Invivo ECG MRI compatible remote sensor

General Description:

The Invivo ECG wireless remote sensor is able to monitor a patient during an MRI imaging scan. The analog front-end circuits and DSP software are able to filter out the harsh RF and Magnetic fields that are used in this process. This data is uploaded to the 3160 base and display units.

The 3160 has three coexistent radio systems consisting of the ECG sensor, the SPO2 (pulse oximitry) sensor and the display radio.

The ECG sensor radio is based on a single chip radio transceiver (nRF2401) produced by Nordic of Tiller, Norway. This IC communicates with the on board DSP controller and programmable logic (CPLD) via data and clock lines in conjunction with chip select and chip enable controls. Configuration is accomplished via the chip select line while transmit and receive is controlled by the chip enable line.

Another feature of the nRF2401 is a "second channel receive" function. This second receive channel has its own data and clock line but shares the control lines with the channel one radio.

Circuit Description of ECG Remote Sensor Radio:

1. For further clarification, please refer to the AB216 schematic file.

2. The nRF2401 clock line connects to the CPLD through R66. This resistor helps dampen the ringing, which can arise from the sharp edges on this 500 ns (nanosecond) signal.

3. R64 provides a similar function to the nRF2401 data line as R66 provides for the clock line.

4. Power supply decoupling is provided by R8, C17, C7 and C9. Low frequencies are decoupled by C7 and the high frequencies are decoupled by C17 and C9. C9 handles the RF range.

5. R60 provides a pull down to the power up control line to prevent this function during processor and logic initialization.

6. R18 controls the current reference source.

7. C69 decouples the internal nRF2401 digital circuitry.

8. C65 and C62 are decoupling capacitors for the nRF2401 power amplifier section.

9. L3 provides DC power to the antenna circuit while blocking the RF output from getting into the VDD_PA line.

10. C63, C73 and L4 are matching circuit components. They match the 400 ohm differential RF output at the two antenna port lines of the nRF2401 to 50 ohms unbalanced.

11. C80 is added to the circuit to help reduce the switching transient noise from the digital section of the nRf2401.

12. L2 is a 2.4 GHz band pass filter for harmonic reduction.

13. C51, L5 and C72 form a high pass filter which is used mainly to eliminate low frequency RF produced by the MRI system from getting into the low noise sensor circuits.

14. X1 is the 16 MHz crystal that is used by the nRF2401 to generate required internal clock functions. This crystal circuit uses semiconductors that are integral to the nRF2401. The resulting clock is also sent to the programmable logic and DSP chips.

15. C2 and C3 are parallel mode load capacitors required by the nRF2401 and crystal for on frequency operation.

16. R16 provides feedback for the oscillator circuit.

17. The C47 trimmer capacitor allows oscillator frequency calibration.

18. The U10 comparator captures the 16 MHz crystal output by referencing to the nRF2401-XC1 pins average DC level through the R51 and C29 RC filter. The faster constant of R52 and C85 allow 16 MHz capture. This is sent to the CPLD that uses this clock for its logic functions. The CPLD also divides this clock to 2 MHz that is used by the DSP.