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TAPR CompactFlash Adapter

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Introduction

Since PCs have become a generic and low cost way to provide network nodes and switches, amateur radio operators have been placing them in environments which were never meant to see a consumer PC operate in. One of the most significant problems encountered with ruggedizing a PC for remote network operation is the hard drive.

When amateurs first incorporated hard drives into our node in the 1980's, older MDF based drives worked in all sorts of horrendous conditions without fail. As times changed, so did hard drives. Newer IDE drives introduced problems related to temperature conditions that the older drives didn't have. Add to this the fact that some of these network nodes get installed in locations that do not allow the most convenient access - like on top of 1500 foot towers or on buildings that have difficult access when we need to fix an outage. Thus, it is important to do as much as possible to reduce the MTBF (mean time between failure) of any aspect of the node.

Over the years at conferences and gatherings, the conversation would turn to how to go about getting PCs to work reliably in remote locations without

costing a fortune doing so. That the power supply and hard drive were the major issues involved was obvious from the start. The power supply issue has been solved over the years as prices for industrial supplies to run PCs off 12volts have dropped.

So, the focus needed to be on the hard drive. About the same time as we started our project, the Linux Router Project was focused on a distribution of Linux small enough to fit on a single 1.44MB floppy disk making building and maintaining routers, terminal servers, and typically embedded networking systems next to trivial (<http://www.linuxrouter.org/>). One problem with their approach was that it didn't answer the question for those that wanted to run other network OSs like FlexNet, NOS, or whatever in their remote node.

The solution was to come in 1998 and be a TAPR kit in 1999.

What is it?

A small circuit board which has a socket to accept a Compact Flash(TM) memory card. It also has an IDE drive connector and power connector to interface to the computer.

What does it do?

It allows one to build a diskless PC system. The Compact Flash card provides 100% hard drive emulation.

How do you use it?

You plug in power and IDE cables from your PC and plug in a Compact Flash card. Initialize the Compact Flash card and install the operating system just as you would a regular hard drive.

What operating systems may I use?

Both Linux and DOS 6.22 have been tested. The only theoretical limitation is the Compact Flash card capacity. e. g. Windows 95 wouldn't fit on an 8Mb Compact Flash card.

Where do you get the Compact Flash card?

At any store that carries digital cameras or digital camera accessories.

Where do you get the flash adapter?

From TAPR.

ACKNOWLEDGMENTS

The Tucson Amateur Packet Radio (TAPR) Compact Flash Adapter project was a result of the efforts of the following people:

John Koster, W9DDD (w9ddd@tapr.org)
Project Manager, Hardware Design

Allen Finne, KB5SQK (dallen@cei.net)
Linux guru

Ed Geiger, KD4AB (egeiger@unitedmechanical.com)
Additional Linux help

The Hardware

There isn't much required. To use the adapter, you need the following:

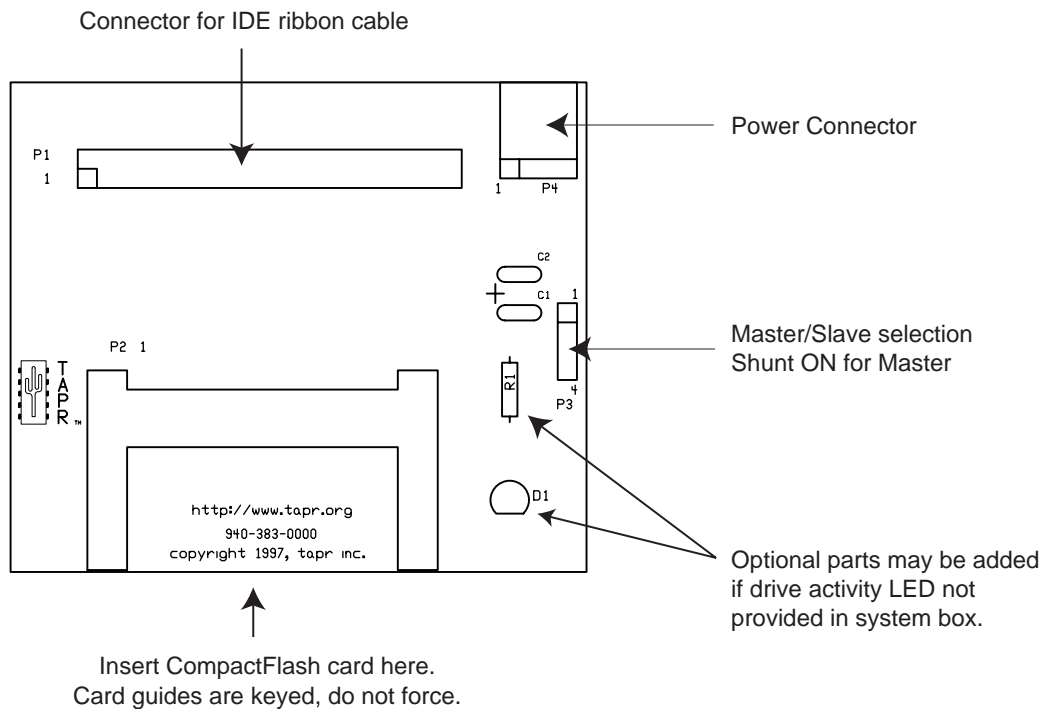
- A CompactFlash card (size depends on the OS and applications to be loaded)
- A spare connector on your IDE ribbon cable
- An unused power connector compatible with the common 3.5" floppy drive
- A place to mount the card

It is possible to operate with as little as an 8Mb CompactFlash™ card. Prices keep falling. Size requirements will depend on the OS (operating system). DOS will probably take the least; you probably can't afford the size required for W95 or W98! (you can use any OS that will work with a standard HD)

If both the primary and slave connectors are already in use, you will need to add a secondary IDE controller. Typically your target system will not have any other HD; however, your development host may already be full.

The power connection is fairly straightforward - be sure red wire is connected to pin 1. It IS possible to force the connector on backwards.

As to mounting, it is suggested that the adapter can be attached to any flat surface within the enclosure or case with double-sided tape. (The heavy duty type such as used for hanging pictures, etc.) Alternatively one could take a flat piece of sheet metal or thin plastic sheet and make a mounting plate to fit into a 5.25" or 3.5" drive bay.



The Software

While Linux has been used as the preliminary testing of the concept, any other NOS or amateur switch software should work on the card.

You can read and write from the Flash, but if the application allows, simply use a RAM disk to store information. The project will be looking for comments from others as they get their specific applications installed and working on the device.

Once you have the hardware mounted, IDE and power cables attached, it is time to load the OS. We'll use DOS installation as an example. You can use one of two methods. One is to hook up the adapter as a slave drive on an operating computer. The other is to use your target system with floppy drive attached. You will need to set the master/slave jumper on the adapter to correspond to its position within the system. If you load the software on a host system and then move the adapter to a target system, don't forget to change the jumper setting (most likely install it) to correspond to the new configuration.

First, you must set the CMOS to recognize the new 'HD'. Most modern BIOS' will autodetect the number of cylinders, heads, and sectors per track (CHS) of your CompactFlash™ memory card. If your BIOS won't autodetect, you may have difficulty finding out what the CHS configuration of your card is. You may be able to get this information from your vendor, but the quickest way would probably be to temporarily install the adapter and card in a system that has a newer BIOS. Table 1 shows a few examples.

Assuming you have a target system with a floppy, you would simply put the boot diskette in the A: drive and boot the system.

- Run FDISK to create a DOS partition and make it bootable
- Run FORMAT C: (or other drive letter if applicable)
- If you have a later version of DOS, run setup to complete installation, otherwise:
- Run SYS C:
- Copy other DOS command files and utilities needed to the 'HD'

The other OS installations have similar steps.

Loading Linux on a CompactFlash™ Card

Allen Finne, KB5SQK has developed a Linux distribution that will load on an 8MB FlashCard. <ftp://ftp.tapr.org/linux> contains information on current loads people have developed.

- 1) fdisk the widget (i.e. flashcard) under linux with one primary partition -
'fdisk /dev/hd?' -replace the ? with whatever your linux system is seeing the Flashcard as;
- 2) mke2fs /dev/hd?1 - as above replace the '?' - and mount the drive as /mnt
- 3) untar the TAPR CompactFlash Card filesystem by Allen Finne, KB5SQK
- 4) Copy the files:
 - a) cd over to the directory the untarred filesystem is in
 - b) cp -a . /mnt
- 5) get a floppy
 - a) cp /mnt/vmlinuz.cur /dev/fd0
 - b) rdev /dev/fd0 /dev/hd?1 (replace the '?' as above')

You just made a bootable floppy that will mount / on the FlashCard.

- 6) reboot with the floppy in. Hopefully it will boot up and mount the widget as /
- 7) after it boots run the command 'lilo'. Lilo can mess up your day, so it is suggested that you disconnect any regular hard drive to make sure that it really is the FlashCard that is mounted as /. This makes sure that when lilo is run, it can't screw up your harddrive.

This should install the lilo handler in the MBR of the FlashCard and point it to the kernel image and root filesystem on the widget.
- 8) re-strap your drives so the the FlashCard is the 'c' drive. And you will have to tell BIOS about the c drive changes.

On some PCs, we had problems trying to get the Flashcard and any other harddrive to work together with the FlashCard as a master. A common solution is to disconnect the other harddrives completely when wanting to try and boot off the FlashCard.

Other Information Sourcec

The CompactFlash Association web has some good information as well as links to sites of manufacturers who make the cards and related products.

<http://www.compactflash.org>

The following additional URLs describe systems using pared down Linux systems for operation from limited storage. Any of these approaches could be used to fit Linux on a CompactFlash™ of modest size.

<http://users.bigpond.com/paulmoody/Mhow11c.html>

<http://www.kinetic.org/cd3.html>

<http://www4.pisoft.it/~andreoli/mulinux.html>

Table 1 - CompactFlash Drive CMOS Setup Parameters

| Capacity | Sectors/Card | Heads | Sectors/Track | Cylinders |
|-----------------|---------------------|--------------|----------------------|------------------|
| 2 MB | 3,936 | 2 | 16 | 123 |
| 4 MB | 7,872 | 2 | 32 | 123 |
| 6 MB | 11,776 | 2 | 32 | 184 |
| 8 MB | 15,680 | 2 | 32 | 245 |
| 10 MB | 20,480 | 2 | 32 | 320 |
| 15 MB | 29,312 | 2 | 32 | 458 |
| 20 MB | 39,168 | 2 | 32 | 612 |
| 24 MB | 46,976 | 2 | 32 | 734 |
| 30 MB | 58,752 | 6 | 32 | 306 |
| 40 MB | 78,336 | 4 | 32 | 612 |
| 48 MB | 93,952 | 4 | 32 | 734 |