CATAKIG

BELL

User Guide

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for version 2.00b4

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Contents

Introduction

I really would like a chance to recreate the Apple II fun someday.

— *Steve Wozniak*[1]

This is the user guide for *Catakig,* an emulator of the 8-bit family of Apple II personal computers. The Apple II was one of the most successful and influential of the early microcomputers first appearing in the late 1970s. It was also the machine that made Apple Computer famous almost overnight, and which continued to fuel the company's growth in the years before the Macintosh found its own success. Various models of Apple II were in production from 1977 all the way to 1993, making it also one of the most long-lived families of personal computers. The four models that Catakig can emulate are the Apple II (the original), the II+, the *//e,* and the *//c.*

Figure 1. The Apple II+ and *//c* personal computers

This document assumes you already have some acquaintance with Apple II computers, though no special expertise should be needed. In particular, very little information on the Apple II's workings, its evolution, or its many capabilities is supplied in this manual, which is intended only as an operational guide to Catakig itself. However, just about all the Apple II material you could imagine existing is available these days on the Internet. Catakig's website[2] has links to some of the more helpful resources.

Catakig version 2 is the successor to version 1, though not a true replacement for it. The first Catakig, released in 1997, was a *classic* application for PowerPC and 680x0 Macintoshes.[3] This older version is also available from the website, and might still be useful to people with PowerMacs running MacOS 8 or 9. Version 2 however represents a complete

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[1] from a 2001 interview in the Guardian Unlimited

[2] `http://catakig.sourceforge.net`

[3] The author will be the first to admit that the 680x0 version ran rather poorly, when it could be made to run at all.

overhaul of the original design, as well as a migration to a newer platform. No attempt has been made to stay backwardly compatible. Moreover, whereas version 1 was a private, closed-source project, version 2 is an open-source project and is intended to attract other contributors over time.

At present, version 2 lacks some nice features that were available in version 1. Some of the more glaring absences are: support for compressed disk images, including those generated by version 1; emulated hard drives, and drives for 3½-inch diskettes; and the saving and restoring of Apple II states. On the other hand, version 2 has some new features that version 1 lacked: emulation of the Apple *//c*; emulation of an Epson dot-matrix printer; support for 2IMG disk images; and full-screen display. Eventually, version 2 should surpass version 1 in all aspects.

Features of Catakig 2

➤ Runs on PowerPC Macintoshes under MacOS X 10.3 and later, or Intel Macintoshes under MacOS X 10.4 and later.

➤ Emulates the **II**, **II**+, *//e*, and *//c* models of the Apple II series.

➤ Runs Apple IIs at their authentic speed of 1 MHz, or many times that speed.

➤ Allows multiple instances of Apple II to co-exist on your desktop, each in a separate window.

➤ Supports full-screen video.

➤ Displays video in either monochrome or full color. Monochrome video can be in any hue of your choice.

➤ Displays low- and high-resolution graphics, as well as their doubled counterparts. Also renders the endearing "quirks" of high-res color graphics.

➤ Plays digitally filtered sound, synchronous with the video.

➤ Saves screen images to PNG, GIF, or TIFF files.

➤ Emulates a pair of *Disk II* drives, for accessing image files of 5¼-inch disks. Supports the DSK, DO, PO, NIB, and 2IMG formats.

➤ Emulates printing: either to plain ASCII text files, or to a virtual Epson dot-matrix printer, with output in PostScript.

Conventions of this Document

Model Names ◆ The term *Apple II* can sometimes be a little ambiguous. It is the name of the first model in the series, but it's also used as a name for the *entire* product line, without regard to specific models. This guide uses a typographic convention to keep everything clear, or to try to. The names of specific models are stylized like the emblems that appeared on the their cases: e.g. the Apple **II**, or the Apple *//e*. As a name for the entire series, or for any machine when the exact model is unimportant, "Apple II" is written with a plain Roman numeral (like that one there).

Host Platform(s) ◆ At present, Catakig 2 is only for Macintoshes running MacOS X. However, it has been written with an eye toward porting it to other operating systems. Although only one OS is supported for now, and possibly forever, this guide sometimes uses

general language, like "host platform", to allow for future developments. Information that's specific to a particular OS is identified as needed.

Editions ✦ This *User Guide* is sometimes available as a separate download from the software's distribution file. It's expected that the guide will be updated on a different schedule than the software, as the author corrects errors and adds more material.[4] The title page though will always give the guide's date of release as well as the version of the emulator it belongs to.

Acknowledgements

In the process of writing Catakig, both versions of it, I've come to owe substantial debt to the following people at the very least:

Tim G.	for contributing new icons for version 2
Ron K.	for insightful discussions on Apple II programming
Nick W.	for clever tricks with Disk II emulation
Michael M.	for advice on digital audio filters
Bill N.	for many shared reminiscences on products and software
Steve W. & Steve J.	without whom writing an Apple II emulator would have been much harder, and pretty futile really.

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[4] And fixes the weaker jokes — where possible.

1. Installation

In order to run Catakig for the first time, you'll initially need to do the following:

❶ Install the Catakig application and its support files onto your favorite local disk.

❷ Install one or more ROM image files corresponding to the Apple II computers and peripherals you wish to use, and that Catakig also supports. Unfortunately, ROM images **are not included** in Catakig's installation, and must be obtained separately.

This chapter covers these two essential steps, which are necessary when getting started. In addition, either at installation time or some later time, you might want to:

❸ Install some disk image files containing Apple II software that interests you. These files can be placed inside Catakig's *Disks* sub-folder, but can also reside anywhere on your file system. You'll notice though after installing Catakig that a few disk images are already sitting in this folder, so that you have some software to try right away. For more about Apple II disks and disk images, and how they work with Catakig, see the *Disks & Drives* chapter.

❹ Supplement Catakig with other utilities: for example a hex editor, a PostScript viewer, a PostScript-to-PDF converter, or the *NuLib* archiving utility. Catakig's website has links to several programs that can be handy to have around, but are not absolutely critical for normal use.

Installing and Uninstalling on MacOS X

Catakig runs on either PowerPC Macs running MacOS X 10.3 or later, or on Intel Macs running MacOS X 10.4 or later. Applying Apple's latest updates for your operating system is also recommended.

Catakig's distribution file for MacOS X is a **DMG** disk image which, when you download it and open it, should appear on your desktop as a new disk volume. If it doesn't appear there (because you have your *Finder* preferences set that way), then choose the *Computer* menu command from the Finder's *Go* menu. This will bring up a window that contains all of your currently mounted volumes, and Catakig's should be among them.

Inside the disk volume you'll find a folder whose name is simply "Catakig". This folder contains the emulator itself along with some supporting material. Drag this folder to somewhere on your computer's internal disk, or any local disk. You can put it in your main Applications folder if you wish, but this is not required.

To uninstall Catakig, simply drag its containing folder into the Trash. To erase its influence completely, also look in the *Preferences* folder inside your personal *Library* folder, where you'll probably find a file named `net.sourceforge.catakig.plist`. This file can also be deleted, although it isn't large and does no harm if ignored. At present Catakig does not install files anywhere else in your file system.

ROM Image Files

Like other computers, an Apple II has chips of ROM (Read-Only Memory) containing the essential machine code, or *firmware*, that lets it start up and do something useful. Among other things, Apple II ROM contains routines for printing text, drawing graphics, executing BASIC programs, computing arithmetic, beeping, and many other functions that the computer's designers knew were essential. ROM, being read-only, is immune to change from running programs. Moreover, it keeps its content even when the power is switched off. ROM therefore serves as a special storage area for data and functions considered fundamental enough to be made permanent and always available.

An Apple II depends heavily on its ROM firmware to be everything that it is. In fact, its operating systems and software won't run without it. Many peripheral and expansion cards also include firmware that's essential to their operation. From the viewpoint of you, the emulator user, it would be delightfully convenient if all this ROM content were buried away somewhere inside the emulator, out of sight and out of mind, so that you never had to think about it. There is actually no *technical* reason why this couldn't be the case. There is however a procedural reason: the ROMs are someone else's intellectual property, and cannot be freely distributed. So unfortunately, you *must* think about the subject of Apple II ROM, at the very least when you first install Catakig.

The content of a machine's ROM can be stored inside a file, which is then called a ROM *image file*, or just ROM *image*. When Catakig launches, it scans every file it finds inside its "ROMS" folder, looking for segments that it recognizes and can make use of.[1] In the current release, the ROM segments that Catakig knows about are:

➤ the 12 KB ROM of the original Apple **II**

➤ the 12 KB ROM of the **II**+

➤ the 16 KB ROM of the enhanced *//e*

➤ the 16 or 32 KB ROM of the various *//c* models

➤ the 256-byte ROM of the Disk II controller card

As far as Catakig is concerned, ROM segments do not have to be at the start of their image files, and they do not have to be the only segments in their files. It would be possible, for example, to have just one big file containing all the ROM segments you've collected. Segments do however need to be aligned within their files at positions that are multiples of 256, in order to be noticed. This is the usual result anyway when Apple II ROM images are created.

Acquiring ROM Images

There are a few different ways to acquire the ROM images that Catakig and other emulators need. Here are two of them:

❶ If you happen to have an Apple II ROM memorized, simply start up a hex-editor and type out all the bytes. Then save. (Rarely done.)

❷ If you own a real Apple II in good working order, boot it up and save the ROM content to a

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[1] Under Catakig 1, the names of the image files were significant and had to conform to a particular convention in order to be recognized. Under Catakig 2 this restriction has been removed.

file. There is software that can do this for you, or with a bit of programming, you can do it manually. Then, transfer this file to the machine you're going to run the emulator on.

[Details of how to create ROM images from scratch, and transfer them to your host platform, may appear in a future version of this Guide.]

2. A Quick Tour

This chapter takes you through a short, sample session with Catakig, and provides a few helpful tips. It does not demonstrate every feature of the emulator, but should give you a good introduction to its essential operation. You should already have gone through the *Installation* chapter before proceeding any further.

First Try

Create a new Apple II. In the main menubar, choose the *New Apple II* command under the *File* menu. You should see a dialog window come up asking you to choose an Apple II model. Models for which you have no ROM will have their names tinted in red. Choose one of the allowed models, then choose the amount of extra RAM you want (though it might as well be *None* for this quick example). Then click on the *Create* button.

A new Apple II will appear, in its own window, and its screen filled with television static. That's because it has no electrical power yet.

Load a disk. From the *Peripherals* menu, choose the *Load Disk Drive 1* command. A dialog sheet window will come down over the Apple II's screen, letting you select a file to load, as if the file were a real disk. For now, make your way to Catakig's *Disks* sub-folder and choose Beagle Bros' *Apple Mechanic*. After you've chosen the disk, it's name should appear in the drive's window.

Turn on the power. Press the space bar, or any regular key, to turn on the Apple II's power. The static will stop, and you should see the screen clear to black with an "Apple II" title at the top. The disk drive light on the left will come on, and the computer will begin booting the disk you loaded.

Run some programs. This particular disk has a master start-up program which lets you easily launch the other programs it contains. After a moment or two, it will put a menu of them on the screen. Run *Song Subroutines* to hear a little demonstration of the Apple II's sound capabilities, or run *Two-Liners* to see some simple demonstrations of Apple II graphics. Or, run *Greetings Demo* to watch an amusing demonstration of both.

At some point you may find yourself in the Apple II's BASIC interpreter, which is a command-line interface. You'll see a flashing or block cursor, with an angle-bracket (`>`) or square-bracket (`]`) character for a prompt. A full description of all the available commands is beyond the scope of this User Guide, but a few handy ones to keep in mind are:

CATALOG	Lists the files on a disk.
LOAD *file*	Loads a BASIC program from disk into memory.
RUN *file*	Loads, then runs a BASIC program.
BRUN *file*	Loads and runs a machine-language program (marked with a B in catalog listings).
RUN	With no file specified, runs the BASIC program currently in mem-

ory.

NEW	Erases the current BASIC program.
LIST	Lists the lines of the current BASIC program to the screen.

Apple II Windows

In Catakig, an emulated Apple II is contained in a window on your desktop. The window displays various hardware features that the real machines would typically have, all brought together as one unified package.

The Apple II's screen is the most obvious feature of the window. It occupies most of the space. Below the screen and toward the left are the disk drives. Each drive has a red indicator light (which illuminates when its motor is "on", like on the real ones), and a rectangular view that shows the name of any disk it holds.

Also below the screen, and toward the right, are two more indicator lights. The one on the left illuminates when data is being sent to the emulated printer. The other indicates the Apple II's current running speed: normal, doubled, sextupled, or paused.

Finally, in the lower-right corner is a black emblem that shows the Apple II's model — which you'll probably know already, since you chose the model yourself in the *New Apple II* dialog box. But in case you forget it from time to time, the emblem is there as a reminder.

Catakig permits multiple Apple IIs to exist at the same time. Just invoke the *New* command again to create another one. Within reason, it is possible to have as many Apple IIs as you like. However, emulation occurs only in the active or frontmost Apple II, and only when Catakig is the foreground application.

Reset & Reboot

Two good menu commands to know about are *Reset* and *Reboot*, which also have keyboard shortcuts. In general, Reset stops the current Apple II program immediately, and returns the machine to a known, "sane" state — though not always. (Each program can direct Reset to behave in any way it wants.) This command corresponds to the same keyboard function that the real machines have.

Reboot, also known as a "cold reset", was something the Apple *//e* and *//c* could do easily from their keyboards, but was not available on the II or II+. Catakig provides the function anyway, for all models. A Reboot acts more or less as if the Apple II had been turned off and then back on again, and forces the computer to start entirely afresh.

It's normally best to have a bootable disk already loaded into Drive 1 before invoking Reboot, since the booting of such a disk is the next thing the Apple II will try to do. If there is no disk in Drive 1, an Apple *//c* will eventually notice and alert you to the fact. The other models will simply spin the drive forever, until you either invoke Reset to stop them, or until you load a disk.

Some Performance Tips

Catakig emulates computers from around 1980 that had 8-bit, 1-MHz microprocessors. You would think, *surely*, that your modern machine with its blazing clock rate about a thousand times faster should have no trouble emulating a humble Apple II. For the most

part, you'd be right. Desktop computers have long been fast enough to emulate an Apple II at full speed.

Nevertheless, Catakig can still be pretty demanding of your computer's time. Not only must it emulate approximately 300,000 instructions of the 6502 CPU every second, but in addition it must render the video frames that you see and the sound waveforms that you hear. Moreover, Catakig allows Apple IIs to run at their authentic 1-MHz speed *or* at many times that speed, which multiplies the demands on the host platform.

The author has taken great pains[1] to make Catakig as efficient as possible. Unless your computer is very old, say built before 1997, it should have no trouble meeting the emulator's demands. However, if you do find Catakig's performance underwhelming, consider one or more of the following remedies:

➤ Avoid any 32-bit, "millions of colors" display modes for your screen. Favor 16-bit, "thousands of colors" modes instead.

➤ If you have multiple screens, avoid letting Catakig's Apple II windows straddle two or more screens at the same time. Keep each window entirely within one screen or another.

➤ Catakig's full-screen mode is genererally faster than its windowed mode. In windowed mode, the operating system is usually doing window clipping and image buffer copying, which slows down rendering.

➤ As mentioned, Catakig can emulate Apple IIs at many times their authentic speed. The price you pay for exercising this feature is a higher demand on the host system's CPU. On an old computer, you might need to stay in "normal" speed in order to enjoy smooth performance. (The "halted" speed is smoothest of all, though not nearly as much fun.)

➤ Network traffic can slow down your computer significantly. Avoid downloading large files or visiting complex websites while an Apple II is running.

➤ When Catakig is the foreground application, other open applications will be in the background — possibly doing something time-consuming, possibly not. Many applications don't do anything significant while in the background, but those that often do include: disk and file utilities, CD and DVD burners, live-action games, web browsers, and multimedia programs like sound and movie players.

When you run Catakig, try quitting such applications, or at least pausing their activities, to stop them from hogging your computer's resources. Let Catakig do that instead.

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[1] You have no idea.

3. Disks & Drives
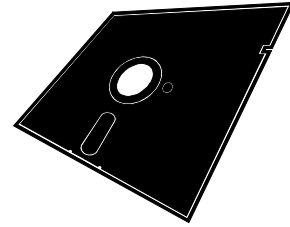
Every Apple II in Catakig comes with a pair of emulated *Disk II* disk drives attached and ready for use. They are represented at the bottom of the Apple II's window: each one has a rectangular display to show the name of the disk it holds, and an indicator light that illuminates when there is disk activity.

Along with the pretend disk drives go pretend disks, which for Catakig and many other emulators must take the form of files on your host platform. This chapter discusses what these files are and how they are used.

Disk Image Files

As is the case for ROMs, the contents of Apple II disks can be captured and stored in files. These files then serve as equivalent substitutes for the real disks, at least as far as the emulator is concerned. The Apple II had several popular forms of disk media, among them: ❶ the ubiquitous 5¼-inch "floppy" disks, with a capacity of 140 KB; ❷ 3½-inch disks with a capacity of 800 KB; and ❸ external hard disks with capacities of many megabytes. The current release of Catakig supports only the first of these.

If you have an Apple II with the right hardware, there is software you can run to make image files out of real disks. The details of this process are not discussed in this guide however. You can also take advantage of the fact that other people have been making disk images for a long time and then putting them on the Internet. Catakig's website has links to a few sources for Apple II software archived in this form.

Unfortunately, the image files for representing Apple II disks come in a bewildering variety of standardized formats.[1] The ones that Catakig recognizes are:

DO A 5¼-inch disk, stored with DOS sector ordering. Might or might not be formatted by DOS.

PO A 5¼-inch disk stored with ProDOS block and sector ordering. Might or might not be formatted by ProDOS.

DSK Exactly like either DO or PO, but you'll have to guess which one. In practice, it's usually DO.

NIB A 5¼-inch disk, stored in the expanded *nybblized* encoding used by the Disk II controller card. These files are about 230 KB in size, even though they still represent only 140 KB worth of content. The filenames are usually suffixed with "nib", or sometimes "nyb".

2IMG An inclusive file format that covers DO, PO, and NIB, as well as larger disk volumes. Filenames are usually suffixed with "2img" or "2mg".

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[1] *"The wonderful thing about standards is that there are so many to choose from."* — Grace Hopper, or possibly Andrew Tanenbaum

Loading & Unloading Disks

To **load** a disk image — as if you were physically inserting a real disk into a real drive — choose one of the *Load Drive* commands from the menu bar. A dialog box will come down over the Apple II's window and allow you to choose a file. Only valid disk image files should be selectable in this dialog. If the disk loads successfully, its name will then appear in the drive's rectangular display.

In general, Drive 1, on the left, is the main drive, and is the one that disks can be booted from. Drive 2, on the right, cannot be used for booting but is otherwise the same.

As for **unloading**, you'll normally have no need to actively remove disks from their drives. Disks are automatically unloaded whenever newly loaded disks replace them, or when an Apple II is closed. However, if for whatever reason you do want to empty a drive, there are *Unload* commands in the menu bar for doing exactly that.

The moment of unloading is a significant one for write-enabled disks that have been modified during their time inside a drive. When a modified disk is being unloaded, its corresponding image file will be re-written as a **NIB** file, and have its filename suffix changed to "nyb" — if it wasn't aleady in that form. (If the disk *hasn't* been modified, its image file will remain untouched.) This possible change of format and filename occurs only at unloading time, and not while the disk is actually being written to under emulation.

Write-protected Disks

Real Apple II disks have ways of indicating that their contents are to be protected from modification. The 5¼-inch disks have a write-enable notch on one side that can be covered with a piece of black tape.[2] The 3½-inch disks have a small square slider that can be pushed to one side, or removed entirely, to indicate write-protection. In either case, the drive will sense the physical feature that means "write-protected" and then prevent the computer from changing any data on the disk.

Disk image *files* don't have these physical features of course. Instead, Catakig goes by the operating system's permissions for the file: if the file cannot be opened for writing, then Apple IIs will see it as a write-protected disk.[3] The color of the disk's name, as displayed in the drive, will indicate its status. **Green** means the disk is writeble; **yellow** means it's write-protected.

Note though that Catakig's assessment of a disk's write-protection is done *only* at the moment it is being loaded. It does no good, for example, to change the image file's attributes while the disk is in use, after you notice it's in the wrong state for your purposes. In general, and when in doubt, it's a good idea to keep your disk images write-protected by default, and only write-enable the ones that need it.

Catakig supports multiple Apple IIs existing at once, and it is possible to have the same disk image loaded into more than one Apple II at the same time, or even loaded into both drives of the same Apple II at the same time — a strange situation that cannot arise on the real machines. Under these circumstances, a write-enabled disk will be writeable in *at most*

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[2] Or in a pinch, a small wad of chewing gum. Preferably licorice.

[3] On MacOS X, the file can also be *locked,* which is a separate attribute from the traditional Unix file permissions, but which also has the effect of write-protection.

one of the drives it's loaded into, the one that last opened the file for writing and succeeded. In all others, the disk will appear write-protected.

4. Printing
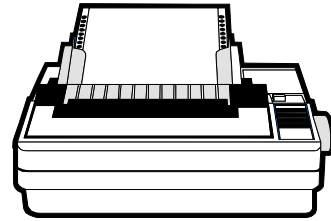
Catakig does not support printing to any *real* printers attached to your host computer. This is just as well, since modern printers do not have control languages that old Apple II software would normally know how to speak.

Instead, Catakig provides emulated printing (naturally) which renders output to files. Other applications can then print these files onto actual paper as desired. File print-outs have the advantage that they can be printed multiple times, and stored indefinitely, and shared with others over the Internet.[1]

Print Sessions in Catakig

When you print things on a *real* Apple II, the computer sends a stream of bytes to its attached printer, which interprets the bytes immediately as they arrive and responds to them appropriately. The printer marks the paper with characters, advances the print-head forward, scrolls the paper, and so on.

Under Catakig, the chain of cause and effect is more indirect. Apple II programs running under emulation will "believe" they are sending data to a printer, but the bytes are actually accumulating in a hidden buffer called a *print session*. The print session just sits there, passively, until you decide to do something with it. When your emulated printing has finished, or when it reaches a good stopping point, you might then want to **save** the session to a print-out file.

When you do save it, you'll have a choice of how to process the collected bytes to turn them into an output file, based on the sort of printer you're pretending to have, and the format of the file. The current release of Catakig provides the following types of processing:

Plain ASCII ❖ The data stream is assumed to be for a plain ASCII printer with no graphics or other fancy features — such as the old *daisy-wheel* printers. The output will be an ASCII text file.

Epson to Postscript ❖ The data is assumed to be intended for an Epson RX-80 dot matrix printer, and is interpreted accordingly. The data may contain Epson control sequences, or it may be just ordinary ASCII. The output will be a PostScript file that resembles the output from real Epson printers.

None ❖ The data stream is not interpreted at all, but simply copied as-is to the output file you specify. This is normally not a very useful option, but might be of interest if you want to capture the raw byte stream and examine it.

Saving a session begins when you invoke the *Save Print Session* command from the menu bar. A dialog window will appear over the Apple II window and allow you to name the

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[1] Another big advantage: they let the author put off support for real printing.

destination file, as well as choose a type of processor. The dialog also shows the number of bytes currently sitting in the session, to give you a rough idea of whether everything is all right (if the number is *zero*, that might be a rude surprise) and about how large the output file will be.

Print sessions are not affected by being saved to an output file. In particular, they are not automatically erased. The data in the session will still be there, and any additional data you send later will continue accumulating on top of the old. In order to reset a print session back to its original, empty state, you need to **clear** it, via the *Clear Print Session* command in the menu bar.

Each Apple II in Catakig keeps its own private print session, which is created and initialized along with the computer. Any printing activity taking place in one Apple II has no effect on the printing in others.