Keywords: LNA,GPS,re-tune,NF,gain step,gain-step,1575,GPS LNA

APPLICATION NOTE 3248

MAX2653 LNA with Gain-Step, Retuned for GPS Applications

Jun 25, 2004

Abstract: This application note presents alternate RF matching networks for the MAX2653 SiGe LNA, tuned for the GPS band (1575MHz center frequency). Performance metrics (supply current, forward gain, NF, IIP3, reverse isolation and input/output return loss) for both high and low gain modes, as well as 2.7V and 3.0V supplies are provided. For V_{CC} = 2.7V, high-gain mode, this application provides 19.2dB Gain, 1.6dB NF, and -5.2dB IIP3 at 5.6mA supply current.

The MAX2653 SiGe Low Noise Amplifier (LNA) is internally optimized for lowest noise performance in the US PCS (1930MHz to 1990MHz) and the European DCS (1805MHz to 1880MHz) receive bands. These LNAs offer a 20dB gain control step, externally adjustable gain and linearity (via single external resistor), 2.7V to 3.3V operation, and a 0.25µA shutdown mode. Maxim does not offer a stand-alone LNA for the GPS (1575MHz center) band that includes a gain-step, but re-tuning the MAX2653 to this lower band offers a excellent solution. These alternative matching values (Table 1) offer 0.5dB more gain, 0.1dB better noise figure, and 2dB better IIP3 - all for nearly identical supply current.

Click here for an overview of the wireless components used in a typical radio transceiver.

For applications that do not require a gain step, Maxim offers the MAX2654 and MAX2655 SiGe GPS LNAs. They offer a bias current control (via external resistor) to set gain and linearity, a 0.1µA shutdown mode and integrated 50Ω output matching. Find the datasheet at http://www.maximintegrated.com/max2654 .

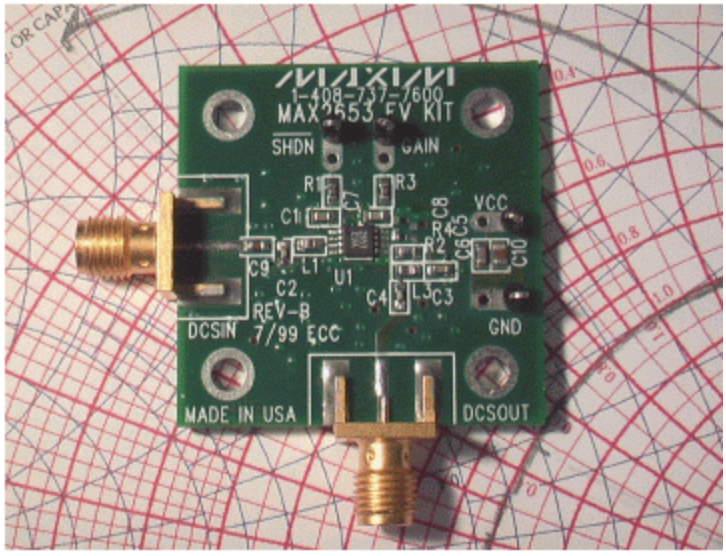

Figure 1. MAX2653 EVKit, with new matching components (C2, L1, L3, C4). No 'hacking' of the PCB necessary.

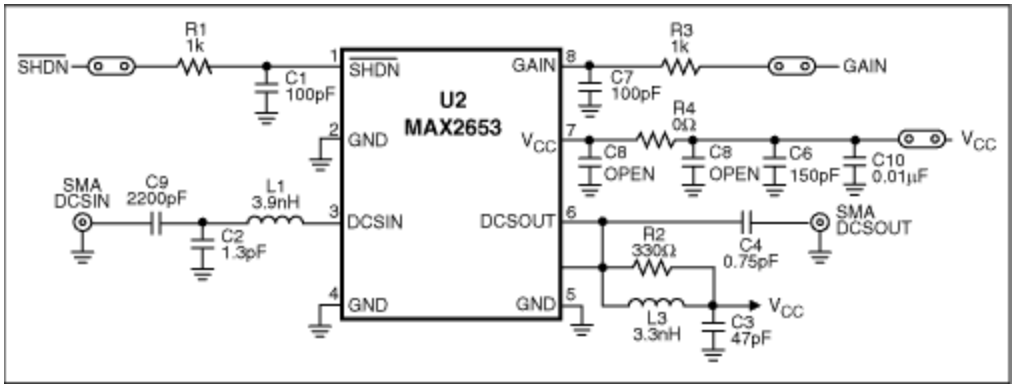

Figure 2. MAX2653 EVKit schematic, with new matching components for 1575MHz GPS band.

Table 1. MAX2653 EVKit replacement components for re-tuning to 1575MHz GPS band.

Designation	Value	Description
C2	1.3pF	shunt-C (to GND) matching component for LNA input0402 ceramic capacitor Murata GJ61555C1H1R3CB01B
L1	3.9nH	series-L matching component for LNA input0603 printed inductor Toko LL1608-FS series
L3	3.3nH	shunt-L (to V_{CC}) matching component for LNA output0603 printed inductor Toko LL1608-FS series
C4	0.75pF	series-C matching component for LNA output0402 ceramic capacitor Murata GJ61555C1HR75CB01B

After replacing the matching components on the EVKit, key performance metrics were re-tested at room temperature—Table 2 provides the results of the re-tuned MAX2653 bench testing. These values are referred to the EVKit SMA connectors; to get values referred to the output of the matching networks, assume approximately 0.2dB loss at each the output and the input. In this fashion, the NF of the circuit is actually about 1.57dB, gain is about 19.2dB, and so on. Additional Gain and NF data over frequency

is provided in Table 3.

Table 2. MAX2653 GPS performance summary. Results are referred to the EVKit SMA connector.

Parameter	Symbol	Conditions		Test Result	Unit
Supply Current	ICC	High Gain Mode	V_{CC}=2.7V	5.61	mA
			V_{CC}=3.0V	5.62	
		Low Gain Mode	V_{CC}=2.7V	2.23	
			V_{CC}=3.0V	2.24	
Gain	G	High Gain Mode	V_{CC}=2.7V	19.0	mA
			V_{CC}=3.0V	19.0	
		Low Gain Mode	V_{CC}=2.7V	-2.3	
			V_{CC}=3.0V	-2.2	
NF	NF	High Gain Mode	V_{CC}=2.7V	1.77	dB
			V_{CC}=3.0V	1.79	
		Low Gain Mode	V_{CC}=2.7V	6.36	
			V_{CC}=3.0V	6.37	
Input 3rd-order Intercept	IIP3	High Gain Mode	V_{CC}=2.7V	-5.2	dBm
			V_{CC}=3.0V	-4.9	
		Low Gain Mode	V_{CC}=2.7V	+0.2	
			V_{CC}=3.0V	+0.2	
Reverse Isolation	|S12|	High Gain Mode	V_{CC}=2.7V	-33.8	dB
			V_{CC}=3.0V	-33.6	
		Low Gain Mode	V_{CC}=2.7V	-22.2	
			V_{CC}=3.0V	-22.3	
Input Return Loss	|S11|	High Gain Mode	V_{CC}=2.7V	-7.7	dB
			V_{CC}=3.0V	-7.7	
		Low Gain Mode	V_{CC}=2.7V	-10.9	
			V_{CC}=3.0V	-11.0	
Output Return Loss	|S22|	High Gain Mode	V_{CC}=2.7V	-12.6	dB
			V_{CC}=3.0V	-12.5	
		Low Gain Mode	V_{CC}=2.7V	-8.1	
			V_{CC}=3.0V	-8.2	

Table 3. MAX2653 GPS gain and NF performance over frequency. Results are referred to the EVKit SMA connector.

Frequency	High-Gain				Low-Gain			
	V_{CC}=2.7V		V_{CC}=3.0V		V_{CC}=2.7V		V_{CC}=3.0V	
	Gain (dB)	NF (dB)	Gain (dB)	NF (dB)	Gain (dB)	NF (dB)	Gain (dB)	NF (dB)
1400	15.4	1.71	15.3	1.69	-5.4	6.36	-5.5	6.32
1450	18.4	1.74	18.4	1.74	-2.9	7.18	-2.9	7.40

1500	18.6	1.75	18.5	1.77	-2.6	6.45	-2.6	6.59
1550	18.6	1.78	18.6	1.75	-2.9	5.70	-2.7	5.51
1575	19.0	1.77	19.0	1.79	-2.3	6.36	-2.2	6.37
1650	18.7	1.86	18.7	1.82	-2.2	6.67	-2.3	6.66
1700	17.3	1.84	17.4	1.87	-3.5	5.64	-3.5	5.56
1750	16.3	1.88	16.3	1.92	-4.3	6.26	-4.1	6.21

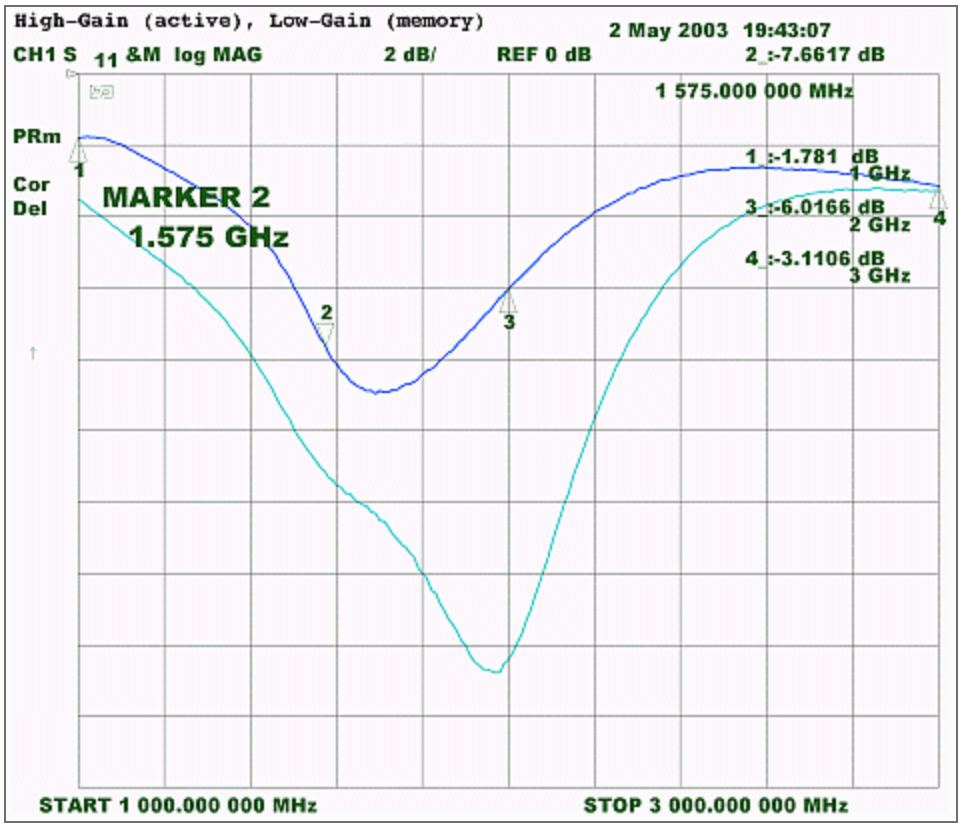

Figure 3. MAX2653 GPS performance, input return loss (S11) for high-gain (active trace) and low-gain (memory trace).

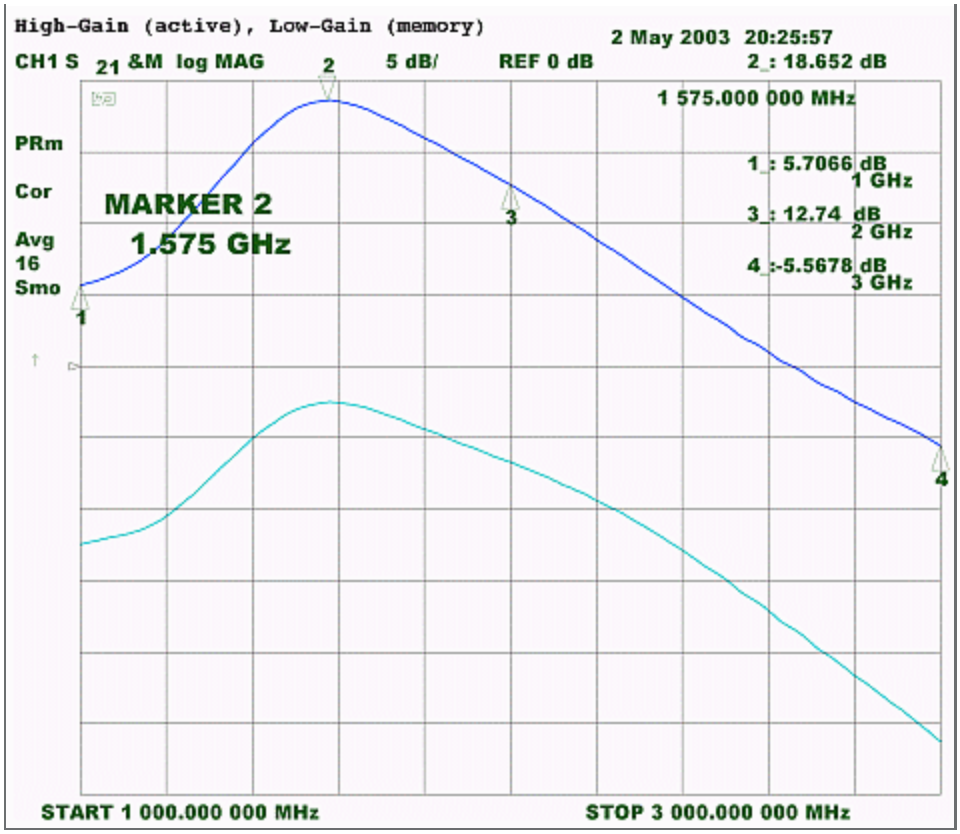

Figure 4. MAX2653 GPS performance, forward gain (S21) for high-gain (active trace) and low-gain (memory trace).

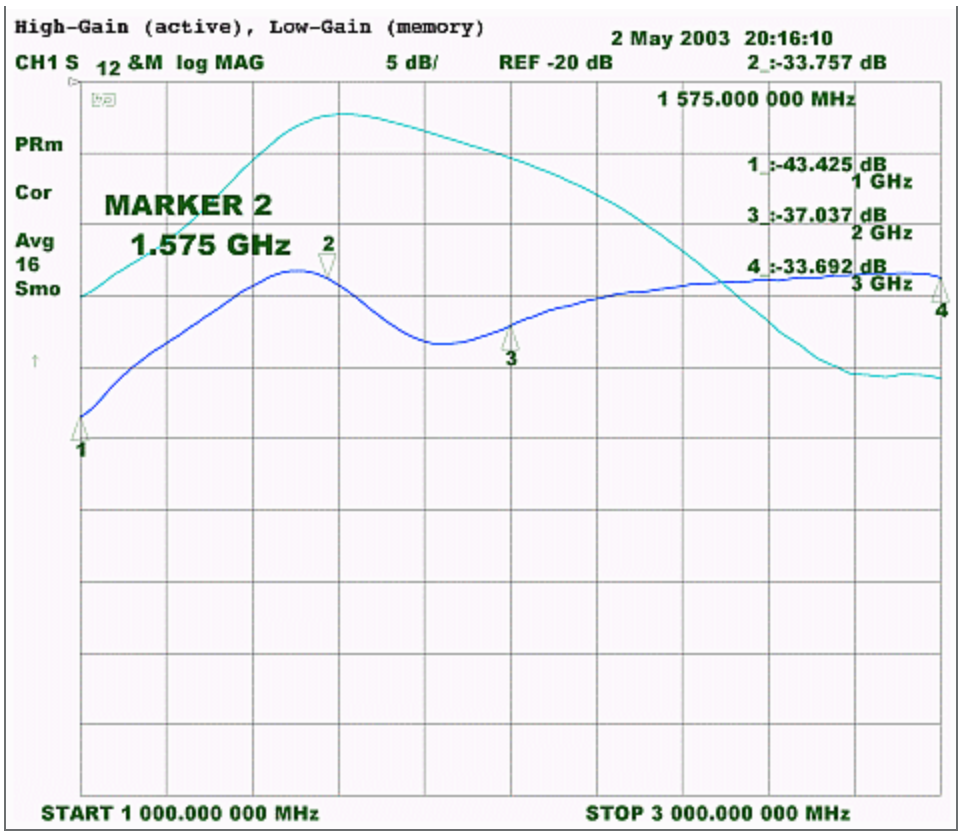

Figure 5. MAX2653 GPS performance, reverse isolation (S12) for high-gain (active trace) and low-gain (memory trace).

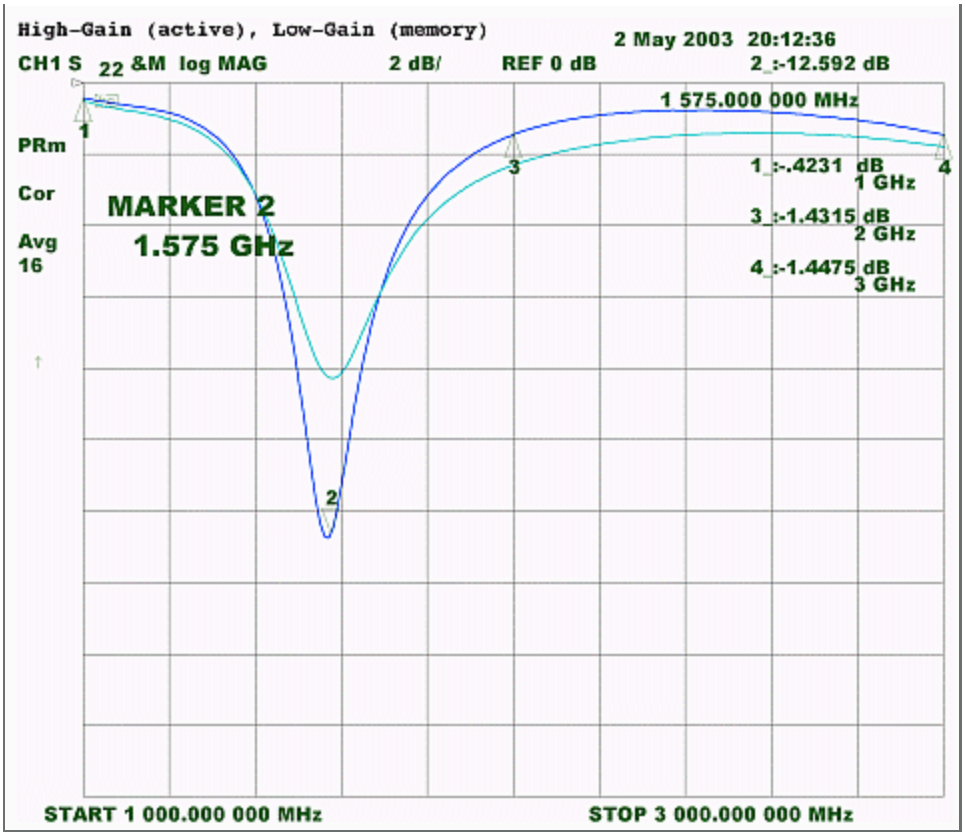

Figure 6. MAX2653 GPS performance, output return loss (S22) for high-gain (active trace) and low-gain (memory trace).

Also See:

- Product Line Page
- Technical Support Page
- Wireless, RF, and Cable ICs
- MAX2653

Related Parts	
MAX2653	GSM900 and DCS1800/PCS1900 Dual-Band, Low-Noise Amplifiers

More Information
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