

tBeacon 0.52

User Manual

Introduction

The beacon is designed for searching of lost objects. Primary purpose: locating downed R/C planes, multicopters, lost balloons, model rockets, etc. An UHF radio transceiver is required for interaction with the beacon. The transceiver have to have support of LPD, PMR, FRS band or 70cm amateur radio band and preferably should be capable of transmitting a **Tone burst** (acoustic signal of 1750 Hz).

Most widespread and affordable models is **Baofeng UV-3R, Baofeng UV-5R, Wouxun KG-UVD1P** among many others.

Search for the beacon may be performed in two ways:

1. The beacon transmits last received GPS coordinates by way of a voice message. It is only available if there is/was a connection to the source of GPS coordinates (NMEA, UBX, MAVLINK, NAZA).
2. The beacon transmits three sequential beeps with decreasing power, listening to which one can determine direction and relative target distance.

The beacon can be activated as follows:

- by handheld radio call, by transmission of a ringing tone on the air.
- and/or
- by timer. The beacon can be activated after specified amount of time passed since power on.

Searching algorithm

The algorithm is described for default settings and is meant for search with the help of handheld radio that supports emitting Tone burst.

Almost all time intervals and parameters can be changed by user and therefore could have influence on the searching algorithm.

1. Transmit the Tone burst on the air within 3-4 seconds (to provide better RF signal passing it is preferable to climb higher or improve receiving conditions by other means).
2. Listen to the beacon's response within 4 seconds.
3. If there's no response, repeat 1 and 2.
4. If there's still no response, it might be that the beacon can't receive our signal, or, which is more likely, we can't receive the beacon's signal. In this case we have to get closer to a supposed impact location (or improve receiving conditions by other means: climbing higher or using a directional antenna etc.) and try again starting from point 1.

5. If the beacon's signal is received, but it transmits "zero-zero-zero" instead of coordinates or it transmits false coordinates, it means that there might be troubles with connection to GPS module or the beacon might be temporarily de-energized during impact.

In this case the beacon can be found in a similar way used in ARDF or "radio foxhunting": shielding a handheld radio using your body or other materials determine direction of maximum and minimum signal level. Also use of directional antenna could help greatly.

6. Taking a bearing, move toward the point, repeating the procedure at regular times and checking the direction. In close proximity to the target it will probably be necessary to remove the antenna from the handheld radio. But do not try to transmit with your radio without antenna!

For the handheld radio that doesn't have a Tone burst function the algorithm is the same with the only difference: the beacon is activated automatically in specified amount of time (24 hours by default) after powering on and transmits for 4 hours (by default) with increasing time interval (from 10 to 60 seconds by default). After each five (by default) signal transmissions the beacon reports coordinates, if they are known.

Beacon's power supply

Beacon's power supply depends on the beacon model. See "Beacon models differences"

The beacon battery runtime is greatly depends on preset parameters. With default settings, average conditions and with LiPo 1S battery 700mAh beacon can last approximately one month.

After powering on the beacon starts flashing with green LED once per second, counting every second. Red LED flashes on at the moment of listening to the on-air transmission. By default it takes place every third second. After eight-hour run green LED stops flashing for energy saving.

Connection to GPS

The beacon supports the following protocols:

- NMEA. Most GPS receivers uses this protocol;
- UBX. Binary protocol of UBLOX receivers that is used, for instance, in APM;
- MAVLINK. Binary protocol of APM telemetry (ArduCopter, ArduPilot etc.);
- NAZA. Binary protocol of DJI telemetry. Used in DJI NAZA flight controllers in link between GPS module and the main controller.

If case your GPS or autopilot uses 5V logic levels it is highly recommended to connect a TX signal to the beacon via $\sim 4.7\text{k}\Omega$ resistor. Examples of connection to GPS receivers or autopilots see in "GPS connection examples".

Beacon's setup and firmware upgrade

The beacon configuration is performed by means of configuration utility. The utility currently available only for Windows OS.

With the help of the utility you can perform following functions: change settings, frequency calibration, beacon's firmware upgrade, bootloader flashing.

Details for connection and power supply for specific beacon's models can be found in "tBeacon models differences".

UART adapter connection

In order to be able to change parameters of the beacon, you have to have an UART adapter. Preferable the one with DTR output.

Connection details and pinouts can be found in "tBeacon models differences".

Note: RX pin of the beacon should be connected to TX pin of the UART. And vice versa: TX of the beacon to RX of the UART.

Be careful connecting of UART adapter to the beacon. Wrong connection may cause beacon's malfunction.

You should also install the appropriate drivers for your UART adapter. After connection and drivers' installation there should appear a virtual COM-port in the system. If there are several such ports in the system you should find out its number. This can be done in Devices Manager.

Notice the number of COM-port, you will need it later.

Flashing Bootloader

The procedure of the first-time bootloader flashing is needed only for DIY beacons, or for beacons made from Orange OpenLRS receiver.

To flash the bootloader you will need to connect the programmer to the beacon' microcontroller and press a key sequence CTRL+B in configurator utility.

NOTE: DO NOT USE USBASP WITH 5V LOGIC LEVELS!

Flashing beacon firmware upgrade

The firmware flashing is necessary only for upgrade and in case of first-time setup of self made beacons. The process is initiated by pressing the button "FLASH FW" while the beacon is connected and powered on and COM-port is chosen correctly. In case of upgrading without connected DTR signal it is necessary to lower DTR momentarily (connect to GND)

immediately after the console window popped-up.

Setting the beacon into config mode

If your UART adapter is equipped with DTR output, you should choose a correct COM-port, press the button "CONNECT" and it goes automatically: beacon will enter configuration mode and the current settings will be displayed in the window.

If DTR output is not connected you will have to power the beacon immediately after pressing the button "CONNECT". Probably, you'll have to retry several times. When connection is OK and parameters are read out, interaction with the beacon is as usual.

Frequency calibration

Each beacon should be adjusted according to the reference grating of frequencies. This procedure requires a handheld radio with the Tone burst transmission function. Purchased beacons have already been calibrated, but repeated procedure wouldn't go amiss.

When the beacon is connected, press the button "FREQ CALIBRATION" and prepare a handheld radio. The handheld radio and the beacon should be set on the same frequencies.

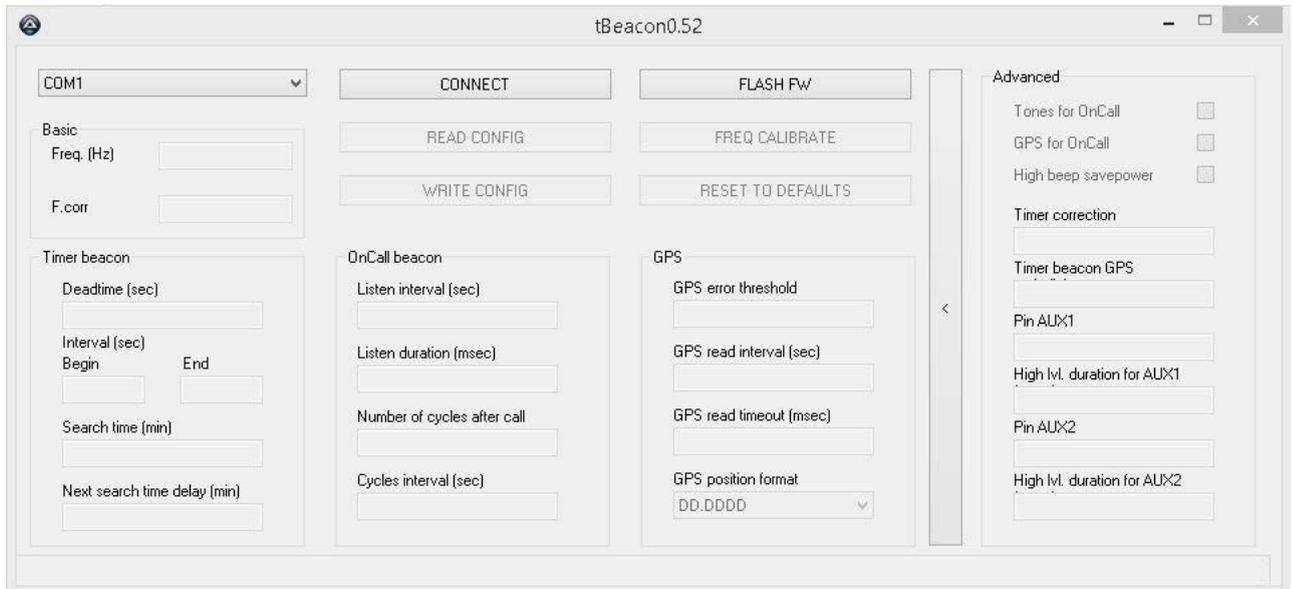
The program will warn that the Tone burst should be emitted until calibration is finished. Press and keep pressing corresponding buttons on the handheld radio until procedure is finished.

Usually calibration takes 20-30 seconds. However deviations are possible.

Don't hold the transmitting handheld radio too close to the beacon, UART adapter and computer.

Changing parameters

Every changeable parameters of the beacon is presented in the window of configurator utility. Description of each parameter is given in the section below.



Do not forget to press "WRITE CONFIG" after changing settings. Reset to defaults takes place when you press "RESET TO DEFAULTS" button. After that you should also write configuration.

Description of beacon's parameters

Brief description of each parameter can be read in configurator in a pop-up tip to a corresponding field.

Freq (Hz, 433075000)

Frequency the beacon will be operating at.

Measured in Hz. For instance, first channel LPD (433.075MHz) is written as: "433075000". First FRS channel is written as 462562500 (462.5625MHz).

By default first LPD channel is chosen: 433.075MHz

F.Corr

Frequency correction factor of specific transceiver module.

Requires individual calibration, see section **Frequency calibration**.

Timer based beacon

This section are for the timer-based beacon parameters, the one that is activated in specified amount of time after powering on.

First-time delay (sec, 86400)

First-time delay before the beacon activation.

Measured in seconds. Default is $86400 = 24 * 60 * 60$, that is 24 hours.

That means that the beacon will be activated and starts transmission in 24 hours after powering on.

Time interval in the beginning (sec, 10)

Time interval between transmissions in the beginning of search period of the timer based beacon.

Measured in seconds. Default is: 10 seconds.

Time interval at the end (sec, 60)

Time interval between transmissions in the end of search period of the timer based beacon.

Measured in seconds. Default is: 60 seconds.

Search time (min, 240)

Search period within which the timer-based beacon is active.

Measured in minutes. Default is: $240 = 4*60$, that is 4 hours.

The beacon will be active within this time, increasing time interval between transmissions.

In the beginning and at the end of the search period time interval is defined by corresponding parameters.

Next search time delay (min, 1200)

Delay until next activity cycle.

Measured in minutes. Default is $1200 = 20 * 60$, that is 20 hours.

Upon completion of search time the beacon goes to sleep for a specified time period. By default the beacon will wake up after 24 hours since power on, will run for 4 hours, and will go to sleep for the next 20 hours. That is: it will wake up every day at the same time.

OnCall beacon

This section are for the onCall beacon parameters, the one that is activated by a handheld radio call.

Listening interval (sec, 3)

Time interval for the beacon to listen to the air waiting for a call.

Measured in seconds. Default is 3.

It is not recommended to set low values due to excessive power consumption. By default, a ringing tone within 3-4 seconds is needed to wake up the beacon.

Listening duration (msec, 50)

Duration of listening to the air.

Measured in milliseconds. Default is 50.

The bigger the value, the more reliable the call recognition and the higher battery consumption.

Number of transmissions after call (times, 3)

Number of transmissions (voice and beeps) of the beacon after call.

Default is 3.

Signals are transmitted in the following order: beeps then voice, if only this type of transmission is enabled in settings.

Transmissions interval (sec, 5)

Transmissions time interval of the beacon after call.

Measured in seconds. Default is 5.

GPS interaction settings. Protocol parameters and port speed are determined automatically.

GPS error threshold (times, 100)

Number of errors permitted in GPS coordinates reading. In case of exceeding the threshold, GPS interaction ceased in order to save battery power. Further reading of coordinates is performed 100 times more rarely.

GPS reading interval (sec, 10)

Time interval for tracking GPS coordinates (sec).

Measured in seconds. Default is 10 seconds.

Specifies time interval within which the beacon wakes up and listens to GPS incoming data. The lower the value is, the more accurate data the beacon has and the higher battery consumption is.

GPS reading timeout (msec, 1500)

Timeout of one attempt of reading of GPS data.

Measured in milliseconds. Default is 1500.

Within this period the beacon have to receive coordinates from GPS receiver. In case the coordinates are received the beacon goes to sleep immediately. Otherwise it waits for the timeout consuming increased current. It is recommended to set a value slightly more than $1000/(\text{GPS transmissions frequency})$.

For example, for 10Hz GPS receiver this value may be set to 150 msec. Default value is perfect for 1Hz receiver.

GPS position format (DD.DDDD)

Default is DD.DDDD

It is possible to choose your favorite format of coordinates. For example, the one that your GPS navigator can support.

For instance Google Maps supports formats 3, 4, 5, 6. For formats 5 and 6 you will have to know additionally degrees of longitude and latitude of your location.

When choosing a format one should remember that the more numbers are transmitted, the more energy is consumed.

Different formats errors:

DD MM SS.S	3 meters
DD MM.MMM	2 meters
DD.DDDD	1 meter
DD.DDDD	10 meters
.DDDD	1 meter
.DDDD	10 meters

Advanced

Advanced parameters. Opens by pressing a reveal button (>). Usually does not require changing.

Beeps for onCall (on)

Determines if it is necessary to transmit beeps after call. Default is on.

GPS for onCall (on)

Determines if it is necessary to report coordinates after wakeup. Default is on.

High beep powersaving(on)

Enabling battery saving at the most powerful beep. Default is on.

This type of signal may be inaudible for some handheld radio squelches.

Timer adjustment (msec, 0)

Timer adjustment. Default is 0.

If the timer on your beacon is fast or slow, it is possible to introduce a correction.

The value determines difference with a wallclock second in msec. Plus, if the beacon is fast. Minus, if the beacon is slow.

For example, if the beacon went off not in 10 minutes (600 sec), but in 9:30 (570 sec), the correction can be made using a formula $1000 - (1000 * 570/600) = 50$.

GPS periodicity (times, 5)

Frequency of coordinates report for timer beacon (0 – don't report, 1 – every transmission, 5 – every fifth transmission etc.).

Default is 5.

Pin number AUX1/2 (number, 0)

Outlets for connection of powerful LED/alarm to the beacon. Logical unit is set after ringing detection, right before coordinates/beep-tone report.

High lvl. duration for AUX1/2 (ms, 100)

Duration of logical high on corresponding pin.

Measured in ms. Default is 100.
