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R4

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Operational Description for the R4-AIS transponder

Distribution

DOCUMENT VALIDATION

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P1A		2003-07-02		First draft

CONTENTS

1 INTRODUCTION

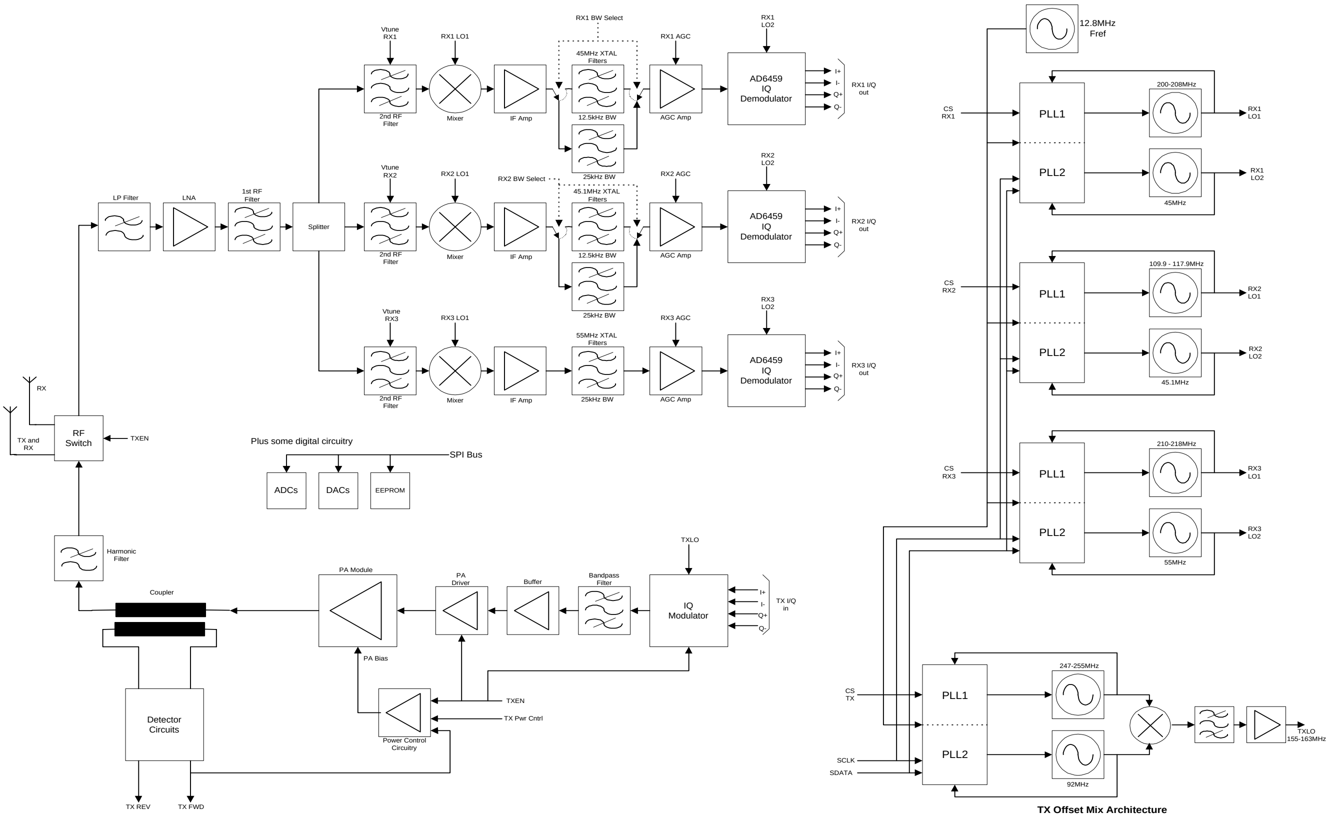
This document describes the major blocks and their function in the transceiver part of the R4 transponder.

2 GENERAL

The R4 transceiver can be divided into the following functional blocks:

1. Transmit/Receive switch
2. Receiver signal splitter
3. Receiver 1
4. Receiver 2
5. Receiver 3
6. Transmitter exciter
7. Transmitter power amplifier

The major functional blocks of the transceiver are shown in the diagram below:



3 TRANSCEIVER FUNCTIONAL BLOCKS

3.1 Transmit/Receive switch

The Transmit/Receive switch enables a single antenna to be used for both transmit and receive operation. The switch is based on several PIN diodes in order to obtain sufficient isolation between the transmitter and receiver. This will also insure fast switching between receive and transmit mode. The bandwidth of the switch is 155 MHz to 163 MHz.

3.2 Receiver signal splitter

The transceiver is able to receive on three different channels simultaneously. This requires three receivers and that the input signal is divided to supply the receivers. The receive signal is therefore fed into a signal splitter network which distributes the signal equally to the receivers and provides isolation between them.

A low noise amplifier before the actual power splitting ensures that no signal power is lost in the splitter. The input signal passes through a filter before the amplifier, which prevents blocking due to high input signals from outside the maritime band. A second filter narrows the receiver bandwidth and provides selectivity.

3.3 Receiver 1, 2 and 3

Receiver 1,2 and 3 each converts an RF signal in the 155 MHz to 163 MHz band down to baseband differential I & Q signals. The signals are then sampled and handled by a DSP-based detector, which provides the received data input for higher levels in the transponder. A single conversion superheterodyne receiver structure has been used, enabling amplification and filtering on an intermediate frequency level.

To enable simultaneous reception of different channels in the maritime band the three receivers have different intermediate frequencies. The receivers are configured as:

Receiver	IF frequency	1st LO frequency	2nd LO frequency	Comment
1	45.0 MHz	200.0 – 208.0 MHz	45.0 MHz	High side injection
2	45.1 MHz	109.9 – 117.9 MHz	45.1 MHz	Low side injection
3	55.0 MHz	210.0 – 218.0 MHz	55.0 MHz	High side injection

Receivers 1 and 2 have the capability of receiving signals with both 25 kHz and 12.5 kHz channel bandwidth. In order to achieve this, the receivers are equipped with two sets of channel filters. The appropriate channel filter is selected by means of semiconductor switches. Receiver 3 is primarily used for receiving signals with 25 kHz channel bandwidth and is therefore only equipped with one set of channel filters.

3.4 Transmitter exciter

The exciter takes its I and Q input signals from the baseband digital to analog converter and modulates them up in frequency to the operating band 155MHz to 163MHz. The exciter also incorporates a driver stage, which provides enough power to drive the PA.

3.5 Transmitter Power Amplifier

The PA consists of a power amplifier module, which provides the required max. output power 12.5W. The operating frequency range of the PA is 155 MHz to 163 MHz. A control circuit sampling the output power achieves a constant output level over the frequency range.

A directional coupler at the output of the PA samples RF during transmissions and provides measurements of forward and reflected power. The sampled RF passes through a detector and the resulting DC is fed to a control circuit, which provides power control and measurements of the VSWR.

The power output can be set to three different levels, 1 W, 2W and 12.5 W. A lowpass filter fitted at the output of the PA connects the transmitter to the T/R switch.

4 DSP SUBSYSTEM

The DSP subsystem is made up of four interconnected DSP microcomputers, the transmitter signal processing being done by the master micro-controller and the signal processing for each receiver being done in the three slave micro-controllers.

4.1 Signal processing functions

Signal processing functions provided are:

- Modulation and demodulation;
- Automatic gain control (AGC);
- Measurement of data time of arrival (ToA);
- Control of data time of transmission (ToT);
- HDLC coding/decoding;
- Measurement and calculation of:
- Noise level (NL);
- Received signal strength (RSS);
- Channel occupancy (CO).

In addition to the transmitter signal processing, the master DSP performs control and measurement of the RF hardware.

4.2 Modulation schemes

The following modulation schemes are supported:

Scheme	Baud rate	Coding	Modulation	Channel bandwidth
AIS	9600	NRZI	GMSK	25kHz
AIS	9600	NRZI	GFSK	12.5kHz
DSC	1200	DSC-specific coding	AFSK	25kHz

4.3 DSP functions

The function of each DSP is as follows:

Master DSP	**Slave1 DSP**	**Slave2 DSP**	**Slave3 DSP**
TX, switchable between AIS and DSC	RX 1 AIS	RX 2 AIS	RX 3 DSC

The TX DSP is also the master control processor for the transceiver.

4.3.1 Power Supply Unit

The PSU provides low voltage supplies for all of the transponder’s internal modules.

The power supply is located on the Baseband PCB.

4.3.2 Communications Processor Module

The CP Module provides all the high level protocol and control facilities for the transponder. Communication between the CP and the It is interfaced to the Transceiver Module is described in the module interfaces section.

4.3.3 GPS Module

The GPS module provides UTC time information and position for use by the CP Module.