

Introduction to Magnetic Resonance Imaging (MRI)



Magnetic Resonance Imaging is a non-invasive diagnostic technology that produces anatomical images. Unlike computed tomography (CT), MRI does not carry the risk of ionizing radiation exposure. The MRI system shown in Figure 1 uses a superconducting magnet to align hydrogen atoms in the body; then excites the atoms with radio frequency (RF) energy from the transmitting RF coil. As the atoms return to equilibrium, energy is released in the form of radio waves which are recorded by the receiving RF coil. The rate at which the atoms return to equilibrium, as well as the energy released, is determined by the location and chemical makeup of the surrounding material. This information is processed to create images of the tissues present in the body.

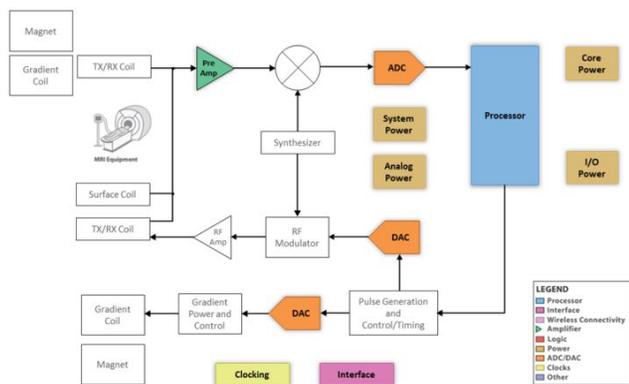


Figure 1. MRI System

Accurate signal processing is critical in order to obtain high-quality images. An important system consideration for the receiving channel is high signal-to noise ratio (SNR). The return signals have narrow bandwidths, with an intermediate frequency (IF) location dependent on the main magnet's strength. Some systems use high-speed pipeline analog to digital converters (ADCs) with wideband amplifiers to sample the IF, leaving large headroom for post-processing gain by a digital down converter of the field programmable gate array (FPGA). Other systems mix the IF to baseband where lower speed, higher resolution successive-approximation-register (SAR) and delta-sigma ADCs can be used.

Texas Instruments' ADS5263 in Figure 2 delivers a very high SNR of 84.6dBFS, with 10MHz input and a sampling frequency of up to 100MSPS. Coupling this with up to 4VPP full-scale input enables a very strong signal and a high-range of signal variations for the best image clarity and contrast. The quad-channel architecture, low power consumption of 380mW/channel and the small footprint of the ADS5263 allows system designers to design smaller, more compact systems than was previously possible with existing single or dual channel solutions. A non-magnetic package option allows for operation in a strong magnetic field.

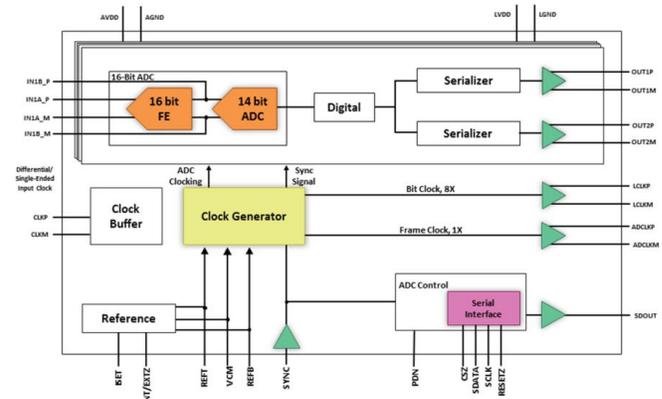


Figure 2. ADS5263 Functional Diagram

High-resolution, high-speed digital-to-analog converters (DACs) are needed to control the magnetic and RF energy in the MRI system. High resolution is required to accurately define the area of the patient to be scanned and high speed is needed to match the high IF's generated by the main magnet.

Digital signal processors (DSPs) can be used to provide gradient processor control for properly manipulating MRI system magnets. DSPs are also useful for implementing signal processing functionalities in MRI devices. MRI reconstruction is based mostly on 2-D fourier transformation. In addition, functionalities like auto and cross-correlation, curve fitting, combining sub-images and motion stabilization are required to pre- and post-process the image to reduce various artifacts.

Analog integrated circuits (ICs) and embedded processors are playing a key role in improving the delivery speed and crisp detail of magnetic resonance images, leading to more accurate diagnoses and effective treatments.

1 Related Documentation/Learn More

ADS5263 product folder:
<http://www.ti.com/product/ADS5263>

ADS5263 EVM:
<http://www.ti.com/tool/ads5263evm>

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