Satellite ACARS reception on L-Band with JAERO.

September 21, 2019 merseyradar Airband Radio 5 Comments

RECENT TWEETS

Tweets by @merseyrada

merseyradar
@merseyradar

More correspondence/support questions received from Homebrew DIY #AirbandBazooka Antenna Builders from and this weekend...Have fun building guys !
Blog page updated this weekend too merseyradar.co.uk/airband-radio/...
https://twitter.com/merseyradar/status/1264512865832259584

15h

merseyradar
@merseyradar

A friend of mine wanted to monitor aircraft ACARS data transmissions from the Inmarsat "Alphasat" 4a-F4 satellite.

He asked me to build a DIY antenna for his proposed ground station.

The test equipment we were using was a simple sdr radio dongle, a windows laptop running JAERO software and some antenna hardware which will be covered in this article.

Inmarsat "Alphasat" 4a-f4.

Amongst other things, this satellite handles aircraft ACARS data messages , It is very far away..it is in a geostationary orbit around 35,770 kilometres (22,200 miles) above the earth. Also its big as far as satellites go..Nicknamed "the A380 of space" It has a mass of 6,649 kg (6.5 tons) and it was launched on board an Ariane 5 Rocket in 2013 from Kourou Spaceport French Guiana by EASA.

This satellite sends and receives messages in L-Band of the microwave radio spectrum, typically around 1.54 ghz.

The footprint is centred over Africa, coverage is all of Europe, most of Africa, the Middle East and parts of Asia.

Here is a photo of 4A-F4, the "business bit" in the middle...it is a huge lump of a thing !

Inmarsat-4A F4. "The A380 of Space"

Indeed Steve, Almost as though Today someone pressed the reset/soft start button. https://twitter.com/steve_djerome/status/1299747164885843968

Aug 29, 2020

merseyradar
@merseyradar

Replying to @merseyradar

I agree @anderthal_neal Similar here In Merseyside

Aug 29, 2020

merseyradar
@merseyradar

Steady Increased traffic over the last few weeks especially heavies heading towards the North Atlantic NAT Tracks but not anywhere near to normal levels yet. Heres the view from my adsb 🇬🇧 @ around 9.45 UTC #potn

Aug 29, 2020

merseyradar
@merseyradar

VY Interesting new Radio @KawasakiAA842 Tecsun PL-330, Thanks for a look at inside... https://twitter.com/KawasakiAA842/status/1296740077859528704

Aug 21, 2020

merseyradar
@merseyradar

Charging with no supply current ? Is this why 2300mah AA batteries never fully charge in the @Uniden_America UBC125 series scanners ? Pulling 5.16v @ 0.17a from USB when radio on, But 5.25v idle at zero amps when charging.. Im confused Perhaps mystery stealth charging

Aug 15, 2020

And an image of what Inmarsat 4A-F4 “Alphasat ” looks like in space with its solar arrays and reflector extended..Considerably bigger !

(Photo credits European Space Agency ESA)

Radio Receiver Options

There are quite a few SDR radios suitable for this application including Airspy Mini and Airspy R2 and the excellent range of radios by SDRPlay.

The signals will need to be amplified so It is important that the receiver has the facility to supply 4.5-4.8 volts DC (bias tee voltage) along the coaxial to power an in-line amplifier or antenna with integral amplifier.

One cheaper option I found was the Nooelec NESDR Smartee v2 SDR Dongle, This is a nice little radio , great for experimenting. Small profile and Aluminium casing. At the time of writing (January 2020), this unit is around $25 USD.

merseyradar
@merseyradar

Really comprehensive nano vna kit from @Nooelec , But I had an because I am using 75 ohm feedline, Why not Calibrate the Nano VNA with Triax 75 ohm termination for more accurate SWR measurements. More testing with latest incarnations of popular #AirbandBazooka very soon.

Aug 11, 2020

merseyradar
@merseyradar

I will miss the majestic @TurkishAirlines A340 "retro livery" TC-JDN recently sold on to new owners, Here she is back in 2015 passing overhead my garden looking awesome in the fading evening light. Effortlessly cruising her way to @BostonLogan as "Turkish 81". #potn

Jul 27, 2020

merseyradar
@merseyradar

Contest Alert..For 3 months I have been using MVT-7000 "King of scanners" by @YUPITERU_JP from year 1992 v @Uniden_America "Pocket Rocket" UBC125XLT from year 2020, Who wins ? Closer than you think, I will need some more time to evaluate but 125 is a hell of a machine for the $

Jul 26, 2020

merseyradar
@merseyradar

The magnificent @Airbus A340 "4 holer" is becoming a less frequent sight, I love watching them pass by my viewing spot here in Here are a few A340s

The Nooelec smartee does a fine job with no fuss, the bias tee voltage is always on and not dependent on software tick boxes. The driver is very easy to install on your computer. The dongle comes with an info card and directs you to a set up guide..easy !.

Please Make sure you order the correct model “Nooelec nesdr smar**tee** v2" *with integrated bias tee*.. and NOT the very similar looking Nooelec nesdr smart dongle which has no bias tee.

You can buy direct from Nooelec or try Amazon in your country/ region, Nooelec have stock held by Amazon warehouses around the world. I purchased mine from Amazon UK and my order took 2 days to arrive . Not bad at all !.

https://www.nooelec.com/store/sdr/sdr-receivers/nesdr-smartee-sdr.html

If you are in the UK, here is the link to the product on Amazon UK site

https://www.amazon.co.uk/NooElec-NESDR-SMArTee-Integrated-R820T2-Based/dp/B079C3FHPG/ref=sr_1_2_sspa?

Prevoius Experiments

I had tried satellite acars using JAERO software on a raspberry pi 3 computer a few months ago using the excellent sdr play RSP1A with a GPS type active magmount antenna with integral amplifier powered by 5v bias tee (antenna photo below), the same antenna is sold by sdr-kits here in the UK.

https://www.sdr-kits.net/L-Band-Receive%20Antenna

from @TurkishAirlines,@lufthansa,@airfrance and @airtahitinuiPF from my photo collection. #potn @planesonthenet

Jul 12, 2020

merseyradar
@merseyradar

All #AvGeeks love the @Boeing 747 #QueenOfTheSkies, we dont see as many now so to cheer us up here are a few B747 photos by @British_Airways,@lufthansa,@KLM taken from my garden here in 🇬🇧 with my and 📸 combo a few years ago. #potn @rnavspotters

Jul 12, 2020

merseyradar Retweeted

Nooelec
@Nooelec

Replying to @merseyradar

Yeah exactly, it would be a form factor thing. Ideally we'd get the size somewhere close to the Balun One Nine v2. We'll do some testing here.

PS fantastic builds!

Jul 9, 2020

merseyradar Retweeted

Nooelec
@Nooelec

Replying to @merseyradar

49:1 might be tough but we can probably get close enough...good idea. We'll look into it!

Jul 8, 2020

merseyradar
@merseyradar

Thinking about upgrading my #raspberrypi2 adsb receiving station here in 🇬🇧 it has run non stop 24/7 for 1772 days feeding data to @FlightAwareADSB @flightaware , @flightradar24 ,@planefinder ,@360radaruk ,@PlanePlotter perhaps an upgrade to #raspberrypi4 is well overdue,

The Nooelec smartee dongle worked fine with this as did the SDRPlay RSP1A (also available from https://www.sdr-kits.net/) which is one fantastic radio.The results though were not exactly brilliant. Perhaps it was my impatience or using a bare bones budget computer or lack of knowledge in this area of radio or a combination of all three but it was a frustrating experience. No matter how much I tried, I could not get reliable decoding. Just parts of messages.

Improved Antenna Build

Anyway on to making an improved antenna for receiving ACARS data signals.

I found a video on youtube from fellow radio amateur Adam (9A4QV) in Croatia *(Adam also constructs & sells the very popular LNA4ALL in line amplifier products)*. He had made a DIY patch antenna from 2 metal sheets and he found it worked well for L-Band alphasat reception. The patch antenna is designed as Right Hand Circular Poarisation (RHCP) to point directly at the satellite.

Jul 7, 2020

merseyradar
@merseyradar

Bought this Zotek ZT102 multimeter from @AliExpress_EN , for $14 USD including delivery, very similar to Aneng M11 model ,arrived 4 weeks later, thought it was broken but 100% okay, not a bad meter at all for small hobby electronics sub $15 bargain from , nice backlight

Jul 4, 2020

merseyradar
@merseyradar

Balun One Nine from @Nooelec is great for HF clandestine monitoring using random long wire made from single pair stripped down CAT5 wire cores wound on a spool. Deploy and put away in seconds at hotel room or garden. Push terminals & VY small binocular core

Jul 4, 2020

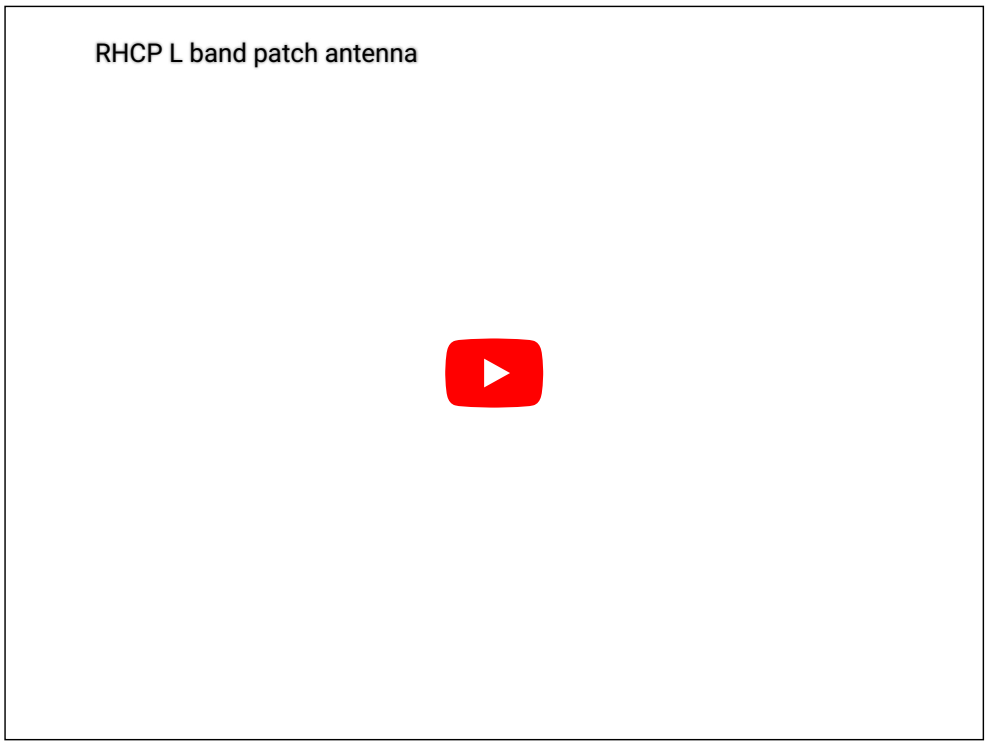
merseyradar
@merseyradar

Hello @Nooelec techys , Balun one nine works fine, neat little design with tiny binocular ferrite core Q: have you ever thought of making unun four nine 49:1 ratio ? Better impedance match for long wire.. Just an idea

Jul 2, 2020

merseyradar
@merseyradar

#makerealisticgreatagain Bring new life into your old 1990s Realistic Pro-2004/5/6 #scannerradio by replacing the tron blue EL backlight panel

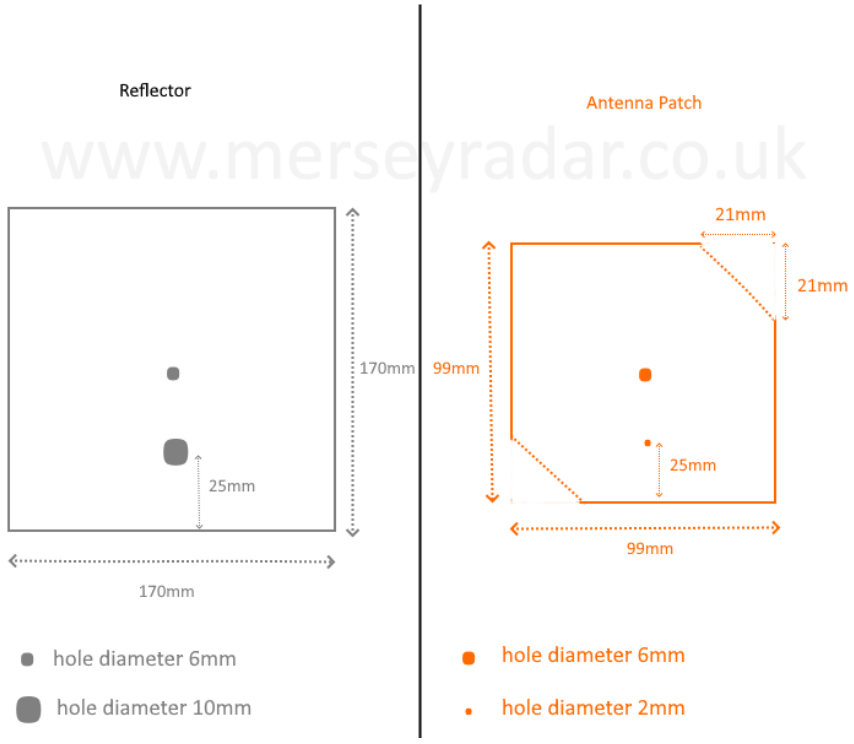


I decided to have a try at replicating this but after watching the video several times over, things were not clear as to the materials Adam used *(In particular the metals used)* and I anticipated much difficulty in soldering a connector on to the antenna front plate so I decided to get in touch with him via email. Luckily Adam responded very quickly and gave me some much needed guidance.

He had used tin plate for the front patch to aid soldering and aluminium plate for the larger rear reflector.

Adam 9A4QV had suggested it would be feasible to use brass plate for the front patch and this was easier to obtain locally so I went for that option.

Here is an image of the dimensions.



tron blue EL backlight panel.
Brilliant scanner for an #AvGeek made in 🇯🇵 Full instructions in my blog page. merseyradar.co.uk/airband-radio/...

Jun 28, 2020

merseyradar
@merseyradar

Replying to @merseyradar

Confirmed..I must be a #RadioGeek..I still have the box and papers 15 years on, told the XYL I always put in the .. Always..

Jun 27, 2020

merseyradar
@merseyradar

Bought the @IcomAmericaInc IC-T7H while on holiday in 15yrs ago. @HamRadioOutlet delivered it to my hotel in NYC. Still my favourite 2/70 HT, all aluminium chassis so strong you can knock a nail in with it . Best of all it has AM airband

Jun 27, 2020

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RECENT POSTS

L-Band DIY antennas for Jaero

Yihua 937D+ 60W Soldering Station.. Bargain !

Satellite ACARS reception on L-Band with JAERO.

SDRPlay RSP1A Receiver Review.

Home made coaxial dipole antenna for civil (and military) airband.

Note that the pair of 6mm diameter holes are positioned in the exact centre of each plate. The 2 plates are joined and electrically shorted together by an M6 x 12 stainless steel machine screw , washers or a spacer and a locknut. There is a constant spacing/ air gap of 7mm between the 2 plates and washers or ideally a spacer is used as a sleeve on the machine screw and between the plates to maintain the 7mm air gap.

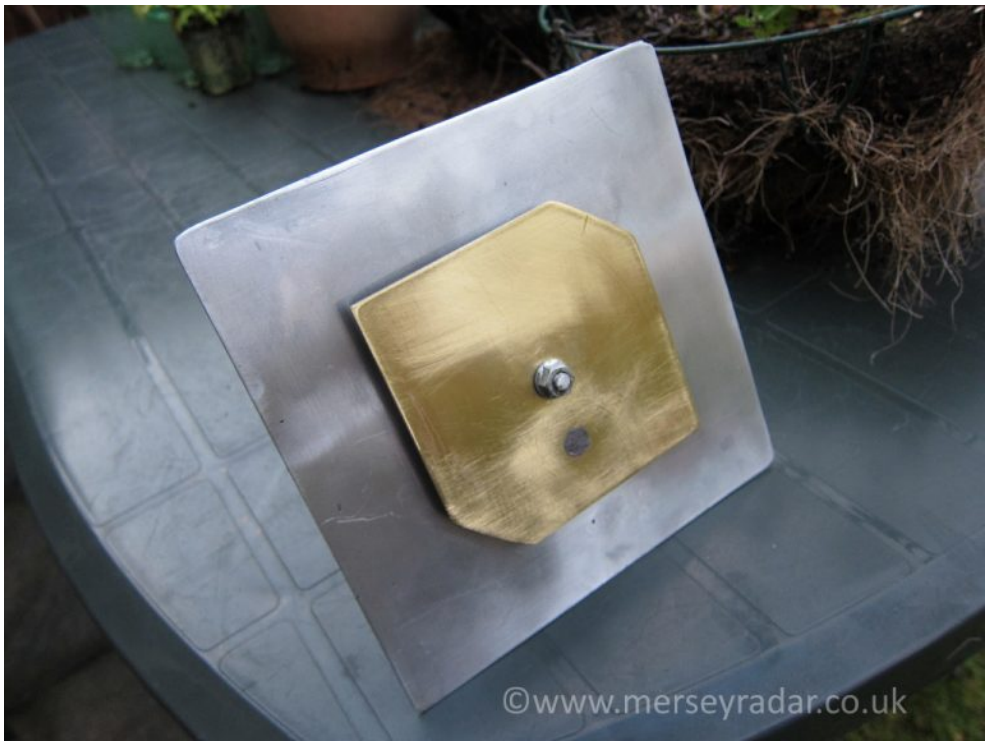
The 10mm hole in the aluminium plate is to accept a BNC connector, the exact centre of the 10mm hole should align perfectly with the exact centre of the 2mm hole in the brass plate.

The 2mm hole in the brass plate is for the ferrule tube of the BNC connector, the tube is quite long and will protrude through the brass element front plate.

Here is a photo of the construction, here the plates are cut and correctly spaced, note the bnc ferrule is poking out of the brass element.

I had to mount a few 10mm diameter stainless steel washers behind the BNC connector to reduce the protrusion of the tube ferrule.

Some gentle use of a smooth file brought the BNC tube ferrule flush with the plate, then its just a case of soldering and making things tidy.



RECENT COMMENTS

merseyradar on L-Band DIY antennas for Jaero

steve weston on L-Band DIY antennas for Jaero

merseyradar on Home made coaxial dipole antenna for civil (and military) airband.

merseyradar on Home made coaxial dipole antenna for civil (and military) airband.

Erik Näsström on Home made coaxial dipole antenna for civil (and military) airband.

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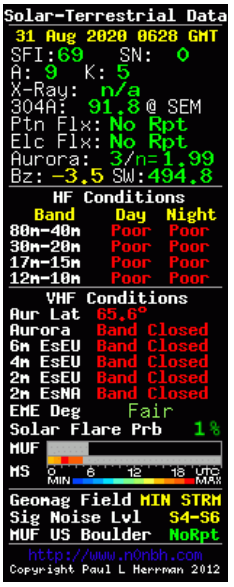
Around the back, something different.

I found a 40mm diameter aluminium furniture leg from ebay, I fixed this to the back of the reflector . Why ? I hear you ask..



Well..Now for some ***inspiration***, I looked long and hard at those images from Inmarsat/EASA and noticed that the Inmarsat boffins have used a large reflector on the satellite and below it there is what looks like a patch antenna...similar to the type used on top of an aircraft fuselage.

See circled area inset below.

Okay..Lets DIY copy their design !.... Enter a 90cm solid glass fibre satellite dish and tripod found on a local auction site for £15 GBP/$20 USD.

When the patch antenna is mounted in the lnb arm pointing at the dish an adjustment has to be made because when the signals are bounced off the dish the become inverted so a Left Hand Circular Polarisation (LHCP) patch antenna or helix antenna is needed to resolve the signals.

The dish LNB clamp accepts standard 40mm LNB collars so the ebay furniture leg is the perfect size, this gives me the ability to obtain the best signal possible by adjusting the patch antenna forwards and backwards in the clamp to find the perfect focus point. The patch antenna has to be orientated for Left Hand Circular Polarisation (LHCP), so the antenna is turned 90 degrees.

The best/easiest way to explain LHCP and RHCP: The signals transmitted from the satellite are "wound up" in a helix pattern and the helix has right hand turns (clockwise), when we try to intercept the signals using a dish we need an antenna with (anti-clockwise) left hand turns to "unwind" the signal and into the radio .

Here is what the patch antenna looks like when its facing the dish, note its turned 90 degrees.

Here you can see the 7mm gap between the plates, the plate spacer nut and the washers on the back of the BNC connector.

Now to employ some signal amplification (You will need it), conveniently powered by 5 volts DC emitted by Smartee dongle (Bias tee voltage), here we are using a purpose made unit by Nooelec, the Sawbird IO.

A purpose made very good LNA amplifier with integral saw filter which is centred @ 1542mhz, just where we need it for the Jaero application.

https://www.nooelec.com/store/sawbird-io.html

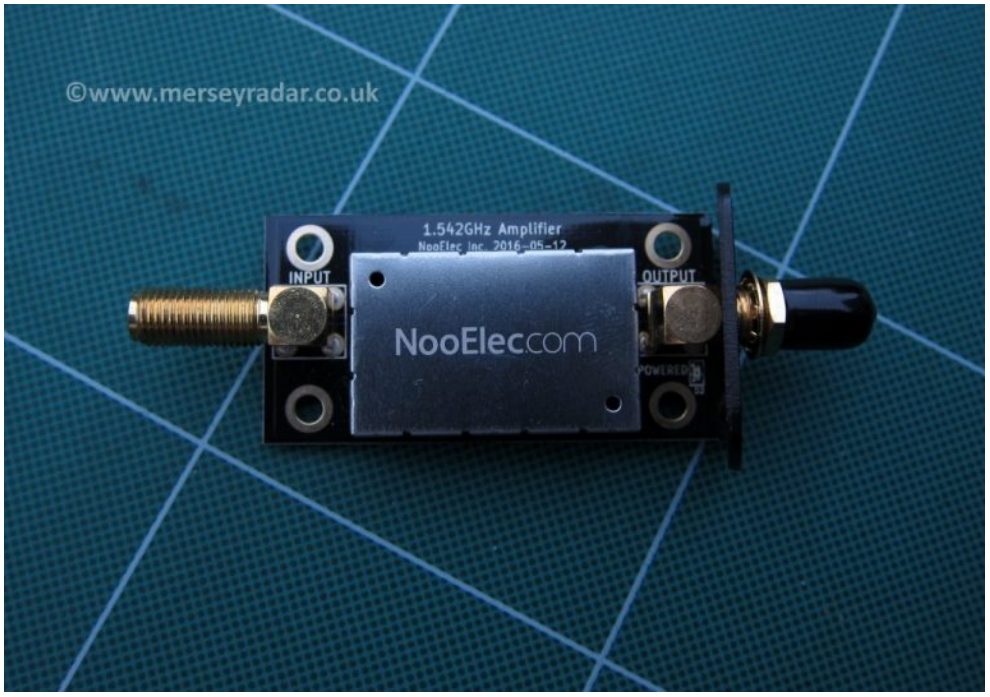
You can purchase these from Amazon in your location, or buy direct from Nooelec. There are a few versions, single LNA and dual/cascaded LNAs, supplied with custom aluminium enclosure or barebones.pcb only.

I purchased the single LNA enclosed as shown below it was around £27 / $35usd.

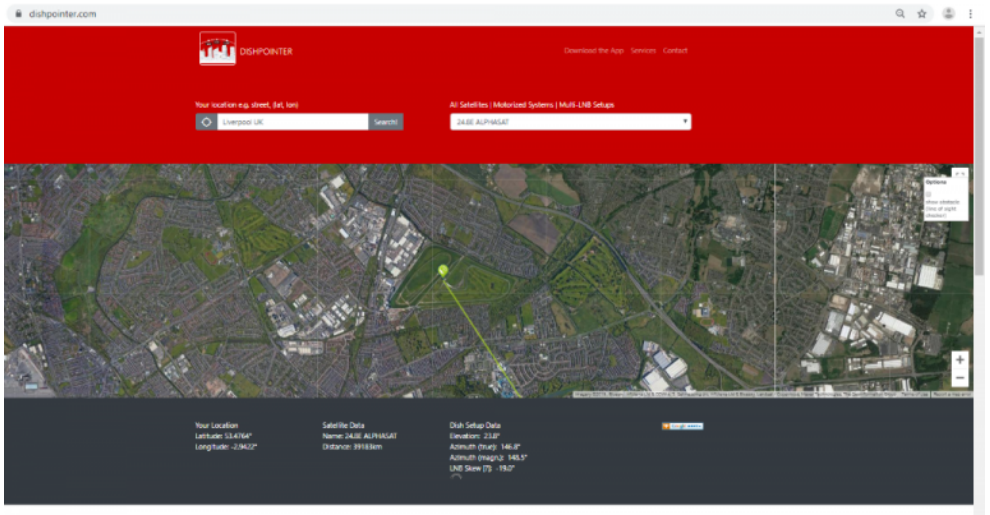
Here is the link for Amazon store in the UK.

https://www.amazon.co.uk/NooElec-SAWbird-iO-Ultra-Low-Applications/dp/B07K1PBJ4X/ref=sr_1_5_sspa?

Inside that nice aluminium casing, the unit look like this.



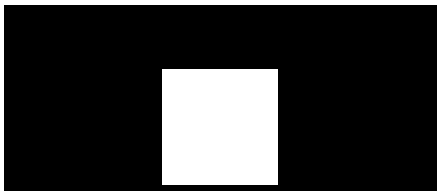
Next I used dish pointer https://www.dishpointer.com/ program to line up the dish and patch with the Inmarsat "Alphasat" satellite at 24.8 degrees east.



This neat website shows you a direct line to the satellite from your location, just move the green dish icon to the exact site of your dish and the webpage does everything for you.

There is a really nice app on the ipad & iphone for this too called “dish align “, this gives an audible and visual signal when you have the ipad in the correct position for the satellite. Excuse the poor quality video but I wanted to show you just how cool this app is, and its free.

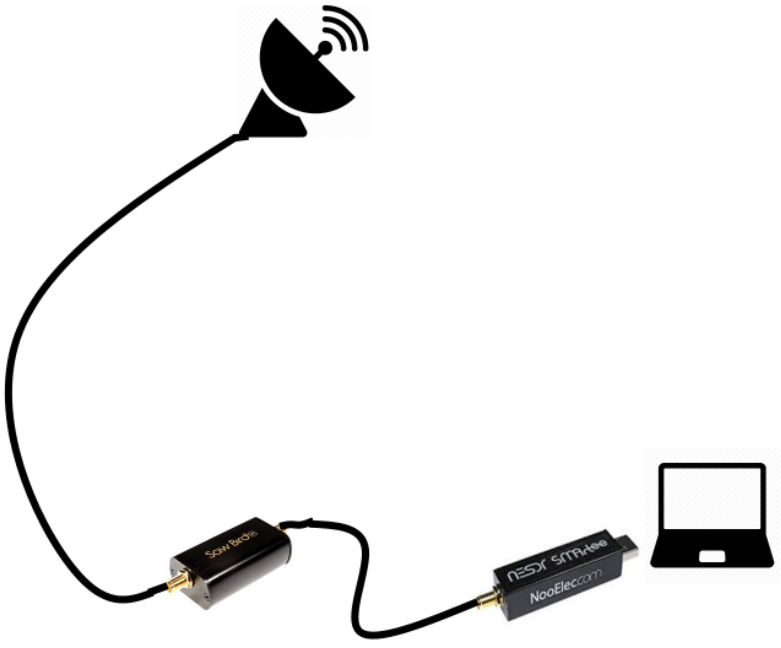
Here I have selected Inmarsat @ 25 degrees east from the drop down list in the app and I placed a sample fixed dish site location into the map page, watch how dish align uses the ipad on board compass and positioning data, also it finds the correct elevation and the ipad/iphone speaker emits a “lock good” tone..how cool is that !
Technology is Marvellous isnt it ? The stuff of dreams not too long ago !



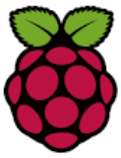
00:00 00:45

So now we have the dish aligned correctly here is a summary diagram of the setup.

You



Installation of JAERO software on Raspberry Pi



Important Note,

You will need to run an older desktop version of rasperian system for Jaero to work, new versions of Pi OS will not work. (*See update Below*)

You will need a Pi image Jessie, this was before the release of Stretch version, most likely (but not definitely) the Jessie version dated 2017-07-05 in the list below.

https://downloads.raspberrypi.org/raspbian/images/

You will need to install the desktop version of the OS.

Plus you will need GQRX sdr radio package installed on your pi before installing Jaero.

The only version of Jaero I could get to work properly on raspberry pi was V1.0.4.6-7.1armv7hl.rpm

Link to download this file from my google drive

Google drive Link to Jaero 1.0.4.6-7.1rpm

Set up the pi with standard raspberian desktop version.

Create a new folder to work with on the pi graphical desktop, name the folder Jaero

And unzip the 7.1 rpm to that folder, click on the Jaero icon and the decoder window should open and it should work.

News Update 27/1/2020 : A guest reader "J" from France has reported to me that he got Jaero v1.0.4.6-7.1 working well with Buster version of pi OS.

He downloaded the rpm Jaero version 7.1 from my link above then used the following commands.

Credit to user J from Bordeaux, France.

Link to .txt file below , I have packaged the commands into a document on my google drive which you can view on your computer.

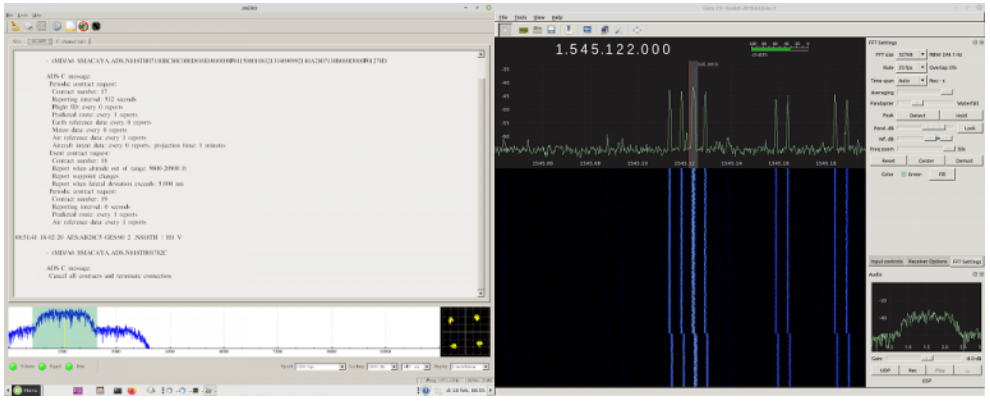
Jaero Setup Commands rpi

More Information : Linux (running on PC) with Jaero

Another Guest reader Ruud from the Netherlands has contacted me and informed us that he found the Jaero install on Raspbnerry pi3 with rasperian

OS was slow and sluggish decoding signals. He found much better results using Linux Mint ,Wine and Jaero 64 bit windows package, now 600bps and 1200bps decoding smoothy with no problems experienced so far..

Here is a screenshot of Ruuds raspberry pi3 system running Jaero 64 windows excecutable.



I include comments/ received from Rudd regarding his system and some tips below, click on the link to open .txt.file

Linux Mint rpi3 Jaero Win64 from Guest Reader Ruud

Tip:

When you have Jaero installed successfully..

Play a test file on your pi system locally to test if the decoder is working and your audio routing is correct

Here is a test file (again hosted on my Google Drive) of satellite acars to download and play on your system.

Test ACARS sound file

Recording with Windows installs

You will need a way of piping the audio output from the sdr radio or dongle to the Jaero program for decoding.

A program is available from Evgenii Muzychenko and that program has up to 256 virtual audio cables, there is a trial and paid versions...great work Evgeni !

https://vac.muzychenko.net/en/

Evgenii is an audio software expert “par excellence” !

This is the original VAC software which all others try to copy and imitate. Developed by Evgeni way back in 1998 and first sold in 2001 on the internet. a single licence is $30 usd which is very reasonable if you are considering this part of the radio hobby seriously.

There have been many developments since the first release and there is a comprehensive user manual and online/email support direct from the developer.

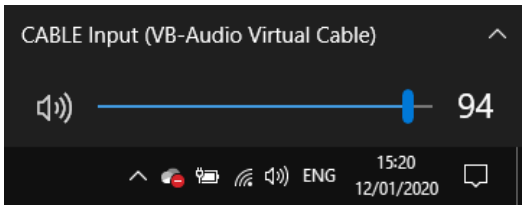
Alternatives...

There is a program called VB Cable Virtual Audio Device, the free version only gives 1 channel but the paid one will give up to 8 virtual cables so you could (providing you have the pc spec to do it) open several instances of sdr# by Youseff Touil, sdr console by Simon Brown or sdr uno by the SDRplay team on different frequencies and open several instances of Jaero and each frequency could be piped through simultaneously to each Jaero. I state again, check each program for their respective audio output options and set the output to VB cable which will link to Jaero. Following the standard VB audio cable install program, you will find the folder VB in program files, there is a small graphical representation of the control panel if you click on the icon for it.

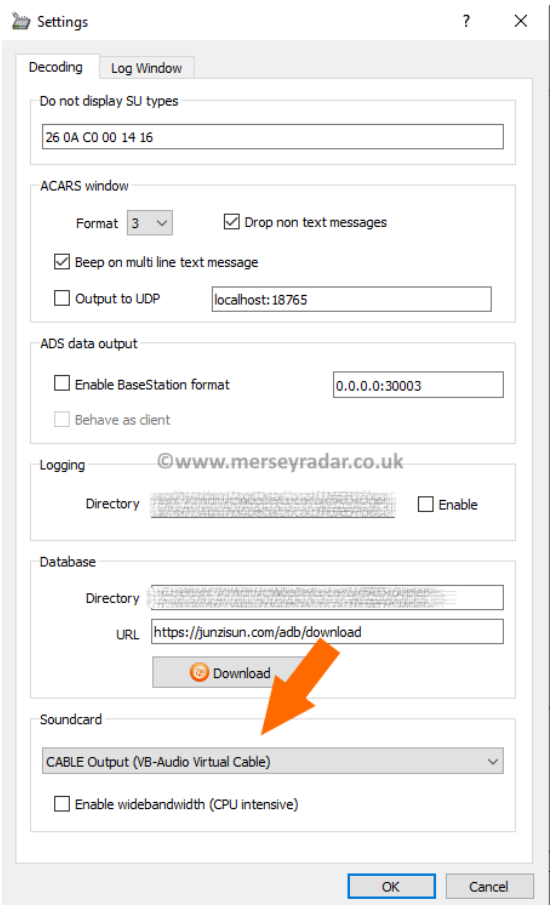
VB Audio cable can be downloaded from here

https://www.vb-audio.com/Cable/

Before starting out to decode signals It is important to set your windows default sound device as VB-Audio Cable .



Next open Jaero and open “Settings” from the top menu , at the bottom of the settings window you will see “soundcard” make sure the Cable Output VB-Audio cable is chosen.



Again you can download the ACARS Satellite test ACARS audio file hosted on my Google Drive and play this locally on your computer when the Jaero window is open

If you have your settings correct.

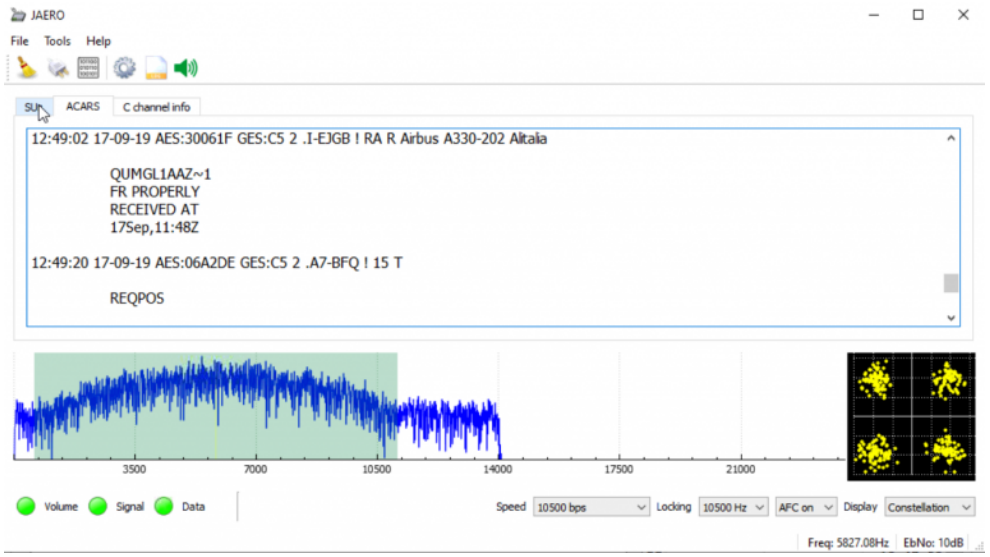
You should see a green light for volume, this indicates that the sound is being piped through correctly by the virtual audio cable settings and a blue line will be jumping around indicating that activity is happening.

For starting out , Next you need to find some acars channels and move sdr sharp, sdr uno, or sdr console to these frequencies, you will see the peaks in your sdr waterfall (around 1.545.029 is a good start), set jaero to 600bps or 1200bps at the bottom of the Jaero window to start with as these are the easiest to decode then later move on to 10500bps.

Successful dish/antenna alignment and freq chosen will result in the signal and data indicators showing green, red on the volume indicator means that too much volume is set in your sdr radio program..turn it down a little, conversely white in the volume indicator means not enough or no volume of audio is being received by jaero, make adjustments to vb cable settings or check that the sdr radio program you are using isn't muted..

Observe the constellation window with the yellow dots, Ideally you should get 4 clusters of yellow dots, one in each of the 4 squares on the chart, this indicates an excellent antenna alignment.

Okay Lets fire up the radio and open Jaero I have set the bit rate to 10500 for this ambitious example !



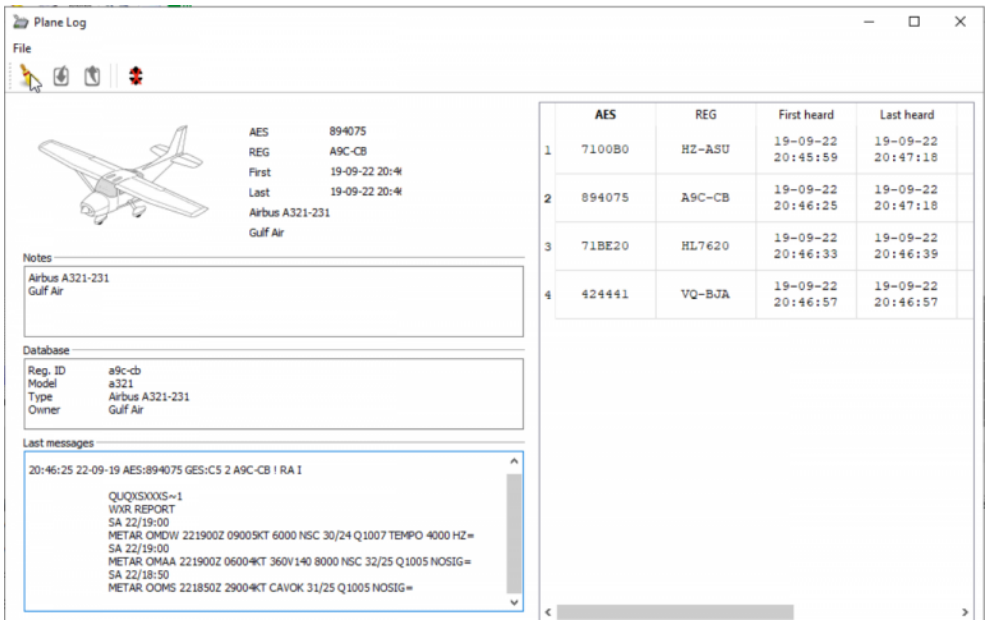
Success ! ..3 solid green lights and some data coming through, and 4 clusters of dots in the centre of the 4 squares.

Some data is coming through..

A message for Alitalia A330 -200 (I-EJGB) !

A sample aircraft list with message window..Gulf Air a321 A9C-CB is quite some distance away from my location in the UK ..she is over 4500 miles away working route Bahrain-Chennai this evening as flight GF68. As you can see in the message window below , this flight is receiving on route sector weather reports for Al Maktoum Airport Dubai (OMDW) , Abu Dhabi Airport (OMAA), and Muscat airport Oman (OOMS).

My dish and antenna can see the satellite and so can the flight crew of GF68 , curvature of the earth is not an issue so we both see the data at the same time.



For me, This is a totally new branch of the great hobby of radio monitoring.

I have learned so much in the making of this little patch antenna I cannot begin to explain.

It is working very reliably and is much better reception wise than the small powered active GPS type antenna I tried months before.

It really was some kind of achievement for me to take 2 bits of metal plate and make an antenna system to receive signals from a 6 metre long box floating around in space over 22,000 miles away.

It worked out much better than I ever expected.

The data signals can be fed to Planeplotter very easily.

I have to send thanks to Adam 9A4QV for the support and guidance on antenna construction.

Also thanks to local satellite aficionado John Locker (Planeplotter Support) http://satcomuk.yolasite.com/ for some excellent advice on all things Satcoms..John you are a star !, and of course finally many thanks to the author of the JAERO decoding software "Jonti" (Johnathan Olds from Wellington, New Zealand)

https://github.com/jontio/JAERO

Update March 2020.

SDR Kits have a new version of outdoor antenna which looks as if its based on a similar external/ housing design to a marine gps antenna.

(Image below kindly supplied by SDR-Kits)

The company state this is purposely made for 1540 mhz L Band.

I have not tried this one myself but here is the link to the product.

https://www.sdr-kits.net/L-Band-Receive-Antenna-A154-10M-Permanent-Use

This Blog post is continued with more DIY L-Band antenna construction notes and trials linked below

> *L-Band DIY antennas for Jaero*

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5 Responses to Satellite ACARS reception on L-Band with JAERO.

Cath Singleton says:
February 7, 2020 at 7:09 pm

Great website, good information, i am a radio ham and listen to all kinds!
Thanks for the tips, and for plenty more reading 🙂

REPLY

merseyradar says:
February 7, 2020 at 7:59 pm

Hi Cath, Thanks for the kind comment, very nice of you , Much Appreciated. There isnt very much in the way of guidance on the internet with all things Jaero/Inmarsat so I thought a blog page detailing my attempts may be useful to others. I am also a radio amateur, you may find some other articles here interesting. Take a look in the "Archives" section in the menu at the right hand side of this blog site.
Many Thanks for your visit and taking the trouble to send over some feedback. Regards, Mike

REPLY

Ruud says:
February 17, 2020 at 7:17 am

Hello,

Thank you for your information.
I tried to use it on a raspberry 3, but is is very slow and using a lot of processing (jaero and gqrx).

Better is to run jaero on Linux mint 19.3 in wine (64 bits jaero executable) that works fine.
So far 600bps and 1200bps is working good.

Regards,
Ruud.

REPLY

merseyradar says:
February 18, 2020 at 9:20 pm

Hi Ruudd,
Many Thanks for writing in and sharing your experiences when testing out Jaero on your Raspberry Pi3.
With your permission (which I received earlier today), I have Incorporated details of your work into this page for others in the radio community to read.
Many Thanks for sharing Ruud, Regards, Mike

REPLY

L-Band DIY antennas for Jaero – Mersey Radar April 7, 2020 at 9:15 pm
[...] http://www.merseyradar.co.uk/airband-radio/satellite-acars-reception-on-l-band-with-jaero/ [...]

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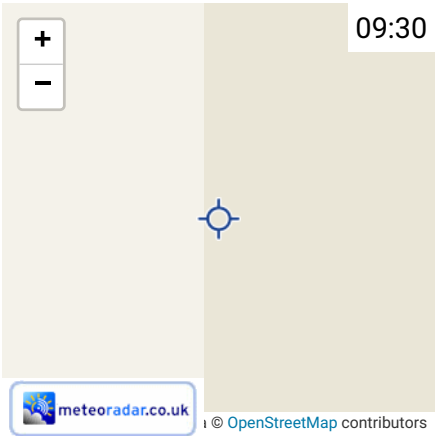

Airband Radio Aviation Photography