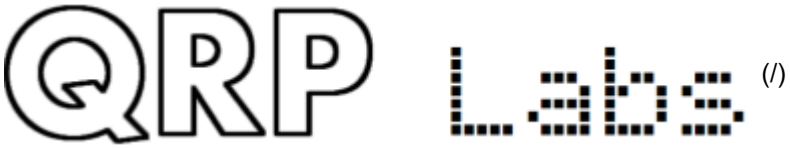

(/)

QRP Labs Shop

Click here for Shop! (http://shop.qrp-labs.com)
Buy me a coffee! (https://www.buymeacoffee.com/g0upl)
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LightAPRS-W 2.0 (+WSPR) tracker (/lightaprsw2.html)

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VFO/SigGen case (/vfobox.html)

Clock case (/clockbox.html)
Custom case (/custombox.html)
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QCX enclosure (/qcxcase.html)
50W Amp enclosure (/50wpabox.html)

Coming Soon

QSX all-band all-mode transceiver (/qsx.html)

Retired kits

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QCX 5W CW transceiver kit (/qcx.html)
OCXO/Si5351A synthesizer (/ocxokit.html)
ProgRock - triple programmable crystal (/progrock.html)
GPS receiver kit QLG2-SE (/qlg2se.html)
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U4B - Balloon tracker

Details

Created: 21 April 2022
Last Updated: 06 July 2023
Hits: 56522

U4B: the world's cheapest, lightest, simplest yet most flexible and expansion capable WSPR high altitude balloon tracker ever! Includes USB interface for configuration, 128K Disk, tons of features... perfect for hobbyists, research, education and more...

Click!
Shop order
$56.09 (http://shop.qrp-labs.com/u4b)

The "U4B" (**U**ltimate**4** for **B**alloons): low cost, lightweight, feature-packed flexible high altitude balloon tracker with applications for hobbyists, researchers, education and more. The PCB is ready assembled, weighing only 1.8g and measuring just 33.0 x 12.7mm (without USB protrusion - remove before flight). Note that the current batch (November 2022 onward) uses a full-size USB connector, not the micro-USB on the first batch. Full-size USB is more reliable and it makes no difference to the final flight configuration size and weight because the USB part of the PCB should be snapped off before flight anyway.

U4B hardware, firmware and the telemetry-over-WSPR protocol was developed by QRP Labs with extensive collaboration with Dave VE3KCL, who launched 83 test flights from June 2015 to April 2022. It's both the longest QRP Labs product development program, and the most tested, by far!

Video about U4B, click here! (https://youtu.be/pfVoIkXHLPo)

SIMPLE: the U4B can be configured just by entering your callsign. Then set up your own tracking page at the QRP Labs website, add antennas and solar cells, a balloon and you're ready to go. Your tracking page will show the live position on a Google map, with the altitude, groundspeed, battery voltage and temperature.

COMPLEX: for the more adventurous, U4B is a complete miniature computer system running QDOS (**Q**RP Labs **D**isk **O**perating **S**ystem). There is a full-screen text editor (connect a PC terminal emulator using the built-in USB to Serial Virtual COM port via a USB cable). A 32-bit Virtual Machine runs compiled BASIC. There's a 128K Disk for storing your programs and data files. 19 GPIO pins and an I2C bus provide ample expansion possibilities if you wish to add your own sensors. A key feature is that you can use the built-in QRP Labs telemetry-over-WSPR system to effortlessly collect not just the basic tracking data (location, altitude, groundspeed, battery voltage, temperature) but also your own sensor data. All over the WSPR monitoring network, collected by the QRP Labs web server automatically and ready for you to download from your tracking page. Or - use one of the other supported digital modes to design your own solution. The possibilities are endless!

List of features:

- 33.0 x 12.7mm PCB (plus removable protrusion with USB connector)
- Weight: 1.8g (with USB protrusion removed)
- Onboard high performance GPS receiver
- 32-bit ARM microcontroller running QDOS (QRP Labs Disk Operating System)
- 128K disk (implemented on EEPROM chip)
- 27mW (approximately) transmitter using Si5351A synthesizer
- TCXO referenced frequency stability
- Band coverage 2200m to 2m
- LM75 temperature sensor
- Status LED
- USB interface for configuration, programming and easy firmware update (just copy the new firmware file into the apparent USB Flash drive)
- Free firmware updates for life, when enhancements are developed as the use cases expand

Advanced QDOS features:

- 19 GPIO pins – of which 9 can be configured as analog inputs and 8 are easily accessible via PCB edge pads; all 19 can be used as digital input or output control pins
- I2C bus for connecting additional sensors e.g. pressure, humidity
- BASIC programming language with full-screen text editor, compiler and debugger
- 128K Disk storage for your programs and data; BASIC can read/write data files
- Command line utility

- Telemetry over WSPR for relaying your additional sensor data

The U4B radio transmitter can transmit the following modes:

- QRP Labs tracking and telemetry over WSPR
- WSPR (including extended mode and slow 15-minute WSPR)
- JT9 (1, 2, 5, 10, 30 minutes)
- JT65 (modes A, B, C)
- Hellshreiber (standard, DX, and slow multi-tone FSK)
- CW (standard speed, QRSS, FSKCW and DFCW)
- Customized “Glyph” patterns can produce a unique idenfier on QRSS

NOTE: Due to the global semiconductor shortage, the price of many ICs has increased dramatically, and there have also been (less drastic) price increases in other parts of the production. The target price for U4B was originally to be below $50 however, due to more expensive components it has been necessary to increase it. If and when the semiconductor situation improves, we expect to reduce the price.

IMPORTANT NOTES:

- Currently the tracking page http://qrp-labs.com/tracking (http://qrp-labs.com/tracking) only operates on 20m band, which has been found to be the most effective band for long-range global picoballoon tracking. We do plan to extend it to the other bands around June 2023.
- Currently the commands to read and write 16-bit I2C aren't working due to a bug in the code. You may need to take this into account if you are planning to interface additional I2C sensors. Plan for bug fix: June 2023
- It has been reported that the additional optional telemetry commands send WSPR packets that are not decoded and so this function apparently doesn't work - again planned for investigation June 2023.
- Also for June 2023 - after the above - we plan to extend the tracking page functionality to provide downloads of the entire flight history and charts of altitude, speed, battery voltage and temperature.

QRP Labs tracking solution

If you use the built-in QRP Labs telemetry-over WSPR system for tracking, your balloon flight will occupy one of 600 telemetry channels.

That is to say, up to 600 balloons could fly this system concurrently without any possibility of interference with each other.

After configuring the U4B with your amateur radio callsign, you can set up your own QRP Labs website flight page in your QRP Labs shop account. Your balloon will then appear in the flight list here http://qrp-labs.com/tracking (http://qrp-labs.com/tracking) and you can click on the flight link, to see your own tracking page. Your flight tracking page shows your latest telemetry, tracking map, and will provide links for downloading the entire dataset belonging to your flight.

Documentation

You need TWO manuals, one is the hardware manual, and the other is the operating manual.

Hardware manual (/images/u4b/u4b_hardware.pdf) (document version 1.00 published 18-Apr-2022)
Operating manual (/images/u4b/firmware/1_00_003/u4b_operation_1_00_003a.pdf)(document for firmware 1.00_003 published 01-May-2022)

Further documentation and resources:

QRP Labs product launch video (https://youtu.be/pfVoIkXHLPo) - filmed April 2022
U4B construction notes (/images/u4b/U4B_construction_notes.pdf) - May 2022 notes by Dave VE3KCL on everything about launching a U4B picoballoon
Stretching Clear Chinese balloons (/images/u4b/Stretching_Clear_Chinese_measuring_rig2.pdf) - May 2022 by Dave VE3KCL
QRP Labs August 2019 video (https://youtu.be/CqNZeh575xw) (functionality was significantly enhanced since then)

Reach For The Skies article (/images/u4b/ReachForTheSkies.pdf) - the 2021 FDIM conference proceedings article by Hans G0UPL and Dave VE3KCL (lots of good practical advice)
Reach For The Skies slides (/images/u4b/ReachSlides.pdf) - the 2021 FDIM talk slides by Hans G0UPL
Reach For The Skies (https://youtu.be/e_rdBRFsmNA) - the 2021 FDIM video presentation
High altitude weak signal adventures (/images/u4b/HighAlt.pdf) - Article by Hans G0UPL for the Dec 2020 74! magazine
Picoballoons groups.io discussion forum (https://groups.io/g/picoballoon) - loads of knowledgeable folk happy to help
Link to Chinese balloon (https://www.aliexpress.com/item/32699218436.html) used on many U4B test flights
Balloons online (https://balloons.online/) - a US/Canadian source of 32" spherical balloons, reach higher altitude than the Chinese ones
Yaokohama balloon (https://yokohamaballoon.com/) - 32" spherical balloons which also look promising, reported to be 5g lighter than the SAG balloon

Photographs

Firmware

Please refer to the operating manual for the firmware update procedure, which is very easy and does not require any special hardware, software, drivers etc. It requires only a PC and a USB cable. Click the file in the first column of the table below, to download the firmware file of interest. Note that firmware files are encrypted and can only be used on the QRP Labs U4B.

The downloads are a zip file; please unzip the file before copying the .U4B into the U4B.

Firmware version history:

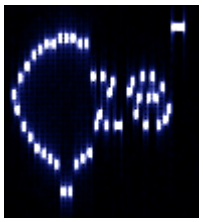
Version	Date	Contents
1_00_003 (/images/u4b/firmware/1_00_003/1_00_003.zip)	01-May-2022	- Operating manual (/images/u4b/firmware/1_00_003/u4b_operation_1_00_003a.pdf) - Hardware test: Ctrl-R to view raw GPS serial data - Hardware test: Now calibrates and displays 25MHz TCXO and 8MHz System clock - Bug fix: Text editor now requires new file is saved before compiling - Bug fix: Now you can compile a file and immediately debug, without needing to close text editor and re-open
1_00_001 (/images/u4b/firmware/1_00_001/1_00_001.zip)	26-Apr-2022	- Adds counter functionality to GPIO pins 0 and 6, and the COUNTER statement. Operating manual (/images/u4b/firmware/1_00_001/u4b_operation_1_00_001.pdf)
1_00_000 (/images/u4b/firmware/1_00_000/1_00_000.zip)	21-Apr-2022	- Initial firmware release for U4B. Operating manual (/images/u4b/firmware/1_00_000/u4b_operation_1_00_000.pdf)

14-Apr-2022 Fly-by

Well. 83 test flights launched by Dave VE3KCL, many of which went multiple times around the world. U4B-13 even went 17 times around the planet taking 305 days. Incredible. But despite my wishes, none of them flew over my house. Sure, there were some near misses. And some that may well flown very close but did so at night when there was no solar power to operate the system. UNTIL... 14-Apr-2022. U4B-28 on its 6'th lap, hit a perfect 6. A bullseye. Home run. Whatdayawanna call it.

U4B-28 flew literally right over my house, its closest approach was at 12 noon local time, providing lots of opportunity for radio observation! At its closest approach according to the flight path, U4B-28 passed less than 1200m (3/4 of a mile) from my house. Given that there is anyway a 2 or 3km uncertainty in horizontal position due to the limitations of 6-character Maidenhead locator positions - it's save to say it was as close as it could possibly get! And anyway don't forget, the thing is 12km up. Speed of the fly-by was around 90km/hour.

There's a gallery of some pictures from the event, with the map path crossing our South Western corner of Turkey (KM46). It was fascinating to consider that somewhere in all that blue sky, a tiny traveller released months ago in Toronto, Canada was now on it's 6th planetary lap, having traveled almost 200,000 km to date and hurtling along at 90km/hour.



For the duration of the fly-by I had my QDX Digimodes Transceiver kit (/qdx) on 20m, with WSJT-X decoding WSPR and Argo the section of spectrum where U4B-28 transmits a balloon glyph every 10 minutes; furthermore Audacity software recording the audio.

The 27mW transmission from the balloon was clearly audible on the speakers. WSPR peaked at +17dB SNR which I believe is the highest I have ever seen here. The balloon glyph was burning my screen until I switched Argo AGC off, whereupon I got a nice clean image. I also plotted the SNR vs time in a spreadsheet, showing the approach and the slower departure; the reason for the difference is that I have a mountain range to my North/North-West which would have restricted my line-of-sight range. There are similar mountains in the departure direction too but they are further away and therefore at a much lower angle.

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