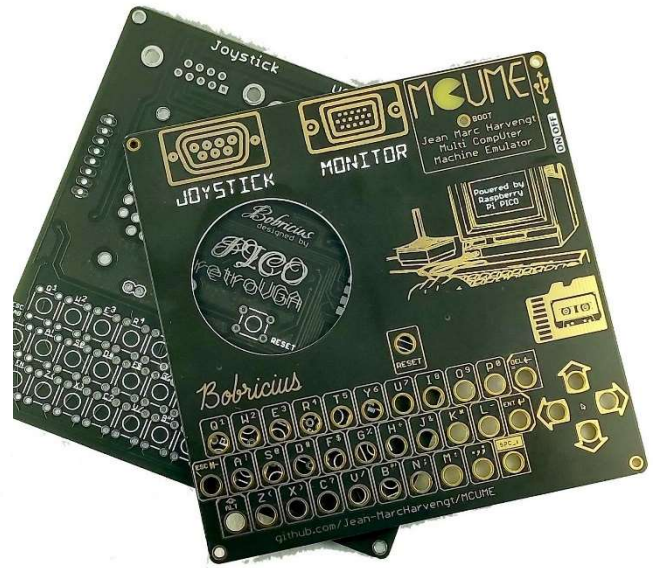


# RetroVGA – by Bobricius

## USER GUIDE



PEMITECHNOLOGY  
FACTORY FOR MATERIALIZING DREAMS



Thank you for your purchase!

### Introduction

**RetroVGA** is a hardware board utilizing a Raspberry Pi Pico for retro computer emulation. The board provides the following features.

- QWERTY keyboard.
- 9pin DSUB ATARI joystick connector.
- Small form factor (100x100mm).
- Reset button.
- Directional buttons.
- Micro SD card slot for storage.
- Absolute minimum components.
- Access to the Raspberry Pi boot button (when front panel installed).
- VGA output.
- Piezo Speaker.
- Power switch controlling internal buck-boost
- Transparent MCUME logo window, for visibility of Pico activity LED.

The Raspberry Pi Pico, can run M.CU.M.E (Multi CompUter Machine Emulator), a universal retro computer emulator for various MCUs, developed by Jean MarchHarvengt. M.CU.M.E supports the following retro console and computer systems on the Raspberry Pi Pico (as of January 2022).

Atari 2600  
Odyssey/Videopac  
Colecovision  
Atari 5200

Zx81  
Zx spectrum  
Atari 800  
C64

Please note that MCUME is under development by Jean MarchHarvengt and is not maintained by Bobricius. For details of system support, project status, credits and any current issues refer to <https://github.com/Jean-MarcHarvengt/MCUME>. The RetroVGA board is also compatible with the Miroslav Nemecek PicoVGA library, <https://github.com/Panda381>.



Attention! Given limitations of the MCU and the level of emulator development, 100% compatibility with all games and features should not be expected! Sound support is limited. Joystick support requires a shortened cable (approx. 30cm maximum).

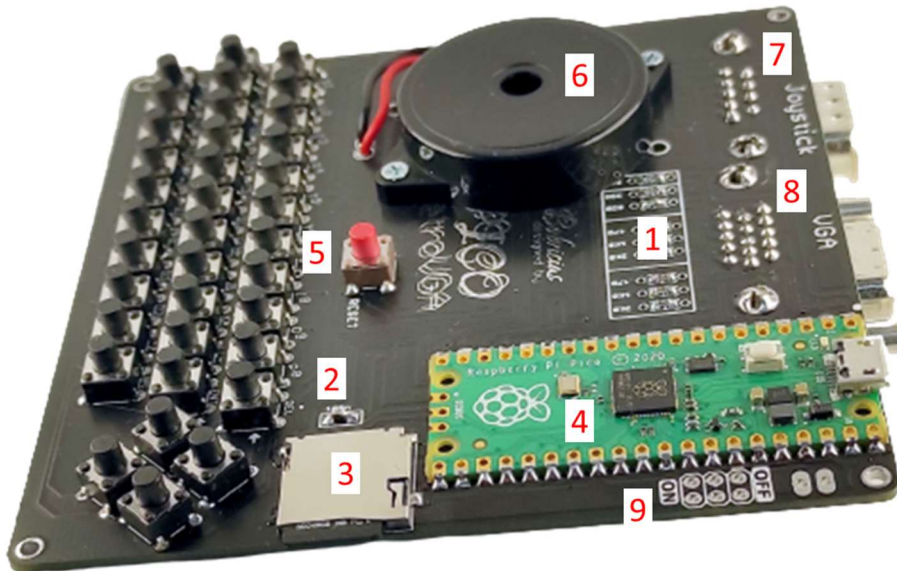
**RetroVGA** is supplied in the following Package Options.

1. Bare main board only, without front panel and no components included.
2. Bare main board + GOLD front panel and no components included.
3. Assembled working units.

For Option 1 and 2 refer to the assembly guide section for details of the additional components required.

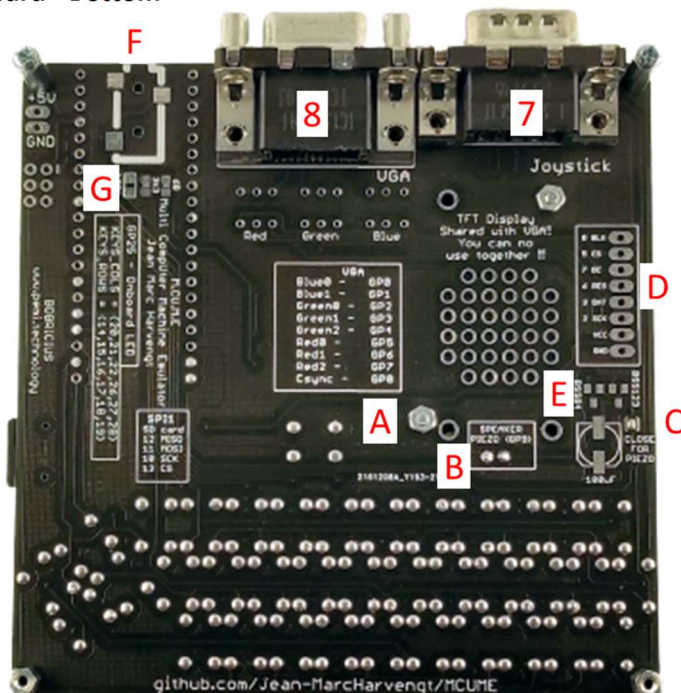
## RetroVGA overview

### Main board – Top



1	SMD or TH resistors*
2	SMD capacitor**
3	Micro SD Card reader
4	Raspberry Pi Pico
5	Tactile switches
6	Piezo buzzer
7	9Pin Dsub Joystick Port
8	15Pin Dsub VGA Port
9	Power Switch
*Option of through hole or smd components	
** Optional	

### Main board - Bottom



A	Piezo Buzzer mechanical fixing
B	Piezo Buzzer cable terminals
C	Piezo Buzzer jumper (close for active)
7	9 Pin Dsub Joystick Port (male)
8	15 Pin Dsub VGA (female)
D	Onboard TFT screen headers*
E	Pads for SMD Power MOSFETs
F	Pads for SMD 3.5mm audio jack *
G	Pads for SMD audio jack filters *
* These are not used and unsupported but are open to developers.	



Warning! The VGA and TFT header share the same outputs. Do not use them together.

### Assembly Guide

For those who have purchased the Package Option 1 or 2, please find below a bill of materials to assist with sourcing the correct components to assemble the board.

#### Bill of Materials (BOM)

\*Position is as marked on the board and/or as indicated in the overview above.

\*\* Example supplier to be used as a guide for alternatives. Note Resistor example is for TH.

Line #	Component	Pcs	Description	Note	At Position*	Example supplier**
001	Raspberry Pi PICO	1		See note on checking the Pico, below in this guide.	4	<a href="https://uk.farnell.com/raspberry-pi/raspberry-pi-pico/raspberry-pi-32bit-arm-cortex/dp/3643332">https://uk.farnell.com/raspberry-pi/raspberry-pi-pico/raspberry-pi-32bit-arm-cortex/dp/3643332</a>
002	DTS63K	37	tactile switch 7mm height, 1N	1N force is recommended	5	<a href="https://uk.farnell.com/multicomp/mcdts6-3k/switch-spst-0-05a-12vdc-tht/dp/9471723">https://uk.farnell.com/multicomp/mcdts6-3k/switch-spst-0-05a-12vdc-tht/dp/9471723</a>
003	2K SMD 0603/0805 TH Ø1.8x3.2mm	2	Resistor (SMD or through hole)	for VGA	1 as marked	<a href="https://uk.farnell.com/multicomp/mf12-2k/res-2k-1-125mw-axial-metal-film/dp/9342788">https://uk.farnell.com/multicomp/mf12-2k/res-2k-1-125mw-axial-metal-film/dp/9342788</a>
004	1K SMD 0603/0805 TH Ø1.8x3.2mm	2	Resistor (SMD or through hole)	for VGA	1 as marked	<a href="https://uk.farnell.com/multicomp/mf12-1k/res-1k-1-125mw-axial-metal-film/dp/9342400">https://uk.farnell.com/multicomp/mf12-1k/res-1k-1-125mw-axial-metal-film/dp/9342400</a>
005	470R SMD 0603/0805 TH Ø1.8x3.2mm	2	Resistor (SMD or through hole)	for VGA	1 as marked	<a href="https://uk.farnell.com/multicomp/mf12-470r/res-470r-1-125mw-axial-metal-film/dp/9343245">https://uk.farnell.com/multicomp/mf12-470r/res-470r-1-125mw-axial-metal-film/dp/9343245</a>
006	820R SMD 0603/0805 TH Ø1.8x3.2mm	1	Resistor (SMD or through hole)	for VGA	1 as marked	<a href="https://uk.farnell.com/multicomp/mf12-820r/res-820r-1-125mw-axial-metal-film/dp/9343563">https://uk.farnell.com/multicomp/mf12-820r/res-820r-1-125mw-axial-metal-film/dp/9343563</a>
007	390R SMD 0603/0805 TH Ø1.8x3.2mm	1	Resistor (SMD or through hole)	for VGA	1 as marked	<a href="https://uk.farnell.com/multicomp/mf12-390r/res-390r-1-125mw-axial-metal-film/dp/9343148">https://uk.farnell.com/multicomp/mf12-390r/res-390r-1-125mw-axial-metal-film/dp/9343148</a>
008	82R SMD 0603/0805 TH Ø1.8x3.2mm	1	Resistor (SMD or through hole)	for VGA	1 as marked	<a href="https://uk.farnell.com/multicomp/mf12-82r/res-82r-1-125mw-axial-metal-film/dp/9343601">https://uk.farnell.com/multicomp/mf12-82r/res-82r-1-125mw-axial-metal-film/dp/9343601</a>
009	DSUB15 FEMALE	1	Connector Female 15 pin high density	for VGA monitor	8	<a href="https://uk.farnell.com/amphenol/l77hde15sd1ch4f/connector-hd-d-sub-rcpt-15pos/dp/2401182">https://uk.farnell.com/amphenol/l77hde15sd1ch4f/connector-hd-d-sub-rcpt-15pos/dp/2401182</a>
010	DSUB9 MALE	1	Connector Male	for Joystick	7	<a href="https://uk.farnell.com/amphenol/l717sde09p1ach4f/connector-d-sub-plug-9pos/dp/2401240">https://uk.farnell.com/amphenol/l717sde09p1ach4f/connector-d-sub-plug-9pos/dp/2401240</a>
011	SD card Reader SMD	1	Micro SD card SMD reader	9pin reader, check pad spacings for alternatives.	3	<a href="https://www.aliexpress.com/item/1925442705.html">https://www.aliexpress.com/item/1925442705.html</a>
012	LD-PZPN-3510	1	Piezo Buzzer	1.1khz square wave. Fixing hole pitch 40mm. Diameter xx	6	<a href="https://www.ebay.co.uk/itm/153996085384">https://www.ebay.co.uk/itm/153996085384</a> <a href="https://www.tme.eu/sk/details/ld-bzpn-3510/piezosireny-bez-generatora/loudity/">https://www.tme.eu/sk/details/ld-bzpn-3510/piezosireny-bez-generatora/loudity/</a>
013	JS202011CQN C&K or MSS-2235 NINIGI	1	Side switch	This is optional for powering on and off.	9	<a href="https://uk.farnell.com/c-k-components/is202011cqn/switch-dpdt-0-6a-6vdc-tht/dp/2320018">https://uk.farnell.com/c-k-components/is202011cqn/switch-dpdt-0-6a-6vdc-tht/dp/2320018</a>





Line #	Component	Pcs	Description	Note	At Position*	Example supplier**
Mechanical Fittings						
014	M2 x 6 screw c/w nuts	2	Black nylon screw with nuts	Used for mounting piezo buzzer	6	<a href="https://www.amazon.co.uk/gp/product/B09439W4WJ/ref=ppx_yo_dt_b_asin_title_o01_s00?ie=UTF8&amp;psc=1">https://www.amazon.co.uk/gp/product/B09439W4WJ/ref=ppx_yo_dt_b_asin_title_o01_s00?ie=UTF8&amp;psc=1</a>
015	M2 x 12 screw	4	Black nylon screw	Used for mounting front panel	Corners of board	
016	M2 washers	16	Black nylon washers/spacers	Spacers between main and front board	Corners of board	
017	M2 x 20 standoffs	2	Black stand off for top end of board	Feet at top of board to raise from VGA and Joystick ports	Corners of board	
018	M2 x 6 standoffs	2	Black stand off for bottom end of board	Feet at bottom end of board	Corners of board	
Items 015 to 018 are not required for Package Option 1 (without a front panel)						

### Raspberry Pi Pico - CHECK



Warning! RetroVGA utilizes overclocking of the Raspberry Pi Pico. It has been found that some Pico do not run at the required 250Mhz. Please undertake the following check before soldering the board.

1. Upload the firmware as detailed in the **Uploading binaries to the Raspberry Pi Pico** section of this guide.
2. If successful, the Pico onboard LED should flash.
3. Unplug the Pico and then plug in again.
4. If the onboard LED flashes again then the board is ok to use.
5. If not, do not solder the board, unfortunately the board you have cannot be overclocked.



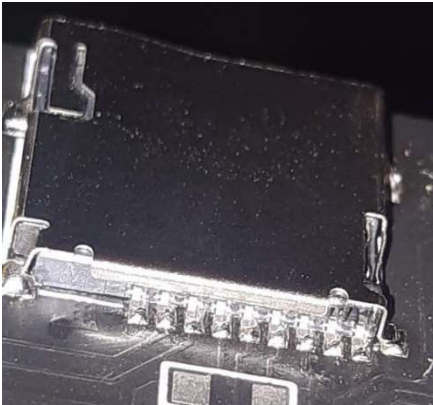
# RetroVGA – by Bobricius

## USER GUIDE



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### Assembly instructions



Soldering the components should be relatively simple for those with some soldering experience and access to suitable soldering tools. Note that there is an SMD component (this is limited to the SD card reader), even if you have chosen the through hole option for the resistors.

If you are not experienced with SMD, take your time, and relax. I recommend good magnification; you can improvise a microscope from a cell phone - in video mode at maximum zoom to help! Bobricius has some useful videos on his YouTube channel.

[https://www.youtube.com/watch?v=PBCdbF2flsc&ab\\_channel=PeterMisenko](https://www.youtube.com/watch?v=PBCdbF2flsc&ab_channel=PeterMisenko)

Start by studying the PCB, both sides and the location of items. I like to perform dry fits where needed so that you have an idea of where everything should go and what might get in the way when soldering. There is no complication with the polarity of the default components on this board, so one less thing to worry about.

For the Raspberry Pi PICO installation, I recommend using temporary header pins or bent wire pins to locate and align the board. Make sure the board is in the right orientation, tack in place then remove the temporary pins and solder all edge holes to finish. Note that you could socket the Pi PICO for removal, by using female headers on the board, but this will mean you cannot install the front plate, as it will be too high for the button access.

I recommend the following sequence when soldering the board together, starting with shortest height items first:

1. SD card Reader
2. Resistors
3. Raspberry Pi PICO (**don't forget to check firmware before soldering**)
4. Tactile switches
5. Piezo Buzzer. If using the piezo buzzer don't forget to close the solder jumper as marked on the back of the main board.
6. Turn board and install joystick and VGA sockets.

### Optional Features/Developer Notes



Warning! Those wishing to tinker with the TFT header and any other unpopulated SMD pads on the board, you are welcome to have a go at your own risk. Please note that these will not be supported!

*Item 2 - 100n SMD 0603/0805 (or Radial Can SMD on bottom of board). This part is optional for SD card power filtering and can be omitted.*

*Item D – A TFT screen header, for developers only.*

*Item E - For a 2040 speaker instead of the piezo. Typically, a BSS123 and BSS84, 22uF - to 100uF SMD electrolyte or MLC capacitor.*

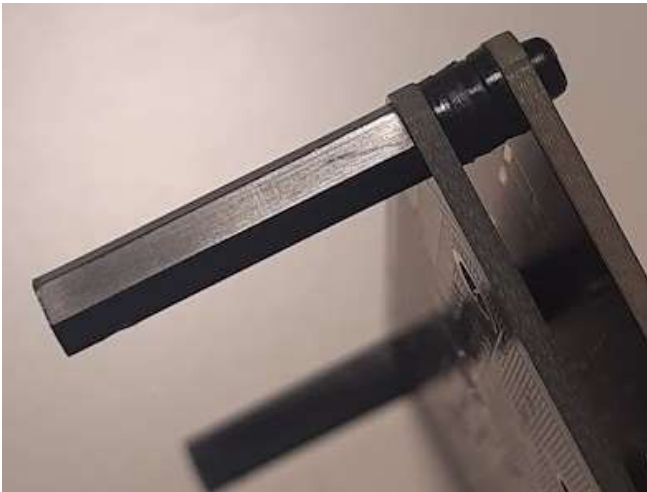
*Item G – 3.5mm audio jack and filters for connection of an external amplifier.*

## Mechanical Assembly

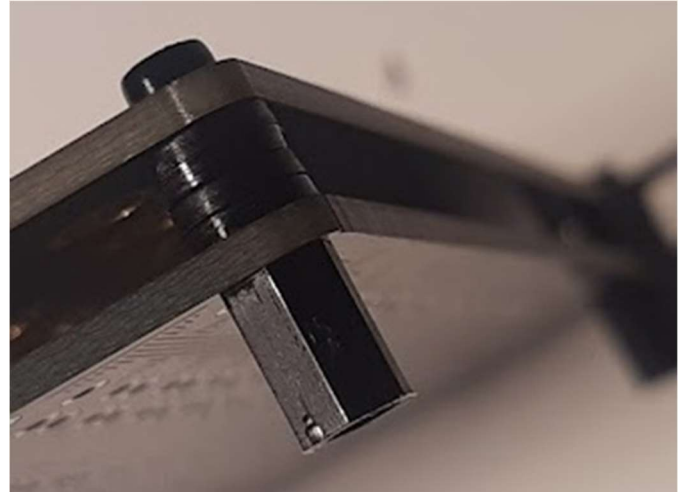
The piezo buzzer can be fixed with two M2 x 8 screws and nuts.

### Package Option 2

If you have Package Option 2 then there are some fixings needed for the front plate. The BOM provides a guide to a neat option. The key considerations as follows. The spacers between the boards, too short and the front panel may not sit level, and too long and the tactile switches may not protrude above the front panel. Feel free to adjust here, I found M2 nylon washers to allow sufficient adjustment. The feet at the back of the board also need to be long enough to raise the board above the VGA and joystick ports. See illustration below as to a typical set up using the guide items in the BOM.



*Feet at top of board*



*Feet at bottom of board*

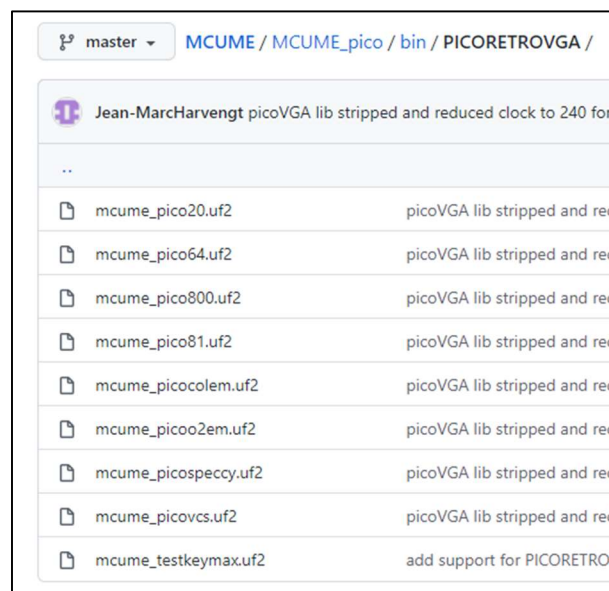
## Software Installation

Once assembly is complete you are ready to install the RetroVGA software to the board. There are two main steps.

1. Upload of an emulator binary to the Raspberry Pi Pico board.
2. Set up of the micro-SD card.

Compiled uf2 binaries for the Raspberry Pi Pico are available from

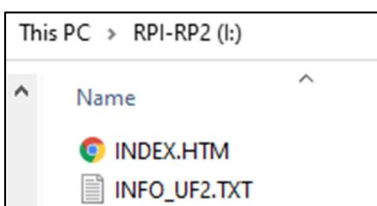
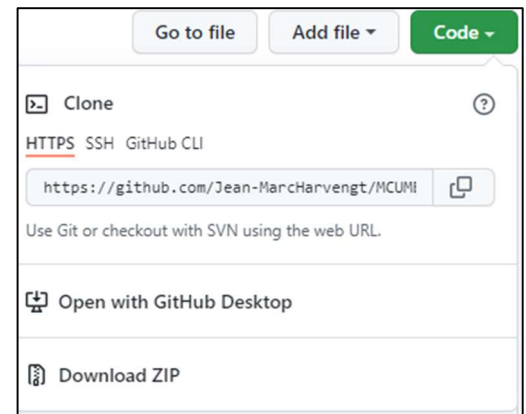
[https://github.com/Jean-MarcHarvengt/MCUME/tree/master/MCUME\\_pico/bin/PICORETROVGA](https://github.com/Jean-MarcHarvengt/MCUME/tree/master/MCUME_pico/bin/PICORETROVGA)





## Uploading binaries to the Raspberry Pi Pico

- Go to <https://github.com/Jean-MarcHarvengt/MCUME>, press the green code button and download the Zip file.
- Extract the downloaded Zip file and navigate to MCUME-master\MCUME\_pico\bin\PICORETROVGA
- This folder contains the .uf2 files needed by the Raspberry Pi Pico.
- Hold the BOOTSEL button on the Raspberry Pi Pico and connect it to your PC via the USB connector.



- The Raspberry Pi Pico will be recognized as a USB device on your PC.
- Grab the required .uf2 file and copy it to the Pico USB device.
- The Raspberry Pi Pico will then disconnect and is ready to go.

## Compilation from source

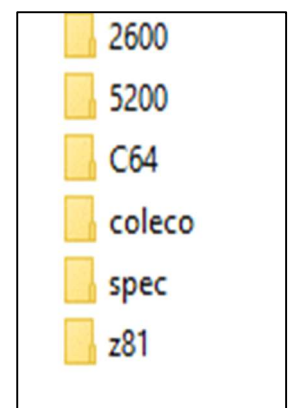
Although binaries are available, it is possible to compile your own from source if you wish but this is not supported by Bobricius. Please note that you will need to set up the Pi Pico C/C++ Toolchain for compilation of the sources.

More information is provided in the <https://github.com/Jean-MarcHarvengt/MCUME> repository.

## Set up of the micro-SD card

The micro-SD card needs to be set up correctly for the associated emulator files to be recognized.

- Format the SD card as FAT32
- An SD root directory is available from the downloaded zip file. Extract the content of SD.zip in the root directory of the SD card.
- There must be a sub-directory for each emulator.
  - "2600" for Atari vcs, put your Atari 2600 roms here (.bin), with sub-directories if required.
  - "5200" for Atari 5200, put your Atari 5200 roms here (.bin).
  - "800" for Atari 800, put your Atari 800 cartridges here (.rom).
  - 'c64" for c64, put your C64 programs here (.prg), with sub- sub-directories if required.
  - "o2em" for odyssey/videopac, put your Videopac/Odyssey roms here (.bin).
  - "coleco" for Colecovision, put your roms here (.rom, including coleco.rom)
  - "spec" for spectrum, put your ".z80" or ".sna" files here into sub-directories if required. Note maximum 48K support only.
  - "z81" for zx81, put your ".p", ".81", ".56", ".80" or ".o" files here (max 56K)



- Insert the card into the SD slot

Now you are ready to go!



## References and Credits

### **Hardware by Bobricuis**

<https://www.tindie.com/products/bobricuis/retrovga-raspberry-pico-multi-retro-computer/>

<https://hackaday.io/project/183398-retrovga-raspberry-pico-multi-retro-computer>

<http://pemi.technology/>

### **Software**

<https://github.com/Jean-MarcHarvengt/MCUME>

Refer to Credits at this link for emulators.

### **Pico VGA hardware and software**

Miroslav Nemecek <https://github.com/Panda381>

### **User Guide**

AdamT @AdamT117 <https://twitter.com/AdamT117>