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APPLICATION NOTE 602

RF IC Building Block Solutions for GPS

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Abstract: Maxim's family of high performance CMOS and Silicon Germanium (SiGe) building block RF ICs for implementing an GPS RF-to-IF receiver are described.

Additional Information:

- [Wireless Product Line Page](#)
- [Application Technical Support](#)
- [Application note 3447, "Complete Stand-Alone GPS Receiver Solution with MAX2742"](#)
- [Application note 1985, "LNA Optimized for GPS \(REP024\)"](#)
- [Application note 3248, "MAX2653 LNA with Gain-Step, Retuned for GPS Applications"](#)
- [Application note 1749, "MAX2655 GPS LNA Stability Measurements"](#)
- [Application note 890, "Silicon Germanium \(SiGe\) Downconverter Tuned for GPS Receivers"](#)
- [Application note 957, "The MAX2681 SiGe Downconverter Mixer Tuned for GPS Front Ends"](#)
- [Application note 2242, "MAX2538 Uses GPS IF LC Filter Optimized for 183.6MHz IF"](#)
- [Application note 640, "A Single Chip Silicon Bipolar Receivers for GPS/GLONASS Applications"](#)



[Click here for an overview of the wireless components used in a typical radio transceiver.](#)

There are many commercially available IF-to-baseband IC solutions for GPS Applications, and many companies have opted to design their own proprietary ASICs, but lack an RF-to-IF front end for downconverting the transmitted GPS frequency to a low-IF frequency. Maxim has produced several RF ICs that have proved an excellent choice for accomplishing these tasks.

The MAX2741/MAX2742/MAX2745 are a family of high-performance CMOS single-chip GPS front-end downconverters. These state-of-the-art devices consume extremely lowpower and do not need the costly IF SAW filters or bulky discrete IF bandpass filters. All devices are fully equipped with a low-noise amplifier, mixer, BPF, automatic gain control amplifier, local oscillator synthesizer, clock buffer, and digital sampler. The selector guide for these products are shown in **Table 1**. For more information on these products, visit the links below for data sheets and application notes.

Table 1. CMOS GPS RF Front-End Receiver IC Selector Guide

| Part | Supply Voltage (V) | Supply Current (mA) | Reference Clock (MHz) | IF Frequency (MHz) | Conversion Gain (dB) | Noise Figure (dB) | IIP3 (dBm) |
|---------|--------------------|---------------------|-----------------------|--------------------------------|---------------------------|----------------------------|-----------------------------|
| MAX2741 | 2.7 to 3.0 | 30 | 2 to 26 | 37.38 (first) 3.78 (second) | 32 (first) 47 (second) | 4.7 (first) 12 (second) | -30 (first) -36 (second) |
| MAX2742 | 2.4 to 3.6 | 14 | 18.414 | 1.023 | 117 | 4.5 | -32 |
| MAX2745 | 2.4 to 3.6 | 21 | 16.368 32.736 | 4.092 | 120 | 3.5 | -25 |

The MAX2654/MAX2655 SiGe LNAs offer high gain, low noise, and high linearity at 1575MHz. Both RF ICs incorporate 50Ω output-matching networks for reduced component count. The MAX2654 RF IC delivers 15.1dB of gain, a noise figure of 1.5dB, and an input third-order intercept point (IIP3) of -7.8dBm. For improved linearity, the MAX2655 RF IC offers 14.1dB of gain, a noise figure of 1.45dB, and an adjustable IIP3 performance of +2.2dBm to +3.8dBm. The supply current for the MAX2654 is a low 5.8mA, whereas the supply current for the MAX2655 is adjustable from 5.9mA to 10.1mA. Both devices also feature a 0.1μA low-power shutdown mode. The MAX2641 SiGe LNA is another excellent choice, offering 15.7dB of gain, an extremely low noise figure of 1.2dB at 1575MHz, and an IIP3 of +1.4dBm. The supply-current draw is a low 3.5mA. The MAX2641 does not offer a low-power shutdown mode or an integrated output-matching network.

Maxim currently does not offer a stand-alone GPS LNA that supports gain-step, but retuning the MAX2563 to the GPS band offers an excellent solution. The MAX2563 is a SiGe LNA designed to operate in the US PCS and European DCS receive bands. After replacing the matching components, the MAX2563 delivers 19.2dB of gain, 1.57dB of noise figure, and -5.2dBm of IIP3. For more information, please see application note 3248, "[MAX2653 LNA with Gain-Step, Retuned for GPS Applications.](#)"

The MAX2680/MAX2681/MAX2682 are a family of Silicon Germanium downconverting mixers that accept RF frequencies in the range of 2.5GHz to 400MHz, which makes it outstanding for GPS Applications at 1575MHz. The IF output can be tuned for IF frequencies between 10MHz and 500MHz. See **Table 2** below for the performance of the MAX2680, MAX2681, and MAX2682.

Table 2. GPS Silicon Germanium (SiGe) Downconverter IC Selector Guide

| Part | Supply Current (mA) | Frequency | | | | | |
|---------|---------------------|------------|---------|-----------|------------|---------|-----------|
| | | 900MHz | | | 1950MHz | | |
| | | IIP3 (dBm) | NF (dB) | Gain (dB) | IIP3 (dBm) | NF (dB) | Gain (dB) |
| MAX2680 | 5.0 | -12.9 | 6.3 | 11.6 | -8.2 | 8.3 | 7.6 |
| MAX2681 | 8.7 | -6.1 | 7.0 | 14.2 | +0.5 | 11.1 | 8.4 |
| MAX2682 | 15.0 | -1.8 | 6.5 | 14.7 | +4.4 | 10.2 | 10.4 |

The following block diagram summarizes the important features of the Maxim's various building-block GPS RF ICs.

MAX2680/MAX2681/MAX2682
 400MHz to 2.5GHz SiGe Downconverter Mixers
 MAX2680: ICC = 5mA, Gain = 7.6dB, NF = 8.3dB, IIP3 = -8.2dBm at 1950MHz
 MAX2681: ICC = 8.7mA, Gain = 8.4dB, NF = 11.1dB, IIP3 = +0.5dBm at 1950MHz
 MAX2682: ICC = 15.0mA, Gain = 4.4dB, NF = 10.2dB, IIP3 = +4.4dBm at 1950MHz
 <0.1 μ A Low-Power Shutdown Mode
 IF Frequency Range: 10MHz to 500MHz
 +2.7V to +5.5V Single-Supply Operation
 Ultra-Small 6-Pin SOT23-6 Package (2.9mm x 2.75mm)

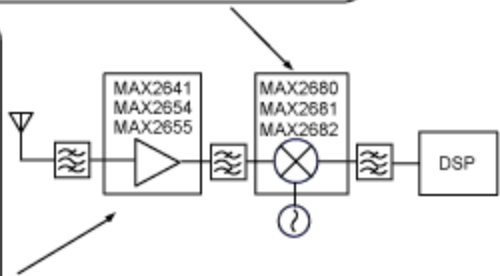
MAX2641/MAX2654/MAX2655
 SiGe LOW-NOISE AMPLIFIERS

Low-Noise Figure:
 MAX2641: 1.3dB at 1575MHz
 MAX2654: 1.5dB at 1575MHz
 MAX2655: 1.45dB at 1575MHz

High Gain:
 MAX2641: 15.7dB at 1575MHz
 MAX2654: 15.1dB at 1575MHz
 MAX2655: 14.1dB at 1575MHz

Input Third-Order Intercept Point (IIP3):
 MAX2641: +1.4dBm at 3.5mA Supply Current
 MAX2654: -7.2dBm at 5.6mA Supply Current
 MAX2655: +2.2dBm to +3.8dBm at 5.9mA to 10.1mA

Integrated 50W Output Matching (MAX2654/MAX2655)
 Variable-IP3 Set by One Bias Resistor (MAX2655)
 0.1 μ A Shutdown Mode (MAX2654/MAX2655)
 +2.7V to +5.5V Single-Supply Operation
 MAX2641: 6-Pin SOT23-6 Package (2.9mm x 2.75mm)
 MAX2654/MAX2655: 6-Pin SC70 Package (2mm x 2mm)



RF ICs for GPS Receivers

| Related Parts | | |
|-------------------------|---------------------------------------------------------------|------------------------------|
| MAX2641 | 300MHz to 2500MHz SiGe Ultra-Low-Noise Amplifiers | Free Samples |
| MAX2653 | GSM900 and DCS1800/PCS1900 Dual-Band, Low-Noise Amplifiers | |
| MAX2654 | 1575MHz/1900MHz Variable-IP3 Low-Noise Amplifiers | Free Samples |
| MAX2655 | 1575MHz/1900MHz Variable-IP3 Low-Noise Amplifiers | Free Samples |
| MAX2680 | 400MHz to 2.5GHz, Low-Noise, SiGe Downconverter Mixers | |
| MAX2681 | 400MHz to 2.5GHz, Low-Noise, SiGe Downconverter Mixers | |
| MAX2682 | 400MHz to 2.5GHz, Low-Noise, SiGe Downconverter Mixers | Free Samples |
| MAX2741 | Integrated L1-Band GPS Receiver | Free Samples |
| MAX2742 | Single-Chip Global Positioning System Receiver Front-End | |
| MAX2745 | Single-Chip Global Positioning System Front-End Downconverter | Free Samples |

More Information

For Technical Support: <http://www.maximintegrated.com/support>

For Samples: <http://www.maximintegrated.com/samples>

Other Questions and Comments: <http://www.maximintegrated.com/contact>

Application Note 602: <http://www.maximintegrated.com/an602>

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