

PicoMite VGA Basic

Version 1.0

A "1980's feel, boot to BASIC" home computer using modern technology and an advanced BASIC interpreter. Assembly is well within the capabilities of most home constructors.

PicoMite VGA Basic

The PicoMite VGA Basic is only 90mm x 50mm but has good specifications:

- Based on a Raspberry Pi Pico running at 126MHz (with option to overclock to 252MHz)
- Powerful structured BASIC interpreter (and say goodbye to line numbers!)
- Connection to a VGA monitor and standard PS/2 keyboard (US, UK, DE, FR or ES)
- Built-in program editor with optional colour-coded listing , automatic jump to error line and automatic load of last edited program on power up.
- 16 Colours available at 320x240 resolution
- 2 Colours available at 640x480 resolution, but coloured "tiles" are available.
- Two "drives" can be used for program and data storage. Drive A uses some of the flash memory on the PicoMite and is always available. If an SD card is fitted it is seen as Drive B. Additionally there is also internal program storage available in flash memory "slots". These can be chained to create programs that are bigger than the user RAM area.
- SD cards are normally standard size and are FAT formatted, allowing data exchange with a PC. A micro SD card socket can be fitted instead if required, but this is purely optional.
- Good quality audio output via a 3.5mm stereo jack socket
- GPIO port with three multi-purpose pins exclusively for the user
- Reset button
- 5V DC input via barrel jack socket, with polarity protection
- Linear voltage regulator for reduced audio noise level

The BASIC interpreter, MMBasic, is by Geoff Graham and Peter Mather. The source code for the PicoMite VGA firmware is available on Github. See MMBasic manual for details.

The audio Filter was designed by Volhout.

The PCB design & this manual are by Mick Ames (Mixel 90).

Support, where reasonably possible, is via [The Back Shed Forum](#)
MMBasic & its manual are available from [Geoff Graham's web site](#)

<p>NOTE: No guarantee is given that this equipment will perform to any specification. No guarantee is given that it is fit for purpose. No Liabilities or damages will be accepted for any reasons whatsoever. By building and/or using this equipment it is deemed that you accept these conditions in full.</p>
--

ERRATA

None

Bill Of Materials

Name	Value	Comment
C1	100u/6V	Aluminium electrolytic
C2	100nF	
C3	22uF Tant	
C4	100nF	
C5	33nF 5%	RS 312-1504
C6	2.7nF 5%	RS 19-0507
C7	68nF 5%	RS 312-1532
C8	33nF 5%	RS 312-1504
C9	2.7nF 5%	RS94-0507
C10	69nF 5%	RS 312-1532
C11	22uF	
D1	1N5818	1A Schottky type
K1	3.5mm x 1.1mm Barrel jack	
K2	3.5mm Jack	RS 705-1490
K3	VGA Skt	Standard connector
K3	VGA Skt	Compact connector (alternative)
K4	PS2 Skt	
K5	6-pin Male Header	
K6	SD Card Skt	DM1AA-SF-PEJ(72)
K6	Micro SD Skt	TFP09-2-12B (alternative)
L1	4.7mH	RS 191-1197
L2	4.7mH	RS 191-1197
Q1	2N7000	
Q2	2N7000	
R1	2R2	
R2	220R	
R3	220R	
R4	10K	
R5	10K	
R6	10K	
R7	10K	
R8	270R	
R9	390R	
R10	820R	
R11	270R	
S1	6x6 Tactile sw	
U1	LM1117T	
U2	PicoMite	with Male header pins & 2x20-way SIP skts

The layout for the MOSFETs Q1 & Q2 on the pcb is source-gate-drain when facing the flat side. Devices that correspond with this layout, in order of desirability, are TN0702N3-G, ZVNL110ASTZ, VN10KN3-G and 2N7000. The latter may be marginal in operation at low temperatures as $V_{gs(th)}$ is a little too high. BS170 should also be a good choice, but install it the opposite way round to the pcb marking.

K3 and K6 both have alternative components

Audio Output

The stereo audio PWM output from the PicoMite has a carrier frequency of about 40kHz (similar to the sample rate of a CD). This is at a high amplitude, but above the highest audible frequencies. However, modern amplifiers and speakers can often amplify it, where it can cause excessive heating in amplifier output stages and in the tweeters used in good quality speakers. It also "beats" with audible frequencies to produce unpleasant distortion in some cases. For this reason it has to be filtered out as much as possible.

The audio filter used in this design is a good compromise between complexity and capability. It has a virtually flat response up to about 12kHz. Above that the response falls rapidly, resulting in very little output at 40kHz. This results in audio reproduction that's good enough for the majority of people, even though the highest frequencies are much reduced and it isn't of hi-fi quality. To achieve this you need to have, in particular, the correct inductor for L1 and L2. The values of C6 and C9 are also important. Note that the highest frequency of hearing is usually taken to be about 20kHz, but in actual fact the majority of adults don't have hearing that can reach that high.

If the PicoMite VGA Basic is only going to be used with headphones then a simpler circuit can be used. Do not do this if it will be connected to an amplifier of any sort as it is quite poor at filtering out the 40kHz frequency. This isn't a recommended modification, but will usually give higher volume on headphones.

- Change R2 and R3 to 4K7
- Omit L1 & L2 completely
- Replace C6 and C9 with 100uF 10V electrolytic types, with + wire towards R2 & R3
- Change C5 and C8 to 100nF
- Replace C7 and C10 with 10k resistors

The maximum volume is set by the values of R2 and R2 and will depend on the sensitivity of the headphones used. The value may be reduced if there is insufficient volume, but it should not go below 1k as they also protect the outputs against short circuit. Low impedance headphones (around 8 ohms or below) are unlikely to give good results as the PicoMite has insufficient output current to drive them. 35 ohm headphones are recommended.

Constructional Notes

It's a good idea to follow the normal construction technique of fitting the lowest components first and working your way up. I prefer to start with any surface-mount devices as they usually need more access for the soldering iron tip. In this case, fit the SD card socket and the audio socket. Next, fit the resistors then the sockets for the PicoMite. Leave larger items such as the VGA and PS/2 sockets until last.

Although the Audio socket and the (standard size) SDcard socket are both surface mount types they are both very easy to fit using a conventional soldering iron. Both have locating holes to ensure that the pads are correctly aligned. The micro SD card socket is more difficult to fit! It is possible to solder it with a fine, pointed tip on a conventional or "pencil" style soldering iron.

Installing the firmware

The Raspberry Pi Pico comes with its own built in firmware loader that is easy to use. Just follow these steps:

- Download the PicoMite VGA firmware from <http://geoffg.net/picomite.html> and unzip the file. The firmware you want will have a ".uf2" extension and will have VGA in the filename. Do not use a file that doesn't have VGA in the name as it won't work.
- Using a USB cable plug the Raspberry Pi Pico into your computer (Windows, Linux or Mac) while holding down the white BOOTSEL button on the Raspberry Pi Pico.
- The Raspberry Pi Pico should connect to your computer and create a virtual drive (the same as if you had plugged in a USB memory stick) called "RPI-RP2". This drive will contain two files which you can ignore.
- Copy the firmware file (with the extension .uf2) to this virtual drive. It only takes a few seconds.
- When the copy has completed the Raspberry Pi Pico will restart and create a virtual serial port on your computer. The LED on the Raspberry Pi Pico will blink slowly indicating that the PicoMite firmware with MMBasic is now running.

While the virtual drive created by the Raspberry Pi Pico looks like a USB memory stick it is not, the firmware file will vanish once copied and if you try copying any other type of file it will be ignored.

Loading the PicoMite firmware will erase the flash memory including the current program, any programs saved in flash memory slots and all saved variables. So make sure that you backup this data before you upgrade the firmware.

Settings

The following options should be used to configure MMBasic for this hardware:

OPTION SDCARD GP14, GP13, GP15, GP12
OPTION AUDIO GP6, GP7

If an I2C connection is to be set up on the Expansion port:
OPTION SYSTEM I2C GP26, GP27

Further usage of MMBasic is not covered here, please see the PicoMite VGA User Manual. This is available , together with the firmware, from Geoff Graham's web site as noted previously.

APPENDIX 1

Pictures of the more unusual components used. Most of these were found to be available from several ebay suppliers. The compact VGA socket was obtained from a Chinese supplier. There is a larger format of VG socket which is available, the PCB is designed to accept either type.

The 3.5mm x 1.1mm barrel jack socket may not be easy to find outside China, where it is very common. USB-A to 3.5mm barrel jack leads are available from various suppliers. If the source of 5V is only going to be via the USB connection then it is unnecessary to fit this or D1.



APPENDIX 2

Expansion Port

Viewed from front of connector pins:

RST 3V3 P26 P27 P28 GND

No protection for the pins has been incorporated.

Note: DO not exceed 3V6 on any of the PicoMite inputs or they may be damaged.

P26, P27 and P28 are addressed as GP26, GP27 and GP28 or as ADC0, ADC1 and ADC2.

Any of them can be used for digital IO or as Analogue inputs (0-3.3)

Note that there are errors on the RP2040 chip that limit the ADC useful resolution to about 8 bits.

Additionally it is possible to use the Expansion Port as an I2C interface:

P26 = I2C2 SDA

P27 = I2C2 SCL

P28 can be used as an interrupt input to trigger a read operation.

The Expansion Port pins are laid out to allow a little RTC module (pictured in Appendix 1) to be plugged into the rightmost five pins.