A DIY Guide to Building a SoftRF Transceiver and SkyView Traffic Display

By Jim Hogue julietsix@gmail.com March 31, 2023

Background

The Soaring Society of America (SSA) has recently launched an effort to establish a network of Open Glider Network (OGN) receivers at appropriate locations across the United States of America. OGN is relatively new to the USA but has been in use for close to a decade in Europe. Our club, the Central Alabama Soaring Association (CASA), has installed several OGN receiver ground stations in our Central Alabama soaring arena, with the intent to provide increased aircraft traffic awareness and tracking of glider operations.

Also, to take maximum advantage of the tracking and automatic flight logging capabilities that OGN offers, as well as to provide a certain amount of improved traffic awareness, CASA has built a small number of SoftRF Transceivers and SkyView Display Devices and installed them in our club aircraft. These SoftRF devices transmit aircraft position and identification information to the OGN ground stations, and also exchange information in-flight with FLARM devices and other SoftRF devices, to allow in-cockpit traffic display and audio alerts.

This Do-It-Yourself (DIY) Guide is intended to document our assembly and installation of these SoftRF devices, including lessons learned. A persistent DIY-capable person should be able to assemble their own devices from the information in this paper.

For more background information as well as technical details on OGN, FLARM, SoftRF and its offshoots (including devices like ours), etc., see the following papers by Moshe Braner:

https://github.com/moshe-braner/SoftRF/blob/master/software/firmware/documentation/SoftRF_MB_user_guide.txt

https://github.com/moshe-braner/SoftRF/blob/master/software/firmware/documentation/SoftRF_MB_under_the_hood.txt

https://github.com/moshe-braner/SoftRF/blob/master/software/firmware/documentation/SkyView.txt

For more information on the SoftRF hardware we are using, see https://github.com/lyusupov/SoftRF . Note that we are using an offshoot of SoftRF software, with advanced capabilities, see https://github.com/moshe-braner/SoftRF

CASA has equipped our fleet with SoftRF devices rather than FLARM, because a SoftRF installation is much less expensive than a FLARM installation (~$200 vs ~$2000). FLARM installations are not affordable for CASA.

Disclaimer

The information in this DIY guide and devices that may be built using it are not represented or implied as being fit for any purpose whatsoever. Use these devices at your own risk. Also, see this disclaimer: https://github.com/lyusupov/SoftRF/wiki/Prime-Edition-MkII#disclaimer

Also, please be aware that the Federal Communications Commission (FCC) regulates devices transmitting on radio frequencies. Devices like SoftRF devices are allowable without FCC authorization under certain conditions, documented in Title 47 Code of Federal Regulations § 15.23 - Home-built devices (https://www.law.cornell.edu/cfr/text/47/15.23). This states in part: "Homebuilt devices like this cannot be marketed, they cannot be provided as or built from a kit, and they can only be built in quantities of five or less for personal use only". Compliance with these regulations is up to you.

Acknowledgements

Many thanks to Davis Chappins for his initiative and energies spearheading the SSA effort to establish a nationwide network of OGN receivers, this precipitated our SoftRF device build effort. And thanks also to Linar Yusupov for his pioneering work creating and developing SoftRF. And special thanks to Moshe Braner for further developing SoftRF with enhanced features and capabilities which make it a very capable traffic awareness system, and also for working so closely with us during our build activities.

A Brief Discussion of Alternative Traffic Displays

We have chosen to use the dedicated SkyView Traffic Display. However, just about any modern glide computer should be able to serve as a display. Connecting to one of these alternate displays may be advantageous for your situation. Devices such as smartphones or "hacked" eReaders that run XCSoar/TopHat will work, as will Clearnav, Oudie, etc. The NMEA sentences coming out of SoftRF are the same as from FLARM, so really any device that can connect to and display the traffic data from FLARM can do it for SoftRF also. Voice alerts should be available out of devices that have audio capability. Or, the latest versions of SoftRF software running on the standard board ("T-Beam") offer voice warnings, but require an amplifier and speaker to be added to the T-Beam. Note that, however, this combination does not have the non-danger traffic advisories, it just provides the collision alerts.

Describing how to connect to any of this wide variety of available display devices is beyond the scope of this paper. Information on this subject may be available at https://github.com/moshe-braner/SoftRF

Building Your SoftRF Transceiver and SkyView Traffic Display

So, how do you build a SoftRF Transceiver and SkyView Traffic Display for yourself or your club? Well, at this point, doing so has quite a few tricky steps to it, so this task is only recommended for people willing to take on a somewhat involved DIY project. Let those with courage and persistence proceed!

Ordering the Parts

The SoftRF Transceiver and SkyView Traffic Display are based on the brilliant "SoftRF" development by Linar Yusupov, see https://github.com/lyusupov/SoftRF . Our devices are based on Linar's "Prime Mark II" and "SkyView EZ". Hereafter in this paper we will refer to the transceiver as "SoftRF" or "SoftRF Transceiver" and the traffic display as "SkyView".

Total cost of parts for one installation should come in somewhat below $200. Of course, per installation cost may be lower with volume buys (savings on shipping, volume discounts).

SoftRF board: This transceiver and processor board is called a "T-Beam". Be sure to get the 915 mhz version, this is the radio frequency used for OGN (and FLARM) in the USA. And get the units with the "OLED" display, this display is handy to confirm tracker operational status. Also, I strongly recommend getting units pre-loaded with the basic SoftRF software, you will be able to load new software onto these units via a simple wi-fi action (even from your smartphone!). The units loaded with "Meshtastic" software can be used, but the first time you load software you will have to "flash" the new software into the processor via a direct USB wired connection, and this is a more involved and complex operation than the wi-fi method.

For quickest delivery at a slightly higher price:
https://www.amazon.com/dp/B09VLFQQG4
For a slightly lower price, but with almost certainly slower delivery (coming from China):
https://www.aliexpress.us/item/2251832780913987.html or
https://www.amazon.com/gp/product/B09VLFQQG4

SkyView board: Be sure to get the one WITH the 2.7 inch ePaper display (the website will open up with "without ePaper" as default). The only source I have found is in China, it may take as long as a month or more to get it, so order early:
https://www.aliexpress.us/item/2251832710248766.html

Mounting Screws: These are needed to secure the SkyView board in its 3D printed case. 2.5mm x 0.45mm x 6mm, four per unit (but really only two per unit are necessary). Here is what we used: https://www.boltdepot.com/Product-Details.aspx?product=22345

GPS antenna: The GPS antenna that comes with the T-Beam is very low performance (slow satellite acquisition and poor reception through structure or buildings). It should be replaced a better/larger one, such as:
https://www.data-alliance.net/antenna-gps-lna-embedded-u-fl-sma/

Get the 25x25x4 mm size and the "4 inch cable to U.FL" connector option. This antenna has proven to acquire satellites through fiberglass skins, and even inside a metal hangar with doors closed!

Radio antenna: The radio antenna that comes with the T-Beam is also inferior performance, so we recommend it be replaced. The radio antenna must be located outside any metal or carbon fiber enclosing structure, meaning that it must have a clear "view" through a canopy, or through a not-too-thick fiberglass or Kevlar skin, and not too close to substantial metal parts. If the SoftRF Transceiver is to be mounted "buried", then choose the Dipole type. Otherwise, the "Rubber Ducky" type (connecting directly to the T-Beam) will probably work fine (but the dipole type is still the best):

Dipole type (best): https://www.data-alliance.net/antenna-900mhz-3g-gsm-omni-directional-rp-sma-or-sma/
Long (better) "Rubber Ducky" type: https://www.amazon.com/dp/B091PRHPTJ
Short "Rubber Ducky" type: https://www.data-alliance.net/antenna-915mhz-omnidirectional-3dbi-w-sma-or-rp-sma-gsm-ism-1-4-wave/

Note that any of these antennas must be mounted or oriented approximately vertically.

Speaker: Probably any 4 ohm reasonably efficient speaker would work, but here is a very compact speaker with integral mounting lugs which works well in a reasonably quiet cockpit:

https://www.amazon.com/dp/B08JCHK7GR

Be sure to get the 4 ohm option.

And you will need this type of connector to connect it to the SkyView:

https://www.amazon.com/dp/B07DVW1BS9

Be sure to choose the 16 pin option.

MicroSD card: Probably just about any of them will work, we chose this one:

https://www.amazon.com/gp/product/B0B5F1PVT4

Power: You have two options here. One is to power your SoftRF Transceiver and SkyView with 12-to-5V converters driven by your aircraft power. THIS IS THE RECOMMENDED OPTION. The second option is to power them with internal batteries. The internal battery option will require you to periodically recharge the SoftRF Transceiver and SkyView, and to remember to turn them off at the end of the flying day!

The power converter option might result in radio interference if the wrong converters are used or they are mounted too close to radio equipment and/or antennas. But we did not have problems with the converters specified below. The converter option also has the added benefit that the SoftRF Transceiver and SkyView automatically turn off when power is shut off or the aircraft battery is removed for charging.

Power converters:

For one SoftRF Transceiver and two SkyViews (example: two-place training glider), we used this triple output converter: https://www.amazon.com/gp/product/B071FLT7XF

For one SoftRF Transceiver and one SkyView (like in a single place glider), we used two of these single output converters: https://www.aliexpress.us/item/2251832061396905.html (Yes, these are from China and it may take a while to get them, but we have used these specific converters in several glider installations and have never had any radio interference issues with them)

(Alternative double output converter: We did see radio interference from this converter in one installation but not in another, so check for this before in-flight use: https://www.amazon.com/dp/B09B2Y71F7)

We recommend fuses and a toggle on/off switch for the 12 V power to these power converters.

Internal batteries:

For the SoftRF: https://www.18650batterystore.com/products/samsung-25r-18650

For the SkyView: https://www.aliexpress.us/item/2251832605382186.html (shipped from China, so could take a while to get)

Our towplane had a "cigarette lighter" 12 volt power output already installed, so we used a standard cigarette lighter plug-in 12-to-5V converter (with two outlets) to power the SoftRF Transceiver and the SkyView. We did not have any radio interference problems, but we have heard of problems with these plug-in converters occasionally. So, check for radio interference before initial flights.

MicroUSB cables: You will also need microUSB cables routed from the power converters to the SoftRF and SkyView, of various lengths depending on your installation. To support these cables, we used zipties as well as adhesive cable clips such as these: https://www.amazon.com/dp/B08ZJF9W33

3D printed cases: For the SoftRF Transceiver, there are many options available that may work, because the T-Beam is used for the popular Meshtastic applications also. Go to the Thingiverse website https://www.thingiverse.com/ and search for "Meshtastic T-Beam"or "SoftRF T-Beam".

Also, Linar has designed an enclosure (although there is no properly oriented window for the OLED display soldered directly to the T-Beam), see https://github.com/lyusupov/SoftRF/tree/master/case/v5 and/or https://www.thingiverse.com/thing:3041339 .

Moshe found this case, and he prefers it because it has some extra room inside for add-ons, such as a serial connection (TTL-RS232 level converter module), a 12-to-5V power converter,

and in the near future a connector for the audio output, etc): https://github.com/moshe-braner/SoftRF/blob/eb9661721b7e73b206af2492c855181c50b348c4/case/Tbeam_larger_box-2_antennas_.zip Note that the hole for the antenna has to be moved a bit.

We chose the following case https://www.thingiverse.com/thing:4753247 because it is sleeker and has a window for the display, but there are some modifications required for our application. These modifications will be detailed in the "Assemble the Devices" section.

For the SkyView, we found only one case design, Linar's, see https://github.com/lyusupov/SoftRF/tree/master/case/SkyView and/or https://www.thingiverse.com/thing:3702447 . Again, there are some modifications required. These modifications will be detailed in the "Assemble the Devices" section.

We had these case parts printed in black ABS. We used this printing service, with OK results: https://aero3ds.com/3d-printing

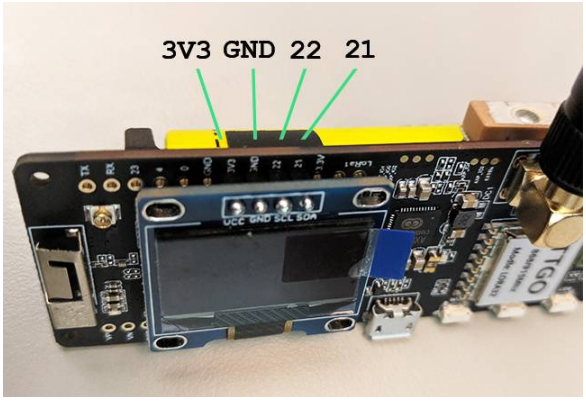
It is highly recommended that you order extra 3D printed parts. It is very easy to damage these parts while executing the required modification and/or during assembly. In particular, the SkyView front case requires drilling between the delicate button levers (see below), and we damaged many front case parts while executing this modification. Order at least twice or three times the number of SkyView front case parts than you think you need! It is inexpensive to order extra parts with your original order because the main effort for the 3D printing provider is in the setup, so once set up just printing additional parts is cheap.

Assemble the Devices

OK, here is where your (presumed) advanced DIY skills start to come into play….. Good luck!

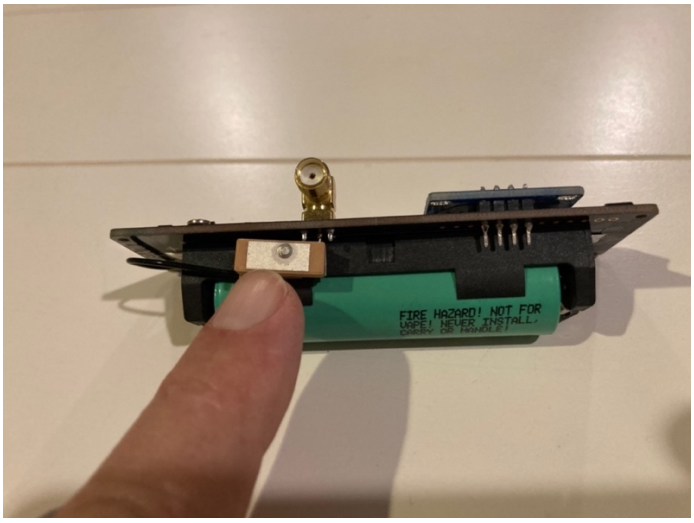
SoftRF Transceiver:

First, solder the OLED display in place on the T-Beam, using the provided pin unit (just cut 4 pins to use). This photo shows which pins connect where: 3V3 on the T-Beam to VCC on the OLED; GND to GND; 22 to SCL; 21 to SDA. DO NOT solder with the battery in place, very dangerous!!!!



If you are installing the battery, install it AFTER soldering. Be sure it is correctly aligned. On the batteries we bought, the minus end of the battery has the larger and flatter metal contact, the positive end has more of a recessed and smaller contact area. BUT confirm this with a voltmeter before installing.

If you stay with the original (small) GPS antenna that came with the T-Beam, you will likely have to slightly relocate it. It is stuck on with foamy double sided tape, gently pull on it and it will come loose. It needs to be moved outboard a bit to clear a stiffener inside the 3D printed case.



The 3D printed case for the T-Beam needs to be modified as follows:

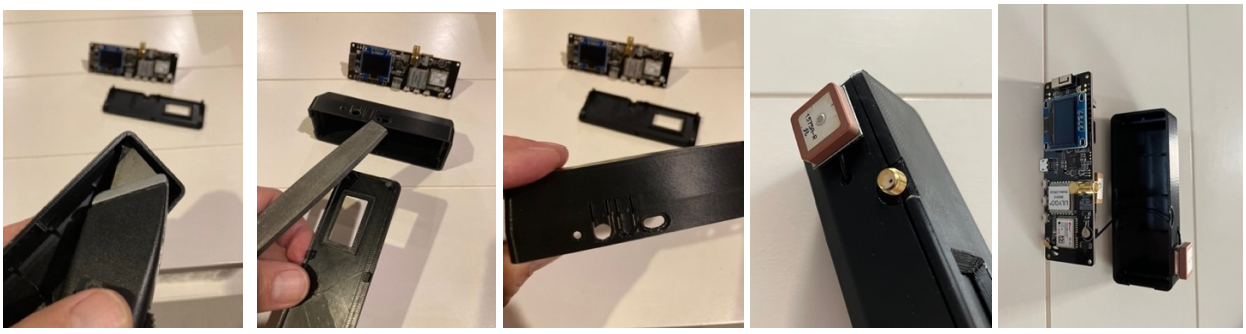
Remove the tiny cylindrical tabs that secure the four corners of the T-Beam board inside the main case, these tabs didn't fit the T-Beams that we received, and they are unnecessary anyway.

File down the holddown tabs on the case front, as printed they are likely too long to allow the case front to fit/snap down flat and fully into place. You will need to file/check/file again etc. with the T-Beam in the case until the face fits flush. Try to do this without snapping the face in place every time you check clearances, because snapping and then removing the face over and over is likely to result in some damage to the holddown tabs, you should try to avoid this.

Drill out or remove the button lever with the rounded "nib" on it, this button has no function when the T-Beam is loaded with the OGN software, and we don't want or need that particular button to be prominently accessible. Careful, it is easy to snap the whole lever off (however this really isn't a problem). Leave the button lever without the "nib" in place, this is an on/off/reset button (not needed if the unit is powered via USB power, e.g. no battery installed).

Drill a hole in the top of the case for the new GPS antenna cable to go through. Drill slowly and carefully, to avoid splitting or splintering this 3D printed part. Route the cable through the hole and mount the new GPS antenna in place using the provided double sticky tape patch.

If you want to use the new larger/better GPS antenna, carefully disconnect the cable of the original (small) GPS antenna from the T-Beam board, using your fingernail or needlenose pliers, and remove the antenna (maybe keep it as a spare). Note the hole on the T-Beam board its cable was routed through. Route the cable from the new antenna through that hole in the T-Beam board and carefully align it with the socket and squeeze it into firm connection with the pliers. Be very careful about alignment, I suspect these connectors are easy to damage.



Align and set the T-Beam in place in the case and snap the front face in place. Done!

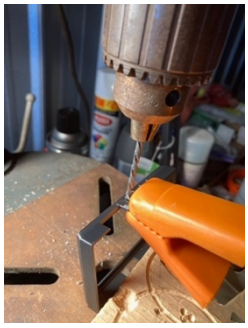
SkyView Display:

First, the 3D printed case for the SkyView needs to be modified as follows:

The button levers on the side of the case front are too stiff, and many times when one button is pushed the adjacent button gets actuated also, giving unexpected results. The only solution we have come up with so far is to drill 3/16" holes between the buttons. HOWEVER this is a sensitive operation which resulted in ruining a few case fronts (specifically, a button lever would break off). So you must stabilize the button levers to each other with some kind of clamp for the drilling operation. And it is best to use a drill press for precise drilling control. See picture below. We ruined at least half of the case front parts we tried to modify, so order two to three times as many case fronts as SkyView units you plan to build.

Also, expand the hole on the back of the case with a file to make room for the FC-16P connector for the speaker. Give it about 1/16 inch or more clearance all around.

If you are using the internal battery, plug it into the board and insert it between the display and the case. Mount the display board in the case using two-four 2.5mm x 0.45mm x 6mm screws.


Connect the speaker wires to the two connectors at one end of the FC-16P connector. Insert the connector through the hole in the case back and plug into the board with the speaker wires towards the top of the case. The MicroSD card will be clicked into its receptacle once data files are loaded on it, so hold off on this for now, more in a section below. The last picture shows the button levers with the holes drilled to increase their flexibility.

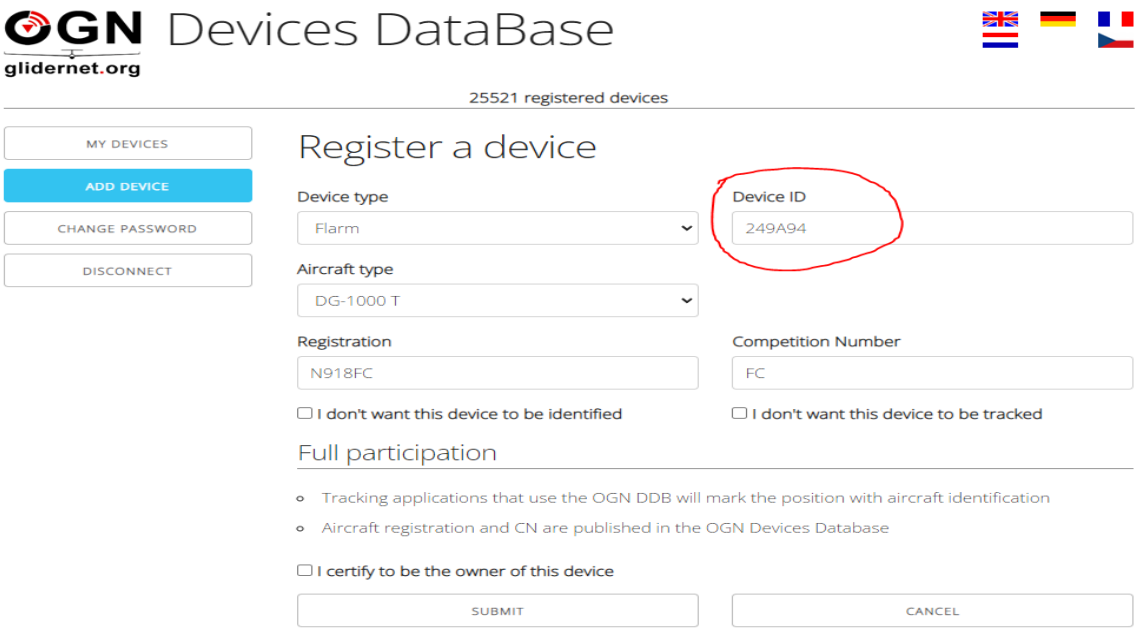


Register the SoftRF Transceiver and Associate Your Aircraft With It

You first need to identify what your tracker's identification number is. Place the SoftRF Tranceiver near a window in order to maximize the GPS satellite reception for first startup. Attach an antenna to it (even the inferior antenna provided with the board will be fine for this step). Never power up a SoftRF Tranceiver without an antenna attached, this may damage the tracker. Plug in a microUSB cable and power block to power it up. A screen showing software version will briefly appear. Then a status check screen will appear (all except BARO will show plusses +), then a screen like this will come up:

The “C77994” (your unit will be different characters) is the T-Beam board “Device ID”. Your track observed on OGN viewers and on in-flight traffic displays will show up with this identifier unless you associate this Device ID with your aircraft by registering on http://ddb.glidernet.org/. (Note that this Device ID is also the last 6 digits of the tracker’s wi-fi SSID.)

To do this registration, go to http://ddb.glidernet.org/ and create an account. Click ADD DEVICE and a page like this will come up:



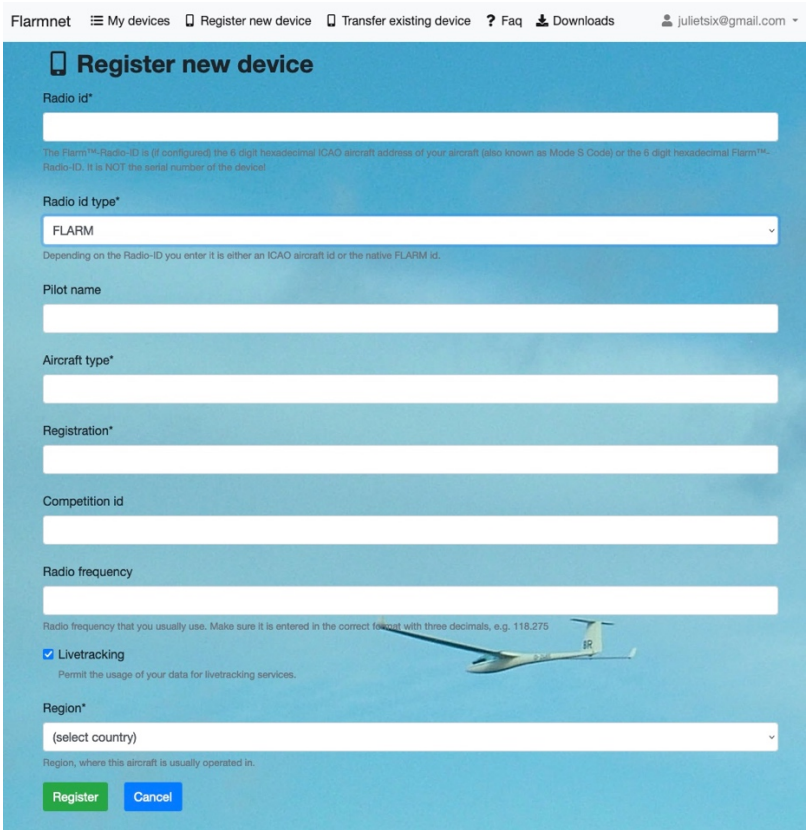
Set the Device type as “FLARM” (not OGN! OGN here refers to a different OGN protocol, yes, I know it’s confusing, but trust us on this). Input your Device ID, circled in red above. Choose your Aircraft type, if you can’t find your glider type go to the bottom of the list and select “Unknown”. If you are registering a towplane, you will find “Towplane” under the “Planes” section, just scroll down, you’ll find it. Type in your Registration (N-number) and Competition Number (SSA-registered competition ID, or if you don’t have one, use any set of numbers/letters which your glider is commonly known by, such as last 2 or 3 characters of your N-number, serial number if you are a 1-26, etc.). Leave the three “I certify….” boxes unchecked in order to fully benefit from the OGN tracking systems. Submit the form.

You now have your SoftRF Transceiver registered. You can register multiple devices to a single account. Within a day or so, when your SoftRF Transceiver is powered up and within range of an OGN receiver, it will now show up as traffic on OGN viewers identified as your N-number and/or competition ID instead of the (unrecognizable) Device ID. Also, it will show up associated with your N-number and/or competition ID in a downloadable database or

registered devices which you and other SkyView users can load into their display units so that in-flight you are identified by N-number and/or competition ID. More on this later.

By the way, if you fly with people who have traditional FLARM devices, encourage them to also register http://ddb.glidernet.org/ the exact same way as described above. By them doing so, their FLARM device will now show up on OGN viewers and on SkyView in-cockpit traffic displays as their N-number and/or competition ID instead of their (unrecognizable) FLARM device number.

Also, if you want your SoftRF Transceiver-equipped aircraft to show up as your competition ID on FLARM devices, you will need to register with Flarmnet, which is a database which FLARM users load into their FLARM traffic viewers. Go to https://www.flarmnet.org/flarmnet/ , register for an account, and log in. Click “Register new device” and a page like this will come up:



Put your T-Beam board Device ID in for Radio ID. Select FLARM for Radio ID Type. Fill in the rest of the blocks (Radio Frequency is optional) and click Register. Within a few days, your SoftRF Transceiver should show up in the Flarmnet database, which means that people who update their on-aircraft Flarmnet datasets after your registration will see you on their FLARM displays identified as your Competition ID instead of your (unrecognizable_ Device ID.

There is an alternate way to register, which we have not tried but might make sense for your installation. It is possible to enter the aircraft ICAO ID (the "Mode S Code (Base 16 / Hex)" from the FAA Registry information page on your aircraft) into the SoftRF settings (see section below) and enable its use instead of the Device ID. You could then register the ICOA ID with OGN and Flarmnet. That way, if you later replace the SoftRF Transceiver with another one for the same aircraft, you don't need to change the registration, you just specify the aircraft ICAO ID in the settings of the replacement device.

Load the Software and Configure Settings

We are using SoftRF and Skyview software with significant improvements from Linar's original, authored by Moshe Braner (many thanks, Moshe!). At this point some of the improvements and features are not yet fully proven out, so consider it all experimental for now. If you run into any issues, please communicate them to the author of this paper or to Moshe.

SoftRF Transceiver:

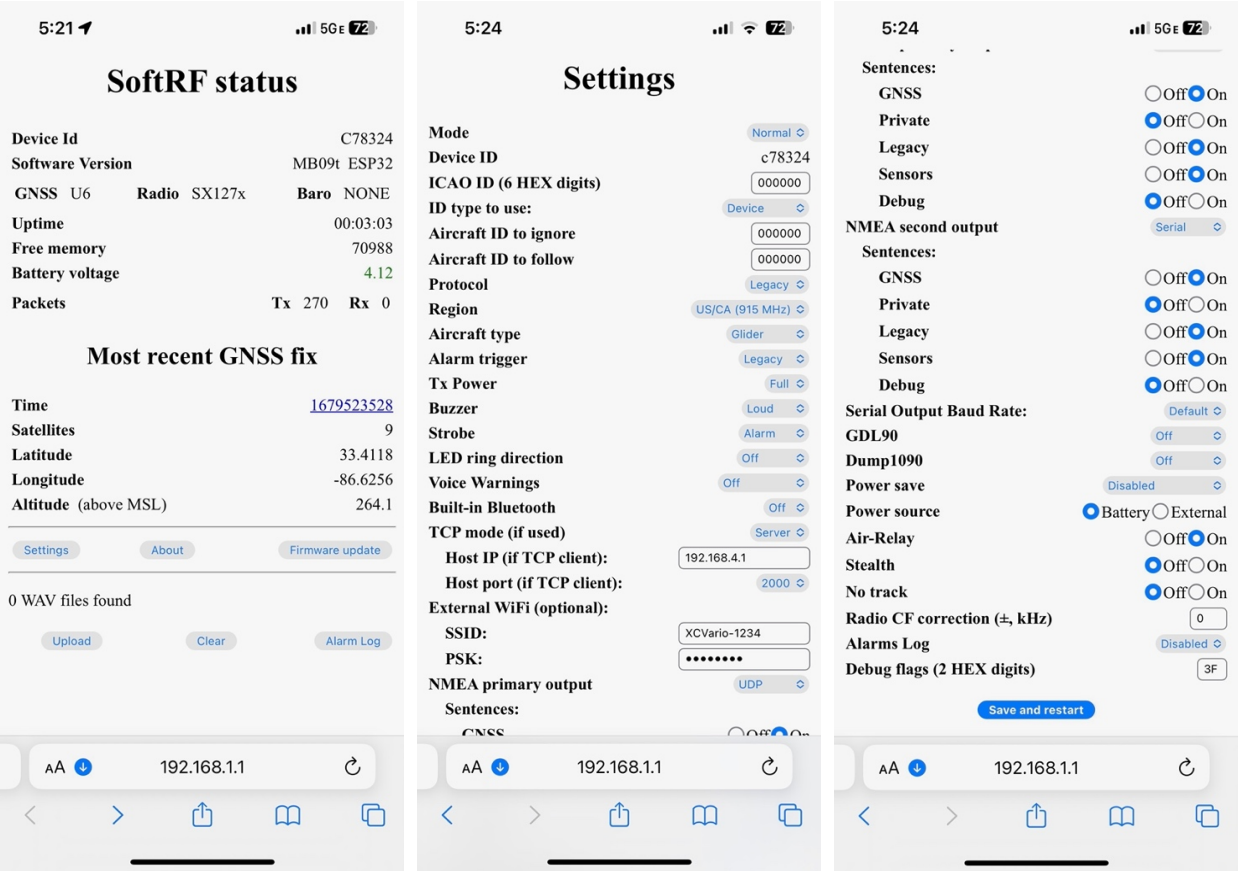
If you bought a "SoftRF" T-Beam, you already have the basic/original SoftRF software installed. On T-Beams with the latest basic SoftRF software installed, you can perform software updates by connecting to your computer or your smartphone to the T-Beam via wi-fi. We did our initial software updates using a computer, but since the devices have been installed in the club aircraft, we have been doing subsequent updates via smartphone.

First, you need to download the software update from the internet. Go to this web page for the latest software: https://github.com/moshe-braner/SoftRF/tree/master/software/firmware/binaries/ESP32/SoftRF Click on the highest version on that page ("SoftRF.MB09u.esp32.zip" as of 24 March 2023), and on the next page click the "Download" button. Find this .zip file on your computer/smartphone and unzip it. This will produce a .bin file which you will "flash" via wi-fi onto the T-Beam board.

To connect your computer/smartphone to the T-Beam, open up the wi-fi list and look for the network name SoftRF-xxxxxx (xxxxxx is your T-Beam's Device ID). Your computer/smartphone may complain there is no internet or network access with this network (it is correct). The wi-fi password for this device (and actually for all devices used in the OGN project, I believe) is "12345678".

Once the wi-fi is connected, open up a browser window and go to 192.168.1.1 and you will see a status page. This page may look a bit different than that shown below since you may be on a different software version. Click on the "Firmware update" button, and you will be asked to "Choose File". Select the .bin file you just downloaded/unzipped, and click the "Update" button. This "flashes" the new software (actually firmware) to the flash memory of the device. Once the update is complete, there will be a delay of up to a minute (don't touch or disconnect anything, otherwise you might "brick" the device), then the T-Beam will restart. Re-connect

with its wi-fi again. Again, open a browser and go to 192.168.1.1. Click the “Settings” button, and configure all settings as shown here:



Again, the page may look a little different, the software may evolve and there may be new settings. If there are differences, just leave those different settings items at the default values.

Click “Save and restart”. The T-Beam will restart with the updated settings. You can confirm the software version on the first page that briefly appears on the OLED display during restart.

In the future, you may update SoftRF Transceiver/T-Beam software via wi-fi the exact same way. Note that you will need to check and configure the settings every time you update, some of the settings default upon update to default values which may be incorrect for our application.

SkyView:

Your SkyView board as originally delivered cannot be updated via wi-fi. So, you will need to “flash” your first software load onto the display board via a direct USB wired connection from your computer. We’ll call this the USB method. But for future updates after this first-time loading, the wi-fi method can be used.

So, first download the software for the SkyView from the internet to your computer. Go to this web page for the latest SkyView software: https://github.com/moshe-braner/SoftRF/tree/master/software/firmware/binaries/ESP32/SkyView Click on the highest version on that page ("SkyView.MB06a.esp32.zip" as of 24 March 2023), and on the next page click the "Download" button. Find this .zip file on your computer and unzip it. This will produce the .bin file which you will flash onto the SkyView board.

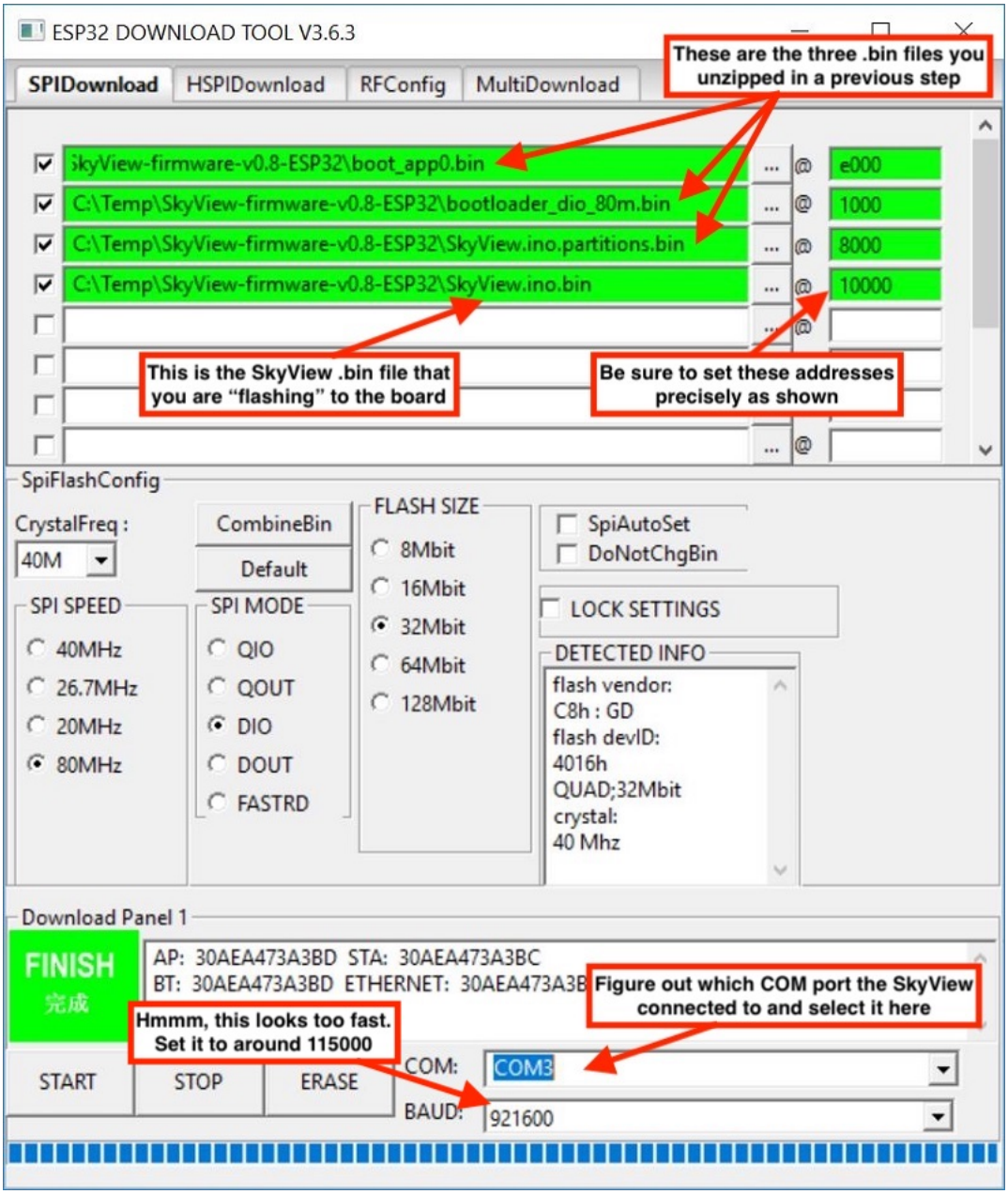
"Flashing" the new software/firmware (.bin file) onto the SkyView board via the USB method will be another test of your DIY skills! Follow these instructions:

Go to this web page https://github.com/moshe-braner/Open-Glider-Network-Groundstation/tree/main/ognbase/binaries and download the file named "USB-flashing-ESP32.zip". Unzip and note the three .bin files, you will also flash these "partition files" onto the board.

The SkyView board is based on the ESP32 processor. Use an ESP32 flash tool on a PC to flash via USB to this processor. Get an ESP32 flash download tool from this location:
https://www.espressif.com/en/support/download/other-tools
Prior to first use of the ESP32 tool, you might also need to install a driver for the CP210X USB to UART bridge from Silicon Labs or the CH9102F driver

Make sure the microSD slot is empty, do not flash with a microSD card installed.

Connect the SkyView to your PC with a microUSB cable and open the ESP32 flash download tool. Figure out which COM port it connected to and select that in the window near the bottom of the tool window. Enter the software update and partition files and addresses into the input windows shown in green, set the addresses as shown, and select configuration options etc. as shown here:

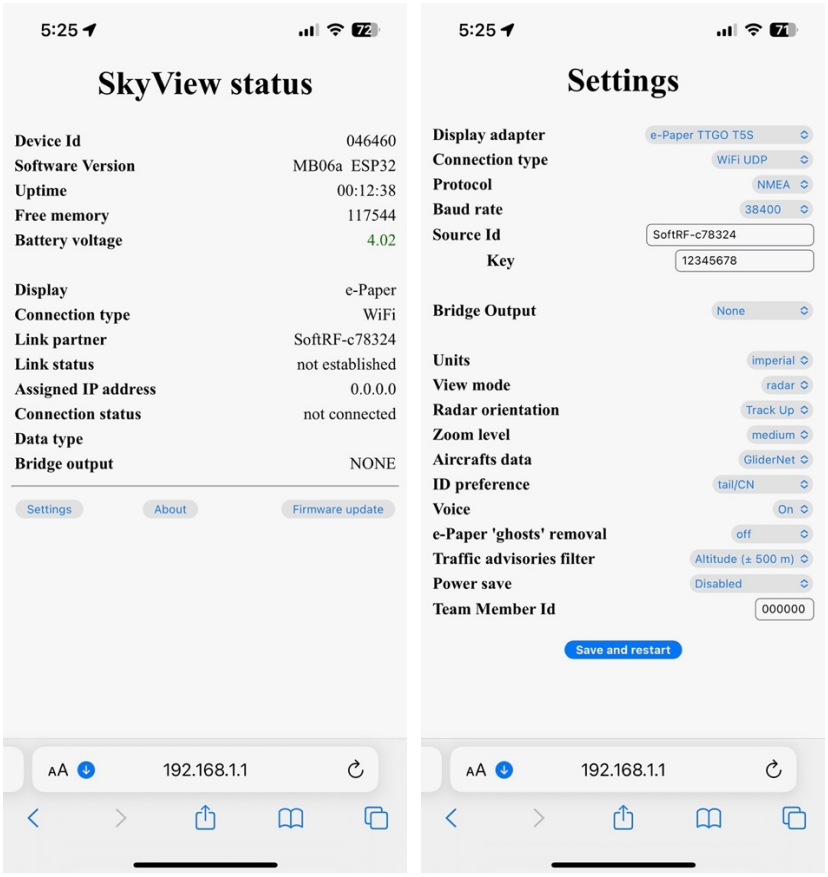


Press **START** button and wait for the flash to complete.

For some boards you may need to push **BOOT** button to activate the flash download mode. Some "Stock" modules may also require you to apply full flash memory erase (use the **ERASE** button) prior to first flashing.

You must now configure your new SkyView software. This is done via wi-fi only, similarly as with the SoftRF Transceiver, except the network name looks like SkyView-xxxxxx (xxxxxx is the display board's Device ID). Your computer/smartphone may again complain there is no network/internet access with this network (it is correct). The wi-fi password for this device is again "12345678". Open up a browser window and go to 192.168.1.1 and you will see a status

page. This page may look a bit different than that shown below since you may be on a different software version. Click the “Settings” button, and configure all settings as shown:



Note that the “Source Id” is the Device ID for the SoftRF Transceiver/T-Beam this display is to be paired with.

Now that you have flashed this first software load, in the future you may update SkyView software/firmware via wi-fi, similarly to how you did it with the SoftRF Transceiver/T-Beam. Note that you will need to check and configure the settings every time you update, some of the settings default upon update to default values which may be incorrect for our application.

Load the MicroSD Card

The microSD card hosts two datasets used by the SkyView: Voice files for the traffic alerts, and an aircraft identification database.

Set up the card for these datasets by creating two folders, one named Aircrafts (yes, I know, wrong spelling….) and another named Audio.

Aircrafts folder: Download a file named "ogn.cdb" from this web page: http://soaringweather.no-ip.info/ADB/data This file is updated daily with information registered on http://ddb.glidernet.org/ associating a SoftRF or FLARM Device ID with an aircraft (registration number and/or competition ID) (you did this registration in an earlier step above). Place this file in the Aircrafts folder on the microSD card. The information in this file allows the display to show registration number/competition ID on the traffic page on the display.

You should periodically update this file so that you will pick up new registered aircraft as new installations are registered with OGN.

Audio folder: Download the file named "google_speech_voices.zip" from this web page: https://github.com/moshe-braner/SoftRF/tree/master/software/data/Audio Unzip, and transfer the three folders (voice1, voice2, and voice3) to the Audio folder on the microSD card.

Once you fly with the system, if you find that you would like louder collision warning voice alerts (due to cockpit noise, speaker placement, etc.), you can download the "voice3_louder.zip" file, unzip, and overwrite the resulting subset of .wav files into the Audio/voice3 folder on the microSD card. This will give you 6 dB louder audio (but with some additional distortion) in collision warnings.

Install the microSD card in the SkyView. Be careful to get the card into the slot correctly, the conducting strips of the SD card face towards the FRONT of the SkyView (nonintuitive) and the slot itself is a bit offset from where you might expect. It should click into place with a gentle push, if not, check orientation. Once fully inserted, the edge of the card is flush with the edge of the case. To remove it, push again gently and it will click and come out.

Installation in the Aircraft

This is personal preference. Our club mounted the SkyViews on our instrument panels using "Strong" Velcro from the local hardware store, this works fine because the devices are so lightweight. Be sure to keep enough clearance on the right side to access the buttons, and enough clearance on the bottom so that the microUSB power cable can be plugged in.

We mounted our SoftRF Transceivers using "Strong" Velcro also, plus in a few instances zipties. Note that there really is no need to access these devices in flight. Be sure to keep enough clearance on the bottom so that the microUSB power cable can be plugged in. Also, make sure that the GPS antenna's view of the sky is not blocked by any metal or carbon (fiberglass or Kevlar should be OK, as long as it is not too thick).

Use of a "rubber ducky" antenna should be OK, if you have room above the SoftRF Transceiver for it to be oriented vertically and that antenna has a good view through only plexiglass or thin fiberglass or Kevlar structure, unobstructed by any metal or carbon structure. Use of a dipole antenna is probably better, and a remote dipole must be used if the SoftRF Transceiver is "buried" in the glider structure. The dipole also must be oriented vertically.

The mounting and wiring of the power converters is up to you. Again, we recommend fuses and a toggle on/off switch for the 12 V power to the power converters.

We routed the microUSB power cables with the adhesive cable clips noted in the parts list plus zipties in a few places.

Initial Ground Test

SoftRF Transceiver: Upon power up, the display will show the software version briefly, then will show status of various systems (all should be plus signs except baro, which will be a minus sign because there is no barometric sensor installed on this device). It will then show the Device ID and the status of received signals (e.g., signals from other SoftRF Transceivers and/or FLARMs) and transmitted signals (periodic transmissions of position information from this device, these commence once it has achieved a position fix via GPS). A single short push on the button lever on the bottom will bring up a display showing number of traffic hits at the moment ("ACFTS"), the number of GPS satellites in view, status of the position fix ("+" means good), time since last power on, and battery voltage. One more short push will display the wi-fi SSID and the IP address. One more short push cycles back to the Device ID display. None of these pages are needed in flight, so there really is no need to access this button in flight. A 2-second press on the button lever will shut the tracker off, and another 2-second press will restart it. This on/off function is probably not necessary, since you are likely powering the units off aircraft power using power converters.

SkyView: Note that the screen is an ePaper device, so even if powered down it will show whatever screen was active at the time of last power down. It can appear that the device is "on" because what looks like an active screen may be displayed. Upon power up, the display will flash a SkyView logo page, the two alert voices will each state "notice" as a test. The screen will then become active. If the SkyView is not receiving traffic data, either because it has not established a wi-fi connection with its paired SoftRF Transceiver or the SoftRF Transceiver is not powered up or is out of range, it will show "NO DATA". Once the SkyView is connected to the SoftRF Transceiver but it does not yet have a GPS fix, it will show "NO FIX". Once a GPS fix is achieved, the radar screen display will appear on the SkyView.

If a second SoftRF Transceiver or a FLARM is powered on nearby, you should be able to see a traffic "hit". See the following section below for what should happen then.

If all this appears as described, then you most likely have an operational system. See the following sections and the "Quick Start" cheat sheet for operating instructions.

"Radar Screen" and Voice Alerts Functions

The SkyView shows all SoftRF/FLARM traffic hits on a "radar screen" display with course-over-ground (CoG) as "up" (alternatively, "north up" can be specified in the settings, if you prefer).

Note that course-over-ground is NOT the direction the nose of the glider is pointed relative to the ground! These could be significantly different in higher wind conditions, such as wave conditions. The radius of this “radar screen” display is shown in the lower left box and is toggle-able up and down. For a traffic hit or hits, a text screen can also be brought up, containing relative location, course/speed, and identification information for each hit. For multiple traffic hits, the operator can toggle through them individually. Screen display descriptions and button functions are noted on the following “cheat sheet”.

However, as we all know, too much “head down” in the cockpit is poor practice. Therefore, the installations described in this paper provide audio (voice) traffic advisories and predictive collision danger warnings for SoftRF- and FLARM-equipped and transmitting aircraft. These advisories and warnings are announced to the pilot by audio (voice) alerts (if the devices are equipped with a speaker) as well as a text “Voice Alert” message appearing briefly on the screen. All CASA gliders are speaker-equipped, and the towplane will soon have a custom system which routes voice alerts to the headset.

These collision danger prediction algorithms are sophisticated (but unverified and experimental at this point) and include consideration of turning and climbing/diving flight paths, including the effects of wind. Similar to FLARM, there are 3 levels of predictive collision danger warnings: a possible collision within 13-19 seconds; within 9-12 seconds; and within 0-8 seconds. Warnings are intended to start at the lower levels and elevate to the higher levels if evasive actions do not eliminate the predicted collision danger.

The voice alerts work like this:

Collision Warnings: When aircraft (with a SoftRF or FLARM device transmitting) is predicted to be a collision danger, a FEMALE voice speaking rapidly announces the aircraft in an abbreviated manner (e.g., "TRAFFIC, 11 o'clock, above" for the 13-19 and 9-12 second warnings; "DANGER, 11 o'clock, above" for the imminent 0-8 second warning). If there are two aircraft at the same warning level, the closer one is chosen. Once a warning is given about an aircraft, no further warnings are given for that specific aircraft as long as it is at the same alarm level. But if the aircraft's alarm level elevates to a more imminent predicted collision, or if it decreases and then elevates to the level it was before or higher, then another warning is given about the same aircraft. These warnings take priority over traffic advisories.

Traffic Advisories (no collision danger predicted): These alerts are given only when there are no predicted collision danger warnings active. When another aircraft (with a SoftRF or FLARM device transmitting) gets closer than 6 km (a little over 3 nautical miles) from your aircraft, a MALE voice speaking more slowly announces its relative position in a longer message (e.g., "traffic, 3 o'clock, 2 miles, 500 feet above"). After that, no further alerts are given about the same aircraft, unless it travels out of range and later comes back in range, or is elevated up to a predicted collision danger.

Summary and Conclusions

With the generous support of the Soaring Society of America's OGN receiver placement initiative, CASA has installed OGN receiver ground stations covering our Central Alabama soaring arena, and more installations are coming. With the help of various people, CASA has assembled and installed SoftRF Transceivers and SkyView Traffic Displays in our fleet. This work has been done with the intention of providing improved traffic awareness in flight, and also to provide ground personnel with position and tracking information on club and visiting aircraft in flight. In addition, the automatic flight and tow logging capability may be used for aircraft flight time recordkeeping and tow height tracking and billing purposes. The information developed and lessons learned are shared in this paper, with the intent to provide benefit to the greater soaring community.

The following section is an example summary writeup to brief users on the system as installed in CASA club aircraft.

SoftRF Transceiver and SkyView Traffic Display Operation for the CASA Fleet

The CASA installed SoftRF/SkyView equipment consists of a SoftRF Transceiver and a SkyView Traffic Display, plus a speaker, power supply, and antenna.

The devices get their power from the aircraft battery/electrical system. There are no batteries in the individual devices. For the gliders, the devices come on anytime the battery is installed in the glider and plugged in. The devices will successfully shut off when the battery is removed at the end of the day for charging. For the towplane, the power source is the "cigarette lighter" plug, which is activated by turning the main switch on. Note that the display screen is "ePaper", which does NOT clear when power is removed. So, don't be bothered if it looks like it is still "on", displaying a "radar screen" or other information.

The only easily-accessible control on the SoftRF Transceiver is an on/off and display cycling switch on the bottom (actually a little lever, just to the right of the microUSB cable connection). There should be no need to ever use this switch, but if a power shutdown is required for some reason, hold this switch for two seconds and then release, "off" will appear in the display, and the unit will shut down. It is powered back up with another two second press. If a full reset is required for some reason, use a pen or stylus to activate the switch furthest from the microUSB cable connection, this will reset the device even if the first button is not responding. Or alternatively, you may also reset by unplugging and reconnecting the microUSB power cable.

Instructions to operate the display unit are shown in the attached "Quick Start" cheat sheet.

Viewing OGN Aircraft Tracking and Using the Auto Flight Logging System

Also, OGN receiver ground stations have been installed at Merkel Field Sylacauga (KSCD), at Shelby County Airport (KEET), and near the town of Opelika (thanks Fenton Mitchell!). These OGN ground stations (along with many, many others worldwide) receive the position and identification signals from nearby SoftRF and FLARM devices and then feeds this information to a worldwide database of real-time tracking information. Several online viewers have been developed to allow real-time viewing of flight tracks worldwide, from any internet-connected computer/tablet/smartphone. There are many viewers, but one recommended viewer to use is PureTrack, see this web page:

https://puretrack.io/?l=33.167203&g=-86.297687&z=13.6

In the future, additional ground stations provided by the SSA will be installed at St Clair County Airport (Pell City) and Northeast Alabama Regional Airport (Gadsden), and perhaps Thomas C Russell Field Airport (Alexander City). And we may eventually have yet another ground station soon near Tuscaloosa (thanks Nathan Lemmon!). This constellation of airports should provide coverage for most flights done in our Central Alabama soaring arena.

Finally, the combination of towplane and gliders equipped with SoftRF or FLARM devices plus an OGN ground station to receive the signals, allows an automated "link up" of towplane-towing-a-glider events. This information is recorded in a database viewable online, see this web page:

https://flightbook.glidernet.org/logbook/KSCD/

Be sure to put in the proper date. CASA is planning to use this information to keep track of airframe flight hours and perhaps to determine tow heights for billing purposes.

If you want your airport to be added to the list of auto-logging sites, contact Davis Chappins, he will get your site added to the system.

CASA OGN Tracker and Display "Quick Start" Cheat Sheet

The system will be on any time a battery is installed in the glider and plugged in. Power consumption of the system is very low. There should be no need to interact with the tracker.

The display will show NO DATA (e.g. not communicating with the tracker) or NO FIX (e.g. has not acquired enough GPS satellites for a position fix) messages while starting up and initializing. Test voice alerts saying "Notice" will occur during startup. Once up running and ready for use, the "radar screen" display will appear. See below for display unit operation and voice alert key.