User Manual

SoftRF (Github astir13/SoftRF fork)

matching SoftRF firmware version 1.3e

2020-12-30

Thanks to all contributrs of the Github SoftRF Project.

1 Acronyms

Baidu The GNSS deployed by China

FANET another open anti-collision protocol

FLARM The protocol used by the equipment traded by the company Flarm; the term legacy is used in the SoftRF setup and display "L", to indicate that the SoftRF does not use the Flarm protocol, as it is private and may not be used; however, the SoftRF uses a protocol, that is understood by Flarm devices and can receive Flarm transmissions as of now.

GLONASS The GNSS deployed by the Russian Federation

GNSS Global Navigation Satellite System; this can be GPS but also Glonass, Baidu or Gallileo, dependent on the chipset on the SoftRF; current SoftRF use GLONASS and GPS

GPS Global Positioning System: the GNSS deployed by the USA

Gallileo The GNSS deployed by the European Union and ESA

OGN The open glider net, see http://wiki.glidernet.org/

OGNTP another open air traffic awareness protocol

RS-232 the cable-based data line protocol used for the communication between SoftRF and other cockpit equipment like Flarm LED, LX Nav/LXNavigation flight computers and smart e-varios like EOS/ERA/S-80 or S-100.

2 Disclaimer

3 Foreword

The SoftRF based air traffic awareness devices use the ISM bands. The devices are good tools to aid pilot situational awareness by often giving successful information about the position, direction, vertical and horizontal speed of other aviation traffic. However, they are not to be trusted all times and in all situations. Do not trust your life to this information, and only trust your eyes for VFR flight anti-collision avoidance.

SoftRF, Flarm, FANET, OGN-Tracker, Pilot-Aware, Skytraxx use transmission and reception via the so-called ISM bands, which are used for many industrial, scientific and medical purposes. Thus, the used frequencies are not exclusively reserved for air traffic transmissions, and can be used for multiple other purposes, also on board of aircrafts. No frequency coordination/licensing is provided by the authorities in most countries, which is very convenient, but there also is no protection against interference from other equipment.

> As a consequence of potential interference from other equipment using the same frequency bands, reception in your own installation or the installation in other planes can be impaired, leading to potential "ghost" traffic, or (worse) masking existing traffic away, i.e. "hiding" other traffic.

Therefore, you should never trust such installations, nor the fact that you can detect all other planes in your vicinity using these tools. Additionally, commercial planes and motorplanes rarely use these protocols, and there is no legal carrige requirement for such equipment.

The above statements are not true for certified Mode-S transponders and TCAS equipment. Air transponders operate on reserved frequencies, may only be operated when certified and properly

tested, with about 1000 times higher transmit power, and are proved to work efficiently and effectively for sailplanes, small aeroplanes and commercial planes of all sizes. In the eyes of the author, certified transponder based communication is the future of air anti-collision for all segments, but in some countries you may not be allowed such equipment in small areoplanes, drones, ultralights, and so on. So the ISM band based air traffic awareness equipment might have a long future ahead.

A note on the protocol: While Flarm is the most used protocol, it is advised to consider using the other protocols like OGN-T because they are open source. Flarm will, thanks to the Open Glider Net initiative, not change protocol anymore, because most pilots highly rely on the existence of the open glider network to track their planes safely throughout each journey. If Flarm would change the protocol one day, remember that you can change your SoftRF to use e.g. OGN-T through the settings menu very easily, and all open glider Net trackers would be able to "see" your plane in real time again.

4 Basics about SoftRF

The SoftRF main purpose is to transmit anti-collision data to other devices. In order to do so, it finds information about the own aircraft and packages it into a protocol, which then is transmitted through the SoftRF antenna on UHF ISM band frequencies.

Following data is transmitted (example from legacy protocol (Flarm v6):

- your position (latitude and longitude),
- the GPS status,
- horizontal speed (speed over ground),
- heading (over ground from GNSS),
- vertical speed (climb or sink rate),
- your identification,
- the type of aircraft,
- stealth mode (for competitions),
- do not track information (opt-out from OGN).

The other purpose is to receive such transmissions from other aircrafts around you and to provide this information to your other cockpit devices to issue alerts and situational awareness. Other devices can be:

- Android tablet or phone with XCSoar App installed
- Flarm LED
- LXNavigation ERA/EOS 80 devices
- LXNav S80/100 devices
- larger Flight computer series from LXNavigation and LXNav, or self-built

From the point in time when the SoftRF has successful reception from GNSS, it is transmitting status and all received information over following interfaces if configured correctly:

- Bluetooth (used for mobile phone/tablet Apps like XCSoar)
- NMEA cable based output (RS-232) at a speed of 38400 baud

5 Installation

The SoftRF has to be built into a stable case, secured against overheating, examples can be seen at https://github.com/lyusupov/SoftRF/tree/master/case.

For running the astir13 fork of the SoftRF firmware, some hardware additions are required that are described in the Wiki found at https://github.com/astir13/SoftRF_standalone/wiki.

5.1 Mechanical

Fasten the SoftRF case and all wirings tightly with other equipment behind the instrument cluster, i.e. using wire straps. As a rule of thumb, an installation shall be able to handle +/-10G, so if your SoftRF weights 200g, the installation shall sustain a 20N force, applied at the SoftRF in each direction.

The optional FlarmLED display shall be mounted securely into the instrument panel using screws, because the supplied adhesive tape is not sufficient, follow the instructions of the producer.

> No mechanical installations may limit or change existing mechanical functions of the aircraft.

5.2 SoftRF Antenna

The golden SMA female connector of the SoftRF has to be connected to a matching SMA male connector leading the RF signal to the SoftRF antenna resonating in the band of your SoftRF's transmissions. If your SoftRF is deployed in the European Union, the frequency is 868.2MHz, and the antenna shall be resonant on this frequency. You can mount the antenna directly onto the SoftRF case or connect the antenna through a 50Ω RF cable such as RG174 for lenghts < 1m. For cable lengths above 1m, good results can be achived using e.g. BELDEN RF 200 cable which at many places can be bought already fully configured with SMA connectors attached.

A well-proven design is a so-called ground plane antenna on top of the instrument cluster cover, like shown in Figure 1.

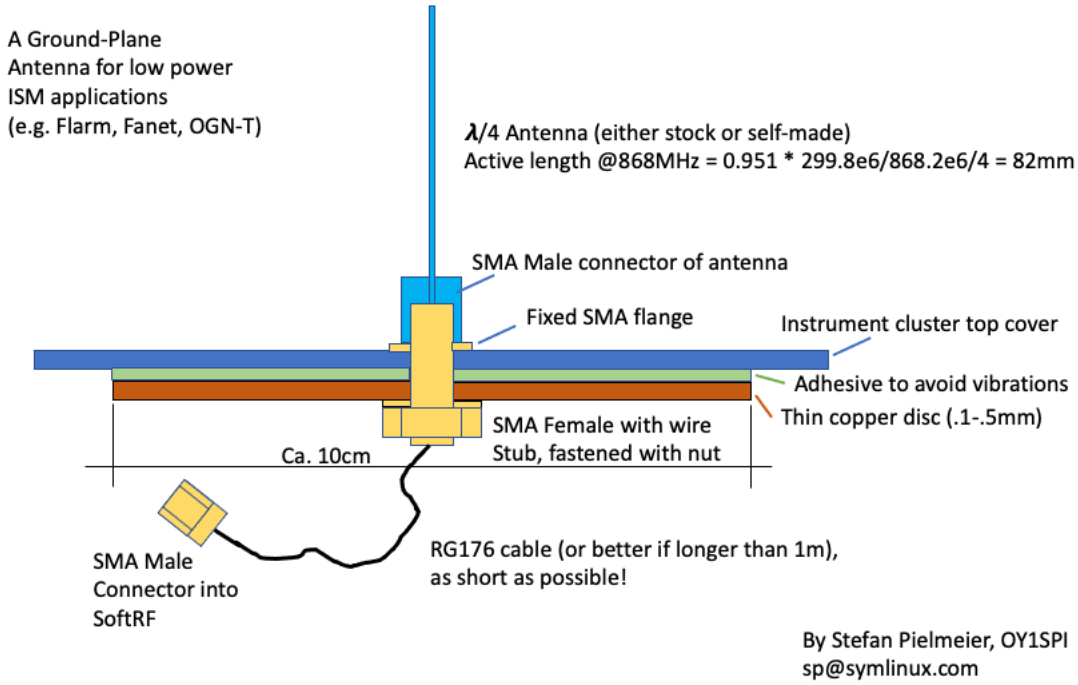

Figure 1: Example ground plane antenna construction that can be used for the SoftRF

Beware that there are many antennas out there that say they are Flarm compatible, but they might actually not be resonant at the required frequency. Before use, it might be relevant to test your antenna with an antenna tester to be sure it is resonant at the right frequencies. Suitable Antenna testers (e.g. Nano VNA from aliexpress) are owned by radio nerds like Amateur Radio girls and guys, find one to help you if you don't know anything about antennas, because this is an important part of achieving a good transmission range.

5.3 GNSS Antenna

The SoftRF needs a valid 3D position from a global navigation satellite system (GNSS), e.g. GPS or GLONASS, to define timing and the own aircraft's

- position,

- horizontal speed (speed over ground),
- vertical speed (climb or decend), and
- heading.

The GNSS antenna is integrated into the SoftRF case's top, just in the middle, see Figure 2. Therefore, the case shall be mounted with the SoftRF display to the side and the SoftRF golden antenna plug to the top, as close as possible to the instrument cluster top cover as possible. No metal parts shall obstruct the GNSS reception field above the SoftRF middle section, otherwise GNSS reception might be impaired.

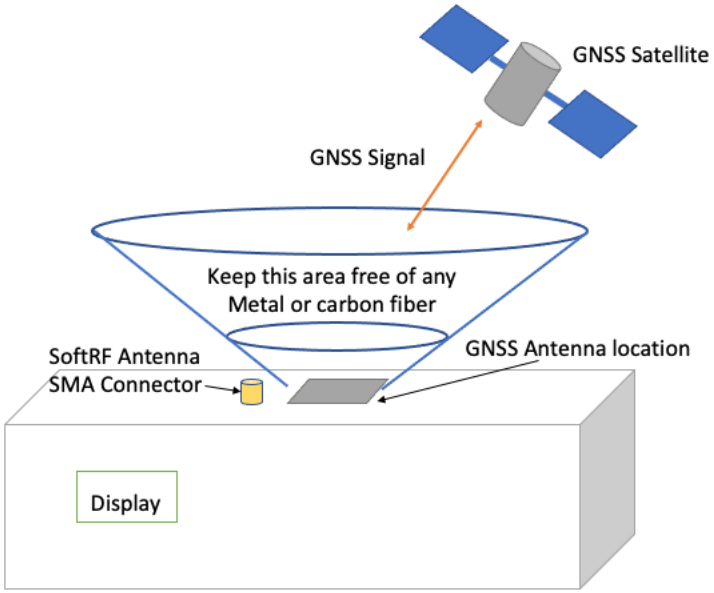

Figure 2: GNSS Antenna location inside the SoftRF case

Check for stable GNSS reception during a test flight, ideally by using a Flarm LED, which is showing stable GNSS reception by a stady "GPS" LED in the lower left corner of the display, see Figure 3.

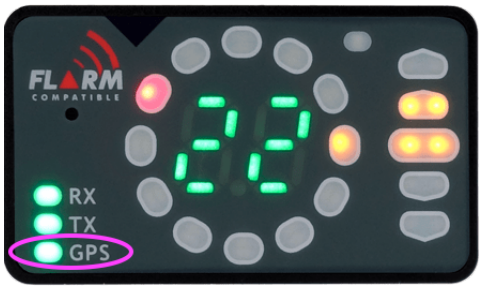

Figure 3: LXNav FLARM LED Display as an expample, notice the steady "GPS" labelled LED

In case your GNSS reception is not stable, consider to place the SoftRF better or to modify the SoftRF to allow for an external GNSS antenna, which is totally feasible.

5.4 Electrical Connections

All electrical connections are accessible through a single 9-pin D-sub connector, which is placed on the right side of the SoftRF chassis. Figure 4 shows the female connector that is part of delivery, but may be modified according to installation needs.

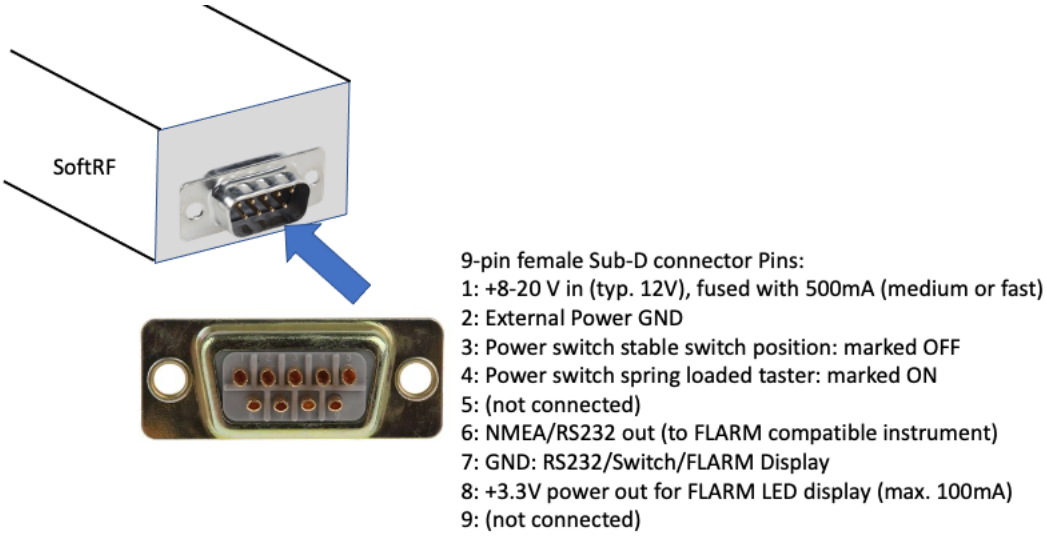

Figure 4: D-Sub 9 connector and pin usage

5.4.1 Electrical power supply

Electrical Power to the SoftRF is supplied to an internal power supply that operates with input voltages of 8 - 20V, supplying all internal SoftRF circuits, and the external Flarm LED display.

The Power is supplied through following of the D-Sub 9 Connector pins:

- Pin 1: + 8-20V = external battery "+"
- Pin 2: Ground = external battery "-"

> The power connection shall include a blow fuse in the positive power cord, with a "M 500mA" fuse value to ensure that a shortcut failure in the SoftRF will blow the fuse.

All power supply cabling behind the fuse has to be sized at least AWG30 (0.05mm^2) to ensure to blowing the fuse in case of a shortcut. It is recommended to use AWG 20 cabling for power connections in general. Cabling between the battery and the fuse has to be strong enough to blow the battery fuse, which is dependent on your the existing installation. For advice on cable sizes for certain currents, refer to FAA Advisory Circular AC 43.13-2B.

Make the fuse accessible for the pilot during flight in case the SoftRF firmware behaves unexpected, the pilot can be sure to take all power from the SoftRF.

Label the fuse in the cockpit clearly for the pilot to identify the fuse and the function, i.e. with a label called "Flarm 0.5A(M)".

To reduce the risk of interference with other equipment, all power cabling shall:

- be paired as close as possible together, i.e. the "+" and "-" cord shall be guided together tightly or as one double cable,
- be distanced as far away as possible from the magnetic compass,
- be distanced as far away as possible from the VHF radio and its cabling.

5.4.2 NMEA out, Flarm LED

The SoftRF D-sub 9 connector provides a RS-232 interface, that can be connected to compatible equipment.

Following NMEA sentences are implemented to be provided to external equipment:

- PFLAV
- PFLAE
- PFLAC

- PGRMZ
- PFLAA
- PFLAU

These should be enough to sufficiently show: own status, closest other traffic (for alerting), most important other traffic around you.

To use this interface connect following D-Sub-9 connector pins with your equipment:

- Pin 6: NMEA out signal (RS-232)
- Pin 7: signal ground
- Pin 8: +3.3V for small (max. 100mA) devices like the Flarm LED

The author does not give any guarantee for correctness, it is the responsibility of the person integrating the equipment to ensure that voltage levels between equipment is compatible. Shortcutting the 3.3V supply might damage the SoftRF.

The NMEA out baud rate is 38400 baud, this needs to be adjusted in the connected equipment in order to ensure proper operation.

The SoftRF does not listen to any NMEA input data, you cannot configure or update the SoftRF via NMEA, but only thogh WIFI, see section 5.5.

5.4.3 Power Switch

In order to conveniently integrate the SoftRF in a sailplane installation without the need to physically access the SoftRF itself, a special power switch function is integrated into the SoftRF.

This power switch shall be of following type Myiama Parts MS500D or similar with following positions:

- Stable middle position: no action; connect to D-Sub-9 Pin 7 (GND)
- Stable OFF position: device shall be OFF; connect to D-Sub-9 Pin 3
- unstable/spring loaded ON position: device ON command; connect to D-Sub-9 Pin 4

The function of the power switch is described in section 6.1.

5.5 Parameters

At least for the first 10 minutes after power-on, the SoftRF creates a WIFI network named "SoftRF-AABBCC", where AABBCC is the SoftRF Device ID of your SoftRF, find it on a label that is found on the SoftRF, and on the small display of the SoftRF.

The password for this WIFI network is 12345678, it cannot be changed.

Connect to this WIFI using your mobile phone or PC, and type following URL into your favourite web browser "http://192.168.111.1/" and hit "Enter".

This shows you a status page similar to Figure 5:

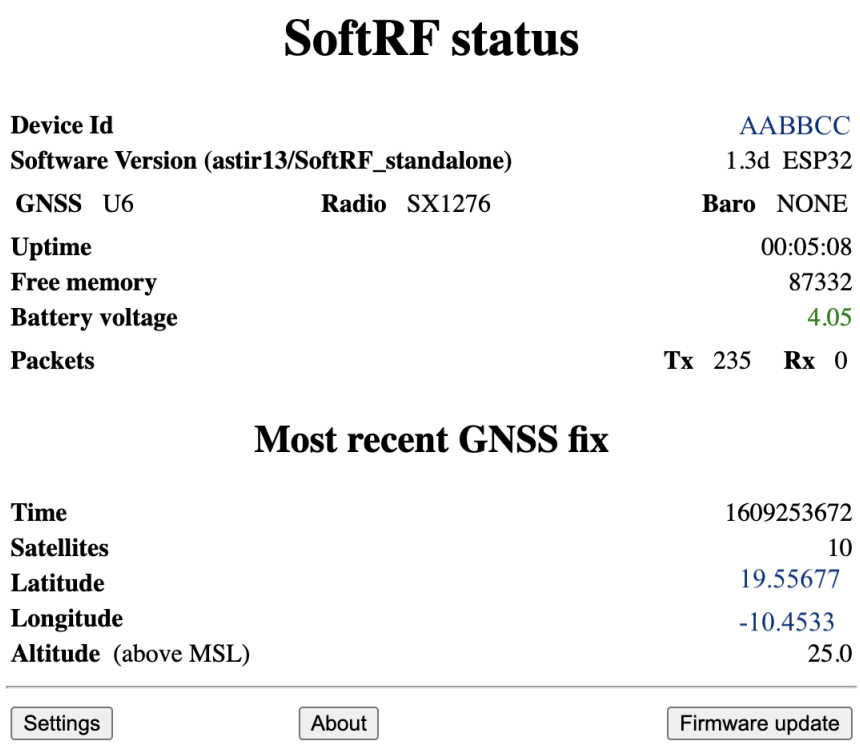

Figure 5: Status page in web browser at http://192.168.111.1

This example shows a status where there are 10 GNSS satellites found, and lat/long is provided. The device ID that will be found on e.g. http://glidertracker.org is shown as "AABBCC".

When pressing the "Settings" button in the lower left area of the screen, another screen is shown, see Figure 6.

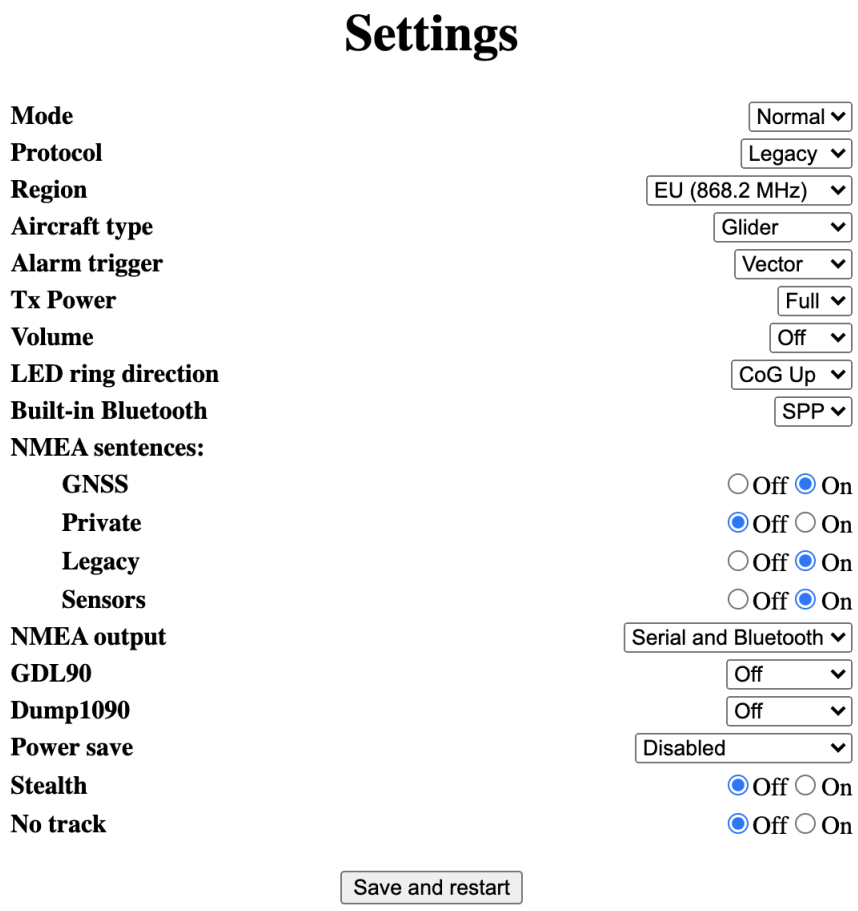

Figure 6: Settings page in web browser at http://192.168.111.1/settings

All settings can be changed. To provide proper operation for sailplane usage, however, only following settings shall be changed to stay on the safe side:

- Protocol: choose "legacy" if you want to see other Flarm devices and if you want to be seen by other Flarm devices; use OGNTP, if you just want to be tracked by the open glider network database, i.e. on http://glidertracker.org. Only use other protocols than "legacy" if you really know what you do and what the consequences are.
- Region: select the right one, to ensure you use a legal frequency. This might have to be changed when you travel with your glider to e.g. Russian Federation from European Union. However, you can not freely choose all frequencies as your SoftRF is born in a certain frequency band, which limits your choices around that band.
- Aircraft Type: choose according to your aircraft type
- Alarm Trigger: "Vector" is an intelligent way to create alerts from course over ground and speed to issue alerts if an impact is expected in 19 seconds or sooner; "Distance" creates alerts for the closest received traffic that is closer than 1000m horizontal and 300m vertical, with different levels of urgency, highest urgency level with distance ¡ 400m;
- Tx Power: Inside the EU, "EU" should always be used which limits TX power to 25mW (14 dBm) at the Antenna, which is the maximum in the EU; FULL is 17 dBm, and LOW is 2 dBm, these might be chosen at other places;
- Built-in Bluetooth: "SPP" shall be chosen if this manual shall apply
- NMEA output: "Serial and Bluetooth" ensures you can use a Flarm LED or other cabled device and a bluetooth device to run e.g. XCSoar App at the same time. If you only want one or the other, choose accordingly, but remember that other pilots might expect bluetooth to work.

- Power Save: "WIFI Off 10 min." allows you to disable WIFI after 10 minutes from power-up. This can be advicable to ensure noone can temper with your settings when waiting for the towplane, etc. and it safes some power.
- Stealth: "On" informs other aircraft and ground receivers (open glider net), that you are in stealth mode, i.e. used at centralized competitions, where you do not want to share your position and climb rate with other gliders, but you want to have awareness of collision relevant traffic around you, see also http://wiki.glidernet.org/opt-in-opt-out.
- No Track: "On" informs the open glider network to hide your position and track (OGN opt-out), including search and rescue, see also http://wiki.glidernet.org/opt-in-opt-out.

When having changed any of these settings, press the "Save and restart" button in the bottom of the page and wait approximately 20 seconds for the device to be restarted before reconnecting to the SoftRF WIFI with your PC or mobile to check if the status is ok and to *verify your settings* are really changed.

Always test the new settings in the concrete installation scenario before using the SoftRF equipment in flight.

5.6 Internal Battery

If not yet installed, install a "protected" LiIon 18650 battery into your SoftRF. The battery is needed to stabilize the power supply for the SoftRF itself and the optional external Flarm LED.

It is highly recommended for fire hazard reasons to apply a high quality 18650 Li-Ion 3.6/3.7V cell from your country that has a battery management system protection included. Buying in your country also ensures all environmental and legal battery requirements are fulfilled. One example for a very suitable type of battery is the NITECORE NL1826R 2600mAh.

Be aware:

- Never install a Li-Ion battery that is damaged, old, was overheated, is below −15 degrees Celsius, or is disformed in any way from its normal size.
- Never install a Li-Ion battery that has no battery management system integrated.
- the SoftRF has a Li-Ion battery charging controller, so there shouldn't be any danger from over- or undercharging, but safe is better than sorry, so use a battery management system battery for double protection, as should be normal in an aeroplane.
- do not use other chemical types of batteries, as the SoftRF assumes a Li-Ion battery to be used.
- Li-Ion batteries with battery management system typically are the ones used in devices where batteries are user-replaceable, as is the case for LED lamps and e-cigarettes.

5.7 setup in OGN Database

You want to be a part of the open glider net community to allow others to see your SoftRF tracking in e.g. http://glidertracker.org, then go to http://wiki.glidernet.org/ddb and register your glider there with the "Device ID" shown in the WIFI Status page, see section 5.5.

5.8 Sticker in Cockpit

Place the sticker shown in Figure 7 in the cockpit for pilots to be able to find documentation about the use of the SoftRF. Simply print this page on paper, cut it out, write the Device ID, then laminate and apply in the cockpit.

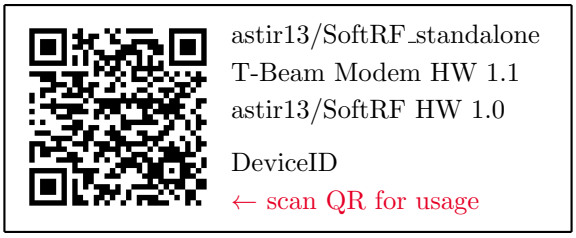

Figure 7: Cockpit sticker with QR code leading to online documentation

5.9 Test

After installation, you shall test the installed SoftRF by placing your aircraft outside, sitting inside with a closed canopy and starting all your cockpit equipment including the SoftRF. Please observe in this ground test positively that:

- total power consumption does not exceed the design maxima for your aircraft (measure current, consult documentation),
- all aircraft equipment operates as usual before the installation of the SoftRF,
- that the VHF Radio does not produce a noise that could result from interference from the SoftRF,
- a radio check via the VHF radio is positive with good readability from a test station,
- your magnetic compass shows the correct direction (compensation might be necessary if power supply wires pass close to the compass),
- the SoftRF has turned on (see the display),
- the SoftRF has GPS reception (see the status page, refer to 5.5),
- the SoftRF transmits (see the status page transmit counter, refer to 5.5),
- (optional) the SoftRF is registered at OGN DB with the correct Device ID (shown in the display),
- (optional) the SoftRF is received by a nearby OGN receiver (if there is one), verify on a glider tracker web page such as http://glidertracker.org; the heading of the SoftRF might be wrong, as the GNSS cannot determine a meaningful heading without movement,
- the SoftRF is received by another nearby SoftRF receiver (or FLARM, ideally with a display or XCSoar to verify your identification and location),
- the SoftRF receives other SoftRF transmitters using the same protocol,
- auto-power off after 10 minutes if you shut down the external power of the SoftRF and when the aircraft does not move.

After a successful ground test, perform a flight test or let an experienced person perform a flight test with all existing and the new equipment switched on to positively confirm that:

- the SoftRF can be received by other aircraft equipped with compatible equipment (ask your friends)
- the SoftRF receives the other aircrafts: e.g. on the XCSoar moving map app
- the SoftRF is received by the nearby OGN Receiver, to check this, log onto http://glidertracker.org, select your plane by clicking on it, and choose from the Settings "track"= 12h and "Select"=12h, this should show your whole flight, dependent also on the altitude of your flight and the location of OGN receivers;
- after a long flight where you covered different OGN receiver areas, check out your SoftRF range as received by the OGN network using this tool: https://ktrax.kisstech.ch/flarm-liverange/.
- keep this range analysis for later reference (yearly check).

If you are encountering unexpected results in these tests, check the installation and antenna characteristics.

Noise in the VHF radio can be removed by following steps:

- identifying the source of the noise: keep your radio on with squelch off, to hear the noise, switch off the other devices one by one until the noise suddenly vanishes; switch on the last device again to confirm that it is the noise generator;
- now use a EMI Suppression Toroidal Ferrite (e.g. 3W800 from Würth), that ranges up to VHF Air Radio frequencies and wind the power supply cabling of the noise generating device 2-3 times through the ferrite (both ground and positive), as close as possible to the casing of the noisy device,
- ensure the 2 cables ground and positive are both following each other closely until the source of power,
- if not effective, apply the ferrite to other cables leaving the device; especially SDCard reader cables, GPS antenna cables are earlier seen to carry noise into other instruments.

5.10 Legalities

For the european union, the EASA CS STAN Issue 3 defines the CS-SC051c standard change for "the installation on of FLARM equipment in ELA2 type aircrafts", giving very good advice on the installation procedures to follow. This document highly recommends to follow that standard change regardless of your country, as it gives good advice.

Find the document at https://www.easa.europa.eu/sites/default/files/dfu/CS-STAN%20Issue%203.pdf

If you are placed in a country that implement EASA rules, you and your aircraft material personnel shall fill out a Form 123 (find it e.g. here: https://www.iaa.ie/publications/docs/default-source/publications/forms/airworthiness-application-forms/easa-form-123-issue-00) and refer to CS-SC051c.

6 Usage

During normal use, the SoftRF offers the following functions:

- transmission of own aircraft information to other aircrafts and ground receiver stations (OGN Receivers), using the chosen protocol (default is Legacy = compatible with Flarm v6)
- reception of other aircraft information using the chosen protocol (default is Legacy = compatible with Flarm v6)
- transmission of GNSS data, current own state, alerts and other aircraft information to connected devices through bluetooth and RS-232 cabling
- charging of the internal battery to continue operation after the main power fails
- display of status on a small internal display, for debug on ground

Some of these functions can be manipulated by the setup menu, refer to section 5.5.

6.1 Power on/off and preflight check

This section assumes, you have a Flarm LED device connected. For installations without Flarm LED, a specific procedure shall be prepared and handed to the pilots by the installation personnel.

6.1.1 Switch ON

To switch the SoftRF ON, perform following steps:

- connect the battery to the aircraft,
- switch the main switch of the aircraft into "ON" position, to provide external power to the SoftRF,

- **press the SoftRF Power button into position "ON" and hold it there for 2 seconds, then release it to middle position**,
- observe the Flarm LED or a LED besides the SoftRF power switch turn on

Before flying with the SoftRF, check its function when outside on the airfield, at least 20 seconds after switching "ON":

- check that the SoftRF is having GNSS reception, the "GPS" LED on the Flarm LED device shall be permanently green and on, as shown in Figure 3
- check that the SoftRF is transmitting by e.g. checking that the LED marked "TX" on the Flarm LED device is blinking green once per second, it is located just above the "GPS" LED;
- if other aircrafts are around, and their SoftRF (or compatible devices) are switched on, check that you receive their signal, shown on a connected XCSoar device or by observing that the "RX" LED on the Flarm LED is blinking, it is located just above the "TX" LED;

6.1.2 In-flight switch OFF

To switch OFF your SoftRF in flight, i.e. because you get distracted by too many alerts during aerotow or otherwise, just switch the SoftRF power switch into the "OFF" position and leave it there. The SoftRF will shut down after 5 seconds.

6.1.3 Switch OFF after flight

To switch off your SoftRF at the end of the flight:

- switch off the main power supply of the aircraft,
- observe the SoftRF to coninue operation for the next 10 minutes and then to show down itself automatically (this extends the life of the battery because it is not stored fully charged)

The auto-shutoff function only happens when the GNSS measured speed is below 10kt for at least 10 minutes while external power is off.

6.2 Power outage

If your aircraft's main power supply fails during flight, the SoftRF will continue to operate on power provided by the internal battery. The duration of operation depends highly on the charge in the battery, but should last at least for 60 minutes with an external Flarm LED supplied as well.

> Do not use the SoftRF as an indicator for the state of the aircraft's main power supply, as the SoftRF will change over to internal battery power if the external supply fails. The user cannot see any difference during flight.

6.3 Power Chip Reset

If the operation of the power switch doesn't work as described above, you can reset the power controller chip of the SoftRF by pressing the power switch into "ON" position and hold it here for ¿8 seconds, then release it to middle position. Then the device is OFF. After that a short press of 2 seconds into "ON" position, it should turn on. If that does not work, check the power supply of the SoftRF, the state of the internal battery, probably best done by the personnel that installed the SoftRF in that aircraft.

6.4 Connecting XCSoar via Bluetooth

In order to make the widespread soaring app "XCSoar" show you other traffic around your plane on the moving map and the opftional screen "Flarm Radar", please follow following steps:

- enter the Android Bluetooth settings menu on your mobile device running XCSoar
- scan for other devices
- the list of devices should show "SoftRF-ABCDEF" where ABCDEF is the Device ID of your device (visible on the little display in the SoftRF and on a sticker visible for the pilot)

- press on the "SoftRF-ABCDEF" device to pair the SoftRF
- open XCSoar in flying mode
- open the XCSoar Config/Devices menu
- identify a unused device that says "Disabled" and select it,
- press the "Edit" button in the bottom,
- for the Port, select the "SoftRF-ABCDEF" device you just paired before,
- for the Driver, select "FLARM",
- for thee K6Bt, select "OFF",,
- press OK

Now the SoftRF is setup and if it currently has GNSS reception, the Devices screen should show you below your SoftRF Device a line with small text saying "GPS fix; Baro; FLARM".

Note: Pressing the "Monitor" button in the Device menu allows you to see the NMEA traffic that is generated by the SoftRF. This might be very useful for debugging problems.

7 Maintenance

As the SoftRF is not mandatory equipment, there is no mandatory maintenance required.

However, to maintain proper operation, it is recommended at regular intervals, not longer than 12 month since the last time, the following maintenance is to be executed.

7.1 Range check

If your flights during the last months have been in an area with compatible OGN receivers, and you had not opted out from OGN actively, you shall check your transmission range still is as at installation time with this tool: https://ktrax.kisstech.ch/flarm-liverange/.

7.2 Internal Battery

Run an internal battery test:

- connect the main aircraft power supply battery,
- switch the SoftRF "ON", see 6.1.1,
- open the Status page as described in section 5.5,
- let the SoftRF charge the internal battery until it reads 4.1-4.2V in the SoftRF status page, if you have enabled WIFI power saving, you might require to read the battery voltage on the SoftRF display or restart the SoftRF to provide WIFI anew,
- disconnect external power, take the time and observe the battery voltage to decline slowly,
- when the SoftRF shuts down 10 minutes later (auto-power off), because the aircraft is not moving and on battery power (as described in section 6.1)
- switch the SoftRF "ON" again, and reconnect to the status page, to read the Battery voltage: if the battery voltage is below 4.00 (Volt), the battery might need a capacity check and possibly replacement, see 5.6.
- if the battery voltage after the 10 minutes test is greater or equal 4.00 (Volt), the battery can be expected to keep up operations for at least 60 minutes when in flight

7.3 Firmware

- connect to the status page as described in section 7.2
- check https://github.com/astir13/SoftRF_standalone/wiki/Updates if there is a new Software Version for your device,
- in case there is a new firmware for your device and you decide the updates are relevant for your use, continue this list:
- continue on a PC (Mac, Linux, Windows are ok): download the new firmware for your device from https://github.com/astir13/SoftRF_standalone/wiki/Updates (you need internet connection for that), be careful to check that the two HW Revisions match the ones on the sticker of your SoftRF (T-Beam and astir13/SoftRF HW revision)
- disconnect from the internet WIFI,
- connect to the SoftRF WIFI,
- open the status page of the SoftRF,
- click on the button "Firmware Update",
- observe a new page opens called "Firmware update",
- click on "Choose File" button,
- select the downloaded file name from your Download directory, it shall end with ".bin", if you downloaded a zip file, you might need to unzip it first to get to the ".bin" file,
- observe the filename be shown besides the "Choose File" button,
- click on the "Update" button, to start the upload,
- **do not shut down power now!**
- observe the update counter to count to 100, then wait for at least 3 minutes without taking power off the SoftRF,
- in case the counter stops for more than 60 seconds without update before reaching 100: wait 60 seconds more, then perform a power chip reset (see section 6.3 and retry;
- after above procedure, the SoftRF should restart and display the new firmware revision in the status page and on the built-in display
- run a functional test, see section 5.9.

8 Technical Data

8.1 Transmit Spectral Purity and Power

For T-Beam HW revsion 1.1, follwing transmit spectrum was recorded in EU power setting, which shows very good spectral cleanness and power below the maximum allowed +14dBm:

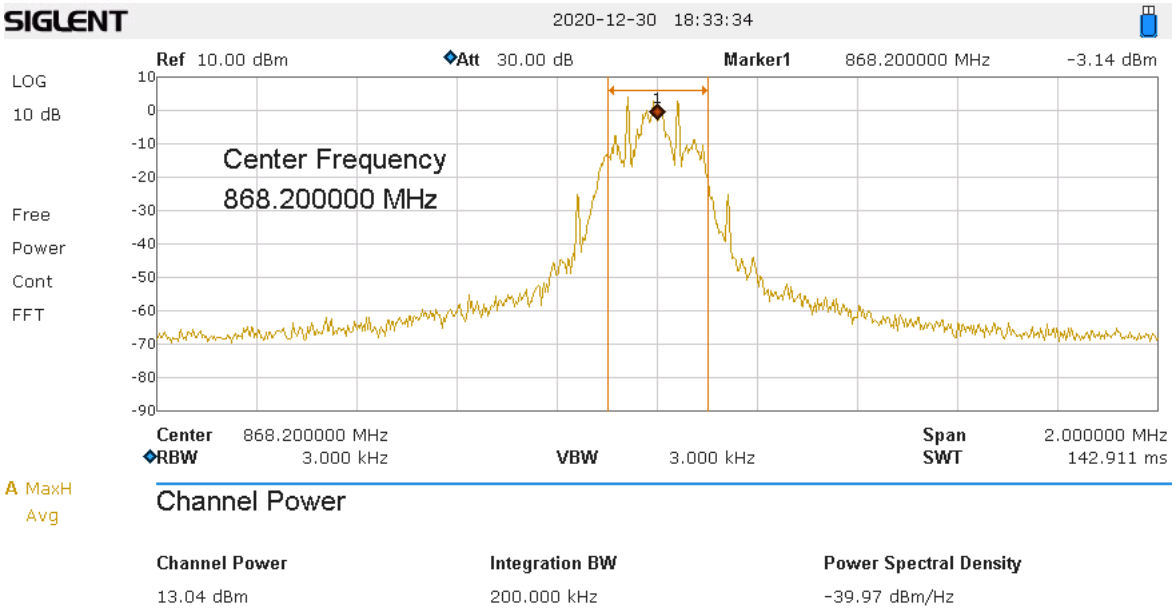

Figure 8: Transmit Spectrum of the T-Bone rev.1.1 Modem, used in astir13/SoftRF HW rev.1.0

8.2 General Data

Applicable for use with the "Legacy" protocol (compatible with Flarm v6):

Item	Value	Unit
Supply Voltage	8-20	V
typical supply current	100	mA
maximum supply current	300	mA
weight	250	g (including battery, antenna, power switch, cabling and Flarm LED)
ambient temperature range	0 - 40	°C
battery type	18650 Li-Ion	with protection
battery voltage typ.	3.7	V
max.	4.2	V
min. protection shut off	3.1	V
channel bandwidth	125	kHz
modulation type	2-FSK	
bitrate	100	kbps
max. transmit power	+14	dBm in "EU" setting
	+17	dBm in "FULL" setting
	+3	dBm in "LOW" setting
max. transmit duty cycle	< 1	%
transmit frequency stability	+/-15	kHz
GNSS chipset	uBlox NEO6M	

9 License