Colour Maximite 2

386 PC Emulator

MS-DOS, FreeDOS and Windows 3.1 on the Colour Maximite 2

For firmware with loadable-program services version 9

Emulator: tiny386, by Chunhui He
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The firmware, the emulator and this guide are at
https://github.com/UKTailwind/CMM2V1.5

About This Guide

This guide is for users of pc386, a 386 PC that the Colour Maximite 2 runs as a loadable program. It covers the files the emulator needs, starting it, its keys, the configuration file that describes each PC, disk images, and installing MS-DOS and Windows 3.1 from their floppy disks. It assumes you can use the MMBasic command prompt and copy files to the SD card.

Support

Questions should be raised on the Back Shed forum (http://www.thebackshed.com/forum/Microcontrollers), and problems with the emulator reported as issues of the repository above.

Copyright

This guide is copyright 2026 Peter Mather and is distributed under a Creative Commons Attribution-NonCommercial-ShareAlike 3.0 Australia license (CC BY-NC-SA 3.0), as the user manual is. The emulator is tiny386, by Chunhui He, under the BSD 3-Clause licence; its other parts, the BIOS files and FreeDOS have their own licences (see Appendix A).

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Introduction

pc386 turns the Colour Maximite 2 into a 386 PC. It is a loadable program: MMBasic runs it with RUN "pc386.app", and it gives the screen, the keyboard, the mouse and the sound to the PC until you leave it. The PC runs FreeDOS, MS-DOS, Windows 3.1 and the DOS programs and games of their time.

The emulator is tiny386, written by Chunhui He, with a front end that joins it to the Colour Maximite 2's display, keyboard, mouse, sound and SD card. It runs on both the original Colour Maximite 2 (the G1) and the Generation 2 (the G2).

What the PC Has

Part	What the PC has
Processor	An Intel 80386 with an x87 maths coprocessor. The configuration file can make it report itself as a 486 or a Pentium instead.
Memory	4 MB as the example files set it, or as much as fits: 2,816 KB on a G1.
Display	A VGA card with VESA modes, shown at 640 x 480 in 256 colours.
Hard disks	Up to four IDE drives, each an image file on the SD card.
Floppy drives	A: and B:, each an image file. A: can be given a list of images to change between, as you would change disks.
Keyboard	The Colour Maximite 2's USB keyboard, as a PS/2 keyboard.
Mouse	The Colour Maximite 2's USB or PS/2 mouse, as a PS/2 mouse.
Sound	A Sound Blaster 16 (port 220, IRQ 5, DMA 1 and 5), an Adlib FM synthesiser (port 388) and the PC speaker, through the Colour Maximite 2's audio output.
BIOS	SeaBIOS and SeaVGABIOS.

The PC has no network card, no serial or parallel ports and no MIDI (MPU-401) port.

Speed

The Colour Maximite 2 emulates each of the 386's instructions in software. On a G2 the PC runs about 5 million instructions a second in a simple loop, and 1 to 2.5 million in Windows. FreeDOS starts in about 35 seconds, and Windows 3.1 is usable, though slower than a real 386.

A G1 runs at 400MHz if its processor is of revision Y, which makes the PC slower. OPTION OVERCLOCK ON runs such a G1 at 480MHz, and the PC is then about as fast as on a G2. The start-up message shows which speed a Colour Maximite 2 runs at.

What You Need

- The Colour Maximite 2 firmware with the loadable-program services of version 9 or later.
- The emulator's files on the SD card (the next chapter).
- For MS-DOS and Windows 3.1, your own copies of their disks, as image files. FreeDOS, which is free, comes ready installed on a disk image.
- A USB keyboard. A mouse is needed for Windows.

Getting Started

This chapter puts the emulator on the SD card and starts the FreeDOS PC that comes with it.

The Files

The emulator's files are in the pc386 folder of the firmware's release:

File	What it is
pc386.app	The emulator.
bios.bin	The PC's BIOS (SeaBIOS).
vgabios.bin	The VGA card's BIOS (SeaVGABIOS).
freedos.img	A 32 MB hard disk with FreeDOS 1.3 installed, its mouse driver included.
pc386.ini	The configuration file of the FreeDOS PC.

Make a folder pc386 on the SD card and copy the files into it. A card reader on a PC is the quickest way: disk images are tens of megabytes, which take many minutes over the serial console.

The First Run

At the command prompt:

```
CHDIR "A:/pc386"
RUN "pc386.app"
```

The screen changes to 640 x 480, SeaBIOS starts, and FreeDOS starts from the hard disk image. It loads its mouse driver and ends at the C:\> prompt, ready for commands. The serial console shows a few lines from the emulator, such as:

```
pc386: 4096 KB of RAM, 640x480, pc386.ini
```

That is the PC's memory, the screen and the configuration file it was started with.

Leaving

Press Ctrl+Alt+End to leave the emulator and go back to the MMBasic prompt. This switches the PC off at once, as if its power had been cut. Before you leave:

- Finish what the PC is doing, and leave Windows if it is running.
- Wait until the PC has stopped writing to its disks.

The PC's disks are the image files on the SD card, so everything written to them is kept for the next time.

Starting Again

The next time, the same two commands start the same PC with its disks as you left them. To start a different PC, name its configuration file:

```
RUN "pc386.app", msdos.ini
```

Using the PC

Starting a PC

```
RUN "pc386.app" [, file.ini] [-stats]
```

Without a file name, the emulator starts the PC that pc386.ini describes. The configuration file and the files it names are found in the current directory, so CHDIR to the emulator's folder first, or give their full names (A:/pc386/bios.bin).

With -stats, the serial console shows every 5 seconds how fast the PC is running, in millions of instructions a second (MIPS), and how much of the time goes on drawing the screen. Two more words are there for finding faults: -keys shows each report from the keyboard, and -mouse each movement of the mouse.

The Emulator's Keys

Three keys, held with Ctrl and Alt, are the emulator's own. The PC does not see them:

Keys	What they do
Ctrl+Alt+End	Leave the emulator and go back to MMBasic.
Ctrl+Alt+Page Down	Put the next floppy image of the list in drive A:.
Ctrl+Alt+Page Up	Put the previous floppy image in drive A:.

Either Ctrl key and either Alt key will do. The keypad's 1 (End), 3 (Page Down) and 9 (Page Up) work too, whether Num Lock is on or off.

Every other key goes to the PC, Ctrl+Alt+Delete included: it restarts the PC, as it would a real one. Ctrl+C goes to the PC as well; it does not stop the emulator.

The Keyboard

The PC is told which key was pressed, by its place on the keyboard, as a real PC's keyboard tells it. DOS turns the keys into characters with its own keyboard layout, which is the US layout unless you load another. For a UK keyboard, for example, put this in AUTOEXEC.BAT:

```
KEYB UK
```

Changing Floppy Disks

The configuration file can give drive A: a list of floppy images (see The Configuration File). The first is in the drive when the PC starts. Ctrl+Alt+Page Down puts the next one in, and Ctrl+Alt+Page Up the one before, going round the list. The word none in the list is an empty drive.

Each time, the top left corner of the screen shows for 3 seconds what is in the drive, for example:

```
A: DISK2.IMG
```

To the PC this is a disk taken out of the drive and another put in. Use it when an installation program asks for its next disk: change the disk, then press Enter.

The Serial Console

While the emulator runs, a terminal on the serial console can type into the PC: letters, digits, punctuation, Enter, Tab, Backspace and Esc, as on a US keyboard. What it types while a key of the USB keyboard is held is left out. These keys are the emulator's:

Key	What it does
Ctrl-]	Leave the emulator.
Ctrl-N	Put the next floppy image of the list in drive A:.
Ctrl-T	Print the PC's text screen on the terminal.

The emulator also prints its messages there, such as which floppy image is in drive A:.

The Mouse

The Colour Maximite 2's mouse is the PC's PS/2 mouse: a USB mouse, or a PS/2 mouse set up with OPTION MOUSE. DOS programs need a mouse driver to use it: the FreeDOS disk loads CuteMouse, and with MS-DOS you can load CuteMouse or Microsoft's MOUSE.COM. Windows 3.1 has its own driver, which it chooses as it is installed.

The Screen

The screen is 640 x 480 in 256 colours (MODE 8,8) on every Colour Maximite 2:

- Text is drawn with characters 8 pixels wide, so 80 columns fill the width of the screen.
- A graphics mode up to 640 x 480 is shown whole, in the middle of the screen. The 320 x 200 modes of DOS games are shown twice as wide and twice as tall.
- A larger VESA mode shows only its middle 640 x 480.
- The colours are the PC's own, as its VGA card has them. The VESA modes of more than 256 colours are shown in 256 fixed colours, so their colours are close but not exact.

Sound

The Sound Blaster 16, the Adlib and the PC speaker are mixed into the Colour Maximite 2's audio output, at the level set by PLAY VOLUME. DOS programs find the Sound Blaster at these settings, which their set-up programs ask for:

Setting	Value
Port	220
IRQ	5
DMA	1 (high DMA 5)

Many programs read them from the BLASTER variable, which AUTOEXEC.BAT can set:

```
SET BLASTER=A220 I5 D1 H5 T6
```

Programs that play music on an Adlib or a Sound Blaster's FM synthesiser find it at port 388.

Making It Faster

- OPTION SD TIMING FAST makes the SD card, and so the PC's disks, much faster.
- On a G1 whose processor is of revision Y, OPTION OVERCLOCK ON runs the processor at 480MHz in place of 400MHz.

The Configuration File

Each PC is described by a configuration file: a text file, usually ending .ini, in the emulator's folder. It names the BIOS files and the disk images, and sets the PC's memory and processor. You can keep several, one for each PC, and start any of them with RUN "pc386.app", name.ini.

The Format

The file has sections, each headed by its name in square brackets, and in each section lines of the form name = value. A line starting with a semicolon is a comment. This is pc386.ini, the FreeDOS PC:

```
; pc386.ini: the PC that RUN "pc386.app" starts
[pc]
bios = bios.bin
vga_bios = vgabios.bin
mem_size = 4M
vga_mem_size = 256K
hda = freedos.img
fill_cmos = 1

[cpu]
gen = 3
fpu = 1
```

File names are found in the current directory, or can be given in full (A:/pc386/freedos.img). Sizes are a number followed by K or M, in capitals.

The [pc] Section

Name	What it sets
bios	The BIOS file: bios.bin.
vga_bios	The VGA BIOS file: vgabios.bin.
mem_size	The PC's memory, for example 4M. If there is not room for that much, the PC gets as much as fits, and the first line on the serial console says how much.
vga_mem_size	The VGA card's memory: 256K, as on a VGA card of the time. More lets the PC use larger VESA modes, but it comes from the same memory as the PC's own.
hda, hdb, hdc, hdd	The PC's first to fourth hard disks: image files. hda is the disk DOS starts from, C:.
cda, cdb, cdc, cdd	A CD-ROM drive in place of that hard disk, holding an image file (.iso). This has not been tried on the Colour Maximite 2.
fda, fdb	The floppy images in drives A: and B: when the PC starts.
fill_cmos	1 puts the hard disks' sizes in the PC's set-up (its CMOS memory), as a BIOS set-up program would. Keep it at 1.

The [cpu] Section

Name	What it sets
gen	3: a 386. 4, 5 or 6: the processor reports itself as a 486, a Pentium or a Pentium Pro, for programs that check.
fpu	1: the PC has a maths coprocessor (an x87). 0: none.

The [pc386] Section

This section is the Colour Maximite 2 emulator's own.

Name	What it sets
floppies	The floppy images that drive A: is given in turn, separated by spaces or commas, up to 16. The word none is an empty drive. The first is in A: when the PC starts, unless fda names one. Ctrl+Alt+Page Down and Ctrl+Alt+Page Up change between them.

new_disk	A size, for example 64M. If the image that hda names is not on the card, an empty one of this size is made when the PC starts.

Which Drive the PC Starts From

As on a real PC, the BIOS starts from drive A: if there is a disk in it, and otherwise from the first hard disk. So a list of floppies that starts with none starts the PC from its hard disk, with the floppies ready to be put in later. A list that starts with a disk starts the PC from that disk, as an installation does.

As the PC starts, SeaBIOS shows "Press ESC for boot menu" for a moment: pressing Esc then lets you choose the drive to start from.

Examples

A PC for installing MS-DOS from its three Setup disks onto a new 64 MB hard disk (Installing MS-DOS):

```
; msdos.ini: MS-DOS installed from its Setup disks onto msdos.img
[pc]
bios = bios.bin
vga_bios = vgabios.bin
mem_size = 4M
vga_mem_size = 256K
hda = msdos.img
fill_cmos = 1

[cpu]
gen = 3
fpu = 1

[pc386]
floppies = DISK1.IMG DISK2.IMG DISK3.IMG none
new_disk = 64M
```

The same PC once MS-DOS is installed. It starts from C:, with Windows 3.1's six disks ready to be put in drive A:

```
; msdosc.ini: MS-DOS from C:, Windows 3.1's disks to hand
[pc]
bios = bios.bin
vga_bios = vgabios.bin
mem_size = 4M
vga_mem_size = 256K
hda = msdos.img
fill_cmos = 1

[cpu]
gen = 3
fpu = 1

[pc386]
floppies = none WIN1.IMG WIN2.IMG WIN3.IMG WIN4.IMG WIN5.IMG WIN6.IMG
```

A PC with no hard disk, started from a floppy:

```
[pc]
bios = bios.bin
vga_bios = vgabios.bin
mem_size = 4M
vga_mem_size = 256K
fda = BOOT.IMG

[cpu]
gen = 3
fpu = 1
```

Disk Images

The PC's disks are image files on the SD card: each holds every sector of a disk, in order, and nothing else. Images of this kind are also called raw images, and other PC emulators use them too.

Hard Disk Images

A hard disk image holds a whole disk: its partition table and its partitions. There are two ways to get one:

- **Make an empty one.** Name it with hda and give its size with new_disk (The Configuration File). The emulator writes the empty image to the card as the PC starts. This takes a while, and the serial console shows a dot for each 4 MB. The PC then sees a new, empty disk, which DOS prepares with FDISK and FORMAT, or MS-DOS Setup prepares for itself.
- **Copy one.** Use freedos.img, or an image made by another emulator that writes raw images.

64 MB is plenty for MS-DOS, Windows 3.1 and a good number of programs. A DOS partition can be up to 2 GB, but a large image takes a long time to make and to copy.

The images are ordinary files, so they can be copied and backed up with the card in a PC. Make a copy before you try something that might spoil a disk. Programs on a PC can open an image to read its files: on Windows, 7-Zip opens one, and OSFMount can show one as a drive. Only do this while the emulator is not running.

Floppy Images

A floppy image is a disk of one of the PC's usual sizes:

Disk	Image size in bytes
3.5 inch, 1.44 MB	1,474,560
3.5 inch, 720 KB	737,280
3.5 inch, 2.88 MB	2,949,120
5.25 inch, 1.2 MB	1,228,800
5.25 inch, 360 KB	368,640

The emulator also takes the larger formats some disks were written in, such as Microsoft's 1.68 MB DMF disks. A file of any other size cannot be used: the note at the top of the screen then says "cannot be used".

Making an Image of a Disk

Put the disk in a PC's floppy drive and copy it, sector by sector, into a file with a disk-imaging program. On Linux:

```
dd if=/dev/fd0 of=DISK1.IMG bs=512
```

On Windows, a program such as WinImage or RawWrite for Windows makes an image of a disk.

Note that many USB floppy drives read only 1.44 MB disks and not 720 KB ones. A 720 KB disk has one square hole; a 1.44 MB disk has a second hole in the opposite corner.

A program whose disk is copy-protected (Lemmings is one) checks for something on the original disk that an image does not keep, so it will not run from an image.

Making an Image from Files

An image can also be made from files: an empty 1.44 MB disk with the files copied onto it. This is the way to take files into the PC. On Windows, WinImage does it. On Linux, mtools does:

```
mformat -C -f 1440 -i FILES.IMG ::
mcopy -i FILES.IMG setup.exe readme.txt ::
```

Put FILES.IMG in the emulator's folder and in the list of floppies. In the PC, put it in drive A: with Ctrl+Alt+Page Down and copy the files from A:.

Installing MS-DOS

MS-DOS 6.2 and 6.22 come on three 1.44 MB Setup disks. MS-DOS is not free: use images of your own disks (Disk Images). This chapter calls them DISK1.IMG, DISK2.IMG and DISK3.IMG.

Preparing

Copy DISK1.IMG, DISK2.IMG and DISK3.IMG to the emulator's folder on the SD card.

Make msdos.ini in the same folder, as in the first example of The Configuration File:

- Its list of floppies starts with Disk 1, so the PC starts from it.
- The list ends with none, the empty drive that Setup asks for at the end.
- Its new_disk line makes the hard disk, msdos.img, 64 MB.

Running Setup

1. Start the PC:

```
CHDIR "A:/pc386"
RUN "pc386.app", msdos.ini
```

The first time, the emulator makes msdos.img, which takes a minute or two, and the serial console shows its progress. Then the PC starts from Disk 1 and Setup's first screen appears.

2. Press Enter to set up MS-DOS. Setup finds the new hard disk and offers to configure its space: choose the recommended choice. Setup then restarts the PC, which starts again from Disk 1, and formats drive C:.

3. Accept the settings Setup shows (the date, the time, the country and the keyboard) and the directory C:\DOS, with Enter. Setup copies the files from Disk 1.

4. When Setup asks for Disk 2, press Ctrl+Alt+Page Down. The top of the screen shows "A: DISK2.IMG". Then press Enter. Do the same when it asks for Disk 3.

5. When Setup asks you to take the disks out of the drives, press Ctrl+Alt+Page Down once more ("A: empty"), then Enter.

6. Setup ends and restarts the PC, which now starts MS-DOS from C:.

Afterwards

From now on, start the PC with a configuration file whose list of floppies starts with none, such as msdosc.ini, the second example of The Configuration File. The PC then starts from C:.

Some lines are worth adding to C:\AUTOEXEC.BAT, with EDIT:

- KEYB with your keyboard's layout, for example KEYB UK.
- SET BLASTER=A220 I5 D1 H5 T6, for DOS programs that use the Sound Blaster.
- A mouse driver, for DOS programs that use the mouse: CuteMouse (free) or Microsoft's MOUSE.COM. Windows does not need one.

Installing Windows 3.1

Windows 3.1 comes on six 1.44 MB disks, and runs on MS-DOS. Use images of your own disks: this chapter calls them WIN1.IMG to WIN6.IMG. Windows runs in its 386 enhanced mode, which needs 2 MB of memory, on both the G1 and the G2.

Preparing

Install MS-DOS first (the previous chapter). Then copy WIN1.IMG to WIN6.IMG to the emulator's folder, and add them to the list of floppies in msdosc.ini, after none:

```
floppies = none WIN1.IMG WIN2.IMG WIN3.IMG WIN4.IMG WIN5.IMG WIN6.IMG
```

Running Setup

1. Start MS-DOS with msdosc.ini.
2. Press Ctrl+Alt+Page Down to put WIN1.IMG in drive A:, then type:

```
A:SETUP
```

3. Choose Express Setup with Enter. Setup copies its first files, then changes to its windows, where the mouse works.
4. Each time Setup asks for the next disk, press Ctrl+Alt+Page Down, check the top of the screen for the right disk, then press Enter or click OK.
5. Setup finds the PC's hardware itself: a VGA display and a "Microsoft, or IBM PS/2" mouse. If it asks, choose these.
6. Set up printers and programs as you wish. At the end, choose to restart (reboot) the PC.

Setup puts C:\WINDOWS on the PATH but does not start Windows when the PC starts. Type WIN at the C:\> prompt to start it, or add WIN as the last line of C:\AUTOEXEC.BAT.

Leave Windows (File, Exit Windows in the Program Manager) before you leave the emulator.

Sound

Windows 3.1 has drivers for the Sound Blaster 1.5 and the Adlib, which Setup does not install. Add them in the Control Panel:

1. Open Control Panel, then Drivers, then Add.
2. Choose "Creative Labs Sound Blaster 1.5". When Windows asks for one of its disks, put that disk in drive A: with Ctrl+Alt+Page Down (or Page Up), then click OK.
3. Set the port to 220 and the interrupt to 5.
4. Add "Ad Lib" the same way, for MIDI music.
5. Restart Windows when it asks.

The Sound Blaster driver plays Windows' sounds and WAV files. MIDI music goes through the Adlib's FM synthesiser. To use it, open Control Panel, then MIDI Mapper, and choose the setup "Ad Lib General", which plays the General MIDI instruments on the FM synthesiser. Then, in a program that plays MIDI, choose the MIDI Mapper as its MIDI output.

When Things Go Wrong

Messages on the Serial Console

Message	What to do
pc386: cannot open bios.bin	The emulator looks for its files in the current directory. CHDIR to its folder first, or give the files' full names in the configuration file.
pc386: cannot open file.ini	The configuration file is not in the current directory, or its name is mistyped.
pc386: file.ini: an error in line N	That line of the configuration file is not of the form name = value, or a section's name is not in square brackets.
pc386: making msdos.img, 64 MB ...: the card is full?	There was not room on the SD card for the new hard disk image.
pc386: the sound stream is at 44101 Hz, not 44100: its pitch is off	This is shown each time the emulator starts. The difference is far too small to hear.
A: name cannot be used	The floppy image is not on the card, or its size is not one of a floppy's (Disk Images).

The PC

- **The Ctrl+Alt keys do nothing.** Some keyboards do not report every combination of keys. Use the keypad's 1, 3 and 9 with Ctrl and Alt, or the serial console's Ctrl-] and Ctrl-N.
- **The mouse does not work in a DOS program.** Load a mouse driver: CuteMouse or MOUSE.COM.
- **A DOS program has no sound.** Run its set-up program and choose a Sound Blaster (16, Pro or plain) at port 220, IRQ 5, DMA 1 (high DMA 5), and an Adlib for music. Many programs also read the BLASTER variable (Using the PC).
- **A program says it needs a 486 or a Pentium.** Set gen = 4 or gen = 5 in the configuration file's [cpu] section. A program that uses instructions the emulator does not have may still not run.
- **A program asks for its original disk.** Its disk is copy-protected, and the protection is not in the image (Disk Images).
- **The PC is slow.** Set OPTION SD TIMING FAST; on a G1 of revision Y, set OPTION OVERCLOCK ON (Using the PC). A large Windows program is slow on any emulated 386.
- **DOS says a disk is damaged after the emulator was left.** The PC was switched off while it was writing (Leaving, in Getting Started). Run SCANDISK (MS-DOS) or CHKDSK on the disk, and keep copies of disk images you care about.

Appendix A: Licences

The emulator and the files that come with it are made from these works. Each keeps its own licence.

Work	Licence
tiny386, the 386 PC (the processor, its maths coprocessor and the PC itself): Copyright (c) 2024-2025 Chunhui He.	BSD 3-Clause.
The emulated devices in tiny386 (the VGA card, the IDE controller, the keyboard controller, the Sound Blaster 16 and others), from QEMU and TinyEMU by Fabrice Bellard and others.	MIT.
fmopl, the Adlib's FM synthesis in tiny386.	LGPL 2.1 or later.
The Colour Maximite 2's front end (pc386_cmm2.c, in the firmware's repository).	The firmware's licence: the LICENSE file of its repository.
The changes made to tiny386 for the Colour Maximite 2 (apps/pc386/patches), which are offered to tiny386.	BSD 3-Clause, as tiny386.
SeaBIOS and SeaVGABIOS (bios.bin and vgabios.bin), unchanged from tiny386's release.	LGPL 3. The source is at www.seabios.org.
FreeDOS 1.3 (freedos.img), as installed by pico-386. Each of its programs has its own licence, most of them the GPL.	GPL and others. The source is at www.freedos.org.

MS-DOS and Windows are Microsoft's and do not come with the emulator: use your own copies.

The emulator's source, and the changes made to tiny386 for the Colour Maximite 2, are in the firmware's repository at https://github.com/UKTailwind/CMM2V1.5, in apps/pc386.