Integrated Low Noise Amplifier and Balun for MRI receiver-on-coils

M. A. de Rooij[1], and W. E. Burdick[1]
[1]GE Global Research, Niskayuna, NY, United States

Introduction

Future MRI systems and applications are being developed to satisfy the persistent demand for higher image resolution and temporal processing. To satisfy those demands the quantity of elements that comprise an imaging coil must be increased dramatically. It is customary for each receiver coil element to be paired with a low noise amplifier (LNA) and one or more baluns. To maximize performance, the LNA is located in close proximity to the receiver coil element; when the LNA is placed near the receiver coil element, an increase in the density of components and structures in the magnet bore and region of interest results. This increased component density can adversely impact image quality by interference with the flux field. The balun is used to provide for coil element-to-element isolation, and to support optimal image quality. Alternative technologies have been sought that would enable the coils to increase the their functional density, i.e., 128 coil elements in the existing receiver coil package volume.

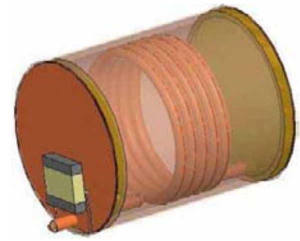

Figure 1 Traditional Balun

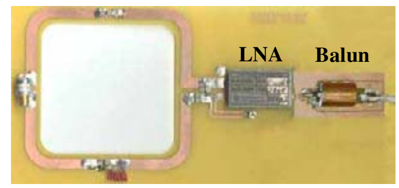

Figure 2: Single Channel Receiver Coil

This paper examines the feasibility, benefits, challenges, and risks associated with locating the LNA inside the balun package volume, without degradation of performance and adverse impact on overall image quality. The risks include achieving a high density LNA-Balun package without adverse impact on LNA performance, difficulty tuning the LNA-Balun, and overheating.

Method

A commercially available LNA is used as a basis for comparison for the LNA-Balun circuit thereby reducing evaluation risk. The LNA schematic is divided into sections including input matching, amplification, output matching, protection and balun. The sections of the LNA-Balun are implemented in sections of a copper-on polyimide flex circuit, as shown in Figure 3. Once the flex has been populated with components, it is folded to form a 3D structure that can be assembled into the balun housing.

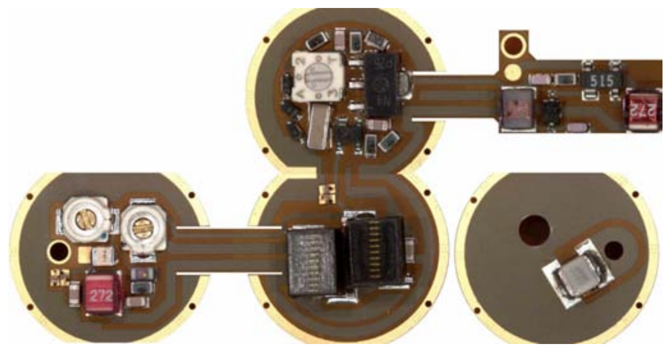

Figure 3 LNA-Balun Flex Assembly

Power for the LNA is provided through the signal co-axial line. The LNA-Balun was compared to a traditional design shown in Figures 2 and 4.

Results

The LNA-balun was fabricated, assembled, and tested yielding the following results:

	S-Parameter	Measured Value
Input impedance	(S_{11})	Z_{in} =2.78Ω
Amplifier Stability	(S_{12})	< -51dB
Amplifier Gain	(S_{21})	=26.7db
Output impedance	(S_{22})	Z_{out} = 57.9Ω
Noise Figure		=0.91dB
Dynamic range (1dB compression)		=12.7dBm
Output linearity		OIP3 = 19dBm
Balun Impedance		Z_{balun} = 2.2kΩ

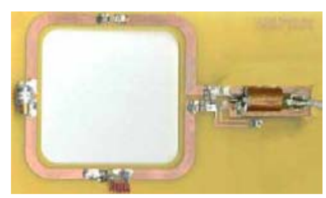

Figure 4 LNA-Balun Receiver

Discussion

An integrated LNA-Balun has been demonstrated its performance verified. A 60% volume reduction has been achieved compared to the individual LNA and balun configuration. The integrated LNA-Balun utilizes commercial electronic packaging technology and manufacturing methods.

Figure 5 Integrated LNA-Balun Prototype