Raspberry Pi GPS/RTC Expansion Board Datasheet

Description

This document relates to boards with V6.4 on the PCB but covers all versions past V6.0

The Uputronics Raspberry Pi GPS/RTC Expansion Board provides a modern multi GNSS GPS receiver and hardware RTC with quick no soldering required connection to all Raspberry Pi boards with the 2x20 header (the original Pi Model A/B are not supported). Featuring PPS (Pulse per second) output to permit the use of the board for PPS disciplined NTP servers, RAW output available from the UBlox™ GPS module and twin super caps for GPS hot start/setting retention & maintaining RTC. Flash is also fitted to permit retention of settings.

A USB-C header is fitted to allow the board to work standalone with other devices such as Windows PC's. This board retains backwards compatibility with previous generation Uputronics Pi GPS boards.

Raspberry Pi Header Pin Configurations

Pin	Raspberry Pi Name	Board Purpose
01	3.3V DC Power	3.3V DC Power
02/04	5V DC Power	5V DC Power used for super caps
03	GPIO02(SDA1,I2C)	GPS/RTC SDA
05	GPIO03(SCL1,I2C)	GPS/RTC SCL
08	GPIO14(TXD0)	GPS SERIAL RXD
10	GPIO15(RXD0)	GPS SERIAL TXD
12	GPIO18	TIME PULSE

Board Physical Specifications

Weight	15g excluding fixings and antenna.
Batteries	2 x 0.2F 3.3V Super Capacitors
Connector Pitch	2.54mm pitch Raspberry Pi 2x20 Header.
Power Usage (from 3.3V)	Acquire 25mA / Tracking 21mA / Cyclic PSM Mode 9mA
GPS Antenna Connector	SMA Female (3V supplied)
USB Connector	C
Operating Temperature	-40°C to +85°C

Thermal vents for compatibility with PoE HAT.

GPS Specifications

The GPS has the following specifications:

- 72-channel u-blox™ M8 engine
- Up to 3 concurrent GNSS (BeiDou,Galileo,GLONASS,GPS/QZSS)
- Default GNSS: GPS/GLONASS.
- -167dBm Navigation Sensitivity
- 10Hz navigation rate in multi GNSS mode, 18Hz in GPS only
- RAW Output available via UBX-RXM-RAWX Message
- 3V supplied to antenna port to power active antenna
- Antenna requirements: Active 3V Ceramic Patch
- Flash to save settings/config and battery backed RAM.
- Default baud rate: 115200bps
- I^{2}C Bus (Address 0x42)

For full documentation please consult the u-blox 8/u-blox M8 receiver description including protocol specification document (UBX-13003221) linked here:

https://store.uputronics.com/files/UBX-13003221.pdf

RTC Specifications

The RTC has the following specifications:

- Micro Crystal RV-3028-C7 Real Time Clock Module
- Factory calibrated ±1 ppm @ 25°C
- I^{2}C Bus (Address 0x52)
- Built in kernel compatibility
- Provides year, month, date, weekday, hours, minutes and seconds

In The Box

1 x Raspberry Pi GPS/RTC Expansion Board
4 x 11mm standoffs w/8 M2.5 Screws
1 x Header with 4.93mm tails

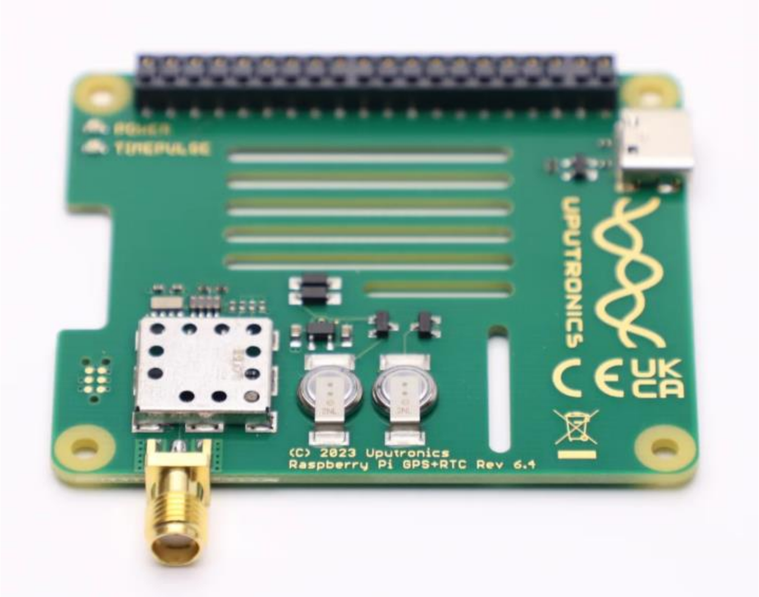
Disclaimer

All Uputronics products are sold as test equipment with no guarantees of performance or operation, they are intended for engineering, research or lab use only not for use in production or commercial systems.

This is not to say there is any quality issue with our boards, people are using these in such varying and dynamic environments its not possible for us to test every possible scenario. Therefore we advise you do your own testing to ensure operation in your environment.

Installation

Attach the header to the Raspberry Pi 2x20 header. Attach the four supplied standoffs to the Raspberry Pi using the M2.5mm screws. Clip the GPS/RTC Expansion Board on top of the header, the header pins push through the bottom with a click. The supercaps should face upwards when correctly installed. Secure the board using the remaining four screws.



RTC Operation

The following guides assume you are using the Raspberry Pi OS. The instructions below were tested with the Nov 19th 2024 Release Debian 12/Kernel 6.6 64 bit.

```
sudo raspi-config
```

Select Interfacing Options and Enable I2C

```
sudo i2cdetect -y 1
```

```
     0  1  2  3  4  5  6  7  8  9  a  b  c  d  e  f

00:          -- -- -- -- -- -- -- -- -- -- -- -- --
10: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
20: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
30: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
40: -- -- 42 -- -- -- -- -- -- -- -- -- -- -- -- --
50: -- -- 52 -- -- -- -- -- -- -- -- -- -- -- -- --
60: -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- --
70: -- -- -- -- -- -- -- --
```

Here you can see the RTC (0x52) and GPS (0x42) on the I2C bus.

```
sudo vi /boot/firmware/config.txt
```

Add the following lines at the top of the file and save.

```
dtoverlay=i2c-rtc,rv3028,addr=0x52
dtparam=rtc=off
```

```
sudo reboot
```

On reboot rerun the i2cdetect line and you should see 52 has been replaced with UU to indicate the kernel driver is loaded. If UU isn't shown the kernel mode driver isn't loaded and the following won't work.

```
sudo apt-get -y remove fake-hwclock
sudo update-rc.d -f fake-hwclock remove
sudo systemctl disable fake-hwclock
sudo vi /lib/udev/hwclock-set
```

Comment out:

```
#if [ -e /run/systemd/system ] ; then
# exit 0
#fi
#/sbin/hwclock --rtc=$dev --systz
```

To read time:

```
sudo hwclock -v -r
```

To write time:

```
sudo hwclock -w
```

Note On RTC

We believe this is now fixed and the following is no longer necessary.
~~If you are losing time over reboot or seeing:~~

```
~~kernel: [  156.227408] rtc-rv3028 1-0052: Voltage low, data is invalid.~~
```

~~This relates to an issue with the current kernel + the RV3028 module needing certain registers to be set correctly. The following script fixes this:~~

```
~~https://github.com/philrandal/gpsctl/blob/master/configure-rv3028.sh~~
```

For more information see:

https://www.satsignal.eu/raspberry-pi/Uputronics-RTC.html
http://www.philrandal.co.uk/blog/archives/2019/04/entry_213.html

GPS/PPS Operation

To verify operation of PPS:

```
sudo apt-get install pps-tools
sudo nano /boot/firmware/config.txt
```

add the following line:

```
dtoverlay=pps-gpio
```

```
sudo nano /etc/modules
```

add the following line:

```
pps-gpio
```

```
sudo reboot
sudo ppstest /dev/pps0
```

To verify the operation of the GPS via serial

```
sudo raspi-config
```

```
3 Interface Options
I6 Serial Port Enable
Would you like a login shell to be accessible over serial : NO
Would you like the serial port hardware to be enabled?: YES
```

Reboot

```
sudo apt-get install minicom
minicom -b 115200 -o -D /dev/ttyS0
```

Note: Older boards defaulted to 9600 baud.

It is beyond the scope of this datasheet to explain how to use this board as a GPS disciplined NTP server.

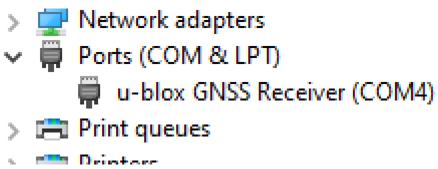
Note On PPS

Since V3.00 of the Ublox firmware the time pulse is not released until all time parameters are known including leap seconds. There it could be up to 12.5 minutes before time pulse is available however positional lock is achieved from cold in the expected sub 30 seconds.

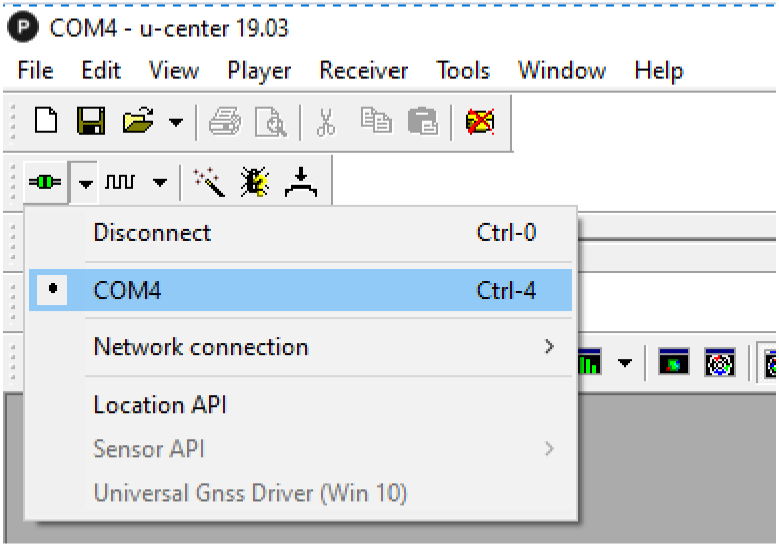
USB Operation / uCenter

Connect a USB-C cable (not supplied) to the board and then the other end to a PC or device that supports USB to Serial. If you are using Windows you can download and install uBlox u-Center to configure the device. Note the USB port “autobauds” so there is no need to set a baud rate. The board is powered from the USB bus so does not need to be connected to a Raspberry Pi in this configuration.

Under Windows you can ascertain the COM port the device is on by opening the Device Manager. Press Windows Key + R and type devmgmt.msc. Expand Ports (COM & LPT) and you should see the following:



In this example the board is on COM4 this will change for your machine. In u-Center click the connection icon:



Its outside the scope of this document to describe the use of this software and its myriad of options but for information to save configuration to flash click View > Messages.

Expand UBX – CFG – CFG
Check Save current configuration ensuring 0 – BBR and 1 – FLASH are selected.
Press Send.