

DESIGN NOTES

Baseband Circuits for an RFID Receiver – Design Note 381

Philip Karantzalis

Introduction

Radio Frequency Identification (RFID) technology uses radiated and reflected RF power to identify and track a variety of objects. A typical RFID system consists of a reader and a transponder (or tag). An RFID reader contains an RF transmitter, one or more antennas and an RF receiver. An RFID tag is simply an uniquely identified IC with an antenna.

Communication between a reader and a tag is via backscatter reflection, similar to a radar system, in the UHF frequencies from 860MHz to 960MHz. This design note describes a high performance RFID receiver.

A Direct Conversion Receiver

Figure 1 shows the block diagram of a direct conversion RF receiver—the receiver demodulates an RF carrier directly into a baseband signal without an intermediate frequency down-conversion (a zero IF receiver).

The antenna, shared by both the transmitter and receiver, detects an RF carrier and passes it through a bandpass filter to an LT[®]5516 demodulator's RF input.

The LT5516 direct conversion demodulator frequency range of 800MHz to 1.5GHz includes the UHF range used

by RFID readers (860MHz to 960MHz). The excellent linearity of the LT5516 provides for high sensitivity to low level signals, even in the presence of large interfering signals.

The LT6231 low noise dual op amp acts as a differential to single-ended amplifier to drive the single-ended input of the lowpass filter.

Analog baseband filtering is performed by the LT1568, a low noise, precision RC filter building block. The LT1568 filter provides a simple solution for designing lowpass and bandpass filters with cutoff frequencies from 100kHz to 10MHz. These cutoff frequencies are sufficient for the 250kHz to 4MHz signal spectrum typically used in UHF RFID systems.

The differential output of an LT1568 drives the inputs of an LTC2298 ADC. The LTC2298 is a 65MSPs, low power (400mW), dual 14-bit analog to digital converter with 74dB signal-to-noise ratio (SNR). The digital signal processor (DSP) that follows the ADC analyzes the received signal from multiple tags and provides additional filtering.

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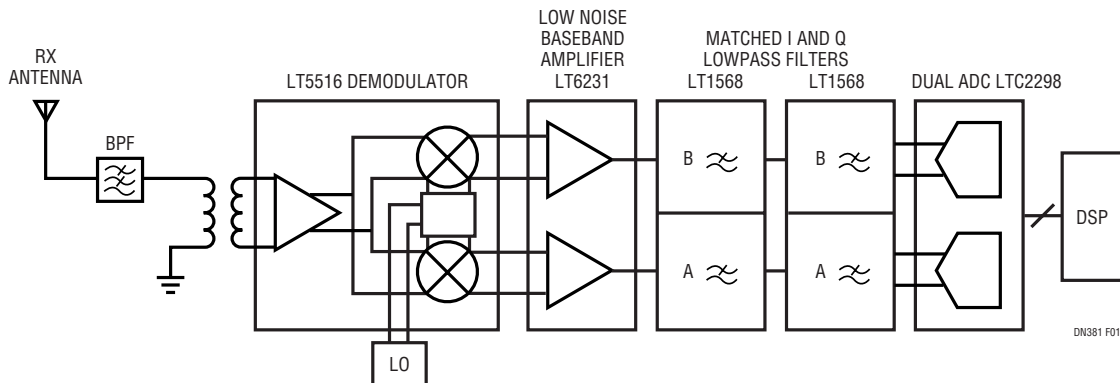


Figure 1. A Direct Conversion Receiver for an RFID Reader

A Low Noise Differential to Single-Ended Amplifier

Figure 2 shows an LT6231 difference amplifier used to convert the LT5516 differential I or Q output to a single-ended output. The addition of external 270pF capacitors across the 60Ω resistors limits the demodulator's output to 10MHz to prevent any high frequency interference from reaching the LT6231 amplifier.

AC coupling to the baseband amplifier is used because DC coupling is not necessary for the amplitude shift keying (ASK) RFID signal.

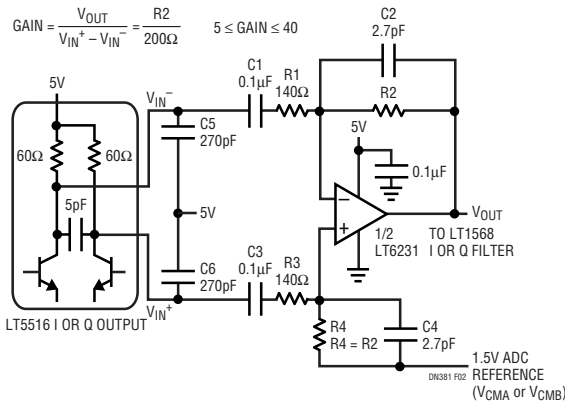


Figure 2. A Low Noise I or Q Baseband Interface

The highpass pole provided by the AC coupling capacitors and the amplifier input resistors is set to 8kHz. The differential amplifier's input resistors are set to 140Ω in order to minimize the input referred noise. The noise floor at the amplifier's output is 4.3nV/√Hz times the amplifier gain (gain ≥ 5). The 1.5V reference provided by the LTC2298 ADC is used to level shift the amplifier's output to the mid-supply point of the following 3V filter and ADC circuits.

A Matched I and Q Filter and a Dual ADC

Figure 3 shows two LT1568 filter building blocks connected as dual, matched, fourth order filters. The LT1568 filter's single-ended input to differential output conversion gain is 6dB. The LT1568 circuit implements an elliptic lowpass filter function with equal resistor values (see Figure 3). Stopband attenuation at 2(f_{-3dB}) is 34dB. I and Q filter matching is assured by the inherent matching of the LT1568s' A and B sides.

The input voltage range of an LTC2298 is adjustable to 2V_{P-P} or 1V_{P-P}.

Conclusion

Using only five ICs (LT5516, LT6231, two LT1568 and an LTC2298), a high performance UHF RFID receiver can be designed with the flexibility to adapt and be optimized to meet the requirements of the present and emerging RFID standards.

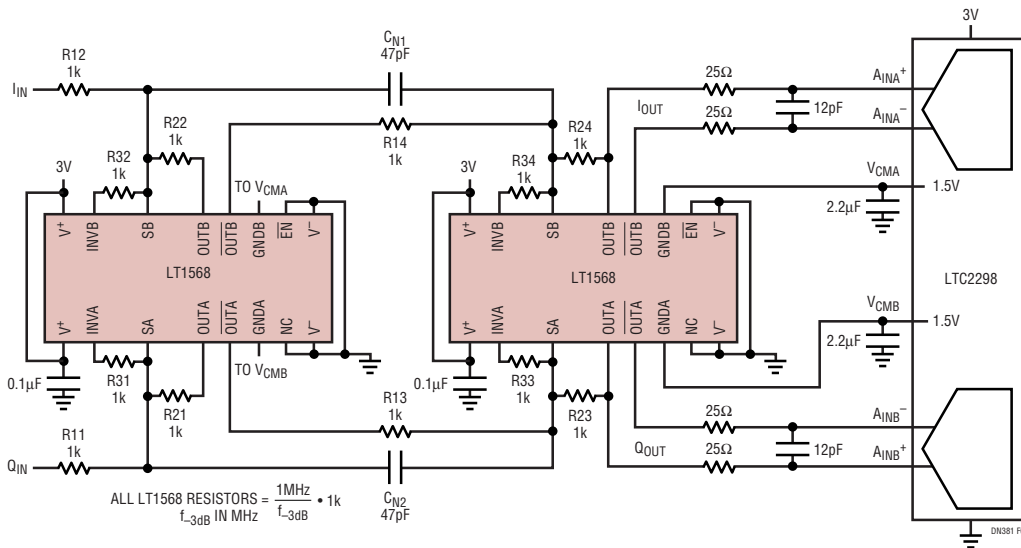


Figure 3. A Matched, 1MHz, 4th Order, I and Q Lowpass Filter and ADC Driver

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Linear Technology Corporation
1630 McCarthy Blvd., Milpitas, CA 95035-7417
(408) 432-1900 • FAX: (408) 434-0507 • www.linear.com

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