Exhibit M: Operational Description

FCC ID: CW21669-3

5A204B-NB VHF Transceiver Module

Technical Manual - Version RE2

January 10,2000

This device complies with Part 15 of the FCC regulations. Operation is subject to the condition that this device does not cause harmful interference. Changes or modifications to this device that are not expressly approved by Rothenbuhler Engineering are prohibited and could void the user's warranty and possibly his authority to operate this product.

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1. Product Overview

This manual covers the 5A204-NB VHF transceiver module. The module is a synthesized 0.1 to 5 watt transceiver, covering the frequency band of 150-174MHz. It is designed for data communication systems.

2. Theory of Operation and Circuit Description

2.1. Synthesizer

In transmit mode, Q12, D6 and L24 form a voltage controlled oscillator. In receive mode, Q7, D7 and L26 form a voltage controlled oscillator. The output of the VCO is buffered by Q11, and fed into the input of a programmable divider/phase comparator, U3.

U3 divides the RF from the VCO down to either 10KHz or 12.4KHz, and compares this divided down signal to a reference. The reference is derived by dividing down a 14.4MHz crystal reference oscillator. A separate modem board programs U3 with the appropriate data for each radio frequency.

2.2. Reference oscillator

Y4 along with Q8 and associated circuitry form a high-stability 14.4MHz reference oscillator. D5 provides DC modulation capability. D4, RT2 and RT1 form a temperature compensation circuit, adjusting the voltage on D4 as the temperature varies.

2.3. Antenna Input

The RF I/O is via the ANT1 connection. This is an OSX female connector. L3, L2, C6, C7, and C8 form a 174MHz low-pass filter.

In receive mode, RF from the low-pass filter passes through L1 and into the receiver front end.

In the transmit mode, the 7.5V is applied to L10, which biases on D2 and D3. When these diodes conduct, D1 passes the transmit signal out to the low-pass filter on the antenna. D3 shorts the transmit to ground at the receivers input, protecting the receiver's LNA from damage.

2.4. Receiver

In the receive mode, RF from the antenna enters the receiver's front-end filter, comprised of L4, L5 and associated components. Q1 amplifies the RF 20dB. L6, L7, and L8 along with their associated components form a band-pass filter, tuned to the receiver's frequency of operation.

Q2 mixes the receiver's RF from Q1 with a local oscillator signal from the PLL. The output of Q2 is tuned to 21.4MHz.

Y1 and Y2 form a 4 pole crystal filter, provided the receiver with its selectivity. Q3 amplifies the 21.4MHz IF signal. The 21.4MHz signal is down-converted to 455kHz, and demodulated by U1. The RX output is an FM detected analog signal.

2.5. Transmitter

The transmit modulation is applied to the VCO and to the reference crystal, providing flat FM modulation response from DC to 5kHz.

The VCO's output is amplified by Q11, Q10, Q4, Q5, and Q6, to a level of up to 5 watts of RF. The maximum power output is dependent upon the voltage applied to the B+ signal (pin 2 of the I/O connector) and power adjustment resistor R105.

3. Radio I/O Connections

The interface to a radio transceiver circuit board is through a 14 pin single in-line connector. Table 1 lists the function of each pin.

Pin #	Function
1	System ground
2	B+ (usually 7.5V DC from the modem PCB)
3	+7.5V transmit, ±5%.
4	+5.0V receive, 0V transmit, ±5%.,.
5	+5.0V regulated input, ±5%
6	Transmit modulation. 2.5V DC RX, 2.5V DC with 1.25V p-p (2.0 Khz deviation) data during transmit.
7	Synthesizer lock detect.
8	PLL enable signal. Latch enable signal for serial interface to PLL.
9	PLL data signal. Data to PLL chip via three wire interface, pins 8,9, and 10.
10	PLL clock signal.
11	No connect
12	RSSI output from radio.
13	Receiver discriminator output from radio.
14	No connect

Table 1

4. Alignment

This test procedure assumes that the transceiver module is part of a wireless modem and will be tested with a properly configured modem board.

4.1. Test Setup

With both the modem PCB and the transceiver PCB must be removed from the enclosure to align them. Connect the two boards together with a ribbon cable, providing access to the adjustments on the transceiver board.

Connect a 12.5V DC source to the DC input of the modem board (5 watt systems) or 7.2V DC (0.1 – 2.0 watt systems). Connect a service monitor to the RF I/O of the radio.

4.2. Transmitter

Program the modem so that it is on the correct operating frequency or in the middle of the operating range. Refer to the proper technical manual for programming information.

With the service monitor in the receive mode, key the transmitter.

Adjust L25 (red) so that there is 4.0V DC on C97 (TP3).

Adjust C91 to set the carrier on the center of the channel. At room temperature (20 deg C) the RF carrier should be set to 300 to 400 Hz above the desired channel frequency.

Adjust C58, C60, C65 and C67 for maximum power output.

Adjust the modem's transmit deviation pot on the modem PCB for 2kHz deviation

With the service monitor set to generate FM, modulate a carrier with a 1kHz tone and 2kHz deviation. Set the RF level to 1mV.

Connect the SINAD meter to J1 pin 13.

Program the modem so that the unit is on the correct operating frequency or in the middle of the operating frequency range.

Adjust the RX VCO using L26 (Orange) so that there is 4.0V at C97 (TP3).

Adjust L11 for a reading of 2.5VDC at pin 13 of J1.

Adjust L4, L5, L6,L7,and L8 for best SINAD. Lower the RF generator's source as the SINAD falls below 20dB, and readjust the inductors until the specified sensitivity is met. Typically, 12dB SINAD will be obtained around 0.7uV.

4.3. FCC Notice

It is the responsibility of the user of this equipment to obtain the proper FCC license to operate this product on the desired channel of operation.

This product complies with part 15 and 90 of the FCC rules and regulations. It may not be modified without the expressed consent of Sonik Technologies Corporation. Modification of this product could void the user's authorization to use the product.

6.2 Specifications

Model Numbers:

5A204-NB.....150-174MHz
FCC ID: .....

Power consumption:

Receive.....<150 mA
Transmit.....<1.3 A

General

Size.....3.0 in. X 3.0 in. X 1.5 in.
DC voltage input ..... 7.2-12.0 VDC (<50 mV RMS noise)
Operating temperature.....-30°C to 60°C
Humidity.....<90% non condensing
Number of channels..... 64
Channel step size 12.5kHz/10kHz

Transmitter

RF power .....0.1-5.0 watts typical
Modulation .....AFSK
Frequency stability 5ppm

Receiver

Sensitivity.....0.7uV for 12 db SINAD
Selectivity.....60dB
Intermod.....60dB

The above specifications are subject to change without notice. Contact the factory for clarification of any product parameters.