

Passive-detector receiver keeps you informed, entertained during flights

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FAA (Federal Aviation Administration) regulations generally forbid the use of receivers onboard commercial aircraft because a superheterodyne receiver's local oscillator can radiate signals that could interfere with aircraft communication and navigation systems. The crystal radio in **Figure 1** directly detects nearby AM signals in the very-high-frequency aircraft band, 118 to 137 MHz, and thus cannot interfere with aircraft equipment. Communications between the pilot and the flight controllers are brief and infrequent, and listening to the aircraft band as a passenger can get boring. However, the circuit in this Design Idea improves on an earlier passive aircraft-band receiver by allowing you to en-

joy an aircraft's in-flight-entertainment system while monitoring pilot-to-ground communications (**Reference 1**).

In **Figure 1**, the shields of the headphone's wires double as an antenna. A series network comprising L_2 and C_3 couples RF energy into a resonant LC tank circuit comprising L_1 and trimmer capacitor C_1 . You adjust C_1 to peak the tank circuit's resonant frequency within the 118- to 137-MHz aircraft band. The crystal detector comprises Schottky diode D_1 that is forward-biased through R_1 and R_2 . Depending on the diode's characteristics, you may have to adjust R_1 to optimize the diode's bias current.

Both sections of IC_1 , a Maxim MAX474 single-supply, 2.7 to 5.25V, rail-

to-rail, dual op amp, boost the level of demodulated audio that D_1 and C_4 recover. Lowpass filters R_5 and C_{12} and R_7 and C_{13} limit audio bandwidth to voice-range frequencies to improve intelligibility and reduce power consumption. Capacitors C_{10} and C_{11} split the amplified audio signal into two channels to drive stereo-headphone amplifier IC_2 , a Texas Instruments TPA4411. Capacitors C_8 and C_9 drive IC_2 's inputs with stereophonic audio signals from the aircraft's entertainment system or a portable CD/DVD player. The TPA4411 headphone amplifier provides a fixed gain of -1.5 , which allows you to maintain a comfortable listening level by adjusting the aircraft-entertainment device's volume control. Potentiometer R_6

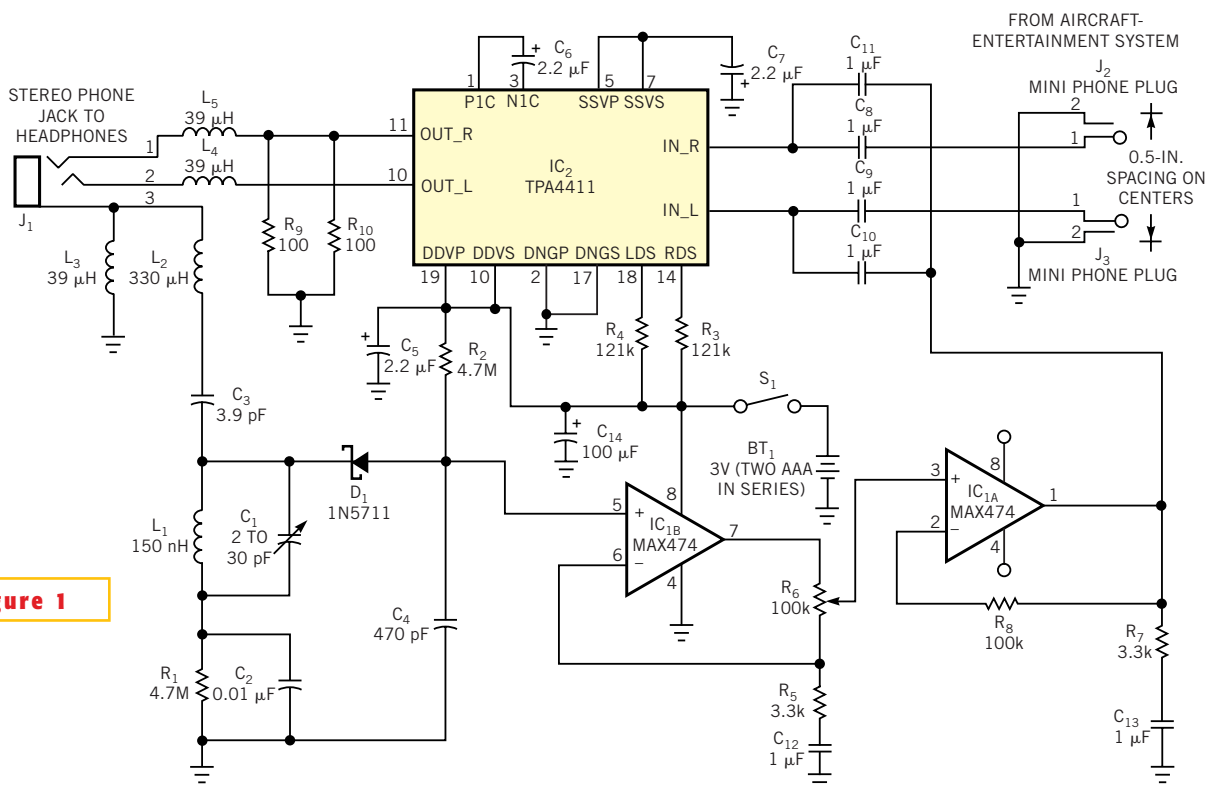


Figure 1

NOTE: MOUNT PHONE PLUGS J_2 AND J_3 ON 0.5-IN. CENTERS TO MATCH AIRCRAFT-ENTERTAINMENT SYSTEM'S AUDIO-JACK SPACING. SELECT R_1 TO BIAS DIODE.

This modern version of the crystal radio allows you to monitor aircraft communications while listening to in-flight-entertainment programs.

controls the aircraft-band audio level, and the user should adjust it during quiet radio periods to minimize noise introduced into the entertainment audio program.

The TPA4411 integrates pop-noise-reduction circuitry, can drive as much as 80 mW into a typical headphone's 8 to 16Ω load, and operates over a power-supply range of 1.8 to 4.5V. Inductors L_3 , L_4 , and L_5 allow audio to pass unimpeded to the headphones and prevents the amplifier's outputs from shunting RF signals meant to be coupled to the receiver's resonant LC tank circuit.

To use the receiver, slowly adjust C_1 until you hear a pilot's communication in progress. Then, quickly tune C_1 to maximize the signal. The tuned circuit's selectivity is low enough such that, once you adjust C_1 , it doesn't require retuning. Although you can use this receiver while awaiting your flight's boarding call, always ask permission from the flight crew before using the receiver aboard an aircraft. You can explain that the circuit does not interfere with the aircraft's navigation and communication systems. Air-

port-security personnel may regard any user-constructed electronic device with suspicion, however.

This receiver's sensitivity is low, and you generally hear only the pilot-to-ground side of two-way traffic. Fortunately, in controlled airspace, a pilot must repeat all commands so that air-traffic controllers can verify that the pilot clearly understood their instructions. Although a comprehensive survey of aircraft-band communications procedures is beyond the scope of this Design Idea, the following example explains certain terms.

While the aircraft remains at the departure gate, you typically hear a pilot repeating flight clearance, altitude restrictions, and other instructions—for example, "KLM 657 heavy, cleared for Amsterdam ... FL320 five minutes after departure. Departure frequency is 127.4, squawk 4312." "Heavy" means that the aircraft is a large jet, "FL320" means that the aircraft is cleared to fly at 32,000 feet, and "squawk" is the aircraft's four-digit identification number. To contact departure control, the pilot retunes the aircraft

radio to 127.4 MHz. When the pilot enters the squawk into the aircraft's transponder, the flight controllers can identify the aircraft on-radar screens as KLM flight 657. Each time the aircraft enters a new segment of the taxiway on its way to the runway and again for take-off clearance, the pilot contacts ground control to get taxi clearances.

Shortly after takeoff, the pilot contacts departure control: "KLM 657, radar contact, climb and maintain FL320, turn right heading 120, proceed on course." From then on, the pilot contacts flight controllers upon reaching predefined altitudes or when entering a different flight-control center's airspace. Approximately 30 minutes before reaching its destination, the aircraft begins its descent, and the pilot contacts approach control. Just before landing, you hear the final clearance: "KLM 657 heavy, winds 030 at 12, cleared to land runway 31." □

REFERENCE

1. Wenzel, Charles, "Passive aircraft receiver," www.techlib.com/electronics/aircraft.htm.

Quickly estimate an electronic system's cooling requirements

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DURING NORMAL OPERATION, an electronic system generates wasted heat that can cause malfunctions and damage components unless you remove it. In an ideal world, you would have the time and resources to perform a rigorous evaluation of an electronic system's cooling requirements early in the design phase and thus avoid the cooling errors others have made in the past (Reference 1). However, circumstances often demand a diagnostic evaluation of a system's cooling methods or a rapid estimate of a proposed system's cooling requirements. For these purposes, you don't need an advanced degree in computational fluid dynamics; this Design Idea outlines a method that may be all that's necessary.

Figure 1 shows a typical cabinet-mounted electronic system that includes

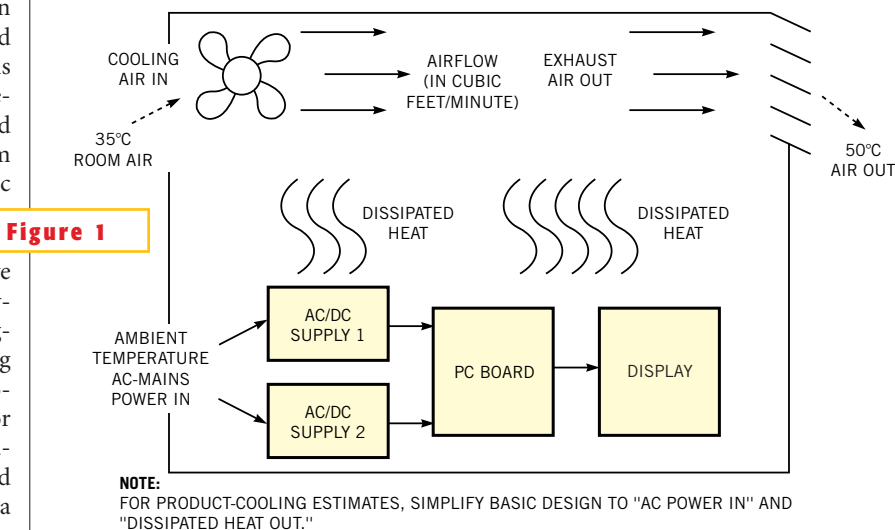


Figure 1

NOTE: FOR PRODUCT-COOLING ESTIMATES, SIMPLIFY BASIC DESIGN TO "AC POWER IN" AND "DISSIPATED HEAT OUT."

To estimate a system's cooling requirements, you can simplify the thermal model to comprise an ac-power input and a dissipated-heat output.