Informations about the „Modular64“ Boards

(Final Prototype)

Last changes

04.03.2021

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1 Features

The special thing about the "Modular64" boards is the compact design, which could be the smallest "Real" C64 ever built in the world, based on a ~100x100mm module board. This was only possible by placing the original chips on a module board. The plug-in boards are about 100x50mm small and can be easily changed and replaced by other boards. So it is very easy to achieve a repair in a few seconds by exchanging the circuit boards.

Due to the compact design, the boards take up only a very small space on the desk, and are therefore ideal to stay permanently on the desk.

1.1 Arrangement of the boards

Due to the arrangement of the boards on the Modul Board, there is no risk of touching components if the height of the components is taken into account during placement (which could cause an electrical connection to an opposite board). The height should not exceed 1 cm. Usually only the IC housings and backside pins, or plastic connectors and pins touch each other, which is no problem electrically.

Important: The interface card board must be inserted into the last slot on the module board at the very back of the module board, as a rear pin connector on the back is led down to the interface board, thus connecting the external ports. For this purpose, an approx. 14 cm long 50 pin ribbon cable with pin connectors is provided.

1.2 Small remote keyboard and small floppy (Pi1541)

What good is a small computer if you have to connect a large keyboard and a large floppy disk? In order to keep everything small and miniaturised, a "Remote Keyboard" circuit board has been specially developed. With this board you can connect to an Android C64 Keyboard Touch App (USB or Bluetooth), so you have a small C64 Keyboard.

To make the 1541 floppy smaller, a Mini Pi1541 can be used. For this purpose a USB power socket has been provided on the interface board to avoid an additional power supply for the floppy.

However, before using this USB power socket, it may be necessary to connect the module board and the interface board with two power lines, depending on the power requirements of the connected devices. Two solder pads for 5V and GND are provided for this purpose. Two slightly thicker lines, which can also withstand higher currents, should be used for this purpose.

2 Supply voltage

For the module-board circuit board is intended the use of a 5V drop-down voltage regulator, with a fixed filtered input voltage of 12V. For example the Pololu D36V28F5. Of course any other 5V voltage regulator can be used, but it should be noted that each voltage regulator has different specifications and functions which should be studied carefully before use to determine if it is suitable for the intended application. If a voltage regulator without overcurrent protection/short circuit protection/polarity reversal protection is used, an additional external fuse circuit should be used to prevent possible damage.

In the case of the Pololu D36V28F5, the exact characteristics of the controller can be found on the website http://pololu.com. This controller has reverse polarity protection up to 40 V, undervoltage and overvoltage protection at the output, overcurrent protection and short-circuit protection. A thermal shutdown function also helps to prevent damage from overheating, and a soft start function limits the inrush current and allows the output voltage to rise gradually during start-up.

To connect a 12V plug-in power supply unit, a placeholder for a 2.1 mm panel jack is provided (inner conductor +12V, outer conductor earth/GND).

The power switch is a three-pole "toggle switch". It should also be noted that a voltage source in the form of a power supply unit or a battery/rechargeable battery must be able to supply not only the correct voltage but also the necessary current (at least 12V/1A). Car chargers or toy train transformers are not suitable as voltage sources and will lead to damage to any components that may be fitted or to malfunctioning of the circuit board. Before connecting the voltage source, check the correct polarity and the correct polarity of all placed components. If a power supply unit is used as a voltage source, it is imperative that it complies with VDE regulations.

Important: Before ICs are inserted into the sockets of the board, all voltage input pins of each IC should be checked while the power supply is on to ensure that the correct voltage is applied to all ICs and their corresponding pins.

2.1 12V/9V Board voltages

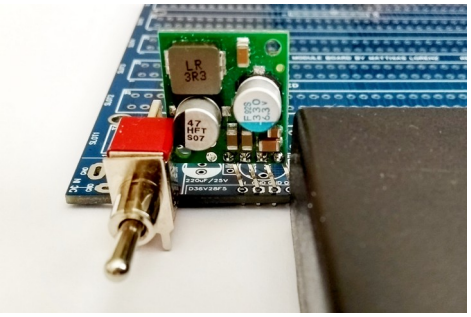
For the 9V/12V voltages, which are provided for the cartridge drive, VIC II and SID chips, 9V and 12V step-up converters are required. For example the U3V12F9 and U3V12F12 from Pololu. It is up to you which regulators are used, if they are suitable for this case.

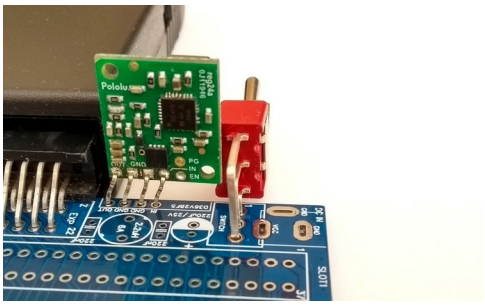
3 The Boards

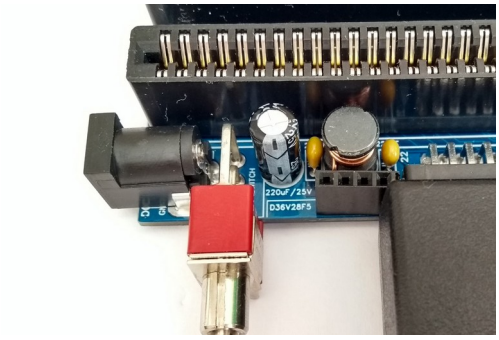
3.1 Modul Board

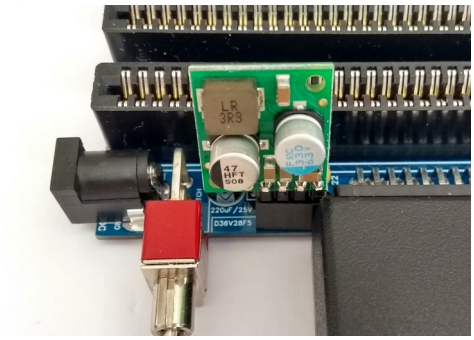
The module board has 6 slots (the LONG version has 9 slots) in which you can insert cards. The module board is supplied with 12V via a 2.1mm DIN socket. In the middle is "Plus", outside is "Minus". To save space when a module is plugged into the expansion port, a special expansion port adapter board was created, which can hold the module vertically and is quite short. With the LONG version it is also possible to solder in a vertical expansion slot, so that a module can be inserted vertically, because there is enough space between the module and the first slot. If the module label is to point to the front, a 180° expansion adapter should be soldered in before soldering the expansion slot, which turns the expansion pins by 180°, and then the expansion slot.

Before the 5V regulator is pin-attached and soldered, certain constellations of plugged slot-boards and expansion modules should be considered and then the suitable mounting position found. It is also possible to plug the controller instead of soldering it. This way the controller is slightly higher than the expansion port. And if you bend it a little bit forward, the controller will not come into contact with any slot 1 board.









Note: When selecting the slot sockets, only the best quality should be used. This is because cheap slots with little contact pressure can cause disturbances due to slight movement of the boards, which can lead to an unstable system. With high quality slots there is a better connection and leads to a stable overall system. You may have to try a little bit until you find the perfect slots. At first you should solder only the backmost 4 slots, namely those for the interface-, CPU-, RAM- and graphic card. If a picture is to be seen, then wiggle once "slightly" on all boards. If the system remains stable, the slots are Ok. If only some of them remain stable, you have to check if an IC is responsible for this (happens with a 74LS08 from Malaysia).

3.2 Interface Board

The interface board, which is screwed under the module board, provides the external connections such as 1541 floppy, joysticks, user port and tape port. This provides space for all connections, which would not be possible with the module board alone, or would have considerably enlarged the Modular64, thus exceeding the target size of approx. 100x100mm (short version).

As already mentioned in point 1.1, the interface board was equipped with an USB power socket, so that no extra power supply is needed on the Pi1541.

To prevent the plugged joystick connectors from interfering with the vertical expansion board and its spacer bolts, the joystick ports have been moved to the right so that they are located just below the expansion port.

Note: before the Interface Board board is connected, the function test should first be carried out without the Interface Board. So first make sure that the module board and the plugged in boards are working and that the C64 responds correctly. Only then the interface board should be connected via the ribbon cable.

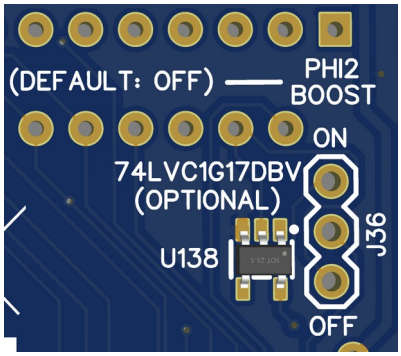
3.3 CPU Card

One important note first: With the CPU board and the crystals, care should be taken to ensure that the crystals do not rest on the board when soldering, or at least insulating plates should be used. This is because the quartz housing could possibly come into contact with one of the quartz pins.

If you don't want to use crystals or a MOS 8701 IC, but a 8701 replacement board, you are welcome to do so. Because there is enough space left for this. But you have to make sure that the replacement board does not touch any other board in the opposite slot.

Around the 8701 IC, as well as the two crystals for PAL and NTSC frequencies, you can choose between PAL and NTSC with the jumper (J14). Of course the VIC II chip must be changed accordingly. However, only 8564/8565 VIC II chips are provided on the Modular 64 (because of the lower heat development).

The PHI2 Boost is an experimental option, in order to have an additional improvement option available for problematic modules/extensions. This boost is activated ("ON") with jumper J36. The PHI2 signal is amplified, and thus subsequent circuits are supplied with a better PHI2 signal. **<u>Please note:</u> This jumper must be set to either "On" or "Off" and must not be left unplugged! If the jumper is not at least set to "Off", the board will not work.**



3.4 RAM Card

This board is deliberately based on the MMU 252535-01 or 251715-01 (for both variants the Color-RAM socket U3 on the video board must be equipped with a 2114 SRAM). The 64-pin IC is almost indestructible (in contrast to the old PLA IC of the old C64 model), and should last longer than all other highly integrated ICs of the C64. A further advantage is the saving of many more ICs, as well as the high distribution, since many millions of the last model were produced until the 90s (from 1987-1994). And last but not least you get a suitable socket for this IC, although this IC is far away from the usual 2.54 grid size.

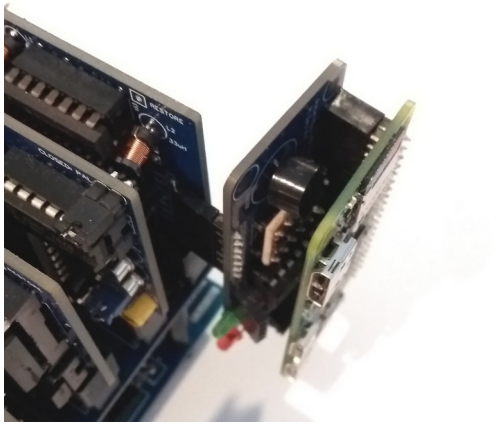
VSP Bug and 41464 DRAM: If you want to avoid the VSP Bug on the Modular 64, you can use the usual SRAM adapter boards. The distance to the sockets has been adopted 1:1 so that the adapters fit directly. However, you should not solder the sockets but the adapter board directly, otherwise the height will cause problems.

Important: If a NOS MMU 251715-01 IC is used and there is no C64 image, SRAM should be used instead of DRAM (DRAM adapter board with soldered SRAM ICs). Maybe MB81464, NEC D41464C-12 or OKI M41464-15 DRAM ICs are also working.

3.5 Interface Card / Pi1541 Zero

Restore button: As there were not enough pins left on the SLOT bus, the RESTORE button connection from the interface board (keyboard) via PIN "RESTORE" (U7) to MMU pin 9 (Restore) had to be connected by airlift. This can then be connected "**laterally**".

Pi1541 Zero connector: On the right side there is a pin row which is intended for a separately available Pi1541 Zero adapter board which can take a Pi Zero. If this Pi1541 Zero is plugged in, you have quasi a Mini 1541 "OnBoard".



To ensure that the internal Pi1541 functions reliably, the CIA 6526 (U8) socket should be equipped with a CSG 6526/216A on the rear side if possible. According to one user, MOS 6526/216A should also work, but during my tests I already had problems with MOS 6526/216A chips. Furthermore the following files on the SD-card of the Raspberry pin should be changed.

File: config.txt

kernel_address=0x1f00000

force_turbo=1

boot_delay=1

arm_freq=1100

over_voltage=8

sdram_freq=500

sdram_over_voltage=2

File: options.txt (only for "7406 Only", without extra level shifter board)

invertIECInputs = 1

invertIECOutputs = 1

With this, problematic demos, which even with an original C64 and a Pi1541 drive according to user reports sometimes do not work, worked perfectly in tests.

3.6 Video Card

The video board can be equipped with VIC II 8564 (NTSC) and 8565 (PAL). The old VIC II chips are not possible with the standard graphics card.

3.7 Sound Card

Before using original SIDs, make sure to double check the voltage jumpers JP1 and JP2. If the wrong voltage is applied, the SID is usually lost forever.

If you want to be on the safe side, you should only use replica SIDs

If an ARMSID is used, the emulation should be set to 6581 in the ARMSID Config Tool and automatic recognition should be switched off. If a SID is to be placed on both channels (left and right), a 3-PIN female connector with soldered pins can be used.

The SID II can be set to address D420, D500, D520, DE00 or DF00.

3.8 Keyboard Remote Card

With the Keyboard Remote board the normal large C64 keyboard can be replaced by a C64 Touch Keyboard. For this purpose there is an Android app that can be used in combination with a smartphone or tablet.

4 Accessories

The above mentioned boards are quasi the "standard components" of the Modular64. Now a few developer boards will follow, which go beyond the normal use and should offer more possibilities.

4.1 Code Injection Card

With this board you can send data from your work computer to the Modular64. CRT or PRG files can be transferred in seconds and then started immediately. In combination with a compiler and automatic transfer, you have a small C64 software development environment on direct hardware and smallest space on your desk.

4.2 Long Boards

If you want to get more out of your Modular64, use more space and more cards, as well as develop, you can now do so in the form of "long" board versions with 9 slots. In addition to the 9 slot module "Long" board, an interface board in "Long" version is also available.

4.3 Bus Analyse Card

This board leads the complete bus to 2 pin rows, whose signals are then very easily available for measurement.

5 Picture Quality

To make it clear what picture quality can be achieved, here are two screenshots with "ODV" Zero Latency S-VIDEO -> HDMI converter and 1080p DELL Touch Monitor (Sharpness 100%). Taken with a Moto G5 smartphone, without any processing. If the picture is worse than seen on the two screenshots, other converters/monitors/cables should be used.