

Damaged Cybernetics

<http://www.futureone.com/~damaged/>

CartDisk dev 3.20 (alpha 7) SHAREWARE (<http://internex.net.au/~papa/CartDisk/>).
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Print this document then read it before you start - you'll be glad you did!

Last Minute notes

If you are thinking **not** to make the hardware until CartDisk is out of its Alpha stage, then I think you should make it now. The hardware will be exactly the same for all future versions (including CartDisk 4.0) - the only thing which will change is the software and you can download new versions quite easily.

I need people who have built the hardware and can try out the software to see if it works properly. Only then can **real** progress be made.

I am offering people who register CartDisk while still in Alpha a discounted registration fee of \$US10 (\$A12 if you're Australian) so I can get enough money to re-hire the post office box. This offer is limited; as soon as CartDisk Beta is released, the offer will be closed. To take advantage of this fabulous offer, fill out the registration form in section 2.4.

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1.0 Abstract

CartDisk (1 word!) is a software program and hardware combination which acts as a translator between your PC and a console cartridge allowing you to transfer data between the two. It currently supports the SNES, MegaDrive and GameBoy.

This development version of CartDisk is useful for you to backup your own cartridges allowing you to legally play them on the various emulators available on the Internet. It **does** allow you to write to a cartridge, be it SRAM, DRAM or FlashROM, however it hasn't been implemented in software (completely) and the hardware has not been (completely) developed yet. A circuit which uses standard SIMMs (DRAM) as a cartridge is almost complete. It was developed entirely by Digital Fantasy and can be viewed at the official CartDisk Internet site.

The interface is able to support **all** consoles, however due to the limitations of the IBM printer port and hardware design (tried to keep it as simple as possible), it may be slow writing to a FlashROM cartridge (2-4 megabytes). Although the interface can support a wide variety of consoles, the software can't (yet). e.g. I was asked to include TGX16 support. It may be possible, however I don't know much about the system - pin outs, max. ROM size/speed and SRAM selection (if any)... If I did, it would be a matter of writing code and designing an adapter to read and write data to and from the system.

You only have to make the interface once! To "adapt" it to a different console system, you simply modify the bit which connects to the cartridge - everything stays the same. Who knows? One day it might even support the Ultra64! It all depends on how many people register.

In future release(s), I will distribute a PCB for a DRAM cartridge, the circuit designed entirely by Digital Fantasy. It supposedly is able to emulate a SNES FastROM cartridge using SIMMs DRAM. Hopefully it may be "adapted" to the MegaDrive by using double the DRAM to fill the extra 8bits... A FlashROM cartridge design for the GB has been finalised, however it requires that you pull apart two GB carts and remove the MBC1 and MBC2 chips. A PCB for this has not been designed as of yet.

1.1 System requirements

You will need:

- An IBM compatible computer, XT or better (Someone is trying a Mac version. Any Mac people out there?).
- An enhanced (EPP/ECP) or bi-directional parallel printer port (make sure it is in EPP/ECP mode in your CMOS).
- MS-DOS or IBM-DOS v3.30+.
- The CartDisk mainboard and at least one adapter (which you make).
- A few console cartridges to play with and a console system to suit (to play your backups on) or an emulator.

1.2 Disclaimer

No information contained in the CartDisk software or hardware was derived from any confidential source, including this document. You may legally make one copy or backup of a game cartridge that you currently own, although distribution of this copy is prohibited by law, although this may be subject to where you live.

DiskDude accepts no liability for any damages whatsoever including direct, indirect or consequential even if he has been advised of the possibility of such damages from the use, misuse or construction of the CartDisk software and/or interface. Furthermore, DiskDude doesn't make any warranty of any kind, expressed or implied, including without limitation, any warranties of merchantability and/or fitness for a particular purpose.

The CartDisk software is provided "as is". You may distribute the shareware version of CartDisk so long as all accompanying files are also distributed, no charge other than duplication costs are applied and **NONE** of the original files are modified in **ANY** way.

In no way shall CartDisk be used for acts of piracy. CartDisk was designed for backup and/or development of Super Nintendo Entertainment System, SEGA MegaDrive/Genesis and Nintendo GameBoy games that you own.

All copyrights and trademarks are owned by their respective owners, even if not acknowledged. No infringements are intended.

2.0 CartDisk

2.1 Hardware Interface

2.1.1 Parts needed

CartDisk interface

2 x 8255a IC	Programmable Peripheral Interface
1 x 74ls139 IC	Dual two to four binary decoder; low power high speed
8 x 470 ohm	Resistors which prevent your printer port from blowing up
4 x 0.1uF	Capacitors (any kind - ceramic are probably best)
1 x 50pin IDC	Connector for various adapters (male)
1 x 25D male	Plug for printer port (and matching backshell)
1 x (m) cable	12 way shielded cable (including earth wire - 13 way)

Test Adapter

1 x 50pin IDC	Connector to connect to the CartDisk mainboard (male)
1 x LED	Tells you if the adapter is getting a power supply
1 x 390 ohm	Resistor protecting LED from blowing up :->

Adapters (SNES, MegaDrive/Genesis, GameBoy)

1 x edge connector	Buy a Game Genie and remove the connector from that (second-hand Game Genie's are cheap); or Use an IBM motherboard edge connector (8 bit version); or Any edge connector with 0.1" contact centers
1 x 50pin IDC	Connector to connect to the CartDisk mainboard (male)

Cable to connect adapter(s) to CartDisk mainboard

2 x 50pin IDC female sockets
1 x 10-15cm 50 way/wire ribbon cable

2.1.2 How to make the interface

Components on overlay:

CartDisk interface (double sided PCB)

U1 and U2	8255a IC's
U3	74ls139 IC
C1-C4	0.1uF capacitors

Test adapter (single sided PCB)

R1	390 ohm resistor
LED1	LED :)
C1	0.1uF capacitor

SNES adapter (single sided PCB)

C1	0.1uF capacitor
----	-----------------

MegaDrive/Genesis adapter (double sided PCB)

C1	0.1uF capacitor
Wire links	A piece of insulated wire to connect between the pads. I'm not too good at designing PCB's (it was my 5th PCB ever!) and I needed an extra layer :)

GameBoy adapter (single sided PCB)

C1	0.1uF capacitor
Wire link	A piece of insulated wire to connect between pads.

PCB files are named as follows:

_O. Overlay image. It tells you which component goes where on the PCB
_T. Top layer of PCB.
_B. Bottom layer of PCB.

e.g. CDISK_O.PS → CartDisk interface overlay image in PostScript format.
 CDISK_B.GIF → CartDisk interface bottom layer in GIF format.

Note: Some PCB patterns don't have a top layer - they are one sided boards. All bottom layers are "mirrored", ready for assembly.

The PCB files are supplied in both POSTSCRIPT and GIF. The PostScript files have an extension of .PS while GIF has .GIF with resolutions of 300dpi. If you use the .GIF, you **must** print the file at 300dpi otherwise it will not be to scale! I recommend using Paint Shop Pro (16bit; the 32bit version crashed when I tried printing 600dpi PCB layouts) for windows to print the GIF files to a specific resolution on your printer. This does not mean you print a 300dpi GIF at 180dpi on your printer - you print a 300dpi GIF at 300dpi. You can download Paint Shop Pro 16bit from the official CartDisk web site on the Internet (<http://internex.net.au/~papa/CartDisk/>).

If you do not have access to a PostScript printer, and cannot print the GIF's at 300dpi, then you will need to download a program to convert the PostScript images to a resolution you can print at (in the form of a .GIF). The utility is called GhostScript (which is what created the .GIF's included with CartDisk) and can be downloaded from the official CartDisk web site.

i.e. If your printer **only** prints at 180dpi, then you will need to convert the PostScript files to GIF's at 180dpi before you print them. They will then be at the correct size. To do this, I created a batch file (PS2GIF.BAT):

```
@echo off
gs -q -r180 -sDEVICE=gifmono -sOutputFile=%1.gif %1.ps
echo.
```

The -r180 tells GhostScript the resolution of the GIF file to be created (180dpi). If you want 600dpi, then you must specify -r600. To run the batch file, do not specify any extensions:

```
C:\CARTDISK>ps2gif cdisk_t
```

This will convert the file cdisk_t.ps to a new GIF file cdisk_t.gif.

For those of you with PostScript printers, you need to copy the file to your printer:

```
C:\CARTDISK>copy /b cdisk_t.ps lpt1:
```

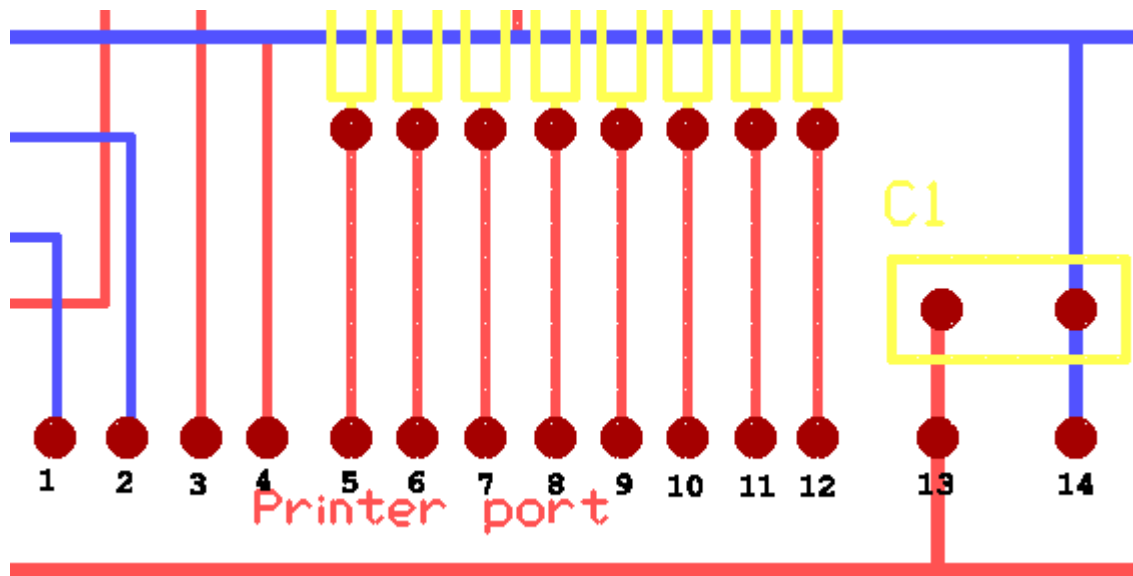
To see if the printout is at the correct size, place one of the ICs over the printout and see if the pins line up.

Making the CartDisk interface (mainboard)

Once you have the files printed, you need to etch the board. Details of this process are beyond the scope of this document - please refer to your etching kit for more information.

Firstly solder the vias (holes underneath U1 and U2 - they link the two sides of the board together) then the components and IDC50 in place. It's best not to use sockets for the ICs because it's too hard to solder the top side of the board (socket gets in the way). Now you need to connect the board to your PC via the shielded cable and DB25 connector.

On the board, where it says "Printer port", there are 14 pads (holes) starting on the far left as in the diagram below:



The key to this is as follows:

PCB pad #	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Printer port pin	p17	p16	p14	p1	p2	p3	p4	p5	p6	p7	p8	p9	GND	+5V

You need a 5 volt DC power supply, nothing else will do!

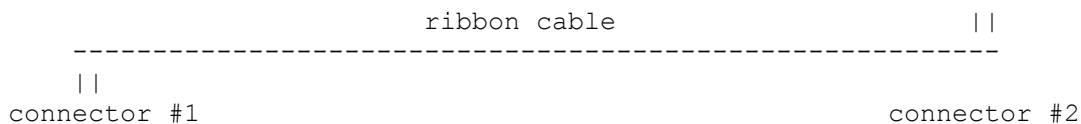
There is no +5V on the printer port so I recommend that you use the Joy Stick port since you get a nice clean, regulated power supply directly from your PC. The pin layout of the Joy Stick port is as follows:

Vcc (+5v)	pin 1 or 8 or 9 or 15
GND	pin 5 or 12

Making the adapter cable

You need to make a cable which connects between the CartDisk interface and the various adapters for different consoles. You only need to make one - it will have two sockets on each end so it'll work with all adapters.

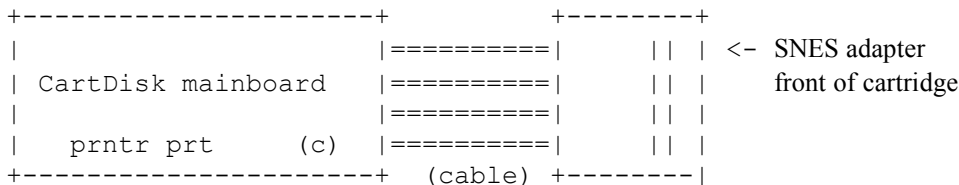
Get your two IDC50 connectors and a piece of 10-20cm 50-way ribbon cable. Open one of the connectors and attach it to the ribbon cable making sure you line up the teeth of the connector with the individual wires of the ribbon cable (you do not need to remove the plastic on the ribbon cable - the teeth bite through it to make the connection). Replace the cover that holds the ribbon cable in place. Do the same for the other side *making sure one faces downwards, the other upwards*.



MAKE SURE THEY LINE UP! The power pins are right next to each other (I was going to put one on each end, but didn't) so if the cable isn't aligned, you will short your power supply - if you use the Joy Stick port for power, you will kill your PC's power supply and may require you to get a new one!

Your cable is now complete.

A WORD OF WARNING: When you connect your adapter to your CartDisk interface by this cable, make sure PIN 1 of the IDC connector on the interface is connected to PIN 1 of the IDC connector on the adapter. It's a simple thing which many people may overlook. The following is an example for the SNES connector:



(I didn't use Word Draw because then WordPad people can't see the drawing)

Figure 1

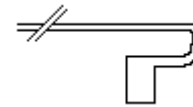


Figure 2

As a general rule of thumb, the IDC connector on all devices are on the left when the board is the right way up, and the IDC connector on the CartDisk mainboard is on the right. Do not have a twist in the cable between the mainboard and adapter. However, you should have the cable loop back on itself at one of the ends (Figure 2 - because one connector is upside down on the cable; see page 5).

Making the adapters (SNES, MegaDrive/Genesis, GameBoy, "test")

This is the same as making the CartDisk mainboard. Just print out the PCB images, etch the board, drill the holes and attach the IDC connector and edge connector for the console cartridge.

You are now ready to test the board - however you still need to make a "test adapter". Make it in the same way as the other adapters, making sure you connect the LED the right way around (it is polarised!). The *cathode* of the LED connects to the pad which is connected to the resistor, the anode connecting directly to the IDC connector (The *cathode* is the pin next to the "flat" part on the base of the LED; the *anode* is the only pin left!).

If you are confident that you didn't make a mistake, try it out first then test the board later... but don't quote me on that!

2.1.3 Testing the interface

Connect the test adapter to the CartDisk interface. First check to make sure the LED lights up. If it doesn't, you made a booboo - fix this first! Now run CartDisk with the test ("t") command as follows:

```
C:\CARTDISK>cartdisk t
```

CartDisk will then run through every combination of data bits and output them to U1, reading them and comparing it from U2. If a mismatch occurs, it will be displayed on the screen. Then it will be reversed, using U2 as the output and U1 as the input. If you have an error prone interface, try adding more capacitors between +5v and GND on every IC to minimise the noise or turn the turbo off! (Your PC may be too fast for the interface - I will include delays in the code for beta/full versions)

However, this assumes that you made no mistake in your wiring. If you do get errors, check this first.

An example error message is: "Error on reading U1 port B: read 50 expected 5F" In this case, four bits were missing when reading U1. This may be a result of wiring errors on the interface on pins 18-21 of U1 or pins 9-12 of the 50 pin IDC connector, OR it may be a result of U2 - it may have written 5F wrong (as 50) and U1 read it correctly as 50... To log all the errors to a file, redirect CartDisk's output like so:

```
C:\CARTDISK>cartdisk t > logfile.txt
```

The way of checking it in more detail is as follows:

The program CDEBUG.EXE is provided to write and/or read data bytes to/from the interface one at a time. What you do is write a byte of data to the interface which makes it latch ("stick") there. You then use your multimeter and see if the data bits are correct. To do this, you need to know a bit of binary! If you have a decent calculator, it will convert it for you, or use Window's calculator (CALC.EXE in your WINDOWS directory).

The 50 pin IDC connector is mapped into 6 different "ports", each with 8bits. The key is as follows:

Port #	CartDisk test reports it as	IDC pin #
1	U1 Port A	1-8
2	U1 Port B	9-16
3	U1 Port C	17-24
4	U2 Port A	25-32
5	U2 Port B	33-40
6	U2 Port C	41-48

Note: IDC pin # 49 is +5v and pin # 50 is GND. Pin numbers start from 1 at the bottom left corner when viewing the PCB so that the text "CartDisk interface © blah blah" is readable (and is positioned in the bottom right corner). Pin # 2 is directly to the right of pin 1 and pin 3 is above pin 1, etc, etc. On the adapters, the pin numbers are mirrored (because of the way the cable is made), so pin # 1 is on the bottom right, pin # 2 bottom left and pin # 3 is above pin #1. Confused? Read it again!

To write a byte, lets say 6C (1101100) to port 2 using CDEBUG.EXE, you type:

```
C:\CARTDISK>cdebug w 6c 2
```

If your CartDisk interface is on LPT2:, you can put a port switch after it:

```
C:\CARTDISK>cdebug w 6c 2 /2
```

Now 1101100 should be appearing on pins 9-16 of the IDC connector. Use your multimeter to check this (5 volts = 1; 0 volts = 0). NB: For you dumb people, connect the black lead to your power supply's ground (GND or 0v) and the red lead to the pin on the IDC connector. Sorry for all you smart people! :)

You may repeat this process until you find which bit (binary digit not "part") isn't working. To read some data from the port, lets say port 5 on LPT2:, you type:

```
C:\CARTDISK>cdebug r 5 /2
```

CDEBUG.EXE will then read the data from port 5 and give you the result IN HEX. This is useful to see if the CartDisk interface is giving your PC back the data properly. To use this however, you need to force data to the IDC connector. You need to have eight wires and connect these to your 5 volt power supply. Connect the other end of these wires to the pins of the IDC connector as outlined in the table above. Note: This will give you binary 1's, to get binary 0's, you must connect some/all of the wires to GND or 0 V... Use your common sense.

2.2 Software

The software is provided as a DOS .EXE file which provides basic functionality. It saves all images in the GameDoctor RAW format (except MegaDrive/Genesis which is stored as a binary file: .BIN).

Note that it is a very basic DOS program. Once everything works fine, I will write a Windows version: CartDisk 4.0 and no changes to hardware are required. However this program will **not** be shareware and will only be available to people who have registered.

Usage: CartDisk [tool] [system] [filename] [port]

```
[tool]:    c - Copy a cartridge
           l - Load a cartridge
           s - Save SRAM on cartridge
           o - Load SRAM on cartridge
           c - Clear SRAM on cartridge
           t - Test Interface
[system]:  s - Super Nintendo
           m - SEGA MegaDrive/Genesis
           g - GameBoy
[port]:    /1 - LPT1: (default)
           /2 - LPT2:
           /3 - LPT3:
```

e.g. You want to copy your SNES "Super Mario World" cartridge. Your interface is connected to your parallel port #2. You type:

```
C:\CARTDISK>cartdisk c s mario.gd /2
```

If your interface was connected to parallel port #1, the port switch is not needed - it is default.

e.g. You want to copy your MegaDrive cartridge "Sonic the Hedgehog" with your interface on parallel port #1. You type:

```
C:\CARTDISK>cartdisk c m sonic.bin
```

Once you have the cartridge on disk in the form of an image file (as above), you can then use it in one of the various emulators available on the Internet. Please note that VSMC by The Brain requires you to have the file in Super Magicom format. CartDisk creates your image in GameDoctor (or raw) format. To convert between the two, download a SNES conversion utility such as uCON from Damaged Cybernetics (<http://www.futureone.com/~damaged/>).

The Genesis emulator GenEm by Markus Gietzen will gladly run images created by CartDisk, however make sure you name them with the BIN extension.

2.3 Registration

CartDisk is SHAREWARE. This means that if you continue using it after an initial fourteen (14) day trial period, you must:

- Send a donation of \$US15.00+ (Bank cheque's only please) to DiskDude via mail **AND** a postcard of your local area (city)! Please make the cheque payable to "John Pappas" and in US funds only (If you live in Australia, then please send \$A18.50+).

CartDisk has been in development for a few years now which has meant many hours of hard work refining the code/hardware. The \$US15.00+ is simply to keep my post office box alive and fund any hardware I need to purchase like IC's and copper clad. The PO BOX rental runs out in February '97 - if no-one registers by then, I will lose it (unless I pay ~\$US35 to hire it again) and will no longer develop **anything** anymore - why should I develop if no-one is interested, and lose money on it as well? Personal experience with *SEGA Load* and *WinBoy!* has shown me that everyone is willing to use my software (and I know that at least 100 people are using it from E-Mail I get), however only *one* person registered by sending a postcard.

Registration motivates me to continue work heading for CartDisk release 4.0. Anyone who registers will get the following:

- Unlimited technical support in getting CartDisk to work
- All future registered versions of CartDisk which are released
- A warm fuzzy feeling knowing that you did something good in that I get to see a picture of your city and add to my very thin collection!

I am sorry that this can **only** be dealt with via Internet e-mail. If demand becomes high, I'll consider other methods of distribution as well.

Please don't ask for prebuilt interfaces, I don't like making them over and over... and will not. Any e-mail I receive which is along the lines of "Can I buy a CartDisk interface from you?" or "Do you know where I can buy a CartDisk interface?" will be automatically trashed.

Please register by printing and filling in the order form on the following page.

Make sure you include a statement of the weather on your PostCard (the best type are the ones with a picture of your city).

Don't forget to pass CartDisk along to friends and others you know!

2.4 Order Form

John Pappas
PO BOX 48
Coburg 3058
VIC, AUSTRALIA

Web: <http://internex.net.au/~papa/CartDisk/>
E-mail: diskdude@poboxes.com

SPECIAL OFFER! - Only valid while CartDisk is in alpha versions.

[] CartDisk version 3.20 alpha pack \$US10.00

Includes:

- * Registered software via Internet E-Mail
- * Lifetime software upgrades via Internet E-Mail
- * Unlimited technical support via Internet E-Mail
- * "DiskDude's Ultra" console utility for Win95 *FREE* when released
(This utility is NOT shareware/freeware)

Total enclosed \$US10.00

(Payment by bank cheque only please)

Name: _____

City/country: _____

E-Mail address: _____

Console system(s): _____

Where did you hear about CartDisk? _____

NOTE: Also include a PostCard of your local area with a statement of the weather. **Australian residents please make payment in AUSTRALIAN currency at \$A12.00 total.**

3.0 Version history

Development version 3.20 alpha

- Redesigned the interface, giving more I/O lines with less components.
- Created PCB for interface, SNES and test adapters.
- Software for DOS written only supporting ROM reading so far.

- Debug program (CDEBUG.EXE) added in for testing purposes.

Development version 3.20 alpha 1

- I said that the two major components of the CartDisk interface were 8225a's in the last version when they're supposed to be 8255a's! Whoops! :-> Fixed up these docs.

Development version 3.20 alpha 2

- My assumption regarding the IDC connector being the wrong way around was correct. I pulled apart my PC and tested it with my HDD cable :) This means that the SNES adapter is wrong in previous versions - it has been fixed. Also, the LED must be put the other way around (in previous versions) for the test adapter.

Development version 3.20 alpha 3

- Added MegaDrive/Genesis support.

Development version 3.20 alpha 4

- Checked all PCB's and corrected:
 - Tiny error in the CartDisk mainboard relating to power connection at the top near the two capacitors.
 - Genesis adapter: Added power to pin A3 and corrected two mistakes for pins B28 and B29 (they were on B29 and B30 respectively).
(SNES and test adapters were fine)

Development version 3.20 alpha 5

- Enabled write to a SRAM (or emulated SRAM using DRAM) cartridge in the code.
- Added GameBoy support.

Development version 3.20 alpha 6

- Moved the documentation from a standard text file to this.
- Fixed up the documentation regarding printing the PCB's at specific resolutions with the GIF file as there seemed to be some confusion.
- I re-checked the cable thing (see version 3.20 alpha 2) and found it to be right the first time! (alpha 1) The reason why I thought it correct in alpha 2, was because the hard disk cable has a loop in it (see section 2.1.2 "Making the adapter cable") and I didn't realise it. If you also put a loop in the cable, everything should be fine without a change in the hardware.

Development version 3.20 alpha 7

- All PCB GIF files are now at 300dpi.
- Added error checking using cartridge checksums.
- Fixed up a lot of the MegaDrive/Genesis code.

To do:

- Read/write SRAM on cartridges.
- Clear SRAM on cartridges.
- Make and test the DRAM cartridge to play SNES and MegaDrive games (using SIMMs) then design a PCB for each.
- Try my luck with SEGA Game Gear then Master System.

4.0 Acknowledgments

- rec.games.video FAQ
- Nintendo GameBoy FAQ
- Sega Genesis Hardware Internals (04/07/1993)
- SNES Kart v1.6 (<http://internex.net.au/~papa/sneskart.htm>)
- Pascal Felber's GameBoy banking web page and advice on GhostScript
- Pascal Felber's GameBoy connector on the PCB :)
- Peter Grey's great hack of the MAD-1x address decoder IC's for SNES

- AutoTrax for PCBs; Borland Turbo Pascal 7.0 for DOS; GhostScript to convert .PS to .GIF

5.0 Information required

- Bank switching the SMS, GG, NES and how to access the save RAM
- Format of the NES, Game Gear and Master System Game Genie codes
- How to properly access the save RAM on the MegaDrive/Genesis

5.0 Known bugs

- None as of yet!

Please report any bugs you may find or "features" to the author via e-mail <diskdude@poboxes.com>.

Make sure you include a small description of what the problem is so it can be reproduced easily to rectify the error. DiskDude can't fix a bug if he don't know what it is!

7.0 Greetings!

Hello and thank you to the following people:

- LordViper This guy is a **legend!** Thanks for the FlashROM and everything else!
- Peter Grey G'day mate! ;)
- Ian Huang Keep that DRAM refresh controller coming!
- Pascal Felber Thanks for all the GameBoy help.
- Dean Hegazi Have a **great** holiday!
- Trevoy Nyari Long time no see...
- Jeremy Shear Let me know how it goes with that Mac version :>
- Trevor Hay Thanks for that info; and the interest in CartDisk... see? I don't hate you.

Finally, **don't forget to register**. Thanks for reading!

CartDisk is brought to you by:

