

# USER MANUAL

## microADSB-IP-WiFi receiver v.1

### =BULLION=



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## What is new in WiFi version .

BULLION WiFi is a new generation product of ANTENI.NET Ltd. Based on the last series microADSB-IP receiver, now there is a wireless embedded module which provides ADS-B interface for data transfer based on WiFi wireless network standard. You don't need a cable to link your ADS-B base station to your computer or network. It integrates IEEE802.11b and TCP/IP & UDP protocols. It can easily make the microADSB receiver to access your wireless network. The device also can be set to work as a USB device. Easy setup through web based interface.

## About microADSB-IP-WiFi receiver

- ✓ **ADS-B interface for data transfer based on WiFi wireless network standard for connection.**
- ✓ **Great coverage & redundancy**
- ✓ **Up to 250 Nm range**
- ✓ **High accuracy independent of distance**
- ✓ **High Update rate**
- ✓ **Provides Identity and the characteristics of the aircrafts**
- ✓ **Supports cockpit display of traffic Information**
- ✓ **Ability to work in USB connection mode and firmware update**
- ✓ **Metal enclosure with good seal (IP65)**
- ✓ **Perfect for outdoor mounting directly to the antenna**
- ✓ **Antenna connector directly soldered on board (no cable lost)**
- ✓ **Still on affordable price for ADS-B receiver**

Finally a quality virtual radar receiver at a price you can afford, substantially lower than other receivers on the market but with all the performance you need.

The microADSB Radar receives real time transmissions from commercial aircraft and through the ADSBscope or PlanePlotter software displays them on your PC, it is like having air traffic control in your living room!

You can watch flights in your local area in real time within a practical range up to 150 Nm with typical 1st floor window sill antenna position, greater if you have an ideal antenna position. Identify those airliners you see flying over, and even watch them stacking at your local airport!

Most large civil aircraft such as commercial airline flights carry equipment that transmits information over a system known as ADS-B.

ADS-B contains information like the name of the flight, the ICAO number of the aircraft, the aircraft's current position, speed and direction, and how fast the aircraft is descending/ascending. This information is received by the microADSB receiver which ADSBscope or PlanePlotter software decodes this placing the aircraft on a map of your local area.

## 1 Terms Of Use:

We present to your attention some open-sources connected with this project from our point of view.

Our developer's experience has been gained from the links listed below or similar:

<http://www.sprut.de/electronic/pic/projekte/adsb/adsb.htm>

[http://www.mikrocontroller.net/articles/1090\\_MHz-ADS-B-Receiver](http://www.mikrocontroller.net/articles/1090_MHz-ADS-B-Receiver)

<http://miniadsb.web99.de/>

<http://www.coaa.co.uk/planeplotter.htm>

<http://ww1.microchip.com/downloads/en/DeviceDoc/70632C.pdf>

<http://www.microADSB.com>

<http://www.anteni.net/>

## 2 Introduction

The User Manual is based on:

Decoder adsbPIC hardware, firmware v.14

An ADS-B-receive system can be used as virtual radar to generate a live picture of the air traffic.

It is made up from 5 stages:

- antenna
- receiver
- decoder
- TCP/IP interface and Wi-Fi
- PC-software

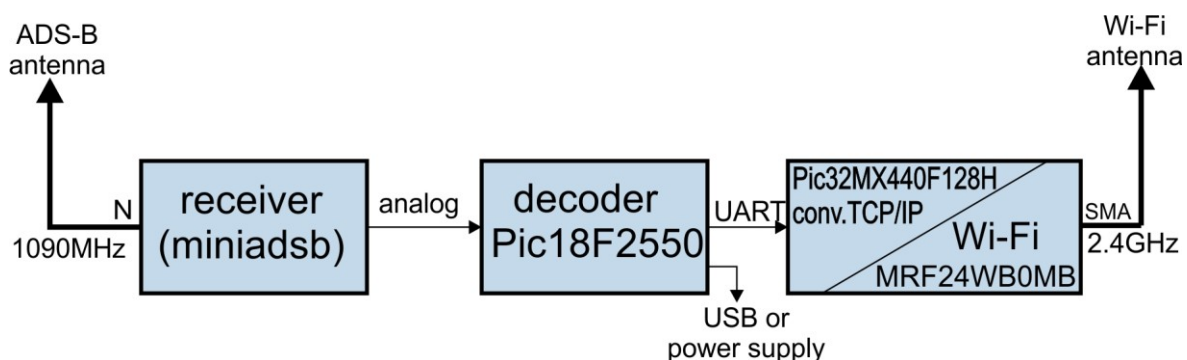


Fig.1: ADS-B receiver

1. The antenna has to receive the 1090 MHz radiation and to convert it into an electric UHF-signal.

2. The receiver selects, amplifies and demodulates the received signals, and generates an analog signal.

3. The decoder converts analog into digital and detects ADS-B transmissions inside digital signal. The ADS-B signals are then forwarded to a PC via WiFi Ethernet connection or USB interface.

4. The PC decodes the ADS-B information and generate the virtual radar display. It supports exchange of ADS-B data via the internet.

This handbook is focused on the **microADSB-WiFi** and the PC-software **ADSBScope** or **PlanePlotter**.

### 3 Antenna 1090MHz

For good performance antenna with vertical polarization, with 50 Ohms impedance, tuned to 1090 MHz has to be used. The antenna connector is N type.

We offer models **MS10905** (5dBi omni-directional antenna) and **MS10910** (9dBi directional panel antenna) at [www.microADSB.com](http://www.microADSB.com).

MS10905 antenna is included only in microADSB-IP-WiFi Opt.3 set

The antenna has to be placed as high as possible at a location with a good 'view' into all directions.

### 4 Mini adsb Receiver

The miniadsb is a small and simple direct detection receiver for 1090MHz.

### 5 adsbPIC-Decoder

The decoder converts the analog signal (from the receiver) into a digital signal, detects the ADS-B-frames in the signal, and sends them to the PC

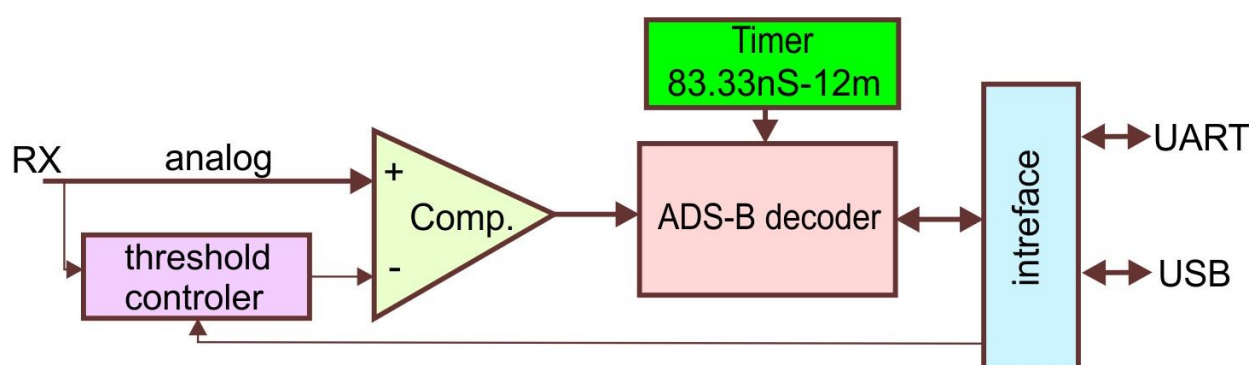


Fig.2: Decoder block- d iagram

The heart piece of the adsbPIC-decoder is a PIC18F2550 microcontroller. It converts the analog signal into a digital signal by use of an internal comparator. Then it tries to detect ADS-B messages inside the digital signal.

## 6 Interface

Decoder associated with Wi-Fi module with serial TTL interface level. This is the main way of transmitting data wirelessly from the receiver to the network.

There is a possibility for direct connection to a computer via USB. This can be done by the wire which is normally used for power supply. Thus can refresh a new firmware of the decoder.

## 7 Switches

By the 4-position switch on the PSB (Fig.3) several additional modes can be set:

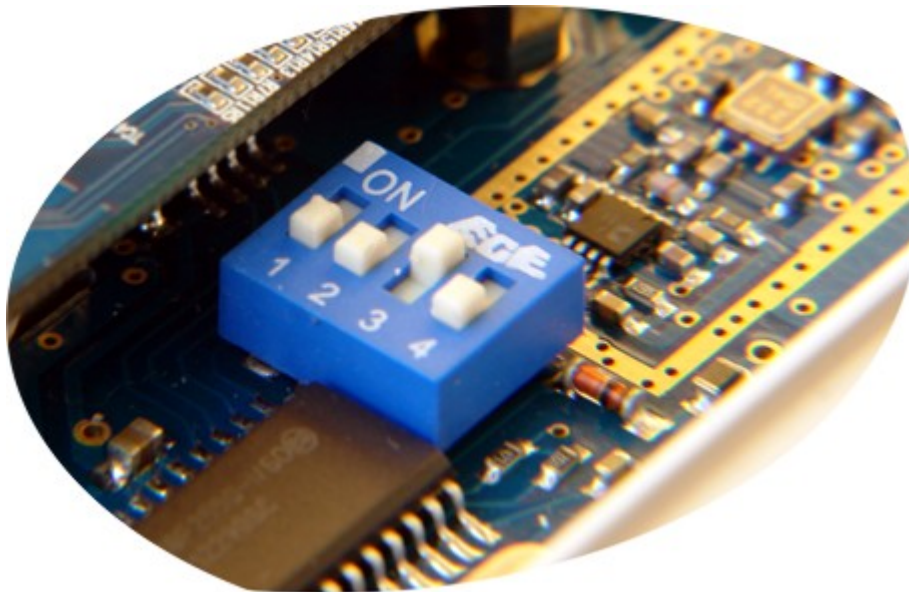


Fig.3: Default state of the switch

### **Switch 1 - DF17**

This switch has no function, if switch 4 is ON.

If switch 4 is OFF, then switch 1 controls which frames are reported to the PC. As long switch 1 is OFF, all received frames will be reported to the PC. But if switch 1 is ON, then only DF17, DF18 and DF19-frames will be transferred.

### **Switch 2 - TimeTAG**

If this switch is ON, then a precise time code (for MLAT) will be generated by the decoder for each received frame. The adsbPIC-decoder time tag is based on a 12MHz clock. (Some other decoders/receivers use a 20 MHz clock instead)

The adsbScope software via USB can activate the time tags by software. If this was done, then the decoder will send time tags even if the switch is in OFF position. The time tag can be used to triangulate aircraft position in collaboration with other decoders. If you don't participate in such a network, then you should deactivate the time tags to reduce the load at the USB/WiFi-Interface.

### **Switch 3 - serial**

If the switch 3 is OFF, then the USB-interface will be used. But if the switch

3 is ON, then the WiFi-Interface will be used instead.

#### **Switch 4 - Remote control**

If switch 4 is ON, then the decoder has to be remote controlled by the adsbScope software if you use a USB interface. The switch 1, will have no effect. After power-on or reset, the decoder will not start to send data by itself; it will wait for a command from the software.

If switch 4 is OFF, then the decoder starts to send data immediately after power-on or reset.

## **8 TCP/IP and WiFi modul**

The received ADS-B messages are transferred by serial to the TCP/IP converter microcontroller PIC32MX440F128H. Radio part was used IEEE 802.11-compliant RF Transceiver: **MRF24WB0MB**

For more information, follow the link:

<http://ww1.microchip.com/downloads/en/DeviceDoc/70632C.pdf>

On the basis of **MRF24WB0MB** is built Wi-Fi module. It is an embedded device which provides for ADS-B data transfer based on WI-FI wireless network standard. It integrates IEEE802.11 and TCP/IP protocol. It can easily make the traditional devices access to wireless network.

#### **Wireless:**

- ✓ Compatible IEEE standard 802.11b
- ✓ Unique serialized MAC address
- ✓ Data Rate: 1 Mbps
- ✓ Distance: up to 400M(1300 feet) via kit antenna. Or more than 2 km with a directional antenna.
- ✓ Working in ISM band 2.400–2.484GHz
- ✓ Support 802.1x and 802.1i safety: WEP、WPA-PSK and WPA2-PSK
- ✓ Support two network configurations: *Infra* and *Adhoc*
- ✓ Small SMA connector.
- ✓ America(FCC)、Canada(IC)、Europe(ETSI) and Japan(ARIB)Radio regulatory approvals. Pass Wi-Fi® certification
- ✓ Support multiple network protocols: TCP、UDP、DHCP、ICMP、DNS
- ✓ WEB interface PC configuration.
- ✓ Receiver Sensitivity The typical sensitivity is -91dBm when on 1Mbps
- ✓ Modulation DSSS
- ✓ The typical transmit Power is +10 dBm
- ✓ Working Environment:
- ✓ Operating Temperature: -20C ~ 85C. Storage Temperature: -40C ~ 125C

There are two concepts we need to know:

AP, in computer networking, a wireless access point (AP) is a device that allows wireless devices to connect to a wired network using Wi-Fi, or related standards. The AP usually connects to a router (via a wired network) if it's a standalone device, or is part of a router itself.

A station (STA) is a device that has the capability to use the 802.11 protocol. For example, a station may be a laptop, a desktop PC, PDA, access point or Wi-Fi phone.



### **Infra Network:**

Infra is created by AP, lots of STA access into it. AP is the network center, all the communication is transfer by AP.

1. Can expand the communication range by wireless router
2. The IP address can be dynamically allocated by the router's DHCP function
3. Can set WPA2 encryption to protect the data safe in network

### **Adhoc Network:**

Adhoc is organized by at least two STA, not exist AP. It has the following characteristics:

1. Not need router
2. Can support many modules to access
3. Need to set static IP

It is a low cost, easy-to-use mode, you can directly connect module by laptop or mobile phone not depending on wireless router.

### **Security Mechanisms**

This module supports multiple wireless encryption modes to make sure the user data safe. The following encryption modes are available:

- OPEN (no encryption)
- WEP64
- WEP128
- WPA-PSK
- WPA2-PSK

## **9 Configuration**

The microADSB-IP-WiFi device is for the ADS-B transparent data transmission. User first needs to configure the following wireless network parameters before communication:

- Network name (SSID)
- Safety mode
- Encryption (depends on your needs to choose)
- Default TCP/UDP connection parameters:
- Protocol type
- Connection type
- Destination address
- Destination port

### **Web parameters configuration**

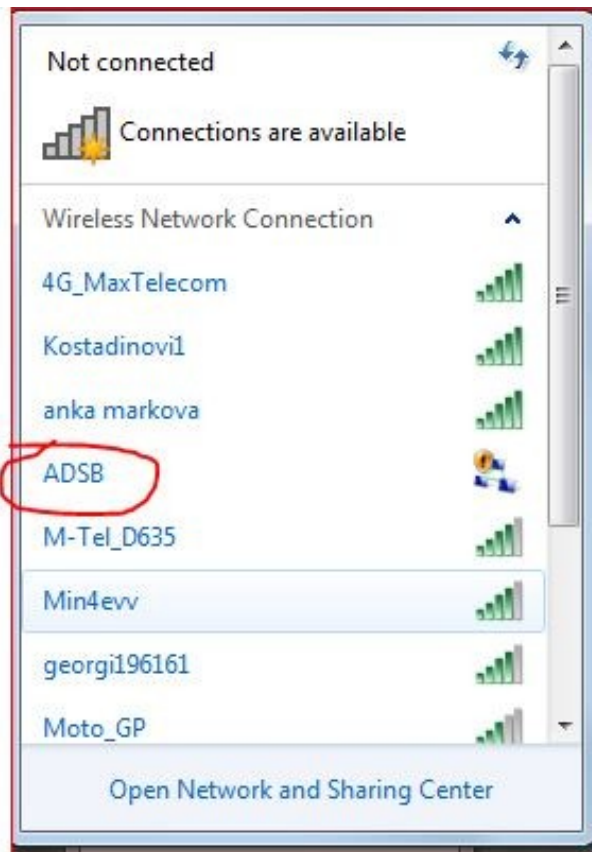
If the laptop supports WIFI, or the mobile phone supports WIFI and ADHOC, you can use the WEB interface to do the configuration.

When you power on your microADSB-IP-WiFi receiver for the first time, module will create a point-to-point network by using default parameters:

- Defaulted SSID: **ADSB**
- Defaulted IP address: **169.254.1.1**

When you search for wireless, Point-to-point network named ADSB will appear in the list of networks: Fig.4

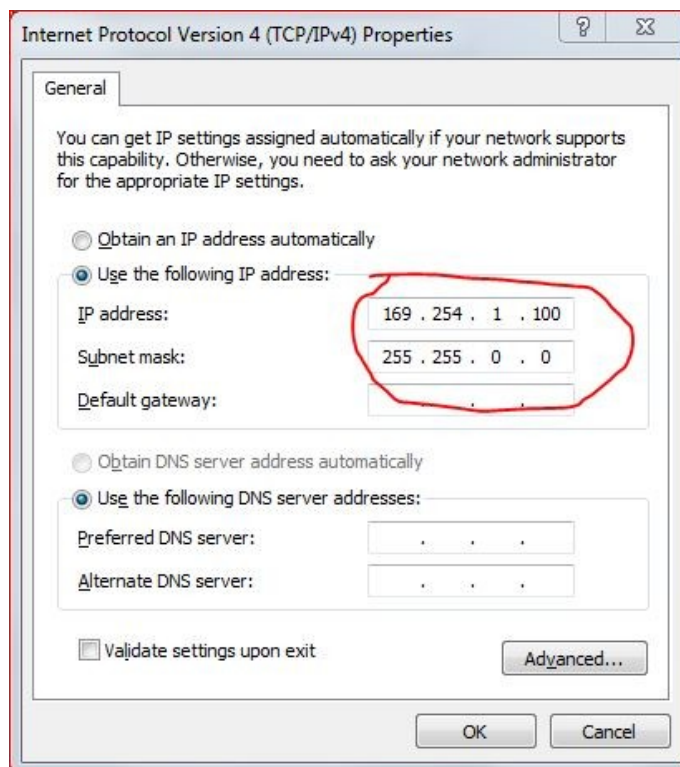




**Fig.4: Wireless networks list**

The network is not encrypted and can be used directly.

After connection, be sure that computer and WIFI module are on the same network. Then begin to configure. Change the computer IP to be static IP address: 169.254.1.xxx (xxx from 2 to 254 – different from 1) Fig.5.



**Fig.5: Computer IP configuration**

After finishing IP configuration, open an browser and input in the address line: <http://169.254.1.1/scconfig.htm> , then press “Enter”.

User login screen appears. Input the default username and password:

User name: **admin**

Password: **admin**

Click “sure”, can see the Web screen as follows:

**BULLION CONFIG**

networktype:

SSID:

SecurityMode:

KeyMode:

KeyIndex:

KEY:

☐ ENABLE DHCP

IP ADDRESS:

SUBNET MASK:

GATEWAY:

DNS ADDRESS:

TCP/UDP:

C/S MODE:

ServerIP:

Port:

BaudRate:

Checkbit:

Datebit:

Stopbit:

DateLen:

DateTime:

UserName:

PassWord:

*do not change*

**Fig.6 Configuration screen of the microADSB-IP-WiFi modul**

**Note:** Changes in configuration take effect after clicking “Save Config”, and then **off and on the power supply of the receiver again**. This makes the configuration saved and valid.

**Must be very careful with! Once lost configuration can be restored only with a special programmer!**

All the parameters will appear and can be changed after successful connection from the screen shown on Fig.6. About the meaning of the parameters, please read the following:

**Networktype:**

✓ If you want to add the receiver to existing wireless network choose “Infra”, then according to the settings of the AP, configure the WiFi parameters (network name, security mode, key).

✓ If need point-to-point connection (such as laptop and mobile phone to connect to module, or module to module communication), please choose “Adhoc”, If there is a network, it will connect to the existing network automatically, if not, it will create a new network.

**Network Name(SSID):** WiFi Network ID: 1 to 32 ASCII characters.

**Security mode:** It contains OPEN、WEP64、WEP128、WPA-PSK、WPA2-PSK. Choose the suitable one as your requirement from the drop-down menu

**Key mode:** You can choose HEX or ASCII under the security mode of WEP64 and WEP128

**Key Index:** You can choose from 1 to 4 under the security mode of WEP64 and WEP128

**Key:** Different type of keys have different length:

WEP64(HEX):10 characters

WEP64(ASCII):5 characters

WEP128(HEX):26 characters

WEP128(ASCII):13 characters

WPA/WPA2-PSK(ASCII):8~63 characters

**Note:** If WPA encryption is chosen, modules first time connects network will take a long time. After that, it will become very fast.

**ENABLE DHCP**

✓ If your receiver needs automatically to obtain an IP, please tick the “ENABLE DHCP”. All other parameters will become invalid.

**Note:** Please don't use this one if on point-to-point mode.

✓ If you need static IP, please input valid values for IP address, Subnet mask, Gateway, DNS address”

**IP ADDRESS:** Only if “ENABLE DHCP” is not ticked: Input your IP address

**SUBNET MASK:** Only if “ENABLE DHCP” is not ticked: Input your subnet mask

**GATEWAY:** Only if “ENABLE DHCP” is not ticked: input Gateway address

**DNS ADDRESS:** Only if “ENABLE DHCP” is not ticked: Input DNS server address

Transport protocol settings:

**TCP/UDP:** Protocol type has to be set. Can be TCP or UDP

**C/S MODE:** The values for C/S mode are SERVER or CLIENT. If CLIENT is chosen then the connected SERVER IP address or domain-name has to be set.

**ServerIP:** Only If C/S mode is Client, the connected SERVER IP address or domain-name has to be defined. The setting is invalid if C/S mode is SERVER.

**Port:** Input the port number. This port number you will need for application software ADSBScope or PlanePlotter. It is recommended to be greater than 1024.

**Advice:** When TCP/UDP is TCP, C/S mode is client, server IP address is the destination PC where the data to be send, IP address and port (port configure to be more than 1024)

Communication settings (Serial Configure):

**BaudRate:** 115200; **Checkbit:** none; **Datebit:** 8; **Stopbit:** 1; **DateLen:** 256; **DataTime:** 10;

**Note: Do not change these options, they are consistent with the output of ADS-B receiver.**

Login in parameters:

**UserName:** (default “admin”) You can set user name for login in the web interface based configuration

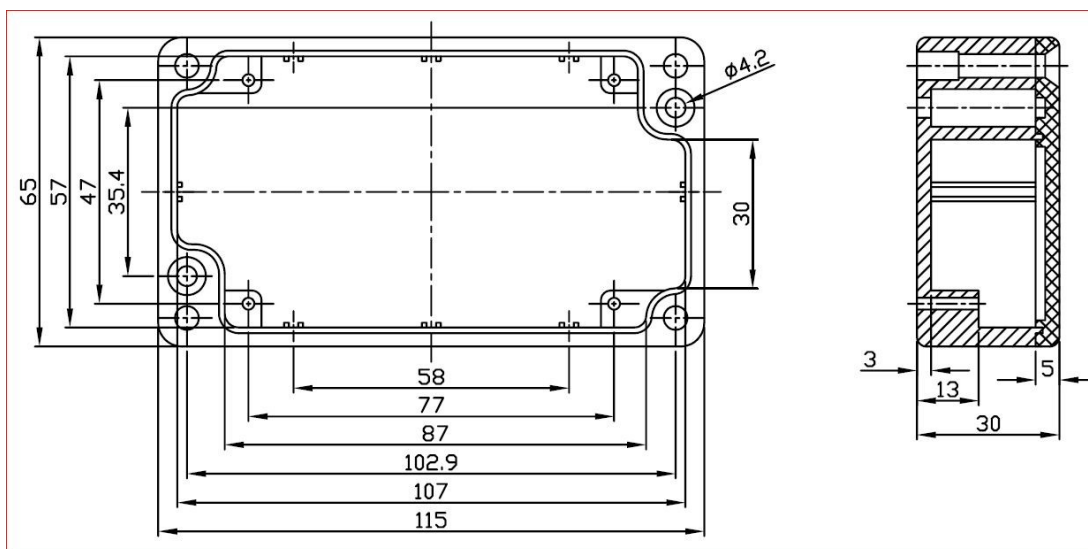
**PassWord:** (default “admin”) You can set password for login in the web interface based configuration

**Note:** Submit all parameters: Please, assure that all the parameters that have been set are valid and complete. If not – this can affect the module to work properly.

Finishing configuration: please press “save config” to save. After the configuration is set, the receiver has to be *powered off* and then *power on* again, the configure parameters will be saved and become valid. **If not power off and power on, the configuration will not take effect.**

## 10 Hardware Installation

The dimensions of the housing of the receiver are given on next Fig.7:



**Fig.7: Dimensions of microADSB-IP-WiFi receiver's enclosure**

Way of assembling the receiver to the antennas is shown on Fig.8.

**Note:** Mounting the antenna high and open space improves reception.



**Fig.8: Connecting the hardware**





**Fig.9: Inside view of microADSB-IP-WiFi BULLION receiver v.1**

Connection to the 1090MHz ADS-B antenna is realized with N male connector.

Connecting to WiFi antenna is through SMA female connector. (Note that it is **not** reverse polarity SMA, which is often used for WiFi)

The USB connection is USB 5 MINI PLUG on the PCB board and USB A male on the other side. The USB cable is used for carrying power supply in WiFi mode and for connecting to PC in USB mode. For powering the device a computer's USB port or the power supply adapter from the set can be used. The consumption of the receiver is **350mAh** at **5VDC**.

## **11 PC-Software**

There is a variety of software applications that can use the data from the receiver and visualize it (AVR format). Here we will explain how to get the receiver to work with two of the most popular programs: **ADSBScope** and **PlanePlotter**.

### **11.1 ADSBScope**

The software ADSBScope exchanges data via LAN or internet. AdsbScope is a Win32-application. It is developed and tested under Windows-XP, Win7 and Win8. To use it at Windows-Vista it may be necessary to use the compatibility mode of these operating systems.

#### **11.1.1 Installation**

The software is part of a CD. You can download the latest version from:

[http://www.sprut.de/electronic/pic/projekte/adsb/adsb\\_fix.zip](http://www.sprut.de/electronic/pic/projekte/adsb/adsb_fix.zip)

Create a directory and copy the software into this directory.

#### **11.1.2 Start the Software**

To start the software double-click the executable file:

adsbscope26f3\_256.exe. AdsbScope will open its program window centered at the monitor, check out the subdirectories and load some data files. If a default program state was saved, then this will be loaded, and

adsbScope will use the saved coordinates, zoom-value, window size and open street map background picture.

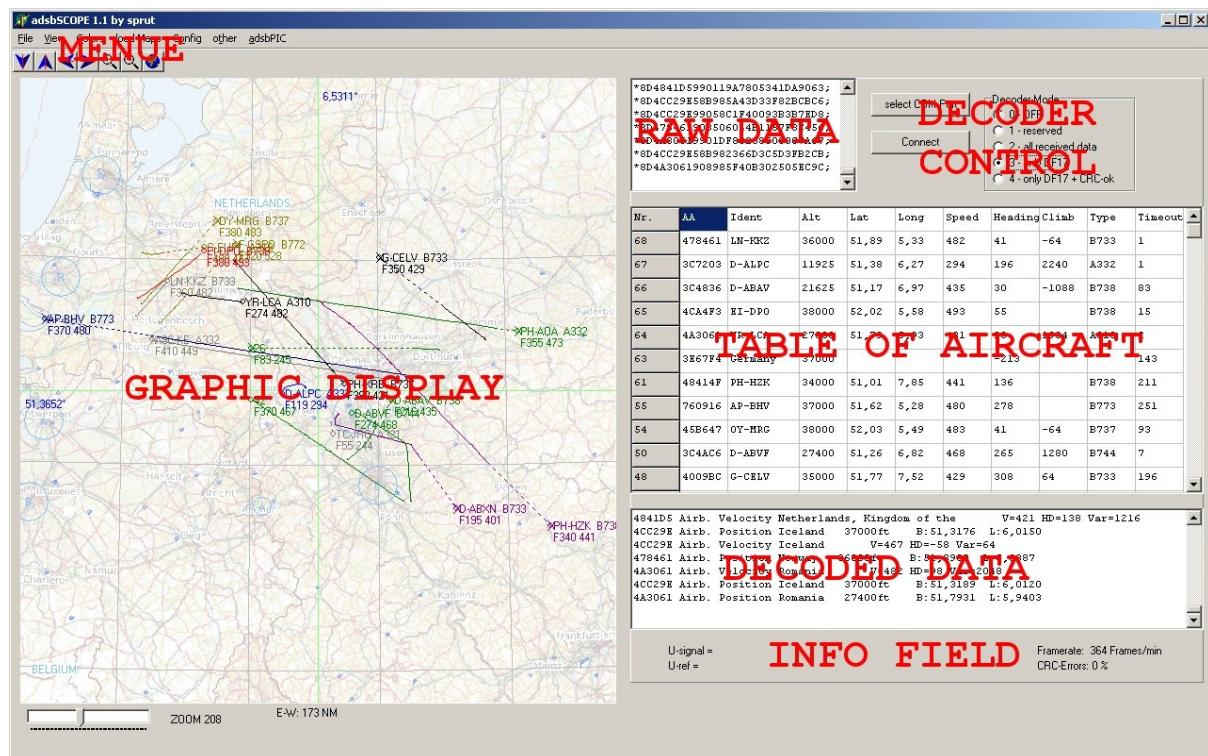


Fig.10: ADSBScope main window

The program window (Fig.10) contains:

- ✓ a menu to control the program
- ✓ a graphic display
- ✓ a text box for raw data
- ✓ a text box for decoded data
- ✓ a table for detected aircraft
- ✓ a decoder control area
- ✓ an information field

If no default program state is available, then it will use the starting position: 6 deg east 51 deg north (and no OSM picture) as start point.

Use the mouse to move to your home destination or load a program state with the coordinates of your home.

All incoming adsb-information is listed in the upper text box.

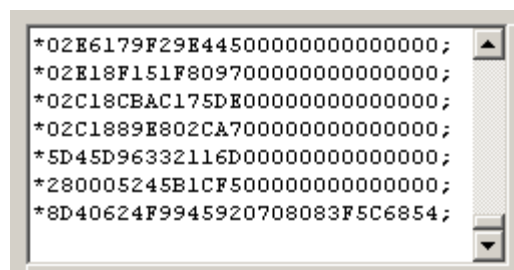


Fig.11: Typical RAW data

At high frame rates the RAW-data zips through this window to fast for the human eye (Fig.11). A simple mouse click on the window interrupts the list of RAW-data. A second click activates the list flow of data again. If the box has collected more then 20000 lines, then it will be erased to save memory space.



The decoded content of the information is listed in the lower text box. If the box has collected more then 20000 lines, then it will be erased to save memory space.

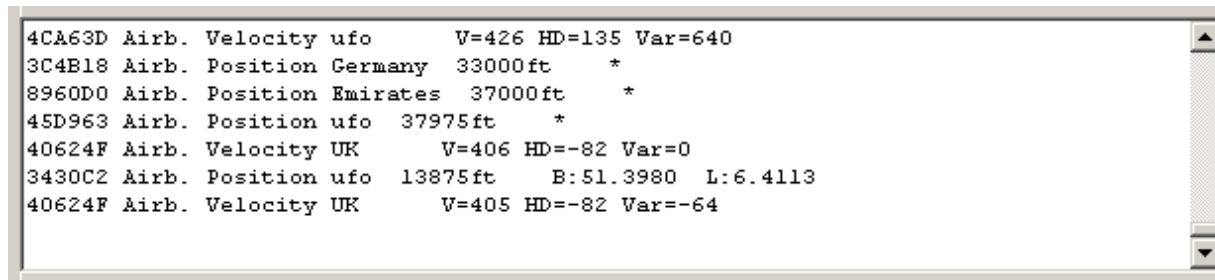


Fig.12: Typical decoded data

Data of detected aircraft is shown in the table between both text boxes.

The picture on the left side of the program window shows position, track history and additional information of aircraft with known position.

The software counts the number of ADS-B frames (data packets) per minute and displays it in the lower right corner of the program window and in the program status bar. Behind this value is shown (in parenthesis) the average number of frames received from one aircraft per minute.

### 11.1.3 Conect ADSBSCOPE to microADSB-IP-WiFi receiver

The software can distribute decoded data and received raw data via network/internet. The default network settings can be changed via the Network window. (Menu: **Other / Network / Network setting**). (Fig.13 and 14)

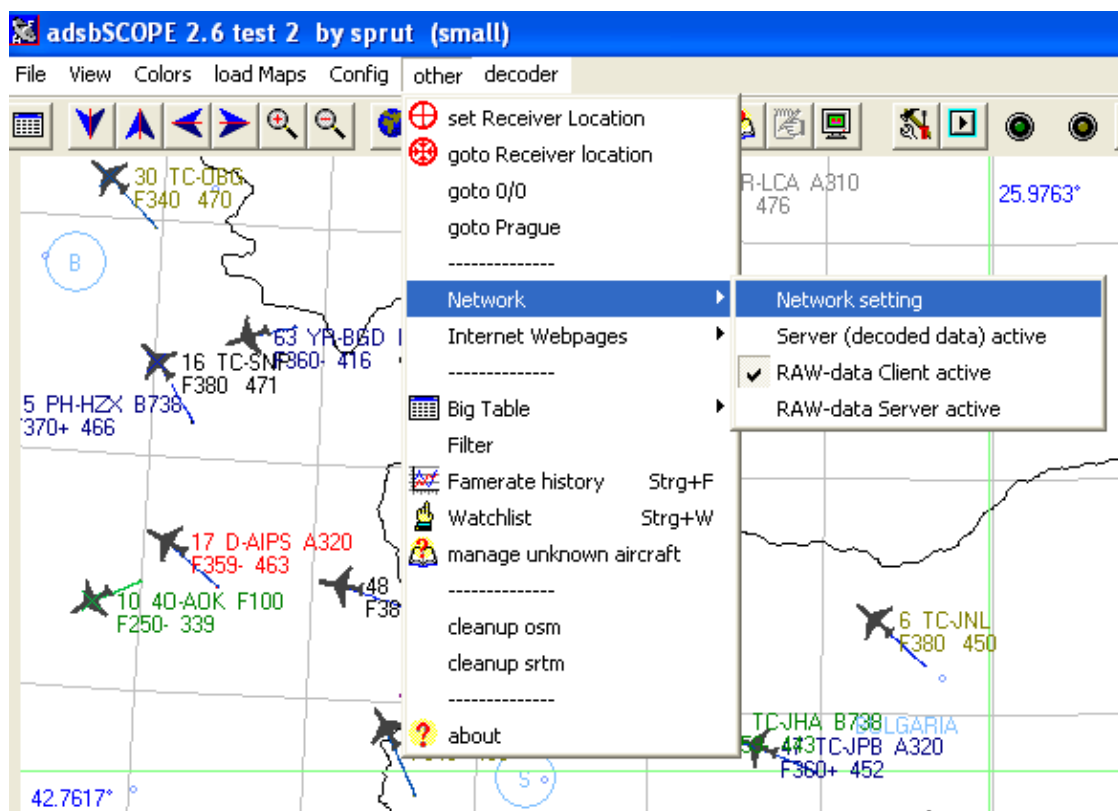


Fig.13: Network setting screen



Fig.14: Network setup

#### 11.1.4 RAW data Client

The software can receive raw decoder data via network. You can connect to an active RAW-data-server via the menu point **other / Network / RAW-data client active** or by a click on the grey **RAW-data Client** button right of the server buttons.

Of course you can choose any other RAW-data-server, e.g. receivers with adsbScope-Software. You can change the IP-address and the port number of the used RAW-data-server via the network-setup. Connections to other RAW-data servers have no time limit.

#### 11.1.5 Server (decoded data)

The software contains a server at port 30003. Via this server the received and decoded information can be forwarded to multiple clients.

The output format is (hopefully) compatible to RadarBox and SBS-Basestation. However, I was not able to test this in detail To start the server one can click the left of the both gray network-server-icons (right of the OSM icon). The server is started, a comment is written in the upper log-window and the icon gets colors. Now clients can connect the server at port 30003. To deactivate the server just click on the icon again.

To test the running server you can start your internet-browser on the same computer and type in <http://localhost/30003/>.

This server is enabled when sending data to Flightradar24. Description of how it works can be found at:

<http://www.flightradar24.com/software>

## 11.2 PlanePlotter

Since version 6.2.3.7x of the PlanePlotter is the possible inclusion of ADSB-IP receiver directly.

You can download the latest version from: <http://www.coaa.co.uk/planeplotter.htm>

To use the IP-receiver with Planeplotter as Mode-S-Receiver one has to choose **"AVR receiver TCP"**

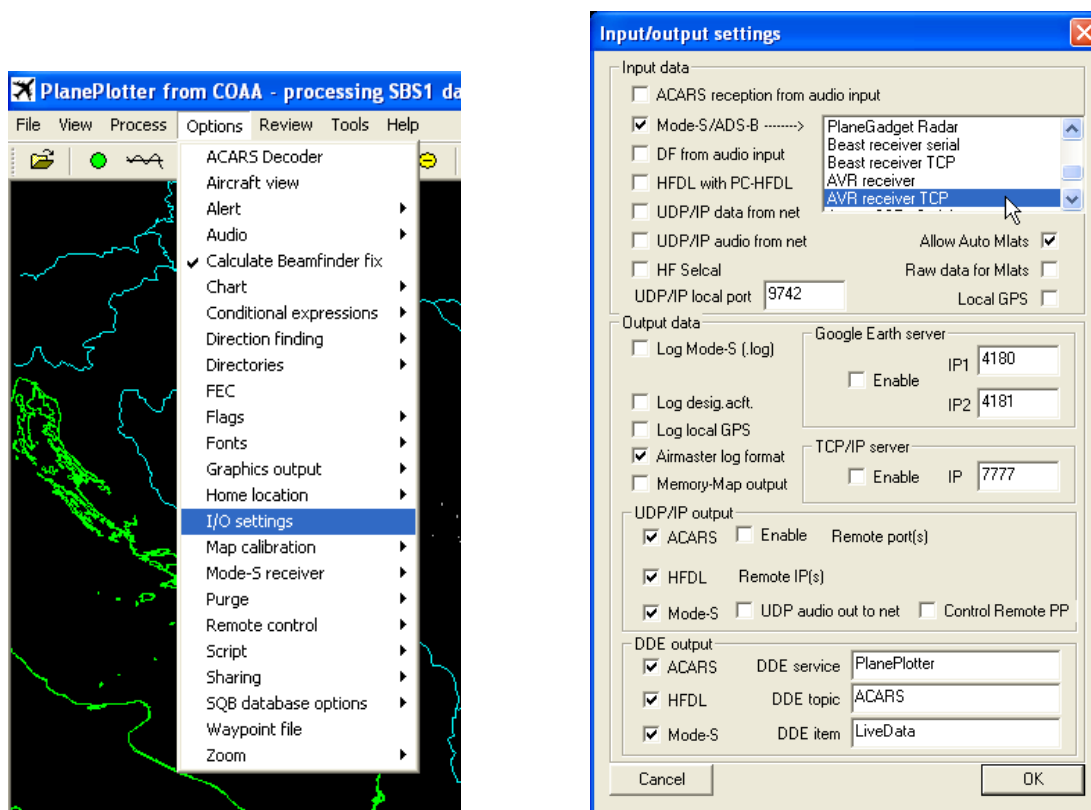


Fig.15: PlanePlotter Login Screen

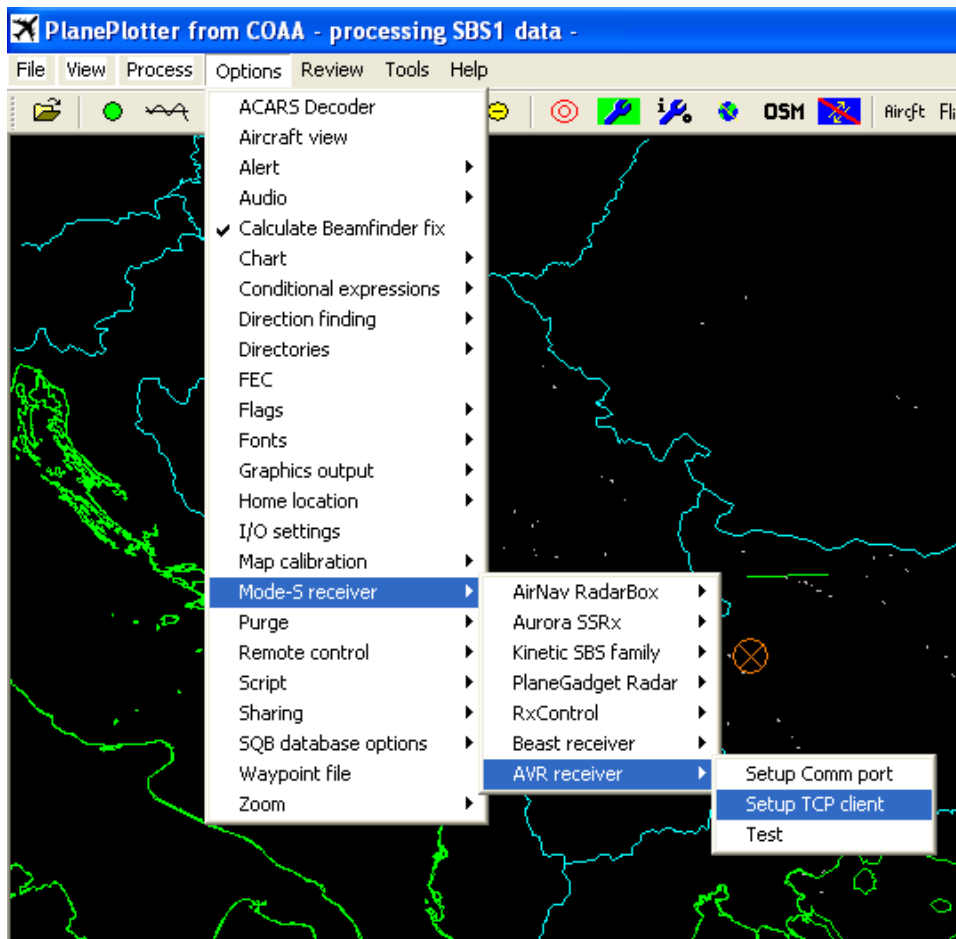


Fig.16: Login Screen

Select the **Mode-S receiver** the **AVR receiver** and **Setup TCP client**.

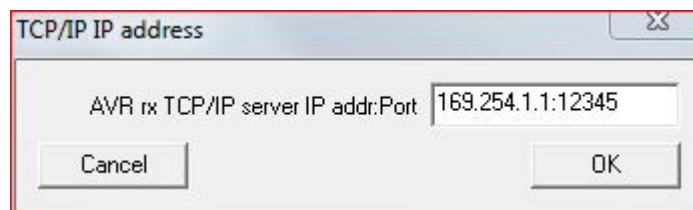


Fig.17: Login Screen

Enter the IP address and port of the receiver.

Activate the processing of the software with a click on the button with the **green** circle.

## 12 Glossary

### ADS-B

Automatic dependent surveillance-broadcast.

This is a cooperative surveillance technique for air traffic control. An ADS-B-equipped aircraft determines its own position and periodically broadcasts this position and other relevant information to potential ground stations and other aircraft with ADS-B-in equipment. (<http://en.wikipedia.org>)

**AVR**

This is a family of microcontrollers. (also known as Atmel-microcontrollers)  
Such microcontrollers are used in some decoders.

**Comparator**

It converts the analog video signal from the receiver into a digital video signal.

**Decoder**

Detects ADSB-data (frames) inside the digital video signal from the comparator and send it to the computer.

**DF**

This is the type of an ADS-B-frame.

**Frame**

ADSB-data is radiated in small packages. Such a package is called a frame. There are different types of frames radiated. The type is called DF (download format). The most valuable frame type is DF17, it contains aircraft coordinates.

Frames contain 56 bits (DF0 ... DF15) or 112 bits (DF16 ... DF31) of information. Every aircraft radiates some hundred frames per minute. Normally every flying aircraft radiates two DF17-frames per second.

**Knots**

Knots is the common unit to measure speed in aeronautic and shipping. One knot is equal to one nautical mile per hour or 1.8 kilometers per hour.

**NM**

Nautical miles (NM) is the common unit to measure distances in aeronautic and shipping. One NM is equal to 1.8 kilometers. One nautical mile is the length of one longitude-minute at the equator. Consequently the circumference of the earth is 21600 NM (360 x 60).

**OSM**

OSM stands for open street map. It's a free collaborative project to create detailed maps of the earth for free use.

**PWM**

Pulse Width Modulation is used in my decoder to generate a reference voltage for the comparator

**RAW-data**

This is the unprocessed data that the decoder delivers to the computer. Normally this is the received frame-data as text-strings.

**Receiver**

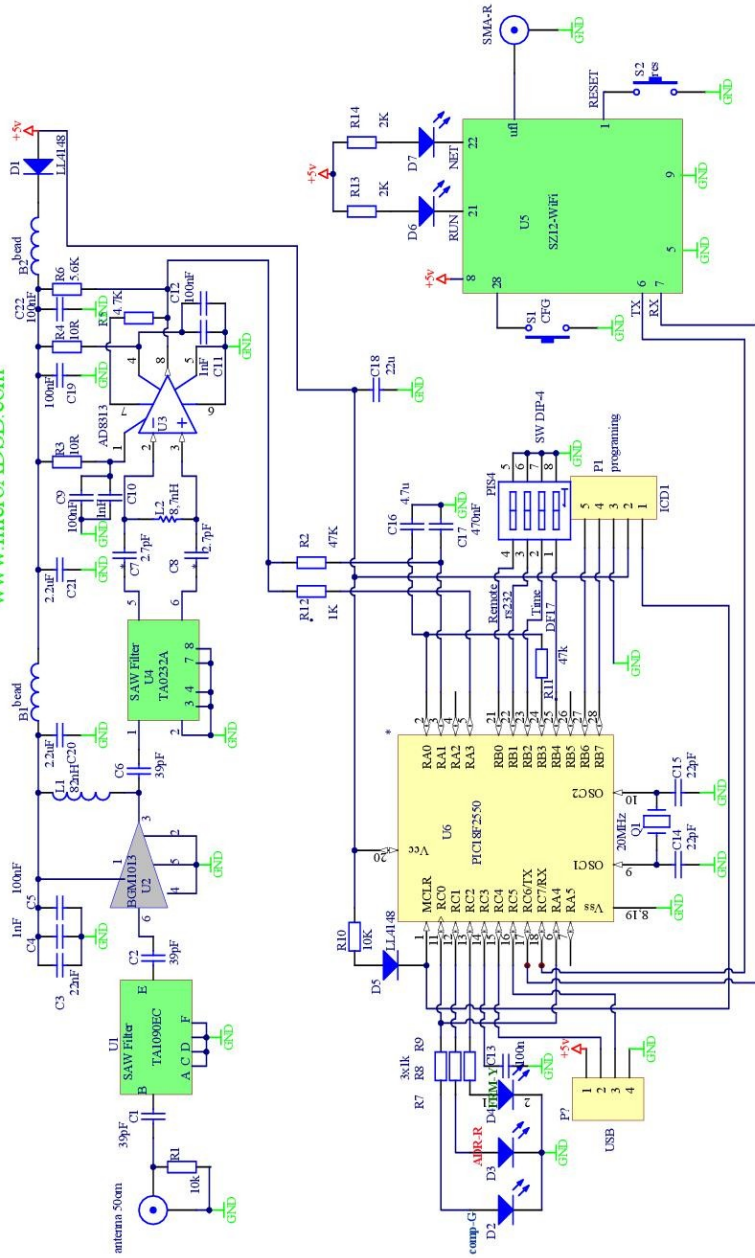
It converts the 1090 MHz-electric signal from the antenna into an analog video signal.

**TAG (timeTAG)**

Here: the precise time tags, which decoders can generate. It makes it possible to measure the time of arrival of every data-frame with a precision of fractions of microseconds

# micro ADSB-WiFi v1 receiver

www.microADSB.com



Title		ADS-B WiFi v1 LZ2RR	
Size	Number	Revision	
A4		BULLION	
Date:	5.5.2014	Sheet of	
File:	D:\0 PROJECTS\ADSB WiFi SCHED	Drawn By:	