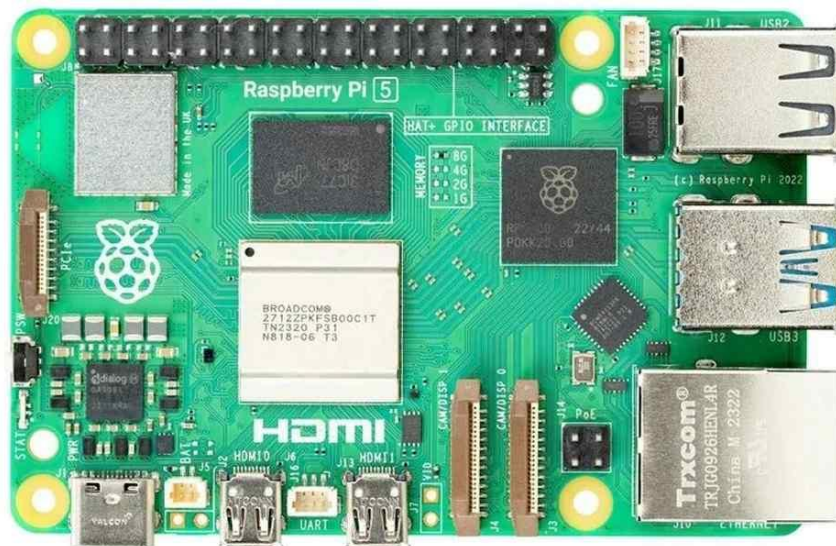


Raspberry Pi

Tutorial

Using RPi.GPIO calls on a Raspberry Pi
Model 5 or Bookworm OS



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Introduction

The Raspberry Pi Model 5 was introduced at the end of 2023. It only works with **Raspberrypi Bookworm OS** or later.

However, the biggest impact for most developers is that the **RPi.GPIO** input/output library does not work on the **Raspberry Pi model 5** or on systems running **Bookworm**. This is because the **RPi Model 5** now has a separate chip called **RP1** for controlling I/O including the pins on the GPIO header (**j8**). In the case of Bookworm, the authors of **RPi.GPIO** have apparently not yet updated their software (this will no doubt change in the future). This means that hundreds of thousands of programs or maybe even millions of programs need to be modified to use one of the newer libraries such as **gpiod** or **lgpio**. The **RP1** chip also controls USB ports, Gigabyte Ethernet, MIPI Camera Controllers and Low Speed Peripherals compatible with earlier versions of the Raspberry Pi.

My own product, the **Raspberry Pi Internet Radio** is also such a program and would have meant a lot of work to convert all the GPIO routines to say **GPIOd** which does run on the **RPi Model 5**. So, I decided to write a simple interface called **GPIOconverter** which converts **RPi.GPIO** calls to one of the newer **GPIO** interfaces. This is a so-called **software shim**. See the following link for more information: [https://en.wikipedia.org/wiki/Shim_\(computing\)](https://en.wikipedia.org/wiki/Shim_(computing)). I eventually settled on using the excellent **python3-igpio** library for the **GPIOconverter** software. **GPIOconverter** has been successfully tested on **LEDs**, **LCD's**, **Stepper Motors** and **Rotary encoders (KY-040, COM-09117 and PEC11R series)**. The architecture of the interface is shown below:

OUTPUT: User Program --> GPIO calls --> GPIOconverter --> LGPIO
INPUT: LGPIO events --> GPIOconverter --> User Program even handlers

The following illustration shows the location of the RPP1 I/O chip.

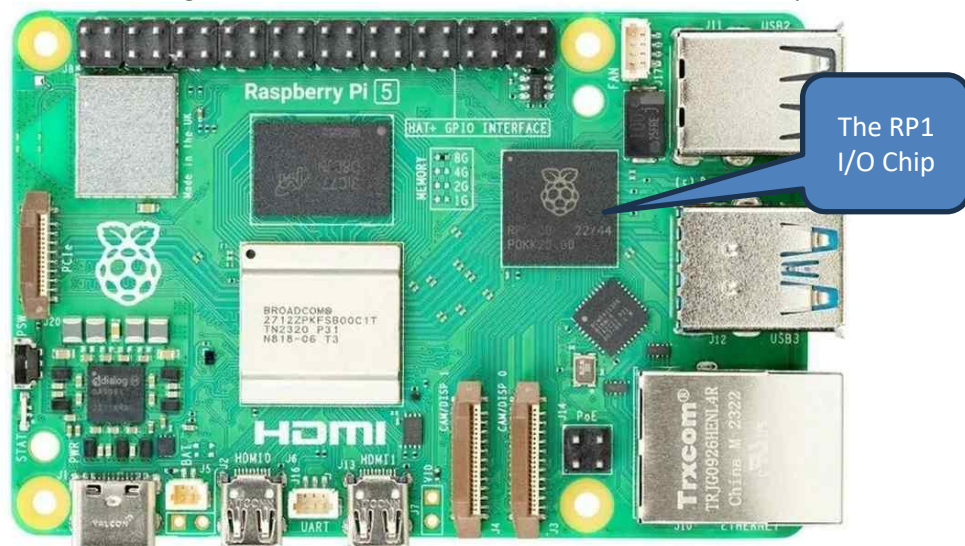


Figure 1 The Raspberry Pi Model 5 RP1 I/O chip

See *Appendix B - The RP1 general purpose I/O Chip* on page 14 for more information.

The latest version of Bookworm is now provided with a **python3-rpi-lgpio** package as a direct drop in for **RPi.GPIO** however I still experienced problems with Rotary Encoder support so I continue to use **GPIOconverter** which can be used as an alternative to **python3-rpi-lgpio**.

GPIO Hardware Notes

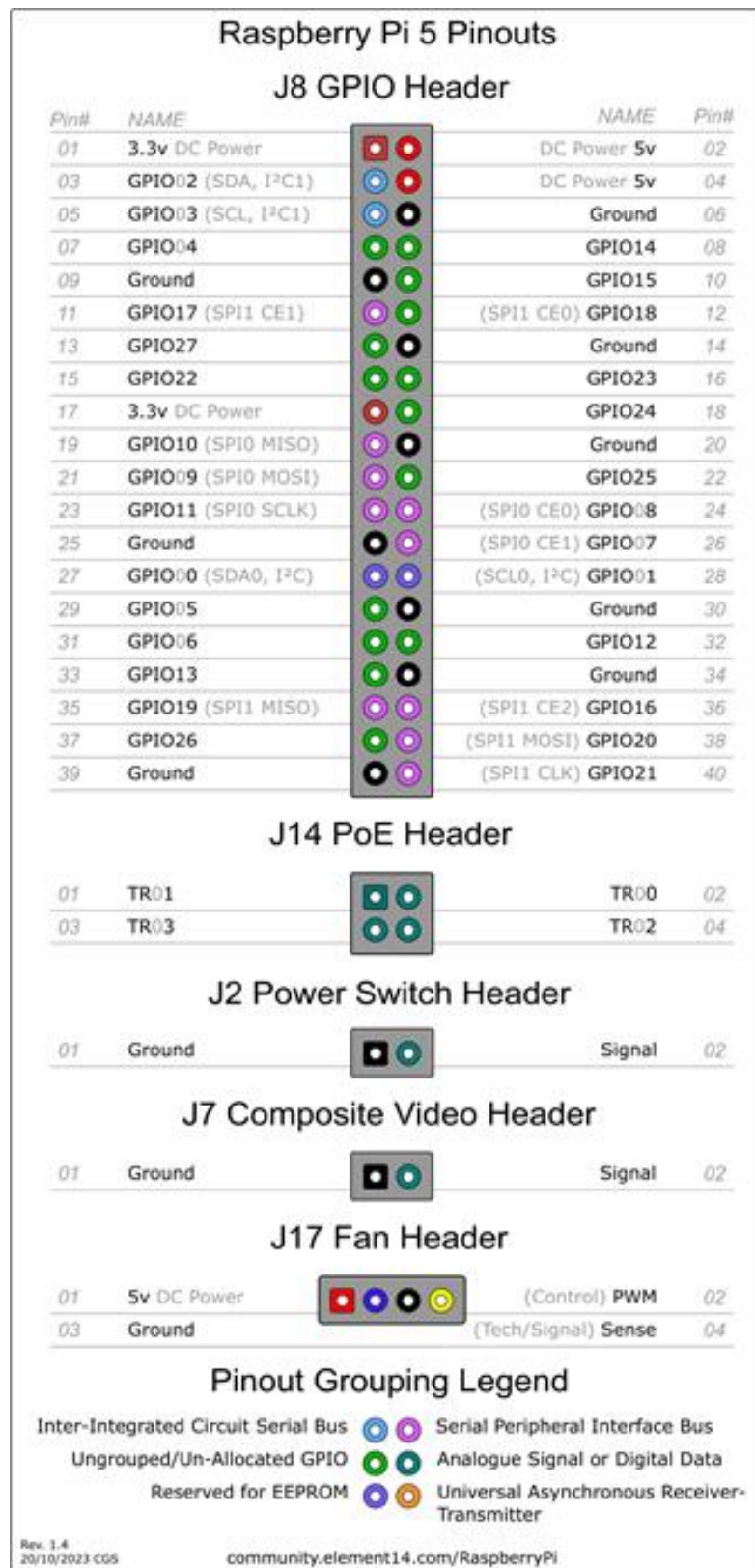


Figure 2 GPIO and other Headers Information

Conventions used in this tutorial

Installation of the radio program requires you to enter lines at the command line prompt. This requires you to log into the Raspberry PI as user '**pi**'. The default password is **raspberrypi**.



Note: Don't carry out any of the following commands just yet. They are just examples.

```
Raspberrypi login: pi
Password: raspberrypi
pi@raspberrypi:~$ Last login: Sun Apr  6 10:18:18 2014 from 192.168.2.100
pi@raspberrypi:~$
```

The prompt line is displayed ending with a \$ sign. The **pi@raspberrypi:~** string means user 'pi' on host machine called 'raspberrypi'. The ~ character means the user 'pi' home directory **/home/pi**. In this tutorial if you are required to do something as user **pi** then only the \$ sign will be shown followed by the command as shown in the example below:

```
$ pinout
```

Some commands produce output which does not need to be shown. In such a case a ':' is used to indicate that some output has been omitted.

```
$ pinout
Description      : Raspberry Pi 5B rev 1.0
Revision         : c04170
: {Output omitted}
J8:
  3V3  (1) (2)  5V
  GPIO2 (3) (4)  5V
  GPIO3 (5) (6)  GND
  GPIO4 (7) (8)  GPIO14
  GND   (9) (10) GPIO15
  GPIO17 (11) (12) GPIO18
  GPIO27 (13) (14) GND
  GPIO22 (15) (16) GPIO23
  3V3   (17) (18) GPIO24
  GPIO10 (19) (20) GND
  GPIO9  (21) (22) GPIO25
  GPIO11 (23) (24) GPIO8
  GND    (25) (26) GPIO7
  GPIO0  (27) (28) GPIO1
  GPIO5  (29) (30) GND
  GPIO6  (31) (32) GPIO12
  GPIO13 (33) (34) GND
  GPIO19 (35) (36) GPIO16
  GPIO26 (37) (38) GPIO20
  GND    (39) (40) GPIO21
For further information, please refer to https://pinout.xyz/
```

END OF EXAMPLE COMMANDS.

Which OS works with my Raspberry Pi model

The following article contains a table showing which model Raspberry Pi's work with which Raspberry Pi OS: https://en.wikipedia.org/wiki/Raspberry_Pi_OS

RPi.GPIO.py

The **RPi.GPIO.py** code is only for use with the **Raspberry Pi Model 5** or for earlier models such as the **Model 3B** or **4B** which are running the **Bookworm 32 or 64-bit OS** or later. The code is designed to intercept traditional GPIO calls and convert them to LGPIO calls. See:

https://abyz.me.uk/lg/py_lgpio.html



NOTE: On the **15th of March 2024** the **Raspberry Pi Foundation** released a new version of the **Bookworm** Operating System Firmware which completely broke the input functionality of the GPIO header pins on the **32-Bit** version of the OS. The **64-Bit** version is still OK at the time of writing. The error manifests itself as "Error: GPIO *nn* Failed to add edge detection" where *nn* is the GPIO number of the relevant pin. However, the **RPi.GPIO.py** program now supports the **gpiochip0** circuitry embedded in the BCM processor. Once **GPIOconverter** is enable it intercepts calls to **RPi.GPIO** and converts them to **lgpio** calls. This only works on **Bookworm** or later. Earlier versions of the OS such as **Bullseye** can continue to use the legacy **RPi.GPIO** calls as normal.

Installing GPIOConverter

There are two methods of installing **GPIOconverter** software:

- 1) Install as a systemwide package usually in **/usr/lib/python3/dist-packages/RPi**
- 2) In the project directory as your **GPIO** program as a local package

Method 2 means that only your local **RPi.GPIO** program(s) will be using **GPIOconverter**. All other system-wide GPIO programs will use the standard GPIO library in **/usr/lib/python3/dist-packages/RPi**

Installation from the ready-made package

You can install the ready-made package from the <https://bobrathbone.com> Web site. Log into your Raspberry Pi and run the following.

```
sudo apt install python3-lgpio
curl -L -O
https://bobrathbone.com/raspberrypi/packages/gpioconverter_1.1_all.deb
sudo dpkg -i gpioconverter_1.1_all.deb
```

Note: The **GPIOconverter** package can only be installed on **Bookworm OS** or later and isn't required on earlier versions of the OS such as **Bullseye**.

Uninstalling GPIOconverter package

Run the following instruction:

```
$ sudo dpkg -r gpioconverter
```

Now restore the standard **RPi.GPIO** library

```
$ sudo mv /usr/lib/python3/dist-packages/RPi_standard /usr/lib/python3/dist-packages/RPi
```

Installation to a local directory

It may well be that you only wish to install the package **GPIOconverter** software in a specific project directory leaving the rest of the system unaffected. If so, you do not need to create the package but only copy the main files to your project directory.

Create a sub-directory called **RPi** in the directory where your GPIO code is installed. For example code in directory **/usr/share/myproject**:

```
$ cd /usr/share/myproject
$ mkdir RPi
$ cp /home/<user>/GPIOconverter/RPi/GPIO.py /usr/share/myproject/RPi/.
```

Where **<user>** is your log in name (usually 'pi')

Enabling GPIO.py

If running on a **Raspberry Pi model 5** or if running **Bookworm (32-bit)** or later. Example:

```
$ touch /usr/share/myproject/RPi/__init__.py
```

The above instruction will cause the code using the GPIO calls to see directory **RPi** as a package. For earlier models such as the 3B or 4 disable the package unless running on **Bookworm 32-bit OS** using the instruction below:

```
$ rm /usr/share/myproject/RPi/__init__.py
```



NOTE: The first part of the above procedure is not necessary if you installed the software from the Debian package (**gpioconverter_1.1_all.deb**) as the installation process does this for you.

Building the GPIOconverter package

This is for developers only. The software is installed from the **GPIOconverter** package (**gpioconverter_1.1_all.deb**). To build it carry out the following procedure:

Install the python3-lgpio package

The **GPIOconverter** package requires the **python3-lgpio** module. Log into the Raspberry Pi and install the **python3-lgpio** package

```
$ sudo apt install python3-lgpio
```

Downloading GPIOconverter from GitHub

Now clone the **GPIOconverter** software to your home directory and run:

```
$ cd
```



```
$ git clone https://github.com/bobrathbone/GPIOconverter
```

Build the GPIOconverter package

```
$ cd GPIOconverter
$ chmod +x build.sh
$ ./build.sh
```

The build script will now create the **GPIOconverter** package. Towards the end of the build you will be asked if you wish to check the package with Lintian. This is only used by developers so - Answer n

```
Check using Lintian y/n: n
```

Installing the GPIOconverter package

At the end of the run the build script will display the instruction to install the package using **dpkg** installer as shown below:

```
Install the gpioconverter_1.1_all.deb package with the following command:
sudo dpkg -i gpioconverter_1.1_all.deb
```

Known Issues

GPIO.setwarnings call limitations

The call **GPIO.setwarnings(True|False)** is currently not implemented in a compatible manner in **lgpio**. The **lgpio** package does not have the equivalent of **GPIO.setwarnings** but has the **lgpio.exceptions** call which can be set to True or False. So, the **setwarnings** call can either be ignored or be used to enable and disable **lgpio** exceptions. Set **IGNORE_WARNINGS** to **True** at the beginning of the **GPIO.py** program to prevent **lgpio exceptions** or control this with the **GPIO.setwarnings** call.

GPIO.cleanup does not clear used GPIOs

The **GPIO.cleanup()** call in the standard **RPi.GPIO** package normally clears all of GPIOs used in a run.

When using **GPIOconverter** it calls the **lgpio.gpiochip_close(chip)** routine. However, **lgpio.gpiochip_close** does not clear the GPIOs used. To overcome this problem, you can call **GPIO.cleanup** with a list containing the used GPIOs as shown in the example below.

```
chan_list = [18,16,17,4]
GPIO.cleanup(chan_list)
```

Or for a single GPIO

```
GPIO.cleanup(16)
```

If you run the following this will close the I/O chip but leave the GPIOs that were used in their current state.

```
GPIO.cleanup()
```

This could be a problem if you are running say a stepper motor which might leave a winding with power on it which might lead to overheating.

Using GPIOconverter with Rotary Encoders

There is a lot of Python software for Rotary Encoders which was originally written by Ben Buxton in 2011. You may find that the Rotary Encoder is sluggish and misses a high number of turns. In the case of the Ben Buxton code this can be corrected by changing the **HALF_STEP** flag from **False** to **True**.

```
# Enable this to emit codes twice per step.  
# HALF_STEP == True: emits a code at 00 and 11  
# HALF_STEP == False: emits a code at 00 only  
HALF_STEP = True  
STATE_TAB = HALF_TAB if HALF_STEP else FULL_TAB
```

Fortunately, the above change doesn't seem to affect operation when running the code using the standard **RPi.GPIO** calls on say a Raspberry Pi **Model 4B**.

Support

It is not possible to provide support for the standard **RPi.GPIO library** as literally hundreds of thousands of programs are using **RPi.GPIO** routines. The code is provided as is and without any warranties or "fit for purpose" etc. However, do contact bob@bobrathbone.com or raise an issue on <https://github.com/bobrathbone/GPIOconverter> for any errors or missing features found in the **GPIOnverter** software.

Source files

As already mentioned the software is stored on **GitHub** at <https://github.com/bobrathbone/GPIOconverter>

The GPIO.py shim software

The **GPIO.py** file uses the Python 3 LGPIO library (python3-kgpio) to handle calls to and from the RP1 i/o chip. More information on LGPIO see: https://abyz.me.uk/lg/py_lgpio.html

Python code examples will be found at: <https://abyz.me.uk/lg/examples.html#Python%20lgpio>

The test_pwm.py program

The **test_pwm.py** program tests the **PWM** (Pulse-Width Modulation) function of **RPi.GPIO** which, which is a technique for creating variable-width pulses to encode or modulate a signal. PWM is used in many applications, including power supplies, DC-DC switching regulators, and DC motor control or in this case to brighten and dim a LED. To use it, amend the "led = 16" statement in the source code The test_pym.py program

First edit the **test_pwm.py** file and change the led GPIO setting to the the GPIO number you are using for the test.

```
# Change the following values to suit your system
Led = 16          # Led GPIO for mode BCM
```

Now run the program. The selected LED should brighten and dim. Press Ctrl-C to end the test.

```
cd /usr/share/myproject/RPi
./test_pwm.py
```

Note: If you are only using **GPIOnverter** in a local project directory then it is necessary to first copy **test_pwm.py** to it and run it from there as shown in the following example.

```
cd /usr/share/myproject
cp RPi/test_pwm.py .
./test_pwm.py
```

The above isn't necessary if you installed the **GPIOnverter** package as previously shown.

The test_group.py program

The **test_group.py** program is a simple test program used to test the **RPi.GPIO** group functions.

First edit the **test_group.py** file and change the list of GPIOs in **chan_list** parameter to change the GPIO list that you are using for the test.

```
chan_list = [18,16,17,4]      # Group GPIOs for mode BCM
chan_list_board = [12,36,11,7] # Group GPIOs for mode BOARD
```

If you are using mode **GPIO.BOARD** then also edit the **chan_list_board** definition. The mapping between **GPIO.BCM** and **GPIO.BOARD** will be found in the **pins** definition in **RPi.GPIO.py**

```
# pins is the mapping between GPIO.BOARD and GPIO.BCM. Format Pin:GPIO
pins = {
    3:2, 5:3, 7:4, 8:14, 10:15, 11:17, 12:18, 13:27, 15:22, 16:23,
    18:24, 19:10,
    21:9, 22:25, 23:11, 24:8, 26:7, 27:0, 28:1, 29:5, 31:6, 32:12,
    33:13, 35:19,
    36:16, 37:26, 38:20, 40:21,
}
```

The program first flashes a single LED as configured by the **led** parameter and then switches alternate LEDs on and off as defined in **chan_list** and then closes the program.

Note: If you are only using **GPIOconverter** in a local project directory then it is necessary to first copy **test_group.py** to it and run it from there as shown in the following example.

```
cd /usr/share/myproject
cp RPi/group_pwm.py .
./group_pwm.py
```

The above isn't necessary if you installed the **GPIOconverter** package as previously shown.

The .gpioconverter file

In the **RPi** directory you will see a file called **".gpioconverter"**.

```
$ ls -la RPi/
:
-rw-r--r-- 1 pi pi    0 Feb 17 13:44 .gpioconverter
:
```

This file is used during package installation only to check if **GPIOconverter** has been previously installed in the **/usr/lib/python3/dist-packages** directory.

If it doesn't find this file it will know that the standard **RPi** package is still installed. It will rename the standard RPi package as **RPi-standard** and then install **GPIOconverter RPi** software in its place.

If it does find this file it will know that this is an upgrade and overwrite the contents of **/usr/lib/python3/dist-packages/RPi** with the upgrade.

Appendix A Licences and Disclaimer

The software and documentation for this project is released under the GNU General Public Licence.

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Acknowledgements

The people at <https://abyz.me.uk/lg/index.html>. who produced the **lgpio** package. No individuals are mentioned by name on their Web site but whoever they are, they have made an excellent product for General Purpose Input Output control on Linux Single Board Computers such as the Raspberry Pi Model 5 with extremely professional documentation. My compliments.

The GitHub member known only by the handle **fgmnts** who kindly implemented PWM support in **GPIOconverter**. See <https://github.com/fgmnts>

Appendix B - The RP1 general purpose I/O Chip

The RP1 general purpose I/O chip is a 12×12mm, 0.65mm-pitch BGA southbridge, which provides the majority of the I/O capabilities for Raspberry Pi 5.

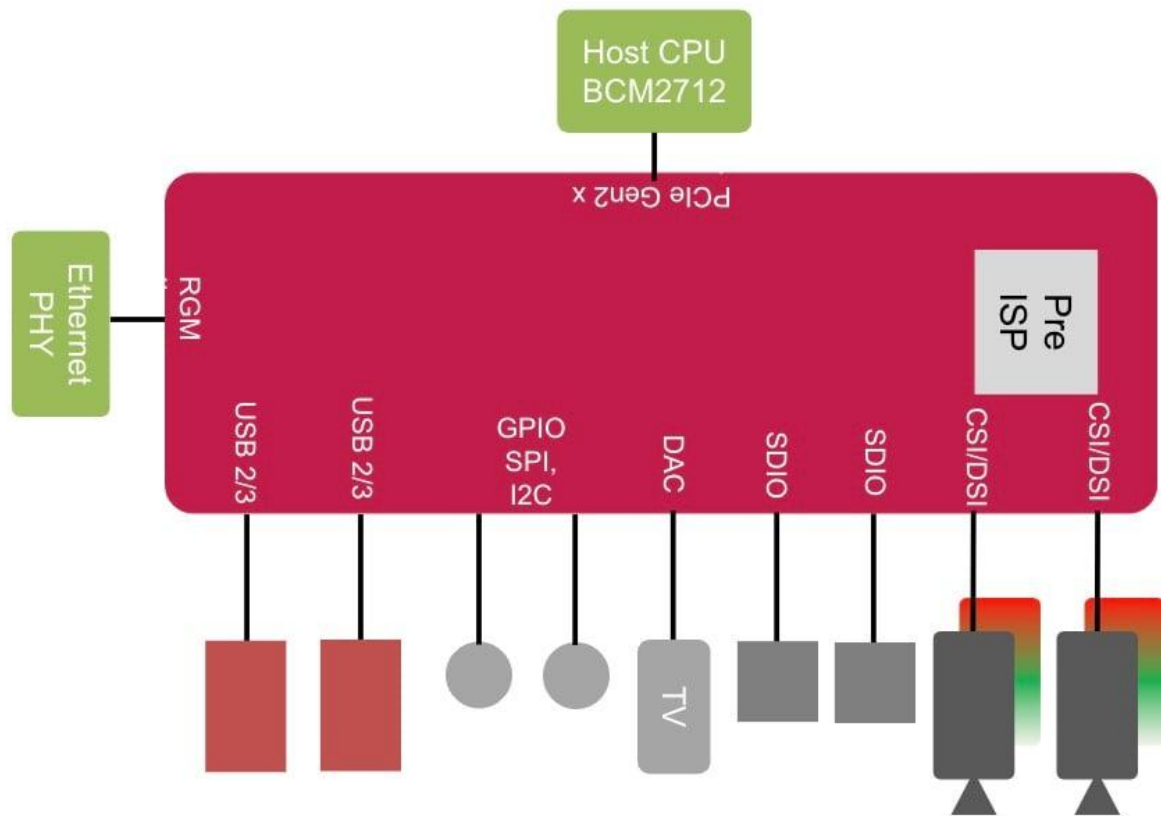


Figure 3 The RP1 General Purpose I/O Chip

The RPi chip provides:

- 4-lane PCIe 2.0 endpoint
- Gigabit Ethernet MAC
- 2× USB 3 host controllers
 - Each has 1× USB 3 and 1× USB 2 port
 - More than twice the usable USB bandwidth vs. Raspberry Pi 4
- 2× SDIO ports/eMMC (not used on Raspberry Pi 5)
- 2× MIPI transceivers (4-lane, supporting DSI and CSI-2)
- Video DAC (3-channel, supporting PAL/NTSC and VGA)
 - Only one channel (composite) used on Raspberry Pi 5
- Low-speed peripherals (SPI, UART, I2C, PWM, GPIO, I2S)
- Delta-sigma PWM audio out

More information on RP1 can be found in the RP1 Peripherals document.

See <https://datasheets.raspberrypi.com/rp1/rp1-peripherals.pdf>

Glossary

BGA	Ball Grid Array – A popular surface mount for Integrated Circuits (ICs)
CSI	Camera Serial Interface
DAC	Digital to Analogue Converter (In this case for audio output cards)
DSI	Display Serial Interface
GND	Ground, 0 Volts
GPIO	General Purpose IO (On the Raspberry PI)
I2C	Two-wire serial communication protocol
I2S	Electrical serial bus for connecting digital audio devices
PWM	Pulse-Width Modulation
RP1	Input Output Controller Chip for Raspberry Pi Model 5 peripherals
SPI	Serial Peripheral Interface – Interface us between digital components
USB	Universal Serial Bus