MEGA65 Welcome Guide

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CONTENTS

Hello! You've reached the MEGA65 Welcome Guide. This Guide is intended for new owners of the MEGA65 personal computer. It contains answers to common questions not (yet) answered in the official documentation, and recommends best practices for continued enjoyment of your new computer. It was written as an unofficial supplement to the MEGA65 User's Guide included with the computer.

I'm Dan, known as dddaaannn#7325 in the MEGA65 Discord and @dan_sanderson on Twitter. If you notice anything in this guide that needs updating, or if you discover a topic not covered by the official manual that you feel new owners should know about, please report an issue. Thank you!

The contents of this Welcome Guide:

CHAPTER

ONE

WELCOME!

Congratulations! You are the owner of the MEGA65 personal computer, a modern recreation of the Commodore 65. The Commodore 65 was the unreleased successor to the highest selling computer of all time, the Commodore 64.

Tip: I have a MEGA65 newsletter! Subscribe by email or RSS for news, features, and activities you can do with your MEGA65.

Tip: Don't own a MEGA65? Pre-order one from Trenz Electronic!

Your MEGA65 comes with an excellent User's Guide that describes the machine's features, including a command reference for its built-in BASIC programming language. This Welcome Guide is an unofficial supplement to the User's Guide, intended for new owners.

By following this guide, you will:

- Explore your MEGA65 right out of the box!
- Learn important concepts for maintaining your MEGA65
- Prepare a microSD card for storage and software upgrades
- Open your MEGA65 to install and upgrade components
- Update your MEGA65 to the latest versions of the software
- Learn about features still in development and known issues with the hardware
- Find out how to learn more and connect with the MEGA65 community

This Welcome Guide will refer to the official User's Guide, so keep it handy!

Note: Your MEGA65 came with a User's Guide that was printed in early 2022, even if your computer shipped more recently. The PDF version has been updated since then to describe features recently added to BASIC 65. Download the latest PDF, and see *Recently added features* in this Guide.

1.1 Why a Welcome Guide?

The MEGA65 is brought to you by the MEGA Museum of Electronic Games & Art e.V., a registered voluntary association and non-profit organization. The core team of talented engineers and a community of contributors and patrons made this possible. They continue to improve and refine the capabilities of your upgradable machine.

This unofficial Welcome Guide is intended to help new owners get up and running. It describes common issues that you may encounter and their remedies. These issues may not apply to future versions of the MEGA65 hardware or software, and may not be described by the official documentation. It is based on the author's own experiences and discussions among new owners troubleshooting these issues.

If you notice anything in this guide that needs updating, or if you discover a topic not covered by the official manual that you feel new owners should know about, please report an issue, email me (I'm Dan), or DM dddaaannn#7325 in the MEGA65 Discord. Thank you!

CHAPTER

TWO

THINGS YOU'LL NEED

The following items are included in your MEGA65 box:

1. Your MEGA65 personal computer
2. Power supply
3. The MEGA65 User's Guide
4. Your personal registration code, on a piece of paper (possibly tucked into the User's Guide)
5. The internal SD memory card (installed inside the MEGA65)

For this Guide, you will also need:

1. A PC running Windows, Mac, or Linux, with Internet access
2. An SD memory card reader for your PC, with microSD card support or an SD-to-microSD adapter
3. A monitor that supports either DVI (HDMI) or VGA, with an appropriate cable or adapter
4. If not using a monitor that supports audio over HDMI, speakers or headphones with a mini audio plug
5. A microSD memory card, type SDHC, between 4 GB and 32 GB
6. A Phillips head screwdriver

The following are optional but will be fun additions to your MEGA65 experience:

1. A joystick or gamepad compatible with Commodore computers, with a nine-pin (DE-9) connector
2. A Commodore 1351 mouse, an Amiga mouse, or a modern replacement such as a mouSTer USB mouse adapter
3. A CR1220 watch battery
4. 3-1/2" floppy disks, either type DD or HD

And if you want to get really serious:

1. The XMOD FTDI JTAG Adapter TE0790-03
2. Mini USB B to USB A cable, to connect between your PC and the JTAG adapter

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Tip: The compatible JTAG adapter is difficult to find right now. Trenz is fulfilling backorders as parts become available. You can preorder the JTAG adapter even though "in stock" says zero, and your order will be fulfilled eventually.

Alternatively, you can use a more common USB UART adapter, with important caveats. See Use of an USB UART adapter as alternative to a JTAG adapter. A misconfigured or mis-wired UART adapter may damage the computer.

Tip: Some MEGA65 units have an issue with the built-in Real-Time Clock (RTC). There is an official solution to install a replacement. See *The Real-Time Clock doesn't advance the time* for how to test for this issue and request a replacement part if needed.

CHAPTER

THREE

TRY THIS FIRST!

You don't want to read stuff, you want to play with your new MEGA65! Well good news, there's *tons* to play with, without ever having to download a file or crack open the case.

The fun is in the digging, so if you're ready to go, stop reading now and dive in. Come back to this section for some things to try before going further. Have fun!

Tip: If you received your MEGA65 in late 2022 or early 2023, your computer has newer firmware and system software than was used to produce the screenshots in this section. The differences are minor.

3.1 Connecting peripherals

Your MEGA65 only needs to be connected to its power supply (included) and a monitor (not included) to operate. The MEGA65 has two connectors for monitors: a VGA connector, and an HDMI connector. Both connections work simultaneously, showing the same display. See *Video display compatibility* later in this Guide for some notes on monitors.

The MEGA65 has two methods of producing sound: over the HDMI connection, or through the dedicated audio jack. You can connect headphones or speakers to the audio jack. To use a display that takes audio over HDMI, you must change a setting, which you'll do in the next step.

If you own an Atari- or Commodore-compatible joystick, gamepad, or mouse with a DE-9 nine-pin connector, you can connect it to one of two nine-pin ports on the lefthand side of the machine. The MEGA65 supports both the Commodore 1351 mouse and the Amiga mouse. The Amiga mouse requires setting a configuration option. Modern mouse replacements such as the mouSTer adapter or the upcoming wireless Amiga tank mouse are expected to work. Personally, I use a 1351 mouse in port 1 and a modern Commodore-compatible gamepad in port 2.

Note: Before connecting a mouse, be sure to set the mouse mode in the configuration step, described later. If an Amiga mouse is connected while the port is in the wrong mode, it may interfere with the behavior of the keyboard.

Hint: For more information on the peripheral ports, see the User's Guide, page 3.

3.2 On-boarding

When you turn your MEGA65 on for the first time, it prompts you for some initial settings. The most important setting is the video mode. Use the Tab key to cycle between digital video without sound over HDMI vs. with sound over HDMI ("enhanced"), and PAL 50Hz vs. NTSC 60Hz display modes. Press Space to test a video setting to make sure it works with your monitor.

Note: If your display isn't working, you may need to adjust the video mode blindly until you find one that works. Older DVI monitors need the "without sound" mode, and monitors vary in their support for 50Hz and 60Hz refresh rates. Use the Tab and Space keys to try the different modes.

Take this opportunity to test your audio set-up. Press the A key to play a musical tone. If you are using audio over HDMI, make sure the video mode is set to "Enhanced (with sound)."

The "CRT emulation" option is a fun choice when using a modern flat panel display: it adds vertical gaps between pixels to simulate the CRT raster line. Try it to see if you like it: press the C key to toggle it on and off.

You can ignore the "Time" setting for now. We will discuss the Real-Time Clock later in this guide. All of these settings can be adjusted later.

Hint: For a description of the on-boarding interface, see the User's Guide, page 28.

3.3 The reset button

As you try out the software that comes bundled with your MEGA65, you will want to reset the machine often. Be sure to locate the reset button on the lefthand side. There are some cases where you will need to completely turn off the MEGA65 using the power switch then turn it on again, but most of the time the reset button does what you need.

3.4 Demonstration menu

Your MEGA65 is configured to run a demonstration program when you turn on the machine. You can use this menu to launch games, utilities, and demos that show off the capabilities of the MEGA65. Try them out! Remember that you can use the reset button to start over.

You can exit from the menu to MEGA65 BASIC, the built-in programming and operating environment. This environ-

ment is similar to the Commodore 64 and 128, where you can give the computer commands, write programs in the BASIC programming language, and load and save programs.

Hint: The User's Guide does an excellent job describing the BASIC environment. See chapter 3, starting page 9.

The demonstration menu is itself a BASIC program. When you exit from the menu to BASIC, this program will still be in memory. You can use the `LIST` command to see its source code. If you want to clear memory to write a new program, use the `NEW` command before entering statements.

```
NEW
10 FOR X=1 TO 100
20 PRINT "MEGA65! ";
30 NEXT X
RUN
```

Once you have tried all of the demo programs, you will probably no longer want your MEGA65 to start the demonstration mode every time it turns on. Select the "Disable auto-boot" menu option to disable it. You can get back to this menu later by loading and running the program with these commands:

```
LOAD "MENU"
RUN
```

If you change your mind and want your MEGA65 to automatically load the demonstration menu when it turns on, use this command to restore this capability:

```
RENAME "MENU" TO "AUTOBOOT.C65"
```

3.5 The Freeze menu

The MEGA65 spends most of its time behaving as a Commodore 65 computer would, either running a program or awaiting instructions in the BASIC environment. Your MEGA65 has additional features that were not part of the original C65 design. You can access many of these features from the Freeze menu.

To open the Freeze menu, hold the Restore key for a second or more, then release it. The MEGA65 will pause whatever it is doing, flicker the border color, then open the Freeze menu. Whatever program was running remains in memory and can be resumed by pressing the F3 key from the Freeze menu. You can also abandon the running program and reset the MEGA65 by pressing F5.

There are many useful features in the Freeze menu. Try them out!

One feature to remember when playing games is the "(J)OY SWAP." This causes the two joystick ports to trade numbers. If you have a joystick in port 2 and you start a game that expects a joystick in port 1, instead of disconnecting and reconnecting the joystick, open the Freeze menu, press J to swap the port numbers, then resume your game.

3.6 Disk images

One of the MEGA65's most useful features is its virtual disk drive. Of course, you can use vintage 3-1/2" floppy disks with the MEGA65's built-in physical drive. More often, you will use files that represent disks ("disk images") that reside on a modern SD memory card. You can use the Freeze menu to tell MEGA65 whether to use the physical drive or a disk image file as a disk drive.

MEGA65 comes bundled with several disk images, including one named `MEGA65.D81` that contains the demonstration menu and all of the demo programs. You can make your own D81 disk images, and can download MEGA65 software as D81 disk image files over the Internet using your PC.

Try browsing one of the disk images included with your MEGA65:

1. If the Freeze menu is not already open, hold the Restore key for a second then release it.
2. Press 0 (zero) to see the options for setting up the first drive.
3. Use the cursor keys to navigate to `DEMOCOMP.D81`. Press Return to select it.
4. Notice that the disk image name appears under the “Internal drive” in the Freeze menu.
5. Press F3 to resume the MEGA65 with this disk image in the virtual drive.

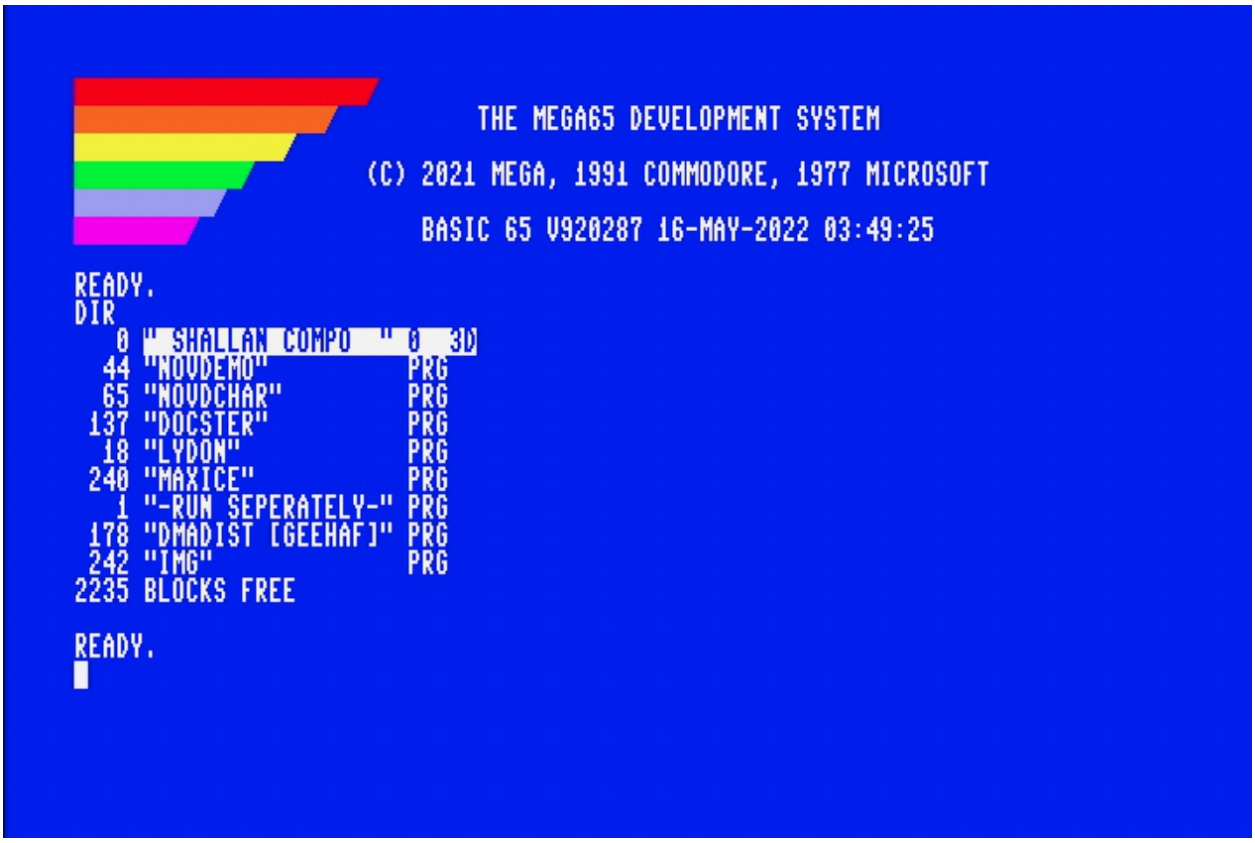
Hint: The User’s Guide describes disk images and the Freeze menu in chapter 7, starting page 59.

3.7 Loading and running a program from disk

You now have the `DEMOCOMP.D81` disk image mounted to device 8 (drive 0). Let's see what's on the disk! Enter the following command at the BASIC `READY.` prompt (type the command then press Return):

```
DIR
```

This lists all of the files on the disk, also known as the *disk directory*.



You can use the `DLOAD` command to load a program off of the disk by name:

```
DLOAD "NOVDEMO"
```

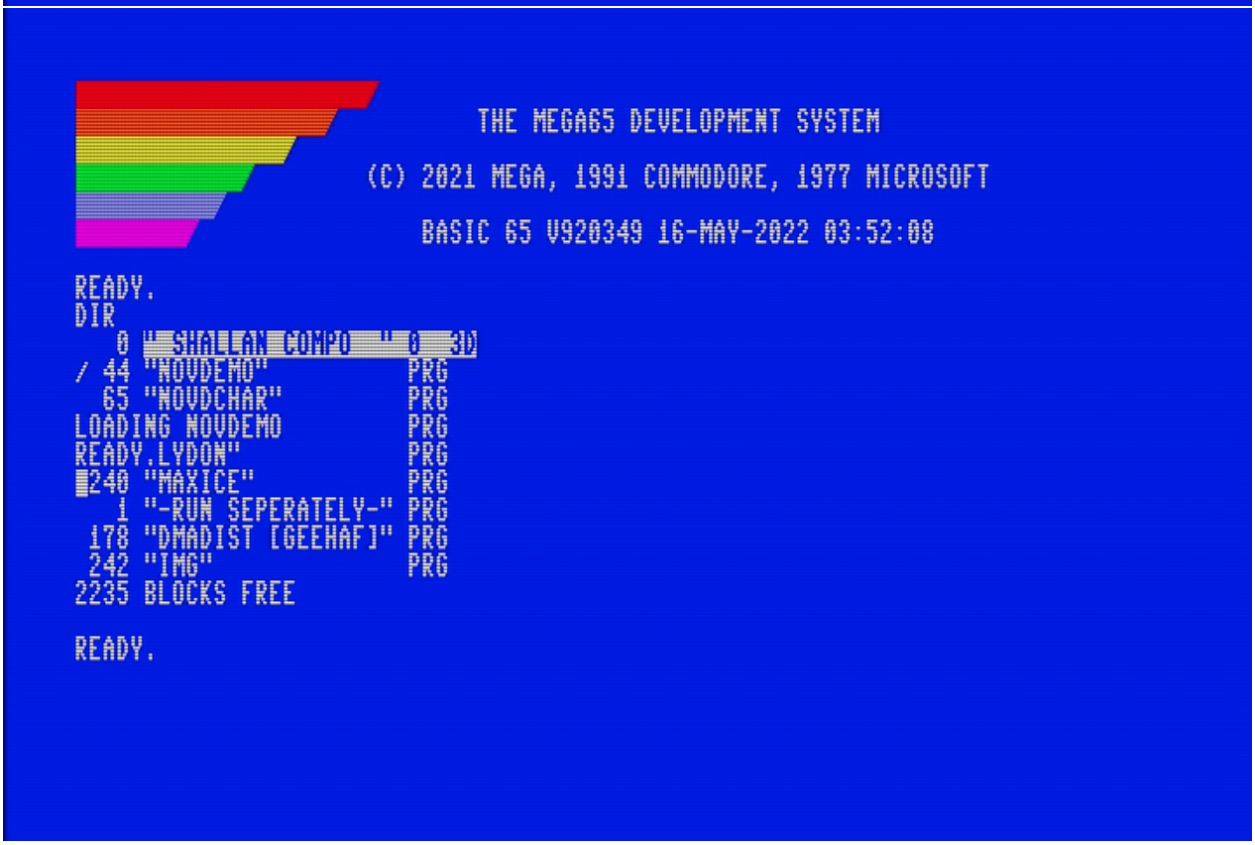
If you've used a Commodore 64, you may remember having to type `,8` or `,8,1` after a `LOAD` command when loading from a disk drive. With MEGA65, unit 8 is the default, so this can be omitted.

Enter the `RUN` command to start the `NOVDEMO` program.

```
RUN
```

Tip: A common trick you may remember from your Commodore 64 is, instead of typing the full filename of something you wish to `LOAD`, you can list the directory of the disk, then move the cursor up to the line with the name of the program and type `LOAD` at the beginning of the line to form the command.

This works on the MEGA65 too, but MEGA65 has a faster way: just type `/` (forward slash) at the beginning of the line, then press Return. Unlike with `LOAD`, you do not need to clear away the extra characters on the line for the `/` to work.



To load and run the program automatically, type the ↑ (up arrow) symbol at the beginning of the line, then press Return.

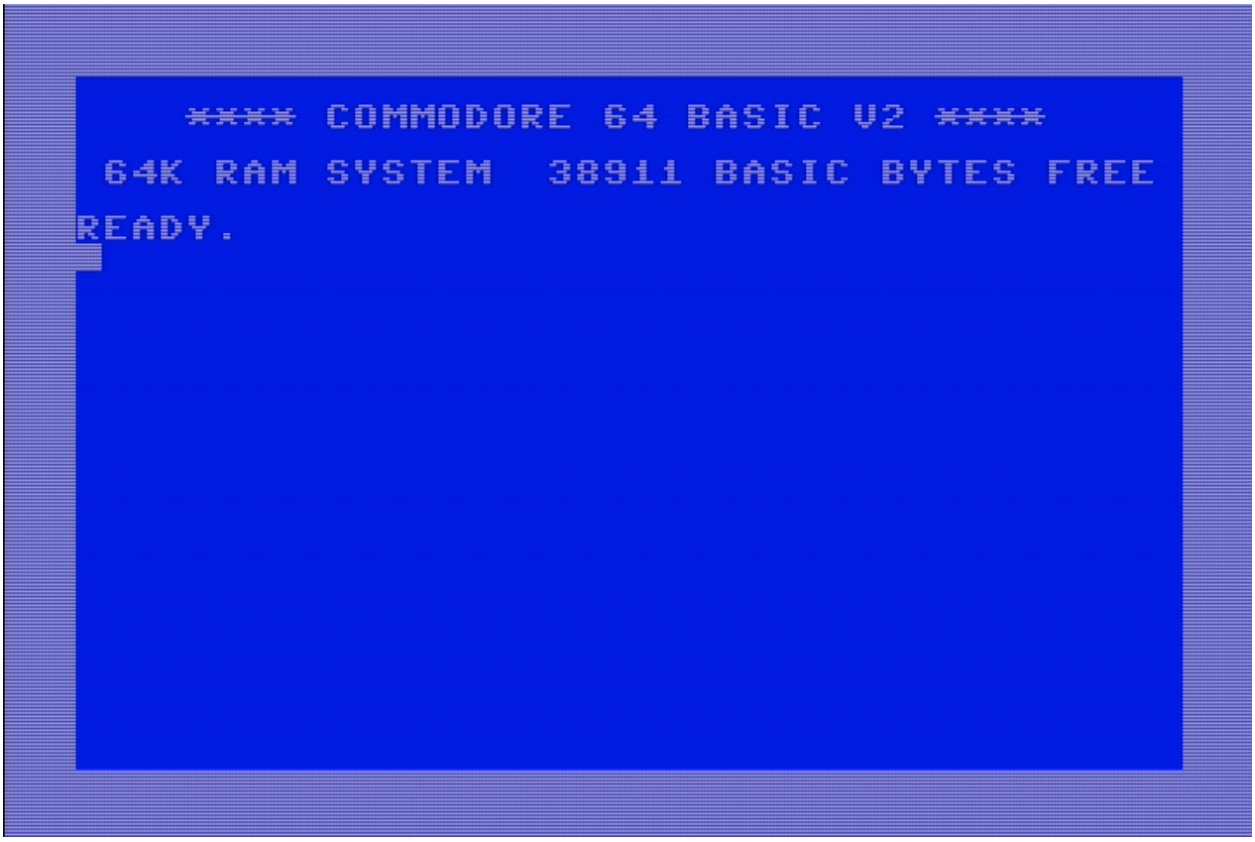
This is the up-arrow key next to the Restore key, not the cursor-up key. (If you received your MEGA65 in early 2022, you may need to update your system software to get this feature.)

When you're done enjoying the demo, you can press the reset button, or use the Freeze menu and press F5 to reset.

3.8 Commodore 64 mode

Like the Commodore 65 on which it is based, the MEGA65 can run in a Commodore 64 compatibility mode. From BASIC, enter this command, then type `YES` to confirm:

```
GO 64
```



The Freeze menu is accessible when in C64 mode, and can be used to mount D81 disk images (or the physical disk drive) with disks containing C64 software.

MEGA65 includes a D81 disk image with C64 games and demos, named `C64.D81`. Use the Freeze menu to mount it to the first drive, then resume C64 mode. Use C64 commands to access the disk in unit 8.

```
LOAD "$",8
LIST
LOAD "DIGILOI",8
RUN
```

Some of the programs on the `C64.D81` disk only work with the PAL video setting. If your monitor supports it, change this setting in the Freeze menu.

Note: MEGA65 currently only supports D81 disk images. Support for the more common `D64` format that represents a Commodore 64 5-1/4" floppy disk may be added in a future update.

C64 mode is not to be confused with the C64 *core*, an alternate way to run C64 software on the MEGA65 which we will discuss later in this guide. The C64 core supports D64 disk images, in a different way.

Do not expect C64 mode to be compatible with all Commodore 64 software. Due to how the Commodore 65 was originally designed, `GO 64` can never be fully compatible. In contrast, the C64 core reproduces the Commodore 64 hardware in the MEGA65 firmware and is expected to run nearly all Commodore 64 software.

Hint: For detailed information about C64 mode, see the User's Guide, chapter 5, starting page 39.

3.9 Other bundled software

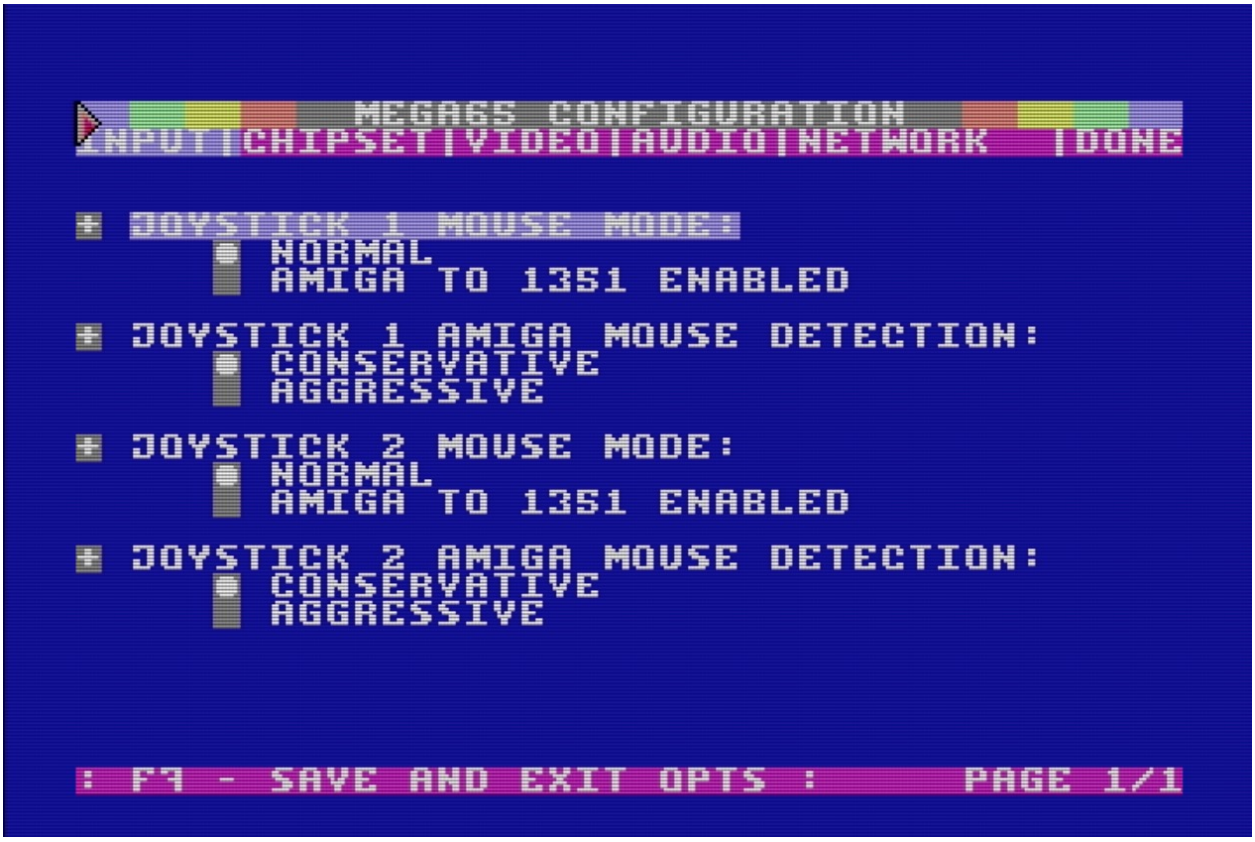
Don't miss the other D81 disk images included with the MEGA65:

- `MEGA65.D81`: The original MEGA65 demo disk
- `C64.D81`: A disk of C64 games and demos
- `BASIC65.D81`: Example BASIC programs that demonstrate major BASIC commands, from the User's Guide
- `DEMOCOMP.D81`: Winners of the Shallan MEGA65 demo competition
- `ELEVEN.D81`: The Eleven programming environment, a modern update to MEGA65 BASIC with a powerful development environment
- `GEOS65.D81`: A version of the GEOS graphical operating system for the MEGA65; use this with a mouse
- `SOLITAIR.D81`: A Solitaire card game for the MEGA65; use this with a mouse

3.10 Configuring your MEGA65

I mentioned that the settings from the on-boarding process can be adjusted later. These settings and more are available in the built-in configuration utility.

To start the configuration utility, turn off your MEGA65, then hold the Alt key (top row near the left) and turn it on. Select option 1: Configure MEGA65 (press 1).

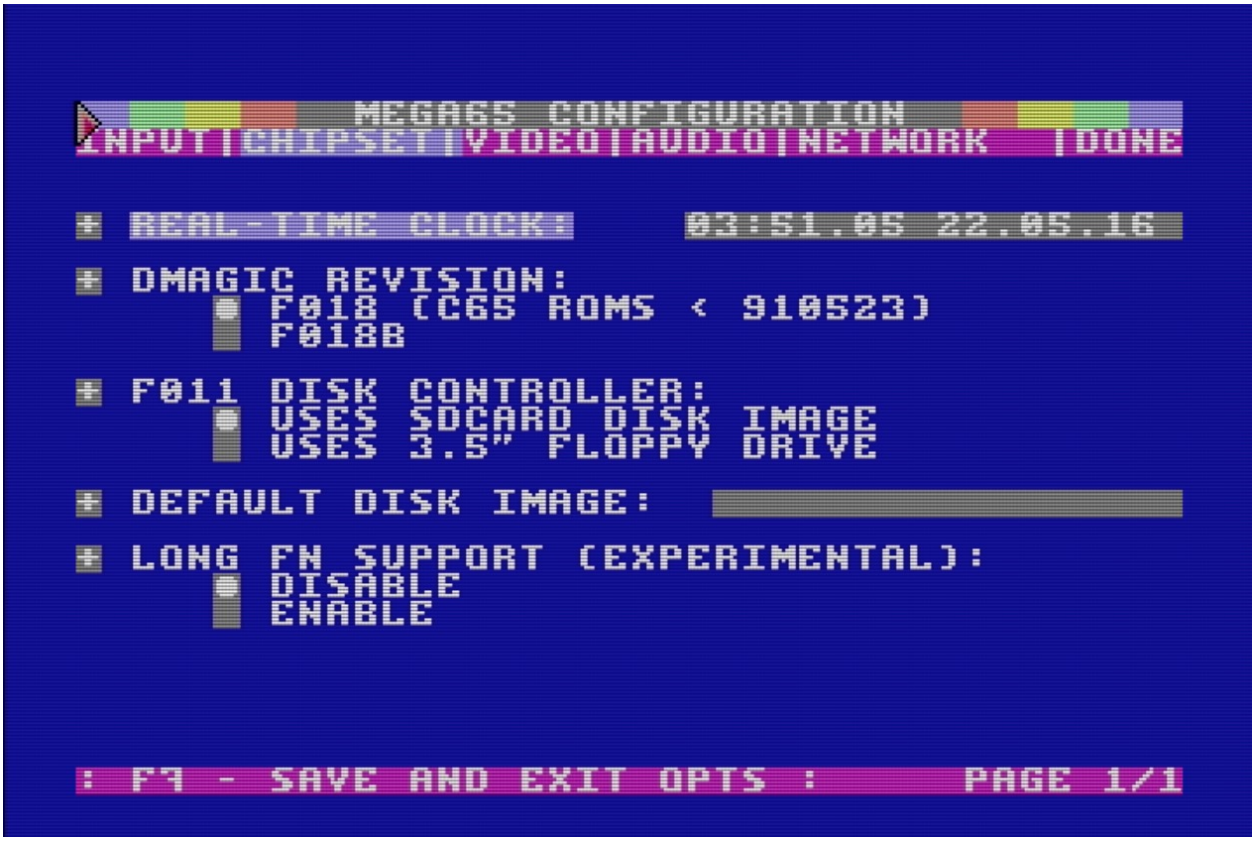


You can use the cursor keys or a mouse to navigate the configuration options. This is also a good way to test whether your mouse is working. Useful options include:

- Input: mouse configuration. You can enable the use of Amiga mice on either port.
- Chipset: Real-Time Clock. This is how you set the date and time, which I told you to skip during on-boarding because you haven't installed the battery yet.
- Chipset: Default Disk Image. Specify a D81 filename to load by default when you turn on the computer.
- Video: All of the video options from the on-boarding screen.

Note: The time and date setting in the configuration utility has been improved between the early 2022 and late 2022 versions of the MEGA65.

If you received your MEGA65 in early 2022, it uses the following time and date format: `HH:MM:SS YY/MM/DD` (That's hours, minutes, seconds, the year, the month, and the day of the month.) It doesn't prevent you from entering invalid numbers. Take care to use the correct date format.



If you received your MEGA65 after late 2022, the time and date are separate settings. *You must press Return in these fields for each setting to take effect.*

Under "Done," you can save these settings as defaults. These settings are stored on the SD card, except for the Real-Time Clock which sets the clock hardware.

CHAPTER

FOUR

IMPORTANT CONCEPTS

Now that you've had a taste of what the MEGA65 can do, it's time to prepare your computer for long term use. But first, let's discuss some important concepts of how the MEGA65 works.

4.1 SD memory cards

The MEGA65 uses an SD memory card for its primary data storage. There are *two* SD card slots: a full-size SD card slot inside the machine, and a microSD card slot accessible on the back of the machine. The MEGA65 comes bundled with an SD card installed in the internal slot.

MEGA65 only uses one SD memory card at a time. If there is a microSD card in the external slot, it ignores the full-size SD card in the internal slot. The SD card contains the operating system software ("ROM"), firmware ("core"), the system utilities (such as the Freeze menu), and D81 disk images.

I recommend installing a microSD card in the external slot, and leaving the internal card with its factory-installed data intact. Following this Guide, you will set up a microSD card with all of the latest versions of the software. You will use this card to transfer software and data between MEGA65 and your PC.

Note: Many features of the MEGA65 expect short MS-DOS-style filenames for files on the SD card: a maximum of 8 characters, a dot, then a maximum of 3 characters (`myprogra.prg`).

Some features will handle files with longer names, but just not display the full name in menus. The Freeze menu and core selection menu (discussed later) do this.

Some features such as loading SD card files from BASIC (`DLOAD "MYPROGRA.PRG",U12`) will fail for files with longer names. The only solution is to rename the file to use a short name using your PC.

(This does not apply to files on CBM disk images, which have their own unrelated limitations on names.)

Hint: The User Guide's explanation of SD cards begins on page 23.

4.2 Cores

The MEGA65 is powered by a Field Programmable Gate Array (FPGA). An FPGA is a special kind of chip that can be programmed to perform the functions of most any integrated circuit (IC). Like an IC, it is fast, and interacts electronically with the rest of the hardware. Unlike an IC, it can be reprogrammed with new logic at any time. FPGA code is sometimes referred to as *firmware*, a term you may recognize from modern computers and other devices. MEGA65's FPGA is programmed to behave like the complete collection of ICs you would find in a Commodore 65: the CPU, video and sound chips, and so on.

The MEGA65 team continues to make improvements to this firmware, and you will want to update your machine with new firmware as updates become available. Other contributors are developing alternate FPGA programming to simulate other computers, such as a Commodore 64.

To make managing multiple sets of firmware easy, MEGA65 describes each set as a *core*. You will download a core data file (described in the manual as a *bitstream*), copy the file to the microSD card, and follow a procedure to install the core in one of seven user-accessible slots. You can access a menu to tell MEGA65 which core to use.

The MEGA65 always retains a copy of its original factory core (in "slot 0"). If something goes wrong while updating another core, you can always go back to the original version.

Hint: This Welcome Guide will describe how to upgrade the MEGA65 core to the latest version. For more general information about cores, see the User's Guide, chapter 6, starting page 47.

4.3 ROMs

While the core recreates the hardware of the Commodore 65, the *ROM* recreates the built-in software of the Commodore 65. This software interfaces with the hardware and provides built-in functionality like BASIC programming.

The original Commodore 65 kept its software on a physical Read-Only Memory (ROM) chip. With MEGA65, this software lives in a file on the SD card named `MEGA65.ROM`. MEGA65 loads this into memory when you turn it on. This file contains the original software from the C65 ROM chip licensed from the copyright holder, with many fixes and improvements. You can upgrade the operating system by replacing this file on the SD card.

Hint: The User Guide describes ROM files starting on page 26.

4.4 The Hypervisor

The MEGA65 has additional built-in functionality not present in the original Commodore 65, such as for managing the startup sequence, SD cards, cores, and configuration. This operating system is known as the Hypervisor.

You see the Hypervisor in action every time you turn on your MEGA65. Normally this screen displays some messages then quickly disappears. If you want to pause the Hypervisor to read these messages, hold the Ctrl key during startup. Release Ctrl to continue.

4.5 PAL and NTSC

Back in the day, PAL and NTSC were competing standards for analog video signals, used for both transmission and rendering on cathode ray tube (CRT) displays. They differed in two major ways:

- The number of horizontal lines used to make the image. PAL uses a vertically dense 625 interlaced lines, compared to NTSC which uses 525 lines.
- The number of times the screen is drawn per second, aka the *refresh rate*. PAL sweeps the screen top to bottom 50 times per second (50 Hz, or 25 interlaced frames per second), while NTSC refreshes at a faster 60 times per second (60 Hz, or 30 frames per second).

Commodore made different versions of its computers for each standard, and sold them in the countries where those standards were used: NTSC in the United States and Japan, and PAL in Europe.

Both the raster line count and the refresh rate affect the execution of computer programs written for vintage computers with analog video output. Software has to use precise timing to render graphics for each frame, and is written to expect the screen to be a certain number of lines tall. Games use the refresh rate to control the timing of other events like playing music. Without extra work by a programmer to account for the differing standards, a program written to be compatible with one video standard might run too fast or too slow, have erratic graphical behavior, or just not work at all on a machine built for the other standard.

The MEGA65 has an analog VGA video output and a digital HDMI video output. Both of these standards are newer than PAL and NTSC and can support multiple resolutions and refresh rates. The MEGA65 must still be set to either PAL mode or NTSC mode (in Configuration or the Freeze menu) to support the vintage software that might be expecting one or the other.

The chances are good (though not guaranteed!) that the monitor you are using with your MEGA65 can support the video signal it outputs in either mode, possibly with some manipulation of the image to account for the differing image heights. If you are having difficulty running a program, try switching to the other video mode. You may need to adjust your monitor's picture settings.

4.5.1 What about SECAM?

The SECAM standard also competed with PAL and NTSC at the time. In countries that used SECAM, Commodore sold PAL machines with an additional device that converted the PAL signal to SECAM. Because they used a PAL video chip, they could run software written for PAL, so there was no SECAM-specific software.

CHAPTER

FIVE

DETERMINING THE VERSIONS OF THINGS

The MEGA65 core (which includes the Hypervisor), ROM, and Freeze menu are all upgradable components. It is often useful to know which versions of these components are currently operating your machine.

5.1 The MEGA65 core version

One way to determine which version of the MEGA65 core is installed is to turn off the computer, then hold the Ctrl key while turning on the computer to pause the Hypervisor screen.

MEGA65 computers delivered in early 2022 ("batch #1") have this version of the MEGA65 core:

```
GIT commit: master,20220109.11,1586ad4
```

MEGA65 computers delivered in late 2022 ("batch #2") will ship with this newer version of the MEGA65 core:

```
GIT commit: master,20221012.18,93d55f0
```

If you have a batch #1 MEGA65, I recommend upgrading to the newer `93d55f0` core. We'll describe how to do this later in this Guide.

These two `master` releases have been tested and declared stable for widespread use by the MEGA65 team. You can also download `development` releases (sometimes called "experimental" releases) to help test newer changes made to the core. Experimental releases have a version string that begins with the word `development`.

The `20221012` portion of the core version is a date, with a four-digit year, a two-digit month, and a two-digit day. The `93d55f0` portion is a hash code that represents the most recent change in the code repository ("GIT commit"). Hash codes are not in any order, so you can't tell if one version is newer than the other by the hash code alone.

Tip: You can check the version of the MEGA65 core while the computer is running without turning it off. At any time with the MEGA65 core running, hold the Mega key (the fancy M in the lower left of your keyboard) and press Tab. Welcome to "Matrix mode!" This is a special mode used by the MEGA65 development team to tweak the memory of the computer while it is running, among other things. It also displays the version of the running MEGA65 core. Press Mega + Tab again to exit.

5.2 The MEGA65 ROM version

You can determine the version of the MEGA65 ROM that is running from the BASIC title screen.

The MEGA65 ROM that shipped with batch #1 in early 2022 has this version number:

```
920287
```

Late 2022 batch #2 computers will ship with this version of the MEGA65 ROM:

```
920377
```

I recommend that all owners of a batch #1 MEGA65 upgrade to ROM 920377. We'll describe how to do this later in this Guide.

The original Commodore 65 ROM data used a number resembling a date to represent the software version, such as `910828` or `911001`. The MEGA65 enhanced versions of the original ROMs continues the numbering sequentially from `92xxxx`. A higher number implies a newer ROM.

You may also see MEGA65 ROMs with a version number that begins with `99`. These are "experimental" releases, similar to the experimental cores, and are used for testing new features.

5.3 Bundled releases

To make it easy to know which versions of these components are known to work well together, the MEGA65 team provides release bundles that have been tested as a set. These releases have version numbers.

- **Release bundle 0.9**, factory-installed for MEGA65s delivered early 2022 (batch #1)
  - Core `master,20220109.11,1586ad4`
  - ROM `920287`
- **Release bundle 0.95**, factory-installed for MEGA65s to be delivered late 2022 and early 2023 (batch #2)
  - Core `master,20221012.18,93d55f0`
  - ROM `920377`

The system software (`.M65` files on the SD card) does not have its own version number. The latest system software is always bundled with the core.

Experimental versions are not included in release bundles. If you want to try an experimental version of a component, you'll be replacing the component individually.

In general, the core, ROM, and system software tend to serve independent functions, and most versions of one are compatible with most versions of the others. This has not always been the case! I recommend upgrading all components from release 0.9 to 0.95 together, as described in this Guide.

CHAPTER

SIX

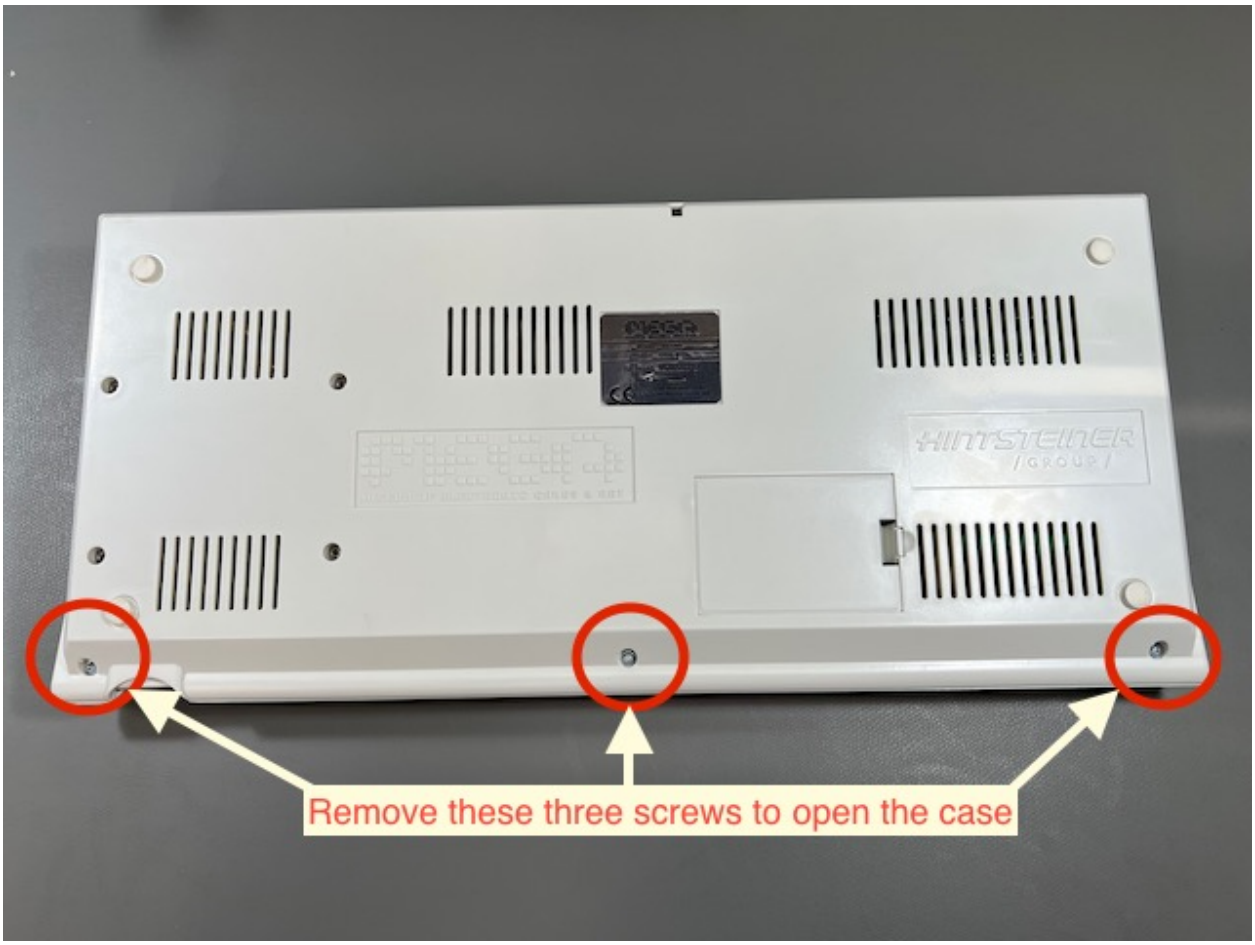
OPENING THE MEGA65 CASE

Your MEGA65 consists of an injection molded plastic case, built-in keyboard and disk drive, ports for peripherals, and internal components. The case is designed to be opened by its owner if needed.

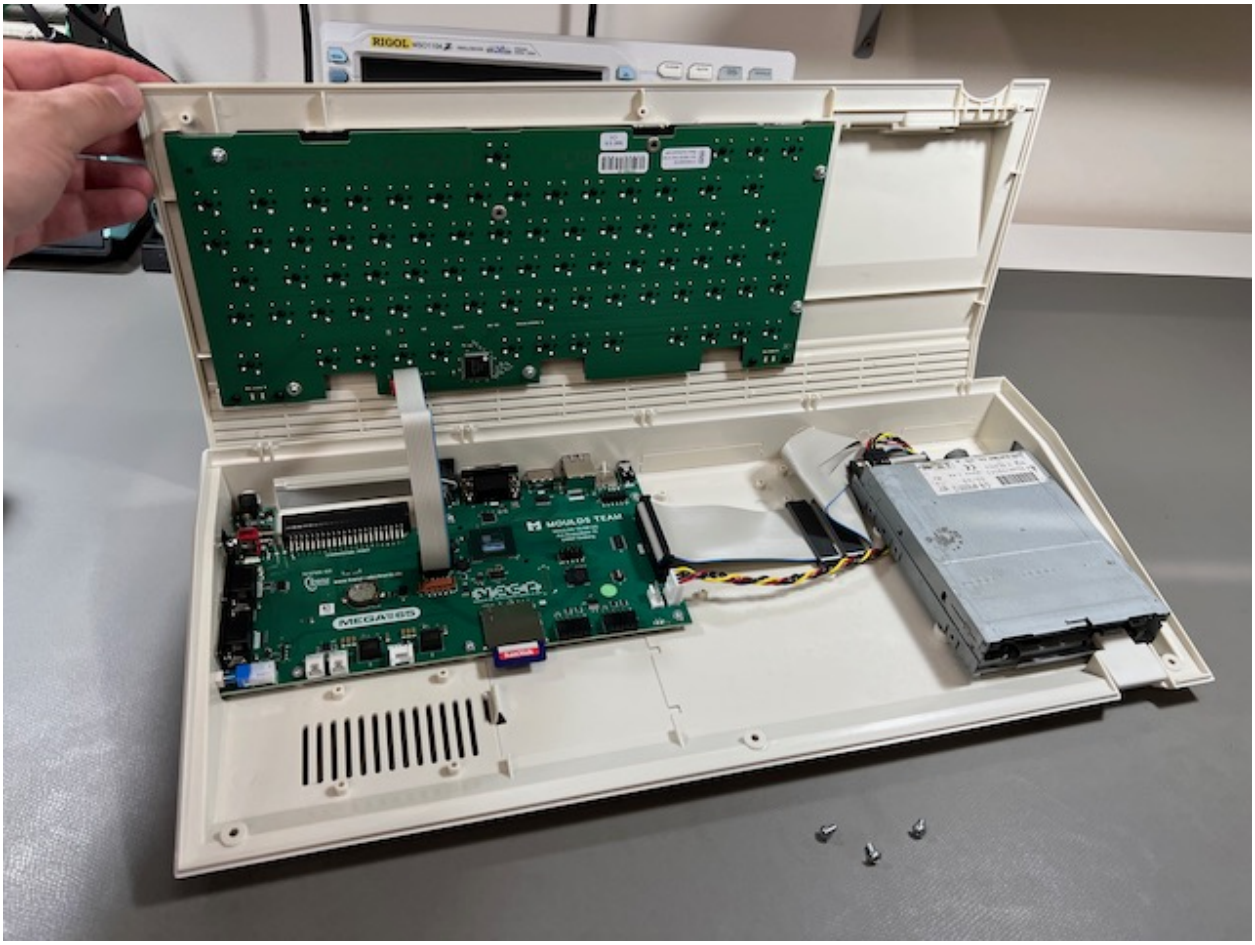
You may want to open the case for the following reasons:

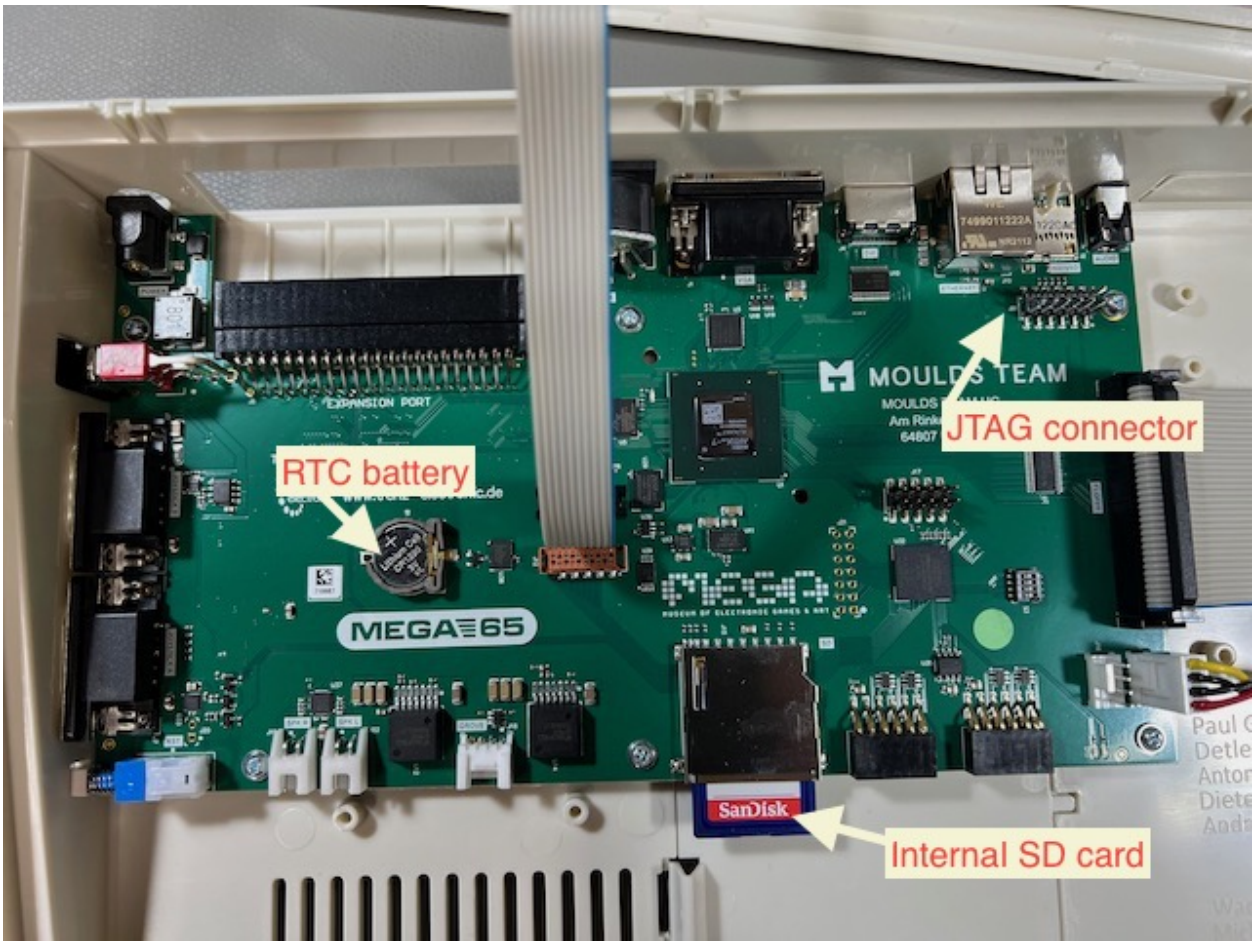
- To access the internal SD card
  - There is a small door in the bottom of the case that provides access to the internal SD card without opening the case, but I find it too difficult to access this way. If you use the external microSD card slot as I recommend in this Guide, you won't need to access the internal SD card.
- To install (or replace) the CR1220 battery for the Real-Time Clock
- To resolve issues with the case by adjusting its assembly (see *Known hardware issues*)
- To install a JTAG adapter (see *Using the JTAG connector*)
- To install a replacement Real-Time Clock if the one built into the MEGA65 isn't working (see *The Real-Time Clock doesn't advance the time*)

To open the MEGA65 case, locate three screws along the bottom front of the case and remove them with a Phillips head screwdriver.



The case separates into a top piece and a bottom piece. The keyboard is attached to the top, while the disk drive, ports, and main board are attached to the bottom. The keyboard is connected to the main board with a ribbon cable.


RIGOL
MOULOS TEAM
MEGA65


RTC battery
JTAG connector
Internal SD card
MEGA65
MOULDS TEAM
EXPANSION PORT
SanDisk

Install the CR1220 battery. Locate the battery holder on the main board. Insert the battery under the tab, with the positive (+) side facing upward. Push down to secure it.

Tip: See Install battery CR1220 in MEGA65 for Real-Time Clock (RTC) for more photos and instructions.

If you'd like to make a backup of the internal SD card for safe keeping, remove the full-size SD card from the internal slot. Connect it to your PC with an SD card reader. On your PC, copy all of the files to a folder. Eject the device from your PC, then return the card to the MEGA65's internal slot.

I recommend leaving the internal card in its factory state and using the external microSD card slot for regular operation. Alternatively, you can use the internal card as your primary card, removing it from the MEGA65 every time you need to use it with your PC. You can even leave the internal slot empty. MEGA65 only needs a memory card in one of the two slots.

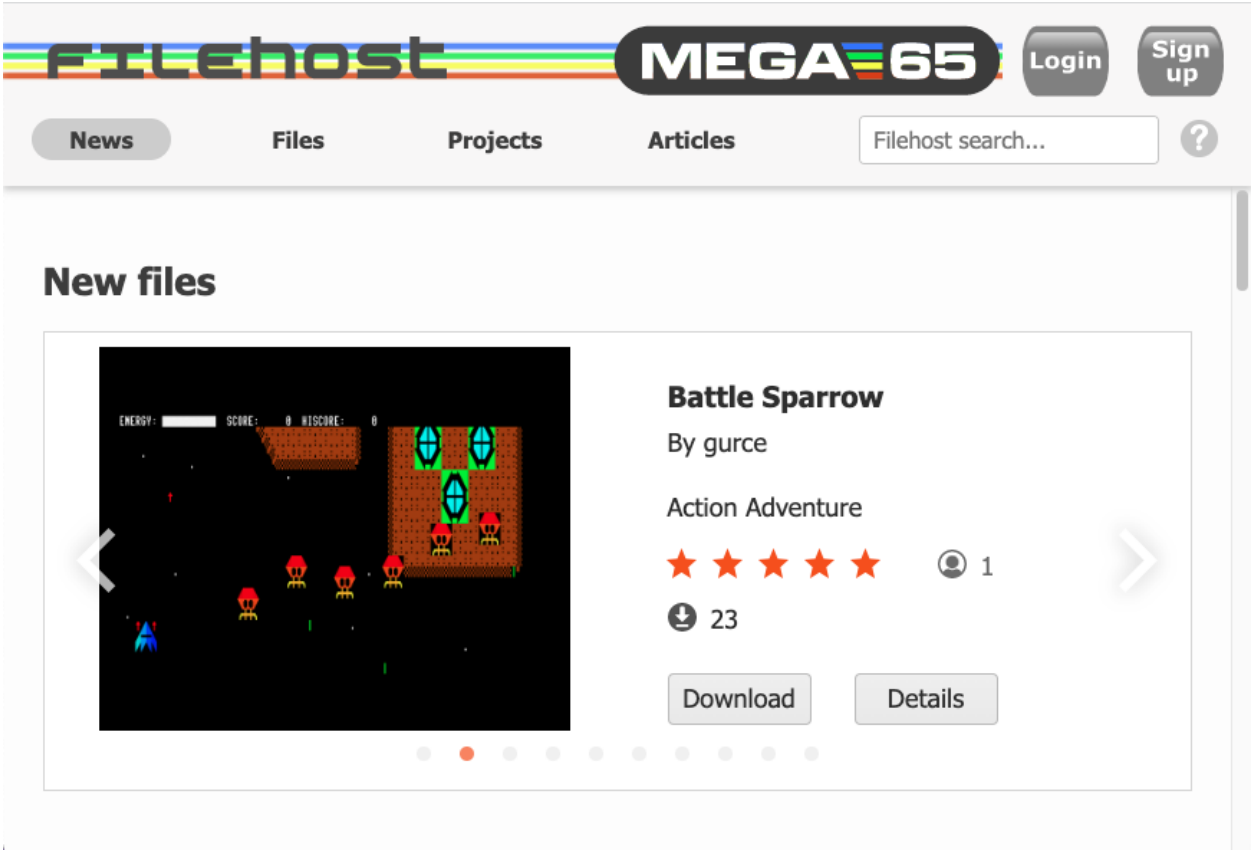
To close the case, align the plastic tabs along the back of the top and bottom case parts, then replace the three screws.

CHAPTER

SEVEN

ACCESSING THE MEGA65 FILEHOST

The MEGA65 Filehost website is the official repository for MEGA65 firmware and ROM updates, tools, games, applications, and documentation.

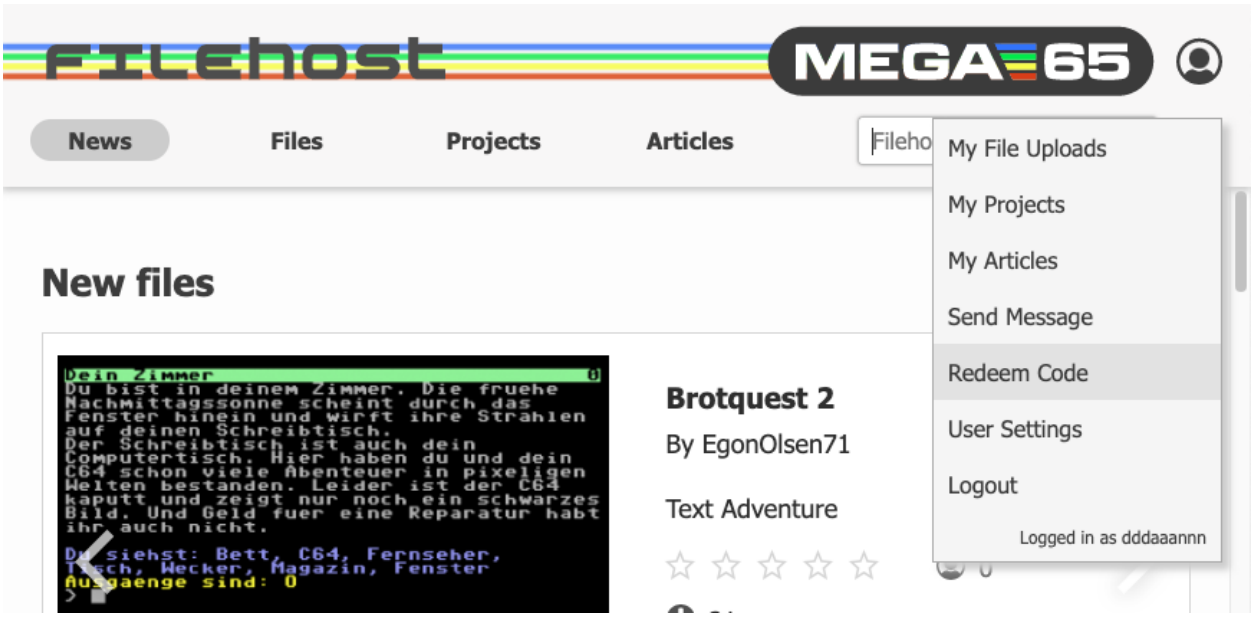


Most files are publicly available, but a few important files require an account and verification of ownership to access. Specifically, the ROMs based on the original C65 contain material that is only licensed to owners of the MEGA65. Creating an account also lets you post ratings and leave comments.

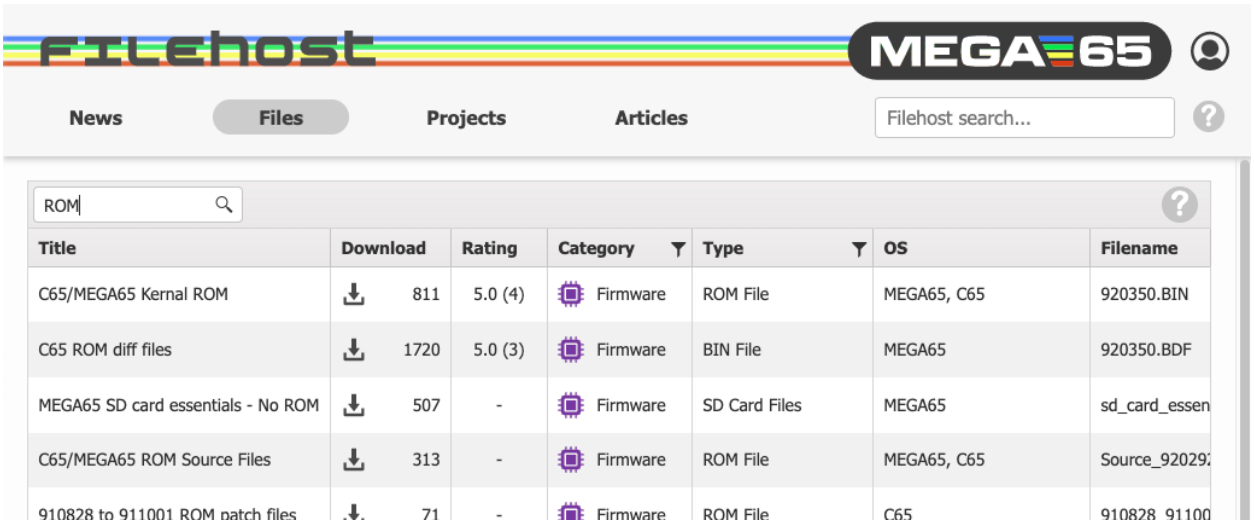
To create and account and register your MEGA65:

1. Visit the Filehost website: files.mega65.org
2. Click “Sign up” and complete the prompts. If you already have an account, click “Login.”
3. Once you are signed in, click the person icon in the upper right (where the sign up/login buttons were) to open the menu, then select Redeem Code.

4. In the dialog that opens, enter the nine-character registration code that was included with your MEGA65 on a piece of paper. It looks something like `123-ABC-456`.
5. Open the menu again and "Logout," then "Login" again.



To verify that you can see the licensed files, click "Files," click the search field, type "ROM" and press enter. If you are registered correctly, the file "C65/MEGA65 Kernal ROM" should be one of the results.



Tip: Not seeing the licensed ROM after registering? Try logging out, then log back in again.

CHAPTER

EIGHT

SETTING UP THE MICROSD CARD

Your microSD card will be your MEGA65's primary storage, and the primary way to transfer files to and from your PC. You will use it to update the firmware and store updated system software and ROMs. You will also use it to manage D81 disk images and store applications you have downloaded.

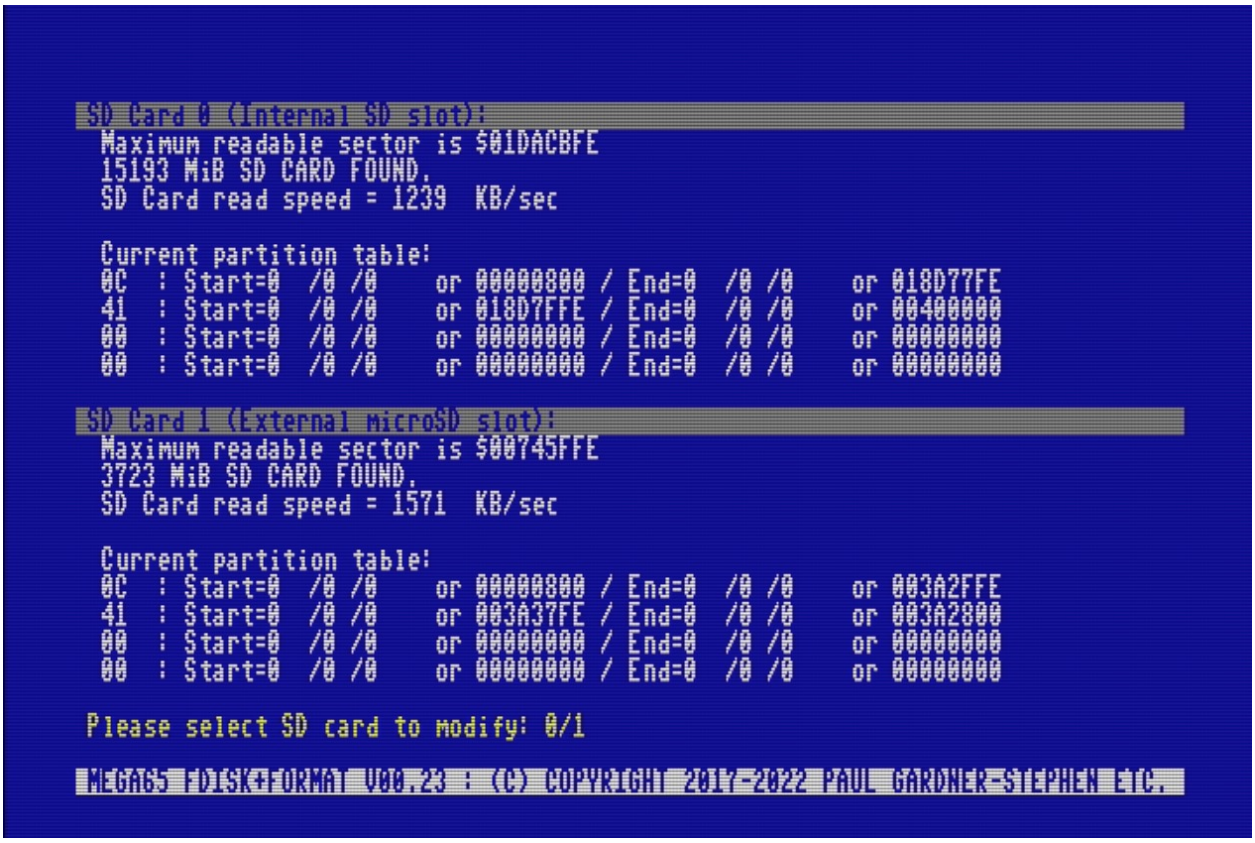
8.1 Preparing the microSD memory card

To use an SD card with the MEGA65, it must be formatted (erased and prepared) using the MEGA65. The SD card works like a regular storage drive when connected to your PC, but it contains additional data not visible to the PC that is used by MEGA65.

To prepare a new microSD card for use, insert it into your MEGA65's external microSD card slot. Turn off your MEGA65, then hold the Alt key (top row near the left) and turn it on. Select option 2: SDCard FDisk+Format Utility (press 2).

The SD card utility will look for cards in the available slots. Confirm that it has detected your microSD card correctly, then select option 1 for the external microSD slot (press 1).

Caution: The SD card utility will erase the internal SD card if you ask it to. Be careful to select the correct card.



If prompted to do so, type the confirmation message, `DELETE EVERYTHING`, then press Return. Be sure to use uppercase (shifted) letters. The MEGA65 formats the SD card, erasing all of its data.

If prompted to "Populate SD card," **press S to skip**. We will copy these files from your PC in the next step.

Hint: For more on preparing SD cards for use, see the User's Manual, starting page 23. Note that the SD card utility has been improved in newer versions of the firmware since the manual was printed.

8.2 Installing the SD card files

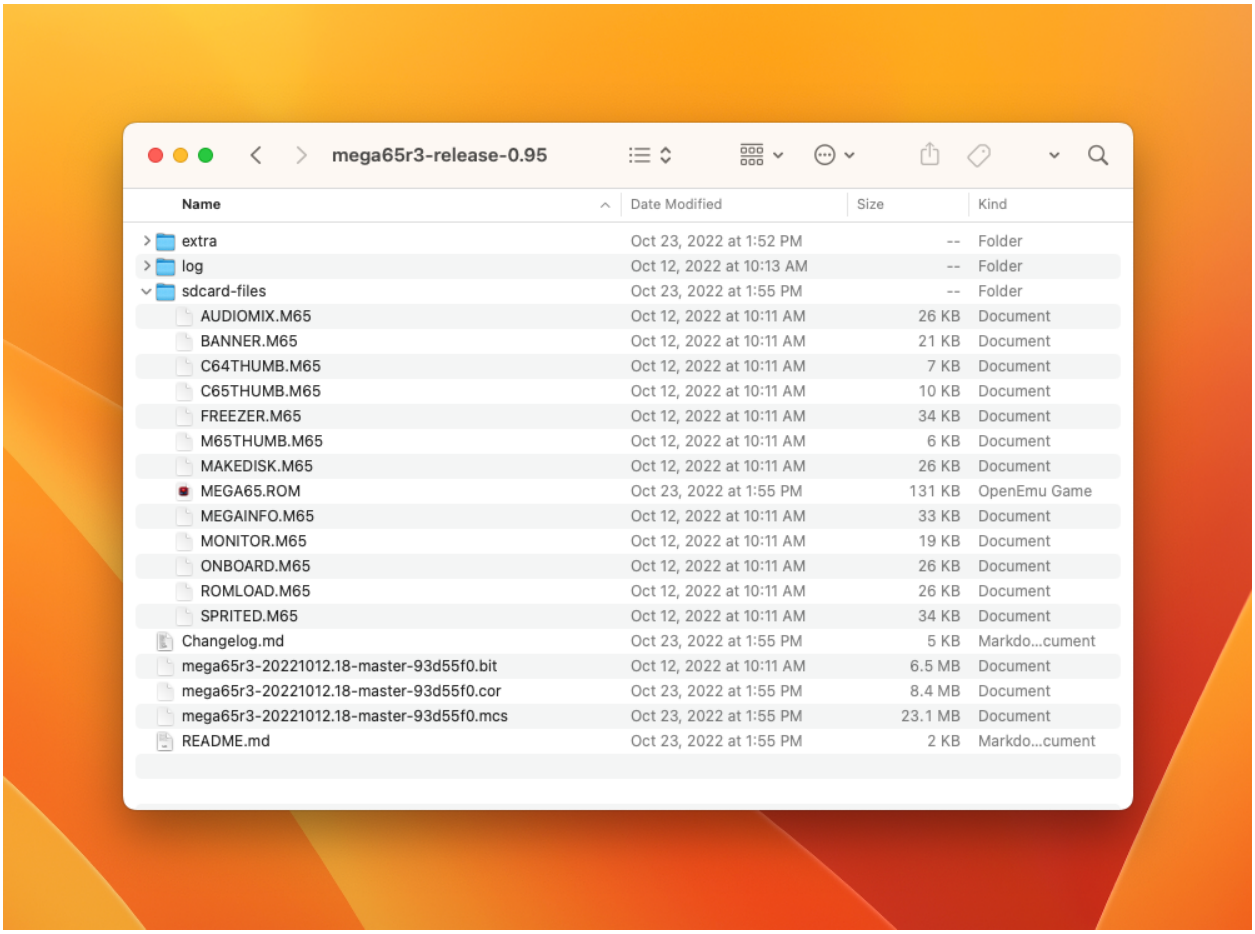
When told to do so by the MEGA65, remove the microSD card from the MEGA65, then insert it into your PC's microSD card reader. Locate the card's folder on your computer and open it. It should appear to be empty.

Note: If the microSD card is not empty, either you populated the card on the MEGA65 after formatting, or you may be trying to upgrade an already populated card. See *Upgrading from a previous version*, below.

Visit the Filehost website. Make sure you are signed in and have registered your owner code with your account (see *Accessing the MEGA65 Filehost*).

Download **MEGA65 Core Release Package (mega65r3) incl. ROM**. (This is only visible to registered owners.)

This retrieves a file named `mega65r3-release-0.95-93d55f0.7z` (release bundle 0.95; see *Bundled releases*). This file is in the 7z archive format, and needs to be unpacked. If you're using macOS, double-click on this file to unpack it. Alternatively, you download and install The Unarchiver, a utility which has a graphical app for macOS and a command-line tool for macOS, Windows, and Linux. Windows users might prefer 7-Zip.



Open the unpacked folder. Locate the file `mega65r3-20221012.18-master-93d55f0.cor`. (There are three files with similar long names; you want the `.cor` file.) **Rename this** to `r3r095.cor`, then copy it to the microSD card.

Open the `sdcard-files` sub-folder. Copy all files from this sub-folder to the root of the microSD card.

8.3 Optional: reinstalling bundled software

The 0.95 release package does not include the bundled software that came on the full-size SD card installed at the factory, such as the demo disk or GEOS. You may wish to copy these files onto the microSD card. (The MEGA65 cannot access the internal full-size SD card when the microSD card is installed.)

If you haven't already, open the MEGA65 case (see *Opening the MEGA65 case*), and remove the full-size SD card from the internal slot. Insert it into your PC's card reader. Locate all of the `.D81` and `.MOD` files, and copy them to your PC. Eject the full-size SD card, replace it in the MEGA65 internal slot, then close the case.

Copy the `.D81` and `.MOD` files from your PC to the microSD card.

If you have the 0.9 release on your internal SD card and you are installing 0.95 on the microSD card, you may want to get the updated demo disk, which has minor bug fixes for the newer ROM. You can download the latest demo disk from Filehost.

8.3.1 Using the SD card image file

If you erased your factory-installed SD card without backing up its contents, you can find the MEGA65 Release SD Card - Intro Disk on Filehost. You must be a registered owner to see this file, because it contains licensed software including the ROM and GEOS. This disk image contains the release 0.95 / batch #2 version of the system software and ROM, as well as the updated demo disk.

This is a `.IMG` file. On macOS, you can double-click this file to open it and access the files inside. Alternatively, you can use a program like Balena Etcher to restore your full-sized SD card from inside the MEGA65. (This overwrites the SD card contents.) Proceed to copy the `.D81` and `.MOD` files from the disk image (or rewritten SD card) to the microSD card.

Tip: If this IMG file contains all of the SD card files for the 0.95 release, then why did we go through all of those steps to format the microSD card and copy those files from different locations? Can't I just write the IMG file to the microSD card?

If you're starting a new microSD card, *and* it is 16 GB in size, *and* you have or are upgrading to the 0.95 core specifically, you can write the IMG to the microSD card with Balena Etcher, and you're done. I recommended the longer procedure because:

- If your microSD card is smaller than 16 GB in size, you can't write the image, even though the files take up much less than 16 GB of space.
- If your microSD card is larger than 16 GB in size, writing the image would create a 16 GB partition, preventing the remaining space from being used.
- If you are upgrading an existing microSD card, you'll need to copy the files individually. Writing an IMG overwrites the complete contents of the card.
- If you are setting up a core other than 0.95, you will need the system software for that core, not what's on the IMG.

If you do decide to write the IMG directly to the microSD card, you will still want to copy the `r3r095.cor` file to the card afterward. You'll need this file on the card to install the release 0.95 core in the next section.

8.4 Installing the microSD card and re-running configuration

Eject the microSD card from your PC, then return it to the microSD card slot on the MEGA65.

The MEGA65 stores its settings on a hidden partition of the SD card. If you changed settings earlier, you will need to set them again in the Configuration utility with the newly prepared card installed. Hold the Alt key and turn on the MEGA65, then select 1 to configure your MEGA65.

8.5 Upgrading from a previous version

If you already have an earlier version of the core, ROM, and system software on your microSD card, you can use the files in the 0.95 release bundle (with ROM) to upgrade without formatting the entire card.

There's one catch. Due to limitations of the MEGA65's SD card driver, it is important that you not simply replace the old files with the new ones on the microSD card using your PC. Under some circumstances, this can result in *fragmentation* of a file, where the file is stored in discontiguous blocks. Modern computers can handle such files, but the MEGA65 can't.

To replace the system files while avoiding fragmentation, **delete the files from the microSD card first,** then copy the new files onto it. Some people recommend renaming the files before deleting them; I don't understand that step, but take it as further warning.

I wrote a Python script that updates an SD card from a release package using this technique for all files to avoid fragmentation. Feel free to adapt it for your purposes.

This article recommends using defragmentation tools on the SD card. I have not tested these.

Tip: This is true for all files on the SD card, including `.D81` disk images. To replace a file on the SD card using your PC, delete it, then copy it fresh.

CHAPTER

NINE

UPDATING THE CORE FIRMWARE

In the previous step, *Installing the SD card files*, you copied the release 0.95 core file to the SD card (which we renamed `r3r095.cor`). If you received your MEGA65 in early 2022, you should upgrade to this new version.

If you received your MEGA65 in late 2022 or early 2023, you already have the release 0.95 core as the factory-installed core (slot 0), and you do not need to upgrade. Skim this section for advice on how to manage cores, for future reference.

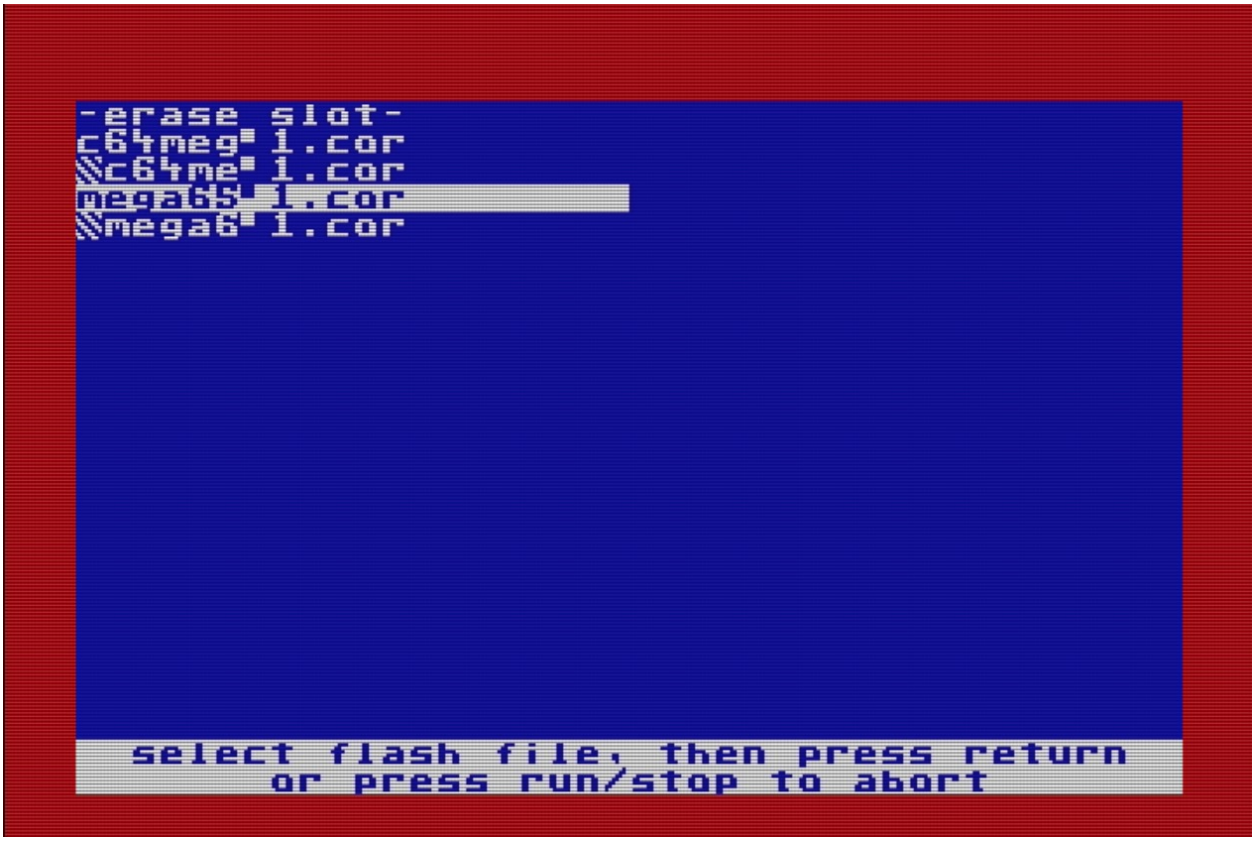
9.1 Installing the MEGA65 core

Make sure the MEGA65 is off, then hold the No Scroll key (in the top row) and turn it on. This opens the core selection and installation menu.

Core 0 is always the factory-installed core and cannot be overwritten. This can help you restore your MEGA65 to a working state if something goes wrong with updating a core. If this is your first time seeing the core selection menu, slots 1 through 7 should be empty.

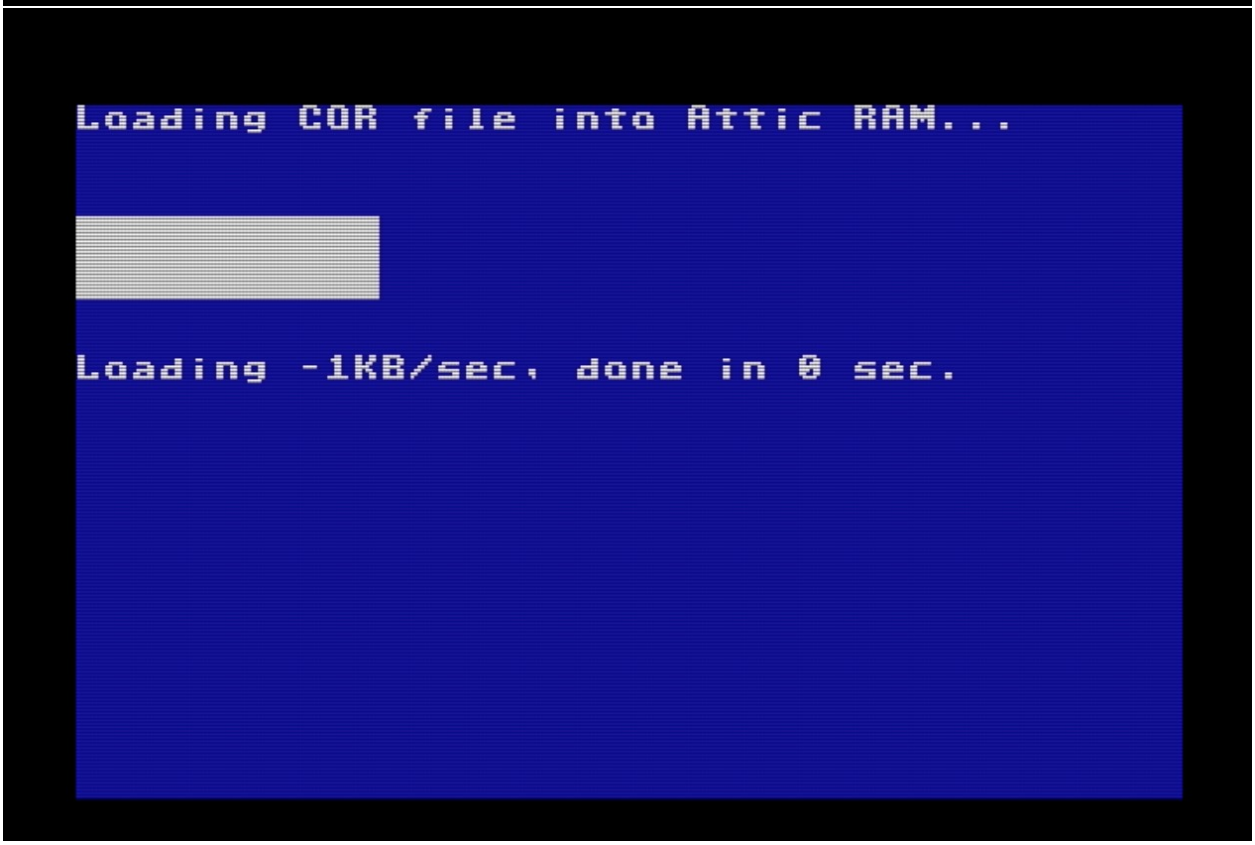
When you turn on your MEGA65 normally, it checks to see if slot 1 contains a core, and uses it if present. Otherwise it falls back to core 0. You will put the new core you just downloaded in slot 1 for regular use.

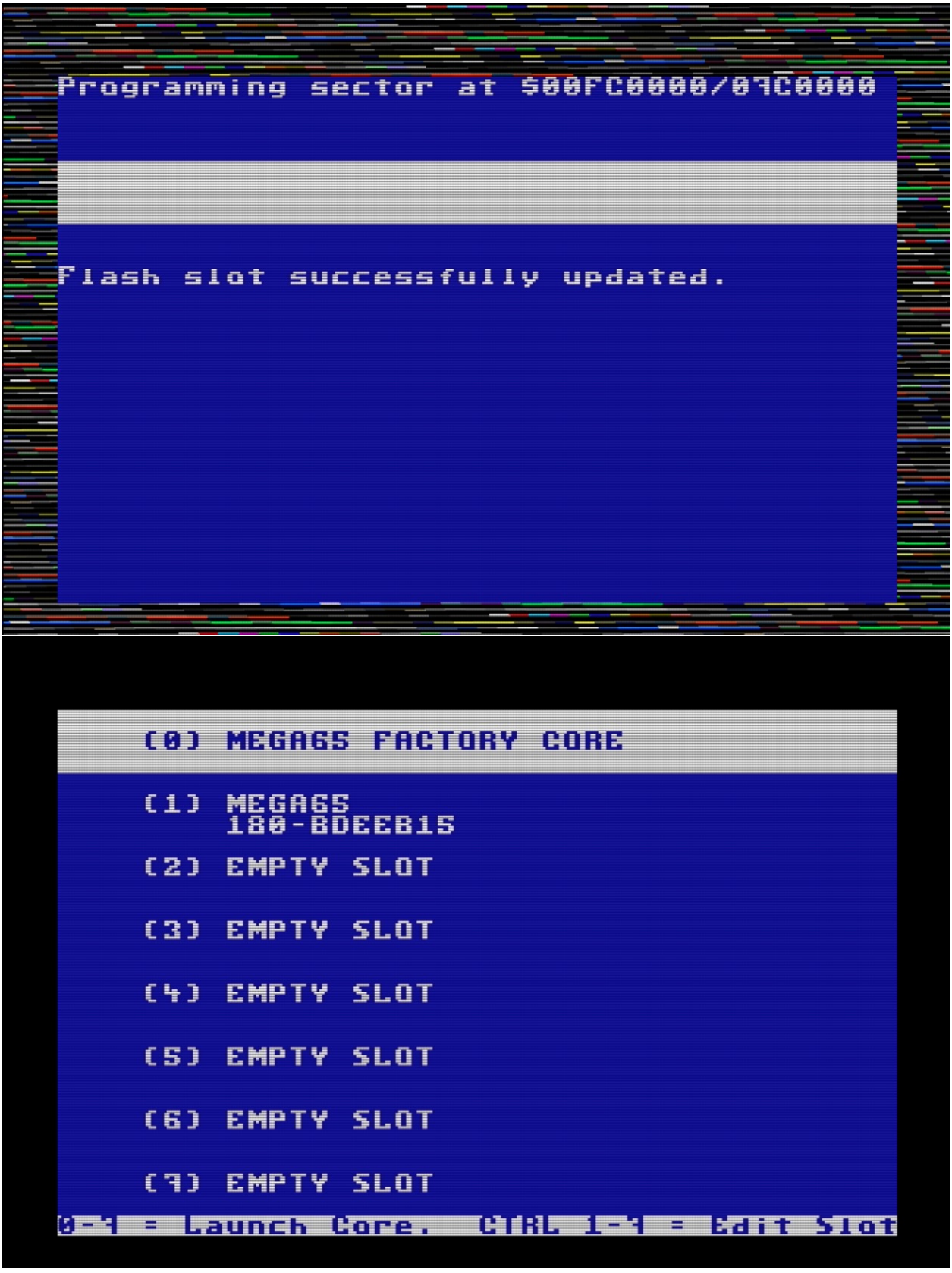
Hold the Ctrl key and press 1. Use the cursor keys to find `r3r095.cor`. (If you didn't rename it to use a shorter name, it may appear as something like "`mega65-1.cor`".) If there is a second one with a stripey thing next to it, select the one *without* the stripey thing. Press Return, then press any key when prompted to install the core.



The flashing process takes a minute or so. When it is complete, you'll see the message, "Flash slot successfully updated," and the border will twinkle. Press any key to return to the core selection menu. Finally, press 1 (without Ctrl) to start the system with the new core.


Checking COR file...
.COR file model id: $03 - MEGA65 R3
Hardware model id: $03 - MEGA65 R3
Verified .COR file matches hardware.
Safe to flash.
Press any key to continue.


Loading COR file into Attic RAM...
Loading ~1KB/sec, done in 0 sec.


Programming sector at $00FC0000/07C0000
Flash slot successfully updated.
(0) MEGA65 FACTORY CORE
(1) MEGA65
180-BDEEB15
(2) EMPTY SLOT
(3) EMPTY SLOT
(4) EMPTY SLOT
(5) EMPTY SLOT
(6) EMPTY SLOT
(7) EMPTY SLOT
0-7 = Launch Core. CTRL 1-7 = Edit Slot

Note: If you use a Mac computer to copy a file to a MEGA65 SD card, it creates another file with a name like `._filename` to store the macOS resource fork. This appears in the core file selection screen as the original name with a stripey thing next to it. Be sure to select the original core file, and not the one with the stripey thing, when installing a core.

If you select the wrong one, MEGA65 will warn that the incorrect file does not have a matching device ID (because it isn't a real core file). Press RUN/STOP to abort and try again with the correct file.

Hint: For more on installing cores, see the User's Guide, chapter 6, starting page 47.

9.2 Symptoms that you're using the wrong MEGA65 core

If you've been following along with this Guide, you should now have a MEGA65 that uses the latest core and ROM when you turn it on. You can confirm the core and ROM versions as described in *Determining the versions of things*.

Some actions, such as accessing the Configuration or SD card utility from the Alt menu, cause the MEGA65 to boot into its factory core (slot 0) instead of the updated core in slot 1. This can cause issues with the older core to reappear, or for the newer ROM to interact poorly with the older core.

I noticed a few common symptoms caused by older versions of the ROM, the core, or a version mismatch:

- *The Freeze menu appears too low on the screen, obscuring the bottom.*
  - You have an older ROM, or an older version of `FREEZER.M65`.
- *The Freeze menu does not display the name of the selected D81 file next to the drive, and the disk does not mount properly.*
  - You are using the newer ROM with the older core.
- *Disk directory misbehavior, such as an extra file, or missing files.*
  - You are using the newer ROM with the older core.

Use "Matrix mode" (hold Mega, hit Tab) to double check that MEGA65 is using the latest core. If it is using the factory core (`1586ad4`) and you have a newer core installed in slot 1, turn off your MEGA65, then turn it back on.

9.3 The C64 core

We mentioned that the MEGA65 can run other cores besides the one that causes your MEGA to act like a Commodore 65. One such core is a Commodore 64.

The C64 core is *not the same* as the C65's Commodore 64 mode, the one you start by typing `GO 64` (see *Commodore 64 mode*). The C64 core completely transforms your MEGA into a Commodore 64, with no C65 or MEGA65 features. It strives to be as compatible as possible with C64 software. The current version supports PAL displays and timings, a simulated C1541 drive that supports D64 image files, and joysticks.

If you'd like to try the C64 core, go to Filehost, then locate and download "C64 for MEGA65". Install it like you did the MEGA65 core update, using slot 2.

The C64 core has its own display configuration, separate from the MEGA65 core. It only supports PAL mode, and defaults to HDMI with audio. If your DVI display does not support audio, you may need to temporarily connect to a VGA monitor to change the setting. While the C64 core is running, press the Help key to open the menu, then cursor down to the video options and press Return to enable them, as needed.

The C64 core can read D64 image files off of the SD card. From the Help menu, press Return on the first line to browse the SD card, then select a disk image to mount to device 8. Press Help again to close the menu. The disk image you selected is now mounted, and you can execute C64 disk commands as usual (such as `LOAD "*",8,1`).

Tip: To avoid cluttering your SD card with D64 images, you can use your PC to create a folder named `c64` and put the D64 files in there. The C64 core will notice the folder and limit its browser to just these files.

See the Commodore 64 for MEGA65 manual for more information.

To return to the MEGA65 core in slot 1, turn off the machine, then turn it on again.

Tip: For information on other cores that work with the MEGA65, see What are "alternative" MEGA65 cores?. You can use alternate cores to convert your MEGA65 into a ZX Spectrum or a Game Boy Color!

CHAPTER

TEN

USING DISKS

We discussed using D81 disk images back in *Disk images*, including:

- How to browse D81 disk images using the Freeze menu
- How to mount a D81 disk image on drive 0 device 8 using the Freeze menu
- How to get a directory listing with the `DIR` command
- How to load and run a program on the disk using the `LOAD` and `RUN` commands
- How to use the `/` and ↑ shortcuts to load or run a file within a directory listing

Disk-related improvements have been advancing quickly, and the latest ROM includes bug fixes and useful features not mentioned in the printed manual.

10.1 Listing a disk directory

The `DIR` command lists all of the files on a given disk. Without arguments, it lists the files on the disk in device 8:

```
DIR
```

If there are too many files than fit on a single screen, the list will scroll off and you will only see the bottom of the list. You can use the `W` argument to tell `DIR` to show the listing in multiple columns, and to wait for a keypress to show more pages. (Try this with the `MEGA65.D81` disk.)

```
DIR W
```

Hint: For more on the `DIR` command, see the User's Guide, page 106.

One disadvantage of the `W` flag is that you cannot use the `/` shortcut to load a program into memory. There is another way to view the complete directory listing and still use this shortcut: load the listing into BASIC memory. Commodore 64 users are familiar with `LOAD "$",8` followed by `LIST`. To do this with the MEGA65:

```
DLOAD "$$"
LIST
```

This still scrolls a long listing off the screen, but now you can use MEGA65 BASIC's listing viewer features to scroll up to previous lines. Use the F9 and F11 keys to traverse the listing, then cursor up to a program you want to load and use the `/` or ↑ shortcuts.

Caution: Loading the directory listing with DLOAD overwrites any BASIC program that resides in memory. The DIR command does not overwrite BASIC memory.

10.2 Using the SD card from BASIC

Recent improvements added the ability to manipulate disk images on the SD card without using the Freeze menu. In general, device U12 is considered the SD card. Only some disk commands work with the U12 device.

To list all of the files on the SD card:

```
DIR U12
```

This does not yet support other features of the DIR command, such as filters or paging.

To mount a D81 disk image from the SD card directly from BASIC, use the MOUNT command:

```
MOUNT "DISKNAME.D81"
```

By default, this mounts the disk image to device 8 (U8). To mount to device 9, add an argument:

```
MOUNT "DISKNAME.D81",U9
```

You can load a program file (.PRG) directly from the SD card, without having to create a D81 disk image. To do this, use the DLOAD command with unit U12, and be sure to include the .PRG filename extension:

```
DLOAD "FILENAME.PRG",U12
```

(Loading a PRG file directly from the SD card does not work with the LOAD command.)

10.3 Using 3-1/2" floppy disks

Your MEGA65 includes a built-in 3-1/2" floppy disk drive for a complete retro experience.

If you don't have 3-1/2" floppy disks lying around, you can still buy them new-old-stock at a reasonable price. I buy mine from FloppyDisk.com. You can also find refurbished floppy disks on eBay.

The MEGA65 floppy drive supports both double density (DD) and high density (HD) disks. *However,* as of this writing, the ability to use the larger capacity of HD disks is still in development. To use an HD disk with the MEGA65, you must apply non-transparent tape over the hole in the upper left (as shown). This convinces the floppy drive to treat the HD disk as if it were DD.


Verbatim
SHIFT

Tip: Until this is fixed in a future software update, an HD disk with the hole exposed will not work with the MEGA65. If your disk isn't working, double-check that the hole is covered.

Using the physical floppy drive is similar to using a disk image. Open the Freeze menu (hold Restore, then release), then select drive number `0`. (The internal drive can only be mounted to drive 0.) In the list of options that includes the D81 disk images, select `- INTERNAL 3.5" -`. Exit the Freeze menu (resume or reset).

Alternatively, you can mount the internal physical drive on device `0` with the `MOUNT` command, no arguments:

```
MOUNT
```

Insert a floppy disk in the drive. If you have not used this disk with the MEGA65 before, it needs to be formatted. This erases all data on the disk! Use the `HEADER` command, providing a disk name in quotes, and a two digit disk ID number preceded by the letter `I`:

```
HEADER "WORK FILES",I01
```

Enter `YES` at the prompt to confirm. Formatting a disk for the first time takes a minute or so.

Hint: See the `HEADER` command in the User's Guide, page 135.

You can now use the floppy disk like you would a D81 disk image. Some things to try:

```
DIR

10 PRINT "HARD AT WORK"
20 GOTO 10
SAVE "HARDLYWORKING"

NEW
DIR
LOAD "HARDLYWORKING"
LIST
RUN
```

10.4 Booting from a disk

A disk (or disk image) that contains a program named `AUTOBOOT.C65` is considered bootable. With such a disk mounted on unit `0`, the MEGA65 will load and run this program automatically when it boots or resets. As we saw in *Demonstration menu*, this is how the demo disk starts automatically when you turn on your MEGA65.

Running the `BOOT` command with such a disk mounted also runs this program:

```
MOUNT "MYGAME.D81"
BOOT
```

By default, the `MEGA65.D81` disk image is mounted on unit `0` when the MEGA65 is turned on for the first time. You can change which disk image is mounted in the MEGA65 Configuration menu. You cannot set this to be the physical drive by default; it has to be a D81 disk image on the SD card. If there is no setting in Configuration, it uses `MEGA65.D81`; to start with nothing mounted, remove or rename the `MEGA65.D81` file on the SD card.

10.5 Using an external disk drive

Your MEGA65 has a 6-pin IEC serial port for connecting vintage Commodore disk drives. With a drive connected, you can use the Freeze menu to assign it to drive 1.

Commodore disk drives use a serial protocol that allows multiple devices to be connected in a chain. Each device must have a unique device ID. For disks, the available device IDs are 8, 9, 10, or 11. These old devices do not have a way to figure out their device IDs automatically. Instead, you use switches on the device itself to tell the drive its device ID. Each device ID must be assigned to a unique drive.

The MEGA65 can assign either device ID 8 or 10 to the drive connected as drive 0 (a disk image or the internal floppy drive), and can assign either device ID 9 or 11 to the drive connected as drive 1 (another disk image or the external serial port). You can toggle the device IDs for drive 0 or 1 in the Freeze menu by pressing 8 or 9, respectively. Make sure your external drive is configured to use the device ID you have assigned to drive 1 in the MEGA65 Freeze menu (either 9 or 11).

Any device that supports the disk serial protocol is expected to work, including new disk devices such as the Pi1541. Notice that some such devices like the SD2IEC need the C64 tape port to supply power to the device, and the MEGA65 has no such port.

10.6 Converting a D64 to a D81

You can find almost every game and application written for the Commodore 64 online in the form of disk images. However, these disk images are typically in the D64 format, which represents a 5-1/4" floppy disk. If you want to try running a C64 application on your Mega65 in its C64 mode, you must first convert the D64 image to a D81 image. (The D81 image represents a 3-1/2" floppy disk.)

One way to do this is with the `cbmconvert` command line tool. This requires your PC (Windows, Mac, or Linux) and familiarity with the command line (Terminal).

`cbmconvert` is only available as source code, so you will need the ability to compile software on your PC. Linux users typically already have compilation tools installed. Mac users can install such tools with the command:

```
xcode-select --install
```

`cbmconvert` version 2.1.5 requires `cmake` to build. On a Mac, you can install this with the Homebrew package manager:

```
brew install cmake
```

To build the `cbmconvert` tool:

1. Download cbmconvert's source code. (See this Github repo for versions 2.1.5 and later, or the download site for links to other versions.)
2. Expand the archive: `unzip cbmconvert-main.zip`
3. Change to the expanded directory: `cd cbmconvert-main`
4. Build the tool: `cmake .; cmake --build .`

The `cbmconvert` tool is now present in the directory. You can put this directory on your command path, copy the `cbmconvert` file to somewhere on your path, or use the path to this directory when running the tool.

To use `cbmconvert` to convert a D64 file to a D81 file:

```
cbmconvert -v2 -d filename.d64 -D8 filename.d81
```

Copy the new D81 file to your microSD card, then return the card to your MEGA65. Open the Freeze menu, then select the D81 image for drive 8. At the MEGA65 BASIC prompt, enter `GO 64` and type `YES` to confirm. The disk is now available on drive 8 from C64 mode.

Note: Not all D64 disks can be converted to D81, especially software with copy protection.

Note: C64 mode is known to not be compatible with all C64 software. If you are experiencing difficulty, try using the Freeze menu to switch from NTSC to PAL video mode or vice-versa (assuming you have a monitor that can show it).

Tip: Remember that the C64 core (not C64 mode) supports D64 disk images directly without needing to convert them to D81 images. See *The C64 core*.

CHAPTER

ELEVEN

USING THE JTAG CONNECTOR

The MEGA65 main board has a 12-pin JTAG connector, a standard for connecting test equipment to devices. It is not intended for regular users of a device—but we MEGA65 owners are not regular users, are we?

With a JTAG USB adapter and software available on Filehost, you can connect your PC directly to the main board to:

- Upload and execute programs being cross-developed on a PC
- Transfer files between your PC and MEGA65 without removing the SD card
- Perform remote debugging on programs and the built-in MEGA65 utilities
- Upload ROMs and cores for testing
- Use your MEGA65 as a SID music player (!)

The MEGA65 does not have a user-accessible port for the JTAG connection. You will have to acquire a JTAG USB adapter and a mini-USB cable, install it, and run the cable out the back of the MEGA65 case.

Tip: You can also use a more common USB UART adapter for most of the purposes described below (sending files and commands). The adapter *must* output 3.3 volts, *not* 5 volts. Test your adapter with a volt meter before using. See Use of an USB UART adapter as alternative to a JTAG adapter for instructions on how to wire a UART to the JTAG connector pins. See also this article by RetroCombs.

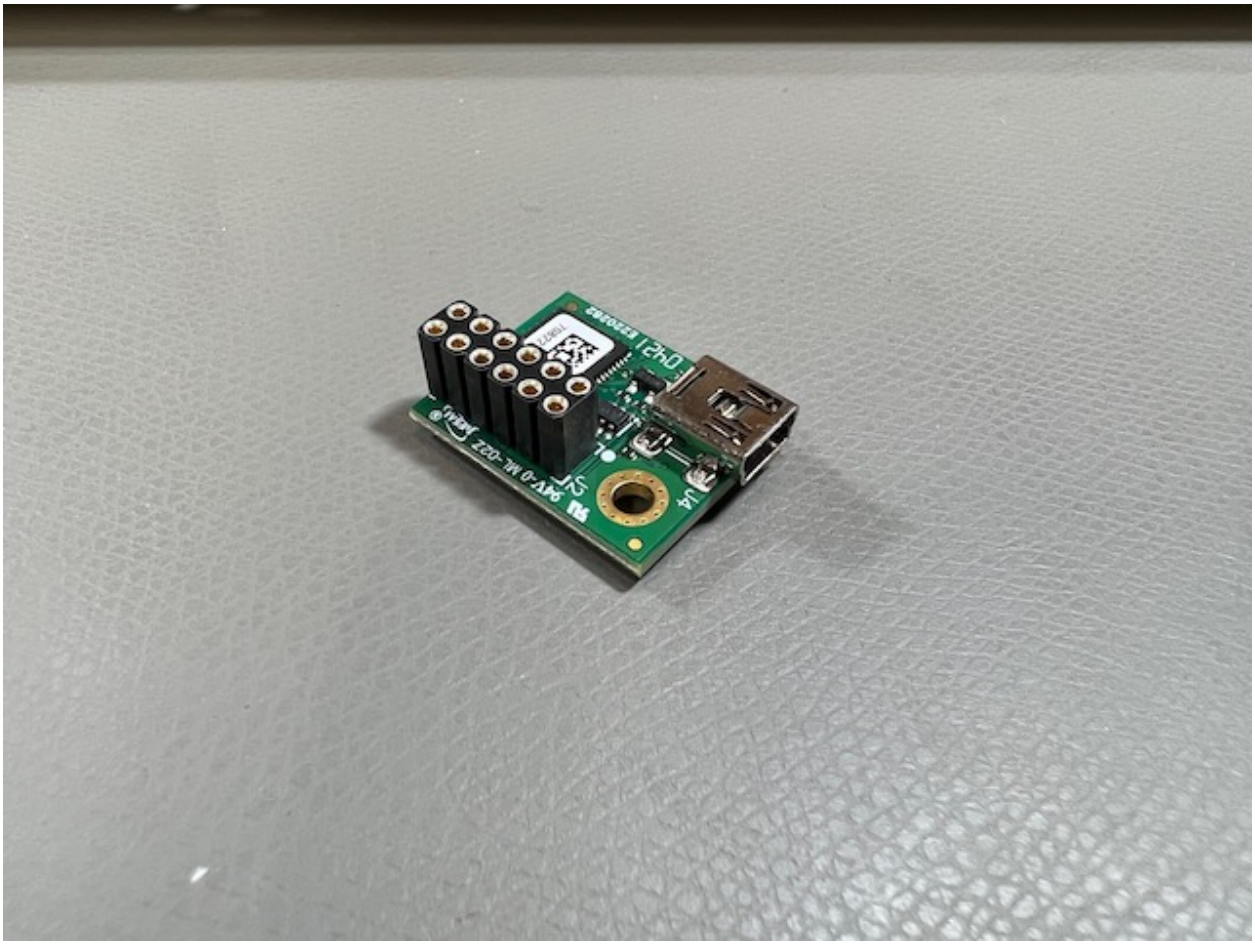
Photos below show how to connect the TE0790-03 JTAG adapter.

Tip: For another version of these instructions with more photos, see JTAG adapter, how to plug and DIP switch settings.

11.1 Acquiring a JTAG adapter

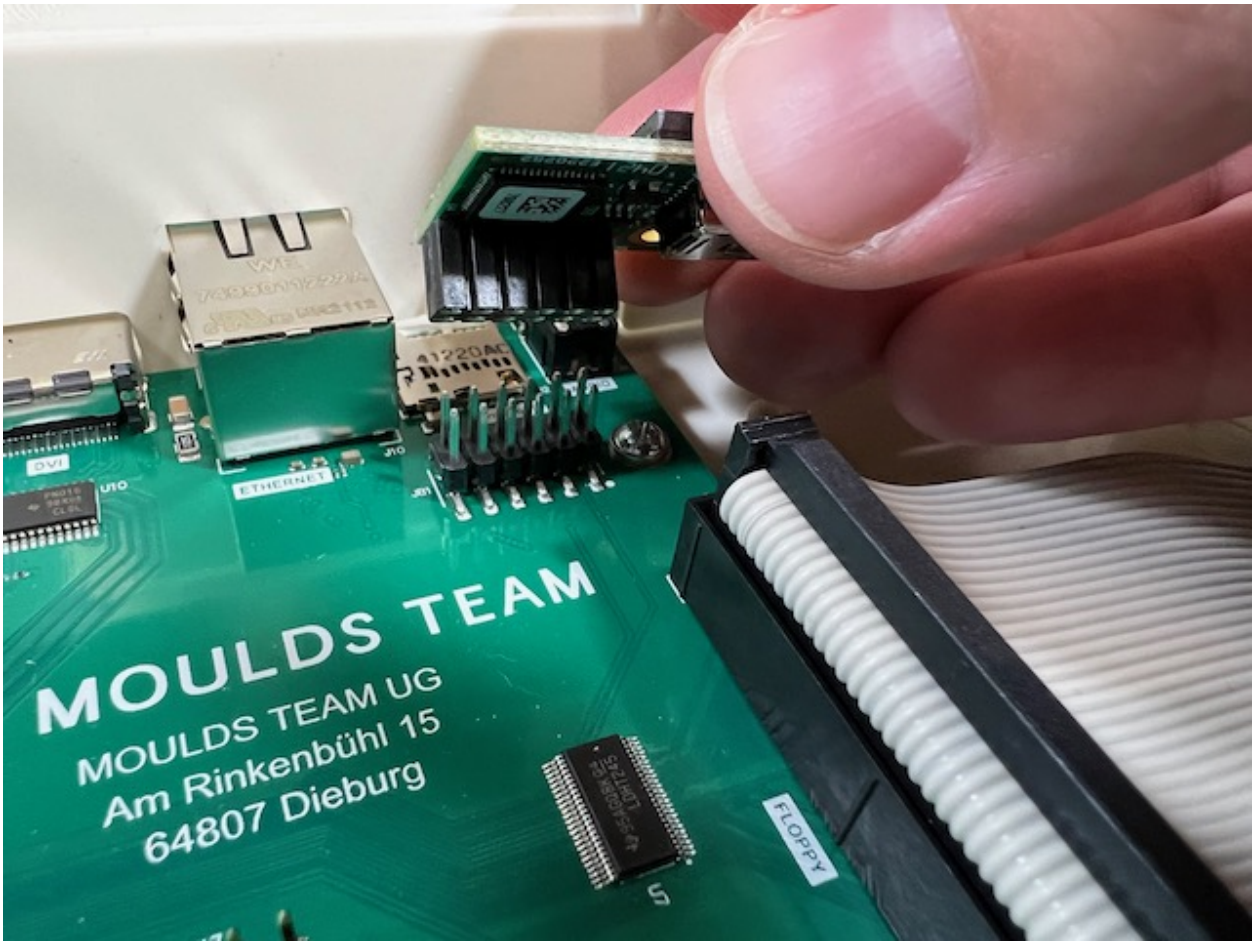
The XMOD FTDI JTAG Adapter TE0790-03L (Trenz Electronic) is compatible with the MEGA65. (The TE0790-03 is the same part with a Xilinx license, which you do not need to use MEGA65 tools.) You might also be able to order the TE0790-03 from DigiKey. As of this writing, this item is difficult to get due to supply chain issues. Trenz is accepting backorders (even though "in stock" says zero) and will be fulfilling them as parts become available.


trenz
electronic
XMOD FTDI JTAG Adapter
Package Content
1 x TE0790
Important Information
http://trenz.org/te0790-info
Attention

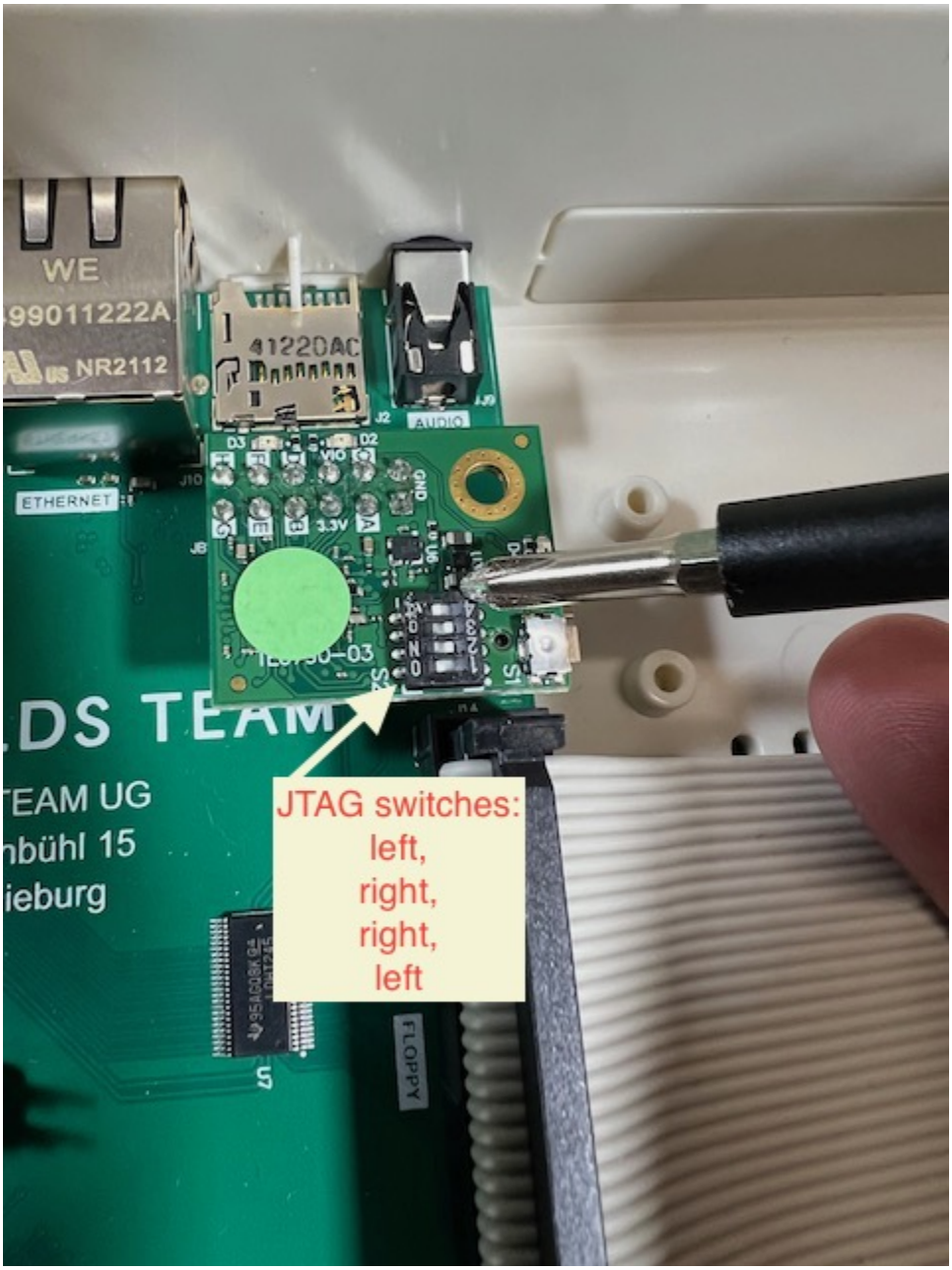


11.2 Installing the JTAG adapter

You will have to open the MEGA65 case to connect the adapter to the 12-pin JTAG connector on the main board, in the back right corner. (See *Opening the MEGA65 case* for an annotated photo of the main board.) The adapter connects with the mini-USB connector facing to the right.



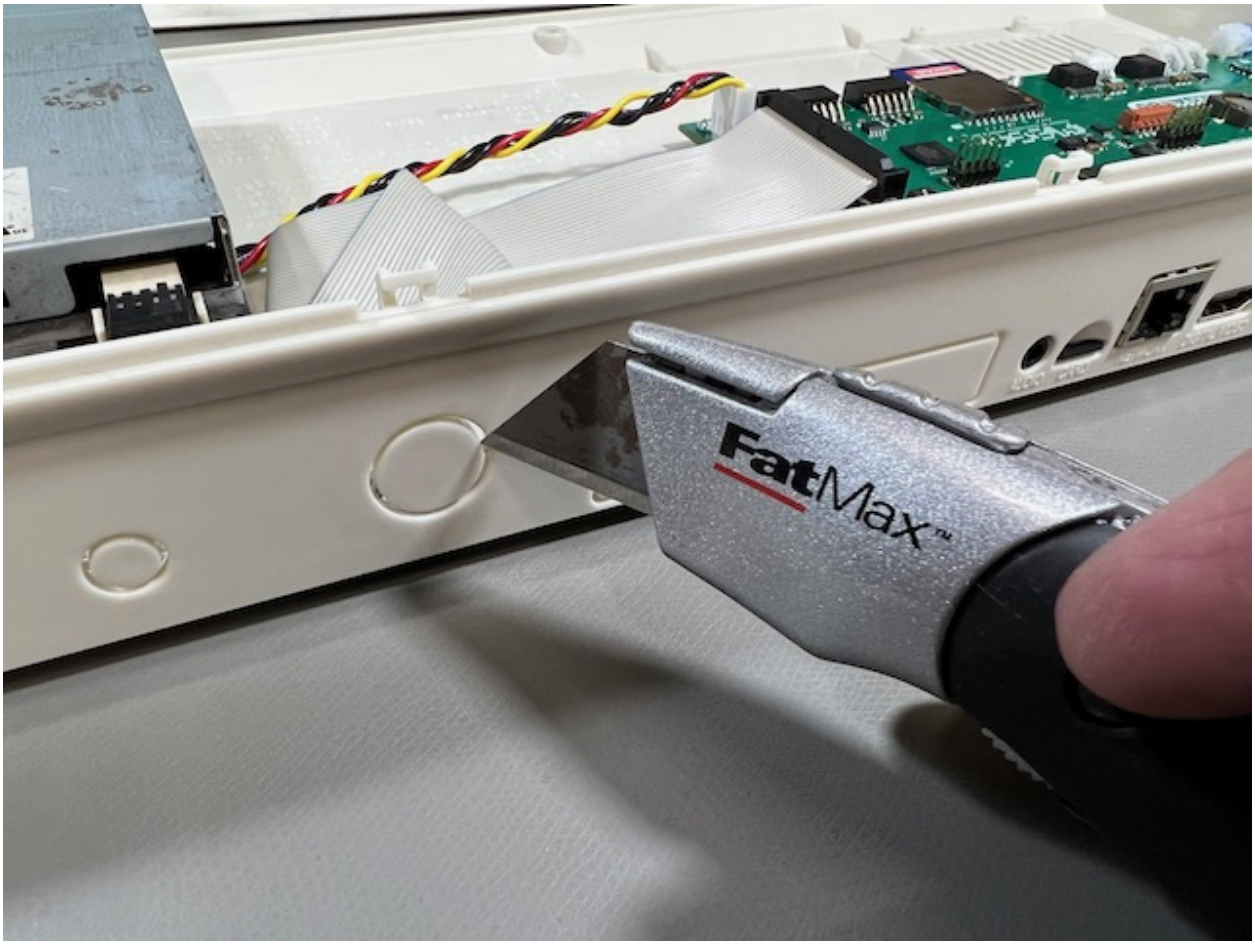
Use a pin or a small screwdriver to set the DIP switches on the connector to left, right, right, left, as shown. This configures the adapter to draw power from the USB connection. (Other documentation suggests left, right, left, right, which draws power from the MEGA65. The USB setting worked fine for me.)

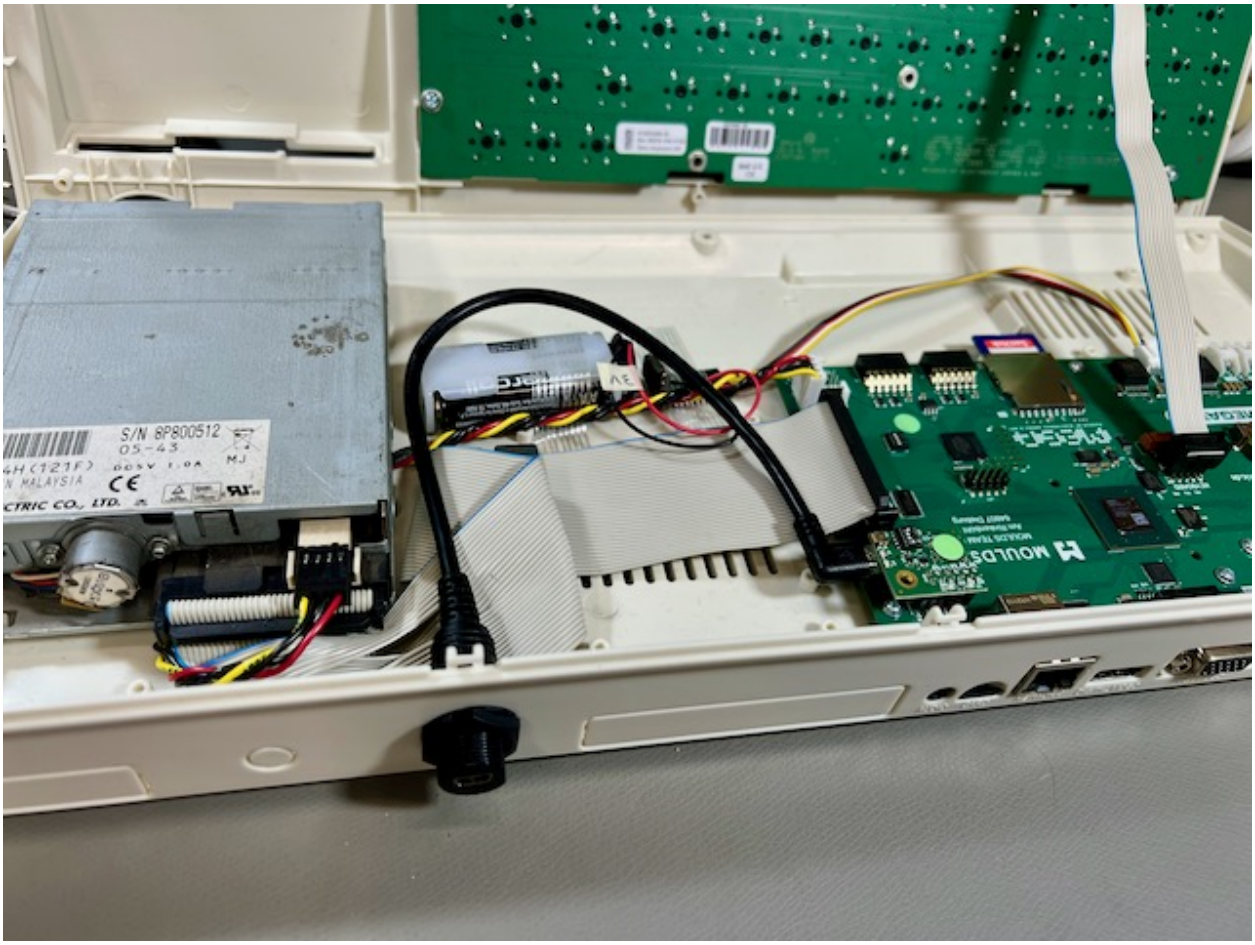


Connect a mini-USB cable to the JTAG connector, and run the cable out the back of the MEGA65 case. You can feed it out the cartridge port (potentially blocking access to the port), or punch out one of the unused port covers in the back case. Connect the other end to your PC.

I used a Mini USB panel mount cable (30 cm/12 in, right-angled) to extend the mini-USB jack to the back of the case, then punched out one of the unused holes for it with a utility knife. The mount cable includes a washer and nut to hold firmly to the 17 mm hole. I then connect it to my PC with a standard USB Mini B Male to USB A Male cable.


Duttek
yitian3532@163.com
Made in China
X002REEXID


FatMax™


S/N 8P800512
05-43
MALAYSIA

Tip: This Ribu mini USB panel socket has a nice metal mount and is more flush with the case than the plastic mount I used. It needs an additional washer to avoid falling into the case.

11.3 Using M65Connect

The M65Connect app is a useful multitool that takes advantage of the JTAG connection.

11.3.1 Setting up

Download the M65Connect app for Windows, Mac, or Linux, available from the Filehost.

If you're on a Mac, you will need to install a library called `libusb`. Install the Homebrew package manager if you don't already have it installed, then run this command:

```
brew install libusb-compat
```

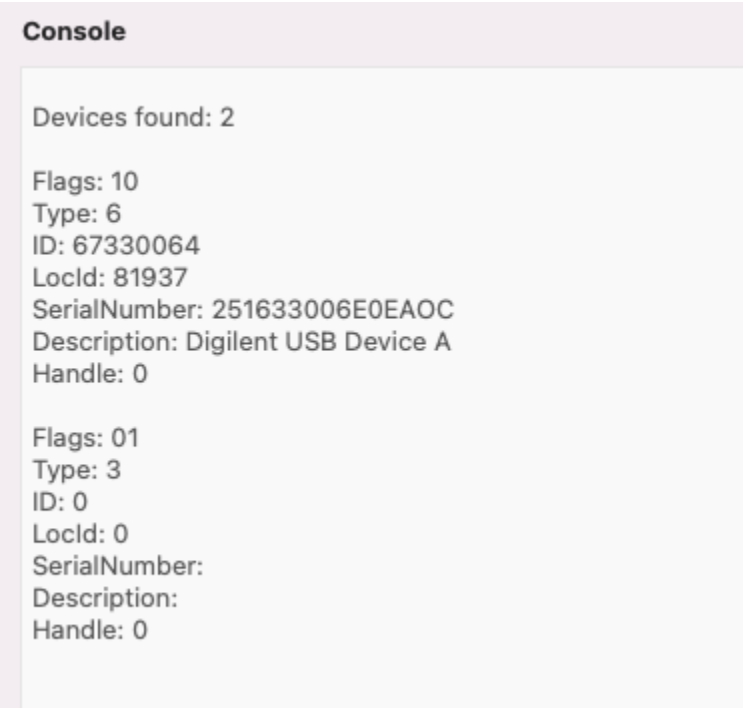
If you're using Linux, open the Help menu and select Manual to view the M65Connect user manual, then follow the instructions in the Requirements section.

To set up M65Connect for the first time:

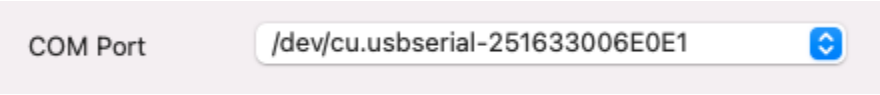
1. Turn off your MEGA65.
2. Connect the MEGA65 to your PC via the JTAG connection and USB cable that you installed.
3. Start M65Connect. It begins by attempting to identify the serial port.
4. Follow the prompts. When prompted, turn your MEGA65 on. If everything is working, the Connection Wizard will detect the connection and close the window. If the window doesn't close in a few seconds, click Abort and proceed with setting up the connection settings manually.

The M65Connect manual has advice on troubleshooting connection issues: go to the Help menu, select Manual. I won't repeat all of it here, but advice that I personally found useful when doing this on my Mac (M65Connect 1.8, Intel MacBook Pro, macOS 12.3.1):

- The Command menu, List FTDI Devices is a good start for making sure the JTAG is connected. Even with the MEGA65 turned off, it should list two devices when connected, one with flags "10" and one with flags "01". My JTAG device description is "Digilent USB Device A".



- The Settings menu, Connection lets you pick a serial port manually. On my Mac, I have four `/dev/cu.usbserial...` devices, some of which have numbers similar to (though not identical to) the device Serial-Number printed by List FTDI Devices.



- If it looks like it should be connected, use the buttons at the top of the M65Connect window to attempt remote actions. For example, `Screenshot` will ask the MEGA65 to take a screenshot and M65Connect will display it. If it fails, it should print error messages in the main M65Connect window.

Tip: In my case, I discovered that the connection would not work if the USB cable was connected to my USB hub. Connecting directly to the USB port on my laptop resolved the issue.

11.3.2 Sending data to MEGA65

The M65Connect app can send data directly to the MEGA65's memory. In most cases the data is loaded directly into memory, then used for its intended purpose. The data goes away when you turn off the MEGA65. This is useful for testing, but not useful for permanent installation.

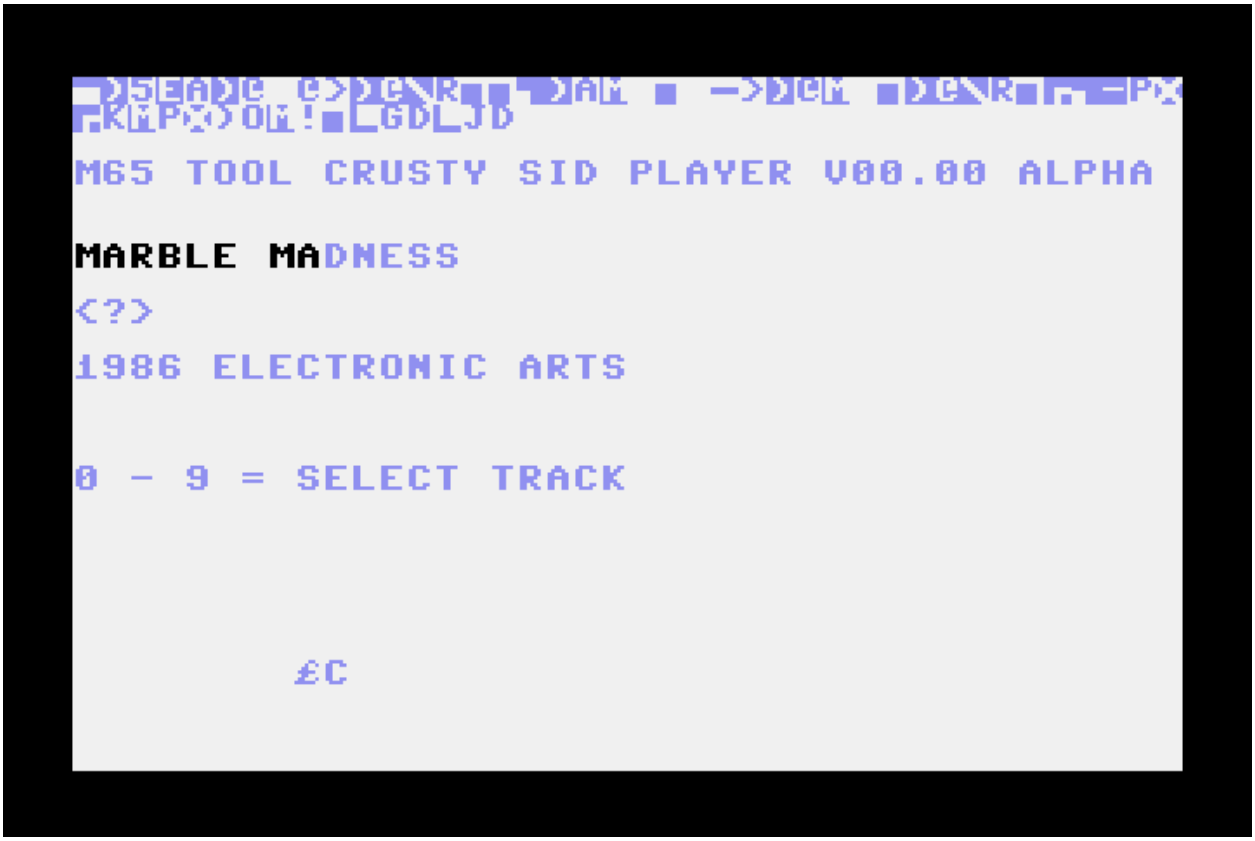
PRG:

- Sends a `.PRG` program file and runs it immediately.
- M65Connect prompts you with options: whether to run in C64 mode, how it would be loaded from disk, and others.

SID:

- Sends a `.SID` music file and plays it using a built-in SID player.
- Press number keys to select tracks in multi-track SIDs.

- It's ugly, but it works!



`BIT`:

- Sends a `.BIT` bitstream file, and resets using this file as the core.
- Note that this takes the `.BIT` file, not the `.COR` file. Most cores provide files in both formats.
- This does not install the core in a slot, it just runs the core for the current session.

`HIC`:

- Sends a "Hickup" file, which temporarily updates the Hypervisor.
- Only useful for developers working on the system software.

`ROM`:

- Sends a MEGA65 ROM and resets with it in memory.

`BAS`:

- Sends a text file as if it is being typed into the MEGA65, such as a BASIC program listing.
- This capability is limited to a subset of the PETSCII character set. It conflates ASCII letter casing and does not support special characters.

Tip: If you're developing a BASIC program on your PC to send to the MEGA65 over the JTAG connection for testing, you might prefer converting it to a PRG and sending the PRG instead of trying to send the BASIC program listing. See "The m65 command line tool" below for an example workflow.

Caution: Many of these upload actions reset the MEGA65 in the process, and will not warn you. Make sure you don't have any unsaved data.

11.3.3 Transferring files to and from the SD card

You can upload files directly to the SD card. Click `SD CARD` to open the file transfer utility on both your PC and the MEGA65.

11.3.4 Other cool things M65Connect can do

M65Connect can also do these cool things:

- Reset the MEGA65 (`RESET`).
- Reset in C64 mode (`Go64`).
- Switch between NTSC and PAL video modes (`NTSC`, `PAL`). This does not reset the machine.
- Take a screenshot of what is on the MEGA65 display (`Screenshot`).
- Type into the MEGA65 from your PC keyboard. Click "Keyboard," then type normally, and access the non-standard keys by clicking on the virtual keyboard that appears.
- Remote machine language monitoring and debugging. See the built-in manual (Help menu, Manual), Terminal tab.

Tip: For more information, see the M65Connect README.

11.4 The m65 command line tool

The `m65` command line tool can do many of the things M65Connect can do, and more. It's a much more technical tool, used by the MEGA65 team and Trenz Electronic to test, troubleshoot, and verify MEGA65 units before shipment. It could also be useful for software developers that want to automate cross-development tasks.

You can download pre-made binaries of the `m65` command line tool from the mega65-tools Github repository. You can also download source code, with build instructions for your platform.

11.4.1 macOS: prepare the tool for use

Getting the downloadable binary to work on a Mac requires a few steps:

1. Download `m65.osx`.
2. Give the file execute permissions: `chmod 755 m65.osx`
3. Rename the file to remove the `.osx` extension: `mv m65.osx m65`
4. Locate the file in Finder. (`open .` will open the current working directory as a folder.)
5. Right-click on `m65`, then select Open. macOS will warn that the binary is not signed. Click the Open button. This will attempt to run the command in a Terminal window, fail, then exit. (This is fine.)

You can now run the `m65` command at a command prompt or in a script. (You can also rename it back to `m65.osx` if you like.)

11.4.2 Determining the serial port

You need to tell `m65` which device to use as the serial port that connects to the MEGA65. Unlike M65Connect, the tool has no built-in way to scan for working ports.

The easiest way to do this is to run M65Connect and get it working, then open the Settings menu, Connection, and note the configured value. (On a Mac, this is something like `/dev/cu.usbserial...`)

Be sure to close M65Connect afterward, so it frees the serial port for use by `m65`.

11.4.3 Running m65

The `m65` command accepts a wide variety of options for each of its functions. Run `m65` without arguments to see a list.

To specify the serial port, use the `-l` option: `-l /dev/cu.usbserial...`

The remaining arguments tell `m65` what to do. For example, to get it to type `?TI$` followed by Return (this prints the current Real-Time Clock value in BASIC):

```
./m65 -l /dev/cu.usbserial... -T "?ti$"
```

For uploading programs, `m65` just takes the filename, and figures out what to do based on the filename extension. To load a `PRG` file into memory:

```
./m65 -l /dev/cu.usbserial... myprogram.prg
```

Tip: The `petcat` command line tool included with the VICE emulator can convert a BASIC program listing in a text file to a PRG that the MEGA65 can run. It supports PETSCII special characters as bracketed labels, such as `{clr}`, and it knows all about MEGA65 BASIC.

For example, say you have a BASIC program listing named `myprogram.bas`:

```
10 screen 320, 200, 5
20 for x=0 to 31
30 pen x
40 circle x*10+10, x*10+10, x*5
50 next x
60 sleep 3
70 screen close
80 color 0
90 print "{clr}{wht}have a {cyn}nice{wht} day!"
```

To convert this BASIC program listing to a PRG file with `petcat`, upload it to the MEGA65, then run it (using your actual serial port device name for `/dev/cu.usbserial...`):

```
petcat -w65 -o myprogram.prg -- myprogram.bas
m65 -l /dev/cu.usbserial... mylisting.prg
m65 -l /dev/cu.usbserial... -T "run"
```

11.5 Finding other JTAG tools

If you're interested in the debugging programs remotely, download the M65 Debugger app from Filehost (Windows, Mac, or Linux). See the m65dbg README for more information on how to use the debugger, including video tutorials.

You can use the `mega65_ftp` command line tool to perform the SD Card file transfer functions of the M65Connect app. This is available from the mega65-tools Github repository. Mac users: this will require a similar approval process used to prepare the `m65` command line tool, described above.

CHAPTER

TWELVE

JOINING THE COMMUNITY

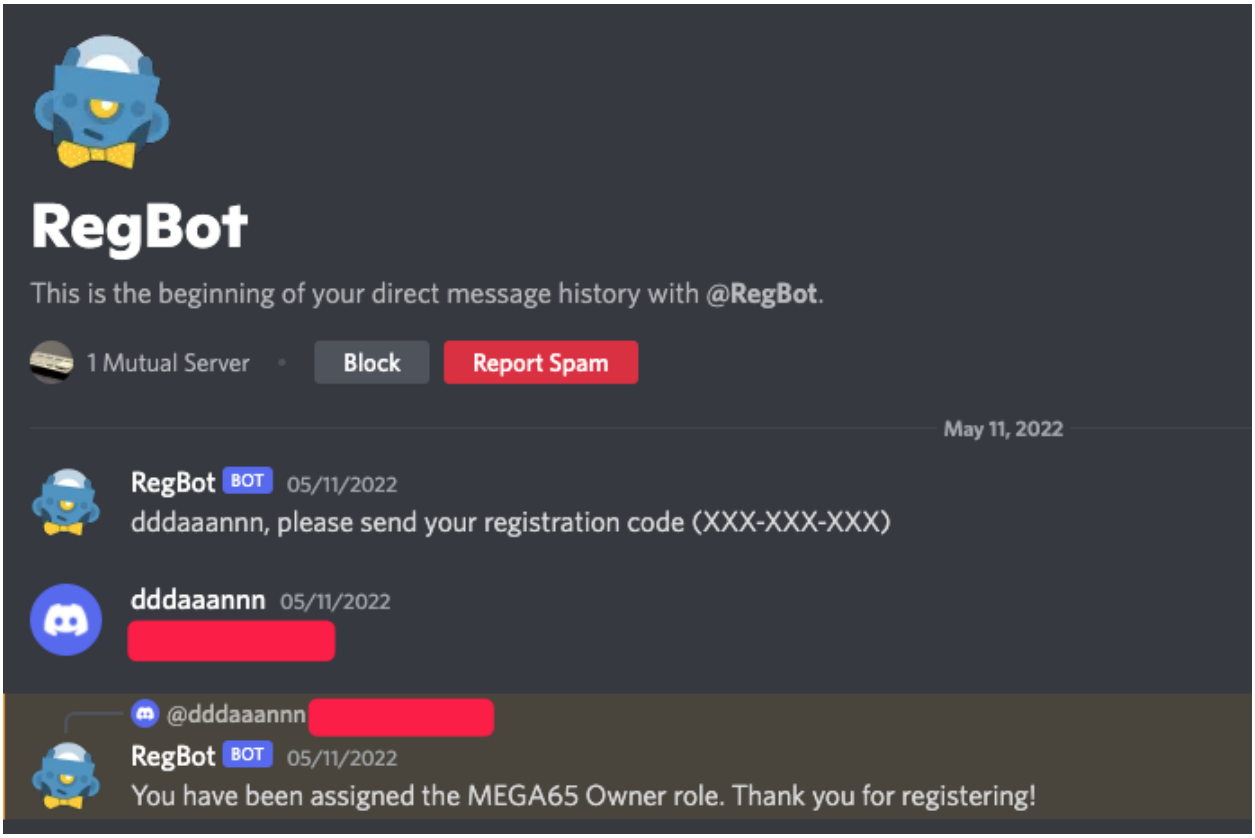
Your fellow MEGA65 owners hang out together online. Come join us!

The official MEGA65 support forum is a traditional web forum for discussions and searchable post history. Note that the account system for the forum is separate from the Filehost, so you will need to register a new account to participate.

For real-time chat, the action is in the official MEGA65 Discord server. Join with your Discord account and app.

Once you are on the Discord server, you can register yourself as a proud MEGA65 owner. This changes your username color to blue, and may potentially have other benefits in the future, such as owner-specific rooms.

To register your ownership role on Discord, go to the `#general` channel and say `!register`. (Yes, they want us to say this publicly in front of everybody. Be proud.) The `@RegBot` automated account ("BOT") will see your request and send you a direct message asking for your registration code. Reply with your nine-character registration code from that piece of paper. RegBot will assign you the ownership role and change your username color.



Caution: Be careful to only reply to RegBot. Don't post your registration code in a public channel, and don't reply to anyone pretending to be RegBot. Look for the "BOT" icon next to RegBot's name.

CHAPTER

THIRTEEN

VIDEO DISPLAY COMPATIBILITY

The MEGA65 has two video outputs: one HDMI and one VGA. They mostly work as you would expect, though it may take some fiddling to display the MEGA65 image in a proper aspect ratio. Some vintage displays have caveats.

13.1 HDMI (DVI)

If you connect the HDMI output to a modern HDMI-capable monitor, you will have a good time. The MEGA65 assumes a narrow 4:3 aspect ratio, but you can usually adjust the aspect ratio on widescreen displays. Most HDMI displays can handle the "Enhanced (with audio)" signal, even if the display doesn't have built-in speakers.

Not all HDMI displays can handle both the 60 Hz NTSC refresh rate and the 50 Hz PAL refresh rate. If you are able to test before buying (or can buy one, try it, and return it if it doesn't work), be sure to test both PAL and NTSC modes, especially if you want to run vintage C64 software or the C64 core.

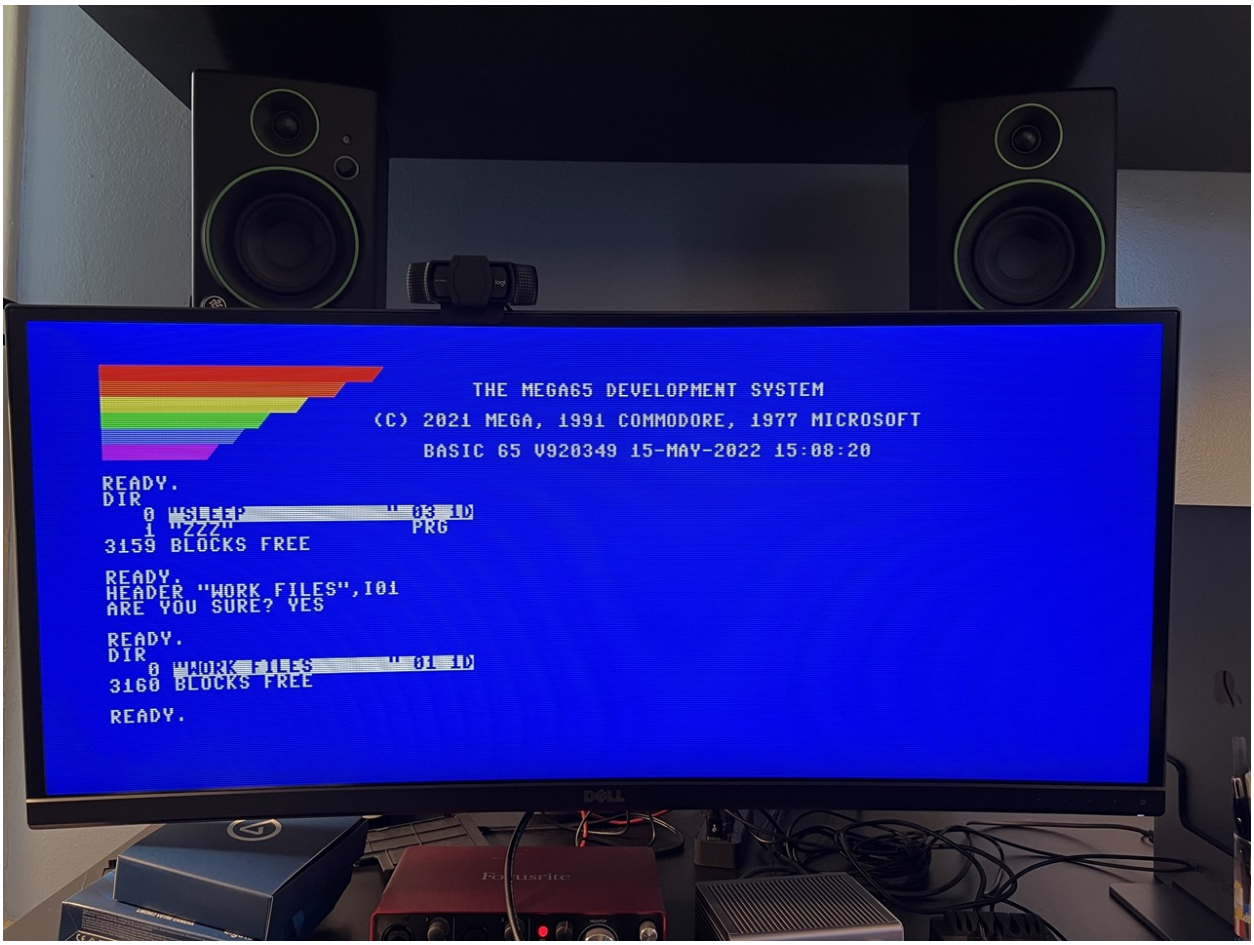
These photos show the MEGA65 connected to a Dell UltraSharp 27 widescreen monitor configured to use a 4:3 aspect ratio in the display settings. (Use the buttons on the bottom of the monitor to navigate to the display settings menu.)


THE MEGA65 DEVELOPMENT SYSTEM
(C) 2021 MEGA, 1991 COMMODORE, 1977 MICROSOFT
BASIC 65 V920349 15-MAY-2022 21:33:11
READY.

Without setting the aspect ratio, most widescreen monitors will stretch the image horizontally to fit. This is undesirable in most cases, but I actually quite like how 80-column BASIC looks when stretched.


THE MEGA65 DEVELOPMENT SYSTEM
(C) 2021 MEGA, 1991 COMMODORE, 1977 MICROSOFT
BASIC 65 V920349 15-MAY-2022 21:32:10
READY.

Just for fun, here is what 80-column BASIC looks like stretched on a Dell 34" curved ultra-wide display:



If your HDMI display supports audio, enable "Enhanced (with audio)" mode in the MEGA65 configuration. Otherwise set it to "DVI only (no audio)."

Note: As of this writing, the Hypervisor utility menu, Configuration, SD card utility, and core selection screens use "Enhanced (with audio)" mode by default. This fails on older DVI displays that don't know how to handle this signal. You may need to use a modern HDMI display or a VGA display to access these screens. See core issue 552.

Tip: Be sure to try "CRT emulation" mode in the MEGA65 configuration with a flat panel display to see if you like it.

13.2 VGA

If you connect the VGA output to a vintage VGA CRT monitor, you will have a good time. The VGA signal and the expected aspect ratio go well together. The MEGA65 outputs a VGA image with a 31 kHz horizontal scan rate.

Tip: Be sure to *disable* CRT emulation in the MEGA65 configuration when using an actual CRT.

13.3 4:3 flat panel displays

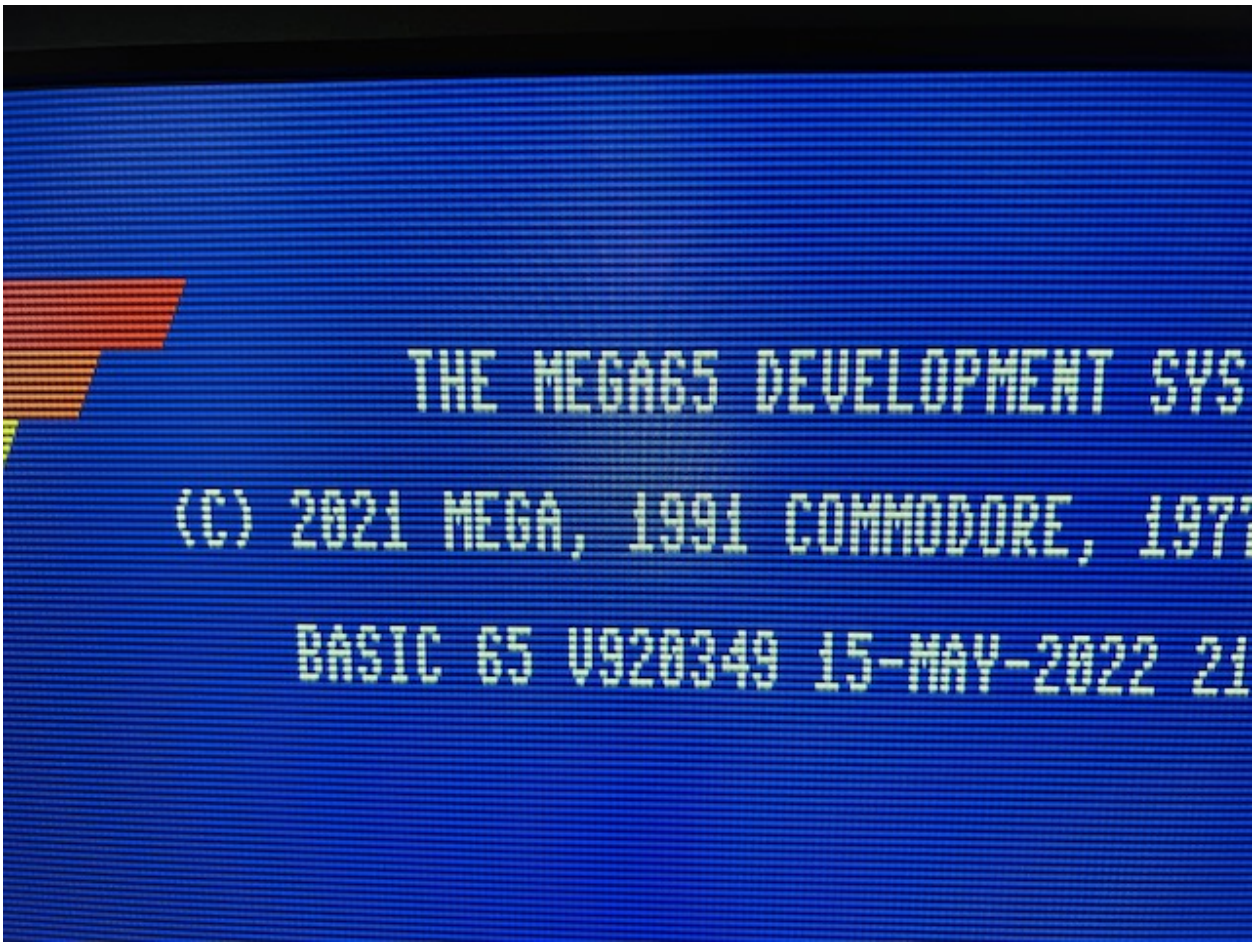
If you're looking for the 4:3 aspect ratio of a vintage monitor that won't distort the MEGA65 image but also want the convenience of a flat panel screen, there are options, with caveats that depend on the model of monitor you find. Flat panel displays of the early 2000's ushered out bulky CRTs before widescreen aspect ratios came into fashion. Many have both VGA and DVI (HDMI-compatible) inputs.

I can't list every caveat for every monitor, but I can describe my experiences with the Dell 2001FP, a popular choice among vintage computer collectors. The 2001FP is a 20" flat panel display with S-Video, VGA, and DVI inputs. I use an HDMI-to-DVI cable to connect the MEGA65's HDMI output to the DVI input, with the MEGA65 video configuration set to "DVI only (no audio)." I also use a VGA cable to connect the MEGA65's VGA output to the VGA input.

Why use both HDMI and VGA connections with the same display? In the case of the 2001FP, I need both to work

around caveats with each mode:

- HDMI provides the highest quality display for regular use. With the factory-installed core, some of the utility menus (configuration, core selection) use the "Enhanced (with audio)" HDMI mode, which fails to display through the 2001FP DVI input. These menus work fine over VGA. This is not a problem for all HDMI monitors: it only affects DVI displays that do not support sound over HDMI. (Utility menus were fixed in later cores, but the factory core still gets used in some cases.)
- To display VGA, the 2001FP must adapt to the signal timing to present it on the flat panel display. This results in periodic drops of pixel columns. It's fine for the configuration menus, but it's a poor experience for regular use.



With both video outputs connected, I can switch the monitor input as needed without too much hassle.

The HDMI-to-DVI cable does not carry the HDMI audio signal, and the Dell 2001FP doesn't have built-in speakers anyway. I use a Dell soundbar and a separate speaker connection to the MEGA65 audio jack.

Tip: Is your HDMI output not working with a vintage DVI display? Double-check that you have "DVI only (no audio)" selected in the MEGA65 video configuration. (Use a modern HDMI display or a VGA connection to see the configuration screen.) "Enhanced (with audio)" mode will corrupt the DVI-only signal.

Tip: If you want a flexible vintage display that works well with vintage computers that use analog RGB signals such as the Amiga, check out 15khz.wikidot.com for recommendations. The Dell 2001FP almost makes the cut: older versions support a 15 kHz signal, newer ones (like mine, alas) do not. I use the 2001FP with my Commodore 64C and an S-Video cable with great success. 15 kHz support is not required for the MEGA65, it's just nice to have for some old machines.

13.4 Video capture cards

One advantage to having two simultaneous video outputs is you can send one to a monitor and another to a device such as a video capture card. I used VGA to the Dell and HDMI to an Elgato Camlink to take the screenshots in this Guide. (You can also take screenshots with the M65Connect app and the JTAG connection. See *Using the JTAG connector*.)

I was not able to capture screenshots of the C64 core with the Camlink. The C64 core only knows how to simulate a PAL machine, and the Camlink apparently doesn't like whatever video signal it produces.

13.5 Resolution and aspect ratio

The MEGA65 core produces an image in a resolution and refresh rate that corresponds with the emulated vintage display format: PAL or NTSC.

In PAL mode, MEGA65 produces an image with a resolution of 720 x 576, and a refresh rate of 50 Hz.

In NTSC mode, MEGA65 produces an image with a resolution of 720 x 480, and a refresh rate of 60 Hz.

The MEGA65 image is intended to be rendered in an aspect ratio of 4:3. If you do the math, you may notice that the output resolutions are not 4-to-3: 720:576 = 5:4, and 720:480 = 3:2. In the intended display, the pixels are not meant to be square. The monitor will reshape the pixels to the intended aspect ratio.

This behavior is produced by the MEGA65 core. Other cores may generate images at other resolutions and refresh rates, and may have their own compatibility issues with some displays.

13.6 A List of Monitors

We're maintaining a list of tested monitors in the MEGA65 Wiki. Feel free to contribute your results!

CHAPTER

FOURTEEN

RECENTLY ADDED FEATURES

The MEGA65 batch #1 shipped from the factory with ROM version 920287 (release 0.9) and a User's Guide printed in late 2021. Batch #2 will ship in late 2022 with ROM version 920377 (release 0.95). MEGA65s will continue to ship with the first printing of the User's Guide until stock is exhausted. Meanwhile, the ROM is considered a work in progress, and the MEGA65 team and contributors continue to enhance it with bug fixes and other improvements.

Below is an *incomplete* list of new features that have been added since the ROM 920287. I can't possibly keep this list up to date, but I wanted to describe a few so you know what you're getting with the updates. I'm leaving out the many bug fixes, which are valuable in their own right.

MEGA65 documentation writers are keeping the downloadable PDF version of the User's Guide up to date with new features. Be sure to download this along with ROM updates.

14.1 New features

Some of the new features that have been added since the factory-installed ROM was delivered in batch #1 include:

- Holding RUN/STOP during boot immediately enters the machine language `MONITOR`.
- Filename pattern matching supports `#` to match a single number character, and `$` to match a single letter character: `DIR "ME$$*"`
- To toggle between 40-column mode and 80-column mode, press ESC then press X. To go directly to 40-column mode, use ESC then 4. To go directly to 80-column mode, use ESC then 8.
- BASIC supports arithmetic shift operators: << and >>. `PRINT 7<<3`
- Single-letter BASIC variables are "fast" variables stored in fixed memory addresses `$FD00-$FEFF`.
- The `PLAY` and `SOUND` commands have improved background playback and use of SID voices, so BASIC games can sensibly have both background music and sound effects.
- Some disk commands can access files on the SD card directly (and not via a mounted D81 disk image) using the virtual device `U12`. `DIR U12` lists the files on the SD card. `DLOAD "FILE.PRG",U12` loads a `PRG` file.
- BASIC programs can access screen and color memory via special byte arrays `T@&(COLUMN, ROW)` and `C@&(COLUMN, ROW)`. Screen coordinates are intuitive in both 40-column and 80-column modes.
- If you accidentally hit the HOME key, you can press ESC then HOME to return the cursor to its original position.
- You can load a program from disk by using `DIR` to view the directory listing, moving the cursor to the program name, pressing `/` (forward slash), then pressing Return. You can load and run a program in a single step using the ↑ (up-arrow) character (next to the Restore key) in the same way.

14.2 New BASIC commands

Many new BASIC commands have been added to the factory-installed ROM, or have been added to the User's Guide since it was printed. See the latest User's Guide for specifics. New commands include:

14.2.1 Disk commands

`MOUNT` controls the mounting of disk images and drives to the unit numbers from BASIC, without having to enter the Freezer.

- To mount a D81 disk image from the SD card to unit 8: `MOUNT "FILENAME.D81"`
- To mount the built-in physical 3-1/2" disk drive: `MOUNT`

`FORMAT` formats (erases) a mounted disk. This is an alias for `HEADER`.

- To prepare a new disk in unit 8 for use: `FORMAT "DISKNAME",I01`
- To quick-erase a previously prepared disk in unit 8: `FORMAT "DISKNAME"`

`CHDIR` and `MKDIR` support sub-directories on D81 disks and the SD card.

- To change to a sub-directory of the current directory on unit 8: `CHDIR "SUBDIR"`
- To return to the root directory on unit 8: `CHDIR "/"`
- To make a sub-directory on unit 8: `MKDIR "SUBDIR"`
- To change to a sub-directory on the SD card: `CHDIR "SUBDIR",U12`
- To change to the parent directory of the current directory (SD card only): `CHDIR "..",U12`

`LOCK` and `UNLOCK` set the status of a file on disk so that it cannot be deleted when locked.

- To lock a file on unit 8: `LOCK "FILENAME"`
- To unlock a file on unit 8: `UNLOCK "FILENAME"`

`IMPORT` takes a SEQ file of PETSCII text as if typed into the BASIC editor. Unnumbered lines are ignored: it does not run commands in immediate mode.

- To import a text file as BASIC: `IMPORT "LISTING"`
  - Any BASIC program already in memory will remain in memory, with only the lines in the listing overwriting what is already there. This makes `IMPORT` useful for adding a file of common routines to an existing program.
- To export the current BASIC program as a text file that can be imported: `DOPEN#1,"LISTING",W:CMD 1:LIST:DCLOSE#1`
  - Every command that outputs text between `CMD 1` and `DCLOSE#1` writes to the file. For example, you can add arguments to `LIST` to only export a portion of a program: `LIST 2000-2999`

14.2.2 Graphics commands

CUT, GCOPY, PASTE act on a rectangle of a graphics screen as a clipboard. GCOPY copies a rectangle of pixels to a buffer; CUT copies the rectangle then fills with the color of the pen. PASTE paints the previously copied rectangle onto the screen at a given location. An example from the manual:

```
10 SCREEN 320,200,2
20 BOX 60,60,300,180,1
30 PEN 2
40 CUT 140,80,40,40
50 PASTE 10,10,40,40
60 GETKEY A$
70 SCREEN CLOSE
```

DOT draws a single pixel on a graphics screen.

```
10 SCREEN 320,200,5
20 DOT 100, 80, 7
30 GETKEY A$
40 SCREEN CLOSE
```

CHARDEF changes the image for a single character based on its arguments. This makes it easy to produce custom fonts or character graphics in a BASIC program.

- To replace the letter A with a happy face:

```
CHARDEF 1,$3C,$7E,$DB,$FF,$BD,$C3,$7E,$3C
```

- To restore the PETSCII font: FONT C

VSYNC <n> waits until screen drawing reaches raster line n. This is useful for games and graphical demos that need code to run once per frame for smooth animation or effects. This was once only possible with machine language programs, but MEGA65 in 40 MHz mode runs BASIC quickly enough for high speed games.

```
10 BORDER 0: VSYNC 150: BORDER 1: VSYNC 180: GOTO 10
```

14.2.3 Memory commands

MEM reserves 8K segments of memory in banks 4 and 5 for use by the program, such that the graphics library does not use them.

- To reserve $40000-$41FFF for program use: MEM 1,0

SETBIT and CLRBIT set and clear a given bit at a given byte memory location. Bit numbers are 0-7 from least significant to most significant.

- Given address $03FFF containing the bit pattern 00110111 ($37), to set bit 6 so it becomes 0110111 ($77): SETBIT $03FFF, 6

WPOKE and WPEEK() write and read, respectively, a 16-bit ("word") value at two consecutive locations in memory, least significant byte first.

- To store the word $FABC across byte addresses $0C000 (the least significant byte $BC) and $0C001 (the most significant byte $FA): BANK 0 : WPOKE $C000,$FABC
- To read the 16-bit value stored at $0C000-$0C001: V = WPEEK($C000)

14.2.4 Other BASIC features

The `FREEZER` command opens the Freeze menu, as if you pressed Restore for a second.

The `INFO` command prints useful information about the system and available BASIC memory.

Tip: For bleeding edge information about new BASIC features as they stabilize and get added to the documentation, see the mega65-user-guide Github repo commit list. We also discuss new features in the community Discord.

CHAPTER

FIFTEEN

KNOWN HARDWARE ISSUES

Thanks to the tireless efforts of a team of volunteers and patrons over many years, the MEGA65 hardware is of high quality, a device that recalls the vintage 8-bit machines of the 1990's while retaining modern advantages like quality key switches.

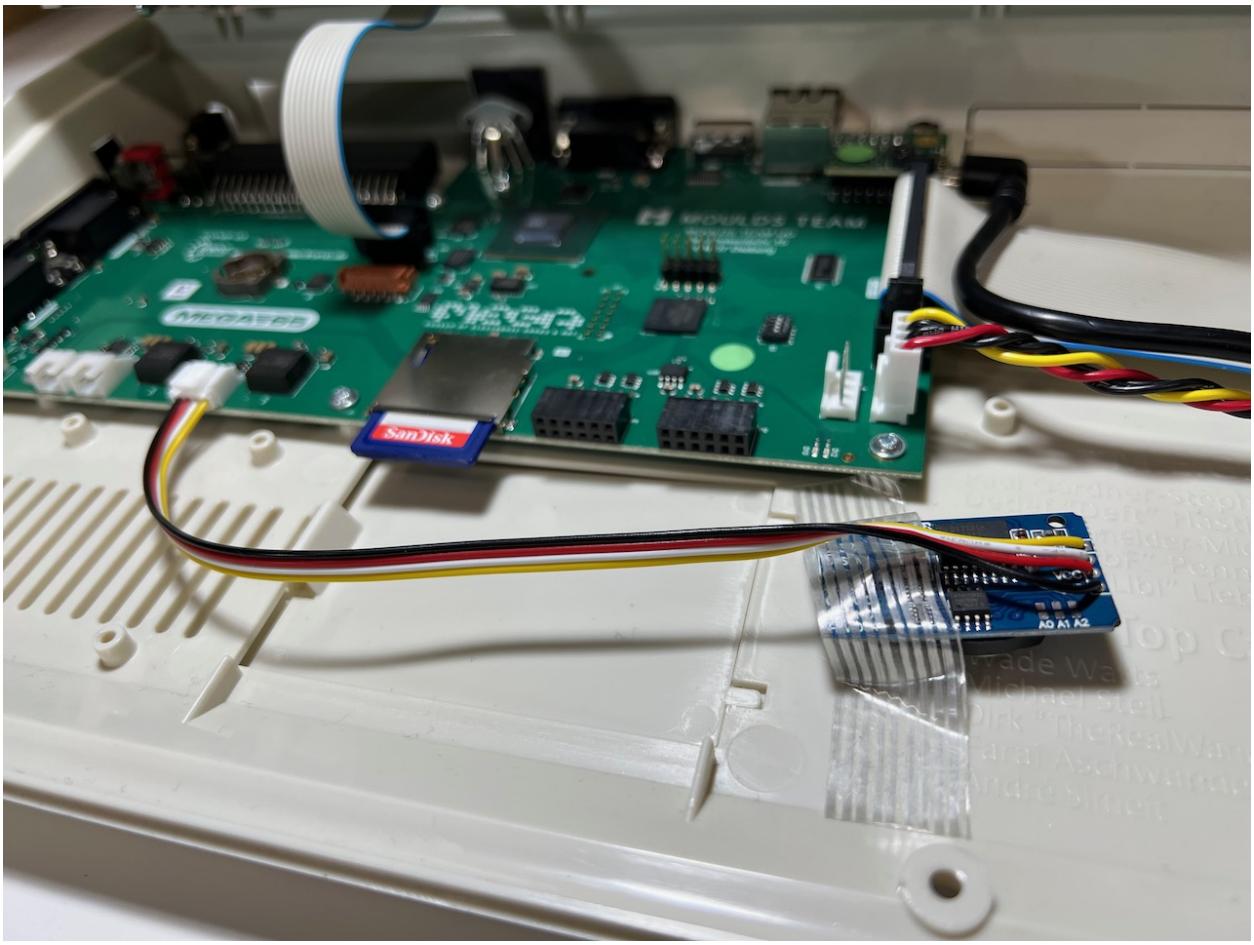
Some minor fit and finish issues were inevitable. Here are a few issues that were reported in the community Discord, and some suggested remedies.

15.1 The Real-Time Clock doesn't advance the time

A significant percentage of MEGA65 units shipped with Real-Time Clock (RTC) hardware that stays stuck at the time you set in the configuration and does not advance, or advances slowly or erratically.

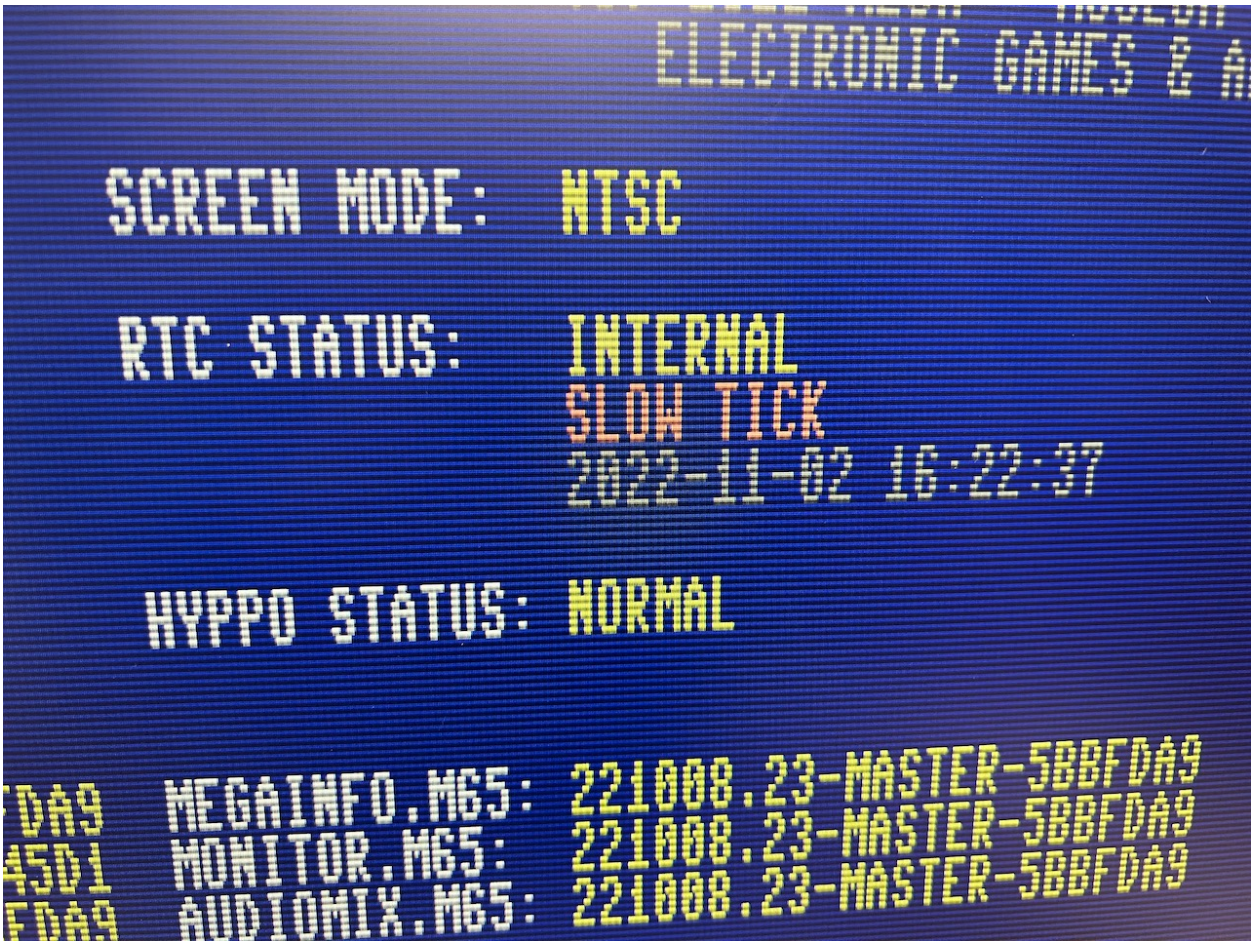
If your MEGA65 has this issue, you can request a replacement RTC unit that attaches to the Grove connector on the main board. The MEGA65 team is making these available **free of charge.** To learn more about this program and to request a Grove RTC:

- **Request a Real-Time Clock replacement (Grove RTC)**

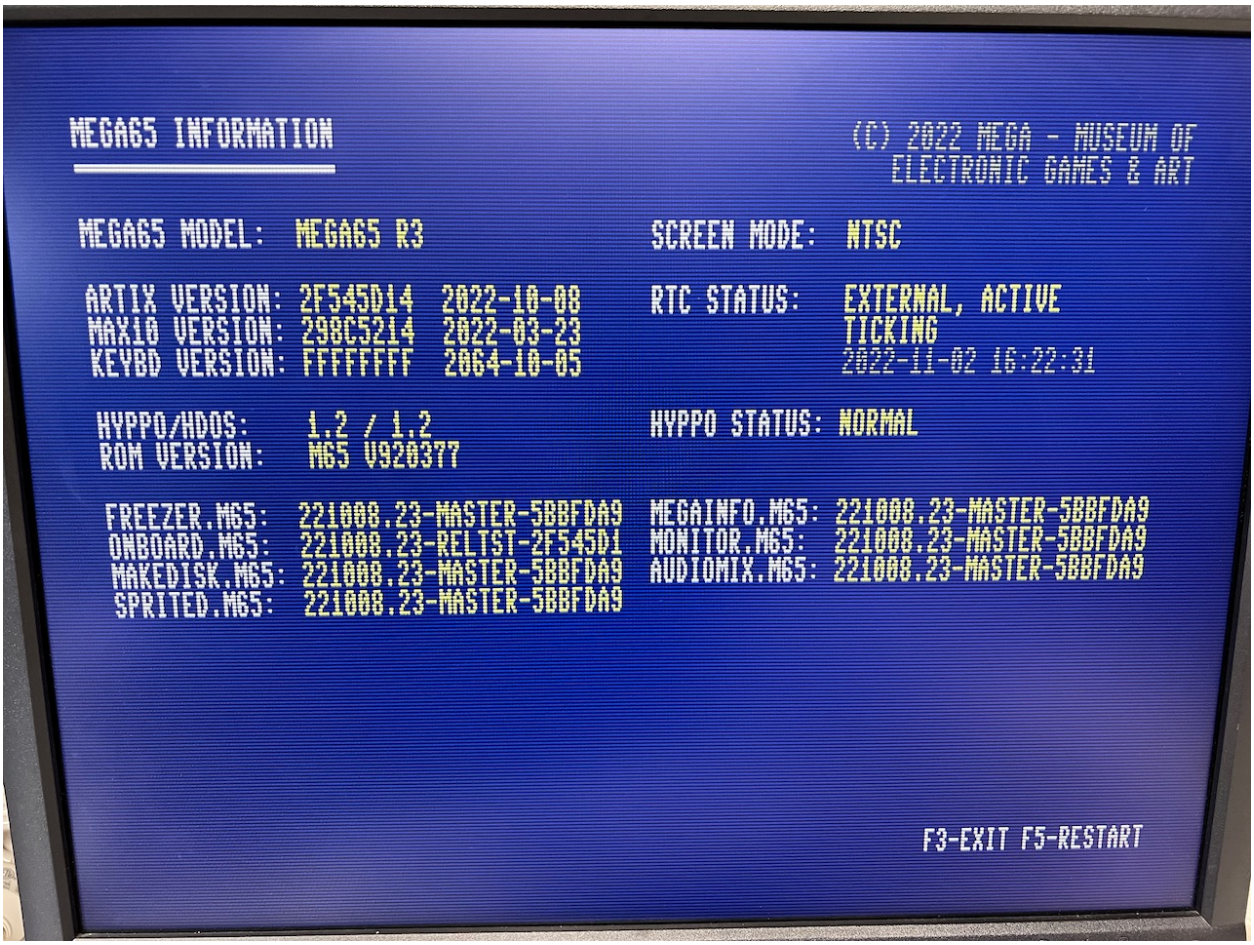


To test whether your MEGA65 is affected, use the MegaInfo utility (available in release v0.95 or higher). Open the Freeze menu (hold Restore then release), then press Help to run the MegaInfo utility. Give the diagnostic utility a few seconds, and it'll report the "RTC status" of your machine.

My MEGA65 had this issue. Prior to installing the Grove RTC, MegaInfo reported that my built-in ("internal") RTC was ticking slowly:



After installing the Grove ("external") RTC, MegaInfo reported a working clock:



15.2 Case fit issues

In some cases, the top and bottom pieces of the plastic case do not fit snugly. A common symptom is a noticeable slip when applying downward pressure to the back of the top case. One possible explanation is a mild manufacturing error from when the limited run cases were commissioned years ago.

The plastic is bendable and with gentle pressure can be coerced into a tighter fit. On the Discord chat, we discussed the use of a hair dryer to soften the plastic for gentle reforming. Be careful not to apply too much heat! Do *not* use a "heat gun," and be judicious when using a hair dryer.

The issue was diagnosed by the manufacturer and will be fixed for future batches. See Issue: The upper case does not properly align with the lower case on the rear side.

15.3 Keyboard slouching and sticking Help key

My MEGA65 arrived with its keyboard appearing to slouch below the top case a bit on the right-hand side, and others reported something similar. The spacebar appeared not vertically straight with the top case, and some people reported that the Help and F13 keys get stuck on the top case when pressed all the way down.

I was able to repair mine with a Phillips head screwdriver. I opened the case and noticed that the screws holding the keyboard to the top piece could be driven further. Careful not to apply too much pressure, I tightened these screws to match the depth of the screws on the lefthand side. This repaired the issue for me.

15.4 Jammed floppy disk pathway

Some owners reported that a floppy disk inserted into the disk drive gets stuck when ejected with the eject button. I did not personally encounter this issue, but others reported success repairing this issue by tightening or loosening screws, similar to the other case fit fixes.

See Issue: Floppy drive eject button and/or inserting floppy disk stuck for more advice.

15.5 C64 cartridge and peripheral compatibility

It is a known issue that not all Commodore 64 cartridges and peripherals work with the current MEGA65 hardware and ROM. The development team is working continuously to improve compatibility over time, well beyond the known-limited C64 compatibility of the original C65 prototype.

Join the `#compatibility` channel on the Discord to discuss any compatibility issues you have found!

15.6 Boot failures with blinking blue LED lights

If the MEGA65 fails to boot its operating system, it will blink the LED lights on the machine in a blue color. This may indicate a problem with the core being loaded. Turn off the power, then hold the No Scroll key and turn it on to access the core selection menu. Select a known-good core, such as the factory-installed core in slot 0.

CHAPTER

SIXTEEN

QUESTIONS AND ANSWERS

Here are a few additional common questions about the status of MEGA65 features.

16.1 Does the cartridge port work?

Yes. If a Commodore 64 cartridge is in the MEGA65 cartridge port when the MEGA65 is turned on, it will attempt to start in C64 mode and execute the cartridge.

C64 mode is known to not be fully compatible with all Commodore 64 software, including some cartridges. If you are experiencing difficulty, try using the Freeze menu to switch from NTSC to PAL video mode or vice-versa (assuming you have a monitor that can show at least partial video with the other mode).

In my personal cartridge collection, I have also had difficulty with some cartridges not being recognized at all, causing the MEGA65 to boot into BASIC.

The C64 core does not yet support the cartridge port, as of this writing. Cartridge support is planned for the future.

16.2 Does the Ethernet port do anything?

The Ethernet port is functional. There is not much software for it yet.

The MEGA65 WeeIP repo by Paul has active open source projects for a telnet-based terminal program Haustierbegriff (PETterminal) and an HTTP file fetcher. See Paul's blog entry exploring the technical details. Contributions welcome!

The Ethernet port is also used for low-level testing and troubleshooting. See *The m65 command line tool* for an example of that.

CHAPTER

SEVENTEEN

RESOURCES

Want the latest and most fun updates? Subscribe to my newsletter!

There are substantial documentation, software, and community resources for the MEGA65, in various states of completion and freshness. While browsing available resources, keep in mind that there have been multiple iterations of the MEGA65 project leading up to the 2022 launch:

- Some resources may refer to the DevKit model, a pre-production version of the MEGA65 that sold 100 units (no longer available).
- Others may refer to the Nexys A7 FPGA board, an alternate way to run the MEGA65 core and ROM.
- Still others may refer to the Xemu emulator platform, which can emulate a MEGA65 on a PC.
- The MEGA65 with the injection molded case and mechanical keyboard uses revision 3A of the board and is sometimes referred to as "R3" or "R3A."

Here are some useful next places to visit:

- The Official MEGA65 website
- The MEGA65 Filehost
  - Filehost Articles
- The MEGA65 Discord
- Questions and answers for MEGA65 starters
- MEGA65 Github repositories
- MEGA65 Wiki
- AmigaLove: Mega65 Quick Start Guide
- retroCombs website and YouTube channel
- Shallan YouTube channel and Github
- My MEGA65 resources page

Thank you for reading this Welcome Guide! If you have feedback on how I can make this Guide better, or just want to say hi, please report an issue, email me (I'm Dan), or DM dddaaannn#7325 in the MEGA65 Discord.

Welcome to the world of personal computing. Enjoy your MEGA65!

```
GO 65
```