PicoMite VGA mini

A baby "1980's" home computer based on the Raspberry Pi Pico with PicoMite VGA edition firmware. Please also see the PicoMite manual.

MMBasic is by by Geoff Graham and Peter Mather. The PCB design & this manual are by Mick Ames.

	Bill of materials		
	Printed circuit board	1	See note 1
	Case 90mm x 70mm x 28mm	1	See notes 3, 4
U1	Raspberry Pi Pico	1	With male header pins fitted
U2	LM1117T 3.3 SOT-223 package	1	See note 2
U3	LM4040 3V0	1	Optional. See Appendix 2
	4-channel level shifter module	1	See note 3
	microSD card module	1	See note 3
	RTC module (tiny version)	1	See note 3
K1	3.5mm x 1.3mm barrel jack socket	1	See notes 3, 5
K2	PS/2 Keyboard socket	1	
K3	VGA socket (compact style)	1	See note 3
K4	3-connection 3.5mm stereo jack socket	1	Pro Signal PSG03613 See note 3
J1	2x13 pin right-angled box header	1	
	Right-angle 6mm tactile switch	1	
R1, R4	4k7 0.25W	2	See Audio Output section
R2, R5	0R (link)	2	See Audio Output section
R3, R6	Not fitted	0	See Audio Output section
R7	2R2 0.25W	1	
R8, R9	4k7 0.25W	2	
R10, R11, R12, R14, R15, R16, R17	220R 0.25W	7	
R13	200R 25 turn cermet potentiometer	1	Vishay M64X201KB40
C2, C3, C9	100nF	3	
C1	100uF 10V electrolytic	1	
C5, C6	Not fitted	0	See Audio Output section
C7	22uF 25V Tantalum electrolytic	1	
C8	10uF 10V electrolytic	1	
D1	1N4001	1	
D2, D3	1N4148 or 1N914	2	
	0.1" female header strip - 20 way	2	Pico mounting. See note 6
H3	0.1" female header strip - 2 way	1	
H4	0.1" female header strip - 4 way	1	
H5	0.1" female header strip - 5 way	1	RTC mounting. See note 6
H1, H6	0.1" male header strip - 3 way	2	
H2	0.1" male header strip - 2 way	1	
	0.1" header link for H6	1	

Component Notes

1. To keep costs down the PCB is supplied as a single piece, to be cut up by the constructor. On it are the main PCB, the two case end plates and an expansion PCB (whose use is completely optional). Cutting is best carried out using a sharp craft knife and a vice. Clamp the PCB in the vice, lining up the line to be cut (the PCB is marked on both sides) along the top of the vice jaws. Score along the line using the vice as a guide. Four or five cuts on both sides of the board will normally be sufficient (you need to go through the copper and partway into the board). Then just bend the PCB and it will snap along the scored line. This needs some force as the FR4 material is remarkably strong. If you sand or file the edges afterwards, wear a dust mask as the glass fibres are very fine.

2. The analogue regulator is optional. Linking the pins on H2 disables the on-board switching regulator on the Pico. The analogue regulator can then be connected to power the system by linking pins 2-3 on H1. Using the analogue regulator is recommended when using line level audio output or if the best ADC performance is required. The SOT-223 package is a surface mount device and is mounted underneath the PCB. The stated rating is 800mA, but there is insufficient heatsink area to handle this. It is possible to get a regulated 3V3 supply and GND from pins 1 & 2 of H1 to use as an auxiliary supply in addition to the PicoMite switching regulator. This could be used, for example, to power a RF transceiver module, such as an ESP8266-01S, mounted in the free pads area.

3. These items were obtained from various ebay sellers. It is likely that they will also be available from other similar sources. See Appendix 1 for pictures of these items.

4. Not all of these cases are supplied with fixing screws! They use self-tapping screws in sizes No.2 x 10mm for the case and No.4 x 6mm for PCB mounting, although the latter are not really needed if the PCB is secured by the end plates. There are at least two variations on this box and they are slightly different internally and in the size & position of the end plates. Attempts have been made to make the PCB fit the two known examples, but the end plates may not fit one type. There is little that can be done about this, unfortunately.

5. Leads are commonly available to connect a 3.5mm x 1.3mm barrel plug to USB-A, so these can be used to connect the VGA mini to a normal 5V phone charger or computer USB socket.

6. The standard height female headers (about 9mm) are actually very slightly too high (probably little less than 0.5mm) to fit this box. 5mm high headers are available but are not easy to find and are more expensive. Note that the low level connectors intended for IC pins are too small to accept male pin headers. Little can be done with the RTC apart from, perhaps, pull the male pins out of the moulding, fit them into the RTC then fit it to the PCB and solder from the bottom. That will gain approximately 2mm in height, which is more than enough.

Audio Output

Various options are available for audio output. The default as described in the Bill of materials is to simply connect headphones via 4k7 resistors. The maximum volume is set by the values of these 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 protect the outputs against short circuit. Low impedance headphones (around 8 ohms or below) are unlikely to give good results.

   As an alternative, the audio socket can be used at line level, to feed an external amplifier or amplified speakers. In this case the component values should be as follows:

R1, R4	1k0
R2, R5	2k2
R3, R6	2k2
C5,C6	47nF

This will give an output at the standard level of approximately 1V p-p.

Constructional Notes

Recommended "non-standard" tools for assembly:
A vice with 4" jaws
A heavy duty craft knife with a couple of sharp blades
Flush-cutting pliers (for both trimming component leads and nibbling the plastic box)
A scalpel for fine trimming of the box.
If you are really unlucky and your box is an odd version you may need a Dremel or similar.

The level shifter is mounted between the headers for the PicoMite. Solder male pin headers or pieces of bare wire to it as usual but then solder them directly into the PCB instead of using a socket, otherwise it won't fit. There is no need to wire LV1, LV2, HV1 & HV2 as these are not used. It may be a good idea to fit this to the PCB first, while there is space to work around it. Note that it has to be low enough for the PicoMite to be mounted above it.

The PCB is a little cramped in places, so it's a good idea to follow the normal construction technique of fitting the lowest components first and working your way up.

There will not normally be a need to install actual pin headers for H1 and H2. Most users will probably decide whether or not to use the linear regulator and hard wire them if necessary.

Note that the PCB will only fit correctly in one side of the case - the top and bottom are not the same.

Temporarily locate the positions of K1 and K4 first, but don't solder them until the end. This will make it easier to get their slots in the right positions on the case.

The case material can just about be cut with a sharp knife. However, pressure on the top or bottom faces over a small area can cause cracking until the case is assembled as there is little support at the ends. A good way is to use the knife to mark the cutout then nibble out as much as possible with cutters, finishing off with the knife and a scalpel. Small holes can be drilled for access to the reset button and R13, although R13 is unlikely to need further attention once set. It is used to obtain a white display, without a green cast, in colour mode.

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It is suggested that the SD card socket is NOT mounted in a female header as that will make it rather insecure (and put it at a difficult height). Instead. solder the pins directly to the pcb at a height such that the bottom side of the module (the side with the socket on) is flush with the edge of the box. This will allow a shallow notch to be cut in the box for the SD card rather than a slot (far more difficult).

PicoMite VGA mini

Installing the firmware
The firmware must be installed as detailed in the PicoMite manual.

In this particular construction, with standard size headers for mounting the Pico, the USB connection is accessible with the end plate at the I/O port end removed. If 5mm headers are used then the Pico will have to be removed for access to the USB port.

Settings
The following options should be set to configure MMBasic for this system:

OPTION SDCARD GP5, GP2, GP3, GP4
OPTION AUDIO GP6, GP7
OPTION SYSTEM I2C GP22, GP15

If the RTC is installed then you can also use
OPTION RTC AUTO ENABLE
to automatically load DATE$ and TIME$ from the RTC on boot up and every hour.
This can be disabled with
OPTION RTC AUTO DISABLE

There are two VGA screen modes:
Mode 1   640x480 with 1-bit colour
Mode 2   320x240 with 4-bit colour (RGB121)

You can switch between these in software using MODE 1 and MODE 2 commands

You can also select a default using
OPTION DEFAULT MODE n where n is the desired mode number

In mode 1 you can also set default colous for the display:
OPTION DEFAULT COLOURS fg [,bg]
if bg is missing it defaults to black.
Colours can be chosen from:
White, Yellow, Lilac, \brown, Fuchsia, Rust, Magenta, Red, Cyan, Green, Cerulean, Midgreen, Cobalt, Myrtle, Blue and Black
This setting is ignored in mode 2.

APPENDIX 1

Pictures of the more unusual components used. Most of these were found to be available from several ebay suppliers. The VGA socket was obtained from a Chinese supplier.
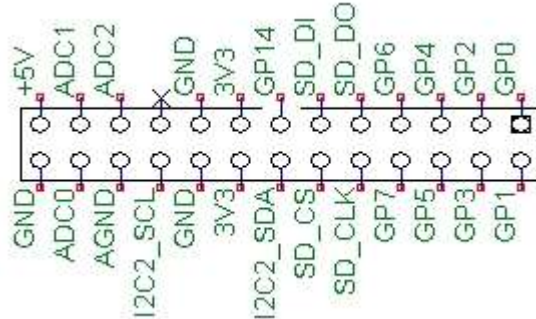
APPENDIX 2

The I/O Port

Viewed from front of connector.

Note that the 5V connection must NOT be connected to any other pin on the connector. The I/O pins are not 5V compatible and it is quite possible that the PicoMite would be damaged. This pin is intended to be used for an external module (future design) to power the VGA mini.

If the RTC isn't required then the I2C2 pins can be used as normal I/O pins GP15 & GP22, although you may not want to include R8 & R9 if this is the case. External 3.3V I2C devices can be connected to the I2C bus. Note that I2C displays are not supported on the PicoMite VGA edition.

The microSD card is also optional, but it is suggested that this is retained as it is a very useful addition. External devices can be added to the SPI bus if GP pins are allocated to their CS signals. Note that SPI displays are not supported on the PicoMite VGA edition. GP10-GP13 are used.

GP8 and GP9 are used for the PS/2 keyboard
GP16, GP17, GP18, GP19, GP20 and GP21 are used for the VGA display

GP0, GP1, GP2, GP3, GP4, GP5 and GP14 are not used internally and are available to the user.
If audio is not in use then GP6 and GP7 are also available.
The ADC pins are available as GP26, GP27 & GP28 if not used as analogue inputs.

ADC Inputs
By default, without U3 installed, the ADC inputs cover the range 0-3.3V. Inputs must not exceed 3.6V maximum. AGND is a low noise ground connection for the ADC inputs. To improve the ADC accuracy the 3V voltage reference U3 can be installed and
OPTION VCC 3.0
used either on the command line or in a program (it is not saved). This will change the ADC range to 0-3V. A 10k resistor followed by a diode to 3.3V will then protect the ADC input against over voltage.

APPENDIX 3

Drawings

PCB Layout
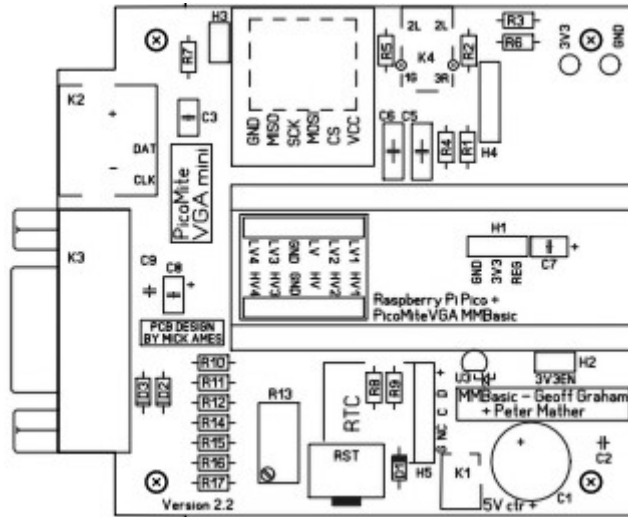
A small area of pads is available next to H4 for the user. The space next to the IO header can be used to add a LED, switch etc. if required. Additionally, the expansion board is designed to pick up on H3 and H4. H3 provides 5V and GND, H4 provides 3V3, GND and two spare pins for the user.

Circuit diagram

Title
PicoMite VGA mini for 90x70x28 box

Author
Mixtel90

File E:\TinyCAD\PicoMiteVGA.22.dsn

Document

Revision 2.2 **Date** 18 Mar 22 **Sheets** 1 of 1

MMBasic by Geoff Graham + Peter Mather

Note
Optional 3V precision voltage

Note
The RTC module has built in pull-up resistors so R8 + R9 are unnecessary. However they can be included if I2C2 is required without a RTC installed.

Note
Use of this module may have mechanical limitations depending on installed

Note
This connector is NOT compatible with the Micromite IO module system also designed by Mixtel90. However, the I2C signals can be wired out to a suitable module.
THERE ARE NO 5V COMPATIBLE IO PINS ON THIS MODULE

Note
D1 is an optional protection diode and can be linked out in most

Note
These components are not required in most cases