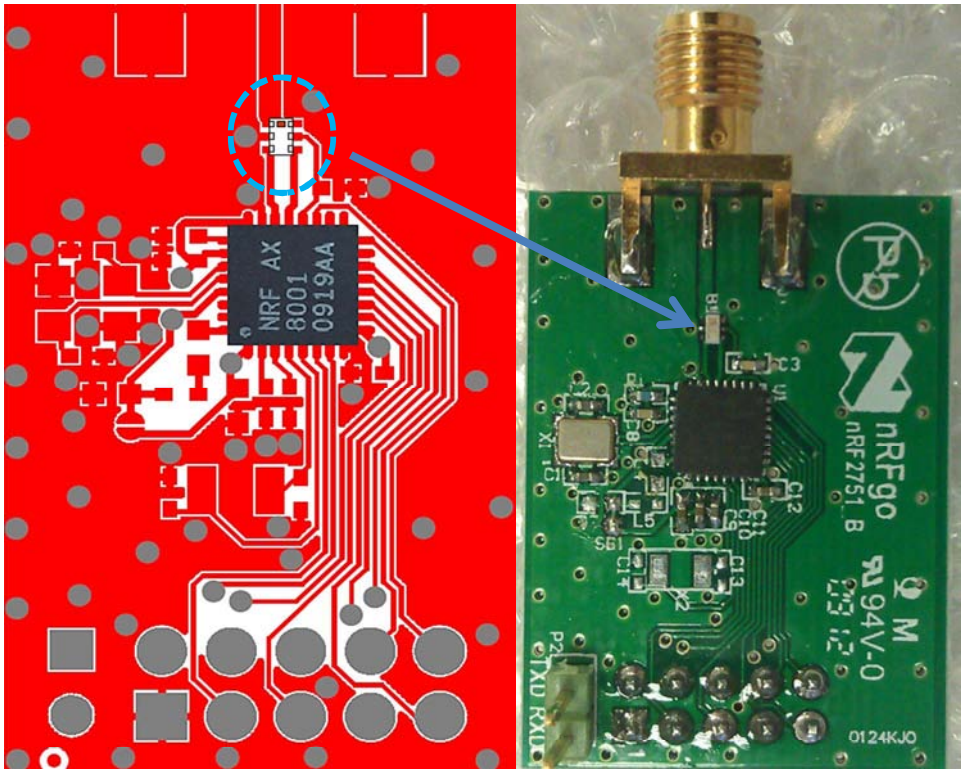
Johanson Technology's RF Front-End Solution
Impedance Matched Balun Filter Integrated Passive for
Nordic's nRF8001 Chipset

June 2012

1. Introduction

The nRF8001 from Nordic Semiconductor is a 2.45GHz is a highly integrated single-chip Bluetooth® low energy Connectivity IC. It integrates a fully compliant Bluetooth v4.0 low energy Radio, Link Layer, and Host stack and features a simple serial interface that supports a wide range of external application microcontrollers.

Johanson Technologyôs, 2450BM14A0002 LPF-Balun was specifically designed for use with the nRF8001 chipset. This matched balun greatly simplifies the RF front-end by considerably reducing component count, system variability, implementation size area, and PCB sensitivity. PCB layout example shown on Figures 1a and 1b.



Figures 1a and 1b. Ref, Design layout example.

The 2450BM14A0002 is an SMD six-pin LTCC device with a small foot print of only 1.6mm X 0.8mm X 0.7mm (EIA 0603). Please refer to Appendix A for the datasheet of balun filter component.

2. Description and Schematics of Reference Designs

Using LTCC integrated monolithic technology, Johanson has developed a solution with a 6-pin impedance-matched chip balun-harmonic filter integrated passive component that is especially matched for the nRF8001 IC, the 2450BM15A0002 providing necessary RF filtering (i.e. FCC, ETSI), a more reliable system, impedance controlled environment, consistency in performance, and a very small RF front end-solution compared to the L/C discrete shown in Figures 1a and 1b.

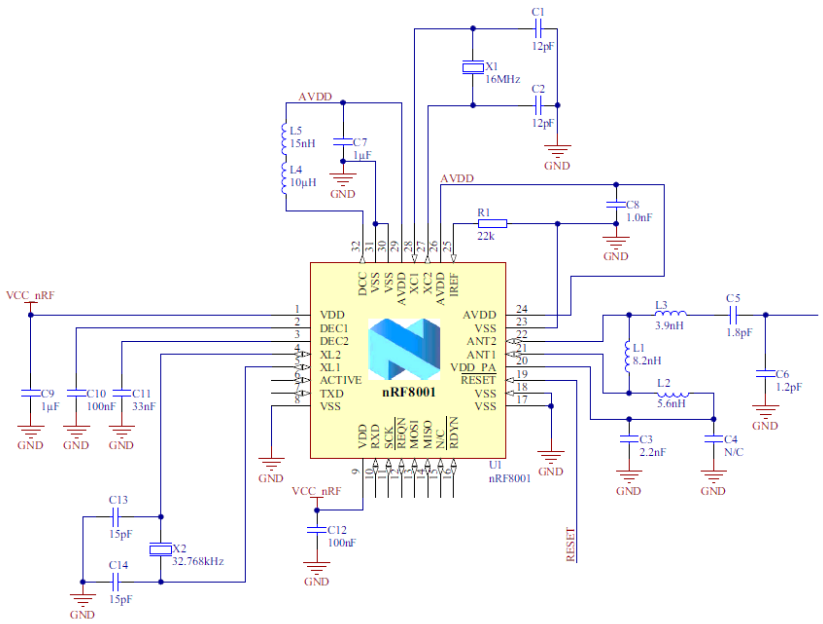


Figure 2a. Discrete L/C Ref. Design solution

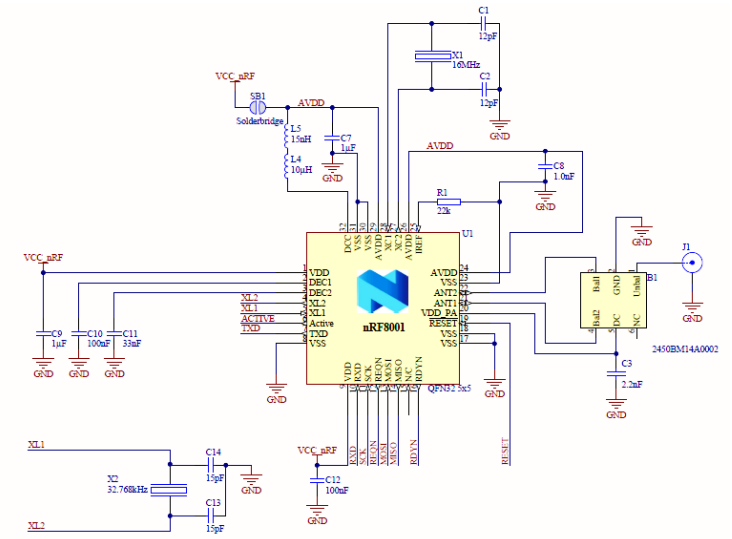


Figure 2b. Integrated Ref. Design solution The rightmost is the JTI impedance-matched balun 2450BM14A0002.

3. Layout

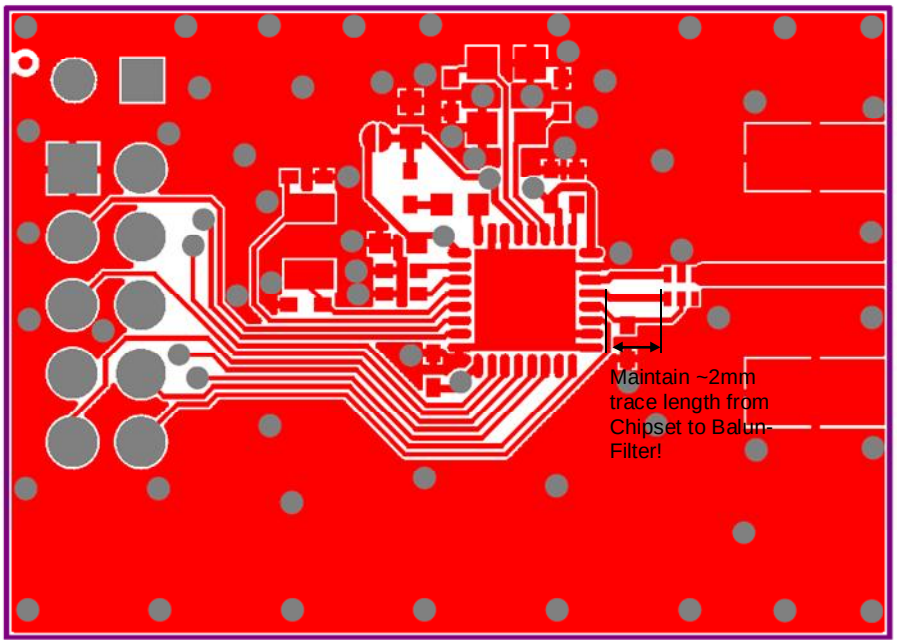


Figure 3. Top Layer for Reference Design

In the event that the reference design cannot be copied to the letter; then, the routing from the RF pins ANT1 and ANT2 must be symmetrical to the matched balun component, 2450BM14A0002. The length of the tracks should be kept to the recommended length (~2mm) and preferably the same length and width that are used in the reference design. This routing must be symmetrical. If it is not, then the output power may be reduced and the harmonics may increase.

The component placement influences the RF performance. It is recommended that the reference PCB layout be copied as closely as possible. In particular, the designer should make note of all dimensions between the nRF8001 and 2450BM14A0002.

To download the gerber files go to: http://johansontechnology.com/nordic

4. Measurement Results

All results presented in this chapter are based on measurements performed with nRF8001 and 2450BM14A0002 Reference Design board. All measurement results presented are the average of each batch tested from typical devices.

Johansonôs 2450BM14A0002 Filter - Balun offers improved suppressed 2nd and 3rd harmonics, it eases implementation and increases margin to FCC/ETSI compliance when compared to solution with discrete passives.

Spectrum analyzer report

Test Name:	Johanson Balun 2mm
Device under test:	nRF8001
Test engineer:	Ketil Aas-Johansen

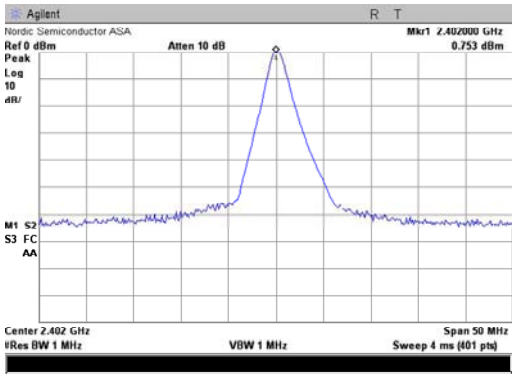


Figure 1: Fundamental

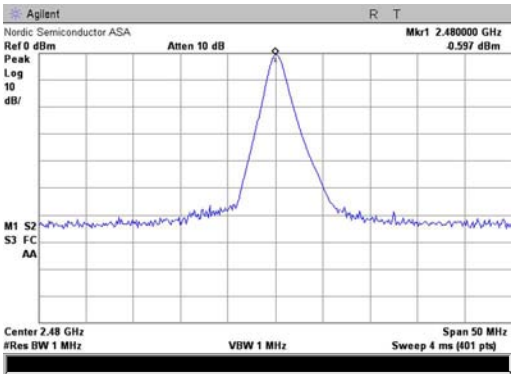


Figure 2: Fundamental Hi

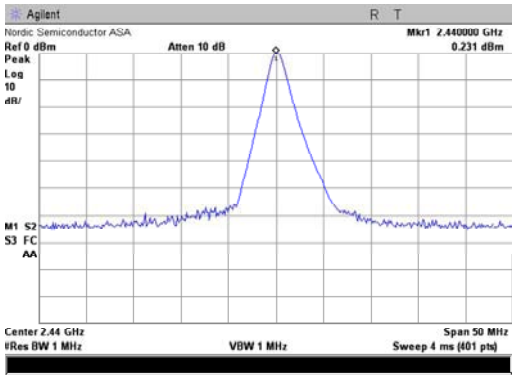


Figure 3: Fundamental Mid

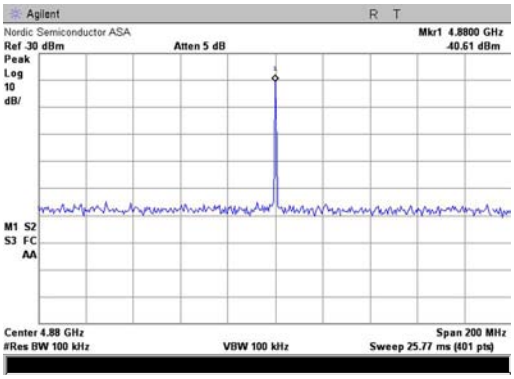


Figure 4: 2nd harmonic

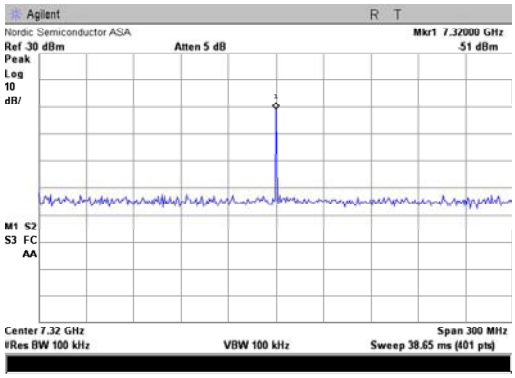


Figure 5: 3rd harmonic

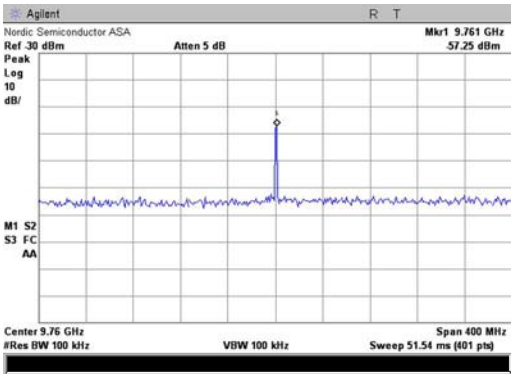


Figure 6: 4th harmonic

	Fundamental	Fundamental Hi	Fundamental Mi	2nd harmonic	3rd harmonic	4th harmonic
Center Frequency [MHz]	2402.00	2480.00	2440.00	4880.00	7320.00	9760.00
Level [dBm]	0.75	-0.60	0.23	-40.61	-51.00	-57.25
Marker Frequency [MHz]	2402.00	2480.00	2440.00	4880.00	7320.00	9761.00

Test Name:	Johanson Balun 2mm
Device under test:	nRF8001
Test engineer:	Ketil Aas-Johansen

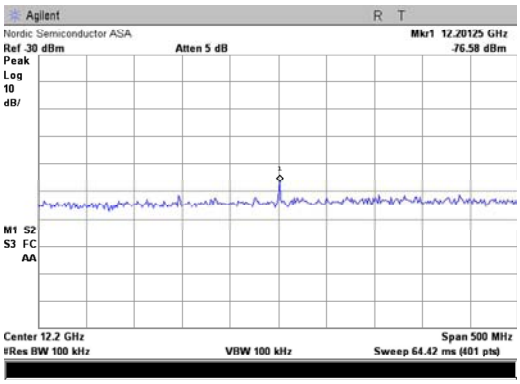


Figure 7: 5th harmonic

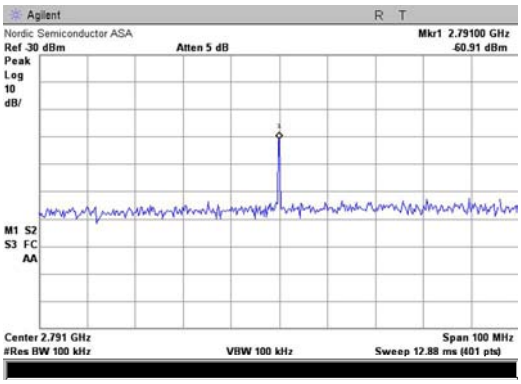


Figure 8: LO

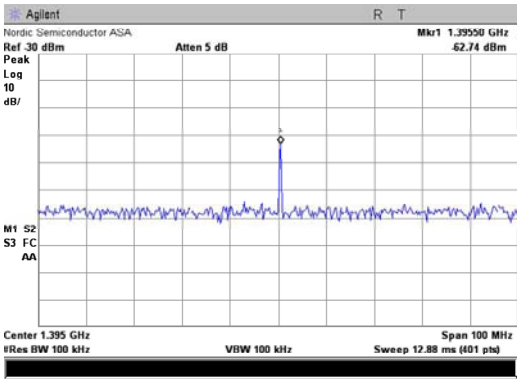


Figure 9: LO/2

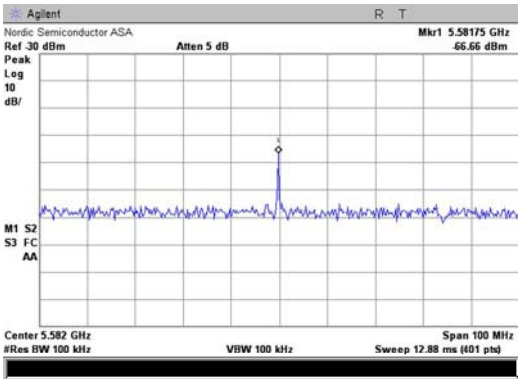


Figure 10: 2LO

	5th harmonic	LO	LO/2	2LO
Center Frequency [MHz]	12200.00	2790.86	1395.43	5581.71
Level [dBm]	-76.58	-60.91	-62.75	-66.66

Appendix A

High Frequency Ceramic Solutions

2.45 GHz Impedance Matched Balun-Filter: Optimized for Nordic's Chipset nRF24L01, nRF24L01+, nRF24LE1, nRF24LU1, nRF24AP2, and nRF8001 **P/N 2450BM14A0002**

Detail Specification: 6/13/2012 Page 1 of 2

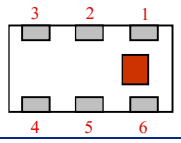
General Specifications	
Part Number	2450BM14A0002
Frequency (MHz)	2400 - 2500
Unbalanced Impedance	50 Ý
Differential Balanced Impedance	Imp. Conjugate match to Nordic nRF24L01, nRF24L01+, nRF24LE1, nRF24LU1, nRF24AP2, and nRF8001
Attenuation: Differential Mode	15 min.@4800~5000MHz 15 min.@7200~7500MHz
Attenuation: Common Mode	20 min.@4800~5000MHz

Insertion Loss	2.0 dB max.
Return Loss	9.5 dB min.
Phase Difference	160° ± 15°
Amplitude Difference	3.5 ± 1.5 dB
Reel Quanity	4,000
Operating Temperature	-40 to +85°C
Recommended Storage Conditions	+5 to +35°C, Humidity: 45-75%RH, 18 mos. Max

Part Number Explanation				
P/N Suffix	Packaging Style*	Bulk	Suffix = S	Eg. 2450BM14A0002S
		T & R	Suffix = T	Eg. 2450BM14A0002T
	Termination Style	100% Tin	Suffix = None	Eg. 2450BM14A0002(T or S)
		Tin / Lead	Please consult Factory	

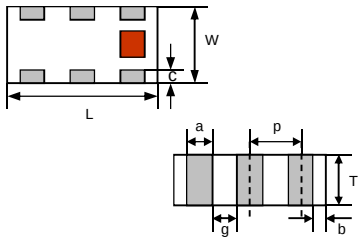
For more pakaging info go to: http://www.johansontechnology.com/ipcpackaging.html

Terminal Configuration	
No.	Function
1	Unbalanced Port
2	GND
3	Balanced Port
4	Balanced Port
5	DC Feed+RF GND or GND
6	NC



Mechanical Dimensions

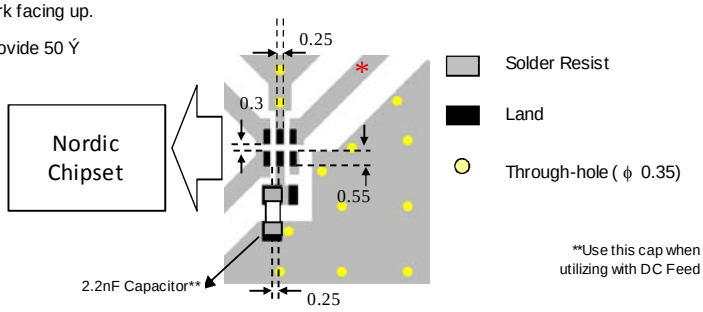
	In	mm
L	0.063 ± 0.004	1.60 ± 0.10
W	0.031 ± 0.004	0.80 ± 0.10
T	0.024 ± 0.004	0.60 ± 0.10
a	0.008 ± 0.004	0.20 ± 0.10
b	0.008 +.004/-.006	0.20 +0.1/-0.15
c	0.006 ± 0.004	0.15 ± 0.10
g	0.012 ± 0.004	0.30 ± 0.10
p	0.020 ± 0.002	0.50 ± 0.05



Mounting Considerations

Mount these devices with maroon mark facing up.

*Line width should be designed to provide 50 Ý impedance matching characteristics.



Units: mm

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www.johansontechnology.com
4001 Calle Tecate ÅCamarillo, CA 93012 ÄTEL 805.389.1166 FAX 805.389.1821

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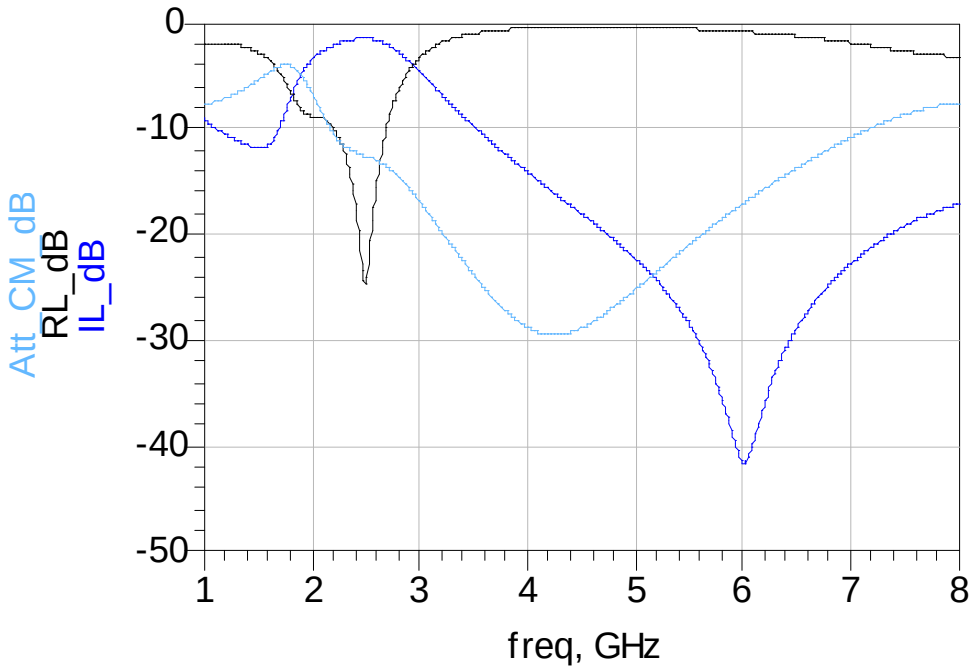
2.45 GHz Impedance Matched Balun-Filter: Optimized for Nordic's Chipset nRF24L01, nRF24L01+, nRF24LE1, nRF24LU1, nRF24AP2, and nRF8001 **P/N 2450BM14A0002**

Detail Specification: 6/13/2012

Typical RF Electrical Performance (T=25°C)



For reference design notes and additional technical info please visit our Nordic Semiconductor dedicated page at:

http://johansontechnology.com/nordic

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