AN-1484
APPLICATION NOTE

One Technology Way • P.O. Box 9106 • Norwood, MA 02062-9106, U.S.A. • Tel: 781.329.4700 • Fax: 781.461.3113 • www.analog.com

Johanson Technology Impedance Matched, Integrated Passive Filter Balun for Use with ADF7023, ADF7023-J, and ADF7024

by Liam O'Hora

INTRODUCTION

This application note describes the use and performance achieved using the Johanson Technology, Inc., 0900PC15F0030 impedance matched, integrated, passive filter balun with the ADF7023, ADF7023-J, and ADF7024 RF transceivers in the 862 MHz to 928 MHz frequency range. The filter balun combined match from Johanson Technology effectively reduces the RF front-end component count and layout space and simplifies the RF front-end printed circuit board (PCB) design, while still maintaining the radio performance requirements. This balun is 100% radio frequency (RF) tested by Johanson Technology, thus reducing system variability. The Additional Information from Johanson Technology section provides more insight about how harmonic emissions are attenuated, as well as further details about the integrated passive device.

Table 1. Key Parameters of the Filter Balun

Parameter	Description
Part Number	0900PC15F0030
Frequency	862 MHz to 928 MHz
Unbalanced Port Impedance	50 Ω
Balanced Port Impedance	Matched to ADF7023, ADF7023-J, and ADF7024 RF port impedance

TYPICAL PERFORMANCE DATA

Table 2 shows typical performance data obtained from the ADF7023 using the 0900PC15F0030 impedance matched filter balun.

Table 2. Typical Performance of the ADF7023 Using the 0900PC15F0030 Filter Balun

Parameter	Value (dBm)
Transmitter (Tx) Output Power	11.5
Harmonics	
Second Harmonic	−36
Third Harmonic	−44
Fourth Harmonic	−47
Fifth Harmonic	−44

EVALUATION BOARD LAYOUT

An outline of the RF board layout is shown in Figure 1. Gerber files of the board layout are available on the Analog Devices, Inc., ADF7023 product website. Because the impedance seen by the balun is inherently dependent on the layout, it is recommended to follow the EVAL-ADF7023DB5Z layout as shown in the Gerber files as closely as possible for optimum performance.

The board schematic is shown in Figure 2.

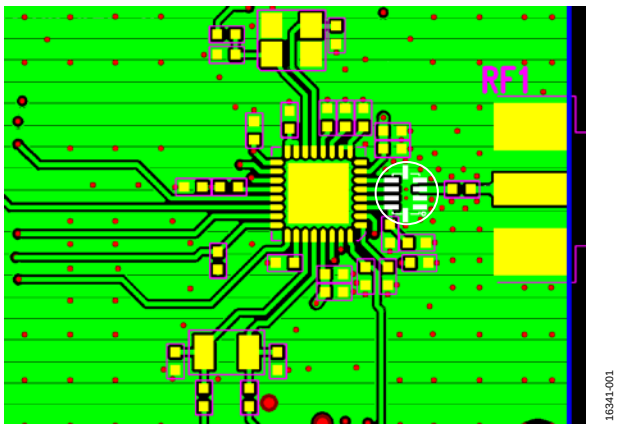

Figure 1. EVAL-ADF7023DB5Z Board Layout Highlighting the Integrated Passive Device Location

TABLE OF CONTENTS

REVISION HISTORY

2/2018—Revision 0: Initial Version

EVALUATION BOARD SCHEMATIC

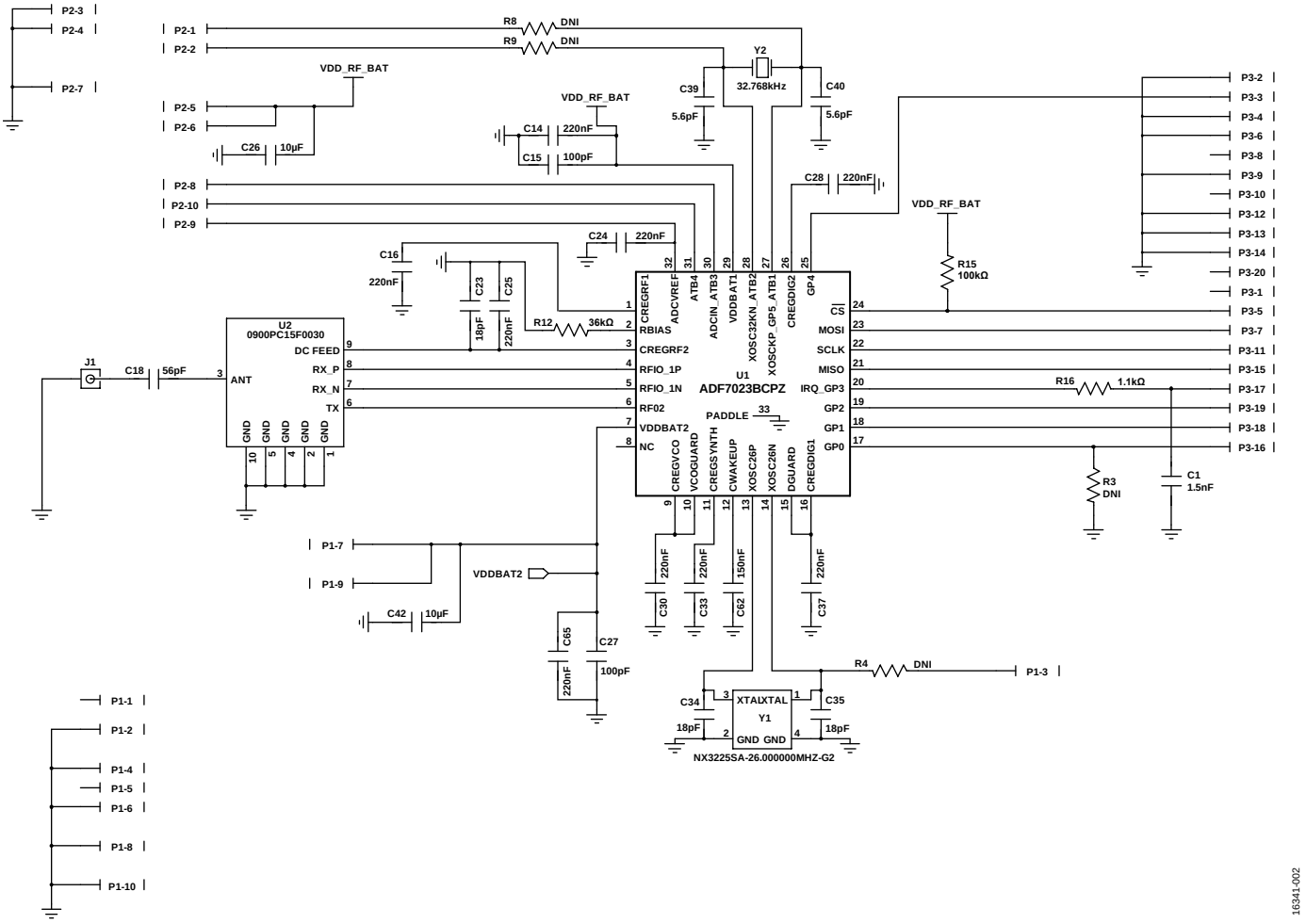

Figure 2. EVAL-ADF7023DB5Z Schematic

ADDITIONAL INFORMATION FROM JOHANSON TECHNOLOGY

The following content is provided courtesy of Johanson Technology, Inc. Johanson Technology is an independent corporation and is not owned by, controlled by, or an affiliate of Analog Devices, Inc. Analog Devices makes no representations or warranties with respect to the Johanson 0900PC15F0030 or any other Johanson Technology products.

GENERAL SPECIFICATIONS AND STORAGE PARAMETERS

Table 3. General Specifications

Parameter	Value
Part Number	0900PC15F0030
Frequency	862 MHz to 928 MHz
Balanced Port Impedance	Impedance matched to Analog Devices ADF7023, ADF7023-J, and ADF7024
Insertion Loss	1.8 dB (typical), 2.3 dB (maximum)
Return Loss	10 dB (minimum)
Phase Balance	180° ± 15°
Amplitude Difference	2.0 dB (maximum)
Attenuation	33 dB (minimum) at 1736 MHz to 1856 MHz 40 dB (minimum) at 2604 MHz to 2784 MHz 40 dB (minimum) at 3472 MHz to 3712 MHz 35 dB (minimum) at 4340 MHz to 4640 MHz
Power Capacity	3 W (maximum) continuous wave
Operating Temperature	−40°C to +85°C

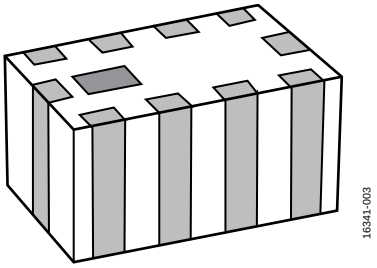

Figure 3. 0900PC15F0030

Table 4. Storage Parameters

Parameter	Value
Storage Temperature Range	−40°C to +85°C
Storage Period	18 months maximum
Recommended Storage Conditions for Unused Tape and Reel Product	5°C to 35°C, 45% to 75% relative humidity, 18 months maximum

MECHANICAL DIMENSIONS

The mechanical dimensions are shown in Figure 4 and explained in Table 5.

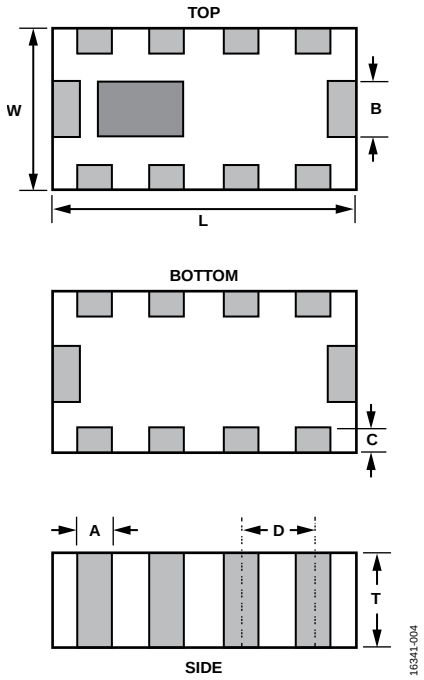

Figure 4. Mechanical Dimensions

Table 5. Mechanical Dimensions

Label in Figure 4	Dimension in Inches (In)	Dimension in Millimeters (mm)
L	0.079 ± 0.008	2.00 ± 0.2
W	0.049 ± 0.008	1.25 ± 0.2
T	0.039 (maximum)	1.00 (maximum)
A	0.010 ± 0.004	0.25 ± 0.1
B	0.012 ± 0.006	0.30 ± 0.2
C	0.008 + 0.004, 0.008 − 0.006	0.20 + 0.1, 0.20 − 0.15
D	0.020 ± 0.004	0.50 ± 0.1

TERMINAL CONFIGURATIONS AND MEASUREMENTS

The terminal configurations are shown in Figure 5 and described in Table 6.

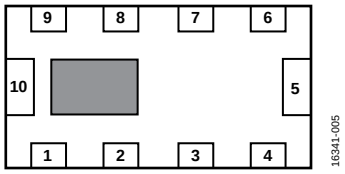

Figure 5. Terminal Configuration

Table 6. Terminal Configuration

Label in Figure 5	Mnemonic	Connection to ADF7023/ ADF7023-J/ADF7024
1	GND	Ground
2	GND	Ground
3	ANT	Antenna connector
4	GND	Ground
5	GND	Ground
6	TX	RFO2 (RFO on the ADF7024)
7	RX_N	RFIO_1N (RFI_N on the ADF7024)
8	RX_P	RFIO_1P (RFI_P on the ADF7024)
9	DC Feed	CREGRF2
10	GND	Ground

The measurement setup is shown in Figure 6. The connections are as follows:

- Port 1 is connected to the ANT pin
- Port 2 is connected to the RX_N pin
- Port 3 is connected to the TX pin
- Port 4 is connected to the RX_P pin

This data is provided courtesy of Johanson Technology, Inc.

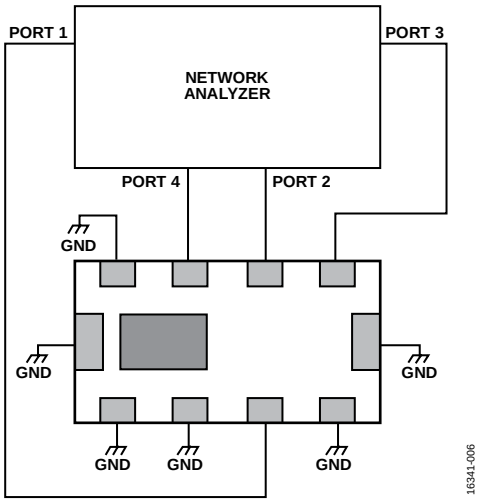

Figure 6. Measuring Diagram

S_{XX} is the reflection coefficient on Port X, and S_{XY} is the transmission coefficient between Port X and Port Y.

In Figure 8, DD means differential to differential, DS means differential to single-ended, and SS means single-ended to single-ended.

The insertion loss (IL) and return loss (RL) scattering parameters (S parameters) applicable to Tx mode are defined in the Tx Mode Measurements section. Likewise, in receiver (Rx) mode, they are defined in the Rx Mode Measurements section.

S parameter files are available upon request from Johanson Technology, Inc.

Tx Mode Measurements

In Figure 6, the following conditions apply for Tx mode:

- Port 1 load impedance: 50 Ω
- Port 3 load impedance: complex conjugate to power amplifier (PA) output impedance of the ADF7023, ADF7023-J, and ADF7024; single-ended PA in Tx mode
- Port 2 and Port 4 load impedance: low noise amplifier (LNA) input impedance in Tx mode of the ADF7023, ADF7023-J, and ADF7024
- IL = S_{31}
- RL = S_{11}/S_{33}

Rx Mode Measurements

In Figure 6, the following conditions apply for Rx mode:

- Port 1 load impedance: 50 Ω
- Port 3 load impedance: PA impedance in Rx mode of ADF7023, ADF7023-J, and ADF7024
- Port 2 and Port 4 load impedance: complex conjugate to LNA input impedance in Rx mode of ADF7023, ADF7023-J, and ADF7024
- IL = S_{DS21}
- RL = S_{SS11}/S_{DD22}

S_{XY} is the transmission coefficient between Port X and Port Y, effectively the loss (or gain) between Port 1 and Port 4 or between Port 1 and Port 2, as follows:

- Amplitude balance is the difference in amplitude between S_{12} and S_{14} in decibels.
- Phase balance is the difference in phase between S_{12} and S_{14} in degrees.

Typical Electrical Characteristics

Figure 7 to Figure 9 show the typical electrical characteristics using the Tx and Rx conditions and setup described in the Terminal Configurations and Measurements section.

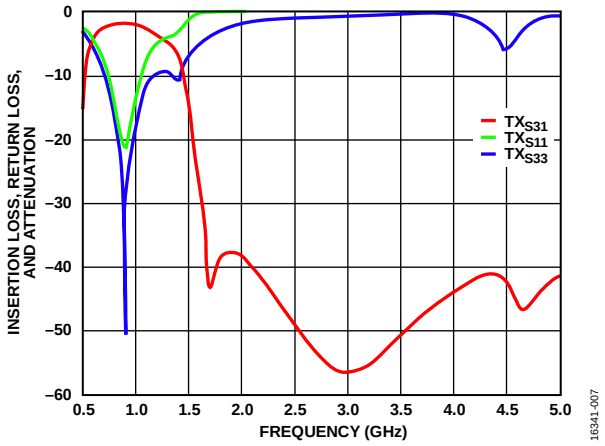

Figure 7. Tx Mode Insertion Loss (TX_{S31}), Return Loss (TX_{S11}), and Attenuation (TX_{S33})

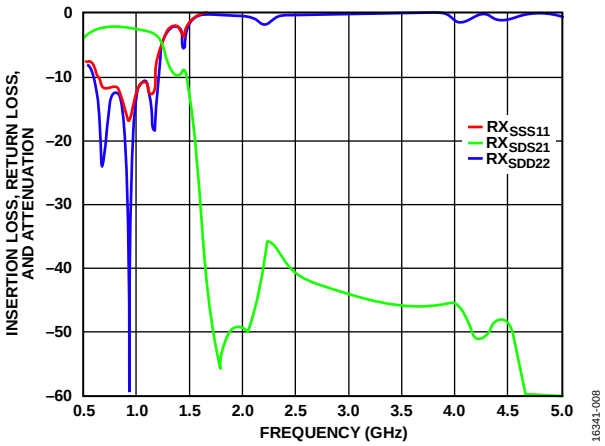

Figure 8. Rx Mode Insertion Loss (RX_{SSS11}), Return Loss (RX_{SDS21}), and Attenuation (RX_{SDD22})

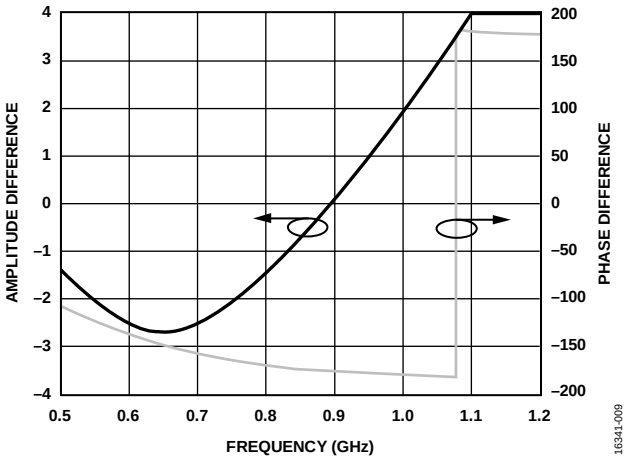

Figure 9. Rx Mode Phase Difference and Amplitude Difference

AN16341-0-2/18(0)