AN1409: EFR32xG28 Sub-GHz and 2.4 GHz Dual-Band Requirements

The EFR32xG28 chip family provides sub-GHz and 2.4 GHz dual-band functionality that requires special design considerations. This application note provides guidance on how to utilize both the sub-GHz and 2.4 GHz port of the device, and shows recommended matching networks and layout for both bands.

Note: This document does not address detailed matching procedures. The 2.4 GHz matching procedure is described in application note AN930.2: EFR32 Series 2 2.4 GHz Matching Guide. The sub-GHz matching procedure is described in application note, AN923.2: EFR32 Series 2 sub-GHz Matching Guide. For more detailed information on PCB layout requirements for proper operation, refer to application note, AN928.2: EFR32 Series 2 Layout Design Guide.

KEY FEATURES

- Provides instructions on how to design dual-band devices
- Specifically discusses the 868/915 MHz + 2.4 GHz use case
- Recommended matching networks for both bands
- Layout design considerations for dual-band applications

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1. Recommended Matching Networks

For the sub-GHz bands in the range of 169 - 470 MHz, no special precautions are needed. Both sub-GHz and 2.4 GHz ports can be used with the matching networks shown below, with separate antennas for each band.

For the 868/915 MHz band, an RF switch is needed to ground the end of the 2.4 GHz matching path to minimize the coupling of the 3rd harmonic of the sub-GHz frequency to the 2.4 GHz antenna when transmitting at 868/915 MHz.

Note: All the parts recommended below are in SMD0201 footprint size.

1.1 Sub-GHz Match Networks

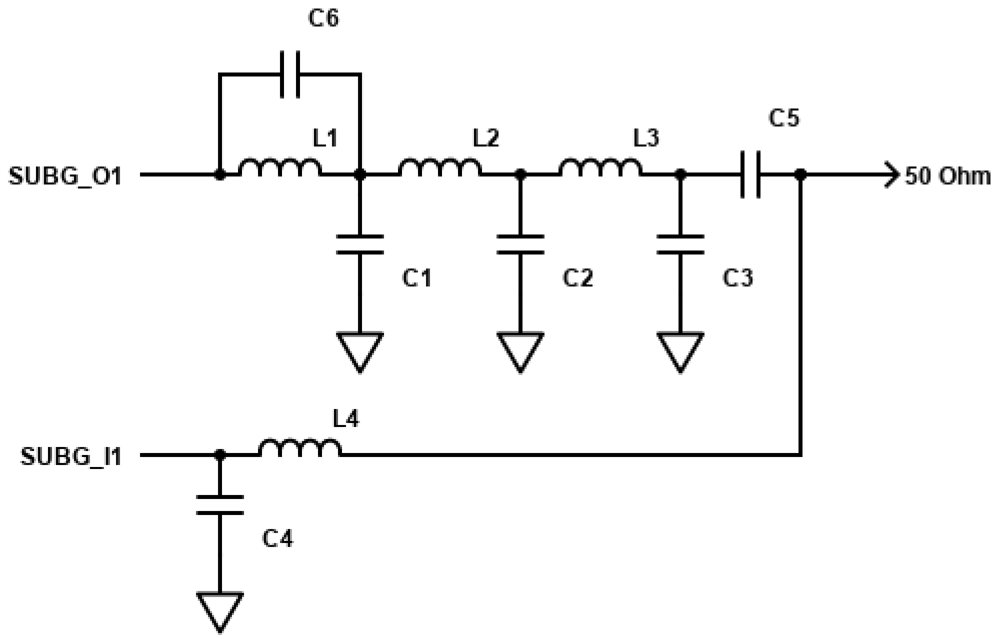

Figure 1.1. Typicl Sub-GHz FR Matching Network Circuit

Table 1.1. Summary of Matching Network Component Values vs. Frequency

Freq. Band	P_{OUT}	PAVDD	L1	L2	L3	L4	C1	C2	C3	C4	C5	C6
169 MHz	10 dBm	1.8 V	22 nH	47 nH	51 nH	220 nH	33 pF	27 pF	15 pF	2.6 pF	220 pF	N.M.
	20 dBm	3.3 V	12 nH	40 nH	51 nH	220 nH	62 pF	27 pF	16 pF	2.6 pF	220 pF	N.M.
315 MHz	10 dBm	1.8 V	22 nH	47 nH	0R	150 nH	15 pF	9.2 pF	N.M.	N.M.	220 pF	N.M.
434 MHz	10 dBm	1.8 V	20 nH	39 nH	0R	82 nH	8.5 pF	4.6 pF	N.M.	N.M.	220 pF	N.M.
470 MHz	17 dBm	3.3 V	5.1 nH	9.1 nH	30 nH	68 nH	N.M.	10 pF	7.6 pF	N.M.	220 pF	N.M.
868 MHz 915 MHz	20 dBm	3.3 V	1.5 nH	1.3 nH	13 nH	18 nH	N.M.	7.2 pF	1.3 pF	N.M.	220 pF	1.9 pF
868 MHz 915 MHz	14 dBm	1.8 V	4.2 nH	16 nH	0R	18 nH	5.9 pF	2.1 pF	N.M.	N.M.	220 pF	N.M.

1.2 2.4 GHz matching network

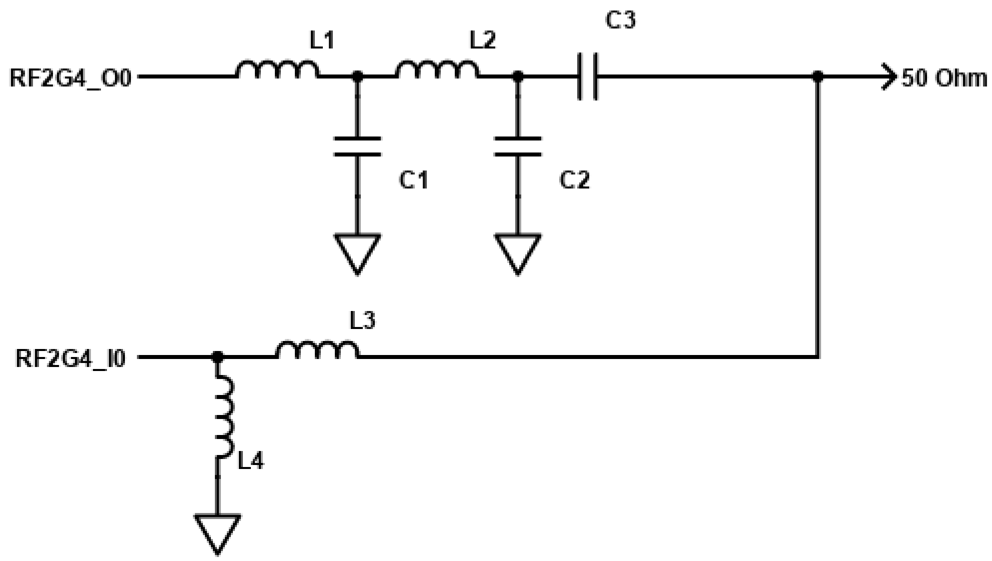

Figure 1.2. 2.4 GHz RF Matching Network Circuit

Table 1.2. 2.4 GHz Matching Network Component Values

Freq. Band	P_{OUT}	PAVDD	L1	L2	L3	L4	C1	C2	C3
2.4 GHz	10 dBm	1.8 V	3 nH	8.2 nH	3.1 nH	1.8 nH	1 pF	0.3 pF	19 pF

1.3 Special Case: 868/915 MHz + 2.4 GHz Dual-Band Matching Network

This dual-band board setup needs attention, because the 3rd harmonic of the sub-GHz band can be radiated out from the 2.4 GHz antenna, due to the coupling of the 3rd harmonic of the sub-GHz band to the 2.4 GHz path (especially, through the bonding wires). The 3rd harmonic of 868/915 MHz is at 2.6 – 2.7 GHz, close to the other path's fundamental frequency of 2.4 GHz, so that path does not attenuate it.

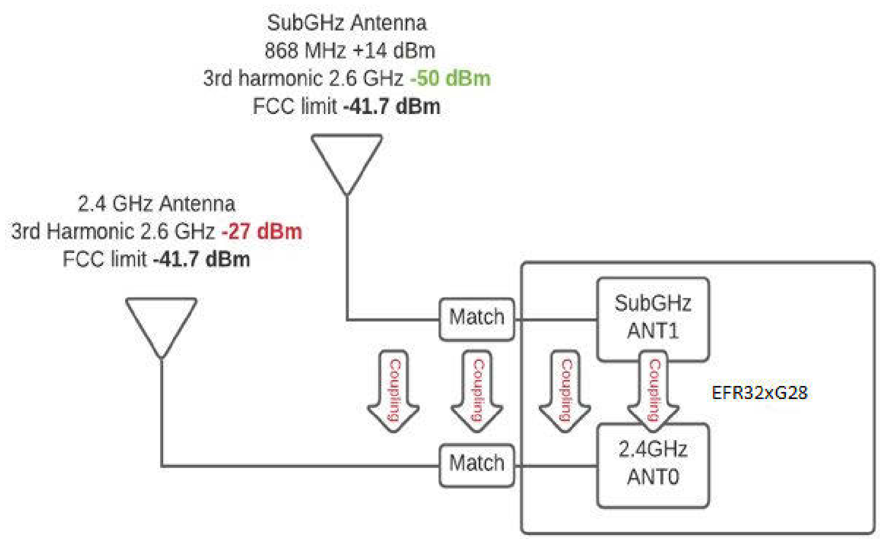

Figure 1.3. 3rd Harmonic Coupling at 868 MHz 14 dBm

The solution is to add an external RF switch to connect the output of the 2.4 GHz matching network to ground, through 50 Ω, when using the sub-GHz RF front-end. This switch will be activated before a sub-GHz transmission starts, so the path through the 2.4 GHz matching network will be terminated before the 2.4 GHz antenna input.

IF THE SOLUTION BELOW IS NOT IMPLEMENTED, THE SYSTEM WILL FAIL FCC RESTRICTED BAND REQUIREMENTS!

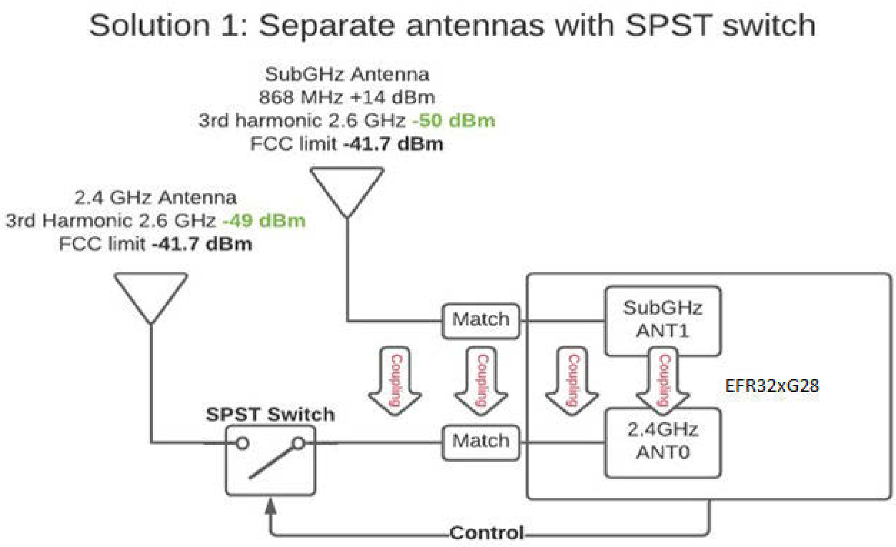

Figure 1.4. Solution to 3rd Harmonic Coupling at 868 MHz 14 dBm

1.3.1 Application Schematic For 868/915 MHz Dual Band RF Matching

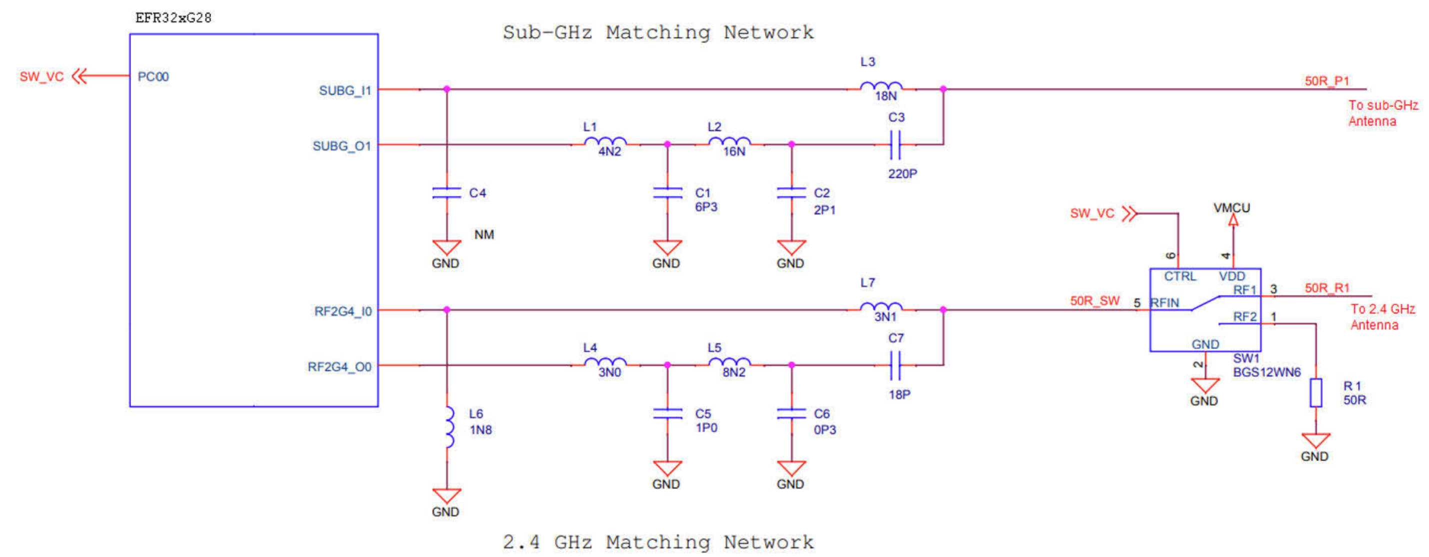

Figure 1.5. 868/915 MHz +14 dBm Dual Band Matching with Ground Switch for 2.4 GHz +10 dBm

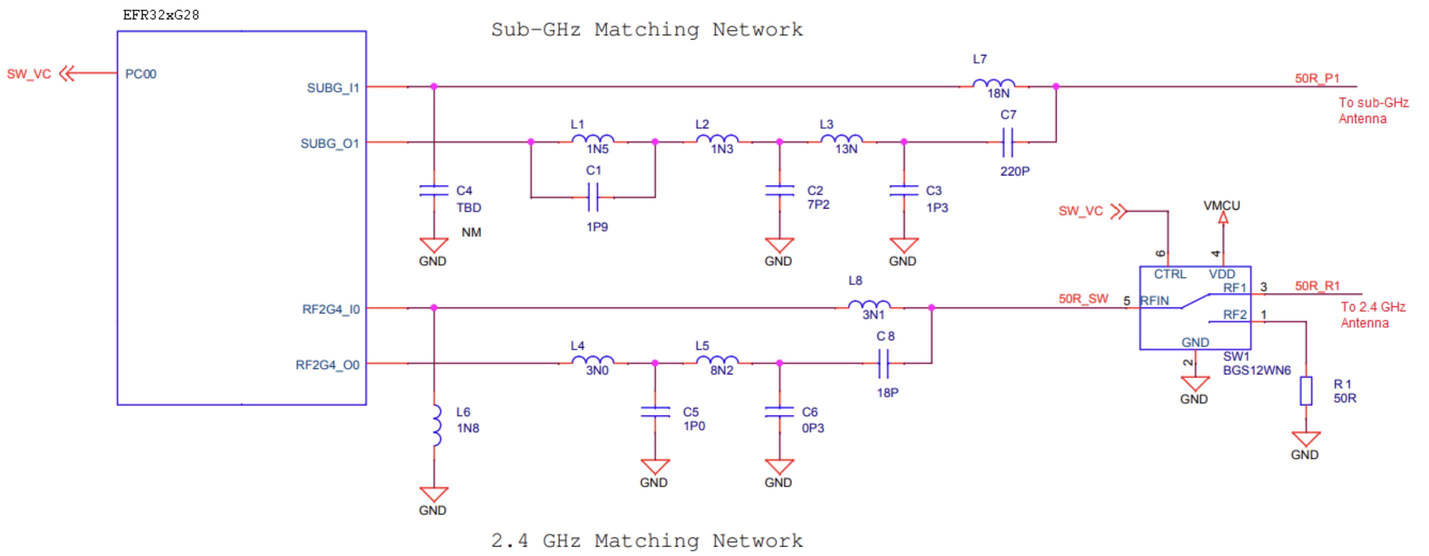

Figure 1.6. 868/915 MHz +20 dBm Dual Band Matching with Ground Switch for 2.4 GHz +10 dBm

1.3.2 RF Switch Parameters

If the switch recommended by Silicon Labs may not be available, here are the requirements for a replacement:

- Minimal Insertion Loss at 2.4 GHz (~0.3-0.4 dB)
- One control pin
- 3 RF Ports (RFIN, RF1, RF2)
- Max Input Power >= 10dBm
- At least 25 dB isolation between ports

1.3.3 RF Switch Special Layout Considerations

- Use DC blocking capacitors, if needed (the one used in Radio Board reference designs does not need DC blocking)
- RF Switches need low-impedance ground connection, so ground vias at the exposed pad or any other grounding pin are neces-sary
- Place the 50 Ω load as close as possible
- If another RF switch is chosen (with higher non-linearity) then TX output filtering after the switch may be needed

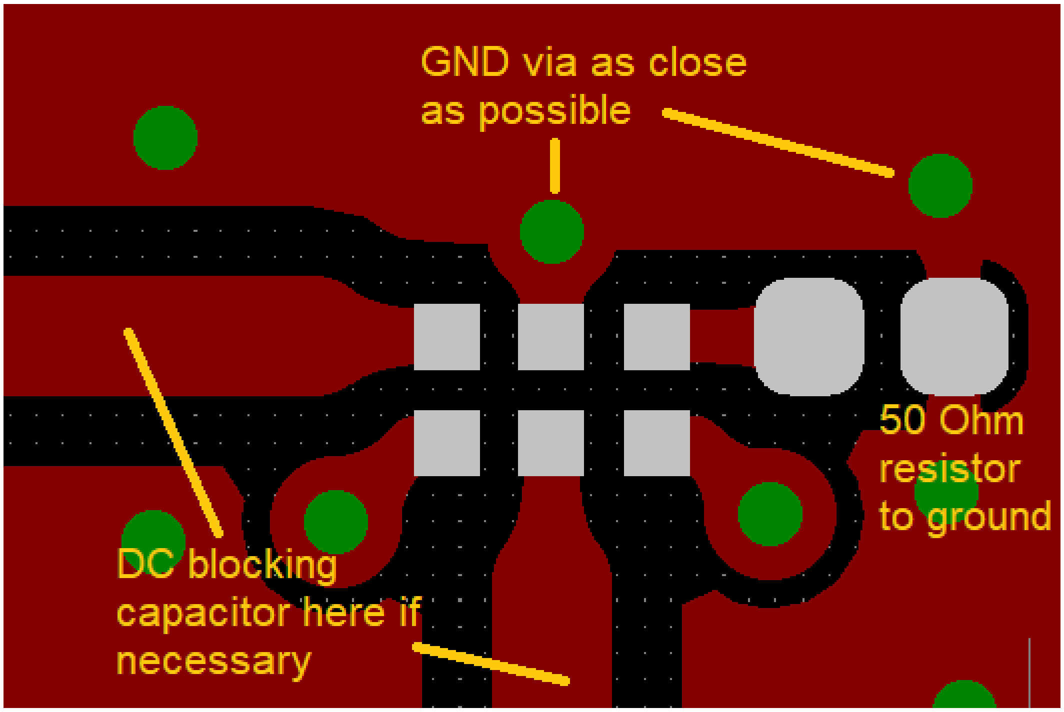

Figure 1.7. RF Switch Layout for Dual Band Matching

2. Reference Designs

- BRD4400B: EFR32xG28 868/915 MHz 14 dBm + 2.4 GHz 10 dBm Radio Board with active RF switch
- BRD4400C: EFR32xG28 868/915 MHz 14 dBm + 2.4 GHz 10 dBm Radio Board with passive RF switch
- BRD4401B: EFR32xG28 868/915 MHz 20 dBm + 2.4 GHz 10 dBm Radio Board with active RF switch
- BRD4401C: EFR32xG28 868/915 MHz 20 dBm + 2.4 GHz 10 dBm Radio Board with passive RF switch

3. Revision History

Revision 0.1

August 2023

- Initial draft

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