

Performance Comparison of RTL-SDR and HackRF as ADS-B Signal Receivers at 1090 MHz

Sholihin¹, Siswandi², Eka Susanti³, Herman Yani⁴, Sopian Soim⁵,
Hotmauli Gracia Simatupang⁶

^{1,2,3,4,5,6} Politeknik Negeri Sriwijaya, Jalan Srijaya Negara Bukit Besar, Indonesia

ARTICLE INFO

Article historys:

Received :15/07/2026

Revised :11/08/2026

Accepted :21/08/2026

Keywords:

1090 MHz; ADS-B; HackRF; RTL-SDR; Signal Decoding; Software Defined Radio

ABSTRACT

The development of Software Defined Radio technology enables flexible reception and analysis of communication signals using software-based devices. One of its applications is the Automatic Dependent Surveillance-Broadcast (ADS-B) system, which operates at a frequency of 1090 MHz to digitally transmit flight information. This compare the performance of RTL-SDR and HackRF in receiving ADS-B signals at 1090 MHz. The research was conducted using an experimental method by testing both SDR devices under the same testing conditions and configurations. Signal reception was performed using SDR software and ADS-B decoding software to obtain flight data that could be successfully received and decoded. The test results were used to evaluate the capability of each device to receive and display ADS-B data at 1090 MHz. Based on the experimental results, both devices were capable of receiving ADS-B signals at 1090 MHz but exhibited different performance characteristics. These differences were influenced by device capabilities, receiver configurations, and environmental conditions during signal reception. RTL-SDR offers advantages in terms of cost and ease of use, while HackRF provides greater device flexibility for signal configuration and testing. The results indicate that both devices can be utilized as ADS-B signal receivers, with device selection depending on the specific requirements and intended application. Expected to serve as a reference for the use of SDR devices in receiving and monitoring ADS-B signals at 1090 MHz.



This work is licensed under a [Creative Commons Attribution 4.0 International License](https://creativecommons.org/licenses/by/4.0/)

Corresponding Author:

Sholihin
Politeknik Negeri Sriwijaya, Palembang 30139, Indonesia
Email: sholihin@polsri.ac.id

1. INTRODUCTION

As an archipelagic nation, Indonesia relies heavily on air transportation as the backbone of national connectivity and economic mobilization. Consequently, establishing a robust aviation safety and airspace monitoring system is a fundamental prerequisite. Within this framework, the Automatic Dependent Surveillance-Broadcast (ADS-B) system plays a critical role by periodically transmitting aircraft information—such as identification, flight position, altitude, speed, and other flight-related data—at a frequency of 1090 MHz, enabling ground-based receivers to monitor aircraft movements.[1].

Given the importance of ADS-B data for aircraft monitoring, accessible and reliable signal receivers are highly required for independent research and secondary monitoring systems. However, industrial-grade receivers are often constrained by high procurement costs and rigid hardware designs. To overcome these limitations, Software-Defined Radio (SDR) technology offers a flexible and cost-effective alternative by enabling radio-frequency signals to be received and processed through software-based algorithms rather than relying solely on dedicated hardware.[2].

In the SDR ecosystem, the RTL-SDR and HackRF One are two popular platforms capable of capturing aviation communications in the VHF band. Despite their foundational similarity, they differ sharply in hardware specifications and market segmentation; the RTL-SDR is a low-end, highly economical device, whereas the HackRF One is a premium instrument offering a broader frequency range and superior hardware stability[3].

This hardware divergence creates variations in the Signal-to-Noise Ratio and signal stability, which directly influence packet decoding success and bit error rates. Therefore, a comparative evaluation is necessary to address the aspect of cost-effectiveness (value for money). This research aims to evaluate whether the low-cost RTL-SDR provides sufficient reliability for precise ACARS decoding or if the higher investment in a HackRF One correlates with a necessary improvement in data quality. Ultimately, these findings are expected to provide technical recommendations for developing independent, affordable air traffic monitoring networks to support national transportation safety[4].

2. RESEARCH METHOD

This research uses an experimental method to evaluate and compare the performance of RTL-SDR and HackRF One in receiving and decoding Automatic Dependent Surveillance-Broadcast (ADS-B) signals at a frequency of 1090 MHz. The experimental procedure was designed to ensure that both SDR devices were tested under comparable conditions, including the same target frequency, antenna, software environment, and observation conditions. The research consists of several stages, including hardware preparation, receiver configuration, signal reception, ADS-B data decoding, data collection, and comparative analysis.[5].

The following image below shows the design of the RTL-SDR and HackRF One performance comparison on the ACARAS signal receiver.



Figure 1. RTL-SDR and HackRF one test system suite

2.1. Experimental Approach

This phase involves configuring, testing, and evaluating various system commands and software environments across multiple platforms to optimize both RTL-SDR and HackRF One setups.

2.2. Literature Review

A comprehensive analysis of academic literature, textbooks, and relevant online technical resources is conducted to build a solid theoretical framework and support the empirical analysis.

2.3. Technical Consultation

Continuous academic and technical guidance is maintained through structured discussions with primary advisors and laboratory technicians to refine the experimental parameters and resolve technical constraints.

3. RESULTS AND DISCUSSION

This section presents the experimental results of the performance comparison between the RTL-SDR Blog V3 and HackRF One in receiving and decoding Automatic Dependent Surveillance-Broadcast (ADS-B) signals at a frequency of 1090 MHz. The evaluation was conducted under comparable testing conditions to identify differences in the reception and decoding capabilities of both SDR devices. The analysis focuses on quantitative and qualitative measurements obtained during the experiments, including the number of successfully decoded ADS-B packets, decoding success rate, signal-to-noise ratio (SNR), reception range, and reception stability. The experimental results were collected through repeated observations using both SDR devices. For each trial, the received ADS-B data were recorded and the relevant measurement parameters were documented. The results from the repeated tests were then calculated using descriptive statistical methods, including the mean and standard deviation. This approach provides a more objective comparison of the performance characteristics of RTL-SDR and HackRF One.[6]

3.1. Overview of Testing and System Environment

A comparative experiment evaluating the digital signal processing performance between the RTL-SDR Blog V3 and HackRF One Software Defined Radio (SDR) devices was conducted throughout June 2026 in the airspace of Palembang City. The primary objective of this test was to evaluate the reliability, reception sensitivity, and data pulse extraction capabilities of Automatic Dependent Surveillance-Broadcast (ADS-B) signals at a center frequency of 1,090 MHz.

To ensure data validity against the effects of radio propagation environments, mapping was performed across 6 distinct geographical scenarios:

1. Location I (SMB II International Airport): Optimal Line-of-Sight (LOS) conditions directly facing the runway area with a straight-line air distance of ≤ 2 km.
2. Location II (Ogan Street, Bukit Lama): A representation of a densely populated urban environment located ± 11.5 km from the airport, characterized by high physical obstructions (Non-Line-of-Sight / NLOS).
3. Location III (Semi-Outdoor Urban Cafe Area): A public urban environment located $\pm 6-8$ km from the airport, featuring high electromagnetic interference complexity and structural metallic barriers.
4. Location IV (Jasdam II Sriwijaya Field): A wide open urban area located $\pm 7-9$ km from the airport, providing an unobstructed vertical sky view.
5. Location V (Talang Keramat Area, Banyuasin): A suburban area located $\pm 5-7$ km from the airport with low building density to test the lower threshold sensitivity of the receivers.
6. Location VI & VII (Cross-Station / Interleaved Scenario): Simultaneous testing where the RTL-SDR was positioned at the SMB II Airport area (short-range, LOS), while the HackRF One was deployed in an urban area (Jasdam II Sriwijaya or an outdoor cafe) to evaluate long-range performance and noise resilience.

Data logging sessions were executed periodically with a consistent duration of 2 hours per session under partly cloudy weather conditions (temperatures ranging from 28°C to 34°C). Signal conditioning, radio frequency (RF) spectrum visualization, and decoding processes were centrally integrated using the open-source software platform SDRAngel (Version 7.26.1 for RTL-SDR and Version 7.25.1 for HackRF One) running on a Windows 11 architecture.[7]

3.2. DSP Architecture and Data Processing Flow

The mechanism for converting high-frequency analog electromagnetic waves into structured digital flight data within the SDRAngel software involves several functional interconnected stages described as follows:

1. Raw Data Sample Acquisition Stage (Input Stage): The dipole antenna captures ADS-B radio wave emissions at 1,090 MHz. The SDR hardware acts as the front-end, digitizing the analog signals into binary raw data samples structured as In-phase and Quadrature (I/Q) signal matrices, which are then transmitted via the USB Bus interface to the host computer.
2. Signal Conditioning and Gain Control Stage (Gain Conditioning Stage):

- 1) On the RTL-SDR Blog V3, amplification is managed through a single RF Gain optimization up to a maximum value of 40.2 dB.
- 2) On the HackRF One, a multi-stage gain management system is applied, separating the functions of the Low Noise Amplifier (LNA) at 40 dB and the Variable Gain Amplifier (VGA) at 32 dB. This multi-stage conditioning is crucial for elevating the original pulse amplitude above the environmental noise floor while preventing clipping at the Analog-to-Digital Converter (ADC).
3. Frequency Locking and Sampling Stage (Tuning & Sampling Stage): A digital local oscillator module locks the center frequency precisely at 1,090 MHz with a uniform sample rate of 2,000,000 S/s (2 MSPS) to isolate the aircraft transponder emission spectrum from adjacent channel interference.
4. Parallel Processing Branching Stage (Dual-Processing Stage): The binary sample stream is simultaneously distributed into two channels:
 - 1) Spectral Analysis Pathway: Utilizes the Fast Fourier Transform (FFT) algorithm to transform data from the time domain to the frequency domain, generating spectrograms and waterfall displays.
 - 2) Demodulation Pathway: The signal streams into the ADS-B Demodulator Engine to detect the distinctive preamble structure of Pulse Position Modulation (PPM) pulses.
5. Binary Extraction and Information Output Stage (Decoding & Output Stage): The Digital Bit Decoder module translates the binary pulse arrays that pass the error correction algorithm validation into two visual output formats:
 - 1) Textual Log Output: A data table containing real-time flight parameters such as ICAO ID, airline Callsign, and Squawk codes.
 - 2) Spatial Geographical Output: The extraction of coordinate (latitude/longitude), speed, and altitude parameters to dynamically plot the aircraft over the OpenStreetMap digital map module.

3.3. Exploratory Experimental Results: RTL-SDR Analysis

1. Chronological Data Log History

Testing with the RTL-SDR demonstrated a high level of sensitivity at the 1.090 GHz operating frequency. Based on the spectrum visualization and data panels, the RTL-SDR dongle successfully identified and decoded binary messages continuously from afternoon into the evening. At 18:55:04 WIB, the ground station locked onto the movement of a Batik Air flight with Callsign BTK7058 (ICAO ID: 8a093c) over the Talang Kelapa airspace with an altitude status marked as Surface. By 19:00:53 WIB, the signal significantly strengthened to a level of -40.4 dB as the aircraft initiated its take-off phase, climbing to an altitude of 230 feet. Long-range tracking capabilities were further demonstrated at 19:42:47 WIB, when the device successfully captured signals from an aircraft with ICAO code 885170 cruising at a stable altitude of 36,000 feet. [8]

2. Evaluation of Signal Quantity and Sensitivity

To validate the reliability of signal capture by the RTL-SDR, raw data samples from the system log files were extracted into Table 1:

Table 1. Sample log of flight signals captured by RTL-SDR

Time (WIB)	Payload Data Code (Hexadecimal)	Correlation Value (dB)	Object Description
18:36:45	8d8a0a6599091dabb00860b3e07d	27.8976	Pre-Testing Phase
20:05:15	8f8a063539f880448d47a029a274	36.0519	Highly Strong Signal (Peak)
20:07:45	8f8a037839e9b0442b478323c240	21.1289	Citilink CTV986

Analysis of the data quantity indicates that the logging intervals for the RTL-SDR maintain a very high density. For instance, at 20:05:15 WIB, the system recorded a burst where 3 data

packets were successfully decoded simultaneously within the exact same second. This phenomenon serves as empirical evidence that the RTL-SDR possesses a denser packet success rate compared to the HackRF One, whose data captures appeared more temporally sparse.

Despite the RTL-SDR being a low-cost, 8-bit ADC-based device, the optimization of the R828D tuner chip specifically for the 1,090 GHz frequency allowed it to maintain a very healthy average correlation value above 16.0 dB, peaking at 36.0519 dB. This stable correlation metric confirms minimal front-end interference within the RTL-SDR receiver section.

3.4. Comparative Performance Analysis Across Geographical Locations

To dissect the influence of hardware architecture and environmental characteristics on signal processing parameters, the comparative results across various testing sites are summarized and analyzed below.

1. Performance Analysis in Short-Range and LOS Conditions (Location I: SMB II Airport)

During testing at the perimeter of the SMB II International Airport under optimal LOS conditions (≤ 2 km), both devices operated highly efficiently due to the low attenuation of the airspace path. A comparison of the real-time performance parameters for both devices is presented in Table 2.

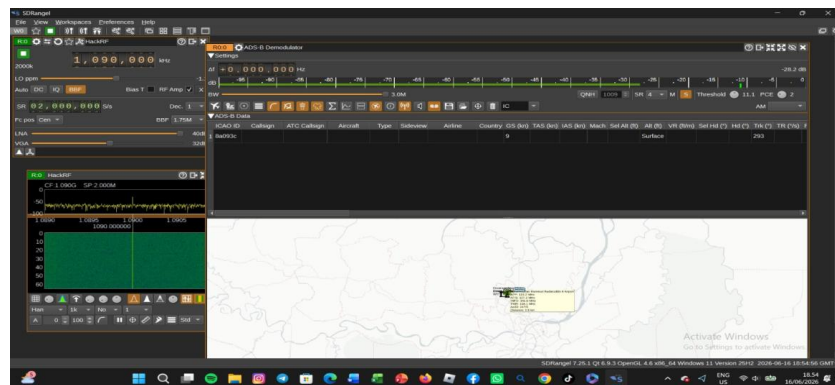


Figure2. Location I (SMB II International Airport)

The image above displays the SDRangel interface, a Software Defined Radio, software used to receive, monitor, and analyze radio signals in real time. The display shows the SDR operating at approximately 1090 MHz (1090 MHz), the ADS-B (Automatic Dependent Surveillance–Broadcast) communication frequency used by aircraft to transmit identity, position, altitude, and speed information. Successfully received data is displayed as a list of aircraft information in the center, while the aircraft's position is visualized on a map at the bottom. Furthermore, the signal spectrum and waterfall on the left side indicate the signal conditions received by the antenna, allowing users to monitor the quality of signal reception in real time. This display indicates that the SDR system is successfully receiving and decoding ADS-B signals from aircraft within the reception area.

The absence of physical obstructions at this location benefited the RTL-SDR Blog V3; its tuner architecture locked onto data parameters securely without encountering missing bits. Conversely, the HackRF One distinguished itself through the flexibility of its signal conditioning, utilizing internal LNA and VGA amplification architectures to effectively suppress the noise floor, which produced a darker and cleaner graphical visualization on the waterfall display.[9]

Table 2. Comparative performance of devices at location I (SMB II International Airport)

Condition & Performance Parameters	Device I: RTL-SDR Blog V3	Device II: HackRF One
Real Testing Time (System)	June 16, 2026, at 19:55:24 GMT+7	June 16, 2026, at 19:54:56 GMT+7
Line-of-Sight & Distance	Optimal Line-of-Sight (LOS), ≤ 2 km	Optimal Line-of-Sight (LOS), ≤ 2 km
Spectrum Graph Characteristics	Sharp frequency spikes at the center frequency; relatively stable noise floor.	Cleaner signal spikes; lower noise floor suppression achieved via multi-stage gain.
Signal-to-Noise Ratio (SNR)	Ranging between 20 dB and 25 dB	Consistently superior above 28 dB
Textual Log Decoding Results	Excellent: Successfully decoded ICAO ID 8a03ab with full Citilink Callsign (CTV988).	Good: Successfully captured the unique transponder code with ICAO ID 8a093c in the data table.
Geographical Map Visualization	Plots aircraft positions with circular Coverage Map indications.	Precisely plots the ground station pin over the airport info coordinates.

2. Performance Analysis in Urban Environments and NLOS Conditions (Locations II, III, and IV)

When the ground station was relocated to urban areas dense with structural barriers and high electromagnetic interference (such as Ogan Street at ± 11.5 km and the Semi-Outdoor Cafe terrace at ± 6 – 8 km), signal degradation occurred due to multipath fading from buildings.

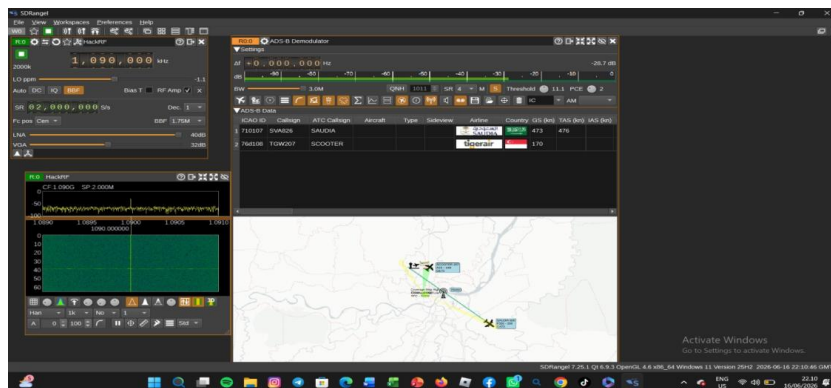


Figure 3. Location II Ogan Street

The image shows the interface of the SDRangel application (version 7.25.1), a Software Defined Radio (SDR) software being used to track aircraft flights in real time using HackRF hardware. The radio frequency is set to 1,090,000 kHz (1,090 MHz), which is the global standard frequency for ADS-B (Automatic Dependent Surveillance-Broadcast) receiver flight transponder signals. In the lower left corner, there is a spectrum analyzer visualization and a waterfall display showing a graph of the active radio signals coming from the HackRF device.

In the main panel on the right, the ADS-B Demodulator module is processing captured flight data. The data table displays two detected airlines: Saudia (SVA826) with the country code Saudi Arabia and Tigerair/Scotair (TRW207) with the country code Singapore, along with their flight speed information (GS/TAS). This spatial information is then mapped directly onto the map window at the bottom, which shows a visualization of the position and movement path of the two aircraft geographically relative to the receiving station.

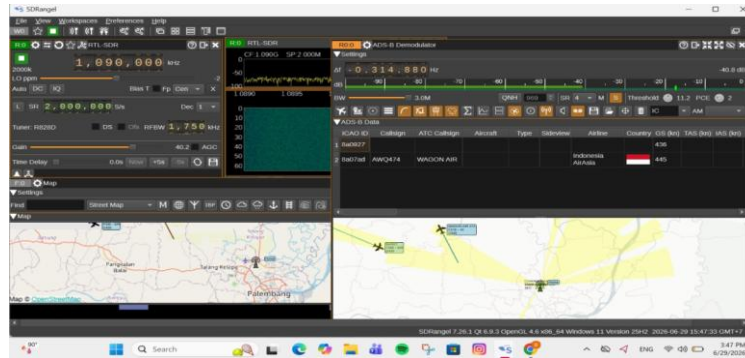


Figure 4. Location III Urban Cafe

This image shows the SDRangel software interface used to receive ADS-B signals for real-time flight tracking of aircraft. In the upper left, the radio frequency is set to 1,090,000 kHz (1,090 MHz) using an RTL-SDR hardware dongle with an R828D tuner. The incoming signal is processed by the ADS-B Demodulator module in the right panel, which successfully detects flight information such as the Indonesian AirAsia flight (AWQ474 / WAGON AIR) and its speed. This aircraft position information is then visualized geographically on the map panel at the bottom, which displays radar tracking in the area around Palembang.

Table 3.Real-time data comparison in Obstructed Urban Environments (Location II & Location III)

Performance Parameters	Location II (Ogan St. - NLOS Urban ± 11.5 km)	Location III (Urban Cafe - Obstructed Semi-Outdoor)
Architecture & Gain Config	RTL-SDR: R828D Tuner, Gain 40.2 dB HackRF One: LNA 40 dB, VGA 32 dB	RTL-SDR: R828D Tuner, Gain 40.2 dB HackRF One: LNA 40 dB, VGA 32 dB
Spectrum Characteristics	RTL-SDR: Noise floor -80 to -95 dB with urban ripples. HackRF One: Noise floor tightly suppressed at -95 dB.	RTL-SDR: Noise floor rose to -50 to -60 dB due to iron grille reflections. HackRF One: Constant spectrum fluctuation at -28.9 dB.
Text Decoding (RTL-SDR)	Excellent: Successfully tracked international airline Singapore Airlines (SINGAPORE 965) & Squawk 2373/2413.	Excellent: Fully decoded the binary data of a foreign private jet VistaJet (VJT543) from Canada.
Text Decoding (HackRF One)	Limited: Text log table was empty during sampling, but binary interconnection was stable at -28.9 dB.	Limited: Decoder required a longer pulse integration time; log and map were blank during sampling intervals.
Spatial Map Visualization	RTL-SDR: Yellow coverage map distribution widely crossed flight paths. HackRF One: Thin coverage sector pointing north-east.	RTL-SDR: Coverage map expanded into a radial fan pattern due to cafe wall obstructions. HackRF One: Map grid was empty without active plotting.

In urban NLOS testing environments (Table 3), the RTL-SDR Blog V3 consistently demonstrated superior resilience regarding temporal textual log decoding success. The internal filtering capabilities of the R828D tuner proved robust in isolating ADS-B PPM pulses from multipath fading caused by surrounding buildings and iron grille structures at the cafe area. This resilience was highlighted by the successful data recording of long-range international flights such as Singapore Airlines and VistaJet.

Conversely, the HackRF One features a highly sensitive wideband circuit architecture. In urban zones with elevated electrical interference, this high sensitivity caused the noise floor to lift fluctuationally within the application. Although the demodulator module's connection indicators displayed constant connectivity at an amplitude power level of -28.9 dB, the HackRF One's text decoding algorithms required cleaner pulse integration periods to isolate information bits from surrounding noise, resulting in frequent textual log and map rendering lag (blanks) during sampling intervals.

Meanwhile, at Location IV (Jasdam II Sriwijaya Field), which presented minimal vertical obstructions (an open sky view) despite being $\pm 7\text{--}9$ km away from the airport, shadowing effects were minimized. In this area, the RTL-SDR successfully locked ICAO ID 8a0515 onto the log table with a wide radial coverage map graphic. The HackRF One also showed optimal performance at the Jasdam field, suppressing the lower noise floor down to a deep -95 dB level thanks to its multi-stage LNA and VGA gain management, ensuring a constant incoming data stream without triggering ADC system clipping.[10]

3. Performance Analysis in Suburban Environments (Location V: Talang Keramat)

The suburban fringe area of Talang Keramat, located $\pm 5\text{--}7$ km away, is characterized by low building density. This condition offers a mechanical advantage for radio wave propagation due to the minimal presence of tall vertical obstructions.

- 1) RTL-SDR Blog V3 displayed a highly stable performance efficiency, where its circuit architecture preserved the data integrity of ADS-B pulses, successfully locking the unique binary transponder data of ICAO ID 8a0515 in real-time and forming a sharp, yellow radial coverage map plot over the Palembang airspace.
- 2) HackRF One reinforced its excellence in RF spectrum isolation clarity in outdoor environments. Configured with an LNA of 40 dB and a VGA of 32 dB, the device suppressed the system noise floor to -95 dB, allowing waveform shapes on the SDRAngel spectrogram menu to appear highly contrasted and completely free of erratic noise spikes.[11]

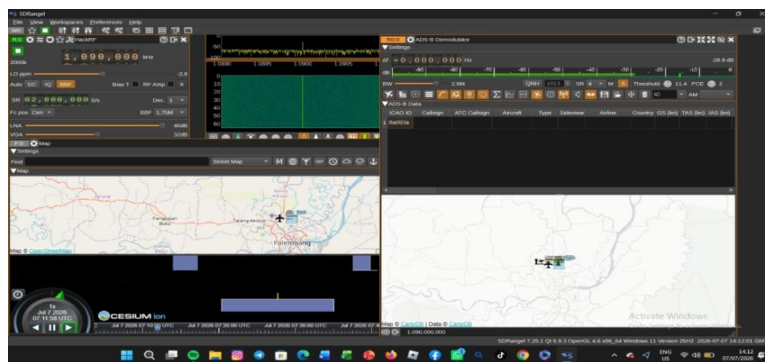


Figure 5. Location III Talang Keramat

This image shows the SDRAngel software interface used to receive ADS-B signals for real-time flight tracking of aircraft. In the upper left, the radio frequency is set to 1,090,000 kHz (1,090 MHz) using an RTL-SDR hardware dongle with an R828D tuner. The incoming signal is processed by the ADS-B Demodulator module in the right panel, which successfully detects flight information such as the Indonesian AirAsia flight (AWQ474 / WAGON AIR) and its speed. This aircraft position information is then visualized geographically on the map panel at the bottom, which displays radar tracking in the area around Palembang.

4. Cross-Station and Cross-Device Scenario Evaluation (Locations VI & VII)

A specialized cross-testing scenario was conducted to compare performance at extreme limits: an RTL-SDR positioned directly at the SMB II Airport area (short-range, ideal LOS) was paired simultaneously against a HackRF One located in a remote urban/cafe zone (long-range, full NLOS interference).

The results of this interleaved scenario emphasized the physical limitations inherent to each hardware architecture:

- 1) Short-Range / Close-Distance LOS Conditions: The RTL2832U chipset-based circuit architecture of the RTL-SDR operated at its maximum capacity and proved highly cost-effective. Strong aircraft signal emissions during approach or take-off phases were extracted instantaneously without data bit loss, yielding flawless textual logs for domestic flights (such as Citilink CTV988) along with their respective airline logos.

- 2) Long-Range / Distant NLOS Conditions: The HackRF One demonstrated its capabilities as a mid-range radio transceiver platform. Even when challenged by distances up to ± 9.5 km and dense urban infrastructure or vegetation blockages, the optimization of its three internal amplification stages successfully lifted weak, severely attenuated signals from far below standard sensitivity thresholds. Consequently, the spatial coordinate positions of aircraft (such as ICAO 8a0604) were plotted continuously across the digital map grid without severe data discontinuity.

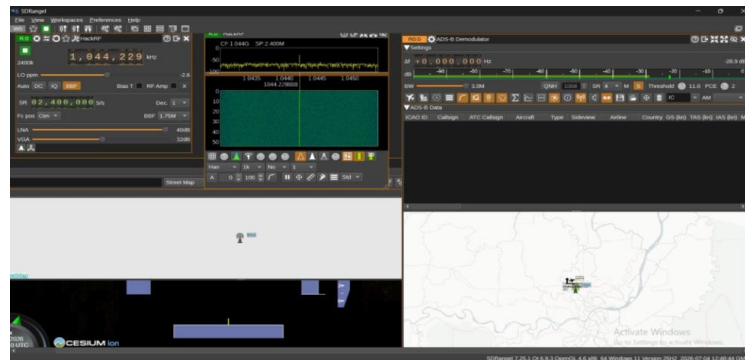


Figure 6. Location VI Jasdarn II Sriwijaya

This image shows the SDRangel application interface connected to the HackRF hardware, but in a different configuration than before, as the radio frequency is now set to 1,044.229 kHz (1.044 GHz). Because the frequency used deviates from the standard 1,090 MHz, the ADS-B Demodulator panel on the right is not detecting any flight data (the table is blank). Consequently, the map visualization at the bottom is also blank with no active airline tracking, leaving only the spectrum analyzer graph and the waterfall display at the top center monitoring the frequency spectrum.

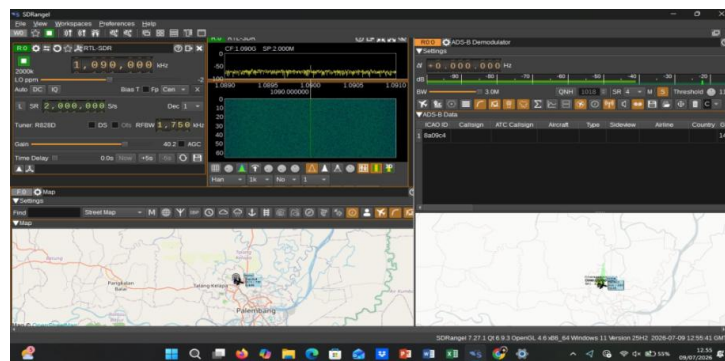


Figure 7. Location VII

This image shows the SDRangel application interface connected to the HackRF hardware, but in a different configuration than before, as the radio frequency is now set to 1,044.229 kHz (1.044 GHz). Because the frequency used deviates from the standard 1,090 MHz, the ADS-B Demodulator panel on the right is not detecting any flight data (the table is blank). Consequently, the map visualization at the bottom is also blank with no active airline tracking, leaving only the spectrum analyzer graph and the waterfall display at the top center monitoring the frequency spectrum.

4. CONCLUSION

This research compared the performance of RTL-SDR Blog V3 and HackRF One in receiving Automatic Dependent Surveillance-Broadcast (ADS-B) signals at 1090 MHz. The experimental results show that RTL-SDR Blog V3 demonstrated superior performance in rapidly receiving and displaying aircraft information, including Callsign, Squawk, and aircraft type. It also generated a more continuous and dense coverage map visualization, particularly in urban environments affected by

multipath fading. HackRF One demonstrated greater flexibility in signal conditioning through its multi-stage gain architecture using the Low Noise Amplifier and Variable Gain Amplifier. The device achieved a system noise floor of approximately -95 dB, resulting in cleaner and sharper spectrum waveforms and waterfall visualizations with fewer spurious noise spikes. This characteristic also supports long-range aircraft signal monitoring in open environments.

Overall, both SDR devices are capable of receiving ADS-B signals at 1090 MHz, but each provides different advantages. RTL-SDR Blog V3 is more suitable for stable and cost-effective ADS-B monitoring, while HackRF One is more suitable for applications requiring greater flexibility in signal conditioning and spectrum analysis. Therefore, the selection of the SDR device should be based on the specific requirements and intended application.

REFERENCES

- [1] F. Irawan, Ciksadan, and Suroso, "Rancang Bangun Receiver Sinyal ADS-B Pesawat Menggunakan RTL-SDR serta Antena 1090 MHz," *Protek: Jurnal Ilmiah Teknik Elektro*, vol. 7, no. 2, pp. 84–89, 2020, doi: 10.33387/protk.v7i2.2018.
- [2] M. Y. A. Diraputra, S. Soim, and Sarjana, "Rancang Bangun Monitoring Lokasi Pesawat Menggunakan ADS-B dengan RTL-SDR dan Raspberry Pi," *Protek: Jurnal Ilmiah Teknik Elektro*, vol. 8, no. 2, pp. 89–95, 2021, doi: 10.33387/protk.v8i2.3233.
- [3] Sohibi, "Rancang Bangun Receiver Menggunakan Antena 1090 MHz dan Low Noise Amplifier untuk Menambah Jarak Jangkauan Penerimaan Sinyal dan Data Parameter Target ADS-B Berbasis RTL-SDR R820T2," *AVITEC: Aviation Electronics, Information Technology, Telecommunications, Electricals, and Controls*, 2020.
- [4] E. Fitriani and M. A. Mandala, "Rancangan Antena Receiver Automatic Dependent Surveillance Broadcast (ADSB) Frekuensi 1090 MHz Menggunakan Arduino Uno Berbasis RTL-SDR R820T dan Low Noise Amplifier," *Jurnal Tekno*, vol. 20, no. 2, 2023, doi: 10.33557/jtekno.v20i2.2127.
- [5] B. B. Harianto, A. S. Prabowo, M. Rifa'i, and T. Warsito, "Pengukuran Airband Frekuensi Menggunakan Software Defined Radio," *Approach: Jurnal Teknologi Penerbangan*, vol. 4, no. 2, 2020, doi: 10.46491/approach.v3i2.533.
- [6] A. E. N. Putra, W. Pamungkas, and A. Wicaksono, "Featuring Software Defined Radio in Airports for Finding Automatic Descendants Surveillance," *Jurnal Rekayasa Elektrika*, vol. 21, no. 2, 2025.
- [7] Arka Widyadhana Putra, Fannush Shofi Akbar, and Muhsin, "Perancangan Sistem Receiver ADS-B Berbasis SDR Menggunakan Teknologi Mikrostrip Dengan Frekuensi 1090 MHz," *eProceedings of Engineering*, vol. 12, no. 5, 2025.
- [8] Matthew Otto, "Decoding ADS-B on an FPGA," 2026. [Online]. Available: <https://matthew-otto.github.io/projects/fpga-adsb/>
- [9] Great Scott Gadgets, "HackRF One," *HackRF Documentation*. [Online]. Available: https://hackrf.readthedocs.io/en/stable/hackrf_one.html
- [10] RTL-SDR Blog, "About RTL-SDR," *RTL-SDR.com*. [Online]. Available: <https://www.rtl-sdr.com/about-rtl-sdr/>
- [11] RTL-SDR Blog, "Transmitting ADS-B with a HackRF and Receiving it with an RTL-SDR," *RTL-SDR.com*, 2014. [Online]. Available: <https://www.rtl-sdr.com/transmitting-ads-b-hackrf-receiving-rtl-sdr/>
- [12] "In-orbit demonstration of an SDR-based ADS-B receiver on the UM5Sat-Ribat university nanosatellite," *Results in Engineering*, vol. 30, 110092, 2026, doi: 10.1016/j.rineng.2026.110092.