

# DESIGN NOTES

## Wideband RF ICs for Power Detection and Control – Design Note 335

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### Introduction

Radio frequency devices are being deployed in ever increasing numbers, not just in cell phones and cordless telephones. Other applications include 802.11 wireless LAN, RFID (radio frequency identification) tags, inventory monitors, satellite transceivers, fixed wireless access and wireless communications infrastructure. All RF devices must carefully monitor and control their RF power transmission to comply with government regulation and minimize RF interference with other radio devices. For this reason, accurate RF power detection is important in both RF receivers and transmitters.

This article presents some solutions using Linear Technology's versatile family of high frequency Schottky diode detectors. Table 1 summarizes the features of this family and lists more applications.

### A Dual-Band Mobile Phone Transmitter Power Control Application

Figure 1 is a simplified block diagram illustrating transmit power control for a dual band mobile phone (the receiver is not shown here). In this example, a 324Ω, 1% tolerance resistor (R1) followed by a 2.2pF capacitor (C1) form a coupling circuit with 18dB to 20dB coupling factor at 850MHz to 1850MHz, referenced to the LTC<sup>®</sup>5509 RF input pin. C1 is also a DC blocking capacitor. R1 should have a tolerance of 1% while C1 should be 2% to 5%. The coupling circuit (R1 and C1) introduces about 0.15dB to 0.2dB losses into the main signal line. R1 should be placed as close as possible to the antenna without forming a "T" connection on the microstrip line and immediately

followed by capacitor C1 and the LTC5509. Ideally, C1, R1 and LTC5509 should be placed on the same side of the PCB as the Tx output microstrip line to the antenna. The component values shown here should be used as a reference. In the actual product implementation, component values may differ slightly depending on the output impedance of the Tx PAs, antenna impedance, component placement and PC board parasitics.

### An RFID Reader Application

RFID (radio frequency identification) is a promising technology for many monitoring and tracking applications, including retail store check-out registers, inventory management, vehicle tracking, tire-pressure monitoring and

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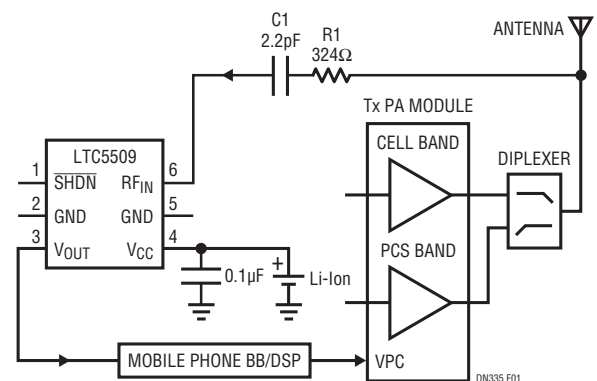


Figure 1. A Dual-Band Mobile Phone Transmit Power Control Using a Resistive Tap

Table 1. Summary of RF Detector Specifications and Applications

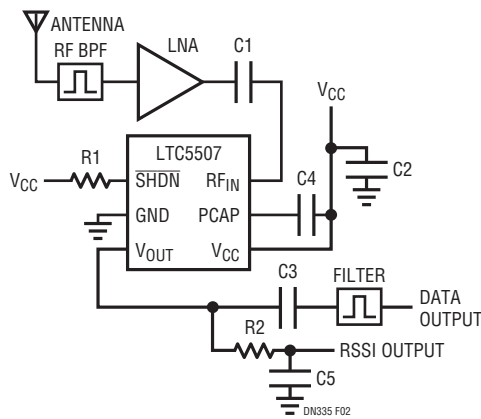
DEVICE	FREQUENCY RANGE	PACKAGE	DYNAMIC RANGE/FEATURES	APPLICATIONS
LTC5505-1	300MHz to 3GHz	ThinSOT™	-28dBm to 18dBm*	General Purpose, Phones, ISM
LTC5505-2	300MHz to 3GHz	ThinSOT	-32dBm to 12dBm*	General Purpose, Phones, ISM
LTC5507	100kHz to 1GHz	ThinSOT	-34dBm to 14dBm*	General Purpose LF & Broadband Detection
LTC5508	300MHz to 7GHz	SC-70†	-32dBm to 12dBm*	General Purpose, WLAN, Microwave
LTC5509	300MHz to 3GHz	SC-70†	-30dBm to 6dBm**	Mobile Phones Tx Power Control
LTC5532	300MHz to 7GHz	ThinSOT	Adjustable Gain & Starting Voltage	Precision RSSI & Envelope Detection

\*Gain compression extends the dynamic range with a trade-off of reduced linearity in the transfer characteristic.

\*\*No gain compression. †Smallest package.

live-stock/agricultural tracking. Common to all of them are the need for well-controlled RF power and a cost-effective means of reliably detecting the received data. Well-regulated RF power allows maximum power transmission to the ID tags while staying within regulatory emission limits. A well-controlled transmitter is possible if an RF detector is used in a closed-loop feedback circuit, similar to the example shown in Figure 1. The choice of RF power detector is determined by the RF frequency, as well as by other constraints such as the required dynamic range and sensitivity.

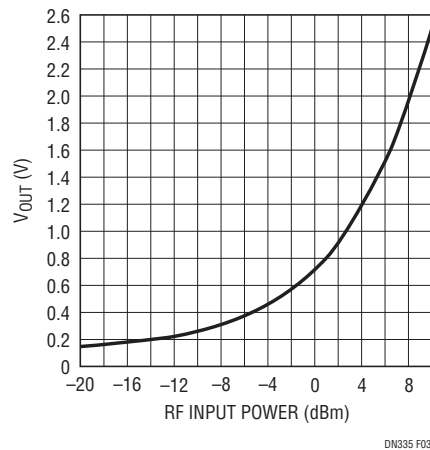
To form a complete RFID reader receiver, an RF Schottky peak detector can also make an excellent low cost data receiver to demodulate ASK or AM modulated signals with data rates up to 3MHz. Because RF detectors such as the LTC5507 can detect RF signals over a wide frequency range, filtering can improve the sensitivity of the receiver. Figure 2 shows a data receiver with an input LNA (low noise amplifier) and an input BPF (bandpass filter). The LNA can be a general purpose, low cost gain block that provides fixed gain at the operating frequency of interest. The added gain increases sensitivity and extends the detection range. A lowpass or bandpass filter at the detector output provides additional receiver selectivity, if needed. The RSSI (receive signal strength indicator) DC-coupled output provides signal strength information using a lowpass filter (R2 and C5) to filter out the modulation components.



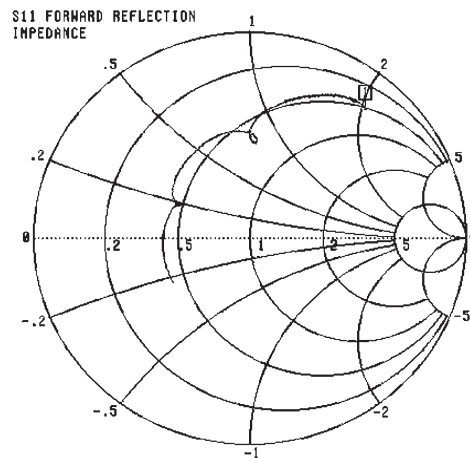
**Figure 2. An RFID Reader ASK Receiver with Output Filter**

### Application of RF Power Detectors at Frequencies Above 7GHz

Although the LTC5532 is optimized for an operating frequency range from 300MHz to 7GHz, it can offer useful performance well above this frequency range. The performance at higher frequencies does fall off but gracefully. Figure 3 shows a plot of the LTC5532's output voltage versus RF input power characteristics at 12GHz. Figure 4 shows the LTC5532's input S11 Smith Chart, extending to 12GHz. Coupling to the LTC5532 at these high frequencies is in principle very similar to lower frequency operation.



**Figure 3. LTC5532 Typical Detector Transfer Characteristics at 12GHz Frequency**



**Figure 4. LTC5532 Input S11 Smith Chart**

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