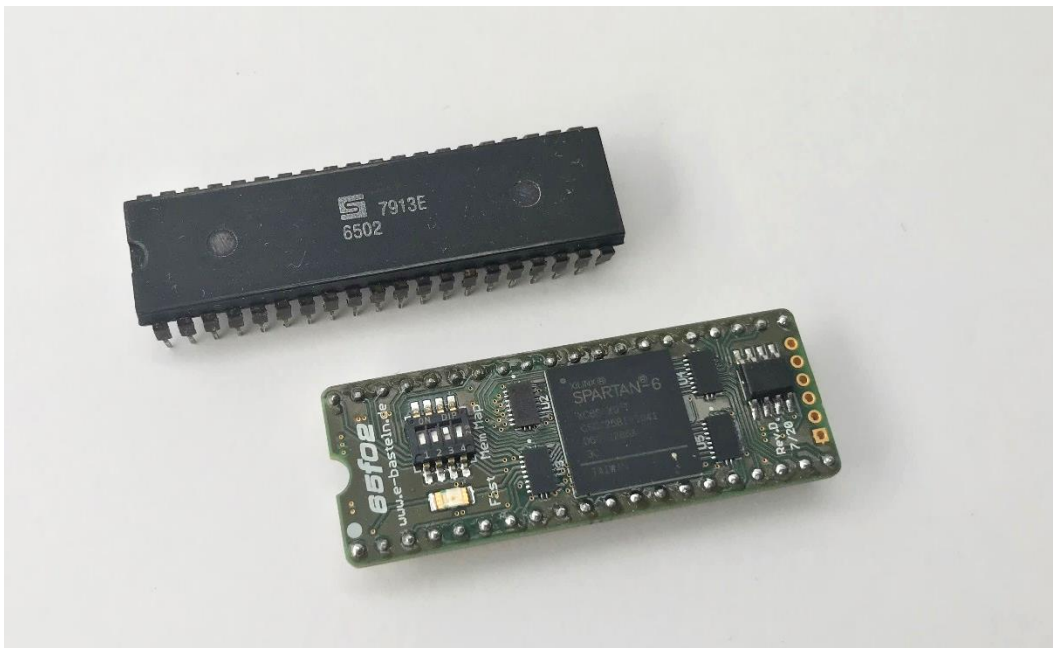


# Installation and operating instructions

## 65F02 Rev D

Roland Langfeld, Jürgen Müller  
20.8.2020, 18.8.2024

65F02 is an FPGA-based processor emulation that is pin-compatible with 65C02, but runs internally at 100 MHz. These instructions apply to the Rev D version.



Contact:

Roland Langfeld

[R.Langfeld@t-online.de](mailto:R.Langfeld@t-online.de)

Jürgen Müller

[juergen@e-basteln.de](mailto:juergen@e-basteln.de)

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# Installation

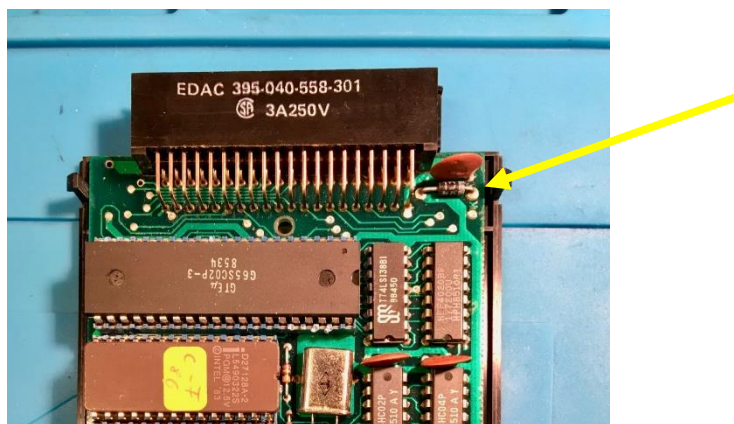
## Prerequisites

The 65F02 can currently accelerate the following chess computers to 100 MHz:

- Mephisto Modular II & B&P
- Mephisto Rebel 5.0
- Mephisto Modular IV & V
- Mephisto Rebel Portoroz (MM X)
- Mephisto Polgar
- Mephisto Milano & Nigel Short
- Mephisto Modena
- Novag Constellation Forte A/B
- Novag Super Constellation
- Novag Constellation Expert
- Chafitz ARB & MGS
- Conchess (all variants except Victoria)

The CPU of the target system must be socketed. The 65F02 is simply inserted into the socket in place of the original CPU; no further connections are required. The power consumption of the 65F02 is 20 to 30 mA higher than that of the original CPU; all chess computers can supply this without any problems.

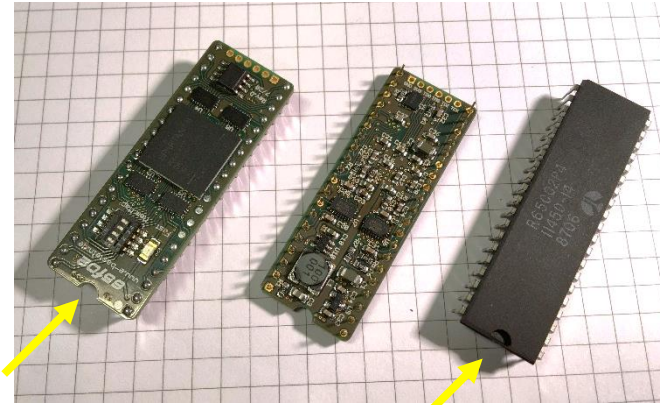
The 65F02 can be used in Mephisto module systems with the older 6 V board electronics if the original protective diode is present in the module (see Fig. 1).



**Figure 1:** Position of the protective diode on the MM II (B&P and Rebell 5.0 similar)

## Insert the circuit board

- Disconnect the chess computer from the mains.
- Note the orientation of the 65C02 CPU (notch on one narrow side, see Fig. 2). In case this has been forgotten: The marking can usually also be found on the CPU socket and as an imprint on the main board.



**Figure 2:** Orientation marks

- Avoid static discharge: Cover the workplace with a piece of aluminum foil as a work surface, sit down, touch the aluminum foil.
- Open the chess computer.
- Lever up the original CPU with a narrow screwdriver or similar, alternately on the narrow sides and remove carefully.
- Place the CPU on conductive plastic foam or a piece of aluminum foil.
- Carefully place the 65F02 loosely on the empty socket for the time being.
- Do all pins sit neatly over the mating parts of the socket?
- Now carefully press the entire surface of the chip, preferably with 3 fingers, and press it evenly into the socket (see Fig. 3)
- Check again carefully that all pins are correctly in the socket.



**Image 3:** Press evenly on the chip to insert it

## Setting the DIP switches

Only change the DIP switches when the power is turned off; changes are read when the power is switched on. The small slide switches engage clearly; they can be easily operated e.g. with a toothpick or watchmaker's screwdriver.

Position

1234

0000 for all systems: 65F02 runs with system clock, NO acceleration

1000 Mephisto Modular II & B&P, Conchess (all variants except Victoria)

0100 Mephisto Modular IV & V, Rebel Portoroz (MM X)

1100 Mephisto Polgar

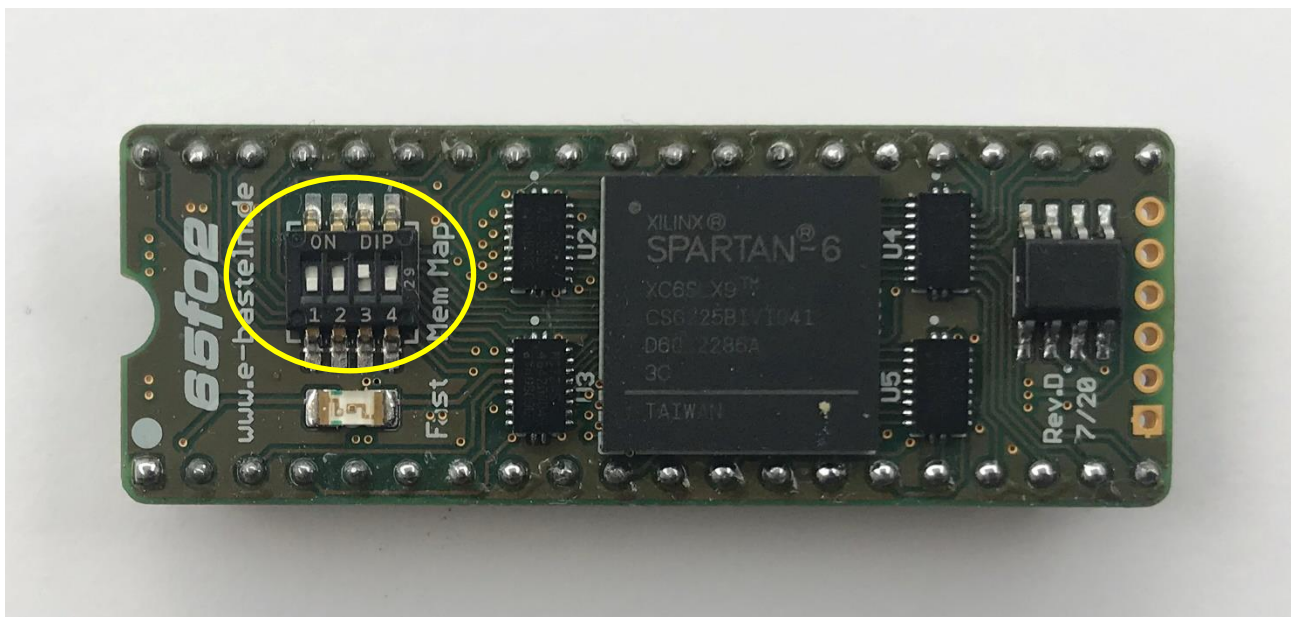
0010 Mephisto Milano & Nigel Short

1010 Mephisto Rebell 5.0, Modena

0110 Novag Constellation Forte A/B

1101 Novag Super Constellation, Constellation Expert

1110 Chafitz ARB & MGS



*Position of the DIP switches. Switch position "1" = "ON" (top).*

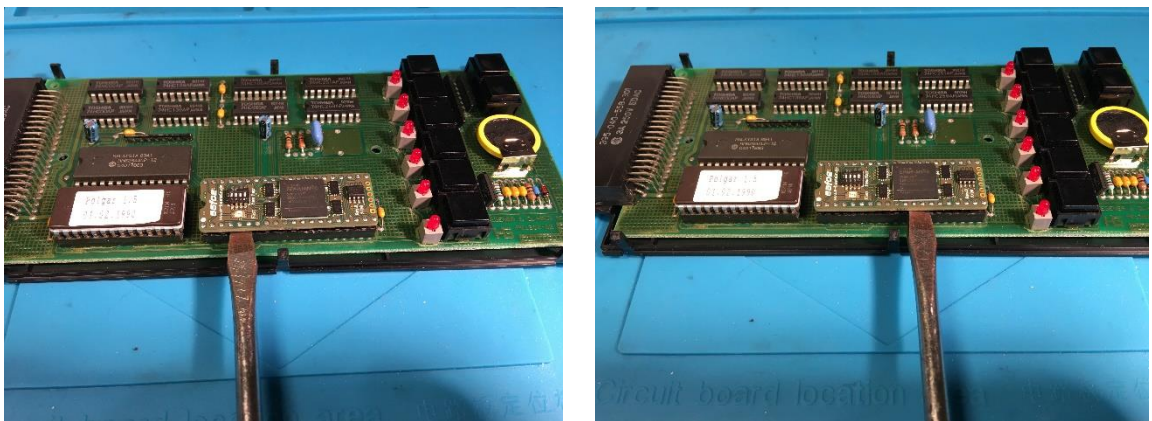
## Remove the circuit board

Reverse the installation procedure, but ATTENTION:

There are also components on the underside of the 65F02 board.

The board must therefore be levered out of the socket as follows:

- NEVER pry at the narrow sides, but
- lever with a wide screwdriver on the long sides between the IC socket and the protruding 65F02 board,
- very slightly by turning the blade to lift the 65F02 by approx. 1 mm,
- Now use the screwdriver to lever out the circuit board evenly mm by mm on both long sides in turn.
- This requires several "cycles". Do NOT lever out completely at one point – lifting the 65F02 at an angle would bend its pins!



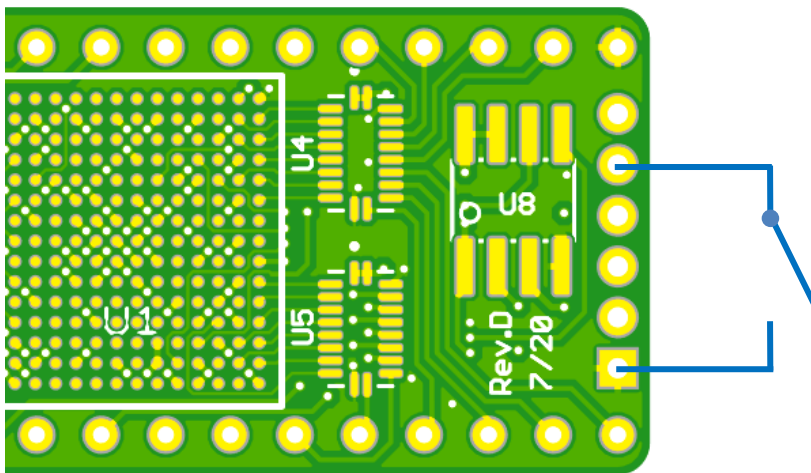
*Fig. 4 a,b:*

*Lever up the circuit board piece by piece on the long sides at the front and rear in turn*

- Replace the old CPU with the correct orientation.  
Watch out for bent pins here too.
- Assemble the module or chess computer, test, done!

## Optional: Switch for original speed

For test or benchmarking purposes, it may be desirable to switch the 65F02 between original speed and accelerated operation. For this purpose, an optional switch can be connected between pins 1 (GND) and 5 (TDI) of the contact strip on the narrow side of the 65F02. The position of the connections is shown below; the pin names can also be found on the underside of the board.



- If this switch is closed, the DIP switches are overruled. The 65F02 then runs without acceleration, just as with DIP switch position "0000".
- Like the DIP switches, this switch should not be actuated during operation. This leads to undefined operating states (but does not damage anything).
- A simple normally open contact is sufficient, e.g. also a reed contact.
- Connection wires can either be soldered directly to the soldering eyes or via a connector strip. Attention: The pins have a somewhat unusual spacing of 2.0 mm. Use straight or angled pins with this spacing, or plug/socket type JST PH. The standard spacing of 2.54 mm will not fit!
- If external speed switching is not required, the contact strip can simply remain unconnected.

# Usage

## Normal operation

- Switch on the module in the chess computer as usual:
- First plug the power supply unit into the socket,
- then switch on the chess computer.
- Device can be operated as before
- Switch off: first at the chess computer, then unplug the power supply

Some chess computers have battery-buffered RAM in order to be able to resume a game after switching the device off and on again. This is currently not supported by the 65F02, which only uses the internal, fast RAM in the FPGA:

- Games are always lost when switching off.
- A reset or "New Game" may also be required when switching on the device in order to restore a defined initial state.

## Troubleshooting

The 65F02 has been thoroughly tested in the listed chess computers. If you should have any problems, please contact Jürgen!

For initial troubleshooting, check the following:

- Is the DIP setting correct?
- Set to 0000 on a trial basis - will it work then?
- With the module open, check: is the LED on the circuit board lit?  
See below for details on the LED!
- Have individual pins been bent and sit outside of the socket?
- Is the chip inserted deep enough into the socket?
- Is the chip installed the right way round?  
(Notch on the 65F02 is where the CPU notch was)
- If still no result: Revert to original 65C02 – will it work then?



## Function of the LED

The LED indicates how effectively the 65F02 is currently accelerating the target computer. It can also help to localize errors:

- When starting (power on), the LED always flashes once briefly. If it remains completely dark instead, the 65F02 is probably not receiving any power and may be plugged in incorrectly.
- The more the CPU is accelerated, the brighter the LED lights up. The following display states are normal:
  - LED off – no acceleration (normal with switch position 0000)
  - LED bright – fast computing with 100 MHz
  - Medium brightness or flickering – alternates between fast computing and intensive access to the original peripherals (e.g. display, speakers).
- Soft, steady pulsing of the LED at approx. 1 Hz indicates that the FPGA is ready for an update via USB.
  - This state is normal if the USB programming adapter has been plugged in (see below).
  - If the pulsing occurs during operation in the chess computer, this indicates that the reset signal of the chess computer is constantly present after switching on. This indicates an installation error.

## Updating the FPGA

New configurations for the FPGA can be uploaded via a USB connection. This allows errors to be rectified or new functions to be provided as required.

A USB programming adapter is included with the 65F02. In addition you will need

- a USB cable – plug type A on the computer side, plug type Mini-B on the 65F02 side, and
- the freely available programming software "TinyProg" (runs under Windows, Mac OS or Linux) – see download and installation guide below.

## Installing the TinyProg software

The 65F02 uses the open source software TinyProg by Luke Valenty. A version adapted to the 65F02 can be downloaded as a .ZIP archive from <https://www.e-basteln.de/computing/65f02/65f02-links/#design-files>.

TinyProg is written in Python. This has the advantage that the program can be used under all common operating systems; however, it requires the installation of the Python programming environment:

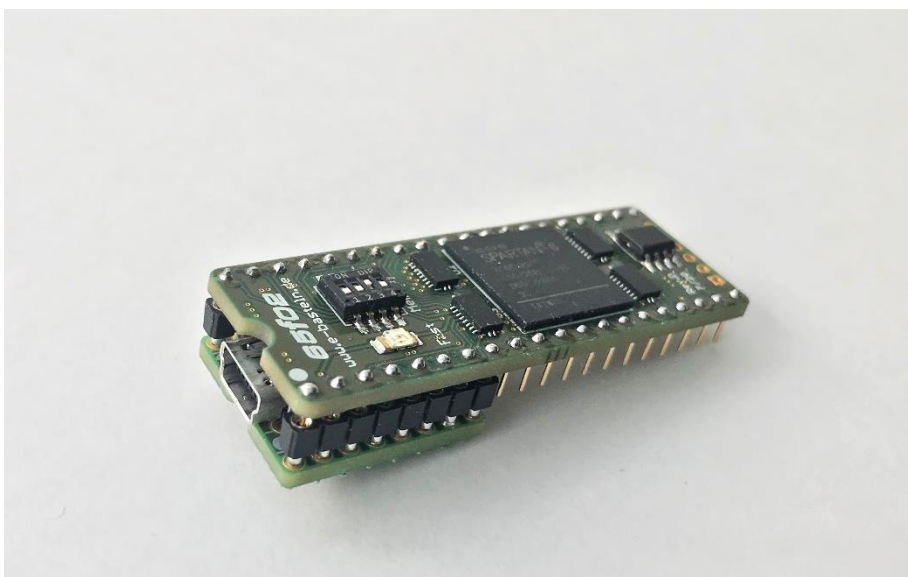
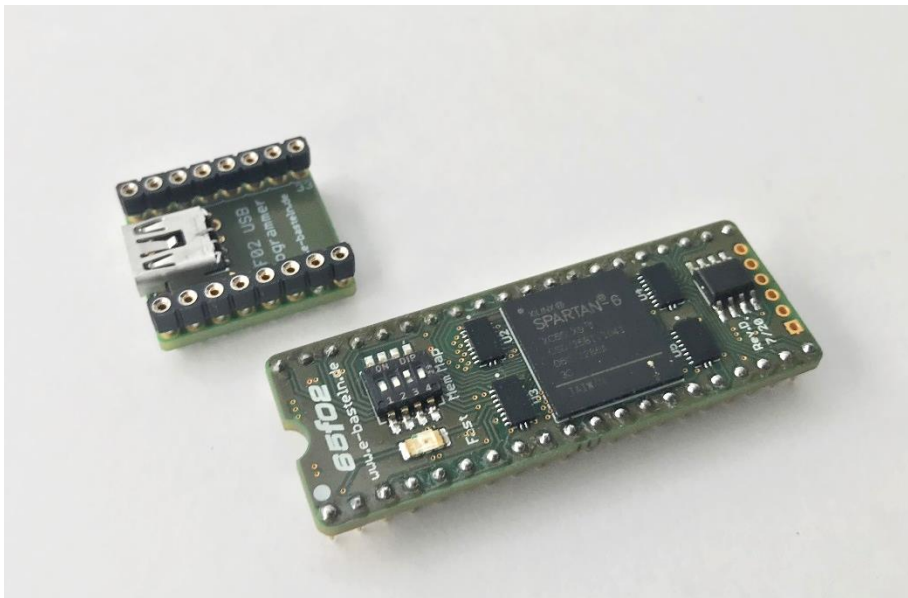
- Install the latest Python version from <https://www.python.org/>.  
Last tested with Python 3.12.3.
- Under MacOS, a missing library and a package manager must also be installed:
  - Install HomeBrew package manager from <https://brew.sh/>
  - Install USB library with `brew install libusb`
- Unpack the downloaded .ZIP archive.
- Call the command line or shell in the unpacked folder
- Install TinyProg with `python -m pip install .`
- Test whether TinyProg has been installed correctly:  
`tinyprog -h` displays a command overview.

## Connecting the USB adapter

- Remove the 65F02 from the chess computer as described above.
- The USB adapter is plugged onto the side of the 65F02 that is marked with the notch. The pictures below show the correct position.
- Then connect the USB cable (Type Mini B) to the computer.

To remove the USB adapter later, proceed in the same way as when removing the 65F02 from the computer:

- Disconnect the USB connection
- Carefully unplug the adapter without tilting it.



## Using the TinyProg software

- Connect the USB cable. The 65F02 is supplied with power via USB. The LED starts to pulse steadily.
- Wait until the operating system has installed the USB driver and confirms that the USB device is available. This can take up to a minute when connecting for the first time.
- Open the command line or shell of the operating system.
- `tinyprog -m` outputs information on the connected FPGA module. Boardmeta" and "bootmeta" data should be displayed.
- `tinyprog -p filename.bin` reprograms the FPGA with the specified binary file. The binary format is specific to the Spartan-6 FPGA. Valid binary files are always 340 604 bytes long!

Programming should take a few seconds; status and progress are displayed. After programming, simply disconnect the USB cable, unplug the USB adapter as described above and reinstall the 65F02 in the computer.

If the programming should fail in exceptional cases, the boot loader is still retained in the FPGA. Disconnect the USB connection for a few seconds, reconnect it and try again.

## Licenses and legal matters

The copyright for this manual, the 65F02 board design and the firmware (with the exception of the open-source components mentioned below) is owned by © 2020-2024 Jürgen Müller and Roland Langfeld.

Commercial use requires our written permission. Permission for non-commercial use is hereby granted; we would be pleased to hear about your experiences with the 65F02.

The 65F02 is a hobby project and not a commercial product. We are happy to provide assistance in the event of problems with the reproduction or application, but cannot assume any formal guarantee or product liability.

### Open-source components

The **Verilog 65C02 CPU** used in the 65F02 FPGA was developed by Arlet Ottens as a 6502 core and extended by Ed Spittles and David Banks with the 65C02 extensions. The source code for Arlet's original 6502 is available on [Arlet's website](#), the extended 65C02 version on [github](#), and technical discussions on the [6502.org forum](#).

Many thanks to Arlet, Ed and David for releasing their work as open source software under the following generous license terms:

(C) Arlet Ottens, (C) 2016 David Banks and Ed Spittles  
Feel free to use this code in any project (commercial or not), as long as you keep this message, and the copyright notice. This code is provided "as is", without any warranties of any kind.

The **TinyFPGA USB boot loader** and the associated TinyProg programming software were developed by Luke Valenty.

The [TinyFPGA boot loader](#) is pre-installed on the 65F02 and is distributed under the [Apache License Version 2.0](#). The [TinyProg](#) Python program is installed on the PC as described in the previous section.

Many thanks to Luke for developing this elegant programming solution and for releasing it as open source software!