

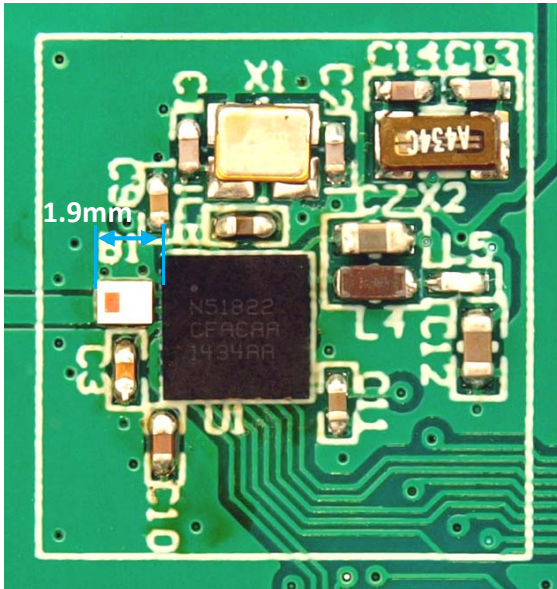
High Frequency Ceramic Solutions

Application Note: AN020

Date: 03/19/2015

M.Carmona/I.Johnson

Application Note for Nordic Semiconductor's CSP package: nRF51822-CEAA, nRF51822-CDAB, nRF51822-CFAC, nRF51422-CEAA, nRF51422-CDAB, nRF51422-CFAC chipsets using Johanson's Integrated RF Front End Solution Impedance Matched Balun Filter (BPF)



Abstract

The nRF51822-CEAA, nRF51822-CDAB, nRF51822-CFAC, nRF51422-CEAA, nRF51422-CDAB, nRF51422-CFAC devices from Nordic Semiconductor are powerful, highly flexible, multiprotocol SoCs designed for Bluetooth® low energy, ANT, and 2.4 GHz ultra-low power wireless applications. The devices are built around an ARM® Cortex™ CPU and integrate fully compliant Bluetooth low energy and ANT stacks. The devices also include a rich selection of analog and digital peripherals - such as ADC, serial interfaces, PWM, and quadrature demodulator - that can be used in a wide range of ultra-low power applications.

This application note describes how to use Johanson Technology's 2450BM08B0003 balun-filter, shares active measured results obtained with the chipsets, provides design files for ease of use on any PCB/Application environment and RF technical support contact info at Johanson Technology.

Introduction

In partnership with Nordic Semiconductor, Johanson Technology has developed an 5-pin LGA EIA 0604 (1.4mmx1.0mmx0.69mm) ceramic passive device that contains the following functions:

- Differential complex impedance ($X+jY$) matching network for the nRF51x22-CxAx CSP family chipsets
- Differential to 50Ω single-ended balun
- Specifically designed BPF to pair with the nRF chipsets for FCC/ETC (+Korea, Japan, China) emissions compliance

This front-end 5-pin device considerably reduces implementation size area by using smaller effective PCB real estate usage. Also, it reduces component count, eliminates RF variability (100% RF tested before T&R), and offers excellent temperature stability (4ppm). AEC-Q200 available.

Design/gerber/layout files download link

www.johansontechnology.com/nordic

Technical Support

www.johansontechnology.com/component/techquestion



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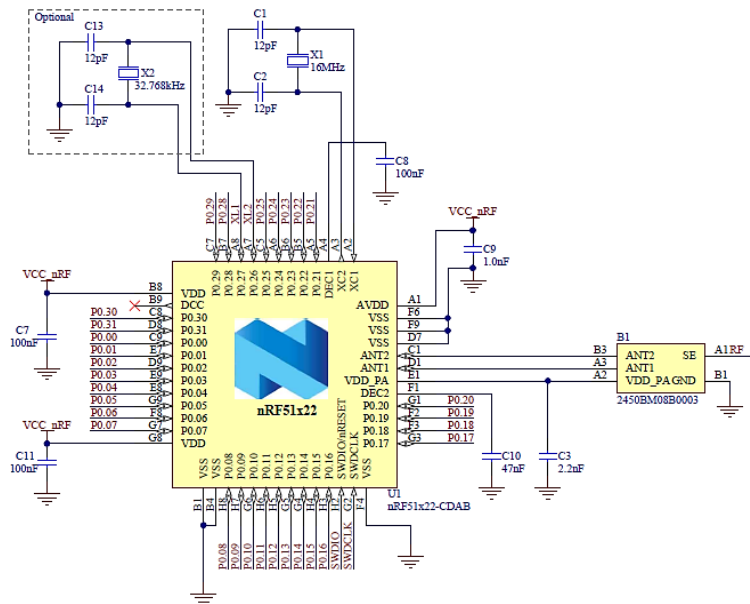
Application Note: AN020

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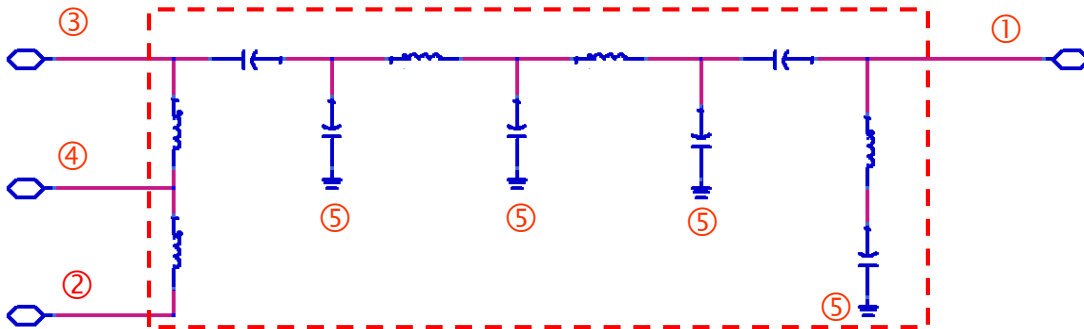
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Application Note for Nordic Semiconductor's CSP package: nRF51822-CEAA, nRF51822-CDAB, nRF51822-CFAC, nRF51422-CEAA, nRF51422-CDAB, nRF51422-CFAC chipsets using Johanson's Integrated RF Front End Solution Impedance Matched Balun Filter (BPF)

Schematic nRF51x22-CDAB & balun-filter 2450BM08B0003



2450BM08B0003 Internal Representative Schematic



To perform parametric simulations with our balun-filter, you can download the s-parameter file at:
www.johansontechnology.com/nordic

High Frequency Ceramic Solutions

Application Note: AN020

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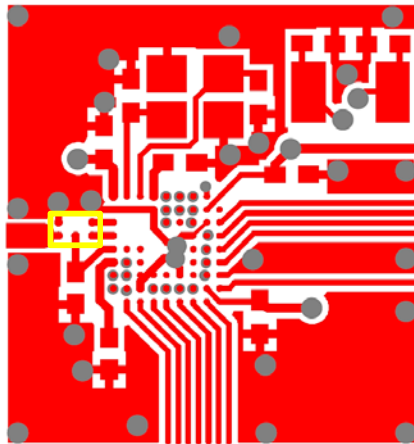
Application Note for Nordic Semiconductor's CSP package: nRF51822-CEAA, nRF51822-CDAB, nRF51822-CFAC, nRF51422-CEAA, nRF51422-CDAB, nRF51422-CFAC chipsets using Johanson's Integrated RF Front End Solution Impedance Matched Balun Filter (BPF)

Johanson 2450BM08B0003 component Description

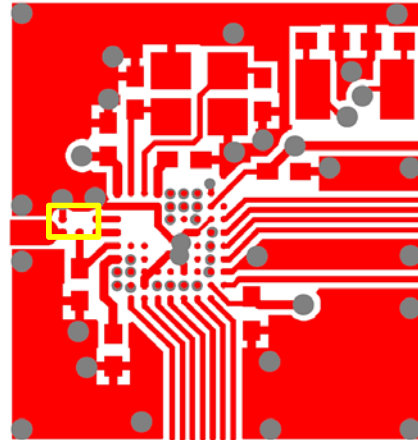
Johanson uses 6/6 RoHS Green Low-Temperature-CoFired-Ceramic (LTCC) integrated passive technology in a 5-pin (LGA bottom-only pads) monolithic structure. This component is 100% RF Tested, making it a more reliable RF contained system, impedance controlled environment, and consistent-guaranteed RF performance in a very small RF front end-solution compared to the L/C discrete solution.

Layout of nRF & balun-filter 2450BM08B0003

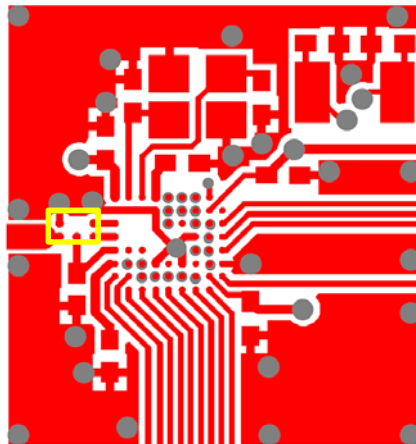
nRF51x22-CFAC reference design



nRF51x22-CEAA reference design



nRF51x22-CDAB reference design



Download the layout/gerber files, BOM, etc at: www.johansontechnology.com/nordic

Contact our RF Applications Engineers to revise your layout at: <http://www.johansontechnology.com/component/techquestion>



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Application Note for Nordic Semiconductor's CSP package: nRF51822-CEAA, nRF51822-CDAB, nRF51822-CFAC, nRF51422-CEAA, nRF51422-CDAB, nRF51422-CFAC chipsets using Johanson's Integrated RF Front End Solution Impedance Matched Balun Filter (BPF)

Measured Conductive measurements of 2450BM08B0003 + nRF51x22-CxAx CSP family chipsets on Reference Design PCB

+4 dBm Setting		nRF51822-CEAAEA		nRF51822-CDABAA		nRF51822-CFACAA	
Board identifier		Board 3	Board 4	Board 5	Board 6	Board 7	Board 8
	Frequency	2450BM08B0003	2450BM08B0003	2450BM08B0003	2450BM08B0003	2450BM08B0003	2450BM08B0003
Fundamental	2,402.00	3.40	3.00	3.45	2.95	2.86	2.88
2nd harmonic	4,804.00	-72.85	-62.44	-70.12	-59.13	-68.65	-73.61
3rd harmonic	7,206.00	-58.78	-56.26	-53.64	-56.77	-56.73	-58.30
4th harmonic	9,608.00	-72.49	-77.27	-74.32	-72.99	-71.80	-75.01
5th harmonic	12,010.00	-60.71	-64.58	-56.75	-58.97	-61.54	-59.13
LO	2,747.43	-75.70	-75.78	-73.91	-74.04	-71.48	-70.84
LO/2	1,373.71	-80.30	-81.54	-80.86	-80.33	-80.60	-80.09
2LO	5,494.86	-71.60	-65.85	-71.13	-73.64	-79.33	-78.39
Fundamental Hi	2,480.00	3.80	3.76	3.92	3.72	3.48	3.13
2nd harmonic	4,960.00	-51.82	-56.92	-50.78	-54.73	-50.77	-52.63
3rd harmonic	7,440.00	-45.30	-45.01	-41.13	-44.98	-44.11	-45.01
4th harmonic	9,920.00	-74.43	-78.38	-72.04	-74.13	-70.33	-79.95
5th harmonic	12,400.00	-50.86	-51.08	-43.58	-45.90	-46.88	-46.29
LO	2,836.57	-70.21	-71.13	-71.28	-71.40	-68.95	-66.45
LO/2	1,418.29	-80.51	-80.79	-80.83	-79.82	-80.35	-79.54
2LO	5,673.14	-68.67	-67.39	-69.31	-70.33	-73.77	-72.93
Fundamental Mid	2,440.00	3.85	3.58	3.86	3.57	3.36	3.18
2nd harmonic	4,880.00	-46.70	-50.70	-46.57	-49.34	-46.53	-48.52
3rd harmonic	7,320.00	-47.55	-47.80	-43.38	-47.73	-46.58	-47.59
4th harmonic	9,760.00	-61.15	-69.11	-62.31	-62.87	-59.70	-65.26
5th harmonic	12,200.00	-45.39	-47.68	-39.78	-41.11	-43.88	-43.21
LO	2,790.86	-75.33	-77.78	-72.62	-73.16	-71.87	-68.09
LO/2	1,395.43	-79.82	-81.84	-80.88	-81.83	-80.93	-79.23
2LO	5,581.71	-69.38	-65.96	-69.13	-71.99	-76.05	-75.16

0 dBm Setting		nRF51822-CEAAEA		nRF51822-CDABAA		nRF51822-CFACAA	
Board identifier		Board 3	Board 4	Board 5	Board 6	Board 7	Board 8
	Frequency	2450BM08B0003	2450BM08B0003	2450BM08B0003	2450BM08B0003	2450BM08B0003	2450BM08B0003
Fundamental	2,402.00	0.11	-0.74	0.13	-1.07	-0.88	-0.75
2nd harmonic	4,804.00	-43.97	-44.62	-44.03	-44.27	-42.67	-44.20
3rd harmonic	7,206.00	-64.21	-61.28	-59.17	-60.75	-61.35	-63.31
4th harmonic	9,608.00	-68.05	-73.95	-71.18	-71.25	-69.42	-73.06
5th harmonic	12,010.00	-61.91	-64.27	-57.49	-58.92	-60.90	-59.41
LO	2,747.43	-74.50	-75.46	-74.23	-74.49	-71.16	-70.74
LO/2	1,373.71	-79.98	-81.41	-80.91	-80.12	-80.37	-78.99
2LO	5,494.86	-71.25	-66.22	-71.17	-73.74	-79.88	-77.82
Fundamental Hi	2,480.00	1.13	0.71	1.28	0.42	0.54	0.07
2nd harmonic	4,960.00	-49.55	-50.29	-49.47	-49.34	-47.65	-49.33
3rd harmonic	7,440.00	-59.33	-56.50	-55.42	-56.53	-57.23	-56.44
4th harmonic	9,920.00	-69.27	-73.28	-70.73	-71.74	-68.51	-71.27
5th harmonic	12,400.00	-57.28	-57.26	-50.97	-53.51	-53.13	-51.06
LO	2,836.57	-70.89	-72.53	-70.81	-70.68	-69.60	-66.65
LO/2	1,418.29	-81.04	-79.82	-81.00	-82.37	-79.27	-79.82
2LO	5,673.14	-68.35	-67.82	-69.33	-70.29	-73.73	-72.73
Fundamental Mid	2,440.00	0.95	0.24	1.05	0.05	0.11	-0.08
2nd harmonic	4,880.00	-47.86	-47.68	-47.59	-47.39	-45.70	-47.85
3rd harmonic	7,320.00	-70.99	-61.90	-65.36	-60.88	-62.52	-66.82
4th harmonic	9,760.00	-67.38	-72.56	-69.98	-70.09	-67.38	-70.55
5th harmonic	12,200.00	-55.37	-59.88	-49.62	-55.22	-55.99	-53.48
LO	2,790.86	-74.48	-77.98	-73.35	-73.33	-72.14	-68.62
LO/2	1,395.43	-82.16	-79.89	-80.41	-80.53	-79.73	-81.85
2LO	5,581.71	-69.43	-66.22	-69.87	-71.21	-75.76	-74.31

If you'd like to see other test result's frequencies contact our RF Applications Engineers to revise your layout at:
<http://www.johansontechnology.com/component/techquestion>



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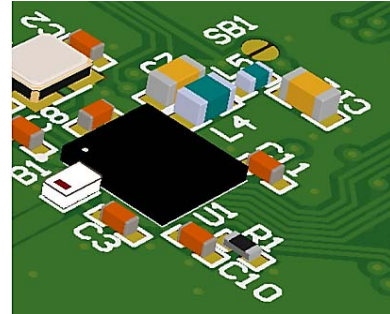
2.45GHz Impedance Matched Balun + Band Pass Filter: Optimized for Nordic's Chipset nRF51822-CEAA, nRF51822-CDAB, nRF51822-CFAC, nRF51422-CEAA, nRF51422-CDAB, nRF51422-CFAC

P/N 2450BM08B0003

Detail Specification: 3/20/2015

General Specifications

Part Number	2450BM08B0003
Frequency (MHz)	2400 - 2500
Unbalanced Impedance	50 Ω
Balanced Differential Impedance	Conjugate match to nRF51822-CEAA, nRF51822-CDAB, nRF51822-CFAC, nRF51422-CEAA, nRF51422-CDAB, nRF51422-CFAC
Average Insertion Loss when connected to the nRF51XX chipset (Active OP)	1dB Typ@25C 1.5dB max. (-45 to +85C)
Insertion Loss when component measured by itself (passive insertion loss)	1.88 typ. dB
Return Loss (dB)	14 Typ./9.5 min.
Attenuation Differential mode (dB):	
24 typ. /15dB min. @ 800-928 MHz	
20 typ. / 10dB min. @ 1000-1200 MHz	
36 typ. / 14dB min. @ 4800-5000 MHz	
25 typ. / 15dB min. @ 7200-7500 MHz	



Phase Difference (degree)	180° ± 10
Amplitude Difference	2.0 max.
Qty/Reel (pcs)	4,000
Operating Temperature Range	-40 ~ +85°C
Storage Temperature Range	-40 ~ +85°C
Storage Period	18 months max.
Power Capacity	2W max (CW)

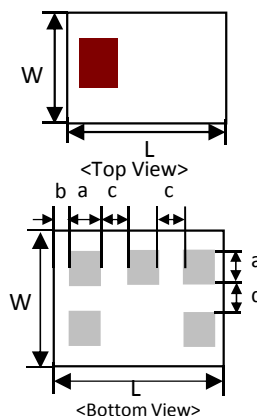
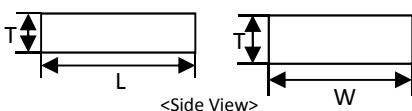
You can download layout files, schematics, and measured s-parameters of this component at: <http://johansontechnology.com/nordic>

Part Number Explanation

P/N Suffix	Packaging Style	Bulk	Suffix = S	E.g.. 2450BM08B0003S
		T & R	Suffix = T	E.g.. 2450BM08B0003T
	Termination Style	100% Tin	Suffix = None	E.g.. 2450BM08B0003(T or S)

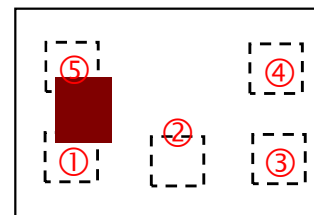
Mechanical Dimensions

	Inches	Millimeter
L	0.055 ± 0.006	1.40 ± 0.15
W	0.039 ± 0.006	1.00 ± 0.15
T	0.027 max.	0.69 max.
a	0.009 +/- 0.002	0.22 +/- 0.05
b	0.004 +/- 0.002	0.0975 +/- 0.05
c	0.011 +/- 0.002	0.28 +/- 0.05
d	0.007 +/- 0.002	0.18 +/- 0.05



Terminal Configuration

No	Function	No	Function
1	Unbalanced Port	4	Balanced Port
2	DC Feed	5	GND
3	Balanced Port		



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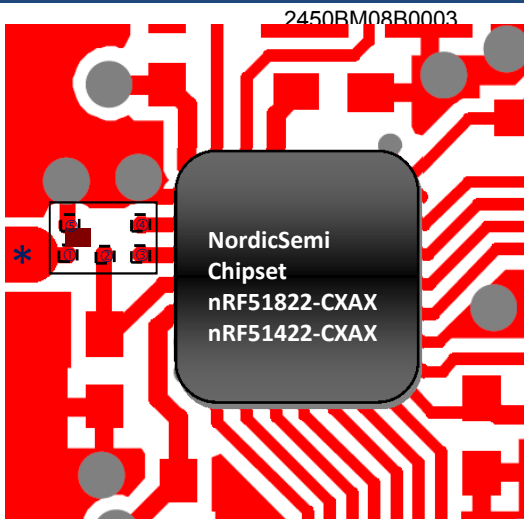
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2.45GHz Impedance Matched Balun + Band Pass Filter: Optimized for Nordic's Chipset nRF5188-CEAA, nRF5188-CDAB, nRF5188-CDAB, nRF51422-CEAA, nRF51422-CDAB, nRF51422-CFAC

P/N 2450BM08B0003

Detail Specification: 3/20/2015

Mounting Considerations



* Line width should be designed to match 50Ω characteristic impedance, depending on PCB material and thickness.

Land

Through-hole (ϕ 0.3)

Download the gerber files at:

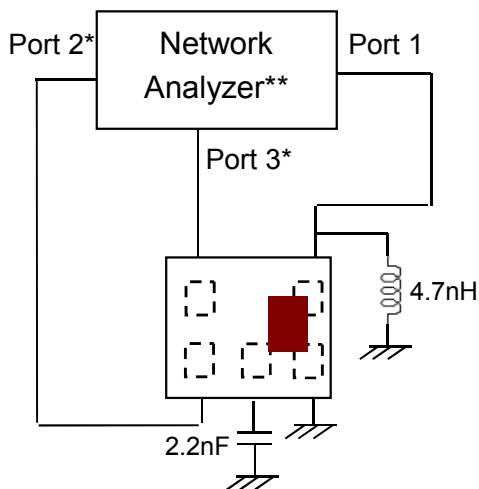
www.johansontechnology.com/nordic

Would you like us to review your layout for free? Please go to this link to contact our RF team:

www.johansontechnology.com/component/techquestion/

If you need 2.45GHz **micro-antennas** to go with your compact design, go to: <http://johansontechnology.com/antennas>

Measuring Diagram



Port 1: Unbalanced Port
Ports 2 and 3: Balanced Port

$$IL = S_{ds21}$$

$$RL = S_{ss11}$$

$$\text{Amp_balance} = \text{dB}(S(2,1)/S(3,1))$$

$$\text{Phase_balance} = \text{Phase}(S(2,1)/S(3,1))$$

*Impedance for ports 2 and 3
= Conjugate to Balanced Impedance/2

**E5071C from Agilent

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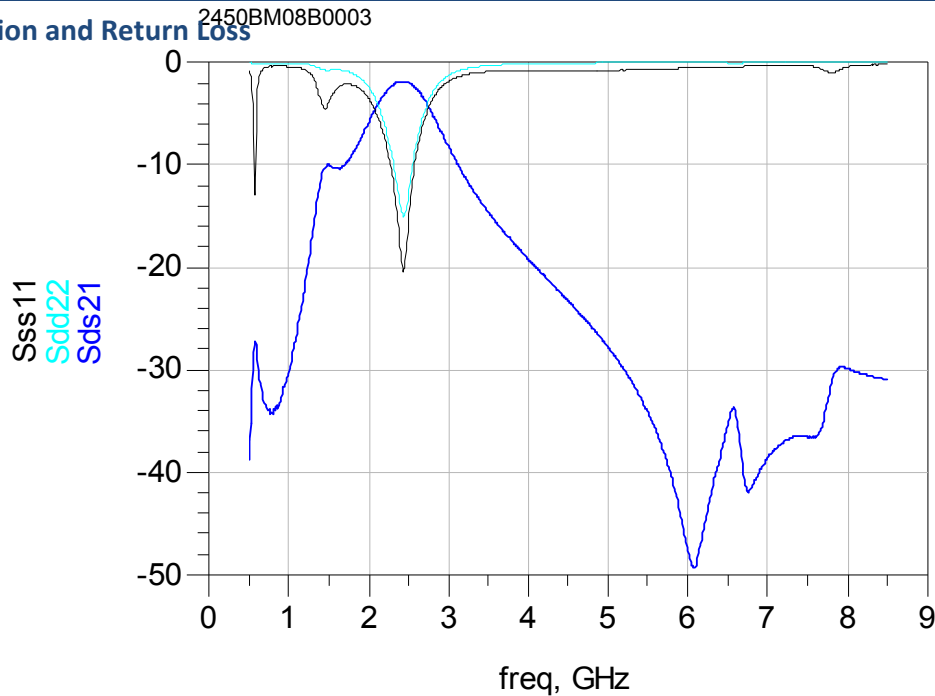
2.45GHz Impedance Matched Balun + Band Pass Filter: Optimized for Nordic's Chipset nRF5188-CEAA, nRF5188-CDAB, nRF5188-CDAB, nRF51422-CEAA, nRF51422-CDAB, nRF51422-CFAC

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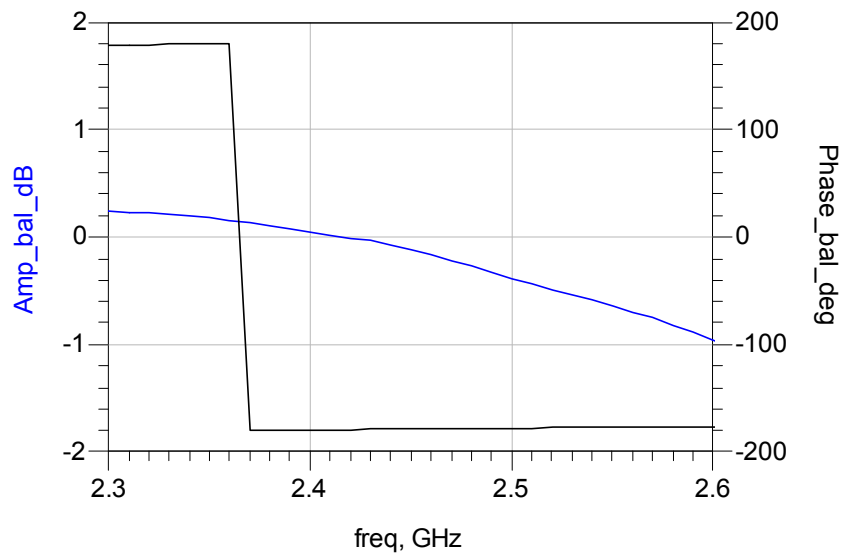
Detail Specification: 3/20/2015

Typical Electrical Characteristics (T=25°C)

Insertion and Return Loss



Amplitude and Phase Balance



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P/N 2450BM08B0003

Detail Specification: 3/20/2015

Application Notes, Layout Files, and more

<http://johansontechnology.com/nordic>

Packaging information

www.johansontechnology.com/ipcpackaging.html

Soldering Information

www.johansontechnology.com/ipcsoldering-profile

MSL Info

www.johansontechnology.com/technical-notes/msl-rating.html

Recommended Storage Condition and Max Shelf Life

www.johansontechnology.com/ipcstorage-shelflife

RoHS Compliance

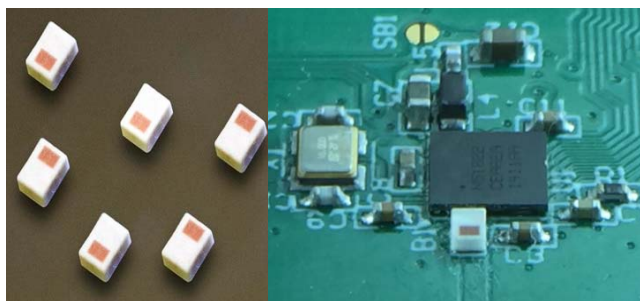
www.johansontechnology.com/technical-notes/rohs-compliance.html

Antenna layout and tuning techniques

www.johansontechnology.com/tuning

Antenna layout review, tuning, and characterization services

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Application Image

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