FIGURE 1: Original ICT Mini Chief advertisement <u>Commodore Magazine</u>, December 1987, p. 92.

Parts List:

Drive:

Commmodore 1571 Disk Drive	$20.00 - $50.00	eBay

Power Supply:

Item	Approximate Cost	Where to find
IBM AT POWER SUPPLY w/switch	$20.00	eBay
DIN MALE,5 PIN,STD,PLUG	$0.54	Jameco P/N 15879 Allelectronics.com
Din FEMALE,5 PIN,STD,SOCKET	$1.45	Jameco P/N 15843 Allelectronics.com
4 conductor 22 AWG shielded cable	?	Jameco
Power cable Y-connector	$5.99	Radio Shack 278-766
Power cable Extension	$3.99	Radio Shack 278-767
4 prong connector 0.1" w/female pins		
(2) #6-32 x 3/8" Flat Head Machine Screws w/nuts	$0.99	Home Depot

Cooling:

12 VDC 110 mA Fan	$2.35	Jameco P/N 75352
(2) #6-32 x 1 ¼" Round Head Slotted Machine Screws w/nuts	$0.99	Home Depot

Hard Drive:

Fuji FK305-26 20 MB MFM	$20.00 - $225.00	Various (eBay)
Western Digital WD1002A-WX1 8-bit Controller Card (ISA)	$10.00 - $20.00	eBay
31/62 Edge Connector	$1.00	Allelectronics.com P/N EBC-62

Chips:

27C256 EPROM	$2.00	eBay
6264-10 SRAM (check datasheet)	$2.00	eBay
74LS42	$1.01	Jameco P/N 75352

Components:

(3) ¼ watt 10K +/- 5% resistors	$1.00	Jameco P/N 691104
(1) ¼ watt 120 oHm +/- 5% resistor	$1.00	Jameco P/N 690646
(2) zener diodes		
(2) red 2x5x7mm rect LEDs	$0.35 each	Jameco P/N 1555761
(2) green 2x5x7mm rect LEDs	$0.35 each	Jameco P/N 1555796

Miscellaneous

SPST Toggle switch	$2.00	Radio Shack, Jameco
Multicolor Flat Ribbon Cable 28AWG, 10 conductors	$3.55 (10 ft)	Jameco
Heatshrink tubing		

| 28 AWG hookup wire | $9.00 for 100 ft | |

Tools/Materials:

Soldering Iron/Solder	Cordless Drill w/bits	Pencil, Sharpie
Wire Cutter	Fast acting Epoxy	Xacto Knife & Scissors
Asst. Phillips/Slotted Screw Drivers	Dremel w/metal cutter	Avery 8161 labels
Needle Nose Pliers	Heat gun	Avery 8167 labels
Electrical Tape	Ruler	

MEMORY MAP

RANGE   **COMPONENT**

$FFFF
    $BF00 – $FFFF   part of 32K ROM Operating System (U2)
    $AA3F – $BEFF   ICT code (U2)
    $8000 – $AA3E   part of 32K ROM Operating System (U2)
$8000
$5000 – $6FFF   ICT SRAM 8K 6264
$400F   6526 CIA1 (U20)
    $400D   Interrupt Control Register
    $400C   Serial Register
    $4001   Port Register B – select the card address
(bits 0,1, & 2) and read/write status of data bus (bits 3 & 4) and
reset the hard drive card (bit 5). Bits 6 & 7 are unused.
    $4000   Port Register A – read/write data to HD bus
$4000   6526 CIA1 (U20)
$2000 – $2003   WD 1770 (U11)
$1C00 – $1C0F   6522 VIA2 (U4)
$1800 – $180F   6522 VIA1 (U9)
$0000 – $07FF   2K RAM (U3)

DISCLAIMER

Information in this document is presented for educational purposes only. In no event will anyone be liable for any direct, indirect or consequential damages resulting from the use or misuse of this information. Use at your own risk.

1. Preparing the 1571

1) Remove 4 screws in recessed holes in the bottom of the drive, remove cover. Put screws in container and label.
2) Remove 4 screws holding power supply.
3) Unscrew ground wire, remove power supply ground connection and then reconnect the ground wire.
4) Remove the power supply.

Drive mechanism

1) Remove 4 screws holding drive mechanism and ground screw. Put screws in container and label. NOTE: The ground screw is different.
2) Disconnect the 4 plugs (CN4, CN5, CN7 and) that connect the drive mechanism to the 1571 PCB. Note the orientation of the plugs, take a picture for reference. Remove the drive lift lever by slowly pulling it away from the front of the drive.
3) Remove the drive mechanism.

Remove mounting plate

1) Locate the 4 screws (2 on each side) connecting the drive mounting plate to the drive mechanism. Remove the 4 screws, put them in a container and label.
2) Place the drive mechanism and mounting plate in a safe place.

Front panel

1) Unplug the plug that connects the front panel LED PCB to the 1571 PCB (CN3). Note the orientation.
2) Remove the front panel by tilting away from the front of the drive and put in a safe place.

Pull ROM chip

1) Locate the 1571 ROM chip (U2) on the board. Using a chip puller carefully remove the chip working slowly.

Remove 1571 board

1) Locate the 4 screws holding the board to the 1571 lower case. Remove the 4 screws. Place the 4 screws and ground wire in a container and label.
2) Remove the 1571 board. Place in an anti-static bag if available and move to a save place.

2. Drilling Holes

Fan Mounting Holes

Power Supply DIN Holes

Toggle Switch Hole

Hard Drive Mounting Holes

3. Cutting the Drive Mounting Plate for Fan access

4. Power Supply

    External AT Power Supply Line

    Internal Power Supply Line

5. 1571 LED OCB Modifications and BOS Toggle Switch

1) Remove the 1571 LED PCB from the 1571 front cover by removing the two screws holding it on. There is also a standoff attached to the PCB but with gentle pressure it should release.
2) Using an Xacto/Hobby knife cut the traces on the 1571 LED PCB indicated by the purple dashed lines in Figure X.

6522 VIA 1 (U9)
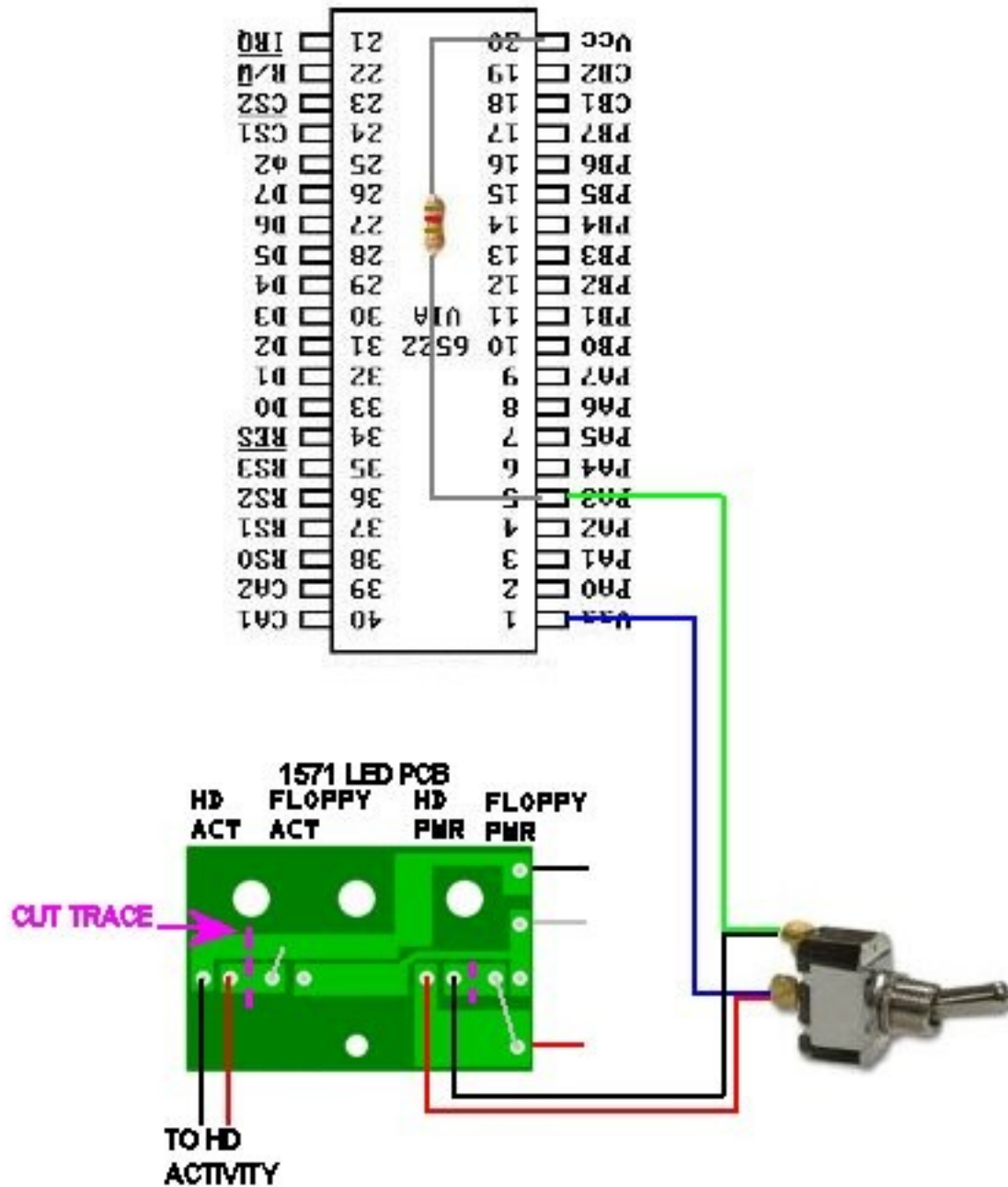
FIGURE 2 : 1571 LED PCB modifications and BOS Toggle Switch installation.
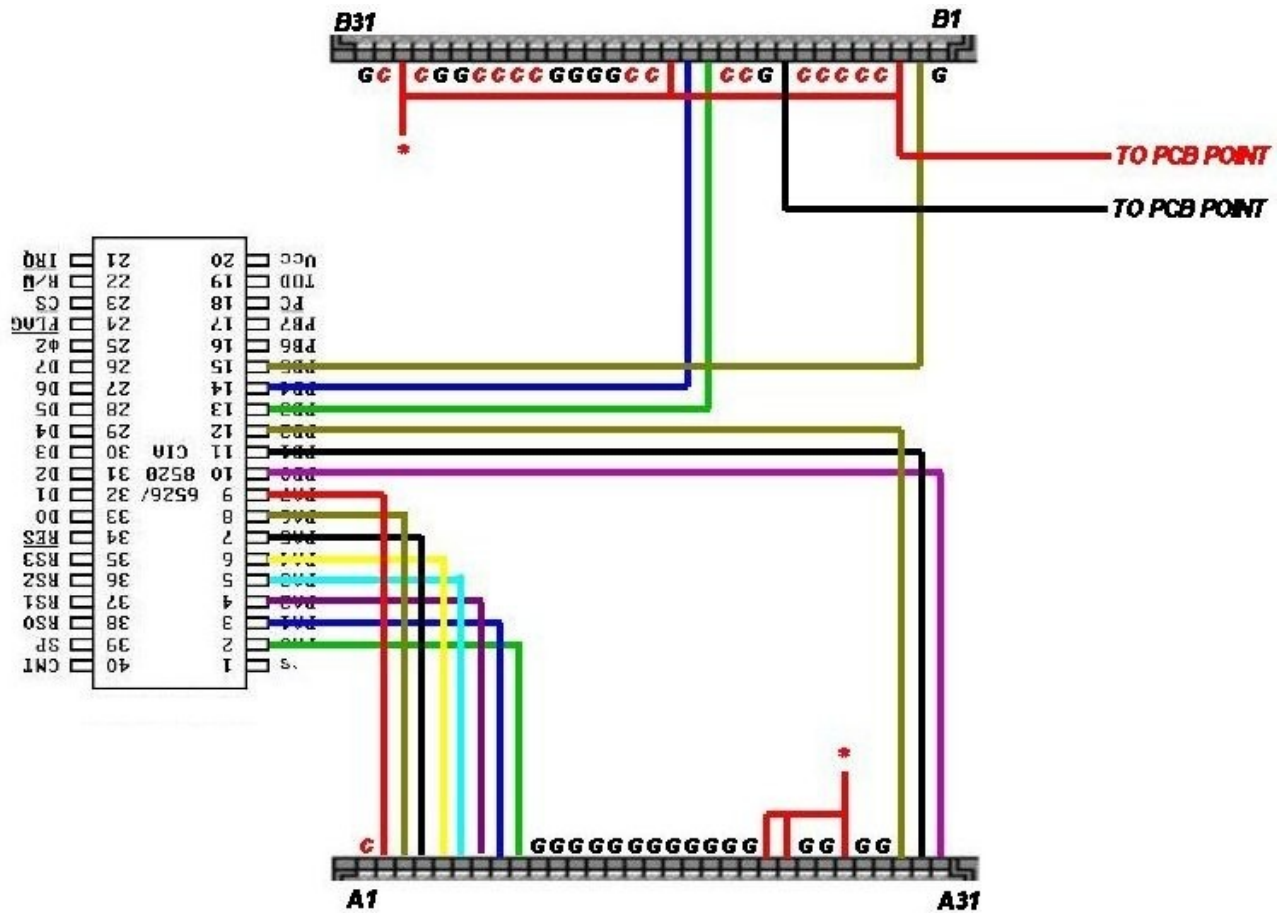
(8)

MINI CHIEF™ Hard Disk System
for the C-64, C-64c, C-128, and
C-128D

SOLDER TO PIN BELOW

SOLDER TO PIN 12 ON 2016 RAM BELOW
SOLDER TO PIN 11 ON 2016 RAM BELOW
SOLDER TO PIN 10 ON 2016 RAM BELOW
SOLDER TO PIN 9 ON 2016 RAM BELOW
SOLDER TO PIN 8 ON 2016 RAM BELOW
SOLDER TO PIN 7 ON 2016 RAM BELOW
SOLDER TO PIN 6 ON 2016 RAM BELOW
SOLDER TO PIN 5 ON 2016 RAM BELOW
SOLDER TO PIN 4 ON 2016 RAM BELOW
SOLDER TO PIN 3 ON 2016 RAM BELOW
SOLDER TO PIN 2 ON 2016 RAM BELOW
SOLDER TO PIN 1 ON 2016 RAM BELOW
NO CONNECTION

UM6264

BEND PINS

TO DIODE ON 74LS42   6264 SIDE VIEW   TO PIN 20 ON 6502

2016 SIDE VIEW

CPU 6502

74LS42

CP 9   8 GND
CUT 10   7
    11   6
    12   5
    13   4
    14   3   CUT
    15   2
Vcc 16   1
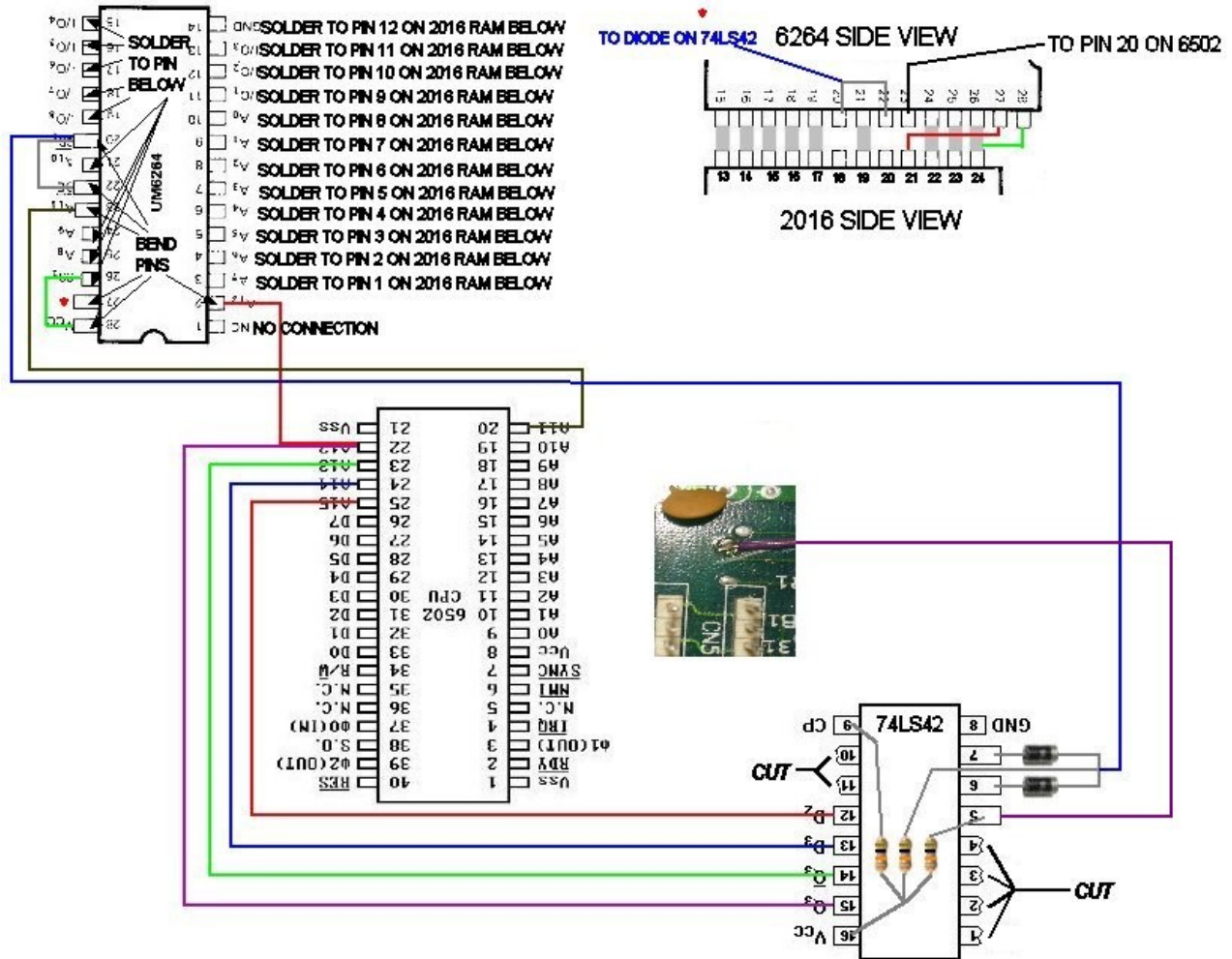
GUIDE TO UPGRADING AN ICT HARD DRIVE

The ICT hard drive, although much slower than the Lt. Kernals and the CMDs, is still one of the most popular and compatible hard drive systems for the C=64/128, and with an REU makes for a great system to run Color 64 on!

I'm sure there are a lot of Data Chief owners that would like to upgrade their systems from 20 to 40 MB, and hopefully I can tell you how! If you aren't technically oriented then please don't try this, although I've done this numerous times without failure, I can't guarantee the results you may get if you don't do this properly. There are a couple of other techniques others have used with good results, but this is how I do it, and I know this works. This technique uses an inexpensive Seagate ST225 20 megabyte hard drive and an IBM XT or Clone.

First off, don't start any project late in the evening. I'm sure a lot of us have paid that price! Using all proper procedures to work with printed circuit boards, (i.e. discharge your body of static electricity, it can and will fry a board) open the top of your Data Chief, and remove the 1571 drive mechanism, taking care to document what you have unplugged and unscrewed. Underneath where the 1571 was, you'll see a Western Digital controller card plugged into the ICT/1571 controller. There are a couple of screws holding the card in place; remove those screws and unplug the card. Now, this is where the XT comes in. Install the Hard Drive and controller into the XT. Now boot the system from the floppy drive. There are a couple of ways to format/prepare the drive and I will go over both of them.

The easiest way is to use Seagates Disk Manager program. This makes it all pretty automatic. Go through the procedures just as if you were readying the drive for use with the XT. The only thing you don't do is allow it to copy DOS to the hard drive. Disk Manager is usually included when you buy the hard drive.

The alternative way is to use DEBUG. Install the hard drive and controller and boot the system. With a DOS disk in floppy drive A, type debug at the A: prompt and hit enter. You will then get a "-" prompt. At this prompt type in g=c800:5 and press enter. This will execute a ROM routine in the WD card. You will then be asked for the interleave factor, this is 1. You will be asked if you are dynamically configuring the drive, answer yes, then enter the following line and press enter. 615 4 613 613 11 5
Answer "no" to virtual config and "yes" to begin formatting. It will take about 15 minutes to format. When it has finished, you will be asked if you want to format bad tracks, answer no. The system will reboot from there, and at the A: prompt type FDISK and press enter. When the FDISK screen comes up just press return through all the prompts. (You will be using all the default settings).

 After you have run FDISK, or if you used the Disk Manager method, either way be sure to park the heads, with a head parking program.

Now you are ready to install the hard drive and controller into the ICT. First install the controller. Once it is installed, if you are upgrading to 40 megs, rather than replacing the original drive, you will need to do the following: While looking down at the WD card you'll see a row of nine double pins on the left side of the card, install a jumper on pin set 1. Now with hard drive in hand, look on the bottom, rear of the drive, you'll see a resistor termination

pack, remove this. (It slips right off) There are two ribbon cables that attach to the hard drive, one is a 34-pin (wide control cable) with a connector for 2 drives. If it is not a twisted cable, then at the rear of your new drive, between the edge connectors is drive select pins (DS1-DS4), with a jumper on DS1. Remove this jumper and slip it onto DS2. If you have a twisted cable you will not have to do this, but all the Data Chief's I've seen come with a straight cable. You'll also have to get an additional 20-pin data cable and plug it into the row of pins directly behind where the original small cable is plugged in to the WD card for the second drive. Now install your second drive and connect all the cabling into their proper places taking care not to plug them in backwards. (There is usually a red stripe on the cables which corresponds to pin 1 on the drive, so you will have a visual aid to help you plug in the cables in the right direction). There are extra plugs coming off the power supply. Connect one of those to the new hard drive, once everything is reinstalled you are ready to run the ICT HD utilities to format each partition, and if all went well you now have a 40 meg Data Chief!

This same procedure can be done with the Mini-Chiefs, I've done it, and however, it involves installing all the internal hardware into a larger case, an old style flip top XT case with a little modification works great.

Again, if you don't know what you are doing, do not attempt this, and if you do, attempt it at your own risk.

1. UNPACKING YOUR DRIVE:
   A. Inspecting for damage.
      1. If the indicator on the SHOCKWATCH label is white, then the carton
         should be in good condition and there should be no damage to your
         drive.
      2. If the indicator on the SHOCKWATCH label is red, or if the carton
         has obvious damage, follow the below procedures:
         a. Procedure for UPS deliveries:
            1. <u>Do not refuse shipment.</u>
            2. Open carton and inspect drive.
            3. If damage is discovered, <u>call your UPS representative</u> and
               request an inspection. UPS will assign an "R" number and
               return to us. <u>Any claims will be filled by us!</u>

         b. Procedure for surface and air carriers:
            1. <u>Do not refuse shipment.</u>
            2. An activated (red) indicator in the label only means that
               the carton was handled more roughly than we like.
            3. If label is red, and it is possible to do so, make a
               notation to that effect on the carrier waybill.
            4. Set the carton aside and inspect product within 15 days.
               <u>DOCUMENT!!!</u> (This is very important!) Note time, date, and
               personnel doing unpacking.
            5. If damage is discovered, inform carrier <u>immediately</u> and
               request an inspection <u>within 15 days!</u>
            6. Leave goods in original container!
         c. Also notify us <u>immediately</u> as to the damage discovered!!
            (301-371-4000)

   B. Package Contents:
      1. The MINI CHIEF™ carton should contain the following items:
         a) One (1) MINI CHIEF™ cabinet with hard drive and floppy drive
            installed.

         b) One (1) power supply.

         c) One (1) power cord.

         d) One (1) serial interface cable.

         e) One (1) MINI CHIEF TM instruction manual. (You're reading it!)

        f) One (1) Commodore 1571 instruction manual.

        g) One (1) demo disk with hard drive utilities.

   C. Hot and cold climate instructions:
      1. Your new **MINI CHIEF™** drive is very sensitive to cold and heat. The drive should be removed from the carton and allowed to reach room temperature before you attempt to operate it. This may take several hours in extreme cases. <u>Operation of the drive while it is below 55 degrees Fahrenheit or while it is above 115 degrees Fahrenheit will void your warranty!</u>

II.   INTRODUCTION:

  A. Your **MINI CHIEF™** drive is a combination hard disk drive and floppy disk drive data storage system in one cabinet. It is designed for use with the Commodore C-64, C-64c, C-128, and C-128D computers and speeds up data storage and retrieval significantly.
  B. Housed in a 1571 cabinet, the **MINI CHIEF™**, includes a 10 or 20 megabyte hard disk unit, a 1571 compatible floppy disk drive, and all interconnecting hardware (including a separate power supply) as well as the needed operating software. The floppy drive works identical to the Commodore 1571 disk drive and the hard drive unit works in tandem with the floppy drive.
  C. The **MINI CHIEF™** is virtually transparent to your computer. The unit, when first powered up, operates as a regular floppy drive. Try any normal floppy disk operation and the unit will respond as a 1571 floppy drive. In floppy mode, when the floppy light flashes to indicate an error, it indicates an error within the floppy operation only. Not the hard drive!
  D. The hard drive in your unit is **factory** partitioned as individual floppy drives. There are 60 floppy partitions for each 10 megabytes of hard storage. Hard disk partitions are numbered starting at 1 and continuing upwards. (10 meg drive = partitions 1 to 60. 20 meg drive = partitions 1 to 120. Etc.) This allows for one-to-one copying of floppy disks to an equivalent format on the hard disk, and allows the user to keep his existing disk index numbering system largely intact. Drive access commands are short to keep typing to a minimum.

III. SETTING UP THE MINI CHIEF™:

MINI CHIEF™ Hard Disk System
for the C-64, C-64c, C-128, and
C-128D

A. Connecting the computer to the **MINI CHIEF™**:
1. WARNING! The user should ensure that only a well grounded, standard 120 VAC 60Hz outlet is used to power the system. Defective power cords and non-shielded serial cables should not be used. Be sure to use the cables enclosed with your **MINI CHIEF™**.
2. To set up:
   a. TURN OFF AND UNPLUG both the computer and the **MINI CHIEF™** before connecting cables!
   b. Connect the **MINI CHIEF™** to your computer via the serial cable enclosed with the drive.
   c. Plug in both the **MINI CHIEF™** and your computer to a well grounded, standard 120 VAC 60 Hz outlet.
   d. Turn on the power switch located on the back of the **MINI CHIEF™**.
   e.
Turn on your computer.
B. Testing the system:
1. When power is first turned on to the system, the floppy drive light should come on for a short time and then go off. This is normal.
2. The hard disk drive light should also come on, blink several times, and then go off. While this is happening, the drive steppers may be heard moving as the drive initializes. This is normal.
3. If the floppy disk light or the hard disk light should come on and remain on for longer than one minute after system power up, there is a problem with the unit. Turn off and unplug both the drive unit and the computer and check that all plugs and cables are firmly plugged in.
4.
If the system still refuses to power up correctly, TURN IT OFF, then call our factory service number (301-371-4000) immediately.
C. 0peration of the hard drive:
1. To access the hard drive, a channel to the hard drive must first be opened. This is done by typing in OPEN15,d#,15,"Hx#";CLOSE 15 <RETURN> (Where d# = device number and x# = partition number). This will get you to the first partition on the hard drive. All partitions come from the factory pre-formatted and each provides 664 blocks free of storage space. Partition H120 has the ICT Utilities stored on it. Do not erase until you've made a back-up copy!
2.
When using any hard disk partition it will operate just as if it were a standard 1571 drive. All normal 1571 commands may be used.

(15)

3. As the hard drive is accessed, you will note that the red light
   flashes. This is normal and indicates to drive is working.
4. You may also note that the floppy light sometimes flashes also, as
   during an error condition. This indicates an error condition with an
   attempted data transfer to or from the hard drive.
5.

Your new **MINI CHIEF™** drive is fully compatible with the **EPYX FAST LOAD™**
cartridge as well as all standard DOS wedge commands.

I. Defining a chain:
    A. Executing an HM4 # # command defines a chains starting and ending
       partition numbers and positions the drive head to the first
       partition in the chain. An HM0 command is used to take the drive out
       of chain mode and a subsequent HM1 command will return the drive to
       the previous chain mode. When in chain mode all drive operations
       affect the entire chain, (e.g.: The directory command, LOAD"$",8
       will return a directory of all the files from every partition in the
       chain.)
II. Anchoring:
    A. Anchoring means that the drive is operating within a specific
       partition, even though it may be chained to adjoining partitions.
       Any drive commands given will always start from the ANCHOR
       partition. You may change the ANCHOR position by using the Hx#
       command where x = the desired partition number.

III. File access within a chain:
    A. Loading from the chain:
       • Within the chain, any program or file may be accessed by
         using the LOAD"filename",d# command v/here filename is the
         name of the program and d# is the device number of the **MINI
         CHIEF™**, The drive will start searching for the file in the
         ANCHOR partition and then work its way to the end of the
         chain where it will then wrap around to the first partition
         in the chain. If the file is not found by the time the
         drive returns to the ANCHOR partition, a FILE NOT FOUND
         error is returned. If the file is found, it is loaded and
         the ANCHOR is moved to the partition where the file was
         found.
    B. Saving to the chain:

       • When storing a program or file within a chain, the drive
         will know which partition has the most blocks free and will
         store the file there. If none of the partitions within the
         chain have sufficient room for the file, then a DISK FULL
         error will be returned. If a DISK FULL error is reported,
         the chain may be easily expanded to include more partitions,
         or a new chain may be created. When a file is saved, the
         ANCHOR is automatically moved to that partition.

       • SPECIAL NOTE: If partition H1 is included in a chain, you
         may NOT save any files to that chain! This is due to
         partition HI being reserved by ICT for future updating.
         Partition HI may still be written to in single partition
         mode and may be read from in any mode.

C. File types:

- Any type of file, not exceeding 664 blocks, may be saved: SEQuential, PRoGram, RELative, USeR, or RANDOM. However, one major rule must be observed. Only one file may be opened at any one time while in chain mode! Otherwise file contamination may occur. If a partition boundary is not crossed (i.e. ANCHOR is unmoved, the contamination may be avoided, however, it is best not to take the chance.

IV. Multiple chains:
A. All partitions on the hard drive may be included in any chain at any time (with the exception of partition H1 as noted above). Furthermore, a chain may be expanded, reduced, or relocated whenever needed.

V. Block count: (BLOCKS FREE)
A. When out of chain mode, each partition contains 664 BLOCKS FREE for storage. As storage space is used, the block count is reduced by the amount used. In chain mode, the sum of all unused space within the chain is totaled. The summation begins at the ANCHOR partition and wraps around as if for a file search. However, due to a quirk of the Commodore operating system, owners of the 20 megabyte version of the **MINI CHIEF™** may encounter a small surprise. If you have such a unit, try this:

Before storing any files on the drive, chain partitions 1 through 119 together using the command, OPEN15,8,15,"HM4 1 119":CLOSE15, Now load and list the directory of the chain and look at the number of blocks free. Kind of small for 119 partitions isn't it? No, we didn't cheat you out of a few thousand blocks. What happens is this:

When using the directory command the largest number of blocks free allowed by Commodore is 65536, Anything greater than this results in the block counter being reset to 0 and the remaining blocks being counted. To verify this, re-partition the chain we created to include partitions 1 through 96 and check your directory again. You should now see 65072 blocks free reported.

VI. Double—sided mode:
A. Since your new **MINI CHIEF™** drive is 100% 1571 compatible, it naturally supports double-sided disk operations. Any two adjacent partitions may be

formatted in double-sided mode but a few things should be kept in mind:

1. You may not mix double-sided partitions with single sided partitions in a chain.
2.

If you format a partition in double-sided mode, the following partition becomes the back side of the disk and will yield strange results should you try to load it by itself.

VII. Bulletin Board Applications:
A. Many **MINI CHIEF™** owners are Bulletin Board SYSOPs who use their drives as databases for the uploading and downloading of various files and programs.

Although many Bulletin Board Systems will work in conjunction with the **MINI CHIEF™** drive, ICT has seen excellent results when it is used with the COLOR 64 BBS (C-64 and C-128) software by Mr. Greg Pfountz and the CITADEL BBS (C-128) software by Mr. Vince Quaresima. These systems have been designed with functional characteristics that take advantage of the powerful partition features of the **MINI CHIEF™**.

The following suggestions are made to BBS users;

1. Set up:

   Proper use of the chain facility is the most important consideration during BBS set up. Chains should be created with sufficient room for the file storage expected. Multiple chains will work well and allow for public files to be separated from SYSOP files. Allow for expandability. You may want to leave space between chains for expansion later on.

2. Operation:

   Prior to setting up and operating your BBS, it is a good idea to make a chart of what partitions you are defining. This way you can keep track of where you have put your message bases, user log, modules, etc. Also, it is recommended that you validate your message base and E-Mail partitions on a daily basis to avoid cluttering up the BAM.

3. System Maintenance:

   It is good practice, in any BBS operation, to do regular housekeeping on your file chains. This should be done using the ICT COMPRESSION UTILITY included on partition H120. This utility packs files towards the end of the chain, freeing up space

at the front end which reduces seek time during normal operation. This compression routine should be done every one or two weeks. More often on smaller chains and very active boards.

The BOS-PAK™
(Buffered Operating System)

I. What it is:

   A. The BOS—PAK™ is a plug-in and run operating system that provides quick
      and easy updating of the hard drive operating system. The following are
      the BOS commands for easy operation:

      HO = Access to floppy drive.

      H1 to H120 = Access to bard disk partitions.

      HCH = Full disk copy from floppy to hard disk.

      HCHB = BAM copy of floppy to hard disk.

      HCF = Copy full disk from hard drive to floppy.

      HI = Updates the Autosave Table in chain mode.

      HP = Parks hard drive head in a safe area for shipment. (<u>VERY
      IMPORTANT!</u>)

 II. The BOS-Switch:
     A. The switch mounted on the front panel of the **MINI CHIEF™** drive is
        called the BOSS™ (Buffered Operating System Switch) and is used in some
        operating modes to select between the floppy drive and the hard drive.
        (Up position =• floppy drive, down position = hard drive.)

III. Operating modes:
     A. The following are the various operating modes currently available on
        the **MINI CHIEF™** hard drive system:
          1. HM0 (MODE 0)
                  a. DISABLES MODE FUNCTION (Disables chain)
                     Mode 0 disables the mode function and returns the hard
                     drive to its fully partitioned operating mode.
                     (EXAMPLE: OPEN15,8,15,"HMO":CLOSE15)
          2. HM1 (MODE 1)
                  a. CHAIN ENABLE (Turns chain on)
                     In this mode the user can re-enable a chain that was
                     turned off using the HM0 command. When the hard drive is
                     first booted, it is automatically given the command to
                     chain partition 1 to itself. (i.e. HM4 1 1)
          3. HM2 (MODE 2)

(21)

    a. SOURCE/DESTINATION (Used for copy programs)
       This mode allows the user to run many copy programs and
       use the BOSS™ to designate the source/destination
       (floppy/hard or hard/floppy) drive. For example, when a
       copy program prompts you to insert the source disk and
       hit return, move the BOSS™ to the up (floppy) position
       and hit return. To use this function you must first
       define what hard partition you are using and then issue
       the HM2 command. <e.g. Load the copy program, then
       OPEN15,8,15,"H2";PRINT#15,"HM2":CLOSE15, then run the
       copy program.)

4. HM3 (MODE 3)
    a. REDIRECT ANCHOR (Used to boot protected software)
       In this mode, the BOSS™ is set to the floppy (up)
       position, a protected program is loaded from the floppy
       drive, and, once booted, the BOSS™ is moved to the hard
       (down) drive position. Now the protected software is
       running and file access is transferred to the hard drive.
       (e.g. OPEN15,8,15,"HM3":CLOSE15, boot protected software,
       switch to hard drive)

5. HM4 (MODE 4)
    a. INITIALIZES CHAIN (Used to create a chain)
       Mode 4 is used to create a chain of one, or more,
       partitions on the hard drive to be used as one, large,
       disk area. The user simply specifies the starting
       partition and the ending partition, (e.g. To set up a
       chain of ten partitions from partition 85 to partition
       94, type in; OPEN15,8,15,"HM4 85 94";CLOSE15.) When this
       command is issued, it also performs the HI (Update
       Autosave Table) command and the HM1 (chain on) command.

6. HM5 (MODE 5)
    a. CP/M MODE (Sets 4 device numbers)
       When using the drive as a CP/M device this command will
       automatically set partition H2 to device A, partition H3
       to device B, partition H4 to device C, and partition H5
       to device D (device numbers 8 to 11 respectively).
       Furthermore, if the BOSS TM is in the floppy (up)
       position, the floppy drive will act as device A.

 I. Various **MINI CHIEF™** hard drive utilities are included on partition H120.
     Please do not erase H120, or reformat the drive, until you have made a
     backup of these utilities!

 II. BACK UP:

          A. Disk back up is handled by the HCF command.
          Simply access the hard drive partition to be backed up and issue
          this command:

          OPEN15,8,15,"HCF":CLOSE15

          The requested partition will be copied to the floppy drive. Copying
          takes about 5 minutes.

 III. H-D UTILITY:
          A. The program H-D UTILITY is the major utility for the hard drive,
             this program allows file and disk drive maintenance and
             familiarizes the user with the drive operation. The program is
             menu driven and allows changing partitions, setting up chains,
             reading directories, etc.

          This program also allows FORMATTING (or newing) all of the hard disk
          partitions either singly or in multiples. Be sure to format only
          when needed and do not NEW partitions without backing up your files!

 IV. ICT TURBO:
          A. ICT has included a serial speed up utility named ICT TURBO on
             partition H120 which speeds up the load times from the hard drive
             to approximately 8 times that of the standard hard drive. This
             speed up resides in two areas on the C-64, C800 - CAOO and CBOO –
             CBFF (program data buffer). To access the utility, LOAD"ICT
             TURBO*",8,1 then NEW, SYS51200 will activate the utility and
             SYS51200+3 will deactivate it, You must turn off any printer
             online while the utility is loading and turn it back on when
             finished. Also, this is a hard drive only utility. Not for floppy
             drive use!

  V. ICT XFER:
          A. This file copy utility allows the copying of single or multiple
             files from one hard disk partition to another by partition
             number,

 VI. COMPRESSION:
          A. The COMPRESSION utility is a chain housekeeping routine that will
             move files from the front of the chain towards the end of the
             chain. This empties the early partitions and packs tight the
             later partitions in order

to reduce the search time to find files. This will also reduce
wasted space on the drive.

VII. DISK DOCTOR DELUXE:
     A. This utility allows disk track & sector editing and includes
       documentation.

VIII. DOS WEDGE:
    A. This is a standard Commodore type DOS wedge program that allows simpler
    disk commands to be used.

IX. RELATIVE   FILE   COPIER:
    A. This works on either single or dual drive-systems and will copy
    RELative files of ail sizes.

The "CIA #3" shown in the schematic is actually the only CIA (MOS 6526A) chip used in the 1571 drive, U20 on my 1571 PCB. The stock 1571 circuitry only uses a small part of this CIA chip (the SP register at $400C); the other two 8-bit data ports are wasted ($4000-4001). The ICT uses these two ports to control an 8-bit Western Digital hard drive card designed for the PC-XT, "classic 8-bit bus". The card address is hard wired active (eg. pins A10-A31 are wired so that the card is always on.). Port A of U20 ($4000) is used to read/write the data to the hard drive card data bus. Port B of U20 ($4001) is used to select the card address (bits 0, 1, & 2) and read/ write status of data bus (bits 3 & 4) and reset the hard drive card (bit 5). Bits 6 & 7 are unused...

The ICT ROM also needs an extra memory buffer- in this case, an 8kB 6264 static ram chip. The chip is mapped at $5000-6FFF but $7000-7FFF is a mirror image of $5000-5FFF (i.e. any data written to $7000 will replace data at $5000...) The static ram is piggy-backed on the 6116 ram (U3) already used by the 1571 circuitry ($0000-07FF). The pin-outs almost match exactly except the 6264 has an extra four pins. Pinouts are shown below. I have not yet disassembled the ICT ROM so information is a bit vague but I suspect there are several versions, each matched to the WD card used, as different cards seem to not work with the data chief I have... The ROM I have included is v7.12 and it controls a Western Digital card WD1002A-WX1.

Any MFM hard drives (20meg max.) you plan to use with the controller need to be low-level formatted on an PC-XT using the FDISK.COM program or an equivalent program such as DISK MANAGER by on-track technologies. The most common drive used with the ICT is the Seagate ST-225 MFM hard drive but other MFM drives will work; I have used a Rodime RO202E and it worked 100% but it is a full height 5.25" 20meg. So the lights about dim when it powers on. Anyway, you will need to partition the drive on the XT but you don't need to format the drive as a logical DOS drive (e.g. FORMAT C:) This MUST be done on a PC-XT as the PC-AT's use different sector mapping and the low-level formats are incompatible (a MFM formatted XT drive can't be read/written to on an AT without reformatting...) and the ICT software has no low-level format routines... I suppose you could write your own but you would need good documentation on the WD card used in your ICT. For me, it is easier to pull the XT out of the closet and power it up to format new/ reformat old drives... That's about the only use that XT has (smirk).

Once the drive has been low-level formatted it is ready to install the card/ drive into the ICT and once powered on the access light should be on and as the hard drives power up to speed the 1571 PCB will hold the serial bus "busy" and after the hard drives initialize the access light will go out and the 1571 will release the serial bus. (my drives/1571 PCB are installed in an old XT case; with the XT motherboard removed it has two full-height drive bays and a 5/12 volt power supply and plenty of room for the 1571 PCB, WD card, and I have even thought of putting a c64 motherboard in it but haven't as of yet). Also, I need to mention the BOSS switch cause the ICT "instructions" do a real piss-poor job of explaining its function-

The BOSS switch just toggles bit 3 of VIA #1 ($1801). This bit is monitored by the ICT ROM and when grounded (floppy setting) the ICT will power up as a 1571 disk drive; when this bit is held high (hard drive setting) the drive powers up with H001 (first partition) being accessed. The BOSS switch is also used to move the "anchor" partition and can be used to move to any partition from another (usually not back, though) but you can use the "HM2" command to select the home partition and switch the BOSS to the floppy position (H000) then move to any partition and as soon as you flip the BOSS switch you will be moved from the current partition to the "home" partition.

Please note: the drive WILL NOT chain partitions in the floppy position so if the
chain command (HM4 SSS EEE) is not working then try flipping the switch to the other
position. If this solves the problem you have the BOSS in the "hard drive" position
and label accordingly.

I have written a few programs for ICT management but none support 1571 mode.

I plan to revise many of these programs and include 1571 mode and some more neat
stuff but as of now most of my ICT utilities are minimal. The one neat program that
really needs explanation is BKP & RSTR. These two programs simply copy track 18,
sector 1 to track 18, sector 18 (usually unused) and back. This allows the first
sector of the directory to be restored when/ if an accidental format is issued (the
ICT only clears the BAM and 18,1 so all that is needed to "unformat" is to restore
these two sectors...) This feature can cause problems if not understood- The track
18,18 is not used until more than 120 files are saved to the disk so on very long
directories this program might cause problems. Also, the program only restores the
last backed up directory so if files have been changed/deleted since the last back-
up/restore the directory will be incorrect and may fail and the BAM is not restored
so after a restore you should verify the partition.

That said, if you have any other questions I can answer you can reach me on
Canthro's Lair BBS, 407-895-5759, 24hr. 2400baud max. Orlando, FL. (#24)
Or on the internet, Email: radwar@orl.mindspring.com

Good luck,
Radioactive Warrior '96

```
CIA (U20) MOS6526A     VIA (U4&9) MOS6522     SRAM (8kB) 6264-15
   ---\/---               ---\/---                ---\/---
GND-1      40-CNT      GND-1      40-CA1      N/C-1      28-VCC
PA0-2      39-SP       PA0-2      39-CA2      A12-2      27-R/*W
PA1-3      38-RS0      PA1-3      38-RS0       A7-3      26-N/C (A13)
PA2-4      37-RS1      PA2-4      37-RS1       A6-4      25-A8
PA3-5      36-RS2      PA3-5      36-RS2       A5-5      24-A9
PA4-6      35-RS3      PA4-6      35-RS3       A4-6      23-A11
PA5-7      34-*RES     PA5-7      34-*RES      A3-7      22-*OE
PA6-8      33-DB0      PA6-8      33-D0        A2-8      21-A10
PA7-9      32-DB1      PA7-9      32-D1        A1-9      20-*CE (*CS)
PB0-10     31-DB2      PB0-10     31-D2        A0-10     19-D7
PB1-11     30-DB3      PB1-11     30-D3        D0-11     18-D6
PB2-12     29-DB4      PB2-12     29-D4        D1-12     17-D5
PB3-13     28-DB5      PB3-13     28-D5        D2-13     16-D4
PB4-14     27-DB6      PB4-14     27-D6        GND-14    15-D3
PB5-15     26-DB7      PB5-15     26-D7          -------
PB6-16     25-PH2      PB6-16     25-PH2
PB7-17     24-*FLG     PB7-17     24-CS1
*PC-18     23-*CS      CB1-18     23-*CS2
TOD-19     22-R/*W     CB2-19     22-R/*W
VCC-20     21-*IRQ     VCC-20     21-*IRQ
   --------               --------


SRAM (2kB, U3) 6116-4     74LS42 (piggy-back over another 74LSxx chip)
   ---\/---                 -\/-
 A7-1      24-VCC        Q0-1 16-VCC
 A6-2      23-A8         Q1-2 15-D0
 A5-3      22-A9         Q2-3 14-D1
 A4-4      21-*WE        Q3-4 13-D2
 A3-5      20-*OE        Q4-5 12-D3
 A2-6      19-A10        Q5-6 11-Q9
 A1-7      18-*CE        Q6-7 10-Q8
 A0-8      17-D7        GND-8  9-Q7
 D0-9      16-D6           ----
 D1-10     15-D5
 D2-11     14-D4
GND-12     13-D3
   --------
```

MINI CHIEF™ Hard Disk System
for the C-64, C-64c, C-128, and
C-128D

WESTERN DIGITAL WD1002A-WX1 HARD DRIVE CONTROLLER

WD1002A-WX1

Replaced by the WD1004A-WX1

Data bus: 8-bit, PC/XT

Size: Full-length, full-height card

Hard drives supported: Two MFM ST506/412 drives

Floppy drives supported: None

Maximum heads/cyl.: 16 heads and 1024 cylinders

[Image]

CONNECTIONS

Function	Location
34-pin control cable connector-hard drive	J1
20-pin data cable connector-drive 0	J2
20-pin data cable connector-drive 1	J3
5-pin connector-DC power	J4

USER CONFIGURABLE SETTINGS

	Function	Location	Setting
»	BIOS enabled	W3	closed
	BIOS disabled	W3	open
»	I/O port address 320h	W4	pins 2 & 3 closed
	I/O port address 324h	W4	pins 1 & 2 closed
»	BIOS ROM size 32K or 64K (hard-wired)	W5	pins 1 & 2 closed
	BIOS ROM size 16K	W5	pins 2 & 3 closed
»	8 head hard drive with RWC supported	W6	pins 2 & 3 closed
	16 head hard drive supported (head select 3)	W6	pins 1 & 2 closed

(28)

»	x Hard Drive Interrupt is IRQ5 (hard-wired)	W7	pins 1 & 2 closed
	Hard Drive Interrupt is IRQ2	W7	pins 2 & 3 closed
»	Single controller setting, primary controller	W8	pins 2 & 3 closed
	Dual controller setting, secondary controller	W8	pins 1 & 2 closed
»	Not used	S1/jumper 5	open
»	Not used	S1/jumper 6	open
»	*Hard Drive Interrupt is IRQ5	S1/jumper 7	open
	*Hard Drive Interrupt is IRQ2	S1/jumper 7	closed
	*XT mode enabled	S1/jumper 8	open
	*AT mode enabled	S1/jumper 8	closed

Note:* This controller can be purchased with several different BIOS revisions.

These jumpers are not applicable when used with some BIOS revisions.

BIOS REVISION "SUPER BIOS" DRIVE TYPE TABLE

Drive   Drive
  0   1

#	S1/1	S1/2	S1/3	S1/4	Cap.	Hds	Cyls.	WP	RWC
0	closed	closed	closed	closed	21MB	4	612	450	450
1	open	closed	open	closed	10MB	4	306	0	153
2	closed	open	closed	open	10MB	2	615	450	450
3	open	open	open	open	21MB	4	615	450	450

BIOS REVISION "G" DRIVE TYPE TABLE

#	Drive 0	Drive 1							
#	S1/1	S1/2	S1/3	S1/4	Cap.	Hds.	Cyl.	WP	RWC
0	closed	closed	closed	closed	20MB	4	612	none	none
1	open	closed	open	closed	10MB	2	612	128	128

#				Cap.	Hds	Cyl.	WP	RWC
2	closed	open	closed	open	20MB	4	612	128	none
3	open	open	open	open	10MB	4	306	0	none

BIOS REVISION "H" DRIVE TYPE TABLE – S1

JUMPERS 3, 4, & 8 CONFIGURE DRIVE 0

JUMPERS 1, 2 & 7 CONFIGURE DRIVE 1

#	S1/1 & 3	S1/2 & 4	S1/7 & 8	Cap.	Hds	Cyl.	WP	RWC
0	closed	closed	closed	42MB	5	977	none	none
1	open	closed	closed	31MB	5	733	300	none
2	closed	open	closed	33MB	6	640	none	none
3	open	open	closed	62MB	8	1024	1024	1024
4	closed	closed	open	42MB	6	820	none	none
5	open	closed	open	10MB	2	612	128	128
6	closed	open	open	20MB	4	612	128	none
7	open	open	open	10MB	4	306	0	none

MISCELLANEOUS TECHNICAL NOTES

The Super BIOS revision includes the following features not found in other revisions: ability to format bad tracks, dual controller operation, automatic configuration, virtual drive operation, and PC/AT compatibility. This controller has a built-in low-level format program. To enter the program run the DEBUG utility supplied with DOS and at the prompt enter: G=C800:5. Two additional jumpers may be present, W1 & W2, and are reserved for factory use and must not be changed.

MINI CHIEF™ Hard Disk System
for the C-64, C-64c, C-128, and C-128D
ISA 31/62 8-bit Edge Connector
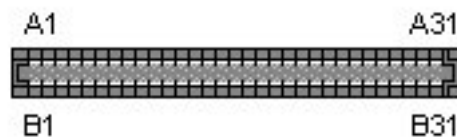
Pin	Name	Direction	Description
A1	/I/O CH CK	Card-to-PC	I/O channel check; active low=parity error
A2	D7	Bidirectional	Data bit 7
A3	D6	Bidirectional	Data bit 6
A4	D5	Bidirectional	Data bit 5
A5	D4	Bidirectional	Data bit 4
A6	D3	Bidirectional	Data bit 3
A7	D2	Bidirectional	Data bit 2
A8	D1	Bidirectional	Data bit 1
A9	D0	Bidirectional	Data bit 0
A10	I/O CH RDY	Card-to-PC	I/O Channel ready, pulled low to lengthen memory cycles
A11	AEN	PC-to-Card	Address enable; active high when DMA controls bus
A12	A19	PC-to-Card	Address bit 19
A13	A18	PC-to-Card	Address bit 18
A14	A17	PC-to-Card	Address bit 17
A15	A16	PC-to-Card	Address bit 16
A16	A15	PC-to-Card	Address bit 15
A17	A14	PC-to-Card	Address bit 14
A18	A13	PC-to-Card	Address bit 13
A19	A12	PC-to-Card	Address bit 12
A20	A11	PC-to-Card	Address bit 11
A21	A10	PC-to-Card	Address bit 10
A22	A9	PC-to-Card	Address bit 9
A23	A8	PC-to-Card	Address bit 8
A24	A7	PC-to-Card	Address bit 7
A25	A6	PC-to-Card	Address bit 6
A26	A5	PC-to-Card	Address bit 5
A27	A4	PC-to-Card	Address bit 4
A28	A3	PC-to-Card	Address bit 3
A29	A2	PC-to-Card	Address bit 2
A30	A1	PC-to-Card	Address bit 1
A31	A0	PC-to-Card	Address bit 0
B1	GND	N/A	Ground

B2	RESET	PC-to-Card	Active high to reset or initialize system logic
B3	+5V		+5 VDC
B4	IRQ2	Card-to-PC	Interrupt Request 2
B5	-5VDC	PC-to-Card	-5 VDC
B6	DRQ2	Card-to-PC	DMA Request 2
B7	-12VDC	PC-to-Card	-12 VDC
B8	/NOWS	Card-to-PC	No WaitState
B9	+12VDC	PC-to-Card	+12 VDC
B10	GND	N/A	Ground
B11	/SMEMW	PC-to-Card	System Memory Write
B12	/SMEMR	PC-to-Card	System Memory Read
B13	/IOW	PC-to-Card	I/O Write
B14	/IOR	PC-to-Card	I/O Read
B15	/DACK3	PC-to-Card	DMA Acknowledge 3
B16	DRQ3	Card-to-PC	DMA Request 3
B17	/DACK1	PC-to-Card	DMA Acknowledge 1
B18	DRQ1	Card-to-PC	DMA Request 1
B19	/REFRESH	Bidirectional	Refresh
B20	CLOCK	PC-to-Card	System Clock (67 ns, 8-8.33 MHz, 50% duty cycle)
B21	IRQ7	Card-to-PC	Interrupt Request 7
B22	IRQ6	Card-to-PC	Interrupt Request 6
B23	IRQ5	Card-to-PC	Interrupt Request 5
B24	IRQ4	Card-to-PC	Interrupt Request 4
B25	IRQ3	Card-to-PC	Interrupt Request 3
B26	/DACK2	PC-to-Card	DMA Acknowledge 2
B27	T/C	PC-to-Card	Terminal count; pulses high when DMA term. count reached
B28	ALE	PC-to-Card	Address Latch Enable
B29	+5V	PC-to-Card	+5 VDC
B30	OSC	PC-to-Card	High-speed Clock (70 ns, 14.31818 MHz, 50% duty cycle)
B31	GND	N/A	Ground

SEAGATE TECHNOLOGY, INC.
1-800-SEAGATE
http://www.seagate.com
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ST-225 ST412 MFM

```
                        /---------\
                        | O O O O | Power
     o o o o o o o o              -----------
 ÚData Cable o o o o o o o o  ÚController Cable   1     5 G G 12
 ÍÍÍÍÍÍÍÍ ÍÍ ³ ³ ³ ³ ³ ³ ³ ³  ÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ ÍÍÍ   ÍÍÍÍÍÍÍÍÍÍ
            ³ ³ ³ ³ ³ ³ ³ ³ ÚÄÄÄÄÄÄÄÄÄÄÄÄÄÄ1
            ³ ³ ³ ³ ³ ³ ³ ³ ÀÄTerminatorÄÙ
            ³ ³ ³ ³ ³ ³ ³ ³
Drive Select->1 2 3 4 ³ ³ ³ À Radial
            ³ ³ ³ ³ ³ ÀÄÄ Reserved
            ³ ÀÂÙ ³ ÀÄÄÄÄ Write Fault
            ³  ³  ÀÄÄÄÄÄÄÄ Factory Test
            ³  ÀÄÄÄÄÄÄÄÄÄÄ Never Used (Drive Select 3 and 4)
            À If twisted cable, use Drive Select 2
```

ST - 225

UNFORMATTED CAPACITY (MB) _____25.6
FORMATTED CAPACITY (17 SECTORS) (MB) _____21.4
ACTUATOR TYPE _____STEPPER
TRACKS _____2,460
CYLINDERS _____615
HEADS _____4
DISCS _____2
MEDIA TYPE _____OXIDE
RECORDING METHOD _____MFM
TRANSFER RATE (mbits/sec) _____5.0
SPINDLE SPEED (RPM) _____3,600
AVERAGE LATENCY (mSEC) _____8.3
INTERFACE _____ST412
SECTORS PER DRIVE _____41,820
TPI (TRACKS PER INCH) _____588
BPI (BITS PER INCH) _____9,827
AVERAGE ACCESS (ms) _____65
SINGLE TRACK SEEK (ms) _____20
MAX FULL SEEK (ms) _____150
MTBF (power-on hours) _____100,000
POWER REQUIREMENTS: +12V START-UP (amps) _2.4
          +12V TYPICAL (amps) __0.9
          +5V TYPICAL (amps) ___0.8
          TYPICAL (watts) _____14.8
          MAXIMUM (watts) _____33
BUFFERED STEP PULSE RATE (micro sec) _____5-200
WRITE PRECOMP (cyl) _____300
REDUCED WRITE CURRENT (cyl) _____N/A (616)

LANDING ZONE (cyl)_____670
IBM AT DRIVE TYPE _____2

Seagate reserves the right to change, without notice, product offerings or specifications. (6/26/90)

S T 2 2 5   SEAGATE

Capacity: 21.4 MB
Speed: 3600 rpm
Average Read Time: 65 ms
 Cylinders: 615
Heads: 4
Sectors: 17


```
NO MORE PRODUCED                                Native|  Translation
                                                ------+-----+-----+-----
Form                    5.25"/HH        Cylinders      615|     |     |
Capacity form/unform    21/   26 MB     Heads            4|     |     |
Seek time   / track  65.0/20.0 ms       Sector/track    17|     |     |
Controller          MFM / ST412         Precompensation  300
Cache/Buffer              KB            Landing Zone      670
Data transfer rate   0.625 MB/S int     Bytes/Sector     512
                     0.625 MB/S ext
Recording method     MFM                        operating | non-operating
                                                ------------+--------------
Supply voltage     5/12 V     Temperature *C      10 45    |   -40 60
Power: sleep              W   Humidity    %        8 80    |     5 90
       standby   14.8 W       Altitude    km   -0.305  3.048| -0.305  9.140
       idle              W    Shock       g       10      |     40
       seek              W    Rotation    RPM    3600
       read/write 33.0 W      Acoustic    dBA
       spin-up           W    ECC         Bit
                              MTBF        h    100000
                              Warranty Month
Lift/Lock/Park     NO         Certificates    CSA,TUV,UL478,VDE
```

Layout

SEAGATE ST213/ST225/ST225R/ST238R/ST250R PRODUCT MANUAL 36025-003

```
  +----------------------------------------------------------+
  |                                                          |XX
  |                                                          |XX J2
  |                                                          |XX
  |                                                          |XX
  |                                                          |+-16
  |                                                          || |J7
  |                                                          || |
  |                                                          |+-2
  |                          Resistor       +-+              |XX
  |                          Termination    | |              |XX
  |                          Pack           | |              |XX
  |                                         +-+              |XX
  |                                                          |XX J1
```

```
 |                                                          |XX
 |                                                          |
 |                                                          |XX Power
 |                                                          |XX J3
 |                                                          |
 +----------------------------------------------------------+
```

Jumpers

SEAGATE ST213/ST225/ST225R/ST238R/ST250R PRODUCT MANUAL 36025-003

Jumper setting
----
x = Factory setting

```
 JP7  Drive select  Configuration Jumper block
 ----------------------------------------------
      +-------------+------+------+------+------+
      |Drive Select | 9-10 |11-12 |13-14 |15-16 |
      +-------------+------+------+------+------+
      |Drive 4      |CLOSED|OPEN  |OPEN  |OPEN  |
      |Drive 3      |OPEN  |CLOSED|OPEN  |OPEN  |
      |Drive 2      |OPEN  |OPEN  |CLOSED|OPEN  |
      |Drive 1      |OPEN  |OPEN  |OPEN  |CLOSED|
      +-------------+------+------+------+------+
 The Drive Select line enables the controller to select and adress
 the drive. Control cable interface options may use either a daisy-
 chain or radial configuration.


 JP7  Manufacturing test
 -----------------------
 x    7- 8   OPEN  Do not install a jumper on the Manufacturing Test
                   jumper on the user configuration jumper block.
                   This is a test function and used during the manu-
                   facturing process ans is not recommended for field
                   use. When the pins are shorted, the stepper motor
                   will continuously seek between Track 0 and the
                   maximum cylinder and will ignore control signals
                   via the interface.


 JP7  Write Fault
 ----------------
 x    5- 6   OPEN  The Write Fault signal may be internally latched.
                   It may be enabled by shorting pins 5-6 at J7. This
                   latch may be cleared when Drive Select goes false
                   (if selected). The standard configuration, with
                   the shorting block removed, causes Write Fault to
                   go false when Write Gate goes false.
                   Not required for standard operation.


 JP7  Recovery Mode
 -----------------
 x    3- 4   CLOSE Recovery Mode is a read/write head microstepping
                   option on the ST225R and ST250R. It is enabled by
                   shorting pins 3-4 at J7. THE ST225R AND ST250R ARE
```

Recovery Mode is initiated when the controller asserts the Recovery
Mode line true at the interface. This changes the step line to a
microstep function after 100 nsec. A step pulse will now cause Seek
Complete to go false 100 nsec. after the drive receives the pulse.
The drive then microsteps off-track using the optimum algorithm,
allowing time for the read/write heads to settle and then takes the
Seek Complete line true.

The controller may then read data. If data is not read correctly, the
controller may issue an additional step pulse. Up to 2 microstep
algorithms may be accessed before the sequence is repeated.

When data is read correctly, the controller exits Recovery Mode by
taking the Recovery Mode line false at the interface. The drive will
then return the heads to the nominal position by taking Seek Complete
false, allowing time for the heads to settle, and resasserting Seek
Complete.

```
JP7  Radial/Daisy-Chain Mode
-----------------------------
x    1- 2   OPEN  Daisy-Chain-Configuration
                  A Daisy-Chain configuration allows connection of
                  a maximum of two drives on a common control cable.
                  A separate data cable is required for each drive.
                  The last drive in the chain (physically farthest
                  from the controller) requires termination. All
                  other drives should not be terminated. The maxi-
                  mum permitted cable length from the controller to
                  the last drive is 10ft (0.31m).
     1- 2   CLOSE Radial Configuration
                  To configure the drive radially, install a jumper
                  on pins 1 and 2 of the user configuration jumper
                  block. If you configure the drive radially, leave
                  the resistor terminator packs installed on all
                  drives. Each radially connected drive has its own
                  control and data cable. Drives in this configu-
                  ration always remain selected.

J3  DC Power and pin connector assignments
------------------------------------------
     +------------+  pin 1    +12 VDC
     | 1  2  3  4 |  pin 2    +12 VDC Gnd
     +------------+  pin 3    + 5 VDC Gnd
                     pin 4    + 5 VDC
```

Install

SEAGATE ST213/ST225/ST225R/ST238R/ST250R PRODUCT MANUAL 36025-003

Notes on installation
=====================

Drive mounting

```
     horizontally             vertically
   +-----------------+   +--+                 +--+ +------------------+
   |                 |   |  |  +-----+ +-----+ |  |                   | x
   |                 |   |  |  |     | |     | |  | x+---------------+x
 +-+-----------------+-+ |  |  |     | |     | |  | ||x             x||
 +---------------------+ |  |  |     | |     | |  | ||  x         x  ||
                         |  |  |     | |     | |  | ||   x       x   ||
     x           x       |  |  |     | |     | |  | ||     x   x     ||
 +------x------x-------+  |  +-----+ +-----+ |  | ||      xx       ||
 +-+------x--x-------+-+ +--+                 +--+ ||     x   x     ||
   |      xx         |                            ||   x         x  ||
   |     x   x       |                            || x             x ||
   +---x-------x----+                             |x               x|
      x           x                             x++---------------++x
        UNACCEPTABLE!                                UNACCEPTABLE!
        Never install PC board on the Top!
```
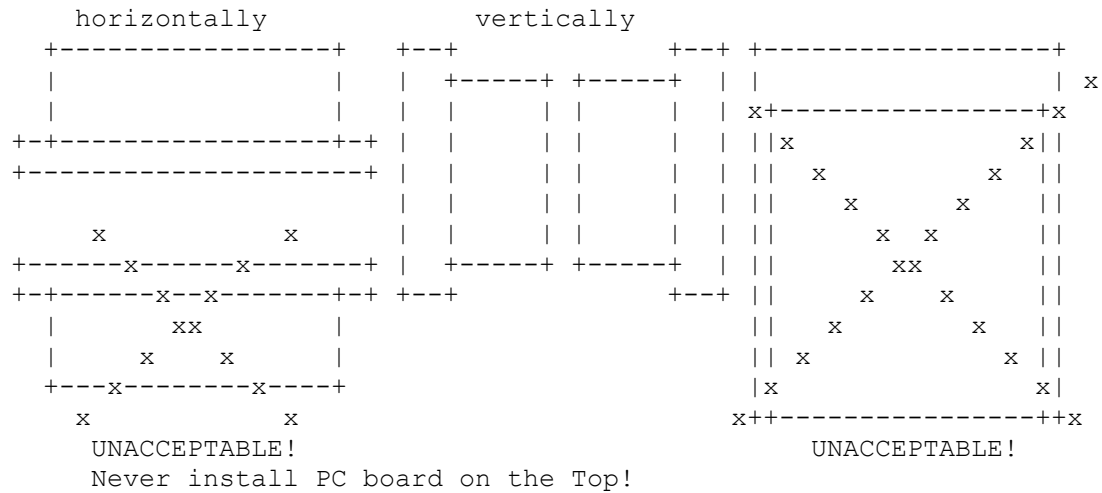

The drive may be mounted horizontally with the PC board down or on
either side. Mounting vertically on either end is a prohibited orien-
tation.
The drive should not be tilted front or back, in any position, by
more than 5*. For optimum performance, the drive should be formatted
in the same position as it will be mounted in the host system.

The mounting screws must not exceed inside the mounting feet more
than 3.2 mm, measured from the outside surface of the foot.

Interface and Recording Method

The ST213 and ST225 are designed for operation with the ST412 inter-
face with MFM encoding at 5.0 MBits/sec. data transfer rate. Opera-
tion of a MFM drive with a RLL controller is not approved by SEAGATE
and will void the drive warranty.

The ST225R, ST238R and ST250R are designed for operation with the
ST412 interface with Run Length Limited (2,7) encoding at 7.5 Mbits/
sec. data transfer rate.

Radial/Daisy-Chain Mode

The Drive Select line enables the controller to select and address
the drive. Control cable interface options may use either a Daisy-
Chain or Radial configuration.

(37)

Drives can be configured in either a daisy-chain or radial mode.

The resistor pack must remain installed on the last drive in a chain.

The resistor pack must remain installed on all radially-selected drives.

Shock and vibrations

All shock and vibration specifications assume that the drive is moun-
ted in an approved orientation with the input levels at the drive
mounting screws.

Read/Write Head Park Zone

ST213/ST225/ST238R
The read/write heads may be parked by issuing a seek to any cylinder
between 615-670

ST225R/ST250R
The read/write heads may be parked by issuing a seek to any cylinder
between 667-670

At power-on the drive will recalibrate to Track 0. If the heads are
parked while power is still applied, any step pulse will cause the
unit to recalibrate to Track 0.

FCC Verification

These drives are devices which are intended to be contained solely
within a personal computer or similar enclosure and not attached to
an external device. As such, they are considered to be subassemblies
even when individually marketed to the customer. As a subassembly, no
Federal Communications Commission certification of the device is re-
quired.

DC Power Requirements

Power may be applied or removed in any sequence without loss of data
or damage the drive.

```
 Input Noise
 -----------
 Maximum permitted input noise ripple: 100 mV (peak-to-peak)
 Maximum permitted input noise: 20 MHz.
 Ripple measured at the host system power supply across an equivalent
 8  resistive load on the +12 V line and an equivalent 3  load on the
```

+5 V line.

DC-Unsafe

A DC-unsafe condition is defined as DC voltage input to the drive
outside the specified tolerances. This condition will cause a micro-
processor reset.
This will prohibit writing, but will not directly cause a Write Fault

Handling and Static-Discharge Precautions

After unpacking, and prior to system integration, the drive may be
exposed to potential handling and ESD hazard. Do not touch the drive
connectors or board components or without observing static-discharge
preferred. Handle the drive by the frame only. Always rest the drive
on a padded surface until it is mounted in the host system.

Auto-Truncation

The drive will enter the auto-truncation mode if the controller
issues an excessive number of step pulses, which would place the
read/write heads outward beyond Track 0 or inward beyond the
maximum data cylinder.

With auto-truncation active, the drive will ignore additional pulses,
take control of the actuator, and recalibrate the heads to Track 0.

```
 Caution: If the controller is still issuing slow-step pulses after
          the drive issues Seek Complete from auto-truncation mode,
          the drive will either reenter auto-truncation mode with
          Direction In true.
```

Precompensation

For optimum performance, precompensation is recommended for the ST213
and ST225 on tracks 300 through 614. Twelve nsec. is recommended for
both early and late bits.

Some controllers provide a default precompensation setting from cyl-
inder 128 to 256. The ST213 and ST225 will perform satisfactorily at
these settings.

Features

SEAGATE ST213/ST225/ST225R/ST238R/ST250R PRODUCT MANUAL 36025-003

Media Defects

A media defect is a read error when the data, which has been
correctly written, cannot be recovered within 16 retries.
A printout will be provided with each drive shipped listing the
location of any defect by head, cylinder, sector and byte. The defect
map will specify the number of bytes from index. For MFM this will be
based on 1.6 sec./byte. RLL encoding is based on 1.056 sec./byte.
Some drives will have the defect map fixed to the drive top cover.

```
 ST213  There will be no more than 11 defects total per drive.
        Cylinders 0, 1, 2 and 3 will be free of defects.
```

ST225 There will be no more than 21 defects total per drive.
ST225R Cylinders 0, 1, 2 and 3 will be free of defects.

```
 ST238R There will be no more than 33 defects total per drive.
        Cylinders 0, 1, and 2 will be free of defects.

 ST250R There will be no more than 42 defects total per drive.
        Cylinders 0, 1, and 2 will be free of defects.
```

Access Time Definition and Timing

Access time is defined as the time from leading edge of the last
step pulse received to Seek Complete (including setting). The step
pulse period must be 5-200 sec.

```
                                   | ST213  |        |
                                   | ST225  | ST225R |
                                   | ST238R | ST250R |
        ---------------------------+--------+--------+
        Track-to-Track      msec.  |  20    |  20    |
                   Average msec. typ. |  65    |  70    |
                   Average msec. max. | 150    | 165    |
        Latency             msec. avg. |   8.33 |  10    |
        ---------------------------+--------+--------+
```

Bit Jitter

Bit jitter reduction determines the relationship between the leading
edge of read data and the center of the data window.
The data separator must provide at least -40dB of bit jitter
reduction at 2F with an offset of less than 1.5 nsec. shift from the
center of the data window.

UL/CSA Listing

The drive family is listed in accordance with UL 478 and CSA

C22.2 (0-M1982), and meets all applicable sections if IEC 380 and
VDE 0806/08.81, as tested by TUV-Rheinland, North America.

Reliability

MTBF 100,000 Power-on hours
PM: Not required
MTTR: 30 Minutes
Service life: 5 Years