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About microADSB-WiFi receiver

✓ Outdoor ADS-B receiver
✓ WiFi interface (IEEE802.11 b/g/n)
✓ Good coverage & redundancy
✓ At affordable price
✓ Up to 250 Nm range
✓ High accuracy independent of distance
✓ High update rate
✓ Provides identity of the aircraft
✓ Supports cockpit display of traffic information
✓ Metal box with very good seal (IP65) with through holes for mounting
✓ N male type coaxial connector for 1090 MHz antenna
✓ SMA rp coaxial connector for WiFi, 2,4 GHz antenna

Finally a quality virtual radar receiver at a price you can afford, priced 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 planes such as commercial airline flights carry equipment that transmits information over a system known as ADSB. 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 with ADSBScope or PlanePlotter software decodes this placing the aircraft on a map of your local area.

0 What is new in v.2 of microADSB-WiFi

MicroADSB-WiFi BULLION v.2 is a the latest model of the well known generation products of ANTEINI.NET Ltd. It is a wireless embedded device. The WIZFi 250 module is used to provide ADS-B interface for data transfer based on WIFI wireless network standards IEEE802.11b/g/n. The implemented wireless module allows users easily
to control, manage and set the microADSB receiver. New options of hardware reset are added. The device can be easily integrated in existing wireless network or used as a peer-to-peer connected device.

- New metal box with very good seal (IP65) with through holes for mounting.
- Replacing the switching regulators of supply with parametric regulator in order to reduce noise at the receiver. Supply voltage limited 7-9V, DC.
- ADS-B antenna connector (N male) is soldered directly to the board
- Ability to work in USB connection mode and firmware upgrade.

0.1 Features & Benefits of WIZFi 250:

- Single band 2.4GHz IEEE802.11b/g/n Wi-Fi module
- Integrated RF power amplifier : Antenna calibration is not required
- 1MB flash memory, 128KB SRAM, 1MB serial flash
- Low power consumption & excellent power management to extend battery life
- The highest compatibility with the most of APs
- Compact size, suitable for mobile or hand-held devices
- Host Interface : UART , SPI
- Support powerful web configuration
- Soft AP (Enough memory retention, L2 switching)
- OTA (Over the Air F/W Upgrading)
- Wi-Fi Direct

1 Terms Of Use:

We offer to your attention some of the open-sources that have inspired this project from my point of view. My 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://miniadsb.web99.de/
http://www.coaa.co.uk/planeplotter.htm

2 Introduction

This handbook is based on:
Decoder adsbPIC hardware with firmware version 14
An ADS-B -receiver system can be used as virtual radar to generate a live picture of the air traffic.
It consists from 5 stages:

1. Reception ADS-B antenna
2. 1090 MHz receiver
3. Decoder
4. TCP/IP interface and Wi-Fi
5. PC-software

![Fig.1 ADS-B receiver](image)

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.
4. The ADS-B signals are then forwarded to a PC via Wi-Fi ETHERNET connection.
5. The PC decodes the ADS-B information and generate the virtual radar display. It may support the exchange of ADSB-data via the internet.

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

### 3 Antenna 1090MHz
Vertical polarized antenna with 50 Ohm impedance, tuned to 1090 MHz, have to be used at the ADS-B side of the receiver.
Appropriate model offered by Anteni.Net Ltd is **MS10905**: outdoor, omni-directional, collinear, DC grounded, 5db gain ([www.microADSB.com](http://www.microADSB.com)).
* microADSB-WiFi v2 option 3 includes such antenna in the set
* microADSB-WiFi v2 option 2 DOES NOT include ADS-B antenna
The antenna has to be placed as high as possible at a location with a good ‘view’ into all directions.

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

![Decoder block diagram](image)

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 detects 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 wireless from the receiver to the network.

7 Switches

The decoder-layout has by default 4 switches to control the work of the decoder.

![Default setting of the 4-position switch](image)
Switch 4 - Remote control
If switch 4 is ON (and switch 3 OFF), then the decoder has to be remote controlled by the adsbScope software if you use a USB interface. The receiver works in USB mode (no data via WiFi). With USB cable connected to the 4 pin connector (shown on schematics in Chapter 13) the receiver works just as microADSB-USB receiver. In this mode the firmware of the receiver can be updated.
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.

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 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 open 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 1 - DF17
This switch has no function, if switch 4 is ON.
If switch 4 is OFF, then this switch 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.

8 TCP/IP and WiFi module
The received ADS-B messages are transferred by serial to the Wi-Fi TCP/IP converter by module: WiZFi -250-H
For more information, visit website at:


The integrated in microADSB-WiFi v2 module WiZFi 250 is an embedded device which provides for ADS-B data transfer based on WiFi wireless network standard. It integrates IEEE802.11b/g/n and TCP/IP protocol. It can easily make device access to wireless network.
The WizFi250 is a small size wireless module. The WizFi250 provides for the highest-level integration, featuring 802.11b/g and 802.11n. It includes a 2.4 GHz WLAN CMOS power amplifier (PA) that meets the output power requirements of most handheld systems. Along with the integrated power amplifier, the WizFi250 also includes integrated transmit and receive baluns, further reducing the overall solution cost. The small size & low profile physical design make it easier for system design to enable high performance wireless connectivity without space constrain. Hardware WAPI acceleration engine, AES, TKIP, WPA and WPA2 are supported to provide the latest security requirement on your network. For the software and driver development, WIZnet provides extensive technical document and reference software code for the system integration.

-Integrated RF power amplifier
-Supports wireless data rates up to 65Mbit/s
-1MB Flash Memory, 128KB SRAM, 1MB Serial Flash
-Supports per packet Rx Antenna diversity
-Low power consumption & excellent power management performance.
-Small size suitable for low volume system integration.
-Easy for integration into mobile and handheld device with flexible system configuration.
-2.412-2.484 GHz two SKUs for worldwide market.
-Lead Free design which supporting Green design requirement, RoHS Compliance.
-Device Package : 28×20 mm (17×20 mm)
-Serial Interface : UART, SPI
-Powerful Web server provides
-Soft AP
-Enough memory retention
-Wi-Fi Security (WEP, WPA/WPA2PSK)
-L2 Switching
-OTA(Over The Air F/W Upgrading)

9 Configuration

The WizFi250 module 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 need to choose)
- Defaulted TCP/UDP connection parameters:
  - Protocol type
  - Connection type
  - Destination address
  - Destination port
9.1 Buttons Description:

<table>
<thead>
<tr>
<th>RES WizFi250 Reset</th>
<th>Through this button, user can restart WizFi250 module.</th>
</tr>
</thead>
<tbody>
<tr>
<td>FUNCT - function</td>
<td>Through the function button, user can enter specific mode without AT commands:</td>
</tr>
<tr>
<td></td>
<td>• <strong>Factory Recovery</strong> : When doing Boot or Reset, press the button for over 3.5 seconds</td>
</tr>
<tr>
<td></td>
<td>• <strong>AP Mode</strong> : When module is working, press it once.</td>
</tr>
<tr>
<td></td>
<td>• <strong>OTA Mode</strong> : When module is working, press it twice.</td>
</tr>
<tr>
<td></td>
<td>• <strong>Factory Default</strong> : When module is working, press it three times.</td>
</tr>
</tbody>
</table>

9.2 LED Description:

<table>
<thead>
<tr>
<th>Mode LED</th>
<th>LOW(ON) : Data Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HIGH(OFF) : Command Mode</td>
</tr>
<tr>
<td>Wi-Fi LED</td>
<td>LOW(ON) : Wi-Fi is associated</td>
</tr>
<tr>
<td></td>
<td>HIGH(OFF) : Wi-Fi is not associated</td>
</tr>
</tbody>
</table>
9.3 Web parameters configuration

If the computer or the mobile device (tablet, phone, etc) supports WIFI, you can use the web interface to do the configuration:

- 1. Press the "Function Button" one time in order to run AP mode and launch the web server. If WizFi250 is changed to AP mode successfully, Wi-Fi LED will be on and you can see WizFi250's SSID by your PC. The SSID initially ends with the MAC address of the WizFi module.

![SSID of the receiver](image)

**Fig.5 SSID of the receiver**

<table>
<thead>
<tr>
<th>Default information of WizFi250 AP Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSID</td>
</tr>
<tr>
<td>Security</td>
</tr>
<tr>
<td>Security Key</td>
</tr>
<tr>
<td>IP Address</td>
</tr>
<tr>
<td>Gateway</td>
</tr>
</tbody>
</table>

- 2. Connect to WizFi250, using the default password (123456789) and WizFi250's IP address or URL (wizfi250.wiznet.com) in your web browser. After that input the user id and user password. (Default ID: admin, Default Password: admin)
Fig. 6 Login page

Fig. 7 WizFi250 configuration home page
Set AP Mode:

If you want to use AP Mode and TCP Server, you can select parameter as shown on picture. If you want to use TCP Server or UDP Server, you don’t need to input <Remote IP> and <Remote Port>.

Fig.8 Wireless mode set-up

If WizFi250 was set successfully, you will see the success message as below.

Fig.9 Success Setting Result

And after checking success result, click the <Next Step> button in order to move on to the next page. If wrong value was inputted, WizFi250 will return fail message like below.
On the next page, users can set AP information like SSID, Security, and Security Key value as below.

If it finishes successfully, the user will see the message as below.
Fig. 12 Success Setting AP values

To receive the data is necessary to set the network to the client computer:

Fig. 13 Client PC Settings
10 Installation

10.1 Mechanical installation

The dimensions of the mechanical housing of the receiver are given to you on the figure below:

Fig.14 Dimensions
Way of reassembling the receiver antennas is shown in the following figure: Mounting the antenna high and open space improves reception.

Fig. 15 Assembling
Fig.16 Assembling

At the receiver is mounted N-connector to connect the ADS-B antenna. Connecting to WiFi antenna is through SMA Rp connector. The microADSB-WiFi receiver v.2 has 2m long cable with 2,1mm plug at the end for 7-9 VDC power supply (adapter is not included in the set).

11 PC-Software

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

11.1 adsbScope

The software **AdsbScope** is exchange data via LAN or internet. AdsbScope is a Win32-application. It is developed and tested under Windows-XP and Win7. To use it at Windows-Vista or Windows 8 it may be necessary to use the compatibility mode of these operating systems.

11.1.1 Installation

The software is part of the included CD/DVD. 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 first copy the content of the resource CD/DVD to your HDD or Flash-Drive. Then double-click the executable file: CD\adsb_Scope\pc_software\adsbscope\27\adsbscope27_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.17 ADSBscope view

The program window 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.
At high frame rates the RAW-data zips through this window to fast for the human eye. A simple mouse click on the window interrupts the list of RAW-data. A second click activates the list 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.

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

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 receiver “BULLION”**

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. 19: Network setting Screen**

**Fig. 20 Network setup**

20
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.
If you want to receive raw data from the microADSB-WiFi v2 the values from Fig.20 has to be inputted.
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 hast to choose “AVR receiver TCP”.

. 
Fig. 21: Login Screen

Fig. 22: Login Screen

Select the **Mode-S receiver** the **AVR receiver** and **Setup TCP client**.
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- equipped. ([http://en.wikipedia.org](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**
ADS-B-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.

Miro