EXHIBIT 4

TECHNICAL DESCRIPTIONS, §2.1033(c)

INTRODUCTION

SEA INC. OF DELAWARE (SEA) is pleased to submit this application for certification of its new Model ESP604 narrowband linear modulation mobile transceiver. The ESP604 is suitable for use on 5 kilohertz channels in the 220-222 MHz band authorized by 47CFR Part 90 Subpart T. The ESP604 is rated for twenty (20) watts peak envelope power (PEP) and is capable of voice and data transmission.

Some of the features of the ESP604 include synthesized channel generation, microcomputer operating system, audio frequency digital signal processing, and a linear RF. power amplifier feedback system to meet the FCC emission requirements. The microcomputer operating system includes provisions for trunked and conventional channel operation. Up to four trunked or conventional radio systems can be selected from the front panel.

TYPES OF EMISSION and DIGITAL MODULATION DESCRIPTION, § 2.1033(c)(4): 4K00J3E and 4K00J2D

Note: §90.210(b)(5) specifies an authorized bandwidth of 4 kHz.

The main RF. carrier is generated at the assigned channel frequency (center of the channel) but is suppressed during the modulation process. The use of quadrature modulation (the so-called SSB phasing method) is used to produce an emission whose frequencies extend ±1950 below and above the suppressed carrier, this emission being functionally equivalent to upper sideband (USB) suppressed carrier modulation. In addition to voice or data modulation, a supplementary pilot tone is included as well as a 300 bit per second binary frequency shift keyed data subcarrier.

There are three modulation modes which are described below:

1. Voice modulation: Representation of the two-tone modulation, pilot tone and trunking data signal are shown in Figure 4.1. The table below provides further explanation of these emissions.

"Tone"	Rel. Audio Frequency	Radio Frequency	Rel. to Carrier Freq.	Comment
1	500 Hz	220.00105 MHz	-1450 Hz	1st test tone
2	1950 Hz	220.00250 MHz	0 Hz	Trunking data signal
3	2400 Hz	220.00365 MHz	+1150 Hz	2nd test tone
4	3900 Hz	220.00445 MHz	+1950 Hz	pilot tone

If the transmitter carrier frequency (fc) is 221.0025 MHz, the equivalent radio frequency for 0 Hz relative audio frequency is fc-1950 Hz = 221.00055 MHz . The voice spectrum is treated as two halves, the lower half consisting of voice frequencies from 300-1600 Hz and the upper half 1600-3000 Hz. The first tone (or any mic input between 300-1600 Hz) is translated to the RF. frequency equaling the sum of (fc-1950 Hz) + mic input frequency. The second tone (or any mic input between 1600-3000 Hz) is translated up to (fc-1950) +700 Hz +mic input frequency. This creates a 700 Hz voice frequency gap at fc±350 Hz into which is inserted the trunking data modulation. This process is made expedient by the digital signal processor.

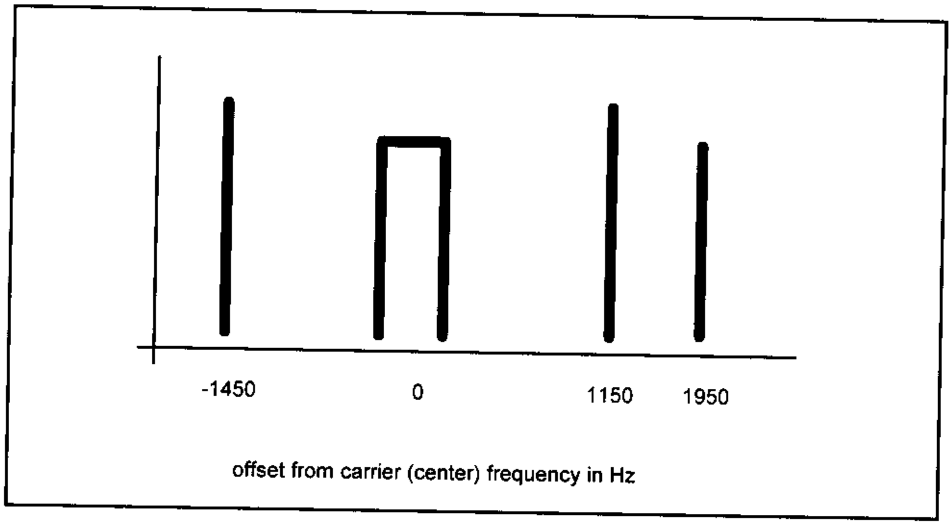

Figure 4.1 Two Tone Modulation Spectrum Diagram

2. Internal data modulation: Two 600 bps data subcarriers are emitted at fixed amplitudes and frequencies 1000 Hz above and 1000 Hz below the channel center. Each data subcarrier is binary phase shift phase keyed (BPSK) at 600 bps for a total bit rate of 2x600 = 1200 bps. The same 300 bps FSK data signal used with voice transmission is inserted at the carrier frequency, between the two BPSK signals. This modulation mode is referred to as *2x600 bps internally generated BPSK* in this report. The spectrum diagram in Figure 4.2 illustrates this modulation mode.

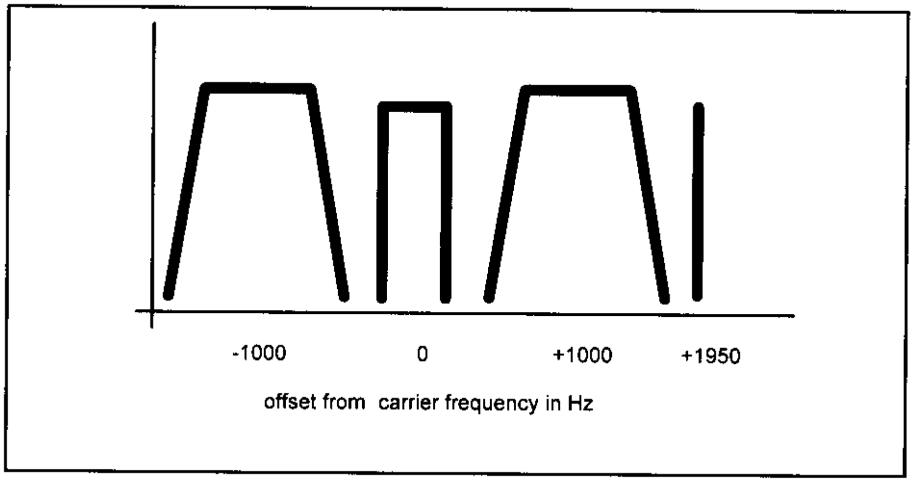

Figure 4.2 Internally Generated 2x600 bps BPSK Spectrum Diagram

3. External data modulation: The audio input band is bandlimited to 300-3600 Hz and emitted as a continuous, flat audio channel centered at the carrier frequency. The spectrum diagram in Figure 4.3 illustrates this modulation mode.

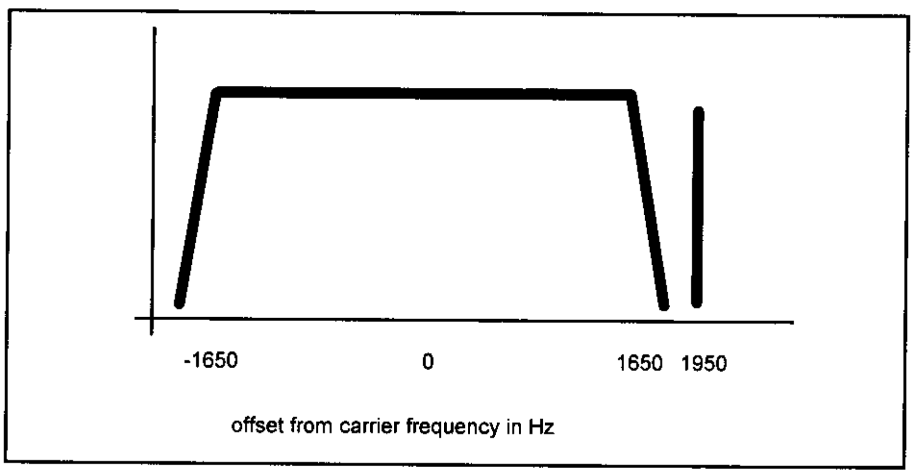

Figure 4.3 Externally Generated Data Modulation Spectrum Diagram

FREQUENCY DETERMINING AND STABILIZATION CIRCUITS, § 2.1033(c)(10)

Please refer to the following diagrams in the ESP604 Instruction Manual (found in Volume II of this filing) for this discussion:

1. RF L.O. Synthesizer Block Diagram, part of Fig. 8.3 .
2. Transmitter Block Diagram, Figure 8.2.

General: The frequency determining circuits perform within +/- 1.5 ppm frequency stability limits over the temperature range of at least -30 to +50 degrees C.

Detailed discussion: The SEA ESP604 relies on a nominal 12.8 MHz temperature compensated crystal oscillator module, OSC1, ideally calibrated to 12.800000 MHz, for its master frequency reference. OSC1 is specified by its manufacturer to maintain frequency stability of less than +/- 1.5 ppm over -30 to +60 degrees C temperature range. In the transmit mode its tuning input voltage is held constant by clamping the voltage from the AFC dac to a fixed dc level (typically 2.5 vdc) which is determined in the radio manufacturing process.

OSC1's output frequency is divided by 2560 to a nominal 5 kHz by synthesizer ICs U101 and U102 for use as the frequency reference for both the 45 and 440 MHz synthesizers.

A single feedback control loop frequency synthesizer is implemented by synthesizer counters and phase detector U101, loop filter U103, and voltage controlled oscillator/buffer VCO101. This synthesizer generates rf frequencies in 5 kHz steps in the nominal range 440 to 444 MHz. The signal is then applied to a divide-by-two circuit which outputs the desired frequency range of 220-222 MHz. This signal is filtered and then applied to quadrature modulator circuit U304 which upconverts the baseband I and Q signals to the desired frequency in the 220-222 MHz band.

The same 220 - 222 MHz signal is applied to the downconversion process used to complete a Cartesian loop feedback system for transmitter linearization.

The synthesizer multiplication factor required for the desired channel is loaded into the synthesizer counters from data stored in the microprocessor control system memory. The microprocessor program will not accept data that would generate transmitter output frequencies outside the range 220 to 222 MHz.

A lock detection signal is fed from synthesizers U101 back to the microprocessor via CR101 which will cause the radio to immediately cease transmission in the event that the synthesizer loses frequency lock. The preprogrammed transmit timing sequence control also inhibits RF. emissions for at least the maximum synthesizer frequency settling time after loading new frequency data into the synthesizer.

Example of frequency determination for FCC channel 1, 220.0025 MHz:

Desired suppressed carrier frequency = 220.0025 MHz.
Master oscillator frequency, fmo = 12.8000000 MHz
Synthesizer reference input = fmo/2560.
Synthesizer output frequency, f1 = (fmo/2560)*88001 = 440.005 MHz
Resultant carrier freq.= f1/2 = 220.0025 MHz .

The transmitter output frequency changes in exact proportion to any change in the 12.8 MHz master oscillator frequency. A one ppm change in master oscillator frequency would result in a one ppm change in transmitter output frequency.

DESCRIPTION OF MODULATION LIMITING, POWER LIMITING AND SPURIOUS RADIATION SUPPRESSION CIRCUITRY, § 2.1033(c)(10)

Several circuits in the transmitter play a significant role in reducing unwanted emissions and limiting output power. These circuits are described below beginning at the audio section and progressing through to the rf output port. Please refer to the block diagrams and schematic wiring diagrams in the Instruction Manual for specific circuits.

1. Digital Signal Processing (DSP): U101 (Digital Board) in Block Diagram Fig. 8.1, when executing its transmission program, provides modulation limiting and frequency filtering as described below.

DSP modulation limiting: With no external modulation applied, the pilot tone (rest level 2 watts CW) and trunking FSK data signal (rest level 2 watts CW) result in a PEP output of about 8 watts. The levels of these two signals are reduced as external modulation input level, Vin, increases.

The envelope magnitude, Vmag, of all digitized audio input drive, Vin, to the DSP is detected and tracked. A variable slope gain compressor is implemented by using Vin plus the pilot and trunking data signals in the numerator of a gain compressing divider and Venv plus a small threshold constant, Vth, in the denominator. As Vin and thus Vmag rise in level, they become larger than Vth and the throughput gain decreases. In the limit, the gain compression ratio becomes infinite, i.e., the gain decreases in inverse proportion to Vin, resulting in zero output increase for increased Vin. This compression is also applied equally to the internally generated pilot and trunking data carrier levels such that as Vin increases, the pilot and data carrier levels decrease to a level 6 or more decibels below their rest levels. Thus the transmitter PEP rises only a few decibels from no input modulation to full modulation because the pilot and data carrier powers are reduced as the input modulation rises. Infinite compression is approached rapidly as the input drive level reaches the level which produces rated PEP output. The compression algorithm can handle input levels at least 20 dB beyond normal drive levels.

DSP audio filtering: High-order bandpass filters are implemented in the DSP to sharply limit the lower and upper audio output frequencies (due to input modulation) to the range ±350 to ±1300 Hz.

2. R/C audio filtering: The output of the dacs in U301 (Digital Board) pass through dual one-pole low pass R/C filters before being applied to the RF modulator (U304, RF Board) in order to remove other audio spurii before RF modulation.

4. RF amplifier chain: Driver U301 contains band limiting circuitry designed to reduce out-of-band amplifier gain outside the 220-222 MHz range. The power amplifier module, U307, contains an internal low pass filter for reducing emissions at harmonic frequencies.

5. Antenna terminal low-pass filter: C344-C348 and L309-L311 provide additional low pass filtering for attenuating second and higher order harmonic emissions.

6. Feedback amplifier linearization: This transmitter contains a control system feedback loop which reduces power amplifier intermodulation distortion products in order to conform to the emission limits in Parag. 90.210(f) of the FCC Rules. The forward part of the loop includes all transmitter circuits from the in phase (I) and quadrature (Q) tx error amps (U301B and A, respectively) to the output of the RF. final amplifier. The system samples the final RF. amplifier output signal, converts it back down to I and Q baseband audio where it is compared in a negative feedback manner with the forward I and Q audio signals. This modifies the forward audio signals in a manner which significantly reduces third and higher-order intermodulation products at the transmitter output. The feedback path starts at the RF power amplifier output. This signal is sampled from a circuit board directional coupler and attenuated 40 dB by R342-R347. It is further attenuated 20 dB by R348-R350. The signal is split and the two channels drive down-conversion mixers CR306 and CR307, where the signals are converted to the feedback I and Q audio signals. The fed back signal is then applied tx error amplifiers where the forward and fed back signals are compared.

7. Mechanical shields: The transmitter chassis is constructed steel is fitted with top and bottom steel-tin shields. Individual brass shields enclose the TX lowpass filter compartment, main VCO and VCXO circuits.

EXHIBIT 5

INTRODUCTION TO TRANSMITTER MEASUREMENTS

Exhibits 6 through 11 on the following pages present the required measured transmitter performance data for parts §2.1046 through §2.1055. Part 90 references are also included in each exhibit as appropriate.

The transceiver was fitted with operating system software and programmed to transmit on the center frequency of the operating band, 221.0025 MHz. All tests were performed on this frequency.

For two-tone modulation, test audio was generated internally to the radio by the digital signal processing system. For data modulation testing, test signals were either internally generated or applied to the data connector located at the rear of the radio. During all tests, a typical 40-bit trunking data word was continuously sent from the microprocessor program source to the digital signal processor for use in modulating the trunking data carrier at a 300 bit per second rate.

CERTIFICATION OF TEST DATA, §2.911(d)

Please see page 5-2 for the test supervisor's statement.

MEASUREMENT PROCEDURES, §2.947

Specific measurement procedures and test setup diagrams are presented along with the resultant data in Exhibits 6 through 11 for the tests prescribed by §2.1046 et. seq.

TEST EQUIPMENT LIST, §2.947(d)

The equipment used for the tests is listed on page 5-3. The audio frequency isolation network schematic wiring diagram is Figure 5.1 on page 5-4.

STATEMENT OF TEST SUPERVISORS

The undersigned performed or supervised the performance of technical tests reported in this application and attests that all procedures were conducted in accordance with good engineering practice and to the best of his knowledge all data reported are accurate.

The qualifications of the undersigned include the following:

Cleveland:

1. BSEE, University of the Pacific, 1975.

2. Twenty-two years experience in the design, development and evaluation of radio communications systems.

Shivley:

1. BSEE, University of Arkansas, 1979.

2. Nineteen years experience in the design, development and evaluation of radio communications systems.

Signed,

John F. Cleveland 6/22/99

John F. Cleveland Date
Senior Project Engineer
SEA Inc. of Delaware

6/22/99

Norman R. Shivley Date
Senior Staff Engineer
SEA Inc. of Delaware

TEST EQUIPMENT LIST

Item	Description	Model
1.	Audio Oscillator	Hewlett-Packard HP204D
2.	Audio analyzer/generator	HP8903A
3.	Audio combiner/isolator	SEA (See Fig. 3.1)
4.	Audio Step Attenuator	HP350A
5.	Audio Isolation Transformer	Mouser TM009, 600/600 ohm
6.	RF Wattmeter	Bird 43 w/Bird 25C Element
7.	50W, 30 dB Attenuator	JFW 050-FH-030-100
8.	Power Splitter	Minicircuits ZFDC-10-1
9.	50 Ohm Terminator	Tektronix 011-0049-01
10.	Oscilloscope	Tektronix 475
11.	10 dB attenuator	Minicircuits CAT-10
12.	Spectrum Analyzers	HP8568B, HP60400, HP4396A
13.	Plotter	HP7470A
14.	D.C. Power Supply	HP6268B
15.	D.C. volt/ammeter	Fluke 75
16.	RF Signal Generators	Fluke 6071, HP8657A
17.	Frequency Counters	HP5382A, HP5384A
18.	Frequency Standard	HP105A
19.	Temperature meter	Fluke 52
20.	Thermocouple Probes (2)	Fluke 80PK-1
21.	Environmental Chamber	Tenney Jr.
22.	50 Ohm Dummy Load	Bird 8085
23.	Audio Spectrum Analyzer	Stanford Research Model 760
24.	D.C. power supply	Instek PS-1830
25.	100 W, 20 dB attenuator	Weinschel 50FH-020-100

Additional test equipment is listed in Exhibit 10 which was used during field testing for spurious radiation.