

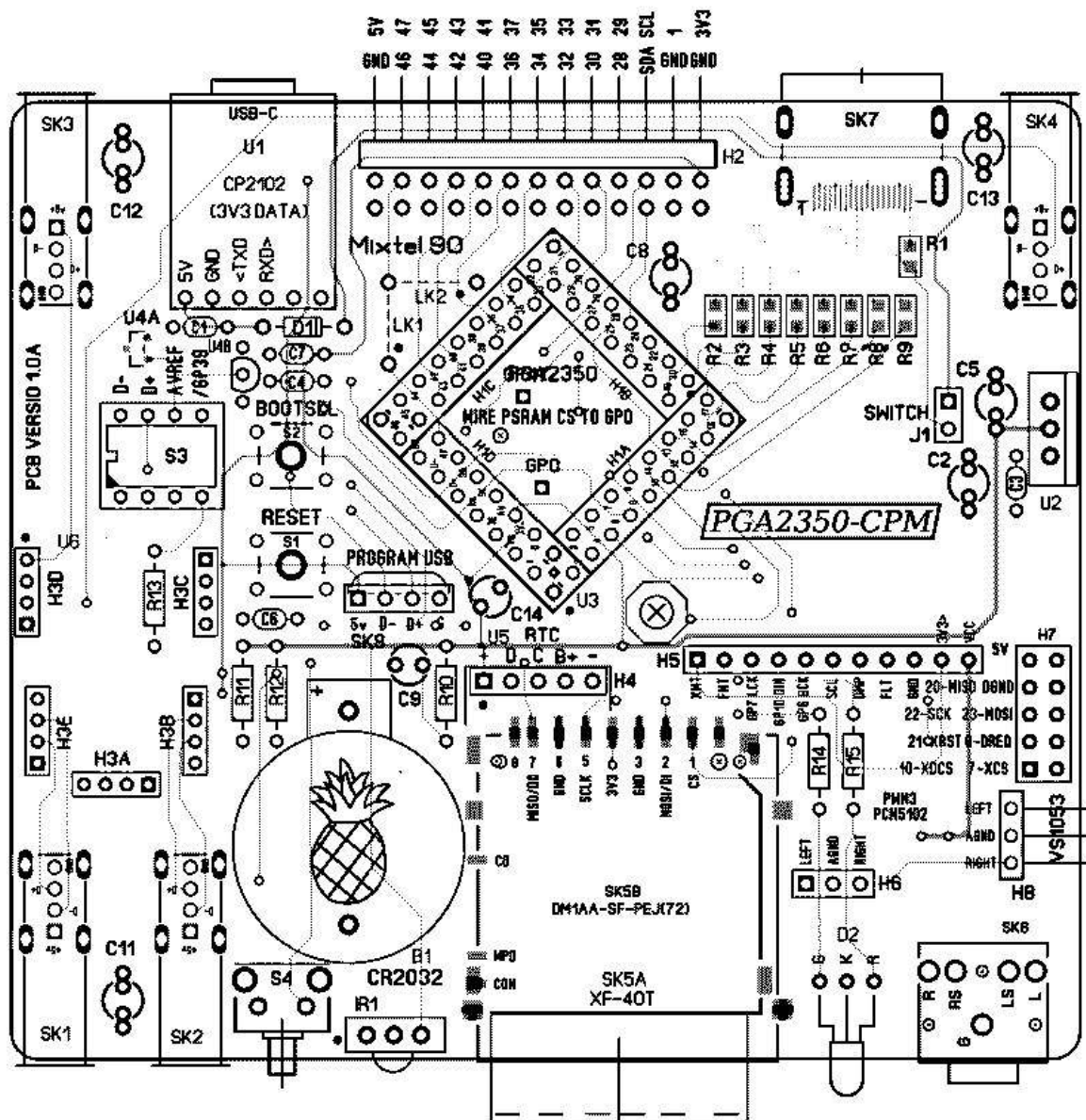
# PGA2350-CPM

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PCB version 1.0A & 1.0B Document version 1.0

First, what this isn't. It does NOT run the old CP/M operating system on a PGA2350 :) In this instance CPM stands for "Colour Pico Mite", a play on the CMM abbreviation for "Colour Micro Mite". It is designed to have quite a bit in common with the CMM2 in particular, using a vaguely similar layout, an (optional) OFF/ON switch, full size SD card and quite a few usable GPIO pins accessible from the rear.

Obviously it is a completely different system. The horsepower is provided by the Raspberry Pi RP2350B chip, in the form of the Pimorini PGA2350 module. Instead of PS2 and Wii connectors it uses a 4-port USB hub with USB-A connectors. Rather than VGA for its video output it has DVI over a HDMI connector and the audio output is much enhanced. The recommended enclosure is the Hammond RM2015S, which looks just like a "baby brother" of the enclosure used for the CMM2.



***Please note that this project is to be regarded as a little experimental. There have been problems in overclocking the PGA2350 module sufficiently to obtain some HDMI resolutions. Also some people have had problems with the PSRAM.*** I have disabled the switching regulator to reduce on-board supply line noise and used a higher powered linear regulator, attempting to keep the 3.3V supply to the module as "stiff" as is reasonably possible in the hope that this will help. The design also keeps the DVI signal traces clear of other traces that may introduce capacitive coupling as much as possible. An attempt has been made to keep the DVI trace lengths more or less equal. Obviously the performance of this system cannot be guaranteed and individual builds may vary depending on the PGA2350 used.

The GPIO connector includes the high speed counter input and access to the system I2C connections as well as 18 GPIO pins, 8 of which can be ADC channels. Two pins can be used as COM1 TX & RX (COM2 is dedicated to the console connection). Both 3.3V and 5V supplies are available.

There is a 4-way DIP switch on the PCB. The first two switches are used to disconnect the USB signals to the hub while installing and updating MMBasic. The third position is used to change the ADC reference voltage to 3V0. This is generally more accurate than using the on-board 3V3 as a reference. The fourth switch connects GP29 to GND via a resistor. If the input is set up using the internal pullup the state of the switch can be read from within the user's program for any purpose whatsoever.

By default the PG2350 uses GP47 (an ADC pin) as the select pin for the PSRAM. On this board the CS signal should be moved to GP0. If you do not wish to do this then you can still use GP47 and break a link to disconnect it from the GPIO port. An alternative (digital only) GPIO pin can then be connected to the port in its place.

In order to make the design as accessible as possible there are A and B versions of the PCB. Version A has 4 USB sockets and requires SMD soldering of the HDMI connector and associated resistors. The version number can be found on the PCB just above the USB hub module. Version B has 3 USB sockets (only one at the back) but uses the Adafruit DVI breakout module so doesn't require the most difficult SMD soldering. Please note that the circuit diagram is for Version A. Version B is very similar.

Both versions use a SMD full size SD card holder but these are relatively easy to fit.

Audio can use one of four different plug-in modules:

VS1053 multi-use CODEC

PCM5102 I2S DAC module

MCP48x2 SPI DAC (8-bit, 10-bit or 12-bit)

PWM filter (Volhout's design)

Any of these can be fitted and connected to the front panel audio jack. Note that the VS1053 output is intended for headphones only.

## Bill of Materials

For versions A and B of the PCB

Name	Value	Comment
B1	CR2032	Battery with holder (optional)
C1	100n	Ceramic cap
C2	22uF	Electrolytic capacitor
C3	100n	Ceramic cap
C4	100n	Ceramic cap
C5	10uF	Electrolytic capacitor
C6	100n	Ceramic cap
C7	100n	Ceramic cap
C8	10uF	Electrolytic capacitor
C9	10uF	Electrolytic capacitor
C11	10uF	Electrolytic capacitor
C12	10uF	Electrolytic capacitor
C13	10uF	Electrolytic capacitor
C14	10uF	Electrolytic capacitor
D1	1N5158	(or similar) 1A Schottky diode
D2	LED	2-colour common cathode 3mm LED
H2	2x13	0.1in 90 degree male pin header
H4	5-way	Male pin header
H5	11-way	0.1in female SIP socket
H6	3-way	0.1in male pin header
H7	2x5 way	0.1in female socket header
H8	3-way	0.1in horiz male pin header
H1A	2x8-way	0.1in female socket header
H1B	2x8-way	0.1in female socket header
H1C	2x8-way	0.1in female socket header
H1D	2x8-way	0.1in female socket header
H3A	1x4	2mm female SIP socket
H3B	1x4	2mm female SIP socket
H3C	1x4	2mm female SIP socket
H3D	1x4	2mm female SIP socket
H3E	1x4	2mm female SIP socket
IR1		38kHz IR receiver
J1	2-way	0.1in male pin header with jumper
LK1	closed	PCB configuration link
LK2	open	PCB configuration link
LK3	GP4	PCB configuration link
R10	2R2	Resistor
R11	4K7	Resistor
R12	4K7	Resistor
R13	470R	Resistor
R14	1K2	Resistor
R15	1K2	Resistor
S1	6x6mm	tactile switch
S2	6x6mm	tactile switch
S3	4-way	DIL switch
S4	B3F-315n	Horizontal 6x6 tactile switch

SK1	Vert. USB-A socket	FCI 73725-0110BLF (RS 771-0048)
SK2	Vert. USB-A socket	FCI 73725-0110BLF (RS 771-0048)
SK3	Vert. USB-A skt	FCI 73725-0110BLF (RS 771-0048)
SK6	3.5mm jack skt	square switched pattern
SK8	USB-C adapter	USB-C on 4-way male pin header
SK5A	XF-40T	Push-pull SD card connector
SK5B	DM1AA-SF-PEJ(72)	Push-push SD card connector

SK5A and SK5B are alternatives. Fit only one.

SP1          11mm          Plastic M3 threaded spacer (for VS1053 only)

U1	USB-C converter	CP2102 type 3.3V data
U2	LM1117T	3V3 LDO regulator TO220
U3	PGA3250	Pimorini module fitted with 4 off 2x8-way 0.1in male pin headers
U5	RTC	Mini RTC to fit Raspberry Pi
U6	FE11SX4	USB hub module fitted with 5 off 4-way 2mm pitch male pin headers
U4A	LM4040-3V0	Voltage reference SOT-23
U4B	LM4040-3V0	Voltage reference TO92

U4A and U4B are alternatives. Fit only one.

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#### For Version A of the PCB

R1	10K	0805 SMD resistor
R2	270R	0805 SMD resistor
R3	270R	0805 SMD resistor
R4	270R	0805 SMD resistor
R5	270R	0805 SMD resistor
R6	270R	0805 SMD resistor
R7	270R	0805 SMD resistor
R8	270R	0805 SMD resistor
R9	270R	0805 SMD resistor

SK4	Vert. USB-A skt	FCI 73725-0110BLF (RS 771-0048)
SK7	HDMI socket	

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#### For Version B of the PCB

See Assembly Notes as there are alternative arrangements

H9	11-way	0.1in female SIP socket
H10	3-way	0.1in female SIP socket

SP1	5mm	spacer etc. See assembly notes.
SP2 & SP3		M2.5 spacer. See assembly notes

Adafruit DVI breakout module

## AUDIO MODULES

VS1053 audio CODEC module      Obtained from AliExpress. See photograph.

PCM5102 I2S DAC audio module      Obtained from AliExpress. See photograph.

### SPI DAC

C81	100n	Ceramic cap
C82	100n	Ceramic cap
C83	10uF	Electrolytic capacitor
C84	100n	Ceramic cap
C85	100n	Ceramic cap
C86	47uF	Electrolytic capacitor
C87	47uF	Electrolytic capacitor
H81	11-way	0.1in male pin header
H82	3-way	0.1in male pin header
R81	120R	Resistor
R82	120R	Resistor
R83	1K	Resistor
R84	1K	Resistor
R85	10K	Resistor
R86	10K	Resistor
U81	LM33CZ	3V3 100mA LDO regulator
U82	MCP48x2	DAC

For U82 order as below:

MCP4802 - 8-bit resolution

MCP4812 - 10-bit resolution

MCP4822 - 12-bit resolution

There are no program changes needed in MMBasic.

### PWM Filter

C91	33nF	Capacitor
C92	33nF	Capacitor
C93	2n7	Capacitor
C94	2n7	Capacitor
C95	68nF	Capacitor
C96	68nF	Capacitor
C97	1uF	Capacitor
C98	1uF	Electrolytic capacitor
L91	4.7mH	Epcos B78108S 4.7mH
L92	4.7mH	Epcos B78108S 4.7mH
R91	220R	Resistor
R92	220R	Resistor
R93	4K7	Resistor
R94	4K7	Resistor
R95	4K7	Resistor
R96	4K7	Resistor

SK6



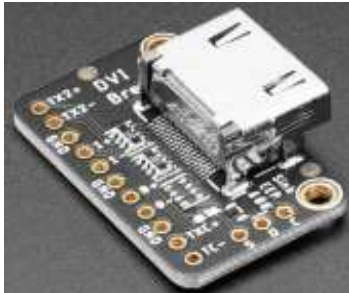
U5



U6



ADFRUIT DVI BREAKOUT



PCM5102 MODULE



VS1053 MODULE



SK8



U1



SK7



## Assembly notes

### Modifying the PGA2350



In the above photo there are two D shape pads with a fine link between them. The left-hand one is connected to GP47 and the right one is PSRAM\_CS. Cut the link. Solder some (I suggest 50- 75mm for ease of handling) of fine, insulated wire (Kynar or wire wrap are good) to the right hand pad. This mod is awkward if the pins have already been fitted but not too bad if they haven't. The flying lead will be used when installing the module.

The neatest way now is to strip and drop the other end of the wire through the GP0 hole of the PGA2350 before soldering the header strip into it. That way the wire is kept short and the module can still be unplugged easily. However it's much more awkward if you want to return it to GP47 for any reason.

## Further Assembly

As usual, assemble the board from the lowest components upwards. Also take special note of areas like the one around the audio jack, where it would be very awkward to fit SK2A after the jack socket!

It is recommended that SK8 is soldered in position rather than plugging it into a header.

When preparing the VS1053 module fit the male pin header from the component side of the module. It is plugged into the main board with its copper side to the top. You need to fit 3 wires from the on-board jack socket connections terminating in a connector to fit H8.

Note that the 4-pin headers and sockets for the USB hub are 2mm pitch and not 2.54mm (0.1in).

The RTC module has an on-board lithium cell, which is not charged from the power rail. Eventually these die (and you have no idea how long the module has been in storage when you get it). By removing the cell and putting a wire link from the pad closest to the connector round to the normally unused pin you can connect it to the CR2032 cell.

When installing the PG2350 first pass the flying lead down through the hole in the PCB then plug the module in. Turn the pcb over and connect the flying lead to the square pad marked GP0. It would be a good idea to shorten the wire, but leave a few mm spare. If you want to go back to GP47 for any reason just move the flying lead to the square GP47 pad. If you do this break LK1 and connect LK2. This will disconnect GP47 from the GPIO port on the rear and replace it with GP38.

The usual MMBasic Heartbeat LED isn't present on the module and the GP25 output is not used as a Heartbeat signal. A red/green (or any other colours but I have assumed red/green) dual LED is fitted. Green is normally controlled by GP4 and red by GP5. If LK3 is changed over green becomes a Power On LED, fed from the 3V3 supply. GP4 is then unused.

It is recommended that U1 is fixed to the PCB with double sided tape to stabilise it.

If you wish to fit a power switch then connect it to J1 instead of a jumper.

The regulator U2 will get warm in normal operation. In this particular application you'll normally be able to get away without a heatsink as the maximum possible current into the unit is 0.5A (U1 is fitted with a fuse). You may consider it prudent to fit one if the ambient temperature is above 25C or so. A simple piece of aluminum sheet or angle section should be adequate. It can overhang the side of the PCB. If you prefer a "proper" heatsink then the Aavid ML7G will fit nicely.

## Version B Notes

USB2 of the hub module is not connected in this version. You can omit its connectors if you wish.

Version B of the PCB can be made in 2 ways. One option is to solder the Adafruit module down to the PCB, the other is to use spacers so different display modules can be plugged in.

In the first instance the module can be either placed onto the PCB and the connections made by using short pieces of wire to stake through. You could use male header pins soldered top and bottom, in which case short spacers with nuts and bolts through the fixing holes could reinforce it.

In either case it may be necessary to fit a 5mm space under the pcb, using the same fixing screw as one of the module fixings. This is because it may not be possible to use the moulded PCB fixing pillar in the enclose as that may have to be at least partially cut away.

For a plug-in system, using the usual female SIP sockets, you will need 11mm spacers to secure it. An enclosed plug-in system will not fit into the RM2015S enclosure, due to the additional height of the display module(s). You will need the RM2015M, which has an overall height of 2in..

The plug-in system uses the same display modules as my PicoMite Multi design. Full details of them are available in that construction pack. They are not detailed here as it is considered that very few people will be interested in using a PGA2350 with a SPI LCD or VGA display.

## Installing MMBasic

Simply follow the instructions in the MMBasic manual, but first turn switches S1/1 and S1/2 (labeled DM and DP respectively) to the OFF position. If you fail to do this then Windows will not recognize the Pico as a folder. Remember to restore these switches to the ON position afterward or the USB hub will not be recognized.

## Configuration

LK1 should be closed to connect GP47 to the GPIO port.

LK2 should be open.

LK3 normally connects the green LED to GP4. You can change this over if you prefer the green LED to indicate Power On.

MMBasic options:

OPTION HDMI PINS GP13, GP15, GP17, GP19

OPTION SYSTEM I2C GP24, GP25

OPTION RTC AUTO ENABLE

OPTION SDCARD GP26, GP3, GP11, GP2

OPTION PSRAM PIN 0

If the VS1053 audio module is used:

OPTION AUDIO VS1053 GP22, GP23, GP20, GP7, GP10, GP6, GP21

If the PCM5102 I2S audio module is used:

OPTION AUDIO OPTION AUDIO I2S GP10, GP6

If the SPI DAC audio module is used:

OPTION AUDIO SPI GP10, GP6, GP7

If the PWM audio module is used:

OPTION AUDIO GP6, GP7

S1/3 can be used to reduce the ADC reference voltage to 3V0 using a precision reference rather than using the 3V3 supply. This can be useful in reducing supply noise on the ADC signals as the inputs will read 0-3V instead of 0-3V3. To implement this close S1/3 and use:

OPTION VCC 3