Invivo Dual Base Radio Module

General Description:

The Invivo Dual Base Radio Module is able to receive data from the remote ECG and SPO2 wireless remote sensors during an MRI imaging scan. This module is under software control of the System FPGA, which is in turn communicating with the main processor. Each 3160 base unit contains two Dual Radio Boards. These boards are located on opposite sides of the base unit. Each board has one ECG receiver and one SPO2 receiver. Each receiver has two antenna ports. One port connects to a horizontally polarized antenna and the other is connected to a vertically polarized antenna. Software algorithms determine which antenna will be selected and this is intended to counteract the extreme multipath fading that occurs in the shielded MRI room. Two receivers for each sensor type adds spatial diversity to the reception. The receivers are also capable of receiving on two channels at one time. The sensors toggle between these two channels creating frequency diversity. The packet transmissions are also packed with three sample points. This creates time diversity.

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

The Dual Base Radio makes use of a single chip radio transceiver (nRF2401) produced by Nordic of Tiller, Norway. This IC communicates with the off board system FPGA controller 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. Each radio chip is capable of transmission as well as reception. Software controls which radio is transmitting, which channel is selected and which antenna is selected for that transmitter. Two transmitters will not transmit on the same channel at the same time.

Circuit Description Dual Base Radio:

1. For further clarification, please refer to the AB195 schematic file.

2. The ECG radio and SPO2 radio circuits are identical. The description given is for the ECG radio only.

3. R1, R2, R3, R4, R5, R6 and R7 are pull up resistors for the digital data, clock and control lines.

4. Snubber networks composed of C5-R8, C6-R9, C7-R10, C8-R11, C9-R12, C10-R13 and C11-R14 are installed if needed to control ringing of mismatched digital control and data lines. These components are currently not installed.

5. R17 provides a pull up to the power up control line, which is always enabled when the board is powered up. The board is powered under external system control.

6. R18 controls the current reference source.

7. C20 decouples the internal nRF2401 digital circuitry.

8. C14 and C15 are decoupling capacitors for the nRF2401 power amplifier section.

9. L2 provides DC power to the antenna circuit while blocking the RF output from getting into the VDD_PA line.

10. C16, C17 and L1 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. C18 is added to the circuit to help reduce the switching transient noise from the digital section of the nRf2401.

12. L3 is a 2.4 GHz band pass filter for harmonic reduction.

13. U2 is the solid-state antenna switch. Blocking capacitors C21, C25 and C26 prevents the switching bias from being shorted by the band pass filter or external antennas. Led circuits composed of R20-D1 and R23-D2 provide an indication of which antenna port is being selected. The external switch selection signal is applied to the U3 inverter. A low on the antenna control signal from J1-Pin16 puts a high on switch select A, which selects the P4 antenna. A high on J1-Pin16 selects P3.

14. Osc1 is the 16 MHz oscillator that is used by both nRF2401 chips to generate required internal clock functions. This clock is split between the two radio chips by R19 and R42.

15. R15 and R16 are pull down resistors for the unused DR1 and DR2 data detect lines which are not used by this system.

16. Power supply decoupling is accomplished by C41, C19, C12 and C13.

17. Five volt board power from the system power supply is used only by the antenna switch, which has a lower insertion loss at this voltage. Regulator VR1 converts the Five volts to 3.3 volts for all other onboard devices. C1, C2, C3 and C4 are voltage regulator decoupling capacitors.