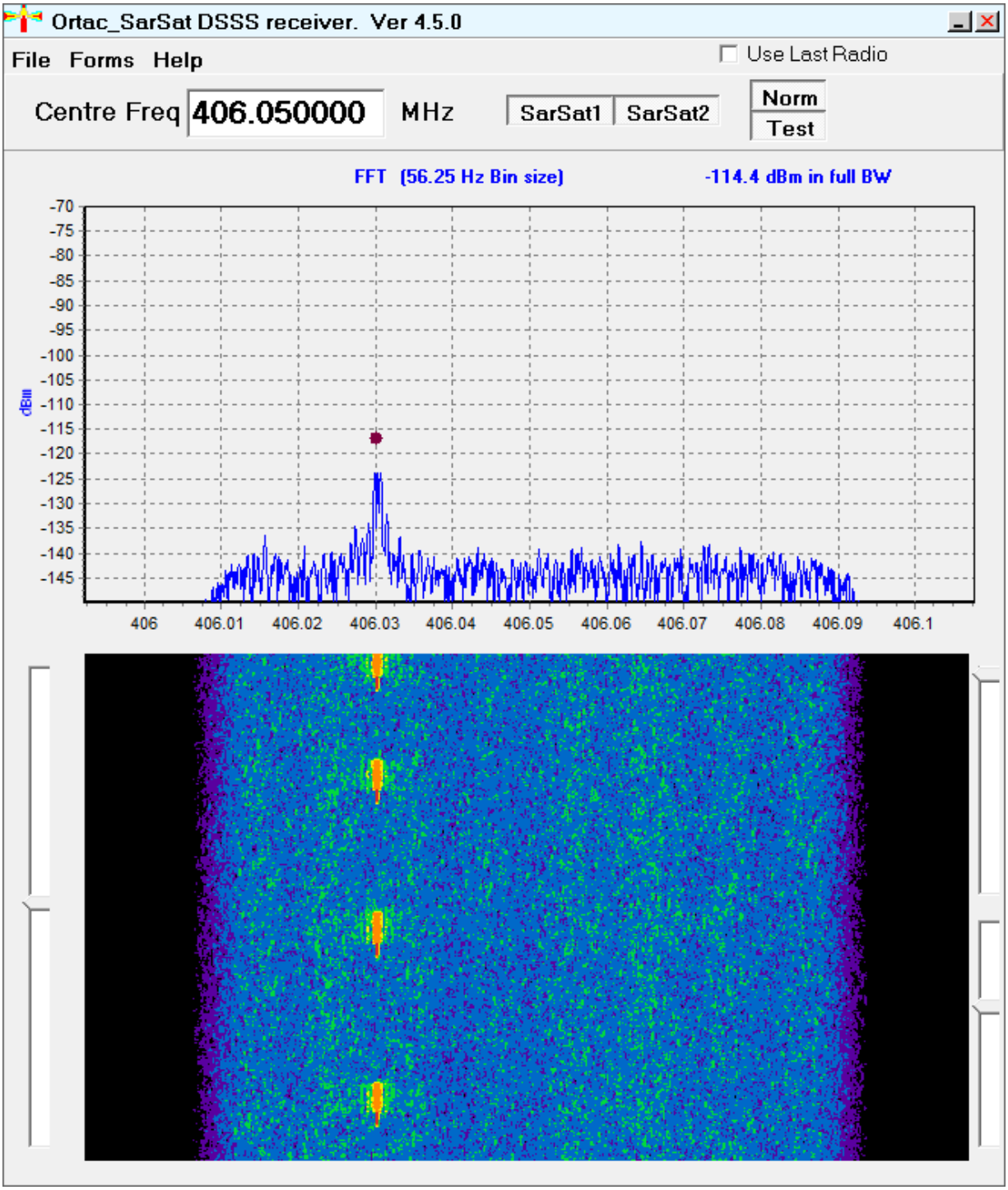


Ortac _SarSat Manual

A 32 bit Windows DSSS SarSat receiver

RFBits.com

Issue 4.5 24th Nov 2025

CONTENTS

1.0 ABOUT ORTAC_SARSAT 4

2.0 ABOUT SARSAT 4
2.1 About Testing Beacons 4
2.2 About 1st Generation Beacons 4
2.3 About 2nd Generation Beacons 4

3.0 COMPATIBLE HARDWARE AND INSTALLATION 5
3.1 RTL2832u R820T2 Dongles 5
3.2 SDRPlay RSP receivers 6

4.0 MAIN RECEIVER FORM. 7
4.1 Title Bar 8
4.2 File Menu 8
4.3 Forms Menu 8
4.4 Help Menu 8
4.5 Overload Flag 8
4.6 FFT Display. 8
4.7 Waterfall 9
4.8 FFT Averaging. 9
4.9 Waterfall Base 9
4.10 Waterfall Gain 9
4.11 SarSat 1 decoder Flag 9
4.12 Full BW dBm 9
4.13 Self Test PRN 9
4.14 Normal PRN 9
4.15 Close 10
4.16 Minimise 10
4.17 Use Last Radio 10
4.18 SarSat 2 decoder enable. 10
4.19 SarSat 1 decoder enable. 10
4.20 Centre Frequency. 10

5.0 RF CTRL 11
5.1 SDRPlay Radios 11
5.2 RTL Radios 11

6.0 SARSAT 1 DECODES 12

7.0 SARSAT 2 DECODES 13

8.0 SARSAT 1 ENG 14
8.1 SS1 Det Ave. 14
8.2 OverPeak 14
8.3 RunTime 14
8.4 Use FM method 14
8.5 Mod depth 15
8.6 Recovered Phase Mod 15
8.7 Debug Data 15
8.8 F_DSFP 15

8.9 Show BCH Fails 15
8.10 Fail >= 3BCH 15
8.11 Zeta 15
8.12 Beta 15
8.13 Alpha 15

9.0 SARSAT 2 ENG 16
9.1 DSS detection threshold 16
9.2 Quality check 16
9.3 Show BCH fails 16
9.4 Fails >= 6 BCH 16
9.5 Early, Norm or Late 16
9.6 Det Level 17
9.7 BCH 17
9.8 IntDump recovered IQ 17
9.9 Phase Error 17
9.10 Frequency Error 17
9.11 Search Depth 17
9.12 TC 17
9.13 Detections 17
9.14 B 17
9.15 A 17
9.16 FB 17
9.17 Test 17
9.18 Norm 17

10.0 IQ REC PLAYER 18
10.1 File name 18
10.2 Recording Directory 18
10.3 File Listing 18
10.4 SarSat 1 test file 18
10.5 SarSat 2 test file 18
10.6 2 x SarSat 1 18
10.7 2 x SarSat 2 18
10.8 SarSat 1 + 2 19
10.9 Explore Directory 19
10.10 Change File Dir 19
10.11 Refresh List 19
10.12 Leave RF connected when playing. 19
10.13 Play 19
10.14 Record 19

1.0 ABOUT ORTAC_SARSAT

Oratac_SarSat is a Windows PC programme that attempts to receive and decode both 1st and 2nd generation SARSAT beacons.

This software is intended for educational and personal use only. There is no guarantee of its performance or accuracy, it must not be used for any purpose that might have causal life-threatening consequences due to failure or error.

The 2nd generation decoder in particular has not been tested on a real beacon and in all probability has major errors in the decodes, these will be corrected when discovered.

It is considered that this programme has a use at Seaports and Airports, where it could be used to monitor local accidental activations of beacons and hence could help in cancelling false alerts.

2.0 ABOUT SARSAT

COSPAS-SARSAT is a satellite-based monitoring system that detects and locates emergency beacons. Professional operators then notify search-and-rescue (SAR) authorities. An overview of the system is at :- https://www.sarsat.noaa.gov/cospas-sarsat-system-overview/

2.1 About Testing Beacons

Do not use this programme to test an actual SARSAT beacon's RF in either Real or Test mode. The satellite system is very sensitive and will inevitably hear your beacon, they will know to whom the beacon is registered.

Please see "https://www.sarsat.noaa.gov/emergency_beacon-testing/ " for full details.

2.2 About 1st Generation Beacons

The present system uses beacons designed to C/S T.001, this can be obtained from :- https://cospas-sarsat.int/en/documents-pro/system-documents/system-documents

These beacons transmit a message of length 330ms or 520ms, containing 112 or 144 bits of data, using phase shift keying. The beacons have a transmit power of 5W max and transmit a data burst every ~30 secs. The important data within the message such as the GPS location is protected by BCH forward error correction. Beacons can transmit is Normal or Test mode, indicated by the frame synch.

SarSat 1 beacons have a narrow band signal ±3kHz and may operate in 3kHz channels from 406.025MHz to 406.076MHz.

2.3 About 2nd Generation Beacons

The 2nd generations of SARSAT beacons are designed to C/S T018.

These beacons transmit a fixed length message of 1 sec and operate at a similar power to the SarSat 1 beacons. However, the modulation used is a form of Direct Sequence Spread Spectrum - Offset QPSK (DSSS-OQPSK). This results in a signal that is ~35kHz wide, all beacons transmit on the same frequency of 406.050MHz.

The use of DSSS-OQPSK means that individual beacons can be decoded even if they overlap in time, it also provides some 25dB immunity to narrow band signals within the bandwidth. To distinguish between Normal and Test beacons a different spreading code is used.

A SarSat 2 beacon contains 250 bits of information, 50 bits are the preamble, 202 bits of data and 48 bits of BCH error correction, the bits are split between the I Q modulation.

3.0 COMPATIBLE HARDWARE AND INSTALLATION

In order for Ortac_SarSat to run a compatible USB radio must be installed on the PC. The programme will search for any installed devices.

if no device is found then the radio requirements are show.

If a single device is found the programme will run using that device.

If multiple devices are found then a list is shown, for the user to select from.

Compatible devices are described here :-

3.1 **RTL2832u R820T2 Dongles**

Examples are :-

RTL-SDR BLOG V3

NooElecom NESDR SMArt v4

Ortac_SarSat requires the RTL2832u device to have the Rafael Micro R820T, R820T2 or R860 RF tuner, the programme is not compatible with devices using alternative now less common tuners such as the Elonics E4000.

Ortac Rx uses the libusb-1.0.dll, which in turn requires the WinUSB hardware device driver. The RTL2832u dongle will initially default to a device driver that does not work with lib-usb-1.dll. There are many places on the web that describe the process to change the default driver to WinUSB using the "Zadig" utility, some examples are:-

https://www.rtl-sdr.com/rtl-sdr-quick-start-guide/

https://zadig.akeo.ie/

Once the correct driver has been configured all that is necessary to install Ortac_SarSat is to run the installer Setup_Ortac_SarSat_Iss(nnn).exe.

By default Ortac_SarSat will install to:-

C:\Program Files (x86)\RFBits\Ortac_SarSat

It will store its ini file, decode files and any IQ recordings at:-

\Users\UserName\AppData\Roaming\RFBits\Ortac_SarSat

3.2 **SDRPlay RSP receivers**

RSP1

RSP1A

RSPdx

RSPduo

Ortac_Rx_SPlay 'plays' with the SDRPlay RSP1, RSP1A, RSPDx and RSPDuo.

It uses the SDRPlay_api.dll, which in turn uses the 'SDRPlayAPIService'. The SDRPlayAPIService must be also be installed.

The SDRPlayAPIService is installed by the SDRPlay SDRuno software, please ensure that SDRuno is installed before running Ortac_SarSat.

With SDRuno is installed, but not running, to install Ortac_SarSat, all that is needed is to run the installer Setup_Ortac_SarSat_Iss(nnn).exe.

By default Ortac_SarSat_Splay will install to:-

C:\Program Files (x86)\RFBits\Ortac_SarSat

It will store its ini file, decode files and any IQ recordings at:-

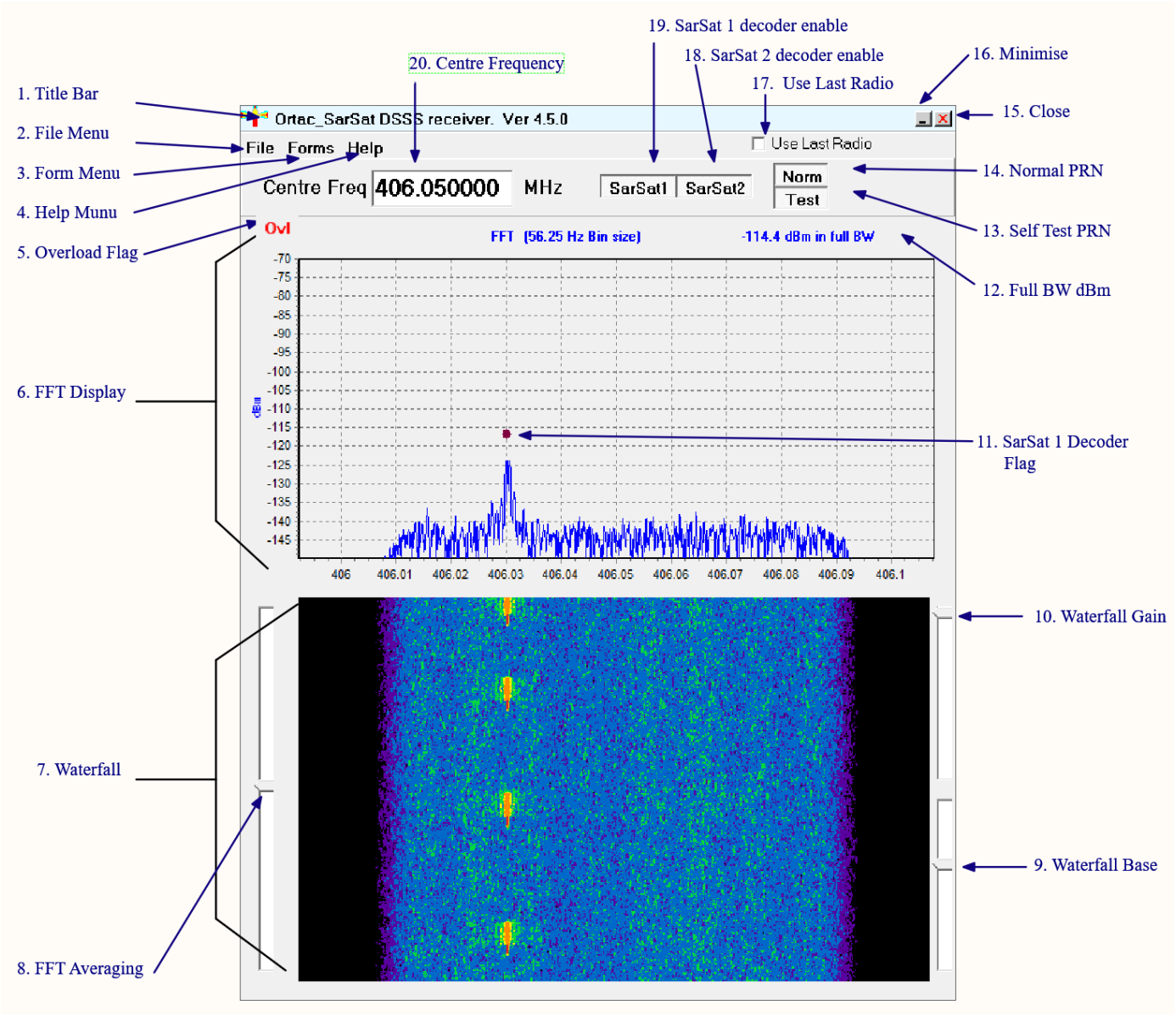
\Users\UserName\AppData\Roaming\RFBits\Ortac_SarSat

4.0 MAIN RECEIVER FORM.

The main receiver form is designed to present a compact display of the main radio setting and functions.

The functions of the buttons and displays are also shown within the programme by pop-up hints.

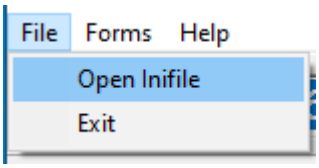
The annotated graphic below is used to further describe the main form, the numbers relate to the following paragraphs numbering.



4.1 Title Bar

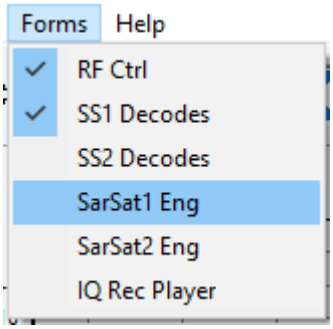
Displays programme name and version number, with type and S/N of Rx.

4.2 File Menu



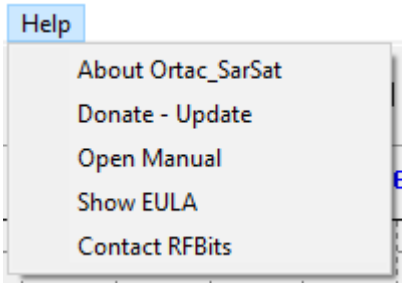
Closes Programme.

4.3 Forms Menu



The are 6 sub forms, these are described in the next section.

4.4 Help Menu



Opens a brief description of the programme.
Opens RFBits.com Web Site.
Opens this PDF manual.
Opens the End User License Agreement.
Opens Email client with RFBits email address

4.5 Overload Flag

If the programme detects that the receiver is being overloaded with too high an RF level, this warning will show. Further the RF Ctrl window will open, so the user can adjust the RF gain.

(Note not all Overload conditions can be detected.)

4.6 FFT Display.

The FFT displays signals seen over the receive bandwidth. The FFT bin size is 56.25Hz and the scale is calibrated in dBm. There is a calibration factor in the RF Ctrl form.

The display can be zoomed, by right mouse button area selection.

4.7 **Waterfall**

The waterfall shows the amplitude history of the FFTs over the last 7 seconds. It shares the same horizontal frequency axis with the FFT. The colour of the waterfall pixels relates to the dBm amplitude of the FFT bins, there are 7 colours used representing increasing amplitudes.

Lowest dBm Highest dBm

The colour dBm scale can be adjusted by the waterfall base control (9) and the waterfall gain control (10). The colour scale is not calibrated.

4.8 **FFT Averaging.**

This slider adjusts the averaging of the FFT, it affects both the FFT and the waterfall. (It does not affect the SarSat 1 detection, which as it own FFT averaging.)

4.9 **Waterfall Base**

This adjusts the level which corresponds to the 1st colour of the waterfall.

4.10 **Waterfall Gain**

This adjusts the range of RF levels that correspond to the set of waterfall colours.

4.11 **SarSat 1 decoder Flag**

This marker flag indicates that a SarSat 1 decoder is running. There a maximum of 3 SarSat 1 decoders.

4.12 **Full BW dBm**

This shows the power in the whole receiver bandwidth, used to estimate the level of the WB DSSS signal.

4.13 **Self Test PRN**

If depressed the SarSat 2 decoder, (if running), will decode DSSS messages which use the Self Test PRN.

4.14 **Normal PRN**

If depressed the SarSat 2 decoder, (if running), will decode DSSS messages which use the Normal PRN.

(Note, running both PRN decoders uses considerable CPU effort. If the programme detects that it is loosing data due to lack of processing power, a red CPU_Ovl warning will appear above the FFT.)_

4.15 **Close**

Close the programme.

4.16 **Minimise**

Sends the main form and the sub forms to the task bar.

4.17 **Use Last Radio**

If checked the programme will try to use the same radio next run, without displaying the radio select form.

4.18 **SarSat 2 decoder enable.**

If depressed then the SarSat 2 decoder will run.

Note that the SarSat 2 decoder requires a fair amount of CPU usage, eg 20% of a 3.5GHz intel I7. The programme is multi-threaded and will use as many processor cores as it can.

If the programme detects it has not completed it's tasks in its allocated time, a red CPU_Ovl warning will appear above the FFT. You can half the CPU load by only have one DSSS decoder running, if that is not enough you can also reduce the Search depth in the 'SarSat2 Eng' form.

Running the programme in 'Administrator Mode' also seems to help, particularly in Win11, where the Task and Process manager report very erroneous CPU usage.

4.19 **SarSat 1 decoder enable.**

If depressed then the SarSat 1 decoder will run. Compared to the SarSat 2 decoder this process is much less intensive.

4.20 **Centre Frequency.**

The programme will always start with a centre frequency of 406.050000MHz. This is the centre frequency of the SarSat 2 DSSS signal.

With the default centre frequency, all the SarSat 1 frequencies are also covered.

For test purposes, the centre frequency can be changed, type the new frequency and press return to enter. Frequencies even with the RTL radios are accurate to 1Hz.

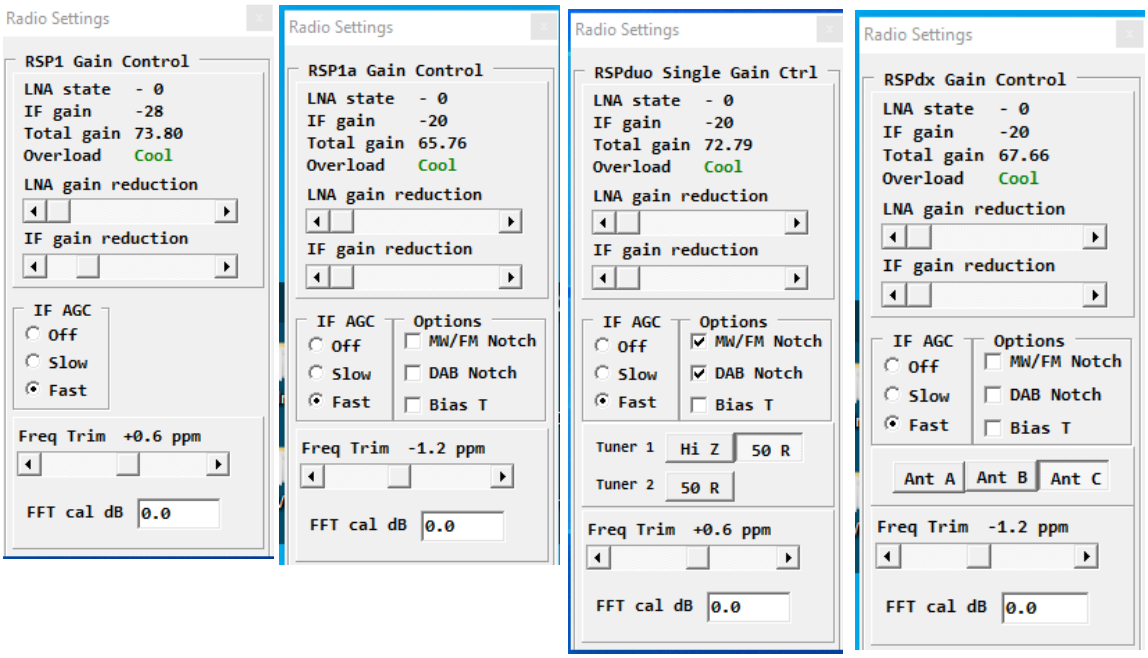
(**All** testing of the receiver was made at 506.05000MHz, at levels less than -10dBm. This was to avoid any possibility of accidental reception by the satellites.)

5.0 RF CTRL

The RF control form is dependent on the radio type in use.

5.1 SDRPlay Radios

RSP1 RSP1a RSPduo RSPdx



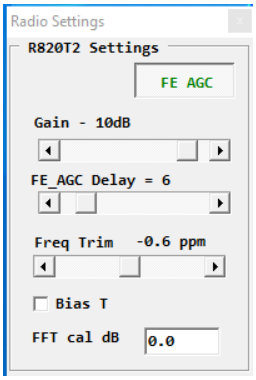
The SDRPlay RF Ctrl forms are basically the same, just the options such as BiasT, notch filters and antenna switches are tailored for the different radio features. (Note that the RSPduo can only be used in single radio mode by Ortac_SarSat.)

The SDRPlay RSPs have their own 'front end' IF AGC, which helps to stop the ADC being overdriven. Instead of Ortac_SarSat controlling the gain within the RSP, the RSP adjusts itself and tells Ortac_SarSat what gain reduction is being used, this allows the dBm to be calculated.

Note that the LNA (RF) gain is not adjusted by this AGC and if needed must be adjusted manually. The LNA gain steps are however compensated for in the dBm report shown by Ortac_SarSat.

There is an overload flag from the radio which is also reported here, this is repeated on the main receiver form.

5.2 RTL Radios

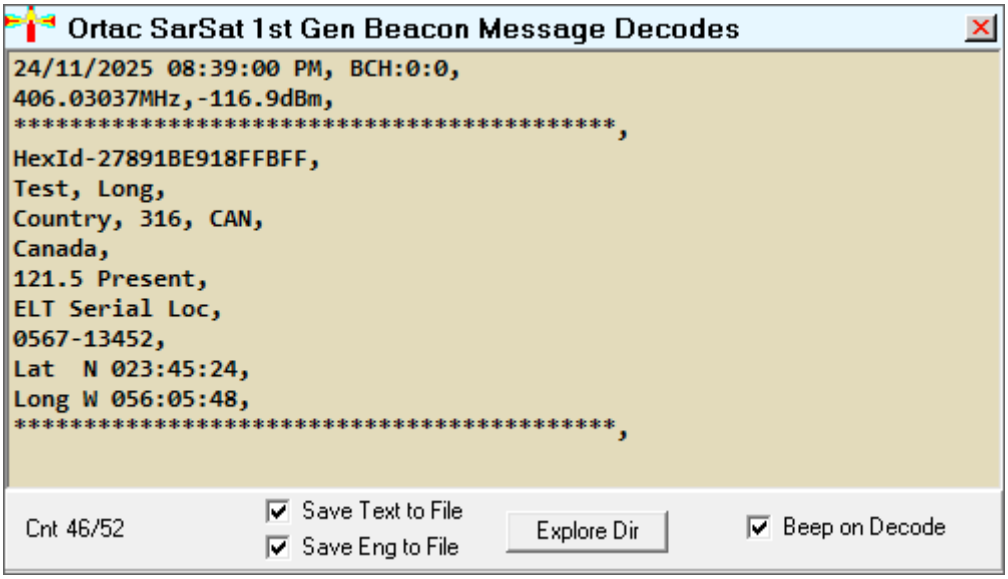


If FE_AGC is selected, Ortac_SarSat automatically adjusts the tuner gain, to maintain the ADC in range. Depending on the speed of the PC, the FE_AGC delay may need to be increased to stop instability. With FE_AGC selected, the dBm report is fairly accurate to 0dBm input.

If FE_AGC is not selected the operator must select a suitable tuner gain. The gain steps are ~10dB, note that the noise figure is hardly affected by the initial 10dB gain reduction, as the gain change is initially made in the IF stages of the tuner.

6.0 SARSAT 1 DECODES

This form displays the details of any decoded 1st generation SarSat messages successfully decoded.

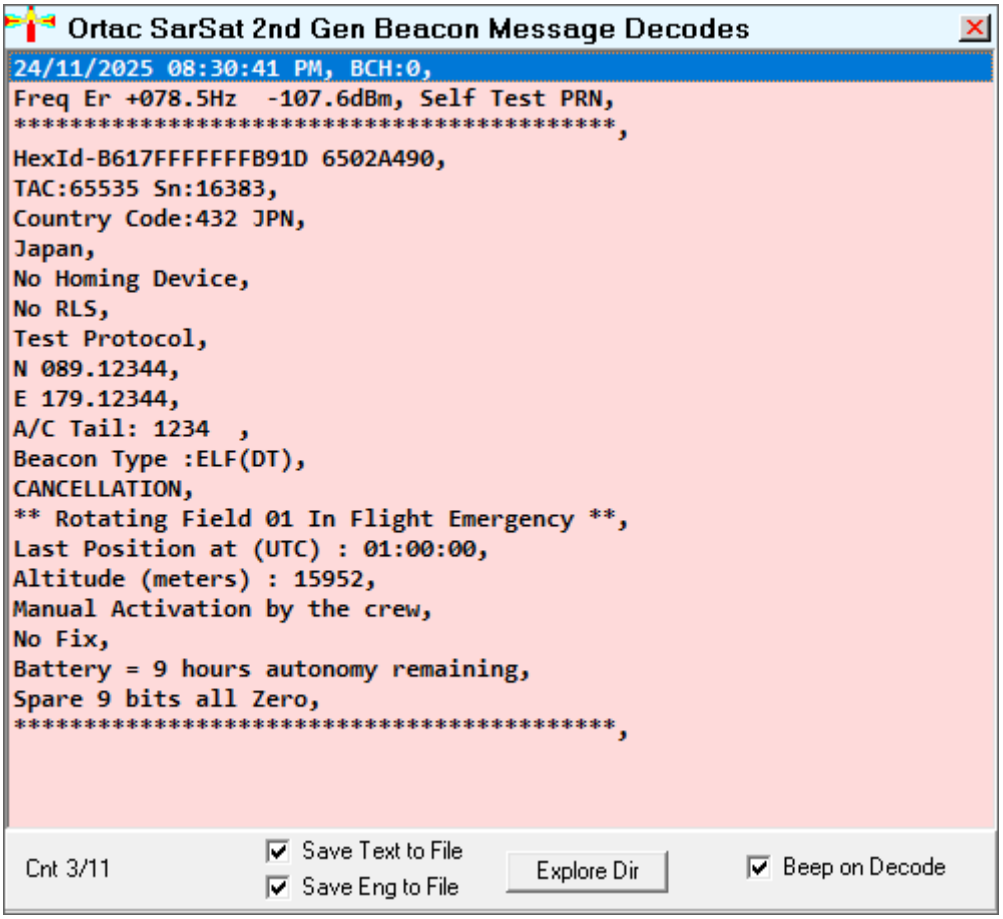


Notes.

1. The Date Time is taken from the PC clock, the BCH errors correct for 1st and 2nd field.
2. The frequency and dBm are estimates from the programme.
3. The '15 Hex Id' is formed from bits 26..85 of the received message, it does not contain positional data and should match the Id printed on a beacon.
4. The 'Cnt' label shows the decode count, current session/total. If this label is double clicked it will reset the current session count.
5. Check the 'Save Text to File' check box to save all decodes to file.
6. Check the 'Save Eng to file' check box to save the engineering graphic to png file.
7. The 'Explore Dir' button open a windows explorer in the default save file directory. Here you can open saved files in a text or graphic editor, copy them to elsewhere or delete them.
8. Beep on decode makes the programme output a 100ms 1.2kHz tone on every decode.

7.0 SARSAT 2 DECODES

This form displays the details of any decoded 1st generation SarSat messages successfully decoded.



Notes.

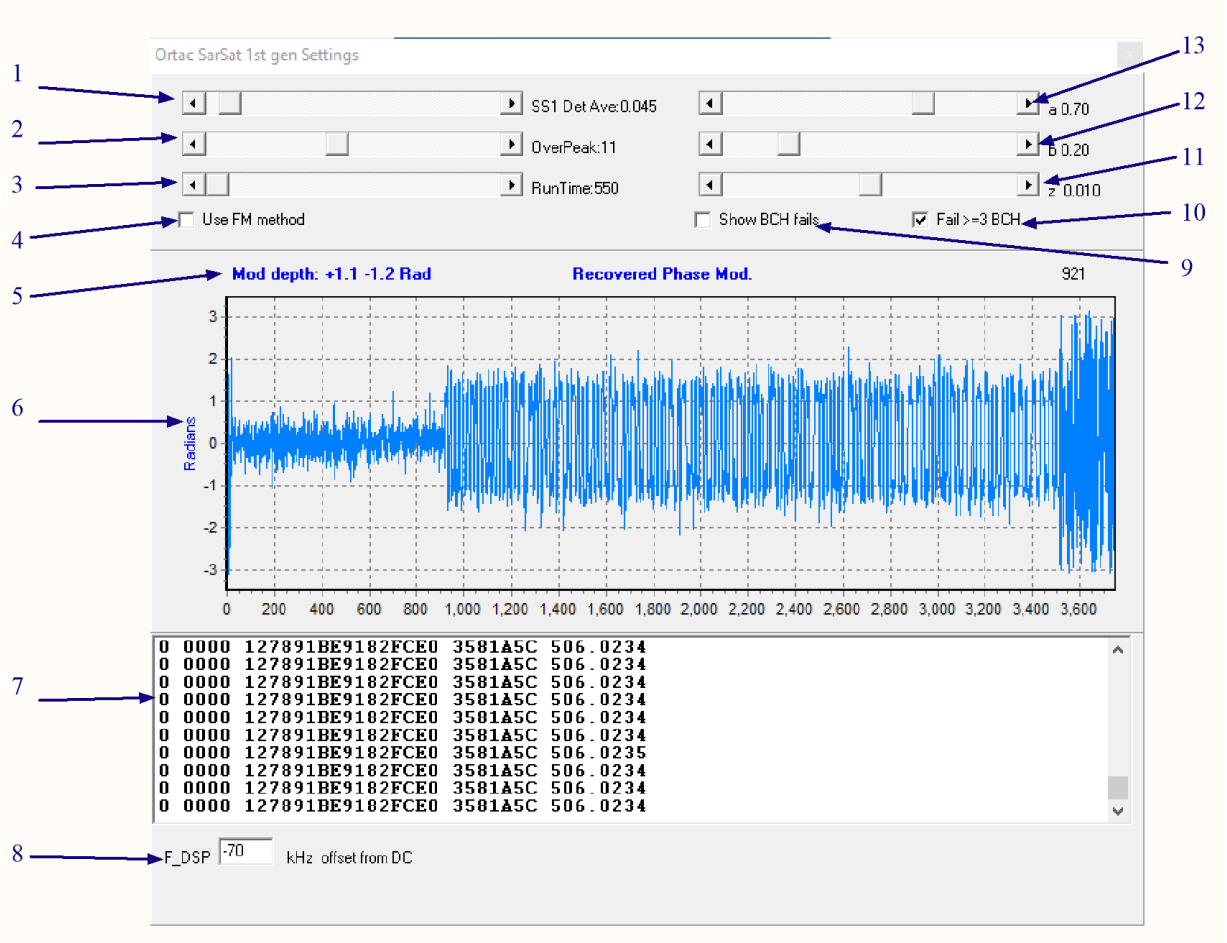
1. The Date Time is taken from the PC clock, the BCH number of BCH errors corrected.
2. The frequency error and dBm are estimates from the programme. (The dBm is an estimate of the de-spread signal strength, ie CW equivalent power, it is derived from the recovered IQ levels.)
3. The '23/15 Hex Id' is formed according to table 3.10 of C/S T.018 1/10, it does not contain positional data.
4. The 'Cnt' label shows the decode count, current session/total. If this label is double clicked it will reset the current session count.
5. Check the 'Save text to File' check box to save all decodes to file.
6. Check the 'Save Eng to File' check box to save the engineering graphic to png file.
7. The 'Explore Dir' button open a windows explorer in the default save file directory. Here you can open saved files in a text or graphic editor, copy them to elsewhere or delete them.
8. Beep on decode makes the programme output a 100ms 1.0kHz tone on every decode, a 50ms 2.0kHz is also output on a successful BCH correction.

8.0 SARSAT 1 ENG

The programme has four SarSat 1 decoders, which are set on frequency and set to run when a signal that looks like a beacon is detected in the FFT. When a decoder is set to run, it places a marker on the FFT, at the level and frequency of the detection, this is aimed at the start of the CW portion of the beacon transmission. The marker is removed when the decoder has run. This allows the programme to decode up to four simultaneous beacons on different frequencies.

In comparison to the SarSat2 decoder, this decoder uses very little CPU effort.

This is the 'engineering form' for the SarSat 1 decoder, it shows the received phase modulation and allows adjustment of some of the programme's internal variables.



8.1 SS1 Det Ave.

This adjusts the FFT smoothing of the internal peak search FFT.

The beacon detection algorithm looks for signals that suddenly appear above this threshold.

8.2 OverPeak

This adjusts the threshold that a peak is considered a valid detection.

8.3 RunTime

Adjusts how long a SarSat 1 decoder is allowed to run in mS.

8.4 Use FM method

Check this to use an FM detector method to recover the bits, at least 6dB less sensitive.

8.5 **Mod depth**

The phase detector measures the average +ve and -ve phase deviation over the data period.

8.6 **Recovered Phase Mod**

This shows the recovered phase modulation of the signal. Note the left axis is accurately calibrated in radians, so you can see how close a beacon is to the spec level of $\pm$1.1 Radian.

8.7 **Debug Data**

This scrolling list show details of the decoded beacons.

The 1st column shows which of the 4 decoders was active.

The 2nd group of figures shows the BCH errors, before and after correction.

The 3rd group shows the hex of the 1st BCH protected field.

The 4th group shows the hex of the 2nd BCH protected field.

The last group shows the estimated frequency of the beacon.

8.8 **F_DSFP**

This is an internal of the programme, it is to do with shifting away from any DC line of the receiver.

8.9 **Show BCH Fails**

If checked, the decode of every signal is shown even if the BCH error checking fails.

8.10 **Fail >= 3BCH**

If checked then error correction is only allowed for up to 2 errors in the 1st protected field, instead of the possible 3. With this option checked there a much fewer decodes on noise.

8.11 **Zeta**

This is an internal of the PLL, which adjust the phase tracking.

8.12 **Beta**

Another internal of the PLL.

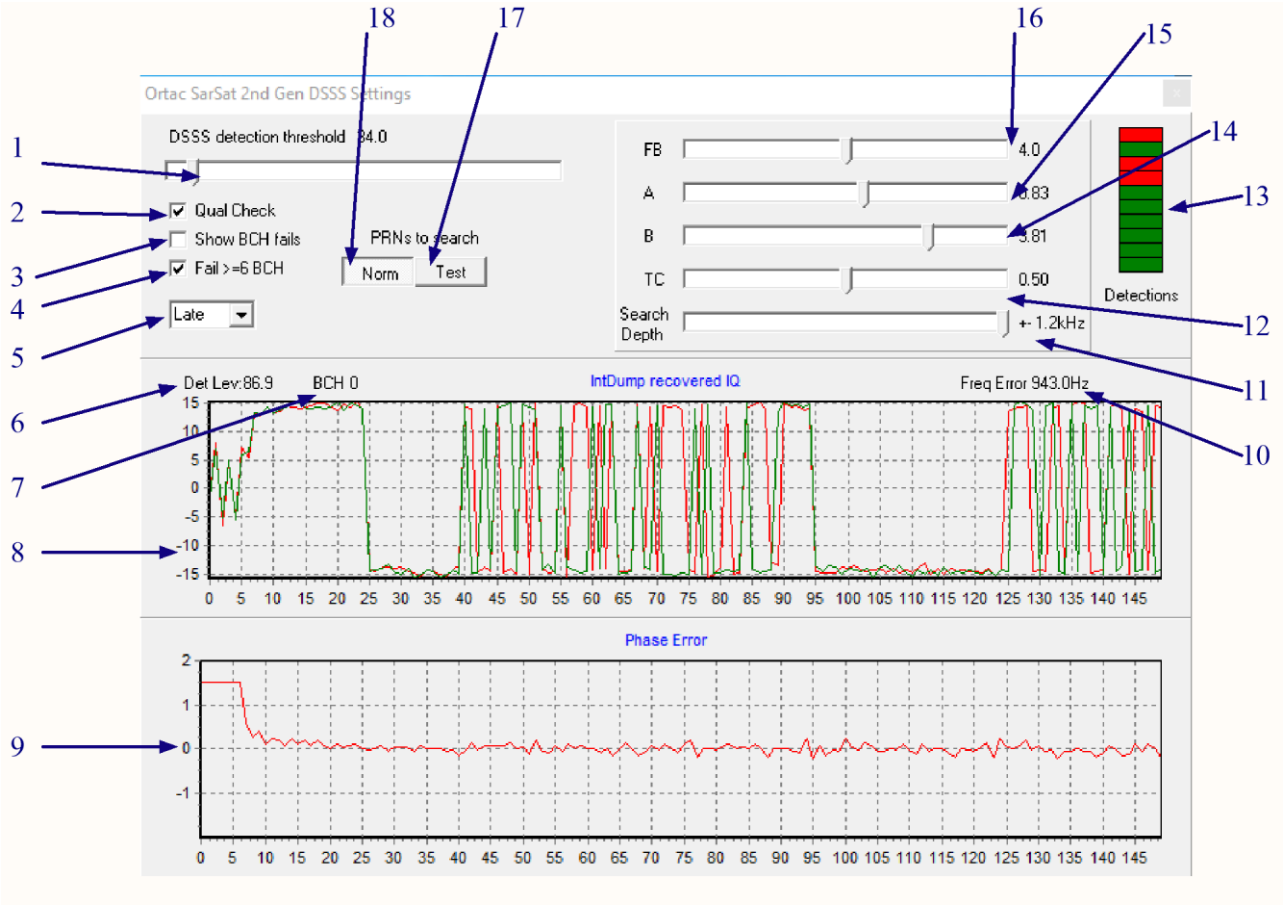
8.13 **Alpha**

Another internal of the PLL.

9.0 SARSAT 2 ENG

The SarSat2 decoder searches in time and frequency to find a match for the Normal and/or Test PRNs. This is a CPU intensive process, involving up to 1 forward and 19 reverse 512-point FFTs every 1.3mS per active PRN. Once a match over the detection threshold occurs, one of 10 decoder threads is set to run. Once the decoder thread has collected the rest of the samples, it runs a custom 'Integrate & Dump' algorithm which locks to and tracks any frequency drift, to de-spread and recover the IQ data of the original modulation. BCH error correction is then applied and if successful the bits are decoded to show the encoded message.

This is the 'engineering form' for the SarSat 2 decoder, it shows some decoder internals and allows adjustment of some of the DSSS decoder variables.



9.1 DSS detection threshold

This is the level that a signal must match the PRN before a detection thread is set to run. If this level is too low, too many false detections occur, too high and weak signals will be missed. (This setting is remembered between runs.)

9.2 Quality check

If this is checked then poor signals are aborted early in the IntDump routine.

9.3 Show BCH fails

If checked, decodes that fail the BCH error corrections will still be decoded and displayed.

9.4 Fails >= 6 BCH

If checked then error correction is only allowed for up to 5 errors in the message, instead of the possible 6. With this option checked there a much fewer decodes on noise.

9.5 Early, Norm or Late

Fine tunes the PRN alignment in the IntDump routine.

9.6 **Det Level**

Shows the PRN match level that fired this detection. It is the level used by the DSSS threshold. Very strong signals can show values of >100, weak signals with noise can be as low as 30.

9.7 **BCH**

Shows the number of bits that were corrected by the BCH error correction. The SarSat 2 BCH error correction can correct up to 6 bit errors in the message.

9.8 **IntDump recovered IQ**

Displays 150 bits of the recovered IQ. The first 25 bits are the preamble, this period is used to lock to the precise frequency of the signal.

9.9 **Phase Error**

Show the correction signal that is used within the IntDump PLL, to capture and track the signal's frequency. In the example shown there is an initial error, which is used to adjust the tracking loop, as the error is reduced you can see the IQ values increase. This capture must finish before the data bits start at position 25.

9.10 **Frequency Error**

The IntDump routine can determine how far it had to tune to capture the signal, this is shown here to a resolution of 0.1Hz.

9.11 **Search Depth**

Controls the bandwidth of the detection algorithm search. Note that the CPU usage is nearly proportional to this bandwidth.

9.12 **TC**

An internal time constant of the IntDump routine.

9.13 **Detections**

Shows the number of active decoder threads. There is a maximum of 10, if the detection threshold is too low, then too many false detections can use all the decoders and a real signal may be lost.

9.14 **B**

An internal 'Beta' of the IntDump PLL.

9.15 **A**

An internal 'Alpha' of the IntDump PLL.

9.16 **FB**

An internal 'Feedback' within the IntDump PLL.

9.17 **Test**

If depressed then the 'Self Test' PRN is search for. (This control is duplicated on the main form.)

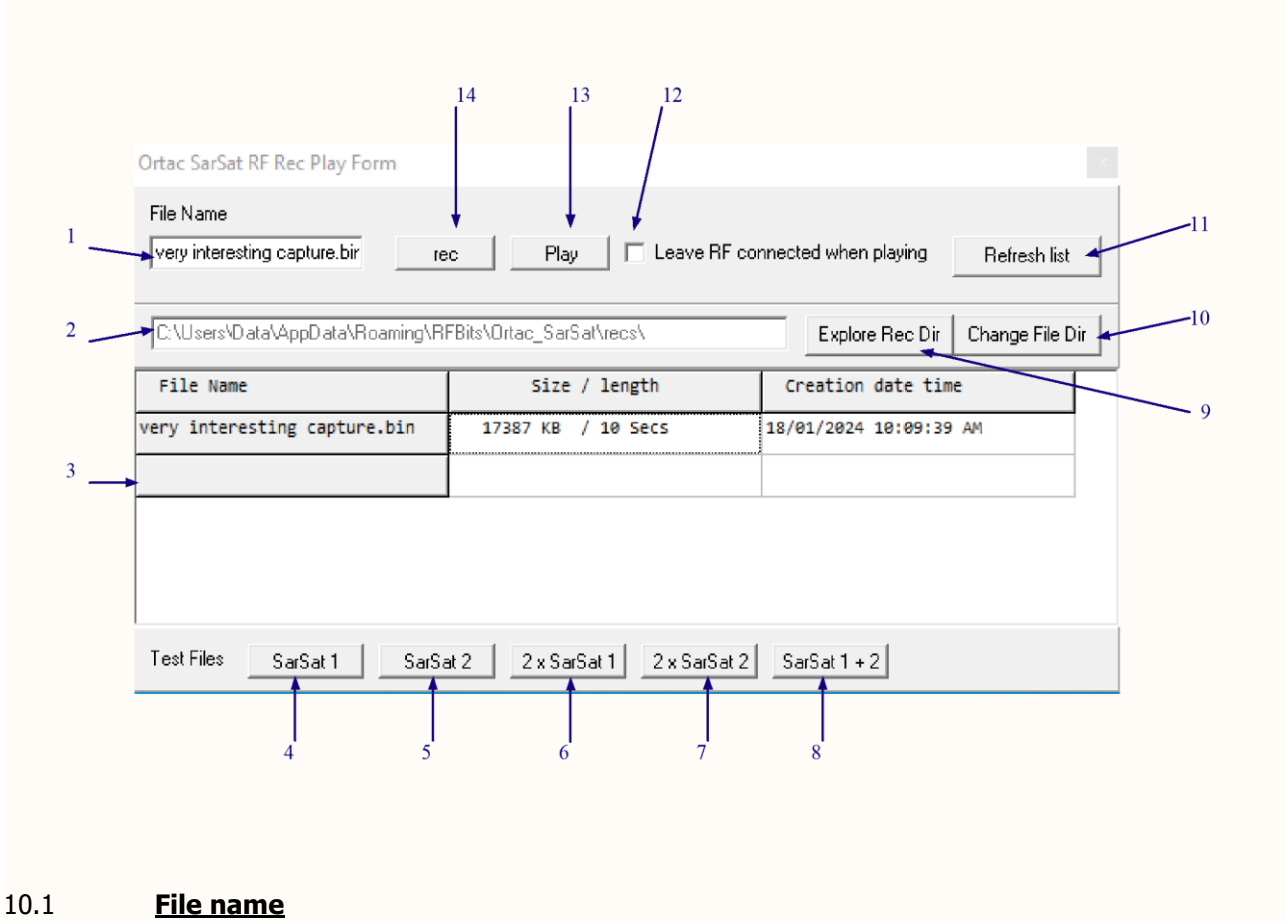
9.18 **Norm**

If depressed then the 'Normal' PRN is search for. (This control is duplicated on the main form.)

10.0 IQ REC PLAYER

The IQ recorder / player enables capture and later playback of the receiver's baseband ±50kHz bandwidth.

The functions of the controls are described here :-



10.1 File name

Type the name of the file to record or playback, (press return to enter).

10.2 Recording Directory

Where the files are stored, see (10) to change.

10.3 File Listing

List of recorded files, double click an entry to play.

10.4 SarSat 1 test file

Plays a short test file of a single SarSat 1 test beacon. This should result in 3 decodes.

10.5 SarSat 2 test file

Plays a short test file of a single SarSat 2 beacon. This should result in 3 decodes.

10.6 2 x SarSat 1

Plays a short test file which has two SarSat 1 beacons, separated by ~5kHz. This should result in 6 or 7 decodes.

10.7 2 x SarSat 2

This file contains two SarSat 2 test beacons, one has the 'Norm' PRN the other the 'Test' PRN. The two signals are on the same frequency and occur at the same time. This should result in 6 decodes.

10.8 **SarSat 1 + 2**

This file contains both types of beacons. Ensure that the DSSS detection threshold is set below 40 as the SarSat 2 beacon is only just above the noise floor, this should then result in 4 SarSat 1 decodes and 2 SarSat 2 decodes.

10.9 **Explore Directory**

Opens a windows explorer at the recording directory. Use this to delete recordings, once done press the 'Refresh list' to update the file listing.

10.10 **Change File Dir**

Use this to change the recording directory.

10.11 **Refresh List**

Updates the file listing, use if files have changed outside the programme.

10.12 **Leave RF connected when playing.**

If this is checked then then the receiver IQ is added to the playback IQ, so both will be processed.

10.13 **Play**

Plays the file named.

10.14 **Record**

Starts the IQ recording, if the file exists it will be overwritten without warning. Recording eats disk space at about 1.8MB per second.