Introduction to Vintage Software Restoration

Vintage Computer Festival East 8.0

May 5-6 2012

Useful Skills and Tools

- A way to examine, move, and edit blocks of memory – “monitor” program, in-circuit emulator, debug program
- A computer with a serial terminal interface and cables – TeraTerm, Hyper Terminal, Modem Software / Xmodem
- A computer with mixed-size disk drives
- Modern interfaces – e.g. Zoom Floppy, Catweasel
- LapLink Cable / Laplink Software
- Vintage Software – ISEPIC, Big Blue Reader, Interesting Concepts Media Master, Move-It, Copy II PC, Hypersoft PC Cross-Zap, ADT, many more…

Papertape Storage: Teletype I/O

- The teletype (papertape) was the most popular mass storage device in early 1977 for microcomputers. Also served as an I/O station and printer
- Non-volatile storage
- 110 baud transfer rate, 20 or 60 ma current loop.
- Loud, slow … there had to be a better way!

Cassette Storage

Benefits

- Audio cassette - Least expensive magnetic recording device
- $2.25/cassette in 1977 for ~ 100,000 bytes of data / tape
- Tape recorders in ’77 $25 - $150
- I/O equipment to interface with computer was $100 – 200.

Drawbacks

- Not much faster than papertape (300 baud KC Std.)
- Volume settings
- Serial storage
- Uneven tape speeds, unreliable motors
- Not all manufacturers make good tapes
- Only shorter tapes reliable
- Programs in middle of the tape would have to be searched for by hit and miss methods

Disk Storage

- Random Access Storage – data stored in the middle or end of the media may be accessed directly.
- Faster than serial storage
- Types:

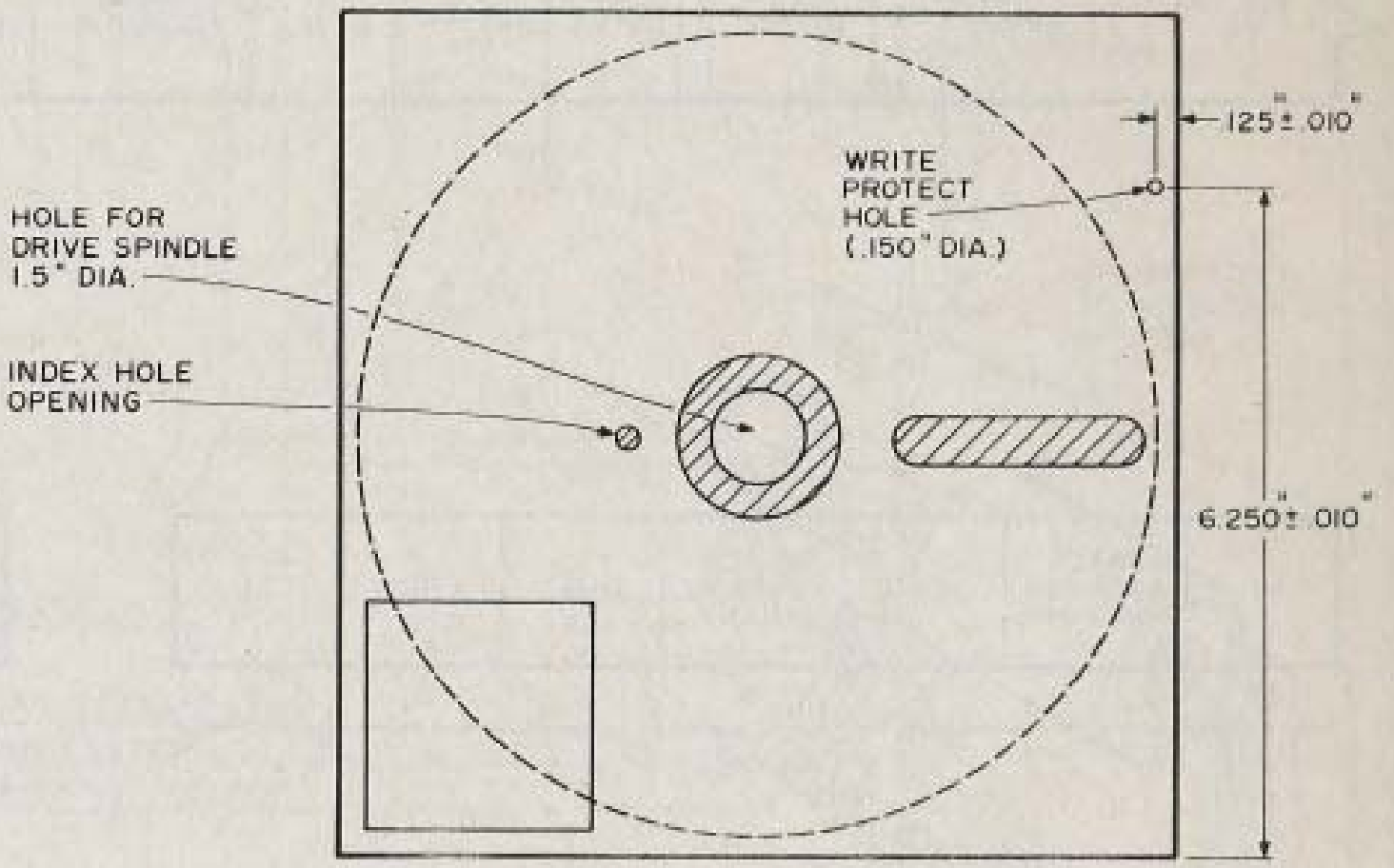
- Hard disk
- Drum
- Floppy disk

Cost $1500 - $100,000

Introduction to Floppy Drives – 6 components

- the disk
- the disk drive
- the drive electronics
- the controller
- the computer interface
- system software

Fig. 1. A floppy disk in its protective envelope.



The floppy disk

- 8” “diskette” are most popular in early 1977, followed by 5 ¼” – there were no 3.5” until the mid 80’s (sic. Apple Lisa II/Macintosh).
- Disk is a large round piece of recording tape enclosed in a protective envelope.
- Made of .003” mylar disk covered by a thin layer of magnetic oxides (same as cassette).
- Disk is divided into concentric circles called tracks starting near the edge of the disk (IBM format is 77)

Floppy Disk Organization

- Tracks are divided into sectors (IBM is 26 sectors/track). The first sector is found at the index hole.
  - **Softsectoring** – data tells drive sector boundaries
  - **Hardsectoring** – index hole marks each sector start point.

- Sectors are divided into two parts
  1. address markers, an id (info on what sector is this, is this a good or bad sector?, error checking, etc.)
  2. the data (128 bytes).

- Let's say an unformatted disk is 400K, early disks would be …
- 188 bytes are used to keep track of the data "format the disk"
- 128K available for data.
- IBM formatted disks (8" "Displaywriter format") inefficient but reliable and fast reading a writing.

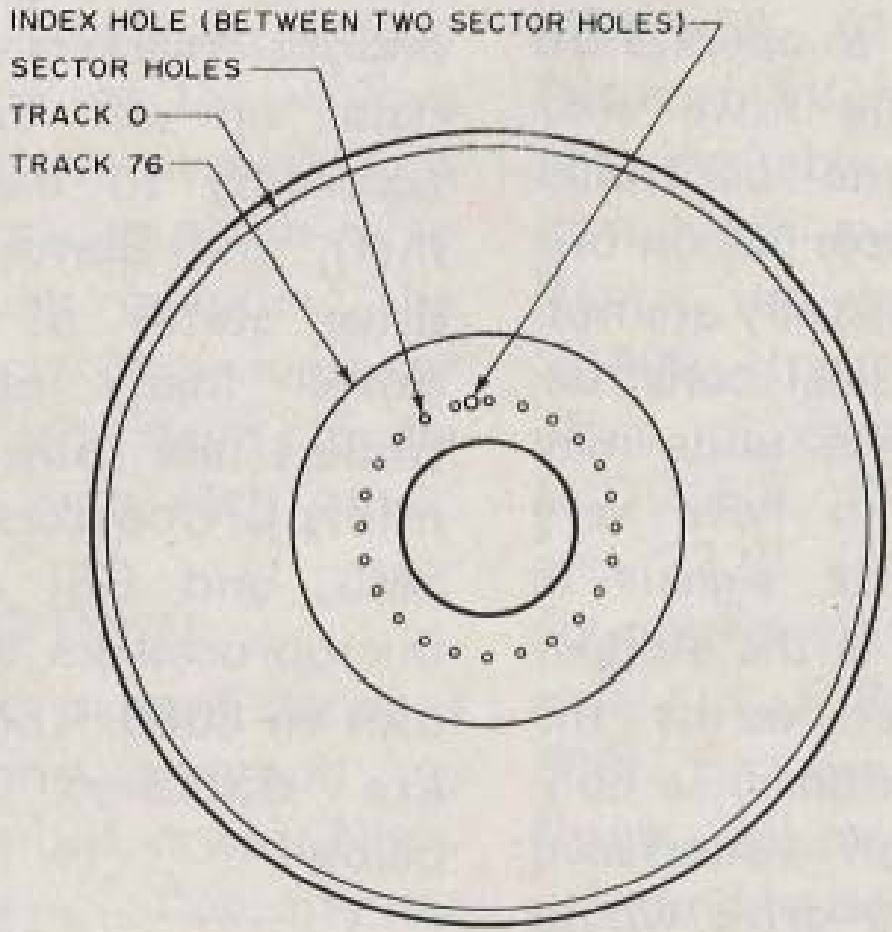


Fig. 2. A hard-sectored floppy disk showing the locations of the tracks.

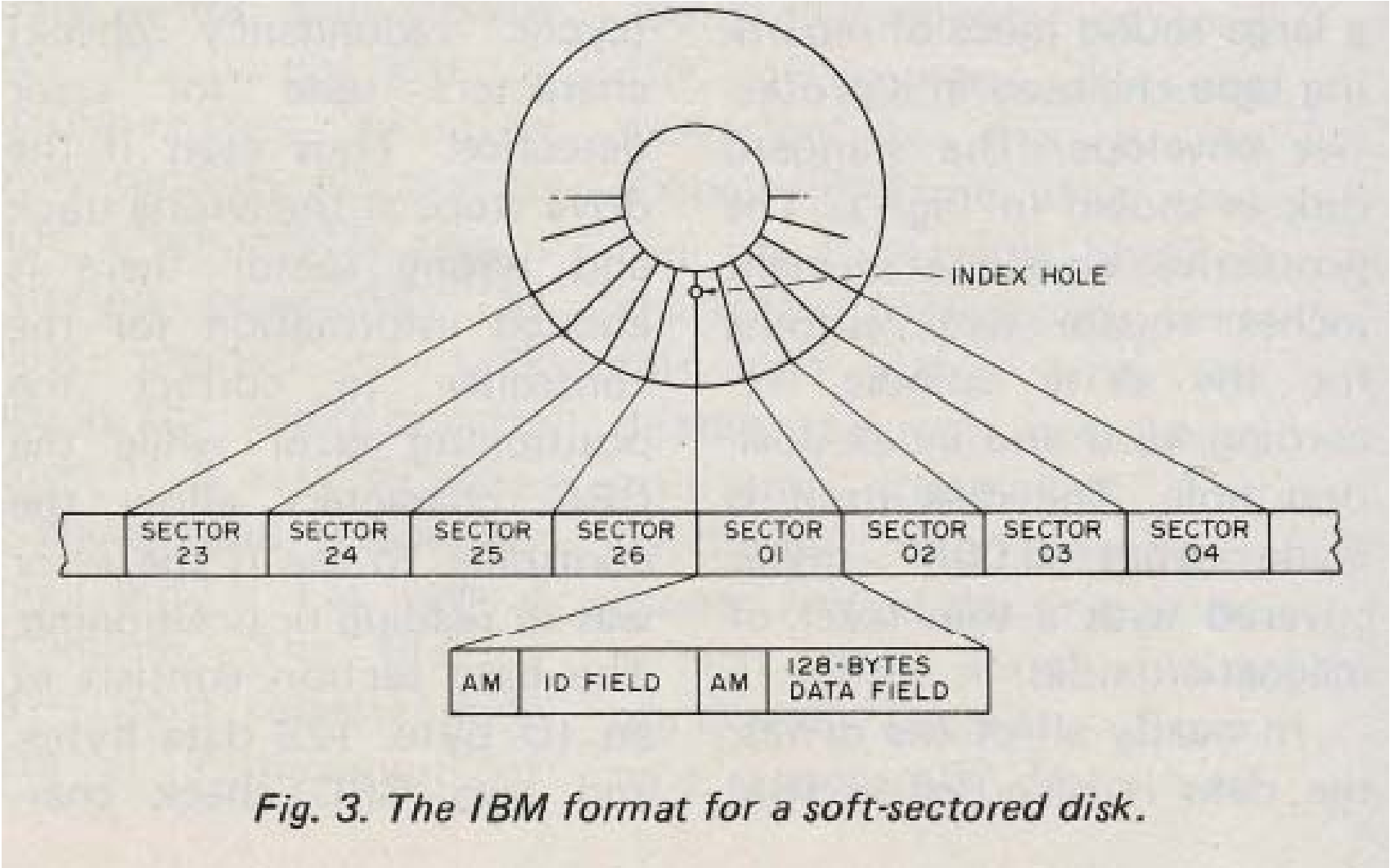


Fig. 3. The IBM format for a soft-sectored disk.

Improvements in controller technology allowed for
Soft-sectored diskettes, which required only one index hole.

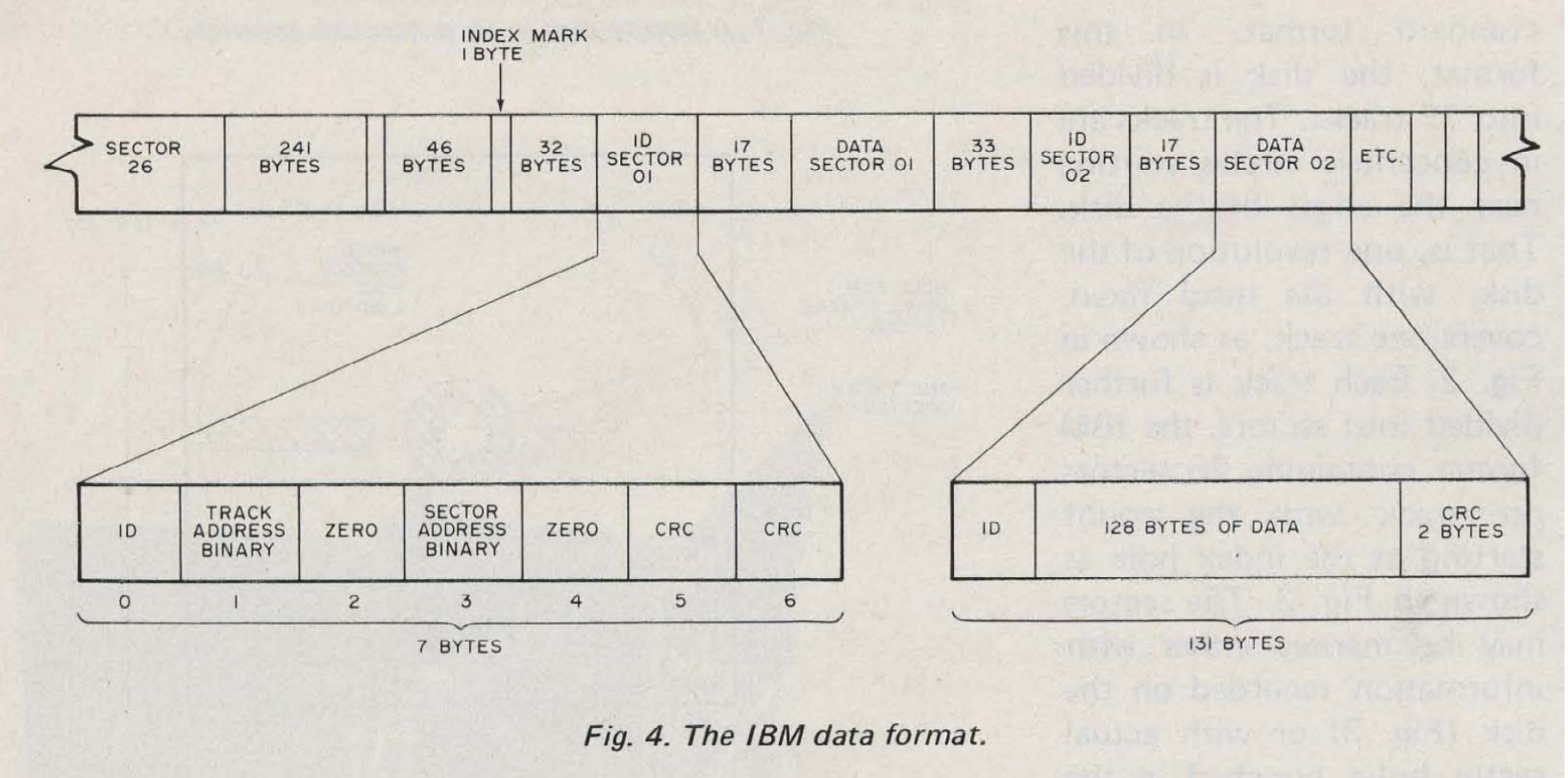


Fig. 4. The IBM data format.

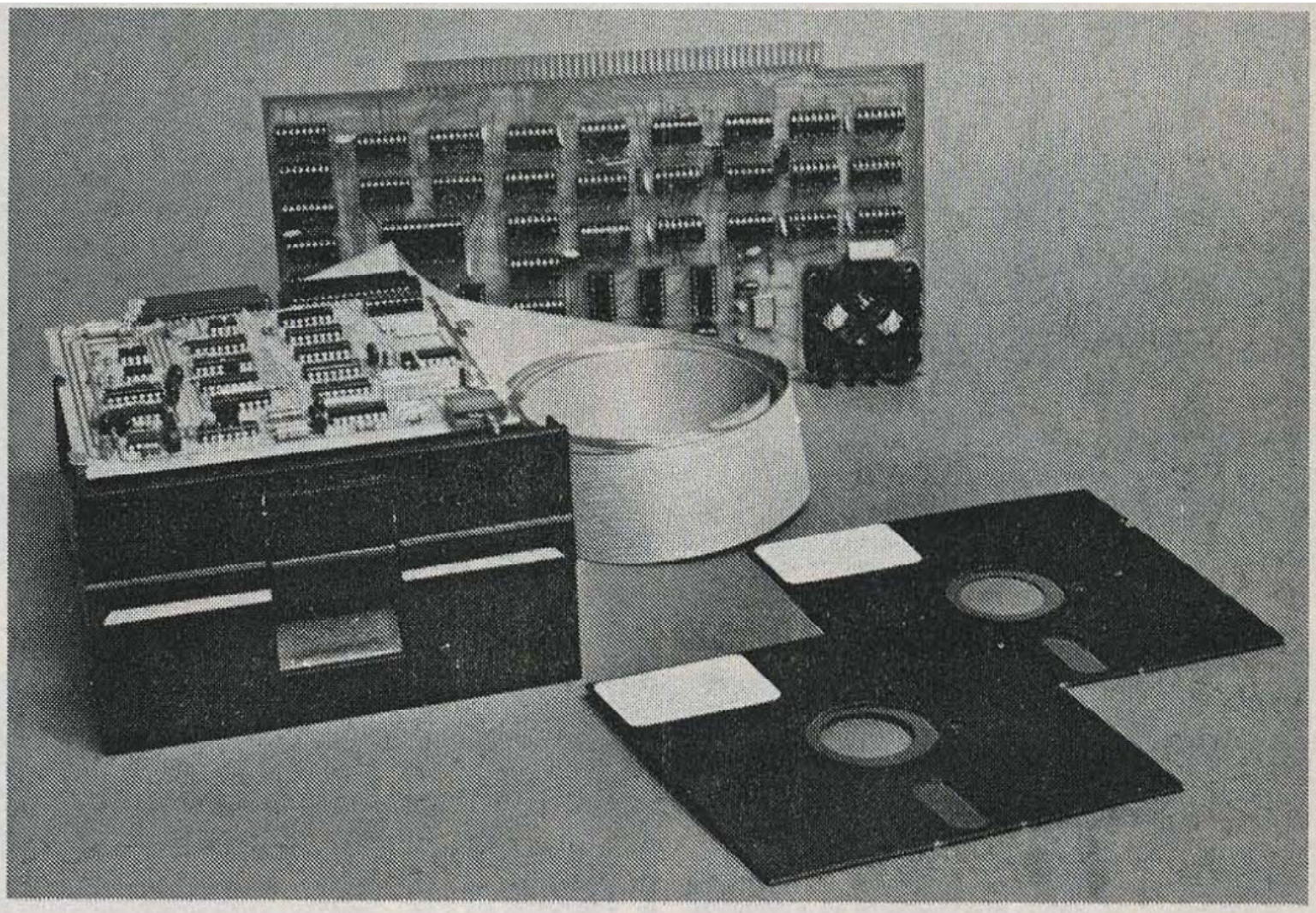
The ID section contains seven bytes, 1) ID, 2) track address, 3) zero, 4) sector address, 5) zero, 6 and 7) two CRC (cyclic redundancy check) characters used for error detection. Thus even if the drive stops at the wrong track and wrong sector there is enough information for the controller to correct the positioning error while the CRC characters allow the controller to see if the error was in reading or positioning. The data section consists of an ID byte, 128 data bytes, and two CRC check characters for a total of 131 characters. There are 33 bytes in the first address marker and seventeen in the second address marker. So to record 128 bytes of data we use a total of 128+3+7+33+17 = 188 bytes. Since an unformatted disk holds about 400K bytes, a formatted disk can hold (128/188) *400K = 250K bytes.

The floppy disk drive

- Shugart SA800 was the early standard from ~1977 (and Shugart remained so into 80's as 5 ¼" became more popular and increased capacity / Seagate Hard drives)
- Drive mechanics to hold disk in place, spin the disk, detect presence of disk, detect whether disk is "write protected" etc.
- Stepper motor to move Read / write drive head into correct track on disk Once in the correct position other mechanics lower and raise the head to do the reading / writing.

The drive controller

- Translates higher level commands from the host computer into instruction appropriate to the disk drive electronics
- Reset – reset drive and related hardware programming
- Seek – position to correct track
- Read – reads a sector of data (128 bytes) and verify
- Write – write a sector of data
- Format – write address markers, gaps, set up sectors, clear all existing data.



The minifloppy disk system available from North Star Computers which includes the minifloppy disk, controller, Altair bus interface and a disk based BASIC. The disk operating system is on ROM on the controller.

The computer interface

- Goes into the computer.
- Connects to the drive controller via a drive cable
- Works one of two ways:
- input and output data through standard parallel interface on computer -
- DMA – direct memory access, the drive controller takes control
- *Of interest*: CP/M uses DMA – Turned out to be the best way to go.
- NOTE: Sometimes the drive controller and computer interface are on the same card.

The software

- Keeps track of what is stored on the disk and where.
- Allows operator to call for information by calling programs or data by **file name** rather than by track and sector.

Disk Operating Systems

In early 1977 most DOS's were made by the drive manufacturer. There were only two DOS's you could buy that were not made by the drive manufacturer.

- FDOS-II – which was simply a better ICOM DOS than the manufacturer offered
- **CP/M –** By Digital Research Corp. $70.

CP/M Commands

Original Commands with version CP/M 1.4

- DIR
- TYPE
- REN
- ERA (erase)
- SAVE
- PIP
- SUBMIT
- ED (text editor)
- ASM – assembler
- DDT (debugger)
- LOAD – loads a file from an intel HEX format *
- DUMP – print a file in HEX
- SYSGEN – make a system disk backup.

(* note that you can't call a file by name with first versions of CP/M)

CP/M

- Made for 8080 systems originally, but also to be used extensively on the Z80, requires 16K and an IBM-compatible disk drive.
- CP/M was quickly adapted to almost every major computer system running 8080 or Z80. The 6502 systems tended to have 6502 drives, and used BASIC as the OS.
- 6800-based systems never adapted CP/M (until much later), they used FLEX a monitor-type DOS.

Practical Examples

- How to copy Commodore binary programs cassette to/from diskette
- The TRS-80 Model II
- 8” disk formats
- Interfacing an 8” disk drive to a PC
- Reading disks using ImageDisk and the Catweasel
- Using the image in an emulator
- Making a 5 ¼” diskette from an image
- Using the image in a real computer using a 5 ¼” drive.

Saving Memory to Disk CBM PET

Here are the directions for saving a block of memory (as in a program written to memory from a machine language program loaded from cassette) to disk.

1. format your disk. I have a 2040 attached to my Commodore PET 2001-16N , here is the BASIC level 2 format command (will also work with VIC-20 and C-64)

```
OPEN 1,8,15
PRINT#1,"N0:DISKNAME, 01"
```

2. Load the cassette program you have, know where it's been loaded. For example, BREAKOUT is loaded by cassette into memory locations 033F to 1491. Use TIM to determine the location of the program.

SYS 1024 - command to load TIM monitor from READY prompt of PET

```
.S "0:BREAKOUT",08,033F,1491
```

this means “..on drive 0, create a file called BREAKOUT on unit 8 that consists of what's in memory locations 033F through 1491…” Note that Drive 0 on unit 8 is the right hand drive of the model 2040.

The disk drive should activate and create the file. Reboot. Load the program

load "breakout",8,0 (assuming the disk is still in the right side drive)

Copy Machine Lang PET Cassette Programs

Here is how to make a copy of a machine language program (loaded from disk or cassette) using the TIM monitor program. TIM is built into the PET ROMs

1. load program on source cassette
2. SYS 1024 (to enter TIM monitor)
3. at the . prompt type:
   S "FILENAME",01, 033F, 1491 [enter]

4. The computer should ask you to press play and record on the tape drive.
   NOTE.
   01 = tape unit 1.
   033F = start location of machine lang program in memory
   1491 - end location of machine lang program in memory.

5. If you're making a copy of a program on a PET with an internal drive and you want to copy to the external drive the tape unit would be 02.

The TRS-80 Model II

- Introduced in 1979.
- First worked on them in 84.
- 4 MHz Z80
- 32K RAM upgradeable to 64k
- One single sided 8” disk drive internal
- Detached keyboard
- Built in screen
- Could add 3 more 8” drives

TRS-80 Model II & External Drives

$3,450 for 32K
$3,899 for 64K

$1,150 for 1 drive
$1,799 for 2 drives
$3,250 for 3 drives

Included Level III BASIC and the TRSDOS Disk Operating System

Model II 8” Disks

Many early computers had a built in OS or at least BASIC. This is not the case for the Model II. The TRS-80 Model II computer required a diskette to operate. The included ROM contained just enough information to read and execute the boot sector off of the floppy drive.

Without some kind of boot disk all you have is an ugly paperweight.

- Single Sided, Double Density format with a Single Density track 0.
- 500K capacity.
- Data rates of 250 kHz or 500 kHz.
- 8” drive electrically similar to 5 ¼” HD drives from the PC era.
- Drive interface was with a WD 1791 controller.
- Compatible with early (PC/AT) floppy controller.
- **NOT** compatible with Commodore, Apple or Amiga format.

What you need

- ISA based 286 or higher computer running MS-DOS (Free).
- Floppy controller if not on motherboard (Free).
- A 486 or higher PCI/ISA computer for Catweasel running Linux (Free).
- 5 ¼” HD drive with READY jumper and DS jumper ($20).
- 8” drive. I suggest a Tandon TM848-2E ($150).

What you need continued…

- Adapter to make your 5 ¼” drive look like an 8” drive and vise-versa (varies).
- 99% isopropyl alcohol for cleaning drives ($3.00 per pint).
- Lint free cleaning swabs ($5.50 per thousand).
- Assorted 50 pin and 34 pin cables.
- Patience (priceless).

8” floppy drive and disks

- Many used a standard 50 pin interface.
- In double sided drives the index hole was at a different location.
- Common formats were FM (single density)and MFM (double density).
- Soft sectored vs. Hard sectored disks.
- Some drives used a 120v motor for disk rotation

Index Hole

Single Sided

Double Sided

Mixed density Disks

The Model II used a mixed density format. The first track was FM encoded. Remaining tracks were MFM encoded. Some PCs cannot handle FM encoded data.

- TestFDC
- List on Dave Dunfield's Site
- Add on floppy controllers
- Look for National Semiconductor PC8477B, or the SMC and Goldstar 37C65 based FDCs
- Last resort is the Catweasel or some other hardware solution (diskferret, kyroflux)

A Sample of tested controllers

S = Single Density
D = Double Density
X = Double Density / 128 byte sectors

P = Passed
F = Failed
N = Not tested

Manufacturer	Model	FDC chip	Class	Data rate 250 SDX	300 SDX	500 SDX
Abit	KT7A	?	Ath	PPF	PPF	PPF
Abit	TX-5IB2	M5135	P1	PPP	PPP	PPP
Abit	KV8PRO	W83627HF	Ath	PPF	PPF	PPF
Abit	KV80	W83627HF	Ath	PPF	PPF	PPF
Adaptec	AHA-1522A	DP8473AV	ISA	PPP	PPP	PPP
Adaptec	AHA-1542B	DP8473AC	ISA	PPP	NNN	NNN
Adaptec	AHA-1542CF	820778L	ISA	PPF	PPF	PPF
Aopen	AP5T	SMC FDC37C669	P1	PPF	FPF	PPF
Aopen	AP5VM	SMC FDC37C669	P1	PPF	FPF	PPF
Aopen	AX63PRO	W83977	P3	FPF	FPF	FPF
Aopen	AX6LC	W83977	P2	FPF	FPF	FPF
Aopen	MK33	?	Ath	PPF	PPF	PPF
ASrock	ALive-SATA2-GLAN	K8T890 CF	Ath64X2	PPF	PPF	PPF
Asus	A7V8X	?	Ath	FPF	FPF	FPF
Asus	P2BF Rev.1.0	W839771FAW	?	FPF	FPF	FPF
Asus	P3B-F	W83977EF	P3	FPF	⊦PF	⊦PF
Asus	P55TVP4	W83877F	P1	FPF	FPF	FPF
Asus	P4P800 Deluxe	i865PE	P4	PPF	NNN	PPF 1
Asus	P3B-F	W93977EF	P3	FPF	FPF	FPF
Asus	P2B-F	W93977EF	P3	FPF	FPF	FPF
Asus	P2B-DS	W83977TF	P3	FPF	FPF	FPF
Asus	K7V	VIA82C686	Ath	PPF	PPF	FFF

Which ones will work for us?

From the notes with TestFDC:

A mainboard that passes the 250 and 500kpbs 'S' tests, but fails the 300kbps 'S' test will not be able to handle single-density with a 1.2M 5.25" HD drive (the most common 5.25" drive types in AT and later machines)…

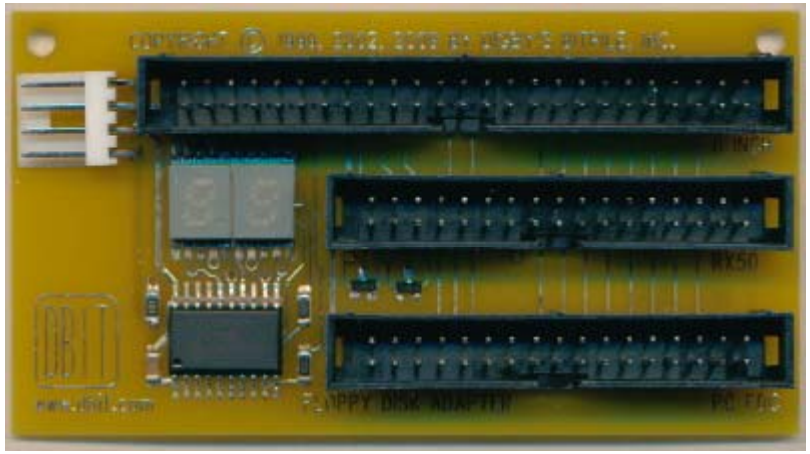
Adapter Options

At this point, if we know that we have a compatible floppy controller, we need to acquire an adapter to convert the 50 pin interface to the standard 34 pin interface.

- Dbit.com's FDADAP – easy $40.
- Frank Durda's – A little dense but very informative http://nemesis.lonestar.org/computers/tandy/hardware/model16_6000/floppyfix.html
- Dave Dunfield's - elegant
- PCB can be easily created using express PCB

FDADAP

- Simple plug and play
- Emulates TG43 automatically
- Also useful to interface to an RX02.



Hand wiring

Frank Durda's method

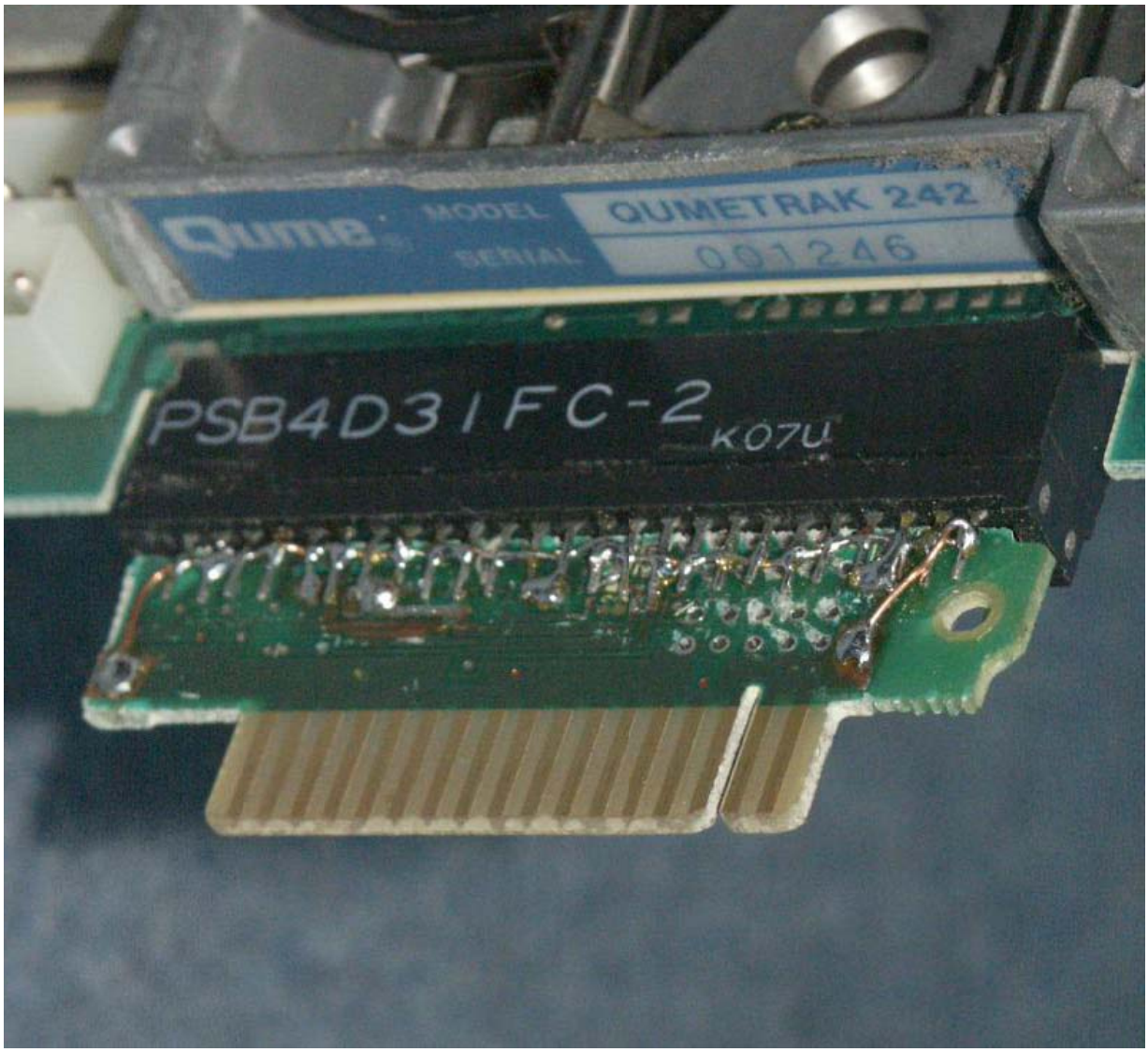
- Get a 50 Pin header and a 34 pin header.
- Crimp each on a short piece of cable
- Wire together all odd pins (grounds)
- Map remaining pins to the 34pin interface

Signal Name(s) - Number in Parens is the 50-Pin connector signal name	50 Pin Connector Pins	Tie To 34 Pin Connector (See Note 1)
Double Sided media detect(10)	10	SPST Switch or tied together
Side Select (14)	14	32
Index (20)	20	8
Ready (22),	22	34
Drive Select 1	26	10
Drive Select 2	28	12
Drive Select 3	30	14
Drive Select 4	32	6
Direction	34	18
Step	36	20
Write Data	38	22
Write Gate	40	24
Track 0	42	26
Write Protect	44	28
Read Data	46	30
Mini-disk Motor on		16 to ground
All other even-numbered pins on the 34 and 50 pin connector should not be connected to anything. All odd-numbered pins are ground.		

Hand Wiring

Dave Dunfield's method

- Get a 50 pin PC Mount edge connector (can be salavged from an ISA motherboard).
- Salvage a 34 pin edge connector from a dead 5.25" drive (look for one with a ground plane)
- Line up pin 1 on both and place PCB section in the PC mount tails.
- Solder together odd pins.


Qtm
MODEL
QUMETRAK 242
SERIAL
001246
PSB4D31FC-2
K07U

Hand Wiring

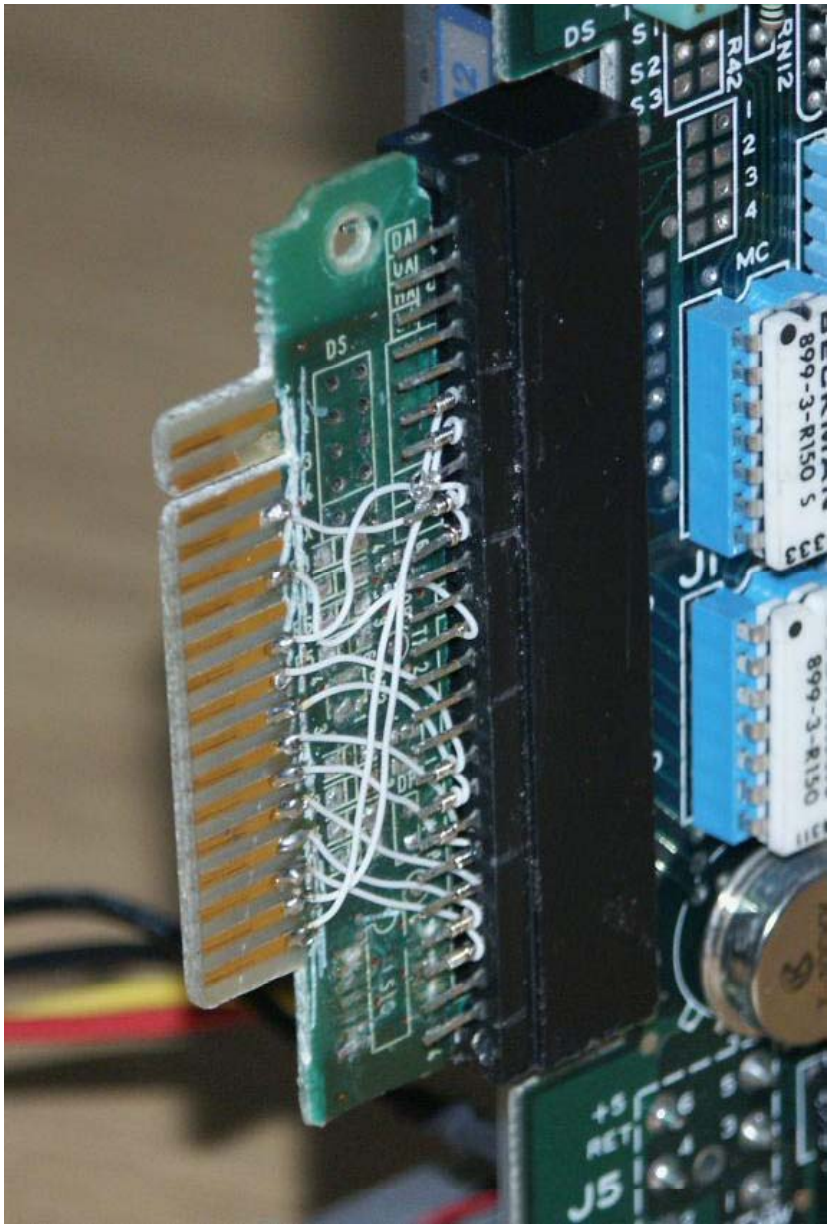
Dave Dunfield's method

- On the even pins, use wire wrap wire and connect the following.

PC(34p)	8"(50p)	Description	
	2	TG43	(see below)
8	20	Index	
12	26	DS1(PC) -> DS0(8")	
16	18	Motor ON/Head Load	
18	34	Direction	
20	36	Step	
22	38	Write Data	
24	40	Write Gate	
26	42	Track 0 detect	All Odd numbered
28	44	Write Protect	pins are GROUND
30	46	Read Data	
32	14	Side1 Select	
34	12	Ready	

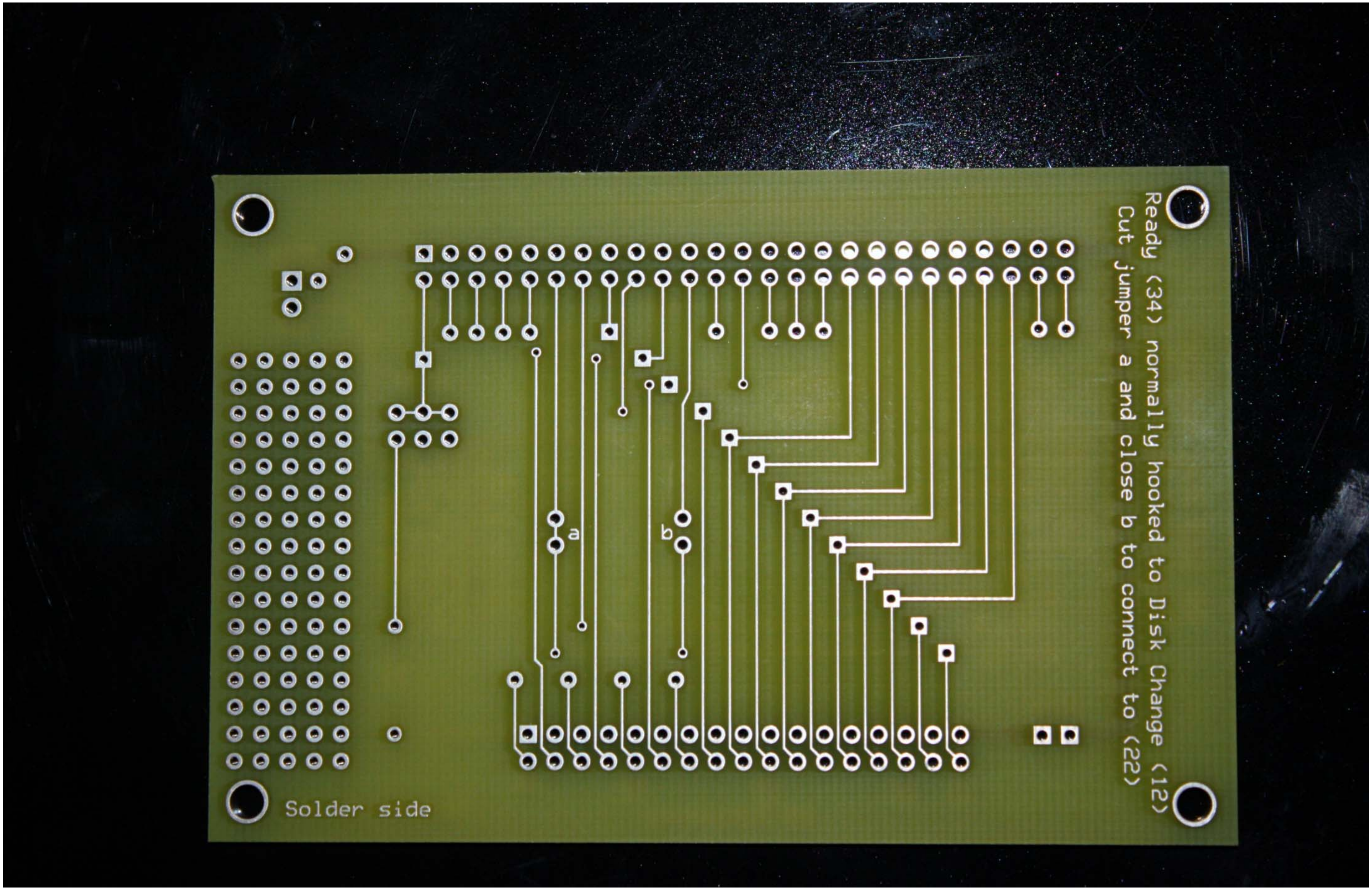
TG43 via parallel port

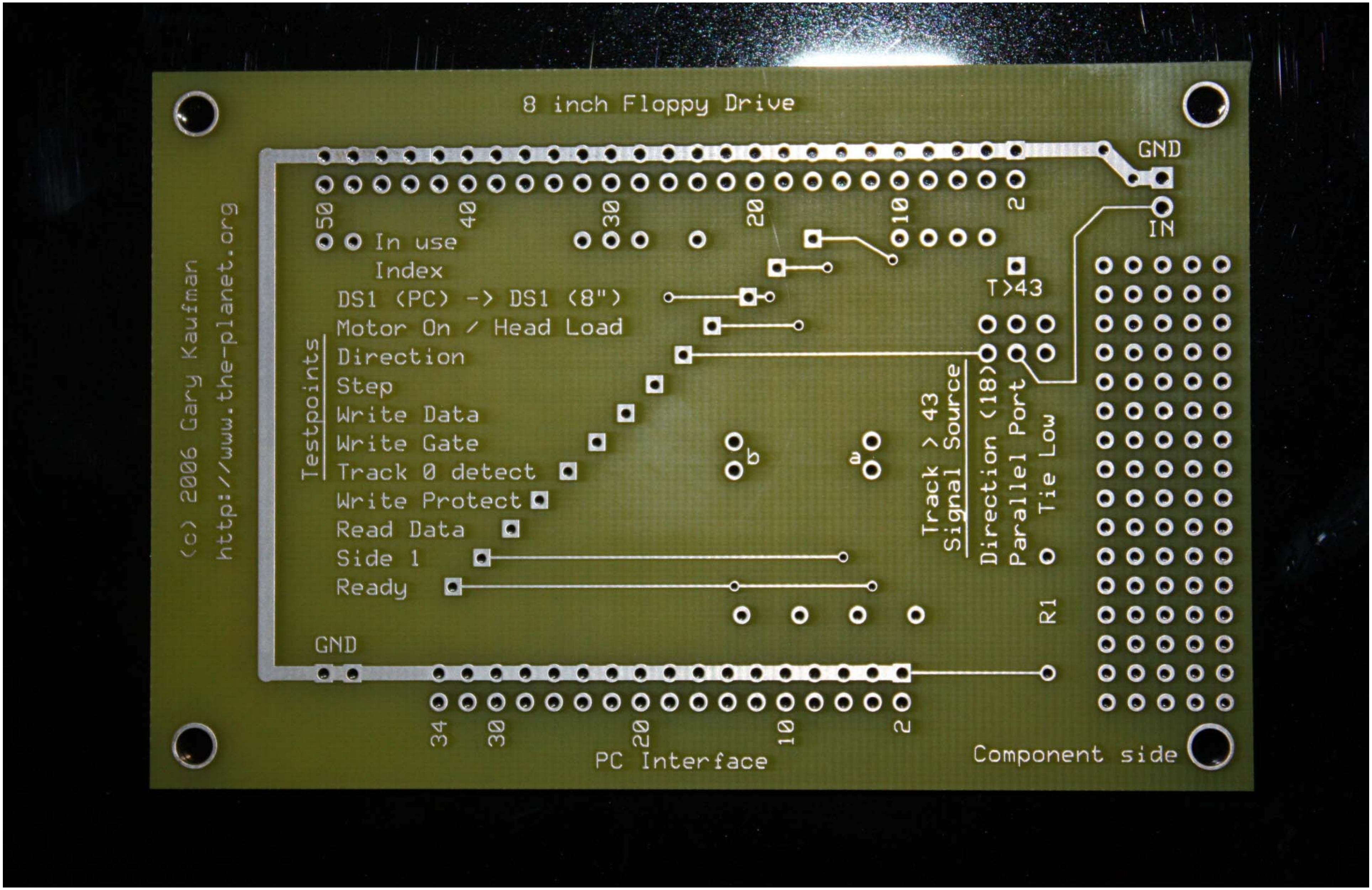
If you are using my ImageDisk program, it provides the capability to generate the TG43 signal from the parallel port. Please refer to the ImageDisk documentation for details.


DS
S1
S2
S3
RN12
R42
1
2
3
4
MC
J1
J5
+5
RET

Make your own PCB

- Using express PCB or some similar program
- 3 adapters for around $60
- Can share with others
- Lots of options can be added.
- A picture of the work by Gary Kauffman follows


Ready (34) normally hooked to Disk Change (12)
Cut jumper a and close b to connect to (22)
a
b
Solder side


8 inch Floppy Drive
GND
IN
50
40
30
20
10
2
In use
Index
DS1 (PC) -> DS1 (8")
Motor On / Head Load
Direction
Step
Write Data
Write Gate
Track 0 detect
Write Protect
Read Data
Side 1
Ready
Testpoints
T>43
Track > 43
Signal Source
Direction (18)
Parallel Port
Tie Low
R1
GND
34
30
20
10
2
PC Interface
Component side
(c) 2006 Gary Kaufman
http://www.the-planet.org

Adapter considerataions

8” plugging into PC

- Configure drive as a 1.2mb 5 ¼” in bios
- Powering drive can be complex. Follow power requirements from manual

Replacing 8” drive on an older machine

- If target machine supports single and double sided disks, make sure to have a switch installed between pin 10 and ground.
- Closed = Double Sided

A word about cleaning

Older diskettes have a tendency to shed. These little pieces of oxide will coat the head of the drive. The heads should be cleaned at the beginning of every session with a lint free swab and 99% isopropyl alcohol.

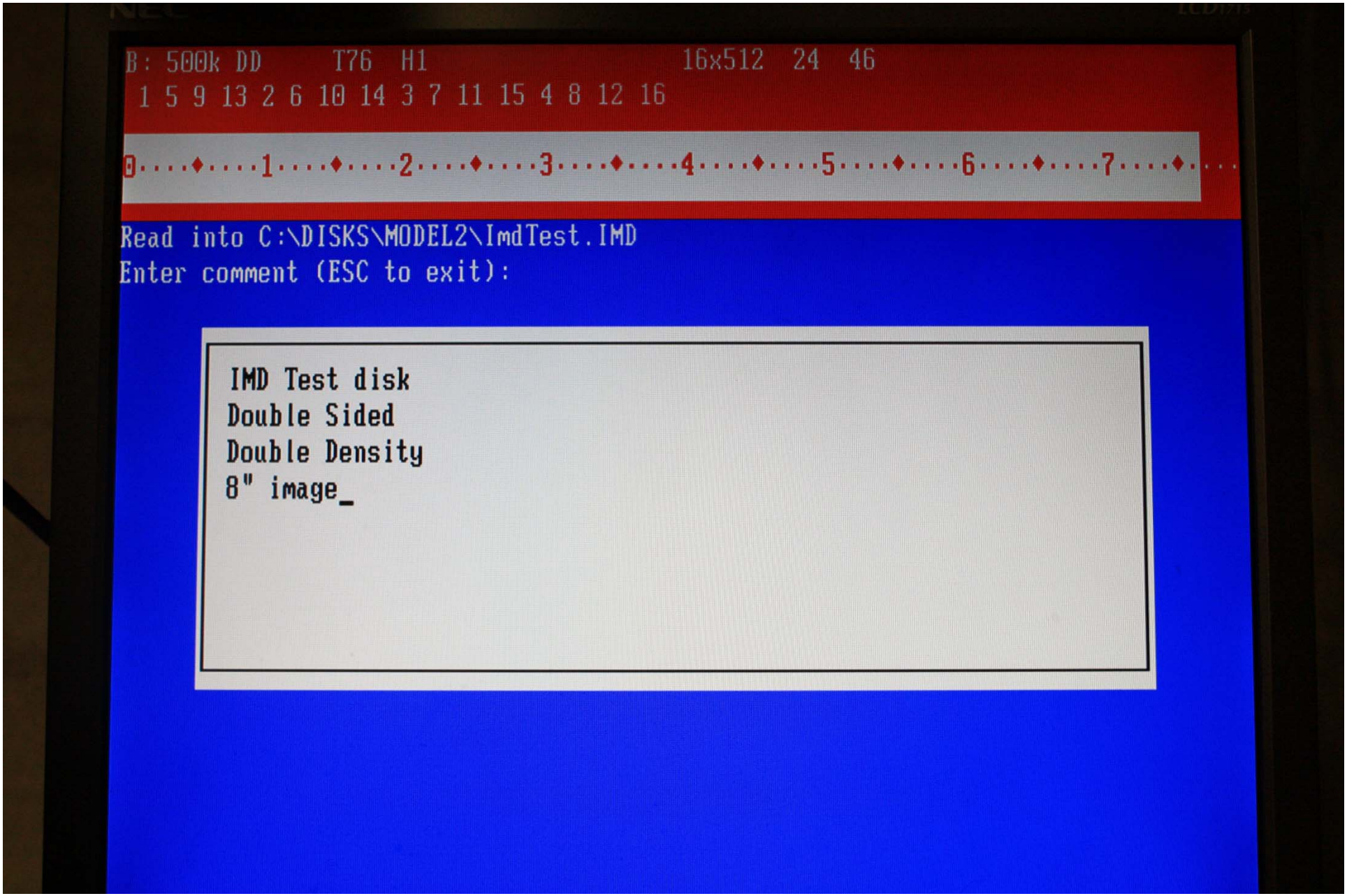
Reading with ImageDisk

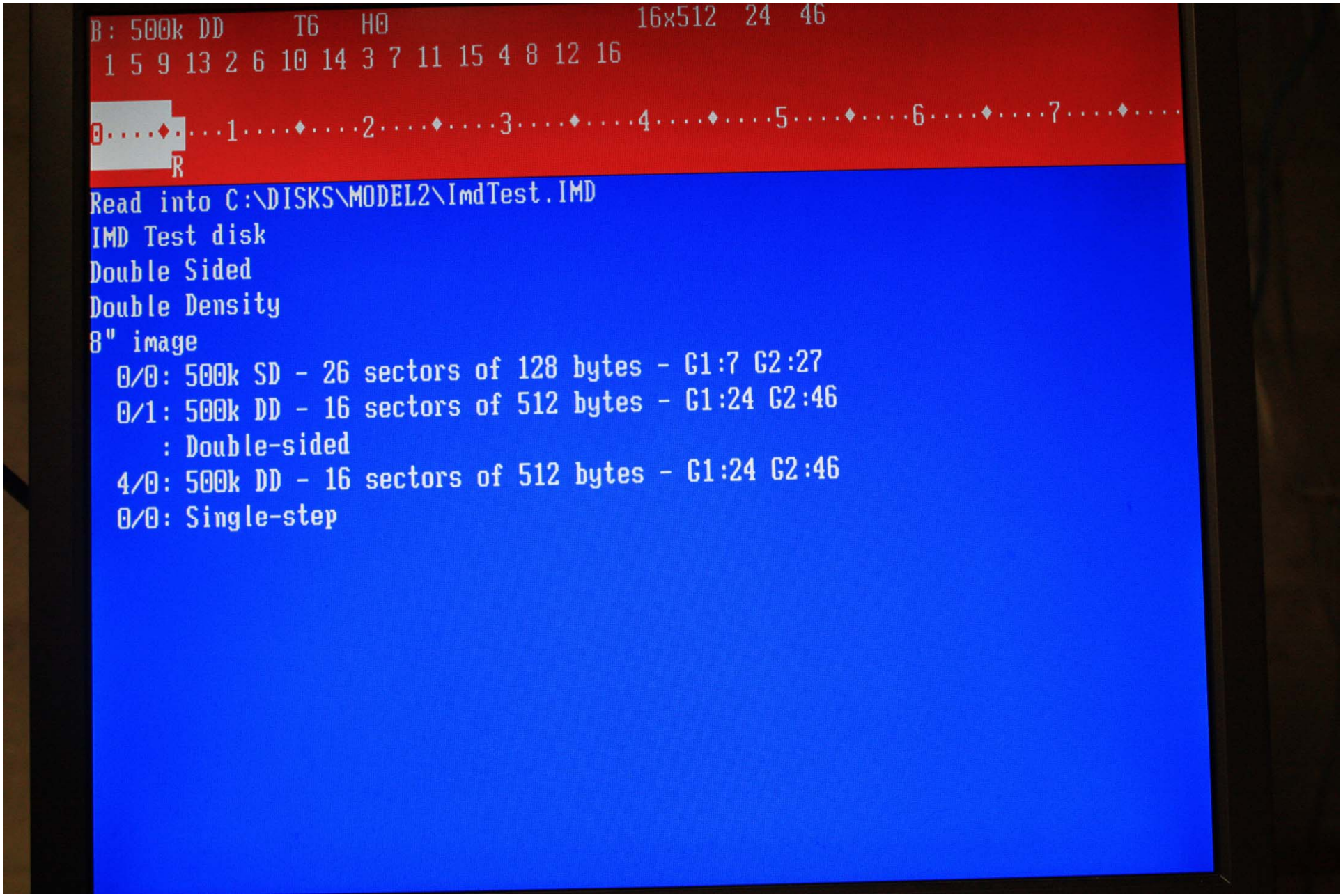
- Plug drive into computer as floppy A or B
- Start MS-DOS
- Download and “install” imagedisk.
- Launch by typing imd
- To read an 8” disk, put settings as the following


0....♦....1....♦....2....♦....3....♦....4....♦....5....♦....6....♦....7....♦....
S)ettings
R)ead disk into file
W)rite disk from file
F)ormat disk
E)rase disk
A)lignment/test
C)lean head
T)est RPM
X)clusion map
F1 = Help
ESC = exit
Drive : B
Cylinders : 77
Sides : As original
Double-step : As original
R/W gap : Calculated
Format gap : Calculated
Format fill : E5
Full analysis : No
Interleave : As read
Retries : 5
Keep bad sector : No
500 kbps -> : 500 kbps
300 kbps -> : 300 kbps
250 kbps -> : 250 kbps

Reading with ImageDisk

- Select R to read a disk
- Enter a file name
- Enter a description. I suggest
  - Number of Sides
  - Density
  - Contents of lable
  - Date read
  - Your name
  - Intended system if known
- Press escape
- Press enter to start reading disk


B: 500k DD T76 H1 16x512 24 46
1 5 9 13 2 6 10 14 3 7 11 15 4 8 12 16
0....♦....1....♦....2....♦....3....♦....4....♦....5....♦....6....♦....7....♦....
Read into C:\DISKS\MODEL2\ImdTest.IMD
Enter comment (ESC to exit):
IMD Test disk
Double Sided
Double Density
8" image_


B: 500k DD T6 H0 16x512 24 46
1 5 9 13 2 6 10 14 3 7 11 15 4 8 12 16
0....♦...1....♦....2....♦....3....♦....4....♦....5....♦....6....♦....7....♦....
R
Read into C:\DISKS\MODEL2\ImdTest.IMD
IMD Test disk
Double Sided
Double Density
8" image
0/0: 500k SD - 26 sectors of 128 bytes - G1:7 G2:27
0/1: 500k DD - 16 sectors of 512 bytes - G1:24 G2:46
: Double-sided
4/0: 500k DD - 16 sectors of 512 bytes - G1:24 G2:46
0/0: Single-step

Writing with ImageDisk

- Writing disks is a similar process
- At the image disk menu make sure you set
  - number of tracks
- single step mode.
- Insert a blank disk and press W for write
- Select disk image to write
- Press enter


** ImageDisk 1.18 / Mar 22 2012 **
Copyright 2005-2012 Dave Dunfield - All rights reserved.
S)ettings
R)ead disk into file
W)rite disk from file
F)ormat disk
E)rase disk
A)lignment/test
C)lean head
T)est RPM
X)clusion map
F1 = Help
ESC = exit
Drive : B
Cylinders : 77
Sides : As original
Double-step : Off
R/W gap : Calculated
Format gap : Calculated
Format fill : E5
Full analysis : No
Interleave : As read
Retries : 5
Keep bad sector : No
500 kbps -> : 500 kbps
300 kbps -> : 300 kbps
250 kbps -> : 250 kbps

Using disk image in emulator

- MESS is a multiplatform computer emulator
- If there is a skeleton for your computer and roms available you can probably get it to boot
- Here is the model II emulator booting a Pickle & Trout CP/M

Other ways to access data

- Once the data is in an image you can manipulate it manually
- Most CP/M formats are publicly documented
- List in dos or Notepad in windows
- A little custom programming can make the data readable

Reading/Writing disks with Catweasel

- The catweasel is a generic floppy interface
- PCI, ISA or Amiga Zorro
- The linux tools by Tim Mann work best
- Cw2dmk –p0 –k3 –d**X** –t77 filename.dmk
- Dmk2cw –p0 –d**X** –k3 –m1 –s 1|2
- Can be converted to ImageDisk using the cw2imd tool in the ImageDisk archive

Using 5.25” drives as replacement

- Must be able to set ready properly
- Should have a drive select
- Any 3 ½” HD drive with same settings can be made to work also.
- Make sure there is a SPST switch between pins 9 and 10.
- Open when using single sided media
- Closed for double sided