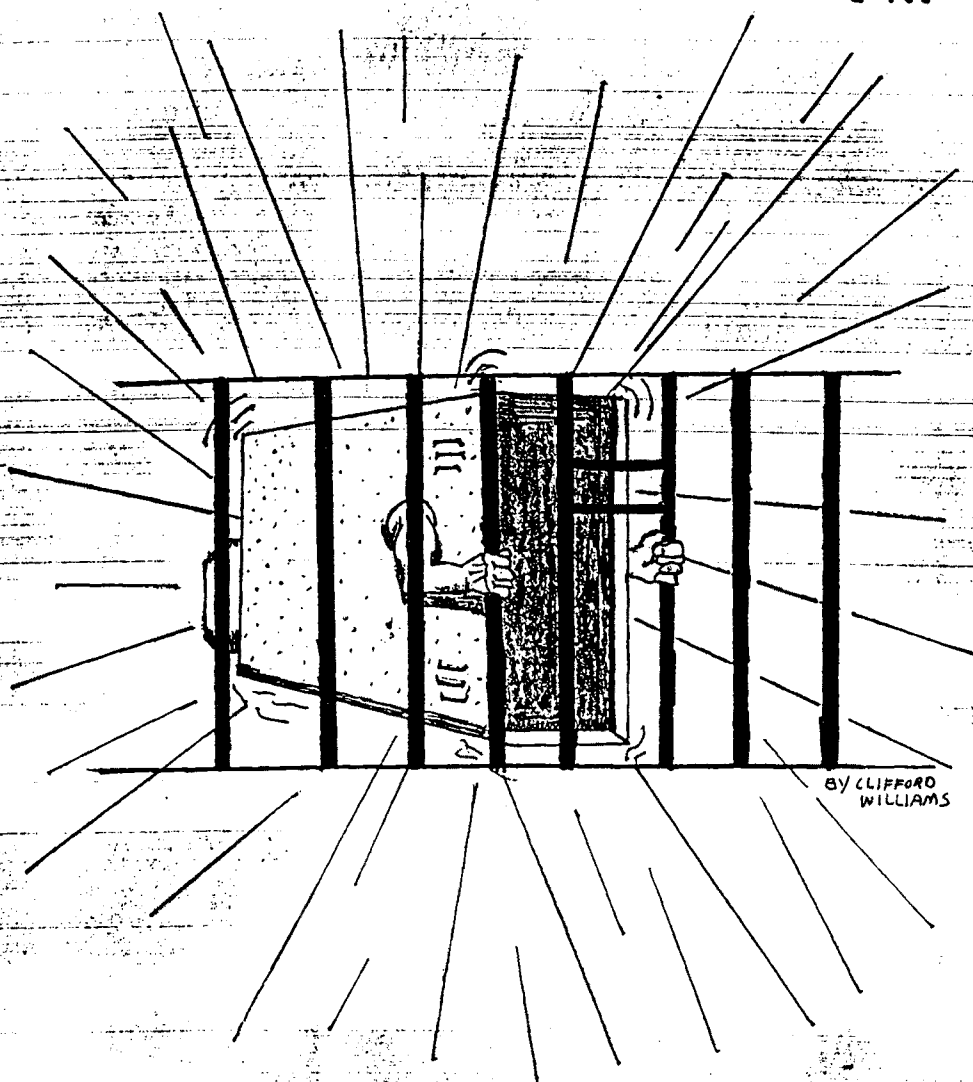


DISK SERVICE MANUAL III

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

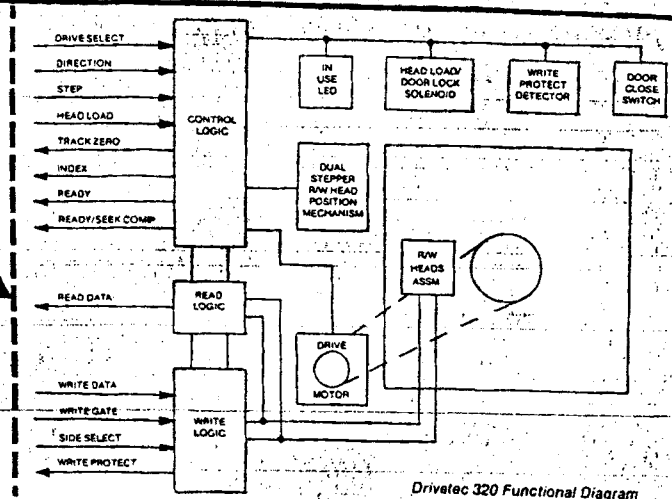
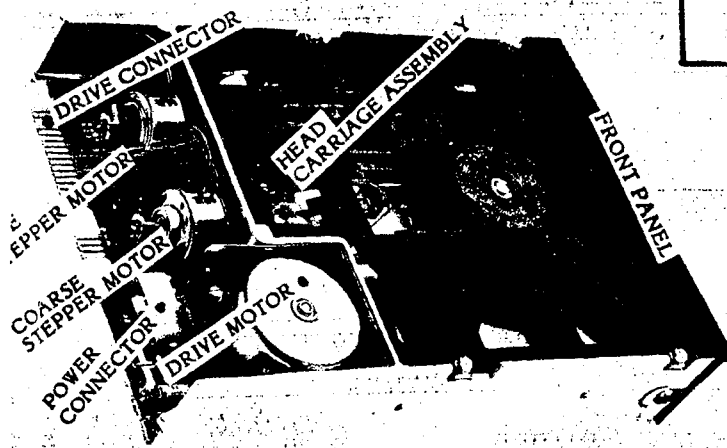
UNLEASH THE POWER OF YOUR SYSTEM!!



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Publishers Of Invaluable Survival Information

DISK SERVICE MANUAL III



Drivetec 320 Functional Diagram

DRIVETEC 320 SUPER-MINIFLOPPY, 5", 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 newest 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 5" skettes. Uses an absolutely vertical clamping mechanism, brushless DC drive motor and on-board μ P. Half-height and low power, the 320 can be easily used to upgrade high performance μ C systems; it is a recommended back-up for hard drives.

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

2200 W. Artesia Blvd.
Compton, CA 90220

PERCOM DATA CORP.

11220 Pagemill Rd.
Dallas, TX 75243

PERSONAL MICROCO, INC.

475 Ellis St.
Mountain View, CA 94043

PROSOFT

Dept. C, Box 560
North Hollywood, CA 91603

QUME CORP.

2350 Qume Dr.
San Jose, CA 95131

RADIO SHACK NATIONAL

900 E. Northside Dr. PARTS
Fort Worth, TX 76102

SHUGART ASSOCIATES

475 Oakmead Parkway
Sunnyvale, CA 94086

SIEMENS CORP.

1186 Wood Ave. South
Iselin, NJ 08830

TANDON Corp.

9333 Oso Ave.
Chatsworth, CA 91311

TEAC CORP.

7733 Telegraph Rd.
Montebello, CA 90640

TEXAS PERIPHERALS

1010 East 8th. St.
Odessa, TX 79761

VR DATA

777 Henderson Blvd., N-6
Folcraft, PA 19032

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

DRIVETEC
1051 South Milpitas Blvd.
Milpitas, CA 95035

DYSAN CORP.
5201 Patrick Henry Dr.
Santa Clara, CA 95050

HEWLETT-PACKARD
1000 NE Circle Blvd.
Corvallis, OR 87330

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

J & M SYSTEMS
137 Utah NE
Albuquerque, NM 87108

GLOSSARY

AM = Amplitude Modulation
BDOS or BIOS = BASIC DOS (Error)
BNC = A Twist-On Coaxial Connector
BPI = Bits Per Inch
CA = Computer-Aided
CAD = CA Design
CAE = CA Engineering
CAM = CA Manufacturing
CE = Cat's Eye (Alignment Pattern)
CP/M = Control Program for μ Ps
CPU = Central Processing Unit
CRC = Cyclic Redundancy Check(word/sum)
CW/CCW = Clockwise/Counterclockwise
DAM = Data Address Mark
DDA = Disk Drive Analysis (Software)
DDD = Disk Drive Data (Software)
DIR :N = Directory List of Drive N
DOS = Disk Operating System
DSn or DS# = Drive Select #/n

DUT = Device Under Test
EDC = Error Detection Code
EI = Expansion Interface
EMI = Electromagnetic Interference
FCB = File Control Block
FDC = Floppy Disk Controller
FM = Standard Freq. Mod. Encoding (SD)
MFM = Modified FM Encoding (DD)
MMFM = Modified MFM Encoding (DD)
FRSN = File Relative Sector Numbers
GAT = Granule Allocation Table
GCR = Group Code Recording
HIT = Hash Index Table
Hz = Cycles Per Second (CPS)
IC = Integrated Circuit (Chip)
ID = Identification or Identifier
IDAM = Identification Address Mark
I/O = Input and/or Output
JS = Jumper Selected
K = Thousands (1,000s)
lab = Laboratory
LED = Light Emitting Diode
micron = Millionth of an Inch (0.000001 Inch)

mil = Thousandth of an Inch (0.001 Inch)
mod = Modification
ms/msec = Milliseconds (0.001 Second)
MTBF = Mean Time Before Failure
OEM = Original Equipment Manufacturer
OS = Operating System
PC = Printed Circuit (Board). Also, Personal Computer.
PLL = Phase-Locked-Loop
pot. = Potentiometer (Variable Resistor)
RPM/RPS = Revolutions Per Minute/Second
SPDT = Single Pole, Double Throw (Switch)
sync = Synchronous
TPI = Tracks Per Inch
TRN = Terminal Resistor Network (Term. Resis. Net.)
 μ C/ μ P = Microcomputer/Microprocessor
UNIX/XENIX = μ C Operating Systems
UPS = Uninterruptable Power Supply
 μ s = Microseconds (0.000001 Second)
VDC = Voltage, Direct Current
VAC = Voltage, Alternating Current

DISK SERVICE MANUAL III

By: John J. Williams

TABLE OF CONTENTS

CHAPTER I.....	GENERAL
CHAPTER II.....	OPERATION ADVICE & TIPS
CHAPTER III.....	ERROR MESSAGES
CHAPTER IV.....	DIAGNOSTICS & TROUBLESHOOTING
CHAPTER V.....	MAINTENANCE
CHAPTER VI.....	SPEED ADJUSTMENT
CHAPTER VII.....	R - W HEAD ALIGNMENT
CHAPTER VIII.....	ELECTRONICS & REPAIRS
CHAPTER IX.....	MISCELLANEOUS REPAIRS
CHAPTER X.....	DRIVE TEST STATION
CHAPTER XI.....	REPAIR SHOP TECHNIQUES
CHAPTER XII.....	DRIVE ANALYSIS SOFTWARE CRITIQUE
CHAPTER XIII.....	DRIVE MODIFICATIONS
APPENDIX A.....	GLOSSARY

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Chapter I: GENERAL

Thru the years, we've purchased many floppy disk drives, some used. We discovered that professional drive shops are expensive, time-consuming and a hassle. We now do all of our own repairs, adjustments, and maintenance (time and parts permitting) - without special equipment or software! We've published survival publications for more than decade (80+), and we practice the self-sufficiency that we preach. We may be old-fashioned, but we believe that if you want to do the job right, in many cases, you've got to do the job yourself!

Due to the enormous amount of information available on disk drives and diskettes, if being thorough is defined as covering everything known about a subject, one would require an encyclopedia here! We tried to be as reasonably thorough and comprehensive as possible. Despite the hundreds of different computer and disk drive models, 95+% of disk drives in use today can be classified into about a dozen distinctly different types. If we don't mention your particular system or drive of the many types mentioned, your drive type will be covered to the extent that you can service it. If you want to become an expert on any particular drive, you should also obtain its service/maintenance/OEM manual from its maker.

We gladly accept advice and information to improve **DISK SERVICE MANUAL** for its later printings and editions. This includes drive service manuals, books, articles, photos, discarded drives, and TRS-80 disk utility software. We particularly seek articles, and we will pay money and provide a byline for those we can use. All articles should be replete with labeled photos and illustrations. We are also interested in drive modifications, and all other secrets and tips. For substantial information that we use in future printings and editions, we will provide you copies of all future editions free of charge. If you manufacture or distribute drives, media or related products, we would like to evaluate your product(s) for future editions, please send us a complimentary sample(s) or loaners. We thank SHUGART, TANDON, BASF, VERBATIM, WESTERN DIGITAL, and many others for their invaluable, thoughtful, and consumer-oriented contributions.

We will repair broken disk drives for free (CONSUMERTRONICS CO. customers only who have ordered at least \$20 in publications from us)! See our address herein. We will fully diagnose your drive(s). If we can fix it, we will fix it and ship it back to you! If we can't reasonably fix your drive(s), we will still return it to you. In either case, all you pay is shipping and insurance costs both ways. We are providing you this FREE service because we want to repair as many disk drives as we can to increase our expertise in this area. We benefit because we later sell this expertise in new printings and editions of **DISK SERVICE MANUAL**. You benefit because, if we can reasonably repair your drives, your cost will be much less than if you sent them to a repair shop. And we'll not only carefully repair your drives on a timely basis, but also clean and lubricate them for FREE! Sorry, we do NOT sell drive parts or subassemblies. NOTE: BEFORE SHIPPING US YOUR DRIVES, YOU MUST FIRST OBTAIN OUR WRITTEN O.K. TO SHIP THEM. TO DO THAT, PLEASE SEND US A DESCRIPTION OF: (1) DRIVE AND COMPUTER MODELS INVOLVED. (2) SYMPTOMS AND/OR ERROR MESSAGES. Send us bare drives, and, if possible, include the drive power supply, and any manuals. Please do NOT send us your computer. Also, we will gladly accept all donations of drives, parts, manuals, etc.

PLEASE DO NOT PHONE US! For all inquiries - please send us a note, and please be sure to enclose a #10 SASE. We will write you back with the new address or information IF we have it, else we can't provide it to you.

Floppy disk drives made by TANDON, RADIO SHACK and TEXAS PERIPHERALS are very similar in their design and construction. Unless stated otherwise, maintenance and repair comments about TANDON drives also relate to RADIO SHACK and TEXAS PERIPHERALS DRIVES.

The terms "drive" and "diskette" denote floppy disk drive and floppy disk(ette), respectively. The term, "5" drive", is shorthand here for a 5.25" floppy disk drive. The acronyms SS, DS, SD, DD and QD denote Single-Sided, Double-Sided, Single-Density, Double-Density, and Quad-Density (DD + 96 TPI), respectively. SD is the most popular form of Frequency Modulation (FM) encoding, while DD is the most popular form of Modified FM (MFM) encoding. Note, that in a few systems, other schemes are used. For example, ATARI computers do not use true DD in systems using their 810 and 1050 drives but a type of 1.5 density called, "dual density," "enhanced density" and even "double density." BASF is popularizing the 1S, 2S, 1D, 2D, 4D designations for SS, DS, SD, DD and QD, respectively. The term, "T00" and "S13" are shorthand for Track #0 and Sector #13. See GLOSSARY for other disk drive and diskette terms.

DISK SERVICE MANUAL III 1-1

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 correct and complete 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 the 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 inside computers or expansion interfaces, in which case, remove enough of the computer or expansion interface's enclosure, cables and subsystems to physically access the drive. Most drives can be worked on in situ.

SAVVY 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."

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 does not 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 or has performed periodic maintenance over 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.

.....AND MORE!!!

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

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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 paper clips (use a felt-tip pen), or get them oily or wet, or expose them to temperature extremes, sunlight, microwaves, 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, 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.

(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 jacket while observing its surface in the Read-Write Window. The contamination is usually visible. Carefully rub it off or flick it off using the alcohol-soaked Q-tip.

Even diskettes subjected to the worse contamination exposure can be saved. Read DISK DRIVE TUTORIAL in Recommendations Chapter.

(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, speakers, 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 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 turn the system 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. Do not remove or insert diskettes in rotating drives with head-loaders. Drives with head-loaders make a clacking sound when either selected (front panel LED is ON) or upon Motor-On (spindle motor is turned ON). The activated head-loader solenoid causes the felt pad (SS) or Head #1 (DS) to press onto the diskette surface. Opening the drive door will not disengage this contact in some 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/or diskette.

(8) **ALWAYS - ALWAYS - ALWAYS** back-up important diskettes. The three-tier approach is preferred for critical diskettes: (A) **MASTER (1 diskette):** Stored 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. Stored away from Working Copies. (C) **WORKING COPIES (1+ diskettes):** The only diskettes used in day-to-day operations. Only new, high-sheen bulk-erased 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 items (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 on drives and diskettes because the particles get onto the Read-

Write head(s), felt pressure pad, and the diskette's recording surface, and wear them out - as if they were rubbed with sandpaper!

(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 because someone moved a connector with system power ON! When removing or replacing connectors, do so gently, firmly and uniformly. Do not force a connector as force can damage or short contacts. Before turning power ON, be sure that all connectors are solidly and squarely connected.

Be sure that ALL non-gold-plated printed circuit board edge connectors are cleaned every time preventive maintenance is done on the system. Use a pink (not white), pencil eraser to remove any oxide from their contacts. Thoroughly clean all eraser debris. The drive cable should have gold contacts.

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!!

When removing and replacing drive and system enclosures, be careful not to snag wires, or short pins or test points to anything. Particularly observe that the power lines going to and from the 120 VAC and power supply do not get pinched or rubbed by the enclosure or by a board or any part. Fuses don't protect you from this kind of disaster! Some drives and systems have sloppy power wiring, so be careful.

A good practice after buttoning a system back up is to run a continuity check between the (disconnected) 120 VAC plug's hot and neutral prongs to the equipment chassis (case). Resistance should be 20+M ohms. Then run a continuity check between the 120 VAC plug's earth (chassis) ground prong to the chassis. Resistance should be zero. Then use a line checker device to check your computer's 120 VAC wall and power strip outlets to verify that they are wired correctly (many are not!).

If your drive is ever subjected to line VAC on either a DC voltage or ground bus, consider that the entire Logic Board is ruined, as well as the Sector Index Optical Couplers, and possibly the Servo Motor Board. However, drive mechanics should still be all right. (The computer and other peripherals may also be damaged or destroyed.) To minimize this possibility, be very careful that you do not pinch an AC line when you re-install your drives and drive enclosures, and use recommended fuses only.

(3) Do not expose drives to extremes in temperature and humidity. Cool temperature and low humidity are ideal. Ambient temperature should be 50 - 90 degrees F. Changes in air pressure cause drives to breathe, resulting in contamination. Don't use drives as shelves for books and papers, or enclose them where they can't ventilate. They must freely vent heat. Put at least 1/4" of space between standing drives for ventilation purposes. We paste onto the cover sides of our free-standing drives, squares of 1/4" thick rubber. Separation is maintained and the drives don't scratch each other when moved.

(4) Don't expose drives to loud noises, vibrations or shock. Drives used near airports, railroads, major highways and industrial sites where noise and vibration levels are high, experience very high failure rates! High noise produces micro-vibrations that rapidly deteriorate drives - even when they are not being used. Our drives rest on 1/2" thick dense foam rubber or cork cushions. If necessary, insert your drives in sound-proof (well-ventilated and dust-free) enclosures.

(5) Avoid using drives in electrically noisy environments, except with an AC voltage regulator, power controller, and proper AC, DC, neutral, chassis ground, and DC ground wiring. See electronics chapter.

(6) To ship drives, carefully package them so that they are fully protected from moisture, shock and vibration. Particularly with DS drives, do not ship with a diskette enclosed, but with a thin cardstock cut in the shape of a diskette (the only cut-out is the center hub hole). Ship with a desiccant. Also, drives that have flip-out doors (TANDON, SHUGART, etc.), must have their doors secured. Either tape the doors shut, or use a folded piece of cardstock wedged into the front panel door grooves. Some drives with spring-loaded doors (ex: SA-851) provide for screwing down the cone lever assembly to the drive wall.

(7) Store drives in a plastic bag with air squeezed out, and enclose a desiccant. To use a long-stored drive, clean it (if necessary), and relubricate it.

(8) In finishing alignments and adjustments, tighten 4-40 and 2-56 screws, small threaded parts, and all screws threaded into plastic (ex: front panel screws) to 20 inch-ounces of torque or less. Do NOT overtighten or cross-thread. Except for alignment and T00 cam screws, finger nail polish is usually a good means of prevent-

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DISK SERVICE MANUAL III

II - 1

Write head(s), felt pressure pad, and the diskette's recording surface, and wear them out - as if they were rubbed with sandpaper!

(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 because someone moved a connector with system power ON! When removing or replacing connectors, do so gently, firmly and uniformly. Do not force a connector as force can damage or short contacts. Before turning power ON, be sure that all connectors are solidly and squarely connected.

Be sure that ALL non-gold-plated printed circuit board edge connectors are cleaned every time preventive maintenance is done on the system. Use a pink (not white), pencil eraser to remove any oxide from their contacts. Thoroughly clean all eraser debris. The drive cable should have gold contacts.

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!!

When removing and replacing drive and system enclosures, be careful not to snag wires, or short pins or test points to anything. Particularly observe that the power lines going to and from the 120 VAC and power supply do not get pinched or rubbed by the enclosure or by a board or any part. Fuses don't protect you from this kind of disaster! Some drives and systems have sloppy power wiring, so be careful.

A good practice after buttoning a system back up is to run a continuity check between the (disconnected) 120 VAC plug's hot and neutral prongs to the equipment chassis (case). Resistance should be 20+M ohms. Then run a continuity check between the 120 VAC plug's earth (chassis) ground prong to the chassis. Resistance should be zero. Then use a line checker device to check your computer's 120 VAC wall and power strip outlets to verify that they are wired correctly (many are not!).

If your drive is ever subjected to line VAC on either a DC voltage or ground bus, consider that the entire Logic Board is ruined, as well as the Sector Index Optical Couplers, and possibly the Servo Motor Board. However, drive mechanics should still be all right. (The computer and other peripherals may also be damaged or destroyed.) To minimize this possibility, be very careful that you do not pinch an AC line when you re-install your drives and drive enclosures, and use recommended fuses only.

(3) Do not expose drives to extremes in temperature and humidity. Cool temperature and low humidity are ideal. Ambient temperature should be 50 - 90 degrees F. Changes in air pressure cause drives to breathe, resulting in contamination. Don't use drives as shelves for books and papers, or enclose them where they can't ventilate. They must freely vent heat. Put at least 1/4" of space between standing drives for ventilation purposes. We paste onto the cover sides of our free-standing drives, squares of 1/4" thick rubber. Separation is maintained and the drives don't scratch each other when moved.

(4) Don't expose drives to loud noises, vibrations or shock. Drives used near airports, railroads, major highways and industrial sites where noise and vibration levels are high, experience very high failure rates! High noise produces micro-vibrations that rapidly deteriorate drives - even when they are not being used. Our drives rest on 1/2" thick dense foam rubber or cork cushions. If necessary, intern your drives in sound-proof (well-ventilated and dust-free) enclosures.

(5) Avoid using drives in electrically noisy environments, except with an AC voltage regulator, power controller, and proper AC, DC, neutral, chassis ground, and DC ground wiring. See electronics chapter.

(6) To ship drives, carefully package them so that they are fully protected from moisture, shock and vibration. Particularly with DS drives, do not ship with a diskette enclosed, but with a thin cardstock cut in the shape of a diskette (the only cut-out is the center hub hole). Ship with a desiccant. Also, drives that have flip-out doors (TANDON, SHUGART, etc.), must have their doors secured. Either tape the doors shut, or use a folded piece of cardstock wedged into the front panel door grooves. Some drives with spring-loaded doors (ex: SA-851) provide for screwing down the cone lever assembly to the drive wall.

(7) Store drives in a plastic bag with air squeezed out, and enclose a desiccant. To use a long-stored drive, clean it (if necessary), and relubricate it.

(8) In finishing alignments and adjustments, tighten 4-40 and 2-56 screws, small threaded parts, and all screws threaded into plastic (ex: front panel screws) to 20 inch-ounces of torque or less. Do NOT overtighten or cross-thread. Except for alignment and T00 cam screws, finger nail polish is usually a good means of prevent-

ERROR MODES & RECOVERIES

Disk errors are easy to occur. A 99.9% 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 that "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 line noise, and previous operation impact current operation - sometimes enough to make a previously unreadable 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 CRC and checksums.

Checksumming adds up all the bytes in a field and produces a check byte(s). Each recorded check byte is compared to the corresponding check byte computed during a READ to Verify that the field data was correctly Read. If they differ, a parity-type error results. The more checksum bytes, the greater the accuracy. Checksums is an easier scheme to implement. However, it's not nearly as reliable as a CRC EDC because errors that compensate each other in magnitude will still produce the same checksum (ex: $10+3 = 7+6$). APPLE, FRANKLIN, MILLIKEN, VICTOR and BURROUGHS microcomputers use checksum EDCs. COMMODORE uses an even parity scheme.

In systems using CRCs, every time the controller Reads a sector, it comes across two 2-byte numbers known as CRCs - one at the end of the Sector Header and one at the end of user data. The controller uses a complex algorithm to calculate header or user sector bytes, and then Read-Writes or Verifies the CRC. In Reads and Verifies, it compares the sector byte calculations to the CRC. If they differ, a CRC or Parity Error results - usually indicating either a damaged diskette or some head misalignment.

The CRC EDC results from a complex algorithm for Verifying field data. A more complex controller (FDC and related circuitry) is required to compute and Verify CRCs than checksums. The field CRC is compared to the one calculated during a READ. If they differ, a "CRC" or parity-type error results.

"Parity" here is a misnomer because parity usually refers to a bit used to denote whether the total number of all other set bits in a group is even or odd. The 16-bit CRC is the remainder when the FDC divides the data bits by a generator polynomial $G(x)$. During a READ, the FDC divides the sequence of Clock-Data bits appended with the READ CRC bytes by $G(x)$. If no detectable error results, this division yields a zero remainder.

See EDN, May 28, 1978, p. 129, for greater details on gaps, the CRC algorithm and controller functions, and BYTE, Sept. 1984, p. 100, for greater CRC details. IBM, RADIO SHACK, KAYPRO, MORROW, EAGLE, and DATAPOINT microcomputers use CRC EDCs.

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 HEAD:** A dirty head results in zone dropouts that may worsen, stay the same or lessen as the head steps in and out. Drive speed variations, and head, Sector Index and/or T00 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-sectored diskettes can be Formatted (machine language program) for any number of sectors per track and sectors per gran. And the number can be varied per track. The encoding scheme can also be varied with DD and SD sectors even appearing on the same 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 EDC-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 Separ-

ator dynamically adjusts the clock rate of the controller to match the flow of Clock-Data bits streaming off of the diskette. The disadvantage with too many sectors per track is too much diskette space must be allocated to Sector Headers and gaps.

Disk drives have the worst trouble with the 6DB6 bit pattern. The 6DB6 bit pattern is thus used as the FORMAT reliability test pattern by most DOSs.

DISK ERROR CATEGORIES

Disk errors can be categorized in two ways:

- (1) Sector Header errors vs. Data Field errors.
- (2) Directory errors vs. all other errors.

All diskette-caused Sector Header, mark (IDAM or DAM) and EDC (CRC or checksum) errors are serious and either cannot be corrected, or corrected only by using sophisticated disk utility software. All errors in the first two Directory sector data fields, and all user sector Data Field errors are generally easier to correct - if you know the hash code algorithm or missing data. The first two Directory sectors contain the GAT and HIT tables, essentially containing information, that, if lost, can be recomputed from the other, Directory entry sectors. Damaged Directory file entry sectors are very difficult or impossible to correct - the files referenced by them will no longer be accessible.

If an error occurs in a Sector Header EDC byte, the controller generates an immediate interrupt (termination), and a Parity or EDC error results. An error in the Data EDC will produce a DATA EDC error message. If the error is in the DAM, it cannot be reconstructed, and the sector is lost - the controller interrupts the instant it sees an unauthorized DAM - resulting in a DATA RECORD NOT FOUND type error during a READ or WRITE.

SEEK ERRORS

A SEEK Error occurs when the track address Read by the FDC after a SEEK is not the same as the track address expected by the FDC. The most common causes are head misalignment, hysteresis, and eccentricity (clamping).

When a sector becomes totally lost - the controller finds unexpected track or sector information after a SEEK operation - from misalignment or a damaged diskette - a SEEK error will be displayed during a READ or WRITE.

Hardware SEEK errors can sometimes be corrected by Restoring the Read-Write Head back to T00 to recalibrate its position, and-or by re-clamping the diskette. If not, either the Read-Write Head and-or T00 Sensor must be re-aligned, and-or the spindle and-or clamp assembly replaced, or the drive discarded.

READ ERRORS

READ (or DIR) errors occur when the EDC computed from the data previously Written on a diskette does not match the EDC values stored in the Sector Header. READ (and WRITE) errors are mostly caused by a defective diskette, head misalignment or contaminated Read-Write Head, and occasionally by hardware failures.

A Soft READ Error is defined as a READ error which can be recovered in less than 11 attempts to Read a record. If a record has not been recovered after 4 re-attempts, restore the drive to T00, re-Seek to the specified track and Read with a maximum of 5 additional attempts. If the record is Read properly, the error is defined as a Soft READ Error. If the record is still not Readable, it is defined as a Hard READ Error. Soft and Hard READ Errors are caused by the same factors that cause Soft and Hard WRITE Errors.

WRITE ERRORS

A WRITE Error is defined as a record which cannot be successfully Read after ten READ attempts during Read-after-Write routine. A "Soft" WRITE Error is a WRITE Error which can be recovered in less than 5 Write attempts. Soft WRITE Errors are caused by defective media (diskette), low signal-to-noise ratio, incorrect or erratic drive speed, contamination, worn felt pressure pad, and-or minor head misalignment.

If the record is not Read properly during a Read-after-Write routine after 4 WRITE attempts, the error is a "Hard" WRITE Error. In the case of a Hard WRITE Error, the sector or track should be locked-out as defective. More than two Hard WRITE Errors per surface calls for diskette replacement. Hard WRITE Errors are caused by the same factors that cause Soft WRITE Errors, but are more severe.

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 WRITE 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 worse 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 or drive 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 user data into the Data Field, and finding an ID Field EDC error. Or because the selected drive is not READY. Or after a failed VERIFY Read after Write.

In the lab, bit densities are around 70,000 flux reversals per inch while repetition rates exceed 15 MHz! The output of the Read-Write Head, is, in fact, a high frequency carrier. Noise, bit dropouts, zone dropouts, and periodic and random amplitude modulations (AM) and bit shifting result in a complex error problem. For more information on drive design problems, see EDN, April 5, 1984, p. 175.

ERROR MESSAGES

The following are common type 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 sector READ/WRITE.
 - (2) ILLEGAL LOGICAL FILE NUMBER: The File Control Block (FCB) in the Directory contains bad data.
 - (3) GAT READ/WRITE ERROR: An error resulted during a Directory GAT sector READ/WRITE.
- DISK DIRECTORY-TYPE ERRORS³
- (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) GAT READ/WRITE ERROR: An error resulted during a Directory GAT sector READ/WRITE.
 - (4) HIT READ/WRITE ERROR: An error resulted during a Directory HIT sector READ/WRITE.
 - (5) FILE or PROGRAM NOT IN DIRECTORY: Your program tried to open a non-existing file during a READ/WRITE. (Shame on you!)
 - (6) DIRECTORY SPACE FULL -- FULL DIRECTORY: The Directory 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) DISK(ETTE) SPACE FULL: The diskette is filled up and can fit no 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 was created for later storage but is still empty.
- (6) FILE or PROGRAM NOT FOUND: The sought file or program was not found.
- (7) ILLEGAL DRIVE NUMBER: The drive number in the file-spec indicated a drive not permitted by the DOS drive configuration parameters, or by the system.
- (8) LOAD FILE FORMAT ERROR: 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

III - 2

(10) 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 user data examined did not compute to the correct 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 head 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 ID during a READ/WRITE. The error is usually displayed after two 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 became available to be 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 in error.
- (8) DRIVE or DEVICE NOT AVAILABLE: The currently selected drive is not available for access (disconnected, turned OFF, improperly inserted diskette, defective Sector Index Optical Coupler, speed far off, etc.).
- (9) DISK (DRIVE) WRITE FAULT: A hardware defect or disconnect in the controller, drive interfacing, and/or drive.
- (10) WRITE PROTECTED DISK(ETTE): 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 (CONSUMERTRONICS CO., P.O. Drawer 537, Alamogordo, NM 88310). If you still want more information on diskette directories, file storage, passwords, error recovery methods, and disk I/O operations read: TRS-80 DISK & OTHER MYSTERIES, and MACHINE LANGUAGE DISK I/O & OTHER MYSTERIES (IJG INC., 1953 W. 11th St., Upland, CA 91786).

DRIVE STORAGE CAPACITIES (WESTERN DIGITAL)

SIZE	DENSITY	SIDES	UNFORMATTED CAPACITY (NOMINAL)	
			PER TRACK	PER DISK
5¼"	SINGLE	1	3125	109,375*
5¼"	DOUBLE	1	6250	218,750
5¼"	SINGLE	2	3125	218,750
5¼"	DOUBLE	2	6250	437,500
8"	SINGLE	1	5208	401,016
8"	DOUBLE	1	10,416	802,032
8"	SINGLE	2	5208	802,032
8"	DOUBLE	2	10,416	1,604,064

SIZE	DENSITY	BYTE TRANSFER TIME	FORMATTED CAPACITY	
			PER TRACK	PER DISK
5¼"	SINGLE	64µs	2304**	80,640
5¼"	DOUBLE	32µs	4608***	161,280
5¼"	SINGLE	64µs	2304	161,280
5¼"	DOUBLE	32µs	4608	322,560
8"	SINGLE	32µs	3328	256,256
8"	DOUBLE	16µs	6656	512,512
8"	SINGLE	32µs	3328	512,512
8"	DOUBLE	16µs	6656	1,025,024

*Based on 35 Tracks/Side

**Based on 18 Sectors/Track (128 byte/sec)

***Based on 18 Sectors/Track (256 bytes/sec)

Chapter IV: DIAGNOSTICS & TROUBLESHOOTING

DISK SERVICE MANUAL III IV

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 the drive (mechanical/electronic), by the drive cable (electrical), and-or by the computer (electronic). A bad controller part, memory IC, or μ P can manifest itself as apparent drive problems. Apparent drive problems can also be nothing more than an improperly configured drive or DOS, or software bugs!

From our experience, 95% of all apparent drive problems relating to a single drive only are caused by a malfunctioning drive, a bad diskette or defective drive cabling or connection. If more than one drive is experiencing the same type of problem when tested with several previously good diskettes, in 95% of the cases, the problem is NOT caused by the drive or by the diskettes, but by something in common to all drives in the system (ex: drive cable, multi-drive power supply, controller, μ P, RAM). Except in the case of a major accident (electrical or mechanical) most problems in a system are caused by the malfunction of only a single part.

Like cars and TVs, some computer systems and drives are lemons! Some are so poorly designed and constructed that you may NEVER completely ferret out all problems. If problems are compound or intermittent, solution can be extremely difficult and time-consuming.

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 makers and shops charge similar stiff fees. All of the major computer makers we were able to check (11 of them) made 25%-35% of their total 1985 incomes from their repair and parts operations alone! For five hours of shop work, you might as well salvage the computer and buy a new one! It can pay you \$\$\$\$ 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 re-assemble your system, and charge you \$ Hundreds 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 replacement costs about \$800.) They may then 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 \$50 in labor to spare hurting your feelings if they repaired to the parts level and charged you \$400 for labor and \$50 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 usually quickly isolate the problem down to the part in 90+% of all cases. The repair can be made, and the original board restored - all within one hour! In 90+% 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 factory, they 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 booby traps to swindle you out of \$ Hundreds of repair and replacement costs.

I don't know what the profit margin in repair shops are but it must be enormous! Keep in mind that most (but not all) repair shops are solely interested 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 then usually declare the drive, interface or even the entire computer system at fault, and charge you even more!

Unless your time is very expensive (be realistic), it pays to learn how to repair your own equipment and make most repairs yourself. Then, if you still can't make a repair, bring it to the shop. If your system is still under warranty, then, by all means, avail yourself to the wasteful repair shop process unless time is at a premium, and you can't get the repair done or a replacement in time. Also consider, by working on your own system, you will probably void all applicable warranties, and, unless you know what you're doing and are careful, you may foul up things worse than they are now! The decision, and all of its risks and benefits are YOURS ALONE! Don't admit to any shop that you worked on the equipment prior to bringing it in, unless you obviously fouled it up more, because that's a green light for them to rip you off for much more! And, once a shop has repaired your equipment, ask for a complete description as to exactly what the problem was and what they did to repair it. Keep good records.

DIAGNOSES

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-Write attempts increases, sometimes beyond what the DOS is programmed to tolerate, resulting in ever 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/billion. (C) Hard READ Errors: 1 bit/trillion. Power supply glitches and externally-generated EMI can increase drive error rates by a factor of a 1,000 or more! And glitched diskettes are very common. When you consider how many SEEK attempts are made and bits Written and Read when operating a drive under practical usages, an error message once in awhile is expected. But be concerned if error rates significantly increase or develop a pattern.

Experience drive users often learn to detect small changes in drive noise level. Drives and diskettes of different types and makes sound somewhat differently. Lead-screw actuated drives are quiet; split-band actuated drives are noisy. Head loaders are also very noisy. There doesn't seem to be a relationship between how a diskette sounds, and its reliability. But one can easily pick-up on malfunctions or impending malfunctions just by sound changes. When listening to drives operate, ignore the normal swishing diskette sound, and normal drive Step and head-load sounds. But chattering 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 felt pad. Make a habit of closely inspecting new diskettes before using them, and after about 5 minutes of use.

Study the drive's service/maintenance/OEM manual and DISK SERVICE MANUAL. Where they might differ, rely upon the manufacturer's manual. Review all problems and error messages and record them, and make a plan of attack PRIOR to the start of work. Never do any maintenance or repair work on a bare, hard surface! Mechanical shock 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 toilet-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 an unsolvable problem, you may contact us for free advice. Please describe your system and problem. WRITE - DO NOT PHONE US. 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 you do it will depend upon whether or not you have a keyed (gapped) drive cable, and whether or not you've installed front panel switches (see modifications chapter). If keyed, you must physically disconnect and remove the drives, switch them over and reconnect them. If the end drive is affected, the TRN IC for the new end drive must be installed, and the one installed in the former end drive be removed. If the cable is not keyed, all you need to do is switch the Drive Select DIP switch or jumpers on each affected drive accordingly.

Consumertronics Co.

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

DEDUCTIVE REASONING

Most μ C owners find life expensive enough without having to keep spare drives, boards and a lot of parts on hand. The owner must solve his problems in a more elegant fashion. Also, he usually cannot afford to own sophisticated electronic gear, nor has the time to learn how 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 problems:

- (1) Are the problems constant or intermittent; progressively increasing with age and use; or thermally-related (occurs before/after warm-up and more severely 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 of the system's hardware?
- (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 problems 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) Poor or wrong connection. (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 jumpering 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" drives with direct-drive brushless DC motors.

The most common spindle motors used with 5" 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 changing to a different drive model, you must also change (in the DOS's drive table) Track-to-Track Access Time, Data Transfer Rates, number of allowable drives, number of attempts before an error is called, 5"/8"/hard drive, SS/DS, SD/DD, 35/40/80/77/100 Track, type of controller used, etc., AS REQUIRED. Be sure that your drives and DOS drive configurations agree with each other. With older drives, you may not be able to change some system times to high enough levels to produce reliable results.

DISKETTE & SOFTWARE SUBSTITUTION

Try various known good formatted diskettes in your drives to eliminate the possibility that the problem is due to bad diskettes or clamping. Don't use master diskettes - only expendable copies, as a bad drive may ruin them - EVEN IF WRITE-PROTECTED! Bulk erase spare diskettes, and try to format them. Then Read their directories using several drives. What happens?

Try various DOSs and user software combinations on your system, and run similar operations with them. Do the errors go away, decrease or increase? Any significant changes here points to either software bugs or wrong DOS/drive configurations.

DISK SERVICE MANUAL III IV - 2 DIAGNOSTICS & TROUBLESHOOTING

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/connector 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 solution (ex: CRAMOLIN) or pink 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 or about the same? Try lightly jiggling the various external cables and connectors. Changes in errors indicate a cable/connect problem.

A related problem is a socketed part that becomes loosened due to shock and vibration. These parts are under spring tension from the socket contacts, and the pins can slip out similarly to a watermelon seed between your fingers. Evenly and firmly press down upon all socketed components. Power up again and test.

INSPECT FOR BAD PARTS

About 75% of all electronic malfunctions leave some sort or visible damage. Look for burns, smoke stains, cracks, pin holes and exploded parts. Electrolytic capacitors usually leak, sweat, crack or form bulges at the plus end. With age, clock backup 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 crystallized, it probably overheated.

The parts to go first are usually the hardest working parts. Except for power supply parts, the most endangered are peripheral drivers. Then the μ P, FDC, RAM and ROM. Peripheral 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 out 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 isn't much you can swap out 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 interface. If you have two like computer systems, label all of their subsystems, PC boards, and plug-in components (ICs, etc.). Then make substitutions. This should pinpoint the subsystem or PC 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 μ P. Substitute RAM chips. Swap out the power supply(ies). Carefully scrub the drive, controller and main PC boards (both sides) with alcohol and a toothbrush. Allow to completely dry. By doing this, you might dislodge an offending solder ball/splash/hair, discover the defect, eliminate an EMI problem caused by crosstalk, or eliminate a short-circuit.

SEE PHOTOGRAPHS FOR MORE DETAIL ON DRIVE ANATOMY

THERMAL & STRESS METHODS

Almost all intermittent type problems are either thermal or stress problems, or due to a loose or dirty connector (see above). 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 enough out of alignment just by warming up or cooling down. Electrical connectors, socketed parts, poor solder joints, carbon resistors, and electrolytic capacitors can open, short or become intermittent when heated or cooled. This problem is particularly bad in aged equipment, and equipment with the history of large temperature variations (poor storage), overvoltages, and/or mechanical shock and vibration. Minute shifting of socket contacts and IC pins can make all the difference in the world between a good connection and an open. And contacts and pins that are hot tend to oxidize, particularly with age and humidity - sometimes simply by removing a socketed part and pushing it back in resolves the problem.

As electronic parts heat up, they slow down, and output lower voltages and more noise. Often, simply removing the cover from the offending subsystem can change temperatures sufficiently to eliminate the problem (until the cover is replaced). If your system is intermittent and consistently either malfunctions or straightens itself out as a function of equipment or room temperature, and/or ON-time, use these methods to ferret out the problems:

(1) Use circuit chillers in aerosol cans. They come with a spout for localized dispensation. These coolants are non-conductive and designed for electronic troubleshooting purposes. If you don't have circuit chiller, you can use a plastic straw to blow on the parts. For larger areas, use a blow drier (set for no heat) and a plastic bag with ice cubes.

Carefully remove the cover of the offending subsystem, then turn it ON. When the problem occurs, spray the coolant on suspect boards, ICs, connectors, electrolytic capacitors, switches, moving mechanical parts (drives, but not on the Read/Write head). Any functional or error-message changes indicate that the part sprayed is the offending part (or close to it). Carefully resolder the bad part (use fresh solder and flux, and clean-up excess flux with alcohol). Do the errors re-occur? If so or the part is damaged, deformed or discolored, replace it. If the errors still persist, suspect a cracked board trace or other defective part near the part.

(2) Low humidity can also be a problem because it can result in a build-up of static charges. Symptoms can be similar to thermal problems. If the computer room is warm and dry (particularly in winter), use a room humidifier. Never operate computer equipment when the relative humidity is less than 10% or greater than 90%. Static charges can result in either temporary or permanent malfunction, and is a major reason for circuit failures.

CAUTION: When testing any "live" (powered) circuit board with line VAC or higher voltage on it, avoid skin and metal contact with these sections and components, and with anything near the CRT. Do NOT wear rings or metal jewelry. Work with only one hand inside the electronics area. Keep all liquids and metal objects away. Work only when you are alert and can concentrate, and when there are others around you.

MECHANICAL METHODS

An effective method to troubleshoot both intermittent and dead systems is by using mechanical methods (with or without thermal methods). Mechanical methods consist of applying GENTLE pressure, motion, shock or vibration to parts and to the PC boards themselves. Don't use your finger, hand or anything conductive. Use a wooden stick, insulated rod (ex: TV alignment tool), or small wooden-handle mallet or screwdriver handle, to gently tap on, apply gentle pressure to, or move around the suspect parts and their connections. Any functional or error changes pinpoint the offending part. Mechanical methods are particularly useful to ferret out shorts or opens caused by poor solders and conductive bridges. Some techniques:

(1) Whenever I work on a totally dead system, after verifying that the problem is not caused by something obvious like bad power or a bad connection, I pick the unit up, turn it upside down (holding only the chassis), and vigorously (but not violently) shake it, slapping it back in the process. (The last time my wife saw me doing this, she sarcastically stated, "You must be an engineer!"). I then verify and firmly restore all connections, reconnect it up, turn power ON again, and see what happens. This is crude and can be risky, but it has miraculously cured dead systems by dislodging solder balls/splashes/hairs, burrs and loose screws. If the equipment is heavy, such as an IBM-PC expansion interface, you MUST be a physically strong person.

(2) Gentle line wiggling is another excellent technique. Frequently, operation changes simply by wiggling cables and lines. This method spots bad connectors, cables, contacts, leads and solders.

DISK SERVICE MANUAL III DIAGNOSTICS & TROUBLESHOOTING IV

(3) Applying gentle pressure can also help detect problem areas. Apply the pressure, using an insulator (wooden stick, screwdriver handle, etc.) to various parts of the system, to uncover bad solder bridge shorts (ex: solder balls/hairs/splashes, metal burrs) and open contacts. I start applying the pressure at the corners of the board. I then work inward. By doing this, if pressure does reveal a bad spot I can zero-in on it.

(4) A similar technique is to use this same insulator to gently tap various areas of the board and components. This can free an offending short, or re-establish a lost contact.

POWER SUPPLY VOLTAGE CHECK

Use your voltmeter to verify and adjust all DC power supply voltages. Are they steady or fluctuate? NOTE: DC voltmeter measurements do NOT uncover problems due to noisy power supplies (logic probe or oscilloscope is required). Power supply noise comes from the AC line, the AC regulator, or from a DC power supply. Very noisy AC voltage and mild brownouts are frequent in many areas, and can vary during the day or on a random basis. Spills, overheating, solder defects, static discharges, impacts, a high voltage AC spikes are the primary causes of damage to electronic components and circuits.

Another major reason for power supply problems are the large cheapo electrolytic capacitors that they use. With age and vibration, they either open-circuit or intermittently short-circuit. Arcs, bulges, holes or cracks call for immediate replacement. Try measuring their resistance (disconnect and discharge first) using a FET (high input impedance) multimeter while gently moving them. The meter should indicate a normal, gradual charge-up. And the charge should hold for a few minutes.

Carbon resistors and pots. also deteriorate with age. More often than not, spraying contacts on an offending pot., switch, relay, connector with contact cleaner (ex: GC SPRA KLEEN), will completely clear up its problems.

If you can't adjust a power supply voltage high enough to meet specs., the problem could be a short or intermittent in the logic servo motor or power supply board. Disconnect the drive's power supply connector (usually P2/J2). Try again. If good, you've got short in one of your boards. If still bad, temporarily disconnect the electrolytic capacitors. If now good, replace the shorted capacitor. If still bad, pull out the power supply schematic and work backward within the power supply. A failure of a 7805 (+5 VDC), 7812 (+12 VDC), or 7824 (+24 VDC) IC is a common cause for a near-zero DC voltage output. Its failure is usually caused by a short-circuit somewhere in the drive. A power supply short in the logic or servo motor board could be caused by any component on that board (usually by a capacitor), by a solder hair/ball/splash, by a stray piece of metal or other conductor, or by two leads accidentally pressed together (recent handling?).

OTHER VOLTAGE CHECK

Once you've located the probable section where the problem is, and you've used the other techniques to no avail, then start checking individual pin voltages. Most systems are TTL. Except for TTL +12 VDC that goes to the stepper and spindle motors and their electronics, peripheral drivers (ex: +12 VDC, -12 VDC to RS-232C), and some memory ICs (+12 VDC, -5 VDC), virtually all circuit voltages are TTL 5 VDC.

By measuring TTL IC pins that are connected to other electronic parts, one can easily tell whether or not a TTL IC is functioning correctly. No voltage should be between 2 and 3 volts in magnitude. ("0" outputs are usually 1.5 volts and less, while "1" outputs are usually 3.5 volts and more). 2-3 volts is a "floating" output strong indication that that part (and/or one of the others connected to that pin) is bad. Check the other pins and leads connected to it, if any of the voltages differ then the problem is either a disconnection between the part and the board (bad solder or contact) or broken board trace.

Use a logic probe to verify that the voltage is not a pulse voltage that's just averaging out to 2-3 volts. We strongly recommend the one we designed, see our ULTIMATE LOGIC PROBE plans.

All grounds should be at zero volts and all power pins pins and leads should be rock-steady at the Vcc supply voltage. Also, all pins not directly connected to either ground or Vcc are input, output, clock and control pins (some control pins may be purposely pegged to ground or Vcc - check for a direct connection). Also look out for

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 voltage 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 malfunctioning chips. An IC emulator consists of a dip clip test clip connected to a PC board consisting of a socket, a quad dual-input exclusive-OR gate (7486) and LEDs (10 ma). The socket holds an identical type IC as the DUT. All socket pins are wired directly to the test clip's contacts that correspond to the DUT pins EXCEPT DUT outputs. Outputs are wired to exclusive-OR inputs. The socketed IC outputs are wired to the other corresponding exclusive-OR inputs; which outputs are wired, (thru 1K ohm resistors) to the LEDs. The circuit is powered. If the DUT is good, its outputs will be identical to its socketed counterpart's and no LED will light. If the DUT is bad, one or more LEDs will light. You don't need to build an IC Emulator for each IC type. One with programmable socket pins will accommodate 100s of part types.

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 functional system, timing problems will usually occur only due to the aging of an already marginal IC, which, along with heat, cause increases in the propagation delay. Usually high temperature aggravates the problem and the marginal or failing IC can be discovered 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 voltages, waveforms and timing info. Also, you will require a logic probe, an oscilloscope (dual channel, 50 MHz, 10:1 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. 43. For APPLE drives, see A+, March and April 1985.

TROUBLESHOOTING GUIDE

Below is listed drive malfunction symptoms, followed by possible causes and recommended remedies. First, test with several diskettes to verify that the problem isn't caused by media or by inadvertent bad clamping. Then clean the Logic Board and system connectors, and verify or replace the drive cable. Also, properly clean and lubricate the drive. If problems still persist. Unless otherwise noted, most of the repairs 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 connections. - Switch drives to test controller Drive Select function.
- (D) **Disconnected Index Sensor:** Verify connection to logic board (usually P10).
- (E) **Maladjusted Index Sensor:** Repair or replace index sensor LED and-or photosensor.
- (F) **Defective Index Sensor:** Replace index sensor LED and-or photosensor.

- (G) **Bad Index Sensor Electronics:** Replace or repair logic board.
- (H) **Poor Compliance:** Replace felt pressure pad, adjust upper arm assembly, repair/replace head loader or clamp assembly, replace head carriage assembly, repair/replace logic board.

(I) **EMI (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) **Spindle Speed Out of Adjustment:** See speed adjustment chapter.
- (B) **Defective Belt:** Verify that the drive belt is not worn, frayed, broken, slipped, 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.

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

(3) WILL NOT SEEK OR RESTORE:

- (A) **Controller Malfunctions:** Verify controller Direction, Step and Select signals.
- (B) **Disconnected Stepper Motor:** Verify connection to logic board (P12).
- (C) **Defective Stepper Motor:** Verify that a guide rail defect, 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.

(4) NO WRITE:

- (A) **Controller Malfunction:** Verify Write Enable, Drive Select, and Write Data signals.
- (B) **Head(s) Or Write-Protect Switch Disconnected:** Verify connections to head(s) (P5, P6), and to 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 Compliance:** (See (1) (H) above.)
- (G) **EMI:** (See (1) (I) above.)

(5) NO READ:

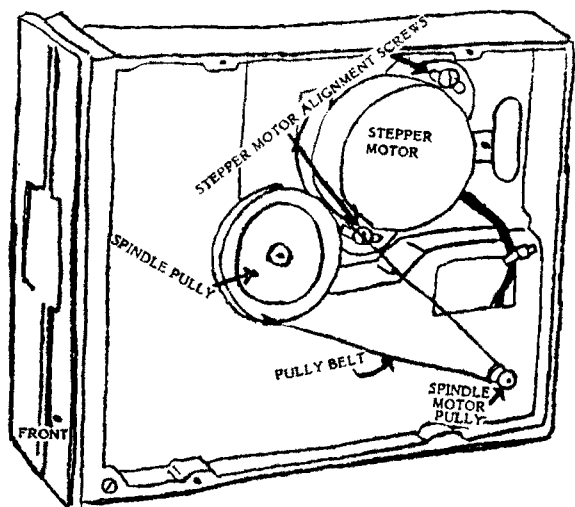
- (A) **Controller Malfunction:** Verify Write Enable OFF, and Drive Select.
- (B) **Head(s) And-Or T00 Sensor Misalignment:** See alignment and miscellaneous repairs chapters.
- (C) **Head(s) Disconnected:** Verify connection to head(s) (P5, P6).
- (D) **Defective Head(s):** Replace head(s), or module assembly.
- (E) **Defective Logic:** Replace or repair logic board.
- (F) **Poor Compliance:** (See (1) (H) above.)
- (G) **EMI:** (See (1) (I) above.)
- (H) **Data Separation (Error Prone Upper Tracks):** Repair or replace controller or FDC. - Isolate drive cable from noise (reroute).

(6) FRONT PANEL LED INOPERATIVE:

- (A) **Interface Not Enabled:** Verify Drive Select, and other jumper 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.

(7) NO T00 SENSOR INDICATION:

- (A) **Defective SEEK:** (See 3) 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.

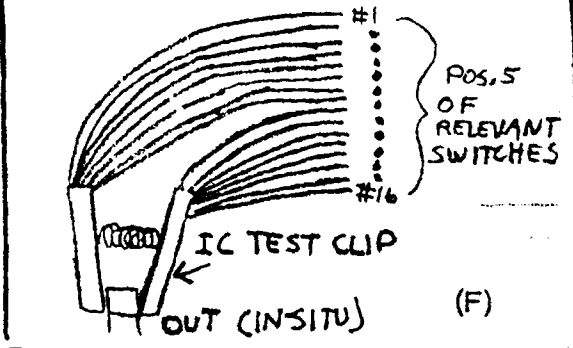
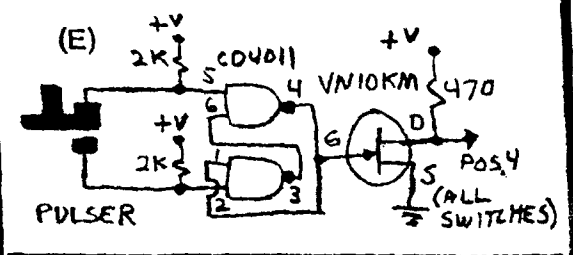
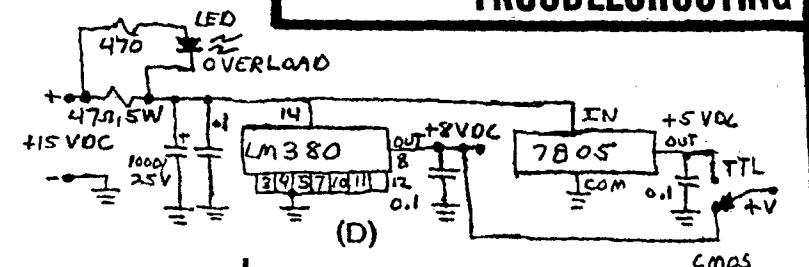
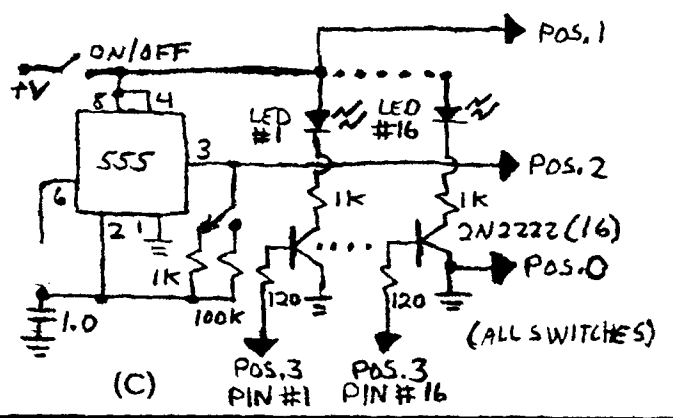
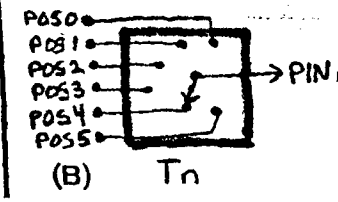
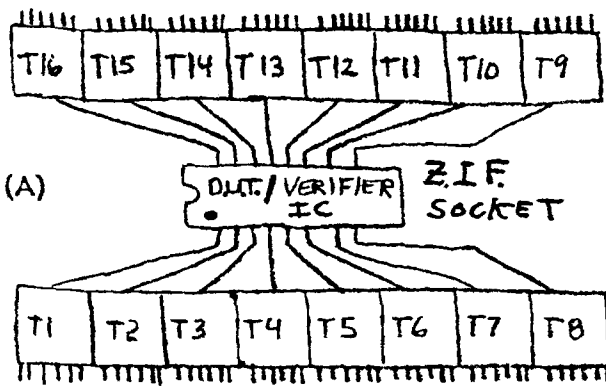


APPLE DRIVE

DISK SERVICE MANUAL III

IV - 5

DIAGNOSTICS & TROUBLESHOOTING



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.

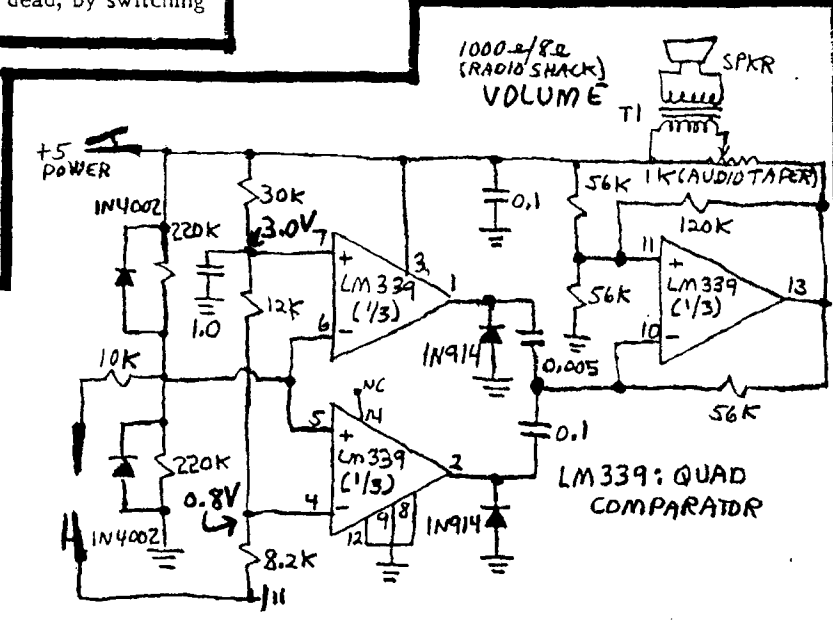
(F) Each IC Test Clip pin is wired to its respective TW switch Pos. 5 pin. This TW switch position is only used when the DUT is in-situ (on the circuit board) and is being compared with an identical and known good IC ("Verifier IC"). All TW switches corresponding to output pins are then switched to Pos.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

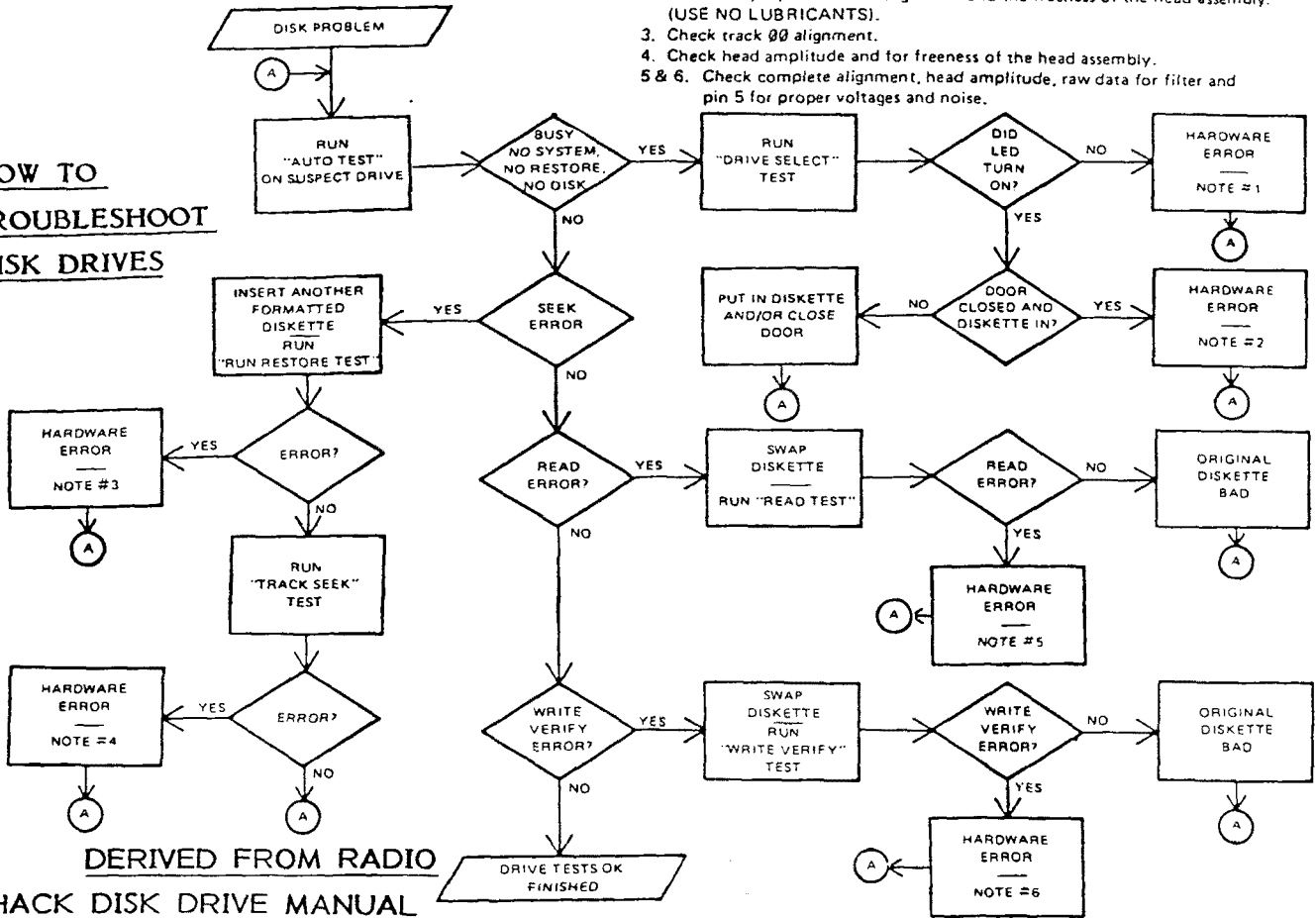
Consumertronics Co.
2011 CRESCENT DR., P. O. DRAWER 537,
ALAMOGORDO, NM 88310

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 0.8- volts. CMOS highs and lows depend upon supply voltage (Vdd). At 5 volts Vdd, High = 3.5+ volts, Low = 1.5- volts. At 10 volts Vdd, High = 7+ volts, Low = 3- 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.

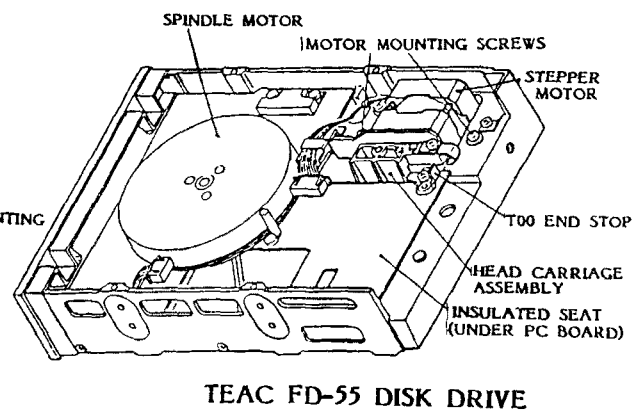
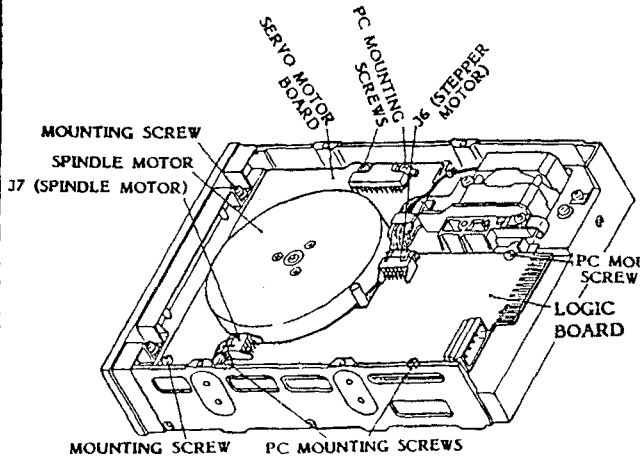
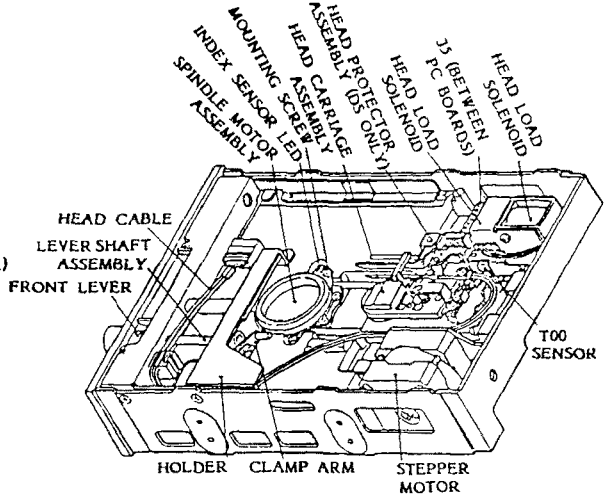
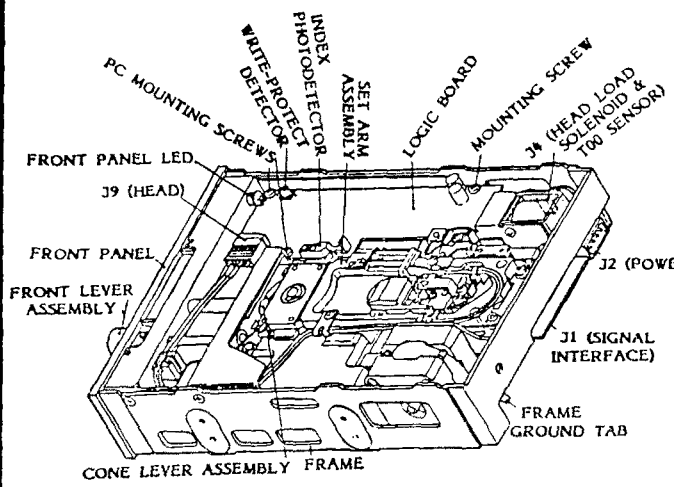


**HOW TO
TROUBLESHOOT
DISK DRIVES**

- NOTES: 1. Check select function-check dip shunt and cable.
 2. Check for proper track 00 alignment and the freeness of the head assembly. (USE NO LUBRICANTS).
 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



TEAC FD-55 DISK DRIVE

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 rail(s) and mechanical linkage to the stepper motor. (C) Spindle motor and pulley lubrication. Less of a factor is stepper 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).
- (2) Clean the drive Read-Write head(s) and felt pressure pad (frequent).
- (3) Clean, and/or align the index hole optical coupler(s) IF required (rare).
- (4) Verify the write-protect notch detector(s), and adjust IF required (rare).
- (5) Verify drive speed, and adjust IF required (frequent in some drives, impossible in others).
- (6) Verify alignment of Read-Write head(s), and align IF required (occasional-to-rare).
- (7) Verify the T00 sensor and T00 end stop, and adjust IF required (rare).
- (8) Inspect for electronic defects, and correct IF required (rare).
- (9) Clean drive connectors (frequent if not gold-plated, rare if gold-plated).

There is a subtle difference between the meaning of "align" and "adjust." "Align" means to set precisely to an absolute position even though a sloppier setting would still function. "Adjust" means to set to a position so that a function (ex: T00 sensor switching) reliably occurs (a 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 drives if located in a computer or expansion interface. Use proper grounding, the right tools and supplies, and never rush.

- (1) **SCREWDRIVERS:** One medium blade, at least 4" long. One fine blade, at least 6" long. One medium phillips, at least 4" long.
- (2) **OTHER TOOLS:** Allen wrench set. Long-nose pliers. Diagonal cutters. Small wooden mallet. Small hand mirror. Pen-light with extension. Soldering iron.
- (3) **SUPPLIES:** Cotton swabs (6" stem, JASCO AUDIO ACCESSORY or equivalent). Blank and formatted diskettes. DOS diskette. Bath towel or cushion. 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, 1:10 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 dispensed 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 surer and easier dispensation in hard-to-reach spots, such as behind the large pulley and through the holes we've made in the glassine window in TANDON drives. It is an acceptable lubricant if ambient temperature is below 60 degrees. However, WD-40 and 3-IN-1 oils do tend to dry out, particularly in hot and dry climates, and should not be used if you schedule drive maintenance more than 6 months apart.

DISK SERVICE MANUAL III V - 1

One expert recommends BREAK-FREE CLP, a teflon-based lubricant made by SAN/BAR CORP., P.O. Box 11787, Santa Ana, CA 92711. Another expert recommends CHEMTRONICS CHEM-OIL and MARVEL'S MYSTERY OIL (auto supply stores - great for cars too). We also recommend the hypodermically-dispensed teflon-based ARCHER's Precision Oiler (RADIO SHACK), SINGER Sewing Machine Oil, and WHITE Sewing Machine Motor Lubricant (SINGER). CAUTION: NEVER lubricate plastic moving parts with petroleum-based oils as the oil will dissolve, soften or warp the plastic. We recommend vegetable, fish or baby oil.

OTHER CHEMICALS

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 cleaning, we use long, cotton swabs, SPRA KLEEN (GC) and 91% alcohol. Suitable spray cleaner and swabs are available 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.

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 dispense the oil only 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. A good method to carefully remove dirt and debris is to use small pieces of electrical tape or tacky wax (see above) to pick them up.

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 removed glassine 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 bar(s). Prior to oiling them, wet a cotton swab with alcohol and wash down the guide rail(s) (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 around 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 door closure 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.

As far as we know, all drive stepper motors have sealed ball bearings. However, spindle motors have brass bushings at both ends, and must be lubricated at least once a year or once per 200 hours of operation. The rear of the spindle motor usually fits into a (colored) plastic cup. Removal of the Logic Board may be required to slide this cup off to apply the lubricant.

CLEANING

READ-WRITE HEAD

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

The easiest and fastest - yet effective way - to clean heads and pads is by using a wet-type diskette-like head cleaner. (CAUTION: Never use a dry-type diskette cleaner!) We recommend the PERBATIM 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 and pads without doing so. I use long stem 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).

PULLY

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 a drive, with no inserted diskette, appears to be on target, insert a diskette. Does the drive spindle 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

DISK SERVICE MANUAL III

MAINTENANCE

V - 2

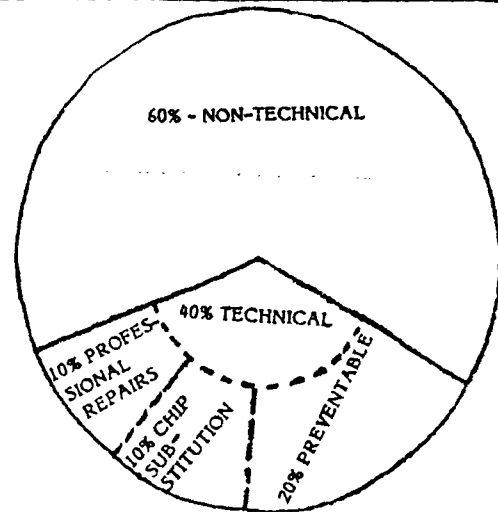
contacts tarnish, with increasing voltage drops resulting at each connection. Eventually, the "1" voltages arriving at the expansion interface are not high enough to be consistently interpreted as "1"s, and data garbage, erratic behavior and lock-up result. Some drives, particularly external ones, can 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 CRAMOLIN. 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. (C) and (D) are not visible. (A) and (B) are. Rotate the diskette within its shell and inspect for dirt, grime, 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 center hole between a finger and thumb and gently rotating the diskette's shell with the other hand.



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!

Consumertronics Co.

2011 CRESCENT DR., P. O. DRAWER 537,

ALAMOGORDO, NM 88310

FM VS. MFM ENCODING

FM (SD), 80 Track, DS (SHUGART SA-465):
 BYTES: 500,000 unformatted (3,125/track). IBM 16-Sector
 Format: 327,680 (2048/track, 128/sector). Non-IBM 10-Sector
 Format: 409,600 (2,560/track, 256/sector).
 TRANSFER RATE: 125,000 data bits/sec., (15,625 bytes/sec.).
 RECORDING DENSITY: 2,961 bits/inch.
 FLUX REVERSALS: 5,922/inch.
 COMPENSATION: Write: None. Read: Automatic (T64 - T79).

MFM (DD), 80 Track, DS (SHUGART SA-465):
 BYTES: 1,000,000 unformatted (6,250/track). IBM 16-Sector
 Format: 655,360 (4096/track, 256/sector). Non-IBM 10-Sector
 Format: 819,200 (5120/track, 512/sector).
 TRANSFER RATE: 250,000 data bits/sec., (31,250 bytes/sec.).
 RECORDING DENSITY: 5,922 bits/inch.
 FLUX REVERSALS: 5,922/inch.
 COMPENSATION: Write: 0.125 us. Read: Automatic (T64 - T79).

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) pulley. "Belt" refers to the drive belt. "Drive speed" refers to the drive SPINDLE speed. Spindle and motor speeds are the same in drives that use direct-drive 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 8" format for compatible data transfer from the increasingly unpopular 8" systems. Most microfloppies 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 enclosure. Always verify that all connectors are firmly and square-mated 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 gets 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-amp. It can be tested by 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 wired in series. The values of the new resistor and pot. should be about 80% and 40%, 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, because dense formats (soft-sectored system) must interpolate sector positioning to a greater degree of accuracy. Systems, such as DIGITAL EQUIPMENT's RAINBOW, provide very little extra buffer space at the end of tracks, and are very intolerant to overspeeds. Some manufacturers have purposely set their drive speeds low to format more sectors per track, and to frustrate file transfer between them and other similar systems. Re-adjusting drive speed up-to rated speed makes the drives unusable by these systems.

Drive speed out-of-adjustment usually combines with radial and azimuthal misalignment, clamping (eccentricity), hysteresis and Read Sensitivity problems to produce errors. That's why two drives of the same model in the same system may vary widely in their tolerances to speed out-of-adjustment.

In TANDON drives, the speed pot. is blue and is located, facing towards the logic board, on the servo motor board (rear of drive), and is difficult to reach. In our TANDONS, we've drilled a 3/8"

DISK SERVICE MANUAL III VI - 1

hole in the bus extender board to get a better adjustment angle. In TEXAS PERIPHERAL drives, the speed pot. is on the logic board, left, facing front. In MPI drives, the speed pot. is also on the logic board. See photos for placements of some speed pots.

Do not adjust a pot. on the logic board unless you are certain that it is the speed pot. - particularly a pot. with loctite or paint on its adjustment screw - unless you keep track of your precise starting point. On some drives, the speed pot. can be reached through a hole in the bottom or back of the drive, others require enclosure removal. Be sure to use a plastic adjustment tool, or a screwdriver with all of its shaft covered by heat shrink tubing (except the tip) so you don't accidentally cause a short circuit. In most drives, CW increases speed, CCW decreases it.

SYMPTOMS & CAUSES

The drive may be grossly out of speed adjustment when DRIVE or DEVICE NOT AVAILABLE errors result. The drive is less severely out of speed adjustment when LOST DATA errors result during a Read-Write. This means that the CPU can't catch the data as fast as the controller is taking it off the diskette. Lesser degree of speed-out-adjustment may cause or contribute to other Read-Write type errors. Alignment, Read Sensitivity, hysteresis and clamping errors are all aggravated by drive speed out of spec.

In most drives, the motor speed is not affected by AC line frequency or DC voltage level (up-to about + or - 3 volts). However, as the motor continues to operate, it may slow down due to its control electronics heating up.

Instantaneous speed variations are due to non-uniform wear, slipping or binding in the motor, belt, and spindle assembly (pully, hub bearings, hub) - the belt being the most likely culprit! It may be oily, dirty, deteriorated or stretched - any of which can cause slippage. If the belt is contaminated, use a Q-tip dipped in alcohol to run over the belt and pulleys to clean it. To test to see if the belt is stretched (rubber belts), first clean it and the pulleys as above, and allow to dry. Then momentarily arrest the pully by finger pressure on it, and if the belt slips off, it is stretched. Visual inspection quickly reveals deterioration. If the belt is either deteriorated or stretched, it must be replaced. A deteriorated belt can be temporarily re-used if flipped over. After replacing or cleaning a belt, always re-adjust the drive speed.

PROCEDURES

CAUTION: Before speed-adjusting 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 #) 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 some cases, a drive with a out-of-spec. speed Writes diskettes that are un-Readable to drives with good speed. If you don't, expect that those files will become permanently inaccessible after you've adjusted speed. Some folks purposely maladjust 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.

Before adjusting speed, inspect, clean and lubricate your drive. We prefer to use drive speed 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 underwent a drive speed modification, you have a turbo version, the drive speed software was not designed for your model, or there is a defect in your computer's clock or a software bug.

Drive speed can also be easily adjusted without any special software. First, remove drive enclosure, then operate the drive with motor running, until warm. In most drives, the pully is connected by a belt to the motor. The pully is about 2.5" across. It should have two concentric zebra-like patterns on it. The outer pattern is for 60 Hz AC power systems, the inner pattern is for 50 Hz (foreign). If your drive is an older one, the pattern may have fallen off (or been removed in a shop).

8" drives do not have this pattern. Neither do modern, beltless drives (ex: SHUGART 465 and TEAC 55). Neither does the NEWTRONICS drives used with COMMODORES (ALPS drives have the zebra pattern). If your 5" drive uses pulleys and does not have this pattern, you have our permission to photocopy one of our drive photos with a zebra-patterned pully, cut-out the zebra pattern and then glue or tape it onto your drive's pully. Regardless of your 5" drive's pully size, the pattern will be correct (24 bars = 60 Hz, 20 bars = 50 Hz). For 8" drives (and 5" drives that spin at 360 RPM), the 5", 50 Hz pattern (20 bars) is correct for 60 Hz.

Chapter VII: R-W HEAD ALIGNMENT

In this chapter, "sensor" means the T00 sensor or "Home Switch" (a microswitch or optical coupler), and "end stop" refers to the T00 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 unless it has definitely slipped! If you loosen the collar, retighten it 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 right 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

Occasionally, 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

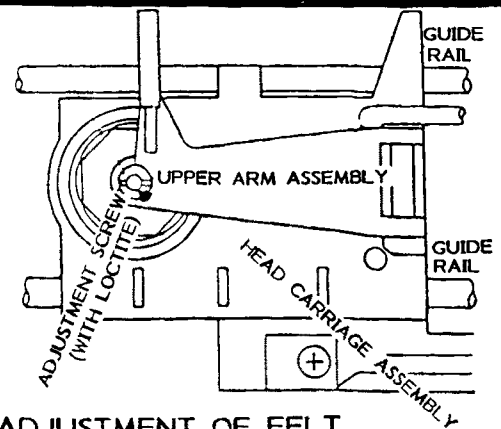
time, and with IN and OUT STEPS. Frequent but random CRC and parity type errors, and lack of reliability in Reading a diskette Formatted by it or another drive results. More than anything else, what separates poor Read Sensitivity from misalignment is the inability of the drive to Read the diskettes 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 pad, 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.

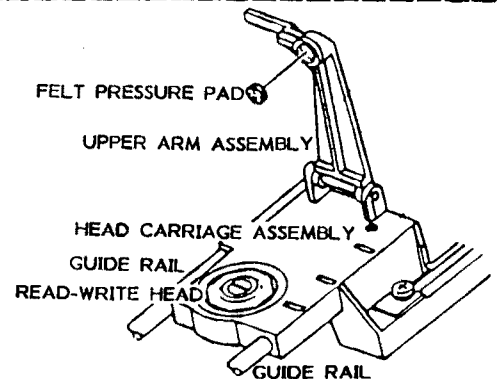
HYSTERESIS

"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 T00 end. The difference between where the head settles in the two approaches is ideally zero, 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.

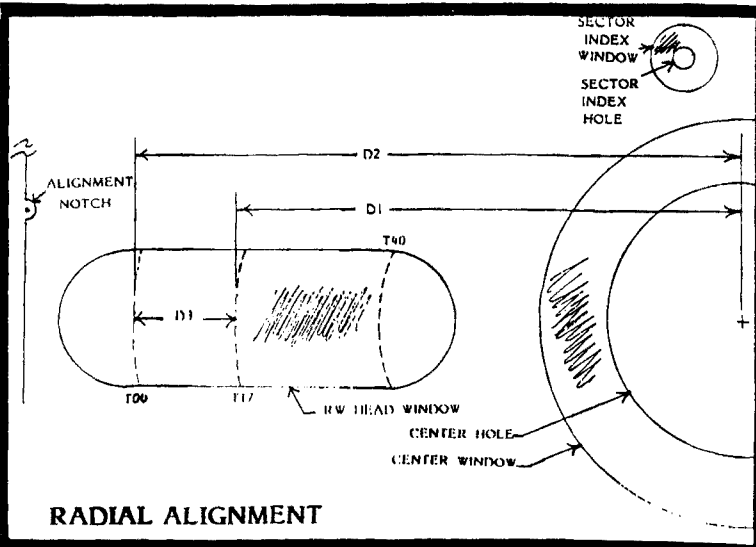
A thin film of oil on clean guide rail(s) and stepper motor bearings helps make up the difference in looseness, and can, by itself, cure a hysteresis problem. If the slop is bad, you should consider scraping the drive as the replacement parts may exceed the cost of a new drive.



ADJUSTMENT OF FELT PRESSURE PAD (TEAC CORP.)



REPLACEMENT OF FELT PRESSURE PAD (TEAC CORP.)



RADIAL ALIGNMENT

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 3.2 mils. Drives with excellent Read Sensitivity and very small eccentricity can tolerate as much as 5 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 these cases, unless the cause is obvious and correctable by you (ex: broken door, T00 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 caused by either dropping the drive or 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 toleranced 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) The gradual wearing away of the tight tolerances in the module assembly, 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 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

VII - 2

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 Read-Write head.

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 may work fine when cold but loses dependability when warm (or vice-versa) due to minute but significant thermally-induced dimensional changes.

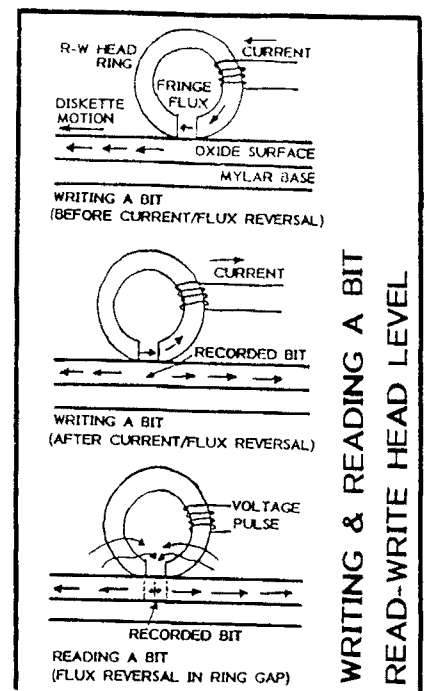
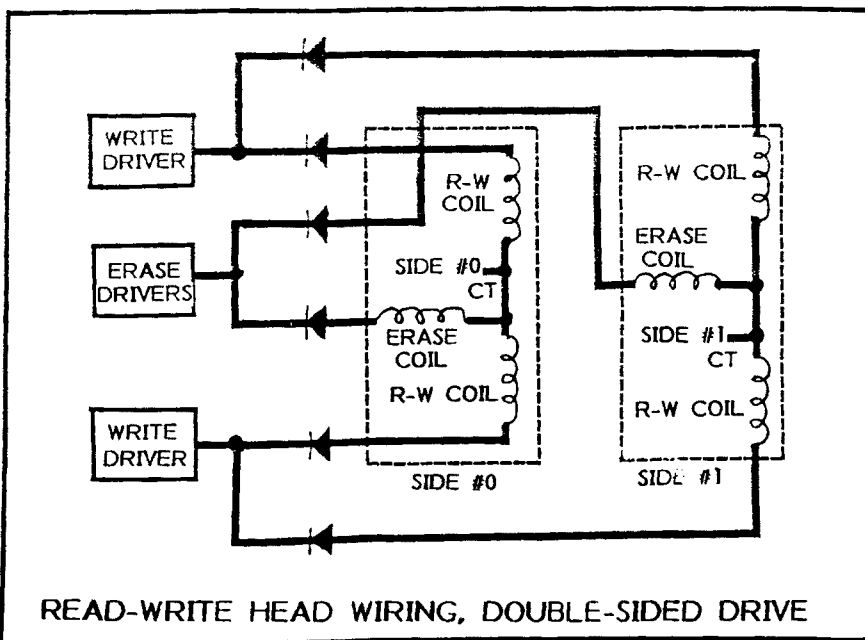
In single drive systems, minor misalignment may not be a problem. Only when it must do a READ/WRITE operation using a diskette Formatted by an aligned drive will problems develop.

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 seldomly 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 in 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 T00 (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).



Load a known good BASIC program into the computer from a good (aligned) drive. Do a LIST to observe that the program Loaded right. Then Save the program to the bad drive under a new name. Load the program under its new name. Do a LIST to verify a correct LOAD by the bad drive. Then do a LOAD and LIST with the bad drive-Formatted diskette inserted into the good drive (or vice-versa). If LOAD and LIST works fine with the bad drive diskette in the bad drive but doesn't work with it in the good drive, then probably the only thing wrong with the bad drive is that it is out of alignment.

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.

T alignment cam screw uses a cam principle - a large rotation is translated into a small linear displacement. And the stepper motor body is much greater in circumference than the linear travel of the head carriage assembly caused by rotating it. Motor-aligned drives are easier to align than cam-aligned drives. Using either method, manual rotational movements are translated into much finer head linear displacements.

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 pulley, 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 looser than snug. 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 #) 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 un-Readable to drives with good alignments. If you don't, expect that those files will become permanently inaccessible after you've made your alignment. Some folks purposely misalign a drive(s) in their system to prevent the theft and unauthorized use of files.

Drive alignment requires concentration, steady nerves, fine touch and excellent eyesight. Do not try to align a drive if you're not up to it, rushed or distracted, or don't have the proper tools.

Before starting an alignment, be sure that the sensor and end stop are functioning and tight. Note that most factory 40 Tk (48 TPI) drives can be formatted to T42 and most 80 Tk (96 TPI) drives to T84 because the sensor is set back as far as it will go. A bad practice of some drive shops is to adjust the sensor so that the maximum track # is now 40 or 80 (prior to alignment). This can make un-Readable the last two (or four) tracks you Formatted before the drive was aligned!

Although you NEVER Write to a 48 TPI diskette with a 96 TPI drive, 96 TPI drives can Read 48 TPI diskettes (the converse is not true) if your DOS or software permits drive double-stepping. The preferred way to align 96 TPI drives to read 48 TPI diskettes is to align T01 of the 96 TPI drive with T00 of the 48 TPI drive.

Professional drive shops normally align the head(s) to T16. In our method, we use the Directory Track, which, in 48 TPI drives is usually T16, T17 or T01 (depending upon the system). There are two methods of finding tracks above T00 once T00 is found:

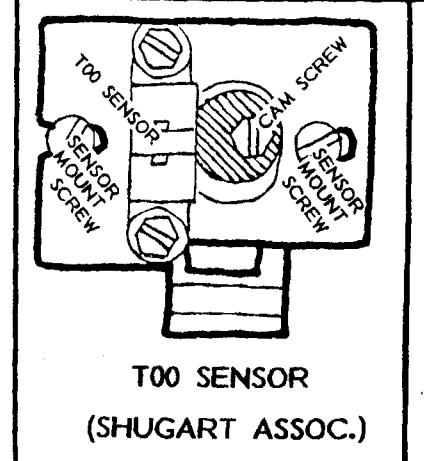
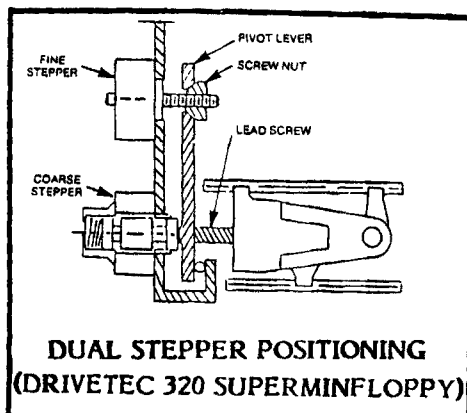
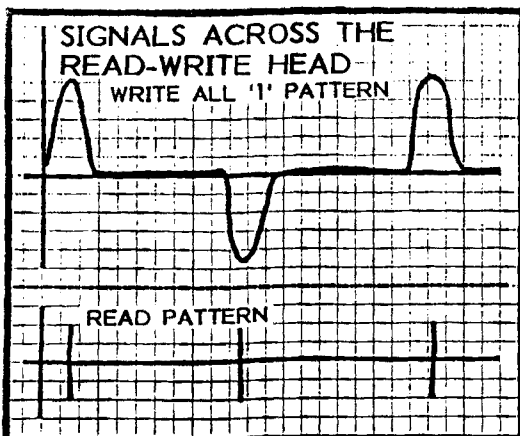
(1) **Formatted Diskettes:** Step the head in a number of times less than the target track #, without updating the track # in the FDC's track register, then order the FDC to Seek the specified track # by reading the diskette headers. You don't need to do it this way if you have a disk utility that will tell you which tracks each of a diskette's programs occupy. By designing a program or data file to occupy just less than one track, and Saving it to the diskette 40 (or 80) times, each time under a different name (ex: "Prog07"), you can then select whatever track you want to align to by Loading the program residing on it, with the exception of the directory and boot tracks.

(2) **Unformatted Tracks:** Step the head in the exact number of times equal to the target track #, fill the track register with the target track # and then issue a Write command for the target track to force the drive to Write the track header onto the diskette.

Some professionals like to be more thorough by verifying alignment of a middle track to T01 and an upper-end track, both which can vary slightly from the alignment to T16 and each other due to small differences in stepper motor incrementations and hysteresis factors. T01 alignment is more critical than any track above the Directory track.

There are three methods used to align drives: (A) Cat's Eye (requires expensive and complex equipment and software but works with all drives). (B) DDA/DDT software and diskettes (requires an expensive program for each drive type). (C) Trial and Error (takes longer but also works with all drives). Since (A) and (B) are expensive and drives need to be aligned seldomly, if ever, (C) is the preferred way for most people, and described herein. The Trial and Error method can be accomplished using the simple alignment circuit, see figure, or by the "feel" method described below.

To correct the misalignment, turn computer system power OFF. Remove the drive's enclosure. Be sure connectors are all firmly seated. Then turn system power ON. Allow drive and system electronics to warm up. On either side of the drive (or both sides in DS drives), in about the center of the drive, one can see the drive head carriage assembly. It may be visible inside a compartment with a glassine cover (**TANDON**). (Don't remove this cover for alignment



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. Do some DIR :Ns. If errors continue, adjust the motor body or cam screw position about 1 degree CW. Do some DIR :Ns. Repeat the CW adjustment and DIR :N procedure until a good DIR :N occurs. If you get one, with a different color fine felt-tip pen, mark the motor or cam screw position with a fine line. Continue adjusting CW about 1 degree each time until the good DIR :Ns stop, then adjust 1 degree CCW. Again, make a fine mark with this felt-tip pen. Now continue adjusting CCW 1 degree at a time until you are exactly between the two alignment marks. The objective is to find the centerpoint between the first outer and inner misalignment positions.

NOTE: In motor-aligned drives, when you loosen the motor screws, maintain a comfortable hold on the motor. Do NOT allow the motor to sag or shake. Should you wish to remove your hand from the motor, retighten its screws to snug first.

Tighten all module assembly or motor screws to snug (NOT tight), and then retest with DIR: N. If alignment shifted (which sometimes happens), repeat the alignment procedure until a new correct aligned position is found. Continue the tightening of the screws and the retesting with DIR: N until the screws are all tight and you get reliable DIR: Ns.

The secret to loosening and tightening screws is to gradually loosen or tighten them in rotation. Similar to vehicle motor head bolts, if you completely loosen some screws while leaving others tight or vice-versa, you can warp the frame and cause misalignment. Do not overtighten the screws as they may shear off or warp the drive frame. Tighten just beyond snug. Then, after the alignment has been set and verified, apply fingernail polish to the edges of each screw.

If while proceeding with your CW adjustment you encounter a stop, return to near your start position, then turn the cam screw or motor body CCW about 1 degree per move until you either hit an alignment area, or you hit the stop on the other end. If, again, you hit a stop, repeat the CW movement. Continue to go back and forth at least 20 times before giving up. Don't get nervous or rushed.

Remember, track-to-track radial distance is only 1/48" (35, 40 and 77 Track), or 1/96" (80 Track), and, in most correctable misalignment cases, the amount of misalignment is only a few thousandths of an inch! **NOTE: DRIVES CANNOT BE ALIGNED BY SKIPPING TRACKS!**

After tightening all your screws, repeat DIR :N ten times. If errors are only occasional and are CRC or Parity types, then alignment is close. Loosen the screws just enough to make a few minute movements to home in on the aligned position with finer adjustments. Retighten the screws. Then use the procedure described earlier to determine whether the drive is still out of alignment (bulk-erase and re-Format the "bad" drive diskette). The "bad" drive diskette should now be Readable and Writable to the good drive and vice-versa.

The object of doing all these DIR :Ns is to keep the drive continuously Reading as long as possible. A better method is to do this using drive diagnostic software. Some DOSs can be configured to perform up-to 255 Read attempts before an error is called. Most DOSs provide an AUTO function. Do an AUTO DIR :N,DIR :N,...,DIR :N. Every time RESET is hit, an attempt is made to repeatedly Read DIR :N. Used with 255 Read attempts per LOAD, one can keep the drive continuously trying to Read a track for minutes. To restart, just hit RESET.

IF IT FAILS

If after 20 attempts, an alignment can't be made, or an aligned drive won't stay aligned (probable Read Sensitivity problem), suspect: Loose stepper motor/module assembly screws; loose contact between the stepper motor and the head carriage assembly; azimuth misalignment; bad stepper motor; loose collar; loose or mald-adjusted sensor or end stop; dirty, stiff or missing felt pressure pad; dirty or poorly lubricated guide rails; or worn or defective spindle or clamp. Inspect these areas, make applicable corrections, and attempt to re-align again. If you still can't find an alignment area, return the cam screw or motor body to its start position, retighten the screws, install the enclosure and seek professional help.

Keep in mind that an alignment is only as good as the mechanical condition of the equipment. The best factory alignment in the world won't correct excessive wear or mechanical or electronic malfunction. Drives that won't stay aligned or that have continuous problems accessing end tracks, are probably excessively worn, and should be scrapped.

DISK SERVICE MANUAL III

R-W HEAD ALIGNMENT

VII - 4

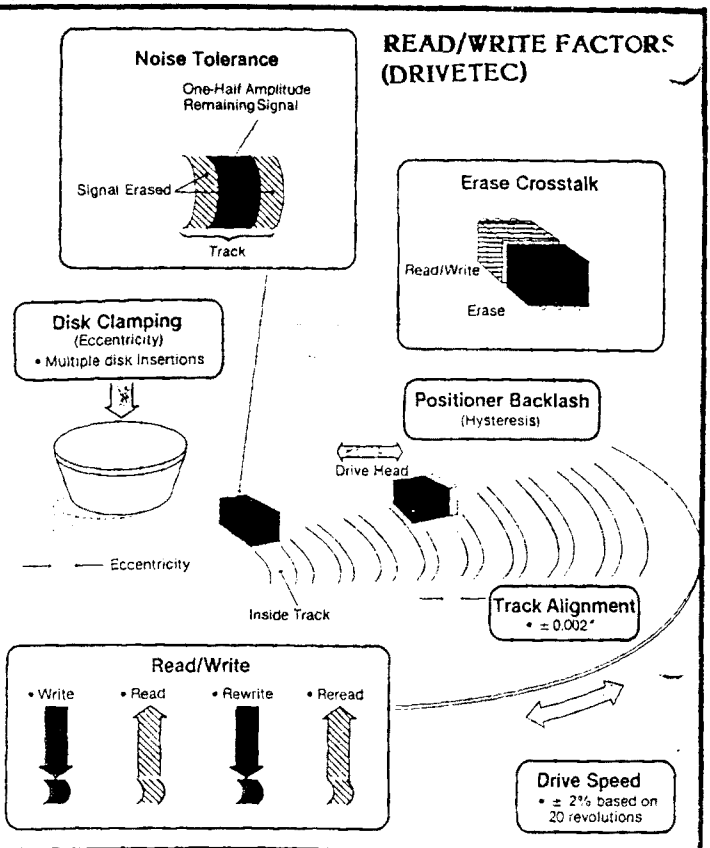
When finished with the alignment, turn the computer power OFF, and install the drive enclosure. With the drive fully assembled and reconnected, turn the system back ON and retest the drive.

Although a good drive diagnostic software package is not required to test drives, one like FLOPPY DOCTOR is highly recommended for the thoroughness and efficiency that drive tests are made. After all head alignments, recheck the end stop and sensor. In about 5% of the cases, either or both will have to be readjusted a small amount after an alignment.

T00 SENSOR & END STOP

Adjustment of the sensor outward should always be followed by a verification, and, if necessary, an adjustment of the end stop. A sensor adjustment is ALWAYS followed by a radial alignment.

Fortunately, neither the sensor nor end stop ever 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 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 T00 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 to prevent excessive head travel. APPLE and COMMODORE 1540/1541 drives (manufactured by ALPS and NEWTRONICS) are the most common.

CHAPTER CONTINUED AFTER PHOTO SECTION.

DISK SERVICE MANUAL

A

ABOUT THE PHOTOGRAPHS

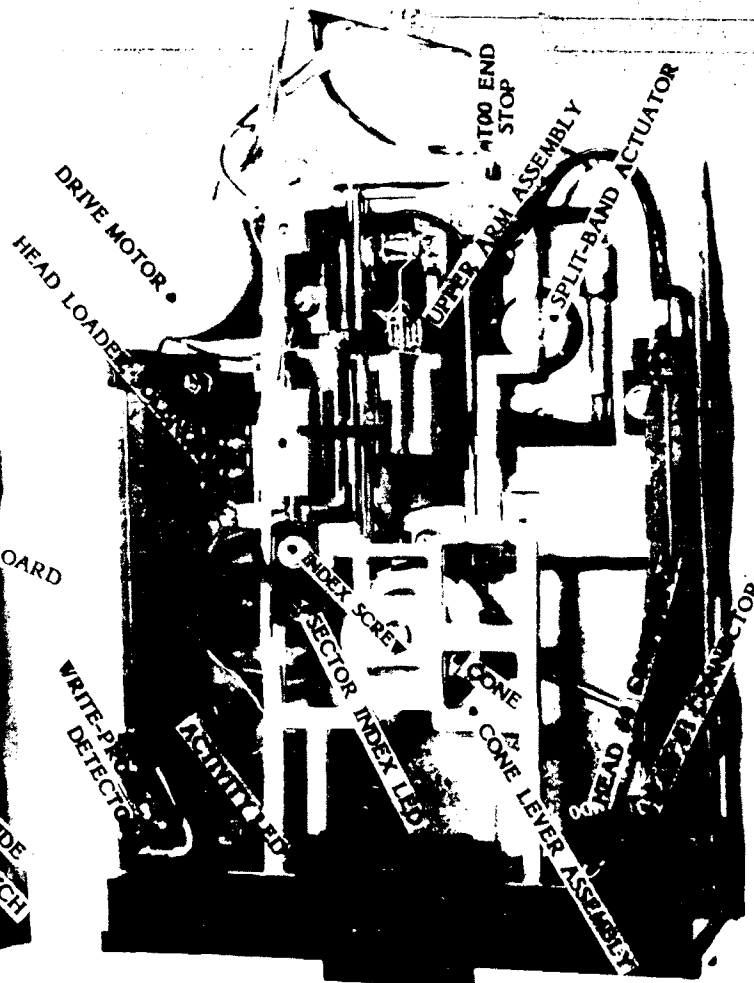
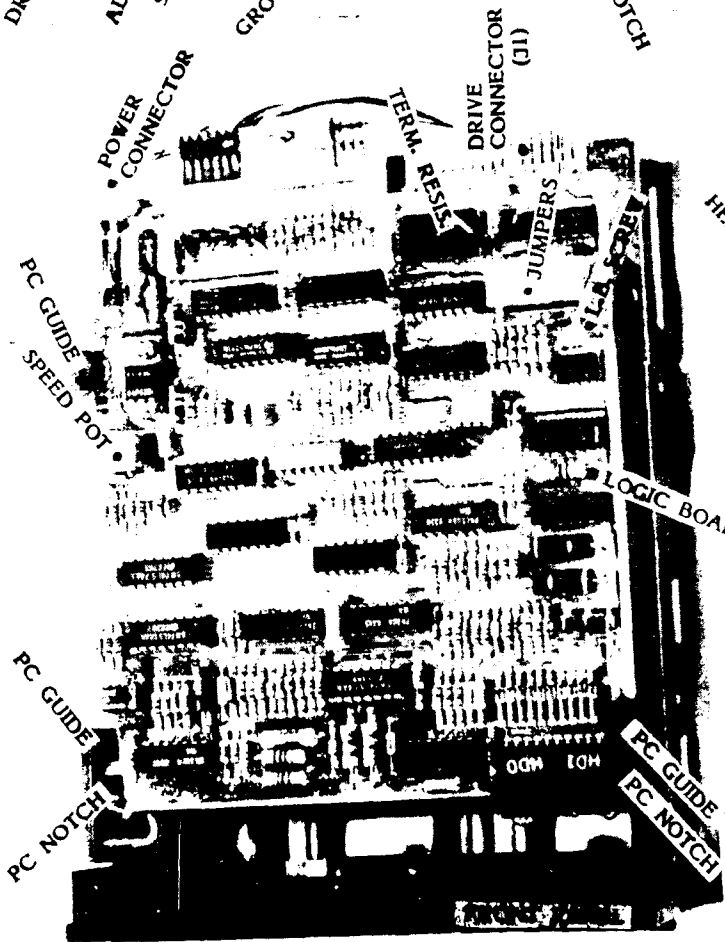
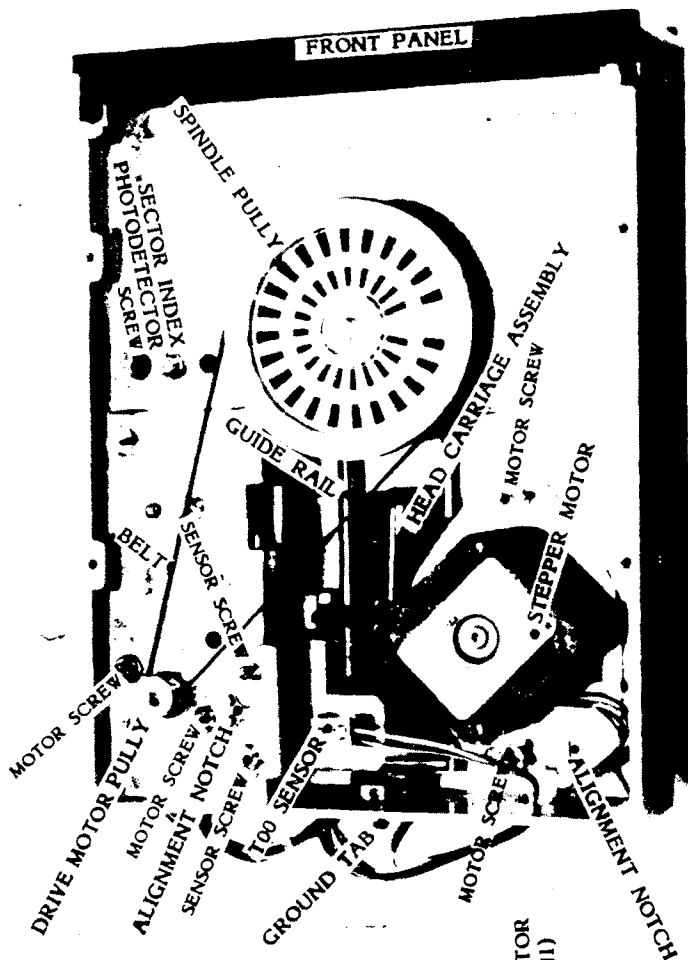
The drives pictured herein are representative of almost all floppy drives now in popular use. They include standard-bus 5", 8" and microfloppy drives, as well as some special drives (ex: APPLE, COMMODORE, SONY). There are hundreds of different drive models - far too many to picture every one here. If 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-Protect 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

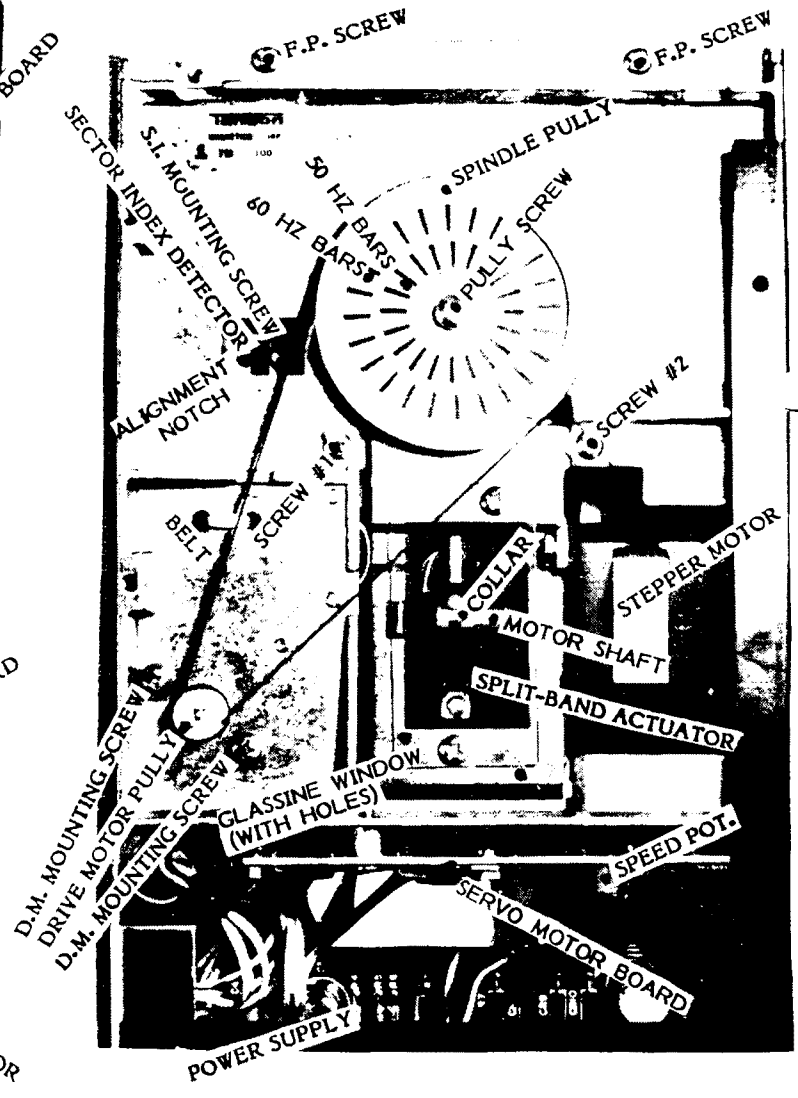
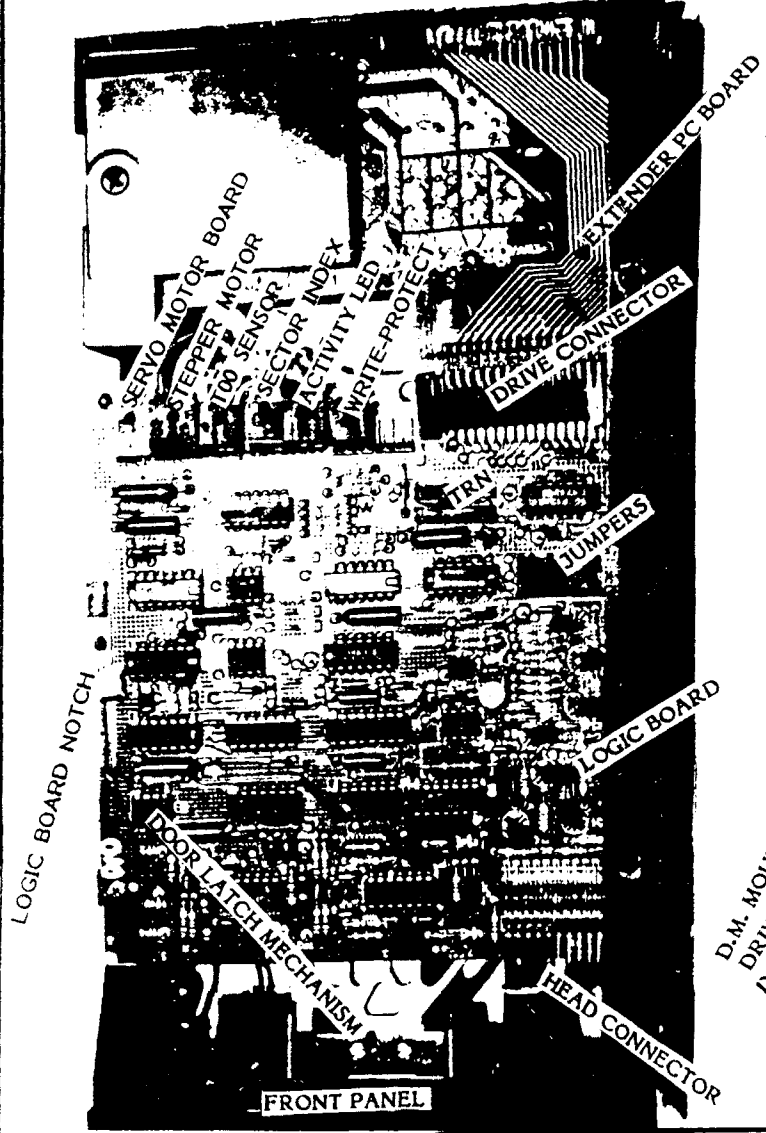
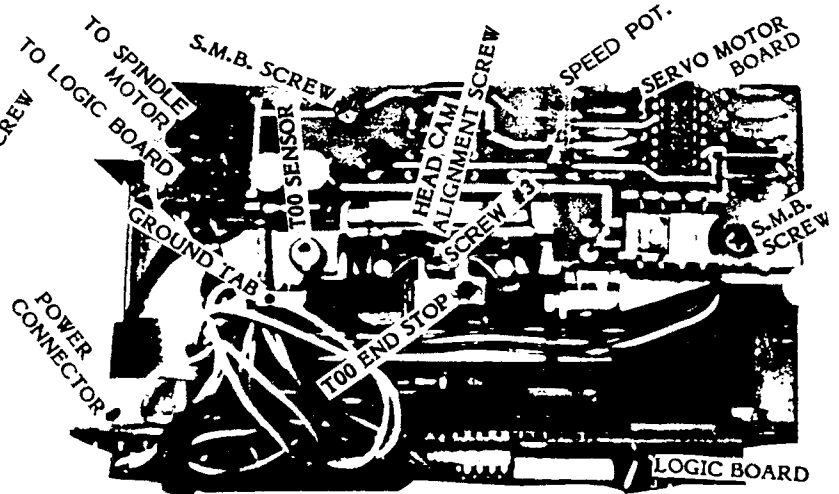
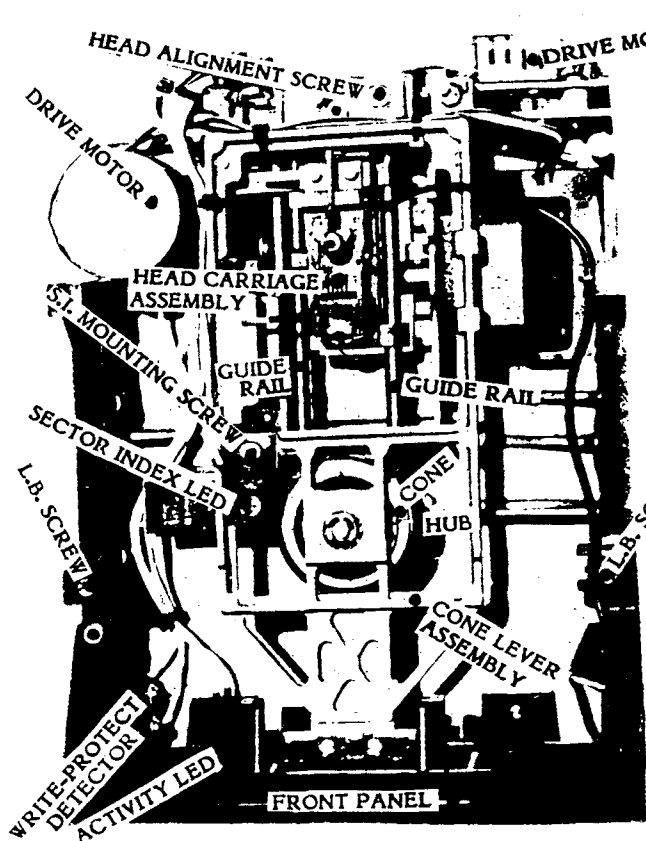
CONTROL DATA 8330, 5" DS, 80 Tk drive must be considered the Cadillac of 5" drives - at least mechanically! Split-band actuated with a rather heavy, well-designed and impressive R/W Head Module. Never had a problem with them.



TANDON TM-100 DRIVE

B

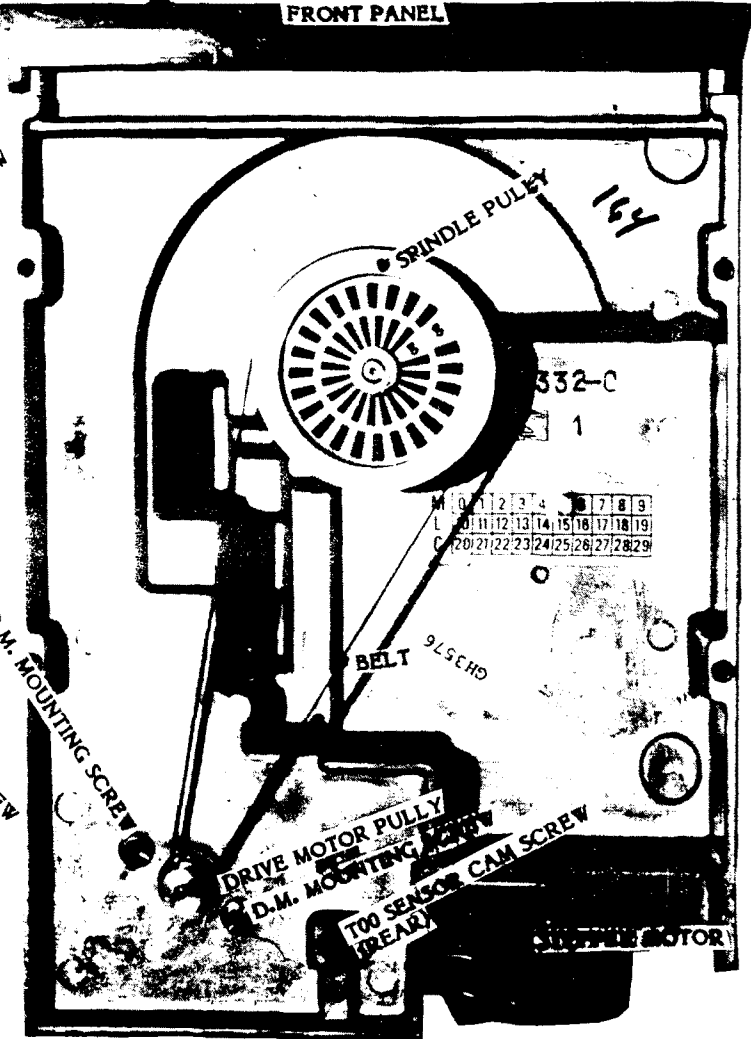
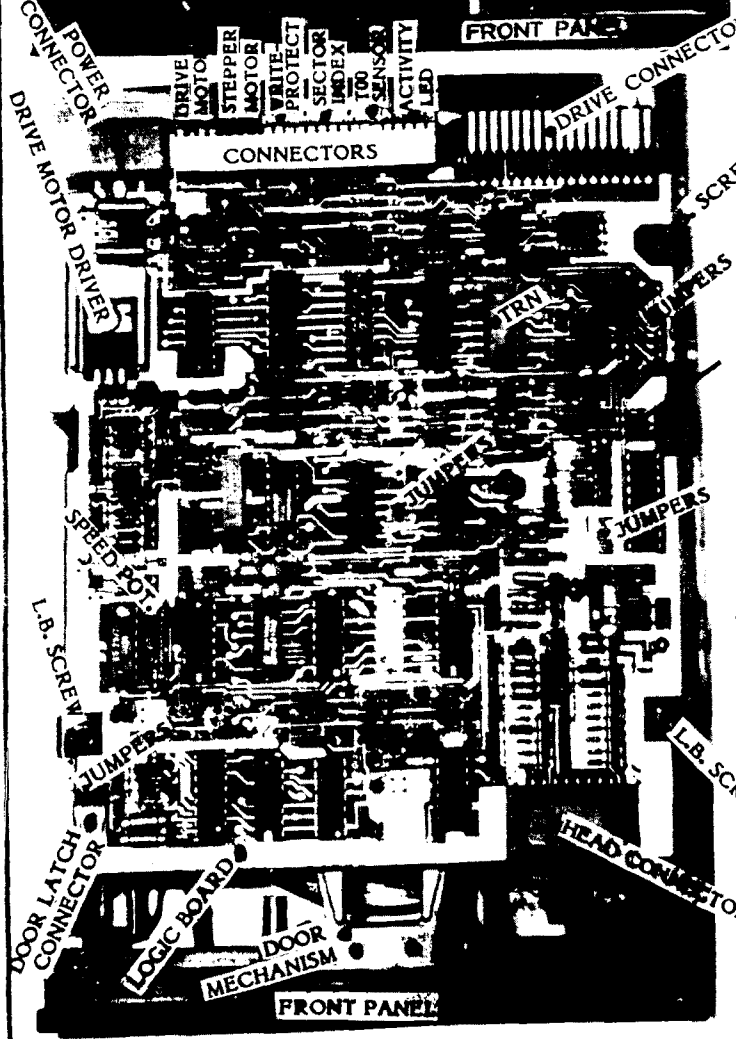
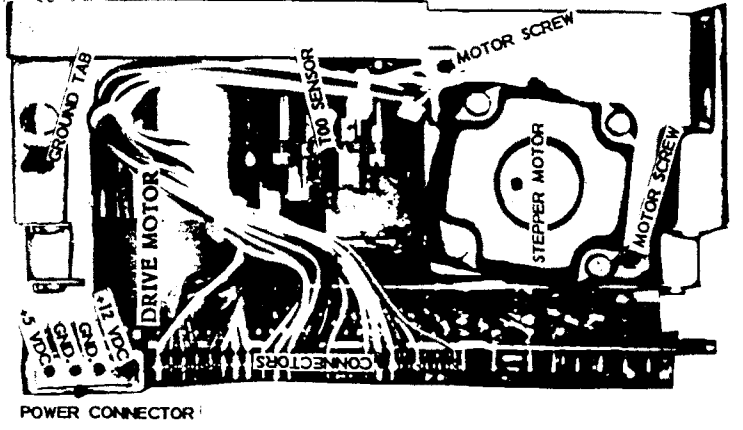
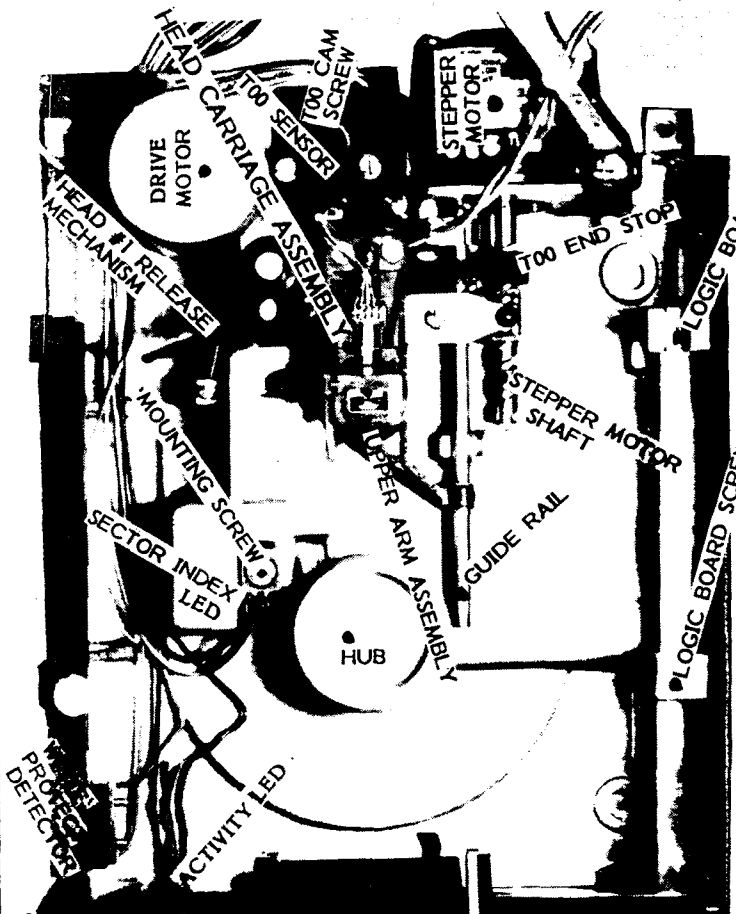
TANDON TM-100-1, 5" 55, 40 Tk, split-band actuated. (TM-100-2 is the DS version.) Except for the ALPS drives used in APPLE, COMMODORE, ATARI and other non-standard bus drives, the TM-100 is the most popular drive in the world! Earlier versions were limited to 35 Tk. Many variations in Logic Board circuitry. 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.

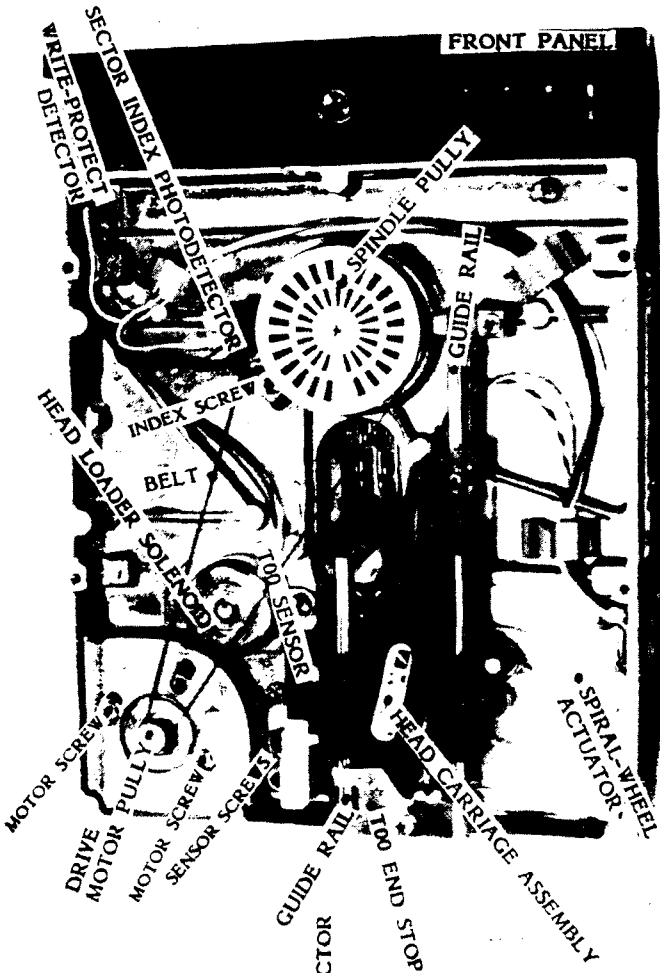


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SHUGART SA-460

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.





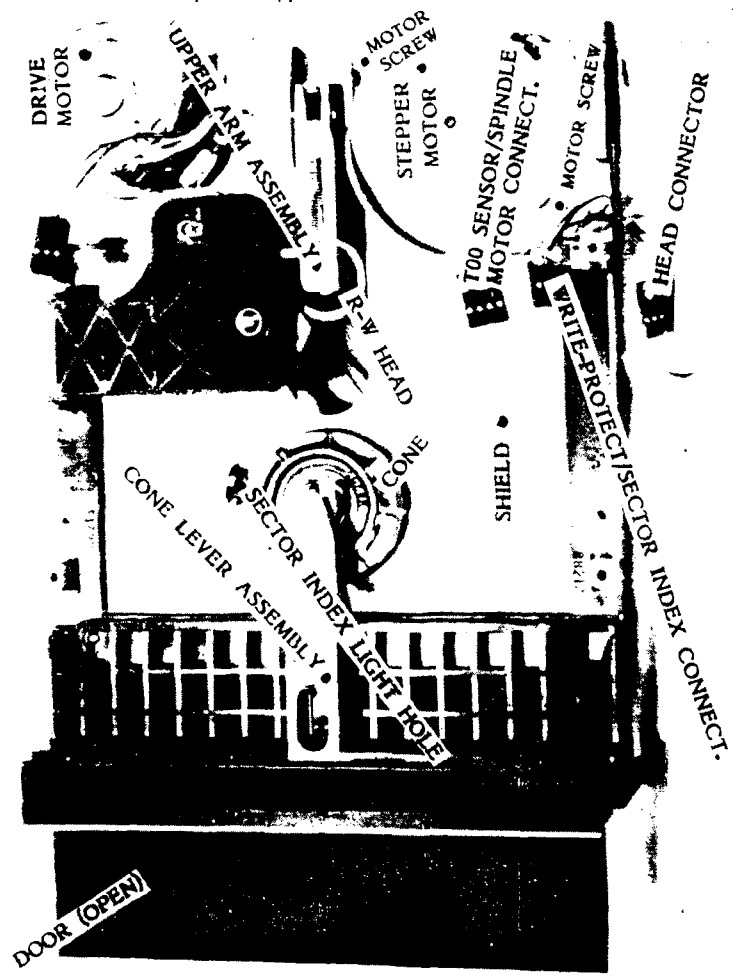
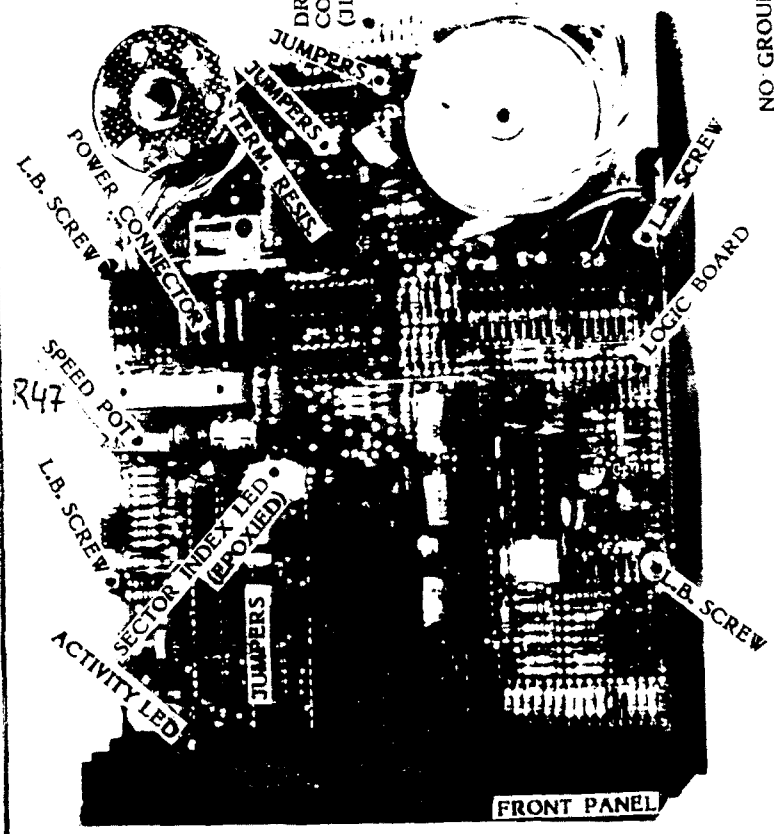
SHUGART SA-465, 5" DS, 80 Tk, half-height drive. Split-band actuated. The band-actuator is held under spring tension to compensate for contraction. This tension also has a damping effect on the band, resulting in quieter operation. Very high quality drive. Never had a problem with them. Has numerous 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 its 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.

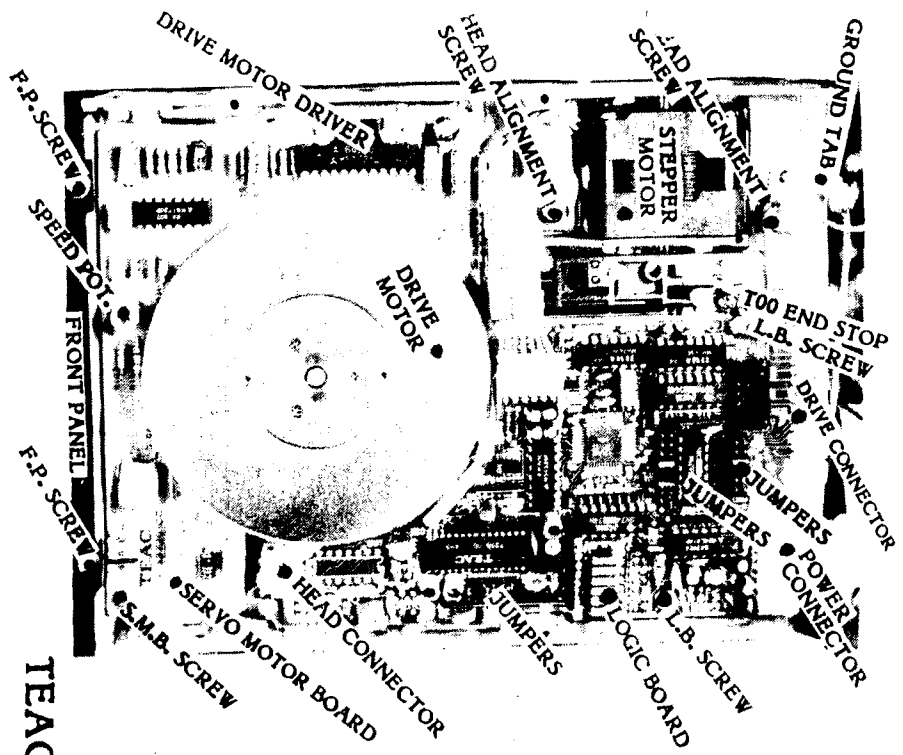
Two SA-465s can be operated from the same power supply and occupy the same cabinet space as one full-size 35/40 Tk drive. By doing so, you will have increased your drive memory storage capacity by a factor of almost 16 if the original drive was 35 Tk, SS, SD; or by a factor of four if the original drive 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.

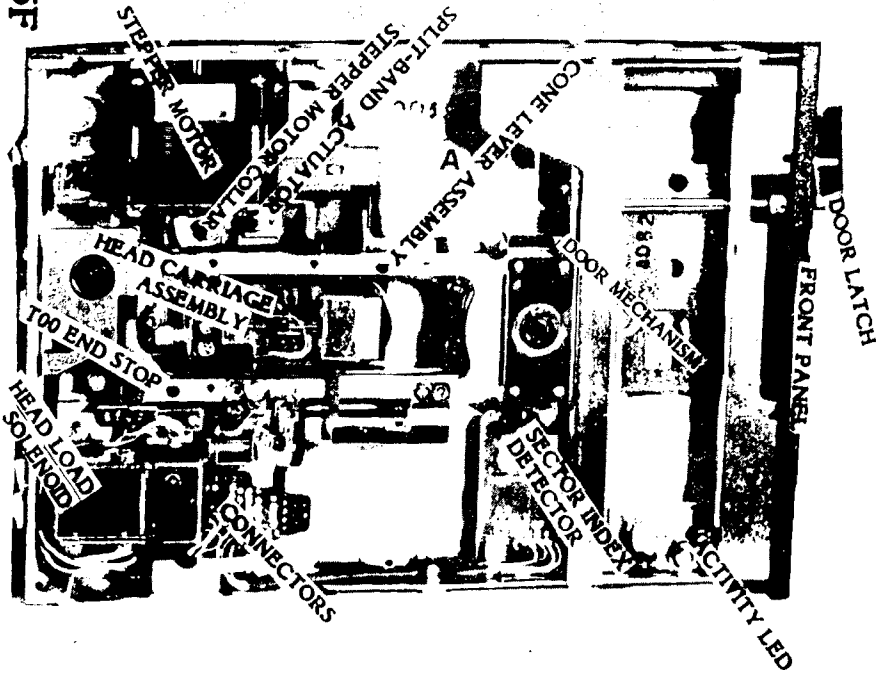
BASF 6106

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.

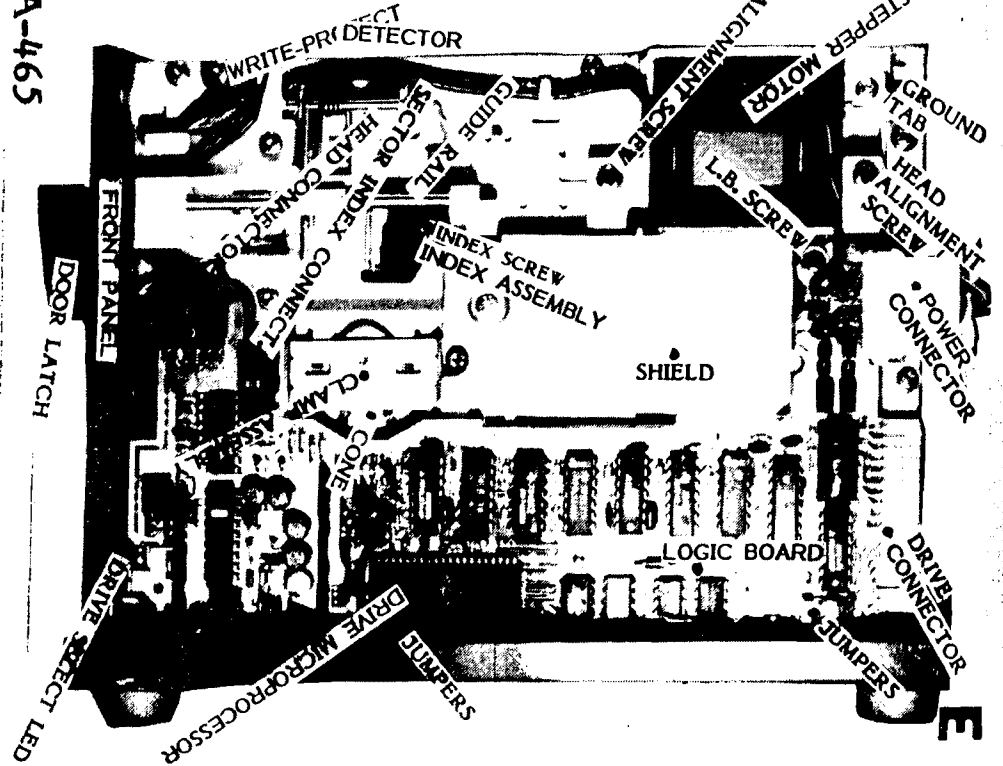
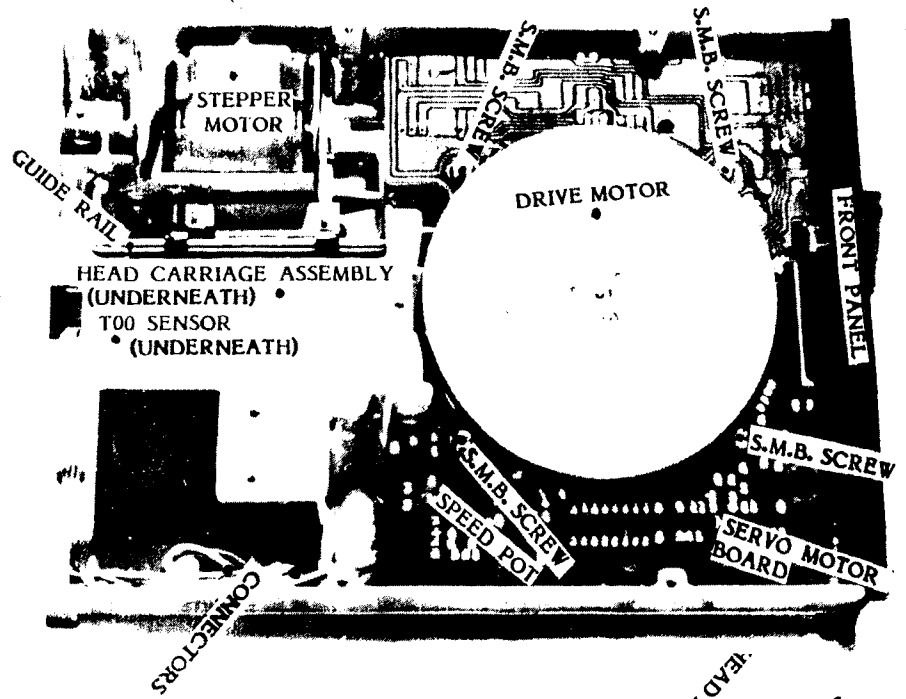


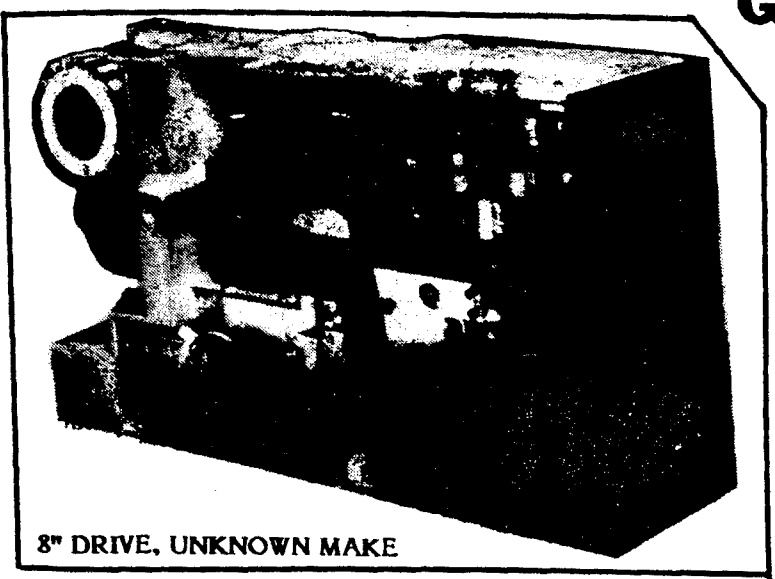
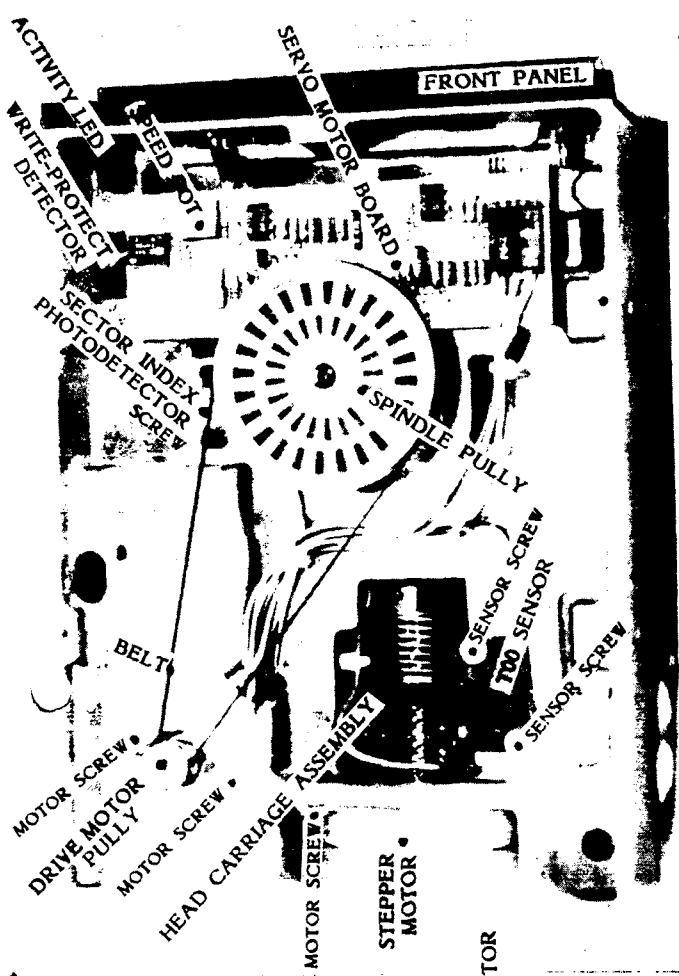


TEAC 55F



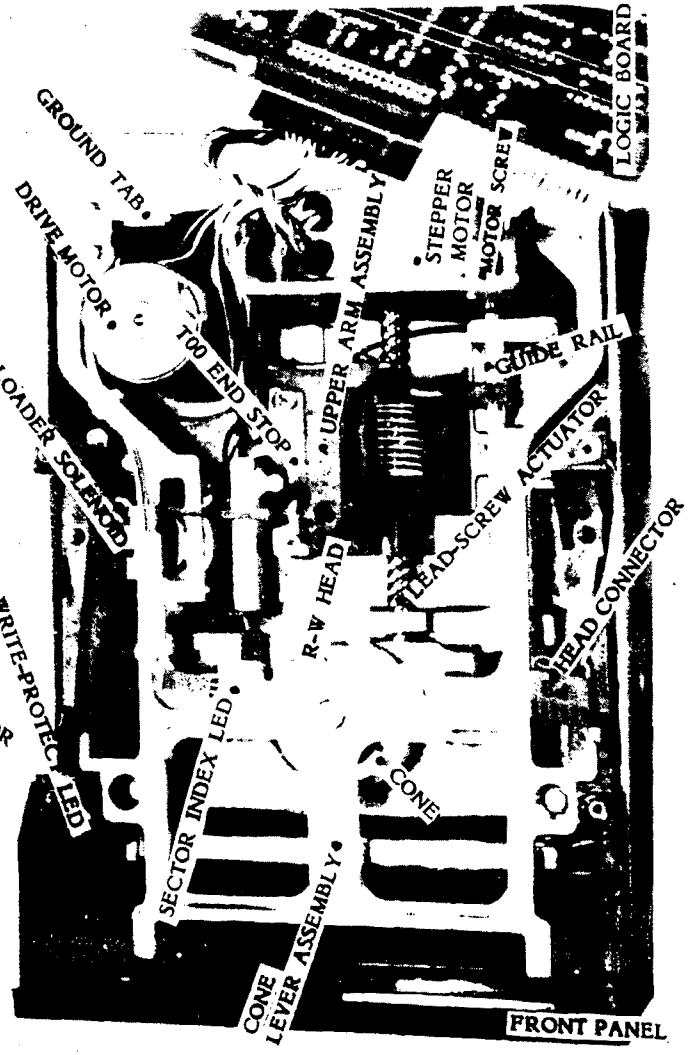
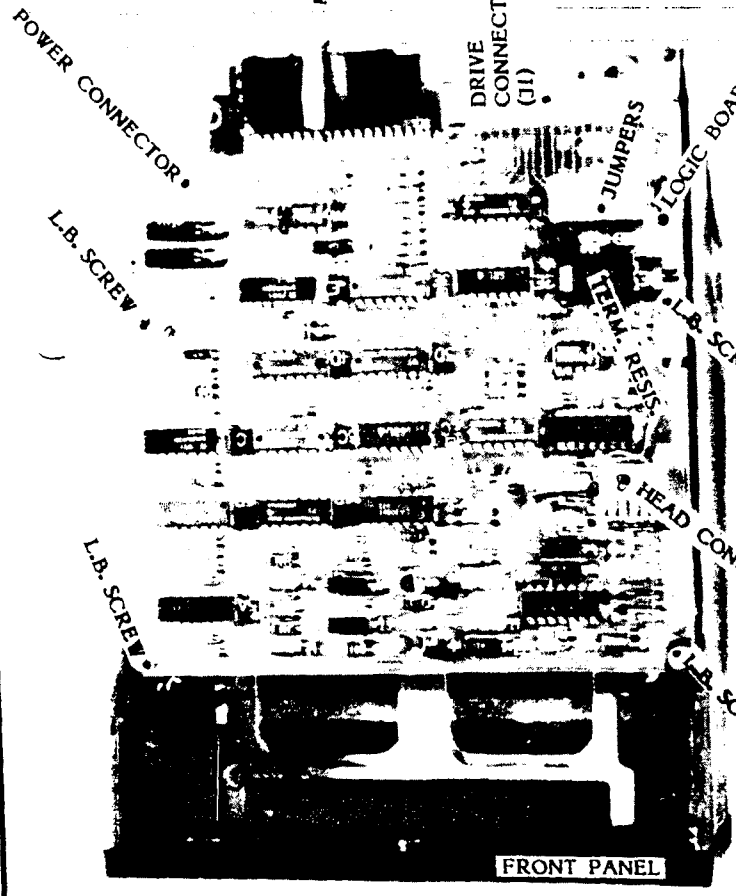
SHUGART SA-465





SIEMENS FDD 100-5

SIEMENS FDD 100-5, 5", SS, 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.

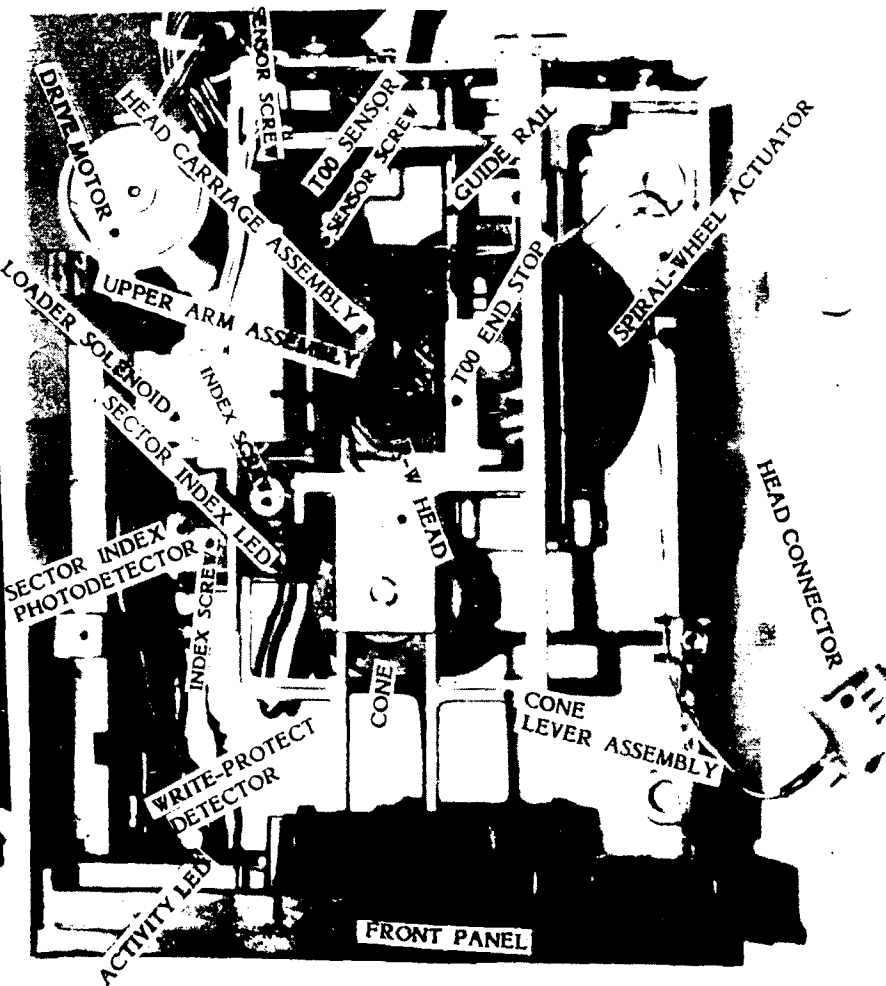
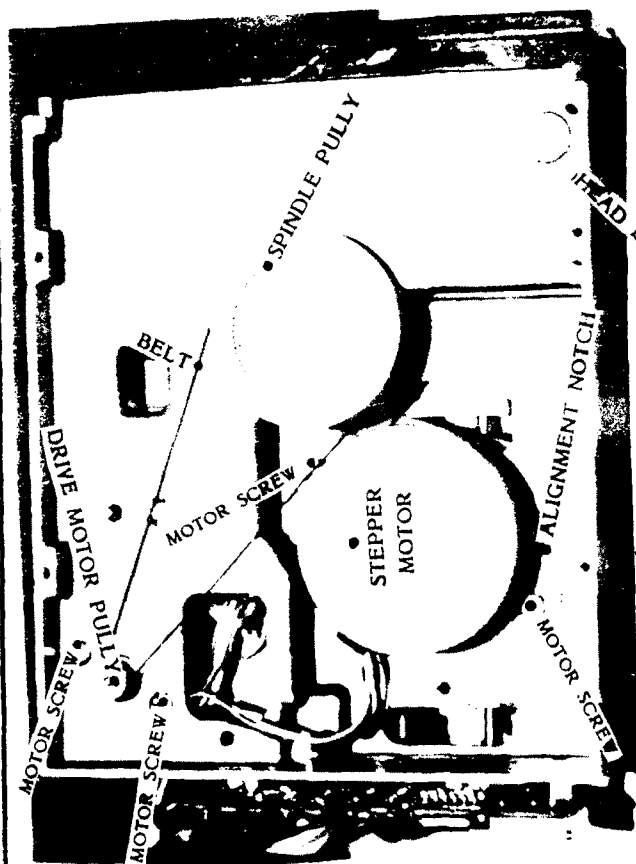
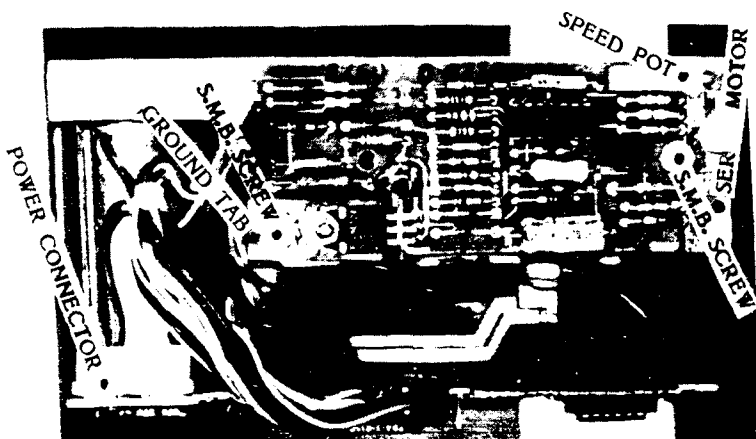
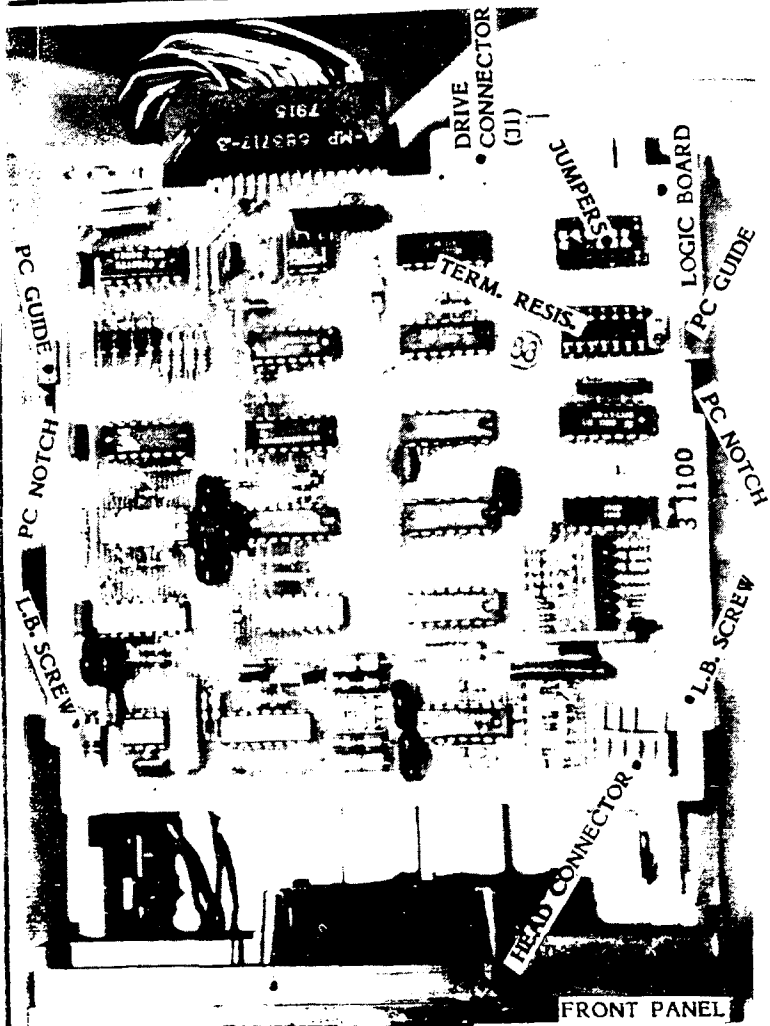


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H

SHUGART SA-400

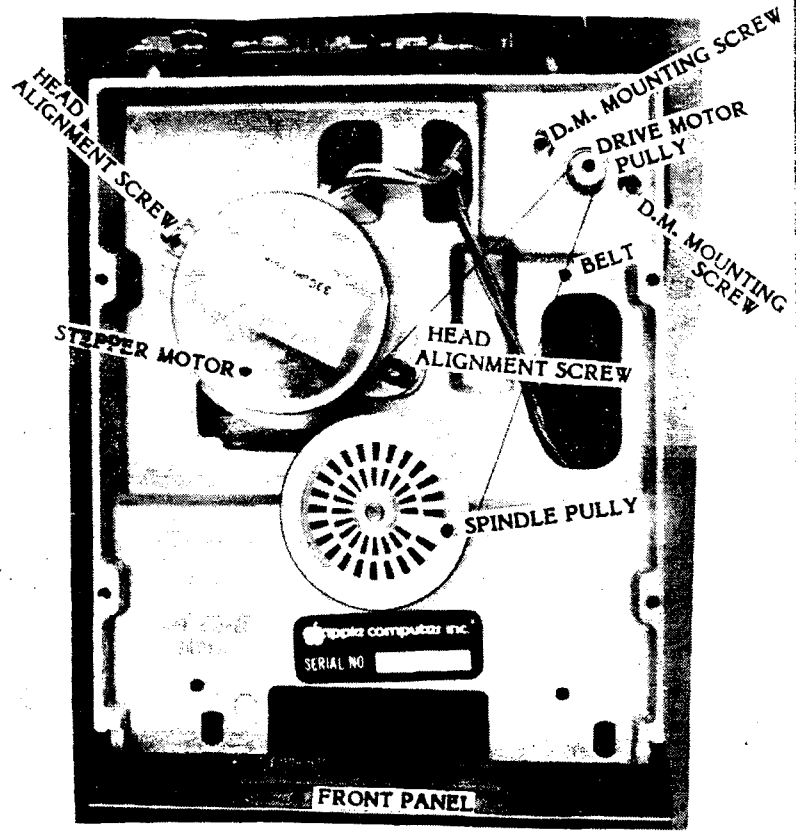
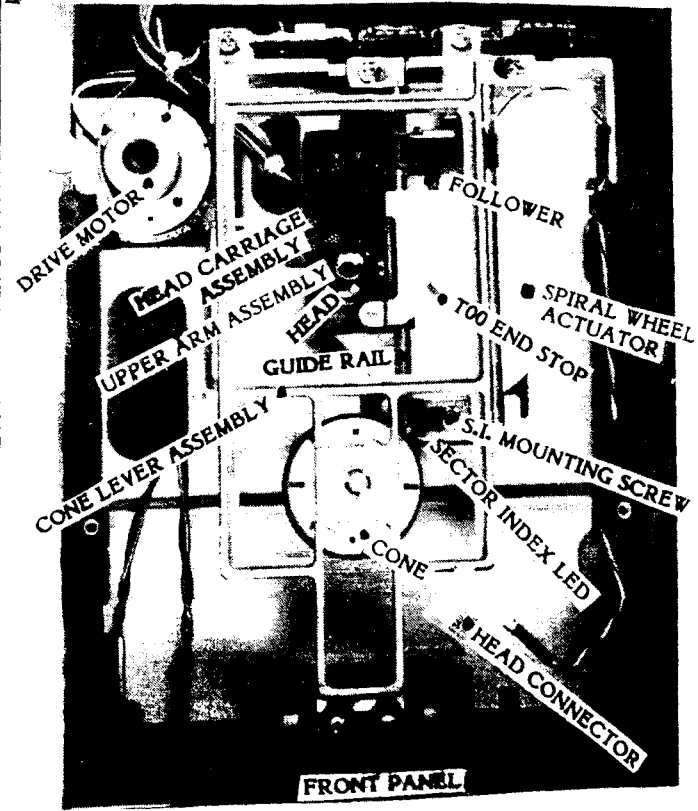
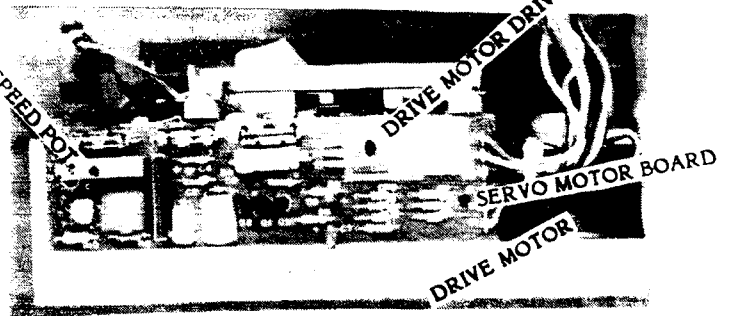
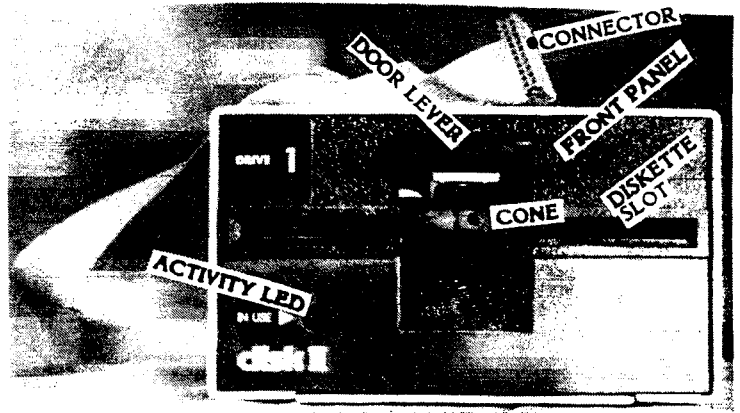
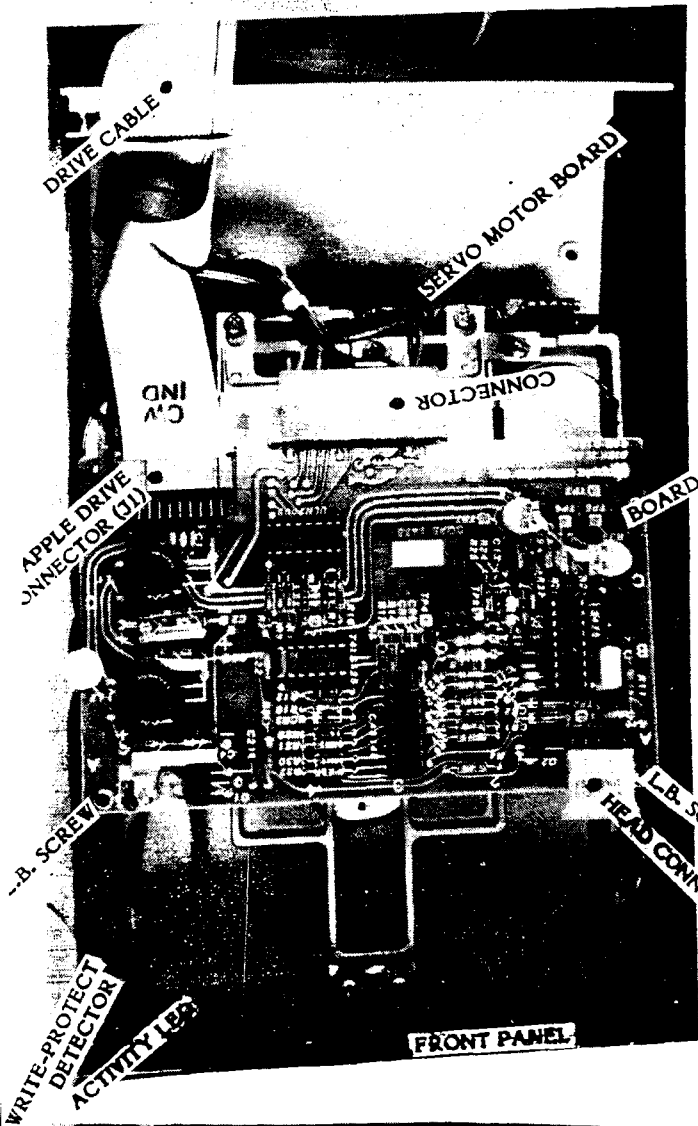
SHUGART SA-400, 5" SS, SD, 35 Tk drive. Spiral-wheel activated. This slow, primitive (by today's standards) drive is now being dumped new for practically a song. Not suitable to most modern computer systems. Avoid this drive! It's not worth fooling with! Definitely limited to 35 Tk, and probably to SD 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.

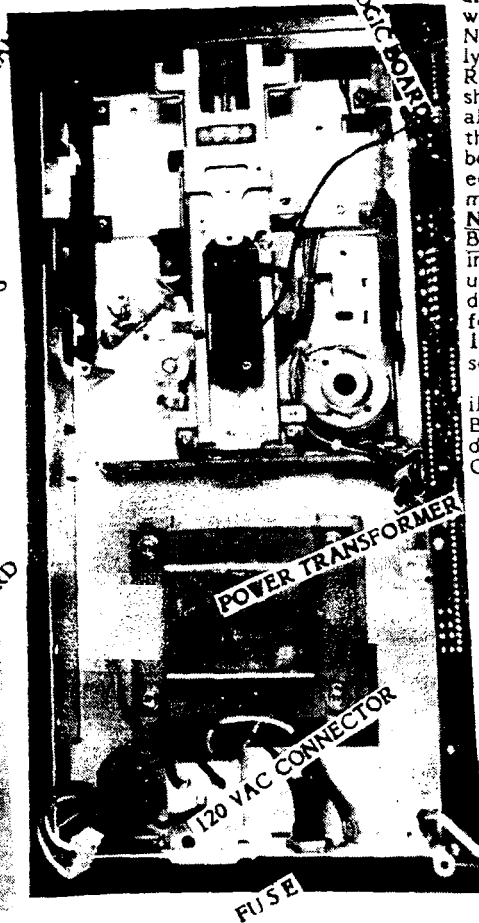
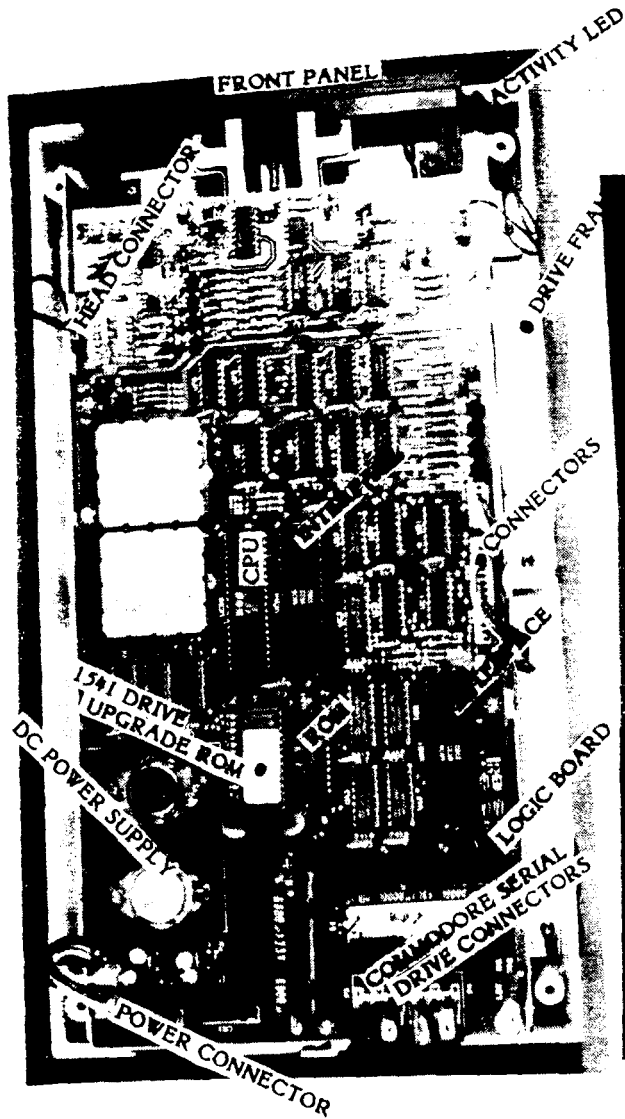
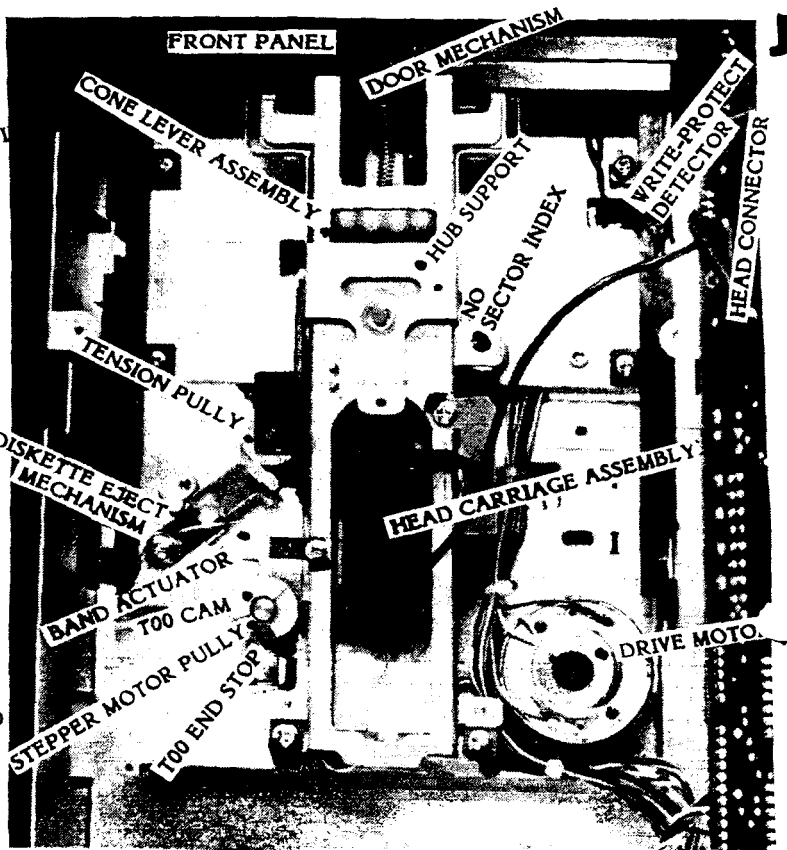
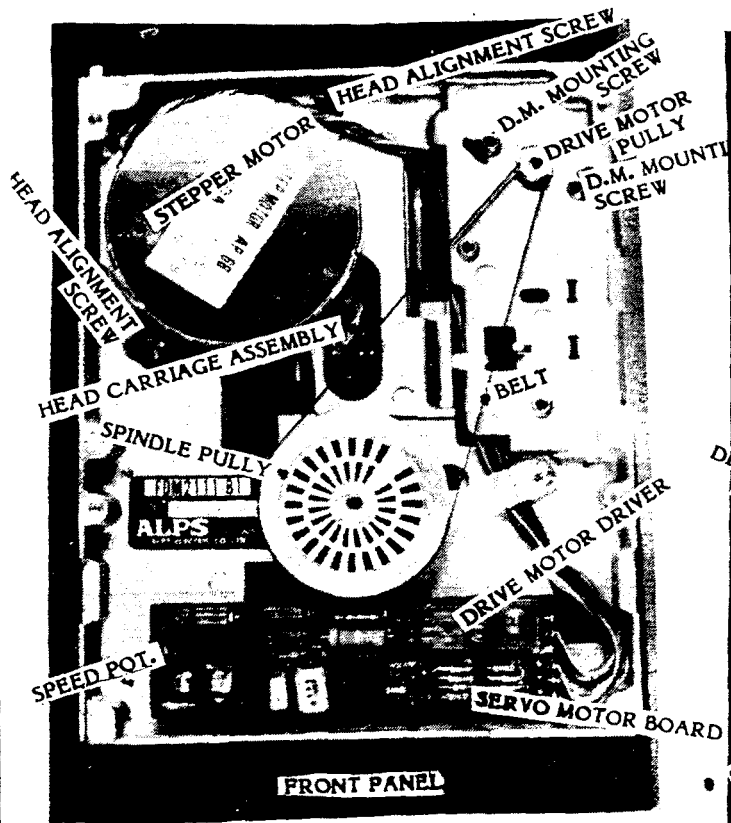


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 ATTN: John J. Williams, MSEE
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 Alamogordo, NM 88310

APPLE DRIVE

APPLE DRIVE, 5", 5S, 35 Tk. Spiral-wheel actuated. Note that construction is very similar to the SHUGART SA-400! 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."

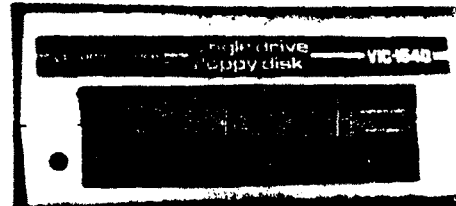




COMMODORE DRIVE

COMMODORE DRIVE, 5", SS, 34 Tk, Band actuated. The "34 Tk" 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 μ Cs 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, 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" and microfloppy drives require +5 (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, 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, if 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 T00 end stop problems are solely mechanical in nature. Drive speed and Read Sensitivity problems are mechanical about 90% of the time. T00 sensor, index optical coupler, 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.

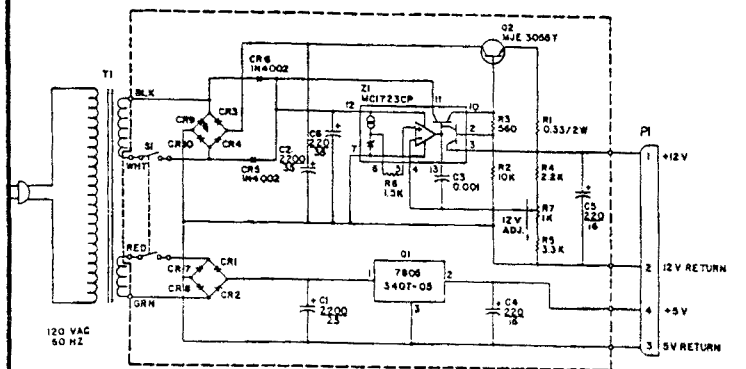
Solid-state components, when properly operated along their power curve, will not wear out until Kingdom Come! However, they also do not always catastrophically fail. When a component operates near its limits, it sometimes becomes overworked and overheated and increasingly degraded until it works only 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.)

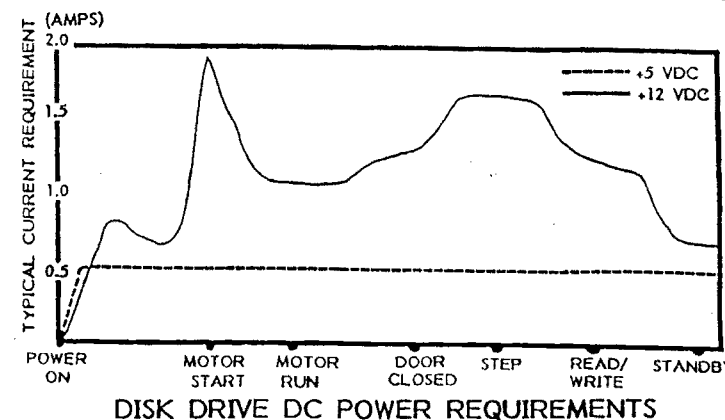
Most board electronic failures are due to an easily obtained and replaced component, such as a failed TTL IC. However, drive boards also contain critical, specialized, proprietary ICs, not known to be separately available, with no known substitutes. If one of these fail, you can't reasonably repair the board yourself. Most newer drives have μ Ps, which are usually also proprietary, and which are more difficult to troubleshoot, and a bear to unsolder!



TM-100 POWER SUPPLY (TANDON)

NOTES:
UNLESS OTHERWISE SPECIFIED:
1. ALL RESISTORS ARE 1/4 WATT, 5%.
RESISTOR VALUES IN OHMS, K=1000.
2. CAPACITOR VALUES IN MICROFARADS AND WORKING VOLTAGE.
3. — INDICATES CLOCKWISE ROTATION.

REGULATOR PINOUTS:
7806: 1-NC, 2-NC, 3-NC, 4-NC, 5-NC, 6-NC, 7-NC, 8-NC, 9-NC, 10-NC, 11-NC, 12-NC, 13-NC, 14-NC, 15-NC, 16-NC, 17-NC, 18-NC, 19-NC, 20-NC, 21-NC, 22-NC, 23-NC, 24-NC, 25-NC, 26-NC, 27-NC, 28-NC, 29-NC, 30-NC, 31-NC, 32-NC, 33-NC, 34-NC, 35-NC, 36-NC, 37-NC, 38-NC, 39-NC, 40-NC, 41-NC, 42-NC, 43-NC, 44-NC, 45-NC, 46-NC, 47-NC, 48-NC, 49-NC, 50-NC, 51-NC, 52-NC, 53-NC, 54-NC, 55-NC, 56-NC, 57-NC, 58-NC, 59-NC, 60-NC, 61-NC, 62-NC, 63-NC, 64-NC, 65-NC, 66-NC, 67-NC, 68-NC, 69-NC, 70-NC, 71-NC, 72-NC, 73-NC, 74-NC, 75-NC, 76-NC, 77-NC, 78-NC, 79-NC, 80-NC, 81-NC, 82-NC, 83-NC, 84-NC, 85-NC, 86-NC, 87-NC, 88-NC, 89-NC, 90-NC, 91-NC, 92-NC, 93-NC, 94-NC, 95-NC, 96-NC, 97-NC, 98-NC, 99-NC, 100-NC.
3407-05: 1-NC, 2-NC, 3-NC, 4-NC, 5-NC, 6-NC, 7-NC, 8-NC, 9-NC, 10-NC, 11-NC, 12-NC, 13-NC, 14-NC, 15-NC, 16-NC, 17-NC, 18-NC, 19-NC, 20-NC, 21-NC, 22-NC, 23-NC, 24-NC, 25-NC, 26-NC, 27-NC, 28-NC, 29-NC, 30-NC, 31-NC, 32-NC, 33-NC, 34-NC, 35-NC, 36-NC, 37-NC, 38-NC, 39-NC, 40-NC, 41-NC, 42-NC, 43-NC, 44-NC, 45-NC, 46-NC, 47-NC, 48-NC, 49-NC, 50-NC, 51-NC, 52-NC, 53-NC, 54-NC, 55-NC, 56-NC, 57-NC, 58-NC, 59-NC, 60-NC, 61-NC, 62-NC, 63-NC, 64-NC, 65-NC, 66-NC, 67-NC, 68-NC, 69-NC, 70-NC, 71-NC, 72-NC, 73-NC, 74-NC, 75-NC, 76-NC, 77-NC, 78-NC, 79-NC, 80-NC, 81-NC, 82-NC, 83-NC, 84-NC, 85-NC, 86-NC, 87-NC, 88-NC, 89-NC, 90-NC, 91-NC, 92-NC, 93-NC, 94-NC, 95-NC, 96-NC, 97-NC, 98-NC, 99-NC, 100-NC.
7805: 1-NC, 2-NC, 3-NC, 4-NC, 5-NC, 6-NC, 7-NC, 8-NC, 9-NC, 10-NC, 11-NC, 12-NC, 13-NC, 14-NC, 15-NC, 16-NC, 17-NC, 18-NC, 19-NC, 20-NC, 21-NC, 22-NC, 23-NC, 24-NC, 25-NC, 26-NC, 27-NC, 28-NC, 29-NC, 30-NC, 31-NC, 32-NC, 33-NC, 34-NC, 35-NC, 36-NC, 37-NC, 38-NC, 39-NC, 40-NC, 41-NC, 42-NC, 43-NC, 44-NC, 45-NC, 46-NC, 47-NC, 48-NC, 49-NC, 50-NC, 51-NC, 52-NC, 53-NC, 54-NC, 55-NC, 56-NC, 57-NC, 58-NC, 59-NC, 60-NC, 61-NC, 62-NC, 63-NC, 64-NC, 65-NC, 66-NC, 67-NC, 68-NC, 69-NC, 70-NC, 71-NC, 72-NC, 73-NC, 74-NC, 75-NC, 76-NC, 77-NC, 78-NC, 79-NC, 80-NC, 81-NC, 82-NC, 83-NC, 84-NC, 85-NC, 86-NC, 87-NC, 88-NC, 89-NC, 90-NC, 91-NC, 92-NC, 93-NC, 94-NC, 95-NC, 96-NC, 97-NC, 98-NC, 99-NC, 100-NC.



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R-W HEAD ALIGNMENT

The purpose of the end stop is to prevent the head carriage assembly from bumping into the drive frame should, for any reason (ex: 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.

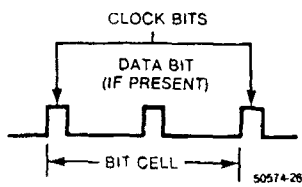
Be particularly careful when you adjust the sensor. You MUST first loosen the sensor mounting screw(s) to slightly loose. If you fail to do this, you can damage the adjustment screw or "E" rings in some drives (TANDON, etc.). In some drives, you must swing away the logic board and shield to access this 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-circuited. 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.

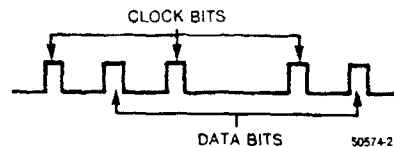
To adjust the sensor and end stop, you may use a disk utility which will Step to the outer tracks, or the Drive Test Station (see that chapter). Else, Format a diskette using a good (aligned) drive. Save a small BASIC program (filespec = "A") on it. "A" should be written to T00. SAVE it again (filespec = "B"). "B" should be written to T01. Many DOSs have a DIR Allocation mode that displays disk file locations. Or use a disk utility to verify that "A" and "B" occupy T00 and T01, respectively.

Position the Read-Write head to T01 by continually Loading in "B" (AUTO BASIC,B,B,...B). 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.

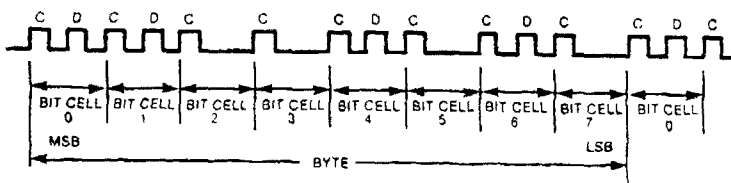
While doing an AUTO BASIC,A,A,...,A, slowly turn the end stop set screw IN until the end stop is softly in contact with the head carriage assembly at T00. Then back OUT (CCW) 1/4 turn. The end stop will then be correctly adjusted.



DATA PATTERN (SHUGART)



BIT CELLS (SHUGART)



BINARY REPRESENTATION OF:

DATA BITS

CLOCK BITS

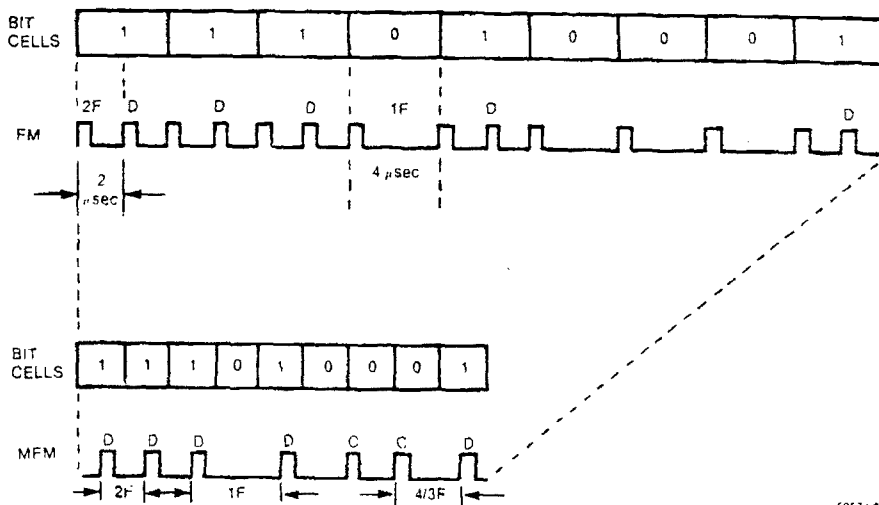
HEXADECIMAL REPRESENTATION OF:

DATA BITS

CLOCK BITS

BYTE (SHUGART)

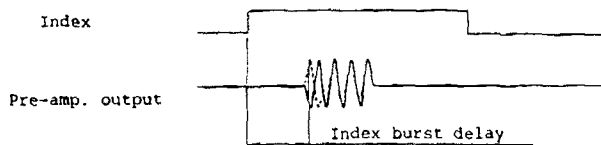
50574-28



FM AND MFM ENCODING (SHUGART)

Items	FD-55A ~ F	FD-55G
Index interval	200±3ms	166.7±2.5ms
Pulse width	2 ~ 5.5ms	1 ~ 8ms
Burst delay	200±200µs	165±165µs

INDEX TIMING

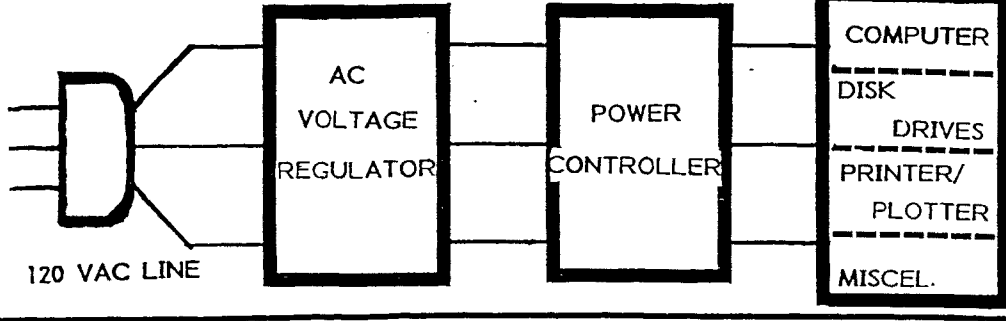


TYPICAL SECTOR INDEX SPECIFICATIONS (TEAC)

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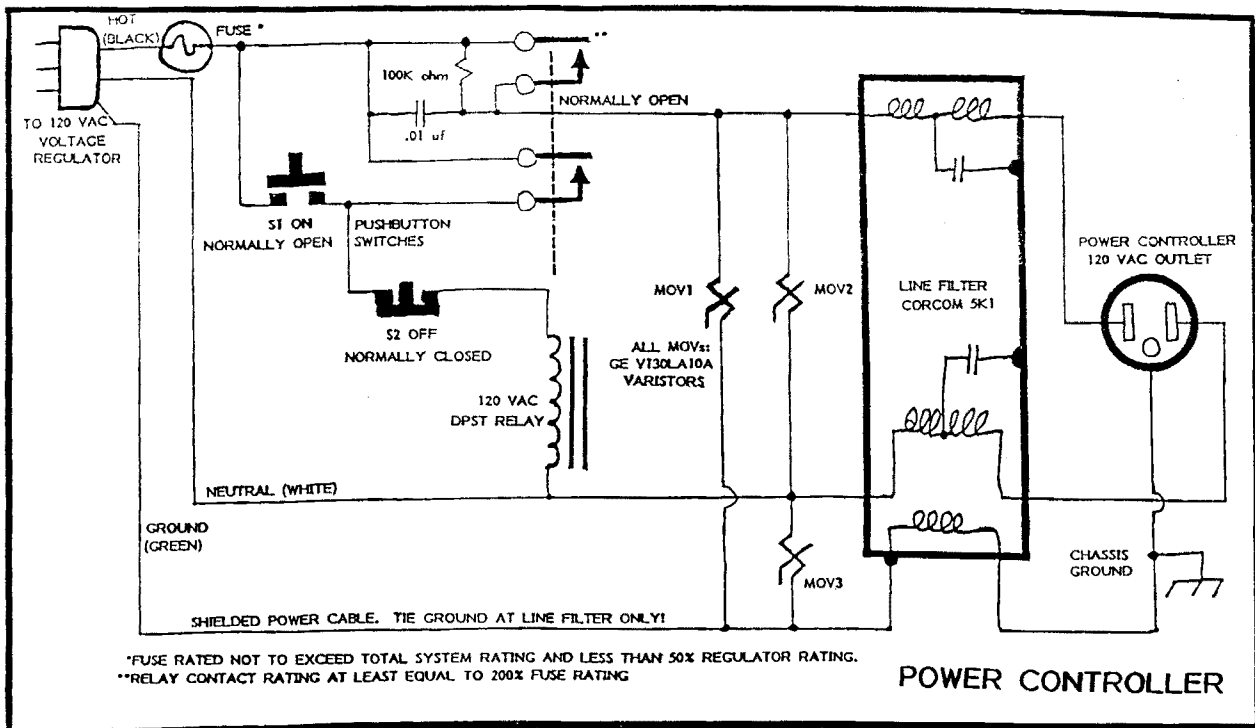
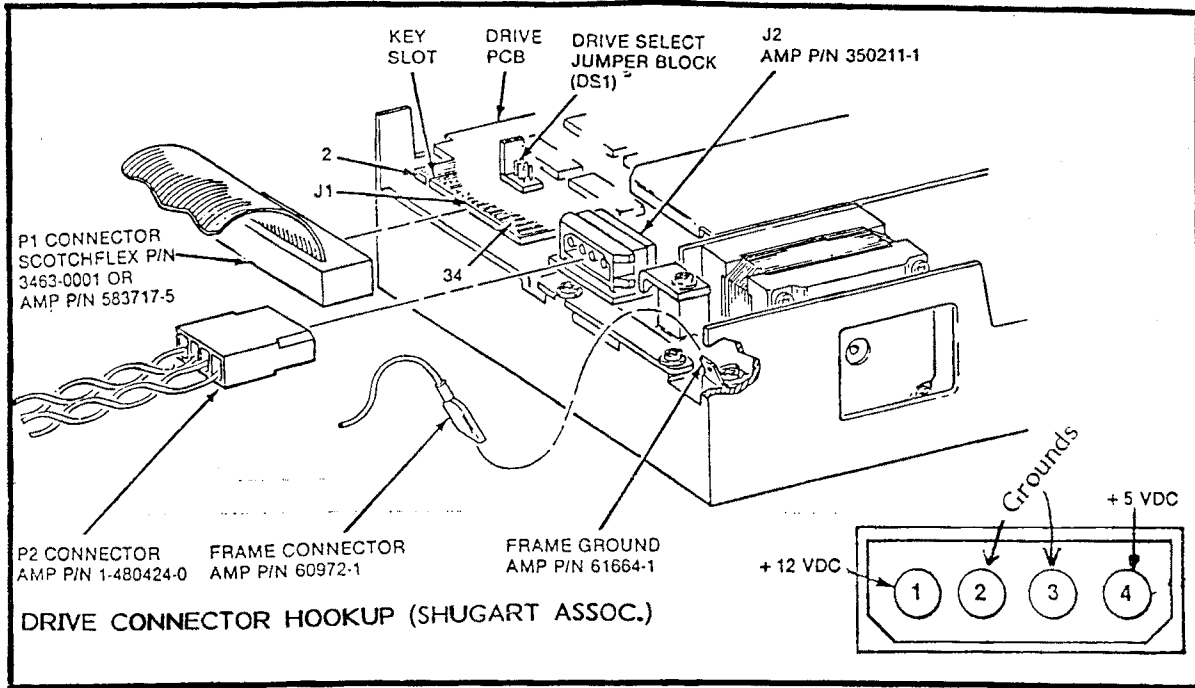
POWER/GROUND SYSTEM



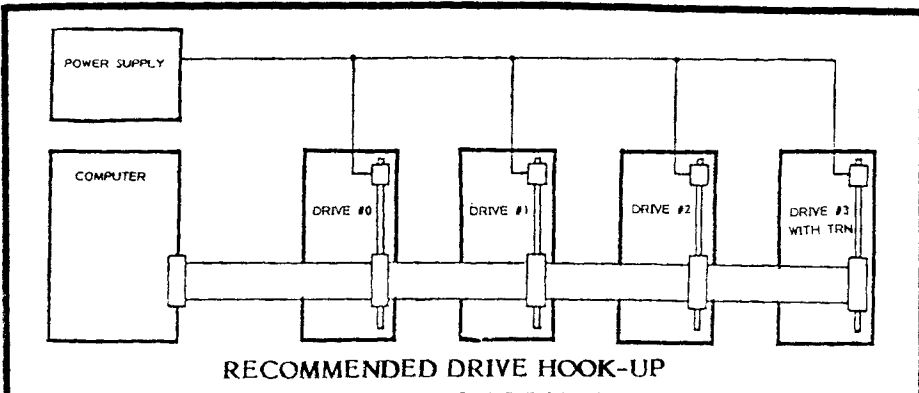
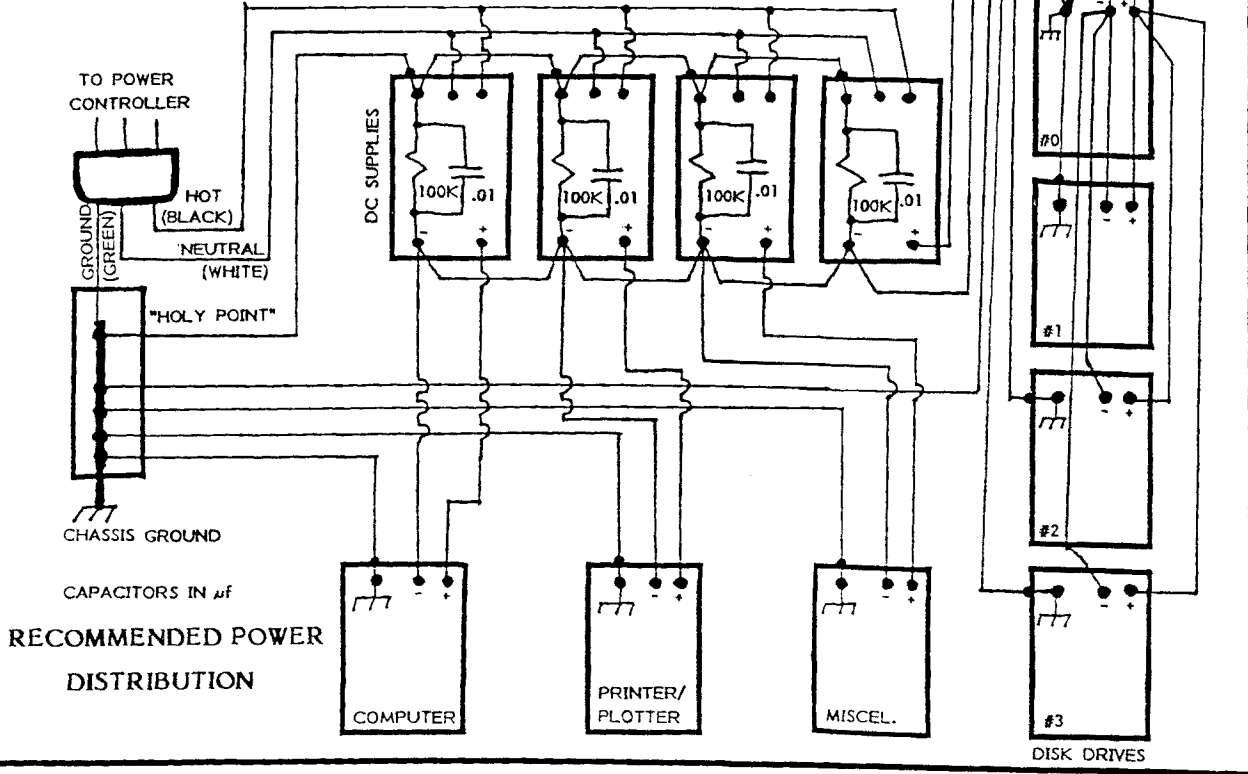
DISK SERVICE MANUAL III VIII - 2

ELECTRONICS & REPAIRS

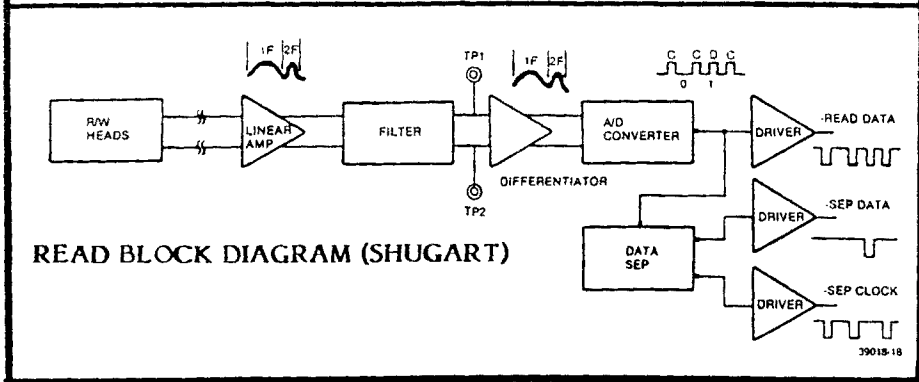
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AC DISTRIBUTION: 3-WIRE TWISTED PAIR CABLE, 12 GAUGE FOR MICROCOMPUTER SYSTEMS.
DC DISTRIBUTION: SEPARATE TWISTED PAIR CABLE FOR EACH DEVICE, 20 OR 18 GAUGE.
GROUNDS: ONLY ONE CONNECTION PER FRAME FOR ALL DC AND AC GROUNDS.

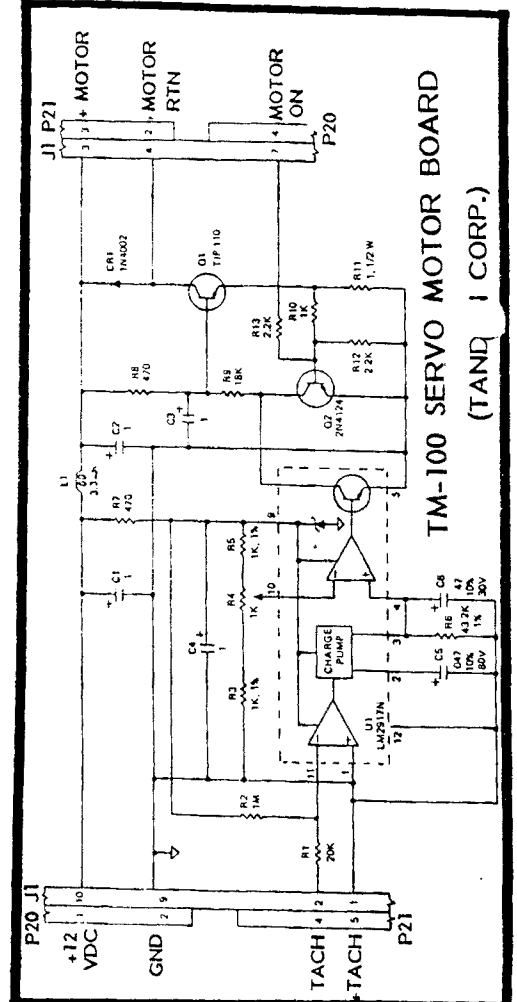


RECOMMENDED DRIVE HOOK-UP



READ BLOCK DIAGRAM (SHUGART)

39018-18



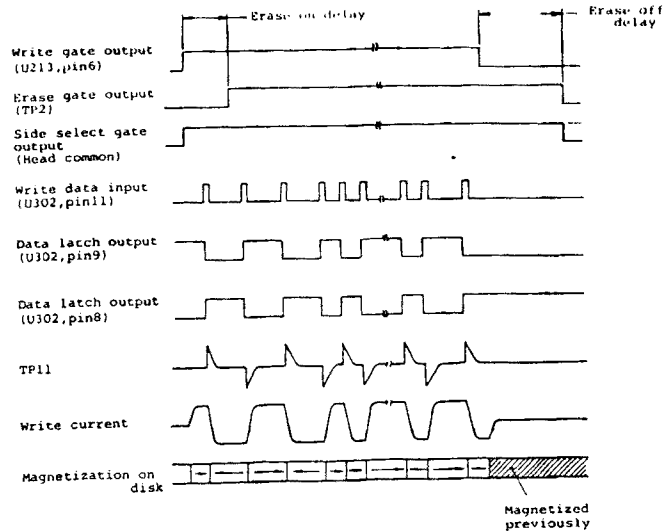
TM-100 SERVO MOTOR BOARD

(TAND I CORP.)

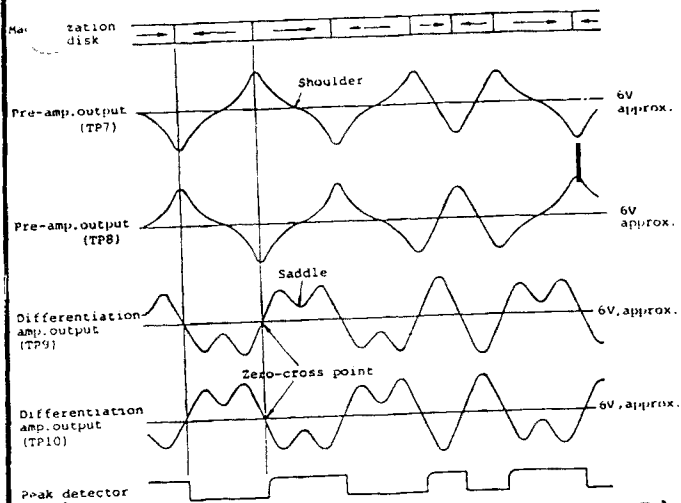
Consumertronics Co.

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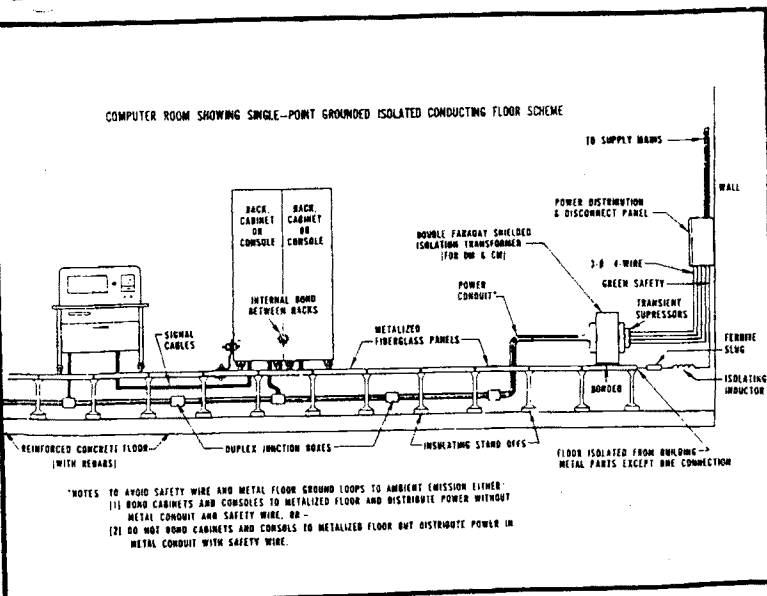
ELECTRONICS & REPAIRS



WRITE CIRCUIT WAVEFORMS (TEAC CORP.)



READ AMP. & PEAK DETECTOR WAVEFORMS (TEAC CORP.)



If a drive function fails, (ex: T00 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 PC 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 lead, solder defect, or short will show up. Circuit chiller can uncover a thermally-related failure.

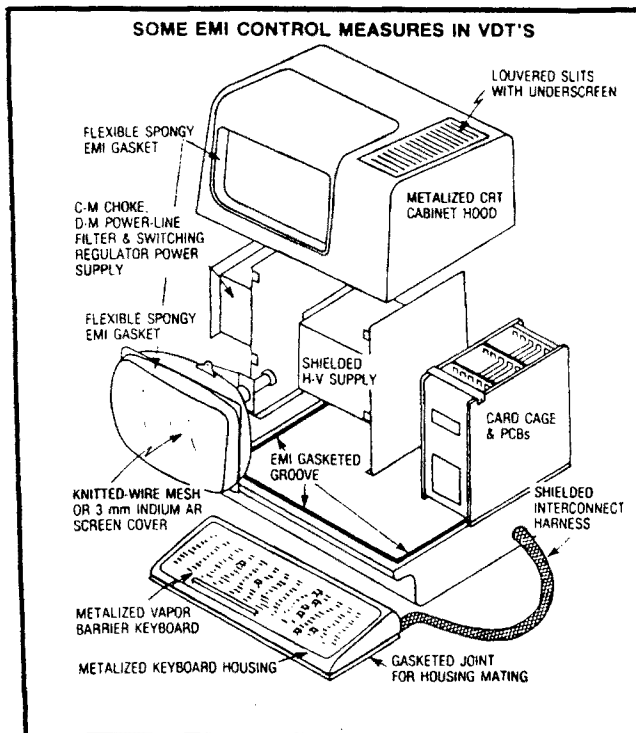
If the problem is still not evident, then examine power, control and signal lines going to and from the suspect circuit using an oscilloscope, logic probe or meter. We've designed a super logic probe with many powerful features. For its plans, please send \$6 for ULTIMATE LOGIC PROBE, CONSUMERTRONICS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

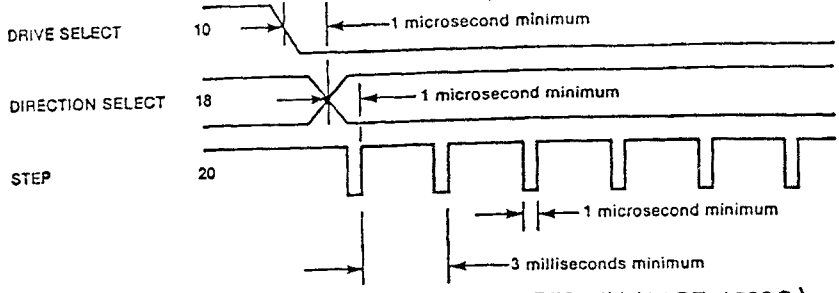
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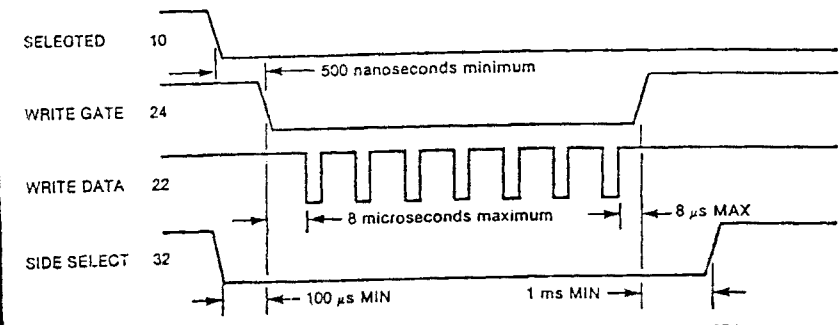


DISK SERVICE MANUAL III

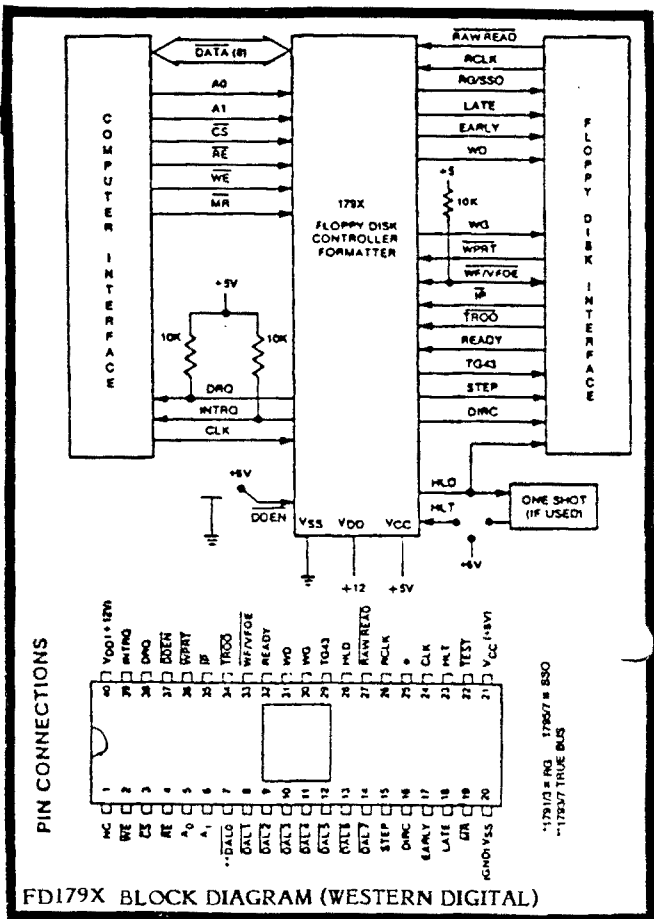
ELECTRONICS & REPAIRS



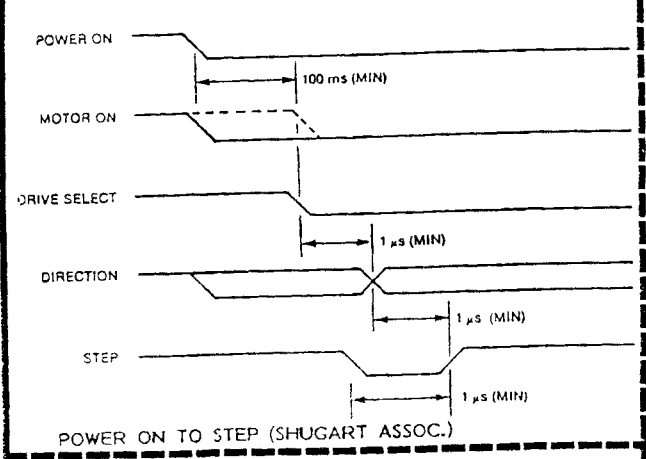
DRIVE SELECT, DIRECTION SELECT AND STEP (SHUGART ASSOC.)



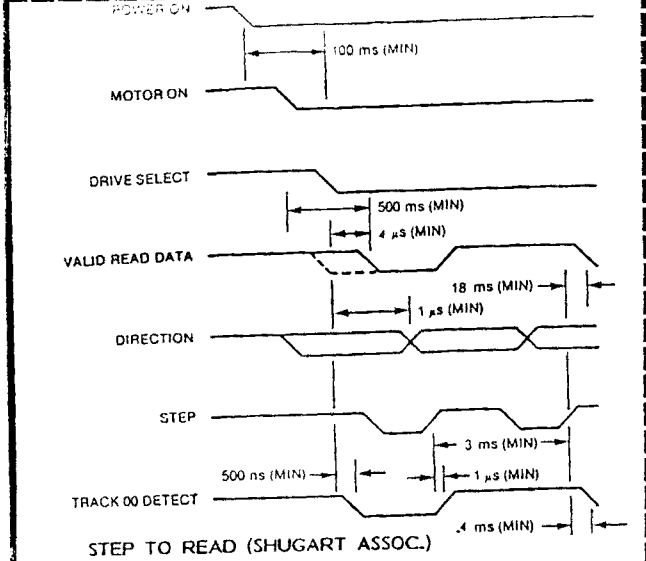
DRIVE SELECT, SIDE SELECT, WRITE GATE AND WRITE DATA (SHUGART ASSOC.)



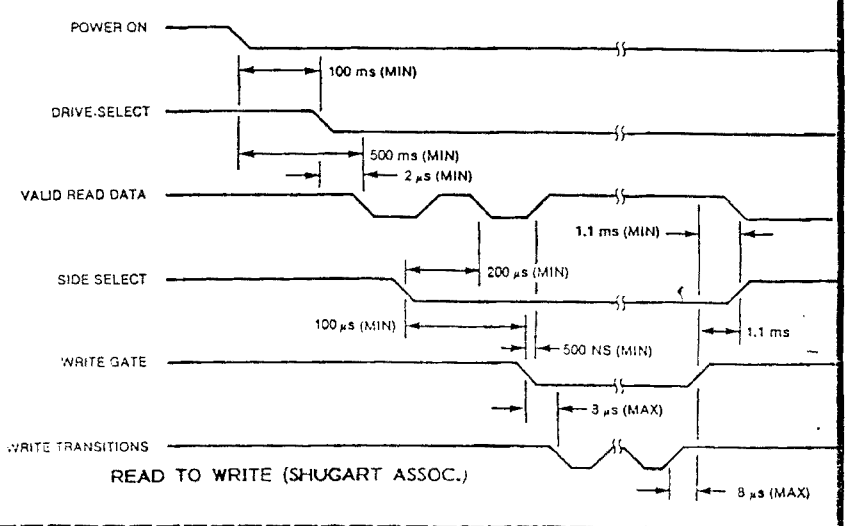
FD179X BLOCK DIAGRAM (WESTERN DIGITAL)



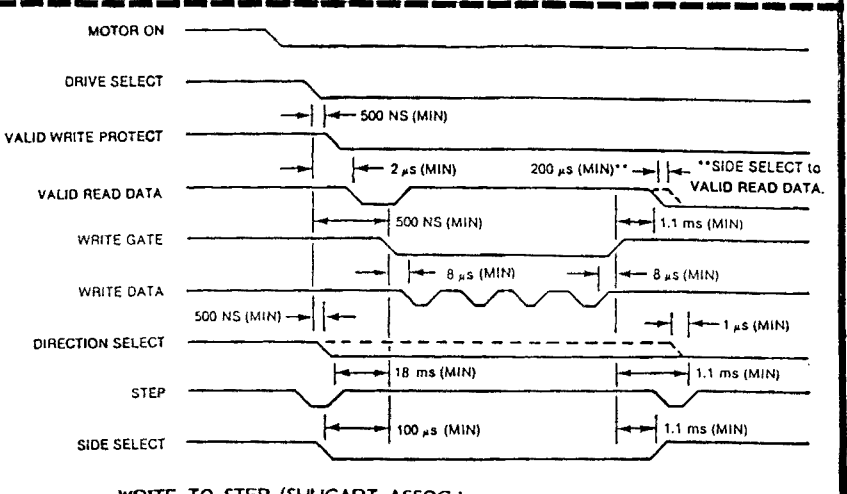
POWER ON TO STEP (SHUGART ASSOC.)



STEP TO READ (SHUGART ASSOC.)



READ TO WRITE (SHUGART ASSOC.)



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 forcing in or out a diskette with a raggedly punched sector index window (typically SS diskettes converted to floppy using a punch). Indexing problems are sometimes caused by a dirty optical coupler. More rarely, the LED or photosensor burns out, or a malfunction occurs in the logic board circuitry.

How critical the index alignment is depends largely upon the controller used in your system. Typically, the elapsed time between the detection of the leading edge of the sector index hole and the beginning of the 500 ID Mark is 200 usec. Most systems tolerate any time between 100 and 300 usec. Most modern controllers tolerate much index misalignment - some between 10 and 400 usec. The only operation that may be adversely affected is FORMAT (and COPY and BACKUP where FORMAT is used). Disk index alignment becomes even more critical if you are using non-standard formats because the arrival of sectors underneath the head is computed from the detection of the index pulse. If you have FORMAT problems, first adjust the drive speed. If they still persist, but all other operations are OK, you probably have index misalignment.

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 fuse is good, that the drive's power supply is correct, and that the DOS's drive configuration specifications (ex: PDRIVE) 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 factory matched. 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 neither has slipped out of its fixture, and clean (with alcohol + Q-tip) and retest them before assuming that either is burned out. A smudge or debris on either of them can cause havoc.

The photosensor is located on the frame (hub) side of the drive; the LED is located on the cone lever assembly. Removal of both the logic board and cone lever assembly are required in most drives.

DO NOT LOOSEN THE MOUNTING SCREWS SECURING THE LED AND DETECTOR FIXTURES! To do so, requires re-alignment when it is almost never needed. In most drives, the LED and sensor can be easily pushed out of their fixtures with a wood Q-tip and the new ones pressed into place, as they are held into place by pressure only. Be sure that the new ones don't extend out enough to snag diskettes by their sector index windows; they should be flush with their fixtures. Replacement of these components require the clipping off and removal of cable ties, and the disconnection from the logic board. Be sure that you install the new LED in the old LED fixture - and not in the old sensor fixture, and that you properly route and secure the cabling.

Unfortunately, we know of no method of aligning the sector index optical coupler without using an oscilloscope (delayed-sweep triggered by the index pulse), electronic counter, or DDA software. Using these methods, the first data pulse (start of index burst) should occur 200 us after detection of the index pulse (100 - 300 us is the acceptable range). If substantial jitter is present in the index pulse, the LED or photosensor is loose, or probably dirty or marginal, or an index electronics part in the logic board is marginal.

The photosensor alignment (almost never required) is much more critical than the LED alignment because the index signal is generated at the sensor. Verify that the LED fixture screw is just a little tighter than snug. If it was loose, retighten it, and then retest.

DISK SERVICE MANUAL III IX - 1

Virtually all index misalignments are corrected by adjusting the photosensor alone. In most drives, this can be done from the pulley side of the drive, just above or below the pulley. You'll find a phillips mounting screw. You'll also see slots in the frame and back of sensor fixture where the blade of a small screwdriver is placed to turn the fixture left and right (do not adjust by moving the screw left and right!). In some drives, these are inside a deep depression, in others, they are flush or nearly flush with the wall. Before adjusting the sensor, loosen this screw to just loose of 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 a slight amount and retest. If the sensor got out adjustment (which commonly occurs), re-adjust it. This the most aggravating of all drive alignments! Tighten the phillips a little more, and retest again. Repeat this process until the index is aligned, and the screw is just tight beyond snug.

CAUTION: 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.

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-protect notch(es) of the inserted diskette. SS and DS drives have 1 switch, floppy drives have 2.

The write-protect switch seldomly, 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 to a write-protected diskette.

Bad alignment can be either in height or linear position. Adjustment simply entails either adjusting/replacing the microswitch tang, or loosening the switch assembly, sliding it into correct position, and then retightening the assembly. Don't over-tighten as the switch can be damaged. 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.

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 micro-switch 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 (TANDONS, SHUGARTS, etc.). These doors are easy to replace, if you have a spare one. Remove the drive enclosure. Unscrew the 2 phillips screws attaching the metal plate ("latch inhibitor") 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 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 each time the door is closed to assure proper diskette seating. While the new door is closed on a diskette, tighten 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 pulley-side of the drive. When you re-attach the front panel, GENTLY tighten these screws as they can be easily stripped out. 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 don't 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 can't be properly mounted, more than likely, you'll get a DRIVE or 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. Then back-off the LED retaining collar and slip the LED out of the LED holder. 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. (C) 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 switch drives. 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 strength diminishes 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 pressure pad (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 to Head #0 is also affected. Field repair of poor DS 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 diskette-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 at fault, 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 so that visual inspection alone is enough to determine whether or not the 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 finger pressure to the drive's upper arm of the head carriage assembly while the drive is operating. Removal of the logic board and shield may be required to access it, or apply temporary gentle pressure with a long-stem Q-tip. If drive reliability substantially increases, then the felt pressure pad is worn or misaligned. If not, it may be missing. You can feel the felt pad when you clean it with a Q-tip, and you should know when it is gone.

After swinging away the logic board, and carefully swinging away or removing the upper arm assembly (2 screws or nuts), the felt pad is then peeled out of its recess in the upper arm using a pair of tweezers. Carefully peel the new pad off of its self-sticking paper backing, and stick it into the pad recess. Presto! Re-install the upper arm assembly. Inspect how the felt pad situates above the head. It should be centered precisely over the Read-Write coils, and its surface should be parallel with the head. Then install the logic board.

Whether you replace the felt pad or not, to obtain the best compliance, you may want to adjust it, which you can do in one of two ways:

(1) **UNEVEN PAD WEAR:** Two set screws or nuts secure the upper arm assembly to the head carriage assembly. By loosening these screws/nuts, the upper arm assembly can be moved around a little to recenter it on the head. If pad wear is highly uneven, use a small fine file to even it up. Retest for reliability, then GENTLY retighten the screws/nuts. Make this adjustment first, if compliance does not improve, then do (2).

(2) **EVEN PAD WEAR:** In most drives, there is a head pressure adjustment screw. It is found on top of the upper arm assembly, on top of a structure called a "spring retainer," just above a 1/2" or so skinny spring between it and the rest of the upper arm. In many drives this tiny screw is boogered-up with loctite or paint, and is a real chore to work on. If possible, tighten (CW) this screw about

DISK SERVICE MANUAL III

MISCELLANEOUS REPAIRS

IX - 2

one turn to increase the spring force, and thus felt pad pressure. Too much felt pad pressure results in excessive head and diskette wear. If it was adjusted earlier, and you replaced the pad, you might want to back off (CCW) the adjustment screw 1 or 2 turns.

LOGIC/SERVO MOTOR BOARD

Replacement of the speed control electronics entails replacing either the servo motor board if the drive has one, or the logic board. The electronics for all other drive functions - including stepper motor function - are located on the logic board. For the logic board, 2, 3 or 4 screws must be removed, and the board slid back until its notches line up with the tabs on the PC guide rail. To swing the logic board away requires disconnecting the head connector(s). To remove the logic board requires disconnecting all other signal and power connections to it. To remove the servo motor board entails disconnecting 2 connectors (P20, P21, most drives), and removing 2 screws (the board is usually mounted on stand-offs).

SPINDLE MOTOR

Replacement of the spindle motor is also easy. Removal of the logic board is required in most drives. Disconnect the motor. Slip off the belt (large pulley first). Remove the two mounting screws on the spindle-side of the drive near the small (motor) pulley, and pull out the motor. Install the new motor, slip the belt back on, reconnect the motor, and replace the logic board. The spindle motors used with almost drives that don't use a direct drive motor are identical and can be swapped between drives.

CONE MECHANISM

Replacement of the cone assembly entails removal of both the logic board and the cone lever assembly in most drives. The cone lever assembly is secured by two mounting screws in the rear of the drive.

The "cone assembly" consists of the plastic cone, and up to 12+ other small parts. There are variations among drives. Remove the "E" ring or retainer clip from the back of the cone lever assembly that secures the cone. The cone assembly then comes apart. Keep track of how the parts are assembled - label them or draw a picture. Usually, only the cone gets bad. After thousands of clamping and turning actions, particularly if abusive, it gets worn, distorted or broken, causing eccentricity problems.

Replace the cone mechanism and lever assembly in the reverse order of removal. Be sure that the door is installed right. Before tightening the mounting screws on the cone lever assembly, insert a 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). 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.

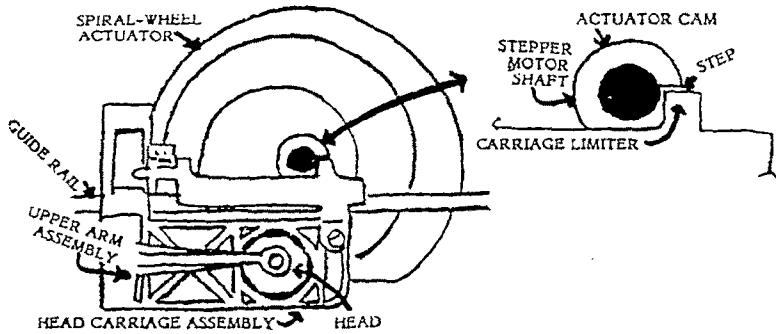
The new spindle assembly is installed in the reverse order of its removal.

HEAD CARRIAGE ASSEMBLY

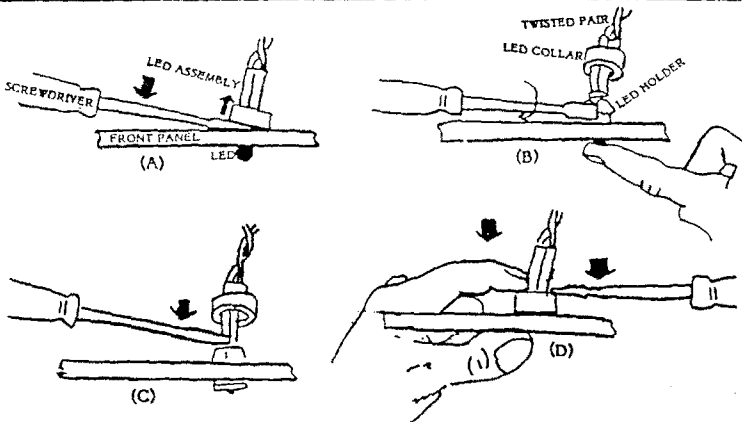
Replacement of the head carriage assembly or module assembly (carriage assembly + stepper motor) is so expensive and difficult that it almost always pays to replace the drive itself (please donate the drive to us for spare parts). It always requires re-alignment of the head(s), and usually re-adjustment 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

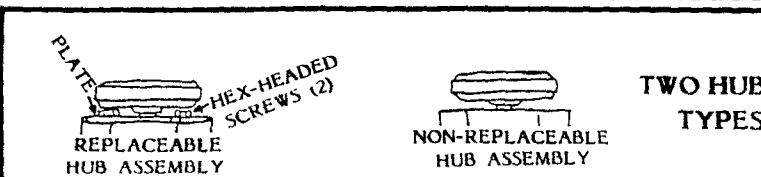
Modern 8" drives, and some others, may require special and complex procedures not described herein. These procedures differ between drive models, and usually require special tools and gauges. They include precise head load mechanism adjustments, head penetration adjustments, microfine head alignments (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.



INNER (HIGH) TRACK ADJUSTMENT: The inner track stop of SHUGART 400 and APPLE drives. *Screw to loosen to make the adjustment. Adjust to 0.020" (use feeler gauge) between the top of the Carriage Limiter and the Step and between it and the Motor Shaft.



FRONT PANEL LEDs: (A) and (B) show the proper procedure for removing front panel LEDs (activity lamps). (C) and (D) show the proper procedure for re-installing them.



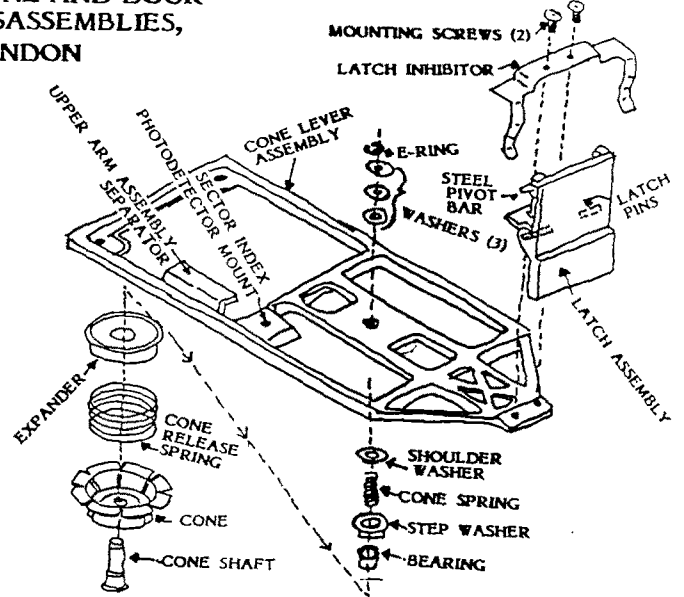
TWO HUB TYPES

DISK SERVICE MANUAL III

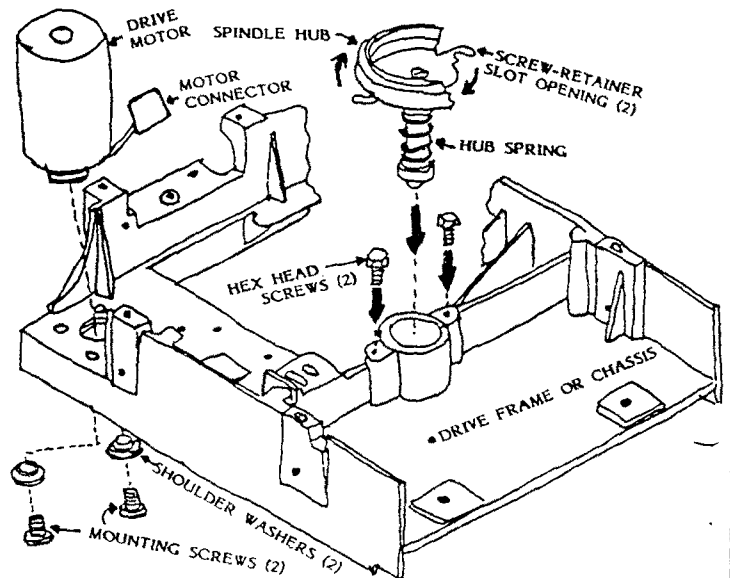
MISCELLANEOUS REPAIRS

IX - 3

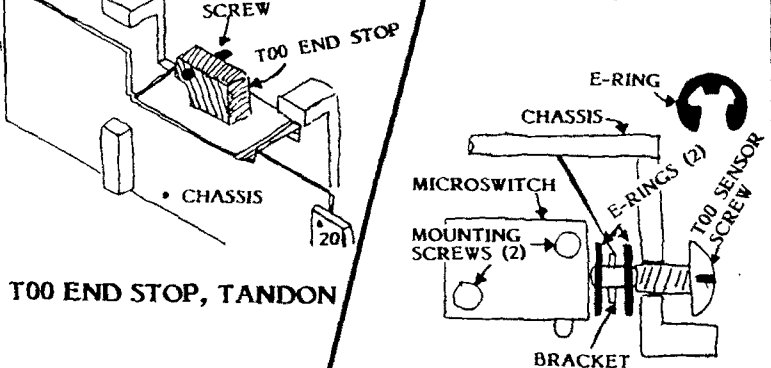
CONE AND DOOR DISASSEMBLIES, TANDON



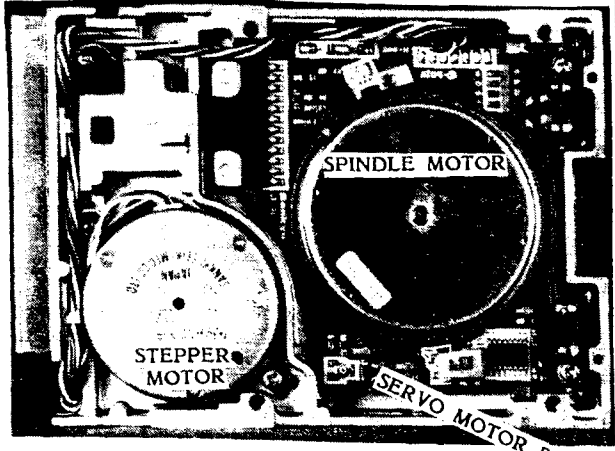
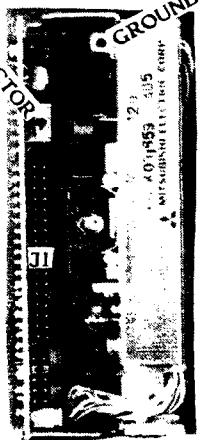
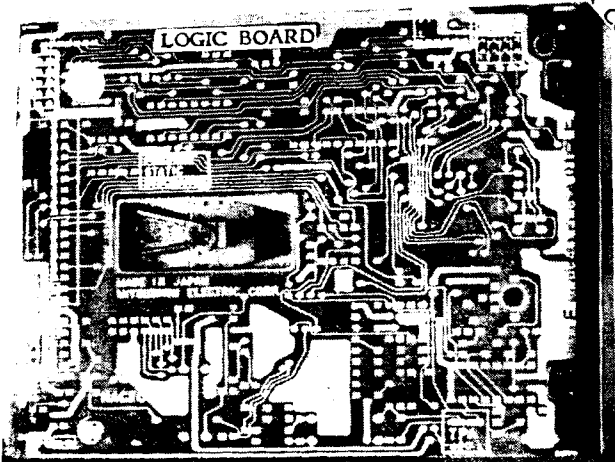
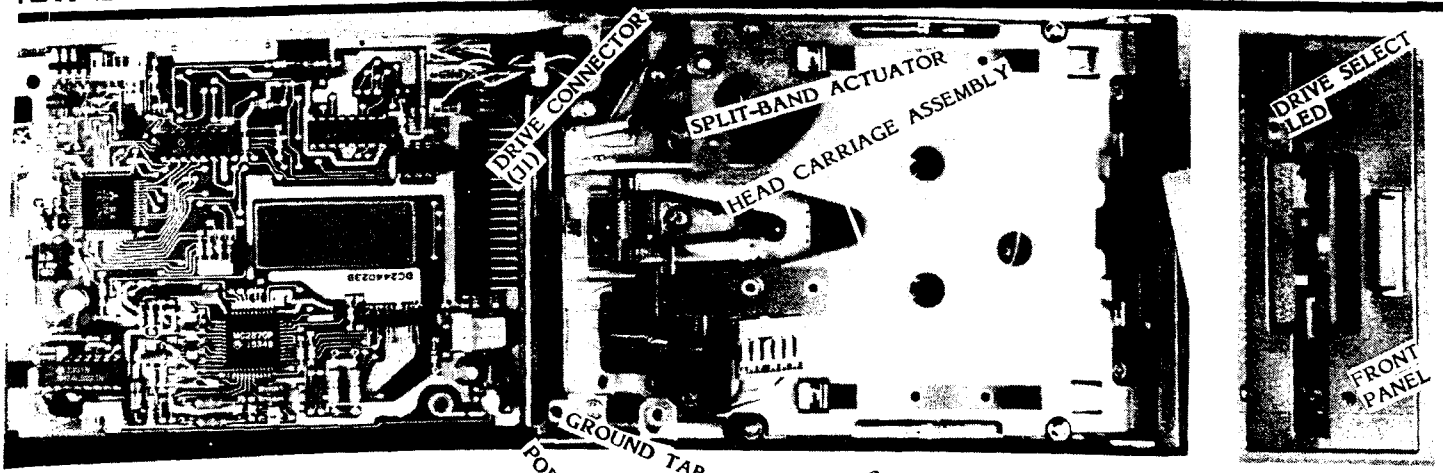
DRIVE MOTOR AND SPINDLE DISASSEMBLIES, TANDON



T00 SENSOR, TANDON



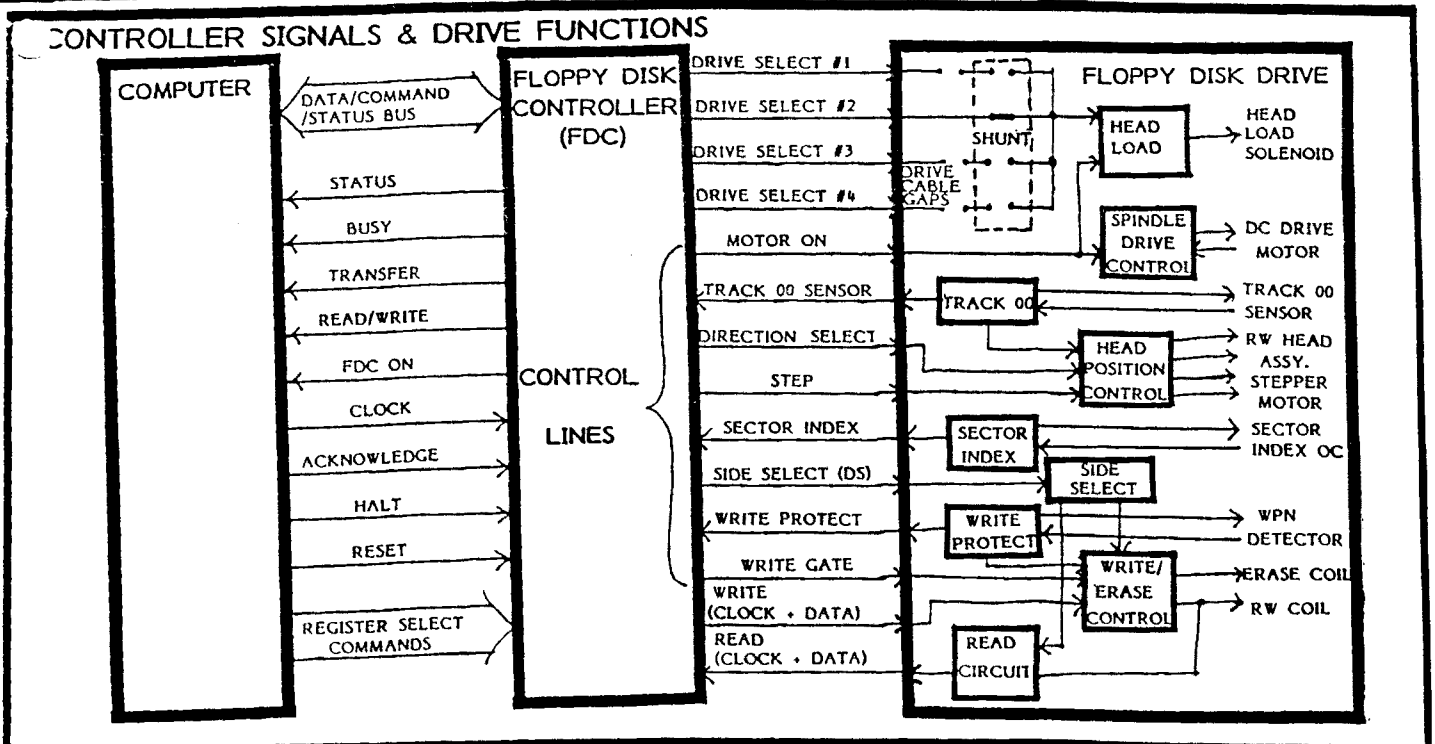
T00 END STOP, TANDON



MITSUBISHI MODEL MF353 3.5" DISK DRIVE

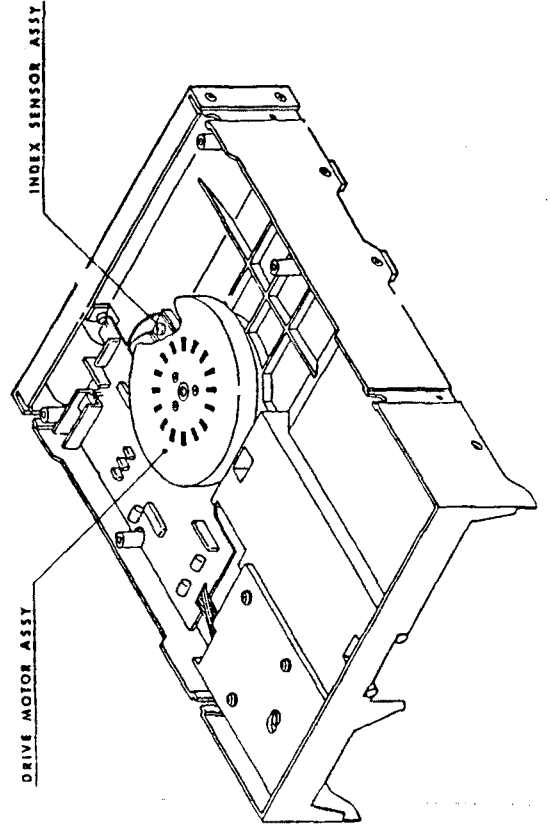
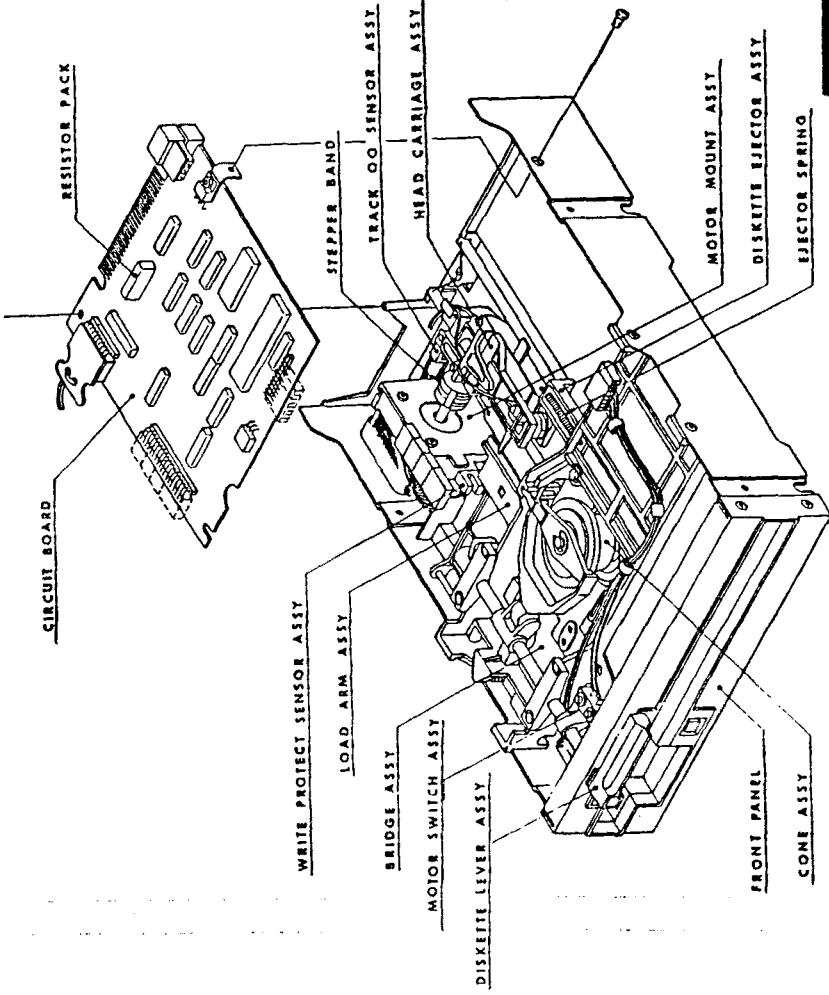
DS, DD (MFM); 80 Cylinders (TKs/side); 135 TPI
 300 RPM Spindle; Brushless DC Motor; Direct Drive
 1,000K Bytes (unformatted); 655.4K Bytes (formatted)

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

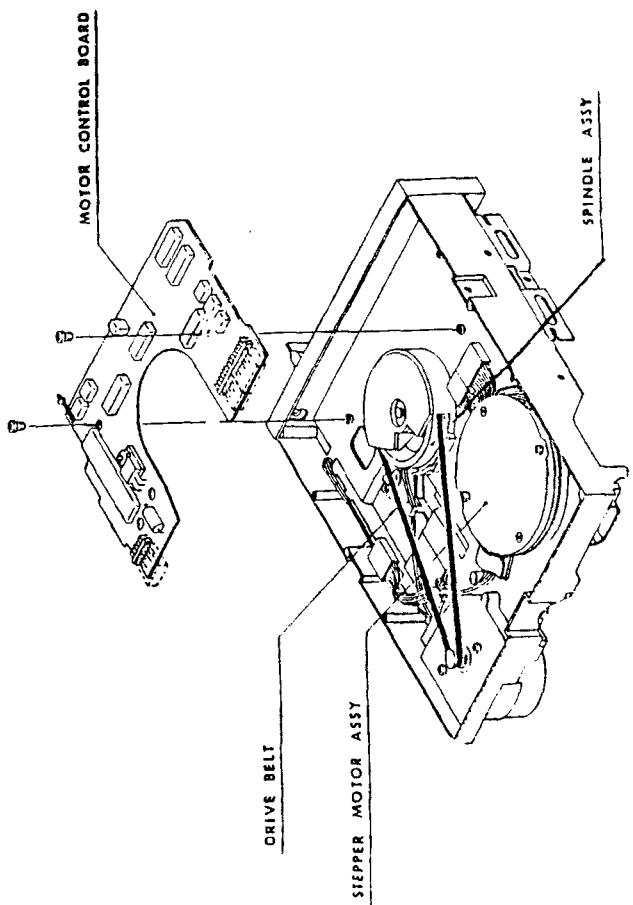
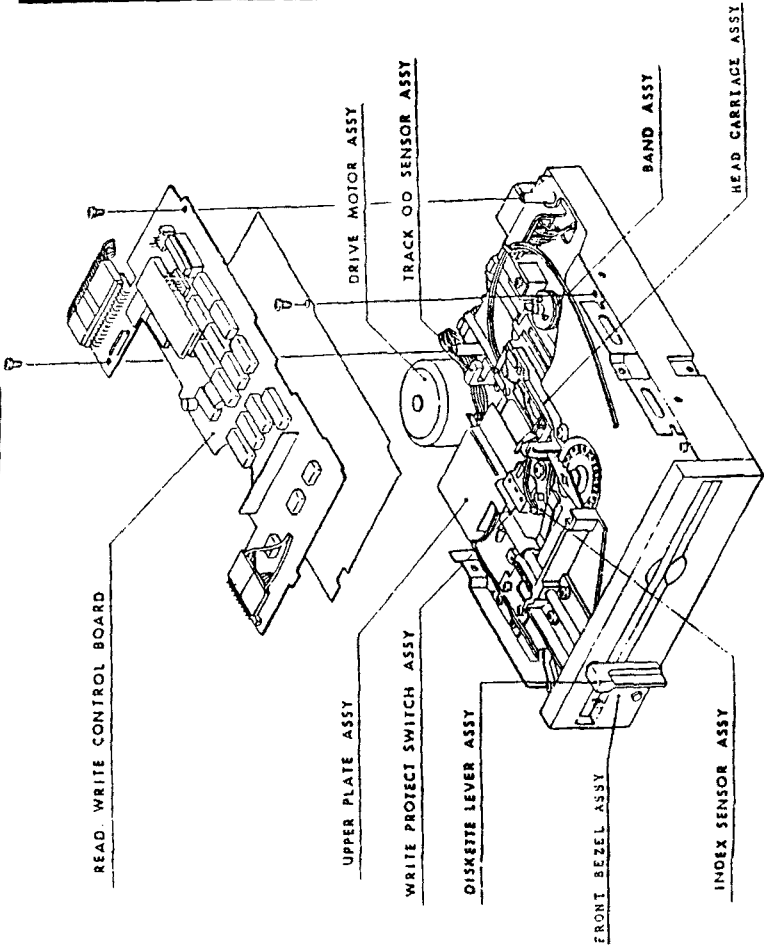


DISK SERVICE MANUAL III
MISCELLANEOUS REPAIRS

IX - 5



TANDON TM84 Mod II EIGHT-INCH DRIVE

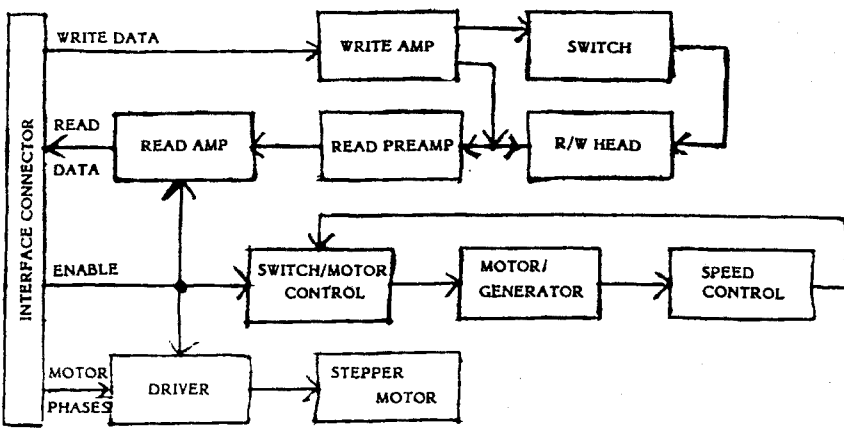


TANDON TM55-2/-4 AND TM50-1/-2
 FIVE-INCH DRIVES

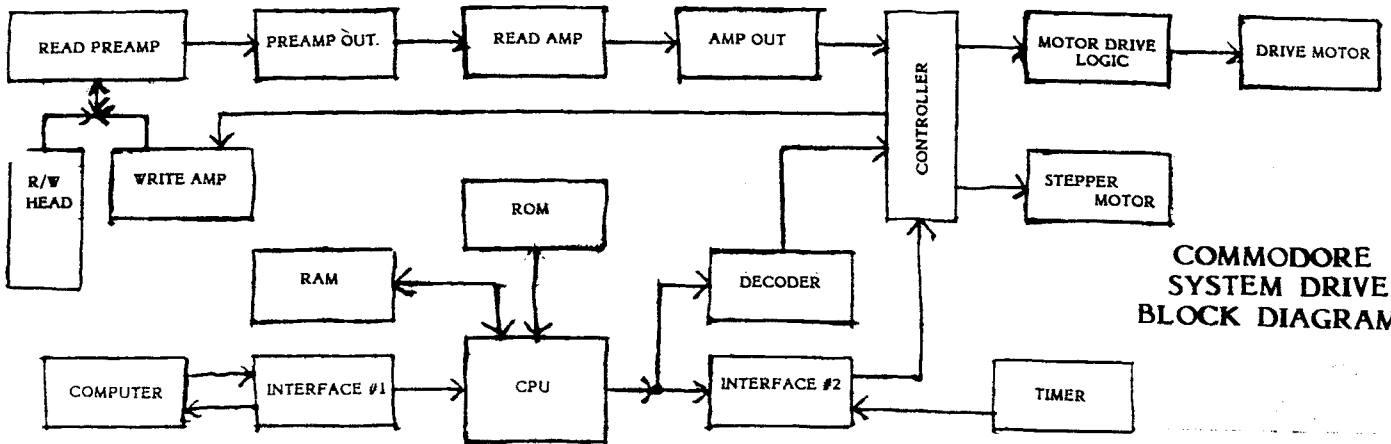
DISK SERVICE IX - 6 MANUAL III MISCELLANEOUS REPAIRS

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

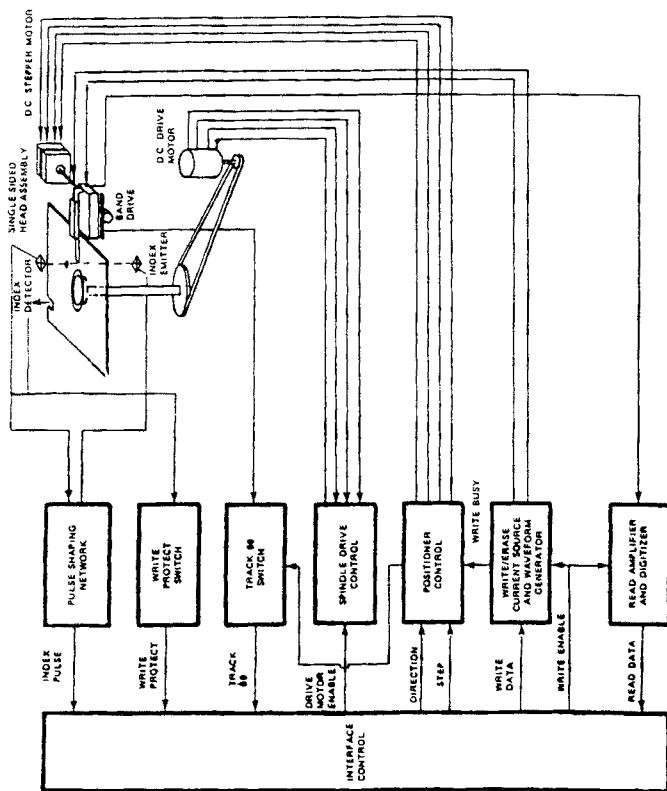
APPLE SYSTEM DRIVE BLOCK DIAGRAM



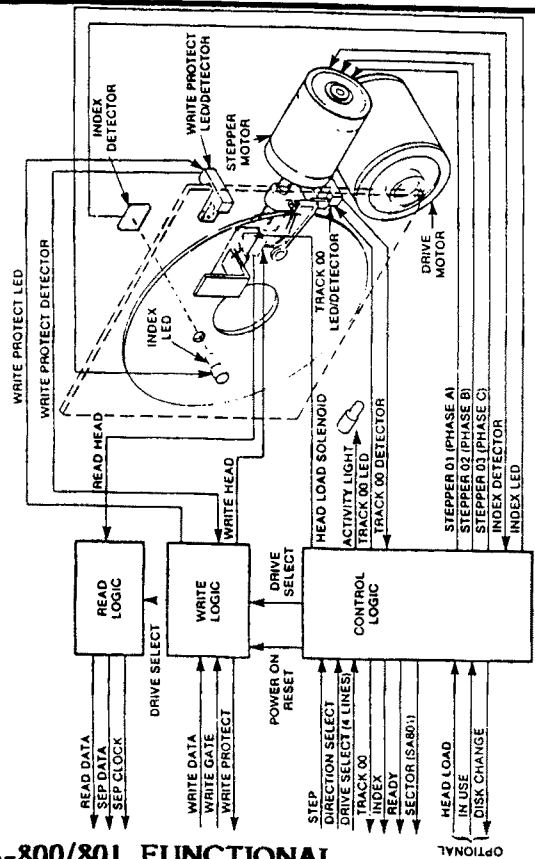
COMMODORE SYSTEM DRIVE BLOCK DIAGRAM



TM-100 FUNCTIONAL DIAGRAM (TANDON)



**SA-800/801 FUNCTIONAL
DIAGRAM (SHUGART)**



Chapter X: DRIVE TEST STATION

The advanced disk drive repairman can build his own Drive Test Station to test all of the major drive functions, and to align drives. The output connector configuration of the circuit shown here is for "standard-bus drives. All 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, T00 sensor, sector index and read data. They are all open-collector outputs from the drive that require 150-1K ohm 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 T00 sensor LED is used to indicate stepping back to T00.

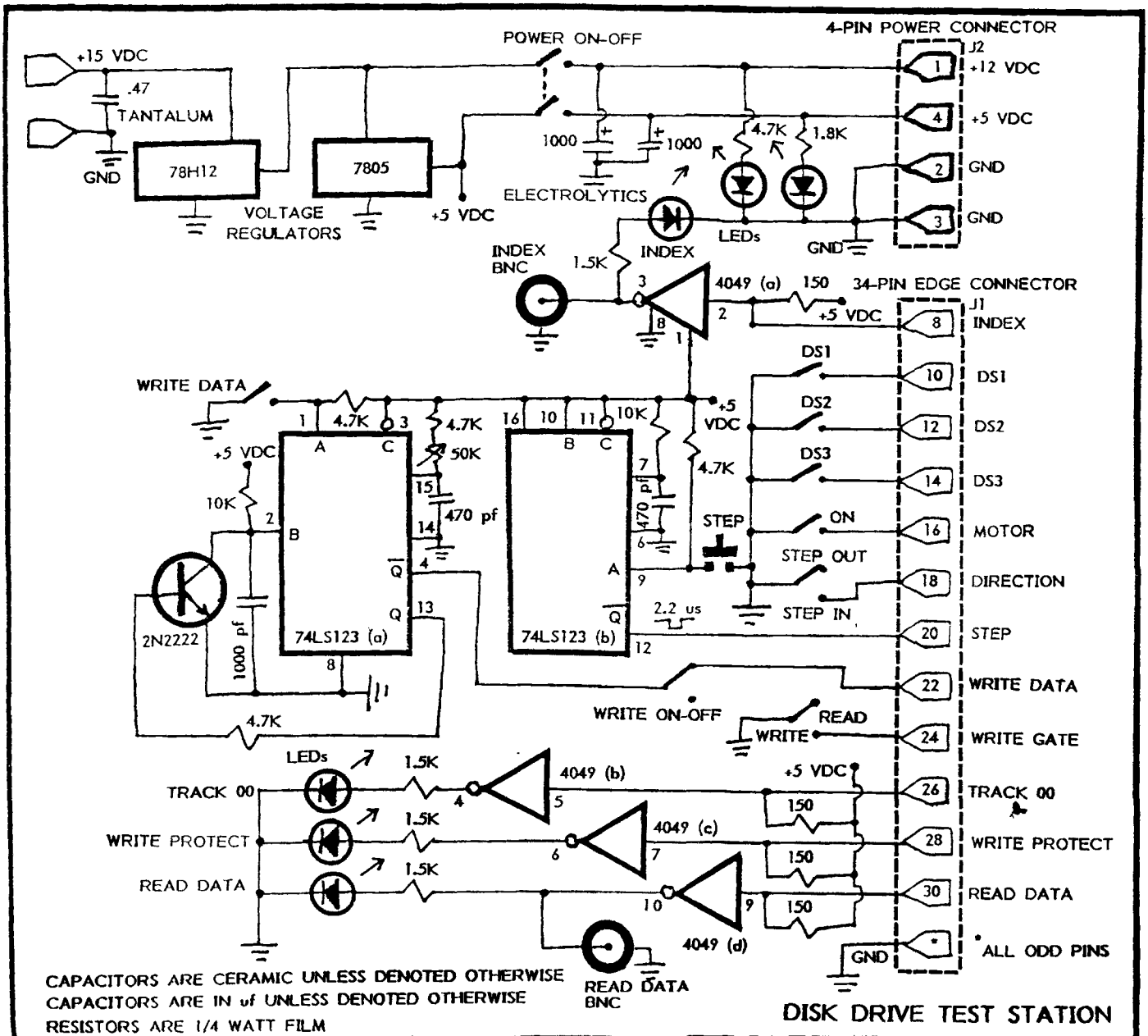
The +5 VDC and +12 VDC drive power can be constructed from a spare drive power supply with optional LEDs added, as shown, to provide indication. The +5 VDC also supplies the Drive Test Station.

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 +5 VDC. 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 msec 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. Loosen the head assembly screws. Gently adjust the alignment cam screw or stepper motor (depending upon drive model) until the signal is strongest. Gently retighten the head assembly screws, while constantly rechecking signal level. Alignment can also be done with the simple circuit shown - without an oscilloscope and with/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 circuit.

TRS-80 MODEL I

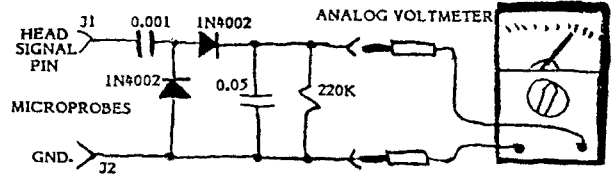
Our primary disk drive evaluator (Exerciser) is a TRS-80 Model I, which we use in conjunction with the Drive Test Station. Any other microcomputer could also be made to work. Although the TRS-80 Model I itself is "obsolete" (100,000+ are still known to be in regular use), it can thoroughly test and evaluate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

No special modification is required other than the installation of a Percom or LNW doubler board (use no other doubler) for DD. You will also have to buy or build special cables to adapt 8", microfloppy and non-standard bus drives. The LNW board will allow testing of 8" drives also. We chose the Model I because its drives are external and thus easier to work on, it supports all known standard-bus 5", 8" and microfloppy SS/DS, SD/DD, 35/40/80 Track drives (and some hard drives), and a tremendous amount of drive utility software is available for it.

DISK SERVICE MANUAL III

DRIVE TEST STATION

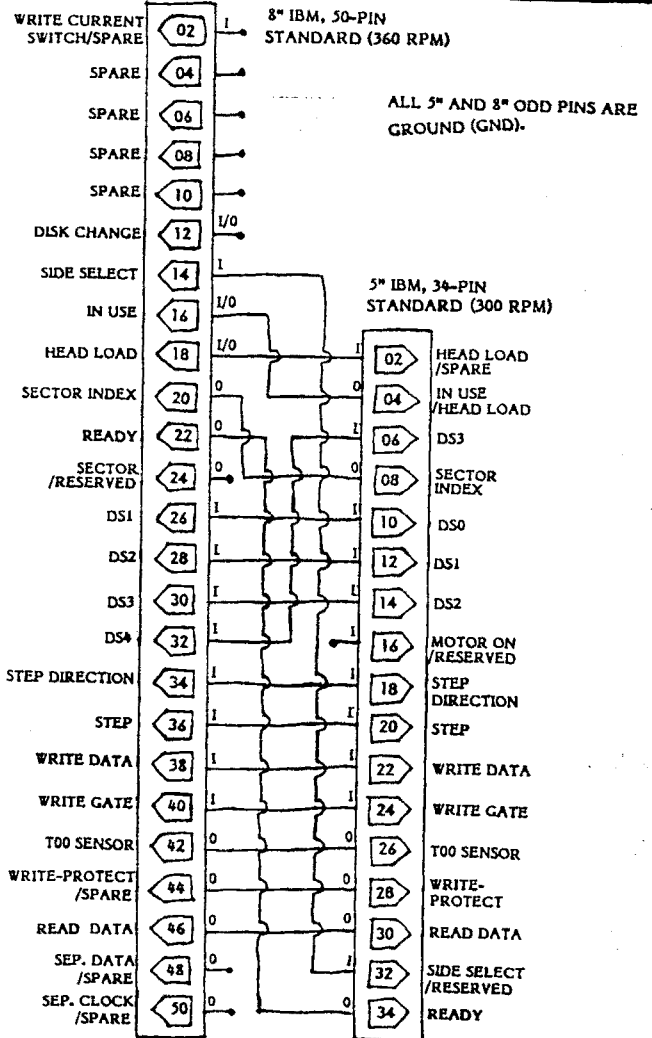
X - 2



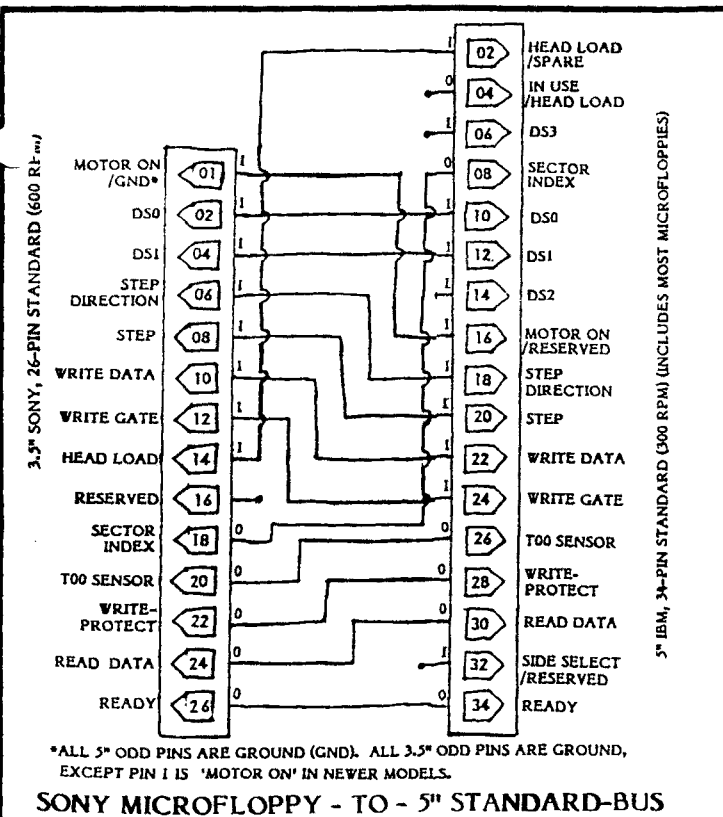
ELECTRICALLY CALIBRATE ALIGNMENT: With this simple circuit, you can electrically calibrate your R/W Head alignment by measuring the signal magnitude picked up by the head. You do this by continuously attempting to load a lengthy program in which most of the bytes are the same, for example, a BASIC program with a lot of "nnnn DATA zzz....." 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 with the analog signal.

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



8" STANDARD-BUS - TO - 5" STANDARD-BUS



SONY MICROFLOPPY - TO - 5" 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 42 TK drives were adjusted to 40 TK only. 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 µP-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 \$75 DYSAN (or other) SS or DS Cat's Eye (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.

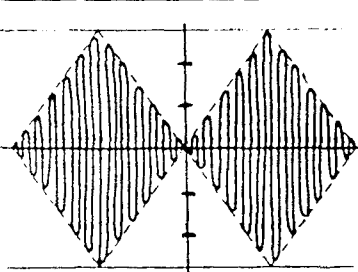
While running the drive continuously, the buffered outputs of the drive's Read circuit (TP1, TP2 on TANDON TM-100s) are connected differentially to the scope (A-B). The scope sync. is connected to the buffered output of the sector index hole detector (TP-7, TANDONS). (Although it will minimize jitter, 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-lobed 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, the maximum allowable radial misalignment error is 1.10 mils (48 TPI drives) - equivalent to a lobe ratio of 80/100 (80%). With most drives, with a little more work, you can achieve 95-100% symmetry using the CE alignment method. Drives aligned to only 70-80% symmetry almost always require a future alignment much sooner than ones aligned to 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 drive shops use their expensive equipment and software as eye wash only, or they have a keen eye for future business!

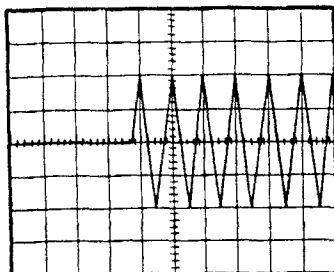
When using a differential oscilloscope to measure misalignment, the offtrack for 48 TPI drives, in inches, is computed to be:

$$\text{OFFTRACK} = (1 - (\text{1st. lobe amplitude} / \text{2nd. lobe amplitude})) \times 0.01 / (1 + (\text{1st. lobe amplitude} / \text{2nd. lobe amplitude}))$$

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



CAT'S EYE PATTERN



INDEX TO DATA

DISK SERVICE MANUAL III XI - 1

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 diskette as being compatible 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 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 disk drive. If you go the professional CE route, and your bad drive eats your \$40-\$90 alignment diskette, which is not uncommon, you are out \$\$\$\$!

NOTE: The software, CE data diskette, and procedures used in the CE alignment method are different than and incompatible to the DDD data diskette used in the DDA software-only 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 alone is totally inadequate because it fails to directly test drive speed, Read Sensitivity, sector index adjustment, clamping (eccentricity), azimuthal alignment, and T00-sensor and end stop positioning. In other words, a CE-aligned drive may pass the CE tests with flying colors and still not function! Usually, for the price of an alignment (\$20-\$50), that's all you get. The "aligned" drive can be returned to you still totally non-functional! Additional repairs will cost you much more - even when no parts are required.

WESTERN DIGITAL CORP. FD 179X-02 FDC FAMILY

BIT	ALL TYPE I COMMANDS	READ ADDRESS	READ SECTOR	READ TRACK	WRITE SECTOR	WRITE TRACK
S7	NOT READY	NOT READY	NOT READY	NOT READY	NOT READY	NOT READY
S6	WRITE PROTECT	0	0	0	WRITE PROTECT	WRITE PROTECT
S5	HEAD LOADED	0	RECORD TYPE	0	WRITE FAULT	WRITE FAULT
S4	SEEK ERROR	RNF	RNF	0	RNF	0
S3	CRC ERROR	CRC ERROR	CRC ERROR	0	CRC ERROR	0
S2	TRACK 0	LOST DATA	LOST DATA	LOST DATA	LOST DATA	LOST DATA
S1	INDEX	DRQ	DRQ	DRQ	DRQ	DRQ
S0	BUSY	BUSY	BUSY	BUSY	BUSY	BUSY

STATUS FOR TYPE I COMMANDS

BIT NAME	MEANING
S7 NOT READY	This bit when set indicates the drive is not ready. When reset it indicates that the drive is ready. This bit is an inverted copy of the Ready input and 'ored' with MR.
S6 PROTECTED	When set, indicates Write Protect is activated. This bit is an inverted copy of WRPT input.
S5 HEAD LOADED	When set, it indicates the head is loaded and engaged. This bit is a logical 'and' of HLD and HLT signals.
S4 SEEK ERROR	When set, the desired track was not verified. This bit is reset to 0 when updated.
S3 CRC ERROR	CRC encountered in ID field.
S2 TRACK 00	When set, indicates Read/Write head is positioned to Track 0. This bit is an inverted copy of the TROO input.
S1 INDEX	When set, indicates index mark detected from drive. This bit is an inverted copy of the IP input.
S0 BUSY	When set command is in progress. When reset no command is in progress.

STATUS FOR TYPE II AND III COMMANDS

BIT NAME	MEANING
S7 NOT READY	This bit when set indicates the drive is not ready. When reset, it indicates that the drive is ready. This bit is an inverted copy of the Ready input and 'ored' with MR. The Type II and III Commands will not execute unless the drive is ready.
S6 WRITE PROTECT	On Read Record: Not Used. On Read Track: Not Used. On any Write: It indicates a Write Protect. This bit is reset when updated.
S5 RECORD TYPE/ WRITE FAULT	On Read Record: It indicates the record-type code from data field address mark. 1 = Deleted Data Mark. 0 = Data Mark. On any Write: It indicates a Write Fault. This bit is reset when updated.
S4 RECORD NOT FOUND (RNF)	When set, it indicates that the desired track, sector, or side were not found. This bit is reset when updated.
S3 CRC ERROR	If S4 is set, an error is found in one or more ID fields; otherwise it indicates error in data field. This bit is reset when updated.
S2 LOST DATA	When set, it indicates the computer did not respond to DRQ in one byte time. This bit is reset to zero when updated.
S1 DATA REQUEST	This bit is a copy of the DRQ output. When set, it indicates the DR is full on a Read Operation or the DR is empty on a Write operation. This bit is reset to zero when updated.
S0 BUSY	When set, command is under execution. When reset, no command is under execution.

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ALAMOGORDO, NM 88310

Chapter XII: DRIVE ANALYSIS SOFTWARE CRITIQUE

The following firms produce DDA software:

- (1) J & M SYSTEMS, LTD (137 Utah NE, Albuquerque, NM 87108) — TRS-80s, KAYPRO, IBM, and SANYO.
- (2) DYMEK CORP. (1851 Zanker Rd., San Jose, CA 95112) — IBM, APPLE, and TRS-80.
- (3) VERBATIM (323 Soquel Way, Sunnyvale, CA 94086) — APPLE, and IBM.
- (4) SHEEPSHEAD SOFTWARE (P.O. Box 486, Boonville, CA 95415) — KAYPRO.
- (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 (883a Cambridge St., Cambridge, MA 01945) — 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, but not all microcomputer systems are supported by DDA software. If your system is not DDA supported, you can overcome this problem if your system uses standard-bus drives (not any non-supported system requiring a specially-configured or proprietary drive), and you can temporarily switch the drives to another standard-bus computer that is DDA supported (even if one system uses hard-sectoring and the other 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/adjustment in all other systems they can be used in. Other systems are DDA supported only to a limited extent due to one factor or another:

- (1) Systems using a NEC controller (ex: DIGITAL EQUIPMENT CORP.) cannot use DDA software for drive speed or sector index adjustments simply because NEC 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 speed-wise.
- (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 fool-up its use. Universal systems, such as CP/M, usually free the system of at least the computer dependence. However, systems that are labeled as "compatible" (ex: IBM compatibles and clones) may not be DDA software compatible. Also, since drives come in many different variations (size, density, # sides, # tracks), and most DDA software will only fully test one configuration, one DDA package may not support all of your drives. Also, so-called compatible systems may have drives in which the head is displaced one or more integer tracks from each other, and are neither drive nor drive utility software compatible. Some DDA packages may not detect displaced (but aligned) tracks, and will OK two perfectly aligned drives that are not physically compatible with each other (due to the difference in head physical positions for T00).
- (5) Most systems that run their controllers from real time clocks (ex: 60 Hz line frequency) are not supported by DDA software because proper index timing resolution for accurate speed and index timing adjustments is not possible.
- (6) We have not found any DDA package that directly tests the T00 sensor and end stop. What is required is continuous stepping back-and-forth between T00 and T01, T02 or T03 so that the T00 sensor and/or end stop can be precisely adjusted.
- (7) Few DDA packages provide actual access time information. This is usually expressed as the amount of time (but sometimes as the actual number of attempts) to load a set program, track or sector, and is intimately related to drive actuation method, head alignment, hysteresis, clamping, Read Sensitivity, and diskette quality. Armed with such a capability, one would have a powerful tool for evaluating both drives and diskettes for quality.

J & M SYSTEMS DDA

We fully evaluated the J & M SYSTEMS, LTD DDA software, of which we have mixed feelings. Most of our comments below also apply to DDA software in general:

ADVANTAGES

- (1) The J & M DDA software lets you quickly check radial and rotational head alignment, hysteresis, clamping, speed, index hole timing, and read sensitivity without using an oscilloscope! You can set drive speed, radial head alignment and sector index photodetect-or position. A quick test is provided so that you can quickly check out most of these factors in one fell swoop. Also, you can use the software with a differential oscilloscope to do a more traditional alignment. And the J & M graphics are outstanding! The clamping (eccentricity) and alignment tests graphically point out that by merely reclamping your diskette, significant changes in eccentricity and alignment occur!
- (2) The price is reasonable: \$79-\$89, and the software includes a separate DYSAN DDD alignment pattern diskette. (DDA software from other producers may combine the DDA and DDD diskettes into one.)
- (3) The J & M software is available for the IBM-PC, TRS-80 Model 1/III/4, TRS-80 Color Computer and TDP-100, KAYPRO, SANYO, etc.
- (4) Even if you don't do your own work, you can use the J & M DDA software to determine when to scrap or sell your drives, or have them repaired. It can also be used to evaluate new or used drives prior to purchase or during the guarantee period to ferret out lemons, to estimate remaining useful life, and to evaluate shop repairs. The hysteresis and Read Sensitivity tests can also be used to indicate when to clean and lubricate your drives. The Read Sensitivity test is a powerful tool to detect deteriorated compliance caused by worn felt pressure pad, misaligned upper-arm assembly, worn head, bad head loader and failing 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 is created by a special drive using special procedures. It's risky to put ANY diskette in ANY suspect drive! What if the head wiring, or write-protect and write enable circuitry are defective or noisy? What if the drive, due to mechanical failure or head defect, loves to eat diskettes (ex: burr on the head, defective cone, loose part)? If your DYSAN DDD diskette is destroyed, you're out \$\$\$\$ and time!! The clamping used by some drives (TANDONS, etc.) will distort diskette center holes - that is why hub rings were invented and are overwhelmingly used! Once distorted, the diskette cannot be properly clamped, and it rotates eccentrically. This is particularly devastating in an alignment DDD diskette where alignment precision is extremely critical. Because DYSAN doesn't install hub rings in their diskettes, you either must accept a much shorter lifetime for them, or take the chance of installing the hub ring yourself (which they warn against). Frankly, I consider the lack of the hub ring in the DYSAN DDD to be an important, if not the most important, reason for NOT buying DDA software! NOTE: We installed our own hub rings in our DDD diskettes without any noticeable changes in the test results.
- (2) What if one of the diskettes are destroyed or gets worn out - say 5 years from now? The company who sold it to you may not still be in business or support your model! In the final analysis, the less you depend upon hard-to-get, special, delicate, and/or expensive tools and parts to do any job - and just stick to the basics - the better off you'll be!
- (3) J & M first sent us software for the wrong model, but quickly and responsibly corrected their mistake. Still, it was an annoyance. According to 80 MICRO (Sept. 1984), their software has a bug, and apparently still has the bug! We are also critical of J & M's supplied manual. It adequately describes how to run its various tests and, less adequately, what they mean. However, it does not describe how one actually makes a Read-Write head, T00, or sector index alignment, or speed adjustment - in spite of the fact that at the end of the alignment chapter (8), it refers you to the last chapter for a non-existing discussion on head alignment. In fact, we can't find any mention of either the T00 sensor or T00 end stop! Nor can we find any mention of a drive make or model! Drive speed adjustment discussion is shallow. The software comes with no illustrations or photos relating to drive anatomy. Unless you are already an expert at aligning and adjusting drives, or have on hand a copy of DISK SERVICE MANUAL and/or a copy of the drive's service/maintenance/OEM manual, I strongly do not recommend that you work on your own drives using the J & M system.

SHEEPSHEAD SOFTWARE produces DDA software for the **KAYPRO**. Although we were unable to obtain and test their DDA software, we found their documentation to be excellent - very specific, detailed and comprehensive with drive illustrations and photos. **DYMEK** documentation is apparently very, very skimpy.

(4) 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 plully 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 seems 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.

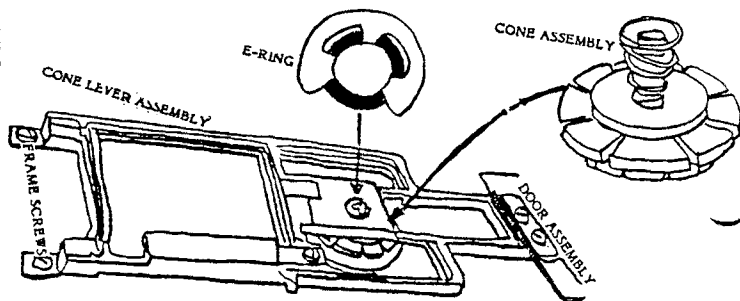
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DISK SERVICE MANUAL III

DRIVE ANALYSIS SOFTWARE XII - 2

so, to us, the J & M software didn't provide significant help to adjust the photodetector.

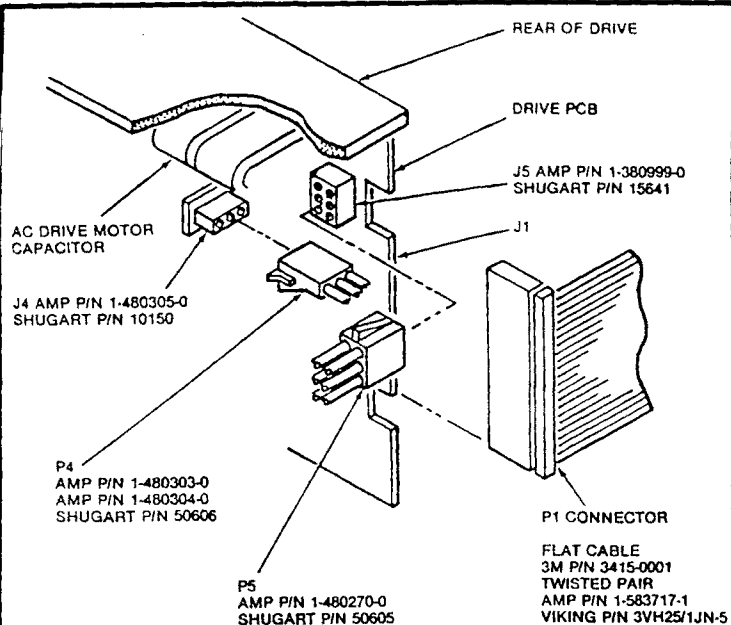
(5) The J & M DDA software may not apply to all the types of drives that your system can use. For example, our drive test station includes a TRS-80 Model I. The J & M DDA software we purchased is good for 5" SS, SD drives only - the only available J & M software for the Model II! It is useless for testing our 80 Track DS, 8" and other drives! In other systems, J & M software for other drive types are also available but are individually priced.



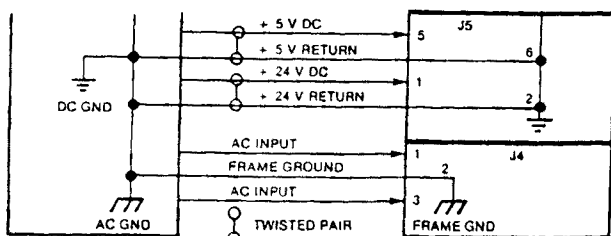
APPLE DRIVE CONE LEVER ASSEMBLY

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INTERFACE CONNECTORS - PHYSICAL LOCATION DIAGRAM



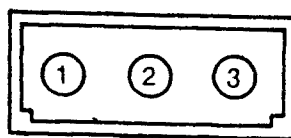
POWER CONNECTORS

P4 PIN	60 Hz		50 Hz	
	110 V (Standard)	208/230 V	110 V	220 V
1	85 - 127 V AC FRAME GND	170 - 253 V AC FRAME GND	85 - 127 V AC FRAME GND	170 - 253 V AC FRAME GND
2	85 - 127 V RTN	170 - 253 V RTN	85 - 127 V RTN	170 - 253 V RTN
3				
MAX CURRENT	0.35 AMPS	0.23 AMPS	0.35 AMPS	0.23 AMPS
FREQ TOLERANCE	± 0.5 Hz		± 0.5 Hz	
P5 PIN	DC VOLTAGE	TOLERANCE	CURRENT	MAX RIPPLE (p to p)
1	± 24 V DC	± 1.2 V DC	1.7 A MAX* 1.3 A TYP	100 mV
2	+ 24 V RETURN			
3**	-5 V RETURN			
4**	-5 V DC OPTIONAL -7 to -16 V DC TRACE 'L'	± 0.25 V DC NA	0.07 A MAX 0.05 A TYP 0.10 A MAX 0.07 A TYP	50 mV NA
5	+ 5 VDC	± 0.25 V DC	1.0 A MAX 0.8 A TYP	50 mV
6	+ 5 V RETURN			

*The 24 V dc power requires a separate ground return line. The +24 V return, other ground return lines, and frame ground must be connected together at the main power supply.

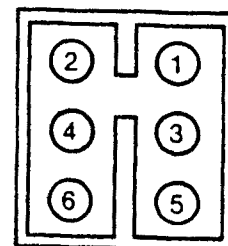
**Not required on LSI PCB's.

VOLTAGE SPECIFICATIONS



J4 CONNECTOR

50574-21



J5 CONNECTOR

50574-20

SA-800/801 POWER SUPPLY
SPECIFICATIONS (SHUGART)

Chapter XIII: DRIVE MODIFICATIONS

SHUNTS & JUMPERS

Early floppies contained only a few selectable features and options. These included DS# (Drive Select #), 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 shunts (called "provided JSs" here). 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 JS changes. Each drive model has its own options set-up. In every known case all mods are done on the logic board. In some drives they are grouped into one area but in others they are scattered all over the logic board. Should you be uncertain on how to make JS changes, refer to your particular drive manual. Some of the possible features and options are:

(1) **DRIVE SELECT:** DS#s are indicated alongside provided JSs as either DS1-DS4 or DS0-DS3 (some drives are limited to only one, two or three DS#s). The JS labels are usually very small and hard to read. If your drive cable is unkeyed (ungapped) you must make the appropriate DS# JS; one, and only one, DS# must be selected. The selected DS# need not have any relationship to drive physical position. If your drive cable is keyed (gapped), you must select the DS# that corresponds with the cable keying; you can, in fact, JS all DS#s without problem. If your system uses only one drive, you must JS MX; 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) 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 DS# to the side select circuitry.

(3) **ACTIVITY LED ACTIVATION:** Several options are available in some drives. Activity LED ON upon: (A) Drive select. (B) Ready or pre-ready. (C) In-use. (D) Any combination of drive select, ready/pre-ready and in-use. By far, (A) is most common. Some 8" drives have solenoid door 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 JS). (B) Motor-On (HM JS). 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 when a diskette is either inserted or removed from the drive (highly recommended) (PM JS). Motor-On may depend upon activity LED (ML JS) and/or head loading options in some drives. JSing motor-On also depends upon whether or not the system sends motor-On commands. No motor-On commands are sent by the IBM-PC and most of its compatibles and clones, and motor-On must be JSed to each drive's drive select.

(6) **AUTOMATIC RECALIBRATION TO T00:** Automatic Recalibration to T00 for each time the drive is selected may be chosen (RE JS). 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 totally hardware controlled inside the drive. 5" drives are traditionally 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 switch(es) 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.

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

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

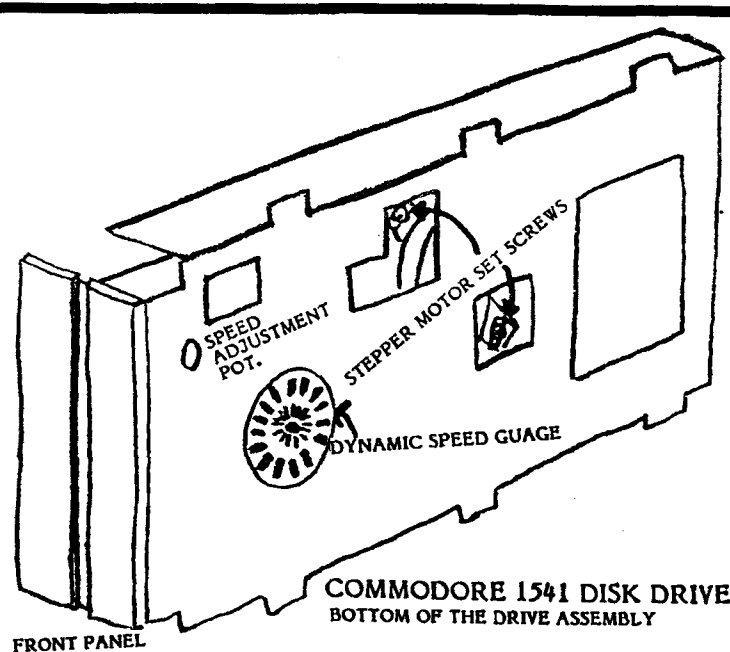
These mods are simple, carefree and safe. All active lines to and from drives and computers are open-collector. You cannot damage either drive or computer electronic components by accidentally selecting two drives as the same drive number, although you won't be able to Read or Write to them while configured 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 (unkeyed) drive cable. Look at all drive connectors. If all contacts are present in all drive cable connectors, the cable is unkeyed. To select between 2 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-type 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 cabling won't interfere with the diskette and write-protect notch detector.

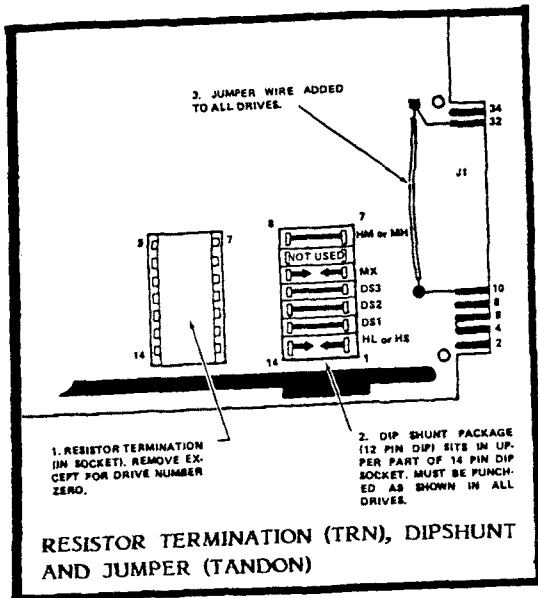
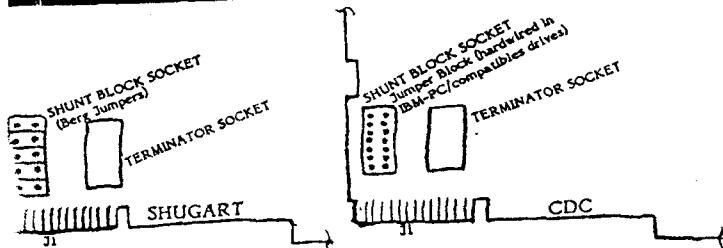
The drive select jumpers, header or dip switch are then removed. In common headers, MX, HL, HM and HS shunts have to be separately jumpered in their previous positions. In most drives, the drive select IC socket contacts are 2-15 (DS1), 3-14 (DS2), 4-13 (DS3), 5-12 (DS4). The lower contact numbers (2-5) are wired to connector J1 contacts. Contact numbers 15-12 are shorted together and are wired to the logic board electronics. Solder the J1-side contacts to the throw positions of the toggle or rotary switch. Solder any logic board-side contact, DS1-DS4 (or DS0-DS3), to the switch pole.

In DS drives, generally J1-32 is used as the side select, and J1-6 is DS4. In SS drives, J1-32 may be used as DS4 (J1-32 may be separately jumpered to J1-6, in which case, remove or cut this jumper). With the drive in operation, and your computer selecting Side #0, measure the voltage at J1-32 when the drive is selected. In most systems, this voltage is +5 volts. To wire the toggle switch to J1-32 for side select, trace the PC land from 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 gauge, stranded, plastic-insulated wire. Solder the other end of the switch contact to any signal ground point. When you switch the toggle switch, Side #1 will be forcibly selected, regardless of what the computer "thinks" it selected.



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LOCATIONS OF SHUNT BLOCK SOCKET AND RESISTOR TERMINATOR SOCKET IN CDC, SHUGART AND TANDON DRIVES

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's J1-32 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 frequently 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 their J1 connector DS# pins. Head electronic swaps are also a method for testing suspect drive electronics.

OTHER DRIVE MODIFICATIONS

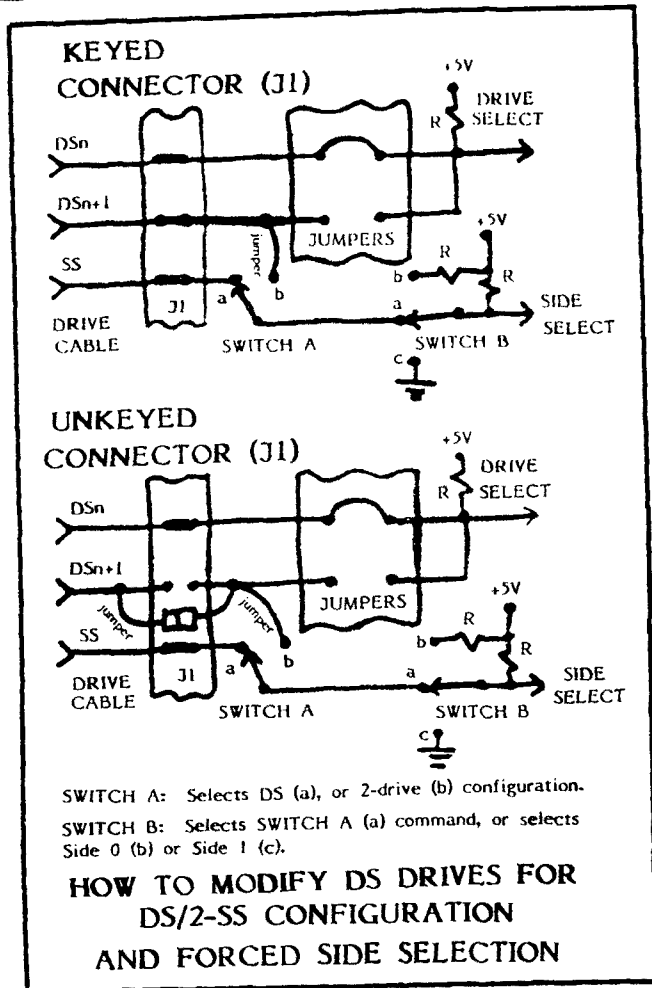
Other drive electronic mods can be made. Some folks install toggle switching of motor-On (switched ON by grounding the motor-On line), and head loader (also activated by grounding the head loader line).

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 modify. 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 floppy by installing an additional sector index optical coupler and write-protect detector opposite the originals. Also requires electronically OR'ing the two photodetector outputs. The 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 floppy is found in RADIO ELECTRONICS, COMPUTER DIGEST, July 1985, 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.



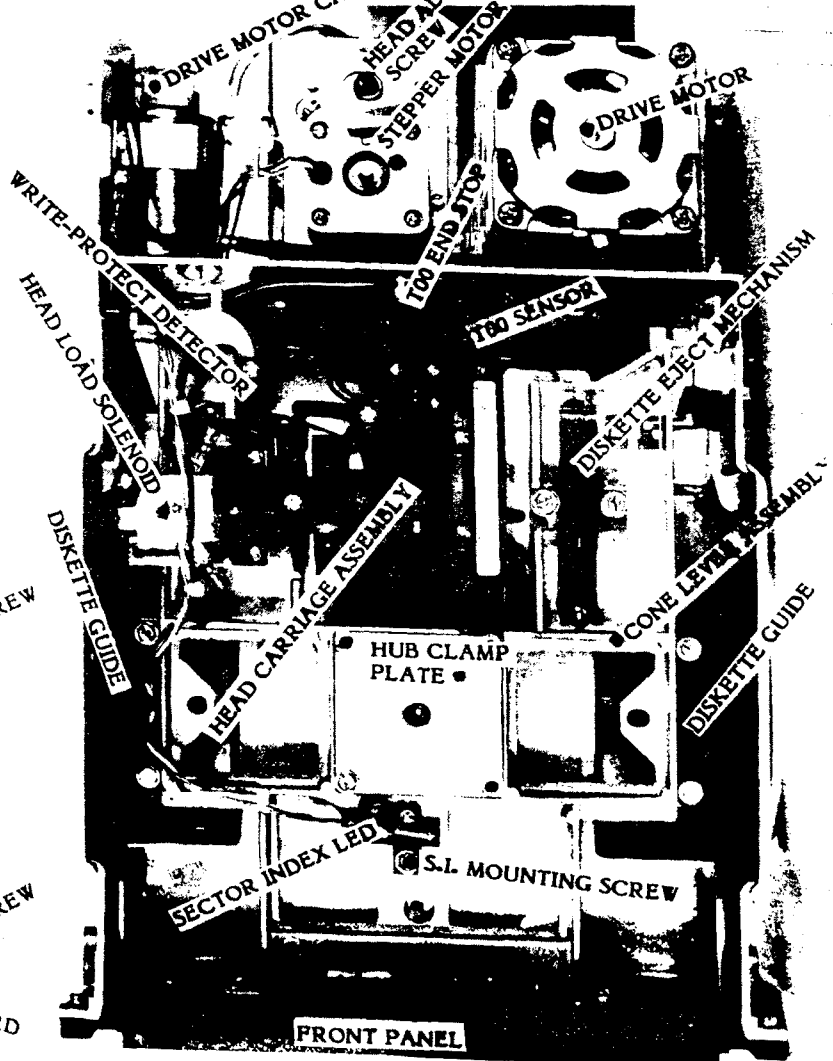
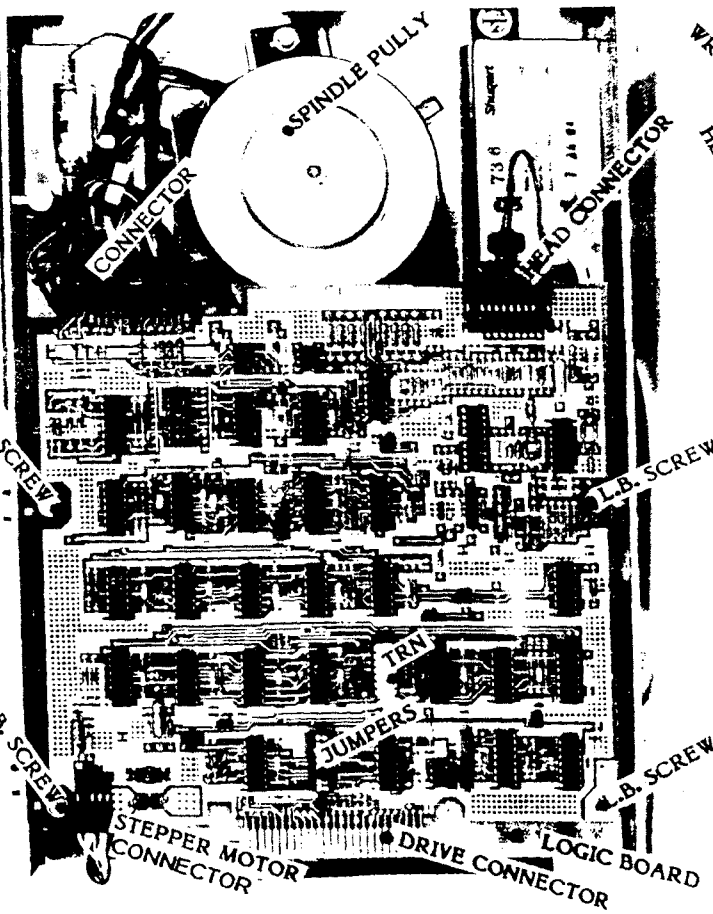
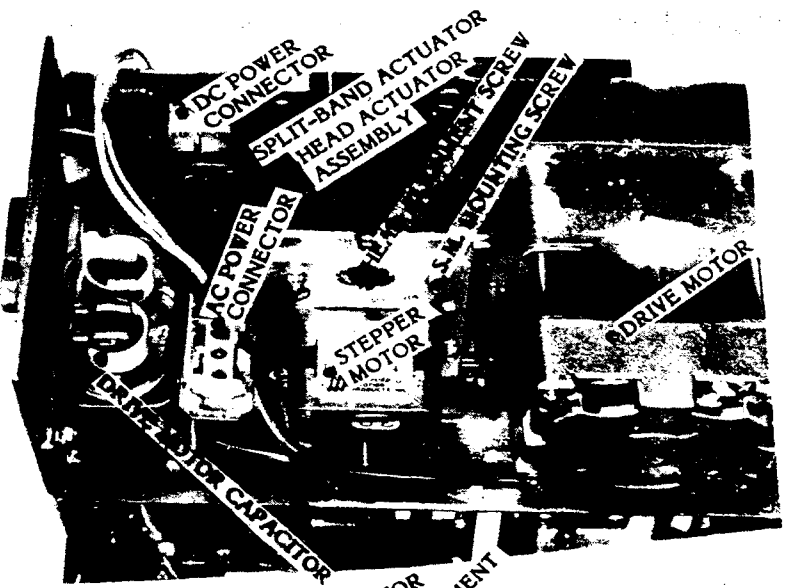
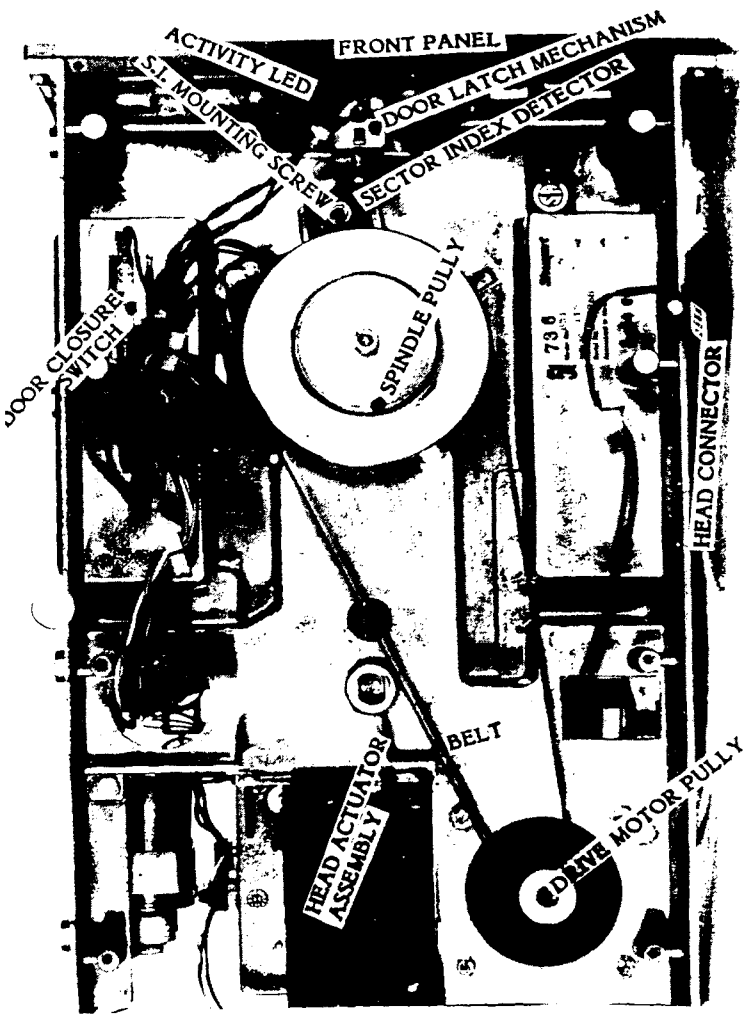
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SHUGART SA-851

L

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

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.

