

Confidentiality Requested

Exhibit 4. Circuit Description -- Pursuant 47 CFR 2.1033(c) 10

This section provides the description of circuits required by subpart 2.1033 of the Commission's rules. The following are included:

- 4.1) Carrier Frequency Generation and Stabilization
- 4.2) Digital Modulation Technique
- 4.3) Modulation Limiting and Post Limiter Filter
- 4.4) Means for Output Power Limiting
- 4.5) Spurious and Harmonic Emissions Suppression
- 4.6) Bluetooth Implementation
- 4.7) Bluetooth General Description
- 4.8) Bluetooth Technical characteristics

4.1 Carrier Frequency Generation and Stabilization

As shown, in Figure 4-1 all of the Voltage Controlled Oscillators (VCO) are derived from the 16.8 MHz reference signal that is generated by a Temperature Compensated Crystal Oscillator (TCXO). The signal from the reference oscillator, after frequency division, is used to control the stability of the receive VCO (U300), which oscillates at a frequency between 1702-1840 MHz or 1870-1882 MHz. Similarly, the receive VCO (U300), after frequency division, is used to control the stability of the transmit VCO (U302), which oscillates at a frequency between 806-825 or 896-901 MHz. All control is accomplished by the digital synthesizer block of U600, which compares the VCO to a sub-multiple/multiple of the 16.8 MHz reference clock in a Phase Locked Loop (PLL) circuit, and in response steers the VCO to be a non-integer multiple of such reference.

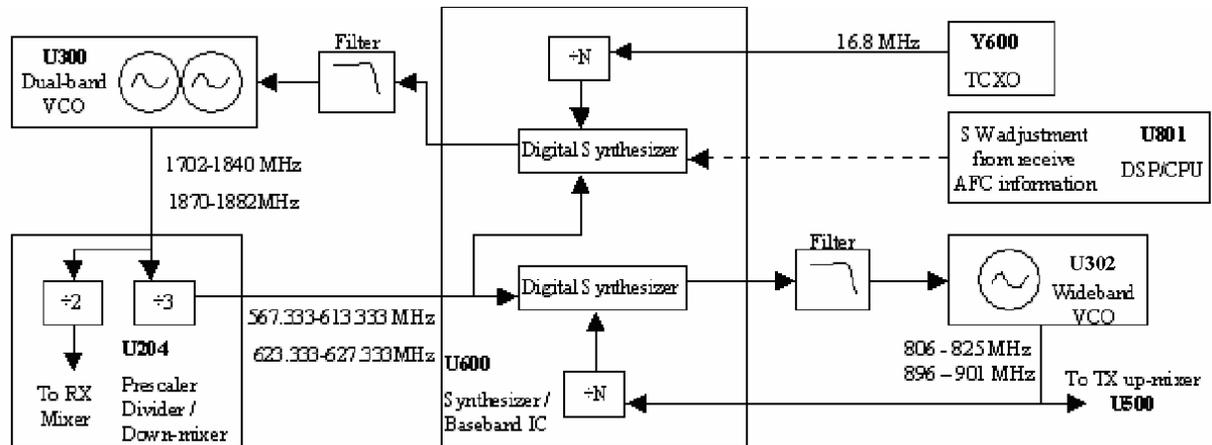


Figure 4-1: Frequency Generation Block Diagram

Thus the frequency stability of any generated frequency is dependent on the characteristics of Y600. The circuitry of Y600 provides electrical compensation that yields an output frequency accuracy of +/- 2.5 PPM throughout the temperature range of -30 to 80 degrees C. This adjustment provides sufficient frequency correction to allow the radio to lock onto a base station channel. After the receiver detects the base station signal, the compatible base station serves as an accurate and stable reference for the transceiver's local reference oscillator by virtue of a transceiver AFC function inherent in the acquisition and lock process. This AFC routine and frequency locking mechanism are implemented using both hardware and software, and improve the frequency accuracy of the transmitter beyond the characteristics of Y600. The hardware and software combined provide an automatic frequency control function, which locks the receiver within 0.4 PPM of the control channel oscillator. Since the base station frequency stability is FCC regulated to be 1.5 PPM or better for the 800 MHz band and 0.1 PPM or better for the 900 MHz band, the absolute accuracy of the transmitter is inherently better than 1.9 PPM in the 800 MHz band and 0.5 PPM in the 900 MHz band. This is accomplished by programming fine synthesizer adjustments to U600 while the radio is in operation. The stable frequency output of U301, is fed to the up-mixer and modulator circuit (U500), which then generates the modulated transmit signal in the frequency range of 806-825 MHz or 896-901 MHz.

4.2 Digital Modulation Techniques

The subject radio makes use of 3 different modulation techniques termed Quad-16QAM, Quad-64QAM, and Quad-QPSK. In voice mode, the radio will function in Quad-16QAM mode only. In data mode, the radio will use any one of the three different modulation techniques (Quad-16QAM, Quad-64QAM, and Quad-QPSK) in a given time division multiplexed slot. The transmitter is configured using TDMA time slotting so that up to 6 radio users can simultaneously share the 25 kHz channel. The following describes each of the modulation techniques:

The modulation technique termed Quad-QPSK is a linear digital modulation of a multi-channel variant of a 4-state Quadrature Phase Shift Keying. Data bits to be transmitted are split into four parallel lower rate streams, each of which is QPSK modulated to its own sub carrier frequency at a rate of 4k symbols per second. The four resulting sub channel signals are then combined in frequency division multiplex fashion to produce the composite Quad-QPSK signal. This spectrally efficient linear modulation can achieve transmission at 32k bits per second in a 25 kHz channel.

The modulation technique termed Quad-16QAM is a linear digital modulation of a multi-channel variant of a 16-state Quadrature Amplitude Modulation. Data bits to be transmitted are split into four parallel lower rate streams, each of which is 16QAM modulated to its own sub carrier frequency at a rate of 4k symbols per second. The four resulting sub channel signals are then combined in frequency division multiplex fashion to produce the composite Quad-16QAM signal. This spectrally efficient linear modulation can achieve transmission at 64k bits per second in a 25 kHz channel.

The modulation technique termed Quad-64QAM is a linear digital modulation of a multi-channel variant of a 64-state Quadrature Amplitude Modulation. Data bits to be transmitted are split into four parallel lower rate streams, each of which is 64QAM modulated to its own sub carrier frequency at a rate of 4k symbols per second. The four resulting sub channel signals are then combined in frequency division multiplex fashion to produce the composite Quad-64QAM signal. This spectrally efficient linear modulation can achieve transmission at 96k bits per second in a 25 kHz channel.

4.3 Modulation Limiting and Post Limiter Filter

The transmitted data or audio is processed using three software algorithms in a Digital Signal Processor (U801) that automatically prevent modulation in excess of 100 percent. The software algorithms consist of a speech coder, a Quadruple-QPSK digital modulator, Quadruple-16QAM digital modulator, Quadruple-64QAM digital modulator, and digital filtering. The digital output of U801 is then converted into an analog signal in the Baseband IC (U600). The baseband vector analog signal is then impressed on the carrier within the up-mixer/modulator IC (U500). The Cartesian feedback technique utilized within U500 minimizes adjacent channel spectral regrowth, thus limiting the signal bandwidth, by linearizing the output of the Power Amplifier/Antenna Switch (U501). A directional coupler, which is integrated within the antenna switch module, provides the coupled signal to U500 for signal linearization through Cartesian feedback. The entire transmit signal generation process is shown in Figure 4-2.

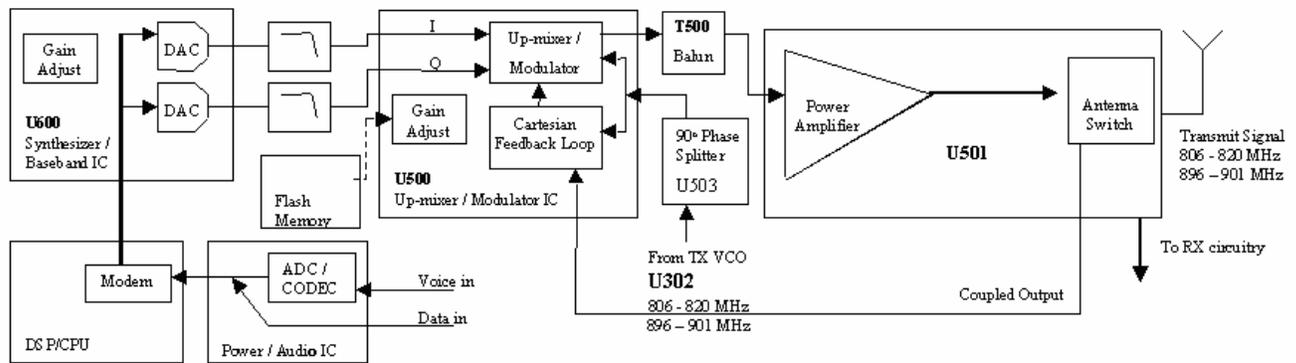


Figure 4-2: Transmitter Modulation System/Line-up System

Since the line-up does not use an isolator to circulate reflected energy away from the PA, the radio uses Circulator Elimination (CE) software. This software uses the information available to the DSP generated in the U500 and U600 to effectively estimate and correct any phase and/or level changes within the Cartesian Feedback loop at the base band level.

4.4 Means for Output Power Limiting

The output power is set by varying the digitally programmable attenuators in the U500 and U600 which change the level of RF power delivered to the power amplifier (U501), shown in Figure 4-2. The procedure to limit output power begins with a factory tuning procedure in which the attenuation is set to zero and the transmitter is configured to transmit in full power automatic level training mode. During automatic level training, U500 and U501 will set the lowest allowable baseband attenuation that results in a maximum power out of the radio without clipping the power amplifier. This power is typically higher than the targeted power setting. To lower the output power, the attenuation setting is iteratively increased until the output power is within the target window. The digital word that corresponds to that particular attenuator setting is stored into the Flash Memory (U802) as the minimum attenuator setting allowed.

During normal user operation, the transmitter periodically performs automatic level training. If

automatic level training resulted in a power higher than the target power, the baseband attenuator would be set to the minimum attenuator setting stored in U802 to achieve the target power. If automatic level training resulted in a power lower than the target power, the baseband attenuator would not be decreased since doing so would clip the Power Amplifier (U500) and potentially increase adjacent channel power.

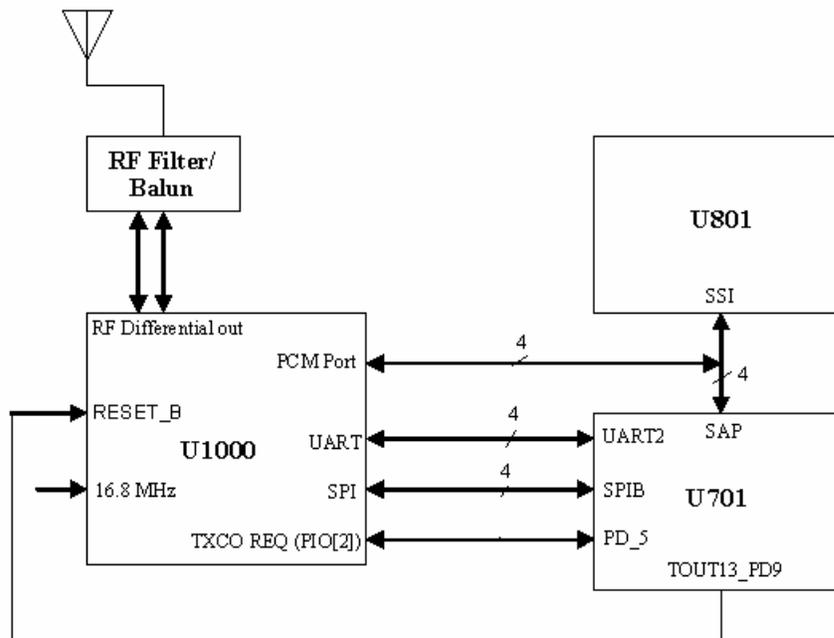
In operation, output power is also attenuated from the maximum rated level in response to measured received signal strength. High-received signal strength indicates close proximity to a companion base station and thus the transmitter power required to maintain a quality link is lowered. To decrease the transmitter output power, increasing the attenuator settings in U600 and U500 reduces the input level to Power Amplifier (U501).

4.5 Spurious and Harmonic Emissions Suppression

Spurious and harmonic emission suppression is achieved by a low-pass response of the antenna switch (U502). Proper shielding within the transceiver also attenuates radiated spurious emissions and harmonics.

4.6 Bluetooth Implementation

The current i605 design implements the Bluetooth antenna on the back side, lower corner of the board on the PTT side of the phone. This was done to separate the Bluetooth antenna as much as possible from the other antennas of the phone (which are at the top, right side of the phone). Another detail is that when the unit is on the belt clip, it will be pointing away from the body. Target free-space gain specification is -5dBi.



4.7 Bluetooth General Description

Bluetooth is used for short range wireless communications that do not require high data rates. Original usage models are telephony, headsets, low-data rate access point, file transfer, automatic synchronization. New Usage models are human interface devices, remote control, printing, cable replacements, Personal Area Network. The pico-net is the term used for a connection between a “master” and one or more “slaves”. The “master” sets up and maintains the pico-net that the “slaves” are part of. A pico-net has a maximum of 7 “slaves” and only one “master”. Members of a pico-net typically are not shared between pico-nets. The sharing of members can be done (called “scatter-net”) but will not be supported by our implementation. At this time, the i605 project will only support a “point to point” connection (only one slave at a time). There are two different types of links: Asynchronous Connection-Less (ACL) and Synchronous Connection Oriented (SCO). The ACL is used for maintenance of the link and for data applications. This type of link uses different packet sizes to improve data rate and error correction mechanisms. The SCO link is mainly used for real-time voice applications, where more data is necessary, sacrificing error correction mechanisms. For battery life improvements, when there is no BT activity the BT protocol has a “sniff” mode of operation. Once the Master and the Slave have established the BT link, both the Master and Slave go to “sleep” and communicate with each other in an established time interval to maintain the BT link. This time interval is called “sniff duty cycle”.

4.8 Bluetooth Technical characteristics

Modulation = GFSK

Band of Operation = 2.4 -> 2.4835 GHz (1MHz channel bandwidth)

Frequency Hopping: 1600 hops per second (translates to 625uS transmission)

BT Maximum Data Rate = 1Mb/s

Data rate will be limited by the UART speed.

It is classified as a CLASS 2 BT device.

Rated power is from +4 to -6 dBm, with a typical of 0dBm.