

Enabling Airspace Awareness: Dual-Band ADS-B Passive Reception for Drones



Abstract

This application note explores the technical implementation of miniature, dual-band ADS-B receivers, focusing on low-power, software defined radio (SDR) architectures to enable drones to maintain situational awareness without compromising flight endurance or hardware complexity.

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1 Introduction

As the density of drones that can fly beyond visual line of sight (BVLOS) increases within shared airspace of manned aircraft, the necessity for “Sense and Avoid” technology has moved from a discretionary feature to a regulatory requirement under the proposed FAA Part 108. To provide collision avoidance, between unmanned drones and manned aviation, drones must possess the ability to detect and interpret the movements of nearby aircraft. Because manned aircraft already broadcast ADS-B signals, drones can leverage reception of the ADS-B signals to meet the new regulatory requirements.

2 The Dual-Band Requirement: 978MHz and 1090MHz

Effective airspace integration requires more than a single-band receiver. The current aviation landscape relies on two distinct frequency standards to broadcast positional data: 1090 MHz Extended Squitter (1090ES) and UAT. The 1090ES is the global standard used by commercial airliners and high-altitude aircraft, providing long-range data for large scale traffic management. Additionally, the 978MHz frequency, often referred to as universal access transceiver (UAT), is optimized for general aviation and lower-altitude operations. For a drone to be truly “airspace aware,” in the U.S., the onboard systems of the drone must be capable of monitoring both bands. A drone that only listens to 1090MHz can remain blind to a low-flying general aviation aircraft on 978MHz, creating a significant safety gap. Therefore, a dual-band approach is the only way to provide comprehensive situational awareness.

3 Engineering Challenges in UAS Integration

Designing an ADS-B receiver for a drone is significantly more difficult than designing one for a fixed ground station. Engineers must contend with strict constraints of size, weight, and power (SWaP). Every additional gram of hardware directly reduces the payload capacity of the drone and flight time. Some drone systems need redundant ADS-B radios to provide public safety and high reliability while navigating urban areas. Furthermore, the electromagnetic environment of a drone is inherently “noisy.” The high-frequency switching of electronic speed controllers (ESCs), the pulse-width modulation of motors, and the presence of high-power telemetry

radios create a difficult signal-to-noise environment. An ADS-B receiver must be highly selective, capable of pulling weak, distance aviation pulses out of a sea of local electromagnetic interference.

4 The TI ADS-B Portfolio: High-Performance, Low-Power Reception

Texas Instruments addresses these challenges for both 1090ES and UAT bands through a highly integrated RF architecture designed specifically for low-power, high reliability applications. TI devices include the CC1312R, CC1352R, CC1352P, CC1312R7, CC1352P7 and next generation SDRs to provide a compact, dual-band receiver capable of monitoring both ADS-B bands. The TI SDRs integrate an Arm Cortex-M0 processor with an RF transceiver front end including an LNA within the devices RF core shown in Figure 4-1. The RF core offers a high-level, command-based application program interface to the main on-chip CPU. These cost effective and highly integrated devices have low power draw in receive mode of 5.8mA and a small 7mm × 7mm QFN package that easily facilitates optimization of SWaP-c for ADS-B receiver board designs for small UAS platforms.

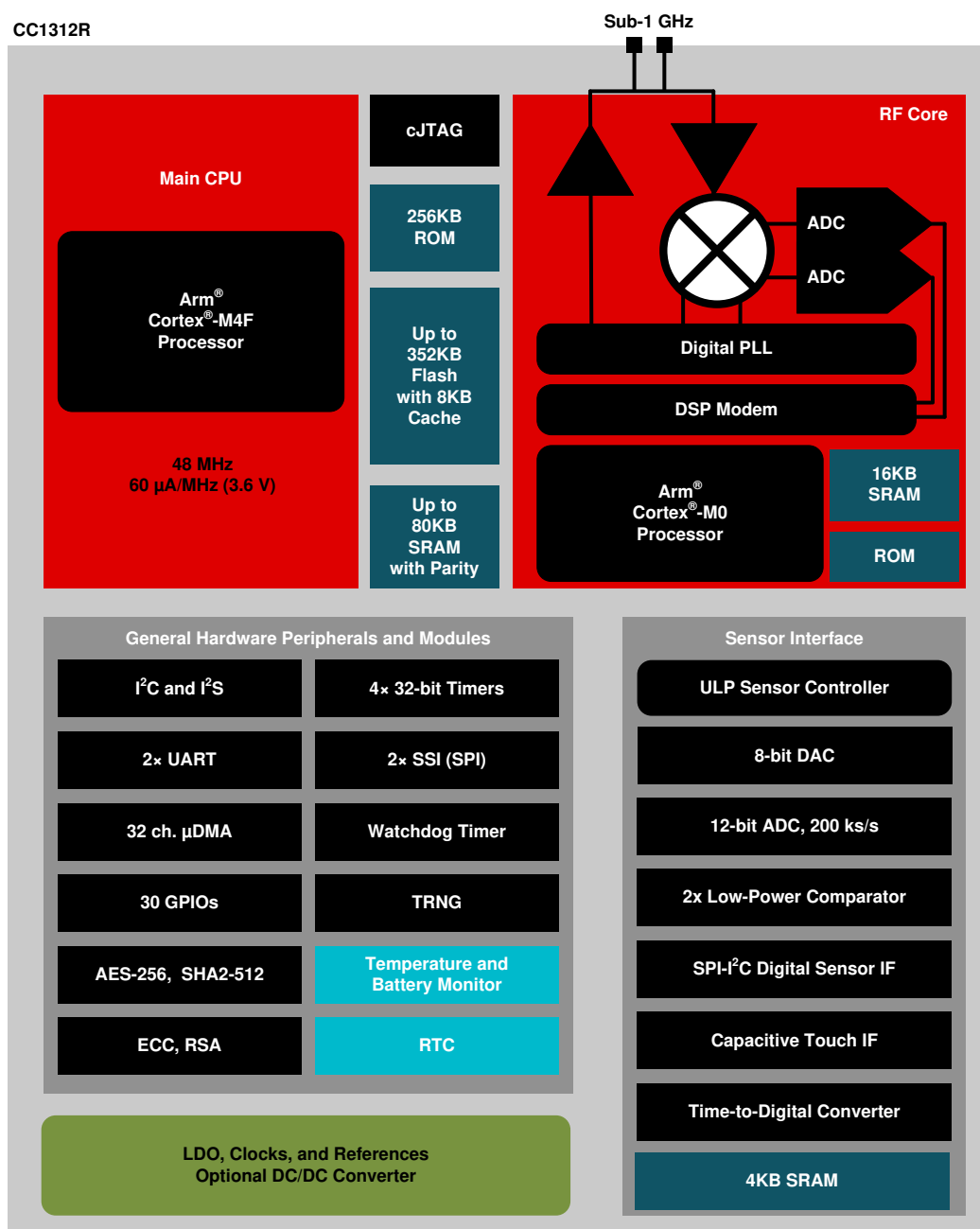


Figure 4-1. CC1312R Block Diagram

By utilizing a sophisticated radio front end, the TI architecture provides the high sensitivity required to detect distant aircraft for either ADS-B band. To combat the electrical noise typical of UAS platforms, the system employs advanced digital signal processing to filter out interference, making sure that the flight controller receives clean, actionable positional data. Most importantly, the power profile of the TI design is optimized for the battery-constrained nature of UAS. Through efficient sleep modes and streamlined data processing, the receiver can operate continuously throughout the duration of a mission, providing a “safety net” of situational awareness without significantly impacting the aircraft’s flight envelope.

Additionally, if more gain is required for the ADS-B receiver, Texas Instruments also provides a small, low-power LNA that can be matched for 1090MHz or 978MHz. The TRF3302 consumes < 4.6mA with an adjustable 1.8V to 3.3V input voltage and comes in a 1.3mm × 1mm package for SWaP sensitive UAS platforms.

5 Summary

As the regulatory landscape for drones continues to evolve, the ability to avoid manned aircraft is becoming a standard requirement for flight certification. By implementing a dual-band ADS-B receiver, drone manufacturers can provide a high level of safety and compliance. TI provides the essential building blocks – combining compact components with ultra-low power consumption – to make this sophisticated airspace awareness a reality for the next generation of drones.

6 References

1. Texas Instruments, [CC1352R SimpleLink™ Arm Cortex-M4F multiband Sub-1GHz & 2.4GHz wireless MCU with EdgeAI support](#), product page
2. Texas Instruments, [CC1352P SimpleLink™ Arm Cortex-M4F multiband Sub-1GHz & 2.4GHz wireless MCU integrated power amplifier](#), product page
3. Texas Instruments, [CC1312R SimpleLink™ 32-bit Arm Cortex-M4F Sub-1 GHz wireless MCU with 352kB Flash](#), product page
4. Texas Instruments, [CC1312R7 SimpleLink™ 32-bit Arm Cortex-M4F Sub-1 GHz wireless MCU with 704kB Flash](#), product page
5. Texas Instruments, [CC1352P7 SimpleLink™ 32-bit Arm Cortex-M4F Sub-1 GHz wireless MCU with EdgeAI support, +20dBm](#), product page
6. Texas Instruments, [TRF3302, 1165MHz-to-1640MHz multiband GPS and GNSS low-noise amplifier \(LNA\)](#), product page

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