NO INDEX - SPEED CAN'T BE ADJUSTED:
(A) Defective Drive Speed Out of Adjustment: See speed adjustment chapter.
(B) Defective Belts: Verify that the drive belt is not worn, frayed, broken, loose or oily (clean or replace).
(C) Disconnected Spindle Motor: Verify proper spindle motor and servo motor board connections (P13, P20 and P21).
(D) Defective Spindle Motor: Replace spindle motor.

DISK SERVICE MANUAL III IV - 4
DIAGNOSTICS & TROUBLESHOOTING

(E) Defective Spindle Assembly: Repair/replace spindle as-
semble.
(F) Bad Spindle Motor Electronics: Replace or repair servos
motor board (or logic board if drive has no servo motor board).

(3) WILL NOT SEEK OR RESTORE:
(A) Controller Malfunction: Verify controller direction, and
Write Select signals.
(B) Disconnected Stepper Motor: Verify connection to logic
board (P12).
(C) Defective Stepper Motors: Verify that a guide rail deflect, or
a loose part is not binding stepper motor or head carriage assembly. - Replace stepper motor, or module assembly.
(D) Bad Stepper Motor Electronics: Replace or repair logic board.

(6) NO WRITE:
(A) Controller Malfunction: Verify Write Enable, Drive Select, and
Write Data signals.
(B) Head(s) Or Write-Protect Switch Disconnected: Verify con-
nection to head(s) (P5, P6), and write-protect switch (P8).
(C) Write-Protect Switch Maladjusted: Verify write-protect
switch operation.
(D) Defective Head(s): Replace head(s), or module assembly.
(E) Defective Logic: Replace or repair logic board.
(F) Poor Compliances: See (1) (H) above.
(G) EMI: See (1) (I) above.

(7) FRONT PANEL LED INOPERATIVE:
(A) Interface Not Enabled: Verify Drive Select, and
driver configurations.
(B) LED Disconnected: Verify front panel LED connection (P9).
(C) LED Defective: Replace front panel LED.
(D) Bad LED Electronics: Replace or repair logic board.

(8) NO T00 SENSOR INDICATION:
(A) Defective SEEK: See (D) above.
(B) T00 Sensor Disconnected: Verify T00 sensor connection
(P11)
(C) T00 Sensor Maladjusted: Adjust T00 sensor.
(D) Defective T00 Sensor: Replace T00 sensor Assembly.
(E) Bad T00 Electronics: Replace or repair logic board.
(F) T00 End Stop In Too Far: Adjust T00 end stop.

APPLE DRIVE
IC TESTER/EMULATOR: This versatile and powerful circuit permits you to test TTL and CMOS ICs either in-situ (while under actual operation) or out of the circuit.

(A) One thumbwheel (TW) switch is required for each pin of the Zero Insertion Force (ZIF) socket.

(B) Each TW switch has six positions (0-5). Pos. 0: Ground. Pos. 1: +V. Pos. 2: Clock Input. Pos. 3: Output. Pos. 4: Pulse Input. Pos. 5: Corresponding ZIF Socket Pin.

(C) Circuitry of Pos. 0-3. Note that while the ground, +V and Clock inputs go to all the corresponding TW switch position numbers, each Pos. 3 TW switch pin goes to its own Pos. 3 output/display circuitry. An alternative is to use XOR gates in the outputs to compare an in-situ DUT to its Verifier IC. Note also that the clock can be either 10 Hz or 1K Hz.

(D) Power supply wiring for both TTL and CMOS tests.

(E) Pulser circuit for Pos. 4, for all TW Pos. 4 pins. A bounce-free pulser output is ideal for simulating control voltages.

(F) Each IC Test Clip pin is wired to its respective TW switch Pos. 5 pin. This TW switch position is only used when the DUT is in-situ (on the circuit board) and is being compared with an identical and known good IC (Verifier IC). All TW switches corresponding to output pins are then switched to Pos. 3. All other pins are switched to Pos. 5.

The IC Tester/Emulator can be used to test ANY 14- or 16-pin IC in ANY mode of operation simply by switching the various TW switches so that the proper inputs and outputs are wired for the DUT. It is also a great help in determining unknown ICs - a lot of ICs now have proprietary numbers (even common ICs). The IC Tester/Emulator can also be used as a Substituter if the in-situ device is totally dead, by switching Verifier IC output TW switches from Pos. 3 to Pos. 5.

By expanding upon these circuits, ICs with greater number of pins than 16 can also be tested. One standard size of TW switches is eight positions. The two extra positions can be used for additional Clock and Pulser inputs. One clock can be used as the Clock while the other as a Data Input. And many digital ICs require more than one control voltage.

AUDIBLE LOGIC PROBE: The audible logic probe is a nifty device that audibly tests ICs for "1" and "0" outputs. It does this by generating a low tone for "0"s and a high tone for "1"s. Designed for TTL use only, it is easily modified to CMOS by changing the resistor ratios defined by the 30K, 12K and 8.2K ohm reference resistors. Shown, they produce a high tone for inputs of 3.0+ volts and a low tone for inputs of 0.3+ volts. CMOS highs and lows depend upon supply voltage (Vdd). At 5 volts Vdd, High = 3.5+ volts, Low = 0.3+ volts. At 10 volts Vdd, High = 7.5+ volts, Low = 1.5+ volts. At 15 volts Vdd, High = 11+ volts, Low = 4+ volts. See ULTIMATE LOGIC PROBE ($7) for the logic probe design we consider to be the ultimate in versatility and capability.
HOW TO TROUBLESHOOT DISK DRIVES

NOTES:
1. Check select function—check dip shunt and cable.
2. Check for proper track 00 alignment and the freeness of the head assembly.
3. Check track 00 alignment.
4. Check head amplitude and for freeness of the head assembly.
5 & 6. Check complete alignment, head amplitude, raw data for filter and pin $5$ for proper voltages and noise.

DERIVED FROM RADIO SHACK DISK DRIVE MANUAL
Chapter V: MAINTENANCE

The three most important wear factors that determine the mechanical life of a drive are: (A) Head cleanliness, (B) Lubrication of the guide rails(s) and mechanical linkage to the stepper motor. (C) Spindle/lubrication motor lubrication, because stepper motors are used less, use better bearings and retain their factory lubrication longer. A properly cared for drive can last 20 years of regular use! A poorly cared for drive can die within a year!

Many drive service manuals and articles tell you to never lubricate your drive, no matter how tempting, and that drive motors are lubricated for the life of the drive. This is bull! Like any precision mechanical instrument, drives must be periodically lubricated or they will wear out and break down. What is really meant by "life-time lubrication" is the life of the lubrication - not the possible life of the drive. Of course, you can over or incorrectly lubricate a drive - that too, must be avoided.

PROCEDURES

First, turn-OFF power to the drive, and disconnect. To perform periodic maintenance:

1. Clean and lightly lubricate drive mechanical components (frequent).
   - Clean the drive Read-Write head(s) and felt pressure pad (frequent).
   - Clean, and/or align the index hole optical coupler(s) if required (rare).
2. Verify the write-protect notch detector(s), and adjust if required (rare).
3. Verify drive speed, and adjust IF required (frequent in some drives, impossible in others).
4. Verify alignment of Read-Write head(s), and align IF required (occasional-to-rare).
5. Verify the T00 sensor and T00 end stop, and adjust IF required (rare).
6. Clean drive connectors (frequent if not gold-plated, rare if gold-plated).
7. Inspect for electronic defects, and correct IF required (rare).
8. Clean the drive Read-Write head(s) and felt pressure pad for dirt and debris. A good method is to pass a ROPER-WHITNEY sheet metal punch, not a paper punch) in the guide rails (which serve as linear bearings). Be sure that all dust, dirt, lint, tobacco byproducts, etc. are removed. Be sure that the oil is dispensed uniformly along the periphery of the guide bars in several spots. Do NOT oil excessively.
9. Paint the contact between the stepper motor shaft and the Read-Write head split band.

There is a subtle difference between the meaning of "align" and "adjust." "Align" means to set precisely to an absolute position even though a stopper setting would still function. "Adjust" means to set to a position so that a function (T00 sensor switching) reliably occurs (precise setting is not required).

RECOMMENDED TOOLS

The following tools and supplies are necessary for drive maintenance and repairs. Be sure that, before you start, you have your work area set up with all tools and supplies at hand so that you don't have to be disturbed looking for them during a critical operation. You may need additional tools to physically access your drive(s) located in a computer or expansion interface. Use proper grounding, short the right tools and supplies, and never rush.

- (1) SCREWDRIVERS: One medium blade, at least 6" long. One fine blade, at least 6" long. One medium phillips, at least 4" long. One medium flat, at least 6" long. One medium blade, at least 6" long. One medium phillips, at least 4" long.
- (2) Diagonal cutters. Small wooden mallet. Small hand mirror. Plastic tubing, clean alcohol. Cotton swaps, clean alcohol, Krylon spray. Circuit chiller spray is a very important diagnostic tool for pin-pointing heat-related electronic and mechanical malfunctions (the most common type). All chillers we tested were satisfactory.
- (3) SUPPLIES: Cotton swaps (6" stem, ASICO AUDIO ACCESSORY or equivalent). Blank and formatted diskettes. DOS diskette. Bath towel or cloth. Pencil and paper. Wire. Electrical tape. Lubricants and chemicals, see below.
- (4) OPTIONALs: Disk diagnostic software (CE or DDA/DDD). 50-100 MHz oscilloscope with A-B (differential) capability, 2-8 channels, 1 M0 probes. Circuits described herein.

LUBRICANTS

Light machine oil, sewing machine oil, 3-IN-1 or WD-40 are recommended as drive lubricants. Do not use a silicone- or graphite-based lubricant. The oil can be dissolved with a spray nozzle, hypodermic injection or by cotton swab.

Even though most repair experts do not recommend WD-40, we've used it for years without any problem. Its spray nozzle permits easier and easier dispensation in hard-to-reach spots, such as behind the large pulley and vicinity lubrication. The oil can be dissolved with a spray nozzle, hypodermic injection or by cotton swab.

If your PC edge connectors are not gold-plated and tend to tarnish, we highly recommend CRAMOLIN (OLD COLONY SOUND LAB, P.O. Box 243, Peterborough, NH 03458). CRAMOLIN comes in two solutions. One removes the oxides from the contacts, and the other coats the contacts with an extremely thin protective film. We are very pleased with CRAMOLIN.

For electronic repairs, SN60 rosin solder (22 SWG), and non-corrosive soldering paste (GC) are recommended.

For cleaning, we use long, cotton swabs, SPRA KLEEN (GC) and 91% alcohol. Suitable spray cleaner and swabs can be purchased in most electronic retail outlets, or use a "Disk Drive Read-Write Head Cleaner" solution (more expensive). CAUTION: Some chemical cleaners are harmful to plastics. DO NOT use these types.

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For electronic repairs, SN60 rosin solder (22 SWG), and non-corrosive soldering paste (GC) are recommended.

Circuit chiller spray is a very important diagnostic tool for pinpointing heat-related electronic and mechanical malfunctions (the most common type). All chillers we tested were satisfactory.

Soft, tacky, layout wax (used in layouts, artwork and publishing) is an ideal shop aid. You can use it to temporarily hold or pick up a screw or other small part at the end of a screwdriver or finger. You can also roll the end of a long-stem Q-tip into it, and use it for picking up hard-to-get debris.

LUBRICATION

The object of lubrication is to disperse the oil where it is needed, and not to the extent where it drips or sags. Before applying lubricant, inspect all the mechanical parts, the Read-Write head(s), and felt pressure pad for dirt and debris.

It is generally only necessary to remove the drive's enclosure to clean and lubricate a drive. In TANDON drives, the glassine window in front of the head assembly (left side of drive) is also temporarily removed. It is recommended to punch two 0.25" holes (use a ROPER-WHITNEY sheet metal punch, not a paper punch) in the window so that future lubrication and cleaning can be made through the holes, without removing the window.

Parts that should be lubricated include:

1. The drive spindle (servo) motor (both sides).
2. The drive motor spindle (behind the large pulley, squeeze the lubricant nozzle between it and the drive wall). Does not apply to drives with direct drive motors.
3. The Read-Write head assembly's guide bars. Prior to oiling them, wet a cotton swab with alcohol and wash down the guide rails (which serve as linear bearings). Be sure that all dust, dirt, lint, tobacco byproducts, etc. are removed. Be sure that the oil is dispensed uniformly along the periphery of the guide bars in several spots. Do NOT oil excessively.
4. The contact between the stepper motor shaft and the Read-Write head split band.
5. The spiral wheel or worm gear. Use quality small-motor grease, such as WHITE's lubricant.
6. Behind the hub and cone (accessible in most drives through the door), even though drive makers claim that spindle bearings never require lubrication.
7. Contact points between the head carriage assembly and the dovetail assembly.
8. Front panel grooves for the door posts, and the door hinges - particularly in TANDON, SHUGART and other drives with pop-out doors. If plastic, use vegetable, fish or baby oil.
9. Contact points for any other moving mechanical parts.

CAUTION: Do not lubricate the drive Read-Write head(s), felt pressure pad, pulley surfaces, pulley belt, optical coupler(s), any wiring and electronics, including connectors, and non-moving parts. Gently wipe away or swab up any excess lubricant.
CLEANING

READ-WRITE HEAD

Lean Read-Write head(s) and felt pressure pad are crucial for both read and diskette life. The head(s) and pad are cleaned after lubrication.

The easiest and fastest - yet effective way - to clean heads and add is by using a wet-type diskette-like head cleaner. (CAUTION: Never use a dry-type diskette cleaner!) We recommend the /ERBATIM Read-Write head cleaner but only for occasional or emergency use. Mechanical head cleaners are a safe and effective way to clean the heads on tape recorders, but NOT on drives. The difference being that tape recorder heads are solidly set, and that small misalignments aren't critical. Head cleaning diskettes commonly cause azimuthal misalignments in Head #1 of DS drives. They also tend to wear away drive heads, and thus ruin their Read Sensitivity. CAUTION: Never touch a Read-Write head or felt pressure pad with a hard, sharp, abrasive or dirty object - that includes your fingers!

Even though most experts insist upon removing the logic board to clean the head(s) and felt pressure pad, I've cleaned hundreds of heads this way. I've even used cotton swabs, and, with the drive door open and diskette removed, I reach the head and pad at about a 45 degree angle between the logic board and frame (most drives). For your first time, a snorkel-neck penlight flashlight can save you a lot of extra disassembly to find the head. But you quickly learn to do it by feel alone.

The head is usually more accessible by stepping (or sliding it manually) to its innermost tracks. You can safely and easily manually slide the head carriage assembly only on band-actuated drives. In lead-screw drives, you can safely manually rotate the stepper motor shaft to move the head. In spiral-wheel drives, you can safely rotate the spiral wheel to move the head.

First spray a cotton swab with the SPRA KLEEN, then run or pat the swab about a dozen times over the head(s) and pad. Using a fresh swab, repeat the process with the alcohol. CAUTION: Any rough motion can misalign the Read-Write Head(s) or felt pad.

SECTOR INDEX OPTICAL COUPLER

With a cotton swab and alcohol, gently clean the sector index optical coupler(s) (after cleaning the head(s) and pad).

PULLEY

The most common cause of erratic drive spindle speed is due to the drive belt slipping on the pulleys. Less frequent causes are a worn or loose belt, aged or defective servo motor board electronics, bad diskette, or defective spindle motor or bearings. And the most common reason why a drive won't boot after being lubricated is because oil inadvertently got onto a pulley or the belt, and the belt is now slipping.

If you observe (under a fluorescent lamp) that the large pulley pattern in the drive, with no inserted diskette, appears to be on target, insert a diskette. Does the drive pulley slow down considerably, become erratic or stop? If it does, and the small motor pulley is still turning, the drive belt is slipping! If the slipping is caused by an oily surface, it can be cured by dipping a Q-tip into alcohol, and while the drive is running empty, gently wedge the Q-tip where the belt comes off of either pulley (NOT where it goes onto the pulley). Dirt and oil will be quickly cleaned off. Repeat as often as necessary. Allow the alcohol to dry, then run the drive again.

CONNECTORS

Some computer systems have problems with cumulative connector voltage drops. The TRS-80 Model I is a classic example. The keyboard is connected to the expansion interface through a ribbon cable jumper. Unless cleaned regularly, the PC board connector contacts tarnish, with increasing voltage drops resulting at each connection. Eventually, the '1' voltages arriving at the expansion interface are not high enough to be consistently interpreted as '1's, and data garbage, erratic behavior and lock-up result. Some drives, particularly external ones, can suffer from cumulative connector voltage drops. Four connectors between drives and their systems are not uncommon.

The best ways to clean connector contacts is either with a pink pencil eraser (don't use a white ink eraser), or with CROMALIN. If the tarnish is erased, care must be taken to remove all eraser debris before re-installation.

DISKETTES

When you find that a particular diskette is giving you a lot of problems, it could be due to several factors. The diskette may be: (A) Contaminated. (B) Physically damaged. (C) Electrostatically damaged. (D) Magnetically damaged. (E) and (D) are not visible. (A) and (B) are. Rotate the diskette within its shell and inspect for dirt, dust, oil, scratches, creases, and discolorations under a good light. If the problem is due to contamination, dip a cotton swab in alcohol and gently scrub the dirty area. Allow to dry. Try again. In most cases, this will eliminate the problem. If the diskette is physically damaged, you may either wish to lock out the bad tracks (if few), not use the bad side, or discard the diskette (save the shell for a "flippy" conversion template).

Diskettes are manually rotated in the shell by gripping the inside of the center hole between a finger and thumb and gently rotating the diskette's shell with the other hand.

FM VS. MFM ENCODING

<table>
<thead>
<tr>
<th>Format</th>
<th>Type</th>
<th>Bits per track</th>
<th>Tracks</th>
<th>Density</th>
<th>Rate</th>
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<td>3,276</td>
<td>128</td>
<td>52.72</td>
<td>256KB</td>
</tr>
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<td>4,000</td>
<td>128</td>
<td>64.69</td>
<td>256KB</td>
</tr>
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<td>4,800</td>
<td>128</td>
<td>78.15</td>
<td>256KB</td>
</tr>
<tr>
<td>IBM 16-sector</td>
<td>805,000</td>
<td>5,600</td>
<td>128</td>
<td>91.60</td>
<td>256KB</td>
</tr>
</tbody>
</table>

Consumertronics Co.
2011 CRESCENT DR., P.O. DRAWER 537
ALAMOGORDO, NM 88310

TYPICAL DRIVE REPAIRS: An analysis of drive repairs by the CASCIO School of Computer Technology shows that 60% of all drive repairs are non-technical. Of the 40% technical repairs required, 20% were preventable, 10% required only chip substitution while 10% required professional repair work. Non-technical repairs include cleaning connector contacts, replacing defective cables, cleaning and lubricating, etc. - things almost anybody can do! Technical repairs include alignment and adjustment, electronic repairs, replacement of parts, etc. If you know enough to use good drive habits and take the time to clean and lubricate your drives, you can prevent 80% of your disk drive repair expenses - without touching a single electronic instrument!
Chapter VI: SPEED ADJUSTMENT

In this chapter, the term "motor" refers to the spindle motor, also known as the "drive motor" or the "servo motor." No references are made to the stepper motor. "Speed pot." refers to the drive speed adjustment/control pot. "Pully" refers to the spindle (drive) pully. "Belts" refers to the belts/spindle inbiie and motor. "Flanges" refers to the same in ibiie that use direct-light motors. In belt-driven drives, the motor rotates much faster than the spindle. For example, when the spindle rotates at 300 RPM (5"), the motor may rotate at 2,000 RPM.

"300 RPM" (5 RPS) refers to the 5" IBM standard. "360 RPM" (6 RPS) refers to the 8" IBM standard. Some newer, ultra-dense 5" drives can be selected either 300 RPM or 360 RPM (ex: SHUGART SA-475). The 360 RPM option permits them to use the 5" format for compatible data transfer from the increasingly unpopular 8" systems. Most microfiches use the 5" standard. A few (ex: SONY) use a 600 RPM (10 RPS) speed for increased data storage.

Always turn OFF power before removing or installing the drive. Always verify that all connectors are firmly and square-faced before turning power ON.

CONTROL CIRCUITRY

In some drives, a smaller servo motor board contains the motor electronics; in others, this circuitry is on the logic board. Servo motor boards are located either in the rear of the drive or on the drive's pully side. Some drives have a speed pot. However, newer drives do not, and if drive speed goes out of adjustment, you may have to replace or repair the affected circuitry - or the drive itself. Most drives use a proprietary IC that controls the motor speed. This part is called a "Linear Analog Servo." No common substitute is available, it is not known to be separately sold, and it is the most critical part in the motor speed control electronics.

Ideal drive speed is within ±0.33% of rated speed. Some systems will tolerate speed out-of-adjustment exceeding 1%. In drives that don't have a speed pot, and drive speed is greater than 2% out-of-adjustment or is causing problems, you have the choices of either replacing the speed control electronics (which can get very expensive), or finding the resistor used in place of the traditional speed pot. (if it has one) and replacing it with a pot/resistor combination. This assumes that the drive speed is out of calibration due to gradual deterioration of the control electronics and-or motor, and not by a catastrophic failure.

The speed control resistor is located in the motor control circuitry, and should control the gain of an operational amplifier used as a pre-amplifier. It can be temporarily clipping a resistor 10 times its value in parallel with it, and observing change in drive speed. The replacement multi-turn (20 - 25 turns) pot. and resistor are priced in series. The values of the new resistor and pot, should be about 80% and 90%, respectively, that of the old resistor.

SPEED POTENTIOMETER

Some drives, due to apparent superior design, may never need speed adjustments and do not have a speed pot. However, we find that TANDON drives, in particular, must be periodically adjusted for speed.

The criticality of drive speed errors largely depends upon the system and diskette format used. Standard formats are more tolerant than denser custom formats, such as DIGITAL EQUIPMENT'S RAINBOW, where very little length buffering is needed, and are very intolerant to overspeeds. Some manufacturers have purposely maladjusted drive speed to prevent the theft and unauthorized use of files. Some system makers purposely maladjust speed to prevent the transfer of programs to other systems.

Drive speed can also be easily adjusted without any special tools. First, remove drive enclosures to expose the drive. Then, inspect, clean, lubricate your drive. We prefer to use direct light software with graphics display to adjust drive speed. If you use drive speed software and it indicates that all of your drives are running much too fast or slow, the problem could be that the clock in your computer is faster/slower than expected by the software. This will happen if your computer under- or over-speeds the drive to match the computer's clock. The problem may be inherent in the clock, or it may be due to a software bug.

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Turn ON system power. Turn OFF all incandescent lighting. Turn ON a fluorescent or neon lamp over the pully. To adjust the speed, the drive must be kept turning long enough to adjust the speed pot. See miscellaneous repairs or alignment chapter on methods for keeping the drive turning using the DOS or drive software. Another method is to use a machine language loop routine that continually commands Motor-On. Still another is to use the Drive Test Station (see that chapter).

An easier method used to keep the drive turning is simply to ground the Motor-On signal (31-16, standard bus). In most TANDON 5" drives, this can be done by jumpering TP 10 (ground) to TP13 (Motor-On). Don't be worried about harming your drive. As far as we know, all drives use pull-up resistors in their inputs (check for a term, resistor block socket), and when disconnected, cannot be harmed by shorting out any J1 (drive input) connector pin. We've even accidentally connected up drives reversing J1. Neither the drive nor computer were harmed.

With the motor continuously running, observe the large pulley under the lamp. For 60 Hz line VAC, the outer pattern should sync, with the 60 Hz light pulsations (inner pattern for 50 Hz power). The drive speed is adjusted to exactly 300 RPM (5 RPS), 360 RPM (6 RPS), or 600 RPM (10 RPS) when the applicable bar pattern appears to be standing still due to the 60 Hz (or 50 Hz) stroboscopic effect of the light on the pattern. (The strobed pattern may be only faintly discernable, and appears yellowish.) Otherwise, the strobed pattern will appear to be drifting CW or CCW. Slowly adjust the speed pot, in the applicable direction to try to stop the drifting. Small, residual fluctuations in drive speed are expected with most drives, resulting in small drift and jitter in the strobed pattern.

Turn OFF system power, and replace the drive enclosure. Turn ON power and try Reading and Writing to a diskette formatted in a known good drive. If the problem is still not corrected, check drive speed again. If drive speed remained within tolerance, the problem is due to an alignment, Read Sensitivity, clamping and-or hysteresis problem, or from a computer problem.

**FIX ERRONEOUS WRITE OPERATIONS:** If your drive(s) has erroneous WRITE operations on power-up or power-down, use this circuit. The MC3487 (RS-422 line-driver) is a 3-state device that replaces the 7438 or 7406 open-collector TTL buffer used in most computers for the Write Gate and Select interface signals. The MC3487 is forced to a high output impedance state when its Pin 4 reaches logical zero. It has TTL-compatible inputs that will sink 5 mA at 0.3 Volts max. It's compatible with the interface requirements of disk drives. The MC3487 insures a high output state during transition periods, computer noise is not allowed to ripple thru to the disk drive(s). The output 7438/7406 is usually found in the computer's FDC circuitry. R1 and R2 are part of the drives' Term. Res. Network, and, depending upon manufacturer, vary from 150 - 1,000 ohms each.

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**Figure** illustrates a PPL data recovery circuit using the Western Digital 1691 Floppy Support device. Both data recovery and Write Precomp Logic is contained within the 1691, allowing low chip count and P L l reliability. The 74S124 supplies the free-running VCO output. The PUMP UP and PUMP DOWN signals from the 1691 are used to control the 74S124's frequency.
Chapter VII:
R-W HEAD ALIGNMENT

In this chapter, "sensor" means the TOO sensor or "Home Switch" (a microswitch or optical coupler), and "end stop" refers to the TOO end stop or "Carriage Limiter."

Drive alignments need only to be done occasionally at most - usually never in properly cared for drives! The most common type of misalignment is radial.

Azimuthal (rotational) misalignment is rare and cannot generally be re-aligned in the field. Head #1 (DS drives) are, by far, most susceptible to azimuthal misalignment. Its primary cause is the use of a dry cleaning diskette. The entire Read-Write head assembly, including stepper motor, may have to be replaced. Factory azimuth alignment is measured on both sides of T16 using herringbone patterns written on a special alignment diskette by a special drive. Described herein is the re-alignment of radial misalignments.

In DS drives, Head #0 is aligned first. If this doesn't also align Head #1, then Head #1 must be separately aligned.

One of the most common misalignment problems in TANDON and other split-band actuated drives is caused by the collar or clamp on the stepper motor shaft (TANDON: inside glassine window) becoming loose. This collar articulates with the head carriage assembly through the split-band. It can be tightened using a small phillips screwdriver or allen wrench. We do not recommend testing it for tightness UNLESS you have misalignment-related problems, and prior to aligning the head. In TANDON drives, the collar screw should point to the front (inverted) stepper motor screw when the head is on T16. Since the collar moves in 1-track increments, you cannot accidentally position it between tracks. You can lubricate the motor shaft and split-band. You can (gently) manually move the head carriage assembly by rotating the collar or by sliding the assembly along its guide rails without any risk of misalignment (split-band actuated drives only). Do NOT loosen a tight collar before making an alignment.

Drives that have the nasty habit of an habitually loosened split-band collar can be repaired by either gluing or pinning the collar to the stepper motor shaft. Before either fix, be sure that the collar is in its correct position. Gluing (epoxy cement) is preferred because drilling the pinning hole through the collar and shaft is a tricky and risky operation.

If the expensive Read-Write head stepper motor becomes defective (from lack of lubrication, dirt or aging), it, or the entire module assembly (stepper motor + head carriage assembly) must be replaced to repair the drive, and the drive must be re-aligned.

READ SENSITIVITY

Cassially, a drive will develop poor Read Sensitivity although the alignment appears to be perfect. Symptoms are that the drive will appear to drift in and out of alignment with temperature and time, and with IN and OUT STEPS. Frequent but random CRC and parity type errors, and lack of reliability in Reading a diskette Formatted by it or another drive results. More than anything else, what separates poor Read Sensitivity from misalignment is the inability of the drive to Read the diskettes it just Wrote to.

The greatest causes of poor Read Sensitivity in aligned drives are worn head, poor compliance (worn felt pressure pad or bad head loader), hysteresis and eccentricity (clamping). They are caused by dirty, worn or damaged head, felt pads, guide rails, spindle bearings, clamp assembly, head loader and diskettes. And by weak READ/ WRITE amplifiers and internal EMI. Although cleaning, alignment and felt pad replacement usually improve Reading Sensitivity, it still can be severe enough to cause great problems and ruin diskettes. Poor Read Sensitivity due to a defective or worn out head or to bad electronics CANNOT be repaired without replacing the head. Bad electronics on the logic board can frequently be repaired.

HYSTERESIS

"Hysteresis" is defined as the inability to retrace exactly on the reverse swing a particular locus of points (ex: track and sector) set on the forward swing. In drives, the alignment hysteresis is determined by first approaching a track from its inner (spindle side) end, then approaching it again but from its outer TOO end. The difference between where the head settles in the two approaches is ideally zero, and is a measure of alignment hysteresis, and is directly related to the mechanical slop between the stepper motor mechanism and the head carriage assembly. This slop is primarily due to guide rail wear and is aggravated by guide rail contamination and lack of lubrication. Another cause is worn or dry stepper motor bearings.

A thin film of oil on clean guide rail(s) and stepper motor bearings helps make up the difference in looseness, and can, by itself, cure a hysteresis problem. If the slop is bad, you should consider scrapping the drive as the replacement parts may exceed the cost of a new drive.

DISK SERVICE MANUAL III
CLAMPING & ECCENTRICITY

Track-to-track distance for 48 TPI drives is 1/48" or 20.83 mils (24 AWG wire thickness). For 96 TPI drives, it's 10.42 mils (30 AWG wire). Head alignment is referenced to the spindle center. Factory limit is 1.6 mils (48 TPI). The maximum allowable alignment error between the head gap centerline and track centerline for any track is 0.2 mils. Drives with excessive head Sensitivity and worse small eccentricity can tolerate as much as 3 mils of misalignment. (Halve these tolerances for 96 TPI drives.)

A drive may become impossible to align if the spindle hub/shaft/ bearings, or the cone become worn or bent. The result is that the diskette rotates in an eccentric manner so that the head, which may be perfectly aligned at one sector, traverses to another track as the diskette turns 180 degrees. This happens because the center of the axis of the diskette is not precisely aligned with that of the ideal spindle. The same symptoms result from the more common problem of a distorted diskette center hole. Eccentricity also results from improper diskette clamping. Carefully reclamp a diskette with the drive motor running (but drive not selected) to eliminate a considerable amount of eccentricity.

OTHER PROBLEMS

If the misalignment is caused by a defective, maladjustment or incorrectly installed drive stepper motor, drive door, guide rails, head carriage assembly, or end stop or sensor, you will not be able to correct the problem completely by aligning the Read-Write head. In the cases, unless the cause is obvious and correctable by you (e.g., broken door, TOO problem), you should send the drive to a professional shop.

MISALIGNMENT

The primary causes of drive Read-Write head misalignments are:

1. Shock and vibration, most frequently cause by either dropping something on the drive (particularly when the drive is operating).
2. Dried-up or dirty guide rails. The head carriage assembly sticks when it tries to STEP. Also, some cheaper drives have guide rails that are not properly tolerated or polished, and the head carriage assembly sticks even when properly lubricated.
3. Dirty or warped diskettes, which snag the head when it moves, wrecking the diskette and jostling the head ("head crash").

Dry diskette-type head cleaners can also snag the head, particularly the more delicate Head #1 (DS drives).

4. Dried or dirty stepper motors, which may make the stepper motor and the head carriage assembly, and inside the stepper motor. The stepper motors are attracted away by the tight tolerances in the stepper motor, particularly between the guide rails and the head carriage assembly.

5. Defective or worn articulation between the stepper motor and the head carriage assembly, and inside the stepper motor.

6. Drives that don't have a sensor (particularly APPLES and COMMODORES), and drives in which the end stop is set too far back in, operate by doing a lot of "bumping" against the end stop. This "bumping" shocks all of the components of the module assembly and much accelerates misalignments. Constant "bumping" can literally beat the drive to death. Some software protection schemes rely heavily upon "bumping" in their protection scheme, and bad

DISK SERVICE MANUAL III

R-W HEAD ALIGNMENT

data blocks cause "bumping" in APPLE and COMMODORE drives. The number one APPLE and COMMODORE drive failure mode is head failure or misalignment due to frequent bumping!

7. A major culprit involved in most drive failures, including misalignments, is overheating. Drives must be properly ventilated during all operational times. Excessive heat causes minute dimensional changes that increase friction, dries up lubricants and fries the head carriage assembly.

DIAGNOSIS

The most common drive errors for marginal misalignments and hysteresis are CRC or Parity errors. Misalignments and hysteresis severe enough so that the track can't be found result in SEEK errors. Marginally aligned drives usually take an excessive amount of time to READ/WRITE due to frequent re-SEEK attempts. Also, it will work fine when cold but loses dependability when warm (or vice-versa) due to minute but significant thermally-induced dimensional changes.

In single drive systems, minor misalignment may not be a problem. Only when it must do a READ/WRITE operation using a diskette Formatted by an aligned drive will problems develop.

The symptoms of radial and azimuthal misalignments are similar. These include frequent Read and Write errors, and incompatibility between drives. The distinction is that azimuthal misalignment seldom cause boot problems whereas boot problems is another major symptom of radial misalignment.

Sensor and end stop maladjustment problems manifest themselves as booting and incompatibility problems:

1. If the end stop is set too close or the sensor is broken, repeated bumping into the end stop will be heard during boots as the head carriage assembly continually tries to trip the sensor.
2. The danger of setting the end stop too far back is that, if the sensor ever fails, the head carriage assembly may hit it with such force as to wreck or misalign it.
3. If the sensor is set too far in, the head won't Read TOO (as it normally does immediately following a reset by the sensor) of another drive's diskette. Instead, it will land on another track and get lost. Although the drive may not be able to Read other diskettes, unlike head misalignment problems, the converse is not usually true. If you bulk erase a diskette and Format with such a drive, it will probably be Readable by other drives. Also, the drive will not be able to format the number of tracks indigenous to that drive.

To verify misalignment, first clean and lubricate the bad drive. Then adjust the spindle speed of both the bad drive and a good drive to its proper speed (see speed adjustment chapter). Then take a magnetic bulk-erased diskette, Format it with the bad drive (label it so it won't get mixed up).

Disk Service Manual III
ALIGNMENT MECHANISMS

SHUGART, MPI, TRS-80 Color Computer (TEC), SIEMENS, etc. drives are all aligned by turning the stepper motor to position the head(s). Look for stepper motor screws, usually loctite or paint coated. Two methods are used: In most drives, the stepper motor body has a flange with slotted screw holes. In other drives, the stepper motor screws clamp down on a ring that fits into a groove on the motor body. Loosening these screws permits the motor to rotate in the ring. Some drives have a slot in the motor flange that corresponds to two ridges in the drive frame. A screwdriver blade is inserted between the ridges and into the flange slot. By turning the screwdriver, the motor is rotated CW or CCW.

Other drives (TANDONs) use an alignment cam screw. This slotted screw may be metal or plastic, and it occupies a metal or plastic oblong hole in the rear of the drive. You should not confuse it with a cam screw used to adjust the sensor in other drives, because as far as we know, no drive uses a cam screw method for both Read-Write head and sensor alignments.

ALIGNMENT CAM SCREW USES A CAM PRINCIPLE - A LARGE ROTATION IS TRANSLATED INTO A SMALL LINEAR DISPLACEMENT. AND THE STEPPER MOTOR BODY HAS A FLANGE WITH SLOTTED SCREW HOLES. IN OTHER DRIVES, THE STEPPER MOTOR SCREWS CLAMP DOWN ON A RING THAT FITS INTO A GROOVE ON THE MOTOR BODY. LOOSENING THESE SCREWS PERMITS THE MOTOR TO ROTATE IN THE RING. SOME DRIVES HAVE A SLOT IN THE MOTOR FLANGE THAT CORRESPONDS TO TWO RIDGES IN THE DRIVE FRAME. A SCREWDRIVER BLADE IS INSERTED BETWEEN THE RIDGES AND INTO THE FLANGE SLOT. BY TURNING THE SCREWDRIVER, THE MOTOR IS ROTATED CW OR CCW.

To align TANDON drives, three module assembly screws must be loosened. These permit movement of the entire module assembly during alignment. These screws are covered with paint or loctite. Two are located just to the rear of the large pully, and one is located in the back of the drive near the alignment cam screw. They require a 7/64" allen wrench. They should be loosened just enough. If you feel significant resistance or binding when aligning the drive, you failed to adequately loosen a module or motor screw. See Screws #1, #2, and #3 in photo section.

In stepper-motor-aligned drives, there are no separate module assembly screws. To align them, you must first loosen two screws securing the stepper motor body to the drive frame.

MAKING THE ALIGNMENT

CAUTION: Before aligning your bad drive, verify that all recent diskettes it has Formatted or Written to are Readable by a known-good drive - particularly in the inner (higher \( \theta \)) tracks. If you find that some diskettes are not Readable, copy over all of their files to diskettes formatted by a good drive, from the bad drive to the good drive. In most cases, a drive with a bad alignment Writes diskettes that are unreadable to drives with good alignments. If you must suspect that some files are unreadable, you may wish to copy them over after you have made your alignment. Some folks purposely misalign drives in their system to prevent the theft and unauthorized use of files.

Drive alignment requires concentration, steady nerves, fine touch and an excellent read/write sensor. If you're not up to it, rushed or distracted, or don't have the proper tools.
purposes not involving a loose collar.) Most drives are easier to access to align if the drive module is physically separated from its power supply. The logic and servo motor boards do not have to be removed.

To align a drive using the alignment cam screw or stepper motor, FIRST use a fine felt-tip pen or scratch awl to mark the initial position of the cam screw or motor body so that you don't lose sight of your start point.

Format a diskette with a good, accurately aligned drive. Do some DIR Ns, which should be OK (N = drive number). Then, insert it into the bad drive and do some DIR Ns. If errors continue, adjust the screws, install the enclosure and seek professional help.

or clamp. Inspect these areas, make applicable corrections, and clean or poorly lubricated guide rails; or worn or defective spindle s sensor drive won't stay aligned (probable Read Sensitivity problem), suspect a sensor adjustment is ALWAYS followed by a radial alignment.

Alternatively, the sensor on end stop gets out of adjustment in most drives. The singularly greatest reason why they get out of adjustment is because some do-it-yourself types love to adjust things when they don't need to be adjusted. "If it works, don't fix it!" However, on rare occasions, either may have to be re-adjusted after (not before) a Read-Write head alignment, sensor failure or physical shock.

Both the sensor and the end stop adjustment screws are located in the rear or rear side of the drive (in most drives). The sensor adjustment screw may be a cam screw. NOTE: The sensor and end stop adjustments, although interrelated, are two separate adjustments. Adjust only the one(s) that needs to be adjusted! If both need to be adjusted, adjust the end stop first.

Some DOSs don't rely upon the sensor for detecting T00 in Formatted diskettes. It knows when the head is on TOO by reading the ID header track number. However, Proper sensor operation is still required to boot the drive, and to Format.

Some drives do NOT come with a sensor, but only rely upon the end stop and sensor for alignment. APPLE and COMMODORE 1540/1561 drives (manufactured by ALPS and NEWTRONICS) are the most common.
DISK SERVICE MANUAL

ABOUT THE PHOTOGRAPHS

The drives pictured herein are representative of almost all floppy drives now in popular use. They include standard-bus 5", 8" and microfloppy drives, as well as some special drives (ex: APPLE, COMMODORE, SONY). There are hundreds of different drive models - far too many to picture every one here. If your particular drive model is not shown, by studying these photos and your drive's anatomy and operation, you should be able to locate all important anatomical features (ex: R/W Head, T00 Sensor and End Stop, Write-Protection Detector, Sector Index Optical Coupler, TRN, motors, Speed Pot., etc.).

We wrote all of the major drive manufacturers at least five times requesting loaner drives and manuals for DISK SERVICE MANUAL. Most never responded. SHUGART, by far, provided the most co-operation. It is no coincidence that most of the finest drives manufactured are SHUGART drives. You can't go wrong with SHUGART! It stands to reason that if your product is state-of-the-art and of exceptionally high quality, you welcome evaluation of it by independent experts.

We welcome all drive manufacturers to provide us loaner drives and manuals to evaluate and photograph for future editions of DISK SERVICE MANUAL and DISK DRIVE TUTORIAL. We welcome all diskette manufacturers to provide samples for DISK DRIVE TUTORIAL.

CONTROL DATA 8330

CONTROL DATA 8330, 5" DS, 80 Tk drive must be considered the Cadillac of 5" drives - at least mechanically! Split-band actuated with a rather heavy, well-designed and impressive R/W Head Module. Never had a problem with them.
TANDON TM-100 DRIVE

TANDON TM-100-1, 5" SS, 60 Ts, split-band actuated. (TM-100-2 is the DS version.) Except for the ALPS drives used in APPLE, COMMODORE, ATARI and other non-standard bus drives, the TM-100 is the most popular drive in the world! Earlier versions were limited to 35 Ts. Many variations in Logic Board circuitry. Requires frequent drive motor speed adjustments. Most frequent cause of sudden misalignment is a loose collar on the stepper motor shaft. Also, the flip-out doors - as with other drives with flip-out doors - tend to easily break. We consider the TM-100 to not be of highest quality, and apparently overpriced.
SHUGART SA-460

SHUGART SA-460, 5" DS, 80 Tk drive. The SA-410 is the SS version. In spite of being lead-screw activated, we operate ours at 6 msec. stepping, in our most critical uses. The SA-460 is no longer made by SHUGART, yet, it is a high-quality and reliable drive. Highly recommended.
SHUGART SA-465, 5" DS, 80 Tk, half-height drive. Split-band actuated. The band-actuator is held under spring tension to compensate for contraction. This tension also has a damping effect on the band, resulting in quieter operation. Very high quality drive. Never had a problem with them. Has numerous positive features. The spindle hub turns when you are inserting a diskette, which provides for much improved clamping. The dynamic clamping mechanism also brings the cone vertically down onto the diskette, and not at an angle as in most drives. The spindle motor directly drives the spindle (no belt), which permits a circular (not elliptical) spindle rotation. The spindle motor is brushless, direct drive, and is 60% smaller than in most other drives. The reduced internal friction of the new stepper motor also reduces average access time from the 150 - 275 msec. of most floppies, to 94 msec. Far fewer electronic components go into its design. The SA-465 dissipates about 50% of the power that older drives dissipate.

Two SA-465s can be operated from the same power supply and occupy the same cabinet space as one full-size 35/40 Tk drive. By doing so, you will have increased your drive memory storage capacity by a factor of almost 16 if the original drive was 35 Tk, SS, SO, or by a factor of four if the original drive was 40 Tk, DS, DD. NOTE: Since diskette directories occupy one full track with most systems regardless of the number of tracks, densities and sometimes sides used, drives with larger track numbers, densities and sides have a greater percentage of sectors allocated for data than for directory.

TEAC 55F, 5" DS, 80 Tk, half-height drive. Split-band actuated. The TEAC 55 has most of the features that the SA-465 has, except that clamping occurs at a slight angle. Also, the actuator is not under spring-tension; therefore the TEAC 55F is more noisy. Also, some drives are significantly more noisy than others. Why?? We've had no significant problems with ours. The TEAC 55F is now under $100 - a very good.

BASF 6106

BASF 6106, 5" SS, 40 Tk drive. Spiral-wheel actuated. Never had a problem with this drive type. Press-in, press-out spring-loaded door is a negative feature. We don't like the Sector Index LED epoxied to the Logic Board. If it fails, you've got a BIG problem! We also don't like the drive connector to be in the middle of the Logic Board rear and the power connector to be in the center of the Logic Board because both odd-ball locations prevent interchangeability with bus extender cards and some power supplies.
MPI B51

MPI B51, 5", "flippy," 40 Tk drive. Split-band actuated. Primary positive features are its rare flippy configuration and its diskette eject mechanism. Spring-loaded door may be objectionable to some users. Diskette eject mechanism failures are common, but drive operation is not affected. Some people prefer a "flippy" drive over a DS one because if you have power fluctuations or drive electrical malfunction, both sides can be glitched in a DS drive. Also, DS drives are more trouble-prone because of the second, opposing R/W Head. While "flippy" drives permit you to use both sides of the diskette without the tedium of modifying diskettes, you avoid DS drive problems and risks.
SIEMENS FDD 100-5

SIEMENS FDD 100-5, 5", 55, 40 Tk drive. Lead-screw actuated. Primary positive features are its wide door opening and quiet operation. Best access time has been 12 msec. Quality is very good, but we have had reliability problems due to low Read Sensitivity on both inner and outer tracks. SIEMENS went out of drive production, and its drive facilities have been sold and resold. SIEMENS-type drives will probably reappear under other names.
SHUGART SA-400

SHUGART SA-400, 5" SS, SD, 35 Tk drive. Spiral-wheel activated. This slow, primitive (by today's standards) drive is now being dumped new for practically a song. Not suitable to most modern computer systems. Avoid this drive! It's not worth fooling with! Definitely limited to 35 Tk, and probably to SD because of poor reliability in Formatting inner tracks at DD. We repeatedly wrote SHUGART about ways to upgrade the SA-400, and, as helpful as SHUGART has been with their other drives, never responded - disappointing considering the vast popularity this drive had in earlier days.
APPLE DRIVE

APPLE DRIVE, 5", 55, 35 Tk. Spiral-wheel actuated. Note that construction is very similar to the SHUGART SA-4001. This should give you a clue as to its capabilities and qualities in respect to state-of-the-art drives. APPLE supplies its Logic Board, which it calls an "Analog Board."
COMMODORE DRIVE

COMMODORE DRIVE, 3", 5", 3½", Band actuated. The "3½" is the limitation of the COMMODORE system - not the disk drive. The drive shown is a 1540 drive with the 1541 ROM upgrade installed. Note that COMMODORE drives are actually µCs themselves - fully loaded with CPU, ROM, RAM and Controller. The drive shown is an ALPS drive. COMMODORE also uses NEWTRONICS drives. Both use the same COMMODORE Logic Board. And both are similarly constructed and actuated. Major differences are in the door mechanism and the Servo Motor Board. In NEWTRONICS drives, the Servo Motor Board (with the Speed Pot.) is located just in front of the Drive Motor. ALPS drives use a flip-out type door; NEWTRONICS drives use a rotated latch mechanism. Differences in circuitry between the 1540 and 1541 has the 1541 Controller and RAM consolidated into large chips.

COMMODORE and ATARI drives are similar. Both use similar basic drives (Logic Boards are different). Both are serial drives. Neither uses a Sector Index Optical Coupler.
Chapter VIII: ELECTRONICS & REPAIRS

DRIVE POWER & GROUNDING

Correct power wiring and grounding of computer systems is critical, and should be carefully observed. If you've ever typed in hours of boring data only to see it flushed down the toilet by one power glitch, you now have an intense appreciation of proper power and ground wiring. The following figures describe the power and ground wiring scheme we most prefer.

You may want to go as far as installing an UPS system. This requires a set of batteries, a battery trickle charger, and inverter (to change the DC back to 120 VAC). These systems can run into the thousands.

POWER SUPPLY ADJUSTMENTS

At least once a year, verify the drive's DC voltages, and adjust them as necessary. 5 V and microfloppe drives require ± (logic) and ± 12 VDC (motors). 8" drives also require ± 120 or 240 VAC, and ± 24 VDC, and some require ± 5 VDC. Turn ON the drive and run until warm. Turn OFF power and remove drive enclosure. A pot(s) in the external drive power supply or power supply Board (rear of drive), or power section of the logic board are usually installed to adjust VDC voltage levels. Proper VAC maintenance usually requires a regulated VAC supply. With a DC voltmeter, and the drive turned ON, carefully check all VDC voltages with respect to DC ground. Unless they are within 5% of rated voltage, carefully adjust the voltages to these ideals, it possible. For power-supply related problems, see diagnostics and troubleshooting chapter.

TROUBLESHOOTING

Only about 10% of drive problems are due to electronic failure. Alignment, clamping, hysteresis, and 100 end-stop problems are solely mechanical in nature. Drive speed and Read Sensitivity problems are mechanical about 90% of the time. 100 sensor, index optical encoder, write-protect, and head loader problems are mechanical about 50% of the time.

See chapter on diagnostics and troubleshooting. Turn OFF drive power before removing or installing its enclosure. Verify all connections prior to turning drive power ON, and turn power ON only as required. NEVER CONNECT OR DISCONNECT THE HEAD CONNECTOR(S) WITH POWER ON!

If troubleshooting of the logic or servo motor board is required and you are not clear as to the wiring of your drive's board, you should first obtain a copy of your drive's service or OEM manual. NOTE: Since many drive models go through several circuit design changes, the actual wiring of your drive's circuitry may substantially differ from the manual's schematic.

To inspect for electronic defects, run the drive until warm. Remove its enclosure. Visually inspect, and gently (with dry fingers) feel around the logic, servo motor, and power supply board components. CAUTION: Avoid touching the larger power supply power transistors and resistors (some run very hot), and the 120 VAC connections.

If anything feels burning hot, produces smoke, or looks or smells scorched, although the drive may not now be defective, drive problems are sure to occur in the near future. Also, if a component should be warm but is stone cold instead, it could either be defective or not properly powered or grounded. Correct any problem. NOTE: The finger test is just a first test. A component can have a perfectly normal temperature and still be bad. Most people's fingers aren't sensitive to small temperature changes. A simple and effective thermal tester for components is described in the May 1985 issue of RADIO ELECTRONICS, p. 110.

Solid-state components, when properly operated along their power curves, will not wear out until Kingdom Come! However, they also do not always catastrophically fail. When a component operates near its limits, it sometimes becomes overworked and overheated and increasingly degraded until it works only intermittently, and then fails. Driver and interface ICs are particularly vulnerable to long-term thermal degradation. Should you suspect electronic degradation problems, use a circuit chiller aerosol to see if that temporarily improves performance. Also, be sure that the circuit board is kept clean, and receives proper ventilation and cooling.

The only surefire approach to diagnose any complex electronic circuit is to monitor all major signals with an oscilloscope or, better yet, a logic analyzer. However, our method is simple and will catch most problems early.

If your drive has a servo motor board, most electronically-caused spindle motor problems can be isolated there. If not, this function, as well as the drive electronics for all other drive functions are controlled by the logic board. Here is where the greatest differences in drive designs exist. Drive boards come in numerous configurations and circuit designs. No board repair should be attempted without heavily relying upon the maker's service/main­tenance/OEM manual. Before considering replacing a PC board, clean and lubricate the drive, adjust drive speed, verify power supply voltages, and verify all connections. Servo motor boards are priced at about $50 each! Logic boards are usually over $150! New SS/DD drives are now under $100 - DS/QD drives have dropped below $130! (Should you scrap your drive, please donate it to us for spare parts.)

Most board electronic failures are due to an easily obtained and replaced component, such as a failed TTL IC. However, drive boards also contain critical, specialized, proprietary ICs, not known to be separately available, with no known substitutes. If one of these fail, you can't reasonably repair the board yourself. Most newer drives have JFETs, which are usually also proprietary, and which are more difficult to troubleshoot, and a bear to unsolder!
The purpose of the end stop is to prevent the head carriage assembly from bumping into the drive frame should, for any reason (ext. failed/maladjusted sensor, unformatted diskette), T00 is not detected. The sensor output is combined with the stepper motor phases to determine when the head is at T00. For proper homing, the sensor must switch somewhere between T00 and T03. Since T03 has the same stepper motor phases as T00, if it switches at T03, the drive will indicate T03 as T00 (and may go insane). If it doesn't switch by T00, the head carriage assembly will continue looking for T00 and will bump repeatedly against the end stop.

When you boot your computer, your drives should step back to T00. If you hear a relatively loud "thunk" or series of "thunks" (because your drive repeatedly attempts to activate the sensor), the end stop is set too far forward or IN to activate the sensor. With the right size screwdriver or allen wrench, back OUT (CCW) the end stop screw about a half-turn. Try again.

Be particularly careful when you adjust the sensor. You MUST first loosen the sensor mounting screw(s) to slightly loose. If you fail to do this, you can damage the adjustment sensor or its wiring in some drives (TANDON, etc.). In some drives, you must swing away the logic board and shield to access this screw(s). In other drives, the mounting screw(s) can be accessed from the pully side of the drive. After you finish and verify your adjustment, tighten these mounting screw(s) just beyond snug. Don't overtighten as you can damage the sensor.

If you can't get the sensor to switch at all, it, its connections, or its logic board electronics (less common) is defective and should be replaced or repaired. Disconnect the sensor from the logic board. Run a continuity (resistance) check of the sensor from its logic board connector. The non-switched resistance between contacts of a microswitch sensor should be greater than 1 Meg. ohm. When switched, contacts should short out and resistance between them should drop close to zero ohms. Optical sensors consists of an optical coupler pair (LED and photosensor). LEDs are diodes and will conduct in one direction. Unfortunately, their forward voltage is high enough that some meters will test them as open-circuit. A proper-polarity resistance check of the photosensor should yield a dark resistance near 5 Meg. ohms, but not open-circuit. (Unless you go through the trouble of building a special photocoupler test circuit, a swap test with a known good sensor is the easiest way to determine if the sensor is bad.) If the sensor passes the resistance check, the problem is very likely in the sensor's circuitry in the logic board.

To adjust the sensor and end stop, you may use a disk utility which will Step to the outer tracks, or the Drive Test Station (see that chapter). Else, format a diskette using a good (aligned) drive. Run a continuity (resistance) check of the sensor from its logic board connector. The problem is very likely in the sensor's circuitry in the logic board.

Position the Read-Write head to T01 by continually Loading in "B" (AUTO BASIC, A, A, ... A). Loosen the sensor mounting screw(s). Slowly rotate its adjustment screw IN (CW) until a T01 access causes it to "click." Then rotate the adjustment screw IN one-half turn more. Tighten the sensor mounting screw(s). Having adjusted the sensor, you MUST realign the drive.

While doing an AUTO BASIC, A, A, ... A, slowly turn the end stop set screw IN until the end stop is softly in contact with the head carriage assembly at T00. Then back OUT (CCW) 1/4 turn. The end stop will then be correctly adjusted.
If a drive function fails, (ex: TOO sensor function), and the failure can't be traced to an external unit that may be a part of that function, then switch or substitute the drive to verify that the defect is in that drive, and not in the system or interface.

The best method to pinpoint the problem to the logic board is to switch the logic board with one in another known good, same-model drive. If, after the FG board switch, the problem also switches drives, then a circuit in the logic board is very likely bad. If the problem doesn't switch with the board, then the problem is in some other part of the drive. If both drives are now bad, the problem may be caused by a combination of factors.

Once the logic board is verified as the culprit, using the manufacturer's manual and a magnifying glass, trace the circuit on the logic board. Examine each component and trace carefully. ICs don't usually fail without leaving a visual clue (scorched, exploded). Sometimes a bad land, solder defect, or short will show up. Circuit chiller can uncover a thermally-related failure.

If the problem is still not evident, then examine power, control and signal lines going to and from the suspect circuit using an oscilloscope, logic probe or meter. We've designed a super logic probe with many powerful features. For its plans, please send $6 for ULTIMATE LOGIC PROBE, CONSUMERTRONICS CO., P.O. Drawer 537, Alamogordo, NM 88310.

If all signals are OK, carefully remove and clean the circuit board (both sides) with alcohol and a toothbrush, allow to dry, then reconnect and test. (When handling the board, be careful that you don't inadvertently cause short circuits by bending parts and test pins.)

If that fails, remove the board, and carefully unsolder and replace components (ICs first, then transistors and capacitors) in the suspect circuit, one at a time, working from the circuit's input stage. Test operation after each replacement. If that fails, you either missed the problem, or it lies somewhere deeper in the logic board. At this point, a decision should be made by you as to troubleshooting further or replacing the board or drive.
**DISK SERVICE MANUAL III**

**ELECTRONICS & REPAIRS**

**VIII - 5**

**DRIVE SELECT**

- 10 microseconds minimum

**DIRECTION SELECT**

- 18 microseconds minimum

**STEP**

- 20 microseconds minimum

3 milliseconds minimum

**DRIVE SELECT, DIRECTION SELECT AND STEP (SHUGART ASSOC.)**

**SELECTED**

- 10

500 nanoseconds minimum

**WRITE GATE**

- 24

**WRITE DATA**

- 22

8 microseconds maximum

8.5 MAX

**SIDE SELECT**

- 32

100 μs MIN

1 ms MIN

**DRIVE SELECT, SIDE SELECT, WRITE GATE AND WRITE DATA (SHUGART ASSOC.)**

**POWER ON**

- 100 ms (MIN)

**MOTOR ON**

**ORIVE SELECT**

**VAUD  READ DATA**

- 100 ms (MIN)

**SIDE SELECT**

- 100 μs (MIN)

**WRITE GATE**

- 500 ns (MIN)

**WRITE TRANSITIONS**

**READ TO WRITE (SHUGART ASSOC.)**

**POWER ON**

- 100 ms (MIN)

**DRIVE SELECT**

- 500 ns (MIN)

**VALID READ DATA**

- 2.5 μs (MIN)

**SIDE SELECT**

- 200 μs (MIN)

**WRITE GATE**

- 500 ns (MIN)

**WRITE TRANSITIONS**

**WRITE TO STEP (SHUGART ASSOC.)**

**MOTOR ON**

**VALID WRITE PROTECT**

- 2.5 μs (MIN)

**VALID READ DATA**

- 500 ns (MIN)

**WRITE GATE**

- 8 μs (MIN)

**WRITE DATA**

- 500 ns (MIN)

**DIRECTION SELECT**

- 18 ms (MIN)

**STEP**

- 100 μs (MIN)

**SIDE SELECT**

- 100 μs (MIN)

**WRITE TO STEP (SHUGART ASSOC.)**
Chapter IX: MISCELLANEOUS REPAIRS

Prior to the removal or installation of the drive enclosure, be sure to turn power OFF. Turn it back ON only as required. Also, verify that all connectors are secure and square before turning the power ON. NEVER CONNECT OR DISCONNECT THE HEAD CONNECTOR(S) WITH POWER ON!

SECTOR INDEX OPTICAL COUPLER

Adjustment of the sector index hole optical coupler (LED + photosensor) is rarely, if ever, required. The primary cause of optical coupler misalignment is clipping off and removal of cable ties, and the disconnection from the sensor. This can be easily pushed out of their fixtures with a wood Q-tip and retested. Bad alignment can be either in height or linear position. Adjusting the sensor, loosen this screw to just loose of snug.

To remove: The LED and sensor fixtures are plastic; too much torque can strip them out. Finger torque on the screwdriver is usually adequate. Since they are not subjected to significant stress, their mounting screws are not likely to loosen, and thus need not be real tight.

Virtually all index misalignments are corrected by adjusting the photosensor alone. In most drives, this can be done from the pull-out end of the drive, just through the sector index window (typically SS diskettes converted to floppy using a punch). Indexing problems are sometimes caused by a dirty optical window. If the sector index hole burns out or a malfunction occurs in the logic board circuitry, most systems tolerate it. This is the most aggravating of all drive alignments! Tighten the Phillips screws slightly, and retest again. Repeat this process until the index is aligned, and the screw is just tight beyond snug.

Adjust the sensor by turning the flat-bladed screwdriver in the slots CW and CCW. If the fixture does not move smoothly and easily, slightly loosen the Phillips screw a little more. When the sensor is adjusted, tighten the Phillips screw slightly and retest. If the sensor got out adjustment (which commonly occurs), re-adjust it. The only operation that may be adversely affected is FORMAT and COPY and BACKUP where FORMAT is used. Typically, the elapsed time between the detection of the index pulse and the leading edge of the sector index hole and the electronic counter, or DDA software.

SECTOR INDEX OPTICAL COUPLER

Indexing problems are one reason for DRIVE or DEVICE NOT AVAILABLE type errors. However, before paralyzing panic sets in, first check to verify that the drive is connected and turned ON, that the diskette is inserted correctly, that the drive's power supply is correct, and that the DOS's drive configuration specifications (ex: PDIVDE) are correct for that drive.

The sector index optical coupler is usually sold as a pair. The LED and sensor share the same connector, (ex: P10), and they are faceted. If either the LED or sensor burns out, and you don't have an oscilloscope to determine which one (80% of the time it's the LED), then replace them both. However, test several known good diskettes, verify their connection, verify that the LED fixture screw is just a little tighter than snug. If it was loose, retighten it, and then retest.

Adjusted, tighten the phillips a little more, and retest again. Repeat this process until the sensor is adjusted, and the screw is just tight beyond snug.

Bad alignment can be either in height or linear position. Adjustment simply entails either adjusting/replacing the inserted diskette. SS and DS drives have I switch, floppy drives have 2.

The write-protect switch seldom, if ever, gets out of adjustment or goes bad. Microswitches, by far, give the most problems, and their problems usually only require the adjustment of the switch tang. When the write-protect tang is bent, you can straighten it. If this does not cure the problem, then the switch or, less likely, the write-protect circuitry on the logic board is bad, or the switch is not properly connected. If an optical coupler, the write-protect detector may only be dirty, and is simply cleaned.

DISK SERVICE MANUAL II 1/1

WRITE-PROTECT DETECTOR

The write-protect switch may be either a microswitch or an optical coupler. They are located in the drive in juxtaposition with the write-protection switch (if it has one) on the inserted diskette. SS and DS drives have 1 switch, floppy drives have 2.

The write-protect switch seldom, if ever, gets out of adjustment or goes bad. Microswitches, by far, give the most problems, and their problems usually only require the adjustment of the switch tang. When the write-protect switch goes bad, your drive may: (A) Produce WRITE PROTECTED DISK type errors for non-write-protected diskettes (most common), or (B) Write a non-write-protected diskette with the write-protect switch set.

Door & door switch

If the drive door or door switch (if it has one) is defective, you will get a DRIVE NOT AVAILABLE error. Some drives use a microswitch as the door switch. Other drives depend upon lack of function of the sector index optical coupler to provide the "door closed" indication.

Don't panic if a flip-out type drive door breaks (TANDON, SHUGARTS, etc.). These doors are easy to replace, if you have a spare one. Remove the drive enclosure. Un-screw the 2 Phillips screws attaching the metal plate ("clutch inhibit") and door mechanism to the cone lever assembly. Remove the old door from behind the front panel. Remove broken pieces that may have fallen into the drive, insert the new door in the same way, being sure to insert the door posts into the 2 front panel guide slots. Re-attach the door and metal plate to the cone lever assembly. Do not tighten the screws yet. Lubricate the door front panel slots and door hinge with vegetable oil. Work the new door back and forth with an inserted diskette to assure proper fit. Read Directory entry to be sure the door is closed to assure proper diskette seating. While the new door is closed, put a fluff in between the screws. Read Directory again to verify. Re-install the enclosure.

It may be easier to work if you swing away the logic board and or remove the front panel. The front panel is secured by two Phillips screws on the pull-out side of the drive. When you re-attach the front panel, GENTLY tighten the screws, and then withdraw the drive. Flip-out doors on TANDON and SHUGART drives are somewhat interchangeable. This means they'll work OK but may not perfectly fit.

You can: temporarily operate a flip-out-door drive without the door:

Two Ways:

1. While accessing the diskette, manually clamp the cone onto the diskette with a finger.

2. For more regular operation, you can temporarily clamp the diskette by using a small wooden, plastic or rubber wedge, gently inserted between the edge of the door frame and the cone lever assembly.
In either case, pressure should be steady but be sure that you do not apply too much pressure, particularly in DS drives.

The biggest risk to damaging the front panel is by removing it to make a repair, then torquing its mounting screws too tightly and stripping them out. If the front panel cannot be properly replaced, much like a DS drive for DEVICE NOT AVAILABLE error. A defective front panel usually has to be replaced.

The front panel LED (drive access lamp) will occasionally burn out. This should not affect drive operation. It is there only to inform the user when the drive is selected. First verify its connection at the logic board. To replace it, you must strip out the old LED by clipping off and removing cable ties and disconnecting the LED at the logic board. Press in the new LED, install its retaining collar, properly route and tie-up its cabling, and connect it at the site of the old LED connector.

**HEAD LOADER**

If the drive's head loader does not reliably operate, the problems could be due to: (A) Electronic malfunction. (B) Defective or dirty solenoid or mechanism. Incorrect jumpering (verify jumper block for drive head options). (D) Low power supply. (E) Bad connections (internal or external).

Verify voltage levels, clean and lubricate the solenoid and mechanism, clean all connectors, and replace the drive. If that doesn't clear it up, you either have a bad solenoid (most likely), or an electronic malfunction. Solenoid reliability tends to deteriorate with age and use (its pull strengths diminish with age), whereas the electronics has a tendency to suddenly fail.

**COMPLIANCE**

"Compliance" is a physical term used to describe how closely the Read-Write head rests upon the diskette surface. The major two causes of poor compliance are missing, defective or misaligned felt (pad) pressure (most common in SS drives) or head loader (if the drive has one).

In DS drives, if Head #1 is physically defective or grossly misaligned, Compliance Check #1 is also affected. Field repair of poor drive compliance is NOT recommended.

As compliance deteriorates, Read and Write reliability decreases. One of the quickest ways to destroy compliance is to use a dry discette-type head cleaner.

Poor-compliance symptoms can also result from a worn head, and marginal Read or Write electronics, if the head or electronics is faulty. Read Sensitivity is generally low and uniform for all tracks. If the problem is mechanical, pressure, and thus Read Sensitivity, usually significantly varies between the inner and outer tracks.

Modern SS drives use felt pressure pads that have colored wear zones that indicate if the felt pad is wearing uniformly and/or needs to be replaced. A quick test to verify a felt pad-caused compliance problem is to GENTLY apply pressure with your thumb to the upper arm of the drive where the felt pad is attached. If the felt pad is worn or misaligned, the pressure should be steady but be sure that you detect wobbling or binding in the pulley when you turn it by hand (no belt, no diskette), lubrication doesn't help, AND the drive indicates lack of eccentricity.

Replace the cone mechanism and lever assembly in the reverse order of removal. Before tightening the mounting screws on the cone lever assembly, install the diskette into the drive and close the door. Gently manually clamp the diskette, then tighten the mounting screws.

**SPINDLE ASSEMBLY**

Replacement of the spindle assembly is more difficult. It should only be attempted IF the drive allows for its replacement, you detect wobbling or binding in the pulley when you turn it by hand (no belt, no diskette), lubrication doesn't help, AND the drive indicates lack of eccentricity.

Substantial variations exist between drives. In some drives, a screw secures the spindle to the pulley. In others, the spindle must be punched out (please donate the drive to us for spare parts).

Both the logic board and the cone lever assembly must be removed in most drives. Precision bearings are pressed or inserted into both sides of the frame where the spindle passes through. There should be a spring or sleeve between the bearings to keep them apart. Depending upon the amount of their wear, the bearings may/may not have to be replaced.
Once the pulley screw is removed, the pulley can be safely twisted off. In some drives that don't have hex-head screws (between the hub and the frame), the remainder of the spindle assembly can be removed by pulling and twisting on the hub (in others, the spindle assembly is installed by cement bonding and can't be replaced). Else, remove these two hex-head screws, and rotate the hub CCW until you can pull it out.

The new spindle assembly is installed in the reverse order of its removal.

**HEAD CARRIAGE ASSEMBLY**

Replacement of the head carriage assembly or module assembly (carriage assembly + stepper motor) is so expensive and difficult that it almost always pays to replace the drive itself (please donate the drive to us for spare parts). It always requires re-alignment of the head(s), and usually re-adjustment of the T00 sensor. Removal of the logic and servo motor boards, and the cone lever assembly are also required. Virtually every drive model uses a different procedure. In most drives, the entire module assembly (head carriage assembly + stepper motor assembly) is replaced as one unit, in others, you can separately replace the head carriage assembly and the stepper motor. Do not attempt this replacement without the maker's service/maintenance/OEM manual.

**OTHER ADJUSTMENTS**

Modern 8" drives, and some others, may require special and complex procedures not described herein. These procedures differ between drive models, and usually require special tools and gauges. They include precise head load mechanism adjustments, head penetration adjustments, microfine head alignments (drives above 100 TPI). These special procedures should only be performed by a properly equipped shop, using the procedures described in the individual drive service manual.
MITSUBISHI MODEL MF353 3.5" DISK DRIVE

DS, DD (MFM); 80 Cylinders (TKs/side); 135 TPI
300 RPM Spindle; Brushless DC Motor; Direct Drive
1,000K Bytes (unformatted); 655,360 Bytes (formatted)

- 256 Bytes/sector; 16 sectors/TK; 250K bits/sec. Rate
- 3 msec Step/TK; 15 msec Settling; 100 msec Latency
- 200 msec Rotation; 250 msec Motor Start

CONTROLLER SIGNALS & DRIVE FUNCTIONS

<table>
<thead>
<tr>
<th>CONTROL LINES</th>
<th>COMPUTER</th>
</tr>
</thead>
<tbody>
<tr>
<td>DATA/COMMAND</td>
<td>STATUS</td>
</tr>
<tr>
<td>/STATUS BUS</td>
<td>BUSY</td>
</tr>
<tr>
<td>TRANSFER</td>
<td>READ/WRITE</td>
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<tr>
<td>FDC ON</td>
<td>CLOCK</td>
</tr>
<tr>
<td>ACKNOWLEDGE</td>
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<tr>
<td>RESIDENT</td>
<td>RESET</td>
</tr>
<tr>
<td>REGISTER SELECT</td>
<td>COMMANDS</td>
</tr>
</tbody>
</table>

| FLOPPY DISK | DRIVE SELECT #1 |
| CONTROLLER  |                  |
| (FDC)        |                  |

- HEAD LOAD
- SPINDLE
- DRIVE SELECT #1
- DC DRIVE
- MOTOR ON
- TRACK 00 SENSOR
- DIRECTION SELECT
- STEP
- SECTOR INDEX
- SIDE SELECT (DS)
- WRITE PROTECT
- WRITE GATE
- READ (CLOCK + DATA)
- WRITE/ERASE
- CONTROL
- HEAD LOAD
- SOLENOID
- WPN DETECTOR
- RW HEAD
- ASSY, STEPPER MOTOR
- SECTOR INDEX OC
- READ CIRCUIT
- RW COIL
WRITE DATA WRITE AMP
READ DATA READ AMP READ PREAMP R/W HEAD
ENABLE SWITCH/MOTOR CONTROL MOTOR/SPEED GENERATOR CONTROL
MOTOR/PHASES DRIVER STEPPER MOTOR

APPLE SYSTEM DRIVE
BLOCK DIAGRAM

READ PREAMP PREAMP OUT READ AMP AMP OUT CONTROLLER MOTOR DRIVE
LOGIC DRIVE MOTOR
R/W HEAD WRITE AMP WRITE AMP
RAM ROM
DECODER
CPU INTERFACE #2 INTERFACE #1
COMPUTER TIMER

COMMODORE SYSTEM DRIVE
BLOCK DIAGRAM

TM-100 FUNCTIONAL DIAGRAM (TANDON)

SA-300/801 FUNCTIONAL DIAGRAM (SHUGART)
The advanced disk drive repairman can build his own Drive Test Station to test all of the major drive functions, and to align drives. He output connector configuration of the circuit shown here is for standard-bus drives. All drives known standard-bus drives use a standard chassis and power supply connector. For non-standard bus, 8" and microfloppy drives, refer to the drive's service/OEM/maintenance manual for pin-out of your logic, control and power connectors.

We've used our Drive Test Station to evaluate and repair over 100 drives.

The primary input signals to the Drive Test Station are the write-protect, TOO sensor, sector index and read data. They are all open-collector outputs from the drive that require 150-kOhm termination (depending upon make) in the Drive Test Station. Read data and sector index signals are pulsed. LEDs are used to provide rough indications of their presence. I recommend installing BNCs in the Drive Test Station so that these signals can be conveniently observed on an oscilloscope. A write-protect LED is provided and will only activate if a write-protected diskette is in the drive. The TOO sensor LED is used to indicate stepping back to TOO.

The +5VDC and +12VDC drive power can be constructed from a spare drive power supply with optional LEDs added, as shown, to provide indication. The +5VDC also supplies the Drive Test Station.

The outputs from the Drive Test Station are mostly switch closures. Motor-On and drive select are activated by grounding. Head direction is OUT when grounded, and IN when +5VDC. Switch debouncing was not found to be necessary. The write gate is enabled (turned ON) by grounding the write enable, and turned OFF by opening it (for read enable).

The STEP function is a series of negative pulses produced by the 74LS123 (2) retriggerable multivibrator when the STEP pushbutton switch is pushed. 74LS123 (1) is wired to provide a series of free-running pulses to be written to the diskette. A Formatted diskette is not required. This data is written to the diskette, but it is only used to provide a steady signal for tracing through the drive's WRITE circuitry to verify that input data is reaching the head.

To operate, simply disconnect the drive from your computer system, and hook it up to the Drive Test Station via appropriate cables and connector. Turn the Station ON. Switch the drive select switch appropriate for that drive. The drive's front panel LED should come ON. Once selected, switch motor-On to activate the spindle motor.

Load in a diskette, and observe the sector index LED. It should start flickering. The write-protect LED should properly indicate the presence/absence of a write-protect tab on the diskette. The read data line should produce a stream of data pulses.
Observe the head carriage assembly. Switch DIRECTION to IN and activate STEP several times. Observe head stepping. Switch DIRECTION to OUT and repeat STEP activations. The head should now step OUT. Continue stepping OUT until the T00 sensor in the drive activates, turning ON its LED in the Station.

The Drive Test Station will read data from a Formatted diskette, or to an unFormatted one written to previously. If the diskette contains valuable data, be sure to write-protect it to avoid accidentally writing to it. Drive speed can be adjusted by using an oscilloscope or counter hook-up to the sector index signal. Pulses should be at 5 Hz (or 200 usec period), and constant to within about 1%.

Head radial alignment can be performed with the Drive Test Station, an oscilloscope, and a standard CE diskette. See alignment chapter. Hook-up the dual-trace oscilloscope directly to the output of the Read-Write head. Select "A-B" (differential) setting. Locate the head assembly screws. Gently adjust the alignment cam screw or stepper motor (depending upon drive model) until the signal is strongest. Gently reposition the head assembly screws, while constantly rechecking signal level. Alignment can also be done with the simple circuit shown - without an oscilloscope and with or without a CE diskette.

The Drive Test Station can also be used to adjust the T00 sensor and T00 end stop simply by using it to step the drive back and forth between T00 and T01 (see alignment chapter).

We are interested in all experiences, insights, enhancements and modifications you have regarding this or any other disk drive test c 11t.

**TRS-80 MODEL I**

Our primary disk drive evaluator (Exerciser) is a TRS-80 Model I, which we use in conjunction with the Drive Test Station. Any other microcomputer could also be made to work. Although the TRS-80 Model I itself is "obsolete" (100,000+ are still known to be in regular use), it can thoroughly test and evaluate more drive types and models than any other non-dedicated microcomputer.

No special modification is required other than the installation of a 34-pin or LNW doubler board (use no other doubler) for DD. You will also have to buy or build special cables to adapt 8", micro floppy 5½", 8" and micro floppy 3½"/DD, 5½/DD, 35/80 Track drives (and external and thus easier to work on, it supports all known standard-bus models than any other non-dedicated microcomputer.

This circuit can be integrated into the Drive Test Station described herein.

**DISK SERVICE MANUAL III**

**DRIVE TEST STATION**

**ELECTRICALLY CALIBRATE ALIGNMENT:** With this simple circuit, you can electrically calibrate your R/W Head alignment by measuring the signal magnitude picked up by the head. You do this by continuously attempting to load a lengthy program in which most of the bytes are the same, for example, a BASIC program with a lot of "nnnn DATA zzzzz..." statements (nnnn = Line #). The object is to align the head until the analog voltmeter output maximizes, usually at about 3 volts. Do not use a digital voltmeter - response is too slow. Before use, verify that the IN4002s are not shorted.

One microprobe is placed on an analog head signal pin while the other is placed on one of the drive's ground pins. The signal pin is found by tracing the logic card's circuitry back from its head connector. You want the ANALOG head signal - preferably the output of the analog amplifier - not the DIGITAL head signal. If you can't tell by the circuitry, you can tell by slowly lowering the head onto the spinning diskette. If the signal progressively increases, you have an analog pin; if it increases abruptly, you have a digital pin. In most modern drives, the analog amplifier and digitizer are packaged together in the same hybrid IC. In that case, carefully probe around the IC's pins until you find one of the analog signal pins.

This circuit can be integrated into the Drive Test Station described herein.

**SONY MICROFLOPPY - TO - 5½ STANDARD-BUS**

**8" STANDARD-BUS - TO - 5½ STANDARD-BUS**
Chapter XI: REPAIR SHOP TECHNIQUES

When we used to rely upon professional drive shops, we discovered that they often changed jumpers (drive select, etc.) and TRNs so that we would have to reconfigure the drive to again work in our system. And our 82 TK drives were adjustable only manually. In removing, packing, shipping, unpacking, reconfiguring, re-installing, and re-testing the drives, we ended up doing much more work than when we serviced the drives ourselves! And there was always the risk of further damage and deterioration just from the additional handling and shipping.

PROFESSIONAL DRIVE SHOPS

Sophisticated shops use a specially-programmed, controller (usually pD-based) whose function is to exercise disk drives. This set-up is called an "Exerciser."

It takes about 30 minutes for a professional drive shop to properly align a drive that is only radially misaligned. They use a special DYSAN or (other) CE alignment diskette (with a high frequency signal on T16, and a $2,000+ differential-type oscilloscope. Because of the amount of set-up required, it would take you 2-3 times longer to perform the same tests.

If the disk drive is not removed from its enclosure by its owner, it is usually removed at the service shop, and the drive is connected to the shop's Exerciser. The alignment diskette is inserted into the drive.

While running the drive continuously, the buffered outputs of the drive's Read circuit (TP1, TP2 on TANDON TM-100a) are connected differentially to the scope (A-B). The scope sync, is connected to the buffered output of the sector index hole detector (TP-7, TANDON). (Although it will minimize jitter, it is not necessary to connect the scope's external sync to the sector index test point.) The scope's vertical amplifier is set for AC coupling and 50 mv/cm; the horizontal sweep is set to 50 ms/cm.

The Read-Write head is carefully moved until a precise double-lobe or CE pattern is achieved. See Figure. To verify alignment, SEeks are made in this order: T16, T00, T16, T32 (or other track > T30), T16.

Ideally, both CE lobes should be symmetrical and equally high. In practice, lobes within 70-80% of each other in magnitude are tar­geted in most shops (90% in a few). Using this (CE) method, you can achieve 95-100% symmetry because alignment errors start to show up at around 65%. We average 85-90% symmetry just using our tria­l-and-error methods - see alignment chapter! Either most drives, or of the disk drive is not removed from its enclosure by its owner, it is usually removed by the service shop, and the drive is connected to the shop's Exerciser. The alignment diskette is inserted into the drive.

While running the drive continuously, the buffered outputs of the drive's Read circuit (TP1, TP2 on TANDON TM-100a) are connected differentially to the scope (A-B). The scope sync, is connected to the buffered output of the sector index hole detector (TP-7, TANDON). (Although it will minimize jitter, it is not necessary to connect the scope's external sync to the sector index test point.) The scope's vertical amplifier is set for AC coupling and 50 mv/cm; the horizontal sweep is set to 50 ms/cm.

The Read-Write head is carefully moved until a precise double-lobe or CE pattern is achieved. See Figure. To verify alignment, SEeks are made in this order: T16, T00, T16, T32 (or other track > T30), T16.

OPTIMAL ALLOCATION

OFFTRACK (for 48 TPI drives) = (1-(lst. lobe amplitude/2nd. lobe amplitude)) X 0.01

"Lobe" refers to the CE pattern lobes. For 96 TPI drives, divide the OFFtrack by 2.

CE ALIGNMENT DISKETTE

The CE alignment diskette is unformatted, but contains two distinct types of signals - the T00 databurst and the CE signal. The T00 databurst or boot data simply permits the system to recognize the disk drive as being comparable to the system, thus permitting it to log on. It has 3 tracks with the CE patterns, written in special locations, by a special drive. Two concentric tracks of the alignment diskette cross at T16 (or at T32 for 96 TPI drives, or at T32 or T36 for 100 TPI drives). T16, approximately half-way between end stops (35 and 40 Track drives), is used to judge head alignment.

DYSAN is the major source for alignment diskettes, but they can also be purchased from TANDON, RADIO SHACK, SHUGART, and other sources. As in the case of DDD/DDD diskettes, you cannot backup a CE diskette using an ordinary drive because some of the tracks created on it are off-center and they are produced by a special diskette writer. If you go the professional CE route, and your bad drive eats your $40-$90 alignment diskette, which is not uncommon, you are out $$SS$$!

NOTE: The software, CE data diskette, and procedures used in the CE alignment method are different than and incompatible to the DDA data diskette. Therefore, the CE method is not considered a method of drive alignment. According to some experts, the CE method can produce more accurate head alignments than the DDA/DDD method. However, the CE method is used because it is totally inadequate because it fails to directly test drive speed, Read Sensitivity, sector index adjustment, (electrolytic), azimuthal alignment, and TC sensor and end stop positions. 

In other words, a CE aligned drive may pass the CE tests with flying colors and still not function. Usually, for the Alignment ($20-$30), that's all you get. The "aligned" drive can be returned to you only non-functional! Additional repairs will cost you much more - even when no parts are required.

STATUS FOR TYPE I COMMANDS

<table>
<thead>
<tr>
<th>BIT</th>
<th>LENT NAME</th>
<th>MEANING</th>
</tr>
</thead>
<tbody>
<tr>
<td>S7</td>
<td>NOT READY</td>
<td>This bit when set indicates the drive is not ready. When reset it indicates that the drive is ready. This bit is reset when updated.</td>
</tr>
<tr>
<td>S5</td>
<td>WRITE PROTECT</td>
<td>On Read Record: Not Used. On Read Track: Not Used. On Write it indicates a Write Protect. This bit is reset when used.</td>
</tr>
<tr>
<td>S4</td>
<td>RECORD TYPE</td>
<td>On Read Record: It indicates the record-type code from data field address mark. On Read Track: It indicates the record-type code from data field address mark.</td>
</tr>
<tr>
<td>S3</td>
<td>CRC ERROR</td>
<td>On Read Record: It indicates a CRC error. On Read Track: It indicates a CRC error. On Write it indicates a CRC error. On Write Track: It indicates a CRC error.</td>
</tr>
<tr>
<td>S2</td>
<td>TRACK 0</td>
<td>On Read Record: When the drive is not ready. On Write it indicates the drive is not ready.</td>
</tr>
<tr>
<td>S1</td>
<td>INDEX</td>
<td>On Read Record: It indicates index mark detected from data field. On Write it indicates the drive is not ready.</td>
</tr>
<tr>
<td>S0</td>
<td>BUSY</td>
<td>This bit when set indicates that the drive is not ready. When reset it indicates that the drive is ready.</td>
</tr>
</tbody>
</table>

STATUS FOR TYPE II AND III COMMANDS

<table>
<thead>
<tr>
<th>BIT NAME</th>
<th>MEANING</th>
</tr>
</thead>
<tbody>
<tr>
<td>S7</td>
<td>NOT READY</td>
</tr>
<tr>
<td>S6</td>
<td>WRITE PROTECT</td>
</tr>
<tr>
<td>S5</td>
<td>RECORD TYPE</td>
</tr>
<tr>
<td>S3</td>
<td>CRC ERROR</td>
</tr>
<tr>
<td>S2</td>
<td>TRACK 0</td>
</tr>
<tr>
<td>S1</td>
<td>INDEX</td>
</tr>
<tr>
<td>S0</td>
<td>BUSY</td>
</tr>
</tbody>
</table>
Chapter XII: DRIVE ANALYSIS SOFTWARE CRITIQUE

The following firms produce DDA software:
(1) J & M SYSTEMS (James E. Sublett), 3824 Jemmick NE, Albuquerque, NM 87108 — TRS-80, KAPYRO, IBM, and SANYO.
(2) DYMEK CORP. (1851 Zanker Rd., San Jose, CA 95112) — IBM, APPLE, and TRS-80.
(3) OXBRIDGE SOFTWARE (522 Soquel Way, Sunnyvale, CA 94086) — APPLE, and IBM.
(4) WRITEHEAD SOFTWARE (P.O. Box 488, Boonville, CA 95419) — KAPYRO.
(5) CHANDLER SOFTWARE (273 West Shore Dr., Marblehead, MA 01945) — all CP/M 2.2 and 3.1 systems (8" SS, SD).
(6) BROMLEY ENGINEERING ($83a Cambridge St., Cambridge, MA 01929) — the HEATH/ZENITH Z-100 (5" and 8"), apparently designed for repair shop use.
(7) A number of readers have highly recommended CSM CO.'s "1541 Disk Alignment" program for their Commodores. Address unknown.

GENERAL COMMENTS

Most ubnot all microcomputer systems are supported by DDA software. If your system is not DDA supported, you can overcome this problem if your system uses a dedicated bus drive (with on-board controller, not a microprocessor-based DDA controller), or if there is a DDA adapter in the bus system (especially if it uses hard-sectoring, and the other system uses soft-sectoring). Although some drive problems produce exaggerated symptoms because of system-related problems, drives out of alignment/adjustment in one system are out of alignment in all other systems they can be used in. Other systems are DDA supported only to a limited extent due to DDA's inability to make one, or more integer tracks from each other, and are neither drive nor index timing adjustments is not possible.

(3) Systems using a NEC controller (e.g. DIGITAL EQUIPMENT CORP.) cannot use DDA software for drive speed or sector index adjustments since these controllers do not provide this information. Where possible, the NEC controller should be substituted by an equivalent WESTERN DIGITAL controller.

(2) Most modern drives do not have a means of adjusting drive speed. Eventual component aging can throw these drives off specification.

(3) Some systems have ROM routines which require certain identifying bytes on the 1st. track. They cannot read DDD diskettes, and thus treat them as foreign diskettes and refuse to use them. In some cases, these problems can be resolved by logging in the drive with a normally formatted diskette if the drive is in good enough condition to properly log-on, and then switching to the DDD diskette.

(4) Most DDA software requires a specific hardware configuration, and uses the DOS only minimally. Any deviations can limit or even nullify its use. Universal software is available for IBM, DEC, Apple, and others. (e.g. NORTON, CALYPSO, etc.)

(5) The price is reasonable: $79-$99, and the software includes a differential oscilloscope to do a more traditional head location, and read sensitivity without using an oscilloscope. You can set drive speed, head alignment, and sector index photodetector position. A quick look produces that the drive is an off-the-shelf component, and the DDA software graphically points out most of these factors in one fell swoop. Also, you can use the software with a regular oscilloscope to do a more traditional alignment. And the J & M graphics are outstanding! The Read Sensitivity test is a powerful tool to detect deteriorated compliances caused by poor geometry, pressure pad, misaligned upper-arm assembly, worn head, bad head loader and falling electronics.

DISADVANTAGES

(1) Although the J & M diskette can be backed-up using a utility such as HYPERZAP and has a hub ring, the DYSAN DDD cannot be backed-up and does NOT have a hub ring! Like CE diskettes, it cannot be backed-up because it comes in a special drive using special procedures.

(2) The price is $79-$99.

(3) The 3 M software is available for the IBM-PC, TRS-80 Model III/IV, TRS-80 Color Computer and TDD-100, KAPYRO, SANYO, etc.

(4) Even if you don't do your own work, you can use the J & M DDA software to determine when to swap or sell your drives, or have them repaired. It can also be used to evaluate new or used drives prior to purchase during the guarantee period to ferret out most of these factors in one fell swoop. Also, you can use the software with a regular oscilloscope to do a more traditional alignment. And the J & M graphics are outstanding! The Read Sensitivity test is a powerful tool to detect deteriorated compliances caused by poor geometry, pressure pad, misaligned upper-arm assembly, worn head, bad head loader and falling electronics.
We evaluated alignments and speed adjustments made using the methods described in DISK SERVICE MANUAL with the J & M software. All of our alignments were within the acceptable range, except the accuracy may have been a little better if we had used the J & M software, and the J & M software would have certainly been faster. We made many alignments using the J & M software. It appears that if you get too far out of range, the J & M graph indicator freezes up, and you can easily lose your place.

We also used the J & M software to adjust speed and sector index photodetector alignment. In one drive, even though the software indicated a perfect 300 RPM, using the zebra pattern on the drive's pulley under a fluorescent lamp, we still detected a small drift! Our optically-coupled digital counter independently checked the fluorescent lamp frequency as 60 Hz ±0.1%. Also, if your system has a speed modification (clock speed-up kit), unless you can switch back to the designed-in speed, the J & M speed tests may not work.

The software indicator does not seem to follow positions of the photodetector. In the drives we adjusted, the indicator seemed to jump all over the place! It sometimes indicated photodetector movement when there apparently wasn't any, and indicated no movement when it was being moved! Also, tightening and loosening of the photodetector screw profoundly affected the reading. Perhaps all of these anomalies can be physically explained. Even small drift! Our optically-coupled digital counter independently checked the fluorescent lamp frequency as 60 Hz ±0.1%. Also, if your system has a speed modification (clock speed-up kit), unless you can switch back to the designed-in speed, the J & M speed tests may not work.

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Chapter XIII: DRIVE MODIFICATIONS

SHUNTS & JUMPERS

Early floppies contained only a few selectable features and options. These included DS5 (Drive Select 5), MX, HS, HM, and a few others. Modern drives offer dozens of features and options. Most of these can be selected by using the provided socket-connected jumpers and or-post-connected shunt switches. Manufacturers' service/maintenance/OEM manuals provide for features and options that require either cutting logic board traces and or-soldering jumpers - some in combination with provided DS changes. Each drive and cable differs. In every instance, all mods are done on the logic board. Should you be uncertain on how to make DS changes, refer to your particular drive manual. Some of the possible features and options are:

(1) DRIVE SELECT: DS5's are indicated alongside provided DS5's as either DS5-DS10, some drives are limited to one, two or three DS5's. The JS labels are usually very small and hard to find. If your drive cable is unkeyed (ungapped) you must make the appropriate DS5 3S; one, and only one, DS5 must be selected. The selected DS5 need not have any relationship to drive physical position. If your drive cable is keyed (gapped), you must select the DS5's corresponding to your situation. If you can, in fact, DS5 all DS5s without problem. If your system uses only one drive, you must JS X3; if not, MX must not be JS.

(2) SIDE SELECT: Most modern DS drives permit JS selection of the drive as either one DS drive (usually the default position) or as two, separate SS drives. Modifying a DS drive to two, separate SS drives usually requires disconnecting the side select input to the side select circuitry, and connecting the second DS5 to the side select circuitry.

(3) ACTIVITY LED ACTIVATION: Several options are available in some drive assemblies, LED activation may be: (A) by computer command. (B) Ready or pre-ready. (C) JSed to or in-use. (D) Any combination of drive select, right or pre-ready and in-use. By far, (A) is most common. Some 8" drives may have solenoid latches that usually activate upon activity LED activation. In no case should the activity LED be JSed to be OFF during disk access.

(4) HEAD LOADING: Two head loading options are generally possible (drives with solenoid head loaders only). Head loading upon: (A) Drive select (HS 3S). (B) Motor-On (HM 3S). Head loading may depend upon activity LED activation in some drives.

(5) MOTOR-ON ACTIVATION: Motor-On will always occur by computer command. Some drives also permit activation of motor-On to a diskette is either inserted or removed from the drive (highly-unusual). Some drives use JSed: (A) Ready or pre-ready. (B) JSed to in-use. (C) JSed to or in-use. (D) Any combination of drive select, right or pre-ready and in-use. By far, (A) is most common. Some 8" drives may have solenoid latches that usually activate upon activity LED activation. In no case should the activity LED be JSed to be OFF during disk access.

(6) AUTOMATIC RECALIBRATION TO T00: Automatic Recalibration to T00 for each time the drive is selected may be chosen (RE 3S). Although this results in better track alignment, it also produces more drive wear and tear, and is time consuming.

(7) WRITE-PROTECT SELECTION: The write-protect function is typically controlled inside the drive. 9" drives are tradition-ally write-protected by covering the write-protect notch. 8" drives write-protect is traditionally the opposite. Some modern floppies will permit a JS selection of either method.

EXTERNAL SWITCH MODIFICATIONS

Some folks modify their drives by the installation of toggle or rotary switches on the drive's front panel. These mods permit the HARDWARE selection of drive select and drive side. These mods have the following advantages:

(1) Save much time keying in COPY, BACKUP, and FORMAT commands.

(2) Save much wear and tear on drive doors and cones. Very useful when one does a lot of COPY, BACKUP, and FORMAT because the diskettes do not have to be physically transferred from drive to drive.

(3) Permit quick temporary changes in drive configuration parameters without re-entering the change into the DOS.

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(4) Very useful in performing drive repairs because any drive can be arbitrarily choosen as the boot drive.

(5) Permits one to disconnect a suddenly defective drive without having to turn-off the system or the drive.

These mods are simple, carefree and safe. All active lines to and from drives and computers are open-collector. You cannot damage either drive or computer electronic components by accidentally selecting two drives as the same drive number, although you won't be able to Read or Write to them while configured this way. Also, since the TRN is generally placed in the drive physically located furthest from the system on the drive cable, it is irrelevant as to what the drive's number is, and, unless a drive is physically switched to or from the furthest cable connector, the TRN does not have to be changed.

This mod requires an ungapped (ungapped) drive cable. Look at all drive connectors. If all contacts are present in all drive cable connectors, the cable is unkeyed. To select between drive numbers or the 2 sides, use a SPDT toggle switch. To select between 3 or 4 drive numbers, use a rotary switch with 3 or 4 throw positions. Mini-switches should be used.

Disassembly usually requires only the removal of the drive enclosure. One first locates a convenient position on the front panel of the drive and installs the switch there. Be sure that the switch and its cables won't interfere with the diskette and write-protect notch detector.

The drive select jumpers, header or dip switch are is then removed. In common headers, MX, HL, HM and HS switches all must be separately jumpered. Unless otherwise stated, the drive select IC socket contacts are 2-13 (DS1), 3-14 (DS2) and 4-13 (DS3), 5-12 (DS4). The lower contact numbers (2-5) are wired to connector JS1 contacts. Contact numbers 15-12 are shorted together and are wired to the logic board electronics. Select the side select contacts to the throw positions of the toggle or rotary switch. Solder any logic board-side contacts, DS1-DS5 (or DS0-DS5), to the switch poles.

In DS drives, generally 31-32 is used as the side select, and 31-32 is used as DS4. In SS drives, 31-32 may be used as DS4 (31-32 may be separately jumpered to 31-6, in which case, remove or cut this jumper). With the drive in operation, and your computer selecting Side 0, measure the voltage at 31-32 when the drive is selected. In most systems, this voltage is 5 volts. To wire the toggle switch to 31-32 for side select, trace the J1-32 to a clear point where you can solder your toggle switch contact. Clean off any land coating, and solder one contact of the toggle switch to this clear point. Use 26 guage, stranded, plastic-insulated wire. Solder the other end of the switch contact to any signal ground point. When you switch the toggle switch, Side 01 will be forcibly selec-ted, regardless of what the computer "thinks" it selected.
DRIVE MODIFICATIONS

Operation is easy. By carefully labeling your switches, you should not be confused as to which drives are switched to which number, and which side is selected. The only danger is in switching a drive during an operation (front panel LED lit), which should never be done. If two drives are inadvertently switched to the same drive number, although neither will work until one is switched to another number, no permanent hardware damage should occur.

KEYED-CABLE MODIFICATIONS

In keyed cables, generally the J1-32 contact is missing in all drive connectors except the 4th one. If you use 3 drives instead of 4, and the last drive is DS, you can jumper the #32 ribbon cable line directly to J1-32 of your last, DS drive. This permits your computer to treat Side 1 of Drive #3 as Drive #4. To do this, find and separate the #32 ribbon cable line, and, with an X-Acto knife, carefully scrape off its insulation. We then solder a 12" jumper to line #32, and another 12" jumper to the top of the drive #3-32 contact. Then solder a male connector pin to one jumper, and a female to the other. We then connect the two jumpers together, and wrap the connection with a short piece of electrical tape.

SS-TO-DS MODIFICATION

Some drive repair shops claim that you can modify SS drives to DS simply by replacing the SS head carriage assembly with the appropriate DS one (ex: SA-410 to SA-460). Although SS-to-DS mod is possible, note that DS drives usually use a different logic board and stepper motors and use a mechanical head separator not found in their SS versions.

Logic boards that permit the connection of two head connectors, frequently found on SS drives, can also be used on DS versions. Also, if the drive develops Read Sensitivity problems due to bad electronics, you can swap the head connector to Head #1 electronics in SS drives or swap both head connectors with each other in DS drives. Also, be sure to swap the DS to SS head DS# pins. Head electronic swaps are also a method for testing suspect drive electronics.

OTHER DRIVE MODIFICATIONS

Other drive electronic mods can be made. Some folks install toggle switching of Motor-On (switched ON by grounding the Motor-On line), and head loader (also activated by grounding the head loader line.

MECHANICAL MODIFICATIONS

The two most frequently encountered major mechanical mods are described below. I've successfully attempted both of these mods, and will vouch that they are both very difficult and risky to make. They should NOT be attempted because the required disassembly is extensive, the drive frame is a bear to work with, and the resultant rough handling and debris are intolerable.

(1) Conversion of SS drives to flippy by installing an additional sector index optical coupler and write-protect detector opposite the originals. Also requires electronically ORing the two photodetector outputs. Exceptions here are COMMODORE and Atari drives that do NOT require (and may not have installed) the sector index optical coupler. A description of how to modify these drives to flippy is found in RADIO ELECRONICS, COMPUTER DIGEST, July 1983, p. 12, and does not require machining. Essentially, this can be done by connecting a 1.8K ohm resistor across the photodetector through a switch. Whenever the switch is ON, the drive will Write to any diskette whether the write-protect notch is covered or not. Therefore, you can Write to either side of diskettes without punching write-protect notches in them. When the switch is OFF, the write-protect detector acts normally, and the drive requires an open notch to Write.

(2) Shaving the inside stops to get extra tracks out of the drive—normally made to convert 35 Tk drives to 40 Tk.
SHUGART SA-851

SHUGART SA-851, 8" DS, 77 Tk, 3 msec. Split-band actuated. The SA-851 is identical to the SA-850 except that it is also compatible to non-IBM systems. A modern, popular, ultra-fast, very reliable 8" drive, the SA-850/851 is highly recommended to replace SA-800/801s.
SHUGART SA-801, 8" SS, 77 Tk, 8 msec. Lead-screw actuated. The SA-801 is identical to the SA-800 except that it is also compatible to non-IBM systems. One of the first and best of the early 8" drives, the SA-800/801 is still widely used.